

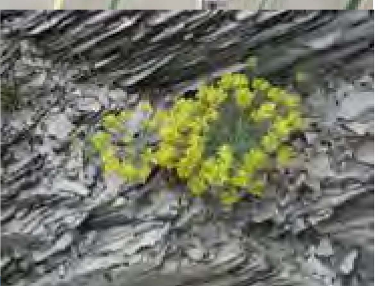

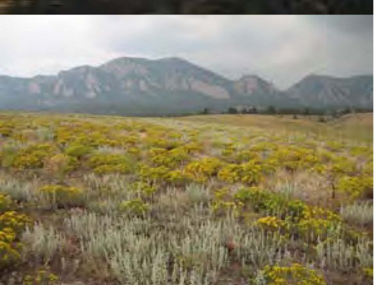

City of Boulder
Open Space and Mountain Parks

Grassland Ecosystem Management Plan

Approved by
City of Boulder Open Space Board of Trustees
August 2009

Accepted by the Boulder City Council
May 2010

Mission of the Open Space and Mountain Parks Department

The Open Space and Mountain Parks Department preserves and protects the natural environment and land resources that characterize Boulder. We foster appreciation and use that sustain the natural values of the land for current and future generations.

City of Boulder Charter Sec. 176. Open Space Purposes - Open space land.

Open space land shall be acquired, maintained, preserved, retained, and used only for the following purposes:

- Preservation or restoration of natural areas characterized by or including terrain, geologic formations, flora, or fauna that is unusual, spectacular, historically important, scientifically valuable, or unique, or that represent outstanding or rare examples of native species;
- Preservation of water resources in their natural or traditional state, scenic areas or vistas, wildlife habitats, or fragile ecosystems;
- Preservation of land for passive recreation use, such as hiking, photography or nature study, and if specifically designated, bicycling, horseback riding, or fishing;
- Preservation of agricultural uses and land suitable for agricultural production;
- Utilization of land for shaping the development of the city, limiting urban sprawl and disciplining growth;
- Utilization of non-urban land for spatial definition of urban areas;
- Utilization of land to prevent encroachment on floodplains; and
- Preservation of land for its aesthetic or passive recreational value and its contribution to the quality of life of the community.

Cover photos (from top):
Chautauqua Meadow - Mark S Johnson; Grasshopper Sparrow - Bill Schmoker; Bell's Twin Pod - Bill May; Agricultural Operations; Snakeweed and Sage - Lynn Riedel; Bronze Copper - Steve Armstead; Prairie Dog - Susan Honeycut;

Acknowledgements

Community Members

Open Space and Mountain Parks would like to give our sincere appreciation and thanks to the many community members who contribute their time and efforts in the preparation and completion of the Grassland Plan.

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Acronyms and Abbreviations

ARV	Acceptable Range of Variation
ANS	Aquatic Nuisance Species
AMP	Area Management Plan
BCCP	Boulder County Comprehensive Plan
BCPOS	Boulder County Parks and Open Space
BOA	Best Opportunity Area
BVCP	Boulder Valley Comprehensive Plan
CAP	Conservation Action Planning
CDOW	Colorado Division of Wildlife
CDPHE	Colorado Department of Public Heath and Environment
CE	Conservation Easement
CFS	Cubic Feet per Second
CIP	Capital Improvement Program
CNHP	Colorado Natural Heritage Program
CRP	Conservation Reserve Program
CU	University of Colorado
CWCB	Colorado Water Conservation Board
DOC	Department of Commerce
DPIF	Derived Partners in Flight
DWB	Denver Water Board
EIA	Ecological Integrity Assessment
EMAP	Ecological Monitoring and Assessment Program
EPT	Ephemeroptera, Plecoptera, and Trichoptera
ESD	Ecological Site Description
EWM	Eurasian watermilfoil
FEMP	Forest Ecosystem Management Plan
GD	Grassland Dependent
GIS	Geographic Information System
GP	Grassland Preserves
GPA	Grassland Planning Area
GPS	Global Positioning Systems
HESCOM	Needle and Thread Grass/Blue Grama Herbaceous Alliance
HRV	Historic Range of Variability
HSM	Habitat Suitability Model
IBI	Index of Biotic Integrity
IPM	Integrated Pest Management

LRMP	Long Range Management Policies
MBP	Mesic Bluestem Prairie
MGPM	Mixedgrass Prairie Mosaic
MM	Marshall Mesa
MMI	Macroinvertebrate Multimetric Index
MNRC	Mean Native Relative Cover
MOA	Multiple Objective Areas
NLF	Northern Leopard Frog
NOAA	National Oceanic and Atmospheric Administration
NRC	Native Relative Cover
NRCS	Natural Resource Conservation Service
NZMS	New Zealand Mud Snail
OSBT	Open Space Board of Trustees
OSMP	Open Space and Mountain Parks
PASSMI	Western Wheatgrass Herbaceous Alliance
PCA	Prairie Dog Conservation Areas
PIF	Partners in Flight
PRA	Passive Recreation Area
RA	Relative Abundance
RAM	Rapid Assessment Mapping
RVA	Range of Variability Approach
SMTH	South Mesa Trailhead
SOP	Strategic Operating Plan
SSURGO	Soil Survey Geographic (Database)
TNC	The Nature Conservancy
TSA	Trail Study Area
UDT	Undesignated Trail
ULTO	Ute Ladies'-Tresses Orchid
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Services
USGS	United States Geological Survey
UWMP	Urban Wildlife Management Plan
VMP	Visitor Master Plan
XTGP	Xeric Tallgrass Prairie

Executive Summary

The grasslands of the City of Boulder's Open Space and Mountain Parks (OSMP) land system are located where the Central High Plains meet the foothills of the Southern Rocky Mountains. These lands and waters have been acquired as part of a system designed to protect the agricultural, ecological, recreational, and scenic values of one of the most rapidly developing regions in North America.

> **Sidebars: Points of Interest**
>
> Sidebars like this appear throughout the document to highlight topics of interest—or share background information.

Over the past decade, OSMP has developed a series of management plans to clarify how the City of Boulder will manage open space properties and provide services, including sustainable natural resource conservation and passive recreation. The Forest Ecosystem Management Plan, which guides the management of OSMP's forested foothills, was completed in 1999. In 2005, the city council accepted The Visitor Master Plan, which outlines the vision and strategies for providing sustainable recreational activities and facilities. This **Grassland Ecosystem Management Plan (Grassland Plan)** focuses upon the conservation of the 24,000 acres of OSMP lands dominated by mixedgrass and xeric tallgrass prairie (**Figure 1**). The Grassland Plan is intended to provide a framework for on-the-ground management actions, public policies and land and water acquisition priorities to conserve the ecological values of Boulder's grasslands and ensure on-going agricultural production.

CHAPTER SUMMARIES

Chapter I
Plan Purpose, Scope & Organization

The Grassland Plan will also be an important resource for OSMP's TSA planning, describing the agricultural and ecological values in the 24,000-acre Grassland Planning Area.

The Grassland Plan is related to other planning documents and policy direction as one of the tools used by OSMP to focus the broad vision provided by the Boulder Valley Comprehensive Plan, the City Charter and OSMP's own long range management policies. The Grassland Plan provides this focus by recommending practical strategies and measures of success. These strategies will be implemented through the department's Strategic Operating Plan and annual work plans.

The planning process used to develop the Grassland Plan was adapted from the Conservation Action Planning approach of The Nature Conservancy (2007).

Chapter II
Conservation Targets

The Grassland Planning Area (GPA) (**Figure 1**) is known to support more than 800 species of vascular plants, over 400 species of vertebrates and many more species in other, lesser-known groups (e.g., insects, mosses, algae). Rather than attempt to address each part of the grassland system individually, OSMP staff worked with partner agencies, biologists, ecologists, naturalists and other community members to identify the aspects of biological diversity that would best serve as the basis for setting objectives, taking action and measuring success.

These "conservation targets" include the **Mixedgrass Prairie Mosaic** and the **Xeric Tallgrass Prairie**—the two dominant cover types in the GPA.

The **Agricultural Operations** target addresses the long-term sustainability of agriculture on OSMP lands and the conservation of native species dependent upon agricultural operations.

The ecological system centered on the black-tailed prairie dog was also identified as a separate conservation target due to the distinctive ecological conditions and community of animals associated with prairie dogs. This target, **Black-tailed Prairie Dogs and Associates,** was also called out because of the unique challenges of managing a prairie dog-based system in a highly fragmented landscape.

OSMP also identified three targets dependent upon ground or surface water: **Wetlands—** including ponds**, Riparian Areas—**including creeks, and the **Mesic Bluestem Prairie.**

The **White Rocks** cliffs were identified as a target because they support a large number of rare species—well out of proportion to the small size of the area.

Chapter III
Assessing Target Viability

OSMP staff determined the viability of targets by first identifying **key attributes** of each target. Key attributes are aspects of the target, which if altered, could result in the improvement, degradation, or loss of the target. These key attributes reflect some aspect of size, structure, composition, landscape context, or an ecological process (e.g., fire, grazing, or flooding). Examples of key ecological attributes include fire frequency, animal species composition, and water quality. Key attributes for Agricultural Operations include the extent of land that is available for agriculture, availability of irrigation water, levels of commodity production, and soil chemistry.

OSMP identified at least one measurable and sensitive indicator for each key attribute so that the status of the key attributes could be assessed. Using the best available information, OSMP staff defined a range of variation for each indicator that described "acceptable" conditions. When indicators for a target are found to be within this range of "acceptable variation", the target is considered to be successfully "conserved". Indicators provide OSMP with the ability to assess and rate the viability of the targets, and measure progress toward achieving desired future conditions in the Grassland Planning Area.

The overall viability rating for the Grassland Planning Area is "Fair"—meaning that conditions are generally outside the range of acceptable variation. The viability ratings of Grassland Plan targets vary. Agricultural Operations, Black-tailed Prairie Dog and Associates and the White Rocks Cliffs were rated "Good" or "Very Good", signifying that key attributes (as measured by indicators) are within the range of acceptable variation. The Mixedgrass Prairie Mosaic, Xeric Tallgrass Prairie, Mesic Bluestem Prairie, and Wetlands were rated "Fair". A "Fair" rating means that many of the key attributes are outside the range of acceptable variation—but could be restored to a "Good" rating with a reasonable level of effort. The Riparian Areas target was rated "Poor", a designation suggesting that it is most in need of action and will require significant investments of time and resources to conserve.

Chapter IV
Conservation Issues

The purchase of land as open space protects the landscape from "development"—addressing the most significant threat facing agricultural and ecological sustainability. However, the "Fair" rating for the Grassland Planning Area points to additional conservation issues. OSMP examined the severity and scope of issues that affect the conservation targets. The most significant conservation issues were incompatible surrounding land uses, invasive non-native plant and animal species, incompatible recreational uses, incompatible dog management by guardians, incompatible water management/use, incompatible fire management and incompatible agricultural practices.

Chapter V
Best Opportunity Areas

A strategic approach to improving conditions in the Grassland Planning Area requires knowing where to find the best opportunities for conserving good conditions, reducing conservation issues, and restoring targets from the impacts of historic activities. OSMP's overall approach is to maintain good conditions where they exist and to restore selected areas to acceptable condition. The Grassland Plan recommends places where action will best conserve the targets.

Best Opportunities for the Conservation for Black-tailed Prairie Dog and Associates

IN RESPONSE to community interest and the unique ecology of prairie dogs, OSMP gave special attention to developing area-based recommendations for the conservation of the Black-tailed Prairie Dog and Associates target. These recommendations seek to provide areas where the target can be conserved, as well as areas where the values of grasslands and agricultural operations unaffected by prairie dogs are the priority. OSMP developed "Best Opportunity Areas" for conservation and restoration of the other Grassland Plan targets as well.

Chapter VI
Conservation Strategies

The Grassland Plan sets 13 conservation objectives that describe specifically, and in measurable terms, what successful implementation of the Grassland Plan means. This chapter also presents and ranks 35 conservation strategies. The highest ranked strategies are those with the greatest benefit, feasibility and least discretionary costs. These objectives and strategies are organized into four strategic initiatives for taking conservation action and two initiatives to support conservation action.

Initiative 1: Large Block Habitat Effectiveness

The focus of this initiative is to improve the conservation value of large habitat blocks so they are more likely to sustain the Grassland Plan targets.

Large blocks of Open Space and Mountain Parks grasslands are more likely than small blocks to be self-sustaining. Larger blocks are more likely to provide a full range of habitat variability, and a wider range of natural disturbances, and therefore more likely to support the habitat needs of a wider range of species—both plant and animal. These areas are also necessary to conserve species requiring large areas. Large habitat blocks also tend to be the OSMP lands most distant from urbanization and represent the best opportunity to conserve species sensitive to the effects of urbanization. OSMP can take advantage of the potential of large habitat blocks areas by adjusting policies affecting use, changing on-the-ground management and finding opportunities to establish compatible practices on adjacent lands.

Conservation Objective 1.1
By 2019, establish prairie dog, prairie dog commensal and prairie dog predator populations and population distribution within the range of acceptable variation.

Conservation Objective 1.2
By 2019, increase the bird conservation scores to at least 3.9 for the Mixedgrass Prairie Mosaic and Xeric Tallgrass Prairie.

Conservation Objective 1.3
By 2019, increase the frequency of singing male grasshopper sparrows in habitat blocks over 247 acres (100 ha) in the Mixedgrass Prairie Mosaic to 60%.

Initiative 2: Grassland Restoration

This initiative focuses on improving ecological processes and conditions to acceptable levels as defined by the viability indicator ratings for the eight Grassland Plan Targets. These improvements will benefit both ecological viability and agricultural sustainability.

Persistent effects of historic land uses are partially responsible for current unacceptable conditions of grassland targets. The Grassland Plan establishes indicator ratings that describe OSMP's best thinking about acceptable conditions and processes. A small number of high-leverage actions have been identified to return the ecosystems of the Grassland Planning Area to acceptable condition and landscape context.

Restoration objectives and strategies identified under this initiative will be folded into the OSMP Restoration Legacy Program, which is developing projects to address system-wide restoration needs. The Restoration Legacy Project was identified as a high priority initiative during a strategic planning process completed by OSMP in 2007.

In 2009, the Restoration Legacy team identified approximately 50 projects in the Grassland Planning Area. The specific projects will mobilize planting, earthmoving, hydrological modification and fencing to restore native vegetation and habitats. The Legacy Program approach to coordinating restoration on a system-wide basis is one way that the Grassland Plan strategies will be integrated into the department's annual work plan.

Conservation Objective 2.1
By 2019, reduce non-native plant species in Best Opportunity Areas of the Xeric Tallgrass Prairie, Mesic Bluestem Prairie, and Mixedgrass Prairie Mosaic targets to achieve at least a "Good" rating for prevalence.

Conservation Objective 2.2
By 2029, achieve "Good" rating for all vegetation composition and structure indicators in Best Opportunity Areas.

Conservation Objective 2.3
By 2019, increase fire frequency so that 50% of Upland Grassland Complex and Mesic

Bluestem Prairie Best Opportunity Areas will have burned within the acceptable fire return interval.

Initiative 3: Aquatic Systems Management

This initiative focuses on wetlands, riparian areas, creeks and ponds.

Aquatic systems on OSMP lands support biodiversity well out of proportion to their relatively small size. These same areas are also identified as having low viability and high level of conservation issues.

Conservation Objective 3.1
By 2019, evaluate and restore riparian hydrology in Best Opportunity Areas.

Conservation Objective 3.2
By 2019, evaluate and restore wetland, riparian and aquatic habitat in Best Opportunity Areas.

Conservation Objective 3.3
By 2015, increase by three (3) the number of bullfrog-free ponds on OSMP-managed lands supporting northern leopard frogs.

Conservation Objective 3.4
Prevent an increase in the extent and diversity of aquatic nuisance species in the Grassland Planning Area.

Conservation Objective 3.5
By 2019, reduce the undesignated trail density in northern leopard frog habitat blocks to at most 13.4 ft/ac (10 m/ha).

Initiative 4: Agro-Ecosystems

This initiative focuses on sustaining agricultural uses while integrating agricultural and ecological conservation objectives.

Agriculture has played an important and dynamic role in shaping the Grassland Planning Area and providing services for people in the Boulder Valley. OSMP staff has adjusted and will continue to adjust agricultural management in response to changing markets and interests of local agricultural producers.

When and where biodiversity conservation objectives and agricultural management goals conflict, OSMP has worked to develop compatible management strategies. The Grassland Plan identifies specific opportunities to continue balancing and blending agricultural and ecological management.

Conservation Objective 4.1
Continue agricultural operations on OSMP lands to address the Charter Purposes of OSMP.

Conservation Objective 4.2

Establish or continue agricultural management practices that support habitat for Ute ladies-tresses orchid, bobolinks and other species of conservation concern.

Initiative 5: Monitoring (see Chapter VII)

Initiative 6: Capacity Building

This initiative is intended to attract external funding sources for Grassland Conservation.

Full implementation of the Grassland Plan would require significantly greater capacity than is available with current funding and staffing. The following strategies were identified to attract additional capacity and funding.

Strategies

- Evaluate current staffing and funding allocations to address capacity needs and meet Grassland Plan priorities--make changes as appropriate
- Fund staff training and service contracts to increase expertise available to implement Grassland Plan strategies. When is it more cost-effective, expertise can be provided by consultants and contractors
- Establish an Open Space and Mountain Parks foundation to sponsor private fundraising for implementing priority Grassland Plan projects
- Pursue grants as appropriate to fund implementation of Grassland Plan strategies
- Work with volunteers and community groups as appropriate to support the implementation of any Grassland Plan strategies
- Work with other land management agencies and universities to address the research agenda in Chapter VII
- Leverage value of OSMP-owned housing to encourage needed monitoring, research or stewardship
- Establish a Grassland Plan Capital Improvement Program (CIP), or add Grassland Plan Implementation to the Strategic Operating Plan

Chapter VII Monitoring

The objective of this initiative is to implement "vital signs" monitoring of the Grassland Plan targets by OSMP staff, researchers and volunteers.

OSMP has outlined a variety of strategies to achieve its conservation objectives. Monitoring the effectiveness of the highest priority strategies will allow staff to repeat effective strategies elsewhere and refine or abandon ineffective strategies. Tracking the presence and, in some cases, abundance of threats like non-native plant and animal species will help OSMP allocate resources appropriately to conserve the Grassland Plan targets.

Monitoring also affords OSMP the means to keep track of target occurrences in good condition and to provide early warnings of potential conservation issues. Responding early is easier and less expensive than trying to improve degraded conditions later.

Monitoring Objectives

- Evaluate the effectiveness of specific strategies in achieving OSMP's conservation objectives
- Track current status and trends of conservation issues affecting the conservation targets
- Track the current status and trends of the conservation targets' viability
- Establish specific indicators and acceptable ranges of variation to fill information gaps

Monitoring of target viability, conservation issues and strategy effectiveness is at the heart of the adaptive management framework upon which the Grassland Plan is based.

Chapter VIII Implementation

The Grassland Plan will be implemented by facility improvements, the development of new programs and policies, integration with other planning efforts, especially TSA planning, and coordinated management activities on the ground. Coordinated management will be enhanced by focusing on Implementation Areas that share similarity of vegetation, agricultural characteristics and landscape context. Developing the phasing and funding of specific projects will be part of the initial implementation of the plan.

The Grassland Plan describes three funding scenarios consistent with the city's business plan model. The "Fiscally Constrained" scenario includes strategies, programs and projects that are currently funded. The "Action Plan" scenario includes the next level of projects that could be undertaken as funding becomes available for restoration or enhancement of community services. The "Vision Plan" scenario includes funding for the full range of identified projects. Capacity building measures are identified to narrow the funding gap between the fiscally constrained and vision plan scenarios.

Chapter I: Plan Purpose, Scope and Organization

Chapter Summary
This chapter describes the purpose and scope of the Grassland Plan.

The purpose of the Grassland Plan is to provide a framework for on-the-ground management actions, public policies and land and water acquisition priorities to conserve the ecological values of Boulder's grasslands and to ensure on-going agricultural production.

The Grassland Plan will also be an important resource for OSMP's TSA planning, describing the agricultural and ecological values in the 24,000-acre Grassland Planning Area.

Purpose of the Grassland Plan

The purpose of the Grassland Ecosystem Management Plan (Grassland Plan) is to provide a framework for on-the-ground management actions, public policies and land and water acquisition priorities to conserve the ecological values of Boulder's grasslands and to ensure on-going agricultural production.

The Grassland Plan is also intended to provide resource information and conservation guidance for OSMP's Trail Study Area (TSA) planning process.

Geographic Scope

Open Space and Mountain Parks (OSMP) staff examined vegetation, soils, and topography to develop a western boundary for the Grassland Plan and to separate grasslands from lands managed under OSMP's Forest Ecosystem Management Plan (FEMP). The geographic scope of the Grassland Plan encompasses all Open Space and Mountain Parks lands east of this boundary. This project area contains approximately 24,000 acres of OSMP lands held in fee, and another several thousand acres protected through conservation easements held by the City of Boulder (see **Table 1** and **Figure 1**).

The conservation significance of the Grassland Plan planning area is enhanced by the proximity of other nearby protected areas. Table Mountain lies adjacent to OSMP lands north of Boulder. This 1,600-acre grassland is managed by the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). The Rocky Flats National Wildlife Refuge (ca. 6,000 acres) is located adjacent to OSMP's southern grasslands, as are several thousand acres of grasslands managed by open space programs of Boulder and Jefferson counties. OSMP will seek partnerships with these land managers and others as appropriate to achieve the objectives of the Grassland Plan.

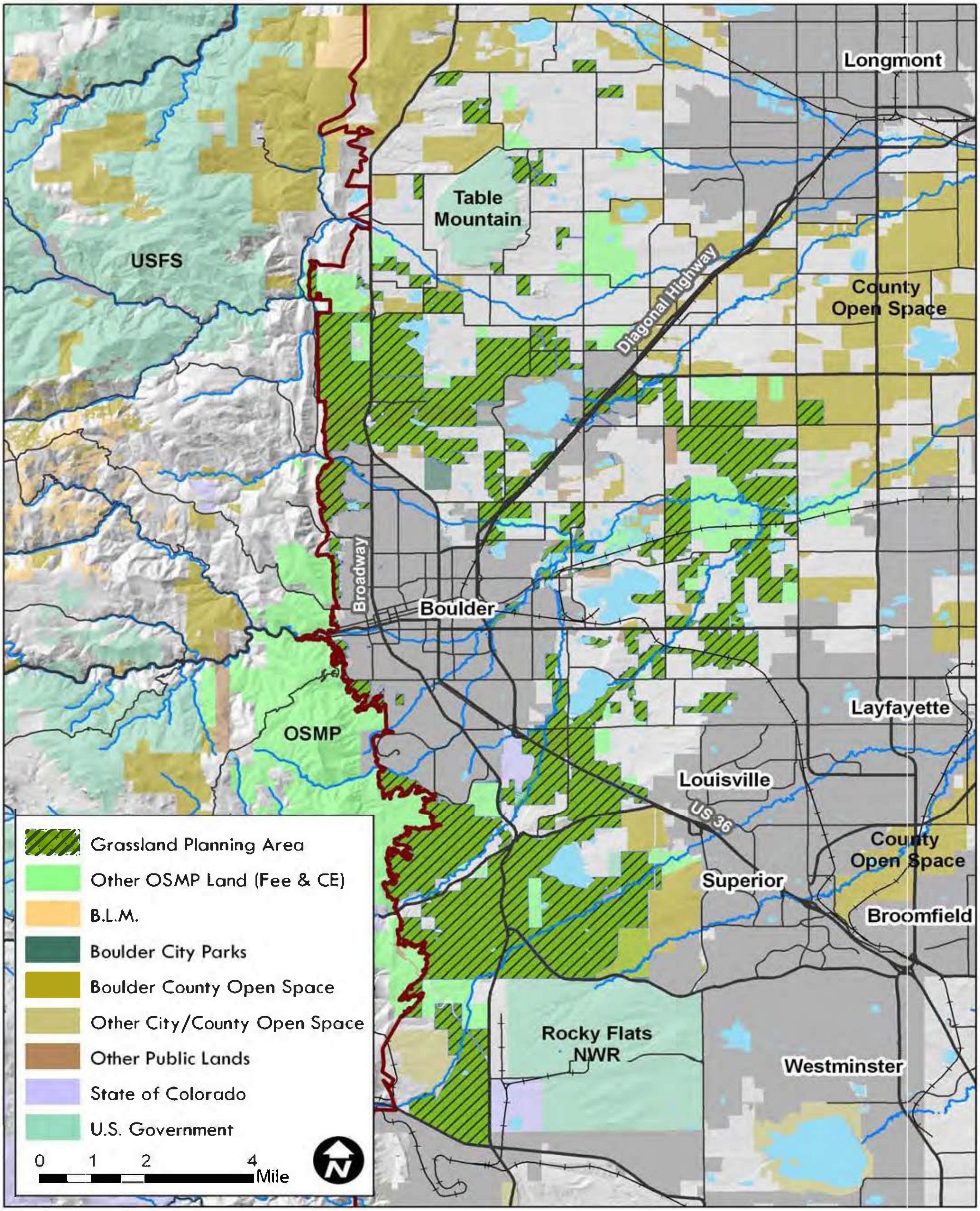


Figure 1: Geographic scope of the Grassland Ecosystem Management Plan – The "Grassland Planning Area"

Relationship to Other Planning Documents and Policy Directions

The Grassland Plan is affected by and will influence other departmental resource and program management plans. There are also relationships with other city plans and policies as well as the operational plans of neighboring land management agencies. **Figure 2** shows how these plans are related.

Establishing a Broad Vision by Setting Priorities

The City of Boulder and Boulder County have agreed upon a set of land use and management goals and policies to implement a shared community vision in a geographic area defined as the "Boulder Valley". These goals and policies comprise the *Boulder Valley Comprehensive Plan* (BVCP). The BVCP is updated periodically and approved jointly by four public bodies including Boulder's City Council and the Boulder County Board of Commissioners. The BVCP states a clear intention for the City to preserve the agricultural and natural values of the lands and waters of the Boulder Valley through acquisition and management of open space. The plan specifically identifies a Natural Ecosystem Overlay. This overlay includes the areas that are most important as habitat for native plants and animals or are especially valued because of their ecological, biological or geological characteristics. Almost all of the Grassland Planning Area (GPA) is included in the Natural Ecosystem Overlay. Details about the relationship of the BVCP and the Grassland Plan are provided in **Appendix A.**

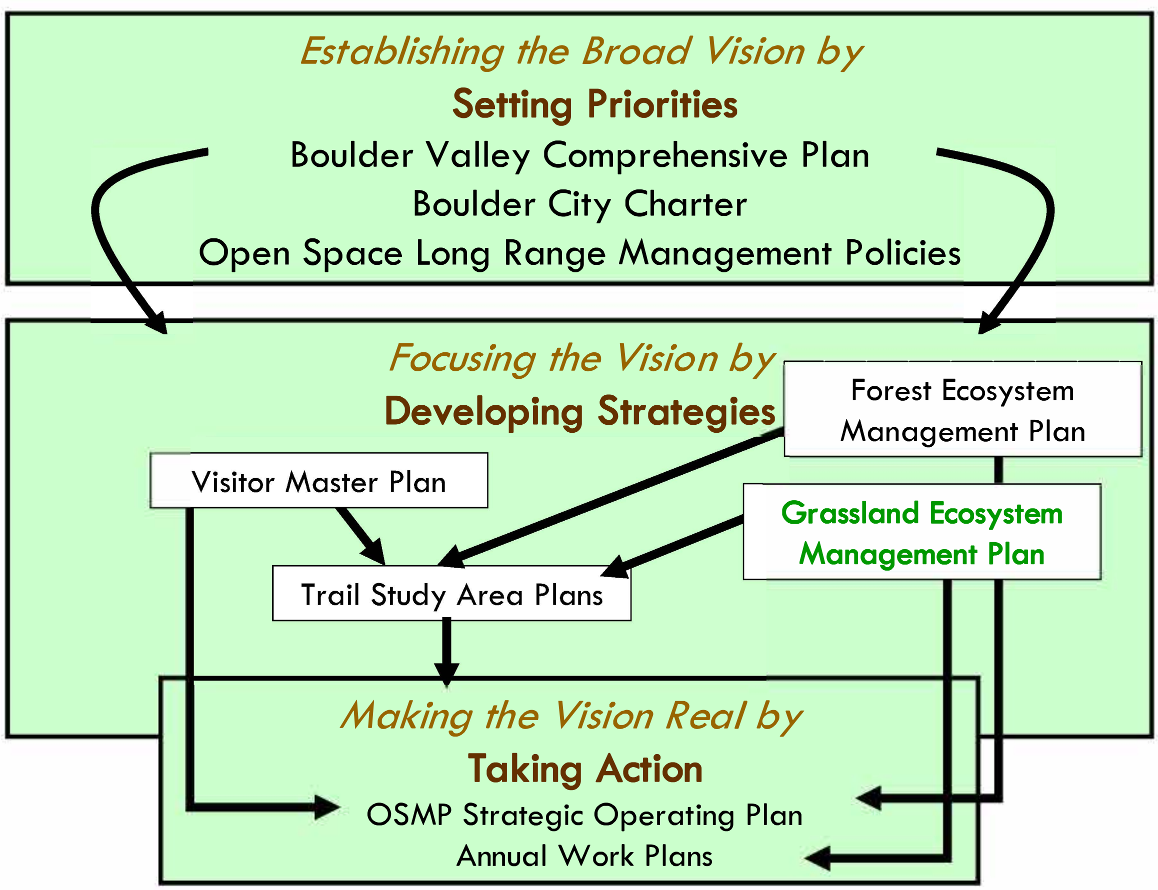


Figure 2: Relationship of Grassland Plan to other planning and policy documents

Section 176 of *Boulder's City Charter* was established by public election. It lists the purposes for which open space land can be acquired, maintained and used. The full text of this section of the charter can be found on the inside cover of the plan and in **Appendix A.** The Grassland Plan describes how OSMP will address the charter purposes calling for the preservation of natural areas, wildlife habitats, fragile ecosystems, and water resources in the Grassland Planning Area as well as providing a framework for the management of agricultural lands and agricultural land uses.

While the city charter and comprehensive plans (see below) provide broad policy guidance, the *Open Space Long Range Management Policies* (LRMP) give specific direction about program goals, decision-making processes and management techniques. The LRMP were approved by City Council in 1995. Chapters IV and V, which address natural resource management and agricultural management respectively, provided important policy guidance for the Grassland Plan.

Focusing the Vision by Developing Strategies
OSMP's *Visitor Master Plan* (VMP) (City of Boulder 2005a) developed a framework to deliver visitor services and provide visitor facilities in a manner consistent with the conservation of natural and cultural resources. The Grassland Plan used the policies and management area designations in the VMP as a starting point for examining the relationship among recreational activities and grassland/agricultural conservation.

One of the ways that the objectives of the Grassland Plan will be acted upon is through on-going integration of new grassland information in the *Trail Study Area (TSA) planning process.* The Grassland Plan provides information about areas of ecological importance that was unavailable when the VMP was developed. With the exceptions of emergency actions needed to protect critical resources, decisions about trails and visitor access in the Grassland Planning Area will be made in the context of TSA planning. The availability of specific information about the current status and desired condition of natural resources will improve OSMP's ability to balance resource protection and visitor access through TSA planning.

The Grassland Plan complements the *Forest Ecosystem Management Plan* (FEMP) (City of Boulder 1999) by providing natural resource conservation objectives and strategies for most of the OSMP land system unaddressed by the FEMP. Refinements to the FEMP will use a planning approach consistent with the Grassland Plan. OSMP will integrate the management of resources that cross the planning area boundaries (e.g., creeks, wide-ranging species) as appropriate. For example, the department is already coordinating the management of 300 acres along the forest/grassland edge. Management prescriptions were developed in the FEMP for areas that are currently forested, but where OSMP seeks to restore them to open savannah—a grassland cover type.

Making the Vision Real by Taking Action
In 2008, the Open Space and Mountain Parks department established a five-year *Strategic Operating Plan* (SOP) to describe the priority actions of the department. This document is updated annually as projects are completed and new initiatives added. Most of the projects in the SOP flow directly from actions identified in the VMP, FEMP, and TSA Plans. Upon approval of the Grassland Plan, its implementation will be incorporated into the SOP and other plans and planning efforts.

The SOP is reviewed annually and new projects are assigned to the appropriate division, workgroups and individuals on the OSMP staff. These projects as well as on-going services combine to form the *Annual Work Plan.* The work plan is integrated with the city budgeting and OSMP budget allocation processes.

Coordination with Other Plans

OSMP also works with Boulder County to implement the policies and goals of the *Boulder County Comprehensive Plan* (BCCP). The BCCP policies on open space are similar to and consistent with the City Charter and the BVCP. The BCCP also provides specific information about species of concern and the location and extent of a variety of natural and agricultural features of interest—many of which are on OSMP lands. OSMP used this information to identify conservation targets and to prioritize places to take action. **Appendix A** includes more information about the goals and designations of the BCCP with relevance to the Grassland Plan.

City of Boulder Open Space Grassland Management: Black-Tailed Prairie Dog Habitat Conservation Plan (City of Boulder 1996) was approved by the Open Space Board of Trustees in 1996. This plan provides guidance on the management of grasslands to protect, preserve, and enhance habitat suitable for black-tailed prairie dogs and was intended as a component in a broader grassland conservation plan. The Grassland Plan integrated several components of this plan, such as the need to conserve prairie dogs in the context of broader grassland conservation goals, the focus on large Grassland Preserves for conserving prairie dogs and their associates and the protection of smaller, more isolated colonies to help ensure some level of survivorship after a plague epizootic. The Grassland Plan replaces the Black-Tailed Prairie Dog Habitat Conservation Plan as the guiding document for OSMP prairie dog management.

The Open Space Board of Trustees approved two area management plans (AMP) in the late 1990's: the *North Boulder Valley AMP* in 1997 (City of Boulder 1997) and the *South Boulder Creek AMP* in 1998 (City of Boulder 1998). These plans provide goals, objectives and site-specific actions for ecological and agricultural management in the GPA. Implementation of the Grassland Plan will continue many of the on-going actions identified in the AMP's, and integrate other actions identified in those plans but not yet started. The department suspended the development of new Area Management Plans in 1998.

OSMP manages two state natural areas in the GPA under *State Natural Area Management Plans.* The South Boulder Creek AMP serves as the management plan for the South Boulder Creek State Natural Area. The Colorado Tallgrass Prairie Management Plan was developed by the City and the Colorado Natural Areas Program in1986. Although the Tallgrass Prairie Management Plan is generally consistent with the Grassland Plan, OSMP intends to recommend updates to the 1986 plan using the information developed over the past twenty years. Although not managed by OSMP, a portion of the White Rocks cliffs is also a designated state natural area.

In 2006, Boulder's city council accepted the vision, goals and guiding principles of Boulder's *Urban Wildlife Management Plan* (UWMP) and the first species-specific management component of the UWMP—dealing with black-tailed prairie dogs (City of Boulder 2006). The prairie dog component of the UWMP described how and where to protect and remove prairie dogs within Boulder's city limits while balancing costs and humane treatment. The prairie dog component of the UWMP identified approximately 150 acres of prairie dog colonies for long-term protection and about 100 acres for near-term removal. An additional 370 acres were designated for interim protection—a designation that anticipated potential future development and the need for prairie dog removal. Prairie dog management designations in the Grassland Plan are consistent with the UWMP's designation of OSMP colonies.

The prairie dog component of the UWMP identified the development of the Grassland Plan as a priority action. The Grassland Plan complements the UWMP by:

- Describing how prairie dog conservation fits into the broader context of OSMP's grassland conservation efforts,
- Identifying areas where OSMP can best conserve prairie dogs and their associated species,
- Identifying areas where the activities of prairie dogs are inconsistent with other grassland conservation objectives,
- Developing relocation criteria that are tied to ecological sustainability objectives for prairie dogs' grassland habitat, and
- Establishing a process by which the prairie dog management objectives of the Grassland Plan and the UWMP can be integrated.

Organization of the Grassland Plan
The Grassland Plan has adapted a planning approach developed by The Nature Conservancy known as the Conservation Action Planning (CAP) Framework. The Grassland Plan is organized around the following steps drawn from the CAP process. The general organization is presented below. Greater detail is provided in the corresponding chapters in the plan.

1. Define Project Scope & Conservation Targets (Chapters I and II)
    - Define the extent of the planning area
    - Select the specific aspects of the planning area (systems, species, and community services) that will be used as representatives of the relevant community services (agricultural conservation) and the overall biodiversity of the project area

2. Assess the Viability of Conservation Targets (Chapter III)
    - Determine how to measure each target's "health" over time
    - Identify how the target is doing now
    - Describe what a "healthy state" might look like (desired future conditions)

3. Identify and Rank Conservation Issues (Chapter IV)
    - Identify the various factors that immediately affect the project's targets
    - Rank conservation issues to allow focus on where action is most needed

Conservation Action Planning

THE NATURE CONSERVANCY has been developing a framework for planning, implementing, and measuring conservation success over the past 20 years. This framework, called "Conservation Action Planning" (CAP), has been tested with a wide range of projects throughout the world. Hundreds of partner agencies have been involved in projects using the CAP framework. Its development has led to the establishment of standards for the practice of conservation in use by the world's leading conservation organizations.

4. Identify Best Opportunity Areas[3] (Chapter V)
    - Identify the places a target's viability would most benefit from protection or having conservation issues addressed

[3] Not a part of TNC's CAP process.

- Identify the places where restoration is most likely to benefit a target's viability

5. Develop Strategies: Objectives and Actions (Chapter VI)
   - State specifically and measurably what successful implementation of the plan looks like
   - Develop practical strategies to achieve success
   - Prioritize the strategies that provide the most impact for the available resources

6. Establish Measures (Monitoring) Chapter VII
   - Identify how to measure results
   - Identify how to track target viability
   - Identify how to track conservation issues

7. Develop Work Plans[4] (Implementation) Chapter VIII
   - Develop business plan scenarios for strategies and monitoring activities
   - Identify staffing for projects
   - Identify funding and other resources for projects

[4] The City's master plan business plan framework was integrated with the "Work Planning" step described in the CAP process.

Chapter II: Target Descriptions

Chapter Summary
Conservation "targets" have been selected to be representative of biodiversity and agricultural production in the Grassland Planning Area. These targets include agricultural operations as well as the native species, natural communities and ecological systems that encompass the biodiversity of OSMP grasslands. Each target includes a number of nested targets: plants, plant associations and animals of conservation concern in the Boulder Valley. The Grassland Plan targets form the basis for the subsequent steps of assessing conditions, setting desired future conditions, identifying conservation issues, developing strategies, and measuring success. The eight targets are:

- Mixedgrass Prairie Mosaic
- Xeric Tallgrass Prairie
- Mesic Bluestem Prairie
- Agricultural Operations
- Black-Tailed Prairie Dog and Associates
- Wetlands
- Riparian Areas
- White Rocks

Focusing Conservation Attention

The grasslands of Boulder's Open Space and Mountain Parks are known to support more than 800 species of vascular plants and over 400 species of vertebrates. In addition, many species of invertebrates (insects, spiders, crustaceans, etc.) and non-vascular plants (algae, mosses, etc.) inhabit these grasslands, yet relatively few of these have been looked for or documented on OSMP lands. In order to develop specific conservation strategies, staff posed the question "What biodiversity are we trying to conserve?"

To answer this question, OSMP, with input from local and statewide experts, identified a set of "conservation targets". Conservation targets are the native species, natural communities and ecological systems that represent and encompass the biodiversity of OSMP grasslands. These conservation targets are the basis for setting specific objectives, taking action on the ground and measuring success.

Identifying targets involved examining vegetation mapping and historical accounts of the Boulder Valley to describe the terrestrial, wetland and aquatic communities that dominate the project area. The planning team then determined which communities and species would not be adequately captured within the broad-scale ecological systems or species groups. OSMP staff's preliminary ideas about conservation targets were shared with a group of grassland ecologists and conservation professionals during a daylong workshop in the winter of 2006. The recommendations from this experts' workshop were used to establish the following list of conservation targets:

Table 1: Approximate extent of conservation targets in the Grassland Planning Area

Conservation Targets	**Approximate Acreage**
• Mixedgrass Prairie Mosaic	9,850 acres
• Xeric Tallgrass Prairie	5,650 acres
• Agricultural Operations[5]	5,400 acres
• Wetlands	1,500 acres
• Riparian Areas	1,200 acres
• Mesic Bluestem Prairie	350 acres
• White Rocks	60 acres
• Black-Tailed Prairie Dog and Associates	See note[6]
Other	
• Developed Areas (farmsteads, trailheads, etc.)	80 acres
• Forest Stands (managed under Forest Ecosystem Management Plan)	300 acres
Total	**ca 24,000 acres**

Nested Targets

Each of the major grassland conservation targets includes habitat for many species of plants and animals as well as a variety of plant associations. Some of these are of conservation concern in the Boulder Valley. Conservation concern means that a species is threatened or endangered according to state or federal law, that they are considered rare or imperiled by the Colorado Natural Heritage Program, or that they have been found to be rare or in need of special conservation action at the local level. Local level conservation status is documented in the Boulder County or Boulder Valley comprehensive plans, or in documents developed by OSMP staff. A list of the species of conservation concern found in the planning area along with their conservation status rankings is included as **Appendix B.** The species of concern are "nested" beneath the major conservation target(s) with which they are associated. This nested target table will be updated and revised throughout implementation of the Grassland Plan as needed.

Nested targets should be conserved if the conservation targets with which they are associated are conserved. In cases where nested target status provides valuable information on the target's health or has unique conservation requirements, these individual species appear in the attributes, indicators, or strategies associated with the larger target.

[5] Acreage of OSMP lands where agricultural operations (irrigation, seeding, annual cropping systems, etc.) have resulted in a dominance of non-native vegetation. Other OSMP lands are also in use for agriculture (e.g., livestock grazing). Some agricultural lands show up in other categories because irrigation practices support a distinct *native dominated* vegetation (e.g., some wetlands and some mesic tallgrass prairie). See Target Descriptions (Chapter II) for more information.

[6] Since the extent of occupied prairie dog acreage fluctuates, and prairie dogs occupy many of the other targets, no acreage figures are given here. Information about the extent of prairie dog occupation is included in the description of the "Black-Tailed Prairie Dog and Associates" target.

Extirpated Species

Some species, such as bison[7], prairie wolves and grizzly bears, which once occurred in the Grassland Planning Area, no longer reside here. OSMP staff and experts' group considered a variety of ways to address these extirpated species. Some felt that all extirpated species such as wolves, grizzly bears, black-footed ferrets and bison should be grouped together as a single target because of their ecological importance. OSMP staff also heard from those who felt that including extirpated species would inappropriately divert resources from the species currently inhabiting the planning area that are in need of conservation.

Appendix B shows the relationship of extirpated species with conservation targets in a nested target table. While the restoration of most of these species is currently beyond the scope of OSMP-specific management, staff proposes to participate in restoration efforts whenever the city's grasslands can reasonably make a meaningful contribution to reintroduction efforts for species extirpated from the Boulder Valley, or broader geographic areas.

Conservation in a Changing Environment - Selecting and Describing Targets

The following descriptions provide a non-technical summary of the nature, distribution, composition, and ecology of the Grassland Plan conservation targets. When referring to "natural" conditions or processes, OSMP has attempted to illustrate the conditions or processes that most closely reflect the range of variation under which the target and the nested plant and animal species evolved. The planning approach recognizes that most ecosystems on OSMP land have been significantly altered in the past—especially during the past 150 years. Although the conditions and processes have changed, and are likely to continue to change, an understanding of how these systems were originally "put together" offers insight for re-establishing sustainability.


photo – Ann Duncan

Looking to the past however will not be sufficient to address the challenges of conserving OSMP grasslands. There is a growing awareness among conservation ecologists and land managers that efforts focused on restoring ecosystems to some original or "historic range of variability" (HRV) are likely to be unsuccessful because of changing environmental conditions (e.g., climate change, increased deposition of nitrogen from the atmosphere, invasive species). An emerging paradigm for the management of novel ecosystems recommends that managers describe and consider current conditions when describing the targets (systems and species) that are the focus of management and when setting conservation objectives for those targets (Seastedt et al. 2008).

[7] Scientific names of plants and animals mentioned in the plan can be found in **Appendix C.**

The Conservation Action Planning process used in the development of Grassland Plan seeks to integrate modifications to "natural" conditions that have occurred and that are likely to occur over the ten-year planning horizon. The descriptions that follow consider natural, historical, current conditions and future trends affecting the composition, structure and landscape setting of the Grassland Plan targets.

Mixedgrass Prairie Mosaic

Background and Setting

The mosaic of foothills mixedgrass communities on OSMP represents plant associations occurring over a wide area of North America. It includes plant associations similar to those occurring in the central, southern and northern Great Plains, as well as in the southwestern and intermountain regions of the Western U. S. The foothill prairies of the Boulder area include mixedgrass prairie communities occurring in large matrix forming stands or in small patches intermingled with xeric tallgrass. About 40%, or 9,850 acres, of the Grassland Planning Area (GPA) are currently mapped as Mixedgrass Prairie Mosaic (**Figure 3**). Some plant associations represent the western edge of High Plains vegetation, while others are related to communities of the northern or southern Great Plains. At the forest-grassland interface or ecotone, mid- and short-grass prairie species blend with Rocky Mountain species to form a distinctive and localized set of plant associations.

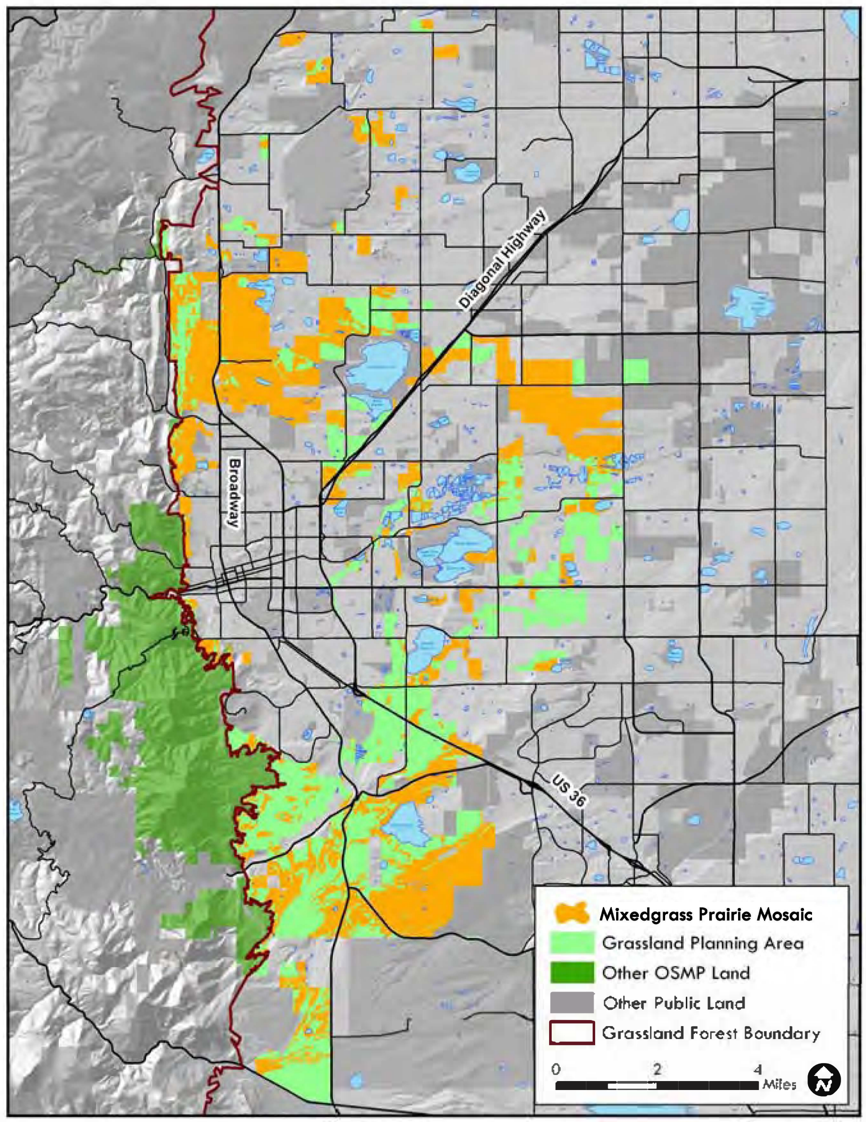


Figure 3 : Mixedgrass Prairie Mosaic in the Grassland Planning Area

Composition

At the foot of the mountains, diverse topography, soils and geology, combine with climate to create habitat for grassland plant associations characterized by mid-height species such as western wheatgrass, needle-and-thread grass, green needlegrass, New Mexico feathergrass, sideoats grama, little bluestem, and Rocky Mountain bluegrass. The mixedgrass prairie also includes shortgrass species such as blue grama and buffalograss.

Stands dominated by western wheatgrass occur in fine-textured clay soils on mid to lower hill slopes, valley bottoms, and shallow, seasonally wet drainages. In rocky sites, needle-and-thread grass co-dominates with western wheatgrass and/or blue grama. New Mexico feathergrass dominates small patches of calcium-rich soils, and little bluestem and sideoats grama are characteristically dominant on north facing edges of low mesas.

Sub-shrubs such as fringed sage, dwarf rabbitbrush, and snakeweed are common in western wheatgrass associations. Three-leaved sumac occurs frequently in mixedgrass prairies on Open Space and Mountain Parks lands. Winter fat and saltbush shrublands, although more widespread elsewhere in the High Plains, are rare in the Boulder Valley. Mixedgrass communities combine with Xeric Tallgrass Prairie patches to form a biologically rich foothills grassland mosaic.

The mixedgrass mosaic supports a diverse fauna including uncommon species such as the short-horned lizard, olive-backed pocket mouse, and several rare butterfly species. Large blocks of mixedgrass prairie provide habitat for numerous grassland nesting birds, the American badger, and elk. Much of the land inhabited by black-tailed prairie dogs in the planning area occurs within this target.

Wetlands, riparian corridors, streams and small water bodies are contiguous with the Mixedgrass Prairie Mosaic. These systems support amphibians and other wildlife that require both upland and wetland or aquatic habitat to complete their life cycles.

Mixedgrass patches with high native plant species diversity provide for a species-rich invertebrate fauna. Taller stature patch types are important habitat for some bird and small mammal species, while other species prefer short stature vegetation. Conservation of Boulder's grassland plant and animal diversity is directly related to maintaining and restoring the compositional and structural diversity of prairie vegetation.

About ten percent of the Mixedgrass Prairie Mosaic is old agricultural fields and areas previously mined for

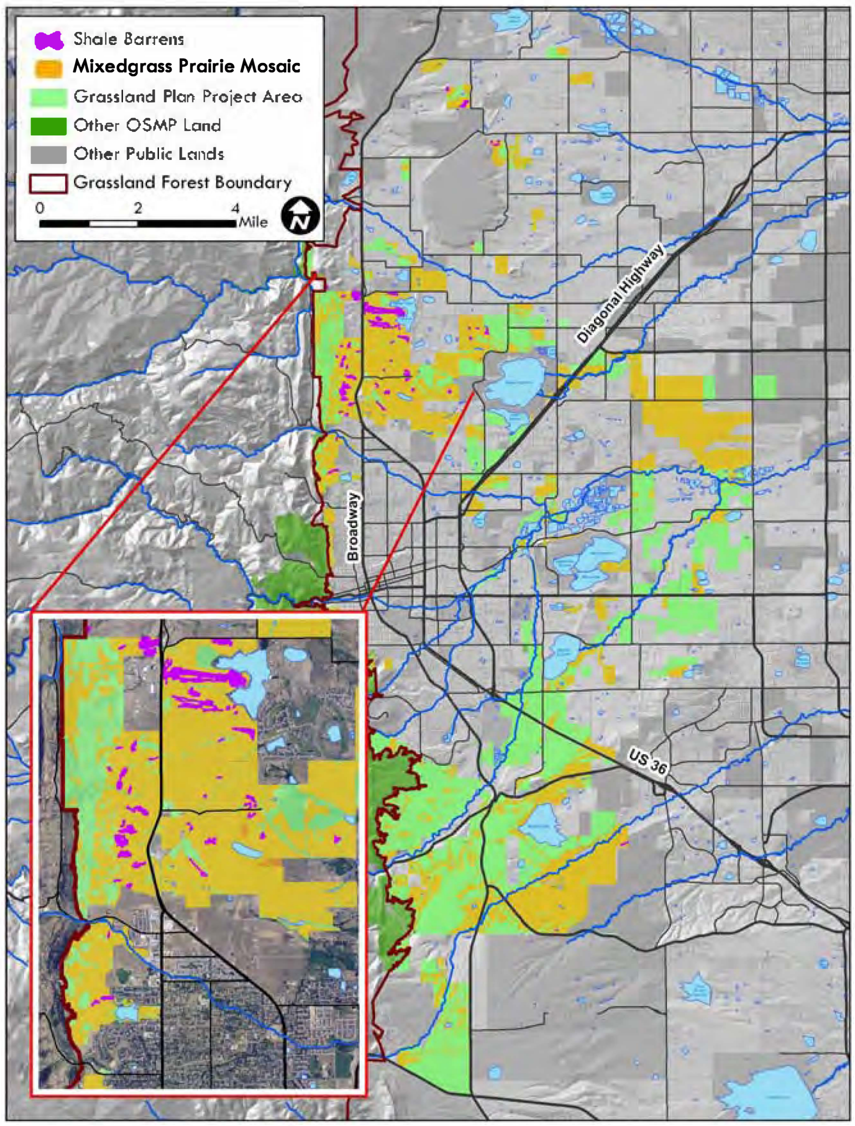


Figure 4 : Distribution of Shale Barrens on Open Space and Mountain Parks

gravel that are in various stages of restoration.

Shale Barrens: An Extraordinary Conservation Opportunity
Shale barrens are an important patch type in the Mixedgrass Prairie Mosaic. Shale barrens are associated with shale outcrops of the Niobrara and Pierre geologic formations in the northern Boulder Valley, and at a few other locations along the forest-grassland interface near Boulder (See **Figure 4**). Bell's twinpod, a Front Range endemic plant, occurs exclusively in shale barrens in Boulder and Larimer County (Kothera 2006).

Currently about 60 acres of OSMP managed lands are mapped as shale barren. Barrens range in character from very sparsely vegetated areas (<10% plant cover) in dark, coarse shaley soils, to areas of moderate vegetation cover (>50%) in finer, shale-derived soils. Many "barrens" plant species have extensive root systems and are well adapted to the water-limited environment created by coarse, shallow soils over shale bedrock (Kelso et al. 2003).


Bell's twin pod photo – Frank Beck

The flora of shale barrens includes a variety of forb species, grasses, and small shrubs. Bell's twinpod, rough sunflower, prairie sage, sidebells penstemon, three-fingered milk vetch, woolly hymenopappus, and spike gilia are characteristic forbs. Common grasses are Indian ricegrass, New Mexico feathergrass, needle-and-thread grass, blue grama, western wheatgrass, little bluestem and purple threeawn. Shrubs and sub-shrubs include sand cherry, three-leaved sumac, serviceberry, yucca, snakeweed, and yellow buckwheat. Western hackberry trees sometimes occur in small stands on some barrens.

Boulder's shale barrens also contribute significantly to the biological diversity. These barrens provide habitat for a large portion of Bell's twinpod populations along the northern Front Range of Colorado. This globally rare and state imperiled Colorado endemic species does not occur anywhere else in the world, and is identified as a conservation target by The Nature Conservancy's Central Shortgrass Prairie Ecoregional Plan (Neely et al. 2006). Two rare plant communities, the Indian Ricegrass Shale Barrens and the New Mexico Feathergrass Herbaceous Associations, are also affiliated with the shale barrens.

Observations at one barrens site in north Boulder noted a steady increase in vegetation cover during a five to ten year period following a wildfire, prairie dog die out, and consistently higher than average precipitation levels (Carpenter 1997). Increased competition from grasses at this site appeared to reduce Bell's twinpod densities. In subsequent years, as prairie dogs returned to the site and drought conditions were more common, plant cover was reduced to less than 25%. The amount of suitable habitat for plants that are poor competitors for resources such as Bell's twinpod varies over time with the dynamics of natural disturbance regimes. As visitation increases on OSMP in North Boulder Valley, social trail development and new designated trails have the potential to affect shale barrens.

Ecological Processes
The major ecological processes influencing mixedgrass prairie are fire, ungulate grazing, and

black-tailed prairie dog burrowing and grazing. Natural disturbance regimes have been significantly altered with European settlement. Historically, natural and human set fires probably occurred more frequently and covered larger areas than in today's landscapes where fuel loads are reduced by livestock grazing and people actively suppress wildfires (Sherriff and Veblen 2007). Spatial patterns, seasonality and intensities of pre-settlement grazing by bison, deer, elk and prairie dogs differ from those of post-settlement livestock grazing, pasture fencing, and water source redistribution. Combined grazing by livestock and prairie dogs in fenced pastures also creates unique grazing regimes that did not occur under pre-settlement conditions. In highly fragmented urban areas, where emigration opportunities are rare or non-existent, population densities of prairie dog colonies increase and grasslands are subject to extended periods of unusually high grazing pressure (Johnson and Collinge 2004).

These modified disturbance regimes are reflected in the current composition of vegetation. Native plant species diversity has probably decreased in many areas because of frequent livestock grazing at the same time of year, or due to the lack of ungulate grazing and/or fire. Shrub and tree species are probably more common. The cycling and distribution of nutrients have been influenced by altered disturbance regimes and urban/industrial nitrogen deposition. These changes combine with additional biotic and abiotic factors to affect the resilience and resistance of mixedgrass plant communities in the face of stresses such as drought and the invasion of aggressive non-native plant species.

Because of changes to disturbance regimes and the introduction of non-native plant species, some of the plant communities that make up the Mixedgrass Prairie Mosaic in the Grassland Planning Area are relatively rare. These include the Green Needlegrass Herbaceous Alliance, Needle-and-Thread and Blue Grama Herbaceous Alliance, and Little Bluestem and Sideoats Grama Herbaceous Alliance.

Observations from the Olde Stage Road Fire (January 2009)

A wildfire burned approximately 1,500 acres of this target in January of 2009. The fire was followed by a very dry winter and a relatively moist spring. The fire removed annual brome grass species and other weedy annual species that had germinated during the late summer and fall prior to the fire. Spring precipitation may have occurred too late for many annuals to germinate.

Anecdotal information from site visits to the area suggests that these environmental conditions may have significantly improved the viability status of the burn area. In general, native perennial grassland species appear to have gained a competitive edge for the first growing season after the fire, presumably due to an increase in plant available nutrients after the fire and the low cover levels of cool season non-native annuals. Dalmatian toadflax and some other perennial noxious weeds may increase in response to the fire, but their prevalence has not been assessed.

Olde Stage Road fire photo: Eric Anderson

Xeric Tallgrass Prairie

Background and Setting

Upland tallgrass plant communities, dominated by big bluestem, are found in the Boulder Valley and vicinity from the forest edge to the eastern fringes of the mesas that occur along the western border of the Grassland Planning Area. In Colorado, tallgrass communities are found in rocky soils at elevations between 5,400 and 7,600 feet along the northern Front Range at the foot of the mountains, and in the southeastern part of the state. Some of the largest areas of tallgrass remaining in the state are in the Boulder area. The Colorado Tallgrass Prairie State Natural Area was designated on OSMP land in 1984, in recognition of the statewide importance of Boulder's tallgrass prairies. The foothills tallgrass communities in the Boulder area share similarities with the tallgrass prairies of the eastern Great Plains, but also have distinctive characteristics of their own (Baker and Galatowitsch 1985, Bock and Bock 1998, Buckner 1994, Hanson and Dahl 1957, Livingston 1952, Moir 1969, Vestal 1914).

Occurrences of tallgrass prairie on mesas can be large. For example, there are over 2,000 acres of Xeric Tallgrass Prairie on the Rocky Flats Mesa (the majority of which is on lands managed by the U.S. Fish and Wildlife Service). There are currently approximately 5,650 acres of xeric tallgrass mapped on OSMP managed lands (**Figure 5**).

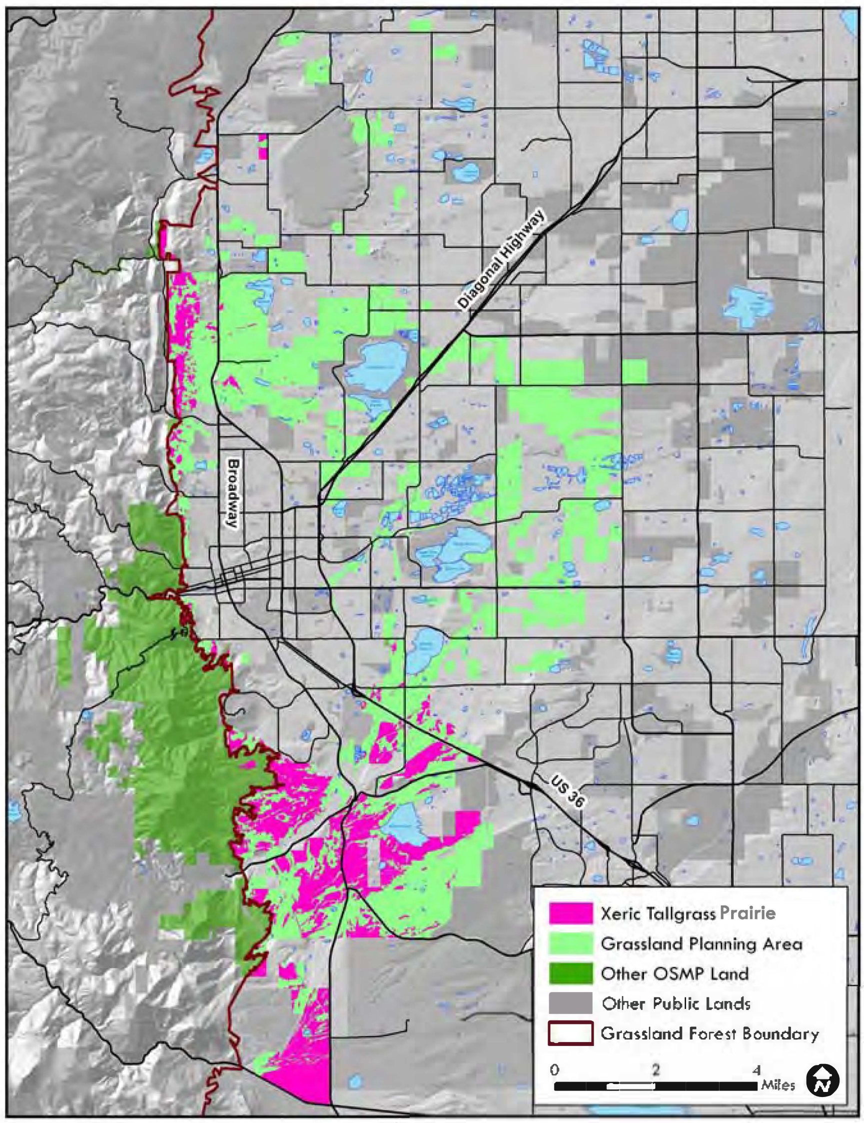


Figure 5 : Xeric Tallgrass Prairie in the Grassland Planning Area

Tallgrass prairie is considered rare and imperiled globally, and is one of the most endangered vegetation types in the world (Hoekstra et al. 2005). The conservation rankings for the communities that occur in Colorado range from "critically imperiled" to "imperiled". Xeric tallgrass communities have been highlighted and identified as conservation targets by The Nature Conservancy's ecoregional assessment of the Southern Rocky

Mountain area. Southern Boulder County and northern Jefferson County may have the largest areas of these xeric tallgrass communities remaining in Colorado.

Precipitation levels at the base of the mountains, combined with supplemental irrigation, the geology and soils, provide habitat for tallgrass plant communities in the Boulder area. Tallgrass stands on slopes, mesas, and ridges occur in soils with large amounts of rock and gravel in the upper profile. The high rock content allows for rapid infiltration of rainfall and snowmelt resulting in more available soil moisture when compared to adjacent finer textured soils supporting other plant associations (Branson et al. 1965). The abundance of coarse materials near the surface also reduces evaporation, and concentrates moisture and soil in spaces among the rocks. Beneath this "rock mulch", clay rich soils absorb and retain enough moisture to support tallgrass prairie and montane plant species. North-facing slopes, which experience less direct exposure to sun, retain snow longer and provide the most mesic habitat for upland tallgrass.

Composition

The Xeric Tallgrass Prairie is characterized by several community types occurring in open meadows, savannas at the prairie-forest interface, and as matrix-forming grasslands on prominent mesa tops. Patches along the prairie-forest interface are relatively small, generally from three to100 acres in size.

Tallgrass and mixedgrass prairie plant species blend with higher elevation species, forming unique ecotonal grassland plant communities. These distinctive prairie communities have species in common with Great Plains tallgrass prairie (big bluestem, yellow Indiangrass, little bluestem, prairie dropseed, and porcupine grass) as well as plant species more typical of the Rocky Mountain montane life zone (Porter aster, mountain muhly grass, and grassyslope sedge).

Relatively large areas of xeric tallgrass persist in the Boulder area, preserved by public open space programs and other government ownership. Several plant communities tracked by the Colorado Natural Heritage Program (CNHP) are well-represented, including the Big Bluestem-Prairie Dropseed Western Great Plains Herbaceous Association, and additional xeric communities within the Big Bluestem (-Yellow Indiangrass) Herbaceous Alliance. Dwarf leadplant, grassyslope sedge, narrow-leaved milkweed, and prairie violet are CNHP-tracked plant species occurring in the xeric tallgrass mosaic. The grassyslope sedge, a montane plant that reaches its lowest elevational extent on the mesas that occur along the western border of the Grassland Planning Area, is ranked "critically imperiled" (S1) in Colorado. The remaining rare plant species are central and northern Great Plains elements at the western edge of their range.

Big Bluestem photo - **Linda Mahoney**

Tallgrass provides habitat for the CNHP-tracked butterflies, Ottoe skipper, Arogos skipper, crossline skipper, and regal fritillary (Pineda and Ellingson 1998). These butterflies depend on characteristic tallgrass plant species like big and little bluestem, prairie violet, and New Jersey tea, and are rare throughout the Great Plains. Large, unfragmented patches of xeric tallgrass create seasonal habitat for a suite of grassland nesting birds, and are used seasonally by elk.

Ecological Processes

Big bluestem prairie communities are shaped and maintained by fire, grazing, drought, wind and other natural processes. Elk, pronghorn, bison and other native grazing animals were previously more common in the Boulder Valley. Based on fire frequency estimates derived from nearby forests, natural and human-set fires probably burned foothills grassland communities every five to 30 years (Sherriff and Veblen 2007).

Changes to ecological processes have accompanied the urban development and mining that have degraded or eliminated much of the xeric tallgrass along the northern Front Range. The influences of grazing, fire, and drought on tallgrass communities have been modified with the alteration of natural disturbance regimes since fire suppression, irrigation, and the introduction of domestic livestock. Prior to widespread and regular fire suppression activities, fires occurred more frequently and covered larger areas than in the fragmented post-settlement landscapes where wildfires have been suppressed. Pre-settlement ungulate grazing patterns and intensities would have been different from post-settlement livestock grazing regimes after fencing fragmented the landscape and water sources were redistributed. The seasonal timing of these disturbances has also been altered since settlement. Irrigation has modulated the effects of drought on vegetation where senior water rights are delivered to Xeric Tallgrass Prairie. Changed disturbance regimes are reflected in the current composition of vegetation with patterns similar to those described for the Mixedgrass Prairie Mosaic.

Xeric Tallgrass Prairie photo – Dave Sutherland

Mesic Bluestem Prairie

Background and Setting

Mesic tallgrass plant communities, dominated by big bluestem, occur in the Boulder Valley in the current South Boulder Creek floodplain and along ancient creek terraces. The largest remnants of Mesic Bluestem Prairie in the state occur in Boulder, separated from the mesic tallgrass prairie in the eastern Great Plains by hundreds of miles. Boulder's tallgrass communities have some characteristic species in common with the Mesic Bluestem Prairies of the eastern Great Plains, but also have distinctive characteristics (Baker and Galatowitsch 1985, Bock and Bock 1998, Buckner 1994, Hanson and Dahl 1957, Livingston 1952, Moir 1969, Vestal 1914).

Tallgrass prairie is considered rare and imperiled globally, and is one of the most endangered vegetation types in the world (Hoekstra et al. 2005). Colorado's Mesic Bluestem Prairie (Big bluestem – Yellow Indiangrass Western Great Plains Herbaceous Vegetation) has a conservation ranking of "critically imperiled". The Boulder area Mesic Bluestem Prairie has been highlighted and identified as a conservation target by The Nature Conservancy's ecoregional assessment of the Southern Rocky Mountain ecoregion (Neely et al. 2001). The Colorado Tallgrass Prairie State Natural Area was designated on OSMP land in 1984, in recognition of the statewide and regional importance of Boulder's Mesic Bluestem and Xeric Tallgrass Prairies.

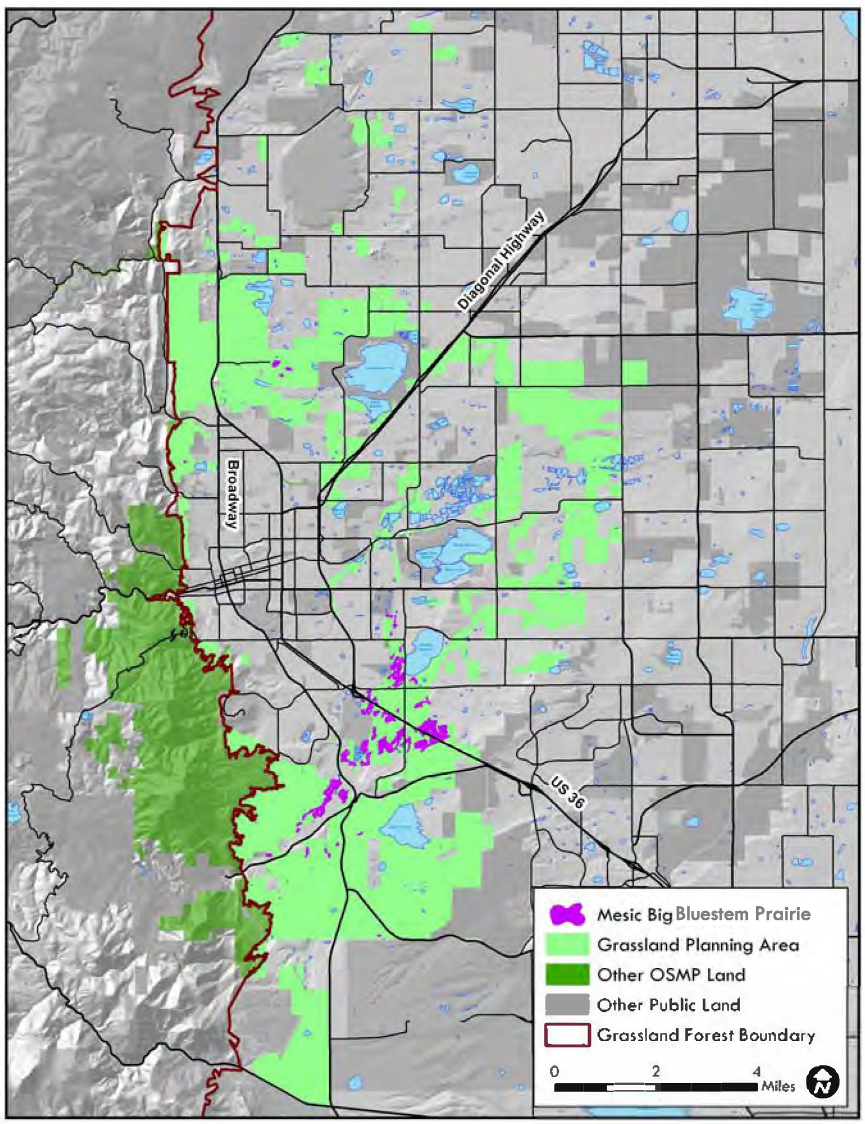


Figure 6 : Mesic Bluestem Prairie in the Grassland Planning Area

In Boulder, Mesic Bluestem Prairie is found in rocky stream-deposited soils at elevations between 5,400 and about 6,000 feet (**Figure 6**). Precipitation levels at the base of the mountains, combined with supplemental irrigation, the geology and soils, provide habitat for Mesic Bluestem Prairie communities in the Boulder area. The high rock content allows for rapid infiltration of precipitation and more available soil moisture when compared to adjacent finer textured soils that support other plant associations (Branson et al. 1965). The abundance of coarse materials near the surface also reduces evaporation, and concentrates moisture and soil in spaces among the rocks. Beneath this "rock mulch", heavier clay layers or clay lenses absorb and retain enough moisture to augment ground water levels and to support mesic tallgrass species.

Mesic Bluestem Prairie covers approximately 350 acres in the Grassland Planning Area, and is concentrated in the southern portion of the OSMP land system. Habitat occurs along South Boulder Creek floodplain and associated terraces with high ground water levels, historically augmented by flood irrigation. Mesic tallgrass stands often form a mosaic with wetland vegetation and small upland prairie patches on raised cobble bars. The Mesic Bluestem Prairie is a small-patch target with about 20 patches ranging in size from five to 65 acres.

Composition

The Mesic Bluestem Prairie provides habitat for several CNHP-tracked butterflies, including the Ottoe skipper, Arogos skipper, and crossline skipper. These species depend on characteristic tallgrass plant species like big and little bluestem, and are considered rare and imperiled throughout the Great Plains (Pineda and Ellingson 1998). Stands of Mesic Bluestem Prairie also provide nesting habitat for a suite of grassland obligate bird species, such as bobolinks, and cover to facilitate northern leopard frog dispersal. The robust rodent populations occurring in mosaics formed by wet meadows and Mesic Bluestem Prairie attract northern harriers, Swainson's hawks, prairie falcons, and other raptors that forage in grassland habitats.

Ecological Processes

Mesic Bluestem Prairie communities are shaped and maintained by fire, grazing, drought, wind and other natural processes. Before European settlement, elk, pronghorn, bison and other native grazing animals were common in the Boulder Valley. Pre-settlement fires may have burned Mesic Bluestem Prairie communities every five to ten years (Sherriff and Veblen 2004); though fire frequency estimates for local grasslands are based on information from nearby forested foothills. After settlement, domestic livestock became the dominant grazers, and fires were suppressed. Settlers were not able to plow the rocky soils along the northern Front Range, which left the floodplain habitat and associated terraces intact. Over the last century, though, mining, grazing, fire suppression, and urban development have degraded or eliminated much of the habitat along the northern Front Range. Altered stream hydrology and agricultural irrigation practices have likely eliminated habitat in some areas and created appropriate mesic bluestem habitat in other areas. The net change in extent of habitat in Boulder Valley is unknown.


photo – Brian Peck

The influences of grazing, fire, and drought on tallgrass communities have been modified with the alteration of natural disturbance regimes since European settlement. Before settlement, fires probably occurred more frequently and covered larger areas than in the fragmented post-settlement landscapes where wildfires have been suppressed. Fire suppression and stream impoundment has led to encroachment by trees and shrubs. Pre-settlement ungulate grazing patterns and intensities would have been different from post-settlement livestock grazing regimes after fencing fragmented the landscape and water sources were redistributed. The seasonal timing of these disturbances has also been altered since settlement, though the winter and spring cattle grazing regime over the last several decades in most of the Mesic Bluestem Prairie may be similar to the seasonal timing of the most concentrated pre-settlement ungulate grazing. Changed disturbance regimes are reflected in the current composition of vegetation with patterns similar to those reported for the Mixedgrass Prairie Mosaic and Xeric Tallgrass Prairie (see above).

Agricultural Operations

Background and Attributes of OSMP Agriculture

Ensuring on-going agricultural production is a well-established function of Open Space and Mountain Parks lands. The city charter lists the "preservation of agricultural uses and land suitable for agricultural production" and "preservation of water resources in their natural or traditional state" as open space purposes. "Water resources in a traditional state" includes the use of water rights for agricultural production on OSMP. Irrigated land and water resources available for agricultural production are critical for maintaining viable agricultural operations on OSMP lands. Approximately 14,600 acres of OSMP lands are leased for agricultural production (**Figure 7**). Of that, about 5,400 acres are irrigated. The primary uses of OSMP agricultural land are hay production and livestock grazing. Annual crops are grown on 300-600 acres of OSMP land each year. Crops currently grown include wheat, corn and barley.

Beef cattle and small grains have long been standard products for Boulder County agricultural producers. Hay as feed for horses has become a significant commodity in the last two decades with the increase in numbers of rural residential homes where people keep horses. Increasing numbers of homeowners are keeping horses on acreages too small to meet year-round forage needs creating a year-round demand for hay.


photo – Dave Sutherland

Marketing organic produce for sale to local restaurants and at farmers' markets is a growing trend in the Boulder Valley. OSMP lessees are involved with natural beef production, but not the production of organic fruits or vegetables. OSMP conservation easements have been used for organic farming in the past.

In addition to agricultural products, ranchers and farmers are turning increasingly to agricultural *services*. Such services represent a small percentage of farm/ranch income for OSMP lessees. OSMP leases include a horse boarding operation and a therapeutic riding facility. Currently there are no community-supported agriculture (CSA) projects, no agro-tourism operations on OSMP, and no seasonal attractions such as dude ranching, Halloween pumpkin patches, or corn mazes.

OSMP staff has rarely influenced the production choices of agricultural users other than prohibiting the use of genetically modified organisms (GMOs). Lessee's choices of specific agricultural commodities are influenced by local commodity markets and their ability to sell a product profitably. Ranch and farm operators have freedom to decide what to grow and to a large degree how to grow it. OSMP lease managers are involved in decisions about specific management practices (stocking rates, seasons of use, herbicide use, etc.) to ensure the sustainability of the land, protect public safety, and to minimize the need for special infrastructure specific to a particular crop or service.

In 1991 (most recent data available—cited in the Boulder County Comprehensive Plan-Online Resource), local commodity prices were identified as one of the major obstacles to farming in Boulder County. However, the growth in the horse hay market and the ability to market natural beef has improved local markets recently. Oil seed crops for biofuels and human consumption may be another opportunity for diversification by traditional agricultural users. Small-scale organic production will also be a viable alternative in the future.

As part of the same 1991 analysis, land prices and speculation by developers for agricultural land was identified as a threat to the future of agriculture in Boulder County. The protection of open spaces is one of several strategies in place to abate this threat. As early as 1986 Boulder's city charter identified two of the key attributes of agriculture—**land** and **water**. Without these two elements, OSMP would not be able to contribute to the continuation of agriculture in Boulder. The department has been very successful in purchasing both lands and water rights to conserve open space in the Boulder Valley, and has used agricultural practices successfully as land management tools. One measure of land suitability for agricultural production is the number of acres that is leased to farmers or ranchers. Currently OSMP leases approximately 14,600 acres of land for agricultural production. There are additional OSMP properties that are suitable for agricultural production, but for a variety of reasons are not leased. This includes small isolated parcels, lands that have agricultural facilities in a state of disrepair, places where agricultural values have been degraded by prairie dogs and places where OSMP is pursuing management objectives incompatible with on-going agricultural operations.

OSMP's portfolio of water rights arises from the four major creek drainages in the Boulder Valley, springs and groundwater. These water rights are used to irrigate over 5,500 acres for hay and pasture production. This portfolio contains many senior water rights establishing a reliable source of irrigation in most years.


Irrigation Diversion

Another attribute for sustainability of Agricultural Operations is the availability of operators to lease open space agricultural properties. According to the 2002 Census of Agriculture (USDA 2004), the majority (88%) of agricultural operations in Boulder County were operated by a family or individual (rather than a corporation). OSMP is one of the largest agricultural landowners in Boulder County (the other is Boulder County Parks and Open Space)—yet OSMP employs no staff to farm or ranch. OSMP depends upon local farmers and ranchers to ensure the on-going agricultural production on 14,600 acres of land.

The availability of operators depends upon having competent, flexible individuals who are willing to agree with the city's lease requirements. Competency is typically assessed by learning about an operator's past experience farming or ranching successfully either on OSMP lands or elsewhere. In addition, the OSMP Long Range Management Policies state that OSMP staff will perform a fiscal analysis of the lessee's ability to perform according to the terms and conditions of the lease.

Flexibility is often a function of the size of the farmer or rancher's operation beyond lands leased from OSMP. Because OSMP has a variety of purposes, it may be necessary from time to time to manage for priorities other than agricultural production or efficiency. At these times, farmers or ranchers who have alternative lands to address their needs offer advantages over operators who are restricted to only lands they lease from OSMP—or even a single OSMP property. Operators with capacity to take on larger areas also reduce the number of leases that the department must track, reducing administrative costs.


Haying

Willingness to farm on OSMP lands is affected by the stresses associated with farming in an urbanizing area, and farming on lands open to public use. A 1985 Colorado State University - Boulder County Agricultural Survey revealed that the number one factor discouraging continued agriculture was not market economics but the stresses and impacts created from urban influences (Boulder County Comprehensive Plan 1997). To date, willingness to lease open space properties has been measured by the response of operators to lease offerings (requests for proposals) or the number of people who contact OSMP during the course of the year interested in leasing land for agriculture. One measure that can be used to forecast long-term availability of lessees is the average age of farm operators. For Boulder County, the average age is 56. This suggests that there are probably more farmers near the end of their farming careers than near the beginning.

Managing for Agriculture in the Context of Multiple Use

In 1967, the City of Boulder began the purchase of open space lands, many of them in the Grassland Planning Area. With few field staff and little on-the-ground management capacity, the city leased properties to local farmers and ranchers to address day-to-day management. Recognizing a long-term responsibility to set management objectives, city-commissioned agricultural management plans were developed in 1975. These plans informed the city's leases with farmers to ensure long-term sustainability of the land.

As the open space staff grew newly hired agricultural managers, rangers, wildlife and plant ecologists developed a better understanding of how agricultural practices were affecting biodiversity conservation. Agricultural activity was recognized as not only a charter purpose but also a tool to enhance the ecological values of the city's natural areas.

Agricultural operations on lands that are currently managed as open space have created novel ecosystems over the past century. Irrigation and livestock grazing have been major sources of change to ecological systems in the Grassland Planning Area. Since natural precipitation alone cannot support agriculture in many settings in the planning area—especially the higher terraces, mesa sides and mesa tops, significant inputs of irrigation water are needed. This water, diverted from creeks supports not only agricultural production but also a wide range of semi-native moist meadows and wetlands dominated by native species. A common occurrence in irrigated pastures is the accumulation of "tail water" (irrigation water that drains from the lower ends of fields) in depressions where marshes and other wetlands are supported.

Semi-native hayfields and pastures and the associated agricultural practices support wildlife not commonly found elsewhere on OSMP lands such as bobolinks, as well as species which are more widespread elsewhere on OSMP but still of conservation concern. These include grasshopper sparrows, lark sparrow, savannah sparrow, northern harrier, and Swainson's hawk. The federally threatened Preble's meadow jumping mouse is present on OSMP lands managed for agriculture. Irrigated pastures and the ditches that serve them support plant species of concern such as the federally threatened Ute ladies'-tresses orchid and the locally sensitive American groundnut and showy prairie gentian. OSMP staff has been working with lessees for several decades to operate in a manner consistent with the conservation of these species.


Bobolink photo – Dave Sutherland

Agricultural management of OSMP has provided significant advantages for the conservation of native species. However there are ecological costs associated with the transformation of land into agricultural uses and agricultural practices can be incompatible with the protection of native biodiversity. Agricultural land uses on OSMP have been increasingly multifunctional. The Grassland Plan will provide more information about how agriculture and ecological conservation interact.

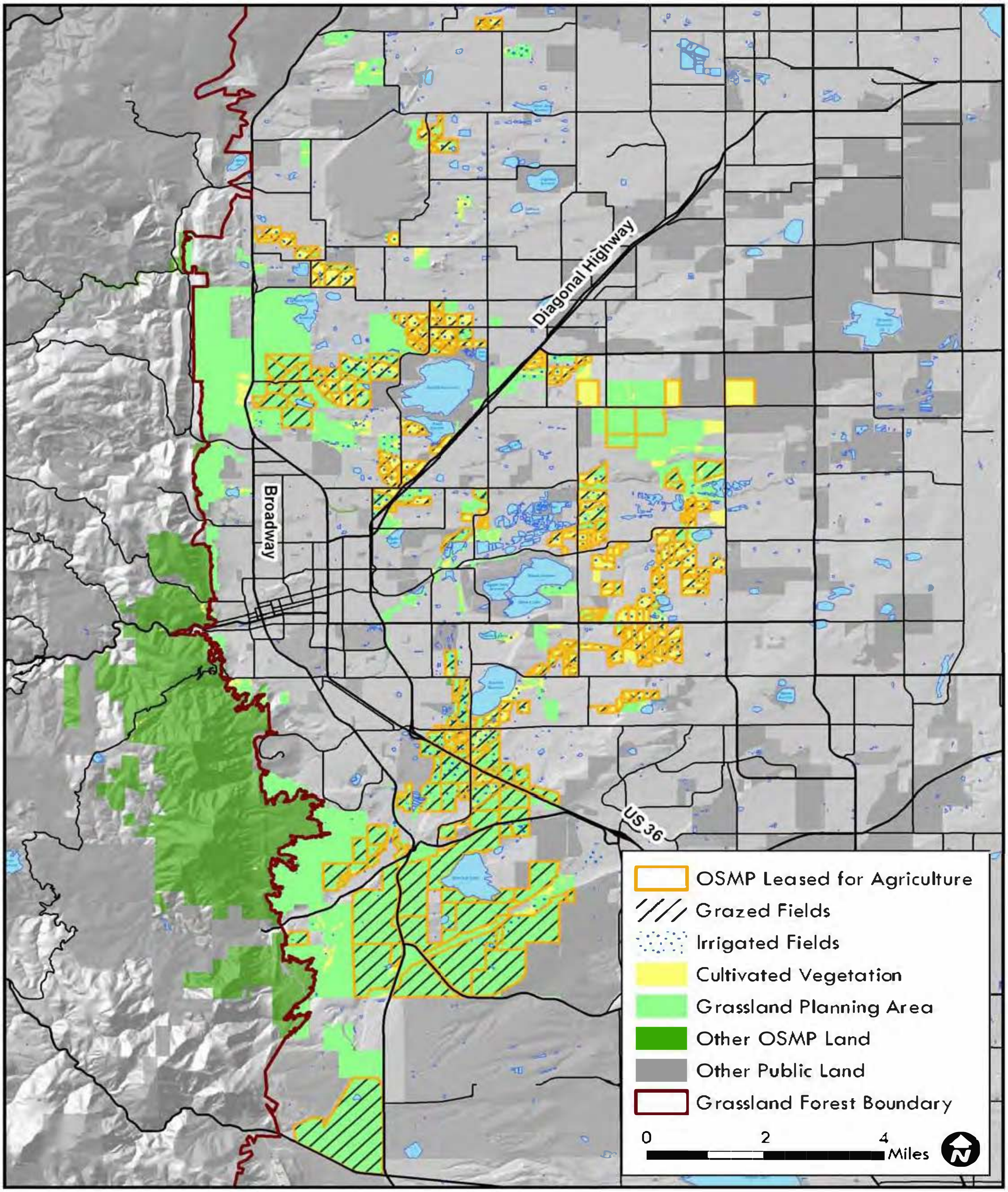


Figure 7 : Cultivated vegetation and agricultural land uses in the Grassland Planning Area

Black-tailed Prairie Dog and Associates

Background and Setting

Black-tailed prairie dogs have far-reaching impacts on the grassland that they inhabit and their presence provides prey and landscape structure necessary for the presence of associated species. Because of these far-reaching effects, prairie dogs are often considered "keystone" species (Kotliar et al. 1999, Hoogland 2006). They are a species that defines the basis of a unique animal community on Open Space and Mountain Parks lands: The "Black-tailed Prairie Dog and Associates".

The black-tailed prairie dog is a medium sized, diurnal, colonial ground squirrel inhabiting subterranean burrows in suitable grassland habitat. The black-tailed prairie dog historically inhabited much of the central plains but through loss of habitat and direct extermination, populations have been significantly reduced (Miller et al. 1990, 1994). Black-tailed prairie dogs exist on Open Space and Mountain Parks throughout grassland areas with large complexes of colonies clustered on the northern half of OSMP lands (**Figure 8**).

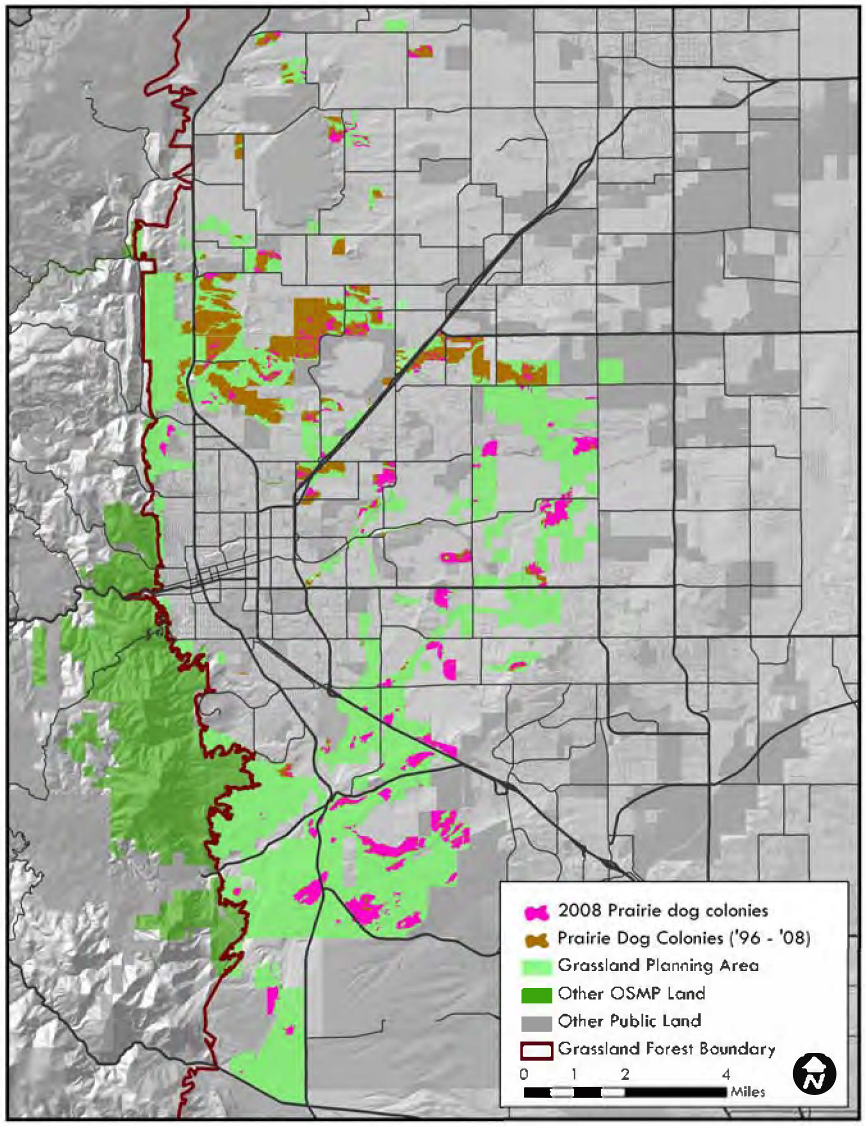


Figure 8 : Black-tailed prairie dog colonies in the Grassland Planning Area (maximum extent and 2008 mapping)

In 2005, approximately 3,500 acres of OSMP grassland habitat was inhabited by black-tailed prairie dogs. Since then, an active epizootic of sylvatic plague reduced the number of acres occupied by approximately 2,000 acres based upon colony mapping conducted in 2008. The conditions present on OSMP prairie dog towns varies widely. Some colonies support a healthy native plant community and several animal species associated with prairie dogs. Others are characterized by a high density of burrows, diminished native vegetation, localized soil loss and no evidence of the vertebrate species considered dependent upon prairie dogs. In many cases, surrounding land use, underlying vegetation communities and other factors are important contributing factors to the ecological status of the colony.

Prairie Dog Biology

Black-tailed prairie dogs are burrowing rodents in the squirrel family that are active during the day. They have a complex social order and generally live in large colonies comprised of multiple "coteries".

Coteries are a territorial family group within a colony. Family groups can range from two to 26 individuals. In South Dakota, Hoogland (2006) found that coteries occupied areas averaging about an acre and ranged in size from 0.12 to 2.5 acres. He also found that the number of burrow entrances per coterie range widely (5-214; average 69). Coteries occupied areas with of multiple tunnels and burrows that are used for sleeping, birthing and escaping predators. The underground tunnel systems of one coterie do not connect with adjacent coteries. Prairie dogs coteries establish boundaries of occupied areas through territorial disputes.


Prairie Dogs photo - Kevin Dobler

A typical coterie has one adult male as well as several females, yearlings and juveniles. Adult females and yearlings of both sexes in a coterie are the offspring of females from that coterie. By contrast, the breeding males within coteries are the offspring of females from other coteries. A prairie dog colony is typically composed of several coteries. Burrows numbers cannot be used as a reliable predictor of the number of prairie dogs living in colony as populations fluctuate seasonally and annually and burrow number typically remains stable (Hoogland 1995).

Prairie dogs give birth once per year. In Colorado, prairie dogs mate in mid-February. Gestation lasts about five weeks. The young are wholly dependent upon adult care when they are born. In mid to late May juveniles emerge from their burrows (Hoogland 1995). Most prairie dog females give birth to three pups, although litter size ranges from one to six.

Black-tailed prairie dogs face the highest mortality during their first year. Mortality averages 53% for males and 45% for females. Males that survive the first year commonly live two to three years and females live four to five years (Hoogland 2006).

The adult male of a coterie defends his territory leading to permanent dispersal of male offspring. This may be a behavioral adaptation to reduce the likelihood of inbreeding. Prairie dogs also probably disperse to find food, burrows or potential mates. Intracolonial (within the colony) and intercolonial (between colonies) dispersals are discussed below:

Intracolonial natal dispersal is the movement of young individuals away from the area of birth. Most females spend their entire lives within the natal territory, while most males remain in the natal territory for only a year. They then disperse before reaching sexual maturity in their second year. Intracolonial *natal* dispersal by yearling males typically occurs in May or June. Intracolonial *breeding* dispersal of (mostly) adult males occurs in late summer or fall (Hoogland 2006).

Intercolonial dispersal is dispersal between colonies. The research of Knowles (1985), Cincotta et al. (1987 a, b), Garrett and Franklin (1988), Roach et al. (2001), and Milne (2004) has led to several important discoveries:

- Dispersers travel as far as 3.7 miles (6 km)
- Dispersers are more vulnerable to predation
- Disperser typically move into an established colony rather than a new colony
- Females are almost as likely as males to show intercolonial dispersal
- Most male dispersers and about half of female dispersers are yearlings
- Dispersal by yearlings and adults is most common in the month or so after the first emergences of juveniles from their natal burrows.
- Prairie dogs disperse singly, not in groups
- Females move long distances to other colonies as either yearlings or adults. Short distance dispersal of females within the home colony is uncommon

There are three primary natural causes of mortality in prairie dogs: predation, the inability to survive the winter, and infanticide. Predators of prairie dogs include American badgers, bobcats, mountain lions, coyotes, foxes, bull snakes, rattlesnakes, hawks and eagles. Food for prairie dogs is scarce during late fall, winter and early spring. A prairie dog's survival during the winter months depends in large part upon its ability to accumulate fats during the summer and early fall. Middle-aged individuals are heavier than older and younger individuals are, and are more likely to survive the winter. Nonparental infanticide, the killing of another prairie dog's juvenile offspring, accounts for the partial or total demise of 39% of all litters within colonies, and thus is a major cause of mortality. In addition to mortality, and dispersal, prairie dog populations may be controlled by spontaneous adjustments in litter size related to resource (food, space) availability (Hoogland 2006).

Bubonic (in humans) or sylvatic (in the wild) plague is a disease introduced to North America during the early 1900's. Black-tailed and other species of prairie dogs are especially susceptible to the disease and periodic episodes of infection (epizootics) are seen across large parts of the species' ranges. In Boulder County, epizootics of plague occur cyclically (every 7-11 years) and result in extensive mortality of prairie dogs. In recent epizootics (1994/5 and 2005-present), mortality in many colonies is nearly complete while other colonies maintain unaffected areas or are unaffected and likely uninfected. Across much of the range of the black-tailed prairie dog, plague represents an unpredictable and uncontrolled threat to populations. On OSMP, epizootic die-offs have resulted in significant reductions in populations. Population expansion (from recolonization or expansion of surviving animals) has led to distributions consistent with or in excess of pre-plague levels. Nonetheless, plague plays a role in defining the spatial scale and arrangement of prairie dogs occupation on OSMP lands. Due to the highly unpredictable nature of outbreaks, and shifting surrounding land uses, the future threat posed by plague is uncertain.


Prairie Dog and Vegetation

Composition
On OSMP lands, black-tailed prairie dogs prefer short to midgrass prairies with suitable soils (not rocky) and relatively flat terrain. However, in areas where adjacent development or other factors have restricted the expansion of prairie dog colonies, they may inhabit less suitable sites (rocky soils, steep slopes or higher stature vegetation). Patterns of development and conflicting land use along with sylvatic plague have shaped the location, condition and extent of black-tailed prairie dog colonies along the Colorado Front Range and on OSMP. Because of their ability to engineer the land on which they live (ground burrowing disturbance as well as clipping of vegetation), and to create habitat and food for a variety of other species, black-tailed prairie dogs have been considered "ecosystem engineers" in the grassland habitats they occupy (Jones et al. 1994).

The existence of several other closely associated species that rely on black-tailed prairie dogs contributes to their function as a keystone species. These species benefit from the prairie dogs directly as prey, indirectly through use of their burrows, or both. These associated species are considered nested targets and include species that are common on OSMP as well as some less common, and several extirpated species.

Burrowing owls, American badgers, ferruginous hawks, and golden eagles are animal species associated with intact prairie dog colonies. These species include predators (American badger, ferruginous hawk and golden eagle) which are sensitive to human disturbance and are frequently found to be using only prairie dog towns distant from development and human disturbance. Other associated species use prairie dog burrows as habitat, most notably burrowing owls. Burrowing owls are most frequently found using abandoned prairie dog burrows for shelter and nesting. Many other species, including a variety of insects, small mammals, reptiles and amphibians, may also use the burrows in prairie dog colonies.


Golden Eagle & Prairie Dog photo - Perry Conway

In addition to these associated species are several species that have been extirpated from black-tailed prairie dog towns in the Boulder Valley, Colorado or the High Plains. These include the mountain plover, plains sharp-tailed grouse (extirpated from the Boulder Valley) as well as the black-footed ferret and the gray wolf (extirpated from the High Plains). The plains sharp-tail grouse prefer areas of low vegetation such as prairie dog colonies as lek sites where the males perform courtship displays to attract females. Reintroduction of these species to OSMP is unlikely in the near future because sites better suited to the recovery of these species exist elsewhere in their historic range. Suitable habitat for these animals is typically considered large contiguous blocks of habitat—recovery has usually focused upon areas larger than the entire Grassland Planning Area.


Tiger Salamander photo - Rich Smith

Prairie Dogs and People
Black-tailed prairie dogs have a long history of interaction with humans. Because of real or perceived conflicts with humans, they have been the targets of extensive control and

extermination. More recently, due to this long-term history of persecution, prairie dogs have become the subject of protection efforts from animal rights advocates. In addition, many community members and scientists value prairie dogs for their educational, ecosystem service, conservation and entertainment benefits. OSMP has a long history of planning for the conservation of black-tailed prairie dogs and assessing conflicts between prairie dogs and surrounding land uses. The most recent attempt to assess the viability of prairie dogs on OSMP and plan for the best management actions to conserve functioning and sustainable prairie dog colonies while minimizing conflicts is contained in the 1996 Black-tailed Prairie Dog Management Plan. The protection of open space lands has provided for areas in which black-tailed prairie dog communities can function without the threat of development or extermination due to conflicts with competing land uses. As a result, OSMP and other public lands present one of the best opportunities for protecting black-tailed prairie dogs along the highly urbanized Colorado Front Range. However, impacts from surrounding lands and sylvatic plague are poorly understood and present a largely uncontrolled threat to prairie dog populations.

Changes to the Landscape-Small Parcels and Nowhere to Go

Naturally functioning prairie dog colonies often exist in a matrix of grassland habitats with only a portion of the available habitat occupied by prairie dogs at any time. This allows prairie dogs to respond to food availability and other habitat conditions by expanding or contracting their colonies and moving across the landscape to forage or find new colony sites. The movement of prairie dogs also results in shifting grassland conditions. In undeveloped areas, prairie dog burrowing and grazing create a patchwork-like disturbance to the prairie landscape—a fine scale mosaic of plant species and animal habitat diversity.

In the urbanized setting of the Grassland Planning Area, the interval between occupation events is probably shorter than under natural conditions as prairie dogs have fewer places into which they can migrate. Urbanization in the Boulder Valley has also decreased the value of grassland habitat for several of the species associated with prairie dogs [e.g., mountain plover have been extirpated (Boulder County 1986); ferruginous hawks avoid areas in proximity to urban or suburban development (Jones and Bock 2002)]. Consequently, some prairie dog colonies offer better opportunities for conserving prairie dogs in the ecological context most likely to allow for long-term sustainability of vegetation and the support of associated animal species. The location, competing and surrounding land use and condition of the habitats in which prairie dog communities exist help to define the best opportunities for conserving prairie dogs and their associates in a sustainable ecological context.

Wetlands

OSMP has included ponds with the wetland target because these two elements share many key attributes, face very similar conservation issues, and are likely to require similar conservation strategies.

Background and Setting

Wetlands occur where soil is inundated or saturated periodically during the growing season. To support wetlands, soils must be saturated long enough to create anaerobic (oxygen free) conditions within the rooting zone of plants. These conditions limit the types of plants that are capable of growing to those adapted to low oxygen environments. In the semi-arid climate of the Boulder Valley, places where the ground is saturated or flooded are relatively uncommon. Nevertheless, these areas have ecological importance well out of proportion to their size or abundance. **Figure 9** shows the approximate location and extent of Wetlands within the Grassland Planning Area. There are currently about 1,500 acres mapped in this target.

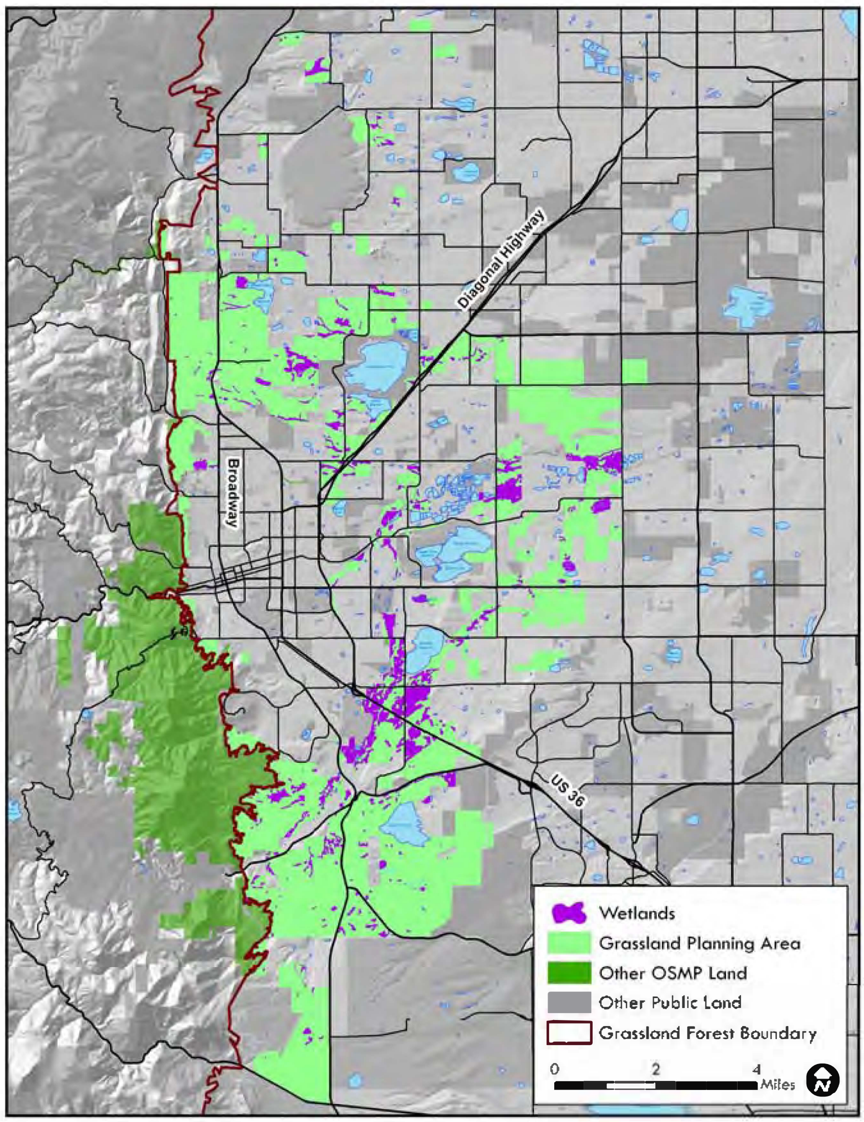


Figure 9 : Wetlands in the Grassland Planning Area

Composition

Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation, irrigation, ditch seepage and other factors, including human disturbance. These differences create a diversity of wetland types. The most common wetland types found within the larger grassland matrix on OSMP land are marshes, wet meadows and riparian wetlands. Seeps and springs also exist on OSMP land, but are much less common and cover a smaller portion of the planning area.

Marshes are characterized by the presence of permanent or semi-permanent shallow water (less than 6.6 feet in depth). On OSMP land, marshes commonly occupy the edges of ponds and lakes, and although rarer, marshes also occur in some depressions with fine textured soils. Emergent plants such as cattails and bulrush and submerged species such as pondweed typically dominate the vegetation in marshes within the Grassland Planning Area. Marshes often exist where ground water or irrigation water accumulates. In many places in the planning area irrigation practices and seepage from irrigation ditches have introduced sufficient water for long enough to create wetlands in areas that would otherwise be dry.

Alkali marshes, a special subset of marshes, also exist on OSMP land. Alkali marshes support halophytic, or salt-loving, vegetation including alkali bulrush and inland saltgrass. These occur in small basins where water from local runoff and irrigation accumulates and evaporates.


Wetland photo - Ann Duncan

Wet meadows are drier than marshes having seasonally or permanently high water tables but lack permanent standing water. They often occur due to flood irrigation practices and are common in low-lying floodplains adjacent to creeks. Soil type and water chemistry influence the type of vegetation found in wet meadows. Sedge meadows form in the larger grassland matrix where organic soils are present and mineral rich groundwater is near the surface. The most common sedge meadow type on OSMP land is the Nebraska sedge meadow, covering approximately 150 acres of the Grassland Planning Area. Clustered field sedge and Emory sedge meadows are also found on OSMP land, but these meadows comprise a smaller portion of the grassland. Nebraska sedge meadows and Emory sedge meadows are relatively rare in Colorado and are tracked by the Colorado Natural Heritage Program.

OSMP's mineral soils also support wet meadows. Arctic rush meadows, the most common wet meadow type on OSMP land, occur where high fresh groundwater tables saturate mineral soils. Inland salt flats can develop in mineral soils infused with an alkali water source. Depressional basins often support inland salt flats.

Natural open bodies of water may have existed in the floodplains of the Grassland Planning Area. For example, oxbow lakes form when parts of the creek are cut off from the main channel, and seasonal lakes occur where annual or periodic floodwaters fill depressions in the floodplain. Depressions, which may have arisen through wind erosion, fill with precipitation, runoff and groundwater. Two such open bodies of water persist in the Grassland Planning Area, although one, Sombrero Marsh, is now influenced by surrounding irrigation ditches and urban runoff. Otherwise, the ponds and lakes on OSMP were created as stock ponds, to store water, or are the result of gravel mining.

Riparian wetlands occur adjacent to running water. Within the planning area, riparian wetlands can be found along Coal Creek, South Boulder Creek, Dry Creek, Bear Canyon Creek, Boulder Creek, Four Mile Canyon Creek and other perennial and ephemeral streams. The adjacent creek is often the major, if not the sole, source of hydrology to riparian wetlands. Erosional and depositional forces of the adjacent creek and floodplain topography influence the soil conditions and vegetation in these wetlands. Riparian wetlands on OSMP contain herbaceous vegetation, woody vegetation (typically willow shrubs) or a combination of these two vegetation types.

Seeps and springs are found where hydrology, geology and topography allow groundwater to reach the soil surface. In the planning area, these are typically associated with pediments and terraces where the upper layers consist of Pleistocene alluvial deposits and are underlain by low permeability Pierre shale formations. Precipitation infiltrates the upper course sediments and percolates downward until reaching the impermeable shale layer. As groundwater reaches the edges of the mesas where the alluvial soils and shale meet, water seeps out and creates small wetlands typically dominated by coarse herbaceous vegetation. This wetland type is relatively uncommon in the planning area.

Spring-fed wetlands also occur in low-lying areas where shallow groundwater flows are interrupted by impermeable soil or bedrock and percolate to the soil surface. Water chemistry in these wetlands is strongly influenced by contact with soil or bedrock of marine origin and often has high concentrations of dissolved minerals. Salt tolerant plants dominate the plant communities in these wetlands. Representative examples of these types of wetlands occur on the Gallagher and Lousberg properties in the Grassland Planning Area.

Because Wetlands support both aquatic and terrestrial plant and animal species, they contain a disproportionately high level of biodiversity relative to other ecosystems. A number of rare plant species, including federally threatened Ute ladies'-tresses orchid and Colorado butterfly plant, as well as state rare toothcup, inhabit OSMP wetlands. Several rare butterfly species, including the prairie Arogos skipper, the prairie regal fritillary, and the two-spotted skipper, rely on wetland plant species for habitat. Bobolink, savannah sparrow, American bittern and northern harrier, all species of special concern in Boulder County, nest in lowland areas containing wetlands and wet meadows. OSMP wetlands also support the northern leopard frog, a species of special concern in Colorado[8].

Ecological Processes

Local and landscape-scale hydrology are the major physical factors influencing wetlands. All wetlands depend on water for their existence. Although wetlands can withstand natural periods of drought, permanent dewatering, prolonged lowering of the water table, or removal of a wetland's water source results in a shift toward upland ecological communities. For wetlands that rely on surface water, changes in the frequency and duration of flooding can alter wetland community composition and structure. Changes in the frequency and intensity of flooding can also alter the flow of nutrients and sediment to riparian wetlands further affecting their community composition and structure.

The provision of water to wetlands is an important beneficial use of the department's water rights portfolio. While natural precipitation and ground water discharge support some wetlands outside the floodplains and lower creek terraces, inputs of irrigation water are often support both agriculture and wetland vegetation in these areas. In addition, "tail-water" or that water that drains from irrigated fields also supports wetland vegetation where it accumulates as it flows

[8] On July 1, 2009 the US Fish and Wildlife Service announced they would begin a review of the northern leopard frog to determine whether to propose adding populations in 19 states west of the Mississippi River and Great Lakes to the federal list of threatened and endangered species.

back to the creeks. Several water sources support wetlands. In many irrigated areas, wetlands and agriculture coexist and provide mutual benefit.

While their influence is not as great as the hydrologic regime in shaping wetlands, fire and grazing play a role in maintaining wetland composition and structure. Periodic fires, particularly in the mesic tallgrass and wet meadows, influence the community composition and structure often by limiting woody growth. Ungulate grazing has a similar effect. Fire suppression and replacing native ungulates with domestic livestock has modified these natural disturbance regimes.

Despite their many values, most wetlands in the Boulder Valley have been significantly degraded or destroyed by land use practices, contamination, gravel mining, and dewatering. In recognition of their functions and values, and the significant conservation issues facing wetlands, Boulder has adopted a wetland protection program, which includes the protection of wetlands through acquisition as open space, and regulatory protection of wetlands in the City of Boulder and on city-owned lands. This program regulates most activities in wetlands by requiring a wetland permit. The City of Boulder wetlands policy is articulated in the BVCP (City of Boulder 2005b), regulatory provisions of the City's land use code (the wetlands protection ordinance), and Open Space and Mountain Parks' LRMP.

Wetlands and OSMP Visitors

Wetlands possess many unique qualities that draw visitors. In addition to providing excellent opportunities for wildlife observation, they also support unique and interesting vegetation. For the purposes of the Grassland Plan, OSMP has included bodies of open water in the wetland target. People enjoy looking out over open water, fishing, hiking along pond shorelines and playing in the shallows of ponds.

Artist photo – Dave Sutherland

Wetlands and ponds, popular and uncommon, are at risk of being loved to death. Unintentional effects from people and their pets are common, especially around ponds where rare plants are susceptible to being crushed by foot traffic and use by wildlife can be decreased when people and dogs are actively enjoying these areas. Many people who visit ponds to give their dogs the opportunity to cool down or play in the water may not be aware that by creating muddy conditions in ponds amphibians and other aquatic life may be unable to feed or survive. Taken alone, each visit may not produce a large effect, but given the levels of visitation and the number of dogs entering and leaving ponds significant cumulative impacts on shoreline vegetation and water quality can occur. Dogs, when not controlled by their guardians, also disturb and chase wildlife. OSMP will integrate information about the Grassland Plan targets with recreational desires to determine how best to provide enjoyable access and conservation through the Trail Study Area process.

Riparian Areas

OSMP has included creeks with the riparian area target because these two elements share many key attributes, face very similar conservation issues and are likely to require similar conservation strategies.

Background and Setting

Riparian areas are characterized as transitional between permanently saturated wetlands and upland terrestrial areas. Riparian areas typically occur adjacent to creeks and rivers or along the shorelines of lakes and reservoirs. Historically, the most widespread riparian areas in the planning area were found along the larger creeks (Boulder Creek, South Boulder Creek, and Coal Creek) where overbank flood events occurred. Smaller riparian areas are also distributed along numerous intermittent creeks and drainages where flood flows are uncommon but elevated ground water levels support riparian vegetation. Riparian areas occurring outside the large or small floodplains are either associated with irrigation ditches or springs. There are about 1,200 acres of OSMP managed lands mapped in this target. Riparian areas make up about two percent of the land cover in the arid west, and about five percent of the Grassland Planning Area (**Figure 10**).

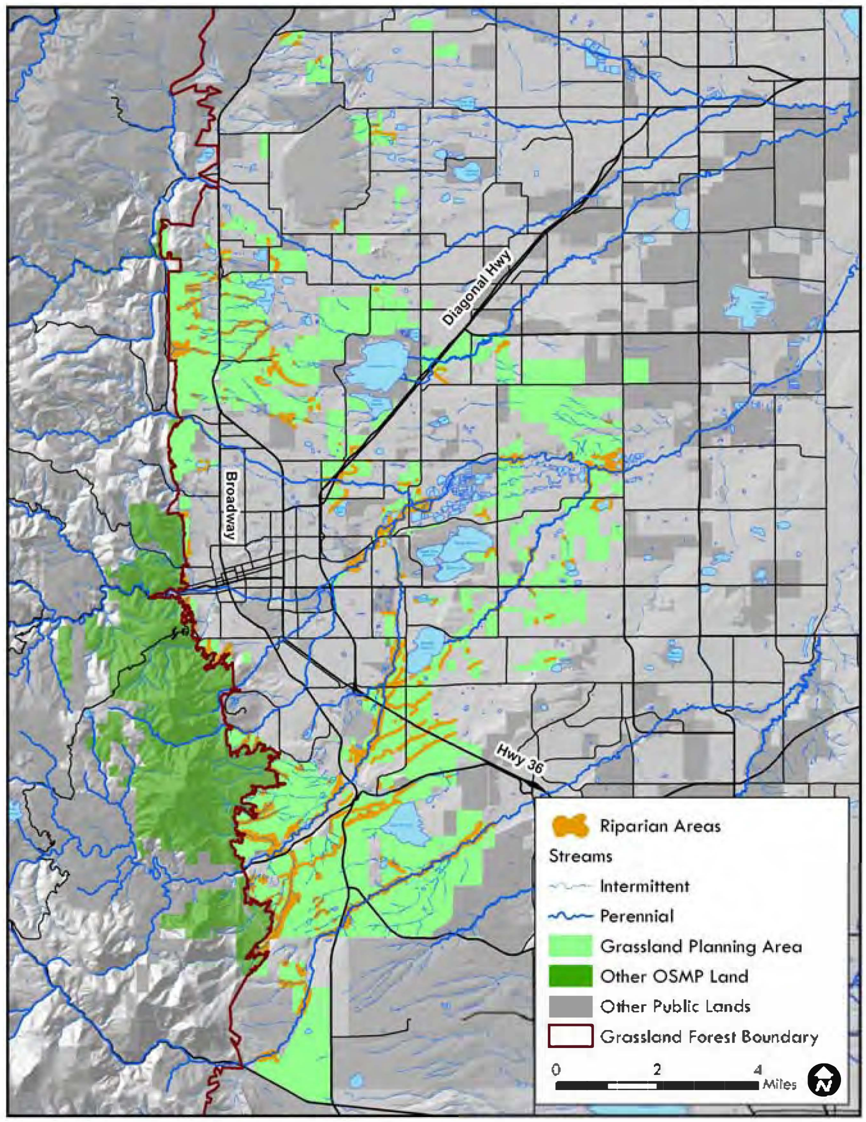


Figure 10 : Riparian Areas in the Grassland Planning Area

This relatively large proportion of riparian land cover is at least in part due to Boulder's intentional acquisition of open space to prevent development on floodplains.

Riparian areas on OSMP reflect the changing environmental gradients from the foothills to the plains. Foothills creeks characterized by high gradient channels and dominated by gravel and cobble substrates gradually give way to slower flowing, lower gradient streams with sandy sediments.

The composition of plant and animal species inhabiting riparian areas changes along this elevational gradient.

Composition

Riparian areas are typically dominated by woody vegetation, either trees or shrubs. In forested riparian areas, narrowleaf cottonwood dominates the higher elevation sites. Plains cottonwood and peach-leaved willow dominate the overstory along lower gradient creeks further east. A hybrid of the two cottonwood species is found in the transition zone. A similar pattern is repeated beneath the tree canopy as composition of the shrub and herbaceous layers shift from montane to plains species. Diverse topography, soil conditions and gradients of available moisture along an east-west continuum sustain a wide range of plant species.

Riparian areas dominated by shrubs occur where soil moisture is not high enough to support the establishment and survival of trees. Riparian shrublands are common along intermittent drainages and in small depressional basins in the northern Boulder Valley and along ditches and small creeks throughout the planning area. Willows are typically the dominant shrub in these systems.

Some plant communities that are found in OSMP riparian areas are particularly uncommon and considered imperiled in Colorado. The Narrowleaf Cottonwood / Bluestem Willow Woodland plant association is found only along foothills streams of the Colorado Front Range and in the Rio Grande Valley of New Mexico. The Red Hawthorn plant association was described in a 1998 report by CNHP on the South Platte and Republican River Basins as being known from Colorado only along Coal Creek; it has not yet been formally recognized by NatureServe.


Cottonwoods

Although they comprise less than two percent of the state's land cover, riparian areas supply habitat for approximately 80 percent of birds, mammals, reptiles, amphibians and fish native to Colorado (Knopf 1985). Many of these species depend almost entirely on these streamside and aquatic habitats for their survival. Several examples of these riparian species are found in the Grassland Planning Area including the federally threatened Preble's Meadow jumping mouse (Preble's) and Ute ladies'-tresses orchid. Although found in streamside forests, the largest populations of the orchid are in low-lying irrigated floodplain meadows. Preble's is found in riparian vegetation along creeks and ditches surrounded by irrigated floodplain meadows.

Foothills riparian shrublands support the highest breeding bird densities of any OSMP ecosystem. Several breeding bird species of foothills shrub patches are shrub specialists, including green-tailed towhee, Virginia's warbler, lazuli bunting and blue-gray gnatcatcher. Riparian areas also support nesting long-eared owls, considered rare and declining in Boulder County.

Creeks support habitat for aquatic organisms including a variety of native and non-native fish, amphibians and invertebrates. Creeks in the planning area support a number of uncommon or rare fish species including brassy minnow, northern red belly dace, common shiner, plains topminnow and orange-spotted sunfish.

The northern leopard frog is a Colorado Species of Special Concern (see note p 35). Despite recent population declines, leopard frogs are still found in a number of aquatic habitats on OSMP including Boulder Creek, South Boulder Creek and Coal Creek. Although the native mollusks (cylindrical papershell and umbillicate sprite) have not been recorded from OSMP, aquatic habitat exists for these species of concern.

Ecological Processes

The major ecosystem processes influencing riparian areas is the availability of moisture, grazing and periodic flooding (by both overbank flows and irrigation). These factors have changed significantly since European settlement. Water diversions and impoundments have had the direct effect of de-watering creeks, thereby altering the extent, composition and structure of riparian vegetation. The redistribution of water has created riparian vegetation in formerly dry areas along ditches and in areas where irrigation water accumulates. Reduced flows have also reduced or eliminated flooding, which in turn has altered patterns of erosion and deposition needed for riparian vegetation establishment and succession. The lack of flooding, and perhaps fire suppression, may be responsible for development of continuous stands of riparian forests, where in the past creeks may have been characterized by smaller stands of trees interspersed with herbaceous or shrub vegetation.

Streambank stabilization and channelization projects have also reduced riparian extent and changed aquatic habitat. In pre-settlement times, periodic, intense grazing by native ungulates probably occurred from time to time in riparian areas. With European settlement and the concurrent extirpation of many native ungulates, riparian areas were grazed by domestic livestock. This likely resulted in prolonged and intense grazing regimes outside the range of natural variability. Agricultural practices have also resulted in changes to water quality from the runoff of soil, manure and agricultural chemicals. Irrigation practices introduced water to some areas in greater amounts and made water locally available later in the growing season than under previous conditions.

The riparian areas in the Grassland Planning Area have been negatively impacted by incompatible agricultural practices, gravel mining, road construction, residential, commercial and industrial development as well flood management and water development projects. Consequently, properly functioning (in the sense of Prichard et al. 1993, 1994) foothills transitional and plains riparian systems are rare along the Colorado Front Range, and in the Boulder Valley (Wohl 2001).

Riparian Areas and OSMP Visitors

The gentle topography, presence of water, and availability of shade have made riparian areas among the most popular locations for recreational trails on the OSMP land system. These areas provide popular and desirable recreational opportunities. In addition to passive recreational use of riparian areas, community members have shown a strong appreciation for the importance of riparian area restoration. Open Space and Mountain Parks has collaborated with interested community

photo- Rich Smith

members and volunteer organizations to improve habitat along several stretches of creeks.

As with ponds and wetlands, the attractiveness of creeks and riparian areas also puts them in danger from some of the unintended effects of recreation and access. Rare plants can be trampled and sensitive animals displaced from the areas they need to nest or feed. Dogs, when not under their guardians' control, also disturb and chase wildlife in riparian areas and can trample and kill riparian vegetation and cause the erosion of stream banks. The intensity of these effects varies with level of use and sensitivity of the area. OSMP is committed to integrating the Grassland Plan in the Trail Study Area process to ensure that visitor access provides enjoyment and appreciation where most appropriate.

White Rocks

Background and Setting

The White Rocks are a Boulder County natural landmark. The cliffs are named for outcrops of light colored Fox Hills sandstone exposed by wind erosion and the undercutting of Boulder Creek (**Figure 11**). The Fox Hills sandstone typically erodes soon after exposure to wind and water, and extensive outcrops are uncommon. The White Rocks is an unusual exposure of the Fox Hills sandstone because the formation persists here as massive 30-50 foot high cliffs.

The ecological interest of the White Rocks is related to its geologic origin. Many erosional alcoves and niches of varying sizes have formed in the soft sandstone of the cliff face. Intermittent flows across the surface of the exposure have formed shallow cracks in the surface of the rock. Steep gullies have formed along fault lines in the sandstone. The cliffs are surrounded by an area of "sandstone breaks" and sandy slopes derived from the erosion of the cliffs. The Fox Hills sandstone is an aquifer, and the White Rock cliffs are known to be a discharge zone. Seeps and springs are found along the cliff face and in the deeper gullies that run through the sandstone (Botham 1981).

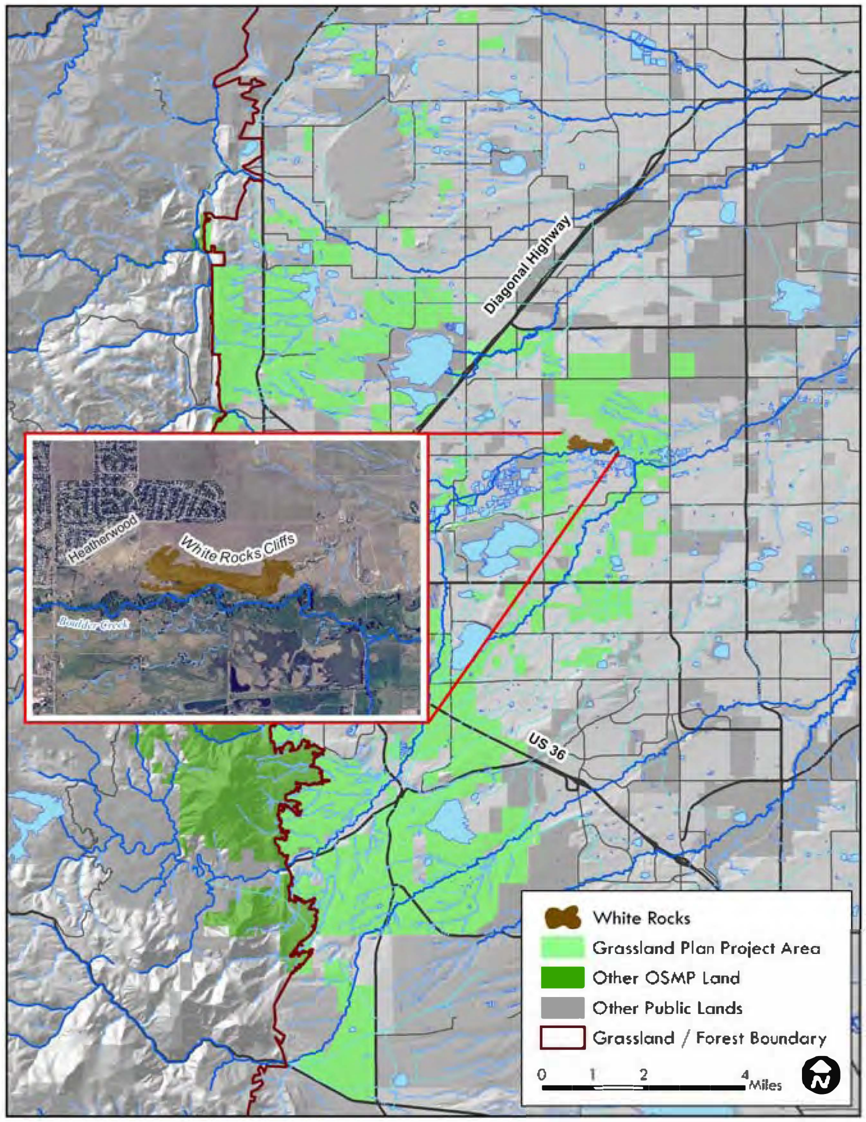


Figure 11 : White Rocks in the Grassland Planning Area

The White Rocks area is small. It occupies an area of approximately 60 acres about 5.5 miles (9 km) northeast of the center of Boulder. As such, it represents far less than one percent of the Grassland Planning Area. The exposure is limited to an area beginning just east of North 75th Street near Boulder Creek and extending eastward toward North 95th Street. The White Rocks cliffs are relatively narrow; their southern limit is the near vertical cliffs just north of Boulder Creek. The exposed surface is visible for less than ¼ mile to the north before disappearing under an overburden of soil and vegetation. The exposed horizontal surface of the sandstone is marked by distinctive polygonal cracks that form so-called "turtle backs" (Netoff 1971).

Composition

The unusual geologic substrate, southern exposure, shading from rock ledges and year-round availability of water all contribute to conditions capable of supporting vegetation more common in the sandy prairies of eastern Colorado (Weber 1948, 1983) and moister environments of northeastern North America. Two rare plant species grow in grotto-like conditions of a large alcove eroded in the cliff face. The black spleenwort is known from only a handful of widely separated localities in North America (Ranker et al. 1994). Another uncommon species found in the moist eroded alcoves, American groundnut is more common in the eastern deciduous forest. Groundnut is found no further west than Boulder County—where it occurs in moist and cool microclimates.


photo- Rich Smith

The cracks in the surface of the sandstone also provide habitat for a wide range of plant species (Clark et al. 2001). These include the fork-tipped threeawn known from very few sites in Colorado. The sandy soils and sandstone breaks around the cliffs provide ideal conditions for the growth of many High Plains plant species plants not found elsewhere near the White Rocks (Weber 1948). These include narrowleaf four-o'clock, silky sophora, lemon scurfpea and the plains black nightshade (Clark et al. 2001). Open Space and Mountain Parks ecologists have identified an uncommon species of bee balm at White Rocks as a sensitive plant species.

The steep soft cliffs, sandy substrate, and juxtaposition near Boulder Creek creates animal habitat not available elsewhere in Boulder County and uncommon throughout Colorado. For many years beginning in 1941, birders noted that the alcoves in the cliffs were among the only "natural" nest sites for barn owls in Boulder County (Stoecker 1972). Barn owls were confirmed at White Rocks in 1972 and from 1978 through 1985 (Thompson and Strauch 1987). Open Space and Mountain Parks staff has observed barn owls at White Rocks as recently as 1992. A survey of the area in 1998 found no barn owls (Jones 1998). The only local records of the six-lined racerunner are from beneath saltbush shrubs at the base of the cliffs.


Six-lined Racerunner photo - Kevin Johnson

The depressions in the hummocky surface of the White Rocks fill seasonally with water and support populations of fairy shrimp and an uncommon crawling water beetle (Bushnell 1983). Also associated with the soft sandstone of the White Rocks is a solitary bee that feeds upon prickly pear pollen and excavates its nests in the rock (Bennett and Breed 1985). When first discovered this species was thought to occur nowhere else (Custer 1928), but has been subsequently collected elsewhere.

A 1970 profile of the White Rocks also identified four rare ant species recorded from the area (*Aphaenogaster fulva, A. huachucana*, *Formica criniventris,* and *Lasius occidentalis*). *A. huachucana* is considered to be potentially globally imperiled according to the NatureServe database.

The White Rocks and People

Historical human land use of the area surrounding the White Rocks cliffs has been dominated by agricultural production. To the north where irrigation is impractical, the primary agricultural land use has been wheat and other small grains production. Irrigable lands to the south of the cliffs and subirrigated areas in the Boulder Creek floodplain have been used to raise hay and pasture grasses. Cattle have historically grazed the sandy breaks at the base of the cliffs and on the exposed rocky surface atop the cliffs.

In recognition of the value of the White Rocks as habitat for plant species uncommon in Colorado, a portion of the formation was designated a Colorado Natural Area in 1979. The City of Boulder owns conservation easements on the full extent of the White Rocks cliffs. From 1974 through the present, the City of Boulder has purchased land or acquired conservation easements near the White Rocks to protect the conservation values of the cliffs as well as the Boulder Creek floodplain and Gunbarrel Hill. Livestock grazing of the natural area has been reduced as part of OSMP's management of the conservation easement.

Chapter III: Viability Assessment

Chapter Summary
This chapter describes the current and acceptable conservation status for each target.

Targets can be described by *key attributes*. Key attributes are aspects of the target, which if altered, could result in the improvement, degradation or loss of the target over the next thirty years. Key attributes can be thought of as characteristics of the target's size, condition, or context in the landscape. *Indicators* are developed to measure, document the condition of and track the status of key attributes, and targets over time.

Successful conservation of the Grassland Plan targets requires an understanding of their viability status. Much like a doctor uses heart rate and blood pressure to evaluate the health of a patient, the viability assessment gives OSMP the ability to "take the pulse" of the Grassland Plan targets and assess the overall viability of the Grassland Planning Area.

Key Attributes

In order to assess the viability of the conservation targets, OSMP first identified a limited number of key attributes for each planning target. **Key attributes** are aspects of the target, which if altered, could result in the improvement, degradation or loss of the target. Key attributes relate to a target's size, condition, or landscape context. Examples of key attributes:

- Because of the importance of native plants and animals, vegetation composition or animal species composition are key attributes for the targets.
- Since fire has been important in the development of the grassland ecosystems, fire regime is a key attribute.
- Wetlands and riparian areas are dependent upon water; consequently, hydrologic regime and water quality are key attributes for these systems.

The key attributes developed for the Grassland Plan targets are listed in **Table 2**. Details about the selection of key attributes in the Grassland Plan can be found with the other viability assessment information in **Appendix D.**

Table 2: Key attributes of Grassland Plan targets

Target	Key Attributes
Mixedgrass Prairie Mosaic	Animal Species Composition Block/Complex Size Fire Regime Habitat Effectiveness Vegetation Composition Vegetation Structure
Xeric Tallgrass Prairie	Animal Species Composition Block/Complex Size Fire Regime Vegetation Composition Vegetative Structure
Mesic Bluestem Prairie	Animal Species Composition Fire Regime Vegetation Composition Vegetation Structure
Agricultural Operations	Agricultural Production Animal Species Composition Physical And Chemical Soil Regimes Vegetation And Soil Conditions
Black-Tailed Prairie Dog & Associates	Animal Species Composition Block/Complex Size Prairie Dog Occupancy
Wetlands	Animal Species Composition Connectivity Hydrologic Regime Vegetation Composition Water Quality
Riparian Areas	Animal Species Composition Connectivity Habitat Effectiveness Habitat Structure Hydrologic Regime Vegetation Composition Vegetation Structure Water Quality
White Rocks	Animal Species Composition Block/Complex Size Vegetation Composition

Table 3: Grassland Plan Indicators and Conservation Targets (Key attributes as shaded rows)

	Mixedgrass Prairie Mosaic	Xeric Tallgrass Prairie	Mesic Bluestem Prairie	Agricultural Operations	Balck-tailed Prairie Dog & Associates	Wetlands	Riparian Areas	White Rocks
Agricultural Production								
Acres in agricultural production				X				
Irrigable land leased for agriculture				X				
Animal Species Composition								
Bird conservation score							X	
Fish index of biotic integrity							X	
Macroinvertebrate index of biotic integrity							X	
Management of class A and class B bobolink nesting habitat				X				
Native frog presence						X	X	
Number of colonies with successful burrowing owl nests					X			
Predator community composition/abundance					X			
Percent occurrence of grassland dependent & sensitive lepidopterans (2)	X (2)	X (2)	X (2)					
Percent of colonies with territorial horned larks					X			
Percent of target with acceptable bird conservation score	X	X						
Presence of barn owls								X
Presence of six-lined racerunner								X
Relative cover of host plants for skipper/butterfly species of concern		X	X					
Species richness of sensitve breeding birds			X					
Submerged aquatic nuisance species richness (see Vegetation Comp.)							X (0.5)	
Block/Complex Size								
Size/distribution of blocks	X	X						X
Acres occupied by prairie dogs					X			
Connectivity								
Buffer width						X	X	
Distance to nearest wetland/riparian area						X	X	
Undesignated trail density in northern leopard frog habitat blocks						X	X	
Impediments to fish passage (#)							X	
Fire Regime								
Percent of target area experiencing an appropriate fire return interval	X	X	X					
Habitat Effectiveness								
Proportion of habitat blocks over 100 ha with singing male grasshopper sparrows	X							
Number of active bald eagle nest sites							X	
Habitat Structure								
Physical instream and riparian metric							X	
Hydrologic Regime								
Instream flow							X	
Number of over-bank flooding events							X	
Physical and Chemical Soil Regimes								
Percent soil organic matter				X				
Prairie Dog Occupancy								
Percent of total occupied land in protected status					X			
Percent of grassland preserves with occupancy between 10 and 26%					X			
Vegetation and Soil Conditions								
Percent of grazed areas in good condition according to an integrated measure of range quality				X				
Vegetation Composition								
Abundance of black spleenwort								X
Management of Ute ladies-tresses orchid habitat			X			X		
Percent of target dominated by exotic species	X	X	X			X	X	
Percent of target with prevalence of exotic species	X	X	X			X	X	
Native species relative cover	X	X	X			X	X	
Native species richness	X	X	X					
Presence of local suite of rare species								X
Presence of populations of Ute ladies-tresses orchid			X			X		
Size of grassyslope sedge populations		X						
Size of of Bell's twinpod populations	X							
Size of of dwarf leadplant populations		X						
Size of prairie violet population		X						
Richness of selected conservative plant species	X	X	X					
Submerged aquatic nuisance species							X (0.5)	
Vegetation Structure								
Absolute cover bare ground	X	X	X					
Cottonwood regeneration							X	
Water Quality								
Total phosphorus						X	X	
Dissolved oxygen							X	
Secchi disk depth						X		

Indicators

The next step in assessing viability was to develop indicators to track the status of the target over time. **Indicators are entities that are measurable and specifically related to a key attribute.**

Criteria for a Good Indicator
(from TNC 2007)

1. **Measurable:** The indicator can be assessed in quantitative or discreet qualitative terms by a procedure that produces reliable, repeatable, accurate information.
2. **Precise & Consistent:** The indicator means the same thing to all people and does not change over time (although status of indicator is expected to change).
3. **Specific:** The indicator is unambiguously associated with the key attribute of concern and is not significantly affected by other factors.
4. **Sensitive:** The indicator shows detectible and proportional changes in response to changes in threats or conservation actions.
5. **Timely:** The indicator detects change in the key attribute quickly enough that you can make timely decisions on conservation actions.
6. **Technically Feasible:** The indicator is one that can be implemented with existing technologies, not one that must await some big future conceptual or technological innovation.
7. **Cost Effective:** The indicator should provide more or better information per unit cost than alternatives.
8. **Publicly Relevant:** The indicator should be useful for publicly communicating conservation values and progress to the community.

Examples of indicators for key attributes:

- Native plant relative cover is an indicator for "vegetation composition"
- Time between fires (fire return interval) for "fire regime"
- Discharge or "instream flow" rate of a creek for "hydrologic regime"
- Total phosphorus, dissolved oxygen and Secchi disk depth for "water quality"

The indicators and associated key attributes for the Grassland Plan are listed in **Table 3.** The rationale and justification for these indicators are included in **Appendix D.**

Acceptable Range of Variation

The attributes of ecological systems and agricultural operations fluctuate over time. Much like a person can be healthy within a range of body temperatures or pulse rates, a target will persist over time within some range of variation in a key attribute. Outside "healthy" limits a person becomes sick and may eventually die. Similarly, a target is degraded and potentially destroyed when a key attribute falls outside its indicators' acceptable range of variation (ARV).

There are few references for the standard key attributes and ARV's for ecological and agricultural targets. OSMP staff developed the Grassland Plan ARVs based upon best available data, general ecological concepts, professional experience and recommendations and opinions from experts. In some cases, there was little or no baseline data, little published research and few experts to provide guidance. In such cases, ARV's were based upon OSMP staff's best professional judgment. All the ARVs should be considered credible first iterations subject to change with the experience gained from plan implementation.

It is also worth noting the use of *acceptable* rather than *natural* ranges of variation. This distinction is made purposefully to avoid the need to define "natural conditions" and communicate that the ARV recognizes that OSMP will be considering factors beyond the department's direct control such as surrounding land use, large scale ecological changes (climate change, atmospheric deposition), persistent non-native species, other OSMP management objectives, etc.

Viability Ratings

A simple four rating system is used to communicate the status of the indicators. The two higher ratings, "Good" and "Very Good", are used when the indicator measurement is within the ARV. The two lower ratings are used when the measurement is outside the ARV. "Very Good" is used to describe the most desirable state, where little management intervention is required on an ongoing basis. In other words, the indicator is measuring a key attribute that appears to be self-sustaining. "Good" refers to measurements that fall within the ARV, but are not self-sustaining, so some management is needed. "Fair" reflects a situation that requires management, but can be restored to a "Good" or "Very Good" rating with reasonable effort. "Poor" ratings describe a situation in which improvement to "Good" or "Very Good" is unlikely and the loss of the target is likely without timely and intense intervention (**Table 4**). Indicators outside or trending outside of the acceptable range of variability reflect the need for management action.

Viability ratings are also used to communicate the status of the target and the entire planning area (by combining the targets). The process of computing these ratings is described in the CAP Handbook (TNC 2007).

Table 4: Viability ratings, their meanings and their relationship to acceptable range of variation (ARV)

Viability Rating	**Description**	
Very Good	Ecologically desirable status; requires little intervention for maintenance.	Within ARV
Good	Indicator within acceptable range of variation; some intervention required for maintenance.	
Fair	Outside acceptable range of variation; requires human intervention.	Outside ARV
Poor	Restoration increasingly difficult; may result in extirpation or loss of target.	

An example:
Table 5 shows that "Fire Regime" is a key attribute of the Mixedgrass Prairie Mosaic. The ARV is that greater than half (> 51%) of the target experiences fire no less frequently than one in 30 years and no more frequently than once in five years. The indicator selected for this attribute is the proportion of the target experiencing fire within this return interval. Detailed information describing the derivation of ARV and viability ratings for each indicator is available in **Appendix D.**

Table 5: Example from Grassland Plan showing relationship of indicator rating, acceptable range of variation and viability rating (after TNC 2007)

Target	Key Attribute	Indicator	Indicator Ratings			
			Poor	Fair	Good	Very Good
Mixedgrass Prairie Mosaic	Fire Regime	Percent of target area experiencing a 5-30 year fire return	<25%	26-50%	51-75%	76-100%
					acceptable range of variation	

The next step in the viability assessment is to determine the current status and set the desired status of each indicator. The current status ratings reflect where the indicators and key attributes are now based upon best available information. In some cases, OSMP lacks the information to characterize current status.

Viability of Grassland Plan Targets

The section that follows contains the viability assessment for each target. The assessment is organized by key attribute grouping. These groupings are Size, Condition and Landscape Context.

- **Size** includes aspects of a target related to extent or number (e.g., 50 breeding pairs, or 1,000 acres)
- **Condition** refers to some aspect of structure, composition, or biotic interaction (e.g., animal species composition, density of vegetation, cover by bare ground, presence or diversity of predators)
- **Landscape Context** refers to aspects of the target that affect the movement of species, the impacts of surrounding lands, and target wide ecological processes such as fire, flooding, or grazing

Table 30 summarizes the viability ratings for the targets and the Grassland Planning Area. It can be found at the end of the chapter on page 77.

How are Targets, Attributes, and Indicators Related?

- **Targets** broadly define what we are planning for—those natural and agricultural resources that we are trying to protect, provide, and manage.
- **Attributes** define essential qualities or components of targets that, when present, result in long-term sustainability of the target. When these attributes are absent or are severely compromised, the target is no longer sustainable without significant management effort and could be lost completely.
- **Indicators** are quantitative and qualitative measures of the attributes; they are what we measure to track conditions of the attributes. One or more indicators are selected for each attribute. Indicators help us characterize existing and desired future conditions for the attributes and inform us of their status or health. Thresholds can be set for indicators to help identify at what point conditions are acceptable or within the range of desired conditions.

Examples:

Target	Attribute	Indicator
Mixedgrass Prairie Mosaic	Fire Regime	% of Target Experiencing Fire every 5-30 years
Black-tailed Prairie Dog and Associates	Prairie dog occupancy	Total area occupied by prairie dogs

Mixedgrass Prairie Mosaic

Size (Good)

Block size was selected as a key attribute for the Mixedgrass Prairie Mosaic. Size is an important aspect for assessing ecological integrity because larger blocks are better able to buffer against the impacts from surrounding land use than smaller patches. In addition, larger areas generally possess a higher diversity of species, and support more biotic and abiotic processes (e.g., fire, grazing, predation and soil forming processes). Habitat blocks with a diversity of species and processes are often more resilient and better able to recover from extremes in natural or new disturbances. The development of the Boulder Valley has decreased the size of habitat blocks and changed the landscape around the remnant patches of natural systems.

Mixedgrass Prairie Mosaic

Overall Viability Rank-Fair

Size-Good
Condition-Fair
Landscape Context-Fair

Larger occurrences (e.g., >5,000 acres) of mixedgrass prairie support a variety of vegetation types and are large enough to provide effective habitat for viable populations of grassland birds. Large patches of mixedgrass prairie provide interior habitat for edge-sensitive species. They also contain sufficient internal variability of slope, aspect, soil moisture and rockiness that result in variable effects from fire and grazing. Large blocks also provide more areas for a range of natural geomorphic disturbances (e.g., landslides, slumps and erosion) that create special habitats for plants and animals (Decker 2007a).

OSMP worked with the Colorado Natural Heritage Program (CNHP) to develop an Ecological Integrity Assessment (EIA) to help establish viability indicators for the Mixedgrass Prairie Mosaic Target. CNHP used the literature about the target as it occurs throughout North America to develop integrity (=viability) criteria for the Mixedgrass Prairie Mosaic.

The EIA's size-based integrity criteria were used by OSMP to answer the question, "How large are *acceptably* large habitat blocks?" "Good" condition was defined as maintaining at least one block of the target over 2,000 acres, but no blocks over 5,000 acres, and "Very Good" as multiple blocks over 2,000 acres or at least one block over 5,000 acres (**Table 6**).

Table 6: "Size" rating criteria for Central Mixedgrass Prairie (Decker 2007a)

Target	Excellent	Good	Fair	Poor
Mixedgrass Prairie Mosaic (Central Mixed Grass Prairie)	> 5,000 acres	2,000-5,000 acres	1,000-2,000 acres	< 1,000 acres

One patch of Mixedgrass Prairie Mosaic falls into the "Good" range. There are no patches of more than 5,000 acres. However, Boulder County Parks and Open Space, as well as the federal government maintain large blocks of relatively unfragmented mixedgrass prairie adjacent to or near OSMP lands (**Figure 12**). The presence of these conserved lands increases the ecological function of the adjacent OSMP grasslands. With coordinated management, these blocks represent significant opportunities for grassland conservation. The size rating information for this target is presented in **Table 7**.

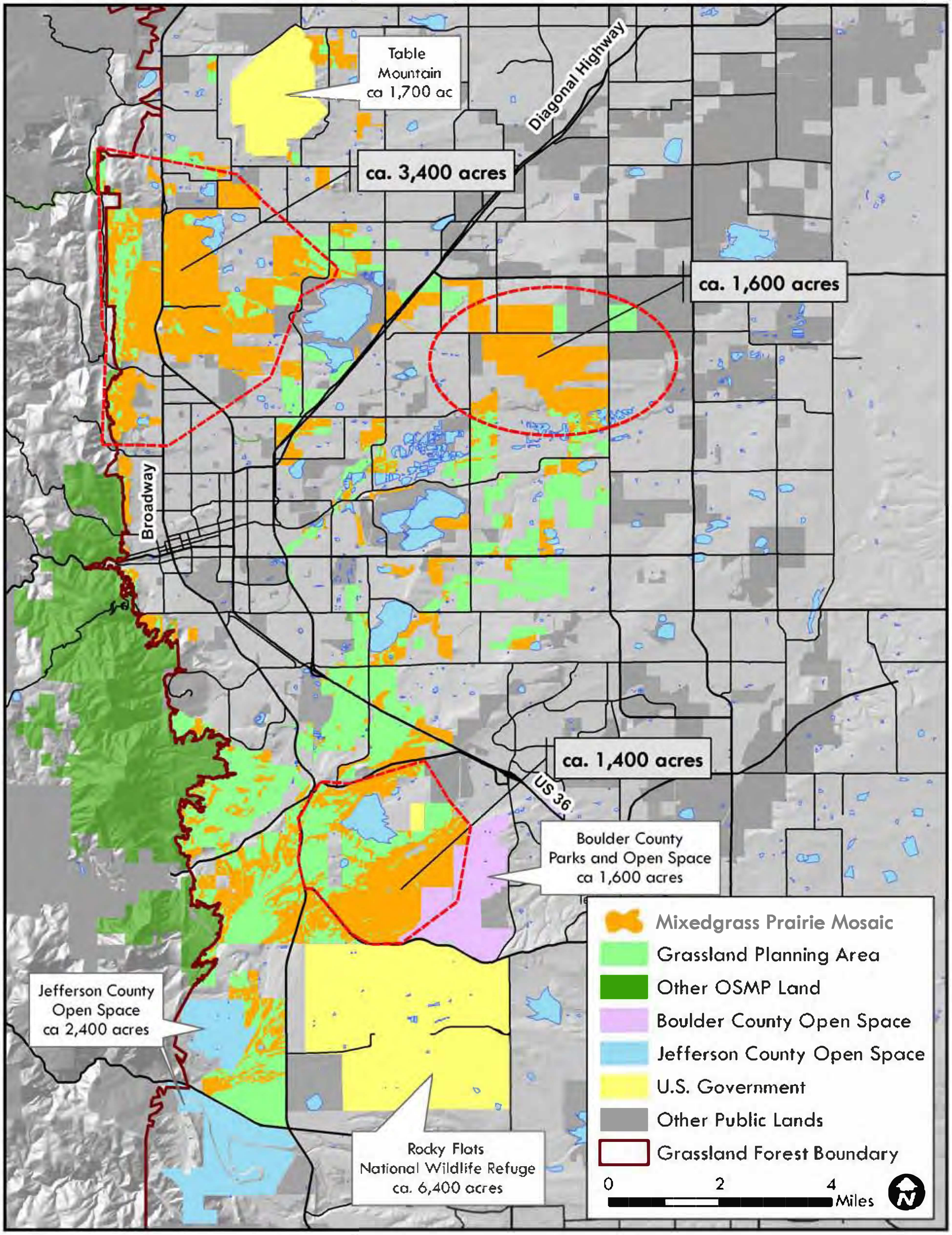


Figure 12: Largest patches of Mixedgrass Prairie Mosaic and nearby public lands with potential to support conservation of this target

Table 7: Key attribute, indicator and rating for the size of the Mixedgrass Prairie Mosaic

Key Attribute	Indicator	Rating
Block Size	**Size distribution of largest blocks**	**Good**

Note: Indicators in **bold** are considered within the acceptable range of variation. (Indicator rating details are included in **Appendix D.**)

Condition (Fair)

OSMP identified three key attributes and ten indicators of condition for the Mixedgrass Prairie Mosaic (**Table 8**). Two of those indicators, shown in bold, are considered within the range of acceptable variation. The remaining eight indicators fall outside that range. Overall, the Mixedgrass Prairie Mosaic is considered to be in "Fair" condition due to degradation of vegetation structure, vegetation composition and animal species composition.

Table 8: Key attributes, indicators and ratings for the condition of the Mixedgrass Prairie Mosaic

Key Attribute	Indicator	Rating
Vegetation Composition	**Size of Bell's twinpod populations**	**Very Good**
Vegetation Composition	**Percent of target dominated by non-native species**	**Good**
Animal Species Composition	Percent occurrence of sensitive butterflies and skipper species[9]	Fair
Animal Species Composition	Percent occurrence of grassland dependent butterflies and skipper species[9]	Fair
Animal Species Composition	Percent of target with acceptable bird conservation score[9]	Fair
Vegetation Composition	Native species relative cover	Fair
Vegetation Composition	Native species richness	Fair
Vegetation Structure	Absolute cover of bare ground	Fair
Vegetation Composition	Percent of target with prevalence of non-native species	Poor
Vegetation Composition	Richness of selected conservative plant species	Poor

Note: Indicators in **bold** are considered within the acceptable range of variation. (Indicator rating details are included in **Appendix D.**)

Western wheatgrass communities dominate this target. Western wheatgrass most commonly occurs on valley soils that are generally more susceptible to weed invasion than rocky pediment surfaces or upper hill slopes. Western wheatgrass communities also tend to receive higher grazing intensity by cattle than do the warm season-dominated plant communities that occur in steeper rocky areas. Prairie dogs also are commonly found in western wheatgrass communities. Higher grazing intensities by livestock and wildlife are associated with higher than acceptable levels of bare ground and, in turn, with the establishment and spread of non-native species.

Indicators like native conservative plant species richness and the bird conservation score are sensitive to management practices that homogenize natural systems. Livestock grazing can have this effect if the same number of animals uses an area repeatedly during the same season and for similar duration. Fire suppression or a regime that repeatedly burns the same area during the same season can also lead to ecological homogenization (MacDougall and Turkington 2007). Prairie dog occupation can provide localized or large patch-scale diversity; however, long-term occupation by prairie dogs across the entire extent of a target's occurrence can lead to a reduction of vegetation diversity and changes in habitat complexity.

[9] Habitat for insects is intermingled among the Mixedgrass Prairie Mosaic, the Xeric Tallgrass Prairie and the Mesic Bluestem Prairie. Consequently, the same rating was applied to the three targets. Similarly, habitat for birds is intermingled among the Mixedgrass Prairie Mosaic and the Xeric Tallgrass Prairie, and the same rating was applied to the two targets.

The overall current condition of the target may reflect the inherently lower resistance and resilience of the prevailing western wheatgrass cover, fire suppression as well as current and historic grazing by livestock and prairie dogs.

Landscape Context (Fair)

Habitat block effectiveness and fire regime are the two attributes identified for the landscape context of the Mixedgrass Prairie Mosaic. The landscape context rating for the target is "Fair" because the fire return interval falls outside of the range of acceptable variation. Habitat effectiveness has not yet been measured. The indicators and ratings are given in **Table 9.**

Table 9 **:** Key attributes, indicators and ratings for the landscape context of the Mixedgrass Prairie Mosaic

Key Attribute	Indicator	Rating
Fire regime	Percent of target area experiencing a 5-30 year fire return	Fair
Habitat Effectiveness	Proportion of habitat blocks over 247 acres (100 hectares) with singing male grasshopper sparrows	Not Rated

In the past, fire has been a primary driver of the mixedgrass prairie. In addition to fires caused by lightning strikes, there is strong evidence that native people set fires regularly for a variety of purposes (Bragg and Steuter 1996). Fire is known to affect nutrient cycling, prevents woody species encroachment, and is required for seed germination in some grassland species. In the absence of fire, litter increases and prevents nutrients from being available to plants; the prevalence of germination sites declines; plant species richness and vigor declines; ground nesting bird habitat declines; and woody species establish and expand in cover. Some non-native species may be able to invade declining plant communities where the fire regime is outside the acceptable range of variation.

Olde Stage Road Fire (2009) photo- Christian Nunes

The climate of the Northern Front Range Foothills and much of the northern Great Plains is characterized by alternating wet and dry periods, typically lasting for several years each. Fuel likely accumulated during the wet periods creating conditions suitable for fires during periods of prolonged drought. Based on fire frequency estimates derived from nearby forests, past fires probably burned large areas of foothills grassland communities at least every 30 years (Sherriff and Veblen 2007). However, studies for the Great Plains (summarized in Wright and Bailey 1982) suggest that on level-to-rolling topography, fire return intervals may have been more frequent, as often as five to 10 years. Wendtland and Dodd (1992) found less frequent fire return in more topographically diverse terrain. Decker (CNHP 2007a) states that using the Fire Regime Condition Class (Hann et al. 2003) the Central Mixedgrass Prairie falls in Fire Regime Condition Class II, with a fire return interval of 0-35 years. Based upon these sources, OSMP set an acceptable range of variability for the indicator at over 50 percent of the target area experiencing a five to 30 year fire return interval.

Currently in the GPA, fires do not burn as frequently or affect as large areas as they did before European settlement. Much of the surrounding prairie has been converted to agriculture and urban land uses. Once converted, these areas are no long effective sources of wildfire. Prescribed fires tend to be small because of containment and safety concerns. Wildfires, especially those that occur during windy conditions can spread quickly; however, these fires are often contained by roads, irrigation ditches, and are typically suppressed by emergency responders. Based upon best available information OSMP estimates that only 26% of this target has experienced a 5-30 year fire return.

Habitat effectiveness reflects the land's actual ability to support particular species or groups of species—in this case area- or edge-sensitive grassland animals. OSMP intends to use the breeding behavior of grasshopper sparrows as an indicator of combined blocks of prairie larger than 247 acres (100 hectares) (Delisle and Savidge 1996, Miller and Hobbs 2000, Miller et al. 1998). "Prairie" in this case refers to the complex formed by the Mixedgrass Prairie Mosaic, Xeric Tallgrass Prairie and Mesic Bluestem Prairie targets. Since human activity can reduce effective block size, a buffer of 656 ft (200 meters) along roads and urban areas (Bock et al. 1999) and 328 ft (100 meters) along trails (Davis 2004) was excluded from the block size calculations. Riparian areas also reduce block size, so riparian areas over 66 ft (20 meters) wide were excluded from block size calculations. OSMP has identified 18 prairie blocks larger than 247 acres. No buffers were placed around agricultural land uses as part of this model. No data has yet been collected on the presence of grasshopper sparrows.

Xeric Tallgrass Prairie

Size (Fair)
As with the Mixedgrass Prairie Mosaic, block size was also identified as a key attribute for the Xeric Tallgrass Prairie. The block-size rating criteria developed by CNHP (Decker 2007b) for this target are shown in **Table 10.** "Good" condition was defined as having at least one block over 5,000 acres, but no blocks over 10,000 acres and "Very Good" as multiple blocks over 5,000 acres or at least one block over 10,000 acres (**Table 11**).

Xeric Tallgrass Prairie

Overall Viability Rank-Fair

Size-Fair
Condition-Fair
Landscape Context-Fair

Table 10: "Size" rating criteria for the Xeric Tallgrass Prairie (Decker 2007b)

Target	Excellent	Good	Fair	Poor
Xeric Tallgrass (Western Great Plains Foothill and Piedmont Grassland)	>10,000 acres	5,000-10,000 acres	1,000-5,000 acres	< 1000 acres

Xeric tallgrass covers about 5,650 acres of the GPA with the largest patch measuring about 2,300 acres (**Figure 13).**

Jefferson County, Boulder County, and the federal government maintain large blocks of habitat adjacent to or near OSMP Xeric Tallgrass Prairie parcels. Some of these areas may support Xeric Tallgrass Prairie and, with compatible management, could contribute to the creation of a block large enough to fall within acceptable range of variability with a "Good" rating.

Table 11: Key attribute, indicator and rating for the size of the Xeric Tallgrass Prairie

Key Attribute	Indicator	Rating
Block Size	Size distribution of largest blocks	Fair

Condition (Fair)

The three key attributes and 13 indicators used to assess the viability of the Xeric Tallgrass Prairie are listed in **Table 12.** Five of those indicators, shown in bold, are considered to be within the range of acceptable variation. The overall condition of the Xeric Tallgrass Prairie is considered to be in "Fair" condition due to degradation of vegetation composition, vegetation structure and animal species composition as reflected by the seven indicators that fall outside the range of acceptable variation.

Table 12 : Key attributes, indicators and ratings for the condition of the Xeric Tallgrass Prairie

Key Attribute	Indicator	Rating
Animal Species Composition	**Relative cover of host plants for skipper/butterfly species of concern (big bluestem and little bluestem)**	**Good**
Vegetation Composition	**Percent of target dominated by non-native plant species**	**Good**
Vegetation Composition	**Size of dwarf leadplant populations**	**Good**
Vegetation Composition	**Size of grassyslope sedge populations**	**Good**
Vegetation Composition	**Size of prairie violet/bird's foot violet populations**	**Good**
Animal Species Composition	Percent occurrence of sensitive butterflies and skipper species	Fair
Animal Species Composition	Percent occurrence of grassland dependent butterflies and skipper species	Fair
Animal Species Composition	Percent of target with acceptable bird conservation score	Fair
Vegetation Composition	Native species relative cover	Fair
Vegetation Composition	Native species richness	Fair
Vegetation Composition	Percent of target with prevalence of non-native plant species	Fair
Vegetation Composition	Richness of selected conservative plant species	Fair
Vegetation Structure	Absolute cover of bare ground	Fair

Note: Indicators in **bold** are considered within the acceptable range of variation. (Indicator rating details are included in **Appendix D.**)

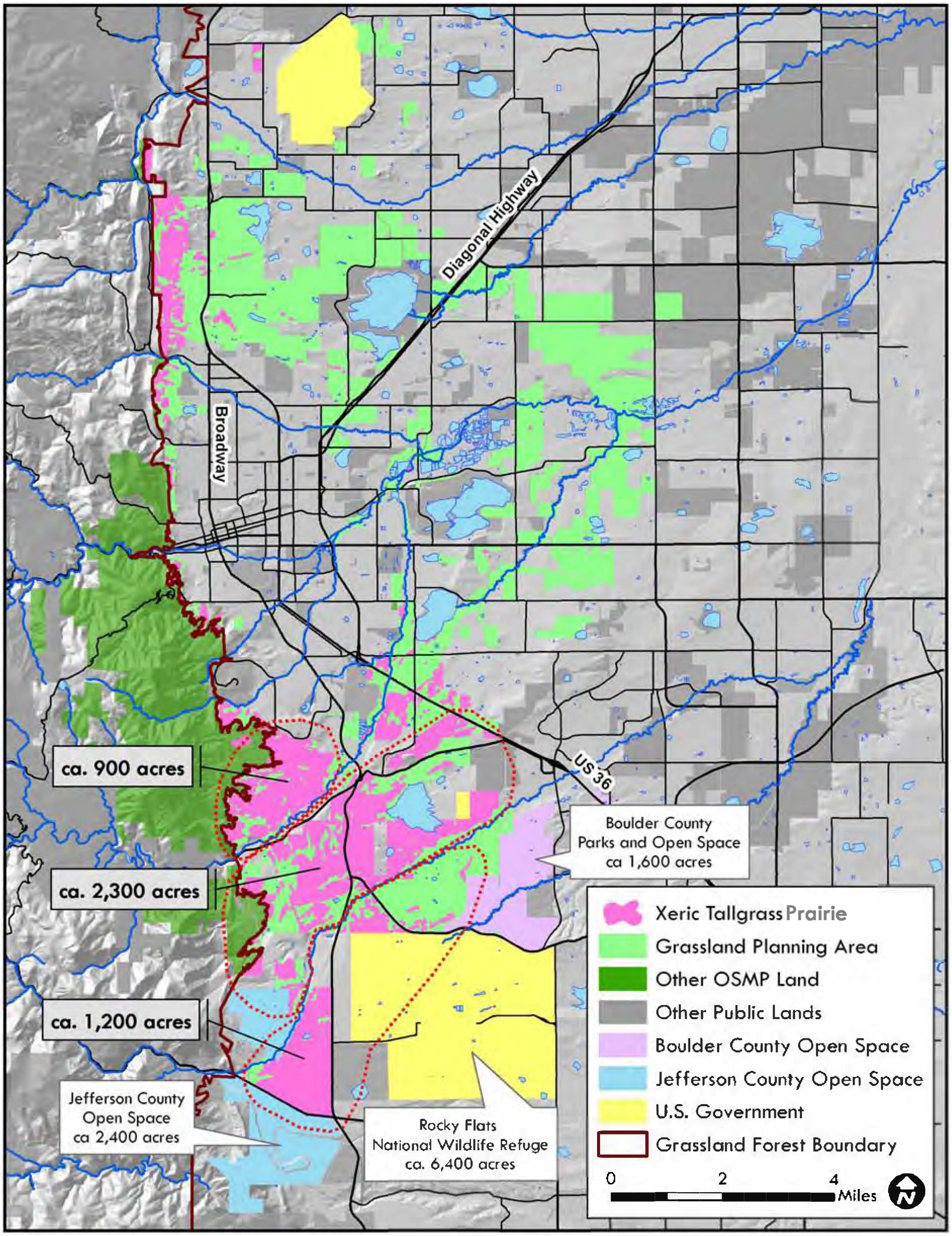


Figure 13: Largest patches of Xeric Tallgrass Prairie and nearby public lands with potential to support conservation of this target

Population levels of three indicator rare plants (**Figure 14)** are rated "Good", suggesting that conservation strategies are well matched to the level of threat facing these populations. Familiarity with the location of rare plant populations and the habitats preferred by these species allows OSMP to avoid or minimize site-specific impacts from trail construction, agricultural management and other activities.

Although less than two percent of the target is *dominated* by non-native plant species, weeds are prevalent[10] on one tenth of the target. This measure of prevalence was developed by OSMP as a possible early warning sign of degradation. Areas rated "Fair" or "Poor" for this indicator will be periodically assessed to determine if weed populations are decreasing, stable, or increasing. The prevalence of weeds is consistent with the other indicators of vegetation composition.

Figure 14: Rare plants indicators of the Xeric Tallgrass Prairie (a) dwarf leadplant, (b) grassyslope sedge, (c) prairie violet

While species-specific rare plant occurrence measures are rated "Good", general measures of the target's vegetation and animal species composition suggest that pervasive stresses were or are active across the Xeric Tallgrass Prairie. Higher than acceptable levels of bare ground and lower than acceptable bird conservation scores suggest that grazing and other processes that remove vegetation may be too intense, or timed during the wrong season to support grassland birds.

Landscape Context (Fair)
Fire regime, measured as fire return interval, is the sole key attribute associated with the landscape context of the Xeric Tallgrass Prairie. Fire is thought to have a similar history and play a similar role in Xeric Tallgrass Prairie as it does in the Mixedgrass Prairie Mosaic.

The threshold of acceptability was defined so that "Good" means that more half (50%) the target experienced the desired fire in 5-30 years. OSMP has maintained fire records for the past 18 years. Over this time, 1,600 acres in the Xeric Tallgrass Prairie have burned. Assuming a similar burn rates for the preceding 12-year period, slightly less than half of the Xeric Tallgrass Prairie has experienced a 5-30 year fire return. Alternatively, looking toward the future, a slightly higher burn rate is needed for more than half of the target to experience an acceptable fire return interval (**Table 13**).

Table 13: Key attribute, indicator and rating for the landscape context of the Xeric Tallgrass Prairie

Key Attribute	Indicator	Rating
Fire Regime	Percent of target area experiencing a 5-30 year fire return	Fair

[10] OSMP defined prevalent as between 6% and 50%, and dominant as over 50%.

Mesic Bluestem Prairie

Mesic Bluestem Prairie

Overall Viability Rank-Fair

Size-not rated
Condition-Fair
Landscape Context-Fair

Size (Not Rated)

OSMP did not develop size-related attributes to measure the conservation status of the Mesic Bluestem Prairie. OSMP staff considered some measure of "natural" or "pre-settlement" extent; however, staff could not identify a reliable method of making such an estimate. Staff also felt that the effects of restoring Mesic Bluestem Prairie to some previous extent required further analysis, especially a better understanding of the relationship between irrigated agriculture and the habitat needs of nested targets. OSMP considered selecting key attributes based upon the habitat patch-size requirements of nested plant and animal targets. However, too little is known about habitat size requirements of the nested plant species to develop meaningful size thresholds. Animals associated with the mesic tallgrass prairie are typically using a matrix formed of this target, surrounding wetlands, cultivated lands, and upland prairie, making it difficult to establish size-based attributes specific to the Mesic Bluestem Prairie.

Condition (Fair)

The three key attributes and 12 indicators used to assess the viability of the Mesic Bluestem Prairie are listed in **Table 14.** Five of those indicators are considered within the range of acceptable variation. The overall condition of the Mesic Bluestem Prairie is considered to be in "Fair", or below the threshold of acceptable variation because of degraded vegetation composition and animal species composition.

Table 14 : Key attributes, indicators and ratings for the condition of the Mesic Bluestem Prairie

Key Attribute	Indicator	Rating
Animal Species Composition	**Relative cover of host plants for skipper/butterfly species of concern (big bluestem and little bluestem)**	**Good**
Vegetation Composition	**Management of Ute ladies'-tresses orchid habitat**	**Good**
Vegetation Composition	**Percent of target dominated by non-native plant species**	**Good**
Vegetation Composition	**Presence of populations of Ute ladies'-tresses orchid**	**Good**
Vegetation Structure	**Absolute cover bare ground**	**Good**
Animal Species Composition	Percent occurrence of sensitive butterflies and skipper species	Fair
Animal Species Composition	Percent occurrence of grassland dependent butterflies and skipper species	Fair
Vegetation Composition	Native species relative cover	Fair
Vegetation Composition	Native species richness	Fair
Vegetation Composition	Richness of selected conservative plant species	Fair
Vegetation Composition	Percent of target with prevalence of non-native plant species	Poor
Animal Species Composition	Species richness of sensitive breeding birds	Not Rated

Note: Indicators in **bold** are considered within the acceptable range of variation. (Indicator rating details are included in **Appendix D.**)

Like the Xeric Tallgrass Prairie, the Mesic Bluestem Prairie exhibits "Good" ratings for rare plant related indicators—both in this case related to the Ute ladies'-tresses orchid. OSMP has worked to understand the role of pollination, grazing, mowing, and irrigation on the survival of this species through adaptive management and sponsored research (Arft 1995, Sipes and Tepedino

1995). Management over the past 20 years has successfully sustained populations in Mesic Bluestem Prairie and Wetlands.

Cover of bare ground falls within the range of acceptable variation. This contrasts with conditions in the Xeric Tallgrass Prairie and Mixedgrass Prairie Mosaic where cover by bare ground was found to be too high. Greater available soil moisture and higher levels of productivity are probably responsible for lower bare ground cover.

Although *dominance* by non-native plants is rated "Good", over 15% of the target has a *prevalence* of exotic plant species. The availability of moisture in the Mesic Bluestem Prairie creates conditions conducive to the establishment and growth of a number of aggressive weeds not found in the surrounding uplands. The prevalence of non-native plants is also reflected in the lower than acceptable species richness, relative cover of native plants and conservative plant richness in particular.

Mesic Bluestem Prairie supports populations of butterfly and skippers that are uncommon throughout their range. OSMP's grasslands represent an opportunity to conserve these species in the Southern Rocky Mountain ecoregion (Neely et al. 2001). OSMP staff considers the occurrence of sensitive and grassland-dependent butterflies to be too low. The relative cover of host plants for skipper/butterfly species of concern is just above the threshold of acceptability. Increased cover of the host plants may improve habitat for sensitive and grassland-dependent butterflies.

Landscape Context (Fair)
OSMP identified fire and hydrologic regimes as the key attributes for the Mesic Bluestem Prairie. As with the preceding targets, the fire return interval was selected as the indicator of an acceptable fire regime. A shorter return interval (5-10 years) was used for the Mesic Bluestem Prairie because higher rates of productivity replenish fuel loads more quickly in Mesic Bluestem Prairie (**Table 15**).

Table15 **:** Key attribute, indicator and rating for the landscape context of the Mesic Bluestem Prairie

Key Attribute	Indicator	Rating
Fire Regime	Percent of target area experiencing a 5-10 year fire return	Fair

No indicators or standards have yet been identified for the hydrologic regime. A system-wide hydrologic assessment could allow OSMP to develop meaningful size- and hydrology-based key attributes and indicators.

Agricultural Operations

Size (Good)
Agricultural production was identified as the sole size-based attribute of Agricultural Operations. OSMP identified two measures to assess the level of agricultural production: acres in production and the percent of irrigable land leased for agriculture (**Table 16**).

Agricultural Operations

Overall Viability Rank-Good

Size-Good
Condition-Fair
Landscape Context-Not Rated

Table 16 : Key attributes, indicators and ratings for the size of agricultural operations

Key Attribute	Indicator	Rating
Agricultural Production	**Acres in agricultural production**	Good
Agricultural Production	**Percentage of Irrigable land leased for agriculture**	Good

Note: Indicators in **bold** are considered within the acceptable range of variation. (Indicator rating details are included in **Appendix D**.)

OSMP currently leases approximately 14,600 acres for agricultural production. This acreage includes almost all irrigated lands, lands in dryland annual cropping systems, those lands that OSMP grazes prescriptively to achieve viability objectives for other targets, and other grazed properties. In addition, agriculture is the dominant use on approximately 3,000 acres of conservation easements protected by OSMP.

Agricultural lands protected by City of Boulder OSMP (fee ownership and easements) account for about 22% of the estimated 80,000 acres in agricultural use in Boulder County (Environment Colorado 2006). Together, the City and Boulder County account for about half the agricultural acreage in Boulder County. One estimate predicts that by 2020 there will be approximately 40,000 acres of land in agricultural use in Boulder County (Environment Colorado 2006). This amount is equal to the extent of land managed for agriculture by Boulder's city and county open space programs in 2008. It is not known whether existing open space agricultural lands alone could support a diverse and sustainable local agricultural economy.

From 1992-2002, most of the 28% decrease in agricultural land in Boulder County was caused by conversion of land to residential, commercial and industrial developments. Increasing land and water values put economic pressure on ranchers and farmers to sell their property. Urbanization also creates a greater number and variety of jobs—many less demanding than farming or ranching. This in turn reduces the availability of farm/ranch labor. Sale of agricultural land reduces the number of operating farms, and reduces the number of people farming thereby decreasing the demand for local businesses that support farming/ranching (i.e. feed stores, tractor parts dealers, farm equipment repair shops, etc.). These merchants and vendors then leave the area—making it more difficult for the remaining farmers and ranchers to obtain goods and services. With the reduction in number of farms and farmers, the local social network of farmers deteriorates reducing the amount of cooperation and availability of assistance. Agricultural producers who remain face challenges from their new neighbors, who are often unaccustomed to the noises, smells and other attributes of agricultural production. Urbanization can also lead to direct impacts to farmers through the trampling of crops, tampering with ditches, gates left open, theft and vandalism.

These factors can interact with each other to create a downward spiral in the number of agricultural operations and the extent of land in agricultural productivity. There is some thought that this feedback loop operates especially quickly once the amount of agricultural land in a region crosses a threshold. After crossing that threshold, the rate of loss of farmland accelerates. Where there is sufficient value or profit associated with a crop such as locally produced organic vegetables or ornamental flowers, agriculture land uses may persist and even increase. There is, unfortunately, no formula to calculate the "critical mass" for land in agricultural production. However, agricultural economists have noted that the rates of agricultural loss and amount of farmland in a county are directly related (Lynch and Carpenter 2003).

Irrigated parcels are the most agriculturally productive in the Boulder Valley. Under Colorado water law, if OSMP or any water right owner fails to use their water rights, those rights can be abandoned, partially abandoned, reduced by decree at the time of a water transfer, and/or reduced in value. Such a loss or reduction would represent unacceptable disposition of OSMP real property, and financial and opportunity costs for OSMP's land and water management programs. OSMP works in partnership with lessees to run water on departmental lands, and uses staff to run water on irrigated properties that are not currently leased. In order to maximize production and protect water rights, OSMP seeks to ensure that irrigable lands are leased to the maximum extent possible. Currently about 85% of irrigable, and nearly all irrigated lands, are leased for agricultural production.

Condition (Fair)

Condition ratings for Agricultural Operations (**Table 17**) are OSMP staff's best professional judgment. No quantitative data have been collected to characterize or estimate physical and chemical soil conditions. Open Space and Mountain Parks is also evaluating existing multi-metric indicators developed to assess grazing land soil stability, hydrologic function, as well as structural and functional resilience to disturbance (Gerrish 2004 and Pellant et al. 2000). OSMP staff has estimated conditions to be within the range of acceptable variation based upon experience with the methodology and familiarity with conditions on the ground.

Table 17: Key attributes, indicators and ratings for the condition for Agricultural Operations

Key Attribute	Indicator	Rating
Physical and Chemical Soil Regimes	**Percent soil organic matter**	**Good**
Vegetation and Soil Conditions	**Percent of grazed areas in good condition according to an integrated measure of range quality**	**Good**
Animal Species Composition	Management of bobolink nesting habitat	Fair

Note: Indicators in **bold** are considered within the acceptable range of variation. (Indicator rating details are included in **Appendix D**.)

Soil organic matter supports agricultural productivity. Organic matter is important as a source of plant nutrients, and improves soil structure, maintains soil aggregation and minimizes erosion. It is possible for grazing or other types of harvest to result in organic soil matter depletion faster than rates of accumulation. When soil organic matter removal exceeds plant growth and decomposition, long-term soil productivity decreases. When soil organic matter is not conserved, soils may degrade to a lower steady state. Restoring higher levels of productivity are often difficult and expensive. OSMP has not yet sampled percent soil organic matter on a regular basis or according to a protocol that would allow staff to estimate trends. However, the indicators use current conditions as a starting point, and include both "stable" and "increasing" levels of soil organic matter in the acceptable range of variation.

Bobolinks are ground-nesting songbirds that nest primarily in wet meadows in the Boulder Valley (Thompson and Strauch 1987). They are protected under the Migratory Bird Treaty Act and are considered "vulnerable to extirpation" ("S3B") by Colorado National Heritage Program and "rare breeding species" by the Boulder County Comprehensive Plan. Bobolink populations in the western United States are unique in that they are separated from the main breeding range of bobolinks further to the east (Hamilton 1962). Bobolinks originally nested in tallgrass or mixed-grass prairie of the mid-western United States and south-central Canada (Bent 1958), but because of land conversion, have now increased their use of irrigated hayfields throughout their range (Martin and Gavin 1995). The bobolink is of particular interest to land managers because of its extreme population decline during the past thirty years and its affinity to breed late in the summer when much of the mowing typically occurs (Martin and Gavin 1995). Bollinger et al.

(1990) documented a 90-100% failure rate of bobolink nests because of hayfield mowing. The consensus is that postponing mowing until July 15 allows for the majority of fledglings to be able to sustain flight and hence avoid mowing impacts (Thompson and Strauch 1987, Vierling 1997, Roeder 1998). The indicator for bobolink management refers to the proportion of high quality breeding habitat in grasslands on which mowing is deferred until after July 15, or the actual date of bobolink fledging as determined by monitoring.

Landscape Context (not rated)
Soil conditions and the availability of water have been the primary landscape drivers for agriculture in the GPA. Lands with productive soils and available water rights are considered most agriculturally significant. Maintaining agricultural uses in these areas was described as a viability factor for Agricultural Operations under "Size".

Although landscape context plays an important role in determining the type of agriculture likely to be found in the GPA, agricultural producers have been able to overcome landscape limitations and have used almost the entire Boulder Valley for agriculture at one time or another. Because there is such a wide range of acceptable conditions for agriculture, no landscape context-based key attributes were identified for the Agricultural Operations target.

Black-tailed Prairie Dog and Associates

Black-tailed Prairie Dog and Associates

Overall Viability Rank-Good

Size-Good
Condition-Good
Landscape Context-Fair

Size (Good)
OSMP staff identified "active prairie dog colonies" as a size-based attribute to track the viability of this target. The indicator for this attribute is the number of acres of active prairie dog colonies in the Grassland Planning Area (**Table 18**). OSMP maps the extent of active colonies annually. Due to resource and time constraints, the department does not count or estimate the numbers or density of individual animals or burrows as part of the annual mapping project. OSMP has conducted mapping of active prairie dog colonies since 1996.

The extent of prairie dogs in the GPA has fluctuated due to open space acquisitions, natural population growth, relocation, predation, disease—including plague and other sources of mortality (**Figure 15**). Although the extent of active prairie dogs colonies has declined precipitously in the GPA during periodic plague outbreaks, populations have repeatedly recovered due to a small number of survivors re-establishing colonies or migration of animals from surrounding unaffected colonies. OSMP has also relocated prairie dogs from outside the GPA into areas vacated by plague.

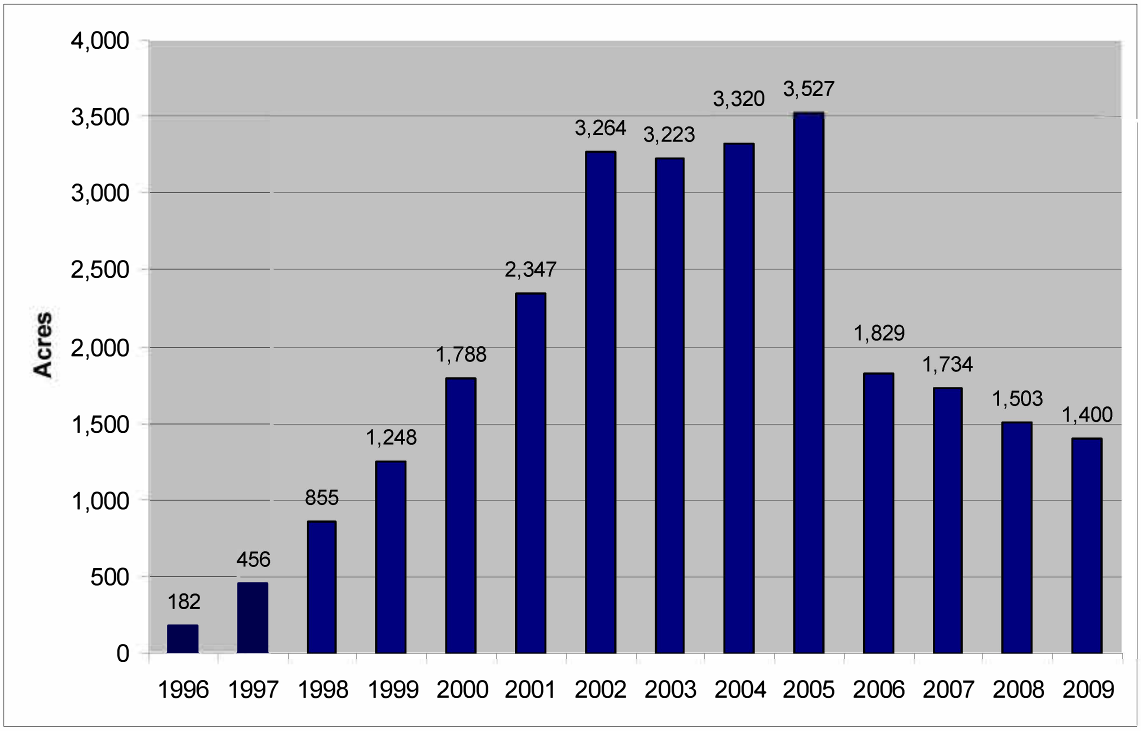


Figure 15: Extent of active black-tailed prairie dog acreage on OSMP lands (1996-2009)

Table 18: Key attribute, indicator and rating for the size of the Black-tailed Prairie Dog and Associates target.

Key Attribute	Indicator	Rating
Extent of active prairie dog colonies in the Grassland Planning Area	**Acres of active prairie dog colonies**	**Good**

Note: Indicators in **bold** are considered within the acceptable range of variation. (Indicator rating details are included in **Appendix D.**)

The size thresholds for the extent of active prairie dog colonies are based upon an analysis of the best opportunities to conserve this target[11]. One outcome of this analysis was the definition of five criteria-based management classifications for OSMP lands that had been occupied by prairie dogs at any time from 1996-2009. The categories are summarized in **Table 19.**

Table 19: Prairie dog management designations

Category	Management Focus
Grassland Preserve	Conservation of prairie dogs and their associated species in large and ecologically diverse grassland habitat blocks.
Multiple Objective Areas	Conservation of prairie dogs and their associated species is one of multiple management objectives.
Prairie Dog Conservation Areas	Conservation of the prairie dog is the primary management objective; associated species managed opportunistically.

[11] The analysis, classifications and the criteria used to define the best opportunities areas are described in detail in Chapter V-Best Opportunity Analysis.

Category	Management Focus
Transition Areas	Conservation of targets other than the prairie dog and associated community takes precedence—removal generally when relocation sites are available.
Removal Areas	Conservation of targets other than the prairie dog and associates incompatible with prairie dogs—management options include immediate removal.

In order to address concerns over the long-term sustainability of the Grassland Preserves, OSMP has established an acceptable range of variability for prairie dog occupancy within Grassland Preserves from 10-26%.

The minimum acceptable occupancy for prairie dogs was defined as ten percent of the Grassland Preserves or **800 acres.** The maximum acceptable occupancy in the planning area was defined as **3,137 acres** or the sum of:

- 26% of the acreage of Grassland Preserves 2,100 acres and;
- the total acreage of Multiple Objective Areas (MOA) 498 acres and;
- the total acreage of Prairie Dog Conservation Areas (PCA) 539 acres

Condition (Good)
Consistent with the intention to conserve wildlife associated with prairie dog activity, OSMP defined three indicators of animal species composition for this target (**Table 20**).

Table 20 : Key attributes, indicators and ratings for the condition of the Black-tailed Prairie Dog and Associates target

Key Attribute	Indicator	Rating
Animal Species Composition	**Number of prairie dog colonies with successful nesting attempts by burrowing owls**	**Good**
Animal Species Composition	Predator community composition/abundance	Fair
Animal Species Composition	Percent of colonies with territorial horned larks	Not Rated

Note: Indicators in **bold** are considered within the acceptable range of variation. (Indicator rating details are included in **Appendix D.**)

For the purposes of the Grassland Plan, two groups of animals were identified as associates of the black-tailed prairie dogs: commensals and predators. **Commensal species** are grassland obligates that benefit from the presence of prairie dogs and are not known to affect prairie dogs adversely. They are found more commonly on prairie dog colonies than on grasslands unaffected by prairie dogs (Koford 1958, Agnew et al. 1986, Haug et al. 1993, Desmond and Savidge 1996, Goodrich and Buskirk 1998, Kotliar et al. 1999, Kretzer and Cully 2001, Smith and Lomolino 2004). Prairie dogs colonies without associated species may contribute to the Grassland Plan's conservation objectives; however, OSMP considers the presence of these predators and commensal species to be an indication of greater ecological function. OSMP identified 18 associates of black-tailed prairie dog (**Table 21**).

Table 21: Commensal and predator species identified as black-tailed prairie dog associates. An asterisk (*) indicates associates that are rare or sensitive to fragmentation or human disturbance.

Commensals	*Predators*
13-lined ground squirrel	*American badger**
*Burrowing owl**	*Bald eagle**
Cottontail rabbit	*Bullsnake*
Deer mouse	*Coyote*
*Horned lark**	*Ferruginous hawk**
*Prairie tiger beetle**	*Golden eagle**
Tiger salamander	*Gray fox*
	*Northern harrier**
	Prairie rattlesnake
	Red fox
	Red-tailed hawk
	*Rough-legged hawk**

Burrowing owls are closely associated with both active and inactive prairie dogs towns and were historically common in Boulder County (Henderson 1909, Betts 1913). Burrowing owls numbers declined later in the 20th century (Alexander 1937) probably due to aggressive government sponsored prairie dog poisoning. Most recent accounts of burrowing owls in the county still rate them as uncommon or rare (Jones 1993, Jones and Mahoney 2003) with habitat fragmentation, winter mortality and the loss of suitable nesting habitat identified as the primary factors responsible for low numbers. Populations have been undergoing non-cyclical declines over several years in Boulder County. The burrowing owl is listed as a species of special concern in the Boulder County Comprehensive Plan and a species of local concern in the Boulder Valley Comprehensive Plan. The species is recognized as a threatened species by the state of Colorado. Although there has been no comprehensive monitoring program in the GPA, four successful burrowing owl nesting locations were identified on OSMP lands in 2008. Each was located on a prairie dog colony in a relatively large block of grassland habitat. Burrowing owls have also been observed elsewhere in Boulder County including sightings in 2006 and 2007 on adjacent Parks and Recreation Lands (although no nesting attempt was confirmed).


Burrowing Owls photo- Perry Conway

Raptor numbers have also declined with the loss of extensive prairie dog colonies because of residential and commercial development—especially development in Superior and Louisville. While bald eagles, golden eagles, northern harriers, red-tailed hawks, rough-legged hawks and ferruginous hawks all feed on prairie dogs, ferruginous hawks and golden eagles are most dependent upon prairie dogs. Rough-legged hawks winter in GPA, but breed further north. The planning area is within the breeding range of ferruginous hawk, but no nesting has been recorded in Boulder County. Given the abundance of prairie dog colonies in the largest blocks of grassland habitat, OSMP feels that the carrying capacity of the landscape could potentially support larger numbers of prairie dog specialists: burrowing owls and ferruginous hawks.

Breeding horned larks **prefer** short, sparsely vegetated areas, conditions commonly associated with occupied or recently abandoned prairie dog towns. The presence of horned larks is an indication of appropriate habitat conditions including prey availability. Horned larks are known to feed upon seeds and ground insects. The presence of horned larks is an indication of an active trophic system reliant upon environmental conditions created and maintained by prairie dogs. Thus, OSMP considers habitat supporting horned larks to provide a higher level of ecological function than prairie dog colonies where horned larks are absent. Horned larks are present on OSMP lands, but no data are currently available to characterize population levels or distribution.

OSMP has developed specific indicators of vegetation condition (bare ground, native species richness, relative cover of native perennial graminoid species and conservative species richness) to describe acceptable conditions in Grassland Preserves being considered as candidates for receiving relocated prairie dogs. These are not currently indicators for the condition of this target, but will be integrated as an early implementation step of the Grassland Plan.

Landscape Context (Fair)
The key attribute identified for the landscape context of the Black-tailed Prairie Dog and Associates target is the distribution of prairie dogs. OSMP defined two indicators of prairie dog distribution (**Table 22**). The first is the percentage of occupied acreage occurring in Grassland Preserves, Multiple Objective Areas (MOA) or Prairie Dog Conservation Areas (PCA). The acceptable range of variability is focused on ensuring that the majority of prairie dogs are found in areas of highest ecological and community compatibility (Grassland Preserve, MOA or PCA). Using 2008 mapping data 75% of occupied acres fall into one of these areas —placing this indicator in the range of acceptable variation with a "Good" rating.

The landscape context second indicator is the number of Grassland Preserves with prairie dog occupancy falling within the range of acceptable variability (10-26%) **(Figure 16**). Based upon 2008 mapping, only the southern grassland preserve falls within the range of acceptable variation (16% occupancy). The East and North Grassland Preserves are below the range at 1% and 2% respectively. These low levels of occupancy are related to a plague epizootic that began in 2005 and was still active in the Grassland Planning Area in 2009.

Table 22: Key attributes, indicator, and ratings for the landscape context of the Black-tailed Prairie Dog and Associates target

Key Attribute	Indicator	Rating
Prairie Dog Distribution	**Percent of occupied land in Grassland Preserves, Multiple Objective Areas and Prairie Dog Conservation Areas**	**Good**
Prairie Dog Occupancy	Grassland Preserves with occupancy between 10% and 26%	Fair

Note: Indicators in **bold** are considered within the acceptable range of variation. (Indicator rating details are included in **Appendix D.**)

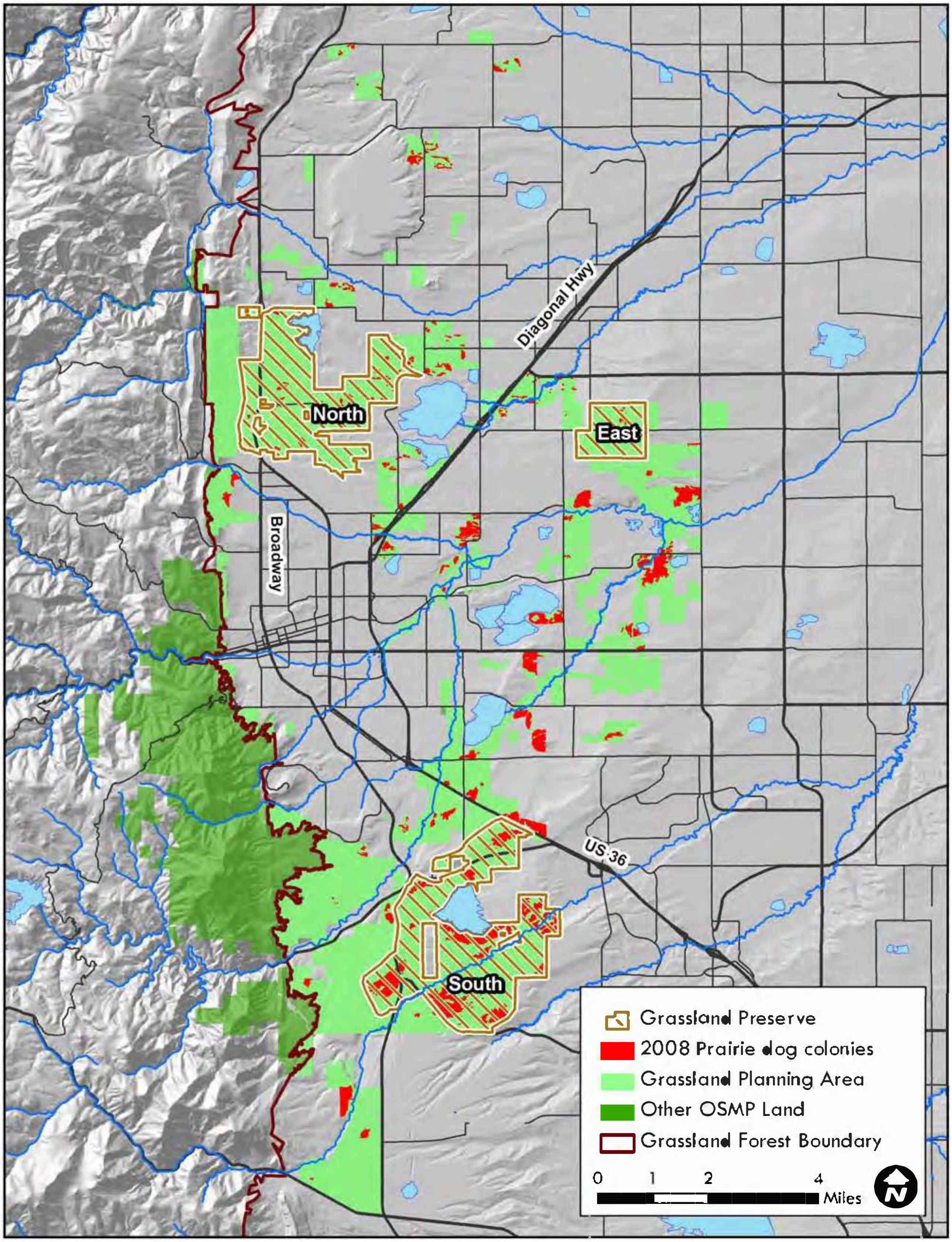


Figure 16: Prairie dog occupancy in Grassland Preserves

Wetlands

Size (Not Rated)
Wetlands, including ponds, like the Mesic Bluestem Prairie, occur as small-patches controlled by soil and hydrology. OSMP has not identified meaningful size-based attributes specific to wetlands.

Wetlands
(including ponds and lakes)

Overall Viability Rank-Fair

Size-Not Rated
Condition-Poor
Landscape Context-Fair

Condition (Poor)
OSMP identified three key attributes of wetland condition and eight indicators to assess the condition of Wetlands (**Table 23**).

Table 23: Key attributes, indicators and ratings for the condition of the Wetlands target

Key Attribute	Indicator	Rating
Vegetation Composition	**Management of Ute ladies'-tresses orchid habitat**	**Good**
Vegetation Composition	**Presence of populations of Ute ladies'-tresses orchid habitat**	**Good**
Vegetation Composition	Native species relative cover	Fair
Animal Species Composition	Native frog presence in suitable habitat	Poor
Vegetation Composition	Percent of target dominated by non-native species	Poor
Vegetation Composition	Percent of target with prevalence of non-native species	Poor
Water quality	Total phosphorus (for ponds)	Not Rated
Water quality	Secchi disk depth (for ponds)	Not Rated

Note: Indicators in **bold** are considered within the acceptable range of variation. (Indicator rating details are included in **Appendix D.**)

Two indicators for Wetlands are intended to track the condition of the Ute ladies'-tresses orchid. As described in the condition description for the Mesic Bluestem Prairie, OSMP has developed management scenarios that appear to be successful at supporting some populations of the orchid. The presence of orchids and the agricultural management practices that support them were rated "Good".

Wetlands, unlike the other Grassland Plan targets, exhibit both high levels of non-native species prevalence and dominance. Indicator ratings for both the prevalence and abundance of non-native species are far outside the range of acceptability (both rated "Poor"). Native plant species composition in OSMP wetlands has been especially degraded by the presence of common teasel, Canada thistle, and Russian olive. The dominance of introduced weeds is also reflected in the "Fair" rating of native species relative cover.


Northern Leopard Frog

Northern leopard frogs are experiencing dramatic population reductions throughout the western portion of their range. OSMP found leopard frogs in less than 30% of the wetlands and ponds surveyed as suitable habitat. OSMP seeks to have leopard frogs in at least half of areas identified as suitable habitat.

OSMP intends to develop indicators of bird species richness to reflect animal species composition more completely.

Landscape Context (Fair)
OSMP identified two key attributes for the Wetlands target, connectivity and hydrologic regime (**Table 24**). Three indicators were developed for connectivity. However, currently none has been developed for wetland hydrologic regime. Because wetlands and riparian areas have similar landscape context attributes (Rocchio 2006a, Rocchio 2006b), these indicators were applied to both targets.

The distance from one wetland to the next nearest neighboring wetland or riparian area was identified as an indicator because many wetland animal species rely upon patches of wetlands as stepping stones for movement and dispersal. Intervening agricultural areas, residential and commercial development, and even native upland habitat can be barriers for movement. Patch isolation affects a wide range of animal species (Lindenmayer et al. 2008, Haig et al. 1998). Island biogeography predicts habitat patches in proximity to other like patches will have greater species richness. Wetlands fall within the acceptable range of variation (rated "Good") for this target with over 75 percent of wetland complexes less than 656 feet (200 meters) from the nearest wetland or riparian area.

The second indicator of connectivity is the width of vegetated buffers around wetlands. Vegetated buffers enhance water quality by removing sediment, nutrients and pathogens; help attenuate fluctuation of groundwater; stabilize shorelines; provide refuges for wildlife during high water; provide movement corridors and foraging and nesting habitat; regulate the local microclimate and provide a physical barrier to light and noise (Sheldon et al. 2005, City of Boulder and Biohabitats 2007). Larger vegetated buffers provide a greater protection from degradation and increase the likelihood that the wetland will have long-term benefit as plant and wildlife habitat. Wetland buffer width fell outside the acceptable range of variability and this indicator was rated "Fair".

Undesignated trail density in northern leopard frog blocks is the third indicator of connectivity. Amphibians, especially northern leopard frogs forage at some distance from open water. While the amphibians present in the Grassland Planning Area have not been studied, researchers elsewhere have found that salamanders forage up to a quarter mile (400 meters) from the ponds

Ute Ladies-Tresses Orchid

THE UTE LADIES-TRESSES ORCHID is a long-lived perennial that reproduces strictly by seed. The flowers are pollinated by bumblebees (Sipes and Tepedino 1995). Ute ladies-tresses is a wetland plant designated as threatened under the Endangered Species Act (USFWS 1992). In Colorado, the orchid is restricted to low- elevation valleys in wetlands and irrigated fields. Within these sites, it is found only in specialized conditions of soil and hydrology.

Under current hydrologic conditions, small numbers of the orchid are found along South Boulder and Boulder Creeks, but the largest populations occur in the mosaic formed by Mesic Bluestem Prairie and wetlands where they are supported by agricultural practices. The sub-populations of the orchid on OSMP lands are among the largest and most important to the conservation of this species throughout its range. The orchid co-occurs with other uncommon forbs such as purple gerardia and great lobelia. Based upon the findings of various studies (Arft 1995, Riedel et al. 1995, Heidel 2001) OSMP has concluded that compatible agricultural management practices such as irrigation, winter grazing and hay cutting are important factors related to the long-term viability of the large orchid populations. In the absence of new threats, these, or other compatible, practices should support viability of the large sub-populations of the orchid found on OSMP lands.

Hydrologic Regime

THE HYDROLOGIC REGIME supporting the wetland target has been altered significantly by human caused changes to the landscape. In some cases, OSMP has the ability to modify hydrology to affect the extent, distribution and condition of wetlands in the GPA. For example, increasing or reducing the amount of water entering wetlands may help control invasive species and increase native plant cover. Identifying and prioritizing specific opportunities for managing hydrology requires a better understanding of the relative degree of wetland hydrologic alteration in the GPA, and assessment of if and how OSMP's water portfolio can creatively be used to improve the landscape context of this target. Such an assessment has been identified as a strategy for the Grassland Plan.

and creeks where they breed. Trails and roads create barriers for amphibian dispersal, introduce disturbances such as human and dog presence and serve as conduits for predators and pathogens (Dr. Brian Smith personal communication, Smith and Keinath 2007). While designated trails are designed to mitigate impact and may be necessary to accomplish other OSMP goals, undesignated trails are typically not designed, and where they occur near wetlands, they may have an especially deleterious effect upon habitat effectiveness.

Not surprisingly, livestock created trails (also un-designed) lead to ponds originally constructed to provide water to livestock, and now used by northern leopard frogs for breeding. Because trail density in most areas around wetland complexes was higher than the high end of the acceptable range of variation, this wetland indicator was rated as"Fair".

Table 24: Key attributes, indicators and ratings for the landscape context of the Wetlands target

Key Attribute	Indicator	Rating
Connectivity	**Distance to nearest wetland or riparian area**	**Good**
Connectivity	Vegetated buffer width	Fair
Connectivity	Undesignated trail density in Northern Leopard Frog habitat blocks	Fair
Hydrologic Regime	Not yet developed	Not Rated

Note: Indicators in **bold** are considered within the acceptable range of variation. (Indicator rating details are included in **Appendix D**.)

Riparian Areas

Riparian Areas

Overall Viability Rank-Poor

Size-Not Rated
Condition-Poor
Landscape Context-Poor

Size (Not Rated)

Riparian and creek systems typically occur as linear patches on the landscape controlled by topography, soil, and ground and surface water. Riparian areas and creeks have been reduced by many of the same factors affecting the wetland and Mesic Bluestem Prairie targets. The size of this target in the GPA is almost certainly less than what it was in pre-settlement times. OSMP has not identified size-related key attributes or modeled a "baseline" for the size of riparian areas or creeks to assist in the development of an acceptable range of variability or against which to compare current conditions. A system-wide hydrologic assessment could allow OSMP to develop and improve size- and hydrology-based indicators and objectives for the agriculture, riparian, wetland and mesic tallgrass targets.

Condition (Poor)

OSMP identified five key attributes associated with riparian condition and 12 indicators track these attributes (**Table 25**). Staff was able to supply indicator ratings for seven of the indicators.

Table 25: Key attributes, indicators and ratings for the condition of Riparian Areas target

Key Attribute	Indicator	Rating
Vegetation Composition **Animal Species Composition**	**Submerged aquatic nuisance species richness**	**Good**
Animal Species Composition	Percent of target with acceptable bird conservation score	Fair
Vegetation Composition	Native species relative cover	Fair
Vegetation Structure	Cottonwood regeneration	Fair
Animal Species Composition	Native frog presence in suitable habitat	Poor
Animal Species Composition	Fish index of biotic integrity	Fair
Habitat Structure	Physical instream and riparian habitat metric	Fair
Vegetation Composition	Percent of target dominated by non-native species	Poor
Vegetation Composition	Percent of target with prevalence of non-native species	Poor
Animal Species Composition	Macroinvertebrate index of biotic integrity	Not rated
Water quality	Dissolved oxygen (lotic--flowing water habitats)	Not rated
Water quality	Total phosphorus (lotic--flowing water habitats)	Not rated

Note: Indicators in **bold** are considered within the acceptable range of variation. (Indicator rating details are included in **Appendix D**.)

There are currently four aquatic nuisance species (ANS) of concern on OSMP lands: Eurasian watermilfoil, New Zealand mud snail, zebra mussel and a colonial alga referred to as "Didymo". All four of these species are characterized by their ability to spread rapidly and the lack of effective controls. OSMP identified the levels of aquatic nuisance species as falling within the range of acceptable variability. Current distributions are limited in scope and considered to be within the acceptable range of variation. OSMP's conceptual model of the ecological severity of ANS infestations is currently unsupported by experimental results. Adjustments to indicator ratings will be made when better information about the distribution, abundance and rate of spread of these ANS is available.

Riparian areas fall outside the range of acceptable conditions for both dominance and prevalence of invasive plant species, as well as relative cover by native plant species. Moisture, rich soils, and the soil disturbances associated with natural erosional processes, past land use disturbances, livestock use, and relatively high levels of visitor activity create conditions that support large populations and a large number of invasive plant species—many of which are uncommon elsewhere on OSMP. Invasive species include herbaceous plants like Canada thistle and common teasel, and woody plants like crack willow and Russian olive.

Regeneration by native peach-leaved willows and cottonwoods has been measured on OSMP lands (D'Amico 1997) and majority of recruitment sites were found to be devoid of seedlings. Non-native species were found to dominate the tree canopy as well as canopy cover by saplings and ground cover by saplings in a study of riparian areas in and around the City of Boulder (Gershman 1999). OSMP proposes measuring the regeneration of native riparian trees as an indicator of condition.


Removing Russian Olive Trees

Non-native species dominance alters the configuration of riparian forests as well as the types of nesting and foraging opportunities for riparian birds. This is especially problematic because intact riparian areas support the most diverse bird community on OSMP lands. The presence of deciduous trees and seasonal flowing water provides functional habitat (foraging and refuge) for over one hundred species of migrating and nesting birds (Jones et al. 2007), many of which are riparian obligates. This suite of birds includes tree-canopy nesters like Bullock's oriole and yellow warbler and shrub-dependent birds like gray catbird and blue grosbeak. The presence of these birds and others in the guild reflects a high level of breeding habitat effectiveness and diversity.

To measure the conservation status of the riparian bird community, OSMP used Partners in Flight (PIF) (Panjabi 2001) scores to rank birds according to conservation value. This scoring system, as modified by Nuttle et al. (2003), provides an effective technique to measure bird community richness without assuming all species are of equal conservation value. The conservation score for birds in riparian areas falls outside the acceptable range of variation.

Native frog presence, a combined measure for riparian and wetland targets, falls outside the range of acceptability.

OSMP has little other information about other ecological attributes within the creeks; however, OSMP proposes measuring water quality (dissolved oxygen and total phosphorus) and collecting standardized bioassessment data on fish, macroinvertebrates, as well as data on physical instream and riparian habitat features. Preliminary thresholds of acceptability have been developed for these measures. A provisional "Fair" rating has been applied to the fish index of biotic integrity because OSMP is seeking to restore certain native fish populations (suggesting that native fish diversity at least is below the threshold of acceptability). Similarly, a provisional

"Fair" rating has been assigned to the physical instream and riparian habitat metric because OSMP is actively planning aquatic habitat improvements on South Boulder Creek (suggesting that this metric is also outside of the ARV).

OSMP is developing an indicator for Animal Species Composition that tracks the Preble's meadow jumping mouse—a federally threatened species known to inhabit the riparian areas and floodplains of the GPA. This indicator will be added when it is available.

Landscape Context (Poor)
Connectivity, habitat effectiveness and hydrologic regime were identified as key attributes for riparian areas. Seven indicators were developed to assess the status of these attributes (**Table 26**).

As indicated under the viability summary for the Wetland target, the indicators for buffer width, undesignated trail density in northern leopard frog habitat blocks and distance to nearest wetland or riparian area were used to rate the landscape context of the Riparian Areas target as well. Distance to the nearest wetland/riparian area falls within the acceptable range of variation. Buffer width and undesignated trail density in northern leopard frog habitat blocks fall outside that range.

A specific measure of connectivity for Riparian Areas is the number of impediments to fish passage in the creeks. Impediments to fish passage are typically associated with water management infrastructure, mostly headgates for irrigation ditches. Other impediments include box culverts at road underpasses where the bottom of the culvert is elevated above the creek bottom and small diameter culverts that result in turbulent and accelerated flows. Each of these impediments has the ability to isolate fish populations and reduce extent and connectivity of habitat. Fish are less likely to find their habitat requirements met in small habitat blocks. Localized environmental conditions in smaller areas are less likely to be acceptable or provide a refuge during high/low flows, high temperatures, depressed oxygen levels, etc. Fish isolated in short reaches are less likely to find mates or conditions suitable for reproduction and are more likely to suffer high rates of

Changes in Hydrology: A Fundamental Challenge

Under natural conditions, snowmelt higher in the watershed contributes a large proportion of water to creeks and riparian areas. When of sufficient volume, flows overtop the creek banks. Flooding recharges groundwater in the riparian areas, modifies the contours of the land, and controls important processes like seed germination and seedling survival (Hubert 2004). In flatter topography, unconfined meandering creeks create point bars, oxbows, backchannels, and pools and riffles in the stream channel. These features represent a diverse habitat conditions that in turn support a variety of aquatic and riparian plants and animals. In fact, low-gradient streams are the site of some of the most diverse riparian habitat (Hubert 2004).

The hydrologic regime for this target has been dramatically influenced by a range of human activities. Gravel mining has resulted in direct loss of much of the floodplain of Boulder and South Boulder Creeks. In some places, ponds were left after gravel was extracted. Elsewhere the ground surface was re-established, but typically by filling the gravel pits with unmarketable fine textured sediments. These "fines" do not allow movement of groundwater between the floodplain and the creek in a way comparable with the natural sediments or support riparian vegetation. Even intact floodplains have been affected by other historic activities such as impoundment and diversion. Much of the contributing watershed now drains into reservoirs upstream of the GPA.

There are numerous diversions upstream of and in the planning area. Diversions and impoundments typically reduce peak flows and flooding frequency, and modify the volume and duration of base flows. Roads, bridges, and bank stabilization reduce the degree of interaction between the stream and floodplain. These human-made features decrease the likelihood that a creek will migrate, and create varied habitat conditions associated within the floodplain.

predation. Currently there are six impediments identified on OSMP lands along South Boulder Creek, four on or near OSMP lands along Boulder Creek and two on Coal Creek—placing this indicator outside the acceptable range of variation.

Hydrology is also a key attribute for the Riparian Area target. This target is shaped by the magnitude, frequency, duration, as well as the timing, and rate of change of the stream's flow regime. Critical elements of the natural flow regimes need to be managed in order to conserve riparian ecosystems and the functions they provide.

Currently OSMP has identified two indicators to rate the hydrologic regime. The first, "number of overbank flooding events from May through June" provides a way of rating the degree of hydrologic connection between the creek and its floodplain. The second indicator, "minimum instream flow", is meant to recognize the need to maintain some water in the creeks. OSMP has used the work of Hydrosphere (2000) to recommend thresholds for the acceptable ranges of variability for instream flow for Boulder and South Boulder Creeks. These indicators are both outside of the acceptable range of variation and rated "Poor".

Ditch Diversion a Barrier to Fish Passage

Fish Passage Structure

Table 26: Key attributes, indicators and ratings for the landscape context of Riparian Areas target

Key Attribute	Indicator	Rating
Connectivity	**Distance to nearest wetland or riparian area**	**Good**
Habitat Effectiveness	**Number of successful bald eagle nest sites in the Grassland Planning Area**	**Good**
Connectivity	Vegetated buffer width	Fair
Connectivity	Impediments to fish passage	Fair
Connectivity	Undesignated trail density in northern leopard frog habitat blocks	Fair
Hydrologic regime	Instream flows	Poor
Hydrologic regime	Number of over-bank flooding events during late May through June measured every 5-10 years	Poor

Note: Indicators in **bold** are considered within the acceptable range of variation. (Indicator rating details are included in **Appendix D**.)

White Rocks

Size (Very Good)
The exposure of the Fox Hills sandstone cliffs above Boulder Creek is a small patch. OSMP currently has a conservation interest (either fee ownership or easements) on the entire White Rocks area (**Table 27**).

White Rocks

Overall Viability Rank-Very Good

Size-Very Good
Condition-Good
Landscape Context-Not Rated

Table 27: Key attribute, indicator and rating for the size of the White Rocks target

Key Attribute	Indicator	Rating
Relative Protected Area	**Percent of area in conservation ownership**	**Very Good**

Note: Indicators in **bold** are considered within the acceptable range of variation. (Indicator rating details are included in **Appendix D.**)

Condition (Good)
OSMP identified two key attributes associated with the condition of the White Rocks and four indicators to track these attributes **(Table 28).**

Table 28: Key attributes, indicators and ratings for the condition of the White Rocks target

Key Attribute	Indicator	Rating
Vegetation Composition	**Presence of full suite of rare plant species**	**Good**
Animal Species Composition	**Presence of six-lined racerunner**	**Good**
Animal Species Composition	Presence of breeding barn owls	Fair
Vegetation Composition	Abundance of black spleenwort	Not Rated

Currently, the rare plant and vertebrate populations (**Table 29**) at White Rocks are not monitored on a regular basis. Documentation of occurrences of these species has been due primarily to staff reconnaissance and city-sponsored inventory work by biologists. Best available documentation and staff observations suggest that excepting barn owls, rare plant and animal species listed in **Table 29** persist at White Rocks. Barn owls, however, have not been documented there since 1992.

Rare ants, bees and fairy shrimp have also been recorded from the White Rocks. However, specialized skills are required to identify these animals. OSMP may develop indicators associated with these species.

Table 29: Rare plants and vertebrates of the White Rocks

Vertebrates	***Plants***
Barn owl	*American groundnut*
Long-eared owl	*Beebalm (horsemint)*
Six-lined racerunner	*Black spleenwort (fern)*
	Forktip threeawn
	Lemon scurfpea
	Narrowleaf four-o'clock

Vertebrates	***Plants***
	Plains black nightshade
	Silky sophora

Landscape Context (not rated)
The 63-acre White Rocks area is nested within one of three large blocks of OSMP lands in the GPA. The target occurs primarily on conservation easements rather than fee ownership. The agreements are protective of the cliffs, prohibiting owners of the underlying fee property from incompatible activities.

Viability Summary

The current overall viability rank for the GPA is "Fair" (**Table 30**). This rating is based upon available indicator and key attribute ratings for the individual targets. There are important key attributes for which OSMP has not yet developed reliable ratings, so the overall viability scores are likely to change as more is learned. Explanations of the viability rankings for each of the conservation elements follow. **Appendix D** contains the indicator ratings and documentation about how they were derived. **Table 31** shows which indicators are within and which are outside of the ARV.

Table 30: Summary viability table for the GPA

	Conservation Targets / Current Rating	Landscape Context	Condition	Size	Viability Rank
1	Mixedgrass Prairie Mosaic	Fair	Fair	Good	**Fair**
2	Xeric Tallgrass Mosaic	Fair	Fair	Fair	**Fair**
3	Mesic Bluestem Prairie	Fair	Fair	-	**Fair**
4	Agricultural Operations	-	Fair	Good	**Good**
5	Black-tailed Prairie Dog and Associates	Fair	Good	Good	**Good**
6	Wetlands	Fair	Poor	-	**Fair**
7	Riparian Areas	Poor	Poor	-	**Poor**
8	White Rocks	-	Good	Very Good	**Very Good**
	Grassland Planning Area Overall Viability Rank				**Fair**

Table 31: Achieving acceptable condition for Grassland Plan targets

Conservation Target	Size	Condition	Landscape Context	Overall Viability Rank
Mixedgrass Prairie Mosaic	Maintain at Good • at least one habitat block over 2,000 acres	Maintain at Good • stable populations (extent) of Bell's twinpod • RAM weed species dominance <3% Improve to Good • occurrence of sensitive butterflies >10% • occurrence of grassland dependent butterflies >50% • RAM weed species prevalence <9% • 75% of sampled sites with: o native species relative cover >88% o native species richness >33 o conservative species richness >17 o bare ground <10% o derived PIF score ≥3.9	Improve to Good • >50% of target experiencing 5-30 fire return interval • >60% of large (>247 acre) habitat blocks with singing male grasshopper sparrows	Fair

Table 31: Achieving acceptable condition for Grassland Plan targets

Conservation Target	Size	Condition	Landscape Context	Overall Viability Rank
Xeric Tallgrass Prairie	Maintain at Fair • at least one block of habitat over 1,000 acres	Maintain at Good • RAM weed species dominance <3% • no decrease in extent: ○ grassyslope sedge ○ dwarf leadplant or ○ prairie violet • 75% of sampled sites with: ○ butterfly host plant cover ≥8% Improve to Good • occurrence of sensitive butterflies >10% • occurrence of grassland dependent butterflies >50% • RAM weed species prevalence <9% • 75% of sampled sites with: ○ native species relative cover >90% ○ native species richness ≥22 ○ conservative species richness >12 ○ bare ground <26% ○ derived PIF score ≥3.9	Improve to Good • >50% of target experiencing 5-30 fire return interval	Fair
Mesic Bluestem Prairie	Key Attributes or Indicators Not Identified	Maintain at Good • RAM weed species dominance <3% • presence of Ute ladies-tresses orchid (ULTO) • on-going management for	Improve to Good • >50% of target experiencing 5-10 fire return interval	Fair

Table 31: Achieving acceptable condition for Grassland Plan targets

Conservation Target	Size	Condition	Landscape Context	Overall Viability Rank
		ULTO • 75% of sampled sites with: ○ bare ground <13% ○ butterfly host plant cover ≥8% <u>Improve to Good</u> • occurrence of sensitive butterflies >10% • occurrence of grassland dependent butterflies >50% • RAM weed species prevalence <9% • species richness of sensitive breeding bird species • 75% of sampled sites with: ○ native species relative cover >85% ○ native species richness >23 ○ conservative species richness >11		
Agriculture	<u>Maintain at Good</u> • >12,000 acres in agricultural production • >80% of irrigable land leased for agriculture	<u>Maintain Good</u> • stable levels of organic soil matter • >60% of grazed land in "good" condition rating from integrated range quality technique <u>Improve to Good</u> • >75% of Class B Bobolink Management Areas mowed after bobolink fledging (July	Key Attributes or Indicators Not Identified	Good

Table 31: Achieving acceptable condition for Grassland Plan targets

Conservation Target	Size	Condition	Landscape Context	Overall Viability Rank
		15, unless otherwise determined) while maintaining 100% of Class A Bobolink Management Areas mowed after bobolink fledging (July 15, unless otherwise determined)		
Black-tailed Prairie Dogs and Associates	Maintain at Good • 800-3,137 acres occupied by prairie dogs	Maintain at Good • >2 prairie dog colonies with successful nesting by burrowing owls Improve to Good • >50% of colonies with territorial horned larks • generalist predators at 50% of colonies in grassland preserves ***and*** sensitive predators at 25% of colonies	Maintain at Good • >70% of land occupied by prairie dogs in protected status Improve to Good • all grassland preserves with prairie dog occupancy from 10-26%	Good

Wetlands	Key Attributes or Indicators Not Identified	Maintain at Good
		• on-going management for ULTO
		• presence of ULTO
		Improve to Good
		• >50% of suitable habitat with native frogs and no non-native frogs
		• RAM weed species dominance <3%
		• RAM weed species prevalence <9%
		• 75% of sampled sites with
			Maintain at Good
			• 75% of wetlands:
			  ○ within 656 ft (200 m) of nearest wetland or riparian area
			Improve to Good
			• 75% of sampled sites:
			  ○ with buffer width > 165 ft (50 m)
			  ○ undesignated trail density in northern leopard frog habitat blocks < 13.4 ft/acre (10 m/ha)
				Fair

Table 31: Achieving acceptable condition for Grassland Plan targets

Conservation Target	Size	Condition	Landscape Context	Overall Viability Rank
		native relative cover ≥67% • 75% of sampled sites (ponds) with Secchi disk depth >1.5 m • 75% of sampled sites (ponds) with total phosphorus concentrations of <20 µg/L		

Riparian Areas and Creeks	Key Attributes or Indicators Not Identified	Maintain at Good
		• no increase in aquatic nuisance species
		Improve to Good
		• >50% of suitable habitat with native frogs and no non-native frogs
		• RAM weed species dominance <3%
		• RAM weed species prevalence <9%
		• >50% of recruitments sites with cottonwood seedling
		• 75% of sampled sites:
		  o fish IBI score >44
		  o macroinvertebrate IBI score >50
		  o exceed state water quality standards for dissolved oxygen
		  o have total phosphorus concentrations less than 0.07 mg/L
		  o instream habitat metric >10
			Maintain at Good
			• 2 or more successful bald eagle nests
			• 75% of sampled sites:
			  o within 656 ft (200 m) of nearest wetland or riparian area
			Improve to Good
			• 75% of sampled sites:
			  o with buffer width > 165 ft (50 m)
			  o undesignated trail density in northern leopard frog habitat block < 13.4 m/ha (10 m/ha)
			• no impediments to fish passage
			• improvement to instream flow
			• 1 or more overbank flooding events
				Poor

Table 31: Achieving acceptable condition for Grassland Plan targets

Conservation Target	Size	Condition	Landscape Context	Overall Viability Rank
		○ native plant relative cover ≥67% ○ derived PIF score ≥20		
White Rocks	Maintain at Very Good • 100% conservation ownership	Maintain at Good • six-lined racerunners present • suite of rare plants present Improve to Good • barn owl exhibiting breeding behavior • population of black spleenwort stable	Key Attributes or Indicators Not Identified	Very Good

Chapter IV: Conservation Issues [12]

Chapter Summary
This chapter identifies and prioritizes issues related to the conservation of the Grassland Plan targets. The analysis of conservation issues includes identifying the stresses to the targets as well as the sources of those stresses. Stresses can result in the destruction or impairment of conservation targets by degrading one or more key attributes. Sources of stress are the human-caused actions or events causing the stresses.

There are a large number of conservation issues in the Grassland Planning Area. The sources of stress that most affect the targets are:

- Incompatible surrounding land uses
- Incompatible recreation
- Incompatible dog management
- Invasive plant species
- Invasive animal species
- Incompatible water management/use
- Incompatible fire management
- Incompatible agricultural practices

Background

Each of the Grassland Plan targets has been degraded to some extent and faces a variety of conservation issues. Conservation issues describe the actions or processes that have degraded or could degrade the Grassland Plan targets, threatening their continued existence. In order for the targets to be sustainable, each of these issues needs to be addressed. This chapter contains a conservation issue assessment, identifying and prioritizing conservation issues, so that strategies can be developed to direct resources to the most critical issues. The analysis considered not only those conservation issues affecting the targets at the time of plan development, but also those likely to have an effect during in the next ten years.

Conservation issues are composed of stresses and sources of stress. Stresses are impaired or degraded key attributes. For example, the fire regime is a key attribute for several Grassland Plan targets. The stress related to this key attribute would be described as "Altered Fire Regime".

Sources of stress are the human-caused actions or events that cause, have caused, or may cause the stress. One source of the stress "Altered Fire Regime" is fire suppression. **Figure 17** shows the relationship of the stress (altered fire regime), the source (fire suppression) and the target (Mixedgrass Prairie Mosaic).

Figure 17: Cause and effect relationship of source, stress and target (after TNC 2007)

[12] after TNC 2007 and Hamel et al. 2006

Conservation Issue Identification

OSMP staff began assessing conservation issues using the results of the viability analysis (Chapter III). The key attributes for each target were reviewed, and staff selected those that were significantly degraded (rated "Fair" or "Poor"). Staff then considered if there were key attributes currently ranked "Good" or "Very Good" that might be in danger of degradation over the next decade without management intervention. Stresses were then identified for each degraded key attribute, and staff listed the specific direct conservation issues acting as sources of stress.

Yucca and Snakeweed: Indicators of Historic Overgrazing
photo – Dan Fogelburg

Some conservation issues result when stresses on a system persist years after the source of stress disappears. For example, some properties within the Grassland Planning Area were overgrazed prior to OSMP ownership. Although they are currently managed with a sustainable level of grazing (or not grazed at all), these areas still display an altered vegetation community. Although OSMP has abated the historic source of stress, the stress persists. OSMP has identified several historical sources of stress in the Conservation Issue analysis. These situations are addressed through ecological restoration.

Issue Ranking

Conservation issues were ranked using a set of criteria to evaluate both the stresses and the sources of the stress. Each stress is ranked according its **scope** and the **severity** of its effect upon each target over the 10-year planning horizon. Sources of stress were rated according to the degree to which they, each acting alone, contribute to the stress (**contribution**) and how difficult reversing the source may be (**irreversibility**). Details of the methodology can be found in **Appendix E.**)

The conservation issue ranking is based upon a combination of the stress and source of stress ratings. Conservation issue ranks can be combined to provide summary rankings for each target and each conservation issue across multiple targets, and to derive overall conservation issue ranking for the Grassland Planning Area.

The overall conservation issue ranking of the GPA is "Very High", reflecting the degraded nature of the conservation targets, and the presence of multiple active threats.

Conservation Issue Narratives

A summary of the conservation issue ranking can be found in **Table 32** at the end of chapter. **Appendix F** provides details of the conservation issue assessment rankings.

Highest Ranked Conservation Issues

Incompatible Surrounding Land Use

Not surprisingly, surrounding land use presents a significant issue for conservation in an area dominated by urban and ex-urban development. For more than 40 years open space acquisition and regional planning have resulted in significant conservation in the Boulder Valley. However, there has also been a simultaneous growth in residential, commercial and industrial development, especially in other towns and cities, many of which abut the GPA directly. Surrounding land uses are directly related to fundamental needs of local residents (e.g., homes and jobs). While OSMP works with private property owners, neighboring municipalities, public utilities and other urban service providers to avoid and minimize *some* of the stresses resulting from incompatible surrounding land uses, it is likely that others stresses will persist unabated.

Incompatible land use is the most significant source of habitat fragmentation in the Grassland Planning Area. Developed areas interrupt movement corridors for animals and have significant impacts on the way fire can move through the landscape. Domestic and feral cats and dogs disturb, harass and prey upon wildlife. Landscaping associated with residential and commercial development is a common source of invasive species seeds. Fertilizer, pesticides, wastewater, road sand and salts affect the quality of OSMP's creeks, ponds and wetlands. Underdrains, impervious surfaces and flood detention ponds also affect watershed hydrology. Neighboring land uses also influence how OSMP chooses to manage prairie dogs and can use fire as a management tool.

Incompatible Recreation

Just as open space is a part of the regional land mosaic use that includes residential, commercial, and industrial development—conservation of natural and agricultural systems on OSMP fits into a broader set of open space purposes, including passive recreation. While the Grassland Plan sets standards for natural and agricultural conservation—these standards must be integrated with the objectives of the Visitor Master Plan to provide sustainable recreational access and enjoyment. OSMP has committed to making most management decisions affecting recreation through the Trail Study Area (TSA) planning process.

In addition to the benefits and enjoyment associated with access and use (see sidebar and **Appendix G**), there are also conservation issues. While much of the recreation on OSMP lands is compatible with the conservation of the Grassland Plan targets, some is not. Trail construction and visitor (and livestock)-created social trails create disturbed ground and ideal conditions for weed establishment. While well-maintained and well-used trails do not support weed growth on the actual trail tread, trailsides are often places dominated by weeds (**Figure 18**). Some of the

> **Community Services: Access and Enjoyment**
>
> THE GRASSLAND PLANNING AREA is a popular destination for OSMP visitors. This popularity translates into support for both the recreational opportunities and the conservation of natural systems and agricultural operations. OSMP encourages appreciation and visitation that sustain the natural value of the land through an active and organized system of educational programs, outreach activities, interpretive materials, and volunteer opportunities. Likewise, the conservation of the Grassland Plan targets is important to ensure a high level of visitor enjoyment. Open Space and Mountain Parks visitors benefit from the knowledge that populations of native species are healthy, and that agricultural operations and natural areas being sustainably managed. More details about the extensive community services delivered in the Grassland Planning Area can be found in Appendix G.

species that exploit trailsides include difficult to control invasive species such as jointed goat grass and knapweed. The impact of trail construction is exacerbated by the role of visitors and their companion animals as vectors for the spread of weed seeds. The impact of invasive species extends beyond the direct effects of native species displacement, affecting the native pollinators and other animals closely tied to displaced native species.


photo – Mark Leffingwell

Some birds, such as ground nesters and raptors, are seasonally sensitive to disturbances associated with people and recreational activities. Direct impacts such as trampling of nests by people, dogs and horses and indirect impacts associated with disturbance can reduce nesting success. When selecting nest sites, some birds will avoid areas with human activity. Prairie dog colonies and other large grassland blocks that could provide habitat for sensitive species may also be less effective where combined with high levels of human activity. Visitor activities may also result in the introduction of non-native predators into places where they would not otherwise be found. The presence of these predators can increase native species mortality. For example, incompatible fishing practices may introduce aquatic nuisance species and pathogens, which can infect or prey upon sensitive amphibians.


(a)

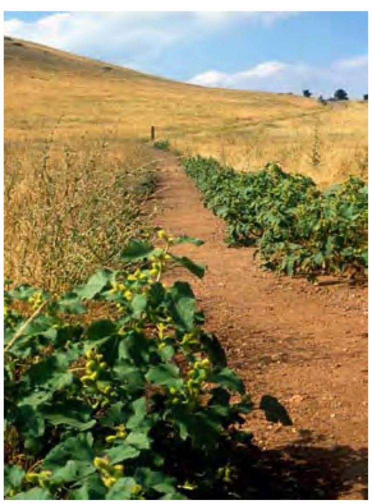

(b)

Figure 18 : Weeds along OSMP trails
(a) jointed goat grass (dark green)
(b) burdock (large and leafy)

Visitor activities in agricultural areas have resulted in crop trampling and damage to agricultural infrastructure such as irrigation structures and livestock fencing and gates.

<u>Incompatible Dog Management by Guardians</u>
Dogs accompanying visitors on OSMP may have both direct and indirect effects on the viability of the Grassland Plan targets. Shoreline and creek bank erosion and turbidity are associated with areas where dogs, typically off leash, access ponds and creeks. Unleashed dogs not under the control of their guardian can directly affect wildlife through predation and both wildlife and livestock by harassment (e.g., chasing deer, birds, cattle or prairie dogs). Dogs on trails may reduce the daytime use of trails by deer and other mammals. In addition, dog waste adds nitrogen to the ecosystem. Nitrogen in turn supports weed growth. Nitrogen and bacteria from dog feces degrade pond and creek water quality.

<u>Invasive Plant Species</u>
Invasive species (as tracked by the RAM method) occupy nearly half of the Wetlands target, 35% of the Riparian Areas target, 31% of the Mesic Bluestem Prairie target, 25% of the Xeric Tallgrass Prairie target, and 43% of the Mixedgrass Prairie Mosaic target mapped using RAM in

2006 and 2007. Not all non-native and/or aggressive species are mapped via RAM. Some of these species cover significant portions of the targets.

Some non-native plant species displace native vegetation because they compete directly with native plants for places to grow, nutrients, sunlight and soil moisture. Heavy growth of exotic species can create self-sustaining monocultures by blocking access to resources and germination sites. Over longer periods, some non-native species affect the soil in ways that inhibit the growth of other plants.

While some non-native invasive plants may be relatively harmless, others degrade habitat for native animals by displacing food plants, pollen sources and cover for nesting or hiding. Weeds can reduce the availability and nutritive value of forage for livestock. Non-native woody plants in grasslands provide perch sites where none would normally be found. These can be used as perches by nest parasites to locate host nests. Some bird species select nesting habitat based upon visual appearance. When invasive species alter the appearance of an area, some species may avoid nesting there. Weeds can also affect the fire regime by creating areas that burn hotter or cooler than uninfested areas.

Global Environmental Change

THERE IS an increasing body of scientific literature building connections between many of the conservation issues facing land mangers and global environmental changes such as climate change and shifts in atmospheric chemistry.

These relationships pose many fundamental questions for the conservation of the Grassland Plan targets and the way OSMP identifies and addresses conservation issues.

If invasive plant and animal are placed at an advantage because of a longer growing season, and greater availability of carbon dioxide and nitrogen; will removing those invasive species have any effect on improving the viability of our target, or will other exotic species fill in behind the ones that have been removed?

What types of management will support the dominant native warm-season grasses if changes in temperature, precipitation and atmospheric chemistry are favoring cool-season species and woody plants?

OSMP, like other land managers is just beginning to grapple with the management issues associated with global environmental change. Staff is working to capitalize upon existing relationships with university and agency scientists to better understand the emerging issues and develop more proactive management actions.

Invasive Animal Species

Fish - Many species of fish have been introduced to the creeks and ponds in the Grassland Planning Area. Most species have been introduced for sport fishing, and prey upon native aquatic species (including aquatic forms of frogs, toads and salamanders). The grass carp was introduced to control aquatic vegetation. Although not a predator, grass carp can alter habitats significantly and create stresses that affect native aquatic communities. They compete with native invertebrates and fishes that feed upon aquatic vegetation, and remove cover and habitat for aquatic animals. Grass carp dislodge vegetation by "digging" with their snouts, thereby increasing turbidity and degrading water quality. Increased turbidity degrades habitat for many aquatic organisms, including the tadpoles of northern leopard frogs and other amphibians.

Bullfrogs - Bullfrogs are an introduced species in Colorado. Since their introduction, they have invaded and become widespread throughout the eastern half of the state, and their populations are growing elsewhere. Declines in the distribution and abundance of the northern cricket frog as well as the northern and plains leopard frogs accompanied the expansion of the bullfrog populations in the state (Hammerson 1999). Bullfrogs have been identified repeatedly as a conservation issue throughout western North America. Bullfrogs become numerous in the lakes, ponds and wetlands they invade and exert intense predatory pressure on other frog species, feeding upon adult and larval frogs (tadpoles). In addition, it is likely that bullfrog larvae compete with other larval frogs for food. Bullfrogs also transmit parasites or pathogens creating greater ecological stress to the native frog populations. Bullfrogs are widespread in suitable habitats on OSMP lands, and are difficult to eradicate once established.


Bullfrog

Invertebrates - Two mollusks, the New Zealand Mud Snail (NZMS) and the Zebra mussel pose significant conservation issues for aquatic systems. The NZMS, already present on OSMP, poses significant risk of alteration of aquatic ecology. At densities often over 40,000 snails/sq. ft^2 (400,000/m^2), this herbivore affects aquatic vegetation where it lives and competes with native invertebrates for food and habitat (Crosier et al. 2003). Since many native invertebrates are eaten by native fish, the NZMS may reduce fish populations.

Zebra mussels have spread to Colorado, but have not yet been reported from the Grassland Planning Area. This mussel has had significant impacts to ponds and lakes throughout North America. The typically large populations of zebra mussels that become established are capable of removing a large percentage of the microscopic plants and animals (phytoplankton and zooplankton) from lakes and ponds; this loss in the food chain in turn affects organisms higher in the food chain. Reduced turbidity allows light to penetrate deeper allowing rooted aquatic plants to become established with cascading effects on aquatic systems. Zebra mussels also kill native mollusks by attaching to their shells.

Introduced crayfish (often purchased as bait) are also a conservation issue in ponds and creeks. These introduced predators feed upon larval stages of amphibians, including the northern leopard frog.

<u>Incompatible Water Management/Use</u>
Water management including impoundments, channelization, irrigation and flood control practices can affect groundwater and surface hydrology. A reduction in the variety of surface flows in creeks has probably homogenized some wetland and riparian types. For example, steady low levels of irrigation throughout the growing season supports more cattail marshes and wet meadows. Because of controls resulting from impoundments, diversions and flood control structures, creeks overtop their banks less often, creating fewer floodplain wetlands and open water-wetland complexes. Drainage tiles and underdrains placed in areas of high groundwater have destroyed some naturally occurring wetlands.

Water management has cascading effects beyond hydrology. The reduction in flood frequency and overbank flows has modified the way cottonwoods and other riparian trees and shrubs become established. Many of the creeks in the GPA are characterized by continuous stands of riparian forests, where in the past creeks may have been characterized by herbaceous and shrub vegetation with isolated stands of trees developing on point bars deposited during major flooding events.

Decreased (or no) in-stream flow reduces the effectiveness of riparian and aquatic habitat for many species. Impoundments typically replace creeks, riparian areas and wetlands with open water.

Incompatible Fire Management

The long history of fire suppression in OSMP grasslands has affected the conservation targets in several ways. The most obvious effect is an increase in woody species in the large matrix forming grasslands and the decline of grasses as they compete with shrubs, saplings and mature trees for moisture, light and nutrients. Increasing tree cover decreases forage availability for livestock, and some habitat effectiveness for edge-sensitive ground-nesting birds. Mature trees provide shade, and are preferred areas for livestock to congregate, which creates disturbances where weeds can become established.

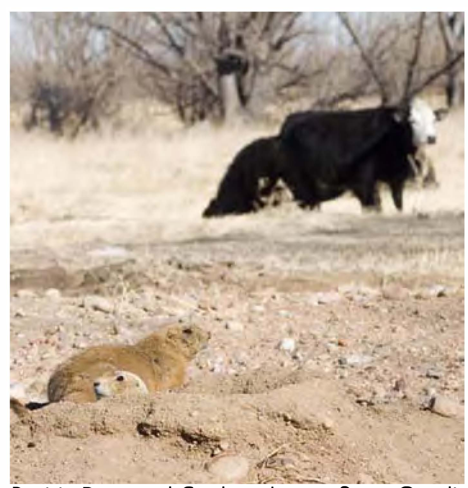
Trees also provide additional cover for terrestrial predators as well as perches from which raptors and nest predators can hunt, and from which brown-headed cowbirds can locate nests of other species. The cowbird, a native brood parasite, lays its eggs in the nests of other birds. The host raises the cowbird chicks at the expense of the host's young. Perhaps in response to the evolutionary pressure favoring survival of individuals who perceived trees as perches for predators and parasites, grassland obligate birds tend to avoid grasslands with even a few trees per acre.

Less obvious effects of fire suppression are decreases in native plant species richness including fewer forbs in upland grassland, and dominance by cattails in wet areas. Fire suppression can also result in changes of soil nutrient status and reductions in aboveground productivity. Accumulating litter leads to decreased light availability at the soil surface and slower seasonal and daily soil warming. Fire suppression can reduce the amount of patch diversity in a large block of grassland. Fire management can also conflict with agricultural operations if too much forage is burned.

Incompatible Agricultural Practices

The conservation of Agricultural Operations is a fundamental objective of the plan; however, some agricultural practices are sources of stress for other targets.

When repetitive livestock stocking practices are used (same season, duration and intensity of use), native plant diversity can be reduced because cattle will selectively feed upon the most palatable species available. Grazing management that emphasized graminoid (grass) production can also reduce the abundance of native plants by reducing the diversity of forbs (wildflowers and other "un-grass like" plants). A focus on forage production may also not account for the residual cover needs of overwintering or breeding animals.



Prairie Dogs and Cattle photo – Steve Gaudin

The lack of established grazing reserves on OSMP means that livestock may be placed on lands where the effects of drought or prairie dog foraging have already reduced forage availability. In these cases, livestock grazing (along with climate and prairie dogs) degrade both ecological and agricultural sustainability of the area.

Livestock can concentrate their activities in creeks, ponds, riparian areas and wetlands especially during hot summer months. Livestock hoof action can cause erosion, trample vegetation and increase turbidity, while urine and manure can further degrade water quality.

As mentioned above, livestock create trails. These trails sometimes attract visitors who use them as alternatives to the designated trail system. Since these trails often dead-end at salt licks, stock tanks and other destinations of little interest to humans, people find themselves cutting cross-country to return to their origin or the designated trail system—sometimes creating new undesignated trails.

Irrigation and haying create bird habitat, including nesting areas for the bobolink, a nested target uncommon in the planning area. Unfortunately, haying often occurs before the young birds have left the nest, creating a situation where OSMP hayfields may be attracting nesting bobolinks but not producing young birds. Such population sinks do not contribute to the growth of the bobolink population range wide, and may contribute to reduction in numbers over time.

Medium Ranked Conservation Issues

Incompatible Prairie Dog Activity (Grazing/Burrowing)
Although a native species, and an integral nested target for one of the Grassland Plan targets, the black-tailed prairie dog is a source of stress for other targets (see sidebar). By virtue of their burrowing and foraging, prairie dogs interfere with agricultural operations, including ditch maintenance, irrigation and forage production. Long-term monitoring on OSMP also indicates that prairie dogs degrade native plant communities, reducing graminoid (grass) cover and increasing cover by bare ground. Our conceptual models suggest that this increase in bare ground is related to the higher levels of weed cover typically associated with long-term prairie dog occupancy. In addition, prairie dog colonies have fewer of the species characteristic of OSMP grasslands. This may result from the inability of some of these species to endure the intense grazing and competition (with weedy plants) found in prairie dog colonies.

Because of the altered plant composition and reduced cover, prairie dog colonies do not support animal species requiring specific food/nectar plants, or those that require cover for foraging, nesting, resting or hiding from predators.

Conservation as a Conservation Issue?

SOME of the conservation issues identified in the Grassland Plan arise when one conservation target is the source of stress for another. For example:

- Some aspects of water management necessary to support agriculture conflicts with sustainable riparian management.
- Prairie dog grazing is incompatible with the productivity of irrigated hayfields and the viability of some types of native grassland.
- Haying practices in some places represent a significant source of mortality for some uncommon grassland nesting birds.

The Grassland Plan proposes several approaches to resolving such conflicts.

In some cases, it is not practical to try to meet all the conservation objectives of the plan in one place. Chapter V describes how OSMP identified where the best opportunities to conserve the specific targets can be found.

Since eliminating a target would be contrary to the goal of the Grassland Plan, OSMP staff has developed strategies that abate the stress by modifying rather than eliminating its source. These strategies are described in Chapter VI.

Sylvatic Plague

While this is a medium ranked conservation issue for the GPA *as a whole*, it is a highly ranked conservation issue for the Black-tailed Prairie Dog and Associates target. Prairie dogs are highly susceptible to plague and since prairie dogs have developed no significant immunity to the disease, mortality is nearly complete when plague infects a colony (Cully 1989, Cully and Williams 2001). Prairie dogs susceptibility to plague may be due to the recent introduction of the disease to North America (circa 1900) and limited opportunity for an evolutionary response such as resistance or other mechanisms to reduce the plague's impact. Another factor that may also make prairie dogs more vulnerable is their densely colonial habits, which facilitate disease transmission from animal to animal (Cully and Williams 2001, Hoogland 2006).

The high levels of mortality resulting from plague pose a significant risk to the conservation of black-tailed prairie dogs. The catastrophic effects on populations are exacerbated by plague's unpredictability and the lack of effective means to control the spread of plague at a landscape scale.

While severe and widespread, the impact of plague on OSMP lands has appeared in the past to be reversible by successful re-establishment of prairie dog populations dispersing from unaffected colonies, population growth from surviving individuals and the relocation of prairie dogs from outside the OSMP system. In addition, while widespread, the impact of plague is by no means comprehensive. Not only do individual animals somehow survive, but also small and isolated colonies on OSMP have been unaffected as plague epizootics have repeatedly moved through the surrounding landscape. As a result, although future plague epizootics may function differently and thus the impact of this issue is uncertain, experience suggests that prairie dog populations increase and decrease cyclically with epizootic die-offs followed by periods of colony expansion to levels seen prior to the epizootic. The level of threat posed by plague will be re-examined if future epizootics function differently or source populations for repopulation decline.

Low Ranked Conservation Issues

Deferred Maintenance of Irrigation Infrastructure

This issue affects Agricultural Operations as well as the Wetlands and Mesic Bluestem Prairie targets. A significant amount of the maintenance to the water delivery systems in the Grassland Planning Area has been deferred. While many irrigation structures on OSMP lands were old and in need of repair of replacement when the properties they serve were purchased by the department, others have deteriorated because of insufficient funding and staffing to maintain acceptable conditions. Staff used the inventory and assessment of irrigation infrastructure to identify, prioritize and estimate the costs and staffing needs for facility maintenance and capital improvements.

Great Horned Owls

The great horned owl was identified as a source of stress to the barn owls that nest at the White Rocks, burrowing owls in the prairie dog target and long-eared owls at the White Rocks and in the Riparian Areas target. Burrowing, long-eared and barn owls are relatively rare in the Grassland Planning Area. The great horned owl displaces barn and long-eared owls and preys upon the young of barn and long-eared owls.

Table 32: Conservation issue summary for the Grassland Planning Area

	Conservation Issues Across Targets	Mixed Grass Prairie Mosaic	Xeric Tallgrass Prairie	Mesic Bluestem Prairie	Agricultural Operations	Black-Tailed Prairie Dog and Associates	Wetlands	Riparian Areas	White Rocks	Overall Conservation Issue Rank
		1	2	3	4	5	6	7	8	
1	Incompatible Trails/Recreation	High	High	High	Low	Very High	Very High	High	High	Very High
2	Incompatible Surrounding Land Use	High	High	High		Very High	High	Very High		Very High
3	Incompatible Dog Management by Guardians	High	High	Low		Very High	High	Medium		Very High
4	Invasive Plant Species	High	High	High	Low	Medium	High	High	High	Very High
5	Invasive Animal Species						Very High	High		High
6	Incompatible Water Management/Use			Low			Medium	Very High		High
7	Inappropriate Fire Management	High	High	High	Low					High
8	Incompatible Agricultural Practices	Medium	Low	Medium	Low	High	High	Medium	Medium	High
9	Incompatible Prairie Dog Activity (Grazing/Burrowing)	High	Medium		Medium					Medium
10	Sylvatic Plague					High				Medium
11	Deferred Maintenance of Irrigation Infrastructure			Low	Medium		Low			Low
12	Great Horned Owls							Medium	Low	Low
	Conservation Issue Status for Targets and Project	Very High	High	High	Medium	Very High	Very High	Very High	High	Very High

Chapter V: Best Opportunity Analysis

Chapter Summary
This chapter contains an analysis of the OSMP land system to determine where the best opportunities exist to conserve each of the targets. The analyses considered where the targets occurred in good condition and where there were relatively few conservation issues. Staff also considered places where good conditions could be restored with a reasonable level of effort.

Many places in the Grassland Planning Area would benefit from conservation action. OSMP staff developed a "Best Opportunity Analysis" to help set priorities about the places conservation actions is likely to have the greatest benefit—answering the question: "*Where are the best opportunities to conserve or restore the targets?*" The analyses considered where good conditions exist, conservation issues are lowest, and where good conditions could be restored with a reasonable level of effort. These "Best Opportunity Areas" (BOAs) will be used by OSMP to prioritize where conservation action is implemented.

In addition to identifying where conservation opportunity is highest for the individual targets, the Best Opportunity Analysis also reveals where conservation action might benefit multiple targets. It can also point out potential conflicts in management. For example, much of the land identified as a Grassland Preserve for the Black-tailed Prairie Dog and Associates target, also represents the best opportunities for conservation and restoration of the Mixedgrass Prairie Mosaic. There is also considerable overlap of agricultural best opportunity areas with those of Wetlands and Mesic Bluestem Prairie. OSMP will be exploring opportunities to take advantage of these overlaps or resolve inherent incompatibilities through site-specific management planning.

Mixedgrass Prairie Mosaic, Xeric Tallgrass Prairie and Mesic Bluestem Prairie

The Mixedgrass Prairie Mosaic and Xeric Tallgrass Prairie were combined for the Best Opportunity Analysis because these targets often occur on the landscape as interspersed patches forming large-scale complexes (referred to here as the Upland Grassland Complex). Mesic Bluestem Prairie was considered independently, but the results are presented together with the Upland Grassland Complex.

The first step in identifying the best opportunities for this combined target was locating the largest blocks within the GPA. Larger blocks have several advantages over smaller ones including increased habitat diversity, greater plant and animal species richness, a greater diversity of food plants and prey species, less edge and fewer conflicts with incompatible adjacent land uses.

Habitat blocks were defined by OSMP ownership and management, the GPA boundary and public roads. OSMP lands connected by OSMP conservation easements were considered part of a contiguous block. OSMP divided habitat blocks into three categories: small (0-250 acres or 0-100 ha), moderate (>250-750 acres or >100-300 ha), and large (>750 acres or > 300 ha). **Figure 19** shows the results of the habitat block analysis.

OSMP staff assembled information about the conservation and restoration potential of the large and moderate sized blocks and compiled this information in a Geographic Information System

(GIS). The evaluations used existing spatial and quantitative data where available, as well as professional judgment and qualitative assessments conducted by OSMP biologists familiar with conditions in the GPA. Considerations and sources of information used to define best opportunities for conservation included:

- Good condition examples of characteristic plant communities from vegetation mapping by OSMP staff ("Good" defined by the viability ratings for native plant relative cover, native species richness, incidence of priority weeds, amount of bare ground, etc.)
- Good condition examples of characteristic bird communities from surveys conducted by OSMP staff and researchers
- Presence of rare/sensitive plant populations and plant communities from vegetation mapping conducted by OSMP staff, and rare plant inventory work conducted by researchers, staff and volunteers
- Low incidence of priority weeds from invasive species mapping conducted by OSMP staff and contractors
- Trail density based on GIS data (lower trail densities preferred)
- Distance from urban edge based on GIS data (greater distance preferred)
- Representation of all community types comprised by the targets using information from the vegetation map database
- Compatibility of adjacent lands (greater compatibility preferred)

Restoration opportunities were identified as areas where vegetation condition and structure were judged to be outside the range of acceptability but capable of being restored with a reasonable investment of resources.

Staff combined some adjacent small and moderate-sized blocks with the large blocks where multiple criteria overlapped and where habitat relationships or conservation issues (e.g., weeds) were not significantly altered by intervening roadways.

The BOAs for conservation and restoration in the Upland Grassland Complex (mixedgrass and xeric tallgrass) and Mesic Bluestem Prairie are shown in **Figure 20.**

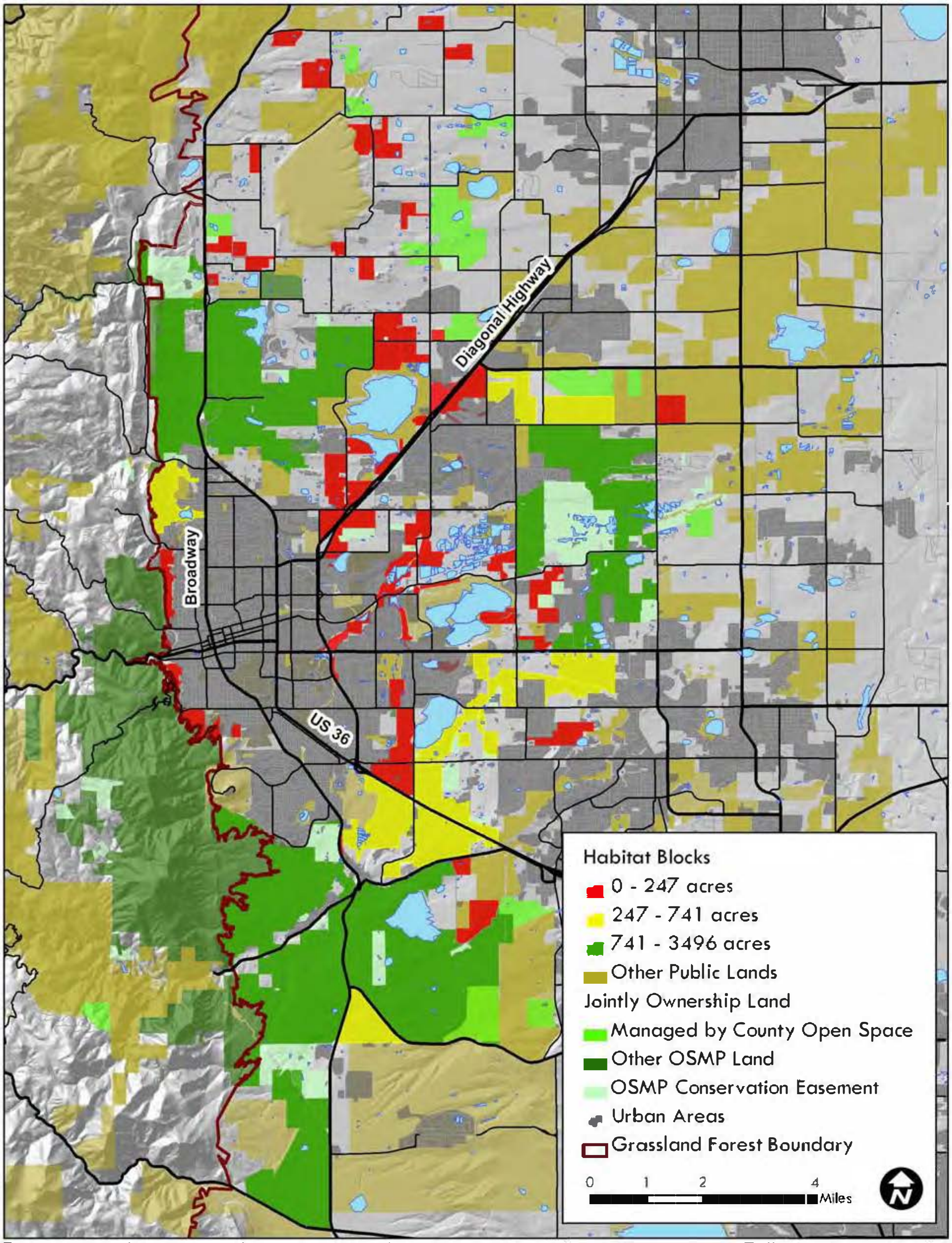


Figure 19 : Block size analysis for the combined Mixedgrass Prairie Mosaic, Xeric Tallgrass Prairie and Mesic Bluestem Prairie

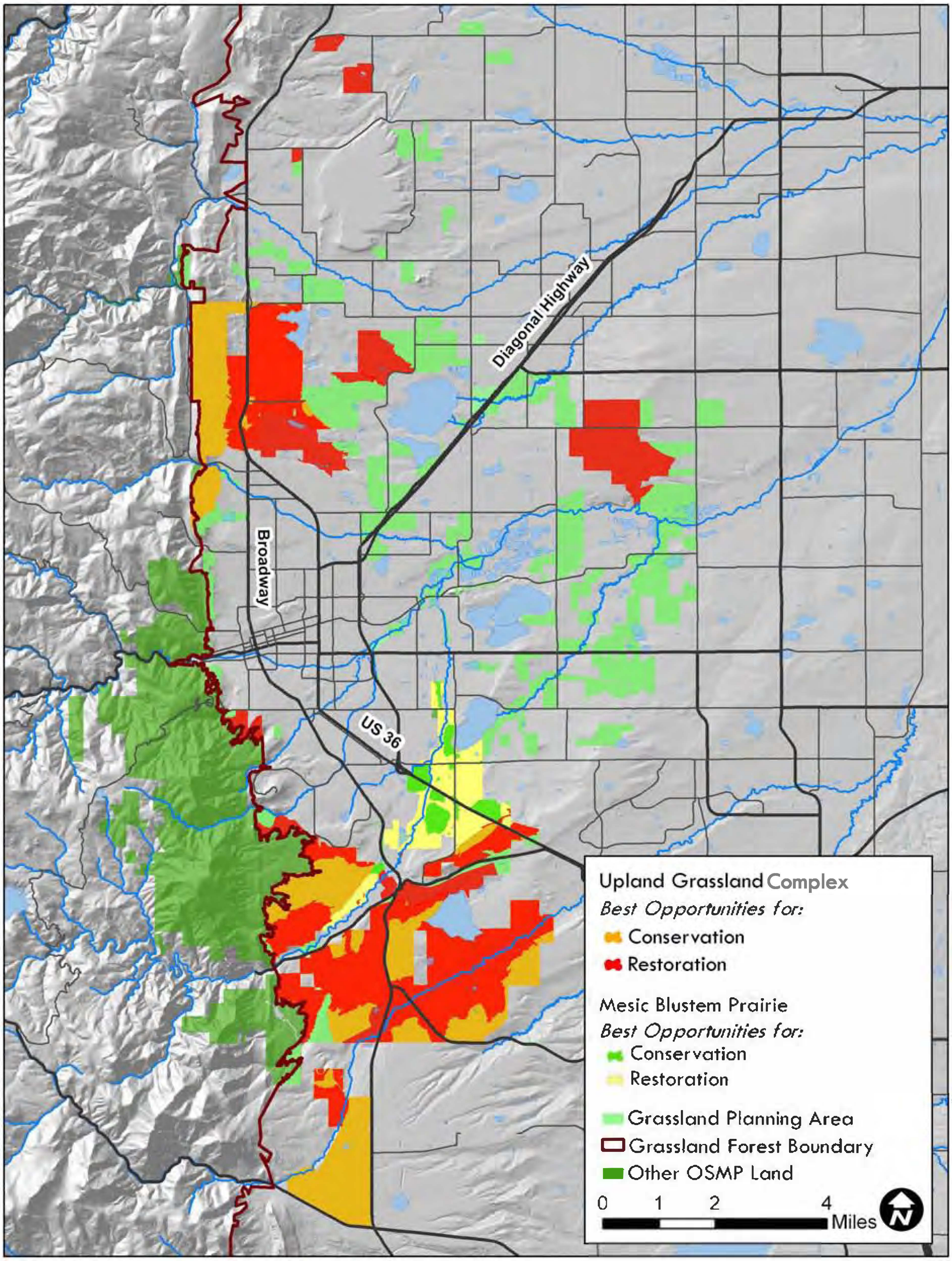


Figure 20: Best Opportunities for conservation and restoration of Upland Grassland Complex (Mixedgrass Prairie and Xeric Tallgrass Prairie) and Mesic Bluestem Prairie

Agricultural Operations

Interest in locating the best opportunities for agriculture dates from the 1970's when federal, state and local agencies developed agricultural land designations in response to unprecedented rates of farmland loss. These designations were used to prioritize lands for agricultural preservation by local municipalities and non-governmental organizations. In Boulder County, significant agricultural lands (sometimes referred to as "prime farmland") are generally irrigated lands with adequate water supply.

Figure 21 shows designations of national, statewide and local agricultural significance. **Table 33** summarizes the criteria used by government agencies to identify the significant agricultural land. The Boulder County Comprehensive Plan Environmental Resources Element (Boulder County 1986) contains details of agricultural land significance criteria. Some lands shown as significant agricultural lands are not irrigated. These discrepancies are due to coarse level mapping, changes in irrigation practices since the designations were made and the inclusion of unirrigated rangelands, high potential dry croplands (Gunbarrel Hill) and lands with high potential for irrigated agriculture but which lack an adequate water supply.


Irrigation

OSMP staff's analysis identified irrigated lands as the best opportunity for agriculture. Even though variations in soil and water availability create a diversity of conditions in irrigated fields, taken as a whole, irrigated lands are the most agriculturally productive in the GPA.

Managing irrigated lands for agriculture also lowers OSMP's management costs and protects the value of the city's water rights. Applying irrigation water is time-consuming, difficult work that requires special skills and knowledge. Although staff irrigates some areas, it would be extremely expensive to hire staff to run water on the extensive areas of irrigated land.

Managing irrigated lands for agriculture protects the value of OSMP's water rights by helping to ensure the water will be used. As long as irrigated lands are managed for agriculture, lessees are motivated to use the associated water rights diligently. However, water rights can be endangered when they are not exercised. Water rights can be jeopardized when irrigated fields are managed in a manner that is incompatible with agricultural production and lessees do not irrigate or irrigate fully. **Figure 22** shows the BOAs for Agricultural Operations (i.e. irrigated lands).

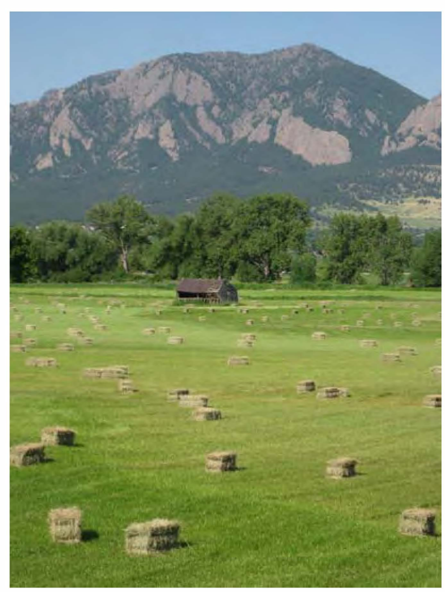

Irrigated Hay Field photo – Whit Johnson

Table 33: Lands of agricultural significance

Significance/Responsible Agency	Basis of Designation	Extent in GPA
National "Prime Farmland" US Department of Agriculture Soil Conservation Service (SCS-now Natural Resource Conservation Service)	Soil moisture regime, soil temperature regime, drainage characteristics, slope, erodibility, soil chemistry, rockiness soil profile, irrigation, and length of growing season.	**1,950 acres (788 ha)**
State "Lands of Agricultural Significance" Colorado Departments of Agriculture and Natural Resources	*Soils that did not meet prime farmland criteria* and are important for the production of food, feed, fiber, forage or oilseed crops including: a) Irrigated lands b) Lands that would be prime farmland but lack adequate water supply c) High potential dry croplands	**4,199 acres (1700 ha)**
County "Agricultural Lands of Local Significance" Boulder County Extension Office Longmont office of the SCS	Three categories of lands, which because of current and historic use and inherent soil properties are the County's most productive agricultural lands: a) Irrigated cropland b) Dry cropland c) Rangeland	**2,323 acres (940 ha)**

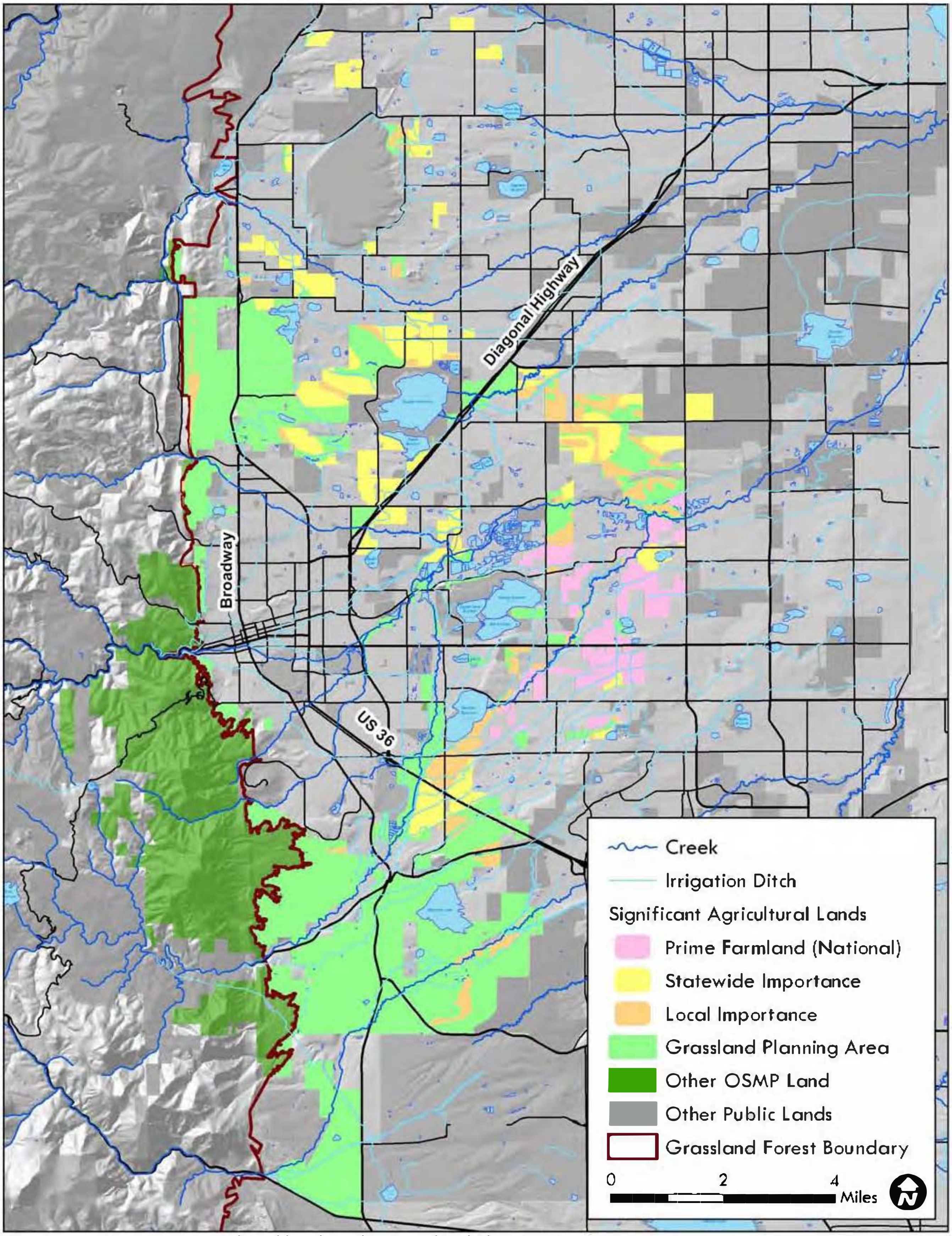


Figure 21: Significant agricultural lands in the Grassland Planning Area

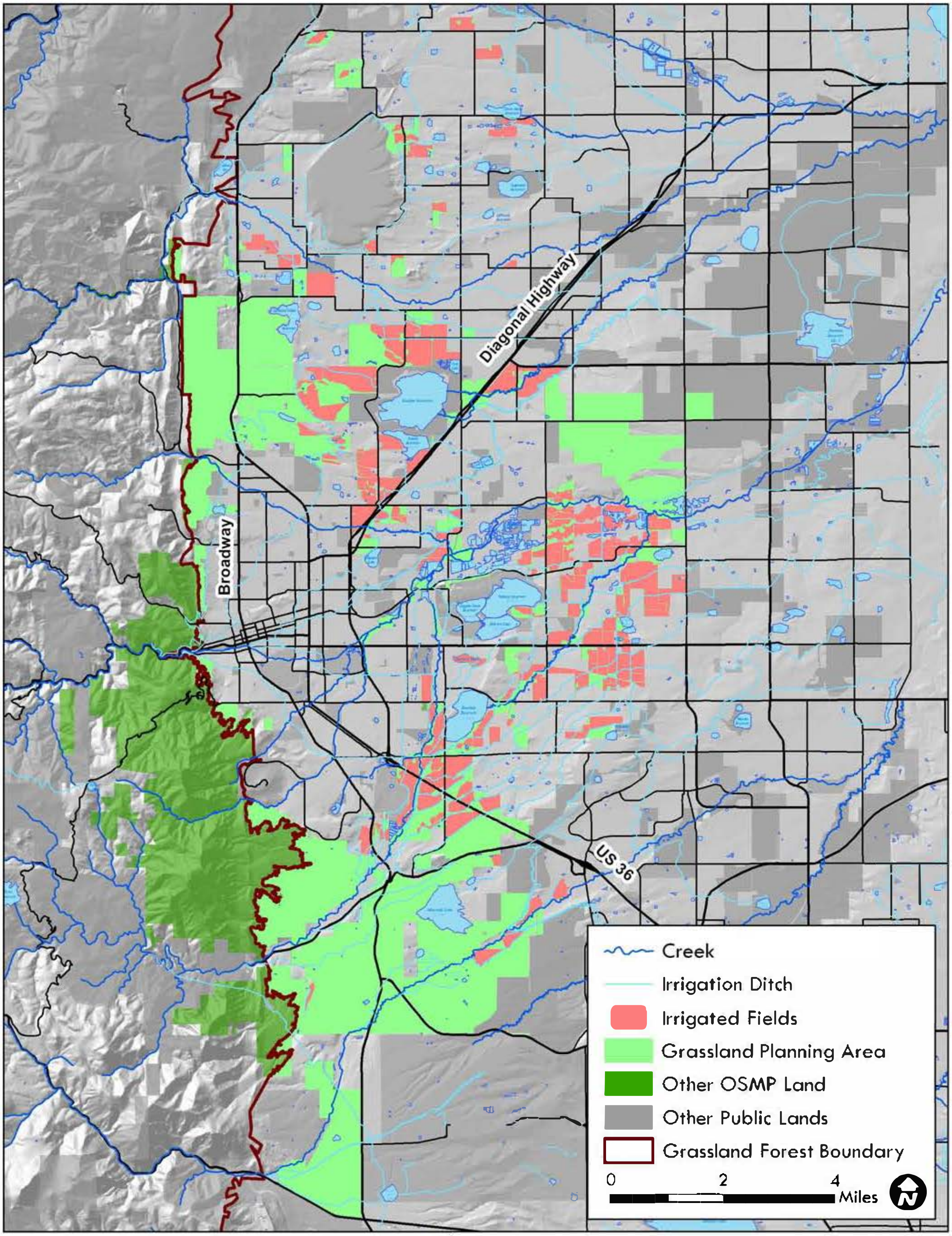


Figure 22: Irrigated fields/Best Opportunity Areas for agriculture in the GPA

Black Tailed-Prairie Dog and Associates

The best opportunity analysis for conserving the black-tailed prairie dog and its associates considers the habitat needs of the prairie dog and design criteria to conserve associated species that are area-sensitive, wide-ranging and sensitive to recreational activities. The best opportunity to conserve prairie dogs and their associates also integrates compatibility with the viability of the other Grassland Plan targets and, to the degree possible, adjacent land use.

Ecological Habitat Suitability
OSMP developed a black-tailed prairie dog Habitat Suitability Model (HSM) using information about vegetation type, slope, soil texture and soil depth. The model characterizes a gradient of habitat suitability and predicts where the most suitable black-tailed prairie dog habitat occurs in the GPA. The results of the HSM were compared to the maximum extent[13] of prairie dogs (1996-2008).

Staff checked the results of the model and found that the majority of "on-the-ground" prairie dog occupancy overlapped with areas identified by the model as "More Suitable". Field visits determined that areas identified as "unsuitable" were generally not used by prairie dogs. **Figure 23** shows the distribution of habitat suitability ratings and the maximum extent of prairie dogs from 1996 through 2008. A detailed description of the HSM is included in **Appendix H**.

Block Size
One of the chief distinctions in identifying best opportunities for the ecological system that includes prairie dogs versus best opportunities for prairie dogs themselves is the size of conservation areas. While prairie dogs can persist in small or large areas, many of the associated species are more likely to occur in larger grassland complexes. Larger areas offer greater prey availability, a wider diversity of vegetation structure, greater likelihood of perch and nesting sites and potentially greater relief from competition with other species. In addition, larger blocks of habitat support larger populations of prairie dogs and common associates. They also tend to have less edge and fewer opportunities for conflicts with neighboring landowners.

Urbanization
Biologists working on OSMP lands have found that bird populations are affected by proximity to urbanization. Urbanization can negatively affect raptors and songbirds through habitat alteration, habitat loss and fragmentation, and direct interference at nesting and roosting sites. Research on OSMP lands has shown that blocks of grassland habitat more distant from urbanization are more likely to attract several of the raptor species identified as sensitive predators (bald eagles, ferruginous hawks, rough-legged hawks and prairie falcons) (Berry et al. 1998).

[13] "Maximum Extent" refers to sum of all areas where prairie dogs occupancy has been recorded from 1996-2008. Prairie dogs have never been recorded to occupy the Total Aggregate Distribution (i.e. "Maximum Extent") at one time.

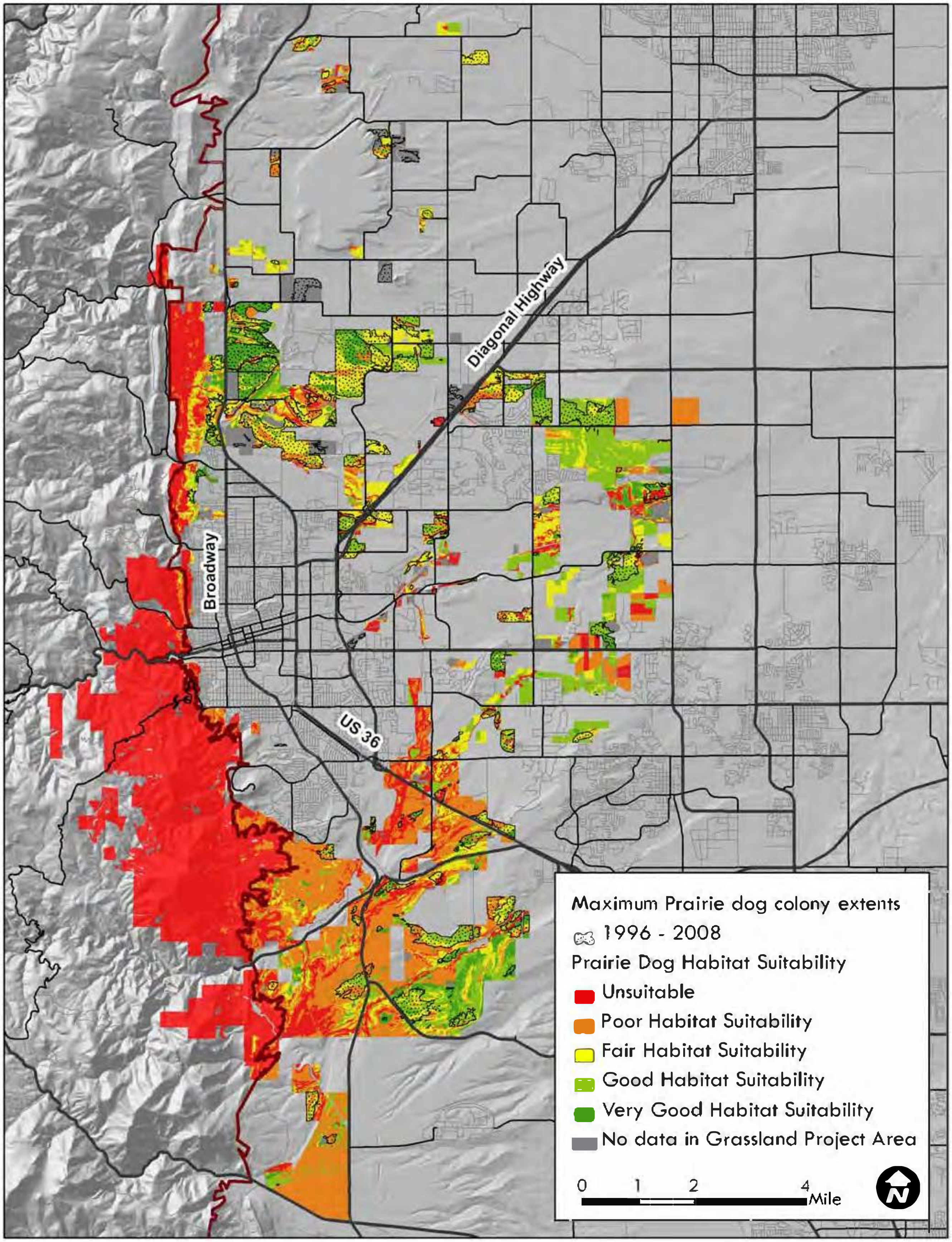


Figure 23: Results of black-tailed prairie dog Habitat Suitability Model

Value to Community

The Boulder community values prairie dogs as a native grassland species alone and in their ability to support other associated species. Prairie dogs provide opportunities for scientific research, education and wildlife viewing. OSMP assessed the need to conserve adequate prairie dog acreage to allow the Boulder community continued opportunities to enjoy prairie dogs and their associated species.

Recreational Activities

Recreational activities can adversely affect wildlife (see meta-analyses in Liddle 1997, Knight and Gutzwiller 1995, Hammit and Cole 1987). For example, researchers working in OSMP grasslands found that prairie dogs significantly reduce the time they spend foraging while avoiding dogs (Bekoff and Ickes 1999). Reduced time foraging can reduce prairie dogs' ability to overwinter or reproduce. Recreational trails are correlated with elevated levels of mortality due to nest predation of nesting birds (Miller and Hobbs 2000). Biologists working on OSMP have also demonstrated that grassland songbirds avoid areas near trails for nesting; and nest survival decreases with increasing proximity to trails (Miller et al. 1998). In order to reduce the impacts of recreation, OSMP assessed habitat blocks that have relatively low trail density and relatively large un-trailed areas in designating best opportunity blocks for this target.

Irrigated Agriculture

Irrigated pastures, hayfields and croplands were not considered as potential best opportunity blocks for prairie dogs and their associates. Irrigation and associated agricultural practices are incompatible with the life history requirements of prairie dogs and most associated species. Burrowing and feeding by prairie dogs in irrigated fields are likewise incompatible with agricultural production and water management.

Adjacent Land Management

Prairie dogs are considered unwanted by many adjacent private property owners. OSMP regularly receives complaints from neighbors concerned about impacts to their property caused by prairie dogs. Prairie dogs can also conflict with public land management. For example, developed city parks lie adjacent to OSMP lands inhabited by prairie dogs. When prairie dogs move onto parks, their presence often reduces the city's ability to deliver valued community services. On the other hand, some neighboring land management agencies including the city's Parks and Recreation department, Boulder County Open Space, and the Rocky Flats National Wildlife Refuge have prairie dog conservation objectives for properties lying adjacent to OSMP. OSMP has sought to identify sites where adjacent land management is most compatible with conservation of this target.

Management Area Designations for Black-tailed Prairie Dog and Associates

By integrating the factors described above, OSMP identified management areas and designation criteria (**Table 34**). These criteria were applied to establish five management designations (**Figure 24**). These criteria will be used in the future to designate any newly established colony on OSMP or colonies on newly acquired properties.

Table 34: Prairie dog colony designation criteria

Criteria for Designation as a Grassland Preserve:

1. Current or recent history of multiple prairie dog colonies (complex of colonies) within grassland block
2. Extensive areas of habitat ranked "Good Habitat Suitability" or "Very Good Habitat Suitability"
3. Large block of grassland habitat
4. Minimal irrigated agricultural use on property that conflicts with prairie dog occupancy
5. Minimal surrounding land use conflicts
6. Minimal conflict with other Grassland Plan targets
7. Distant from urban area (relatively speaking)
8. Not bisected by roads
9. Proximity to other lands managed for grassland conservation, or for prairie dogs and associated species

Criteria for Designation in Other Management Categories:

1. Sensitive associated species known to occur or suspected to occur in the colony (Sensitive associated species are ferruginous hawk, rough-legged hawk, northern harrier, golden eagle, American badger and burrowing owl.)
2. Good or Very Good Habitat Suitability based on Ecological Habitat Suitability Model
3. No conflict with OSMP irrigated agricultural uses or other city department land uses
4. No significant recent restoration history or investment (completed within past 10 years or "in-progress" as defined by restoration criteria)
5. Directly adjacent to Grassland Preserve Area
6. No significant or rare plant communities intolerant of prairie dogs

- **Multiple Objective Area (MOA)**
  5 or more criteria met,
  or criteria #3, #4, and #6 met
  or presence of badger or nesting burrowing owls (regardless of number of criteria met)
- **Transition Area**
  3-4 criteria met and criteria #3 or #4 or #6 not met
- **Removal Area**
  0-2 criteria met
- **Prairie Dog Conservation Area:**
  Meets criteria #3, #4, #6, and landscape context, plant communities and other site characteristics make it appropriate

The following exceptions apply to the designation criteria:

- If criterion #1 applies, colony cannot be designated a Removal Area.
- If presence of burrowing owl or badger is confirmed, colony must be designated as a Grassland Preserve or Multiple Objective Area[14].
- If colony is irrigated agricultural land and is not embedded in a grassland preserve, it must be designated as either a transition area or removal area.

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[14] Burrowing owls tend to return each spring to the same areas to nest. However, there can be as much as a five-year gap between nesting attempts. OSMP will annually evaluate prairie dog colonies to determine if they should be maintained as a MOA or Grassland Preserve. The determination will be based upon a variety of criteria including, but not limited to, the number of years since last use, reproductive success of last nesting attempt, level of human and dog activity.

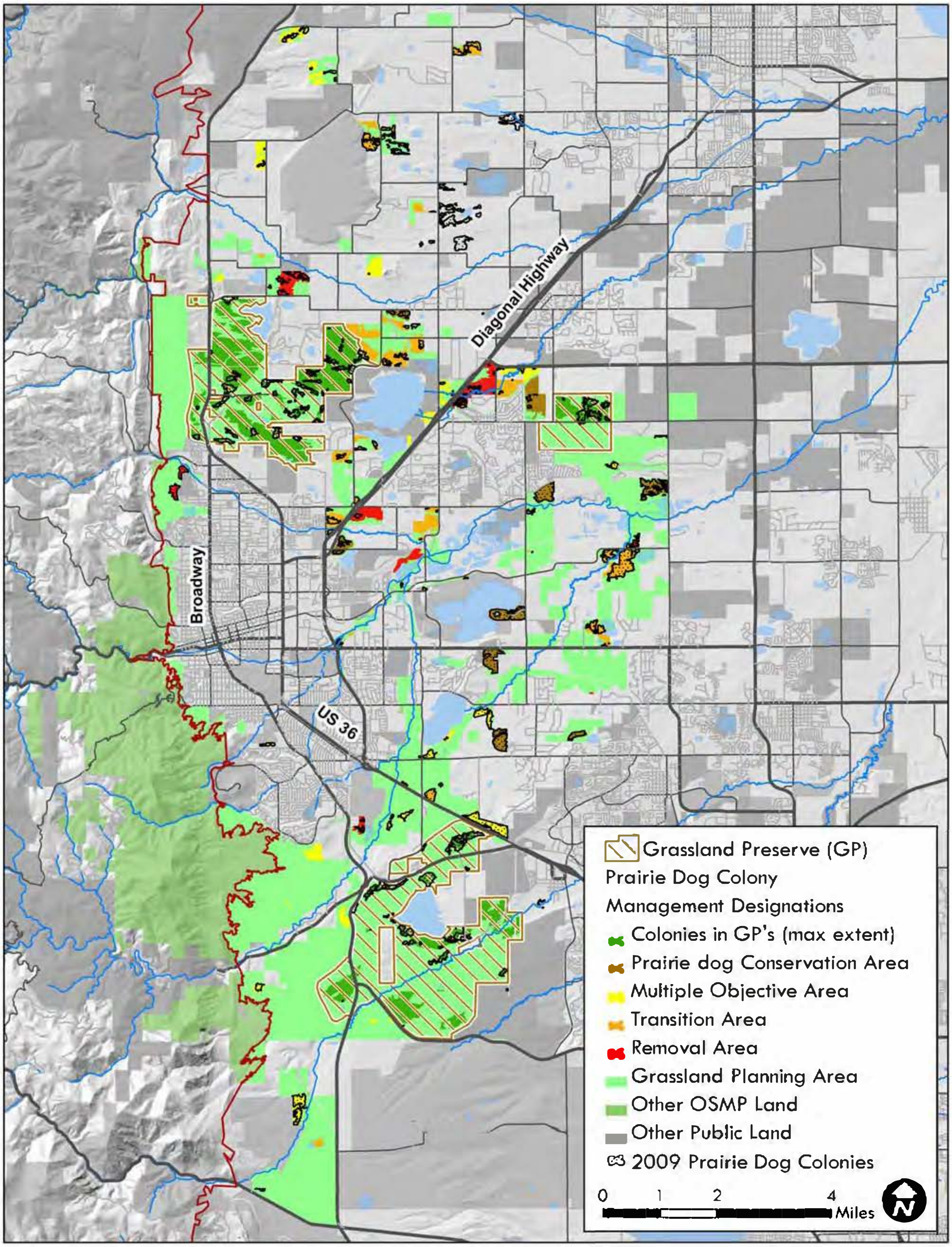

Figure 24: Prairie dog colony management designations

<u>Grassland Preserves (GP)</u>
Grassland Preserves are areas where prairie dogs and their associated species are part of large and ecologically diverse grassland habitat blocks. These areas are considered the best opportunity to conserve prairie dogs and their associated species. In most cases, prairie dogs will be allowed to persist without removal in Grassland Preserves. However, removal will be allowed for the purposes of maintaining existing irrigation facilities such as headgates, ditches, lateral ditches, reservoirs and irrigated fields. In addition, to ensure protection of habitat within Grassland Preserves, the need for limited removal from a Grassland Preserve will be assessed if prairie dogs occupy more than 26% of the Grassland Preserve (i.e. viability drops below "Good") and indicators of vegetation composition fall below thresholds identified in relocation criteria (**Appendix I**). Inactive, previously occupied colonies within Grassland Preserves could serve as relocation receiving sites (where there is an existing burrow infrastructure) and if the area meets relocation criteria (**Appendix I**). However, prairie dogs will not be relocated into irrigated fields nested within Grassland Preserves. Following a die-off or other disappearance of prairie dogs from an area, they could be excluded to allow for habitat restoration or to protect existing habitat restoration projects.

While Grassland Preserves contain significant extents of habitat suitable for prairie dogs, they also contain less suitable habitat (**Figure 25**).

<u>Multiple Objective Areas (MOA)</u>
In Multiple Objective Areas, preservation of prairie dogs and their associated community is one of several management objectives. Prairie dogs will be allowed to persist without removal except for the purpose of maintaining existing irrigation facilities such as headgates, ditches, lateral ditches, reservoirs or irrigated fields. MOAs will not be used as receiving sites for relocated prairie dogs. Exclusion of prairie dogs attempting to re-colonize an MOA could occur to allow habitat recovery.

<u>Prairie Dog Conservation Areas (PCA)</u>
PCAs are areas where the conservation of the prairie dog is the primary management objective and are managed opportunistically for associated species. These areas would serve as receiving sites for relocation with the minimum requirements described in the relocation criteria. No removal of prairie dogs would occur in PCAs except for the purpose of maintaining an existing irrigation facility such as a headgate, ditch, lateral ditch, reservoir or irrigated field. Prairie dogs will not be relocated into irrigated agricultural fields within PCAs.

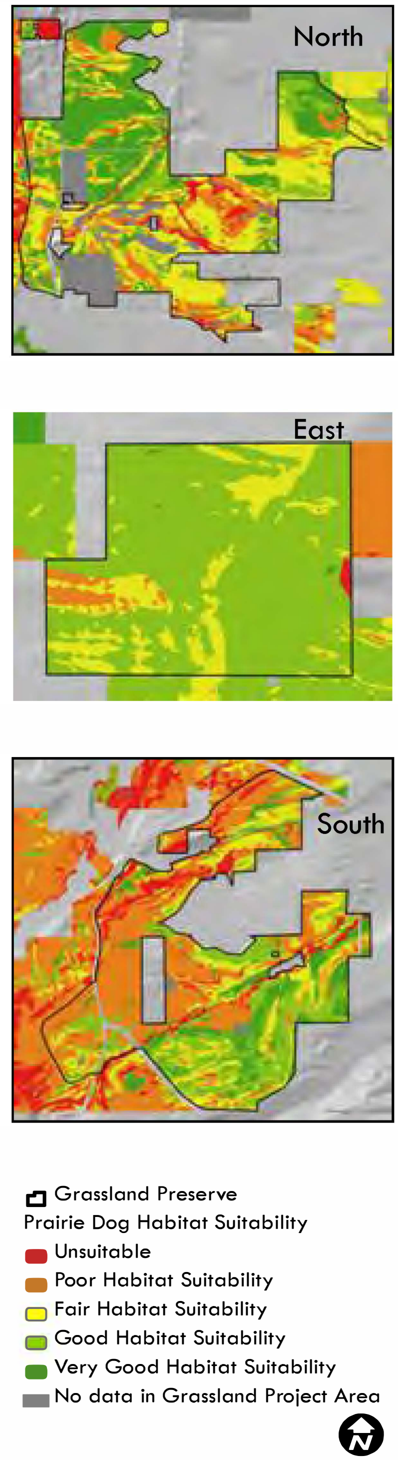

Figure 25: Habitat Suitability of Grassland Preserves

Transition Areas

Transition Areas are grassland areas where the preservation of conservation targets other than the prairie dog and associated community takes precedence. Prairie dogs may inhabit transition areas, but will be relocated away from the property when feasible (i.e. relocation receiving site available). Following relocation, die-off or other natural events such as dispersal that leads to a reduction of the population and result in uninhabited areas, re-colonization could be prevented or discouraged using barriers, re-seeding, grading, burrow destruction, passive relocation or other methods available to the department. After efforts are made to trap and relocate all remaining prairie dogs, removal through lethal control will be allowed in accordance with applicable regulations and policies, and if numbers do not exceed 20 individuals. Removal would be allowed at any time for maintenance of existing irrigation facilities such as a headgate, ditch, lateral ditch, reservoir or irrigated field. Continued irrigation will also be allowed in irrigated fields regardless of prairie dog occupancy.

Prairie Dog Relocation photo- Perry Conway

Removal Areas

In removal areas, prairie dogs are incompatible with OSMP management objectives. The designation of a property as a Removal Area provides the option to remove prairie dogs from the property in accordance with applicable regulations and policies. Following removal, efforts would occur to prevent re-colonization including restoration or irrigation of the property, destruction of burrow system, exclusion structures, etc. Continued irrigation will be allowed in irrigated fields regardless of prairie dog occupancy.

Wetlands and Riparian Areas

OSMP staff knowledgeable about wetland and riparian resources developed criteria to select best opportunity areas for conservation. Staff then used GIS data to identify areas where important resources (i.e. rare species and communities) overlap, trail and road density are relatively low, native species diversity is relatively high and large habitat blocks provide continuity or connectivity to other important habitats. Staff sought to identify the areas with fewest active conservation issues. At least one representative example of each wetland or riparian type on the OSMP landscape was included in the list of areas with the best opportunity for conservation or restoration. Specific considerations for identifying wetland and riparian BOAs are included:

- High occurrence of rare or sensitive species or communities (plants, reptiles, amphibians, birds, mammals, fish)
- High occurrence of native species or communities and low occurrence of non-native species
- High ecological functioning
- Little or no change in management needed to maintain viability

- Conservation issues are few and of low intensity
- Large block of riparian or wetland habitat connected to or contiguous with other "Good" quality habitat

Staff identified restoration opportunities based on the degree to which ecosystem functions have been altered by past or present land use. Ecosystem alteration was evaluated based on site conditions, historic records of land use (i.e. mining, grazing, dewatering) and staff's knowledge of OSMP lands. Best opportunities for restoration of the targets were identified using the following criteria:

- Remnants of previously high functioning ecosystems
- Indicator ratings of "Fair" or better
- Areas where partnerships are possible or funding for restoration is available
- Areas where restoration has been successful in the past and additional efforts would likely be effective

An unpriortized list of best opportunities to conserve and restore Wetland and Riparian Areas targets is included in **Appendix J. Figure 26** shows the approximate location of wetland and riparian best opportunity conservation and restoration areas.

Figure 27 shows the combined extent of all Best Opportunity Areas.

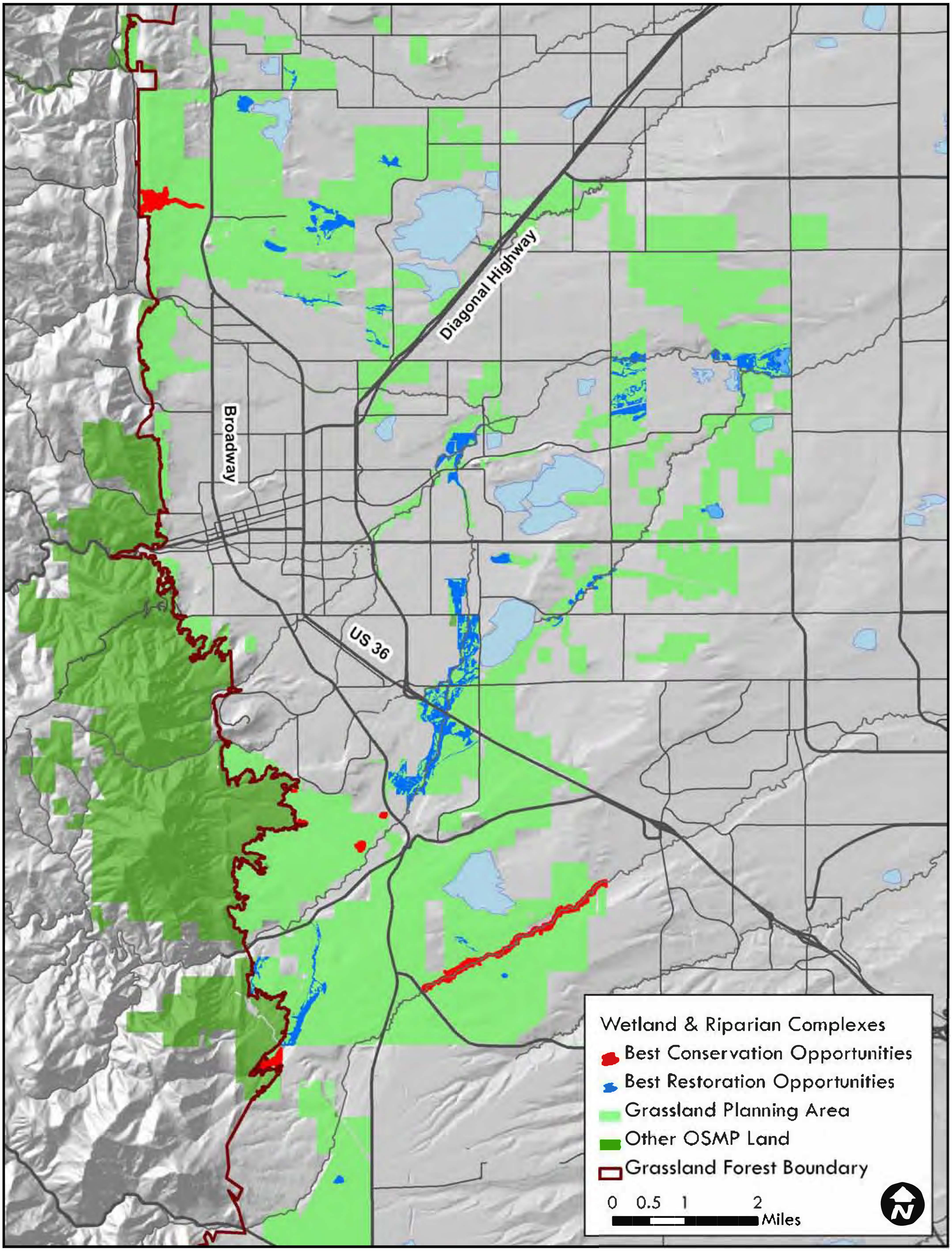

Figure 26: Wetland and Riparian Areas Best Opportunity Areas for conservation and restoration

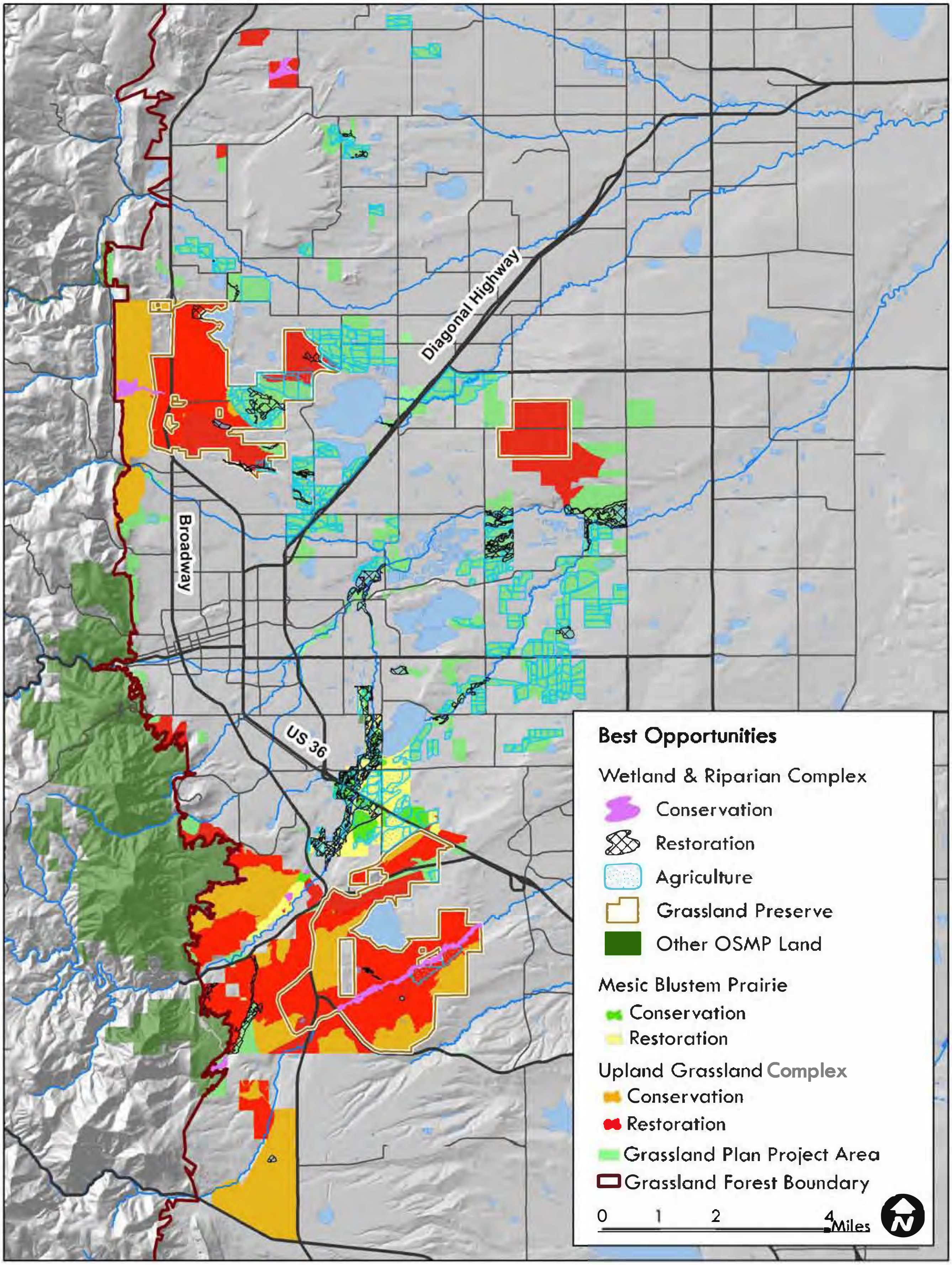

Figure 27: Grassland Plan Best Opportunity Areas

Chapter VI: Conservation Strategies

Chapter Summary
This chapter describes what successful implementation of the plan will look like, and the actions that OSMP will undertake to achieve success. Success is described in terms of 13 objectives for addressing the conservation issues and restoring the viability of targets. Thirty-five strategies have been selected based on an evaluation of their benefit, feasibility and cost. Like strategies have been packaged into six Grassland Conservation Initiatives.

Conservation Objectives

Conservation objectives are statements of what OSMP needs to accomplish. They are the ends towards which OSMP will be managing the Grassland Planning Area and serve as benchmarks for gauging successful implementation of the plan. There are 13 objectives for the Grassland Plan (**Table 35**).

Whenever possible, the objectives incorporate quantifiable measures of success. However, some of the objectives could not be quantified due to a lack of information. This Grassland Plan will undergo periodic review to assess progress made on identified objectives and quantify objectives as data become available.

Table 35: Conservation objectives for the Grassland Plan

1.1	By 2019, establish prairie dog, prairie dog commensal and prairie dog predator population levels and distributions within the ranges of acceptable variation.
1.2	By 2019, increase the bird conservation scores to at least 3.9 for the Mixedgrass Prairie Mosaic and Xeric Tallgrass Prairie.
1.3	By 2019, increase the frequency of singing male grasshopper sparrows in habitat blocks over 247 acres (100 ha) in the Mixedgrass Prairie Mosaic to 60%.
2.1	By 2019, reduce non-native plant species in Best Opportunity Areas of the Xeric Tallgrass Prairie, Mesic Bluestem Prairie, and Mixedgrass Prairie Mosaic targets to achieve at least a "Good" rating for prevalence.
2.2	By 2029, achieve "Good" rating for all vegetation composition and structure indicators in Best Opportunity Areas.
2.3	By 2019, increase fire frequency so that 50% of Upland Grassland Complex and Mesic Bluestem Prairie Best Opportunity Areas will have burned within the acceptable fire return interval.
3.1	By 2019, evaluate and restore riparian hydrology in Best Opportunity Areas.
3.2	By 2019, evaluate and restore wetland, riparian and aquatic habitat in Best Opportunity Areas.
3.3	By 2015, increase by three (3) the number of bullfrog-free ponds on OSMP-managed lands supporting northern leopard frogs.
3.4	Prevent an increase in the extent and diversity of aquatic nuisance species in the Grassland Planning Area.
3.5	By 2019, reduce the undesignated trail density in northern leopard frog habitat blocks to at most 13.4 ft/ac (10 m/ha).
4.1	Continue agricultural operations on OSMP lands to address the Charter Purposes of OSMP.
4.2	Establish or continue agricultural management practices that support habitat for Ute ladies-tresses orchid, bobolinks and other species of conservation concern.

Strategic Initiatives

OSMP has identified six strategic initiatives for implementing the Grassland Plan. The first four initiatives contain strategies intended to improve the viability of or reduce the number and/or level of conservation issues facing the Grassland Plan conservation targets. The initiatives include a brief description, statement of purpose and list the relevant conservation objectives including a brief description of each strategy.

Implementing
1. Large Block Habitat Effectiveness
2. Ecological Restoration
3. Aquatic System Management
4. Agro-Ecosystems

Supporting
5. Monitoring (See Chapter VII)
6. Capacity Building (See Chapter VIII)

The Grassland Plan includes 35 conservation strategies (**Table 37,** p. 126). The strategies have been rated to identify those with the greatest benefit, feasibility and cost effectiveness. Details about the factors that were used to determine benefit, feasibility and cost are outlined in **Table 36** and described in **Appendix K.**

Table 36: Criteria used for evaluating Grassland Plan conservation strategies (detailed methods provided in **Appendix** K)

Benefit	Feasibility	Cost
• Contribution toward improving viability • Contribution toward abating conservation issues • Scope and scale of outcome • Duration of outcome • Leverage toward successful implementation of other conservation actions	• Availability of lead individual to implement • Appeal to motivation of applicable community members • Ease of implementation ("do-ability")	• One time costs • Annual staffing • Annual materials and supplies

The final two initiatives include the important actions that need to be taken in support of initiatives one through four. They are focused upon monitoring the progress of the Grassland Plan and building capacity to take action.

The following section presents the Grassland Plan initiatives along with the associated conservation objectives and strategies. Because of the interrelatedness of the targets, many of the objectives have association with other initiatives, and several of the strategies help achieve objectives other than those under which they are listed. Every effort was made to place the conservation objectives and strategies where they had the most *direct* relevance. More detail about the Grassland Plan conservation strategies is included in **Appendix L**[15]. **Table 37** summarizes the ratings for benefit, feasibility and cost for each of the Grassland Plan conservation strategies.

[15] Several strategies appear under multiple objectives. Strategies are described and reference by number in **Appendix L** .

Initiative 1: Large Block Habitat Effectiveness

The focus of this initiative is to improve the conservation value of large habitat blocks so they are more likely to sustain the Grassland Plan targets.

Large blocks of Open Space and Mountain Parks grasslands are more likely than small blocks to be self-sustaining. Larger blocks are more likely to provide a full range of habitat variability, and a wider range of natural disturbances, and therefore more likely to support the habitat needs of a wider range of species—both plant and animal. These areas are also necessary to conserve species requiring large areas. Large habitat blocks also tend to be the OSMP lands most distant from urbanization and represent the best opportunity to conserve species sensitive to the effects of urbanization. OSMP can take advantage of the potential of large habitat blocks areas by adjusting policies affecting use, changing on-the-ground management, and finding opportunities to establish compatible practices on adjacent lands.

Conservation Objective 1.1
By 2019, establish prairie dog, prairie dog commensal and prairie dog predator populations and population distribution within the range of acceptable variation.

Strategy #	Strategy	Rating
2	Enhance prescribed grazing program through improvements to fencing, livestock watering facilities, stocking rate and seasonal use adjustments, and the establishment of one or more grass banks	Very High
4	Minimize the adverse effects of trail development in areas of special conservation value or sensitivity within the Grassland Planning Area, as part of TSA planning	Very High
7	Identify high-value grassland bird nesting areas and consider enacting seasonal protection measures through the TSA planning process, and, when necessary, prior to TSA planning	Very High
11	Develop a protocol to coordinate relocation of prairie dogs onto OSMP lands that is compatible with both the Urban Wildlife Management Plan and the Grassland Plan	Very High
14	Establish, maintain, remove and exclude prairie dog colonies in accordance with prairie dog management designations	High
17	Collaborate with neighboring land management agencies to establish compatible land management practices	High
19	Promote conservation of the Grassland Plan targets by increasing awareness of grassland values and conservation issues	High
22	Construct or maintain hunting perches near reservoirs and prairie dog colonies to encourage use by raptors	High
23	Construct and maintain alternate nesting structures for sensitive raptors in best opportunity sites	High

Strategy #	Strategy	Rating
24	Consider closing, restoring and discouraging the (re) establishment of undesignated trails in areas of special conservation value or sensitivity as part of the TSA planning process, and if necessary, prior to TSA planning	High
25	Consider establishing on-leash requirements in areas of special conservation value or sensitivity as part of the TSA planning process, and, if necessary, prior to TSA planning	High
26	Consider providing additional no-dog opportunities to protect areas of conservation value and sensitivity as a part of TSA planning	High
27	Consider changes to the VMP management area designation in part of the Gunbarrel/Heatherwood Passive Recreation Area to "Natural Area" as part of the TSA planning process, or prior to TSA planning	Medium
35	Assess changes to agricultural and water management in the Northern Grassland Preserve to achieve sustainability of numerous Grassland Plan targets.	Medium

Conservation Objective 1.2
By 2019, increase the bird conservation scores to at least 3.9 for the Mixedgrass Prairie Mosaic and Xeric Tallgrass Prairie.

Strategy #	Strategy	Rating
7	Identify high-value grassland bird nesting areas and consider enacting seasonal protection measures through the TSA planning process, and, when necessary, prior to TSA planning	Very High
12	Establish specific indicators and acceptable ranges of variation to fill information gaps	Very High
13	Treat non-native plant species in the grassland planning area using appropriate integrated pest management techniques	High
14	Establish, maintain, remove and exclude prairie dog colonies in accordance with prairie dog management designations	High
15	Construct, repair, enhance and maintain irrigation delivery system	High
18	Create a large block of conserved grassland in the northern portion of the OSMP land system through acquisitions and management agreements	High
19	Promote conservation of the Grassland Plan targets by increasing awareness of grassland values and conservation issues	High
22	Construct or maintain hunting perches near reservoirs and prairie dog colonies to encourage use by raptors	High

Strategy #	Strategy	Rating
24	Consider closing, restoring and discouraging the (re) establishment of undesignated trails in areas of special conservation value or sensitivity as part of the TSA planning process, and if necessary, prior to TSA planning	High
25	Consider establishing on-leash requirements in areas of special conservation value or sensitivity as part of the TSA planning process, and, if necessary, prior to TSA planning	High
26	Consider providing additional no-dog opportunities to protect areas of conservation value and sensitivity as a part of TSA planning	High
27	Consider changes to the VMP management area designation in part of the Gunbarrel/Heatherwood Passive Recreation Area to "Natural Area" as part of the TSA planning process, or prior to TSA planning	Medium
28	Identify and obtain water rights needed to support irrigated agriculture	Medium
30	Remove trees from grasslands at 75% of best opportunity sites	Medium

Conservation Objective 1.3
By 2019, increase the frequency of singing male grasshopper sparrows in habitat blocks over 247 acres (100 ha) in the Mixedgrass Prairie Mosaic to 60%.

Strategy #	Strategy	Rating
1	Develop a safe and effective prescribed fire program for the Grassland Planning Area	Very High
2	Enhance prescribed grazing program through improvements to fencing, livestock watering facilities, stocking rate and seasonal use adjustments, and the establishment of one or more grass banks	Very High
4	Minimize the adverse effects of trail development in areas of special conservation value or sensitivity within the Grassland Planning Area, as part of TSA planning	Very High
7	Identify high-value grassland bird nesting areas and consider enacting seasonal protection measures through the TSA planning process, and, when necessary, prior to TSA planning	Very High
13	Treat non-native plant species in the grassland planning area using appropriate integrated pest management techniques	High
14	Establish, maintain, remove and exclude prairie dog colonies in accordance with prairie dog management designations	High
19	Promote conservation of the Grassland Plan targets by increasing awareness of grassland values and conservation issues	High

Strategy #	Strategy	Rating
24	Consider closing, restoring and discouraging the (re) establishment of undesignated trails in areas of special conservation value or sensitivity as part of the TSA planning process, and if necessary, prior to TSA planning	High
25	Consider establishing on-leash requirements in areas of special conservation value or sensitivity as part of the TSA planning process, and, if necessary, prior to TSA planning	High
26	Consider providing additional no-dog opportunities to protect areas of conservation value and sensitivity as a part of TSA planning	High
27	Consider changes to the VMP management area designation in part of the Gunbarrel/Heatherwood Passive Recreation Area to "Natural Area" as part of the TSA planning process, or prior to TSA planning	Medium
30	Remove trees from grasslands at 75% of best opportunity sites	Medium

Initiative 2: Ecological Restoration

This initiative focuses on improving ecological processes and conditions to acceptable levels as defined by the viability indicator ratings for the eight Grassland Plan targets. These improvements will benefit both ecological viability and agricultural sustainability.

Persistent effects of historic land uses are partially responsible for current unacceptable conditions of grassland targets. The Grassland Plan establishes indicator ratings that describe OSMP's best thinking about acceptable conditions and processes. A small number of high-leverage actions have been identified to return the ecosystems of the Grassland Planning Area to acceptable condition and landscape context.

Restoration objectives and strategies identified under this initiative will be folded into the OSMP Restoration Legacy Program, which is developing projects to address system-wide restoration needs. The Restoration Legacy Project was identified as a high priority initiative during a strategic planning process completed by OSMP in 2007.

In 2009, the Restoration Legacy team identified approximately 50 projects in the Grassland Planning Area. The specific projects will mobilize planting, earthmoving, hydrological modification and fencing to restore native vegetation and habitats. The Legacy Program approach to coordinating restoration on a system-wide basis is one way that the Grassland Plan strategies will be integrated into the department's annual work plan.

Conservation Objective 2.1
By 2019, reduce non-native plant species in Best Opportunity Areas of the Xeric Tallgrass Prairie, Mesic Bluestem Prairie, and Mixedgrass Prairie Mosaic targets to achieve at least a "Good" rating for prevalence.

Strategy #	Strategy	Rating
1	Develop a safe and effective prescribed fire program for the Grassland Planning Area	Very High
2	Enhance prescribed grazing program through improvements to fencing, livestock watering facilities, stocking rate and seasonal use adjustments, and the establishment of one or more grass banks	Very High
3	Manage agricultural activities to minimize soil erosion and protect soil fertility	Very High
4	Minimize the adverse effects of trail development in areas of special conservation value or sensitivity within the Grassland Planning Area, as part of TSA planning	Very High
13	Treat non-native plant species in the grassland planning area using appropriate integrated pest management techniques	High
14	Establish, maintain, remove and exclude prairie dog colonies in accordance with prairie dog management designations	High
17	Collaborate with neighboring land management agencies to establish compatible land management practices	High
18	Create a large block of conserved grassland in the northern portion of the OSMP land system through acquisitions and management agreements	High
19	Promote conservation of the Grassland Plan targets by increasing awareness of grassland values and conservation issues	High
24	Consider closing, restoring and discouraging the (re) establishment of undesignated trails in areas of special conservation value or sensitivity as part of the TSA planning process, and if necessary, prior to TSA planning	High

Conservation Objective 2.2
By 2029, achieve “Good” rating for all vegetation composition and structure indicators in Best Opportunity Areas.

Strategy #	Strategy	Rating
1	Develop a safe and effective prescribed fire program for the Grassland Planning Area	Very High
2	Enhance prescribed grazing program through improvements to fencing, livestock watering facilities, stocking rate and seasonal use adjustments, and the establishment of one or more grass banks	Very High
3	Manage agricultural activities to minimize soil erosion and protect soil fertility	Very High

Strategy #	Strategy	Rating
4	Minimize the adverse effects of trail development in areas of special conservation value or sensitivity within the Grassland Planning Area, as part of TSA planning	Very High
13	Treat non-native plant species in the grassland planning area using appropriate integrated pest management techniques	High
14	Establish, maintain, remove and exclude prairie dog colonies in accordance with prairie dog management designations	High
18	Create a large block of conserved grassland in the northern portion of the OSMP land system through acquisitions and management agreements	High
19	Promote conservation of the Grassland Plan targets by increasing awareness of grassland values and conservation issues	High
30	Remove trees from grasslands at 75% of best opportunity sites	Medium

Conservation Objective 2.3
By 2019, increase fire frequency so that 50% of Upland Grassland Complex and Mesic Bluestem Prairie Best Opportunity Areas will have burned within the acceptable fire return interval.

Strategy #	Strategy	Rating
1	Develop a safe and effective prescribed fire program for the Grassland Planning Area	Very High
17	Collaborate with neighboring land management agencies to establish compatible land management practices	High
18	Create a large block of conserved grassland in the northern portion of the OSMP land system through acquisitions and management agreements	High
19	Promote conservation of the Grassland Plan targets by increasing awareness of grassland values and conservation issues	High

Initiative 3: Aquatic Systems Management

This initiative focuses on wetlands, riparian areas, creeks and ponds.

Aquatic systems on OSMP lands support biodiversity well out of proportion to their relatively small size. These same areas are also identified as having low viability and high level of conservation issues.

Conservation Objective 3.1
By 2019, evaluate and restore riparian hydrology in Best Opportunity Areas.

Strategy #	Strategy	Rating
15	Construct, repair, enhance and maintain irrigation delivery system	High
16	Establish instream flows in South Boulder Creek and Coal Creek	High
19	Promote conservation of the Grassland Plan targets by increasing awareness of grassland values and conservation issues	High

Conservation Objective 3.2
By 2019, evaluate and restore wetland, riparian and aquatic habitat in Best Opportunity Areas.

Strategy #	Strategy	Rating
2	Enhance prescribed grazing program through improvements to fencing, livestock watering facilities, stocking rate and seasonal use adjustments, and the establishment of one or more grass banks	Very High
3	Manage agricultural activities to minimize soil erosion and protect soil fertility	Very High
4	Minimize the adverse effects of trail development in areas of special conservation value or sensitivity within the Grassland Planning Area, as part of TSA planning	Very High
5	Construct and maintain fish passage structures along South Boulder Creek and Boulder Creek	Very High
6	Improve aquatic habitat in South Boulder Creek	Very High
9	Manage Ute ladies-tresses orchid habitat with compatible grazing, haying and irrigation practices	Very High
10	Refrain from mowing the "Class A Bobolink Management Areas" until after bobolink fledging (July 15 unless otherwise determined)	Very High
15	Construct, repair, enhance and maintain irrigation delivery system	High
16	Establish instream flows in South Boulder Creek and Coal Creek	High
19	Promote conservation of the Grassland Plan targets by increasing awareness of grassland values and conservation issues	High
20	Protect Boulder Creek from the spread of New Zealand Mudsnails by restricting access to the creek between 55th Street and 75th Street	High
21	Continue integrated pest management efforts to remove Eurasian watermilfoil	High
23	Construct and maintain alternate nesting structures for sensitive raptors in best opportunity sites	High

Strategy #	Strategy	Rating
26	Consider providing additional no-dog opportunities to protect areas of conservation value and sensitivity as a part of TSA planning	High
28	Identify and obtain water rights needed to support irrigated agriculture	Medium
29	Establish and support the survival of plains cottonwoods and diverse and abundant shrub communities in riparian areas	Medium
31	Treat wetlands dominated by non-native or invasive species using appropriate integrated pest management techniques	Medium
32	Participate in native fish recovery efforts with the Colorado Division of Wildlife	Medium
34	Establish ten Class B Bobolink Management Areas and refrain from mowing each area until after bobolink fledging (July 15 unless otherwise determined) one year out of three	Medium

Conservation Objective 3.3
By 2015, increase by three (3) the number of bullfrog-free ponds on OSMP-managed lands supporting northern leopard frogs.

Strategy #	Strategy	Rating
8	Manage selected ponds as northern leopard frog breeding habitat	Very High
19	Promote conservation of the Grassland Plan targets by increasing awareness of grassland values and conservation issues	High

Conservation Objective 3.4
Prevent an increase in the extent and diversity of aquatic nuisance species in the Grassland Planning Area.

Strategy #	Strategy	Rating
17	Collaborate with neighboring land management agencies to establish compatible land management practices	High
19	Promote conservation of the Grassland Plan targets by increasing awareness of grassland values and conservation issues	High
20	Protect Boulder Creek from the spread of New Zealand Mudsnails by restricting access to the creek between 55th Street and 75th Street	High
21	Continue integrated pest management efforts to remove Eurasian watermilfoil	High
29	Establish and support the survival of plains cottonwoods and diverse and abundant shrub communities in riparian areas	Medium

Conservation Objective 3.5
By 2019, reduce the undesignated trail density in northern leopard frog habitat blocks to at most 13.4 ft/ac (10m/ha).

Strategy #	Strategy	Rating
2	Enhance prescribed grazing program through improvements to fencing, livestock watering facilities, stocking rate and seasonal use adjustments, and the establishment of one or more grass banks	Very High
24	Consider closing, restoring and discouraging the (re) establishment of undesignated trails in areas of special conservation value or sensitivity as part of the TSA planning process, and if necessary, prior to TSA planning	High
26	Consider providing additional no-dog opportunities to protect areas of conservation value and sensitivity as a part of TSA planning	High

Initiative 4: Agro-Ecosystems

This initiative focuses on sustaining agricultural uses while integrating agricultural and ecological conservation objectives.

Agriculture has played an important and dynamic role in shaping the Grassland Planning Area and providing services for people in the Boulder Valley. OSMP staff has adjusted and will continue to adjust agricultural management in response to changing markets and interests of local agricultural producers.

When and where biodiversity conservation objectives and agricultural management goals conflict, OSMP has worked to develop compatible management strategies. The Grassland Plan identifies specific opportunities to continue balancing and blending agricultural and ecological management.

Conservation Objective 4.1
Continue agricultural operations on OSMP lands to address the Charter Purposes of OSMP.

Strategy #	Strategy	Rating
2	Enhance prescribed grazing program through improvements to fencing, livestock watering facilities, stocking rate and seasonal use adjustments, and the establishment of one or more grass banks	Very High
3	Manage agricultural activities to minimize soil erosion and protect soil fertility	Very High
10	Refrain from mowing the “Class A Bobolink Management Areas” until after bobolink fledging (July 15 unless otherwise determined)	Very High
15	Construct, repair, enhance and maintain irrigation delivery system	High

Strategy #	Strategy	Rating
17	Collaborate with neighboring land management agencies to establish compatible land management practices	High
19	Promote conservation of the Grassland Plan targets by increasing awareness of grassland values and conservation issues	High
28	Identify and obtain water rights needed to support irrigated agriculture	Medium
33	Evaluate the suitability of alternative agricultural practices for OSMP lands	Medium
34	Establish ten Class B Bobolink Management Areas and refrain from mowing each area until after bobolink fledging (July 15 unless otherwise determined) one year out of three	Medium

Conservation Objective 4.2
Establish or continue agricultural management practices that support habitat for Ute ladies-tresses orchid, bobolinks and other species of conservation concern.

Strategy #	Strategy	Rating
1	Develop a safe and effective prescribed fire program for the Grassland Planning Area	Very High
2	Enhance prescribed grazing program through improvements to fencing, livestock watering facilities, stocking rate and seasonal use adjustments, and the establishment of one or more grass banks	Very High
9	Manage Ute ladies-tresses orchid habitat with compatible grazing, haying and irrigation practices	Very High
13	Treat non-native plant species in the grassland planning area using appropriate integrated pest management techniques	High
15	Construct, repair, enhance and maintain irrigation delivery system	High
19	Promote conservation of the Grassland Plan targets by increasing awareness of grassland values and conservation issues	High
28	Identify and obtain water rights needed to support irrigated agriculture	Medium
34	Establish ten Class B Bobolink Management Areas and refrain from mowing each area until after bobolink fledging (July 15 unless otherwise determined) one year out of three	Medium

Initiative 5: Monitoring (See Chapter VII-Monitoring)

The objective of this initiative is to implement "vital signs" monitoring of the Grassland Plan targets by OSMP staff, researchers and volunteers.

Monitoring of target viability, conservation issues and strategy effectiveness are at the heart of the **adaptive** ***management framework upon which the Grassland Plan is based. The Grassland Plan monitoring initiative is described in detail in Chapter VII.***

Initiative 6: Capacity Building (See Chapter VIII-Implementation)

This initiative is intended to attract external funding sources for Grassland Conservation. The discussion of capacity building is included in Chapter VIII.

Table 37: Grassland Plan strategies showing overall rating and ratings for benefit, feasibility and cost

Strategy #	Strategy	Overall Rank	Benefit	Feasibility	Cost
1	Develop a safe and effective prescribed fire program for the Grassland Planning Area	Very High	Very High	High	High
2	Enhance prescribed grazing program through improvements to fencing, livestock watering facilities, stocking rate and seasonal use adjustments, and the establishment of one or more grass banks	Very High	Very High	Very High	Very High
3	Manage agricultural activities to minimize soil erosion and protect soil fertility	Very High	Very High	High	Medium
4	Minimize the adverse effects of trail development in areas of special conservation value or sensitivity within the Grassland Planning Area, as part of TSA planning	Very High	Very High	Medium	Low
5	Construct and maintain fish passage structures along South Boulder Creek and Boulder Creek	Very High	Very High	Very High	Very High
6	Improve aquatic habitat in South Boulder Creek	Very High	Very High	Very High	Medium
7	Identify high-value grassland bird nesting areas and consider enacting seasonal protection measures through the TSA planning process, and, when necessary, prior to TSA planning	Very High	Very High	Medium	Medium
8	Manage selected ponds as northern leopard frog breeding habitat	Very High	Very High	Very High	Medium
9	Manage Ute ladies-tresses orchid habitat with compatible grazing, haying and irrigation practices	Very High	Very High	Very High	Low

Strategy #	Strategy	Overall Rank	Benefit	Feasibility	Cost
10	Refrain from mowing the "Class A Bobolink Management Areas" until after bobolink fledging (July 15 unless otherwise determined)	Very High	Medium	Very High	Low
11	Develop a protocol to coordinate relocation of prairie dogs onto OSMP lands that is compatible with both the Urban Wildlife Management Plan and the Grassland Plan	Very High	High	High	Low
12	Establish specific indicators and acceptable ranges of variation to fill information gaps	Very High	High	Very High	Low
13	Treat non-native plant species in the grassland planning area using appropriate integrated pest management techniques	High	Very High	High	Very High
14	Establish, maintain, remove and exclude prairie dog colonies in accordance with prairie dog management designations	High	Very High	Medium	Very High
15	Construct, repair, enhance and maintain irrigation delivery system	High	Very High	Medium	Very High
16	Establish instream flows in South Boulder Creek and Coal Creek	High	Very High	High	Very High
17	Collaborate with neighboring land management agencies to establish compatible land management practices	High	High	Medium	Medium
18	Create a large block of conserved grassland in the northern portion of the OSMP land system through acquisitions and management agreements	High	Very High	Medium	Very High
19	Promote conservation of the Grassland Plan targets by increasing awareness of grassland values and conservation issues	High	High	High	High

Strategy #	Strategy	Overall Rank	Benefit	Feasibility	Cost
20	Protect Boulder Creek from the spread of New Zealand Mudsnails by restricting access to the creek between 55th Street and 75th Street	High	Medium	High	Low
21	Continue integrated pest management efforts to remove Eurasian watermilfoil	High	High	High	High
22	Construct or maintain hunting perches near reservoirs and prairie dog colonies to encourage use by raptors	High	Medium	High	Low
23	Construct and maintain alternate nesting structures for sensitive raptors in best opportunity sites	High	Medium	High	Low
24	Consider closing, restoring and discouraging the (re) establishment of undesignated trails in areas of special conservation value or sensitivity as part of the TSA planning process, and if necessary, prior to TSA planning	High	High	Medium	Low
25	Consider establishing on-leash requirements in areas of special conservation value or sensitivity as part of the TSA planning process, and, if necessary, prior to TSA planning	High	High	Medium	Low
26	Consider providing additional no-dog opportunities to protect areas of conservation value and sensitivity as a part of TSA planning	High	High	Medium	Low
27	Consider changes to the VMP management area designation in part of the Gunbarrel/Heatherwood Passive Recreation Area to "Natural Area" as part of the TSA planning process, or prior to TSA planning	Medium	Medium	Medium	Low
28	Identify and obtain water rights needed to support irrigated agriculture	Medium	Medium	Very High	Very High

Strategy #	Strategy	Overall Rank	Benefit	Feasibility	Cost
29	Establish and support the survival of plains cottonwoods and diverse and abundant shrub communities in riparian areas	Medium	High	Medium	Very High
30	Remove trees from grasslands at 75% of best opportunity sites	Medium	High	Medium	Very High
31	Treat wetlands dominated by non-native or invasive species using appropriate integrated pest management techniques	Medium	High	Medium	Very High
32	Participate in native fish recovery efforts with the Colorado Division of Wildlife	Medium	Low	High	Low
33	Evaluate the suitability of alternative agricultural practices for OSMP lands	Medium	Low	Very High	Medium
34	Establish ten Class B Bobolink Management Areas and refrain from mowing each area until after bobolink fledging (July 15 unless otherwise determined) one year out of three	Medium	Medium	Medium	Low
35	Assess changes to agricultural and water management in the Northern Grassland Preserve to achieve sustainability of numerous Grassland Plan targets.	Medium	Medium	Medium	Low

Chapter VII: Monitoring

Chapter Summary
This chapter describes the monitoring approach for the Grassland Plan. Monitoring is used to:
1) Evaluate the effectiveness of specific strategies,
2) Track the status and trends of conservation issues facing the Grassland Plan targets and
3) Track the status and trends in the viability of the targets.
Monitoring projects are summarized and given a priority rating in **Appendix M.**


photo – Mark Crupi

Monitoring is an integral component of the adaptive management framework. Monitoring is the tool with which OSMP will determine whether the conservation strategies have been effective in achieving our conservation objectives. Monitoring will also allow OSMP to track the current status of our targets' viability as well as the level to which conservation issues are affecting the targets. Additionally, repeated monitoring allows the department to track the trends in targets' viability and conservation issues facing the targets.

Monitoring Objectives

Staff established the following monitoring objectives for the Grassland Plan:

Evaluate the effectiveness of specific strategies in achieving OSMP's conservation objectives.
In previous chapters, OSMP has outlined a variety of strategies it intends to implement to achieve its conservation objectives. At a minimum, OSMP intends to monitor the effectiveness of the highest priority strategies. This will allow staff to repeat effective strategies in other portions of the Grassland Planning Area and refine or abandon ineffective strategies.

Track current status and trends of the conservation issues affecting the conservation targets.
Staff has identified a number of conservation issues that degrade targets' viability. Examples of conservation issues include non-native plant and animal species. Tracking their presence and, in some cases, abundance within the Grassland Planning Area is important to assessing the long-term viability of the conservation targets. Tracking the trends of the sources of stress to the conservation targets will enable staff to allocate appropriate resources to managing these issues.

Track the status and trends in the conservation targets viability.
Most of the highest priority strategies are associated with key attributes of targets that are not currently within an acceptable range of variability. For example, implementing targeted integrated pest management strategies should help move the condition of the Mixedgrass Prairie Mosaic from "Fair" to "Good". In some cases, however, a given target may already be within the acceptable range of variability for most of its key attributes. This does not mean OSMP in uninterested in keeping track of the status of that target's key attributes. In fact, maintaining a target in the "Good" condition is often easier and less expensive than trying to improve its

condition once it is degraded. Monitoring the key attributes of targets that are already within an acceptable range of variability will help ensure targets in "Good" condition stay that way.

Establish additional indicators and acceptable ranges of variation to fill information gaps. OSMP staff identified the need to develop indicators for vegetation density as a component of grassland bird habitat, the viability of the threatened Preble's meadow jumping mouse, and rapid assessment of rangeland/grassland condition. More information about these indicators is included in **Appendix L.**

Coordinate with monitoring and data collection activities of other agencies and community groups. Other agencies and community groups are engaged in data collection activities within the Grassland Planning Area. For example, the Boulder County Audubon Society and Boulder County Nature Association track the status of avian species of concern throughout the county including species that inhabit the Grassland Planning Area. Information about the status and distribution of these species (all of them nested targets) is extremely valuable and can be used to inform management decisions. Similarly, Boulder County Parks and Open Space and the U.S. Fish and Wildlife Service may have monitoring information that would be useful to inform OSMP's conservation actions. Coordinating monitoring approaches among agencies could also make information sharing easier and reveal larger scale conditions and trends.

Monitoring Indicators

Appendix M contains a list of the indicators selected by staff to fulfill the monitoring objectives noted above. In addition to listing the indicators, **Appendix M** summarizes how (methods), when (sampling season and frequency), where (location), and who (lead and associated staff) will conduct the monitoring. **Appendix M** also includes information regarding whether OSMP is currently implementing the monitoring (i.e. "on going") or whether it is planned. For some indicators, OSMP is currently monitoring the indicator, but plans to enhance the current monitoring – often by expanding the monitoring to cover the entire Grassland Planning Area. These indicators have the word "Enhance" listed as their status.

Most importantly, the table establishes a priority for the monitoring. Prioritizing the monitoring ensures that staff is focused on measuring the effectiveness of the highest ranked strategies and/or tracking the greatest conservation issues facing the conservation targets. Staff gave a "Very High" ranking to the indicators associated with grassland vegetation composition and structure, grassland nesting birds, establishment prairie dog protection and native frog presence. "High" ranked monitoring indicators include those associated with rare plant species, sensitive birds, prairie dog associates, agricultural production and condition, aquatic faunal communities and habitat, non-native plant species and fire return interval.

All of the highly ranked monitoring indicators help fulfill one or more of the monitoring objectives. Most of the highly ranked indicators will help staff evaluate the effectiveness of the highly ranked strategies. For example, the grassland vegetation indicators will help staff evaluate the effectiveness of prescribed grazing regimes and IPM strategies. The grassland vegetation indicators will help staff track the status and trends in several targets' key attributes. Other highly ranked indicators, such as those associated with non-native plant species and fire return intervals, allow staff to monitor important conservation issues facing the targets. The agricultural production and condition indicator allows staff to monitor the status of the agricultural conservation target, even though the target is currently in acceptable condition.

Research

There are significant gaps in what land managers know about grassland ecology and managing for agricultural sustainability. Managers have more questions than answers about the key attributes of the targets, the nature of threats and the efficacy of management techniques. Boulder is well situated to benefit from research programs at both the University of Colorado and Colorado State University. In addition to policy guidance, acquisition recommendations and the on-the ground management actions described in Chapter VI, the Grassland Plan has also identified several priorities for future research. The following were identified as research priorities for the Grassland Plan:

- Identification of the factors determining burrowing owl nest site selection and nesting success in Front Range prairie dog colonies.
- Investigations of fire effects on native plant communities, nested targets, and invasive plant species.
- Investigations of fire and grazing interactions.
  - native plant community effects
  - grassland bird effects
- Comparison and evaluation of the cost and effectiveness of reclamation and restoration methods for native plant communities, including the evaluation of seed and soil inoculates to determine which are best for reclamation and agricultural plantings in Boulder Valley.
- Investigations into the effectiveness of control and management techniques for invasive species, prioritizing ANS and OSMP "high priority" weed species.
  - The relevant ecological impacts and efficacy of control techniques for New Zealand mud snail, and Eurasian watermilfoil. Specific investigations of interest with respect to Eurasian watermilfoil are determining rates of spread in lotic systems; seasonal influence on water quality (pH, temperature, dissolved oxygen, in-stream flow, etc.); vegetative, physical, and chemical environmental associations; and reproduction and fragment survival rates.
  - Canada thistle and diffuse knapweed ecology and management in the Colorado Front Range.
  - Comparison of the effectiveness of control techniques and development of management recommendations for areas infested by jointed goatgrass.
  - Environmental associations of Dalmatian toadflax, specifically, identifying factors associated with this species' ability to invade native grassland communities.
- Investigations into the effects recreational land uses (trails, trail use, presence of dogs, off-trail travel) have on native animals.
- Evaluation of costs and benefits of native grasses and forbs as hay crops.

- Evaluation of the compatibility between current OSMP agricultural practices and amphibian and reptile conservation with an emphasis on state/federal listed species.
- Comparison of the cost and efficacy of various methods of prairie dog relocation.
- Investigations of recovery of native grassland plant communities at extirpated prairie dog towns, due to plague, among areas managed under varying livestock grazing regimens.
- Comparisons of biodiversity between prairie dog-occupied areas and uncolonized grassland areas among areas managed under varying livestock grazing regimens.
- Investigations into landscape and management response to ecosystem change (climate/atmospheric chemistry).
- Contributions to OSMP's system-wide knowledge of key landscape elements and flow processes. Elements include, but are not limited to, core habitat blocks, landscape connectivity factors, critical habitat for species of special concern, and areas of exceptional biodiversity value. Flows describe anything moving across elements (e.g., water, disturbance events, nutrients, animals, pollen, seeds, invasive species, etc.).

- <u>Surveys and Inventories</u>
  - Cavity nesting bird use of plains riparian forests.
  - Reptile inventory and identification of breeding areas and hibernacula on OSMP.
  - Invertebrates, small mammals, and/or amphibians/reptiles, with emphasis on areas slated for development in the OSMP Trail Study Area planning process.

Chapter VIII: Implementation

Chapter Summary
This chapter describes recommendations for the next steps including funding scenarios to implement the Grassland Plan. A framework for plan implementation is described in which strategies are implemented through specific Capital Improvements, Other Improvements, Programs and Studies. This chapter also describes Grassland Plan Implementation Areas where strategies and projects will be coordinated "on-the ground".

Plan Implementation

The purpose of the Grassland Plan is to provide a framework for on-the-ground management actions, public policies and land and water acquisition priorities to conserve the ecological values of Boulder's grasslands and ensure on-going agricultural production. The plan provides guidance about which on-going actions should be continued and what strategies should be developed. Further development includes integration with TSA planning, designing and constructing capital projects, formulating and carrying out monitoring protocols, undertaking detailed studies and establishing new programs. Several projects have been described as part of OMSP's Strategic Operating Plan. Although descriptions of the detailed projects and tasks that will be undertaken are beyond the scope of the Grassland Plan, the following framework is proposed to organize plan implementation.

The City of Boulder master planning framework provides useful guidance for categorizing implementation projects and actions. The following categories are adapted from the approach used in the city's recent Source Water Master Plan (City of Boulder 2009):

- Facility Improvement
- Program Development
- Policies, Studies and Plans
- Coordinated Resource Management

Facility improvement includes both capital improvements and minor projects.

Capital improvements involve the construction of new facilities or the improvement of existing facilities. The cost of capital improvements is typically greater than $50,000. The construction of fish passage and the water delivery structures, land and water acquisitions, and large-scale restoration are examples of capital projects associated with the Grassland Plan strategies. OSMP has established Capital Improvement Programs (CIP) and CIP budget allocations for land acquisition, visitor infrastructure improvements, and for the acquisition and protection of water rights. The department is considering changes to how it approaches capital budgeting, including proposals to integrate ecological management and restoration in a CIP.

Minor projects may also involve either new construction or enhancing existing facilities. Minor project cost less than $50,000. The Grassland Plan identifies a number of strategies that call for minor projects such as the placement of artificial perches or nesting platforms, smaller restoration and maintenance projects and fencing modifications. Minor projects may be funded as part of CIPs or through the annual operating budget.

Program development refers to new initiatives recommended in the Grassland Plan that are not currently in place or are in place but may not be funded as part in the department's current budget and work plan. Programs recommended in the Grassland Plan may need additional development or may require a change in emphasis or additional capacity to carry out in the context of the full work program (e.g. Grassland Prescribed Fire Program, Integrated Pest Management, Prairie Dog removal, ecological monitoring). Program development is can be funded from the annual operating budget or through a CIP. New initiatives may result in modifications of staffing assignments or reallocation of funding from other areas.

Policies, Studies and Plans include the implementation of recommended changes or development of policies (e.g., prairie dog relocation in the context of the city's UWMP), as well as studies called for in the plan (e.g., evaluation of alternative agricultural practices and land use scenarios) and the integration of the Grassland Plan with other planning efforts (e.g., input into TSA planning). Some capital improvement projects will require feasibility studies as part of implementation (e.g., habitat improvements, land and water acquisitions). The projects in this category are often funded by CIP budgets but may be integrated as part of operating costs through actions of staff or consultants.

OSMP will use a **Coordinated Resource Management** approach to integrate the various on-going operations and new initiatives described in the Grassland Plan. Coordinated management will bring together the various working groups to develop a project schedule for particular areas of OSMP lands. Coordinating management will enhance staff's ability to improve the viability of all the Grassland Plan targets. An important part of coordinated management is establishing a geographic focus or specific implementation area.

Grassland Plan Implementation Areas

Implementing the Grassland Plan strategies will require a phased approach. For some strategies, an incremental improvements approach across the Grassland Planning Area will be the most effective way of making progress. For other strategies, especially those that require careful coordination, focused implementation in a specific geographic area may be a better way to accomplish the plan's objectives. The Grassland Plan Implementation Areas (**Figure 28**) not only have the benefit of providing opportunities for OSMP to coordinate management, but also make it easier to describe and understand where, when and what will happen with Grassland Plan implementation. These areas will also provide OSMP staff with a useful tool to incorporate Grassland Plan implementation into the development of OSMP's annual work plan.

Much like the forest stands used to focus management activities in the forested foothills, these implementation areas serve as geographically cohesive management units. For each area, OSMP will develop and apply specific conservation and restoration actions over the course of several years. These detailed management prescriptions will be developed for each implementation area integrating the relevant strategies from the Grassland Plan.

Although each implementation area is not homogenous, they are defined based on overall similarity of vegetation, ecological processes, agricultural characteristics and landscape context. Details about the Grassland Plan Management Areas are available in **Appendix N.**

Grassland Plan Funding

As part of early plan implementation, staff will identify the specific tasks required to make progress on each of the grassland plan strategies. Some of these projects and task lists have already been developed as part of CIP planning, SOP implementation and work program development by the various groups responsible for managing the eight targets. Although the Grassland Plan provides rough estimates of strategy costs, staff will be able to provide better estimates once projects are specifically defined.

Funding Scenarios

OSMP is publicly funded, and the bulk of that funding comes from City of Boulder sales tax revenue. Revenue is tightly linked to the strength of the local economy. The City of Boulder uses a business plan model to describe how the department could respond to varying levels of revenue. This model includes three scenarios, or levels, of funding and implementation. The "Fiscally Constrained" scenario includes strategies, programs and projects that are currently funded. The "Action Plan" scenario includes the next level of projects that could be undertaken as funding becomes available for restoration or enhancement of community services. The "Vision Plan" scenario includes funding for the full range of identified projects.

OSMP depends to a large degree upon full-time and seasonal staff to accomplish the conservation actions identified in the Grassland Planning Area. The department also relies heavily upon volunteers for some programs (e.g., monitoring and collaborative planning), and agricultural lessees provide critical management actions throughout the Grassland Planning Area.

Cost Analysis in Funding Scenarios

- Costs associated with land and mineral acquisition were not included in the development of the three funding scenarios for the Grassland Plan (described below) because these costs are part of the implementation of the Open Space and Mountain Parks Land Acquisition and Management Plan.
- Costs associated with visitor services, such as ranger patrol, education and outreach, coordination of volunteers, and TSA planning were excluded from the funding estimate of the Grassland Plan because these services are provided as part of Visitor Master Plan implementation.

Fiscally Constrained Scenario

The Fiscally Constrained (2010) level of funding for Grassland Plan related activities ranges from approximately $1.4 to $1.8 million. This includes funding for capital expenditures, employees (standard and seasonal) as well as vehicles, materials and other equipment. This represents approximately five percent of OSMP's total approved 2010 budget ($26.4 million) and approximately 14 percent of the operations budget ($10.3 million) (**Figure 29**).

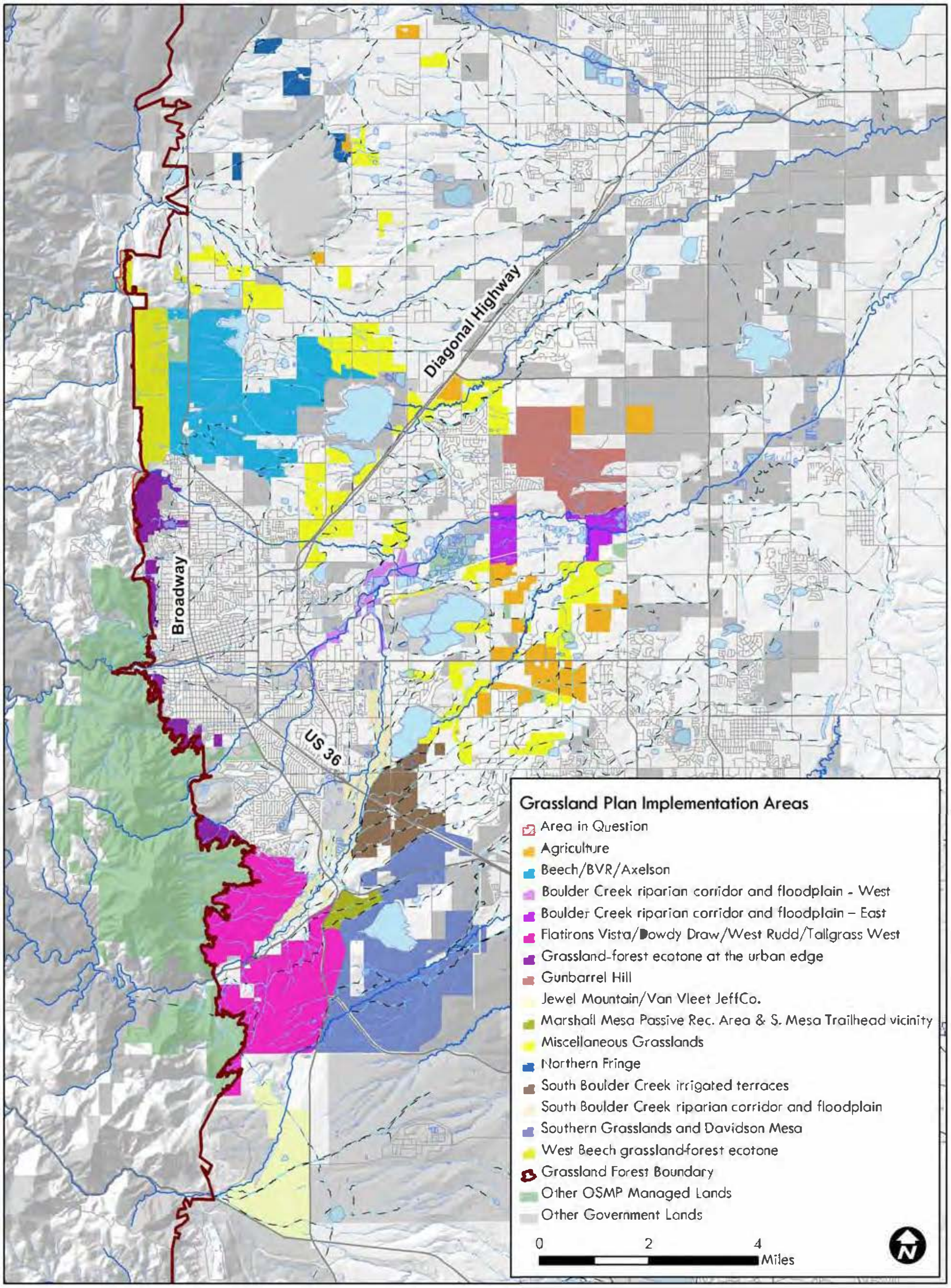

Figure 28: Grassland Plan Implementation Areas

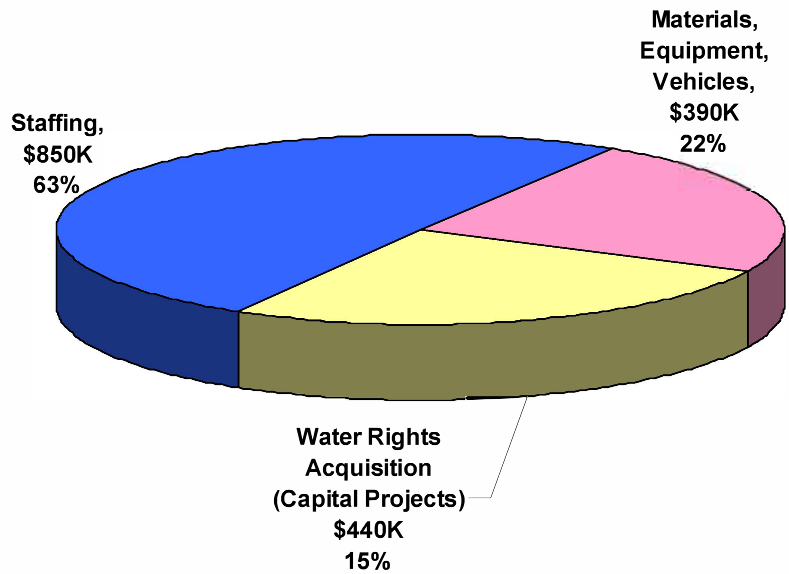

Figure 29: Fiscally Constrained Funding Distribution for the Grassland Plan (1 year)
Grassland Plan = $1.7 million (OSMP 2010 Budget Allocation $26 million)

The Fiscally Constrained scenario includes capital funding for water acquisitions, but none for other conservation or restoration strategy implementation. Consequently, most of the strategies are implemented to the degree they can be supported by the annual operating budget. OSMP does not anticipate achieving the Grassland Plan goals over the next ten years under the Fiscally Constrained scenario. However, some projects may be implemented with grant funding.

<u>Vision Plan Scenario</u>
The Vision Plan level of funding reflects the operating and capital funding necessary to implement all the strategies identified in the Grassland Plan over the ten-year planning horizon. Because some projects do not occur in all years, implementation costs in the Vision Plan scenario vary from year-to-year. The annual Vision Plan funding ranges from $2.1 million to almost $3.3 million (**Table 38**).

The chief differences between the Vision Plan and Fiscally Constrained scenarios are:
1) additional funding for larger capital projects, many of which are associated with riparian area restoration, 2) comprehensive funding of prairie dog removal/relocation, and 3) adequate funding to implement restoration and management strategies to achieve the plan's objectives over the next ten years. The Vision Plan also anticipates an increase in personnel costs of 2.5% per year.

Table 38: Grassland Plan funding scenarios

Fiscally Constrained	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Standard and Fixed Term Staffing	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000
Seasonal Staffing	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000
Vehicles, Materials, Supplies, Fees	$390,000	$390,000	$390,000	$390,000	$390,000	$390,000	$390,000	$390,000	$390,000	$390,000
Capital Funding (Water)	$440,000	$440,000	$580,000	$600,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000
Total	**$1,700,000**	**$1,700,000**	**$1,800,000**	**$1,800,000**	**$1,400,000**	**$1,400,000**	**$1,400,000**	**$1,400,000**	**$1,400,000**	**$1,400,000**
Action Plan	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Standard and Fixed Term Staffing	$750,000	$759,375	$768,867	$778,478	$788,209	$798,062	$808,037	$818,138	$828,365	$838,719
Seasonal Staffing	$170,000	$170,000	$180,000	$140,000	$160,000	$130,000	$160,000	$130,000	$150,000	$120,000
Vehicles, Materials, Supplies, Fees	$910,000	$1,040,000	$940,000	$940,000	$620,000	$660,000	$610,000	$620,000	$670,000	$610,000
Capital Funding (Water)	$540,000	$540,000	$610,000	$620,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000
Total	**$2,400,000**	**$2,500,000**	**$2,500,000**	**$2,500,000**	**$1,800,000**	**$1,800,000**	**$1,800,000**	**$1,800,000**	**$1,900,000**	**$1,800,000**
Vision Plan	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Standard and Fixed Term Staffing	$750,000	$768,750	$787,969	$807,668	$827,860	$848,556	$869,770	$891,514	$913,802	$936,647
Seasonal Staffing	$230,000	$234,000	$258,500	$185,000	$222,000	$166,000	$225,000	$166,500	$203,000	$148,000
Vehicles, Materials, Supplies, Fees	$1,420,000	$1,690,000	$1,490,000	$1,480,000	$840,000	$920,000	$820,000	$840,000	$940,000	$820,000
Capital Funding (Water)	$640,000	$640,000	$640,000	$640,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000
Total	**$3,000,000**	**$3,300,000**	**$3,200,000**	**$3,100,000**	**$2,100,000**	**$2,100,000**	**$2,100,000**	**$2,100,000**	**$2,300,000**	**$2,100,000**

Several of the capital projects anticipated in the Grassland Plan are focused upon the restoration of the most degraded target, Riparian Areas. For example, city staff has developed a multi-year funding proposal related to proposed improvements at Gross Reservoir that will substantially address South Boulder Creek instream flows. Without such an investment plan, funding this project would exceed the Fiscally Constrained levels.

Although other riparian and aquatic habitat restoration projects, such as fish passage structures or riparian revegetation, are of the scale of other capital improvements, there has been no historical capital improvement program directed specifically toward restoration projects. OSMP has been able to take action on such projects in the past because staff has sought and identified opportunities to cost-share with partner agencies and grantors. Open Space and Mountain Parks has used in-kind contributions of staff time and cash from the operating and visitor infrastructure capital budgets. The department is currently considering other approaches to budget allocation to facilitate ecological restoration, including restoration in the Grassland Planning Area.

In addition to considerable focus on riparian areas, the Vision Plan also includes full funding for prairie dog relocation and removal. This high-ranked strategy is funded at a very low level in the Fiscally Constrained scenario.

Table 39 below shows the funding gaps between the Fiscally Constrained and the Vision Plan scenarios by strategy. Some of the smaller gaps can be addressed through careful budgeting of annual operating funds. Some of the larger gaps may be filled by attracting grants and partnerships.

Table 39: Funding gap—Fiscally Constrained versus Vision Plan scenarios

Strategy	**Total Estimated Gap Between Fiscally Constrained and Vision Plan Scenarios** (over ten years)	**Strategy Ranking**
Construct, repair, enhance and maintain irrigation delivery system	$ 1,900,000	High
Establish, maintain, remove and exclude prairie dog colonies in accordance with prairie dog management designations	$ 1,800,000	High
Treat non-native plant species in the grassland planning area using appropriate integrated pest management (IPM) techniques. Including: • Treating wetlands dominated by non-native or invasive species using appropriate IPM techniques • Continuing IPM efforts to remove Eurasian watermilfoil	$ 910,000	High
Identify and obtain water rights needed to support irrigated agriculture	$ 700,000	Medium
Improve aquatic habitat in South Boulder Creek	$ 750,000	Very High
Develop a safe and effective prescribed fire program for the Grassland Planning Area	$ 485,000	Very High
Establish and support the survival of plains cottonwoods and diverse and abundant shrub communities in riparian areas	$ 387,000	Medium

Strategy	Total Estimated Gap Between Fiscally Constrained and Vision Plan Scenarios (over ten years)	Strategy Ranking
Construct and maintain fish passage structures along South Boulder Creek and Boulder Creek	$ 227,000	Very High
Monitoring Projects	$ 207,000	Not Rated
Establish instream flows in South Boulder Creek, and Coal Creek	$ 160,000	High
Remove trees from grasslands at 75% of best opportunity sites	$ 150,000	Medium
Enhance prescribed grazing program through improvements to fencing, livestock watering facilities, stocking rate and seasonal use adjustments, and the establishment of one or more grass banks	$ 140,000	Very High
Establish specific indicators and acceptable ranges of variation to fill information gaps	$ 46,500	Very High
Manage selected ponds as northern leopard frog breeding habitat	$ 35,000	Very High
Evaluate the suitability of alternative agricultural practices for OSMP lands	$ 25,000	Medium
Assess changes to agricultural and water management in the Northern Grassland Preserve to achieve sustainability of numerous Grassland Plan targets.	$ 15,000	Medium
Participate in native fish recovery efforts with the Colorado Division of Wildlife	$ 5,000	Medium
Construct or maintain hunting perches near reservoirs and prairie dog colonies to encourage use by raptors	$ 4,000	High
Construct and maintain alternate nesting structures for sensitive raptors in best opportunity sites	$ 4,000	High

Action Plan Scenario

The annual funding difference between the Fiscally Constrained and Vision plans ranges from $0.7 million and $1.3 million depending upon year. The Action Plan scenario was developed in recognition that there may sometimes be growth in funding which relaxes the fiscal constraint, but not to the degree needed to enact the Vision Plan. The Action Plan scenario is a hypothetical funding program mid-way between the Fiscally Constrained and Vision Plan scenarios. The annual Action Plan level of funding is shown in **Table 38** for years 2011-2020.

If additional funds become available between 2011 and 2020, they will be considered for allocation to Grassland Plan implementation. Such additional funding would increase the capacity of OSMP to address the funding gaps shown in the table above, in accordance with the priority of the strategy and opportunities to leverage other funds.

Implementing the Grassland Plan at the Vision Plan level will require significantly greater capacity than is available with current funding and staffing. Given current economic conditions, the current Fiscally Constrained situation could become even more constrained in the future. While some program contraction would be inevitable should resources become more constrained, capacity-building strategies could reduce this impact and may allow implementation beyond the

Fiscally Constrained scenario by enhancing existing and attracting additional external capacity and funding. The following strategies were identified to attract additional capacity and funding:

- Evaluate current staffing and funding allocations to address capacity needs and meet Grassland Plan priorities--make changes as appropriate
- Fund staff training and service contracts to increase expertise available to implement Grassland Plan strategies. When it is more cost-effective, expertise can be provided by consultants and contractors
- Establish an Open Space and Mountain Parks foundation to sponsor private fundraising for implementing priority Grassland Plan projects
- Pursue grants as appropriate to fund implementation of Grassland Plan strategies
- Work with volunteers and community groups as appropriate to support the implementation of any Grassland Plan strategies
- Work with other land management agencies and universities to address the research agenda in Chapter VII
- Leverage the value of OSMP-owned housing to encourage needed monitoring, research or stewardship
- Establish a Grassland Plan Capital Improvement Program (CIP), or add Grassland Plan Implementation to the Strategic Operating Plan[16]

[16] Establishing and funding a Grassland Plan or Ecological Restoration CIP would not increase capacity; the funding would have to come from somewhere. However, OSMP may find efficiencies if the CIP were established as a focus for departmental activity.

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Glossary

Agro-tourism: the concept of agro-tourism is a direct expansion of eco-tourism, which encourages visitors to experience agricultural life at first hand.

Allelopathy: the suppression of growth of one plant species by another due to the release of toxic substances.

Aquifer: a water-bearing stratum of permeable rock, sand or gravel.

Area-sensitive: animals that require either a relatively large habitat patch within which to live, occur in higher densities in larger patches or the probability of occurrence increases with area.

Biodiversity: biological diversity in an environment as indicated by numbers of different species of plants and animals.

Ecotonal: a transitional zone between two communities containing the characteristic species of each.

Edge-sensitive or Interior specialists: animals that require habitat characteristics associated with interior patches (i.e. away from habitat edge) to fulfill parts of their lifecycle (breeding, foraging, etc.).

Ephemeral: lasting a very short time; seasonal.

Epizootic: affecting a large number of animals at the same time within a particular region or geographic area.

Extirpate: to destroy completely on a local scale.

Forbs: herbaceous flowering plants that are not graminoids (grasses, sedges and rushes), especially one growing in a field, prairie or meadow.

Geology: a science that deals with the history of the earth and its life, especially as recorded in rocks.

Halophytic: a plant that grows in salty soil and usually has a physiological resemblance to a true xerophyte.

Herbaceous: 1. a.) of, relating to or having the characteristics of an herb b.) of a stem: having little or no woody tissue and persisting usually for a single growing season. 2. having the texture, color or appearance of a leaf.

Homogenize: to blend (diverse elements) into a uniform mixture.

Hummocky: a rounded knoll or hillock.

Hydrology: a science that deals with the properties, distribution and circulation of water on and below the earth's surface and in the atmosphere.

Impoundment: a body of water confined within an enclosure.

Interior habitat: Habitat some distance away from an edge, which is usually more ecologically productive due to edge effects and habitat fragmentation. Examples:

- Forest: Interior habitat = 650-1,300 feet (200-400 m) from forest edge (Robbins et al. 1989)
- Grassland: Interior habitat = 650 feet (200 m) from suburban edge (Bock et al. 1999)

Mesic: characterized by, relating to or requiring a moderate amount of moisture.

Montane: of, relating to, growing in or being the biogeographic zone of relatively moist cool upland slopes below timberline dominated by large coniferous trees.

Novel ecosystem: ecosystems containing new combinations of species that arise through human action, environmental change and the impacts of the deliberate and inadvertent introduction of species from other regions (Hobbs et al. 2006).

Oxbow: a bow-shaped lake formed in a former channel of a river.

Periphyton: organisms that live attached to underwater surfaces.

Point bars: a depositional feature of streams. Point bars are found in abundance in mature or meandering streams. They are crescent-shaped and located on the inside of a stream bend.

Riffles: a rapid, or consistent flow over rocks in a stream.

Riparian: relating to or living or located on the bank of a watercourse (as a river or ditch) or sometimes of a lake.

Rotenone: a crystalline insecticide $C_{23}H_{22}O_6$ obtained from the roots of several tropical plants that is highly toxic to fish and other gill-breathers but is of low toxicity to warm-blooded animals

Shale Barrens:

Shale: A fissile rock that is formed by the consolidation of clay, mud or silt, has a finely stratified or laminated structure and is composed of minerals essentially unaltered since deposition.

Barrens: an extent of usually level land having an inferior growth of trees or little vegetation.

Subterranean: being, lying or operating under the surface of the earth.

Sylvatic: affecting only wild animals.

Terrestrial: living on or in or growing from land.

Topography: 1. the configuration of a surface including its relief and the position of its natural and man-made features. 2. the physical or natural features of an object or entity and their structural relationships.

Ungulate: having hooves.

Xeric: characterized by, relating to or requiring only a small amount of moisture.

Xerophyte: a plant adapted for life and growth with a limited water supply.

APPENDIX A: Policy Context

Guidance for developing the Open Space and Mountain Parks Grassland Plan is provided at two levels. First, numerous planning documents have been developed to guide the practices of the Open Space and Mountain Parks Department. These documents are described below, and include the City of Boulder Charter, the 2007-2012 Strategic Operating Plan, Long Range Management Policies (City of Boulder 1995), resource management plans and area management plans.

The second level of plan guidance is provided at a regional level. Regional plan guidance is provided by the Boulder Valley Comprehensive Plan (City of Boulder 2005b) and the Boulder County Comprehensive Plan (Boulder County 1999).

Open Space and Mountain Parks Departmental Mission

The Open Space and Mountain Parks Department preserves and protects the natural environment and land resources that characterize Boulder. We foster appreciation and use that sustain the natural values of the land for current and future generations.

City of Boulder Charter

The management of Open Space and Mountain Parks lands is guided by the City Charter, as approved by the City of Boulder voters in 1986.

Sec. 176. Open Space Purposes - Open space land.

Open space land shall be acquired, maintained, preserved, retained, and used only for the following purposes:

- Preservation or restoration of natural areas characterized by or including terrain, geologic formations, flora, or fauna that is unusual, spectacular, historically important, scientifically valuable, or unique, or that represent outstanding or rare examples of native species;
- Preservation of water resources in their natural or traditional state, scenic areas or vistas, wildlife habitats, or fragile ecosystems;
- Preservation of land for passive recreation use, such as hiking, photography or nature study, and if specifically designated, bicycling, horseback riding, or fishing;
- Preservation of agricultural uses and land suitable for agricultural production;
- Utilization of land for shaping the development of the city, limiting urban sprawl and disciplining growth;
- Utilization of non-urban land for spatial definition of urban areas;
- Utilization of land to prevent encroachment on floodplains; and
- Preservation of land for its aesthetic or passive recreational value and its contribution to the quality of life of the community.

Boulder Valley Comprehensive Plan

The Boulder Valley Comprehensive Plan (BVCP) establishes coordination between the City of Boulder and Boulder County on planning issues involving both agencies. The Boulder Valley is a Community Service Area within Boulder County where the City and County have agreed upon a set of land use and management policies to implement joint planning objectives. The BVCP states that the environment of the Boulder Valley is a critical asset that must be preserved and protected and provides the framework within which growth and development may be permitted to take place (City of Boulder 2005b).

The current Boulder Valley Comprehensive Plan, adopted by both the City and the County in 1977, and updated most recently in December 2005, includes the following sections that have provided guidance for the Grassland Plan:

BVCP Policies-Environment, Economy and Community Design

The environmental policies include the fundamental position that the natural environment is a critical asset, which must be preserved and protected. The BVCP recognizes the effects of land use decisions upon the natural environment and calls upon the City and County to support several objectives including the preservation and enhancement of biodiversity and native ecosystems, ecosystem processes, as well as ecosystem connections and buffers. Other environmental policies specifically address the importance of wetlands conservation, the management of invasive non-native species and sustainable public access to public lands.

Agricultural conservation is included in policies for community design that encourage the preservation and sustainable use of significant agricultural lands and related water supplies as a renewable source of food and fuel. The BVCP economic policies also recognize that on-going agricultural production in the Boulder Valley preserves the valued rural character of the landscape and provides an opportunity for local production of food, fuel, fiber and horticulture products.

The Open Space and Mountain Parks Program Summary

This summary describes the City's current Open Space lands as providing "the basic structure of the Boulder Valley Comprehensive Plan" (City of Boulder 2005b). The BVCP reiterates the charter purposes and functions of Open Space and Mountain Parks and describes the charter-defined role of the OSMP. Other community, environmental and design policies set goals for protecting many features of the Boulder Valley, including the appearance of major entryways, agricultural areas, critical habitat areas and aquifer and groundwater recharge areas.

The Land Use Map Description-Natural Ecosystem Overlay

This section of the BVCP refers to the comprehensive plan land use map, which includes a natural ecosystem overlay. The BVCP defines natural ecosystems as “areas that support native plants and animals or possess important ecological, biological or geological values that represent the rich natural history of the Boulder Valley” (City of Boulder 2005b). Boulder Valley natural ecosystems may also contain features that are rare, unique or sensitive to human disturbance and are essential to maintain the scientific and educational importance of places representing the rich natural history of the Boulder Valley. The Natural Ecosystems overlay identifies these areas as well as ecological connections among habitat blocks and lands that buffer natural ecosystems from the effects of adjacent land use. Most of the GPA is covered by the Natural Ecosystems overlay (**Figure A-1**).

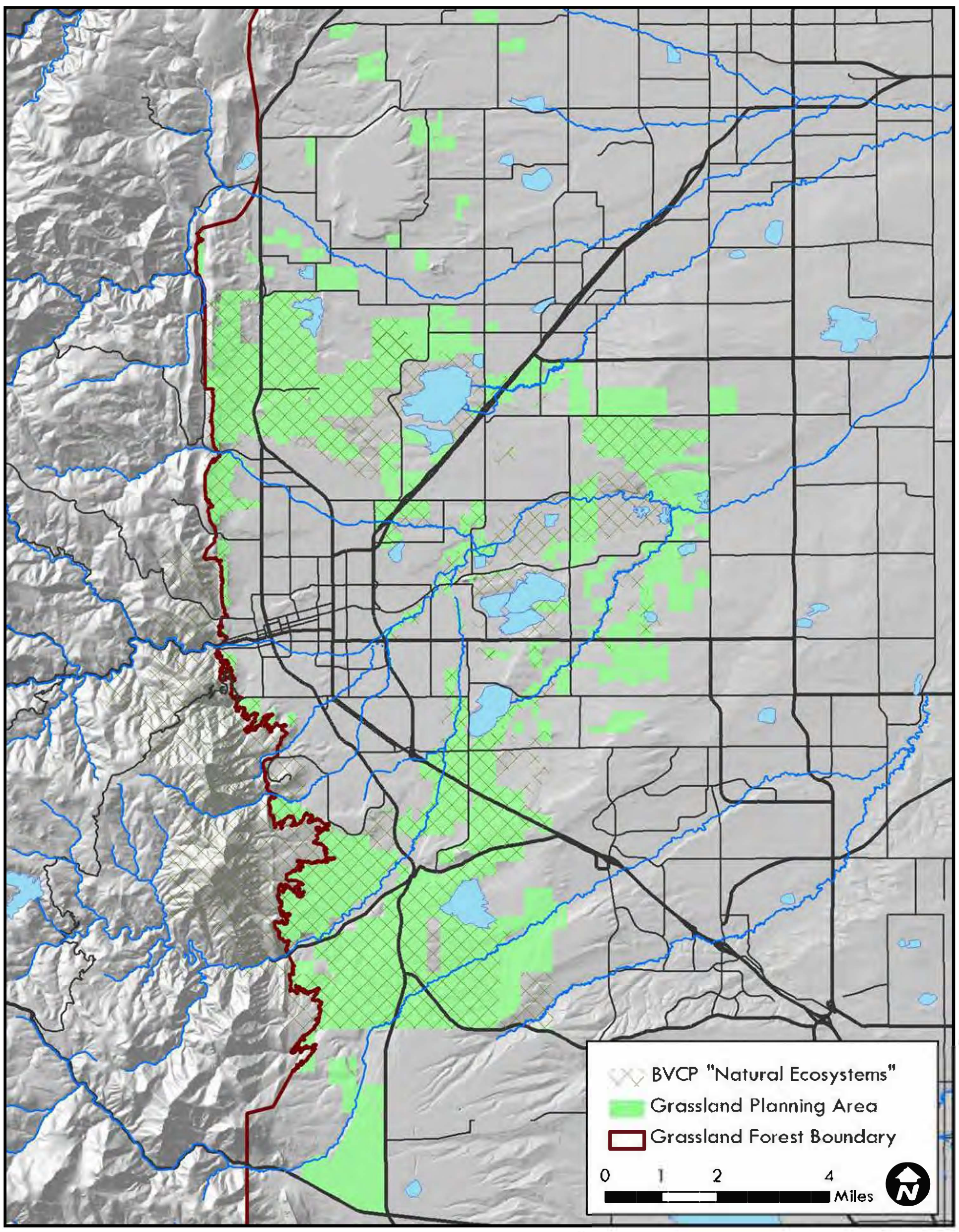

Figure A-1: Boulder Valley Comprehensive Plan Natural Ecosystem Overlay in the Grassland Planning Area

Boulder County Comprehensive Plan (BCCP) (Boulder County 1999)
County comprehensive plans are mandated by state law and address county land use. Much of the Open Space and Mountain Parks land system is under the land use jurisdiction of Boulder County. The plan is also a guide for development in the County's rural areas, outside municipal planning boundaries. Revisions are prepared with the cooperation of municipalities but are not subject to their approval. The BCCP includes goals and land use designations with related objectives and policies that are relevant to the Grassland Plan. **Figure A-2** shows the location of BCCP map elements in the context of the GPA.

Goals-Environmental Management and Agriculture
The BCCP states that unique or distinctive natural features and ecosystems should be conserved using an ecological approach. The plan also emphasizes the conservation of Critical Wildlife Habitat, Significant Natural Communities, Wetlands, Significant Riparian Corridors, Rare Plant Sites, and Environmental Conservation Areas.

The county comprehensive plan also recognized the economic importance of agricultural resources and states support for a diverse and sustainable agricultural economy largely through the conservation and protection of agricultural lands.

Designations
The BCCP includes designation of Natural Landmarks, Natural Areas, Critical Wildlife Habitat, Critical Plant Associations, Rare Plant Sites and Natural Communities, Wetlands and Riparian Areas and Environmental Conservation Areas. Each of these designations was established to achieve a separate set of objectives and is addressed though a set of policies.

Natural Landmarks
Natural Landmarks are prominent features that are important because of their scenic value and associated ecological, geologic or cultural attributes. The BCCP seeks to protect and conserve Natural Landmarks by mitigating the effects of development and assisting landowners to maintain these areas. Policies relevant to Natural Landmarks direct the county to track the status of these areas, consider and designate new designations when appropriate and use land use review, open space acquisition and other incentives as conservation tools.

There are two Natural Landmarks associated with the GPA: Table Mountain and Valmont Dike. Although not owned by the city, the federally-owned Table Mountain is adjacent to city owned lands in the GPA, and could form the nucleus of a large block of grassland habitat. Portions of Valmont Dike are owned by the city and managed as Open Space.

Natural Areas
The BCCP defines natural areas as places where the natural character persists either as native vegetation and associated biological and geological features, or as habitat for rare species, or places where the natural features including geology have special scientific or educational value. The objectives for Natural Areas are protection for the resources that characterize the sites and allowing select opportunities for education and research. Policies relevant to Natural Areas direct the county to track the status of these areas,

consider and designate new designations when appropriate and use land use review, open space acquisition and other incentives as conservation tools.

There are three Natural Areas within the GPA: Marshall Mesa, South Boulder Creek (including Tallgrass Prairie) and White Rocks. South Boulder Creek, Tallgrass Prairie and a portion of the White Rocks are also state-designated natural areas.

Critical Wildlife Habitat
This designation is derived from critical habitat designated by the Colorado Division of Wildlife and includes other areas "which the county may choose to designate" (Boulder County 1999). There are no specific objectives for Critical Wildlife Habitat. The wildlife habitat policies are focused upon avoiding impacts to wildlife habitat through land use review and managing and studying wildlife habitat through the county's open space program.

There are eight areas within the GPA identified in the BCCP as Critical Wildlife Habitat: Boulder Valley Ranch, Cottonwood Grove on Boulder Creek, Sawhill Ponds, White Rocks, Cottonwood Grove and Heronry, South Boulder Creek, Tallgrass Prairie and Marshall Mesa.

Critical Plant Associations, Rare Plant Sites and Natural Communities
These designations are identified by the county using staff, volunteers and other professionals. While there are no specific objectives, the associated policies emphasize the protection of these areas through land use controls, acquisitions by the county open space program as well as cooperation and technical assistance with other agencies and landowners.

There are four county-identified Natural Communities in the GPA: three wet prairie parcels and one xeric tallgrass parcel.

Rare Plant Sites in the GPA include areas supporting Bell's twinpod, dwarf leadplant, American groundnut, black spleenwort, prairie gentian, and Ute ladies'-tresses orchid.

Critical Plant Associations are not mapped in the 1999 BCCP. Maps printed in 1991 show the following Critical Plant Associations in the GPA: New Mexico feathergrass mixed prairie, needle and thread grass mixed prairie and big bluestem-switchgrass-little bluestem-Indian grass tallgrass prairie.

Wetlands and Riparian Areas
The BCCP refers to, but does not define or show, the location of significant wetlands. Significant riparian corridors are shown on a map but qualified as the result of a limited review. Policies associated with wetlands and riparian areas focus on conservation of these resources through land use review as well as acquisition and coordination and technical assistance with other agencies and landowners.

The following areas in the GPA are identified as significant riparian corridors: Boulder Creek downstream of the Green Ditch headgate, Coal Creek from the Jefferson County line to S. 66th street (projected) and South Boulder Creek from the mouth of Eldorado Canyon to the South Boulder Ditch headgate.

Environmental Conservation Areas

Environmental Conservation Areas are large and relatively undeveloped areas of the county that possess a high degree of naturalness, contain high quality or unique landscape features and/or have significant restoration potential. Size, quality and geographic location make them an important tool for combating the effects of habitat fragmentation. The County's objective for Environmental Conservation Areas is the protection of values associated with large habitat blocks in conserving wide-ranging, ecologically specialized or human sensitive species by managing adjacent land uses (providing buffers) and fostering connectivity among blocks. The policies direct the County to use land use review, acquisition and management of these areas to maintain and restore their ecological function.

County Environmental Conservation Areas overlap with much of the GPA, especially in the northern, southern and northeastern area where large blocks of Open Space and Mountain Parks land form the basis of the Environmental Conservation Area designation.

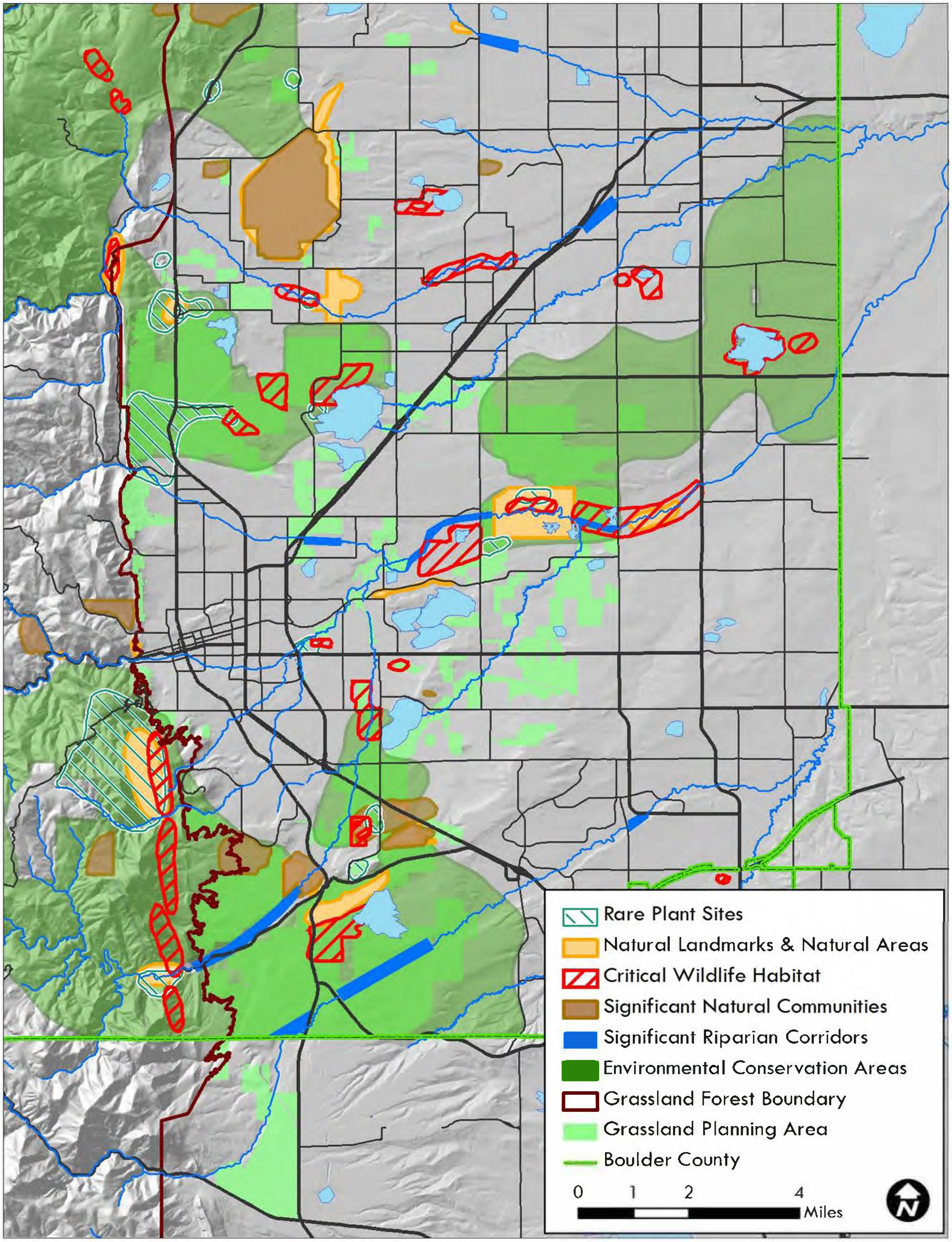

Figure A-2: Boulder County Comprehensive Plan Environmental Resource Element designations in the Grassland Planning Area

APPENDIX B: Nested Targets

Common name	Scientific Name	ESA*	G-Rank	S-Rank	CDOW	Boulder County	BVCP	OSMP
Mixedgrass Prairie Mosaic								
American badger	*Taxidea taxus taxus*							SC-2
American elk	*Cervus elaphus nelsoni*							SC-X
Cross-line skipper	*Polites origenes rhena*		G5	S3				SC-2
Ferruginous hawk	*Buteo regalis*		G4	S3B,S4N	SC	SC		SC-1
Golden eagle	*Aquila chrysaetos*					SC		SC-2
Grasshopper sparrow	*Ammodramus savannarum*					SC		SC-2
Lark bunting	*Calamospiza melanocorys*					SC		SC-2
Loggerhead shrike	*Lanius ludovicianus*					SC		SC-2
Mottled duskywing	*Erynnis martialis*		G3G4	S2S3			LC	SC-2
Northern harrier	*Circus cyaneus*					SC		SC-2
Ottoe skipper	*Hesperia ottoe*		G3G4	S2			LC	SC-1
Plains pocket gopher	*Geomys bursarius lutescens*							SC-3
Prairie Arogos skipper	*Atrytone arogos iowa*		G3	S2			LC	SC-3
Prairie tiger beetle	*Cicindela nebraskana*		G4	S1?				
Savannah sparrow	*Passerculus sandwichensis*					SC		SC-3
Short-eared owl	*Asio flammeus*					SC	LC	SC-2
Short-horned lizard	*Phrynosoma douglassii*							SC-3
Swainson's hawk	*Buteo swainsoni*					SC		SC-2
Beebalm, horsemint	*Monarda pectinata*							Sensitive
Bell's twinpod	*Physaria bellii*		G2G3	S2S3		RP	LC	
Lilac penstemon	*Penstemon gracilis*							Sensitive
Silver-leaf scurf pea; s-l wild alfalfa	*Psoralidium argophyllum*							Sensitive
Weatherby's spike-moss	*Selaginella weatherbiana*					RP		Sensitive

Common name	Scientific Name	ESA*	G-Rank	S-Rank	CDOW	Boulder County	BVCP	OSMP
Mixedgrass Prairie Mosaic								
Shale Barrens Sparsely Vegetated Herbaceous Alliance								Sensitive
Indian Ricegrass Shale Barren Herbaceous Vegetation	*Achnatherum hymenoides* Shale Barren Herbaceous Vegetation		G2	S2				
New Mexico Feathergrass Herbaceous Vegetation	*Hesperostipa neomexicana* Herbaceous Vegetation		G3	S3		SNC		
Western Wheatgrass - Green Needlegrass Herbaceous Vegetation	*Pascopyrum smithii - Nassella viridula* Herbaceous Vegetation		G3G4	S2				
Western Wheatgrass - Blue Grama Herbaceous Vegetation	*Pascopyrum smithii - Bouteloua gracilis* Herbaceous Vegetation		G5	S4				
Needle-and-Thread Colorado Front Range Herbaceous Vegetation	*Hesperostipa comata* Colorado Front Range Herbaceous Vegetation		G1G2	S1S2		SNC		
Little Bluestem - Sideoats Grama Western Great Plains Herbaceous Vegetation	*Schizachyrium scoparium - Bouteloua curtipendula Western* Great Plains Herbaceous Vegetation		G3	S1				
Green Needlegrass Herbaceous Vegetation	*Nassella viridula* Herbaceous Vegetation		GU	SNR				

Common name	Scientific Name	ESA*	G-Rank	S-Rank	CDOW	Boulder County	BVCP	OSMP
Xeric Tallgrass Mosaic								
American elk	*Cervus elaphus nelsoni*							SC-X
Cross-line skipper	*Polites origenes rhena*		G5	S3				SC-2
Ferruginous hawk	*Buteo regalis*		G4	S3B,S4N	SC	SC		SC-1
Golden eagle	*Aquila chrysaetos*					SC		SC-2
Grasshopper sparrow	*Ammodramus savannarum*					SC		SC-2
Lark bunting	*Calamospiza melanocorys*					SC		SC-2
Lark sparrow	*Chondestes grammacus*							SC-X
Northern harrier	*Circus cyaneus*					SC		SC-2
Ottoe skipper	*Hesperia ottoe*		G3G4	S2			LC	SC-1
Prairie Arogos skipper	*Atrytone arogos iowa*		G3	S2			LC	SC-3
Prairie regal fritillary	*Speyeria idalia*		G3	S1			LC	SC-1
Short-eared owl	*Asio flammeus*					SC	LC	SC-2
Swainson's hawk	*Buteo swainsoni*					SC		SC-2
Ball cactus	*Pediocactus simpsonii*							Sensitive
Birdfoot violet, prairie violet	*Viola pedatifida*		G5	S2			LC	
Dwarf leadplant, dwarf indigo bush	*Amorpha nana*		G5	S2S3		RP	LC	
Grassyslope sedge	*Carex oreocharis*		G3	S1				
Narrow-leaved milkweed	*Asclepias stenophylla*		G4G5	S2				
Porcupine grass	*Hesperostipa spartea*							Sensitive
Prairie dropseed	*Sporobolus heterolepis*							Sensitive
Silver-leaf scurf pea; s-l wild alfalfa	*Psoralidium argophyllum*							Sensitive
Weatherby's spike-moss	*Selaginella weatherbiana*					RP		Sensitive

Common name	Scientific Name	ESA*	G-Rank	S-Rank	CDOW	Boulder County	BVCP	OSMP
Xeric Tallgrass Mosaic								
Big-Bluestem - Little Bluesetem Western Great Plains Herbaceous Vegetation	*Andropogon gerardii - Schizachyrium scoparium* Western Great Plains Herbaceous Vegetation		G2?	S2		SNC		
Big Bluestem - Prairie Dropseed Western Great Plains Herbaceous Vegetation	*Andropogon gerardii - Sporobolus heterolepis* Western Foothills Herbaceous Vegetation		G2?	S1S2		SNC		
Ponderosa Pine / Big Bluestem Xeric Tallgrass Tree Savannah Herbaceous Vegetation	*Pinus ponderosa / Andropogon gerardii* Xeric Tallgrass Tree Savannah Herbaceous Vegetation		NA	NA				Sensitive
Ponderosa Pine / Mountain-mahogany / Big Bluestem Wooded Herbaceous Vegetation	*Pinus ponderosa / Cercocarpus montanus / Andropogon gerardii* Wooded Herbaceous Vegetation		G2	S2?				
Yucca / Big Bluestem Xeric Tallgrass Shrub Savannah	*Yucca glauca / Andropogon gerardii* Xeric Tallgrass Shrub Savannah		NA	NA				Sensitive

Common name	Scientific Name	ESA*	G-Rank	S-Rank	CDOW	Boulder County	BVCP	OSMP
Mesic Bluestem Prairie								
American elk	*Cervus elaphus nelsoni*							SC-X
Bobolink	*Dolichonyx oryzivorus*		G5	S3B		SC		SC-2
Common garter snake	*Thamnophis sirtalis parietalis*		G5S3		SC			SC-2
Dickcissel	*Spiza americana*							SC-3
Northern harrier	*Circus cyaneus*					SC		SC-2
Prairie Arogos skipper	*Atrytone arogos iowa*		G3	S2			LC	SC-3
Prairie regal fritillary	*Speyeria idalia*		G3	S1			LC	SC-1
Short-eared owl	*Asio flammeus*					SC	LC	SC-2
Wilson's phalarope	*Phalaropus tricolor*		G5	S4B,S4N				
Ute ladies'-tresses	*Spiranthes diluvialis*	LT	G2	S2		RP	LC	
Big Bluestem - Yellow Indiangrass Western Great Plains Herbaceous Vegetation	*Andropogon gerardii - Sorghastrum nutans* Western Great Plains Herbaceous Vegetation		G2	S1S2				

Common name	Scientific Name	ESA*	G-Rank	S-Rank	CDOW	Boulder County	BVCP	OSMP
Agricultural Operations								
Bobolink	*Dolichonyx oryzivorus*		G5	S3B		SC		SC-2
Dickcissel	*Spiza americana*							SC-3
Grasshopper sparrow	*Ammodramus savannarum*					SC		SC-2
Lark sparrow	*Chondestes grammacus*							SC-X
Northern harrier	*Circus cyaneus*					SC		SC-2
Savannah sparrow	*Passerculus sandwichensis*					SC		SC-3
Swainson's hawk	*Buteo swainsoni*					SC		SC-2
Toothcup	*Rotala ramosior*		G5	S1			LC	
American groundnut	*Apios americana*		G5	S1		RP	LC	
Tulip gentian, showy prairie gentian	*Eustoma grandiflorum*					RP		Sensitive
Wild hops	*Humulus lupulus*							Sensitive
Ute ladies'-tresses	*Spiranthes diluvialis*	LT	G2	S2		RP	LC	
Semi-native Irrigated Meadows			NA	NA				Sensitive

Common name	Scientific Name	ESA*	G-Rank	S-Rank	CDOW	Boulder County	BVCP	OSMP
Black-tailed Prairie Dog and Associates								
American badger	*Taxidea taxus taxus*							SC-2
Bald eagle	*Haliaeetus leucocephalus*		G5	S1B,S3N	T		LC	SC-1
Black-tailed prairie dog	*Cynomys ludovicianus ludovicianus*		G4	S3	SC		LC	SC-1
Burrowing owl	*Athene cunicularia*		G4	S4B	T	SC	LC	SC-1
Ferruginous hawk	*Buteo regalis*		G4	S3B,S4N	SC	SC		SC-1
Golden eagle	*Aquila chrysaetos*					SC		SC-2
Northern harrier	*Circus cyaneus*					SC		SC-2
Prairie tiger beetle	*Cicindela nebraskana*		G4	S1?				
Rough-legged hawk	*Buteo lagopus*							SC-X

*A key to abbreviations is found on p. B-13

Common name	Scientific Name	ESA*	G-Rank	S-Rank	CDOW	Boulder County	BVCP	OSMP
Wetlands								
American bittern	*Botaurus lentiginosus*					SC		SC-1
American elk	*Cervus elaphus nelsoni*							SC-X
American white pelican	*Pelecanus erythrorhynchos*		G3	S1B				
Black-necked stilt	*Himantopus mexicanus*		G5	S3B				
Bobolink	*Dolichonyx oryzivorus*		G5	S3B		SC		SC-2
Common garter snake	*Thamnophis sirtalis parietalis*		G5S3		SC			SC-2
Dickcissel	*Spiza americana*							SC-3
Eared grebe	*Podiceps nigricollis*					SC		SC-2
Least bittern	*Ixobrychus exilis*					SC		SC-2
Northern harrier	*Circus cyaneus*					SC		SC-2
Northern leopard frog	*Rana pipiens*		G5	S3	SC			SC-1
Osprey	*Pandion haliaetus*					SC		SC-2
Prairie Arogos skipper	*Atrytone arogos iowa*		G3	S2			LC	SC-3
Prairie regal fritillary	*Speyeria idalia*		G3	S1			LC	SC-1
Sharp sprite	*Promenetus exacuous*		G5	S2			LC	SC-2
Short-eared owl	*Asio flammeus*					SC	LC	SC-2
Two-spotted skipper	*Euphyes bimacula*		G4	S2			LC	SC-2
Wilson's phalarope	*Phalaropus tricolor*		G5	S4B,S4N				
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*					SC		SC-2
Checker mallow	*Sidalcea neomexicana*							Sensitive
Colorado butterfly plant	*Gaura neomexicana*	LT	G3T2	S1			LC	
Oceanspray, rock spirea	*Holodiscus discolor*							Sensitive
Toothcup	*Rotala ramosior*		G5	S1			LC	
Tulip gentian, Showy prairie gentian	*Eustoma grandiflorum*					RP		Sensitive
Ute ladies'-tresses	*Spiranthes diluvialis*	LT	G2	S2		RP	LC	
Wild hops	*Humulus lupulus*							Sensitive
Nebraska Sedge Herbaceous Vegetation	*Carex nebrascensis* Herbaceous Vegetation		G4	S3				
Clustered Sedge Herbaceous Vegetation	*Carex praegracilis* Herbaceous Vegetation		G3G4	S2				
Ameican Mannagrass Herbaceous Vegetation	*Glyceria grandis* Herbaceous Vegetation		G2?	S2				
Western Snowberry Shrubland	*Symphoricarpos occidentalis* Shrubland		G4G5	S3				
Prairie Cordgrass Western Herbaceous Vegetation	*Spartina pectinata* Western Herbaceous Vegetation		G3?	S3				

Common name	Scientific Name	ESA*	G-Rank	S-Rank	CDOW	Boulder County	BVCP	OSMP
Riparian Areas								
American elk	*Cervus elaphus nelsoni*							SC-X
American redstart	*Setophaga ruticilla*					SC	LC	SC-2
Bald eagle	*Haliaeetus leucocephalus*		G5	S1B,S3N	T		LC	SC-1
Black bear	*Ursus americanus amblyceps*							SC-1
Black-crowned night-heron	*Nycticorax nycticorax*					SC		SC-2
Brassy minnow	*Hybognathus hankinsoni*				T			SC-1
Brown thrasher	*Toxostoma rufum*					SC		SC-2
Common garter snake	*Thamnophis sirtalis parietalis*		G5S3		SC			SC-2
Common shiner	*Luxilus cornutus*				T		LC	SC-1
Cylindrical papershell	*Anodontoides ferussacianus*		G5	S2	SC		LC	SC-2
Fringed myotis	*Myotis thysanodes thysanodes*		G4G5	S3				SC-2
Gray catbird	*Dumetella carolinensis*					SC		SC-3
Great blue heron	*Ardea herodias*					SC		SC-2
Hops azure	*Celestrina humulus*		G2G3	S2			LC	SC-1
Lark sparrow	*Chondestes grammacus*							SC-X
Lazuli bunting	*Passerina amoena*							SC-3
Lewis' woodpecker	*Melanerpes lewis*		G4	S4		SC		SC-2
Long-eared owl	*Asio otus*					SC		SC-2
Mottled duskywing	*Erynnis martialis*		G3G4	S2S3			LC	SC-2
Mountain lion	*Felis concolor hippolestes*							SC-1
Northern leopard frog	*Rana pipiens*		G5	S3	SC			SC-1
Northern redbelly dace	*Phoxinus eos*		G5	S1	E		LC	SC-1
Olive-sided flycatcher	*Contopus cooperii*					SC		SC-2
Plains topminnow	*Fundulus sciadicus*						LC	SC-2
Preble's meadow jumping mouse	*Zapus hudsonius preblei*	LT	G5T2	S1	T		LC	SC-1
Snowy egret	*Egretta thula*		G5	S2B				
Spiny softshell	*Apalone spinifera hartwegi*							SC-3
Two-spotted skipper	*Euphyes bimacula*		G4	S2			LC	SC-2
Umbillicate sprite	*Promenetus umbilicatellus*							SC-2
Willow flycatcher	*Empidonax traillii*					SC		SC-2
Wood duck	*Aix sponsa*					SC		SC-3
Yellow warbler	*Dendroica petechia*							SC-X
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*					SC		SC-2

Animals shown in black text, plants in green text.
Species shown with white background, Natural Communities shown with green.

*A key to abbreviations is found on p. B-13

Common name	Scientific Name	ESA*	G-Rank	S-Rank	CDOW	Boulder County	BVCP	OSMP
Riparian Areas								
American groundnut	*Apios americana*		G5	S1		RP	LC	
Carrionflower	*Smilax lasioneuron*							Sensitive
Chaffweed	*Centunculus minimus*		G5	S1			LC	
Colorado butterfly plant	*Gaura neomexicana*	LT	G3T2	S1			LC	
Oceanspray, rock spirea	*Holodiscus discolor*							Sensitive
Pondweed	*Potamogeton diversifolius*		G5	S1				
Ute ladies'-tresses	*Spiranthes diluvialis*	LT	G2	S2		RP	LC	
Wild hops	*Humulus lupulus*							Sensitive
Narrowleaved Cottonwood / Bluestem Willow Woodland	*Populus angustifolia / Salix irrorata* Woodland		G2	S2				
Plains Cottonwood - (Peachleaf Willow) / Coyote Willow Woodland	*Populus deltoides - (Salix amygdaloides) / Salix (exigua, interior)* Woodland		G3G4	S3				
Skunkbush Intermittently Flooded Shrubland	*Rhus trilobata* Intermittently Flooded Shrubland		G2G3	S2				

Common name	Scientific Name	ESA*	G-Rank	S-Rank	CDOW	Boulder County	BVCP	OSMP
White Rock Cliffs								
Barn owl	*Tyto alba*					SC		SC-3
Long-eared owl	*Asio otus*					SC		SC-2
Six-lined racerunner	*Cnemidophorus sexlineatus viridis*							SC-3
American groundnut	*Apios americana*		G5	S1		RP	LC	
Beebalm, horsemint	*Monarda pectinata*							Sensitive
Forktip three-awn	*Aristida basiramea*		G5	S1		RP	LC	
Spleenwort	*Asplenium adiantum-nigrum*		G5	S1		RP	LC	

Common name	Scientific Name	ESA*	G-Rank	S-Rank	CDOW	Boulder County	BVCP	OSMP
EXTIRPATED SPECIES								
Mixedgrass Prairie Mosaic								
Gray wolf	*Canis lupus nubilus*	LE			E		LC	
Grizzly bear	*Ursus arctos*	LT			E		LC	
Pronghorn	*Antilocapra americana americana*						LC	
Mountain plover	*Charadrius montanus*		G2	SB2	SC	SC	LC	SC-3
Long-billed curlew	*Numenius americanus*					SC	LC	SC-3
Sharp-tailed grouse	*Tympanuchus phasianellus jamesi*		G4T4	S1	E	SC	LC	SC-3
Rocky Mountain blazing star	*Liatris ligulistylis*		G5?	S1/S2		LC		
Xeric Tallgrass Mosaic								
Pronghorn	*Antilocapra americana americana*						LC	
Bison	*Bison bison*						LC	
Grizzly bear	*Ursus arctos*	LT			E		LC	
Gray wolf	*Canis lupus nubilus*	LE			E		LC	
Sharp-tailed grouse	*Tympanuchus phasianellus jamesi*		G4T4	S1	E	SC	LC	SC-3
Mesic Bluestem Prairie								
Long-billed curlew	*Numenius americanus*					SC	LC	SC-3
Black-tailed Prairie Dog and Associates								
Gray wolf	*Canis lupus nubilus*	LE			E		LC	
Sharp-tailed grouse	*Tympanuchus phasianellus jamesi*		G4T4	S1	E	SC	LC	SC-3
Bison	*Bison bison*						LC	
Black-footed ferret	*Mustela nigripes*	LE	G1	S1	T			SC-3
Mountain plover	*Charadrius montanus*		G2	SB2	SC	SC	LC	SC-3
Wetlands								
Long-billed curlew	*Numenius americanus*					SC	LC	SC-3
Riparian Areas								
Grizzly bear	*Ursus arctos*	LT			E		LC	
Sharp-tailed grouse	*Tympanuchus phasianellus jamesi*		G4T4	S1	E	SC	LC	SC-3
Northern river otter	*Lontra canadensis*		G5	S3/S4	T		LC	SC-3
White Rock Cliffs								

Key to abbreviations used in table:

ESA: United States Endangered Species Act
LE-Listed Endangered
LT-Listed Threatened

G-Rank: Global Rank S-Rank: Colorado Rank
NatureServe/Heritage Program Imperilment Ranks
1- Critically Imperiled
2- Imperiled
3- Rare or Uncommon
4- Widespread/Abundant
5- Secure
U- Unrankable (due to a lack of information or substantially conflicting information)
NR- Unranked
B- Breeding population
N- Non-breeding population

CDOW: Colorado Division of Wildlife Species of Concern List
E-Endangered
T-Threatened
SC-Special Concern

Boulder County: Boulder County and Boulder County Nature Association Rare Plants and Significant Natural Communities and Bird Species of Concern
RP-Rare Plant
SC-Special Concern
SNC-Significant Natural Community

BVCP: Plant and Animals Species of Local Concern in the Boulder Valley
LC-Local Concern

OSMP: Open Space and Mountain Parks Species of Concern
SC-1 Special Concern Priority 1 (animal)
SC-2 Special Concern Priority 2 (animal)
SC-3 Special Concern Priority 3 (animal)
SC-X Special Concern Unpriortized (animal)
Sensitive-Sensitive Plant Species or Community

APPENDIX C: List of Scientific Names for Species Appearing in the Plan

Plants

Common Name	Scientific Name
alkali bulrush	*Bolboschoenus maritimus* ssp. *paludosus*
American groundnut	*Apios americana*
artic rush	*Juncus arcticus ssp. ater*
bee balm (horsemint)	*Monarda pectinata*
Bell's twinpod	*Physaria bellii*
big bluestem	*Andropogon gerardii*
black spleenwort	*Asplenium adiantum-nigrum*
blue grama	*Chondrosum gracile*
bluestem willow	*Salix irrorata*
buffalograss	*Buchloe dactyloides*
bulrush	*Schoenoplectus* spp.
Canada thistle	*Breea arvensis*
cattails	*Typha* spp.
cheatgrass	*Anisantha* spp.
chokecherry	*Padus virginiana* ssp. *melanocarpa*
clustered field sedge	*Carex praegracilis*
Colorado butterfly plant	*Gaura neomexicana* ssp. *coloradensis*
common reed	*Phragmites australis*
common teasel	*Dipsacus fullonum*
crack willow	*Salix fragilis*
cut-leaf teasel	*Dipsacus laciniatus*
"Didymo"	*Didymosphenia geminata*
diffuse knapweed	*Acosta diffusa*
dwarf leadplant	*Amorpha nana*
dwarf rabbitbrush	*Chrysothamnus nauseosus* ssp. *nauseosus*
Eurasian watermilfoil	*Myriophyllum spicatum*
Emory sedge	*Carex emoryi*
fork-tipped threeawn	*Aristida basiramea*
fringed sage	*Artemisia frigida*
garden loosestrife	*Lysimarchia vulgaris*
garlic mustard	*Alliaria petiolata*

Common Name	Scientific Name
great lobelia	*Lobelia siphilitica* ssp. *ludoviciana*
grassyslope sedge	*Carex oreocharis*
green ash	*Fraxinus pensylvanica* var. *lanceolata*
green needlegrass	*Nassella viridula*
Indian ricegrass	*Achnatherum hymenoides*
inland saltgrass	*Distichlis stricta*
Japanese knotweed	*Reynoutria japonica*
jointed goat grass	*Cylindropyrum cylindricum*
leafy spurge	*Tithymalus uralensis*
lemon scurfpea	*Psoralidium lanceolatum*
little bluestem	*Schizachyrium scoparium*
Mediterranean sage	*Salvia aethiopis*
mountain muhly grass	*Muhlenbergia montana*
myrtle spurge	*Tithymalus myrsinites*
narrowleaf cottonwood	*Populus angustifolia*
narrowleaf four-o'clock	*Oxybaphus decumbens*
narrow-leaved milkweed	*Asclepias stenophylla*
Nebraska sedge	*Carex nebrascensis*
needle-and-thread grass	*Hesperostipa comata*
New Jersey tea	*Ceanothus herbaceus*
New Mexico feathergrass	*Hesperostipa neomexicana*
ox-eye daisy	*Leucanthemum vulgare*
peach-leaved willow	*Salix amygdaloides*
perennial sowthistle	*Sonchus arvensis*
plains black nightshade	*Solanum americanum*
plains cottonwood	*Populus deltoides* ssp. *monilifera*
pondweed	*Potamogeton* spp.
porcupine grass	*Hesperostipa spartea*
Porter aster	*Aster porteri*
prairie cordgrass	*Spartina pectinata*
prairie dropseed	*Sporobolus heterolepis*
prairie sage	*Artemisia ludoviciana*
prairie violet (bird's foot violet)	*Viola pedatifida*
prickly pear cactus	*Opuntia macrorhiza*

Common Name	Scientific Name
purple gerardia	*Agalinis tenuifolia*
purple loosestrife	*Lythrum salicaria*
purple threeawn	*Aristida purpurea*
red hawthorn	*Crataegus macracantha* var. *occidentalis*
reed canarygrass	*Phalaroides arundinacea*
Rocky Mountain bluegrass	*Poa agassizensis*
rough sunflower	*Helianthus pumilus*
Russian knapweed	*Acroptilon repens*
Russian olive	*Elaeagnus angustifolia*
saltbush	*Atriplex canescens*
salt cedar	*Tamarix ramosissima*
sand cherry	*Cerasus pumila* ssp. *besseyi*
sedge	*Carex* spp.
serviceberry	*Amelanchier alnifolia*
showy prairie gentian	*Eustoma grandiflorum*
sidebells penstemon	*Penstemon secundiflorus*
sideoats grama	*Bouteloua curtipendula*
silky sophora	*Vexibia nuttalliana*
smooth brome	*Bromus inermus*
snakeweed	*Gutierrezia sarothrae*
spike gilia	*Ipomopsis spicata*
switchgrass	*Panicum virgatum*
thistle	*Breea*, *Carduus*, and *Cirsium* spp.
three-fingered milk vetch	*Orophaca tridactylica*
three-leaved sumac (skunkbrush)	*Rhus aromatica* ssp. *trilobata*
toothcup	*Rotala ramosior*
Ute ladies'-tresses orchid	*Spiranthes diluvialis*
western hackberry	*Celtis reticulata*
western wheatgrass	*Pascopyrum smithii*
wild asparagus	*Asparagus officinalis*
willow	*Salix* spp.
winter fat	*Krascheninnikovia lanata*
woolly hymenopappus	*Hymenopappus filifolius*
yellow buckwheat	*Eriogonum brevicaule*

Common Name	**Scientific Name**
yellow Indiangrass	*Sorghastrum avenaceum*
yellow starthistle	*Centaurea solstitialis*
yucca	*Yucca glauca*
yellow iris	*Iris pseudacorus*

Animals

Common Name	**Scientific Name**
American badger	*Taxidea taxus taxus*
American bittern	*Botaurus lentiginosus*
American buffalo (bison)	*Bison bison*
American robin	*Turdus migratorius*
Arogos skipper	*Atrytone arogos iowa*
bald eagle	*Haliaeetus leucocephalus*
barn owl	*Tyto alba*
black-footed ferret	*Mustela nigripes*
black-tailed prairie dog	*Cynomys ludovicianus*
blue grosbeak	*Passerina caerulea*
blue-gray gnatcacther	*Polioptila caerulea*
bobcat	*Lynx rufus*
bobolink	*Dolichonyx oryzivorus*
brassy minnow	*Hybognathus hankinsoni*
bronze copper	*Lycaena hyllus*
brown-headed cowbird	*Molothrus ater*
bullfrog	*Rana catesbiana*
bullsnake	*Pituophis catenifer*
Bullock's oriole	*Icterus bullockii*
burrowing owl	*Athene cunicularia*
common shiner	*Notropis cornutus*
cottontail rabbit	*Sylvilagus spp.*
coyote	*Canus latrans*
crawling water beetle	*Peltodytes* sp.
crayfish	*Orconectes* spp., *Procambarus simulans, Cambarus diogenes*
creek chub	*Semotilus atromaculatus*
crossline skipper	*Polites origenes*
cylindrical papershell	*Anodontoides ferussacianus*
deer	*Odocoileus hemionus*
deer mouse	*Peromyscus maniculatus*
dickcissel	*Spiza americana*
eared grebe	*Podiceps nigricollis*
elk	*Cervus canadensis*

Common Name	**Scientific Name**
European starling	*Sturnus vulgaris*
fairy shrimp	*Branchinecta packardi*
ferruginous hawk	*Buteo regalis*
frog	*Rana* spp., *Pseudocris triseriata*
golden eagle	*Aquila chrysaetos*
grass carp	*Ctenopharyngodon idella*
grasshopper sparrow	*Ammodramus savannarum*
gray catbird	*Dumetella carolinensis*
gray fox	*Urocyon cinereoargenteus*
great horned owl	*Bubo virginianus*
Great Plains gray wolf	*Canis lupus nubilus*
green sunfish	*Lepomis cyanellus*
green-back cutthroat trout	*Oncorhynchus clarkii stomias*
green-tailed towhee	*Pipilo chlorurus*
grizzly bear	*Ursus arctos*
horned lark	*Eremophila alpestris*
lake chub	*Couesius plumbeus*
lark sparrow	*Chondestes grammacus*
lazuli bunting	*Passerina amoena*
least bittern	*Ixobrychus exilis*
long-eared owl	*Asio otus*
mountain lion	*Felis concolor*
mountain plover	*Charadrius montanus*
New Zealand mud snail	*Potamopyrgus antipodarum*
northern cricket frog	*Acris crepitans*
northern harrier	*Circus cyaneus*
northern leopard frog	*Rana pipiens*
northern redbelly dace	*Phoxinus eos*
olive-backed pocket mouse	*Perognathus fasciatus*
orange-spotted sunfish	*Lepomis humilis*
osprey	*Pandion haliaetus*
Ottoe skipper	*Hesperia ottoe*
plains leopard frog	*Rana blairi*
plains sharp-tailed grouse	*Tympanuchus phasianellus jamesi*
plains topminnow	*Fundulus sciadicus*

Common Name	Scientific Name
prairie falcon	*Falco mexicanus*
prairie rattlesnake	*Crotalus viridis*
prairie regal fritillary	*Speyeria idalia*
prairie tiger beetle	*Cicindela nebraskana*
Preble's meadow jumping mouse	*Zapus hudsonius preblei*
pronghorn	*Antilocapra americana*
red fox	*Vulpes vulpes*
red-tailed hawk	*Buteo jamaicensis*
rough-legged hawk	*Buteo lagopus*
savannah sparrow	*Passerculus sandwichensis*
short-horned lizard	*Phrynosoma hernandesi*
six-lined racerunner	*Cnemidophorus sexlineatus viridis*
solitary bee	*Perdita opuntiae*
Swainson's hawk	*Buteo swainsoni*
tiger salamander	*Ambystoma tigrinum*
thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*
toad	*Bufo* spp.
trout	*Oncorhynchus* spp., *Salmo trutta, Salvelinus fontinalis*
two-spotted skipper	*Euphyes bimacula*
umbillicate sprite	*Promenetus umbilicatellus*
Wilson's phalarope	*Phalaropus tricolor*
Virginia's warbler	*Verimvora virginiae*
yellow warbler	*Dendroica petechia*
yellow-headed blackbird	*Xanthocephalus xanthocephalus*
zebra mussel	*Dreissena polymorpha*

APPENDIX D: Viability Details

References for citations in appendices can be found in the "Literature Cited" section of the Grassland Plan

Within each target indicators are sorted by *key attribute type* (landscape context, condition and size), then alphabetically by *key attribute,* and finally alphabetically by *indicator* name.

Conservation Target: Mixedgrass Prairie Mosaic
Category: Landscape Context
Key Attribute: Fire Regime
Key attribute comment: In the past, fire has been a primary driver of the mixedgrass prairie. In addition to fires caused by lightning strikes, there is strong evidence that native people set fires regularly for a variety of purposes (Bragg and Steuter 1996).

Fire and grazing by ungulates and prairie dogs created patch heterogeneity in time and space that supported a high level of biological diversity. Fire is known to affect nutrient cycling, prevents woody species encroachment, and is required for seed germination of some species. In the absence of fire, litter increases and prevents nutrients from being available to plants; the prevalence of germination sites declines; plant species richness and vigor declines; ground nesting bird habitat declines; and woody species establish and expand in cover. Some non-native species may be able to invade declining plant communities where the fire regime is outside the acceptable range of variation.

There have not been experiments to compare burned/unburned areas in this ecological system to determine the long-term effects of chronic fire exclusion. However, the disruption of ecological functions in a fire-driven system tends to increase with increasing departure from historic frequencies. Ecological disruption is often most evident as shifts in vegetation species composition and structure, but may also include loss of key ecosystem components (Hann et al. 2003).

The lack of significant woody vegetation in the mixedgrass prairie suggests that grazing, especially grazing by livestock, may be able to act as a surrogate for some fire effects (McPherson 1997, Bragg and Steuter 1996).

Indicator: Percent of target area experiencing a 5-30 year fire return (MGPM)

Indicator Ratings:

Poor: <25%
Fair: 26-50%
Good: 51-75%
Very Good: 76-100%
Indicator ratings comment: The indicator rating thresholds were chosen based upon a literature review and professional judgment.

In the past, fires probably burned foothills grassland communities at least every 30 years based on fire frequency estimates derived from nearby forests (Sherriff and Veblen 2007). However, studies for the Great Plains (summarized in Wright and Bailey 1982) suggest that on level-to-rolling topography, fire frequencies of 5 to 10 years are reasonable estimates of historic condition. The conclusions of Wright and Bailey (1982) are supported by the work of Wendtland and Dodd (1992). They used historic records to determine a fire return interval of 5-30 years near Scotts Bluff National Monument in northwestern Nebraska. They also found less frequent return in more topographically diverse terrain and more frequent fire in smooth to gently rolling terrain. The level of documentation to be found in most cited sources of grassland fire return interval is limited. However, most authors express a relatively high level of confidence based upon conceptual models that take into consideration sources of ignition, fuel availability and the limited historic accounts of fires. Decker (2007a) states that using the Fire Regime Condition Class (Hann et al. 2003) the Central Mixedgrass Prairie falls in Fire Regime Condition Class II, with a fire return interval of 0-35 years, and stand replacement severity. Based upon these sources OSMP identified a 5-30 year fire return interval as the desired range of variation for the MGPM.

The threshold of acceptability (i.e. the threshold between "Fair" and "Good") was set so that most (i.e. greater than 50%) of the planning area fell within the estimated desired range of variability. OSMP recognizes that it may not be feasible to burn some portion of the MGPM. For instance, the proximity to developed areas may limit the ability to burn a given parcel.

Under current conditions, burning grasslands takes extensive planning and can only be implemented when environmental conditions are appropriate. Often the window of opportunity for grassland burns is short. Therefore, the likelihood of burning large areas annually is low. The larger the proportion of MGPM "out of prescription", the more difficult it is for OSMP managers to ensure the entire target is burned within the acceptable fire return interval.

While OSMP considered basing the indicator ratings on departure from the acceptable fire frequency (less than one interval, one interval, more than one interval), the department lacked sufficient information.

OSMP records the location and extent of grassland burns by creating polygons of burned areas within shapefiles. Attribute information includes the date of the burn. Records of grassland burns on OSMP for the period 1997-2007 are thought to be complete. Information about burns that occurred prior to 1997 was less thoroughly recorded and records are considered less complete. Information about fire history is often limited to the term of OSMP ownership, unless burn polygons happen to extend onto nearby lands that were subsequently purchased as OSMP.

A rating of “Good” (51% minimum) period would require burning of nearly 5,000 acres in a 30-year period.
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: 0.26
Current Rating: Fair
Current rating comment: Using the best available information from the past 18 years, approximately 1,550 acres of the MGPM have burned. If this rate is extrapolated over 30 years, approximately 26% of the MGPM would have burned in the proposed fire return interval. This places the target within the “Fair” rating.
Confidence of the current rating: High

Desired Rating: Good
Desired rating comment: As with msot of the indicators, the objective is to have conditions rated as either "Good" or "Very Good". Since the current situation is far from the range of acceptable condition, and the planning horizon is only ten years, OSMP staff considers achieving “Good” conditions a reasonable

starting point. If grassland burning turns out to be supported by the community and easy to accomplish, we may be able to set our sights higher.

If all grasslands were in prescription, it would be necessary to burn at least 160 acres annually to ensure a fire return frequency of 30 years for 51% of the target (at today's acreage).

OSMP's approach will be to develop field specific burn plans to address issues of setting, topography, and cover to develop appropriate return intervals. It is possible that some areas will not be burned because of neighboring land uses, topography, contamination, or other factors.

Other comments: Documentation of the GIS analysis can be found at: S:\OSMP\PLAN\GEMAP\Viability\Fire Ecology.

Conservation Target: Mixedgrass Prairie Mosaic
Category: Landscape Context
Key Attribute: Habitat Effectiveness
Key attribute comment: In order to conserve grasslands, OSMP must ensure not only that the land is protected from development and vegetated with native plant species, it should also support the habitat needs of the rare and sensitive nested species. Habitat effectiveness considers the landscape in the context of specific disturbances, and reflects the land's actual ability to support particular species or groups of species—in this case sensitive grassland animals.

This indicator is focused upon habitat block size. Habitat block size is, in part, a function of the conservation requirements of area sensitive species. Badgers and grasshopper sparrows are two examples of species that require (relatively) large habitat blocks. Grasshopper sparrows are better suited as an indicator species because they are more easily observed.

Grasshopper sparrows appear to be the most area sensitive of our grassland nesting birds (Bollinger 1995, Delisle and Savidge 1996, Helzer 1996, Herkert 1994, Johnson and Temple 1986, McMaster and Davis 1998, Wiens 1969). Delisle and Savidge (1996) found grasshopper sparrows to avoid nesting within 50 m of edge habitats while Bock et al. (1999) found the species to be significantly more abundant in interior grasslands than those near development. The sensitivity of this species is reflected in continental scale declines. North American breeding bird surveys reported an annual population decline of 3.9% for grasshopper sparrows and Vickery (1996) cites habitat degradation and conversion of native grasslands into crop production as primary causes for this decline.

Although their average defended territory size is ≤2 ha (Dechant et al. 2003), the estimated minimum size requirement [defined as the area at which the probability of observing a species is 50% of its maximum (Robbins et al. 1989)] of grasshopper sparrows was 134 ha in mixedgrass habitats of Canada (Davis 2004), 100 ha for grassland barrens in Maine (Vickery et al. 1994), and 30 ha for high-quality prairie in Illinois (Herkert 1994). The minimum size requirement is a conservative measure of occurrence probability for area-sensitive species because the detection functions rises asymptotically as block size increases (Robbins et al. 1989).

Further, Wyoming Partners in Flight Best Management Practices recommends keeping grassland blocks >100 ha intact to benefit area-sensitive birds (Wyoming PIF 2002) and Dejong (2001) found the density of grasshopper sparrows increased with grassland patch size, indicating a significant area-sensitive relationship. Mean patch size where grasshopper sparrows were detected on her study site in South Dakota was 640 ha. Larger habitat patches are efficient in their capacity to hold more area-sensitive species (Bock et al. 1999, Davis 2004) which in turn experience less intra-specific competition for resources (Dejong 2001) and suffer less predation and nest parasitism (Dechant et al. 2003) than in smaller habitat blocks.

OSMP proposes to use the grasshopper sparrow as an indicator for habitat effectiveness. For each habitat block larger than 100 ha (247 acres), OSMP hypothesizes that at least one male grasshopper sparrow will be detected singing during the breeding season.

Habitat blocks are defined as blocks of mixedgrass prairie mosaic, xeric tallgrass, wetland, or mesic bluestem prairie. Blocks are bounded by recreational trails plus a 100 m buffer, roads plus 200 m buffer or riparian areas over 20 m in width (no buffer).

Indicator: Proportion of habitat blocks over 100 ha with singing male grasshopper sparrows

Indicator Ratings:

Poor: < 40%
Fair: 40 - 59%; or >59% but not in all habitat blocks > 300 ha
Good:
Very Good: >80% (+ all habitat blocks > 300 ha)
Indicator ratings comment: The indicator rating thresholds were developed in the absence of local observational data, but based upon the assumption that the habitat effectiveness of the targets increases when singing male grasshopper sparrows are found in more of the large (>100 ha) habitat blocks. The failure to detect birds in otherwise intact habitat blocks would indicate stresses acting upon targets. Lacking baseline data to provide a specific threshold, OSMP defined "Good" as the detection of male grasshopper sparrows singing in more than a majority (at least 60%) of the large habitat blocks. In the judgment of OSMP biologists, singing male grasshopper sparrows should also be detected in ALL of the largest (those over 300 ha or 741 acres) habitat blocks in order for this indicator to be considered in good condition.

Once the value for "Good" was proposed, the thresholds between "Fair" and "Poor", and "Good" and "Very Good" were developed using best professional judgment. The thresholds should be refined once data are collected for this measure.
Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: Unknown
Confidence of the current rating: Low

Desired Rating: Good
Desired rating comment: The thresholds for the indicator ratings should be refined once data are collected for this measure.

Conservation Target: Mixedgrass Prairie Mosaic
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment:
Because the habitat of butterflies and skippers is intermingled among the Mixedgrass Prairie Mosaic, Xeric Tallgrass Prairie and Mesic Bluestem Prairie, a single indicator is proposed to assess the viability of all three targets.

Butterflies are excellent indicators of grassland health. Our goal is to maintain or increase occurrence levels of 11 CNHP watch-listed species in specific OSMP habitats.

CNHP-tracked grassland dependent butterflies and skippers with associated conservation targets (MGPM=Mixedgrass Prairie Mosaic, XTGP=Xeric Tallgrass Prairie, MBP= Mesic Bluestem Prairie)

Common Name	Scientific Name	Grassland Plan Target		
		MGPM	XTGP	MBP
Simius roadside skipper	*Amblyscirtes simius*	X	X	-
Arogos skipper	*Atrytone arogos*	-	X	X
Dusted skipper	*Atrytonopsis hianna*	-	X	X
Hops feeding azure	*Celestrina humulus*	-	-	X
Mottled dusky wing	*Erynnis martialis*	-	X	-
Colorado blue	*Euphilotes rita coloradensis*	-	X	-
Two-spotted skipper	*Euphyes bimacula*	-	-	X
Ottoe skipper	*Hesperia ottoe*	-	X	X
Crossline skipper	*Polites origenes*	-	X	X
Rhesus skipper	*Polites rhesus*	X	X	-
Regal fritillary	*Speyeria idalia*	-	X	-

Indicator: Percent occurrence of CNHP-tracked grassland dependent butterflies and skipper species

Indicator Ratings:

Poor: <4%
Fair: 4-10%
Good: 10-25%
Very Good: >25%
Indicator ratings comment: All known sampling events of butterflies and skippers in the grassland conservation targets (MGPM, XTGP and MBP) were used to calculate a percent occurrence measure for the 11 species of CNHP-tracked butterflies and skippers. Because these species are rare, each observation per sampling event contributes to the total number of occurrences. For example, if two individuals of one species and one individual of another were observed in one transect and no individuals were observed in the next three transects, percent occurrence would equal 3/4 = 75%. This method acknowledges varying levels of abundance of lepidoptera among sampling events. It also helps identify sampling locations that are especially important habitat. CNHP tracked species were encountered in 25 (or 23%) of 110 sampling events.

Staff placed the percent occurrence for CNHP species (23%) from all historical sampling events near the upper end of "Good" because many of the detections were recorded as part of targeted inventory of the best habitat on OSMP lands (Pineda and Ellingson 1998) rather than random or stratified random sampling. OSMP does not consider targeted inventory to be an appropriate method for tracking relative change in butterfly occurrence.

The studies that used replicable sampling methodology detected an 8.8% occurrence of CNHP tracked species. Staff chose 10% species occurrence as the "Good"/"Fair" threshold to reflect OSMP's intention to improve habitat quality (native plant relative cover/species richness) on OSMP lands.
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: 0.088
Current Rating: Fair

Desired Rating: Good
Desired rating comment: Similar to grassland birds, previous butterfly sampling on OSMP has been conducted in areas of high vegetative quality. Changes to fire and grazing regimes (by both prairie dogs and cattle) and maintenance of large, intact habitat blocks could increase the dominance of big and little bluestem and expand the distribution of these species. For example, well-timed prescribed burns (instead of wildfire) in areas dominated by weeds may improve habitat quality for big and little bluestem.

Other comments: Monitoring of CNHP-tracked species should be undertaken every 5-10 years to identify population trends. Monitoring should occur for at least two consecutive years to address the influence of annual environmental variation (precipitation, temperature, etc.) and variability of detection frequency.

Conservation Target: Mixedgrass Prairie Mosaic
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: Because the habitat of butterflies and skippers is intermingled among the Mixedgrass Prairie Mosaic, Xeric Tallgrass Prairie and Mesic Bluestem Prairie, a single indicator is proposed to assess the viability of all three targets.

Butterflies are excellent indicators of grassland health. Butterfly assemblages, because of a range of sensitivities to environmental perturbations, may be useful in ecological integrity assessments (Nelson and Epstein 1998). OSMP's goal is to maintain or increase the current occurrence levels of selected grassland dependent species. Occurrence refers to encountering an individual of a species during a monitoring event.

Fire, grazing and herbicide use, techniques that OSMP has and is likely to continue to use to manage native plant species composition and richness, could have adverse impacts upon butterflies and skippers. In order to track the impact of our grassland management on butterflies and skippers, butterflies and skippers are being included as an indicator of ecological integrity of the Mixedgrass Prairie Mosaic, Xeric Tallgrass Prairie and Mesic Bluestem Prairie. Because the habitat of these animals is intermingled in the Grassland Planning Area, a single indicator is proposed to assess the viability of all three targets.

Several of the skippers and butterflies included as nested targets have been identified as conservation targets by The Nature Conservancy and others in the Southern Rocky Mountain Ecoregional Assessment (Neely et al. 2001). Successful conservation of foothills grasslands, especially tallgrass areas, is integral to accomplishing ecoregional conservation goals.

Indicator: Percent occurrence of grassland dependent butterflies and skipper species

Indicator Ratings:

Poor: <25%
Fair: 26-50%
Good: 51-75%
Very Good: >75%
Indicator ratings comment: Staff used OSMP butterfly studies to determine grassland dependent species occurrence per sample-year (transects, spot mapping, etc.). Sample-years included in the analysis were: 2001, 2002 (Armstead), 1999, 2000 (Collinge), and 2007 (Robinson). Data derived from Collinge were not able to be analyzed separately by year and therefore were treated as one year's sampling. Grassland dependent species occurred in 30 of 68 grassland sample-years for a 44% occurrence rate (Armstead 2003, Colllinge et al. 2003, Robinson and Bowers 2007).

OSMP staff believes that there are opportunities to improve butterfly and skipper habitat, and consequently placed the percent occurrence of grassland dependent species from all historical studies at the upper end of the "Fair" rating (see current rating notes). Indicator ratings separated by quartiles to reflect the increasing conservation value of higher levels of incidence of grassland dependent species.

Selected grassland dependent butterflies and skippers with associated conservation targets (MGPM=Mixedgrass Prairie Mosaic, XTGP=Xeric Tallgrass Prairie, MBP= Mesic Bluestem Prairie)

Common Name	Scientific Name	Grassland Plan Target		
		MGPM	XTGP	MBP
Simius roadside skipper	*Amblyscirtes simius*	X	X	-
Arogos skipper	*Atrytone arogos*	-	X	X
Dusted skipper	*Atrytonopsis hianna*	-	X	X
Hops feeding azure	*Celestrina humulus*	-	-	X
Mottled dusky wing	*Erynnis martialis*	-	X	-
Colorado blue	*Euphilotes rita coloradensis*	-	X	-
Two-spotted skipper	*Euphyes bimacula*	-	-	X
Ottoe skipper	*Hesperia ottoe*	-	X	X
Crossline skipper	*Polites origenes*	-	X	X
Rhesus skipper	*Polites rhesus*	X	X	-
Regal fritillary	*Speyeria idalia*	-	X	-
Orange-headed roadside-skipper	*Amblyscirtes phylace*	-	X	X
Leonard's skipper	*Hesperia leonardus*	X	X	X
Pahaska skipper	*Hesperia pahaska*	X	X	-
Green skipper	*Hesperia viridus*	X	X	-
Boisduval's blue	*Plebejus icarioides*	-	X	-
Uncas skipper	*Hesperia uncas*	-	X	X
Indra swallowtail	*Papilio indra*	X	X	-
Delaware skipper	*Atrytrone logan*	-	X	X

Confidence of these indicator rating descriptions: High

Indicator Measurements:

Date: 4/15/2008

Current Indicator Measurement: 0.44

Current Rating: Fair

Current rating comment: Half of the grassland dependent species depend upon big and little bluestem for larval food. These plant species are typically present in grasslands with "Good" vegetation condition. Analysis of the existing data suggests that the vegetation condition of the MGPM, XTGP and MBP can best be described as "Fair" (i.e., most vegetation condition indicators are rated as "Fair"). It is appropriate that current ratings of insects and their particular habitat requirements are similar.

Confidence of the current rating: Medium

Desired Rating: Good

Desired rating comment: Although the studies used to estimate current butterfly status sampled in areas of high vegetative quality (Armstead 2003, Colllinge et al. 2003, Robinson and Bowers 2007), there are areas in these conservation targets that would benefit from increased fire frequency, decreased human pressure, and changes in grazing (Kettler and Pineda 1999, Pineda and Ellingson 1998). Changes in grazing could mean the timing and intensity of livestock grazing, or the intensity of grazing by prairie dogs. This could increase local dominance of larval host-plants, which is correlated to butterfly winter survival and recruitment rates.

Other comments: Monitoring of grassland dependent species should be undertaken every 5-10 years to identify population trends. Monitoring should occur for at least two consecutive years to address the influence of annual environmental variation (precipitation, temperature, etc.) and variability of detection frequency.

Conservation Target: Mixedgrass Prairie Mosaic
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: This measure was developed to be applicable to the Mixedgrass Prairie Mosaic and Xeric Tallgrass Prairie targets.

Birds are perhaps the best known and most easily measured animal grouping in grasslands. They have been demonstrated to be sensitive to a number of the threats known to exist in North American grasslands including those thought to affect OSMP grasslands. They are sensitive to changes in grazing and fire regimes, the establishment of exotic plant species, increased predation by dogs, human travel on trails, incompatible nearby land uses and reduction of habitat block size by a variety of sources of fragmentation (Vickery et al. 1994, Johnson 1996, Brennan and Kuvlesky 2005, Knick and Rotenberry 1995).

Local threats to breeding and non-breeding adults and overall population status set the parameters for Partners in Flight (PIF) scores (Carter et al. 2000 Panjabi 2001). The original scores were modified by an algorithm developed by Nuttle et al. (2003) to place all birds in one of five conservation categories ranging from zero for all non-native species to 4 for rare local breeders such as the northern harrier. This system has been used by others (Wood et al. 2004, Smith et al. 2005, Lanham et al. 2005, Legrand et al. 2007, Conover et al. 2007) to measure the effectiveness of forest management, pine-grassland restoration and field border management with respect to avian conservation.

The "Derived PIF (DPIF) conservation score" is the metric of interest and the sampling effort (transect, point count) is the experimental unit. The DPIF was calculated using the following methods:

1.) Remove all aerial foragers (swallow spp.) from studies' species list.
2.) Sum all other individuals/transect to gain transect total bird count.
3.) Use algorithm in Nuttle et al. (2003) to place birds into 1 of 5 conservation categories (PIF rank).
4.) Calculate relative abundance (RA) for each species within a specific suite of grassland birds (see below) using the following formula:
Total # of Individuals of species "x" detected in Transect 1/ Total # of all individuals (except swallows) detected in transect 1
5.) Within each transect, multiply RA of each species by the PIF rank of that species to gain (RA x PIF rank score) for each grassland bird species for that transect.
6.) Sum (RA x PIF rank score) for all birds within each transect.
7.) Multiply the (RA x PIF rank score) of each transect by the species richness of 21 selected species detected in each transect. The selected species are listed below. This step corrects for the lack of local avian abundance in the conservation value scores.

Only birds from the selected species list (n=21) are included in the calculation of Rank Score. Aerial foragers (e.g. swallows) were excluded from the total count for the transect because they are colonial nesters and tend to be present in flocks, a behavior which would skew the data to overcount aerial foragers, and undercount others.

1. American kestrel
2. Barn owl
3. Bobolink
4. Burrowing owl
5. Common nighthawk
6. Common poorwill
7. Dickcissel
8. Ferruginous hawk
9. Golden eagle
10. Grasshopper sparrow

11. Horned lark
12. Lark bunting
13. Lark sparrow
14. Loggerhead shrike
15. Northern harrier
16. Prairie falcon
17. Sage thrasher
18. Savannah sparrow
19. Short-eared owl
20. Swainson's hawk
21. Vesper sparrow
22. Western meadowlark

Indicator: Percent of target with acceptable bird conservation score

Indicator Ratings:

Poor: < 75% of transects with a derived PIF score of 1.0
Fair: At least 75% of transects with a derived PIF score of 1.0
Good: At least 75% of transects with a derived PIF score of 3.9
Very Good: At least 75% of transects with a derived PIF score of 8.1
Indicator ratings comment: There were 223 sample-years including studies by Lenth et al. (2006), Bock et al. (1999) and surveys conducted by OSMP staff to determine the effects of recreation and agricultural management on bird communities (currently unpublished--Tallgrass West and High Plains Trail). The mean DPIF conservation score from these samples is 5.69.

The Tallgrass West area exhibits good potential bird habitat but is currently rebounding from historic grazing effects. Staff considered Tallgrass West a reliable estimate for the variability within the "Good" rating. Therefore, staff placed the mean DPIF score of Tallgrass West sampling (~5.3) in the lower range of "Good". Next, staff subtracted one half of one standard deviation from the Tallgrass West samples' mean to estimate the "Good"/"Fair" threshold (3.9), and added one standard deviation to define the "Good"/"Very Good" threshold (8.1). Interestingly, the mean DPIF score of the two highest scoring areas sampled was 8.1. Staff then chose a "Poor"/"Fair" threshold of 1.0 using best professional judgment.
Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: Unknown
Current Rating: Fair
Current rating comment: Using data recently collected on OSMP (Tallgrass West and High Plains: 2006-07), 60% of samples had a DPIF score > 3.9 (i.e., are considered "Good") and 75% of the samples had a DPIF > 2.8. Using these data the current rating would be "Fair". However, the samples included in this data set are biased because they were taken from sites in one part of the system where conditions are not representative of OSMP grasslands.
Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Mixedgrass Prairie Mosaic
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: Native relative cover serves as an indicator of the quality of vegetation occurring in a sample. However, taken alone, relative cover does not provide a full picture of community

composition, because it refers only to that portion of the sample that is vegetated. Native relative cover is proposed as one of several indicators of vegetative composition. The others are: two indicators of the presence of invasive species and two measures of native species richness. One measure of vegetative structure, absolute cover of bare ground, provides additional data on the condition of the MGPM.

This indicator was developed separately for the two dominant alliances in the MGPM target. These alliances are the Needle-and-Thread/Blue Grama Herbaceous Alliance (HESCOM) and the Western Wheatgrass Herbaceous Alliance (PASSMI).

Indicator: Native species relative cover

Indicator Ratings:

Poor: HESCOM < 75% of samples NRC ≥60%;
PASSMI < 75% of samples NRC ≥ 33%

Fair: HESCOM At least 75% of samples NRC ≥ 60%;
PASSMI At least 75% of samples NRC ≥ 33%

Good: HESCOM At least 75% of samples NRC ≥ 88%;
PASSMI At least 75% of samples NRC ≥ 86%

Very Good: HESCOM At least 75% of samples NRC=100%;
PASSMI At least 75% of samples NRC=100%

Indicator ratings comment: OSMP examined 13 years of point cover transect data collected from multiple plots. The data included 99 transect-years of data for transects in PASSMI and 37 transect-years of data for transects in HESCOM.

Median values for native species relative cover for the transect-years were calculated for both alliance types. Based upon the recommendations of the grassland plant ecologist and the agricultural resource specialist that the native relative cover of the PASSMI type was below the threshold of acceptability, the median value for the PASSMI alliance was placed at the center of the "Fair" rating. The range for the PASSMI "Fair" rating was created as one standard deviation above and 1.5 standard deviations below the median value. The threshold between "Good" and "Very Good" was set at 2 standard deviations above the median relative native cover. All values below "Fair" were given the rank of "Poor". Final ratings were developed as the percentage of transects with a value below or above the threshold of acceptability. Given the current status of the MGPM for this indicator and the relatively long time scale (>10 years) that is expected to be needed to improve the status, the conservation objective for the next ten years was set at 75% of the target should have a native relative cover of at least 86%. This recognizes the desire to balance conservation of other targets (prairie dogs and their associated community; agriculture) with the conservation of the MGPM.

The median value for native relative cover in the HESCOM type serves as the boundary between "Fair" and "Good", based on the professional judgment that the composition of this type was in better condition than the western wheat type. The range for this rating was created as two standard deviations around the median value. (Two standard deviations above the median describes "Good" conditions; two standard deviations below the median describe "Fair".) As with the PASSMI type, final ratings were developed as the percentage of transects with a value below and above the threshold of acceptability.

The information from this analysis was used as the basis for indicator ratings and was combined with guidance found in Rondeau (2001) for the Foothills Grassland large patch target in the Southern Rocky Mountain Ecoregional Assessment and in Appendix K of Neely et al. (2006) for both the Western Great Plains Foothill & Piedmont Grassland and the Central Mixedgrass Prairie ecological systems.

Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: 75% of the HESCOM transects have a NRC > 66%
75% of the PASSMI transects have a NRC > 58%
Current Rating: Fair
Current rating comment: The status is based on five transects sampled in 2006 for HESCOM and seven transects sampled in 2006 for PASSMI.
Confidence of the current rating: Medium

Desired Rating: Good
Desired rating comment: OSMP established native species relative cover thresholds for "Very Good", "Good", "Fair" and "Poor" categories. Rather than stating that a system-wide mean falls within the "Good" category, OSMP desires that most of the planning area falls in the "Good" category. Thus, OSMP's desired rating is that "at least 75% of the samples" have a native relative cover greater than or equal to 86% for the PASSMI type and 88% for the HESCOM type.

Conservation Target: Mixedgrass Prairie Mosaic
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: Native species richness is a direct measure of biological diversity. It is sensitive to management practices that tend to homogenize natural systems such as a repetitive grazing regime (same season of use, similar stock rates, similar duration, continuous prairie dog occupation), fire suppression or a fire regime that repeatedly burns the same area during the same time of year. Species richness is used in the Ecological Viability Specifications for the Foothills Grasslands in the Southern Rocky Mountains Ecoregional Plan (Rondeau 2001). Species richness is best if used with other indicators of community composition to gauge conservation status (Fleishman et al. 2006).

There are two dominant alliances in the MGPM target. The first is the Needle-and-Thread Blue Grama Herbaceous Alliance (HESCOM) and the second is the Western Wheatgrass Herbaceous Alliance (PASSMI).

Indicator: Native species richness

Indicator Ratings:

Poor: HESCOM < 75% of samples have a native species richness ≥5;
PASSMI < 75% of samples have a native species richness ≥3
Fair: HESCOM At least 75% of samples have a native species richness ≥5;
PASSMI At least 75% of samples have a native species richness ≥3
Good: HESCOM At least 75% of samples have a native species richness ≥31;
PASSMI At least 75% of samples have a native species richness ≥ 33
Very Good: HESCOM At least 75% of samples have a native species richness > 54;
PASSMI At least 75% of samples have a native species richness > 44
Indicator ratings comment: OSMP examined 13 years of point cover transect data collected from multiple plots. The data included 97 transect-years of data for transects in PASSMI and 31 transect-years of data for transects in HESCOM.

Median values for native species relative cover for the transect-years were calculated for both alliance types. Based upon the recommendations of the grassland plant ecologist and the agricultural resource specialist that the species richness of the PASSMI was below the threshold of acceptability, the median value was placed at the center of the “Fair” rating. As an initial step, the range for the PASSMI "Fair" rating was set at two standard deviations around the median value. The next standard deviation above the “Fair” rating was given the rank of “Good”; and all values below “Fair” were given the rank of “Poor”. All values above “Good” were given the rank of "Very Good". Final ratings were defined as a percentage of transects with a value below or above the threshold of acceptability.

The median value for species richness in the HESCOM type was placed at the boundary between "Fair" and "Good", based on the professional judgment that this type was in better condition than the western wheat type. The threshold between "Good" and "Very Good" was set at two standard deviations above the median, while the threshold between "Fair" and "Poor" was set at two standard deviations below the median native species richness. As with the PASSMI type, final ratings were defined as a percentage of transects with a value below or above the threshold of acceptability.

OSMP staff prepared the statistical analysis and used the data to define the indicator ratings. The confidence is based upon the consensus that species richness could be higher, and the availability of a relatively long-term data set spread across the OSMP land system.

The current status for the MGPM vegetation composition indicators that evaluate dominance ("Good") and high occupancy ("Poor") by non-native species tracked through the RAM method lend further support to the professional judgment that this target is in "Fair" condition related to the key attribute of vegetation composition.

Western wheatgrass communities most commonly occur in valleys and on lower slopes in soils that are generally more susceptible to weed invasion than communities occupying rocky soils on pediment surfaces or upper hill slopes. Western wheatgrass communities also tend to receive higher grazing intensity by cattle than warm season-dominated plant communities in rocky, steep areas. Prairie dogs most commonly occupy western wheatgrass communities. The overall current condition of western wheatgrass communities probably reflects grazing pressures over time and an inherently lower resistance and resilience when compared to plant communities occupying rocky terrain on pediment surfaces and upper hill slopes (Buckner 2007).
Confidence of these indicator rating descriptions: Medium

Indicator Measurements:
Date: 4/15/2008
Current Indicator Measurement: 75% of the HESCOM transects have a native species richness >16
75% of the PASSMI transects have a native species richness >7
Current Rating: Fair
Current rating comment: The status is based on five transects sampled in 2006 for HESCOM and seven transects sampled in 2006 for PASSMI.
Confidence of the current rating: High

Desired Rating: Good
Desired rating comment: OSMP established native species richness thresholds for "Very Good", "Good", "Fair" and "Poor" categories. Rather than stating that a system-wide mean fall within the "Good" category, OSMP desires that most of the planning area falls in the "Good" category. Thus, OSMP's desired rating is that "at least 75% of the samples" have a native species richness greater than or equal to 33 for the HESCOM type and 31 for the PASSMI type.

Conservation Target: Mixedgrass Prairie Mosaic
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: While additional, more quantitative research is needed to fully understand the complex impacts of invasive species on ecosystems (Hulme and Bremner 2006), some impacts have been documented. Eagle et al. (2007) detailed a wide range of impacts from yellow starthistle in California;

Vaccaro (2005) documented loss of biodiversity resulting from cattail leaf litter in Great Lakes wetlands; Katz and Shafroth (2003) and Simons and Seastedt (1999) documented impacts of Russian olive on various ecological functions; Levine et al. (2003) reviewed underlying impacts of exotic plant invasions; Tickner et al. (2001) reviewed the literature on riparian invasions; Bakker (unpublished) reviewed impacts of woody plants on grassland dependent birds; and Rumble and Gobeille (1998) looked at bird use in different successional stages of cottonwood forests and potential impacts of replacement by other woody species, mainly invasive green ash.

In addition to being a key attribute for the target, this indicator is intended to help address the concerns raised by Fleishman et al. (2006) regarding the limitations of species richness. This indicator seeks to provide information about the extent of areas within the target dominated by a subset of noxious weeds that are both of significant concern to OSMP and practical to monitor. For this indicator, "dominated" means over 50% canopy cover. Canopy cover measures for the RAM methodology are documented in (Dewey and Anderson 2006).

In 2007, OSMP staff chose to use a variant of the RAM protocol referred to as the gross area polygon because of the types of weeds that were encountered and a desire to speed data collection. Gross area polygons are intended to provide a way to address extremely widespread infestations. This may have led to some over-mapping (showing invasive species where they did not actually occur) especially of diffuse knapweed.

The indicator ratings were assigned in response to a number of sources (Rondeau 2001, Neely et al. 2006, Decker 2007a) aassociated with ecological integrity assessments.

The RAM methodology was applied to almost the entire target; however, certain low priority sites were excluded based on their position within Visitor Master Plan Trail Study Areas and large habitat blocks. Isolated and smaller parcels not included in the TSAs up for review at the time of sampling were omitted. The only known consequence is that CRP lands in the northeast (ca. 1600 ac) were not mapped. The effect of this omission on the overall estimate is not known.

Indicator: Percent of target dominated by non-native species (Rapid Assessment Mapping)

Indicator Ratings:

> **Poor:** >5%
> **Fair:** 3-5%
> **Good:** 1-<3%
> **Very Good:** <1%
> **Indicator ratings comment:** The RAM species included OSMP priority species, a synthesis of state, county and local species of concern. These species are typically considered most threatening to ecosystem health, recreation and agriculture. From this list, certain ubiquitous species unlikely to be managed were removed (e.g. cheatgrass, smooth brome and wild asparagus). The list of RAM species for 2006 is available in Dewey and Anderson (2006:2-3). In addition to these, the 2007 data collection also included other species documented in Johnson (2007).
>
> Levels of infestation, as a percent of target area, were calculated from RAM data using GIS for each target. The indicator ratings were assigned in response to a number of sources (Rondeau 2001, Neely et al. 2006, Decker 2007a) associated with ecological integrity assessment. The indicator ratings are comparable to those developed for conservation action plans in other areas (e.g. Lower Purgatorie, Huerfano Uplands, Laramie Foothills and the Rocky Mountain Front Range).

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: 0.023
Current Rating: Good
Current rating comment: OSMP calculated the current (2006-7) percent cover for RAM species within six cover classes for each target. The percent of a target in the cover class "> 50%" was used for this indicator.
Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Mixedgrass Prairie Mosaic
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: For documentation of the relevance of exotic species as an indicator, please see Key Ecological Attribute Indicator "Percent target area dominated by exotic species tracked through the RAM method".

This indicator provides additional information about the extent of the target likely to become dominated by invasive species. This indicator was developed to provide advanced warning of changing conditions because a target may have not be dominated by RAM species, but those species might be approaching dominance. The inclusion of this indicator will allow us to track these high occupancy areas and manage them before they become dominated by RAM species.

Indicator: Percent of target with prevalence of non-native species (Rapid Assessment Mapping)

Indicator Ratings:

Poor: >15%
Fair: 9-15%
Good: 3- <9%
Very Good: <3%
Indicator ratings comment: Levels of infestation were calculated from RAM data using GIS. OSMP staff looked for weed management plans or integrity assessments upon which to base thresholds; however, no examples were found for using sub-dominance (high occupancy) as a leading indicator. Consequently, the indicator ratings for this indicator are based on professional judgment rather than the work of others. Because of the lower abundance by RAM species for this indicator, the percent of area for each indicator (tolerance of area occupied) is higher.
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: 0.194
Current Rating: Poor
Current rating comment: OSMP calculated the current (2006-7) percent cover for RAM species within six cover classes for each target. The percent of a target in the cover classes "6-25%" and ">25-50%" were used for this indicator.
Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Mixedgrass Prairie Mosaic
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: Native species richness is a direct measure of biological diversity. It is sensitive to management practices that tend to homogenize natural systems such as a repetitive grazing regime (same season of use, similar stock rates, similar duration, continuous prairie dog occupation) or a fire regime that always burns the same area during the same time of year. Species richness is used by Rondeau (2001) in the Ecological Viability Specifications for the Foothills Grasslands in the Southern Rocky Mountains Ecoregional Plan.

Species richness is best if used with other indicators of composition and other key ecological attributes (e.g. endemism, functional significance, and the severity of threats) (Fleishman et al. 2006). This indicator uses a subset of native plant species that provide a better indication of ecological condition than a measure of the richness of all native species. Coefficients of Conservatism, also called “C values”, have been assigned to the majority of native species occurring in Colorado by a panel of experts (Rocchio 2007). C-values range from zero to 10, representing the potential for each species to "occur in a landscape relatively unaltered from pre-European settlement conditions”. C-values above six indicate progressively higher levels of conservatism, with a C value of 10 representing an obligate association with high quality natural areas and the processes that support them (Rocchio 2007).

Native species richness may be high in the target for a variety of reasons. Some native plant species increase over time under livestock and/or prairie dog grazing. If only one indicator for species richness of all native species were to be used, OSMP’s objectives for species richness could be met for grasslands that are in one seral stage, or that in other ways do not represent the range of functioning natural systems in the Mixedgrass Prairie Mosaic target. Staff examined the C-values of the plant species in the target and determined that species with C-values of five and above included those more likely to decrease in the presence of heavy grazing pressure. In addition, several characteristic species of the target’s alliances had been assigned C values of 5 and higher.

Indicator: Richness of selected conservative plant species

Indicator Ratings:

Poor: < 75% of samples ≥4
Fair: At least 75% of samples ≥4
Good: At least 75% of samples >17
Very Good: At least 75% of samples >24
Indicator ratings comment: OSMP staff examined all PASSMI transect-years in the target, including those in disturbed states of the target. Based upon the staff judgment that areas of this target unoccupied by prairie dogs could be described as “Fair”, staff placed the mean species richness for all unoccupied transect-years in the middle of the “Fair” category and used one standard deviation above and below this mean to define the “Fair” range. Two standard deviations above the mean marked the cutoff between “Good” and “Very Good”.

The HESCOM samples were few and highly variable. OSMP analyzed the HESCOM data in a manner similar to the analysis done on the PASSMI data and described above. With the exception of the “Poor”/”Fair” threshold, the HESCOM thresholds were similar to the PASSMI ratings. Consequently, the PASSMI ratings are being used for the target until more data is available to describe the HESCOM alliance.
Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Date: 4/15/2006
Current Indicator Measurement: 75% of the transects have a conservative species richness ≥ 2.25
Current Rating: Poor

Current rating comment: Currently (2006 data-based upon seven transects), the 25th percentile is 2.25, so the PASSMI alliance is in the "Poor" category.

Current (2006) status of conservative spp. richness (C>4) and status in 2001 which is the last time all PASSMI transects were sampled.

	2006	2001
N of cases	7	21
Minimum	2.000	1.000
Maximum	16.000	24.000
Mean	6.286	7.095
Standard Dev	5.499	5.049
Method = CLEVELAND		
1 %	2.000	1.000
5 %	2.000	1.000
10 %	2.000	1.600
20 %	2.000	2.700
25 %	2.250	4.500
30 %	2.600	5.000
40 %	3.300	6.000
50 %	4.000	7.000
60 %	4.700	7.000
70 %	7.800	7.400
75 %	10.250	9.000
80 %	12.400	9.000
90 %	15.200	12.400
95 %	16.000	17.950
99 %	16.000	24.000

The data upon which the current rating is based comes from lower elevation sites that, if not occupied by prairie dogs, are largely near prairie dog occupation - and many are grazed annually by cattle. When monitoring is expanded to include sites in other "states" and types of mixedgrass prairie, a larger number of conservative species may be documented in a larger proportion of the sample sites. When the next most recent (2001) data from all PASSMI transects is analyzed, the 25th percentile is at 4.5 a rating of "Fair".
Confidence of the current rating: Very High

Desired Rating: Good
Desired rating comment: It may very difficult to achieve an acceptable rating for this indicator. OSMP has set the objectives high until more is known about range of variability and status of the target based on results of system-wide sampling. For example, when sampling sites are established in shale barrens, little bluestem-sideoats grama, and the foothills transitional community types, OSMP expects to detect additional conservative species.

Conservation Target: Mixedgrass Prairie Mosaic
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: Bell's twinpod is a member of the Mustard family, restricted to outcrops of the Niobrara and Pierre formations along the northern Front Range of Colorado. One of the largest occurrences of this Colorado endemic is in the northwest portion of the Grassland Planning Area. Shale barrens, habitat for Bell's twinpod and a nested target in the MGPM, contribute significantly to the biological diversity on OSMP.

The species is ranked G2S2. Range-wide, there are 25 extant documented occurrences with approximately one million individual plants. However, the species faces a variety of threats including mining, suburban development along the Front Range, road construction and invasion of its habitat by noxious weeds such as diffuse knapweed (*Acosta diffusa*).

Bell's twinpod was selected as an indicator of condition because it is widespread but only in good quality shale barrens in the Mixedgrass Prairie Mosaic, and its status is a measure of overall plant community condition.

Indicator: Size of Bell's twinpod (*Physaria bellii*) populations

Indicator Ratings:

Poor: >20% of sub-occurrences are declining in area and/or number of individuals
Fair: 11– 20% of sub-occurrences are declining in area and/or number of individuals
Good: 90 – 99% of sub-occurrences are stable or increasing in area and/or number of individuals
Very Good: 100% of sub-occurrences are stable or increasing in area and/or number of individuals
Indicator ratings comment: Conditions in 2007 (number of sub-occurrences and individuals present on OSMP land) will be used as the baseline status for this indicator. Monitoring data will be compared to the baseline at five year intervals. OSMP staff has collected inventory data from the late 1980's through 2007. These data were compiled by OSMP staff. Discreet sub-occurrences were mapped and recorded in the OSMP GIS database.

The ratings were developed using the Occurrence Viability Standards for Bell's Twinpod (NatureServe 2008a).
Confidence of these indicator rating descriptions: High

Indicator Measurements:

Date: 6/15/2007
Current Indicator Measurement: Current status = baseline
Current Rating: Very Good
Current rating comment: The confidence is based upon the consensus that Bell's twinpod occurrences on OSMP have been stable or increasing over the last ten years or more.
Confidence of the current rating: High

Desired Rating: Very Good

Conservation Target: Mixedgrass Prairie Mosaic
Category: Condition
Key Attribute: Vegetation Structure
Key attribute comment: Bare ground refers to organic or mineral soil that is not covered by vegetation (canopy cover), standing dead vegetation, litter or rock. The amount of bare ground and the way it is distributed relate directly to a site's susceptibility to wind and water erosion (Pellant et al. 2000). In the Boulder area, strong winds are a particularly important erosional force. Soil texture, organic matter content, rock content, topography and land use history also contribute to soil surface condition.

The optimal proportions of bare ground, and other cover types required for soil stability, soil moisture retention, adequate nutrient cycling, regeneration site availability and functional wildlife habitat vary by site and community type. PASSMI communities on OSMP typically occur in fine-textured soils in valleys and on hill slopes with lower rock content than occurs on ridges and rocky pediment surfaces. In sites with fine-textured, erodable soils, high cover levels of bare ground can result in significant amounts of soil movement. As soil surface organic matter decreases through erosion, water infiltration and retention is reduced, and the site potential in terms of native perennial seedling establishment and plant survival is diminished. These degraded conditions may create habitat for ruderal native and non-native plant species.

Bare ground cover tends to be higher on average in HESCOM than PASSMI. Due to this difference, separate indicator ratings have been developed. Soils in HESCOM communities typically have higher rock content, and coarser texture, which reduce erosion potential. On HESCOM sites with very steep slopes, the potential for soil movement increases (Kohnke and Franzmeier 1995).

Shale barrens, which are patches with high cover of bare ground, are embedded in the MGPM and have not been included in the analysis due to their small size and distinctive character. The barrens are typically less than five acres in size and frequently have bare ground absolute cover levels of greater than 50%. When community composition and structure data is available for OSMP shale barrens, separate indicator ratings for this patch type may be developed.

Wildlife habitat requirements for bare ground and litter cover, and vegetation structure and composition, vary by species. Patch types with higher cover levels of bare ground create habitat for some wildlife species, while lower bare ground cover combined with optimum litter and vegetation cover provide functional habitat for other wildlife species. Some wildlife species require multiple habitat types during their life cycle. As more information is obtained on the habitat requirements of local grassland species, indicator ratings for bare ground and other ground cover types may be adjusted. Black-tailed prairie dogs create patches with a higher proportion of bare ground.

Indicator: Absolute cover bare ground

Indicator Ratings:

Poor: HESCOM <75% of samples ≤25% AND >10%;
PASSMI <75% of samples ≤ 33%

Fair: HESCOM < 75% of samples ≤25% AND >10%;
PASSMI at least 75% of samples ≤33%

Good: HESCOM at least 75% of samples ≤25% AND >10%;
PASSMI at least 75% of samples ≤10%

Very Good: HESCOM at least 75% of samples ≤25% AND >10%;
PASSMI at least 75% of samples <3%

Indicator ratings comment: Fifty-five transect-years were used for the absolute cover of bare ground analysis for the PASSMI alliance. Based upon the recommendations of the grassland plant ecologist and the agricultural resource specialist that the average absolute cover of bare ground in the PASSMI type was slightly above (i.e. too much bare ground) or near the threshold of acceptability, the mean value was placed at the upper end (i.e., closer to "Good") of the "Fair" rating. An acceptable range of natural variation was defined as falling between 0% and 10% absolute bare ground. The "Poor"/"Fair" threshold was placed two standard deviations from mean. For the first iteration of this measure, OSMP used the 25th percentile as the threshold between "Good" and "Very Good". (By default, 25% of transect-years fell in the "Very Good"). Future sampling across the PASSMI alliance, designed to capture the range in variation in soil cover, may result in adjustments to the acceptable range.

Thirty-seven transect-years were used to develop the absolute bare ground indicator ratings for the HESCOM alliance. As with the PASSMI alliance, the average current condition of the HESCOM sites is characterized as being slightly above (i.e. too much bare ground) or near the threshold of acceptability, based upon the recommendations of the grassland plant ecologist and the agricultural resource specialist. Transect data combined with field observations during vegetation mapping have led to the characterization that HESCOM communities generally exhibit a higher percent cover of bare ground than PASSMI communities. The acceptable range of variation (10-25%) is based on a slight modification of the interquartile range (13-24%) of the transect-years.

This modification was made to represent the natural variation in bare ground cover that has been observed among HESCOM examples on OSMP. No range either "Very Good" or "Poor" is proposed at this time. Future sampling across the HESCOM alliance, designed to capture the range in variation in soil cover, may result in adjustments to the acceptable range and thresholds for "Very Good" and "Poor".

Among the current NRCS Ecological Site Descriptions (ESD), the ESD for Loamy Plains (Sprock et al. 2004a) is the closest match for the MGPM target. This ESD specifies an optimum cover range for bare ground at 0-3%; the ESD recognizes that extended drought can result in bare ground cover of 10-20%. This is consistent with the bare ground indicator ratings developed by OSMP for this target. A combination of factors in the Ecological Site Descriptions are used to characterize community condition, including vegetation composition, productivity, and generalized descriptions of litter and bare ground cover and distribution. The acceptable bare ground cover range for PASSMI and HESCOM incorporates the concept that communities will be dynamic in terms of ground cover and site potential varies across the landscape.

The acceptable range of variation also assumes alternating periods of recovery and disturbance. In productive PASSMI communities in semiarid climates, the absence of periodic disturbances such as ungulate grazing and/or fire for extended periods of time can cause excessive plant litter accumulation that slows nutrient cycling and reduces seed germination and establishment (Sprock et al. 2004a). Litter build up can lead to plant mortality, which can result in increased bare ground and erosion as plants die back. Prolonged, season-long grazing can cause plant mortality, excessive bare ground and subsequent erosion.
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:
Date: 4/15/2008
Current Indicator Measurement: 75% of the HESCOM transects are ≤ 27% bare ground
75% of the PASSMI transects are ≤ 48% bare ground
Current Rating: Fair
Current rating comment: The status is based on seven transects sampled in 2006 for PASSMI. Too few transects were available in 2006 to estimate current status in HESCOM. By combining data from 2005 and 2006, a larger sample size (9) was obtained. The data upon which the current rating is based comes from lower elevation sites that, if not occupied by prairie dogs, are largely near prairie dog occupation, and many are grazed annually by cattle. When monitoring is expanded to include sampling sites in other "states" and types of mixedgrass prairie, the estimate of bare ground cover may decrease.

Percent cover (absolute cover) of bare ground from the HESCOM transects sampled in 2005 and 2006 combined.

	% bare ground 2005+2006
N of cases	9
Minimum	9.000
Maximum	66.000
Mean	22.333
Standard Dev	17.859
1 %	9.000
5 %	9.000
10 %	10.200
20 %	12.000
25 %	12.000
30 %	12.400
40 %	14.050

50 %	14.500
60 %	16.300
70 %	24.100
75 %	27.250
80 %	29.500
90 %	52.000
95 %	66.000
99 %	66.000

Data from the PASSMI transects sampled in 2006

	% bare ground
N of cases	7
Minimum	3.000
Maximum	69.000
Mean	33.143
Standard Dev	23.348
1 %	3.000
5 %	3.000
10 %	4.800
20 %	11.100
25 %	13.500
30 %	15.600
40 %	24.300
50 %	39.000
60 %	39.700
70 %	44.400
75 %	48.250
80 %	52.800
90 %	65.400
95 %	69.000
99 %	69.000

Desired Rating: Good

Other comments: This indicator/key attribute is not applicable to the shale barrens nested in this target. Any plots that are placed or happen to fall into shale barrens would be removed from a target-wide bare ground analysis.

Conservation Target: Mixedgrass Prairie Mosaic
Category: Size
Key Attribute: Block Size

Indicator: Size distribution of large blocks

Indicator Ratings:

Poor: No blocks over 1,000 acres
Fair: At least one block over 1,000 acres, but no block over 2,000 acres
Good: At least one block over 2,000 acres, but no block over 5,000 acres
Very Good: Multiple blocks over 2,000 acres or one block over 5,000 acres

Indicator Measurements:

Current Indicator Measurement: One block over 2,000 acres
Current Rating: Good

Desired Rating: Good

XERIC TALLGRASS PRAIRIE

Conservation Target: Xeric Tallgrass Prairie
Category: Landscape Context
Key Attribute: Fire Regime
Key attribute comment: Fire historically was a primary driver of system dynamics in the tallgrass prairie. There is strong evidence that native people set fires regularly for a variety of purposes (Bragg and Steuter 1996). Umbanhowar (1996) suggested a decrease in fire activity post-settlement after analyzing charcoal deposition in cores of deposits from four lakes in the Great Plains. Fires started by American Indians were mentioned much more often than lightning-caused fires in historical accounts. Indian-set fires occurred in every month except January, with peak frequency of occurrence in the months of April and October. Lightning-caused fires sharply peaked in July and August.

The effects of fire on tallgrass prairie vegetation have been summarized by Reichman (1987:107–111). Fire and grazing (ungulates, prairie dogs) created patch heterogeneity in time and space that related to overall biological diversity. Fire affects nutrient cycling, prevents woody species encroachment, and is required for seed germination in some species. In the absence of fire, litter increases and prevents nutrients from being available to plants; the prevalence of germination sites declines; plant species richness and vigor declines; ground nesting bird habitat declines; and woody species establish and expand in cover. Some non-native species may be able to invade declining plant communities where the fire regime is outside the acceptable range of variation. For all these reasons, grasses tend to increase in the years immediately following a burn.

There have been no experiments on OSMP lands to compare burned/unburned areas in this ecological system to determine the long-term effects of chronic fire exclusion. The lack of significant woody vegetation in the xeric tallgrass prairie suggests that grazing, especially grazing by livestock, may be able to act as a surrogate for some fire effects (McPherson 1997).

Indicator: Percent of target area experiencing a 5-30 year fire return (XTGP)

Indicator Ratings:

Poor: <25%
Fair: 26-50%
Good: 51-75%
Very Good: 76-100%
Indicator ratings comment: The indicator rating thresholds were chosen based upon a literature review and professional judgment.

Abrams (1985) used fire scars on trees in forests embedded within the tallgrass prairie of northeastern Kansas to estimate a mean fire return interval of 11-20 years for the period from 1858 to 1983. However, this estimate was based on a small sample size. Fires in tallgrass prairie are thought to have returned every 3-4 years, sometimes less frequently; however fire return intervals in the tallgrass prairie of 10 years or more are rare (Reichman 1987:106). In Kansas, tallgrass produces the greatest biomass when burned every two to four years.

However, conditions differ for tallgrass in the more arid Front Range foothills where productivity rates are lower and fuels accumulate more slowly. Historically fires probably burned foothills grassland communities at least every 30 years based on fire frequency estimates derived from nearby forests (Sherriff and Veblen 2007). Kaufmann et al. (2006) suggest more frequent fires (15-20 years) based upon ponderosa pine savanna models. In the foothills of El Paso County at Aiken Canyon, Wieder and Bower (2004) reported that grasslands burned twice as often as the adjacent woodlands during the period from 1872 until 1935, findings consistent with those of Veblen et al. (2000) for the northern Front Range.

OSMP believes more sustainable conditions are associated with a greater proportion of the target experiencing the appropriate fire return interval. The indicator ratings reflect this thinking.

Under current conditions, burning grasslands takes extensive planning and can only be implemented when environmental conditions are appropriate. Often the window of opportunity for grassland burns is short. Therefore, the likelihood of burning large areas annually is low. The larger the proportion of XTGP "out of prescription", the more difficult it is for OSMP managers to ensure the entire target is burned within the acceptable return interval.

While OSMP considered basing the indicator ratings on departure from the acceptable fire frequency (less than one interval, one interval, more than one interval), the department lacks information about fires from more than 20 years ago.

OSMP records the location and extent of grassland burns by creating the outline of burns as polygons within shapefiles. Attribute information attached to the polygons includes the date of the burn. Records of grassland burns on OSMP for the period 1997-2007 are thought to be complete. Information about burns that occurred prior to 1997 was less thoroughly recorded and records are considered less complete. Information about fire history is often limited to the term of OSMP ownership, unless burn polygons happen to extend onto nearby lands that are subsequently purchased by OSMP.

A rating of “Good” (51% minimum) period would require that approximately 960 acres burn during a 10-year period, 1,920 acres over a 20-year period and 2,900 acres over a 30-year period.
Confidence of these indicator rating descriptions: High

Indicator Measurements:
Date: 4/15/2008
Current Indicator Measurement: 0.47
Current Rating: Fair
Current rating comment: Using the best available information from the past 18 years, approximately 1,600 acres have burned in the XTGP. If this rate is extrapolated over 30 years, approximately 47% of the XTGP would have burned in the proposed fire return interval. This places the target within the “Fair” rating.
Confidence of the current rating: High

Desired Rating: Good
Desired rating comment: Currently, the XTGP is near the "Fair"/"Good" threshold. If grassland burning is supported by the community and easy to accomplish, we may be able to burn a larger proportion of the target.

OSMP's approach will be to develop field-specific burn plans to address issues of setting, topography and vegetation cover in order to develop appropriate return intervals. It is possible that some areas will not be burned because of neighboring land uses, topography, contamination or other factors.

Conservation Target: Xeric Tallgrass Prairie
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: Because the habitat of butterflies and skippers is intermingled among the Mixedgrass Prairie Mosaic, Xeric Tallgrass Prairie and Mesic Bluestem Prairie, a single indicator is proposed to assess the viability of all three targets.

Butterflies are excellent indicators of grassland health. Our goal is to maintain or increase occurrence levels of 11 CNHP watch-listed species in specific OSMP habitats.

CNHP-tracked grassland dependent butterflies and skippers with associated conservation targets (MGPM=Mixedgrass Prairie Mosaic, XTGP=Xeric Tallgrass Prairie, MBP= Mesic Bluestem Prairie)

Common Name	Scientific Name	Grassland Plan Target		
		MGPM	XTGP	MBP
Simius roadside skipper	*Amblyscirtes simius*	X	X	-
Arogos skipper	*Atrytone arogos*	-	X	X
Dusted skipper	*Atrytonopsis hianna*	-	X	X
Hops feeding azure	*Celestrina humulus*	-	-	X
Mottled dusky wing	*Erynnis martialis*	-	X	-
Colorado blue	*Euphilotes rita coloradensis*	-	X	-
Two-spotted skipper	*Euphyes bimacula*	-	-	X
Ottoe skipper	*Hesperia ottoe*	-	X	X
Crossline skipper	*Polites origenes*	-	X	X
Rhesus skipper	*Polites rhesus*	X	X	-
Regal fritillary	*Speyeria idalia*	-	X	-

Indicator: Percent occurrence of CNHP-tracked grassland dependent butterflies and skipper species

Indicator Ratings:

Poor: <4%
Fair: 4-10%
Good: 10-25%
Very Good: >25%
Indicator ratings comment: All known sampling events of butterflies and skippers in the grassland conservation targets (MGPM, XTGP and MBP) were used to calculate a percent occurrence measure for the 11 species of CNHP-tracked butterflies and skippers. Because these species are rare, each observation per sampling event contributes to the total number of occurrences. For example, if two individuals of one species and one individual of another were observed in one transect and no individuals were observed in the next three transects, percent occurrence would equal 3/4 = 75%. This method acknowledges varying levels of abundance of lepidoptera among sampling events. It also helps identify sampling locations that are especially important habitat. CNHP tracked species were encountered in 25 (or 23%) of 110 sampling events.

Staff placed the percent occurrence for CNHP species (23%) from all historical sampling events near the upper end of "Good" because many of the detections were recorded as part of targeted inventory of the best habitat on OSMP lands (Pineda and Ellingson 1998) rather than random or stratified random sampling. OSMP does not consider targeted inventory to be an appropriate method for tracking relative change in butterfly occurrence.

The studies that used replicable sampling methodology detected an 8.8% occurrence of CNHP tracked species. Staff chose 10% species occurrence as the "Good"/"Fair" threshold to reflect

OSMP's intention to improve habitat quality (native plant relative cover/species richness) on OSMP lands.

Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: 0.088
Current Rating: Fair

Desired Rating: Good

Desired rating comment: Similar to grassland birds, previous butterfly sampling on OSMP has been conducted in areas of high vegetative quality. Changes to fire and grazing regimes (by both prairie dogs and cattle) and maintenance of large, intact habitat blocks could increase the dominance of big and little bluestem and expand the distribution of these species. For example, well-timed prescribed burns (instead of wildfire) in areas dominated by weeds may improve habitat quality for big and little bluestem.

Other comments: Monitoring of CNHP-tracked species should be undertaken every 5-10 years to identify population trends. Monitoring should occur for at least two consecutive years to address the influence of annual environmental variation (precipitation, temperature, etc.) and variability of detection frequency.

Conservation Target: Xeric Tallgrass Prairie

Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: Because the habitat of butterflies and skippers is intermingled among the Mixedgrass Prairie Mosaic, Xeric Tallgrass Prairie and Mesic Bluestem Prairie, a single indicator is proposed to assess the viability of all three targets.

Butterflies are excellent indicators of grassland health. Butterfly assemblages, because of a range of sensitivities to environmental perturbations, may be useful in ecological integrity assessments (Nelson and Epstein 1998). OSMP's goal is to maintain or increase the current occurrence levels of selected grassland dependent species. Occurrence refers to encountering an individual of a species during a monitoring event.

Fire, grazing and herbicide use, techniques that OSMP has and is likely to continue to use to manage native plant species composition and richness, could have adverse impacts upon butterflies and skippers. In order to track the impact of our grassland management on these species, butterflies and skippers are being included as an indicator of ecological integrity of the Mixed Grass Prairie Mosaic, Xeric Tallgrass Prairie and Mesic Bluestem Prairie. Because the habitat of these animals is intermingled in the Grassland Planning Area, a single indicator is proposed to assess the viability of all three targets.

Several of the skippers and butterflies included as nested targets have been identified as conservation targets by The Nature Conservancy and others in the Southern Rocky Mountain Ecoregional Assessment (Neely et al. 2001). Successful conservation of foothills grasslands, especially tallgrass areas, is integral to accomplishing ecoregional conservation goals.

Indicator: Percent occurrence of grassland dependent butterflies and skipper species

Indicator Ratings:

Poor: <25%
Fair: 26-50%
Good: 51-75%
Very Good: >75%

Indicator ratings comment: Staff used OSMP butterfly studies to determine grassland dependent species occurrence per sample-year (transects, spot mapping, etc.). Sample-years included in the analysis were: 2001, 2002 (Armstead), 1999, 2000 (Collinge), and 2007 (Robinson). Data derived from Collinge were not able to be analyzed separately by year and therefore were treated as one year's sampling. Grassland dependent species occurred in 30 of 68 grassland sample-years for a 44% occurrence rate (Armstead 2003, Colllinge et al. 2003, Robinson and Bowers 2007).

OSMP staff believes that there are opportunities to improve butterfly and skipper habitat, and consequently placed the percent occurrence of grassland dependent species from all historical studies at the upper end of the "Fair" rating (see current rating notes). Indicator ratings separated by quartiles to reflect the increasing conservation value of higher levels of incidence of grassland dependent species.

Selected grassland dependent butterflies and skippers with associated conservation targets (MGPM=Mixedgrass Prairie Mosaic, XTGP=Xeric Tallgrass Prairie, MBP= Mesic Bluestem Prairie)

Common Name	Scientific Name	Grassland Plan Target		
		MGPM	XTGP	MBP
Simius roadside skipper	*Amblyscirtes simius*	X	X	-
Arogos skipper	*Atrytone arogos*	-	X	X
Dusted skipper	*Atrytonopsis hianna*	-	X	X
Hops feeding azure	*Celestrina humulus*	-	-	X
Mottled dusky wing	*Erynnis martialis*	-	X	-
Colorado blue	*Euphilotes rita coloradensis*	-	X	-
Two-spotted skipper	*Euphyes bimacula*	-	-	X
Ottoe skipper	*Hesperia ottoe*	-	X	X
Crossline skipper	*Polites origenes*	-	X	X
Rhesus skipper	*Polites rhesus*	X	X	-
Regal fritillary	*Speyeria idalia*	-	X	-
Orange-headed roadside-skipper	*Amblyscirtes phylace*	-	X	X
Leonard's skipper	*Hesperia leonardus*	X	X	X
Pahaska skipper	*Hesperia pahaska*	X	X	-
Green skipper	*Hesperia viridus*	X	X	-
Boisduval's blue	*Plebejus icarioides*	-	X	-
Uncas skipper	*Hesperia uncas*	-	X	X
Indra swallowtail	*Papilio indra*	X	X	-
Delaware skipper	*Atrytrone logan*	-	X	X

Confidence of these indicator rating descriptions: High

Indicator Measurements:

Date: 4/15/2008

Current Indicator Measurement: 0.44

Current Rating: Fair

Current rating comment: Half of the grassland dependent species depend on big and little bluestem for larval food. These plant species are typically present in grasslands with "Good" vegetative condition. Analysis of existing data suggests vegetation condition of the MGPM, XTGP and MBP can best be described as "Fair" (i.e., most vegetation condition indicators are rated "Fair"). It is appropriate that current ratings of insects and their particular requirements are similar.

Confidence of the current rating: Medium

Desired Rating: Good

Desired rating comment: Although the studies used to estimate current butterfly status sampled areas of high vegetative quality (Armstead 2003, Colllinge et al. 2003, Robinson and Bowers 2007), there are areas in these conservation targets that would benefit from increased fire frequency, decreased human pressure, and changes in grazing (Kettler and Pineda 1999, Pineda and Ellingson 1998). Changes in grazing could mean the timing and intensity of livestock grazing, or the intensity of grazing by prairie dogs. This could increase local dominance of larval host-plants, which is correlated to butterfly winter survival and recruitment rates.

Other comments: Monitoring of grassland dependent species should be undertaken every 5-10 years to identify population trends. Monitoring should occur for at least two consecutive years to address the influence of annual environmental variation (precipitation, temperature, etc.) and variability of detection frequency.

Conservation Target: Xeric Tallgrass Prairie

Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: This measure was developed to be applicable to the Mixedgrass Prairie Mosaic (MGPM) and Xeric Tallgrass Prairie (XTGP) targets. The text here is identical to that in MGPM viability description.

Birds are perhaps the best known and most easily measured animal grouping in grasslands. They have been demonstrated to be sensitive to a number of the threats known to exist in North American grasslands including those thought to affect OSMP grasslands. They are sensitive to changes in grazing and fire regimes, the establishment of exotic plant species, increased predation by dogs, human travel on trails, incompatible nearby land uses and reduction of habitat block size by a variety of sources of fragmentation (Vickery et al. 1994, Johnson 1996, Brennan and Kuvlesky 2005, Knick and Rotenberry 1995).

Local threats to breeding and non-breeding adults and overall population status set the parameters for Partners in Flight (PIF) scores (Carter et al. 2000 Panjabi 2001). The original scores were modified by an algorithm developed by Nuttle et al. (2003) to place all birds in one of five conservation categories ranging from zero for all non-native species to 4 for rare local breeders such as the northern harrier. This system has been used by others (Wood et al. 2004, Smith et al. 2005, Lanham et al. 2005, Legrand et al. 2007, Conover et al. 2007) to measure the effectiveness of forest management, pine-grassland restoration and field border management with respect to avian conservation.

The "Derived PIF (DPIF) conservation score" is the metric of interest and the sampling effort (transect, point count) is the experimental unit. The DPIF was calculated using the following methods:
1.) Remove all aerial foragers (swallow spp.) from studies' species list.
2.) Sum all other individuals/transect to gain transect total bird count.
3.) Use algorithm in Nuttle et al. (2003) to place birds into 1 of 5 conservation categories (PIF rank).
4.) Calculate relative abundance (RA) for each species within a specific suite of grassland birds (see below) using the following formula:
Total # of individuals of species "x" detected in Transect 1/ Total # of all individuals (except swallows) detected in transect 1
5.) Within each transect, multiply RA of each species by the PIF rank of that species to gain (RA x PIF rank score) for each grassland bird species for that transect.
6.) Sum (RA x PIF rank score) for all birds within each transect.
7.) Multiply the (RA x PIF rank score) of each transect by the species richness of 21 selected species detected in each transect. The selected species are listed below. This step corrects for the lack of local avian abundance in the conservation value scores.

Only birds from the selected species list (n=21) are included in the calculation of Rank Score. Aerial foragers (e.g. swallows) were excluded from the total count for the transect because they are colonial nesters and tend to be present in flocks, a behavior which would skew the data to overcount aerial foragers, and undercount others.

1. American kestrel
2. Barn owl
3. Bobolink
4. Burrowing owl
5. Common nighthawk
6. Common poorwill
7. Dickcissel
8. Ferruginous hawk
9. Golden eagle
10. Grasshopper sparrow
11. Horned lark
12. Lark bunting
13. Lark sparrow
14. Loggerhead shrike
15. Northern harrier
16. Prairie falcon
17. Sage thrasher
18. Savannah sparrow
19. Short-eared owl
20. Swainson's hawk
21. Vesper sparrow
22. Western meadowlark

Indicator: Percent of target with acceptable bird conservation score

Indicator Ratings:

Poor: < 75% of transects with a derived PIF score of 1.0
Fair: At least 75% of transects with a derived PIF score of 1.0
Good: At least 75% of transects with a derived PIF score of 3.9
Very Good: At least 75% of transects with a derived PIF score of 8.1
Indicator ratings comment: There were 223 sample-years including studies by Lenth et al. (2006), Bock et al. (1999) and surveys conducted by OSMP staff to determine the effects of recreation and agricultural management on bird communities (currently unpublished--Tallgrass West and High Plains Trail). The mean DPIF conservation score from these samples is 5.69.

The Tallgrass West area exhibits good potential bird habitat but is currently rebounding from historic grazing effects. Staff considered Tallgrass West a reliable estimate for the variability within the “Good” rating. Therefore, staff placed the mean DPIF score of Tallgrass West sampling (~5.3) in the lower range of “Good”. Next, staff subtracted one half of one standard deviation from the Tallgrass West samples’ mean to estimate the "Good"/"Fair” threshold (3.9), and added one standard deviation to define the “Good"/"Very Good” threshold (8.1). Interestingly, the mean DPIF score of the two highest scoring areas sampled was 8.1. Staff then chose a "Poor"/"Fair" threshold of 1.0 using best professional judgment.

Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: Unknown
Current Rating: Fair

Current rating comment: Using data recently collected on OSMP (Tallgrass West and High Plains: 2006-07), 60% of samples had a DPIF score > 3.9 (i.e., are considered "Good") and 75% of the samples have a DPIF > 2.8. Using these data the current rating would be "Fair". However, the samples included in this data set are biased because they were taken from sites in one part of the system where conditions are not representative of OSMP grasslands.
Confidence of the current rating: Low

Desired Rating: Good

Conservation Target: Xeric Tallgrass Prairie
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: OSMP has not found references that provide documentation of the relative percent cover of big bluestem and little bluestem needed to sustain viable populations of those skipper and butterfly species that require big and/or little bluestem as larval host plants. There have been several studies of grassland butterflies on OSMP (Pineda and Ellingson 1998, Collinge et al. 2003, Armstead 2003, Robinson and Bowers 2007). While these studies have characterized good quality butterfly habitat in a general way, they do not specify host plant cover levels. Few of the ESCO vegetation sample sites overlap with the butterfly study sites, so that correlation between big and little bluestem cover and the occurrence of butterfly species of concern cannot be made with current data sets.

Indicator: Relative cover of host plants for skipper/butterfly species of concern (big bluestem and little bluestem)

Indicator Ratings:
Fair: < 75% of samples ≥8%
Good: At least 75% of samples ≥8
Indicator ratings comment: While it is likely that the skippers and butterflies that depend on big and little bluestem benefit from high cover of these species, it is possible that extremely high cover of big and little bluestem might adversely affect the skippers and butterflies. For example, very high cover of big and little bluestem might reduce the cover and richness of other plant species that are needed for the habitat to provide a full suite of functions. Staff used this model, which suggests there may be an "intermediate" level of big and little bluestem cover that provides optimal habitat for skippers and butterflies, as the basis for developing the indicators ratings. Unfortunately, there is no literature available to guide staff, leaving staff to use their best professional judgment.

Staff examined 189 transect-years of XTGP point cover transect data and 140 transect-years of MBP point cover transect data collected from multiple sites to develop the indicator ratings. Using thinking similar to that used to establish thresholds for other vegetation composition indicators, staff assumed the XTGP was generally in "Good" condition. The transect-year data for the XTGP suggested that most of the time the combined relative cover of big and little bluestem exceeded 8%. (The 25% percentile for the XTGP data set was 8.15%.) Consequently, staff set the threshold between "Fair" and "Good" at 8%.

Given the uncertainty associated with the upper and lower bounds of this threshold (i.e. how much is too little relative cover of big and little bluestem and how much is too much?), staff did not set a "Poor"/"Fair" or "Good"/"Very Good" threshold. In future system-wide monitoring, staff intends to couple vegetation transects with butterfly/skipper transects to better understand the relationship between big and little bluestem cover and butterfly/skipper presence and abundance.

As with other indicators, staff would like to see most of the planning area attain and maintain a "Good" status. Therefore, the final indicator ratings note that at least 75% of the transects should have a combined relative cover for big and little bluestem of ≥ 8%.
Confidence of these indicator rating descriptions: Medium

Indicator Measurements:
Date: 1/15/2008
Current Rating: Good
Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Xeric Tallgrass Prairie
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: Native relative cover serves as an indicator of the quality of vegetation occurring in a sample. However, taken alone, relative cover does not provide a full picture of community composition because it refers only to that portion of the sample that is vegetated. Native relative cover is proposed as one of several indicators of vegetative composition. The others are: two indicators of the presence of invasive species and two measures of native species richness. One measure of vegetation structure, absolute cover by bare ground, provides further data on the condition of the XTGP.

Indicator: Native species relative cover

Indicator Ratings:
Poor: < 75% of samples NRC ≥60%
Fair: At least 75% of samples NRC ≥60%
Good: At least 75% of samples NRC >90%
Very Good: At least 75% of samples NRC = 100%
Indicator ratings comment: OSMP examined 193 transect-years of point cover plot/transect data from multiple sites to develop indicator ratings. Based upon the recommendations of the grassland plant ecologist and the agricultural resource specialist that the native relative cover of the XTGP was above the threshold of acceptability, and that the Jewel Mountain site was an example of "Good" condition, the mean value for the Jewel Mountain samples was placed at the center of the "Good" rating. One standard deviation above the Jewel Mountain mean yielded a value greater than 100%, so 99% was used for the upper end of "Good" and 100% defined "Very Good". The boundary between "Fair" and "Poor" was set using the lowest cover value for Jewel Mountain and two standard deviations below the mean for the Tallgrass Natural Area samples. Final ratings were defined as a percentage of transects with a value below or above the threshold of acceptability. The objective of 75% of samples being within the "Good" or "Very Good" category reflects OSMP's desire to have most of the planning area within the "Good" or "Very Good" categories while balancing the conservation of other targets (i.e. prairie dogs and associated community, agriculture).

The information from this analysis was used as the basis for indicator ratings and was combined with guidance found in Rondeau (2001) for the Foothills Grassland Large Patch Target in the Southern Rocky Mountain Ecoregional Assessment and in Appendix K of Neely et al. (2006) for both the Western Great Plains Foothill & Piedmont Grassland and the Central Mixedgrass Prairie ecological systems.

OSMP staff prepared the statistical analysis and used the data to define the indicator ratings. The confidence is based upon the consensus that native species relative cover is acceptable in the majority of XTGP sites, and the availability of a relatively long-term data set spread across the OSMP land system.

Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Date: 4/15/2008

Current Indicator Measurement: 75% of the transects have a native relative cover of ≥ 79%.

Current Rating: Fair

Current rating comment: The current status is based on 43 transects-years sampled in 2005 and 2006.

Confidence of the current rating: High

Desired Rating: Good

Desired rating comment: 100% native relative cover will be difficult to achieve given the wide distribution of many non-native species on OSMP. Since the current ratings are largely based on sampling in high quality sites, the future addition of sampling in sites of moderate quality may lower the system-wide mean values, making a desired rating of "Good" more attainable than a rating of "Very Good".

Conservation Target: Xeric Tallgrass Prairie

Category: Condition

Key Attribute: Vegetation Composition

Key attribute comment: Native species richness is a direct measure of biological diversity. It is sensitive to management practices that tend to homogenize natural systems such as a repetitive grazing regime (same season of use, similar stock rates, similar duration, continuous prairie dog occupation), fire suppression or a fire regime that repeatedly burns the same area during the same time of year. Species richness is used in the Ecological Viability Specifications for the Foothills Grasslands in the Southern Rocky Mountains Ecoregional Plan (Rondeau 2001). Species richness is best if used with other indicators of conservation status (Fleishman et al. 2006).

Indicator: Native species richness

Indicator Ratings:

Poor: < 75% of samples ≥10

Fair: At least 75% of samples ≥10

Good: At least 75% of samples ≥22

Very Good: At least 75% of samples >42

Indicator ratings comment: OSMP examined 158 transect-years of data from multiple plots to develop indicator ratings. Mean values for species richness were calculated. Based upon the recommendations of the grassland plant ecologist and the agricultural resource specialist that the species richness of the XTGP was above the threshold of acceptability, the mean value was placed at the center of the "Good" rating. One standard deviation above and below the mean defined the "Good" range. The "Fair"/"Poor" boundary was placed two standard deviations below the mean. Final ratings were defined as a percentage of transects with a value below or above the threshold of acceptability.

The broad range within the "Good" rating reflects a relatively broad range of mean species richness values among different xeric tallgrass communities and site conditions. Some xeric tallgrass communities considered to be in overall good condition have inherently lower native species richness than other communities. This variation in species richness among xeric tallgrass types may reflect differences in substrate age and character, hydrology and land use history between sample areas.

OSMP staff used the statistical analysis to define the indicator ratings. The confidence is based upon the consensus that species richness is acceptable in the majority of XTGP sites, and the availability of a relatively long-term data set spread across the OSMP land system.

The current condition of xeric tallgrass communities may reflect an inherently higher resistance to non-native species invasion and resilience in response to moderate intensity disturbances displayed by big bluestem-dominated plant communities occupying rocky terrain on pediment surfaces and upper hill slopes in the Boulder area (Buckner 2007).
Confidence of these indicator rating descriptions: High

Indicator Measurements:
Date: 4/15/2008
Current Indicator Measurement: 75% of samples have a native species richness ≥ 19
Current Rating: Fair
Current rating comment: The current status is based on 29 transects-years sampled in 2005 and 2006.
Confidence of the current rating: High

Desired Rating: Good

Conservation Target: Xeric Tallgrass Prairie
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: While additional, more quantitative research is needed to fully understand the complex impacts of invasive species on ecosystems (Hulme and Bremner 2006), some impacts have been documented. Eagle et al. (2007) detailed a wide range of impacts from yellow starthistle in California; Vaccaro (2005) documented loss of biodiversity resulting from cattail leaf litter in Great Lakes wetlands; Katz and Shafroth (2003) and Simons and Seastedt (1999) documented impacts of Russian olive on various ecological functions; Levine et al. (2003) reviewed underlying impacts of exotic plant invasions; Tickner et al. (2001) reviewed the literature on riparian invasions; Bakker (unpublished) reviewed impacts of woody plants on grassland dependent birds; and Rumble and Gobeille (1998) looked at bird use in different successional stages of cottonwood forests and potential impacts of replacement by other woody species, mainly invasive green ash.

In addition to being a key attribute for the target, this indicator is intended to help address the concerns raised by Fleishman et al. (2006) regarding the limitations of species richness. This indicator seeks to provide information about the extent of areas within the target dominated by a subset of noxious weeds that are both of significant concern to OSMP and practical to monitor. For this indicator, "dominated" means over 50% canopy cover. Canopy cover measures for the RAM methodology are documented in (Dewey and Anderson 2006).

In 2007, OSMP staff chose to use a variant of the RAM protocol referred to as the gross area polygon because of the types of weeds that were encountered and a desire to speed data collection. Gross area polygons are intended to provide a way to address extremely widespread infestations. This may have led to some over-mapping (showing invasive species where they did not actually occur) especially of diffuse knapweed.

The indicator ratings were assigned in response to a number of sources (Rondeau 2001, Neely et al. 2006, Decker 2007a) aassociated with ecological integrity assessments.

The RAM methodology was applied to almost the entire target; however, certain low priority sites were excluded based on their position within Visitor Master Plan Trail Study Areas and large habitat blocks. Isolated and smaller parcels not included in the TSAs up for review at the time of sampling were omitted.

The only known consequence is that CRP lands in the northeast (ca. 1600 ac) were not mapped. The effect of this omission on the overall estimate is not known.

Indicator: Percent of target dominated by non-native species (Rapid Assessment Mapping)

Indicator Ratings:

Poor: >5%
Fair: 3-5%
Good: 1-<3%
Very Good: <1%
Indicator ratings comment: The RAM species included OSMP priority species, a synthesis of state, county and local species of concern. These species are typically considered most threatening to ecosystem health, recreation and agriculture. From this list, certain ubiquitous species unlikely to be managed were removed (e.g. cheatgrass, smooth brome and wild asparagus). The list of RAM species for 2006 is available in Dewey and Anderson (2006:2-3). In addition to these, the 2007 data collection also included other species documented in Johnson (2007).

Levels of infestation, as a percent of target area, were calculated from RAM data using GIS for each target. The indicator ratings were assigned in response to a number of sources (Rondeau 2001, Neely et al. 2006, Decker 2007a) associated with ecological integrity assessment. The indicator ratings are comparable to those developed for conservation action plans in other areas (e.g. Lower Purgatorie, Huerfano Uplands, Laramie Foothills and the Rocky Mountain Front Range).

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: 0.016
Current Rating: Good
Current rating comment: OSMP calculated the current (2006-7) percent cover for RAM species within six cover classes for each target. The percent of a target in the cover class "> 50%" was used for this indicator.
Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Xeric Tallgrass Prairie
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: For documentation of the relevance of exotic species as an indicator, please see Key Ecological Attribute Indicator "Percent target area dominated by exotic species tracked through the RAM method".

This indicator provides additional information about the extent of the target likely to become dominated by invasive species. This indicator was developed to provide advanced warning of changing conditions because a target may have not be dominated by RAM species, but those species might be approaching dominance. The inclusion of this indicator will allow us to track these high occupancy areas and manage them before they become dominated by RAM species.

Indicator: Percent of target with prevalence of non-native species (Rapid Assessment Mapping)

Indicator Ratings:

Poor: >15%
Fair: 9-15%
Good: 3- <9%
Very Good: <3%
Indicator ratings comment: Levels of infestation were calculated from RAM data using GIS. OSMP staff looked for weed management plans or integrity assessments upon which to base thresholds; however, no examples were found for using sub-dominance (high occupancy) as a leading indicator. Consequently, the indicator ratings for this indicator are based on professional judgment rather than the work of others. Because of the lower abundance by RAM species for this indicator, the percent of area for each indicator (tolerance of area occupied) is higher.
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: 0.103
Current Rating: Fair
Current rating comment: OSMP calculated the current (2006-7) percent cover for RAM species within six cover classes for each target. The percent of a target in the cover classes "6-25%" and ">25-50%" were used for this indicator.
Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Xeric Tallgrass Prairie
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: Native species richness is a direct measure of biological diversity. It is sensitive to management practices that tend to homogenize natural systems such as a repetitive grazing regime (same season of use, similar stock rates, similar duration, continuous prairie dog occupation) or a fire regime that always burns the same area during the same time of year. Species richness is used by Rondeau (2001) in the Ecological Viability Specifications for the Foothills Grasslands in the Southern Rocky Mountains Ecoregional Plan.

Species richness is best if used with other indicators of composition and other key ecological attributes (e.g. endemism, functional significance, and the severity of threats) (Fleishman et al. 2006). This indicator uses a subset of native plant species that provide a better indication of ecological condition than a measure of the richness of all native species. Coefficients of Conservatism, also called “C values”, have been assigned to the majority of native species occurring in Colorado by a panel of experts (Rocchio 2007). C-values range from zero to 10, representing the potential for each species to "occur in a landscape relatively unaltered from pre-European settlement conditions”. C-values above six indicate progressively higher levels of conservatism, with a C value of 10 representing an obligate association with high quality natural areas and the processes that support them (Rocchio 2007).

Native species richness may be high in the target for a variety of reasons. Some native plant species increase over time under livestock and/or prairie dog grazing. If only one indicator for species richness of all native species were to be used, OSMP’s objectives for species richness could be met for grasslands that are in one seral stage, or that in other ways do not represent the range of functioning natural systems in the Xeric Tallgrass Prairie target. Staff examined the C-values of the plant species in the target and determined that species with C-values of five and above included those more likely to decrease in the presence of heavy grazing pressure. In addition, several characteristic species of the target’s alliances had been assigned C values of 5 and higher.

Indicator: Richness of selected conservative plant species

Indicator Ratings:

Poor: < 75% of samples ≥7
Fair: At least 75% of samples ≥7
Good: At least 75% of samples >12
Very Good: At least 75% of samples >23
Indicator ratings comment: OSMP staff examined all Xeric Tallgrass transect-years, including those in disturbed states of the target. Based upon the staff judgment that the Jewel Mountain area represented "Good" condition, staff placed the mean conservative species richness for all Jewel Mountain transect-years in the middle of the "Good" category and used one standard deviation above and below this mean to define the "Good" range. Two standard deviations below the mean marked the cutoff between "Fair" and "Poor".

The broad range within the "Good" rating reflects a relatively broad range of mean species richness values among different xeric tallgrass communities and site conditions. Some xeric tallgrass communities considered to be in overall good condition have inherently lower native species richness than other communities. This variation in species richness among xeric tallgrass types may reflect differences in substrate age and character, hydrology and land use history between sample areas.

Indicator Measurements:

Date: 6/15/2005
Current Indicator Measurement: 75% of samples of a conservative species richness ≥ 9
Current Rating: Fair
Current rating comment: Current status (2005 and 2006) of conservative species richness (C>4) for all (including disturbed) Xeric Tallgrass transects. (Not all transects evaluated each of those years.)

	2005+2006
N of cases	29
Minimum	5.000
Maximum	28.000
Mean	14.103
Standard Dev	6.241
1 %	5.000
5 %	5.950
10 %	7.000
20 %	8.300
25 %	9.000
30 %	10.000
40 %	11.000
50 %	13.000
60 %	14.900
70 %	17.800
75 %	19.000
80 %	19.700
90 %	24.000
95 %	24.200
99 %	28.000

Desired Rating: Good
Desired rating comment: It may difficult to achieve an acceptable rating for this indicator. OSMP has set the objectives high until more is known about range of variability and status of the target based on results

of system-wide sampling. For example, when sample sites are established in xeric tallgrass areas at the forest-grassland interface, OSMP expects to detect additional conservative species.

Conservation Target: Xeric Tallgrass Prairie
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: The distribution of dwarf leadplant is centered in the northern Great Plains from Manitoba and Ontario into North and South Dakota, Minnesota and Iowa (USDA 2008). The Colorado populations of dwarf leadplant occur at the western edge of the species' range and are several hundred miles disjunct from the bulk of its range. In the Boulder area, leadplant is closely associated with grassland communities dominated by big bluestem and occurs primarily on north and northeast-facing slopes of outwash mesas below 6,500 feet. The largest populations on OSMP are found at the forest-grassland interface (OSMP rare plant files, OSMP herbarium records).

The CNHP ranks dwarf leadplant as imperiled to vulnerable (S2S3) within Colorado, which indicates that there are fewer than 100 populations in the state. The global conservation status is "secure" (G5), meaning the species is relatively common elsewhere (NatureServe 2008b).

Dwarf leadplant is one of the few shrub species occurring in prairie grasslands in the northern Great Plains. Along with other grassland shrub species, leadplant provides structure and food for birds and other wildlife. It is a nitrogen-fixing legume. Leadplant is restricted to areas that are protected from heavy grazing (Johnson and Larson 1999). Local post-fire monitoring results indicate that dwarf leadplant recovers rapidly within the growing season after a spring or summer burn. Like many prairie plant species, it may depend on periodic fire for long-term population viability.

Dwarf leadplant was selected as an indicator of condition, because it is a rare plant species that is relatively common in the Xeric Tallgrass Prairie, and its status is a measure of overall plant community condition.

Indicator: Size of dwarf leadplant (*Amorpha nana*) populations

Indicator Ratings:

Poor: >20% of sub-occurrences are declining in areal extent and/or number of individuals
Fair: 11– 20% of sub-occurrences are declining in areal extent and/or number of individuals
Good: 90 – 99% of sub-occurrences are stable or increasing in areal extent and/or number of individuals
Very Good: 100% of sub-occurrences are stable or increasing in areal extent and/or number of individuals
Indicator ratings comment: Data accumulated as of 2007 on the number of sub-occurrences and estimated number of individuals present on OSMP land will be used as the baseline status for dwarf leadplant. Inventory data will be compared against the 2007 baseline every five years.

Multiple years of inventory data from the late 1980's through 2007 were compiled by OSMP staff. Discreet sub-occurrences were delineated and then recorded in the OSMP GIS database. Currently there are approximately 10 sub-occurrences.

The number and distribution of sub-occurrences required to maintain a viable population within the OSMP system is not known. As additional data is collected, it may be possible to develop population viability standards.
Confidence of these indicator rating descriptions: High

Indicator Measurements:

Date: 4/15/2008

Current Indicator Measurement: Current status = baseline

Current Rating: Very Good

Current rating comment: The confidence is based upon the consensus that dwarf leadplant occurrences on OSMP have been stable over the last ten years or more, and the availability of a relatively long-term data set spread across the OSMP land system.

Confidence of the current rating: Low

Desired Rating: Good

Conservation Target: Xeric Tallgrass Prairie

Category: Condition

Key Attribute: Vegetation Composition

Key attribute comment: Grassyslope sedge is an upland plant occurring in montane grasslands in southern Wyoming, Colorado, northern New Mexico, and northern Arizona. In the Boulder area, grassyslope sedge may be easily overlooked, because it is inconspicuous and similar to sun sedge (*Carex pensylvanica* subsp. *heliophila*), a common local sedge of dry grasslands and open forest. The documented occurrences on OSMP land are on the West Rudd property in the northern part of the Eldorado Mountain/Dowdy Draw TSA and on the Jewel Mountain property on Rocky Flats Mesa (OSMP rare plant files, OSMP herbarium records). Another occurrence on the Rocky Flats Mesa is in the area included currently in the Rocky Flats National Wildlife Refuge (University of Colorado Herbarium records). The conservation ranking is G3S1, indicating that the species is considered vulnerable and at a moderate risk of extinction globally, and critically imperiled in Colorado (NatureServe 2008c).

Typically, *C. oreocharis* is found in localized patches on higher elevation (7,500-10,600 ft) dry slopes and montane grasslands in granitic soils. In the Boulder area, this species occurs between 5,400 and 5,600 feet, the lowest extreme within its elevational range. The species is associated locally with the rocky substrates of pediments, and with xeric tallgrass plant communities. Grassyslope sedge may be distributed more widely on the Rocky Flats Mesa and mesas of similar geologic origin and age in southern Boulder County.

Grassyslope sedge was selected as an indicator of condition, because it is a rare plant species associated with relatively high quality sites in the Xeric Tallgrass Prairie, and its status is a measure of overall plant community condition.

Indicator: Size of grassyslope sedge (*Carex oreocharis*) populations

Indicator Ratings:

Poor: Both of the two OSMP occurrences (100%) are declining in areal extent and/or stem density

Fair: One of the two OSMP occurrences (50%) are declining in areal extent and/or stem density

Good: 100% of occurrences are stable or increasing in areal extent and/or stem density

Very Good: 100% of occurrences are stable or increasing in areal extent and/or stem density

Indicator ratings comment: Data accumulated as of 2008 on the occurrences present on OSMP land will be used as the baseline status for grassyslope sedge. There are two known occurrences with known acreages, but stem densities are unknown at this time as OSMP has not sampled stem densities in these occurrences. Inventory data will be compared against the 2008 baseline every five years to assess status over time. Inventory data from 1985 through 2007 were compiled by OSMP staff. Occurrences are recorded in the OSMP GIS database.

The number and distribution of occurrences required to maintain a viable population within the OSMP system is not known. As additional data is collected, it may be possible to develop population viability standards.

Confidence of these Indicator rating descriptions: High

Indicator Measurements:

Date: 1/15/2008

Current Indicator Measurement: Current status = baseline

Current Rating: Good

Current rating comment: The confidence is based upon the general consensus that the West Rudd occurrence on OSMP has been relatively stable over the last twenty years. The general consensus is based on OSMP herbarium records, CNHP Element Occurrence Records, and more recent observations and inventories.

Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Xeric Tallgrass Prairie

Category: Condition

Key Attribute: Vegetation Composition

Key attribute comment: The prairie violet occurs across the Great Plains, though in Colorado it is considered rare. The Colorado populations of this species occur at the western edge of the species' range and are several hundred miles disjunct from the main part of the range. In the Boulder area, prairie violet is closely associated with grassland communities dominated by big bluestem and occurs primarily in rocky soils along the grassland/forest interface between 5,500 and 6,100 feet in elevation (OSMP rare plant files, OSMP herbarium records).

The CNHP lists prairie violet as secure globally but imperiled on a local level and (G5S2) (NatureServe 2008d).

Prairie violet is an important nectar source for the regal fritillary butterfly, which is rare in Colorado. Like many prairie plant species, prairie violet may depend on periodic fire for long-term population viability.

Prairie violet was selected as an indicator of condition, because it is a rare plant species associated with relatively high quality sites in the Xeric Tallgrass Prairie, and its status is a measure of overall plant community condition.

Indicator: Size of Prairie violet/bird's foot violet (*Viola pedatifida*) populations

Indicator Ratings:

Poor: >20% of sub-occurrences are declining in areal extent and/or number of individuals

Fair: 11– 20% of sub-occurrences are declining in areal extent and/or number of individuals

Good: 90 – 99% of sub-occurrences are stable or increasing in areal extent and/or number of individuals

Very Good: 100% of sub-occurrences are stable or increasing in areal extent and/or number of individuals

Indicator ratings comment: Data accumulated as of 2007 on the number of sub-occurrences and individuals present on OSMP land will be used as the baseline status for prairie violet. Inventory data will be compared against the 2007 baseline every five years to assess status over time.

Multiple years of inventory data from the late 1980's through 2007 were compiled by OSMP staff. Discreet sub-occurrences were delineated and then recorded in the OSMP GIS database.

Currently there are approximately 10 sub-occurrences, the majority of which occur in the Grassland Planning Area.

The number and distribution of sub-occurrences required to maintain a viable population within the OSMP system is not known. As additional data is collected, it may be possible to develop population viability standards.
Confidence of these indicator rating descriptions: High

Indicator Measurements:

Date: 1/15/2008
Current Indicator Measurement: Current status = baseline
Current Rating: Very Good
Current rating comment: The confidence is based upon the general consensus that prairie violet occurrences on OSMP have been stable or increasing over the last ten years or more, and the availability of a system-wide, relatively long-term data set.
Confidence of the current rating: Low

Desired Rating: Good

Conservation Target: Xeric Tallgrass Prairie
Category: Condition
Key Attribute: Vegetation Structure
Key attribute comment: Bare ground refers to organic or mineral soil that is not covered by vegetation (canopy cover), standing dead vegetation, litter or rock. The amount of bare ground and the way it is distributed relate directly to a site's susceptibility to wind and water erosion (Pellant et al. 2000). In the Boulder area, strong winds are a particularly important erosional force. Soil texture, organic matter content, rock content, topography and land use history also contribute to soil surface condition.

The optimal proportions of bare ground and other cover types required for soil stability, soil moisture retention, adequate nutrient cycling, regeneration site availability and functional wildlife habitat vary by site and community type. XTGP communities on OSMP typically occur on ridges, rocky terraces and pediment surfaces. The high rock content and coarse texture of XTGP soils reduce erosion potential. Vegetation and litter cover are also important factors in reducing soil movement and retaining organic matter and soil moisture. In areas that exceed the acceptable range of variability for bare ground, surface organic matter decreases through erosion, water infiltration and retention is reduced and the site potential in terms of native perennial seedling establishment and plant survival is diminished. These degraded conditions may create habitat for ruderal native and non-native plant species. On sites with very steep slopes, the potential for soil movement increases (Kohnke and Franzmeier 1995).

XTGP communities on the oldest, long-stable geologic surfaces in the area (e.g., the Rocky Flats pediment) have a relatively high mean cover of bare ground, and appear to be resistant to invasion by many non-native plant species. This resistance to invasion may be correlated with well-developed root biomass and other sub-soil conditions associated with these long-established plant communities (Buckner 2007).

Wildlife habitat requirements for bare ground and litter cover, and vegetation structure and composition, vary by species. Patch types with higher cover levels of bare ground create habitat for some wildlife species, while lower bare ground cover combined with optimum litter and vegetation cover provide functional habitat for other wildlife species. Some wildlife species require multiple habitat types during their life cycle. As more information is obtained on the habitat requirements of local grassland species, indicator ratings for bare ground and other ground cover types may be adjusted.

Indicator: Absolute cover bare ground

Indicator Ratings:

Poor: < 75% of samples <40%
Fair: At least 75% of samples <40%
Good: At least 75% of samples <26%
Very Good: At least 75% of samples <10%
Indicator ratings comment: Staff examined 193 transect-years to develop the absolute bare ground indicator ratings for this target. Based upon the recommendations of the grassland plant ecologist and the agricultural resource specialist that the average absolute cover of bare ground was below the threshold of acceptability (i.e. there is not too much bare ground), the median value of the 193 transect-years was placed within the "Good" rating. The "Good" category included a range in values from slightly below the median for the Jewel Mountain transects to one standard deviation above that median. An acceptable range of variation was defined as falling between 0% and 25% absolute cover of bare ground. Future sampling, designed to more fully capture the range of variation in soil cover across a wider selection of sites within this target, may result in adjustments to the acceptable range.

The current NRCS Ecological Site Descriptions that relate to local foothills grassland communities do not specify an optimum cover range for bare ground, perhaps due to variation in site potential within Ecological Sites. A combination of factors in the Ecological Site Descriptions are used to characterize community condition, including vegetation composition, productivity, and generalized descriptions of litter and bare ground cover and distribution. The acceptable mean soil cover range for XTGP communities reflected in the indicator ratings incorporates the concept that communities will be dynamic over time and space in terms of ground cover, and that site potential varies across the landscape.

The acceptable range of variation also assumes dynamic disturbance regimes that include periods of rest and recovery between periods of disturbance. In productive grassland communities in semiarid climates, the absence of periodic disturbances such as ungulate grazing and/or fire for extended periods of time can cause excessive plant litter accumulation that slows nutrient cycling and reduces seed germination and establishment (Sprock et al. 2004a). Litter build up can lead to plant mortality, which can result in increased bare ground and erosion as plants die back. Prolonged, season-long grazing can cause plant mortality, excessive bare ground, and erosion.
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:

Date: 1/15/2008
Current Indicator Measurement: 0.35
Current Rating: Fair
Current rating comment: The current status is based on 43 transects-years sampled in 2005 and 2006.
Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Xeric Tallgrass Prairie
Category: Size
Key Attribute: Block Size

Indicator: Size distribution of large blocks

Indicator Ratings:

- **Poor:** No blocks over 1,000 acres
- **Fair:** At least one block over 1,000 acres, but no block over 5,000 acres
- **Good:** At least one block over 5,000 acres, but no block over 10,000 acres
- **Very Good:** Multiple blocks over 5,000 acres or one block over 10,000 acres

Indicator Measurements:

- **Current Indicator Measurement:** One block over 2,000 acres
- **Current Rating:** Fair

Desired Rating: Fair

MESIC BLUESTEM PRAIRIE

Conservation Target: Mesic Bluestem Prairie
Category: Landscape Context
Key Attribute: Fire regime
Key attribute comment: In the past, fire has been an important ecosystem process in tallgrass prairie, affecting species composition and structure. In addition to lightning being the primary natural ignition source, there is strong evidence that native people set fires regularly for a variety of purposes (Steinauer and Collins 1996).

Fire is known to affect nutrient cycling, prevents woody species encroachment, and is required for seed germination in some species. In the absence of fire, litter increases and prevents nutrients from being available to plants; the prevalence of germination sites declines; plant species richness and vigor declines; ground nesting bird habitat declines; and woody species establish and expand in cover. Some non-native species may be able to invade declining plant communities where the fire regime is outside the acceptable range of natural variation.

There have not been experiments to compare burned/unburned areas in this ecological system to determine the long-term effects of chronic fire exclusion. However, the disruption of ecological functions in a fire-driven system tends to increase with increasing departure from historic frequencies. Ecological disruption is often most evident as shifts in vegetation species composition and structure, but may also include loss of key ecosystem components (Hann et al. 2003).

Indicator: Percent of target area experiencing a 5-10 year fire return

Indicator Ratings:

> **Poor:** <25%
> **Fair:** 25-50%
> **Good:** >50-75%
> **Very Good:** 76-100%
> **Indicator ratings comment:** Historically fires probably burned foothills grassland communities at least every 30 years based on fire frequency estimates derived from nearby forests (Sherriff and Veblen 2007). However, studies for the Great Plains (summarized in Wright and Bailey 1982) suggest that on level-to-rolling topography, a fire frequency of 5 to 10 years is a reasonable estimate of historic condition. The conclusions of Wright and Baily (1982) are supported by the work of Wendtland and Dodd (1992). They used historic records to determine a fire return interval of 5-30 years near Scotts Bluff National Monument in northwestern Nebraska. They also found less frequent return in more topographically diverse terrain and more frequent fire in smooth to gently rolling terrain. The level of documentation in most cited sources of grassland fire return interval is limited. However, most authors express a relatively high level of confidence based upon conceptual models that take into consideration sources of ignition, fuel availability and the limited historic accounts of fires.
>
> The estimated fire frequency of five to ten years for the Mesic Bluestem Prairie target is based on consideration of fire return intervals estimated in the western Great Plains for level to rolling topography, and in the mesic tallgrass prairies of the eastern Great Plains. Typical estimates of fire frequency for eastern Great Plains tallgrass prairie communities range between 1 to 5 years and 4 to 10 years, and most sources acknowledge that fire return intervals probably varied widely due to interactions with grazing animals, practices by indigenous people, and temporal climate variation (Steinauer and Collins 1996, Reichman 1987, Collins and Wallace 1990).

Abrams (1985) used fire scars on trees in forests embedded within the tallgrass prairie of northeastern Kansas to estimate a mean fire return interval of 11-20 years for the period from 1858 to 1983. However, this estimate was based on a small sample size. Fires in tallgrass prairie are thought to have returned every 3-4 years, sometimes less frequently; however fire return intervals of ten or more years were rare (Reichman 1987:106). In Kansas, tallgrass produces the greatest biomass when burned every two to four years.

The indicator rating thresholds are based on professional judgement and included consideration of proposed metrics in the Central Mixedgrass Prairie Ecological EIA (Decker 2007a).

OSMP believes more sustainable conditions are associated with a greater proportion of the target experiencing the appropriate fire return interval. The indicator ratings reflect this thinking. While OSMP considered basing the indicator ratings on departure from the acceptable fire frequency (less than one interval, one interval, more than one interval), the department lacks information about fires from more than 20 years ago.

OSMP records the location and extent of grassland burns by creating the outline of burns as polygons within shapefiles. Attribute attached to the polygons information includes the date of the burn. Records of grassland burns on OSMP for the period 1997-2007 are thought to be complete. Information about burns that occurred prior to 1997 was less thoroughly recorded and records are considered less complete. Information about fire history is often limited to the term of OSMP ownership, unless burn polygons happen to extend onto nearby lands that are subsequently purchased by OSMP.

Under current conditions, burning grasslands takes extensive planning and can only be implemented when environmental conditions are appropriate. Often the window of opportunity for grassland burns is short. Therefore, the likelihood of burning large areas annually is low. The larger the proportion of MBP "out of prescription", the more difficult for OSMP managers to ensure the entire target is burned within the acceptable return interval.
Confidence of these Indicator rating descriptions: High

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: 0.28
Current Rating: Fair
Current rating comment: Approximately 80 acres of the MBP have burned from 2000-2007. Extrapolating this rate across ten years, we might expect approximately 28% of the MBP to burn in the period from 2000-2009. This would also place the indicator in the "Fair" category.
Confidence of the current rating: High

Desired Rating: Good
Desired rating comment: As with all indicators, the objective is to have conditions rated as either good or very good. The MBP is currently in the "Fair" range; however, OSMP staff considers achieving a "Good" condition an obtainable goal. If grassland burning continues to be supported by the community and easy to accomplish, we may be able to burn a larger proportion of the target.

OSMP's approach will be to develop field specific burn plans to address issues of setting, topography, and vegetation cover in order to develop appropriate return intervals. It is possible that some areas will not be burned because of neighboring land uses, topography, contamination or other factors.

Other comments: The MBP target is made up of relatively small patches that typically occur in a mosaic with wetland community types, and sometimes with xeric tallgrass communities. More area has been burned near MBP patches within these mosaics than is reflected in the acreages reported only for the MBP target over the last 18 years. In the future, OSMP's approach will be to develop specific burn plans to address issues of setting, topography, and vegetation cover in order to develop appropriate return intervals. It is possible that some areas will not be burned because of neighboring land uses, topography, and contamination. The "current rating" is likely to improve when the burn planning area is more accurately defined.

Conservation Target: Mesic Bluestem Prairie
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: Because the habitat of butterflies and skippers is intermingled among the Mixedgrass Prairie Mosaic, Xeric Tallgrass Prairie and Mesic Bluestem Prairie, a single indicator is proposed to assess the viability of all three targets.

Butterflies are excellent indicators of grassland health. Our goal is to maintain or increase occurrence levels of 11 CNHP watch-listed species in specific OSMP habitats.

CNHP-tracked grassland dependent butterflies and skippers with associated conservation targets (MGPM=Mixedgrass Prairie Mosaic, XTGP=Xeric Tallgrass Prairie, MBP= Mesic Bluestem Prairie)

Common Name	Scientific Name	Grassland Plan Target		
		MGPM	XTGP	MBP
Simius roadside skipper	*Amblyscirtes simius*	X	X	-
Arogos skipper	*Atrytone arogos*	-	X	X
Dusted skipper	*Atrytonopsis hianna*	-	X	X
Hops feeding azure	*Celestrina humulus*	-	-	X
Mottled dusky wing	*Erynnis martialis*	-	X	-
Colorado blue	*Euphilotes rita coloradensis*	-	X	-
Two-spotted skipper	*Euphyes bimacula*	-	-	X
Ottoe skipper	*Hesperia ottoe*	-	X	X
Crossline skipper	*Polites origenes*	-	X	X
Rhesus skipper	*Polites rhesus*	X	X	-
Regal fritillary	*Speyeria idalia*	-	X	-

Indicator: Percent occurrence of CNHP-tracked grassland dependent butterflies and skipper species

Indicator Ratings:

Poor: <4%
Fair: 4-10%
Good: 10-25%
Very Good: >25%
Indicator ratings comment: All known sampling events of butterflies and skippers in the grassland conservation targets (MGPM, XTGP and MBP,) were used to calculate a percent occurrence measure for the 11 species of CNHP-tracked butterflies and skippers. Because these species are rare, each observation per sampling event contributes to the total number of occurrences. For example, if two individuals of one species and one individual of another were observed in one transect and no individuals were observed in the next three transects, percent occurrence would equal 3/4 = 75%. This method acknowledges varying levels of abundance of lepidoptera among sampling events. It also helps identify sampling locations that are especially important habitat. CNHP tracked species were encountered in 25 (or 23%) of 110 sampling events.

Staff placed the percent occurrence for CNHP species (23%) from all historical sampling events near the upper end of "Good" because many of the detections were recorded as part of targeted inventory of the best habitat on OSMP lands (Pineda and Ellingson 1998) rather than random or stratified random sampling. OSMP does not consider targeted inventory to be an appropriate method for tracking relative change in butterfly occurrence.

The studies that used replicable sampling methodology detected an 8.8% occurrence of CNHP tracked species. Staff chose 10% species occurrence as the "Good"/"Fair" threshold to reflect OSMP's intention to improve habitat quality (native plant relative cover/species richness) on OSMP lands.

Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: 0.088
Current Rating: Fair

Desired Rating: Good
Desired rating comment: Similar to grassland birds, previous butterfly sampling on OSMP has been conducted in areas of high vegetative quality. Changes to fire and grazing regimes (by both prairie dogs and cattle) and maintenance of large, intact habitat blocks could be used to increase the dominance of big and little bluestem and expand the distribution of these species. For example, well-timed prescribed burns (instead of wildfire) in areas dominated by weeds may improve habitat quality for big and little bluestem.

Other comments: Monitoring of CNHP-tracked species should be undertaken every 5-10 years to identify population trends. Monitoring should occur for at least two consecutive years to address the influence of annual environmental variation (precipitation, temperature, etc.) and variability of detection frequency.

Conservation Target: Mesic Bluestem Prairie
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: Because the habitat of butterflies and skippers is intermingled among the Mixedgrass Prairie Mosaic, Xeric Tallgrass Prairie and Mesic Bluestem Prairie, a single indicator is proposed to assess the viability of all three targets.

Butterflies are excellent indicators of grassland health. Butterfly assemblages, because of a range of sensitivities to environmental perturbations, may be useful in ecological integrity assessments (Nelson and Epstein 1998). OSMP's goal is to maintain or increase the current occurrence levels of selected grassland dependent species. Occurrence refers to encountering an individual of a species during a monitoring event.

Fire, grazing and herbicide use, techniques that OSMP has and is likely to continue to use to manage native plant species composition and richness, could have adverse impacts upon butterflies and skippers. In order to track the impact of our grassland management on butterflies and skippers, butterflies and skippers are being included as an indicator of ecological integrity of the Mixedgrass Prairie Mosaic, Xeric Tallgrass Prairie and Mesic Bluestem Prairie. Because the habitat of these animals is intermingled in the Grassland Planning Area, a single indicator is proposed to assess the viability of all three targets.

Several of the skippers and butterflies included as nested targets have been identified as conservation targets by The Nature Conservancy and others in the Southern Rocky Mountain Ecoregional Assessment (Neely et al. 2001). Successful conservation of foothills grasslands, especially tallgrass areas, is integral to accomplishing ecoregional conservation goals.

Indicator: Percent occurrence of grassland dependent butterflies and skipper species

Indicator Ratings:

Poor: <25%
Fair: 26-50%
Good: 51-75%
Very Good: >75%
Indicator ratings comment: Staff used OSMP butterfly studies to determine grassland dependent species occurrence per sample-year (transects, spot mapping, etc.). Sample-years included in the analysis were: 2001, 2002 (Armstead), 1999, 2000 (Collinge), and 2007 (Robinson). Data derived from Collinge were not able to be analyzed separately by year and therefore were treated as one year's sampling. Grassland dependent species occurred in 30 of 68 grassland sample-years for a 44% occurrence rate (Armstead 2003, Colllinge et al. 2003, Robinson and Bowers 2007).

OSMP staff believes that there are opportunities to improve butterfly and skipper habitat, and consequently placed the percent occurrence of grassland dependent species from all historical studies at the upper end of the "Fair" rating (see current rating notes). Indicator ratings separated by quartiles to reflect the increasing conservation value of higher levels of incidence of grassland dependent species.

Selected grassland dependent butterflies and skippers with associated conservation targets (MGPM=Mixedgrass Prairie Mosaic, XTGP=Xeric Tallgrass Prairie, MBP= Mesic Bluestem Prairie)

Common Name	Scientific Name	Grassland Plan Target		
		MGPM	XTGP	MBP
Simius roadside skipper	*Amblyscirtes simius*	X	X	-
Arogos skipper	*Atrytone arogos*	-	X	X
Dusted skipper	*Atrytonopsis hianna*	-	X	X
Hops feeding azure	*Celestrina humulus*	-	-	X
Mottled dusky wing	*Erynnis martialis*	-	X	-
Colorado blue	*Euphilotes rita coloradensis*	-	X	-
Two-spotted skipper	*Euphyes bimacula*	-	-	X
Ottoe skipper	*Hesperia ottoe*	-	X	X
Crossline skipper	*Polites origenes*	-	X	X
Rhesus skipper	*Polites rhesus*	X	X	-
Regal fritillary	*Speyeria idalia*	-	X	-
Orange-headed roadside-skipper	*Amblyscirtes phylace*	-	X	X
Leonard's skipper	*Hesperia leonardus*	X	X	X
Pahaska skipper	*Hesperia pahaska*	X	X	-
Green skipper	*Hesperia viridus*	X	X	-
Boisduval's blue	*Plebejus icarioides*	-	X	-
Uncas skipper	*Hesperia uncas*	-	X	X
Indra swallowtail	*Papilio indra*	X	X	-
Delaware skipper	*Atrytrone logan*	-	X	X

Confidence of these Indicator rating descriptions: High

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: 0.44
Current Rating: Fair
Current rating comment: Half of the grassland dependent species depend upon big and little bluestem for larval food. These plant species are typically present in grasslands with "Good" vegetative condition. Analysis of existing data suggests that the vegetation condition of the MGPM, XTGP and MBP can best be described as "Fair" (i.e., most vegetation condition indicators are rated as "Fair"). It is appropriate that current ratings of insects and their particular requirements are similar.
Confidence of the current rating: Medium

Desired Rating: Good
Desired rating comment: Although the studies used to estimate current butterfly status sampled in areas of high vegetative quality (Armstead 2003, Colllinge et al. 2003, Robinson and Bowers 2007), there are areas in these conservation targets that would benefit from increased fire interval, decreased human pressure, and changes in grazing regime (Kettler and Pineda 1999, Pineda and Ellingson 1998). Changes in grazing could mean changing the timing and intensity of livestock grazing, or changing the intensity of grazing by prairie dogs. This could increase local dominance of larval host-plants, which is correlated to butterfly winter survival and recruitment rates.

Other comments: Monitoring of grassland dependent species should be undertaken every 5-10 years to identify population trends. Monitoring should occur for at least two consecutive years to address the influence of annual environmental variation (precipitation, temperature, etc.) and variability of detection frequency.

Conservation Target: Mesic Bluestem Prairie
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: OSMP has not found references that provide documentation of the relative percent cover of big bluestem and little bluestem needed to sustain viable populations of those skipper and butterfly species that require big and/or little bluestem as larval host plants. There have been several studies of grassland butterflies on OSMP (Pineda and Ellingson 1998, Collinge et al. 2003, Armstead 2003,Robinson and Bowers 2007). While these studies have characterized good quality butterfly habitat in a general way, they do not specify host plant cover levels. Few of the ESCO vegetation sample sites overlap with the butterfly study sites, so that correlation between big and little bluestem cover and the occurrence of butterfly species of concern cannot be made with current data sets.

Indicator: Relative cover of host plants for skipper/butterfly species of concern (big bluestem and little bluestem)

Indicator Ratings:

Fair: $< 75\%$ of samples $\geq 8\%$
Good: At least 75% of samples $\geq 8\%$
Indicator ratings comment: While it is likely that the skippers and butterflies that depend on big and little bluestem benefit from high cover of these species, it is possible that extremely high cover of big and little bluestem might adversely affect the skippers and butterflies. For example, very high cover of big and little bluestem might reduce the cover and richness of other plant species that are needed for the habitat to provide a full suite of functions. Staff used this model, which suggests there may be an "intermediate" level of big and little bluestem cover that provides optimal habitat for skippers and butterflies, as the basis for developing the indicators ratings. Unfortunately, there is no literature available to guide staff, leaving staff to use their best professional judgment.

Staff examined 189 transect-years of XTGP point cover transect data and 140 transect-years of MBP point cover transect data collected from multiple sites to develop the indicator ratings. Using similar thinking it used to establish thresholds for other vegetation composition indicators, staff assumed the XTGP was generally in "Good" condition. The transect-year data for the XTGP suggested that most of the time the combined relative cover of big and little bluestem exceeded 8%. (The 25% percentile for the XTGP data set was 8.15%.) Consequently, staff set the threshold between "Fair" and "Good" at 8%.

Given the uncertainty associated with the upper and lower bounds of this threshold (i.e. how much is too little relative cover of big and little bluestem and how much is too much?), staff did not set a "Poor"/"Fair" or "Good"/"Very Good" threshold. In future system-wide monitoring, staff intends to couple vegetation transects with butterfly/skipper transects to better understand the relationship between big and little bluestem cover and butterfly/skipper presence and abundance.

As with other indicators, staff would like to see most of the planning area attain and maintain a "Good" status. Therefore, the final indicator ratings note that at least 75% of the transects should have a combined relative cover for big and little bluestem of ≥ 8%.
Confidence of these indicator rating descriptions: Medium

Indicator Measurements:
Date: 1/15/2008
Current Rating: Good
Current rating comment:
Confidence of the current rating: Low

Desired Rating: Good

Conservation Target: Mesic Bluestem Prairie
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: Breeding is a strong and direct measure of biodiversity support. Although this target serves important functions as migratory habitat, this indicator focuses upon the degree to which mesic bluestem prairie serves as breeding habitat for the following nine indicator species (sensitive indicator species shown with asterisk (*)):

American bittern *
Least bittern *
Wilson's phalarope *
Bobolink
Dickcissel
Eared grebe *
Northern harrier *
Osprey *
Yellow-headed blackbird

Indicator: Species richness of sensitive breeding birds

Indicator Ratings:

Poor: No breeding of any indicator species
Fair: Successful breeding by all but sensitive species
Good: Successful breeding by all indicator species
Very Good: Multiple (>1) records of successful breeding by all indicator species
Indicator ratings comment: Provisional indicator ratings. This provides an opportunity to work with staff or volunteers to document breeding and breeding success by indicator species.
Confidence of these Indicator rating descriptions: Low

Indicator Measurements:

Current Indicator Measurement: Unknown
Current rating comment: Documented successful breeding in 2008 by bobolink, osprey, yellow-headed blackbird. No records for other species.

Desired Rating: Good

Conservation Target: Mesic Bluestem Prairie
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: Ute ladies tresses orchid (*Spiranthes diluvialis*) is a long-lived perennial that reproduces strictly by seed. The flowers are pollinated by bumblebees (Sipes and Tepedino 1995). Ute ladies tresses orchid is a wetland plant designated as threatened under the Endangered Species Act (USFWS 1992). In Colorado, the orchid is restricted to low-elevation valleys in wetlands and irrigated fields. Within these sites, it is found only in specialized conditions of soil and hydrology.

Ute ladies tresses orchid was selected as an indicator of condition because it is a rare plant species associated with the mosaic formed by mesic bluestem prairies and wetlands. It is often coincident with other uncommon forbs such as purple gerardia (*Agalinus tenuifolia*) and great lobelia (*Lobelia siphilitica*). The orchids on OSMP lands are among the largest sub-populations in the range of the species and are important to the conservation of this species.

The Ute ladies tresses orchid's natural history presents challenges to monitoring. Several of its life stages are difficult to detect. In any given year, mature plants may be in two non-flowering states, either vegetative or dormant (persisting only belowground) (Lesica and Steele 1994). In addition, if this species behaves as another member of the genus there may be immature vegetative states lasting as long as nine years. Though individual plants can be identified in localized searches, the orchid can only be reliably located over larger areas when in flower. Time-intensive demographic studies have been undertaken on OSMP and elsewhere to determine the viability of local sub-populations (Arft 1995, Riedel et al. 1995, Heidel 2001). Based upon the findings of these studies, OSMP has concluded that compatible agricultural management practices (irrigation, winter grazing, as well as the timing and distribution of hay cutting) are among the most important factors related to the long-term viability of large Ute ladies tresses orchid populations.

The areas to be surveyed for this indicator are:
1) The Van Vleet property meadows north of US 36 in the South Boulder Creek floodplain (field numbers X and Y);
2) The Van Vleet property meadows south of US 36 in the South Boulder Creek floodplain (field numbers A and B); and
3) The Yunker property (field number Z) east of Cherryvale Road and south of US 36.

Indicator: Management of Ute ladies-tresses orchid habitat

Indicator Ratings:

Poor: Prolonged (> 5 years) or permanent change in management practices (i.e. loss/reduction of irrigation water, lack of grazing, etc.) on more than one of the three main blocks of Ute ladies-tresses orchid

Fair: Prolonged (> 5 years) or permanent change in management practices (i.e. loss/reduction of irrigation water, lack of grazing, etc.) on one of the three main blocks of Ute ladies-tresses orchid

Good: Maintain 2008 agricultural and irrigation practices on the three main blocks of Ute-ladies tresses orchid

Very Good: Maintain 2008 agricultural and irrigation practices on the three main blocks of Ute ladies-tresses orchid

Indicator ratings comment: Agricultural practices have created conditions suitable for the establishment, growth and reproduction of the Ute ladies tresses orchid. Over almost two decades of management, OSMP staff and lessees have come to understand how the timing and stocking rates of grazing as well as irrigation and hay-cutting practices can be manipulated to sustain orchid populations. In the absence of new threats, these, or other compatible, practices should support viability of the large sub-populations of the orchid found on OSMP lands.

Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Current Indicator Measurement: Practices maintained

Current Rating: Good

Confidence of the current rating: High

Desired Rating: Good

Conservation Target: Mesic Bluestem Prairie

Category: Condition

Key Attribute: Vegetation Composition

Key attribute comment: Native relative cover serves as an indicator of the quality of vegetation occurring in a sample. However, taken alone, relative cover does not provide a full picture of community composition because it refers only to that portion of the sample that is vegetated. Native relative cover is proposed as one of several indicators of vegetative composition.

Indicator: Native species relative cover

Indicator Ratings:

Poor: < 75% of samples with NRC >55%

Fair: At least 75% of samples with NRC >55%

Good: At least 75% of samples with NRC >85%

Very Good: At least 75% of samples with NRC=100%

Indicator ratings comment: Staff used 126 transect-years of point cover plot/transect data from multiple sites to develop the indicator ratings for this indicator. OSMP staff began the analysis by placing the mean native species cover for all transect-years in the middle of the "Good" category and using one standard deviation above and below this mean to define the range of "Good" conditions. The "Fair"/"Poor" threshold was set two standard deviations below the mean. This approach resulted in too a wide range for "Good" native relative cover. Using input from the grassland plant ecologist, OSMP staff refined the "Good" category using transects that could be considered representative of "Good" conditions based upon best professional judgment. Staff then placed the mean native cover of this subset of samples in the middle of the range of "Good" conditions and used one standard deviation above and below the mean to define the range of "Good" conditions. The "Fair"/"Poor" threshold was maintained as two standard deviations from the mean for all transect-years.

Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Date: 1/15/2008
Current Indicator Measurement: 75% of samples have NRC > 72%
Current Rating: Fair

Desired Rating: Good

Conservation Target: Mesic Bluestem Prairie
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: Native species richness is a direct measure of biological diversity. It is sensitive to management practices that tend to homogenize natural systems such as a repetitive grazing regime (same season of use, similar stock rates, similar duration, continuous prairie dog occupation) or a fire regime that always burns the same area during the same time of year. Species richness is used by Rondeau (2001) in the Ecological Viability Specifications for the Foothills Grasslands in the Southern Rocky Mountains Ecoregional Plan.

Species richness is best if used with other indicators of composition and other key ecological attributes (e.g. endemism, functional significance, and the severity of threats) (Fleishman et al. 2006). Native species richness may be high in some cases due to the presence and diversity of native plant species that increase over time under livestock and/or prairie dog grazing. While conservation objectives for vegetation composition can still be met when a minority of MBP grasslands are in a state that includes high species richness of native increaser species, conservation objectives would not be met if the majority of MBP grasslands were in that state. This example underscores the importance of using the native species richness indicator in conjunction with other metrics to more fully understand and assess the condition of this target.

Indicator: Native species richness

Indicator Ratings:

Poor: <75% of samples >6
Fair: At least 75% of samples >6
Good: At least 75% of samples >23
Very Good: At least 75% of samples >33
Indicator ratings comment: OSMP staff used 126 transect-years of point cover plot/transect data from multiple sites to develop indicator ratings. The mean value for species richness was calculated. The mean value for all transect-years was placed at the boundary between "Fair" and "Good", based upon the observations of the grassland plant ecologist and the agricultural resource specialist that the species richness of the MBP was low due to a number of stresses (e.g., historic grazing, hydrologic changes). One standard deviation above the mean defined the "Good"/"Very Good" boundary. The "Fair"/"Poor" boundary was placed two standard deviations below the mean.

OSMP staff prepared the statistical analysis and used the data to define the indicator ratings. The confidence is based upon the general consensus that species richness is somewhat less than acceptable in the majority of MBP sites, and the availability of a relatively long-term data set spread across the OSMP land system.
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: 75% of samples have a native species richness >15
Current Rating: Fair

Current rating comment: The current status for the MBP vegetation composition indicators that evaluate non-native species dominance ("Good") and high occupancy ("Poor") tracked through the RAM method lend further support to the professional judgment that this target is in fair condition related to the key attribute of vegetation composition.
Confidence of the current rating: High

Desired Rating: Good

Conservation Target: Mesic Bluestem Prairie
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: While additional, more quantitative research is needed to fully understand the complex impacts of invasive species on ecosystems (Hulme and Bremner 2006), some impacts have been documented. Eagle et al. (2007) detailed a wide range of impacts from yellow starthistle in California; Vaccaro (2005) documented loss of biodiversity resulting from cattail leaf litter in Great Lakes wetlands; Katz and Shafroth (2003) and Simons and Seastedt (1999) documented impacts of Russian olive on various ecological functions; Levine et al. (2003) reviewed underlying impacts of exotic plant invasions; Tickner et al. (2001) reviewed the literature on riparian invasions; Bakker (unpublished) reviewed impacts of woody plants on grassland dependent birds; and Rumble and Gobeille (1998) looked at bird use in different successional stages of cottonwood forests and potential impacts of replacement by other woody species, mainly invasive green ash.

In addition to being a key attribute for the target, this indicator is intended to help address the concerns raised by Fleishman et al. (2006) regarding the limitations of species richness. This indicator seeks to provide information about the extent of areas within the target dominated by a subset of noxious weeds that are both of significant concern to OSMP and practical to monitor. For this indicator, "dominated" means over 50% canopy cover. Canopy cover measures for the RAM methodology are documented in (Dewey and Anderson 2006).

In 2007, OSMP staff chose to use a variant of the RAM protocol referred to as the gross area polygon because of the types of weeds that were encountered and a desire to speed data collection. Gross area polygons are intended to provide a way to address extremely widespread infestations. This may have led to some over-mapping (showing invasive species where they did not actually occur) especially of diffuse knapweed.

The indicator ratings were assigned in response to a number of sources (Rondeau 2001, Neely et al. 2006, Decker 2007a) associated with ecological integrity assessments.

The RAM methodology was applied to almost the entire target; however, certain low priority sites were excluded based on their position within Visitor Master Plan Trail Study Areas and large habitat blocks. Isolated and smaller parcels not included in the TSAs up for review at the time of sampling were omitted. The only known consequence is that CRP lands in the northeast (ca. 1600 ac) were not mapped. The effect of this omission on the overall estimate is not known.

Indicator: Percent of target dominated by non-native species (Rapid Assessment Mapping)

Indicator Ratings:
Poor: >5%
Fair: 3-5%
Good: 1-<3%
Very Good: <1%
Indicator ratings comment: The RAM species included OSMP priority species, a synthesis of state, county and local species of concern. These species are typically considered most threatening to ecosystem health, recreation and agriculture. From this list, certain ubiquitous species unlikely to be

managed were removed (e.g. cheatgrass, smooth brome and wild asparagus). The list of RAM species for 2006 is available in Dewey and Anderson (2006:2-3). In addition to these, the 2007 data collection also included other species documented in Johnson (2007).

Levels of infestation, as a percent of target area, were calculated from RAM data using GIS for each target. The indicator ratings were assigned in response to a number of sources (Rondeau 2001, Neely et al. 2006, Decker 2007a) associated with ecological integrity assessment. The indicator ratings are comparable to those developed for conservation action plans in other areas (e.g. Lower Purgatorie, Huerfano Uplands, Laramie Foothills and the Rocky Mountain Front Range).

Indicator Measurements:
Date: 4/15/2008
Current Indicator Measurement: 0.019
Current Rating: Good
Current rating comment: OSMP calculated the current (2006-7) percent cover for RAM species within six cover classes for each target. The percent of a target in the cover class "> 50%" was used for this indicator.
Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Mesic Bluestem Prairie
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: For documentation of the relevance of exotic species as an indicator, please see Key Ecological Attribute Indicator "Percent target area dominated by exotic species tracked through the RAM method".

This indicator provides additional information about the extent of the target likely to become dominated by invasive species. This indicator was developed to provide advanced warning of changing conditions because a target may have not be dominated by RAM species, but those species might be approaching dominance. The inclusion of this indicator will allow us to track these high occupancy areas and manage them before they become dominated by RAM species.

Indicator: Percent of target with prevalence of non-native species (Rapid Assessment Mapping)

Indicator Ratings:
Poor: >15%
Fair: 9-15%
Good: 3- <9%
Very Good: <3%
Indicator ratings comment: Levels of infestation were calculated from RAM data using GIS. OSMP staff looked for weed management plans or integrity assessments upon which to base thresholds; however, no examples were found for using sub-dominance (high occupancy) as a leading indicator. Consequently, the indicator ratings for this indicator are based on professional judgment rather than the work of others. Because of the lower abundance by RAM species for this indicator, the percent of area for each indicator (tolerance of area occupied) is higher.
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:
Date: 4/15/2008
Current Indicator Measurement: 0.165
Current Rating: Poor

Current rating comment: OSMP calculated the current (2006-7) percent cover for RAM species within six cover classes for each target. The percent of a target in the cover classes "6-25%" and ">25 50%" were used for this indicator.
Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Mesic Bluestem Prairie
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: See comment under the indicator: Management of Ute ladies-tresses orchid Habitat

This indicator is proposed as an easily-implemented check that flowering plants are detected on a regular basis. Over time, OSMP intends to refine this indicator by combining presence/absence checks with demographic sampling to track vegetative and dormant individuals in the areas of the orchid's habitat supporting the largest sub-populations.

These areas to be surveyed for this indicator are:
1) The Van Vleet property meadows north of US 36 in the South Boulder Creek floodplain (field numbers X and Y);
2) The Van Vleet property meadows south of US 36 in the South Boulder Creek floodplain (field numbers A and B); and
3) The Yunker property (field number Z) east of Cherryvale Road and south of US 36.

Indicator: Presence of populations of Ute ladies-tresses orchid

Indicator Ratings:
Poor: Absent
Fair: Absent
Good: Present
Very Good: Present
Indicator ratings comment: Presence indicates that the species is being conserved as part of this target; absence indicates a failure to conserve the species.
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:
Date: 8/15/2007
Current Indicator Measurement: Orchid is present
Current Rating: Good
Current rating comment: Orchids were recorded in the three fields in 2007.

Desired Rating: Good

Conservation Target: Mesic Bluestem Prairie
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: Native species richness is a direct measure of biological diversity. It is sensitive to management practices that tend to homogenize natural systems such as a repetitive grazing regime (same season of use, similar stock rates, similar duration, continuous prairie dog occupation) or a fire regime that always burns the same area during the same time of year. Species richness is used by Rondeau (2001) in the Ecological Viability Specifications for the Foothills Grasslands in the Southern Rocky Mountains Ecoregional Plan.

Species richness is best if used with other indicators of composition and other key ecological attributes (e.g. endemism, functional significance, and the severity of threats) (Fleishman et al. 2006). This indicator uses a subset of native plant species that provide a better indication of ecological condition than a measure of the richness of all native species. Coefficients of Conservatism, also called "C values", have been assigned to the majority of native species occurring in Colorado by a panel of experts (Rocchio 2007). C-values range from zero to 10, representing the potential for each species to "occur in a landscape relatively unaltered from pre-European settlement conditions". C-values above six indicate progressively higher levels of conservatism, with a C value of 10 representing an obligate association with high quality natural areas and the processes that support them (Rocchio 2007).

Native species richness may be high in the target for a variety of reasons. Some native plant species increase over time under livestock and/or prairie dog grazing. If only one indicator for species richness of all native species were to be used, OSMP's objectives for species richness could be met for grasslands that are in one seral stage, or that in other ways do not represent the range of functioning natural systems in the Mesic Bluestem Prairie target. Staff examined the C-values of the plant species in the target and determined that species with C-values of five and above included those more likely to decrease in the presence of heavy grazing pressure. In addition, several characteristic species of the target's alliances had been assigned C values of five and higher.

Indicator: Richness of selected conservative plant species

Indicator Ratings:

Poor: < 75% of samples >3
Fair: At least 75% of samples >3
Good: At least 75% of samples >11
Very Good: At least 75% of samples >16
Indicator ratings comment: OSMP staff examined all Mesic Bluestem Prairire transect-years, including those in disturbed states. Based upon the best professional judgment that most examples of the target are slightly depauperate in terms of conservative species richness, staff placed the mean for all of the transect-years as the "Good"/"Fair" cutoff and used two standard deviations below this mean to define the "Fair"/"Poor" boundary. One standard deviation above the mean marked the cutoff between "Good" and "Very Good".
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:

Date: 9/15/2005
Current Indicator Measurement: 75% of samples have a conservative species richness of 7 or greater.
Current Rating: Fair
Current rating comment: Current status information for conservative species richness is the 25th percentile for the most recently available (2005) data set (i.e. 75% of the transects or transect-years have at least that species richness). Since few transects were sampled for frequency in 2006, the 2005 data was used for species richness analysis.

Current status (2005) of conservative species richness (C>4) for 8 Mesic Bluestem Prairie transects.

	2005
N of cases	8
Minimum	6.000
Maximum	17.000
Mean	10.125
Standard Dev	3.796
Method = CLEVELAND	
1 %	6.000

5 %	6.000
10 %	6.300
20 %	7.000
25 %	7.000
30 %	7.000
40 %	7.700
50 %	9.500
60 %	11.300
70 %	12.100
75 %	12.500
80 %	12.900
90 %	15.800
95 %	17.000
99 %	17.000

Confidence of the current rating: Very High

Desired Rating: Good
Desired rating comment: It may difficult to achieve an acceptable rating for this indicator. OSMP has set the objectives high until more is known about range of variability and status of the target based on results of system-wide sampling.

Conservation Target: Mesic Bluestem Prairie
Category: Condition
Key Attribute: Vegetation Structure
Key attribute comment: Bare ground refers to organic or mineral soil that is not covered by vegetation (canopy cover), standing dead vegetation, litter or rock. The amount of bare ground and the way it is distributed relate directly to a site's susceptibility to wind and water erosion (Pellant et al. 2000). In the Boulder area, strong winds are a particularly important erosional force. Soil texture, organic matter content, rock content, topography and land use history also contribute to soil surface condition.

The optimal proportions of bare ground, and other cover types required for soil stability, soil moisture retention, adequate nutrient cycling, regeneration site availability and functional wildlife habitat vary by site and community type. Vegetation and litter cover are important factors in reducing soil movement and retaining organic matter and soil moisture. In areas that exceed the acceptable range of variability for bare ground, surface organic matter decreases through erosion, water infiltration and retention is reduced, and the site potential in terms of native perennial seedling establishment and plant survival is diminished. These degraded conditions may create habitat for ruderal native and non-native plant species. On sites with very steep slopes, the potential for soil movement increases (Kohnke and Franzmeier 1995).

Wildlife habitat requirements for bare ground and litter cover, and vegetation structure and composition, vary by species. Patch types with higher cover levels of bare ground create habitat for some wildlife species, while lower bare ground cover combined with optimum litter and vegetation cover provide functional habitat for other wildlife species. Some wildlife species require multiple habitat types during their life cycle. As more information is obtained on the habitat requirements of local grassland species, indicator ratings for bare ground and other ground cover types may be adjusted.

Indicator: Absolute cover bare ground

Indicator Ratings:
Poor: < 75% of samples <21%
Fair: At least 75% of samples <21%
Good: At least 75% of samples <13%
Very Good: At least 75% of samples <3%

Indicator ratings comment: OSMP staff used 140 transect-years for the absolute bare ground analysis for the MBP. Based upon the recommendations of the grassland plant ecologist and the agricultural resource specialist that the average absolute cover of bare ground was below the threshold of acceptability (i.e there is not too much bare ground), the mean value was placed in the middle of the "Good" rating. The "Good" category was defined by one standard deviation above and one below the mean for all transect-years. Future sampling across a wider selection of MBP sites, designed to better capture the range in variation in soil cover, may result in adjustments to the acceptable range.

The acceptable range of variation assumes dynamic disturbance regimes that include periods of rest and recovery between periods of disturbance. In productive grassland communities in semiarid climates, the absence of periodic disturbances such as ungulate grazing and/or fire for extended periods of time can cause excessive plant litter accumulation that slows nutrient cycling and reduces seed germination and establishment (Sprock et al. 2004b). Litter build up can lead to plant mortality, which can result in increased bare ground and erosion as plants die back. Excessive litter build up resulting from the absence of natural disturbances for 20 years or more, or prolonged, season-long grazing can cause mortality of the diagnostic, warm season mesic tallgrass species and a shift to a cool season dominated community.

The NRCS Ecological Site Descriptions provide generalized descriptions of litter and bare ground cover and distribution. For example, the description for the Loamy Plains ecological site (Sprock et al. 2004a) indicates this site would typically have three percent or less bare ground in small (2-3 inch) patches. Cover by bare ground during extended drought could increase to as much as 10-20 percent with patches enlarging to 6-12 inches in diameter.

Indicator Measurements:

Current Indicator Measurement: 0.12

Current Rating: Good

Current rating comment: Current rating for bare ground is the 75th percentile for 14 transect-years in 2005 and 2006 (i.e. 75% of the transects or transect-years have less than or equal to 12% bare ground). Not all transects were sampled for cover in 2006, so the combined 2005 and 2006 data set was used for the bare ground cover analysis.

Confidence of the current rating: Medium

Desired Rating: Good

Desired rating comment: See indicator rating descriptions.

AGRICULTURAL OPERATIONS

Conservation Target: Agricultural Operations
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: As written, this indicator was developed to be applicable to irrigated hayfields (part of the Agriculture Operations Conservation Target). However, as OSMP expands its survey of nesting bobolinks to include non-irrigated sites (i.e., wet meadows and wetlands), this indicator may be modified.

Bobolinks are ground-nesting songbirds which nest primarily in wet meadows in the Boulder Valley (Thompson and Strauch 1987). They are protected under the Migratory Bird Treaty Act and are considered "vulnerable to extirpation" ("S3B") by Colorado National Heritage Program and "rare breeding species" by the Boulder County Comprehensive Plan. Bobolink populations in the western United States are unique in that they are separated from the main breeding range of bobolinks further to the East (Hamilton 1962).

Bobolinks originally nested in tallgrass or mixedgrass prairie of the mid-western United States and south-central Canada (Bent 1958), but because of land conversion, have now increased their use of irrigated hayfields throughout their range (Martin and Gavin 1995). The use of this habitat creates a potential management conflict as most irrigated hayfields are managed under maximum yield principles, which translates to several harvests (i.e., mowing) each season. The bobolink is of particular interest to land managers because of its extreme population decline during the past thirty years and its affinity to breed late in the summer when much of the mowing typically occurs (Martin and Gavin 1995). Bollinger et al. (1990) documented a 90-100% failure rate of bobolink nests because of hayfield mowing. On OSMP hayfields, Roeder (1998) documented no breeding bobolink mortality at four nests and attributed this to the fact that mowing did not occur until after the young had fledged and parental activity ceased.

Efforts by OSMP staff to manage irrigated hayfields to conserve bobolinks began in 1993 when the Burke II property was closed to visitor use. However, records date to 10 years before that which document successful breeding attempts by bobolinks on the Burke II property. Thompson and Strauch (1987) reported a mean fledgling date of July 8th for nests on the Burke I, Burke II, and Gephard OSMP properties, but the general consensus is that postponing mowing until July 15th will allow for the majority of fledglings to be able to sustain flight and hence avoid mowing impacts (Thompson and Strauch 1987, Vierling 1997, Roeder 1998). The incubation period for bobolinks is about two weeks and nestlings leave the nest between 10 and 14 days later (Martin and Gavin 1995). Male bobolinks usually arrive in Boulder County around the end of May and females tend to arrive one week later (Thompson and Strauch 1987). However, exact time of nesting is not known for OSMP properties.

OSMP managers seek to maintain traditional agricultural land use (haying, grazing) while preserving and maintaining natural systems and native species. In order to identify key bobolink breeding sites and thus inform management decisions, OSMP initiated a hayfield bird monitoring program in 2000. Using these data, staff identified key breeding sites in terms of abundance and density of singing male bobolinks, a common metric used to assess grassland bird abundance. These highest density breeding areas were designated as "Class A Bobolink Management Areas". OSMP staff also designated a set of second tier breeding areas as "Class B Bobolink Management Areas".

Indicator: Management of bobolink nesting habitat

Indicator Ratings:

Poor: ≤100% of Class A Bobolink Management Areas mowed after 7/15 annually and <30% of Class B Bobolink Management Areas mowed after 7/15 in one out of three years

Fair: 100% of Class A Bobolink Management Areas mowed after 7/15 annually and 30 - 75% of Class B Bobolink Management Areas mowed after 7/15 in one out of three years
Good: 100% of Class A Bobolink Management Areas mowed after 7/15 annually and >75% of Class B Bobolink Management Areas mowed after 7/15 in one out of three years
Very Good: 100% of Class A Bobolink Management Areas mowed after 7/15 annually and 100% of Class B Bobolink Management Areas mowed after 7/15 in one out of three years
Indicator ratings comment: Recent research in New York suggests that bobolinks prefer older (>8 years since plowing) and larger (≥30 ha) hayfields (Bollinger and Gavin 1992).

In 2007, OSMP staff and volunteers detected bobolinks at 42% (n=70) of all hayfields sampled (n=165).
Using abundance and density information from the hayfield bird monitoring program, staff chose four top-tier fields to be designated Class A Bobolink Management Areas (in these areas, mowing would only occur after 15 July annually) and identified 14 second-tier fields as candidates for consideration as Class B Bobolink Management Areas. In these areas, mowing would only occur after 15 July in one of every three years.

OSMP staff determined that five of the 14 fields identified as candidates for designation as Class B Bobolink Management Areas were either already being managed in a manner consist with the Class B Management Area Criteria or could easily be managed in such a manner. Agricultural production was identified as the appropriate priority management activity at four of the sites. No determination was made at the remaining five sites because of complexities in land use.

OSMP staff will explore other options in some of the Class B Bobolink Management fields including land-use changes (i.e., winter grazing). Staff will also examine bobolink use of un-mowed habitats (i.e., wet meadows and wetlands) and may focus on studying local fledging dates.

Indicator Measurements:
Date: 4/15/2008
Current Rating: Fair
Trend: Unknown
Source: Rapid Assessment
Current rating comment: Bobolink (BOBO) data from hayfield bird surveys conducted in 2006 and 2007 along with management designations.

42% (n=70) fields censused had Bobolinks (of 165 total fields)
Total acres currently hayed = 3159
Total acres of fields with Bobolinks = 1539
Total acres in Class A Bobolink Management Areas = 267 (17 % of total acres with Bobolinks)
Total acres in Class B Bobolink Management Areas = 366 (24 % of total acres with Bobolinks)
Total acres recommended for Bobolink conservation = 633 (41% of total acres with Bobolinks, 20% of all acres currently hayed)

Class A Bobolink Management Areas (4)

Property	Field	# of BOBO per year	BOBO density/ yr (/10 acres)	Area (acres)	Management Designation
Church	355	33/2	1.75	96	Class A
Burke II	263	32/2	3.0	54	Class A
Van Vleet	315	39/2	2.1	92	Class A
Van Vleet	331	23/2	4.6	25	Class A

Candidate Class B Bobolink Management Areas (14)

Property	Field	# of BOBO per year	BOBO density/ yr (/10 acres)	Area	Management

				(acres)	Designation
Deluca	13	9/2	1.4	32	See Note 1
Deluca	14	11	2.0	27	
Deluca	19	12	3.3	18	
Hester	18	13	2.6	25	
Campbell	21	20	2.6	39	
Swartz	254	8/2	5.0	8	See Note 2
St. Walburga	303	2/2	1.0	22	See Notes 2,3
Baseline 75	285	5	2.0	13	
Baseline 75	280	12/2	6.0	10	See Notes 2, 4
Gallagher	133	11	1.4	39	Class B
Spicer	260	19	3.3	29	Class B
Teller Farm N.	186	5/2	0.75	38	Class B
Bell II	194	10/2	1.25	40	Class B
Bell II	199	17/2	3.3	26	Class B

Note1: Complicated land uses preclude decision; some options available including land-use shift.
Note 2: Managed primarily for agricultural productivity.
Note 3: Adjacent field (#308) may be an option to manage for BOBO.
Note 4: There is potential to only winter graze.
Note 5: Already managed consistently with Class B Management Area criteria.

Desired Rating: Good

Conservation Target: Agricultural Operations
Category: Condition
Key Attribute: Physical and Chemical Soil Regimes
Key attribute comment: Organic matter is living plant tissue and decomposed or partially decomposed material from living plants and animals. Organic matter is important as a source of plant nutrients, and improves soil structure, maintains soil aggregation and minimizes erosion. These functions are all associated directly with agricultural productivity.

Agricultural practices must be managed to conserve soil organic matter. It is possible for grazing or other types of harvest to deplete organic soil matter faster than it can accumulate. When removal exceeds plant growth and decomposition, long-term soil productivity decreases. When soil organic matter is not conserved, soils may transform from a higher steady state of productivity to a lower steady state. Restoring higher levels of productivity are often difficult and expensive.

Indicator: Percent soil organic matter

Indicator Ratings:

> **Fair:** Decreasing soil organic matter
> **Good:** Stable soil organic matter
> **Very Good:** Increasing soil organic matter
> **Indicator ratings comment:** OSMP will use the first few years of monitoring this indicator to determine the range of variability across the system. When that information is available, ratings may be refined.
> **Confidence of these indicator rating descriptions:** High

Indicator Measurements:

> **Date:** 3/15/2008
> **Current Indicator Measurement:** Unknown
> **Current Rating:** Good

Current rating comment: OSMP has not yet sampled percent soil organic matter on a regular basis or according to a protocol that would allow staff to estimate trends.

Desired Rating: Good
Desired rating comment: Conserving soil organic matter is one means of maintaining the long-term sustainability of grasslands for agricultural and ecological values.

Other comments: Because different types of agricultural management affect soil organic matter differently, the effect of these practices can be compared by system-wide sampling that includes each of the three types of agricultural land use on OSMP:
- Annual Cropping Systems in Drylands
- Irrigated Pasture/Hayfield
- Grazing of native grasslands

Conservation Target: Agricultural Operations
Category: Condition
Key Attribute: Vegetation and Soil Conditions
Key attribute comment: The use of qualitative information (e.g., observations) to determine range and soil conditions has a long history of use in land management inventory and monitoring. Because it is qualitative this approach has limitations. It is suitable for use only by people knowledgeable and experienced in grassland management. Visual assessments can be an efficient way of conducting preliminary evaluations of soil/site stability, hydrologic function, and integrity of the biotic community and help identify areas that are potentially at risk of degradation. This indicator is intended to provide early warnings of potential problems and opportunities rather than to identify the cause of resource problems. This indicator is not intended to be the basis for making long-term or wide-ranging management decisions.

The rapid assessment methodology of Gerrish (2004) provides a subjective measure of grassland condition. Areas ratings are based upon ten critical pasture, grazing, and soil factors. A single evaluation provides a "snapshot" of condition. Repeated observations can help managers track the trend of an area and provide a leading indicator of responses to management changes. The evaluation criteria are:

- Desirability of Plant Population
- Plant Diversity
- Plant Density
- Plant Vigor
- Legumes in Stand
- Severity of Use
- Uniformity of Use
- Soil Resources
- Undesirable Canopy
- Plant Residue

This indicator is proposed as a provisional measure. OSMP recognizes that it relies heavily upon subjective judgment that it may not be easily repeatable, and that the methods require further documentation. The work of Pellant et al. (2000) describes an alternative method that is more fully documented and potentially less subjective.

Indicator: Percent of grazed areas in good condition according to an integrated measure of range quality

Indicator Ratings:
Poor: <40%
Fair: 40-60%
Good: 60-80%

Very Good: >80%
Indicator ratings comment: The ratings represent the direct relationship between sustainability of agricultural operations and a suite of related site conditions.
Confidence of these indicator rating descriptions: High

Indicator Measurements:
Current Indicator Measurement: Unknown
Current Rating: Good
Current rating comment: The methodology has not yet been applied across OSMP's agricultural lands.

Desired Rating: Good
Desired rating comment: It is OSMP's objective to have the majority of lands in agricultural use with "Good" or "Very Good" site stability.

Conservation Target: Agricultural Operations
Category: Size
Key Attribute: Agricultural Production
Key attribute comment: The extent of land in farms in Boulder County has decreased by 28% between 1992 and 2002. Current estimates indicate there are about 80,000 acres of agricultural land in the county (Environment Colorado 2006). One model used to generate estimates of agricultural land predicts that by 2020 there will be approximately 40,000 acres—equal to the extent of land currently (2008) managed for agriculture by Boulder's city (15,000 acres) and county (25,000 acres) open space programs. If current trends continue, OSMP lands will be an increasingly critical component of agriculture land in the county.

Much of the loss of agricultural land is caused by conversion of land to residential, commercial and industrial developments. Urbanization often results in a negative feedback loop. Conditions in an increasingly urbanizing landscape tend to increase land and water values, creating economic pressure on landowners to sell their farms. Urbanization also creates a wider range of employment opportunities and reduces the availability of farm/ranch labor. Sale of agricultural land results, in turn, in the loss of farms and farmers. As farming and ranching becomes less common, there are fewer farmers and ranchers in the local social network. This can reduce the amount of cooperation and assistance shared by agricultural producers adding additional stressors to agricultural operations. Agricultural producers face challenges from urban dwellers, who are often impatient or intolerant of the noise and smell associated with production practices. Impacts from activities of urban dwellers include trampling crops, leaving gates open, theft, vandalism and contamination of ditches.

These factors can interact with each other to create a downward spiral in a region's amount of agricultural land. There is the potential for this feedback loop to operate especially quickly once the amount of agricultural land in a region crosses a threshold. After this point, the rate of loss of farmland increases more quickly and agriculture soon disappears from the region. Where there is sufficient value or profit associated with a crop such as locally produced organic vegetables or ornamental flowers and plants, agriculture land uses may persist. These tend to be small operations in an urban context.

The effect of land and water values is locally diminished or eliminated when open space programs acquire land and water for conservation—including agricultural conservation. When there is strong community support for purposes of the open space program, there is pressure to retain rather than dispose of land and water in agricultural use. Farmers and ranchers still face issues of labor, commodity and service availability as well as the social factors that make farming in an urbanizing landscape more difficult.

OSMP currently leases approximately 15,000 acres for agricultural production. This acreage includes almost all irrigable lands, lands in dryland annual cropping systems, those lands that OSMP grazes prescriptively to achieve viability objectives and additional grazing of available forage.

OSMP's agricultural lands account for about 18% of the estimated 80,000 acres in agricultural use the county. Together the city and county account for about half the land used for agriculture in the county. While the current situation appears to be sustainable, it is likely that the amount of private lands in agricultural use will decline in the future. It is unknown whether existing open space agricultural lands alone could support a diverse and sustainable local agricultural economy. Increasing the amount of OSMP lands in agricultural use could further stabilize the agricultural economy while providing areas for experimentation and additional, localized prescriptive use.

Indicator: Acres in agricultural production

Indicator Ratings:

Poor: <8,000 acres
Fair: > 8,000 and <12,000 acres
Good: 12,000-16,000 acres
Very Good: >16,000 acres
Indicator ratings comment: OSMP staff began the development of indicator ratings examining the current situation. The "Poor"/"Fair" threshold was set to the extent of currently irrigated lands (approximately 5,500 acres) plus the acreage that would need to be grazed in association with prescribed burning (approximately 2,500 acres). (For the purposes of this indicator, staff assumed the desired fire return interval would be approximately 7 years. A fire return interval of 7 years would mean approximately 2,500 acres of the XTGP, MGPM, MBP and Wetland targets would be burned each year.) The department has acquired lands and water for irrigated agriculture as part of its long-term agricultural conservation strategy. OSMP leases these lands and waters to farmers and ranchers who provide the labor to irrigate. The cost of irrigation is borne by the lessee and is recouped when the crop is sold. OSMP lacks the capacity, and probably could not afford to hire staff, to run this irrigation water. If OSMP were to fail to use its water rights, the department could lose them. This would represent unacceptable financial and opportunity costs for OSMP's land and water management programs.

The "Fair"/"Good" threshold was set to include irrigated lands plus the acreage that would need to be grazed in association with prescribed burning, as described above, and those lands where livestock grazing or other agricultural management is needed to conserve the viability of other Grassland Plan targets. The "Very Good" rating includes the land included in the "Good" rating as well as additional lands where grazing could occur without adversely affecting OSMP's conservation goals. Placing additional land in agricultural use may be beneficial in the future to offset development of private agricultural land and to provide greater flexibility in the use of agriculture as prescriptive management tool.

Rating	Description	Acres
Poor	Less than Fair	<8,000
Fair	Irrigated lands plus minimum associated with prescribed burns	8-12.000
Good	Land in "Fair" plus lands grazed to conserve viability of other targets	12-16,000
Very Good	Land in "Good" plus other areas where grazing would not adversely affect conservation of other targets	>16,000

Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Date: 3/15/2008

Current Indicator Measurement: Currently there are approximately 15,000 acres of OSMP leased for agricultural production.
Current Rating: Good
Current rating comment: Inventory of OSMP lands
Confidence of the current rating: High

Desired Rating: Good
Desired rating comment: At this point staff feels that there is no compelling reason to change the amount of OSMP land in agricultural use. Without a county-wide definition of agricultural sustainability, staff cannot estimate how much OSMP land might be needed. Nor can staff predict the rate at which private lands are likely to be converted from agriculture to other uses.

It is likely that OSMP may add or remove some areas from agricultural use to implement the plan. The grassland plan establishes new ecological viability objectives. Several of these objectives are likely to be achieved through the application of agricultural management practices such as grazing and irrigation. It will take OSMP time to establish new understanding or confirm existing ideas about using agricultural practices most effectively to conserve grasslands. Some areas might be best managed by either temporarily or permanently removing agricultural uses. On the other hand, increasing the extent of leased areas may be needed to provide greater flexibility in when and where grazing is used as a management tool.

Conservation Target: Agricultural Operations
Category: Size
Key Attribute: Agricultural Production
Key attribute comment: Irrigable lands and associated water rights are a fundamental component of OSMP's agricultural operations. There are three principle types of agricultural land use on OSMP properties: livestock grazing, livestock forage production, and a small amount of dry land farming. Livestock forage production depends entirely upon the availability of irrigable land and irrigation water. Some agricultural operations are solely focused upon forage production. Others, mostly livestock producers, lease a combination of irrigated lands for forage production and unirrigated lands for grazing. Dry land farming takes place on about 300-600 acres of OSMP. Such farming does not require irrigable land or water rights.

OSMP's water rights and infrastructure of ditches and headgates were acquired and developed primarily to support agriculture in the Boulder Valley. They represent a significant investment of community resources. Irrigable land provides the highest per acre yields and under most market conditions, the greatest per-acre revenue. OSMP lacks the staffing resources to irrigate many or large areas. Leasing water and irrigable lands to local farmers and ranchers has been an effective way to maintain water rights and agricultural land values and provide a modest source of revenue for the OSMP department.

In addition to their value as productive agricultural lands, irrigated pastures and hayfields support a number of ecological values including habitat for rare plant and animal species. Natural conditions have been significantly altered, yet ecological functions persist in these "novel ecosystems".

Indicator: Irrigable land leased for agriculture

Indicator Ratings:
Poor: <60% of irrigable land
Fair: 60-80% of irrigable land
Good: 80-90% of irrigable land
Very Good: > 90% of irrigable land
Indicator ratings comment: The ratings represent the direct relationship between sustainability of agricultural operations and the proportion of irrigable land available to agricultural producers.

Indicator Measurements:

Date: 4/15/2008

Current Indicator Measurement: 0.85

Current Rating: Good

Current rating comment: The current rating was derived by using GIS to calculate which irrigable lands are included in an active lease.

Confidence of the current rating: High

Desired Rating: Good

Desired rating comment: The characteristics of irrigable lands vary across the OSMP system. Variables include soil quality, soil depth, infrastructure condition, season and amount of available irrigation water. OSMP staff has chosen to apply irrigation water in amounts and at times of year to maximize agricultural efficiency and production, and to enhance the associated ecological values of agricultural lands where appropriate. Consequently, water may not be available for some irrigable lands which then go unleased.

BLACK-TAILED PRAIRIE DOG AND ASSOCIATES

Conservation Target: Black-Tailed Prairie Dog and Associates
Category: Landscape Context
Key Attribute: Prairie Dog Distribution
Key attribute comment: In addition to being a native denizen of OSMP grasslands, prairie dogs create local habitats for a wide variety of species by virtue of their extensive burrowing and vegetation clipping. Because of their localized abundance, black-tailed prairie dogs are also important prey items for mid- and large-bodied grassland predators. OSMP seeks to maintain prairie dog complexes as part of the grassland ecosystem. The exact extent of prairie dog activity or the number of prairie dogs required for long-term sustainability is unknown. Although local populations have demonstrated resilience to population declines, at some level too few prairie dog colonies, or too few prairie dogs, could mean there are insufficient numbers to provide ecological function or survive a localized outbreak of disease or other cause of mortality. The effects of past land use and fragmentation in the Grassland Planning Area means that prairie dog habitat has been disturbed and that there are not unlimited opportunities for colony growth and prairie dog emigration. OSMP must also consider upper limits on the extent of prairie dog colonies to ensure conservation of other Grassland Plan targets (ESCO 2007).

OSMP staff believes that it is necessary to establish areas where prairie dog conservation is a management focus while minimizing conflict with other grassland plan targets. Ideally, these areas [Grassland Preserves, Multiple Objective Areas (MOA), and Prairie Dog Conservation Areas (PCA)] would include patches of prairie dog colonies within a matrix of uncolonized grassland habitat (Lomolino and Smith 2003). The areas would not be fully occupied. Long-term and complete occupation of Grassland Preserves, Multiple Objective Areas and Prairie Dog Conservation Areas by prairie dogs will provide fewer opportunities for colony expansion, results in decrease of native grass vigor and persistence, and confers less protection from stochastic events such as disease (plague) outbreaks (Cully and Williams 2001, Lomolino and Smith 2003, Collinge et al. 2005). OSMP seeks to have most of its prairie dog colonies in areas appropriate for prairie dog occupation and thus categorized as either Grassland Preserve, MOA or PCA.

Indicator: Percent of occupied land in Grassland Preserves, Multiple Objective Areas or Prairie Dog Conservation Areas

Indicator Ratings:
> **Poor:** <50%
> **Fair:** 50-70%
> **Good:** >70-85%
> **Very Good:** >85%
> **Confidence of these indicator rating descriptions:** Medium

Indicator Measurements:
> **Date:** 10/15/2007
> **Current Indicator Measurement:** 0.75
> **Current Rating:** Good
> **Current rating comment:** Current rating is based on the 2008 prairie dog mapping.
> **Confidence of the current rating:** High

Desired Rating: Good
Desired rating comment: OSMP staff wishes to preserve black-tailed prairie dogs, the ecosystem they help create, and the matrix habitat unoccupied by prairie dogs that allows for expansion and contraction of colonies within each habitat block designated as a Grassland Preserve, MOA, or PCA.

Other comments: OSMP staff wishes to preserve black-tailed prairie dogs, the ecosystem they help create and the matrix habitat unoccupied by prairie dogs that allows for expansion and contraction of colonies within each habitat block designated as a Grassland Preserve, MOA or PCA.

Conservation Target: Black-Tailed Prairie Dog and Associates
Category: Landscape Context
Key Attribute: Prairie Dog Occupancy
Key attribute comment: OSMP staff believes that it is necessary to establish areas where prairie dog conservation is a management focus. These grassland preserves should not necessarily always be fully occupied but rather prairie dogs should occupy a portion of those areas – patches of prairie dog colonies in a matrix of uncolonized grassland habitat (Lomolino and Smith 2003). Full (100%) occupation of prairie dog conservation areas would not create a sustainable metapopulation where colonies naturally expand, contract and die-out based on population growth, resource availability, predation and disease, and where inter-colony prairie dog dispersal maintains genetic diversity within the metapopulation (Roach et al. 2001, Stapp et al. 2004) . Furthermore, fully occupied conservation areas confer less protection from stochastic events such as disease (plague) outbreaks (Cully and Williams 2001, Lomolino and Smith 2003, Collinge et al. 2005). Large areas of grassland, completely occupied by prairie dogs, would limit OSMP's ability to conserve several other targets, which are incompatible with prairie dogs (ESCO 2007). Therefore, it will be important to manage for areas unaffected by prairie dogs as well.

Indicator: Grassland preserves with occupancy between 10 and 26%

Indicator Ratings:

> **Poor:** No grassland preserves within ARV
> **Fair:** At least one grassland preserve outside the ARV
> **Good:** All grassland preserves within the ARV
> **Indicator ratings comment:** Indicator ratings were determined using historic mapping of prairie dog colonies and the creation of "habitat blocks" or grassland preserves across the GPA. Grassland preserves are relatively large areas of OSMP land with continuous suitable and unsuitable habitat separated by barriers to prairie dog movement and colony expansion such as highways and major waterways (Johnson and Collinge 2004, Collinge et al. 2005).
>
> Occupancy of 10-26% in a grassland preserve, regardless of suitability, was determined to be the range of habitat block occupancy where there were large blocks of habitat for a large prairie dog metapopulation - and for other grassland targets that needed habitat unaffected by prairie dogs - to persist over the long term (Johnson 2002). We chose the desired range to reflect patches that had sufficient 1) space for colonies to expand, 2) distance between colonies and 3) areas of unoccupied habitat.
> **Confidence of these indicator rating descriptions: Medium**

Indicator Measurements:

> **Current Indicator Measurement:** Two of three grassland preserves outside of ARV
> **Current Rating:** Fair
> **Current rating comment:** Current indicator status was determined by evaluating 2008 colony extents of prairie dogs in each habitat block and calculating percentage occupancy in each habitat block. Large shifts in prairie dog populations during and following plague epizootics are likely to make this indicator dynamic over time, sometimes requiring frequent re-assessment as conditions change.
> **Confidence of the current rating:** High

Desired Rating: Good

Other comments: It may be difficult to manage some areas for intermediate levels of prairie dog occupancy.

Conservation Target: Black-Tailed Prairie Dog and Associates
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: The conservation objectives for this target include, but are not limited to black-tailed prairie dogs. OSMP also seeks to conserve two groups of animals that rely upon black-tailed prairie dogs and the conditions they create--commensals and predators. While prairie dogs colonies without these species contribute to the Grassland Plan's conservation objectives, OSMP staff considers the presence of commensals and predators an indication of greater ecological function.

The black-tailed prairie dog commensal species identified for this plan are:

Burrowing owl*
Deer mice
Tiger salamander
Cottontail rabbit
13-lined ground squirrel
Prairie tiger beetle*
Horned lark

*Sensitive commensal

These species are grassland obligates, benefit from the presence of prairie dogs and are not known to affect prairie dogs adversely. They are found more commonly on prairie dog colonies than on grasslands unaffected by prairie dogs (Koford 1958, Agnew et al. 1986, Haug et al. 1993, Desmond and Savidge 1996, Goodrich and Buskirk 1998, Kotliar et al. 1999, Kretzer and Cully 2001, Smith and Lomolino 2004).

Burrowing owls have experienced large global population declines. DeSante and George (1994) estimate population declines over fifty percent in British Columbia, Alberta, California, Nevada, Colorado and New Mexico. Populations have not been increasing in western states or provinces (James and Espie 1997). The species is listed as a state threatened species in Colorado. Populations have been undergoing non-cyclical declines over the past several decades in Boulder County, and the species is listed as a species of special concern in the Boulder County Comprehensive Plan. The Boulder Valley Comprehensive Plan identifies burrowing owls as a species of local concern. OSMP has identified burrowing owls as a species of concern.

Unoccupied prairie dog burrows are used as nests and refugia for breeding burrowing owls. The presence of burrowing owls is an indication of sufficient prey availability (Desmond et al. 2000). Burrowing owls are known to feed on smaller rodents and insects associated with prairie dog colonies (Haug et al. 1993). The presence of burrowing owls is an indication of an active trophic system reliant upon environmental conditions created by prairie dogs. Breeding success (≥1 fledgling per nesting attempt) by burrowing owls is evidence of not only the availability of nesting opportunities but also of habitat that can sustain the reproduction of this sensitive commensal species (Plumpton 1992, Haug et al. 1993).

OSMP staff believe habitat that supports nesting burrowing owls provides a higher level of ecological function than prairie dog colonies where burrowing owls are absent. Burrowing owl nesting success is a direct measure of site quality and function because breeding is the most energetically expensive time in the burrowing owl's life cycle. A successful nesting attempt on a prairie dog colony on OSMP requires sufficient prey, nest site availability and relatively low levels of human disturbance. These habitat characteristics can not be inferred by the presence of individuals during the breeding season because those owls may be passing through rather than nesting. Furthermore, successful nesting locations may indicate long-term commitment by burrowing owls to an area. Burrowing owls are short-distant migrants and they tend to re-use nest sites where brood rearing was successful in the past (Haug et al. 1993).

Indicator: Number of prairie dog colonies with successful nesting attempts by burrowing owls

Indicator Ratings:

Poor: 0 prairie dog colonies surveyed have successful burrowing owl nesting attempts.
Fair: 1-2 prairie dog colonies surveyed have successful burrowing owl nesting attempts.
Good: 3-4 prairie dog colonies surveyed have successful burrowing owl nesting attempts.
Very Good: >4 prairie dog colonies surveyed have successful burrowing owl nesting attempts.
Indicator ratings comment: Burrowing owl presence or nesting success has not been systematically monitored on OSMP prairie dog colonies. Successful nesting occurred on OSMP lands during the 2008 breeding season. Staff combined knowledge from incidental sightings with habitat quality assessment to set indicator ratings for breeding burrowing owls.
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:

Date: 7/15/2008
Current Indicator Measurement: 4
Current Rating: Good
Current rating comment: Prior to 2008, burrowing owl presence was not systematically monitored. Recent observations have been largely anecdotal with no established protocol. With the release of an updated burrowing owl survey protocol by Colorado Division of Wildlife (2008) and recent publications confirming the efficacy of this protocol, staff began to conduct burrowing owl surveys in summer 2008.
Confidence of the current rating: Medium

Desired Rating: Good
Desired rating comment: The conservation objective for this indicator is to have at least three nesting pairs annually. That level of productivity has not been documented on OSMP lands in the past. However, our surveying efforts have been limited. The desired rating is based upon the availability of large areas of apparently suitable burrowing owl habitat.

Conservation Target: Black-Tailed Prairie Dog and Associates
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: The conservation objectives for this target include, but are not limited to black-tailed prairie dogs. OSMP also seeks to conserve two groups of animals related to black-tailed prairie dogs, commensals and predators. Prairie dogs colonies without these species contribute to the Grassland Plan's conservation objectives but OSMP considers the presence of these species to be an indication of greater ecological function.

The black-tailed prairie dog commensal species identified for this plan are:

Burrowing owl*
Deer mice
Tiger salamander
Cottontail rabbit
13-lined ground squirrel
Prairie tiger beetle*
Horned lark

*Sensitive commensal

These species are grassland obligates which benefit from the presence of prairie dogs and are not known to affect prairie dogs adversely. They are found more commonly on prairie dog colonies than on grasslands unaffected by prairie dogs (Koford 1958, Agnew et al. 1986, Haug et al. 1993, Desmond and Savidge 1996, Goodrich and Buskirk 1998, Kotliar et al. 1999, Kretzer and Cully 2001, Smith and Lomolino 2004).

Breeding horned larks prefer short, sparsely vegetated areas—a situation commonly associated with occupied or recently abandoned prairie dog towns. The presence of horned larks is an indication of appropriate habitat conditions including prey availability. Horned larks are known to feed upon seeds and ground insects. The presence of horned larks is an indication of an active trophic system reliant upon environmental conditions created and maintained by prairie dogs. As a result, OSMP believes that habitat that supports horned larks provides a higher level of ecological function than prairie dog colonies where horned larks are absent.

Indicator: Percent of colonies with territorial horned larks

Indicator Ratings:

Poor: <25%
Fair: 25-50%
Good: >50-75%
Very Good: >75%
Indicator ratings comment: Territorial and nesting behaviors indicate that the individual has selected the habitat as appropriate, and potentially of sufficient quality to attract a mate (Krebs and Davies 1993). They are also direct measures of breeding attempts. Simple observation of horned larks is less useful because they may merely reflect the presence of migrant individuals.

We used average horned larks nesting territory size (~1.5 ha) from Dinkins et al. (2003) to determine how many prairie dog towns would qualify as potential breeding sites. Staff estimated the "Good"/"Fair" threshold at 50% using this information and observations from recent surveying efforts. Staff then used best professional judgment to assign other ratings. OSMP sought to acknowledge the importance of having populations of horned larks distributed throughout across the land system. It is understood by staff that some prairie dog colonies may carry more than a single pair of horned larks. Others, because of local conditions or size, may support none.

This indicator is proposed to be an average of values collected over a three year period. This approach will reduce the influence of annual variation of abundance and distribution due to detection probability and ecological factors.
Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Current Indicator Measurement: Unknown
Current rating comment: OSMP lacks data to provide a current rating or estimate. Since this indicator is based upon a three-year average, data from the first and second year of surveys will be used as interim measure to estimate condition and guide management.
Confidence of the current rating: Medium

Desired Rating: Good
Desired rating comment: The desired rating is based upon the objective of having a majority of prairie dog colonies support the commensal horned larks. This objective is provisional, and may be changed based upon measured values.

Conservation Target: Black-Tailed Prairie Dog and Associates

Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: This key attribute acknowledges the strong relationship between predators and an ecologically functioning prairie dog colony. Although it is unlikely that the current suite of predators will exert a limiting effect on prairie dog numbers, predators play an integral role in the functioning of a healthy prairie dog complex (Kotliar et al. 1999). The presence of predators, especially sensitive predators dependent upon prairie dogs, reflects a greater level of ecosystem integrity and complexity of a prairie dog colony when compared to colonies lacking predators (Desmond and Savidge 1996, Goodrich and Buskirk 1998, Kotliar et al. 1999).

Ecosystem integrity is often dependent on top-down regulation by predators. Top-down means that species occupying the highest trophic level (predators) exert a controlling influence on species lower down the trophic ladder (or food chain) (Terborgh et al. 1999). Ecologists studying the loss of predators have found them to be important regulators of prey species numbers (see summary in Miller et al. 2001). The elimination or reduction of predators can result in changes to plant species composition, due to relatively uncontrolled numbers of the herbivores that feed upon seeds and seedlings. The widespread prairie dog colonies in the Grassland Planning Area may be due in part to the absence of an effective predator such as the black-footed ferret.

The black-tailed prairie dog predator species identified for the Grassland Plan are:
Generalists
Bullsnake
Coyote
Fox (red or gray)
Rattlesnake
Red-tailed hawk

Sensitive
Badger
Bald eagle
Ferruginous hawk
Golden eagle
Rough-legged hawk
Northern harrier

Indicator: Predator community composition/abundance

Indicator Ratings:

> **Poor:** No predators present
> **Fair:** At least one generalist predator detected at 50% of colonies
> **Good:** At least one generalist predator species detected at 50% of the colonies AND one sensitive predator species detected at 25% of colonies
> **Very Good:** At least one generalist predator species present at 50% of colonies AND at least one sensitive predator species present on 25% of colonies AND breeding by either badger, ferruginous hawk or northern harrier on OSMP system
> **Indicator ratings comment:** Generalist predators are ubiquitous and commonly recorded on OSMP prairie dog colonies. OSMP's conservation objective ("Very Good") requires that a portion (≥25%) of current colonies attract a sensitive predator. This threshold (25%) was deemed appropriate given the life history of the listed sensitive species and the variation in size and landscape context of OSMP prairie dog colonies. "Very Good" meets all qualifications of "Good" and requires documentation of a breeding attempt by a sensitive predator on or near a prairie dog colony. "Very good" may be difficult to achieve due to fragmentation and disturbance of habitat. However, OSMP's objective is to manage for habitat capable of supporting breeding by

sensitive predators. The presence of adjacent large grasslands managed by other agencies may contribute to the ability of local systems to support breeding populations of these predators.

Monitoring design will consider habitat quality, colony size and surrounding land use since most predators, especially sensitive species, require larger, relatively undisturbed tracts of land for foraging/hunting. Surveying will be performed during the summer to coincide with breeding for predator species. However, some surveys might be performed later than that to assess colony use by species that usually only winter in the Boulder Valley.
Confidence of these indicator rating descriptions: Medium

Indicator Measurements:
Date: 10/15/2007
Current Rating: Fair
Current rating comment: Incidental observation data collected during 2007 prairie dog mapping; no documented nest sites in 2007.
Confidence of the current rating: Low

Desired Rating: Very Good
Desired rating comment: OSMP considers the sustainability of the predator community (including sensitive predators) to be a strong measure of conservation success.

Other comments: These indicator ratings are based on a three-year average to account for variability in prairie dog abundance due to plague events and natural life cycles, and annual variations in predator populations and ranges.

Some of these species occur semi-regularly on OSMP prairie dog colonies in winter (ferruginous hawk, northern harrier, bald eagle, rough-legged hawk) but far less often in during the breeding season. Monitoring will be designed to distinguish over-wintering from breeding individuals.

Conservation Target: Black-Tailed Prairie Dog and Associates
Category: Size
Key Attribute: Extent of Active Prairie Dog Colonies in GPA
Key attribute comment: OSMP staff identified active prairie dog colonies as a size-based attribute to track the viability of this target. The indicator for this attribute is the number of acres of active prairie dog colonies in the Grassland Planning Area. OSMP maps the extent of active colonies annually. Due to resource and time constraints, the department does not count or estimate the numbers or density of individual animals or burrows as part of the annual mapping project. OSMP has conducted mapping of active prairie dog colonies since 1996.

The extent of prairie dogs in the GPA has fluctuated due to natural population growth, relocation, predation, disease—including plague and other sources of mortality. Although the extent of active prairie dogs colonies has declined precipitously in the GPA during periodic plague outbreaks, populations have repeatedly recovered due to a small number of survivors re-establishing colonies or migration of animals from surrounding unaffected colonies. OSMP has also relocated prairie dogs from outside the GPA into areas vacated by plague.

Prairie dogs can survive in small isolated patches in the GPA. However, while these small colonies perpetuate the species, they do not represent the optimal situation for conserving associated species. Larger prairie dog colonies in the context of intact grasslands are better able to support associated species. Larger colonies are, in general, more likely to persist over time, in part, because they support more individuals. Ideally, OSMP would be able to protect a large contiguous (5,000 acre) prairie dog complex rather than many smaller areas. However a preserve system that includes many, separate colonies may reduce the likelihood of local extirpation by plague, and allows recolonization from unaffected individuals or nearby colonies. The threat of plague aside, the landscape context resulting from urban and agricultural land uses in the Boulder Valley provides few if any opportunities for the "single large" prairie dog complex. In fact, such complexes are ecoregionally uncommon (Grunau et al. 2006).

Through an examination of habitat suitability and landscape context, OSMP identified three relatively large complexes as the best opportunities to conserve this target and a number of smaller areas to ensure the on-going existence of the target in the Boulder Valley. The large complexes (Grassland Preserves and associated Multiple Opportunity Areas) comprise approximately 8,450 acres. These areas however are sufficiently far from one another and separated by enough unsuitable habitat (urban Boulder, four lane highways, etc.) that they cannot be considered to function as one preserve. The three areas are approximately 4,000, 3,500 and 700 acres in size. In addition six smaller and isolated colonies, or Prairie Dog Conservation Areas, were identified as places where prairie dogs with or without associated species would be conserved.

Rather than manage for a specific acreage of prairie dogs based upon a population viability model, OSMP derived a range of acceptability for acreage based upon what could actually be provided on the landscape. Since the large Grassland Preserves are meant to be sustainable for long-term occupation, OSMP developed an occupancy range from 10 to 26%. Populations above 26% were considered to be too high based upon habitat availability, and the desire to have a matrix of habitats near prairie dog colonies. Populations below 10% were considered too low because there would be less habitat (disturbance, prey) for the associated species.

Data collected over the past decade suggests that prairie dog populations will be able to rebound from plague outbreaks, and that the range of acceptable variation falls well within population levels from which the local prairie dog population has recovered in the past. OSMP mapped fewer than 200 acres of active prairie dogs after a plague epizootic in the early 1990's. In 2005, there were 3,500 acres of active colonies. Some of that increase was due to new land acquisitions; however, most of it resulted from natural recolonization or human-mediated relocation. The frequency of plague infection is highly variable and unpredictable. During the inter-epizootic intervals, colonies tend to increase in extent. However, it is possible that plague epizootics will operate differently in the future or conditions affecting the availability of animals for recolonization will shift. In this situation, viability standards, and strategies for maintaining this target, will be re-examined.

Indicator: Acres of active prairie dog colonies

Indicator Ratings:

> **Fair:** >3,137 acres or <800 acres
> **Good:** 800-3,137 acres
> **Indicator ratings comment:** OSMP staff has developed a land designation system for prairie dogs that places OSMP lands that had been occupied by prairie dogs at any time from 1996-2008 into one of five management classifications. The management classifications are criteria-based, so that as new areas are occupied by prairie dogs, they can be appropriately designated. The designations are Grassland Preserves, Multiple Objective Areas, Prairie Dog Conservation Areas, Transition Areas and Removal Areas. The conservation of this target is the focus in Grassland Preserves and Multiple Objective Areas. The conservation of prairie dogs, with or without associates, is the focus of the PCAs.
>
> Full occupancy by prairie dogs in Grassland Preserves would not provide opportunities for colony expansion or vegetation recovery. In order to address concerns over the long-term sustainability of the Grassland Preserves, OSMP has established an acceptable range of variability for prairie dog occupancy from 10 to 26%.

The minimum acceptable occupancy for prairie dogs was defined as ten percent of the Grassland Preserves or 804 acres. The maximum acceptable occupancy in the planning area was defined as the sum of:

- 2,100 acres = 26% of the acreage of Grassland Preserves
- 498 acres = the acreage of Multiple Objective Areas
- 539 acres = the acreage of Prairie Dog Conservation Areas

3,137 acres

In addition to occupancy standards, OSMP followed the model of Grunau et al. (2006) to establish vegetative condition standards to characterize acceptable conditions in prairie dog colonies. Conditions within Grassland Preserves may fall below the threshold that permits relocation. In these cases, OSMP staff will need to determine if it is possible to relocate to PCAs in order to maintain this indicator within the range of acceptable variation.

Indicator Measurements:

Current Indicator Measurement: 1733
Current Rating: Good
Current rating comment: The current rating is based upon 2008 OSMP prairie dog mapping. Plague is known to be active in the GPA, and it is likely 2009 numbers will be lower.

Desired Rating: Good
Desired rating comment: See "Key attribute and indicator", and "Indicator rating" comments above.

WETLANDS

Conservation Target: Wetlands
Category: Landscape Context
Key Attribute: Connectivity
Key attribute comment: This indicator is used for both the Wetlands and Riparian Areas targets.

Vegetated buffers are of established benefit to wetlands and creeks because they provide the following functions: water quality enhancement via the removal of pollutants such as sediment, nutrients, and pathogens prior to reaching the creek or wetland; hydroperiod regulation and hydrologic cycle continuity; streambank stabilization; wildlife habitat enhancement; microclimate regulation; physical barriers to light and noise; and habitat connectivity (Sheldon et al. 2005, City of Boulder P&DS and Biohabitats 2007).

The greater the vegetated buffer, the less likely a wetland will be degraded and the more likely the wetland will be able to provide a wide range of ecological functions to a high degree for a long time (aquatic habitat for plants and animals, sediment trapping and nutrient removal functions).

Indicator: Buffer width (vegetated area within 100 m of the wetland)

Indicator Ratings:

Poor: < 75% of wetlands have a mean buffer width > 1 m
Fair: At least 75% of wetlands have a mean buffer width > 1 m
Good: At least 75% of wetlands have a mean buffer width > 50 m
Very Good: At least 75% of wetlands have a mean width > 100 m
Indicator ratings comment: OSMP staff began with the ratings Rocchio suggests in his work on Colorado freshwater marshes and riparian areas (Rocchio 2006a, Rocchio 2006b). We modified the "Fair" and "Poor" categories slightly so that if we achieved a "Poor" rating it would reflect a situation where the target is both not effectively conserved AND it would be hard to bring back to "Fair".

As a check on the indicator ratings, OSMP staff used the synthesis of Sheldon et al. (2005) on buffer widths needed to provide many of the ecological functions listed above. Their summary of the literature indicates a buffer width of 5-20 m is needed to remove coarse particle pollutants; a buffer width of 20-100 m is needed to remove fine particle pollutants; and buffer width of 5-40 m is needed to remove dissolved pollutants. With respect to protecting wildlife habitat, recommended buffer width is even more variable, but many of the studies listed by the authors fall in the 30-100 m range. Their final summary recommendation is for a buffer width of: 8-23 m for wetlands with minimal habitat functions and low-intensity land uses adjacent to the wetland, 15-46 m for wetlands with moderate habitat functions and moderate or high-intensity land uses adjacent to the wetland and 46-92 m for wetlands with high habitat functions, regardless of the intensity of the land uses adjacent to the wetland.

Because many OSMP wetlands have high habitat functions or have high habitat function as the management goal, the 46-92 m buffer length is most appropriate for OSMP creeks and wetlands. This buffer range most closely fits the 50-100 m category. Thus, OSMP's management goal is that most (i.e. at least 75%) wetlands and creeks have at least a 50 m buffer.
Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Date: 2/15/2008
Current Indicator Measurement: 75% of the wetlands have a buffer width of 20 m or more
Current Rating: Fair

Current rating comment: OSMP does not currently collect field measurements of wetland buffer widths. We used the estimated mean buffer width for creeks as an approximation for wetland buffer widths on OSMP. This reduces the level of confidence in our estimate of current condition.

Ideally, average buffer width is estimated in the field. At a given wetland, an investigator would visually estimate the buffer width of the wetland in each of the four cardinal directions. Then the four estimates would be averaged to obtain mean buffer width.

However, the analysis for current condition was not conducted in the field. Instead, OSMP staff used Hawth Tools in GIS to place 100 points randomly along the creeks, intermittent creeks and ditches (as defined by the USGS GIS hydrology layer) within OSMP boundaries. Twelve of the 100 points fell outside the Grassland Planning Area and were eliminated from the analysis. At each of the remaining points, we examined aerial photography with trails (designated and undesignated), roads and prairie dog layers overlain on the aerial photography to estimate average buffer width surrounding the water body (creek, intermittent creek, ditch). Using the measurement tool in GIS, we measured the extent of the buffer. We defined buffers as the vegetated area surrounding the creek. Vegetation does not have to be native vegetation to perform some of the ecological services that buffers provide such as pollutant removal; however, the vegetation should not be mowed. In particular mowed turf grass associated with development does not provide the same functions as non-mowed grass. Trails, roads, development, row cropped agriculture and prairie dog colonies (since prairie dogs tend to remove a significant portion of ground cover) are not well vegetated, thus cannot perform pollutant removal and many habitat functions that well vegetated buffers provide. These land uses were considered limits to the buffer widths.

Buffer distances were measured perpendicular to the water body on both sides of the water body, resulting in two buffer width measurements for each sampling point. When buffer width exceeded 100 m, we stopped measurement and recorded 100 m as the width of the buffer. The two buffer width measurements for each sampling point were averaged resulting in a mean buffer width for the sampling point.

We calculated the 25th percentile for the resulting data set of 88 mean buffer widths to determine the status of the indicator. With our data set, the 25th percentile was 20 m, placing our status as "Fair". Only 10% of the sampling points had a mean buffer width of <1 m. The median for our data set was 61 m. 27% of the sampling points had a mean buffer width > 100 m.
Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Wetlands

Category: Landscape Context
Key Attribute: Connectivity
Key attribute comment: This indicator is used for both the Wetlands and Riparian Areas targets.

This key attribute is a common element of conservation ecology and is felt to be broadly applicable to a wide range of animal species (Haig et al. 1998, Lindenmayer et al. 2008). The indicator is a direct measure of proximity of like habitat blocks. While proximity is not the only measure of connectivity, it is fundamental and relatively easy to measure. Barriers between habitat patches are addressed by other key attribute indicators.

The existing OSMP vegetation map, along with topographical relief layers and aerial photography from 2006 were used to create the wetland/riparian complexes for this key attribute. OSMP wetlands and riparian corridors often consist of two or more mapped vegetation types. Adjacent riparian and/or wetland vegetation map units were merged together by dissolving common boundaries in GIS to create initial wetland/riparian "clumps". These clumps were examined in conjunction with aerial photography and topographical information to determine if one or more clumps should be combined and considered a single wetland/riparian complex. A complex is a contiguous, functioning wetland/riparian unit that could consist of multiple vegetation-mapping units. Typically, upland vegetation, development and/or topography defined the edges of the complex. OSMP staff identified 414 wetland/riparian complexes in the Grassland Planning Area using this method.

Only riparian areas associated with creeks and ditches were included in the analysis because intermittent creeks and ditch laterals may be incapable of supporting populations of native frogs.

Indicator: Distance to nearest wetland or riparian area

Indicator Ratings:

Poor: > 75% of wetland/riparian complexes are < 1,000 m from the nearest wetland/riparian complexes
Fair: At least 75% of wetland/riparian complexes are < 1,000 m from the nearest wetland/riparian complexes
Good: At least 75% of wetland/riparian complexes are < 200 m from the nearest wetland/riparian complexes
Very Good: At least 75% of wetland/riparian complexes are < 200 m from the nearest wetland/riparian complexes
Indicator ratings comment: The indicator ratings were based upon recommendations for habitat protection of northern leopard frogs (Smith and Keinath 2007). Their work synthesized a large number of works on the ecology and natural history of amphibians (see literature cited in Smith and Keinath 2007).
Confidence of these Indicator rating descriptions: High

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: At least 75% of wetland/riparian complexes are < 142 m from the nearest wetland/riparian complexes
Current Rating: Good
Current rating comment: OSMP staff conducted a GIS analyses to determine the nearest distance between wetland and riparian complexes and summarized the results in SYSTAT. The table below shows the distribution of distances to nearest wetland/riparian complex. Over 80% of the wetland/riparian complexes lie within 200 m of another wetland/riparian complex, making OSMP's current rating "Good"/"Very Good".

	DISTANCE in meters
N of cases	414
Minimum	1.909
Maximum	2760.574
Mean	121.569
Standard Dev	216.332
1 %	2.476
5 %	4.195
10 %	6.513
20 %	13.060
25 %	16.252
30 %	20.623
40 %	30.472
50 %	51.772
60 %	84.154

70 %	120.115
75 %	142.286
80 %	170.433
90 %	299.883
95 %	452.877
99 %	882.612

Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Wetlands
Category: Landscape Context
Key Attribute: Connectivity
Key attribute comment: Trails and roads around wetlands and riparian areas create barriers for amphibian and small mammal dispersal, introduce disturbances such as human and dog recreation and serve as conduits for predators and pathogens (Smith and Keinath 2007). Consequently, OSMP seeks to maintain a low density of trails/roads around known leopard frog breeding areas to reduce mortality and impediments to dispersal of northern leopard frogs.

Indicator: Undesignated trail density in northern leopard frog habitat blocks

Indicator Ratings:
Fair: All northern leopard frog habitat blocks with undesignated trail density greater than 10 m/ha.
Good: All northern leopard frog habitat blocks with undesignated trail density less than 10 m/ha.
Very Good: All northern leopard frog habitat blocks have no undesignated trails.
Indicator ratings comment: The existing OSMP vegetation map, along with topographical relief layers and 2006 aerial photography, was used to create the wetland/riparian complexes for this indicator. OSMP wetlands and riparian corridors often consist of two or more mapped vegetation types. Riparian and wetland vegetation map units adjacent to each other were merged by dissolving common boundaries, creating initial wetland/riparian "clumps". These clumps were examined in conjunction with aerial photography and topographical information to determine which clumps should be combined and considered a single wetland/riparian complex. A complex is defined as a contiguous, functioning wetland/riparian unit consisting of one or more vegetation mapping units. Typically, upland vegetation, developed areas or topography defined the edges of the complex. OSMP staff identified 414 wetland/riparian complexes in the Grassland Planning Area using this method.

OSMP staff conducted a GIS analysis to identify wetland/riparian complexes and then selected those for which there were records of northern leopard frogs from surveys conducted in 1996, 2006, 2007 and 2008. OSMP then created a 200-m buffer around these complexes. In order to ensure that the complexes did not include non-habitat, roads, parking lots, tilled fields and other lands unlikely to be used by northern leopard frogs were removed from consideration. The resulting areas were termed "northern leopard frog habitat blocks".

OSMP staff calculated the undesignated trail density within the northern leopard frog habitat blocks using GIS. Although the scientific literature notes that trails and roads around wetlands and riparian areas are problematic as they create barriers for amphibian and small mammal dispersal, introduce disturbances such as dog and human use likely to disrupt avian breeding success, and serve as conduits for predators and pathogens, we could not find any literature suggesting density thresholds. Smith and Keinath (2007) indicate this type of information is lacking for amphibians in general. OSMP staff has not located studies examining these thresholds for mammals and birds.

In the absence of scientific literature, OSMP staff set "Very Good" to a density of zero meters of undesignated trails within the northern leopard frog habitat block. This would represent a situation free from barriers to dispersal and recreational disturbance and minimize predator conduits due to undesignated trails. This was also considered as an appropriate rating for "Good" because the contributions of adverse effects from designated trails and roads (average value in northern leopard frog habitat blocks is 43.6 m/ha). However, staff recognized that it would be more realistic to set the threshold at a higher level and to address staff's capacity to close undesignated trails. Staff set the "Fair"/"Good" threshold at 10 m/ha. This rating was established approximately midway between the zero and the measured mean value of undesignated trail density in northern leopard frog habitat blocks (22 m/ha).

Indicator Measurements:

Date: 2/15/2008
Current Indicator Measurement: All northern leopard frog habitat blocks have an undesignated trail density of less than 101 m/ha
Current Rating: Fair
Trend: Unknown
Source: Rapid Assessment
Current rating comment: While protection of NLF habitat blocks will be one consideration for the placement of trails, the decision on how best to balance access and resource protection will ultimately be made during TSA planning. Consequently, the density of designated trails in a given area will be determined by TSA plans rather than the Grassland Plan. What undesignated trails remain after TSA planning will be slated for removal.

Desired Rating: Good
Desired rating comment: It is unlikely that OSMP will be able to remove or successfully close/reclaim all the undesignated trails in the buffers of northern leopard frog habitat blocks over the ten-year planning horizon.

Conservation Target: Wetlands
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: One of the important biodiversity support functions of wetlands and riparian areas is amphibian breeding habitat. A number of sites were selected from those wetlands considered suitable habitat for frogs. These sites were sampled during the summer of 2007. Of these, some had only native frogs; some had both native and non-native frogs; some had only non-native frogs; and some had no frogs (McKibben 2008).

Indicator: Native frog presence in suitable habitat

Indicator Ratings:

Poor: 0-25% of sites with native frogs alone
Fair: >25%-50% of sites with native frogs alone
Good: >50%-99% of sites with native frogs alone
Very Good: All sites with only native frogs
Indicator ratings comment: The threshold of acceptability was set so that the majority (>50%) of suitable sites would suport native frogs in the absence of non-native frogs. The other thresholds were set 25% above and below the separation of "Fair" and "Good". No known external sources of information were available to better inform these thresholds. Given current conditions and understanding of the available tools for effective management, establishing "Good" conditions during the 10-year Grassland Plan horizon seems like a reasonable, perhaps ambitious objective.
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:

Current Indicator Measurement: 0.18

Current Rating: Poor

Current rating comment: The current rating was derived from data collected by OSMP staff in the field during the summer of 2007 (McKibben 2008).

Confidence of the current rating: Low

Desired Rating: Good

Conservation Target: Wetlands

Category: Condition

Key Attribute: Vegetation Composition

Key attribute comment: Ute ladies-tresses (*Spiranthes diluvialis*) is a long-lived perennial that reproduces strictly by seed. The flowers are pollinated by bumblebees (Sipes and Tepedino 1995). Ute ladies-tresses is a wetland plant designated as threatened under the Endangered Species Act (USFWS 1992). In Colorado, the orchid is restricted to low-elevation valleys in wetlands and irrigated fields. Within these sites, it is found only in specialized conditions of soil and hydrology.

Ute ladie s-tresses orchid was selected as an indicator of condition because it is a rare plant species associated with the mosaic formed by mesic bluestem prairies and wetlands. The orchids on OSMP lands are among the largest sub-populations in the range of the species and are important to the conservation of this species. The orchids are often coincident with other uncommon forbs such as purple gerardia (*Agalinus tenuifolia*) and great lobelia (*Lobelia siphilitica*).

The Ute ladies-tresses orchid's natural history presents challenges to monitoring. Several of its life stages are difficult to detect. In any given year, mature plants may be in two non-flowering states, either vegetative or dormant (persisting only belowground) (Lesica and Steele 1994). In addition, if this species behaves as another member of the genus there may be immature vegetative states lasting as long as nine years. Though individual plants can be identified in localized searches, the orchid can only be reliably located over larger areas when in flower. Time-intensive demographic studies have been undertaken on OSMP and elsewhere to determine the viability of local sub-populations (Arft 1995, Riedel et al. 1995, Heidel 2001). Based upon the findings of these studies, OSMP has concluded that compatible agricultural management practices (irrigation, winter grazing and properly timed and distributed hay cutting) are important factors related to the long-term viability of the large populations of the Ute ladies-tresses orchid in irrigated fields.

The areas to be surveyed for this indicator are:
1) The Van Vleet property meadows north of US 36 in the South Boulder Creek floodplain (field numbers X and Y);
2) The Van Vleet property meadows south of US 36 in the South Boulder Creek floodplain (field numbers A and B); and
3) The Yunker property (field number Z) east of Cherryvale Road and south of US 36.

Indicator: Management of Ute ladie s-tresses orchid habitat

Indicator Ratings:

Poor: Prolonged (> 5 years) or permanent change in management practices (i.e. loss/reduction of irrigation water, lack of grazing, etc.) on more than one of the three main blocks of *Spiranthes*

Fair: Prolonged (> 5 years) or permanent change in management practices (i.e. loss/reduction of irrigation water, lack of grazing, etc.) on one of the three main blocks of *Spiranthes*

Good: Maintain 2008 agricultural and irrigation practices on the three main blocks of *Spiranthes*

Very Good: Maintain 2008 agricultural and irrigation practices on the three main blocks of *Spiranthes*
Indicator ratings comment: Agricultural practices have created conditions suitable for the establishment, growth and reproduction of the Ute ladies-tresses orchid. Over almost two decades of management, OSMP staff and lessees have come to understand how irrigation and hay cutting practices as well as the timing and stocking rates of grazing can be manipulated to sustain orchid populations. In the absence of new threats, these, or other compatible, practices should support viability of the large sub-populations of the orchid found on OSMP lands.
Confidence of these indicator rating descriptions: Medium

Indicator Measurements:
Current Indicator Measurement: Practices maintained
Current Rating: Good

Desired Rating: Good

Conservation Target: Wetlands

Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: Native relative cover serves as an indicator of the quality of vegetation occurring in a sample. However, taken alone, relative cover does not provide a full picture of community composition because it refers only to that portion of the sample that is vegetated. Native relative cover is proposed as one of several indicators of vegetative composition.

Indicator: Native species relative cover

Indicator Ratings:
Poor: < 75% of samples have NRC ≥ 33%
Fair: At least 75% of samples NRC ≥ 33%
Good: At least 75% of samples NRC ≥ 67%
Very Good: At least 75% of samples NRC ≥ 95%
Indicator ratings comment: Indicator ratings were developed using OSMP staff's best professional judgment.

Indicator Measurements:
Date: 4/15/2008
Current Indicator Measurement: 75% of samples NRC ≥ 46%
Current Rating: Fair
Current rating comment: OSMP staff analyzed 138 wetland plots. Data from these plots were collected as part of the vegetation mapping effort in 2002 and 2004. The following table summarizes this analysis. Most (75%) of the wetland plots had a native species relative cover of at least 46%. Approximately 10% of the wetlands contained only native species and very few wetland plots contained only non-native species.

	REL_NAT	BARE	LITTER
N of cases	138	138	138
Minimum	0.000	0.000	0.000
Maximum	100.000	62.000	85.000
Median	76.773	0.000	1.500
Mean	67.234	2.964	8.703
Standard Dev	28.490	9.719	16.045
1 %	0.000	0.000	0.000
5 %	14.251	0.000	0.000

10 %	20.386	0.000	0.000
20 %	39.201	0.000	0.000
25 %	46.154	0.000	0.000
30 %	52.239	0.000	0.000
40 %	63.174	0.000	0.000
50 %	76.773	0.000	1.500
60 %	83.039	0.000	3.000
70 %	89.357	0.000	15.000
75 %	91.525	0.000	15.000
80 %	93.812	0.000	15.000
90 %	100.000	11.400	15.000
95 %	100.000	15.000	52.400
99 %	100.000	62.000	64.760

Desired Rating: Good

Conservation Target: Wetlands
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: While additional, more quantitative research is needed to fully understand the complex impacts of invasive species on ecosystems (Hulme and Bremner 2006), some impacts have been documented. Eagle et al. (2007) detailed a wide range of impacts from yellow starthistle in California; Vaccaro (2005) documented loss of biodiversity resulting from cattail leaf litter in Great Lakes wetlands; Katz and Shafroth (2003) and Simons and Seastedt (1999) documented impacts of Russian olive on various ecological functions; Levine et al. (2003) reviewed underlying impacts of exotic plant invasions: Tickner et al. (2001) reviewed the literature on riparian invasions; Bakker (unpublished) reviewed impacts of woody plants on grassland dependent birds; and Rumble and Gobeille (1998) looked at bird use in different successional stages of cottonwood forests and potential impacts of replacement by other woody species, mainly the invasive green ash.

In addition to being a key attribute for the target, this indicator is intended to help address the concerns raised by Fleishman et al. (2006) regarding the limitations of species richness. This indicator seeks to provide information about the extent of areas within the target dominated by a subset of noxious weeds that are both of significant concern to OSMP and practical to monitor. For this indicator, "dominated" means over 50% canopy cover. Canopy cover measures for the RAM methodology are documented in (Dewey and Anderson 2006).

The methodology was applied to almost the entire target; however certain low priority sites were excluded based on their position relative to priority planning areas and large habitat blocks. The isolated and smaller parcels not included in priority planning areas were omitted. The only consequence is that the CRP lands (ca. 1600 ac) were not mapped. The effect of this omission on the overall estimate is not known but probably affects the wetland target little.

The RAM species included OSMP priority weed species, a synthesis of state, county and local weed species of concern. These plants are typically considered most threatening to ecosystem health, recreation and agriculture. From this list, certain ubiquitous species unlikely to be managed were removed (e.g. cheatgrass, wild asparagus and smooth brome). The list of RAM species for 2006 is available in Dewey and Anderson (2006:2-3). In addition to these, the 2007 data collection also included other species such as perennial sowthistle and Japanese knotweed (Johnson 2007).

Levels of infestation, as a percent of target area, were calculated from RAM data using GIS for each target.

Cattails (*Typha latifolia and T.* angustifolia) were not tracked through RAM but are important invasive species in wetlands. Crews did not walk through cattail marshes for RAM surveys. Consequently, OSMP underestimated the level of infestation in seasonal and semi-permanent wetlands, especially deepwater areas and those dominated by tall, dense vegetation where visibility is limited.

Indicator: Percent of target dominated by non-native species Rapid Assessment Mapping)

Indicator Ratings:

Poor: >5%
Fair: 3-5%
Good: 1-<3%
Very Good: <1%
Indicator ratings comment: The indicator ratings were assigned in response to a number of sources associated with ecological integrity assessments including Rondeau (2001), Neely et al. (2006), Decker (2007b). The indicator ratings are comparable to those developed for conservation action plans in other areas (e.g. Lower Purgatorie, Huerfano Uplands, Laramie Foothills and the Rocky Mountain Front Range).

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: 0.075
Current Rating: Poor
Current rating comment: OSMP calculated the current (2006-7) percent cover for RAM species within six cover classes for each target. The percent of a target in the cover class "> 50%" for the wetland target was used for this indicator.
Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Wetlands
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: For documentation of the relevance of exotic species as an indicator, please see Key Ecological Attribute Indicator "Percent area dominated by exotic species tracked through the RAM method" for this target.

This indicator also provides information about the extent of areas within the target likely to become dominated by RAM mapped species. Any given target may have a low percent of area dominated by RAM species, but high percent with high occupancy. The inclusion of the second indicator will allow OSMP to track these high occupancy areas. High occupancy areas, depending on trend, could result in dominance in the future and should be an indicator of viability.

Indicator: Percent of target with prevalence of non-native species (Rapid Assessment Mapping)

Indicator Ratings:

Poor: >15%
Fair: 9-15%
Good: 3- <9%
Very Good: <3%
Indicator ratings comment: Levels of infestation were calculated from RAM data using GIS. OSMP sought indicator ratings sources associated with ecological integrity assessment upon which to base thresholds; however, no examples were found for using sub-dominance as a leading indicator. Consequently, the indicator ratings for this indicator are not substantiated by other

work. Because of the lower abundance by RAM species for this indicator, the percent of area for each indicator (tolerance of area occupied) is higher.
Confidence of these indicator rating descriptions: Medium

Indicator Measurements:
Date: 4/15/2008
Current Indicator Measurement: 0.24
Current Rating: Poor
Current rating comment: OSMP calculated the current (2006-7) percent cover for RAM species within six cover classes for each target. The percent of a target in the cover classes "6-25%" and ">25-50%" was used for this indicator.
Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Wetlands
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: See comment under the indicator: Management of Ute ladies-tresses orchid habitat

This indicator is proposed as an easily-implemented check that flowering plants are detected on a regular basis. Over time, OSMP intends to refine this indicator by combining presence/absence checks with demographic sampling to track vegetative and dormant individuals in the areas of the orchid's habitat supporting the largest sub-populations.

The areas to be surveyed for this indicator are:
1) The Van Vleet property meadows north of US 36 in the South Boulder Creek floodplain (field numbers X and Y);
2) The Van Vleet property meadows south of US 36 in the South Boulder Creek floodplain (field numbers A and B); and
3) The Yunker property (field number Z) east of Cherryvale Road and south of US 36.

Indicator: Presence of populations of Ute ladies-tresses orchid

Indicator Ratings:
Poor: Absent
Fair: Absent
Good: Present
Very Good: Present
Indicator ratings comment: Presence indicates that the species is being conserved as part of this target; absence indicates a failure to conserve the species.
Confidence of these indicator rating descriptions: Medium

Indicator Measurements:
Date: 8/15/2007
Current Indicator Measurement: Orchid is present
Current Rating: Good
Current rating comment: Orchids were recorded in the three fields in 2007.

Desired Rating: Good

Conservation Target: Wetlands

Category: Condition
Key Attribute: Water Quality
Key attribute comment: Amphibians need good water clarity to support several phases of their life histories. In particular, northern leopard frog egg masses need clear water and sun penetration to grow. Additionally, water clarity can be a surrogate measure for pond productivity (when poor water clarity is due to algal concentration rather than sediment concentration). Given the position of OSMP ponds on the landscape, we expect most ponds to be characterized by low to moderate levels of algal productivity.

Indicator: Pond Secchi disk depth

Indicator Ratings:

Poor: < 75% of ponds have a Secchi disk depth of > 0.5 m
Fair: At least 75% of ponds have a Secchi disk depth of > 0.5 m
Good: At least 75% of ponds have a Secchi disk depth of > 1.5 m
Very Good: At least 75% of ponds have a Secchi disk depth of > 4.2 m or the disk can been seen to the pond's bottom
Indicator ratings comment: There is significantly more scientific literature on the water clarity of lakes/reservoirs than ponds. OSMP staff relied on this literature for the indicator ratings for OSMP ponds.

Because we expect most ponds in the OSMP grassland to be oligotrophic to mesotrophic, we set "Poor" to a typical Secchi disk depth of a hypereutrophic lake. We use the traditional separation between eutrophic and mesotrophic lakes, 1.5 m (Carlson 1977), to serve as the separator between "Fair" and "Good". Thus, if most of our ponds were mesotrophic or oligotrophic, as expected, the system would fall in the "Good" category. The "Very Good" rating is based on the USEPA recommended target Secchi disk depth for lakes in one of the sub-ecoregions that includes the Grassland Planning Area (USEPA 2000b).
Confidence of these indicator rating descriptions: High

Indicator Measurements:

Current Indicator Measurement: Unknown
Current rating comment: OSMP does not currently measure water clarity in the ponds/lakes it manages.

Desired Rating: Good

Conservation Target: Wetlands
Category: Condition
Key Attribute: Water Quality
Key attribute comment: High levels of phosphorus are problematic for pond ecosystems causing excessive primary production, typically in the form of algae. This adversely affects the pond's trophic system. At high levels of phosphorus (> 50-100+μg/L), algal communities are often dominated by cyanobacteria, many of which are toxic. Some cyanobacteria have been linked to livestock and wildlife poisoning and mortality (Carmichael 2001, Alonso-Andicoberry et al. 2002, Lopez-Rodas et al. 2008) and even human mortality (Carmichael 2001). The decomposition of high concentrations of algae also reduces dissolved oxygen concentrations to levels lethal to many aquatic organisms.

Indicator: Pond total phosphorus

Indicator Ratings:

Poor: < 75% of ponds have TP < 30 μg/L
Fair: At least 75% of ponds have TP <30 μg/L
Good: At least 75% of ponds have TP < 20 μg/L

Very Good: At least 75% of ponds have TP < 15 µg/L
Indicator ratings comment: There is significantly more scientific literature on the nutrient characteristics of lakes/reservoirs than ponds. OSMP staff relied on this literature to support the proposed indicator ratings.

Given the position of OSMP ponds on landscape, soils and underlying bedrock, we expect that most ponds should have few natural inputs of phosphorous and be characterized by low to moderate levels of productivity. In other words, most ponds in the OSMP grassland are expected to be oligotrophic to mesotrophic. We use the traditional separation between eutrophic and mesotrophic lakes, 30 µg/L (Carlson 1977), to serve as the separator between "Fair" and "Poor". "Good" and "Very Good" ratings are based on the USEPA recommended target phosphorus concentrations for lakes in sub-ecoregions that include the Grassland Planning Area (USEPA 2000b, USEPA 2001b). If OSMP had a "Good" or "Very Good" rating, most of the ponds would be oligotrophic and/or mesotrophic, in line with our estimation of the ponds' natural levels of productivity.

Indicator Measurements:
Current Indicator Measurement: Unknown
Current rating comment: OSMP does not currently measure water chemistry parameters in the ponds/lakes it manages.
Confidence of the current rating: Medium

Desired Rating: Good
Desired rating comment: See indicator rating description

RIPARIAN AREAS

Conservation Target: Riparian Areas
Category: Landscape Context
Key Attribute: Connectivity
Key attribute comment: This indicator is used for both the Wetlands and Riparian Areas targets.

Vegetated buffers are of established benefit to wetlands and creeks because they provide the following functions: water quality enhancement via the removal of pollutants such as sediment, nutrients, and pathogens prior to reaching the creek or wetland; hydroperiod regulation and hydrologic cycle continuity; streambank stabilization; wildlife habitat enhancement; microclimate regulation; physical barriers to light, noise; and habitat connectivity (Sheldon et al. 2005, City of Boulder P&DS and Biohabitats 2007).

The greater the vegetated buffer, the less likely a wetland will be degraded and the more likely the wetland will be able to provide a wide range of ecological functions to a high degree for a long time (aquatic habitat for plants and animals, sediment trapping and nutrient removal functions).

Indicator: Buffer width (vegetated area within 100 m of a creek)

Indicator Ratings:

Poor: < 75% of creek sampling sites have a mean buffer width > 1 m
Fair: At least 75% of creek sampling sites have a mean buffer width > 1 m
Good: At least 75% of creek sampling sites have a mean buffer width > 50 m
Very Good: At least 75% of creek sampling sites have a mean width > 100 m
Indicator ratings comment: OSMP staff began with the ratings Rocchio suggests in his work on Colorado freshwater marshes and riparian areas (Rocchio 2006a, Rocchio 2006b). We modified the "Fair" and "Poor" categories slightly so that if we achieved a "Poor" rating it would reflect a situation where the target is both not effectively conserved AND it would be hard to bring back to "Fair".

As a check on the indicator ratings, OSMP staff used the synthesis of Sheldon et al. (2005) of buffer widths needed to provide many of the ecological functions listed above. Their summary of the literature indicates a buffer width of 5-20 m is needed to remove coarse particle pollutants; a buffer width of 20-100 m is needed to remove fine particle pollutants; and buffer width of 5-40 m is needed to remove dissolved pollutants. With respect to protecting wildlife habitat, recommended buffer width is even more variable, but many of the studies listed by the authors fall in the 30-100 m range. Their final summary recommendation is for a buffer width of: 8-23 m for wetlands with minimal habitat functions and low-intensity land uses adjacent to the wetland, 15-46 m for wetlands with moderate habitat functions and moderate or high-intensity land uses adjacent to the wetland and 46-92 m for wetlands with high habitat functions, regardless of the intensity of the land uses adjacent to the wetland.

Because many OSMP riparian areas have high habitat functions or have high habitat function as the management goal, the 46-92 m buffer length is most appropriate for OSMP creeks and wetlands. This buffer range most closely fits the 50-100 m category. Thus, OSMP's management goal is that most (i.e. at least 75%) wetlands and creeks have at least a 50 m buffer.
Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Date: 2/15/2008
Current Indicator Measurement: 75% of the wetlands have a buffer width of 20 m or more
Current Rating: Fair

Current rating comment: OSMP does not currently collect field measurements of riparian area widths. We estimated mean buffer width for creeks using GIS.

Ideally, average buffer width is estimated in the field. At a given creek, an investigator would visually estimate the riparian area perpendicular to the creek in each direction. Then the two estimates would be averaged to obtain mean buffer width for the creek.

However, the analysis for current condition was not conducted in the field. Instead, OSMP staff used Hawth Tools in GIS to place 100 points randomly along the creeks, intermittent creeks and ditches (as defined by the USGS GIS hydrology layer) within OSMP boundaries. Twelve of the 100 points fell outside the Grassland Planning Area and were eliminated from the analysis. At each of the remaining points, we examined aerial photography with trails (designated and undesignated), roads and prairie dog layers overlain on the aerial photography to estimate average buffer width surrounding the water body (creek, intermittent creek, ditch). Using the measurement tool in GIS, we measured the extent of the buffer. We defined buffers as the vegetated area surrounding the creek. Vegetation does not have to be native vegetation to perform some of the ecological services that buffers provide such as pollutant removal; however, the vegetation should not be mowed. In particular, mowed turf grass associated with development does not provide the same functions as non-mowed grass. Trails, roads, development, row cropped agriculture and prairie dog colonies (since prairie dogs tend to remove a significant portion of ground cover) are not well vegetated, thus cannot perform pollutant removal and many habitat functions that well vegetated buffers provide. These land uses were considered limits to the buffer widths.

Buffer distances were measured perpendicular to the water body on both sides of the water body, resulting in two buffer width measurements for each sampling point. When buffer width exceeded 100 m, we stopped measurement and recorded 100 m as the width of the buffer. The two buffer width measurements for each sampling point were averaged resulting in a mean buffer width for the sampling point.

We calculated the 25th percentile for the resulting data set of 88 mean buffer widths to determine the status of the indicator. With our data set, the 25th percentile was 20 m, placing our status as "Fair". Only 10% of the sampling points had a mean buffer width of <1 m. The median for our data set was 61 m. 27% of the sampling points had a mean buffer width > 100 m.
Confidence of the current rating: High

Desired Rating: Good

Conservation Target: Riparian Areas
Category: Landscape Context
Key Attribute: Connectivity
Key attribute comment: This indicator is used for both the Wetlands and Riparian Areas targets.

This key attribute is a common element of conservation ecology and is felt to be broadly applicable to a wide range of animal species (Haig et al. 1998, Lindenmayer et al. 2008). The indicator is a direct measure of proximity of like habitat blocks. While proximity is not the only measure of connectivity, it is fundamental and relatively easy to measure. Barriers between habitat patches are addressed by other key attribute indicators.

The existing OSMP vegetation map, along with topographical relief layers and aerial photography from 2006 were used to create the wetland/riparian complexes for this key attribute. OSMP wetlands and riparian corridors often consist of two or more mapped vegetation types. Adjacent riparian and/or wetland vegetation map units were merged together by dissolving common boundaries in GIS to create initial wetland/riparian "clumps". These clumps were examined in conjunction with aerial photography and topographical information to determine if one or more clumps should be combined and considered a single wetland/riparian complex. A complex is a contiguous, functioning wetland/riparian unit that could consist of multiple vegetation-mapping units. Typically, upland vegetation, development and/or topography defined the edges of the complex. OSMP staff identified 414 wetland/riparian complexes in the Grassland Planning Area using this method.

Only riparian areas associated with creeks and ditches were included in the analysis because intermittent creeks and ditch laterals may be incapable of supporting populations of native frogs.

Indicator: Distance to nearest wetland or riparian area

Indicator Ratings:

Poor: < 75% of wetland/riparian complexes are < 1,000 m from the nearest wetland/riparian complexes
Fair: At least 75% of wetland/riparian complexes are < 1,000 m from the nearest wetland/riparian complexes
Good: At least 75% of wetland/riparian complexes are < 200 m from the nearest wetland/riparian complexes
Very Good: At least 75% of wetland/riparian complexes are < 200 m from the nearest wetland/riparian complexes
Indicator ratings comment: The indicator ratings were based upon recommendations for habitat protection of northern leopard frogs (Smith and Keinath 2007). Their work synthesized a large number of works on the ecology and natural history of amphibians (see literature cited in Smith and Keinath 2007).
Confidence of these Indicator rating descriptions: High

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: At least 75% of wetland/riparian complexes are < 142 m from the nearest wetland/riparian complexes
Current Rating: Good
Current rating comment: OSMP staff conducted a GIS analyses to determine the nearest distance between wetland and riparian complexes and summarized the results in SYSTAT. The table below shows the distribution of distances to nearest wetland/riparian complex. Over 80% of the wetland/riparian complexes lie within 200 m of another wetland/riparian complex, making OSMP's current rating "Good"/"Very Good".

	DISTANCE in meters
N of cases	414
Minimum	1.909
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40 %	30.472
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60 %	84.154
70 %	120.115

75 %	142.286
80 %	170.433
90 %	299.883
95 %	452.877
99 %	882.612

Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Riparian Areas
Category: Landscape Context
Key Attribute: Connectivity
Key attribute comment: In small habitat blocks, fish are less likely to find their habitat requirements met. Localized environmental conditions in smaller areas are less likely to be acceptable or provide a refuge during high/low flows, high temperatures, depressed oxygen levels, etc. Fish isolated in small reaches are less likely to find mates or conditions suitable for reproduction and are more likely to suffer high rates of predation.

Impediments to fish passage are typically associated with water management infrastructure, mostly headgates and low-head diversion dams for irrigation ditches. Other impediments include box culverts at road underpasses where the bottom of the culvert is elevated above the creek bottom and small diameter culverts that result in turbulent and accelerated flows. Drop/grade control structures can also be impediments to fish passage. Each of these impediments has the ability to isolate fish populations and reduce extent and connectivity of habitat.

Indicator: Impediments to fish passage

Indicator Ratings:
Poor: >0
Fair: >0
Good: 0
Very Good: 0
Indicator ratings comment: The number of impediments seems to be the most direct measure of connectivity for creeks. Currently there are at least six impediments identified on OSMP lands along South Boulder Creek, four on or near OSMP lands along Boulder Creek and two on Coal Creek. OSMP and others are currently designing and constructing fish passages at barriers along Boulder and South Boulder Creeks.
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:
Date: 3/15/2008
Current Indicator Measurement: 12
Current Rating: Fair
Current rating comment: Direct analysis (count) of impediments by OSMP staff.
Confidence of the current rating: High

Desired Rating: Good

Conservation Target: Riparian Areas
Category: Landscape Context
Key Attribute: Connectivity
Key attribute comment: Trails and roads around wetlands and riparian areas create barriers for amphibian and small mammal dispersal, introduce disturbances such as human and dog recreation and

serve as conduits for predators and pathogens (Smith and Keinath 2007). Consequently, OSMP seeks to maintain a low density of trails/roads around known leopard breeding areas to reduce mortality and impediments to dispersal of northern leopard frogs.

Indicator: Undesignated trail density in northern leopard frog habitat blocks

Indicator Ratings:

Fair: All northern leopard frog habitat blocks with undesignated trail density greater than 10 m/ha.
Good: All northern leopard frog habitat blocks with undesignated trail density less than 10 m/ha.
Very Good: All northern leopard frog habitat blocks have no undesignated trails.
Indicator ratings comment: The existing OSMP vegetation map, along with topographical relief layers and 2006 aerial photography, was used to create the wetland/riparian complexes for this indicator. OSMP wetlands and riparian corridors often consist of two or more mapped vegetation types. Riparian and wetland vegetation map units adjacent to each other were merged by dissolving common boundaries, creating initial wetland/riparian "clumps". These clumps were examined in conjunction with aerial photography and topographical information to determine which clumps should be combined and considered a single wetland/riparian complex. A complex is defined as a contiguous, functioning wetland/riparian unit consisting of one or more vegetation mapping units. Typically, upland vegetation, developed areas or topography defined the edges of the complex. OSMP staff identified 414 wetland/riparian complexes in the Grassland Planning Area using this method.

OSMP staff conducted a GIS analysis to identify wetland/riparian complexes and then selected those for which there were records of northern leopard frogs from surveys conducted in 1996, 2006, 2007 and 2008. OSMP then created a 200-m buffer around these complexes. In order to ensure that the complexes did not include non-habitat, roads, parking lots, tilled fields and other lands unlikely to be used by northern leopard frogs were removed from consideration. The resulting areas were termed "northern leopard frog habitat blocks".

OSMP staff calculated the undesignated trail density within the northern leopard frog habitat blocks using GIS. Although the scientific literature notes that trails and roads around wetlands and riparian areas are problematic as they create barriers for amphibian and small mammal dispersal, introduce disturbances such as dog and human use likely to disrupt avian breeding success, and serve as conduits for predators and pathogens, we could not find any literature suggesting density thresholds. Smith and Keinath (2007) indicate this type of information is lacking for amphibians in general. OSMP staff has not located studies examining these thresholds for mammals and birds.

In the absence of scientific literature, OSMP staff set "Very Good" to a density of zero meters of undesignated trails within the northern leopard frog habitat block. This would represent a situation free from barriers to dispersal and recreational disturbance and minimize predator conduits due to undesignated trails. This was also considered as an appropriate rating for "Good" because the contributions of adverse effects from designated trails and roads (average value in northern leopard frog habitat blocks is 43.6 m/ha). However, staff recognized that it would be more realistic to set the threshold at a higher level and to address staff's capacity to close undesignated trails. Staff set the "Fair"/"Good" threshold at 10 m/ha. This rating was established approximately midway between the zero and the measured mean value of undesignated trail density in northern leopard frog habitat blocks (22 m/ha).

Indicator Measurements:

Date: 2/15/2008
Current Indicator Measurement: All northern leopard frog habitat blocks have an undesignated trail density of less than 101 m/ha

Current Rating: Fair
Current rating comment: OSMP staff conducted a GIS analysis to identify wetland/riparian complexes and then selected those for which there were records of northern leopard frogs from surveys conducted in 1996, 2006, 2007 and 2008. OSMP then created a 200m buffer around these complexes. In order to ensure that the complexes did not include non-habitat, roads, parking lots, tilled fields and other lands unlikely to be used by northern leopard frogs were removed from consideration. While protection of NLF habitat blocks will be one consideration for the placement of trails, the decision on how best to balance access and resource protection will ultimately be made during TSA planning. Consequently, the density of designated trails in a given area will be determined by TSA plans rather than the Grassland Plan. What undesignated trails remain after TSA planning will be slated for removal.

Desired Rating: Good
Desired rating comment: It is unlikely that OSMP will be able to remove or successfully close/reclaim all the undesignated trails in the buffers of northern leopard frog habitat blocks. Therefore, staff set the desired rating above 0, but below the current average of 22 m/ha

Conservation Target: Riparian Areas
Category: Landscape Context
Key Attribute: Habitat Effectiveness

Indicator: Number of successful bald eagle nests in the Grassland Planning Area

Indicator Ratings:
Poor: 0
Fair: 1
Good: 2 or more
Very Good: 2 or more
Indicator ratings comment: There are currently (2008) two active bald eagle nests in the Grassland Planning Area. Both are on lands where OSMP has ownership and some management interest. It is unclear if the GPA is large enough to support more.

Indicator Measurements:
Current Indicator Measurement: 2
Current Rating: Good

Desired Rating: Good

Conservation Target: Riparian Areas
Category: Landscape Context
Key Attribute: Hydrologic Regime
Key attribute comment: Riparian ecosystems (including the stream) are shaped by the magnitude, frequency, duration, timing and rate of change of the stream's flow regime. Critical elements of the natural flow regimes need to be conserved in order to conserve the riparian ecosystems and the functions they provide. The base flow, or minimal instream flow, is one indicator recognizing the need for water in a riparian system.

Colorado has established a state program to dedicate waters to instream flow. An instream flow water right is a water right held by the Colorado Water Conservation Board and is based on a biological need and water availability, whichever is less.

Indicator: Instream flows

Indicator Ratings:

Poor: Varies according to creek--see supplemental information.
Fair: Varies according to creek--see supplemental information.
Good: Varies according to creek--see supplemental information.
Very Good: Varies according to creek--see supplemental information.
Indicator ratings comment: OSMP staff used information from instream flow studies on South Boulder Creek and water resource management information to develop the viability ratings. Little flow data has been located for Lefthand Creek from which to establish instream flow ratings. Even less data is available for the smaller, mostly intermittent, streams such as Fourmile Canyon Creek, Dry Creek #3 and Dry Creek #2. No instream flow recommendations are provided for those creeks.

For South Boulder Creek, OSMP relied upon recommendations of Hydrosphere (1994) as well as best professional judgment to set the viability ratings. For upper South Boulder Creek (the reach from Eldorado Canyon to South Boulder Creek Road), Hydrosphere recommends two instream flow rates. The first, “irrigation season” or “summer”, begins in April and ends in October. The “storage season” or “winter” begins in November and runs through March. Hydrosphere (1994) used instream flow rates needed by adult trout as the basis of their recommendation. OSMP has used this recommended instream flow rate as the “Good” rating. The upper reach of South Boulder Creek also has an instream flow water right. This instream flow rate is lower than the recommendation made by Hydrosphere (1994). OSMP set “Fair” during the summer months to the summer instream flow right [15 cubic feet per second (cfs)] and “Fair” in the winter months to the flow rate needed (based on best professional judgment) to marginally support fish (7 cfs). “Poor” represents instream flow rates below the “Fair” levels. The “Very Good” rating (i.e. fully functioning without managing/interference from land managers) would require a significant increase in the stream's hydrology. This is likely unattainable.

For the lower reach of South Boulder Creek (from South Boulder Road to the confluence with Boulder Creek), OSMP used a similar approach to develop the indicator ratings. The “Good” category rating is partially based on the recommendation from the Hydrosphere (1994) study. The “Very Good” rating is what an approximation of the creek’s natural hydrology looks like. The “Fair”/”Poor” rating is simply “some flow throughout the year”. Significant improvements and changes would need to be made to attain "Fair" conditions for this indicator.

For Boulder Creek, OSMP used the instream flow water right as the basis for “Fair”. Typically, Boulder Creek exceeds this flow rate even during the lowest flow. Therefore, a “Poor” rating would be anything below the instream flow water right. Because Boulder Creek often holds sufficient water to support its fishery, OSMP suggests that current conditions are “Good” (for instream flow – certainly Boulder Creek lacks other hydrologic characteristics). The creek’s natural hydrology is the basis for “Very Good”.

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: Varies according to creek--see supplemental information.
Current Rating: Poor
Confidence of the current rating: Very High

Instream Flow Supplementary Information

Creek/Reach	Instream Flow Indicator Rating Categorical Current state: shaded; Italics = Goal			
	Poor	**Fair**	**Good**	**Very Good**
South Boulder Creek Gross Reservoir Outlet to South Boulder Road	Monthly avg. of < 15 cfs from April to October and < 7 cfs from Nov. to March	Monthly avg. of at least 15 cfs from April to October and at least 7 cfs from Nov. to March	*Monthly avg. of at least 22 cfs from April to October and at least 8 cfs from Nov. to March*	Conditions approximate natural hydrology with peak flows of 300+ cfs in June and variable low flows of 2-20 cfs in Jan.-Feb. with a mean winter flow of about 8 cfs
South Boulder Creek South Boulder Road to confluence	Monthly avg. of < 6 cfs	Monthly avg. of < 6 cfs	*Monthly avg. of at least 6 cfs*	Conditions approximate natural hydrology with peak flows of 300+ cfs in June and variable low flows of 2-20 cfs in the winter with a mean winter flow of about 8 cfs
Boulder Creek	Avg. monthly flow of < 15 cfs	Avg. monthly flow of 15 cfs	*Avg. low flow about 25 cfs and peak flows of 175 cfs AND dates of flow minimum and maximum approaching natural seasonality*	Avg. monthly flows approximating natural hydrology with peak flows in late May to June approaching 400+ cfs and low flows in October through Nov. of about 25 cfs

South Boulder Creek
Hydrosphere (1994) suggests that the natural flows in South Boulder Creek ranged from over 300 cfs in June to less than 10 cfs in Jan.-Feb. (Natural flow refers to the estimated flow at the Eldorado gage after adjusting for Denver Water Board's importation of water through the Moffat Tunnel, its storage of water in Gross Reservoir, and its diversion of water via the South Boulder Creek Diversion Canal located 5 miles downstream of Gross Reservoir. Hydrosphere (1994) based this on gage data from 1950 to 1992.) Winter water flows are particularly variable having a range of 2 cfs to 20 cfs.

Currently, in the reach from the Eldorado gage to South Boulder Road (upper reach) flows are above 20 cfs from May through mid-August (i.e. part of the "irrigation" season) (**Table L-1**). During the "storage" season (Nov. through March) there is usually less than 1 cfs below the Community Ditch diversion. In the lower reach (South Boulder Road to confluence with Boulder Creek) during peak runoff conditions, there are about 15 cfs to the Valmont Inlet. During the rest of the irrigation season, creek is rapidly depleted from 10-15 cfs at Howard Ditch to 6-12 cfs at East Boulder Ditch and 2-4 cfs below East Boulder Ditch. During the storage season, there is typically no water (or < 1 cfs) in the lower reach.

Colorado Water Conservation Board has instream water rights for the upper reach of 15 cfs during the summer and 2 cfs during the winter. Instream water rights are based on biological need (usually fisheries) and available water, whichever is less.

Hydrosphere (1994) initially set instream flow goals to sustain existing coldwater fishery and macroinvertebrate populations. They used stream width (morphology) calculations done by the CDOW and the R2-Cross method to estimate minimum flow requirements for fisheries. R2-Cross method looks at the minimum water depth, wetted perimeter and flow velocity needed to sustain adult trout populations. It was concluded that these flows would also support other components of the coldwater fishery and macroinvertebrates.

Table L-1: Initial instream flow goals and amount needed to reach the goal for the Upper and Lower reaches of South Boulder Creek (from Hydrosphere 1994)

Reach	Irrigation season (April-Oct.)		Storage season (Nov.-March)	
	Goal	Amount Needed to Reach Goal	Goal	Amount Needed to Reach Goal
Upper	22 cfs	Minor amount	8 cfs	8 cfs
Lower	6 cfs	6 cfs	2.5 cfs	2.5 cfs

Boulder Creek

Observed flows in Boulder Creek tend to be at a minimum in January and February when flows are typically less than 25 cfs and at a maximum in late May and early June when flows peak at about 175 cfs. Natural flows[1] tend to be at a minimum in October and November when flows are typically less than 25 cfs and at a maximum in late May and early June when flows peak at nearly 450 cfs (WBLA 1988).

At low flow levels, Boulder Creek is observed to be a "gaining stream" which means that ground water discharges into the stream and thereby cause the stream flow to progressively increase in the downstream direction (Bruce and O'Riley 1997).

Coal Creek

OSMP commissioned an instream flow planning study for Coal Creek to identify instream flow objectives and develop preliminary strategies to meet those objectives (Hydrosphere 2000). Rather than focus on conditions needed for a single species, the consultants proposed a model intended to provide conservation of the entire riparian and aquatic systems by incorporating more of the hydrologic variability inherent in natural creek systems (Richter et al. 1997). Although this Range of Variability Approach (RVA) was not used by Hydrosphere, they did estimate monthly instream flow goals deficits based upon almost 40 years of flow data for Coal Creek (**Table L-2**). With the exception of the month of July, Coal Creek has an instream flow deficit throughout the year.

Table L-2: Preliminary Instream flow goals and instream flow deficits for Coal Creek from Plainview to Superior (from Hydrosphere 2000)

	March	April	May	June	July	Aug-Feb
Instream Flow Goal	1.5	8	12	5	0.7	0.4
Instream Flow Deficit	0	3	5.5	3.9	0.7	0.3

Hydrosphere (2000) recommended that the RVA be used to develop a more detailed analysis of instream flow needs for Coal Creek.

[1] "Natural flow is the observed stream flow that is adjusted to remove the effects of upstream man-made activities such as water diversions, reservoir storage, or water imports from other basins."

Fourmile Canyon Creek
There is no gage data to aid in identifying instream flow goals. According to staff work, Fourmile Creek is naturally intermittent with most of its hydrology coming from rain, groundwater inflow and surface runoff rather than snowmelt. There are artificial contributions (urban runoff, irrigation return flows and seepage from ditches) to creek flow as well.

Dry Creek #3, Dry Creek #2, other smaller drainages (Hendrickson/BLIP Gulch)
There is little available flow information for these drainages. Dry Creek #3 may have been an intermittent stream but now seems to be perennial. Dry Creek #2 may not have year-round flow.

Lefthand Creek
This creek barely touches properties in the Grassland Planning Area.

Desired Rating: Good

Conservation Target: Riparian Areas
Category: Landscape Context
Key Attribute: Hydrologic Regime
Key attribute comment: Riparian ecosystems (including the creek) are shaped by the magnitude, frequency, duration, timing and rate of change of the stream's flow regime. Critical elements of the natural flow regimes need to be conserved in order to conserve the riparian ecosystems and the functions they provide. The instream flow is one indicator recognizing the need for water in a riparian system. Over-bank flooding events are also a critical element structuring riparian systems and maintaining biological and ecological processes. Over-bank flooding from late May to June would be the natural time when creeks in the Grassland Planning Area would experience peak flows. OSMP hopes to further refine this indicator by looking at hydrologic data for South Boulder Creek and suggest the frequency of over-bank flooding events. Given the unnatural hydrology of creeks in the Grassland Planning Area and the lack of data from before alteration, this approach may not be able to provide a set of thresholds that accurately reflects natural conditions.

Indicator: Number of over-bank flooding events during late May through June measured every 5-10 years

Indicator Ratings:
- **Poor:** 0
- **Fair:** 0
- **Good:** >0
- **Very Good:** >0
- **Indicator ratings comment:** Due to the inherent variability of overbank flooding in natural systems, it is extremely difficult to calculate a precise number or frequency of overbank flooding events needed to create a self-sustaining riparian area. However, OSMP staff is confident that the frequency should be greater than zero.

Indicator Measurements:
- **Date:** 4/15/2008
- **Current Indicator Measurement:** Unknown
- **Current Rating:** Poor
- **Current rating comment:** Best professional judgment (note indicator ratings relatively undeveloped).

Desired Rating: Good
Desired rating comment: Best professional judgment (note indicator ratings relatively undeveloped).

Conservation Target: Riparian Areas
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: The index of biotic integrity (IBI) framework uses biota to provide scientifically defensible evidence of environmental condition. The multi-metric index was first developed by Karr (1981) for use in small warmwater streams in central Illinois and Indiana. Karr's original version had 12 metrics that reflected fish species richness and composition, number and abundance of indicator species, trophic organization and function, reproductive behavior, fish abundance and condition of individual fish.

Species Richness and Composition Metrics
- Total Number of Fish Species (total taxa)
- Number of Catostomidae Species (suckers)
- Number of Darter Species
- Number of Sunfish Species

Indicator Species Metrics
- Number of Intolerant or Sensitive Species
- Percent of Individuals that Are Green Sunfish (Centrarchidae)

Trophic Function Metrics
- Percent of Individuals that Are Omnivores
- Percent of Individuals that Are Insectivorous Cyprinidae
- Percent of Individuals that Are Top Carnivores or Piscivores

Reproductive Function Metrics
- Percent of Individuals that Are Hybrids

Abundance and Condition Metrics
- Abundance or Catch per Effort of Fish
- Percent of Individuals that are Diseased, Deformed, or Have Eroded Fins, Lesions, or Tumors (DELTs)

Each metric received a score of five points if it had a value similar to that expected for a fish community characteristic of a system with little human influence. A score of one point was awarded if the metric had a value similar to that expected for a fish community departing significantly from the reference condition. A score of three points was awarded to those metrics with intermediate values. The total IBI score is the sum of the 12 metric scores and ranges from 60 (best) to 12 (worst). Since Karr's initial work, some authors have reduced the lowest score to zero.

There have been efforts to adapt Karr's fish IBI to Colorado (Schrader 1989, Bramblett and Fausch 1991, Fausch and Schrader 1987). Recent efforts in Colorado to establish bioassessment criteria have grown out of the U.S. Environmental Protection Agency's (USEPA) Environmental Monitoring and Assessment Program (EMAP). The USEPA partnered with other federal, state and local agencies as well as universities in 12 western states to conduct an ecological assessment of non-tidal stream and rivers in these states (Stoddard et al. 2005). As part of this assessment, representatives from the Colorado Department of Public Health and the Environment, Colorado Division of Wildlife and Colorado Watershed Network met with representatives from the EMAP project to develop a fish IBI for Colorodo (Beyea and Theel 2007). The group selected the following metrics ("Plains Bioregion"), which sum together for a maximum total score of 100:
- Number of nonnative individuals
- % of species that are native herbivores
- % of hider individuals
- % of native species that are long-lived and tolerant to sediment
- % of native individuals that prefer warmwater habitats
- Number of individuals that are benthic and tolerant to sediment

Zuellig (2001) examined fish communities in urban areas, including Boulder, and used a modified habitat quality index that could be used to customize a fish IBI for the Grassland Planning Area.

Indicator: Fish index of biotic integrity (IBI)

Indicator Ratings:

Poor: <25% of the sampling sites have a IBI score >44
Fair: 25-74% of the sampling sites have a IBI score >44
Good: 75-99% of the sampling sites have a IBI score >44
Very Good: 100% of the sampling sites have a IBI score >44
Indicator ratings comment: Beyea and Theel (2007) suggest the following IBI scores to classify streams in the Plains Bioregion:
0-29: most disturbed stream
30-66: moderately disturbed stream
67-100: least disturbed stream

Their suggested classification is based on a common practice of using the 25th percentile of IBI scores for a set of reference sites as the threshold between "least" and "moderately" disturbed and the 5th percentile of the reference sites as the threshold between "moderately" and "most" disturbed. After some additional analysis, Stoddard et al. (2005) suggest relaxing those criteria for streams in the Plains Bioregion. They propose using the following classification:
0-35: most disturbed stream
35-44: moderately disturbed stream
45-100: least disturbed stream

Following the Stoddard et al. (2005) suggestion and recognizing that OSMP desires that most (75%), if not all, of OSMP streams to fall in the least disturbed category, OSMP set the "Good" to at least 75% of the sampling sites have an IBI score greater than 44.

Past studies of the fish in South Boulder Creek and Boulder Creek indicate that several native species that have historically occurred are no longer present and others are present in low numbers. Consequently it is unlikely that the indicator would be rated higher than "Fair". OSMP has decided to assign a provisional "Fair" rating to this indicator until measurements are taken.

Indicator Measurements:

Current Indicator Measurement: Unknown
Current Rating: Fair
Current rating comment: OSMP has not applied a fish IBI in the Grassland Planning Area.

Desired Rating: Good

Conservation Target: Riparian Areas
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: See comments under the fish IBI indicator for this target.

Macroinvertebrate communities can provide an integrative measure of water chemistry and physical stream conditions (Rosenberg and Resh 1993) and can therefore be useful at predicting the overall integrity of the system (Meyer 1997, Karr 1999). Several measurable metrics are available to assess macroinvertebrate assemblage structure, composition and function. These can be used to create an IBI (Fore et al. 1996, Karr and Chu 1999). Weigel et al. (2002) used the following metrics in their work in Mexican streams:

Taxa richness and composition
Catch per unit effort
Generic richness
% of genera from mayfly, stonefly, and caddisfly orders (EPT)
Relative abundance of midges %

Tolerance
Organic pollution tolerance (Hilsenhoff Biotic Index)
Percent Inhabitants of fine depositional substrate

Feeding morphology
Percent predator individuals
Percent gatherer genera

Recent efforts in Colorado to establish bioassessment criteria have been organized by the Colorado Department of Public Health and Environment' Water Quality Control Division Standards Unit. Paul et al. (2005) developed a macroinvertebrate multi-metric index (MMI) for assessing biological conditions in creeks. They used the following metrics (for the "Plains Bioregion"):

- Percent Midges (Composition)
- EPT Taxa (Richness)
- Organic pollution tolerance [Hilsenhoff Biotic Index] (Tolerance)
- Percent burrowers (Habitat)
- Percent predators (Trophic)

Zuellig (2001) examined macroinvertebrate communities in urban areas, including Boulder, and used a modified habitat quality index that could be used to develop a macroinvertebrate IBI.

The city of Boulder Utilities division is interested in developing a macroinvertebrate IBI for use in the Grassland Planning Area to assess water quality in South Boulder Creek.

Indicator: Macroinvertebrate index of biotic integrity (IBI)

Indicator Ratings:

Poor: <25% of the sampling sites have a IBI score >50
Fair: 25-74% of the sampling sites have a IBI score >50
Good: 75-99% of the sampling sites have a IBI score >50
Very Good: 100% of the sampling sites have a IBI score >50
Indicator ratings comment: Beyea and Theel (2007) suggest the following macroinvertebrate MMI scores to classify streams in the Plains Bioregion:
0-43: most disturbed stream
44-55: moderately disturbed stream
56-100: least disturbed stream

Their suggested classification uses the 25th percentile of macroinvertebrate MMI scores for a set of reference sites as the threshold between "least" and "moderately" disturbed and the mean of the remaining 25% of references sites as the threshold between "moderately" and "most" disturbed. After some additional analysis, Stoddard et al. (2005) suggest relaxing those criteria for streams in the Plains Bioregion. They propose using the following classification:
0-40: most disturbed stream
41-50: moderately disturbed stream
51-100: least disturbed stream

Following the Stoddard et al. (2005) suggestion and recognizing that OSMP desires that most (75%), if not all, of OSMP streams to fall in the least disturbed category, OSMP set the "Good" to at least 75% of the sampling sites have an MMI score greater than 50.

Indicator Measurements:

Current Indicator Measurement: Unknown

Current rating comment: OSMP has not sampled with the intent to report a macroinvertebrate multimetric index.

Desired Rating: Good

Conservation Target: Riparian Areas

Category: Condition

Key Attribute: Animal Species Composition

Key attribute comment: One of the important biodiversity support functions of wetlands and riparian areas is amphibian breeding habitat. A number of sites were selected from those wetlands and riparian considered suitable habitat for frogs. These sites were sampled during the summer of 2007. Of these, some had only native frogs; some had both native and non-native frogs; some had only non-native frogs and some had no frogs (McKibben 2008).

Indicator: Native frog presence in suitable habitat

Indicator Ratings:

Poor: 0-25% of sites with native frogs alone

Fair: >25%-50% of sites with native frogs alone

Good: >50%-99% of sites with native frogs alone

Very Good: All sites with only native frogs

Indicator ratings comment: The threshold of acceptability was set so that the majority (>50%) of the suitable sites would support native frogs in the absence of non-native frogs. The other thresholds were set 25% above and below the separation of "Fair" and "Good". No known external sources of information were available to inform these thresholds further. Given current conditions and understanding of the available tools for effective management, establishing "Good" conditions during the 10-year Grassland Plan horizon seems like a reasonable, perhaps ambitious objective.

Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:

Current Indicator Measurement: 0.18

Current Rating: Poor

Current rating comment: The current rating was derived from data collected by OSMP staff in the field during the summer of 2007 (McKibben 2008).

Confidence of the current rating: Low

Desired Rating: Good

Conservation Target: Riparian Areas

Category: Condition

Key Attribute: Animal Species Composition

Key attribute comment: Intact riparian areas support the most diverse bird community on OSMP lands. The presence of deciduous trees and seasonal flowing water provides functional habitat (foraging and refuge) for over one hundred species of migrating and nesting birds (Jones et al. 2007), many of which are riparian obligates. This suite of birds includes tree-canopy nesters like Bullock's oriole and yellow warbler and shrub-dependent birds like gray catbird and blue grosbeak. The presence of these birds and others in the guild reflects a high level of breeding habitat effectiveness and diversity.

To measure the importance of the riparian bird community, OSMP used PIF scores to rank birds according to conservation value. In this scoring system (from 0-4), a common species like American robin (PIF rank = 2) is valued less than a more rare species like Bullock's oriole (PIF rank =3), but is valued higher than a non-native species like European starling (PIF rank =0). This scoring system, developed by Nuttle et al. (2003), provides an effective technique to measure bird community richness without assuming all species are of equal conservation value.

Indicator: Percent of target with acceptable bird conservation score

Indicator Ratings:

Poor: < 75% of target with derived PIF score of ≥12
Fair: At least 75% of target with derived PIF score of ≥12
Good: At least 75% of target with derived PIF score of ≥20
Very Good: At least 75% of target with derived PIF score of ≥30
Indicator ratings comment: The data used to develop indicator ratings were drawn from studies of high quality riparian corridors (Coal Creek, Boulder Creek). Ratings may not apply to some ditches and smaller creeks mapped as part of this target.

For the analysis, OSMP used bird abundance data from the following sources:
1997 Audubon Coal Creek Sampling (3 point count plots)
1997 Audubon Boulder Creek Sampling (23 point count plots)
1998-2007 Audubon Coal Creek sampling (18 point count transects)

OSMP derived mean abundance scores for each species by dividing number of individuals detected of each species by the number of visits to the sampling area ("sample"). Only data from May through July were used. OSMP removed species from the analysis for any of the following reasons: 1) grassland nesting birds, 2) aerial foragers (swallow species), 3) birds that do not breed in the Boulder Valley (detections due to migrations/spring movements), 4) birds that neither nests nor forage in riparian areas (over-head detections).

OSMP used the methodology of Nuttle et al. (2003) to calculate "derived Partners in Flight (PIF) ranks". The methodology provides all birds a conservation value (PIF rank) from 0-4 using seven Partners in Flight conservation scores (Panjabi 2001).

OSMP then multiplied abundance values for all remaining birds by PIF rank for each sample and summed these scores ("derived PIF score") within each sample to provide a derived PIF score for each of the 44 samples.

Finally, OSMP calculated the 25th percentile for derived PIF score from each data set. Within a given data set, the 25th percentile is the value above which 75% (i.e. most) of the data points lie. OSMP used the 25th percentile in many of its indicator ratings because OSMP seeks to have most of the grassland in "Good" condition rather than having the grassland in "Good" condition on average.

OSMP staff familiarity with relative habitat was used to correlate scores with indicator ratings. For example, OSMP fenced the Coal Creek riparian corridor in December 1999 to manage livestock access. This treatment was used to help define indicator ratings (i.e., after fencing = more diverse bird community). A similar habitat quality assessment was contained in Audubon's 1997 study on Boulder Creek (Jones et al. 2008).

The overall 25th percentile for 44 data points in all data sets combined was 18.8. Derived PIF scores were grouped similarly based on analysis. Scores from samples (point counts) surveyed by Jones et al. (2008) in high quality habitat in Boulder Creek (mature cottonwoods, fencing) were similar to samples (transects) surveyed after fencing was installed in Coal Creek.

Point count/Very Good, 25th percentile = 29.5 (n=3)
Transect/After fence, 25th percentile = 29.0 (n=12)

Likewise, samples in good quality habitat were similar to samples in Coal Creek before fencing.
Point count/Good, 25th percentile = 18.7 (n=15)
Transect/before, 25th percentile = 19.6 (n=6)

Finally, samples from poor quality habitat averaged the smallest derived PIF score.
Plot/Poor, 25th percentile = 12.2 (n=8)
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:
Date: 4/15/2008
Current Indicator Measurement: 18.8
Current Rating: Fair
Current rating comment: This rating system would place us in the upper end of fair. With somewhat limited data collected by non-staff, this seems appropriate. Refinement of this rating system could be accomplished with staff surveys or a more detailed analysis of Audubon's Coal Creek data, which is currently in a format that is not easily analyzed.
Confidence of the current rating: Medium

Desired Rating: Good
Desired rating comment: As fencing allows shrubs to become more abundant in Coal Creek drainage, birds of higher conservation value that rely on such vegetative structure to breed should increase in number.

Conservation Target: Riparian Areas
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: Invasive species are the primary threat to 42% of U.S. threatened and endangered species. Invasive species are the second biggest threat to biodiversity in the country, and perhaps the greatest threat on Open Space and Mountain Parks lands. The economic loss and expenditures resulting from the invasion or introduction of invasive species in the United States is over $100 billion per year. Aquatic nuisance species (ANS), in particular, can affect water quality; alter aquatic habitat and food webs; and interfere with water-based recreation, transportation and utility operations.

There are currently four ANS of concern on or threatening OSMP lands: Eurasian watermilfoil, New Zealand mud snails, zebra mussels and a colonial alga referred to as "Didymo". All four of these species are characterized by their ability to spread rapidly and the lack of effective controls.

Eurasian watermilfoil is an aquatic plant that lives in all types of water throughout North America. It forms dense mats that impair all forms of water-based recreation; impact fish habitat; reduce water movement in lakes, streams and irrigation canals; and provide ideal breeding habitat for disease carrying mosquitoes.

New Zealand mud snails rapidly spread in western streams and rivers. They can consume 75% of the algae in a stream and can alter stream food webs. Mud snails reduce the number of native aquatic insects that are a major food for fish and provide no value to fish when eaten. Most survive through the fish's digestive tract. Mud snails reproduce asexually.

Zebra mussels are found in all water types throughout the eastern U.S. and have recently been found in Colorado. Though they have not been observed in Boulder County, it is expected that they will be detected soon. Zebra mussels clog power plant and public water intake pipes, damage boat engines, foul fishing gear and deteriorate underwater structures. They filter feed upon microscopic plant and animal life and out-compete native mussels and fish. Water clarity improvements resulting from filter feeding improves habitat for aquatic vegetation, including Eurasian watermilfoil.

Didymo is a diatom that grows in warm and shallow water. Under certain conditions it can form large mats on the bottom of lakes, rivers and streams where it alters aquatic habitats and sources of food for fish. The microscopic algae can be spread in a single drop of water.

Indicator: Submerged aquatic nuisance species richness

Indicator Ratings:

Poor: Increase from current levels
Fair: Increase from current levels
Good: Current levels
Very Good: Decrease from current levels

Indicator Measurements:

Date: 3/15/2008
Current Indicator Measurement: Current levels set as baseline
Current Rating: Good
Current rating comment: Current distributions are limited in scope, and our conceptual model of the ecological severity of infestations is either undeveloped or unsupported by experimental results. Adjustments to indicator ratings can be made when better information about the distribution and abundance of ANS is available.

Desired Rating: Good

Conservation Target: Riparian Areas
Category: Condition
Key Attribute: Habitat Structure
Key attribute comment: Ecological function is reflected in the quality of the physical habitat. The physical structure of a creek forms the foundation for the biological communities. This indicator assesses the structure of the surrounding physical habitat, which is reflected in the quality of the creek as habitat and the condition of the aquatic community (Barbour et al. 1999). For creeks, the standard methods include an evaluation of the variety and quality of the substrate, channel, bank structure and riparian vegetation. The Environmental Protection Agency developed Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers to provide suggestions on cost-effective approaches to aquatic habitat problem identification and trend assessment and foster the development and application of monitoring techniques (Barbour et al. 1999).

This multi-metric index is applicable to aquatic habitat, and could be used to measure conditions in South Boulder Creek, Boulder Creek, Coal Creek, Dry Creek carrier and any other perennial or nearly perennial stream. The protocols described by Barbour et al. (1999) allow for calculation of several metrics from information collected about physical habitat. Metrics that can be derived include:

- Channel mean width and depth
- Channel volume and residual pool volume
- Mean channel slope and sinuosity

- Channel incision, bankfull dimensions and bank characteristics
- Substrate mean diameter, % fines, % embeddedness
- Substrate stability
- Fish concealment features (areal cover of various types, e.g., undercut banks, brush)
- Large woody debris (volume and number of pieces per 100 m)
- Channel habitat types (e.g., % of reach composed of pools, riffles, etc.)
- Canopy cover
- Riparian vegetation structure and complexity
- Riparian disturbance measure (proximity-weighted tally of human disturbances)

Indicator: Physical instream and riparian habitat metric

Indicator Ratings:

Poor: < 75% of sites have an average metric score is > 6
Fair: At least 75% of sites have an average metric score is > 6
Good: At least 75% of sites have an average metric score is > 10
Very Good: At least 75% of sites have an average metric score is > 15
Indicator ratings comment: These metrics are scored on a scale from 0-20 in accordance with condition category descriptions agreed upon for the study area. Barbour et al. (1999) establishes four categories based on the following average metric scores: 0-5 = "Poor", 6-10 = "Marginal", 11-15 = "Suboptimal" and 16-20 = "Optimal". The indicator ratings proposed equate these categories with "Very Good", "Good", "Fair", and "Poor".

Indicator Measurements:

Current Indicator Measurement: Unknown.
Current Rating: Fair
Current rating comment: This indicator is based upon a number of direct measures through an established process. OSMP staff has not employed this protocol and cannot generate an estimate.

However, OSMP is actively planning aquatic habitat restoration on South Boulder Creek. Consequently it is unlikely that the indicator would be rated higher than "Fair". OSMP has decided to assign a provision "Fair" rating to this indicator until measurements are taken.

Desired Rating: Good
Desired rating comment: See indicator rating descriptions

Conservation Target: Riparian Areas
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: Native relative cover serves as an indicator of the quality of vegetation occurring in a sample. However, taken alone, relative cover does not provide a full picture of community composition because it refers only to that portion of the sample that is vegetated. Native relative cover is proposed as one of several indicators of vegetative composition.

Indicator: Native species relative cover

Indicator Ratings:

Poor: < 75% of samples with > 33% native plant relative cover
Fair: At least 75% of samples with > 33% native plant relative cover
Good: At least 75% of samples with > 67% native plant relative cover
Very Good: At least 75% of samples with > 95% native plant relative cover
Confidence of these Indicator rating descriptions: Low

Indicator Measurements:

Current Indicator Measurement: 0.57

Current Rating: Fair

Current rating comment: OSMP staff analyzed data from 35 riparian plots. (Most data were collected from 5 m x 5 m plots as part of vegetation mapping effort in 2002 and 2004.) 75% of these plots had relative cover of native species of at least 57%. Less than 10% of the plots had less than 33% native species relative cover. More than 10% of the plots had over 95% native species relative cover.

Desired Rating: Good

Conservation Target: Riparian Areas

Category: Condition

Key Attribute: Vegetation Composition

Key attribute comment: While additional, more quantitative research is needed to fully understand the complex impacts of invasive species on ecosystems (Hulme and Bremner 2006), some impacts have been documented. Eagle et al. (2007) detailed a wide range of impacts from yellow starthistle in California; Vaccaro (2005) documented loss of biodiversity resulting from cattail leaf litter in Great Lakes wetlands; Katz and Shafroth (2003) and Simons and Seastedt (1999) documented impacts of Russian olive on various ecological functions; Levine et al. (2003) reviewed underlying impacts of exotic plant invasions: Tickner et al. (2001) reviewed the literature on riparian invasions; Bakker (unpublished) reviewed impacts of woody plants on grassland dependent birds; and Rumble and Gobeille (1998) looked at bird use in different successional stages of cottonwood forests and potential impacts of replacement by other woody species, mainly the invasive green ash.

In addition to being a key attribute for the target, this indicator is intended to help address the concerns raised by Fleishman et al. (2006) regarding the limitations of species richness. This indicator seeks to provide information about the extent of areas within the target dominated by a subset of noxious weeds that are both of significant concern to OSMP and practical to monitor. For this indicator, "dominated" means over 50% canopy cover. Canopy cover measures for the RAM methodology are documented in (Dewey and Anderson 2006).

In 2007, OSMP staff chose to use a variant of the RAM protocol referred to as the gross area polygon because of the types of weeds that were encountered and a desire to speed data collection. Gross area polygons are intended to provide a way to address extremely widespread infestations. This may have led to some over-mapping (showing invasive species where they did not actually occur) especially of diffuse knapweed.

The indicator ratings were assigned in response to a number of sources associated with ecological integrity assessments. These include Rondeau (2001), Neely et al. (2006) and Decker (2007a).

The methodology was applied to almost the entire target; however, certain low priority sites were excluded based on their position within Visitor Master Plan Trail Study Areas and large habitat blocks. Isolated and smaller parcels not included in the TSAs up for review at the time of sampling were omitted. The only known consequence is that CRP lands in the northeast (ca. 1600 ac) were not mapped. The effect of this omission on the overall estimate is not known.

Indicator: Percent of target dominated by non-native species (Rapid Assessment Mapping)

Indicator Ratings:

Poor: >5%
Fair: 3-5%
Good: 1-<3%
Very Good: <1%
Indicator ratings comment: The RAM species included OSMP priority species, a synthesis of state, county and local species of concern. These species are typically considered most threatening to ecosystem health, recreation and agriculture. From this list, certain ubiquitous species unlikely to be managed were removed (e.g. cheatgrass, smooth brome and wild asparagus). The list of RAM species is available for 2006 is available in Dewey and Anderson (2006:2-3). In addition to these, the 2007 data collection also included other species documented in Johnson (2007).

Levels of infestation, as a percent of target area, were calculated from RAM data using GIS for each target. The indicator ratings were assigned in response to a number of sources associated with ecological integrity assessment. These include Rondeau 2001, Neely et al. 2006 and Decker 2007a. The indicator ratings are comparable to those developed for conservation action plans in other areas (e.g. Lower Purgatorie, Huerfano Uplands, Laramie Foothills and the Rocky Mountain Front Range).

Indicator Measurements:

Date: 4/15/2008
Current Indicator Measurement: 0.07
Current Rating: Poor
Current rating comment: OSMP calculated the current (2006-7) percent cover for RAM species within six cover classes for each target. The percent of a target in the cover class "> 50%" was used for this indicator.
Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Riparian Areas
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: For documentation of the relevance of exotic species as an indicator, please see Key Ecological Attribute Indicator “Percent target area dominated by exotic species tracked through the RAM method”.

This indicator provides additional information about the extent of the target likely to become dominated by invasive species. This indicator was developed to provide advanced warning of changing conditions because a target may have not be dominated by RAM species, but those species might be approach dominance. The inclusion of this indicator will allow us to track these high occupancy areas and manage them before they become dominated by RAM species.

Indicator: Percent of target with prevalence of non-native species (Rapid Assessment Mapping)

Indicator Ratings:

Poor: >15%
Fair: 9-15%
Good: 3- <9%
Very Good: <3%
Indicator ratings comment: Levels of infestation were calculated from RAM data using GIS. OSMP staff looked for weed management plans or integrity assessments upon which to base thresholds; however, no examples were found for using sub-dominance (high occupancy) as a

leading indicator. Consequently, the indicator ratings for this indicator are based on professional judgment rather than the work of others. Because of the lower abundance by RAM species for this indicator, the percent of area for each indicator (tolerance of area occupied) is higher.
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:
Date: 4/15/2008
Current Indicator Measurement: 0.192
Current Rating: Poor
Current rating comment: OSMP calculated the current (2006-7) percent cover for RAM species within six cover classes for each target. The percent of a target in the cover classes "6-25%" and ">25 50%" were used for this indicator.
Confidence of the current rating: Medium

Desired Rating: Good

Conservation Target: Riparian Areas
Category: Condition
Key Attribute: Vegetation Structure
Key attribute comment: Cottonwood trees are a key attribute of western riparian ecosystems. Cottonwoods provide a number of valuable functions for the riparian ecosystem (bird habitat, thermoregulation of the stream, nutrient regulation, etc.) If riparian areas are to continue to have a cottonwood canopy, young cottonwoods are needed to replace the older trees.

Cottonwood regeneration is linked to a stream's hydrology. Cottonwoods need periodic, seasonal flooding, sediment deposition, appropriate attenuation rates, channel movement and other hydrological characteristics to establish and grow. Many (e.g. Rood and Mahoney 1990) suggest that the altered hydrology of most western streams (dams and water diversion) inhibits the establishment and growth of cottonwood seedlings. Given this, this indicator (cottonwood regeneration) may be useful as a surrogate for natural hydrology. In other words, achieving a "Good" or "Very Good" rating for this key attribute may mean that some ecologically important attributes of the stream's natural hydrology are present.

The presence/absence of cottonwood seedlings is not conclusive proof that a riparian forest is regenerating. Most (up to 90%) seedlings do not survive their first year (Johnson 2000). However, the presence of seedlings is measurable, whereas measuring cottonwood regeneration is much more difficult. The consequence of using this indicator is that rather than being a surrogate for the presence of natural hydrology, the indicator may only suggest that some attributes of natural hydrology exist.

Indicator: Cottonwood regeneration

Indicator Ratings:
Poor: < 25% of recruitment sites have cottonwood seedlings
Fair: 25-50% of recruitment sites have cottonwood seedlings
Good: 50-75% of recruitment sites have cottonwood seedlings
Very Good: > 75% of recruitment sites have cottonwood seedlings
Indicator ratings comment: The indicator ratings are based on the following conceptual model. Because cottonwoods produce a large number of seeds, one would expect most regeneration sites (depositional bars in and along the creek) to have at least one cottonwood seedling. Therefore, "Poor" is set to a condition where most (75%) of the regeneration sites lack any cottonwood seedlings and "Very Good" is set to a condition where most (75% or more) of regeneration sites have at least one cottonwood seedling. Based upon best professional judgment OSMP ecologists set the dividing line between "Fair" and "Good" to be half (50%) of the regeneration sites have at least one cottonwood seedling. If more than half of the regeneration sites have at least one

cottonwood seedling then the rating is "Good". If fewer than half of the regeneration sites have at least one cottonwood, then the rating is "Fair".

Indicator Measurements:

Current Rating: Fair
Current rating comment: Based on 1996 field data (D'Amico 1997)

Desired Rating: Good
Desired rating comment: See indicator rating descriptions

Conservation Target: Riparian Areas
Category: Condition
Key Attribute: Water Quality
Key attribute comment: Fish, macroinvertebrates and aquatic forms of amphibians require oxygen for survival. Low levels of dissolved oxygen can stress adult aquatic life and inhibit reproduction.

Indicator: Dissolved oxygen (lotic--flowing water habitats)

Indicator Ratings:

Poor: < 75% of sampling sites exceed the state water quality standards for dissolved oxygen
Fair: < 75% of sampling sites exceed the state water quality standards for dissolved oxygen (For coldwater streams: 7.0 mg/L during spawning season and 6.0 mg/L outside of spawning season. For warmwater streams: 5.0 mg/L).
Good: At least 75% of sampling sites exceed the state water quality standards for dissolved oxygen
Very Good: At least 75% of sampling sites exceed the state water quality standards for dissolved oxygen and at least 75% of sampling sites on coldwater streams have at least 9.0 mg/L dissolved oxygen during most of the growing season
Indicator ratings comment: State water quality standards (CDPHE 2008) are often the absolute minimum aquatic life needs for survival. Some more sensitive species can experience stress even when the standards are met. Consequently, we used the state standard as the cutoff point between "Fair" and "Good". The "Very Good" category adds a requirement that recognizes that optimal dissolved oxygen concentrations for spawning and fry/juvenile development are closer to 9-12 mg/L.

The Colorado dissolved oxygen water quality standard for coldwater streams is 7.0 mg/L during spawning season, and 6.0 mg/L outside of spawning season. The standard for warmwater streams is 5.0 mg/L.
Confidence of these indicator rating descriptions: High

Indicator Measurements:

Current Indicator Measurement: Unknown
Current rating comment: OSMP does not currently measure dissolved oxygen in the streams on OSMP property.
Confidence of the current rating: Medium

Desired Rating: Good
Desired rating comment: See indicator rating descriptions

Conservation Target: Riparian Areas
Category: Condition
Key Attribute: Water Quality
Key attribute comment: High levels of phosphorus are problematic for aquatic ecosystems causing excessive primary production typically in the form of algae and skewing the aquatic system's food web.

Indicator: Total phosphorus (lotic--flowing water habitats)

Indicator Ratings:

Poor: 75% or more of sampling sites have total phosphorus concentrations > 0.10 mg/L
Fair: < 75% of sampling sites have total phosphorus concentrations < 0.07 mg/L
Good: At least 75% of sampling sites have total phosphorus concentrations < 0.07 mg/L
Very Good: At least 75% of the warmwater sampling sites have total phosphorus concentrations < 0.06 mg/L and 75% of the coldwater sampling sites have total phosphorus concentrations < 0.007 mg/L
Indicator ratings comment: Most states, including Colorado, do not have a state standard for total phosphorus.

Given the position of OSMP streams on the landscape (close to the Continental Divide) and the area's bedrock composition, we expect that most streams should have few natural inputs of phosphorus and be characterized by low to moderate levels of productivity. In other words, most streams in the OSMP grassland are expected to be oligotrophic to mesotrophic in nature. Dodd et al. (1998) suggest the dividing line between moderately (mesotrophic) and highly (eutrophic) productive streams is a total phosphorus concentration of 0.07 mg/L. Beyea and Theel (2007) identify 25 µg/L (=0.025 mg/L) and 100 µg/L (=0.1 mg/L) as the stressor threshold for least-disturbed and most-distrubed sites in the Southern Rockies bioregion respectively. The Ohio EPA (1999) recommended a total phosphorus concentration of 0.08 mg/L in headwater (warmwater) streams to protect the streams' aquatic biotic integrity. While this work was primarily conducted on streams in the Midwest, we will use it in the absence of similar work conducted in this area. If we expect most streams in the planning area to have low to moderate levels of productivity, the dividing line suggested by Dodd et al. (1998) may be appropriate for the "Fair" to "Good" threshold for OSMP streams. The "Very Good" rating is based on the USEPA recommended target phosphorus concentrations for streams in sub-ecoregions that include the Boulder area (USEPA 2000a, USEPA 2001a). The "Poor" rating is based on USEPA's recommended threshold to protect against eutrophication (USEPA 1986). It is also conincident with Blake and Theel's (2007) threshold between moderately and most disturbed streams in the Southern Rockies bioregion.

It will be very hard or nearly impossible for portions of streams below wastewater treatment plants (WWTP) (if the stream receives the WWTP effluent) to be anything but "Poor". Because there are no state water quality standards for total phosphorus, total phosphorus in discharge is not typically measured or managed. Most WWTP do not have a means of removing total phosphorus from the waste stream.
Confidence of these indicator rating descriptions: High

Indicator Measurements:

Current Indicator Measurement: Unknown
Current rating comment: OSMP does not currently measure total phosphorus in the streams on OSMP property.
Confidence of the current rating: Medium

Desired Rating: Good

WHITE ROCKS

Conservation Target: White Rocks
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: The White Rocks was one of four known breeding locations for barn owls in Boulder County, and the only occurring within the Grassland Planning Area. The selection of the White Rocks as a conservation target for the Grassland Plan was due in part because the area has been used as nesting habitat in the past. The most recent barn owl observation was in 1992.

While more robust indicators (e.g., nesting success, number of birds, etc.) might provide greater certainty of successful conservation, limited resources (and management ability) suggest a minimal annual effort to detect the presence of breeding behavior through observational survey and call playbacks. Use of GPS units to map the location of nests (if any are found) may improve our ability monitor this indicator.

Indicator: Presence of breeding barn owls

Indicator Ratings:

Fair: barn owls absent
Good: barn owls present and exhibiting breeding behavior
Indicator ratings comment: These first iteration indicator ratings are meant to detect the presence of breeding barn owls. Our current inability to locate individuals suggests that OSMP consider the reasons that barn owls may have abandoned the White Rocks and take appropriate action. No "Good"/"Very Good" threshold or "Fair"/"Poor" threshold is suggest at this time.
Confidence of these indicator rating descriptions: Low

Indicator Measurements:

Date: 2/15/1992
Current Indicator Measurement: Barn owls have not been documented at the White Rocks since 1992.
Current Rating: Fair

Desired Rating: Good
Desired rating comment: Conservation of this target requires successful conservation of the barn owl. The species is not known to occur elsewhere on OSMP grasslands.

Conservation Target: White Rocks
Category: Condition
Key Attribute: Animal Species Composition
Key attribute comment: In Boulder County, the six-lined racerunner is only known from sandy soils derived from the White Rocks cliffs. While indicators that are more robust might provide greater certainty of successful conservation, limited resources (and management ability) suggest the minimal effort of locating these lizards on an annual basis. Use of GPS units to map the location of lizard occurrences will improve our ability to detect trends in the extent of occupied habitat or abundance in the future.

Indicator: Presence of six-lined racerunner

Indicator Ratings:

Fair: No six-lined racerunners observed
Good: Six-lined racerunners observed

Indicator ratings comment: This first iteration indicator is meant to detect the disappearance of the racerunner. Inability to locate individuals could be cause to alter the management of this area. No "Good"/"Very Good" threshold or "Fair"/"Poor" threshold is suggest at this time.

Indicator Measurements:

Date: 8/15/1997
Current Indicator Measurement: The presence of racerunners was last documented in 1992. There are no records of more recent surveys.
Current Rating: Good
Current rating comment: Most recent documentation of this lizard comes from Dale who found racerunners repeatedly at the White Rocks in 1992. Livo observed two on the nearby Culver property in 1996. Undocumented observations have been reported as recently as 2002. Current status is unknown (Dale and Merritt 1993, Livo 1997).

Desired Rating: Good

Conservation Target: White Rocks
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: The White Rocks is the only known locality in Colorado for the black spleenwort, and one of a handful of populations known in North America. Its conservation is of ecoregional/continental importance.

Indicator: Abundance of black spleenwort

Indicator Ratings:

Poor: Plants not evident in documented locations, or elsewhere
Fair: Portion of transect occupied by green fronds reduced by over ten percent when compared to 1983 baseline. Eastern population present.
Good: Portion of transect occupied by green fronds stable or reduced by no more than ten percent when compared to 1983 baseline. Eastern population present.
Very Good: Portion of transect occupied by green fronds stable or increasing when compared to 1983 baseline. Eastern population present.
Indicator ratings comment: The individual ratings were based on the only available baseline information, a 1983 census (Keammerer 1983). The population had never been studied prior to 1983, and the location probably received very little human activity. Therefore, it is felt that this point represents a reasonable starting point or baseline for monitoring. There is no information about natural fluctuations of this population. However, given the stable environment, relative inaccessibility of the plants and anecdotal observations by rangers and biologists throughout the past decades, it is thought that the populations probably do not shift dramatically over time. The ten percent reduction threshold separating "Fair" and "Good" was chosen because it was thought to represent a level of change that included some amount of natural variability. Therefore, when the population drops by more than 10% in a single year, additional management is needed.

Indicator Measurements:

Date: 12/15/2005
Current Indicator Measurement: Unknown
Current rating comment: Visual observation indicates that the populations of black spleenwort continue in much the way as they have always existed since first being identified at the White Rocks.

Desired Rating: Good

Desired rating comment: OSMP desires to conserve the White Rocks by conserving the rare plant and animal species that occupy the area. Conservation of this plant is one component of that work.

Other comments: The fern has been recorded from the Weiser conservation easement. The rare plant crew should request permission to search for the plant there and document any new locations. These may be added to the monitoring program.

Conservation Target: White Rocks
Category: Condition
Key Attribute: Vegetation Composition
Key attribute comment: The White Rocks supports several plant species uncommon in Boulder County. These are:
Fork-tipped three awn (*Aristida basiramea*): rare in Colorado; edge of range
American groundnut (*Apios americana*): rare in Colorado; edge of range
Narrowleaf four o'clock (*Oxybaphus decumbens*): rare; sand endemic
Silky sophora (*Vexibia nuttalliana*): rare; sand endemic
Lemon scurfpea (*Psoralidium lanceolatum*): rare; sand endemic
Plains black nightshade (*Solanum americanum*): rare; sand endemic

The absence of an active threat and limited resources (and management ability) suggest minimal effort of locating these plants on an annual basis. Use of GPS units to map the location of individual plants and patches will improve our ability to detect trends in patch size or abundance in the future.

Indicator: Presence of full suite of rare species

Indicator Ratings:

Fair: One or more species absent
Good: Suite of rare species present
Indicator ratings comment: These first iteration indicator ratings are meant to detect the disappearance of any of the listed rare plant species. Inability to locate individuals of any species could be cause to alter the management of this area. No "Good"/"Very Good" threshold or "Fair"/"Poor" threshold is suggest at this time.
Confidence of these Indicator rating descriptions: Medium

Indicator Measurements:

Current Indicator Measurement: Unknown
Current Rating: Good
Current rating comment: The most current information available for these plants is the work of Clark et al. (2001). All species were located at that time.
Confidence of the current rating: Low

Desired Rating: Good
Desired rating comment: Conservation of this target requires successful conservation of these species that are not known to occur elsewhere on OSMP grasslands.

Conservation Target: White Rocks
Category: Size
Key Attribute: Relative Protected Area
Key attribute comment: The nested targets found at White Rocks are of limited distribution in the Grassland Planning Area. Some occur no where else in the planning area, county or state. OSMP seeks to ensure protection of the area to ensure protection of these rare species occurrences. Development of the property would likely result in loss of the nested targets. Land uses associated with undeveloped areas in Boulder County (agricultural, recreation) could also result in damage to habitat or loss of the nested target.

Indicator: Percent of area in conservation ownership

Indicator Ratings:

Poor: 0-75%
Fair: >75-90%
Good: >90-<100%
Very Good: 1
Indicator ratings comment: These indicators merely represent the direct relationship between conservation success and proportion of the area in protective status. The target is relatively small, so the acceptable range of variation was skewed toward conservation ownership for the entire area.
Confidence of these Indicator rating descriptions: High

Indicator Measurements:

Date: 7/15/2008
Current Rating: Very Good

Desired Rating: Very Good

APPENDIX E: Conservation Issue Rating Methods (from TNC 2007)

Conservation Issues Analyses – Overview (Stresses, Sources of Stress, Underlying Causes)
Stresses represent altered or impaired key ecological attributes that reduce the viability of our conservation targets. Sources of Stress represent the proximate cause of the stress (e.g., river channelization, overharvesting, fire suppression). Many sources of stress are driven by social, economic or political underlying causes that often are the focus of our conservation strategies.

Stress Ranking: Severity
Severity of Damage -- the level of damage to the conservation target that can reasonably be expected within 10 years under current circumstances (i.e., given the continuation of the existing situation).

- Very High: Likely to destroy or eliminate the conservation target over some portion of the target's occurrence at the site.
- High: Likely to seriously degrade the conservation target over some portion of the target's occurrence at the site.
- Medium: Likely to moderately degrade the conservation target over some portion of the target's occurrence at the site.
- Low: Likely to only slightly impair the conservation target over some portion of the target's occurrence at the site.

Stress Ranking: Scope
Scope of Damage -- the geographic scope of impact on the conservation target at the site that can reasonably be expected within 10 years under current circumstances (i.e., given the continuation of the existing situation).

- Very High: Likely to be very widespread or pervasive in its scope, and affect the conservation target throughout the target's occurrences at the site.
- High: Likely to be widespread in its scope, and affect the conservation target at many of its locations at the site.
- Medium: Likely to be localized in its scope, and affect the conservation target at some of the target's locations at the site.
- Low: Likely to be very localized in its scope, and affect the conservation target at a limited portion of the target's location at the site.

Source of Stress Ranking: Irreversibility
Irreversibility -- reversibility of the stress caused by the Source of Stress.

- Very High: Not reversible (e.g., wetlands converted to a shopping center).
- High: Reversible, but not practically affordable (e.g., wetland converted to agriculture).
- Medium: Reversible with a reasonable commitment of resources (e.g., ditching and draining of wetland).
- Low: Easily reversible at relatively low cost (e.g., off-road vehicles trespassing in wetland).

Source of Stress Ranking: Contribution

Contribution -- expected contribution of the source, acting alone, to the full expression of a stress (as determined in the stress assessment) under current circumstances (i.e., given the continuation of the existing management/ conservation situation).

- Very High: The source is a very large contributor of the particular stress.
- High: The source is a large contributor of the particular stress.
- Medium: The source is a moderate contributor of the particular stress.
- Low: The source is a low contributor of the particular stress.

APPENDIX F: Conservation Issue Assessment Details

1 Mixedgrass Prairie Mosaic

	Stresses	Severity	Scope	Stress Rank	User Override
1	Altered Fire Regime	Medium	Very High	Medium	
2	Altered Vegetation Composition and Structure	High	Very High	High	
3	Altered Animal Community Composition	High	Very High	High	

1. Mixedgrass Prairie Mosaic

Threats - Sources of Stress	Altered Fire Regime	Altered Vegetation Composition and Structure	Altered Animal Community Composition	-	-	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*Medium*	*High*	*High*	-	-	-	-	-

1. Incompatible Prairie Dog Activity (Grazing/Burrowing) *(Problematic Native Species)* Threat to Target Rank: High

Contribution	Medium	High	High					
Irreversibility	High	High	High					
Threat Rank (override)								
Threat Rank	Low	High	High	-	-	-	-	-

2. Incompatible Agricultural Practices *(Livestock Farming & Ranching)* Threat to Target Rank: Medium

Contribution	Low	High	High					
Irreversibility	Low	Low	Low					
Threat Rank (override)								
Threat Rank	Low	Medium	Medium	-	-	-	-	-

3. Incompatible Trails/Recreation *(Recreational Activities)* Threat to Target Rank: High

Contribution		Medium	High					
Irreversibility		High	High					
Threat Rank (override)								
Threat Rank	-	Medium	High	-	-	-	-	-

1. Mixedgrass Prairie Mosaic

Threats - Sources of Stress	Altered Fire Regime	Altered Vegetation Composition and Structure	Altered Animal Community Composition	-	-	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*Medium*	*High*	*High*	-	-	-	-	-

4. Invasive Plant Species *(Invasive Non-Native/Alien Species)* Threat to Target Rank: High

Contribution		Very High	High					
Irreversibility		High	High					
Threat Rank (override)								
Threat Rank	-	High	High	-	-	-	-	-

5. Incompatible Dog Management by Guardians *(Invasive Non-Native/Alien Species)* Threat to Target Rank: High

Contribution			High					
Irreversibility			high					
Threat Rank (override)								
Threat Rank	-	-	High	-	-	-	-	-

6. Incompatible Surrounding Land Use *(Housing & Urban Areas)* Threat to Target Rank: High

Contribution		Low	Very High					
Irreversibility		High	Very High					
Threat Rank (override)								
Threat Rank	-	Medium	High	-	-	-	-	-

1. Mixedgrass Prairie Mosaic

Threats - Sources of Stress	Altered Fire Regime	Altered Vegetation Composition and Structure	Altered Animal Community Composition	-	-	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*Medium*	*High*	*High*	-	-	-	-	-

7. Inappropriate Fire Management *(Fire & Fire Suppression)* Threat to Target Rank: High

Contribution	Very High	Very High	Medium					
Irreversibility	High	High	Medium					
Threat Rank (override)								
Threat Rank	Medium	High	Medium	-	-	-	-	-

2 Xeric Tallgrass Prairie

	Stresses	Severity	Scope	Stress Rank	User Override
1	Altered Fire Regime	High	High	High	
2	Altered Vegetation Composition and Structure	High	High	High	
3	Altered Animal Community Composition	High	High	High	

2. Xeric Tallgrass Prairie

Threats - Sources of Stress	Altered Fire Regime	Altered Vegetation Composition and Structure	Altered Animal Community Composition	-	-	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*High*	*High*	*High*	-	-	-	-	-

1. Incompatible Prairie Dog Activity (Grazing/Burrowing) *(Problematic Native Species)* Threat to Target Rank: Medium

Contribution	Low	Low	Low					
Irreversibility	Very High	Very High	Very High					
Threat Rank (override)								
Threat Rank	Medium	Medium	Medium	-	-	-	-	-

2. Incompatible Agricultural Practices *(Livestock Farming & Ranching)* Threat to Target Rank: Low

Contribution	Low	Medium	Medium					
Irreversibility	Low	Low	Low					
Threat Rank (override)								
Threat Rank	Low	Low	Low	-	-	-	-	-

3. Incompatible Trails/Recreation *(Recreational Activities)* Threat to Target Rank: High

Contribution		Medium	High					
Irreversibility		High	High					
Threat Rank (override)								
Threat Rank	-	Medium	High	-	-	-	-	-

2. Xeric Tallgrass Prairie

Threats - Sources of Stress	Altered Fire Regime	Altered Vegetation Composition and Structure	Altered Animal Community Composition	-	-	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*High*	*High*	*High*	-	-	-	-	-

4. Invasive Plant Species *(Invasive Non-Native/Alien Species)* Threat to Target Rank: High

Contribution		Very High	High					
Irreversibility		High	High					
Threat Rank (override)								
Threat Rank	-	High	High	-	-	-	-	-

3 Mesic Bluestem Prairie

	Stresses	Severity	Scope	Stress Rank	User Override
1	Altered Fire Regime	Medium	High	Medium	
2	Altered Vegetation Composition and Structure	High	High	High	
3	Altered Animal Community Composition	High	High	High	
4	Altered Hydrologic Regime	High	Medium	Medium	
5	Habitat Destruction	Very High	Medium	Medium	

3. Mesic Bluestem Prairie

Threats - Sources of Stress	Altered Fire Regime	Altered Vegetation Composition and Structure	Altered Animal Community Composition	Altered Hydrologic Regime	Habitat Destruction	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*Medium*	*High*	*High*	*Medium*	*Medium*	-	-	-

1. Incompatible Agricultural Practices *(Livestock Farming & Ranching)* Threat to Target Rank: Medium

Contribution	Low	High	Medium					
Irreversibility	Low	Low	Low					
Threat Rank (override)								
Threat Rank	Low	Medium	Low	-	-	-	-	-

2. Incompatible Trails/Recreation *(Recreational Activities)* Threat to Target Rank: High

Contribution		Medium	High					
Irreversibility		High	High					
Threat Rank (override)								
Threat Rank	-	Medium	High	-	-	-	-	-

3. Invasive Plant Species *(Invasive Non-Native/Alien Species)* Threat to Target Rank: High

Contribution		Very High	Medium					
Irreversibility		High	High					
Threat Rank (override)								
Threat Rank	-	High	Medium	-	-	-	-	-

3. Mesic Bluestem Prairie

Threats - Sources of Stress	Altered Fire Regime	Altered Vegetation Composition and Structure	Altered Animal Community Composition	Altered Hydrologic Regime	Habitat Destruction	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*Medium*	*High*	*High*	*Medium*	*Medium*	-	-	-

4. Incompatible Dog Management by Guardians *(Invasive Non-Native/Alien Species)* Threat to Target Rank: Low

Contribution			Low					
Irreversibility			Medium					
Threat Rank (override)								
Threat Rank	-	-	Low	-	-	-	-	-

5. Incompatible Surrounding Land Use *(Housing & Urban Areas)* Threat to Target Rank: High

Contribution		High	Very High	Medium				
Irreversibility		Very High	Very High	Very High				
Threat Rank (override)								
Threat Rank	-	High	High	Medium	-	-	-	-

6. Incompatible Water Management/Use *(Dams & Water Management/Use)* Threat to Target Rank: Low

Contribution				Low	Medium			
Irreversibility				Medium	High			
Threat Rank (override)								
Threat Rank	-	-	-	Low	Low	-	-	-

3. Mesic Bluestem Prairie

Threats - Sources of Stress	Altered Fire Regime	Altered Vegetation Composition and Structure	Altered Animal Community Composition	Altered Hydrologic Regime	Habitat Destruction	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*Medium*	*High*	*High*	*Medium*	*Medium*	-	-	-

7. Inappropriate Fire Management *(Fire & Fire Suppression)* Threat to Target Rank: High

Contribution	Very High	High	Low					
Irreversibility	High	High	Medium					
Threat Rank (override)								
Threat Rank	Medium	High	Low	-	-	-	-	-

8. Deferred Maintenance of Irrigation Infrastructure Threat to Target Rank: Low

Contribution		Medium	Medium	Medium	Medium			
Irreversibility		Low	Low	Medium	Low			
Threat Rank (override)								
Threat Rank	-	Low	Low	Low	Low	-	-	-

4 Agricultural Operations

	Stresses	Severity	Scope	Stress Rank	User Override
1	Altered Availability of Land	Medium	Medium	Medium	
2	Altered Soil Fertility	Medium	Low	Low	
3	Reduced Ability to Irrigate	High	Medium	Medium	
4	Enhanced Mortality	High	Low	Low	

4. Agricultural Operations

Threats - Sources of Stress	Altered Availability of Land	Altered Soil Fertility	Reduced Ability to Irrigate	Enhanced Mortality	-	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*Medium*	*Low*	*Medium*	*Low*	-	-	-	-

1. Incompatible Prairie Dog Activity (Grazing/Burrowing) *(Problematic Native Species)* Threat to Target Rank: Medium

Contribution	High	Medium	High					
Irreversibility	High	High	High					
Threat Rank (override)								
Threat Rank	Medium	Low	Medium	-	-	-	-	-

2. Deferred Maintenance of Irrigation Infrastructure Threat to Target Rank: Medium

Contribution			Very High					
Irreversibility			Medium					
Threat Rank (override)								
Threat Rank	-	-	Medium	-	-	-	-	-

3. Incompatible Trails/Recreation *(Recreational Activities)* Threat to Target Rank: Low

Contribution	Medium		Low					
Irreversibility	Medium		High					
Threat Rank (override)								
Threat Rank	Low	-	Low	-	-	-	-	-

4. Agricultural Operations

Threats - Sources of Stress		Altered Availability of Land	Altered Soil Fertility	Reduced Ability to Irrigate	Enhanced Mortality	-	-	-	-
Stresses	#	1	2	3	4	5	6	7	8
	Rank	*Medium*	*Low*	*Medium*	*Low*	-	-	-	-

4. Invasive Plant Species *(Invasive Non-Native/Alien Species)* Threat to Target Rank: Low

Contribution	Medium							
Irreversibility	High							
Threat Rank (override)								
Threat Rank	Low	-	-	-	-	-	-	-

5. Inappropriate Fire Management *(Fire & Fire Suppression)* Threat to Target Rank: Low

Contribution	Low							
Irreversibility	Low							
Threat Rank (override)								
Threat Rank	Low	-	-	-	-	-	-	-

6. Incompatible Agricultural Practices *(Livestock Farming & Ranching)* Threat to Target Rank: Low

Contribution				High				
Irreversibility				Low				
Threat Rank (override)								
Threat Rank	-	-	-	Low	-	-	-	-

5 Black-Tailed Prairie Dog and Associates

	Stresses	Severity	Scope	Stress Rank	User Override
1	Altered Animal Community Composition	Very High	Very High	Very High	
2	Altered Vegetation Composition and Structure	Medium	High	Medium	
3	Excessive Predation/Mortality	High	Very High	High	

5. Black-Tailed Prairie Dog and Associates

Threats - Sources of Stress	Altered Animal Community Composition	Altered Vegetation Composition and Structure	Excessive Predation/Mortality	-	-	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*Very High*	*Medium*	*High*	-	-	-	-	-

1. Incompatible Surrounding Land Use *(Housing & Urban Areas)* Threat to Target Rank: Very High

Contribution	Very High	High						
Irreversibility	Very High	Very High						
Threat Rank (override)								
Threat Rank	Very High	Medium	-	-	-	-	-	-

2. Incompatible Agricultural Practices *(Livestock Farming & Ranching)* Threat to Target Rank: High

Contribution		Very High	High					
Irreversibility		High	High					
Threat Rank (override)								
Threat Rank	-	Medium	High	-	-	-	-	-

3. Invasive Plant Species *(Invasive Non-Native/Alien Species)* Threat to Target Rank: Medium

Contribution		High						
Irreversibility		High						
Threat Rank (override)								
Threat Rank	-	Medium	-	-	-	-	-	-

5. Black-Tailed Prairie Dog and Associates

Threats - Sources of Stress	Altered Animal Community Composition	Altered Vegetation Composition and Structure	Excessive Predation/Mortality	-	-	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*Very High*	*Medium*	*High*	-	-	-	-	-

4. Incompatible Trails/Recreation *(Recreational Activities)* Threat to Target Rank: Very High

Contribution	Very High							
Irreversibility	High							
Threat Rank (override)								
Threat Rank	Very High	-	-	-	-	-	-	-

5. Sylvatic Plague *(Invasive Non-Native/Alien Species)* Threat to Target Rank: High

Contribution	High		High					
Irreversibility	Medium		Medium					
Threat Rank (override)								
Threat Rank	High	-	Medium	-	-	-	-	-

6. Incompatible Dog Management by Guardians *(Invasive Non-Native/Alien Species)* Threat to Target Rank: Very High

Contribution	Very High							
Irreversibility	Medium							
Threat Rank (override)								
Threat Rank	Very High	-	-	-	-	-	-	-

6 Wetlands

	Stresses	Severity	Scope	Stress Rank	User Override
1	Altered Vegetation Composition and Structure	High	High	High	
2	Altered Animal Community Composition	Very High	High	High	
3	Altered Hydrologic Regime	High	Medium	Medium	
4	Altered Water Quality	Medium	Medium	Medium	
5	Habitat Fragmentation	High	Medium	Medium	
6	Disease	Very High	Very High	Very High	
7	Habitat Destruction	Very High	Medium	Medium	

6. Wetlands

Threats - Sources of Stress	Altered Vegetation Composition and Structure	Altered Animal Community Composition	Altered Hydrologic Regime	Altered Water Quality	Habitat Fragmentation	Disease	Habitat Destruction	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*High*	*High*	*Medium*	*Medium*	*Medium*	*Very High*	*Medium*	-

1. Invasive Animal Species *(Invasive Non-Native/Alien Species)* Threat to Target Rank: Very High

Contribution	Low	High		Low		High		
Irreversibility	High	Very High		Very High		High		
Threat Rank (override)								
Threat Rank	Medium	High	-	Low	-	Very High	-	-

2. Incompatible Dog Management by Guardians *(Invasive Non-Native/Alien Species)* Threat to Target Rank: High

Contribution	Low	Medium		Medium		Low		
Irreversibility	High	High		High		High		
Threat Rank (override)								
Threat Rank	Medium	Medium	-	Low	-	High	-	-

3. Invasive Plant Species *(Invasive Non-Native/Alien Species)* Threat to Target Rank: High

Contribution	Very High	High	Low	Low				
Irreversibility	High	High	Medium	High				
Threat Rank (override)								
Threat Rank	High	High	Low	Low	-	-	-	-

6. Wetlands

Threats - Sources of Stress	Altered Vegetation Composition and Structure	Altered Animal Community Composition	Altered Hydrologic Regime	Altered Water Quality	Habitat Fragmentation	Disease	Habitat Destruction	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*High*	*High*	*Medium*	*Medium*	*Medium*	*Very High*	*Medium*	-

4. Incompatible Water Management/Use *(Dams & Water Management/Use)* Threat to Target Rank: Medium

	1	2	3	4	5	6	7	8
Contribution	Medium	Medium	Very High		Very High		Medium	
Irreversibility	High	High	Medium		Very High		High	
Threat Rank (override)								
Threat Rank	Medium	Medium	Medium	-	Medium	-	Low	-

5. Incompatible Surrounding Land Use *(Housing & Urban Areas)* Threat to Target Rank: High

	1	2	3	4	5	6	7	8
Contribution	Medium	High	Medium	Medium	High			
Irreversibility	Very High	Very High	Very High	Very High	Very High			
Threat Rank (override)								
Threat Rank	High	High	Medium	Medium	Medium	-	-	-

6. Incompatible Agricultural Practices *(Livestock Farming & Ranching)* Threat to Target Rank: High

	1	2	3	4	5	6	7	8
Contribution	Medium	Medium		Medium	Low	Low		
Irreversibility	Medium	Medium		Medium	Medium	Very High		
Threat Rank (override)								
Threat Rank	Medium	Medium	-	Low	Low	High	-	-

6. Wetlands

Threats - Sources of Stress	Altered Vegetation Composition and Structure	Altered Animal Community Composition	Altered Hydrologic Regime	Altered Water Quality	Habitat Fragmentation	Disease	Habitat Destruction	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*High*	*High*	*Medium*	*Medium*	*Medium*	*Very High*	*Medium*	-

7. Incompatible Trails/Recreation *(Recreational Activities)* Threat to Target Rank: Very High

Contribution	High	High		Medium	High	High		
Irreversibility	High	High		High	High	High		
Threat Rank (override)								
Threat Rank	High	High	-	Low	Medium	Very High	-	-

8. Deferred Maintenance of Irrigation Infrastructure Threat to Target Rank: Low

Contribution	Medium	Medium	Medium				Medium	
Irreversibility	Low	Low	Low				Low	
Threat Rank (override)								
Threat Rank	Low	Low	Low	-	-	-	Low	-

7 Riparian Areas

	Stresses	Severity	Scope	Stress Rank	User Override
1	Habitat Fragmentation	High	High	High	
2	Altered Water Quality	Medium	Medium	Medium	
3	Altered Animal Community Composition	Very High	High	High	
4	Altered Hydrologic Regime	Very High	Very High	Very High	
5	Altered Vegetation Composition and Structure	High	High	High	

7. Riparian Areas

Threats - Sources of Stress	Habitat Fragmentation	Altered Water Quality	Altered Animal Community Composition	Altered Hydrologic Regime	Altered Vegetation Composition and Structure	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*High*	*Medium*	*High*	*Very High*	*High*	-	-	-

1. Incompatible Trails/Recreation *(Recreational Activities)* Threat to Target Rank: High

Contribution	High	Medium	High		Medium			
Irreversibility	High	High	High		High			
Threat Rank (override)								
Threat Rank	High	Low	High	-	Medium	-	-	-

2. Incompatible Surrounding Land Use *(Housing & Urban Areas)* Threat to Target Rank: Very High

Contribution	Very High	Very High	Very High	High	Medium			
Irreversibility	Very High	Very High	Very High	Very High	Very High			
Threat Rank (override)								
Threat Rank	High	Medium	High	Very High	High	-	-	-

3. Incompatible Water Management/Use *(Dams & Water Management/Use)* Threat to Target Rank: Very High

Contribution	Very High	Low	Medium	Very High	High			
Irreversibility	High	Very High	Very High	High	High			
Threat Rank (override)								
Threat Rank	High	Low	High	Very High	High	-	-	-

7. Riparian Areas

Threats - Sources of Stress	Habitat Fragmentation	Altered Water Quality	Altered Animal Community Composition	Altered Hydrologic Regime	Altered Vegetation Composition and Structure	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*High*	*Medium*	*High*	*Very High*	*High*	-	-	-

4. Incompatible Dog Management by Guardians *(Invasive Non-Native/Alien Species)* Threat to Target Rank: Medium

Contribution	Medium	Medium	Medium		Low			
Irreversibility	High	High	High		High			
Threat Rank (override)								
Threat Rank	Medium	Low	Medium	-	Medium	-	-	-

5. Incompatible Agricultural Practices *(Livestock Farming & Ranching)* Threat to Target Rank: Medium

Contribution	Low	Low	Medium		Medium			
Irreversibility	Medium	Medium	Medium		Medium			
Threat Rank (override)								
Threat Rank	Low	Low	Medium	-	Medium	-	-	-

6. Invasive Plant Species *(Invasive Non-Native/Alien Species)* Threat to Target Rank: High

Contribution	Low	Low		Low	Very High			
Irreversibility	High	Low		Medium	High			
Threat Rank (override)								
Threat Rank	Medium	Low	-	Medium	High	-	-	-

7. Riparian Areas

Threats - Sources of Stress	Habitat Fragmentation	Altered Water Quality	Altered Animal Community Composition	Altered Hydrologic Regime	Altered Vegetation Composition and Structure	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*High*	*Medium*	*High*	*Very High*	*High*	-	-	-

7. Invasive Animal Species *(Invasive Non-Native/Alien Species)* Threat to Target Rank: High

	1	2	3	4	5	6	7	8
Contribution		Low	Very High					
Irreversibility		Very High	Very High					
Threat Rank (override)								
Threat Rank	-	Low	High	-	-	-	-	-

8. Great Horned Owls *(Problematic Native Species)* Threat to Target Rank: Medium

	1	2	3	4	5	6	7	8
Contribution			Low					
Irreversibility			High					
Threat Rank (override)								
Threat Rank	-	-	Medium	-	-	-	-	-

8 White Rocks

	Stresses	Severity	Scope	Stress Rank	User Override
1	Altered Animal Community Composition	High	Very High	High	
2	Altered Vegetation Composition and Structure	Medium	Very High	Medium	

8. White Rocks

Threats - Sources of Stress	Altered Animal Community Composition	Altered Vegetation Composition and Structure	-	-	-	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*High*	*Medium*	-	-	-	-	-	-

1. Incompatible Agricultural Practices *(Livestock Farming & Ranching)* Threat to Target Rank: Medium

Contribution	High	High						
Irreversibility	Low	Low						
Threat Rank (override)								
Threat Rank	Medium	Low	-	-	-	-	-	-

2. Invasive Plant Species *(Invasive Non-Native/Alien Species)* Threat to Target Rank: High

Contribution	High	High						
Irreversibility	High	High						
Threat Rank (override)								
Threat Rank	High	Medium	-	-	-	-	-	-

3. Great Horned Owls *(Problematic Native Species)* Threat to Target Rank: Low

Contribution	Very High							
Irreversibility	Very High							
Threat Rank (override)	Low							
Threat Rank	Low	-	-	-	-	-	-	-

8. White Rocks

Threats - Sources of Stress	Altered Animal Community Composition	Altered Vegetation Composition and Structure	-	-	-	-	-	-
Stresses #	1	2	3	4	5	6	7	8
Rank	*High*	*Medium*	-	-	-	-	-	-

4. Incompatible Trails/Recreation *(Recreational Activities)* Threat to Target Rank: High

Contribution	Very High							
Irreversibility	Low							
Threat Rank (override)								
Threat Rank	High	-	-	-	-	-	-	-

APPENDIX G: Visitor Services in the Grassland Planning Area

OSMP encourages a myriad of visitor experiences in the Grassland Planning Area. Access and enjoyment are supported by 31 trailheads (74% of all trailheads on OSMP) and 80 miles (56% of the total miles in OSMP) of trails. These include the Dry Creek and South Boulder Creek Trails--some of the most visited trails on the OSMP land system. About 22 miles of these trails have been built to be wheelchair accessible. Among other activities, visitors enjoy biking, hiking, running, horseback riding, hang/para-gliding, nature study, dog walking, painting, meditating and photography in the Grassland Planning Area.

Open Space and Mountain Parks seeks to provide a variety of opportunities for passive recreation. The generally flat terrain of the Grassland Planning Area makes for easy hiking, biking and running in contrast to the trails in the mountain backdrop, which tend to be steeper and more challenging. The trails system in the grasslands also provides variety in terms of the length of one's visit. There are long distance opportunities for those interested in spending hours running or biking, or the full day hiking. Opportunities for short trips also abound. Visitors have trail access to not only open grasslands with their spectacular views of open country and the distant forested foothills but also to shaded streamside areas where one can fish or just enjoy a break from the heat during hot summer days.

The open nature of grasslands provides exceptional wildlife viewing opportunities year round. Birding opportunities are especially rich given the diversity of habitat types, and the winter offers the special treat of abundant raptors especially around prairie dog colonies. Prairie dogs colonies are easily visible from trail where large numbers of animals are active during the day engaging in many interesting behaviors. They are popular destinations for families with children and out of town guests.

Other opportunities for nature study include the diversity of plant life and plant communities. Grassland wildflowers begin blooming early in spring and continue through autumn, each week bringing a new composition of colors, species and diversity of blooms. Working farming and ranching operations are also of great interest to OSMP visitors who enjoy seeing livestock, especially the playful calves and foals in the spring. The cycle of haying operations also adds visual interest to the landscape. As the fields are cut, the hay lies in windrows, then in bales on the newly mown fields.

OSMP offers formal education programs, informal outreach programs, interpretive materials and volunteer opportunities to enhance visitors' enjoyment of the grassland and provide ways to learn about these ecosystems.

OSMP provides free, guided nature hikes for schools, community groups and the public in the Grassland Planning Area. Between 2005 and 2008, 73 CU, K-12 school and scout groups took part in nature programs focused on grassland related topics. Seventy groups participated in educational programs about riparian and wetland areas associated with grasslands. During the same time, OSMP staff led 93 guided "Natural Selections" nature hikes offered to the public that specifically focused on prairie ecosystems, including prairie dog towns, the uniqueness of the tallgrass prairie, Native Americans, pioneers, grassland plants and birds, nature journaling, photography, geology, rejuvenation hikes and special-areas focus in the Southern and Northern Grassland HCAs. Although most trips are hikes, some are bicycle or wheelchair tours.

OSMP offers five to ten wheelchair accessible hikes each year, primarily in the grasslands, highlighting the rich flora and fauna of these areas. There are also joint wheelchair hikes with Audubon society twice a year focused on bird watching in the grasslands. Each year we sponsor an Adaptive Mountain Bike Clinic, offering wheelchair users the chance to use all terrain wheelchairs on some challenging trails in the grasslands.

In 2004, OSMP helped organize and participated in a regional Grassland BioBlitz. The overarching purpose was to conduct a 24-hour species inventory of grassland ecosystems to capture a snapshot of the species diversity and richness. Ecologists collected and counted plant and animal species on the Jewel Mountain OSMP property. Concurrently, OSMP's education staff provided hikes into the area as well as interpretive stations where the public could learn about what the scientists had found and the area's biodiversity in general.

In addition to staff led activities, OSMP seeks to enhance the visitor experience through interpretive signs located throughout the system including: prairie dog signs on Foothills Trail, mining and local history signs at the Marshall Mesa trailhead and grassland ecosystem signs along the new Spring Brook Loop trail. Additional grassland interpretive signs are planned for the expanded trailheads at Flatirons Vista and Doudy Draw.

OSMP's printed materials also encourage visitors to get to know their grasslands. Sections of the Marshall Mesa and Doudy Draw / Eldorado Mountain brochures focus on the prairie, and OSMP grasslands were the feature article in the Winter 2002 issue of the ***Open Space Naturally*** newsletter. The free OSMP wildflower brochure provides color illustrations of many grassland plants, and ***Walking through History on Marshall Mesa*** explores the coal mining history of this area in an ecological context.

Other venues for sharing the richness and beauty of the grasslands include a 2008 video, produced by OSMP about the restoration of the Coal Creek riparian area. The video has been featured on Boulder's television channel.

Staffed interpretive tables at trailheads are another way OSMP communicates messages to visitors. This type of outreach has occurred annually at many trailheads in the grasslands, including but not limited to: Chautauqua Trailhead, Sanitas, Bobolink, Marshall Mesa, Doudy Draw, Flatirons Vista, South Mesa, Dry Creek, and Foothills Trails. These interpretive tables may have an animal mount (such as a prairie dog, badger or hawk), some scat samples of animals active in the area recently and a flower brochure to enrich the visitor's awareness of their surroundings and inform the hike they are about to take. Staff at the table answer questions and are prepared to share vignettes about the area or current information about OSMP management. Trailhead outreach is also used to inform people about guided hikes and invite people to visit new trails as they open.

Not all outreach is stationary. OSMP staff and volunteers have been roving trails, with a focus on enhancing the visitor's experience with information or just a friendly smile.

OSMP's exceptionally creative and popular Meadow Music program was originally designed to be given in the Chautauqua meadow. It has become so popular, with hundreds attending each week, that it has been moved to the larger nearby Chautauqua Park. The music, written and performed by OSMP staff, uses comedy and prose to sing to the beauty and complexity of our locally preserved lands, including OSMP's grasslands.

At Boulder's Farmers' Market OSMP has staffed a booth that often included displays of plants and animals found on the prairie. Conversational topics include issues such as weeds and their management, dogs and the natural history of prairie dogs, coyotes, foxes, raptors and other denizens of the prairie.

Some community members find on-going volunteerism their preferred way to connect with and pursue in depth understanding of OSMP's grasslands. The Department provides many opportunities for volunteers. In 2008, more than 700 volunteers contributed over 11,000 hours in the grasslands helping staff in the following programs:

- Herbarium volunteers collect plant specimens for OSMP's herbarium and monitor rare plants and weeds. Some of these volunteers have been part of the program for more than 20 years.
- Wildlife monitors track bats, frogs, hayfield birds and raptors.
- Trail Guides visit trails, enhancing visitors' experiences by providing information on area features, natural and cultural history and seasonal management.
- The Stewardship Program provides opportunities for individuals, families, businesses and organizations to learn about and care for the land through shared work in the field. Projects include habitat restoration, area and trail care, and building and restoring trails and structures.
- Volunteer Naturalists provide nature programs, mostly interpretive hikes, for children and adults throughout the year.
- Hosts greet the public and provide information and outreach at community events, trailheads and facilities.

OSMP will continue to offer a wide variety of opportunities for the public to learn about and participate in grasslands. All visitors approach OSMP from a unique place on a spectrum from awareness to appreciation to action. In structuring education and volunteer programs, OSMP will continue to provide venues for people to enjoy the grasslands at all points along that spectrum. Brochures, interpretive signs, staff at information tables and trail guides all provide brief contacts to raise awareness; nature hikes for the public and school groups create more in-depth experiences that foster appreciation. OSMP's many volunteer programs help visitors give back to the grasslands they have come to appreciate and to help spread the word to others.

APPENDIX H: Black-Tailed Prairie Dog Habitat Suitability Model

References for citations in appendices can be found in the "Literature Cited" section of the Grassland Plan

Introduction

OSMP developed a Habitat Suitability Model to predict where the best habitat for black-tailed prairie dogs was likely to be found in the Grassland Planning Area. Information about the location and extent of areas of suitable habitat was then combined with other factors (block size, trail density, proximity to human activity, known occurrences of sensitive prairie dog associates) to develop recommendations for management designations to conserve affected Grassland Plan targets.

Habitat Suitability Model

The GIS habitat suitability model for black-tailed prairie dogs developed by the Grassland Planning Team (planning team) was based completely upon ecological habitat attributes using the best available data. Previously published GIS-based habitat suitability models have used similar habitat variables, often with less precision than our model. For example, most models used vegetation classes derived from 30-m Landsat satellite imagery - such as GAP (Proctor 1998, Gribb et al. 2001). Such data is useful for large spatial scales (e.g., a statewide assessment) but over-generalizes vegetation classes at smaller spatial scales. Landsat imagery cannot distinguish between different grassland, forest and woodland community types and likely has difficulty differentiating riparian woodland from shrub land or other woodland types. The planning team's vegetation data were derived exclusively from field surveys recorded on one-meter aerial imagery. Vegetation communities as small as 0.25 acre (the equivalent of a square with 100-ft sides) can be discerned from these data. Field maps were entered into GIS as vector data allowing vegetation community boundaries to be more precisely drawn when compared to maps created from Landsat imagery.

Methods

Proctor (1998) found that vegetation and then slope were the two most important variables predicting prairie dog occupancy in Montana. Soil texture and soil depth, in that order, were included in Proctor's model but were less important in predicting occupancy.

The planning team used Model Builder in ArcInfo (ArcGIS, ESRI, Redlands, CA) to develop their habitat suitability model (Figure H-1). Each feature within each habitat variable was ranked, and then each habitat variable was weighted according to previous literature (Proctor 1998, Clippinger 1989, Gribb et al. 2001). Using Model Builder, each variable was converted to grid, and then reclassified before calculating the weighted geometric mean. The final output had a cell size of 10 m^2, the minimum resolution of the input variables.

Habitat Model Variables & Ranks

Four variables, or habitat features, were chosen to be a part of the prairie dog habitat suitability model. Each value within these habitat features was ranked 0-9 with zero indicating inhospitable, one indicating low suitability. Nine indicated highly habitat suitability for prairie dogs. Rankings were developed by the planning team using published literature and best professional judgment in the absence of documentation.

1. Vegetation
    a. We used OSMP's Vegetation Map GIS database to classify the vegetation variable in the model. We ranked vegetation at the United States National Vegetation Classification "Alliance" level based on the best professional judgment of the Grassland Ecologist and Agricultural Resource Specialist. Alliance ranks were based on prairie

dogs' preference for each vegetation type and the alliance's resilience to grazing by prairie dogs (see Table H-1).

2. Slope
    a. Flatter slopes are preferred by prairie dogs (Clippinger 1989, Proctor 1998, Roe and Roe 2003). Therefore, higher ranks in the model were given to flatter slopes (0-5%) and lower values were progressively given to higher slope values (see Table H-2). The GIS data layer used for this analysis was created from the USGS 10-m Digital Elevation Model of the Boulder Valley.

3. Soil Texture
    a. Soil texture classes were derived using the Natural Resource Conservation Services' (NRCS) Soil Survey Geographic (SSURGO) Database Soils GIS layer. Soil mapping units were grouped into major texture classes and ranked according to their suitability for prairie dog burrow excavation and perceived preference of prairie dogs for a given soil texture. For example, "rock" was assigned a rank of zero, whereas "fine sandy loam" was given a rank of nine indicating a greater prairie dog preference for fine sandy loam soil mapping units because of a greater ability to dig burrows (Table H-3).

4. Soil Depth
    a. Soil depth rankings were also derived using the NRCS SSURGO Soils GIS layer. Soil depth – defined here as the depth to bedrock or to the water table - is an indicator of the suitability of a given soil for prairie dog burrow excavation. The average burrow is 2-5 m deep (Hoogland 1995). Each soil series was ranked using the "Shallow Excavations" rank in the NRCS Soil Survey. If the soil type was a rock outcrop, then the soil was given a rank of zero for soil depth. "Severe" soils were given a rank of three; "Moderate" soils were given a rank of six; and "Slight" soils were given a rank of nine (see Table H-4).

       Soils with a rank of "Severe" show bedrock or a spring and summer water level at 0.5 – 1 meter (Moreland and Moreland 1972, Price and Amen 1980). "Moderate" soils have a greater depth to bedrock or water and "Slight" have limited barriers to excavations.

Weighted Geometric Mean Analysis

The weighted geometric mean, as compared to the weighted arithmetic mean, more accurately models species' habitat requirements. This is due to certain habitat features being inhospitable or entirely unsuitable to many species. If a species cannot occupy a given habitat type, no number of other variables coincident with that habitat type will make it habitable - a zero value cannot be ameliorated by higher values of other habitat variables (Beier et al. 2007). For example, if an organism cannot forage or burrow on rock outcrops (a rank of zero for rock outcrops), then it is understood that values greater than zero for any other habitat variables coincident with rock outcrops - will not increase the habitat rank of that habitat type.

ArcGIS Spatial Analyst Raster Calculator

The following expression was used to calculate the Weighted Geometric Mean in the Raster Calculator tool in ArcGIS's Spatial Analyst extension. This expression took the place of the "Weighted Sum Overlay" which is just the Weighted Arithmetic Mean stated differently.

[pow(pow([Habitat_re],4) * pow([Sloperank],3) * pow([soiltext],2) * pow([soildepth],1), 0.25)]
This translates into the GIS calculating each 10 x 10 m cell value in the analysis extent to: (VegMap Alliance ranks^4 * Slope ranks^3 * soil texture ranks ^ 2 * soil depth ranks ^1)/4.

Ranking Classification
The planning team used ArcGIS's symbology tool to calculate the mean and standard deviation of the cell values of the weighted geometric mean analysis and symbolize the data (Figure H-2). The planning team then excluded zero values to calculate the mean and standard deviation because of the overabundance of zero values due to completely unsuitable habitat such as rock outcrops, forests and very steep slopes in the western portion of the OSMP system. The planning team used the standard deviation values to classify the data set *without* zero values excluded into five categories:

<u>Unsuitable</u>
- Unsuitable habitat = All values > 1.5 standard deviations below the mean

<u>Less Suitable</u>
- Poor quality habitat = 1.5-0.5 standard deviations below the mean
- Fair quality habitat = 0.5 standard deviations above and below the mean

<u>More Suitable</u>
- Good quality habitat = 0.5-1.5 standard deviation above the mean
- Very good quality habitat= >1.5 standard deviations above the mean

Testing the Model
The results of the HSM were compared to mapping of prairie dog occupation (in plague and non-plague years). All prairie dog activity on OSMP was in the Grassland Planning Area. The majority of actual prairie dog occupancy was found to overlay areas identified by the model as "More Suitable", and some minimal prairie dog occupation overlapped areas characterized by the model as "Less Suitable". OSMP staff visited selected areas of "Unsuitable habitat" and determined that these areas were generally not used by prairie dogs. A map showing the model output is included as Figure H-3.

Table H-1: Vegetation alliance ranks.

Vegmap Alliance Number	Vegetation Alliance Description	Rank
100	CRP	6
101	Fallow	2
102	Moving Water	0
103	Quarry	0
104	Standing Water	0
105	Development	0
106	Easement	0
107	Restoration	2
118	Lodgepole Pine Forest Alliance	0
124	Ponderosa Pine Forest Alliance	0
134	Ponderosa Pine - Douglas-fir Forest Alliance	0
157	Douglas Fir Forest Alliance	0
259	Green Ash - (American Elm) Temporarily Flooded Forest Alliance	0
267	Paper Birch Forest Alliance	0
274	Quaking Aspen Forest Alliance	0
278	Box-elder Temporarily Flooded Forest Alliance	0
300	Quaking Aspen Temporarily Flooded Forest Alliance	0
310	Narrowleaf Cottonwood Temporarily Flooded Forest Alliance	0
399	Ponderosa Pine - Quaking Aspen Forest Alliance	0
426	Quaking Aspen - Douglas-fir Forest Alliance	0
530	Ponderosa Pine Woodland Alliance	0
533	Ponderosa Pine - Douglas-fir Woodland Alliance	0
552	Douglas-fir Woodland Alliance	0
565	Ponderosa Pine Temporarily Flooded Woodland Alliance	0
568	Douglas-fir Temporarily Flooded Woodland Alliance	0
610	Quaking Aspen Woodland Alliance	0
632	Netleaf Hackberry Woodland Alliance	2
636	Eastern Cottonwood Temporarily Flooded Woodland Alliance	0
641	Narrowleaf Cottonwood Temporarily Flooded Woodland	0
642	Box-elder Temporarily Flooded Woodland Alliance	0
645	Peachleaf Willow Temporarily Flooded Woodland Alliance	0
835	Rubber Rabbitbrush Shrubland Alliance	0
896	Mountain-mahogany Shrubland Alliance	0
919	Choke Cherry Shrubland Alliance	1
923	White Squaw Currant Shrubland Alliance	1
938	Skunkbush Intermittently Flooded Shrubland Alliance	1
947	(Coyote Willow, Sandbar Willow) Temporarily Flooded Shrubland Alliance	0
952	Rocky Mountain Maple Temporarily Flooded Shrubland Alliance	0
954	(Black Hawthorn, Fleshy Hawthorn) Temporarily Flooded Shrubland Alliance	0
959	Woods' Rose Temporarily Flooded Shrubland Alliance	0
961	Western Snowberry Temporarily Flooded Shrubland Alliance	0
976	Bluestem Willow Temporarily Flooded Shrubland Alliance	0
996	Water Birch Seasonally Flooded Shrubland Alliance	0
1192	Big Bluestem - (Yellow Indiangrass) Herbaceous Alliance	3
1195	Timothy Herbaceous Alliance	5

Vegmap Alliance Number	Vegetation Alliance Description	Rank
1213	(Tall Fescue, Meadow Fescue) Herbaceous Alliance	4
1225	Little Bluestem - Sideoats Grama Herbaceous Alliance	5
1232	Western Wheatgrass Herbaceous Alliance	10
1234	Needle-and-Thread - Blue Grama Herbaceous Alliance	7
1252	Sand Dropseed Herbaceous Alliance	0
1260	Mountain Muhly Herbaceous Alliance	0
1261	Green Needlegrass Herbaceous Alliance	0
1262	Indian Ricegrass Herbaceous Alliance	5
1267	Alkali Sacaton Herbaceous Alliance	0
1272	New Mexico Needlegrass Herbaceous Alliance	2
1281	Poverty Oatgrass Herbaceous Alliance	0
1282	Blue Grama Herbaceous Alliance	9
1316	Parry's Oatgrass Herbaceous Alliance	0
1332	Saltgrass Intermittently Flooded Herbaceous Alliance	3
1335	Nuttall's Alkali Grass Intermittently Flooded Herbaceous Alliance	0
1347	Prairie Cordgrass Temporarily Flooded Herbaceous Alliance	0
1354	Western Wheatgrass Temporarily Flooded Herbaceous Alliance	8
1358	Foxtail Barley Temporarily Flooded Herbaceous Alliance	4
1374	Baltic Rush Seasonally Flooded Herbaceous Alliance	3
1381	Reed Canary Grass (introduced) Seasonally Flooded Herbaceous Alliance	0
1414	Woolly Sedge Seasonally Flooded Herbaceous Alliance	0
1417	Nebraska Sedge Seasonally Flooded Herbaceous Alliance	0
1419	Clustered Field Sedge Seasonally Flooded Herbaceous Alliance	0
1422	Marsh Spikerush Seasonally Flooded Herbaceous Alliance	0
1433	Threesquare Herbaceous Alliance	0
1436	Cattail Herbaceous Semipermanently Flooded Alliance	0
1443	Hardstem Bulrush - (Softstem Bulrush) Semipermanently Flooded Herbaceous Alliance	0
1444	Saltmarsh Clubrush Semipermanently Flooded Herbaceous Alliance	0
1488	Ponderosa Pine Tallgrass Savannah Herbaceous Alliance	2
1536	Smooth Sumac Shrub Savannah Herbaceous Alliance	0
1537	Skunkbush Shrub Savannah Herbaceous Alliance	4
1538	Mountain-mahogany Shrub Herbaceous Alliance	0
1540	Soapweed Yucca Shrub Savannah Herbaceous Alliance	5
1546	Rubber Rabbitbrush Shrub Short Herbaceous Alliance	0
1814	Cheatgrass Annual Grassland	1
1836	Open Cliff Sparsely Vegetated Alliance	0
1838	Rock Outcrop Sparsely Vegetated Alliance	0
1864	Sand Flats Temporarily Flooded Sparsely Vegetated Alliance	0
2528	Snakeweed Dwarf-shrubland Alliance	6
2529	Intermediate Wheatgrass Semi-natural Herbaceous Alliance	4
2578	(American Mannagrass, Fowl Mannagrass) Seasonally Flooded Herbaceous Alliance	0
3561	Smooth Brome Semi-Natural Herbaceous Alliance	5
3562	Kentucky Bluegrass Semi-Natural Herbaceous Alliance	6
3563	Crested Wheatgrass Semi-Natural Herbaceous Alliance	7

Vegmap Alliance Number	Vegetation Alliance Description	Rank
3564	Canada Thistle Weedy Forb Great Plains Herbaceous Vegetation [Provisional]	0
9000	American Plum Shrubland Alliance	1
9001	Smooth Sumac Shrubland Alliance	2
9002	Emory Sedge Seasonally Flooded Herbaceous Alliance	0
9003	Ponderosa Pine Wooded Mixed Herbaceous Alliance (Savannah)	0
9004	Redtop (introduced) Seasonally Flooded Herbaceous Alliance	1
9005	Mountain Ninebark Shrubland	0
9006	Wood's Rose Shrub Herbaceous Alliance (Savannah)	0
9007	Crack Willow (introduced) Temporarily Flooded Woodland Alliance	0
9008	Russian Olive Semi-Natural Woodland Alliance	1
9009	Soapweed Yucca Evergreen Shrubland	5
9010	Montane Talus Sparsely Vegetated	0
9011	Cultivated Alfalfa / Smooth Brome Hay	6
9012	Cultivated Grass Hay	5
9013	Introduced Species Agricultural Pasture	7
9014	Disturbed Cultivated Agricultural Pasture	5
9016	Canada Bluegrass Semi-Natural Herbaceous Alliance	6
9017	Black Tailed Prairie Dog Grassland Complex	8
9018	Cultivated Alfalfa Hay	3
9019	Cultivated Corn (Annual)	0
9020	Cultivated Barley (Annual)	1
9021	Cultivated Oats (Annual)	0
9022	Cultivated Winter Wheat (Annual)	1
9023	Bracken Fern Herbaceous Alliance	0
9024	Pursh seepweed Seasonally Flooded Herbaceous Alliance	0
9025	Three-leaved Sumac Upland Shrubland Alliance	3
9026	Equisetum hyemale Semipermanently Flooded Herbaceous Alliance	0
9027	Desert False Indigo Temporarily Flooded Shrubland Alliance	0
9028	Creeping Oregon-Grape Dwarf-Shrubland Alliance	0
9029	Sun Sedge-Agassiz Kentucky Bluegrass Herbaceous	0
9030	Fendler's Ceanothus Deciduous Shrubland	0
9031	Non-Native Dominated Temporarily Flooded Woodland	0
9033	Annual-dominated Upland Disturbance	0
9035	Perennial Forb Disturbance Community	4
9036	Perennial Graminoid Disturbance Community	6
9037	Shale Barrens Sparsely Vegetated Alliance	0

Table H-2: Slope ranks used in prairie dog HSM

Slope from (%)	Slope to (%)	Rank
0	0	9
0	5	8
5	10	7
10	15	5
15	20	3
20	25	2
25	30	1
30	35	0
35	40	0
40	100	0

Table H-3: Soil texture ranks

Soil #	Soil Class	Rank
1	Clay	2
2	Cobbly Clay Loam	5
3	Clay Loam	6
4	Colluvial Land	2
5	Fine Sandy Loam	9
6	Gravel Pit/ Mine dump	0
7	Loam	9
8	Rock	0
9	Sandy Clay Loam	6
10	Silty Clay Loam	6
11	Sandy Loam	9
12	Stony Sandy Loam	8
13	Stony Loam	8
14	Terrace Escarpments	4
15	Very Cobbly Sandy Loam	7
16	Very Fine Sandy Loam	8
17	Very Gravelly (new soil)	3
18	Very Gravelly Sandy Loam	7
19	Very Stony Sandy Loam	7
20	Gravelly Sandy Loam	8

Table H-4: Soil depth ranks

SSURGO Soil Description	Soil Depth Rank
ASCALON SANDY LOAM, 0 TO 1 PERCENT SLOPES	9
ASCALON SANDY LOAM, 1 TO 3 PERCENT SLOPES	9
ASCALON SANDY LOAM, 3 TO 5 PERCENT SLOPES	9
ASCALON SANDY LOAM, 5 TO 9 PERCENT SLOPES	9

SSURGO Soil Description	Soil Depth Rank
ASCALON-OTERO COMPLEX, 0 TO 3 PERCENT SLOPES	9
ASCALON-OTERO COMPLEX, 3 TO 5 PERCENT SLOPES	9
ASCALON-OTERO COMPLEX, 5 TO 9 PERCENT SLOPES	9
ASCALON-OTERO COMPLEX, 9 TO 20 PERCENT SLOPES	9
Argiustolls-Rock outcrop complex, 15 to 60 percent slopes	0
BALLER STONY SANDY LOAM, 9 TO 35 PERCENT SLOPES	3
Baller-Rock outcrop complex, 15 to 50 percent slopes	0
CALKINS SANDY LOAM, 0 TO 1 PERCENT SLOPES	6
CALKINS SANDY LOAM, 1 TO 3 PERCENT SLOPES	6
COLBY SILTY CLAY LOAM, 3 TO 5 PERCENT SLOPES	9
COLBY SILTY CLAY LOAM, 5 TO 9 PERCENT SLOPES	9
COLBY-GAYNOR ASSOCIATION	6
COLLUVIAL LAND	9
Denver-Kutch-Midway clay loams, 9 to 25 percent slopes	3
Englewood clay loam, wet, 0 to 3 percent slopes	6
FERN CLIFF-ALLENS PARK-ROCK OUTCROP COMPLEX, 15 TO 60 PERCENT SLOPES	0
Flatirons very cobbly sandy loam, 0 to 3 percent slopes	3
Flatirons very stony sandy loam, 0 to 5 percent slopes	3
Flatirons very stony sandy loam, 5 to 9 percent slopes	6
Flatirons very stony sandy loam, 9 to 15 percent slopes	6
GOLDVALE-ROCK OUTCROP COMPLEX, 9 TO 55 PERCENT SLOPES	0
GRAVEL PITS AND MINE DUMPS	0
HARGREAVE FINE SANDY LOAM, 1 TO 3 PERCENT SLOPES	3
HARGREAVE FINE SANDY LOAM, 3 TO 9 PERCENT SLOPES	3
HELDT CLAY, 0 TO 3 PERCENT SLOPES	6
HELDT CLAY, 3 TO 5 PERCENT SLOPES	6
Haverson loam, 0 to 3 percent slopes	3
Haverson loam, 3 to 9 percent slopes	3
JUGET-ROCK OUTCROP COMPLEX, 9 TO 55 PERCENT SLOPES	0
KUTCH CLAY LOAM, 3 TO 9 PERCENT SLOPES	3
LAPORTE VERY FINE SANDY LOAM, 5 TO 20 PERCENT SLOPES	3
LONGMONT CLAY, 0 TO 3 PERCENT SLOPES	3
LOVELAND SOILS	3
Leyden-Primen-Standley cobbly clay loams, 15 to 50 percent slopes	3
Leyden-Standley-Primen cobbly clay loams, 9 to 15 percent slopes	6
MANTER SANDY LOAM, 0 TO 1 PERCENT SLOPES	6
MANTER SANDY LOAM, 1 TO 3 PERCENT SLOPES	6
MANTER SANDY LOAM, 3 TO 9 PERCENT SLOPES	6
MANVEL LOAM	9
MCCLAVE CLAY LOAM	6
NEDERLAND VERY COBBLY SANDY LOAM, 1 TO 12 PERCENT SLOPES	3
NIWOT SOILS	3
NUNN CLAY LOAM, 0 TO 1 PERCENT SLOPES	6
NUNN CLAY LOAM, 1 TO 3 PERCENT SLOPES	6
NUNN CLAY LOAM, 3 TO 5 PERCENT SLOPES	6
NUNN CLAY LOAM, 5 TO 9 PERCENT SLOPES	6
NUNN SANDY CLAY LOAM, 0 TO 1 PERCENT SLOPES	6
NUNN SANDY CLAY LOAM, 1 TO 3 PERCENT SLOPES	6

SSURGO Soil Description	Soil Depth Rank
NUNN-KIM COMPLEX	6
Nederland very cobbly sandy loam, 15 to 50 percent slopes	3
PEYTON-JUGET VERY GRAVELLY LOAMY SANDS, 5 TO 20 PERCENT SLOPES	3
PINATA-ROCK OUTCROP COMPLEX, 5 TO 55 PERCENT SLOPES	0
RENOHILL LOAM, 3 TO 9 PERCENT SLOPES	3
RENOHILL SILTY CLAY LOAM, 1 TO 3 PERCENT SLOPES	3
RENOHILL SILTY CLAY LOAM, 3 TO 9 PERCENT SLOPES	3
ROCK OUTCROP	0
Rock outcrop, sedimentary	0
Rock outcrop-Cathedral-Ratake complex, 50 to 100 percent slopes	0
Rogert-Herbman-Rock outcrop complex, 30 to 70 percent slopes	0
SAMSIL CLAY, 3 TO 12 PERCENT SLOPES	3
SAMSIL-SHINGLE COMPLEX, 5 TO 25 PERCENT SLOPES	3
SIXMILE STONY LOAM, 10 TO 50 PERCENT SLOPES	3
TERRACE ESCARPMENTS	3
Torrifluvents, very gravelly, 0 to 3 percent slope	6
Ustorthents, cool-Rock outcrop complex, 15 to 50 percent slopes	0
VALMONT CLAY LOAM, 1 TO 3 PERCENT SLOPES	6
VALMONT CLAY LOAM, 3 TO 5 PERCENT SLOPES	6
VALMONT COBBLY CLAY LOAM, 1 TO 5 PERCENT SLOPES	6
VALMONT COBBLY CLAY LOAM, 5 TO 25 PERCENT SLOPES	6
Valmont clay loam, 0 to 3 percent slopes	6
Veldkamp-Nederland very cobbly sandy loams, 0 to 3 percent slopes	3
WELD FINE SANDY LOAM, 1 TO 3 PERCENT SLOPES	6
WELD LOAM, 1 TO 3 PERCENT SLOPES	6
WELD-COLBY COMPLEX, 0 TO 3 PERCENT SLOPES	6
WELD-COLBY COMPLEX, 3 TO 5 PERCENT SLOPES	6
Yoder variant-Midway complex, 15 to 60 percent slopes	3

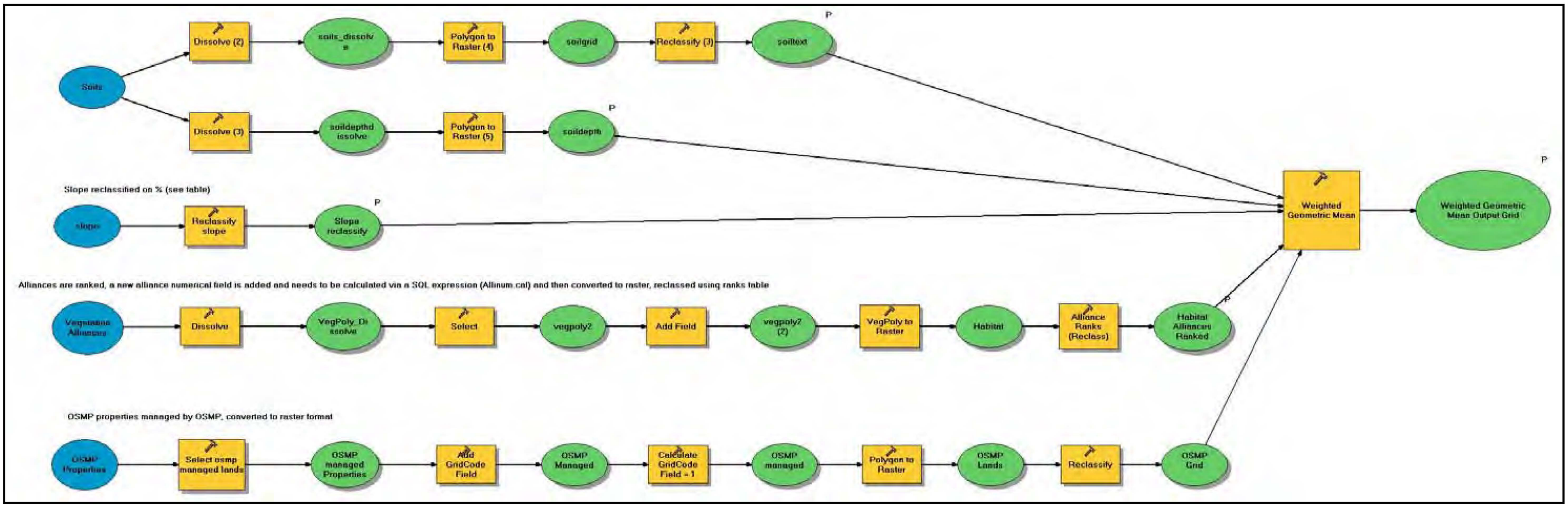

Figure H-1: Prairie dog Habitat Suitability Model using ESRI's Model Builder Tool.

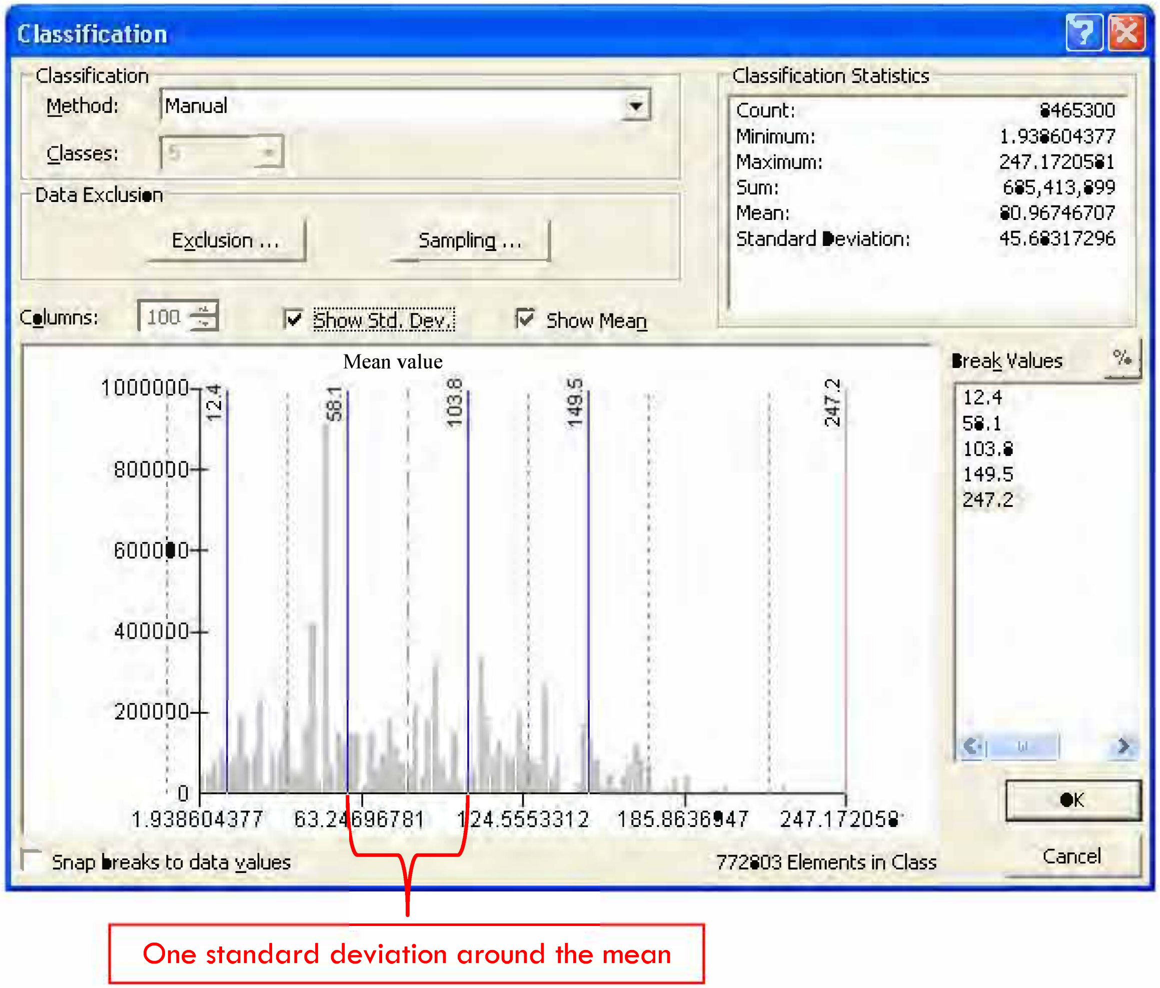

Figure H-2: Data distribution with mean and standard deviation lines and class breaks

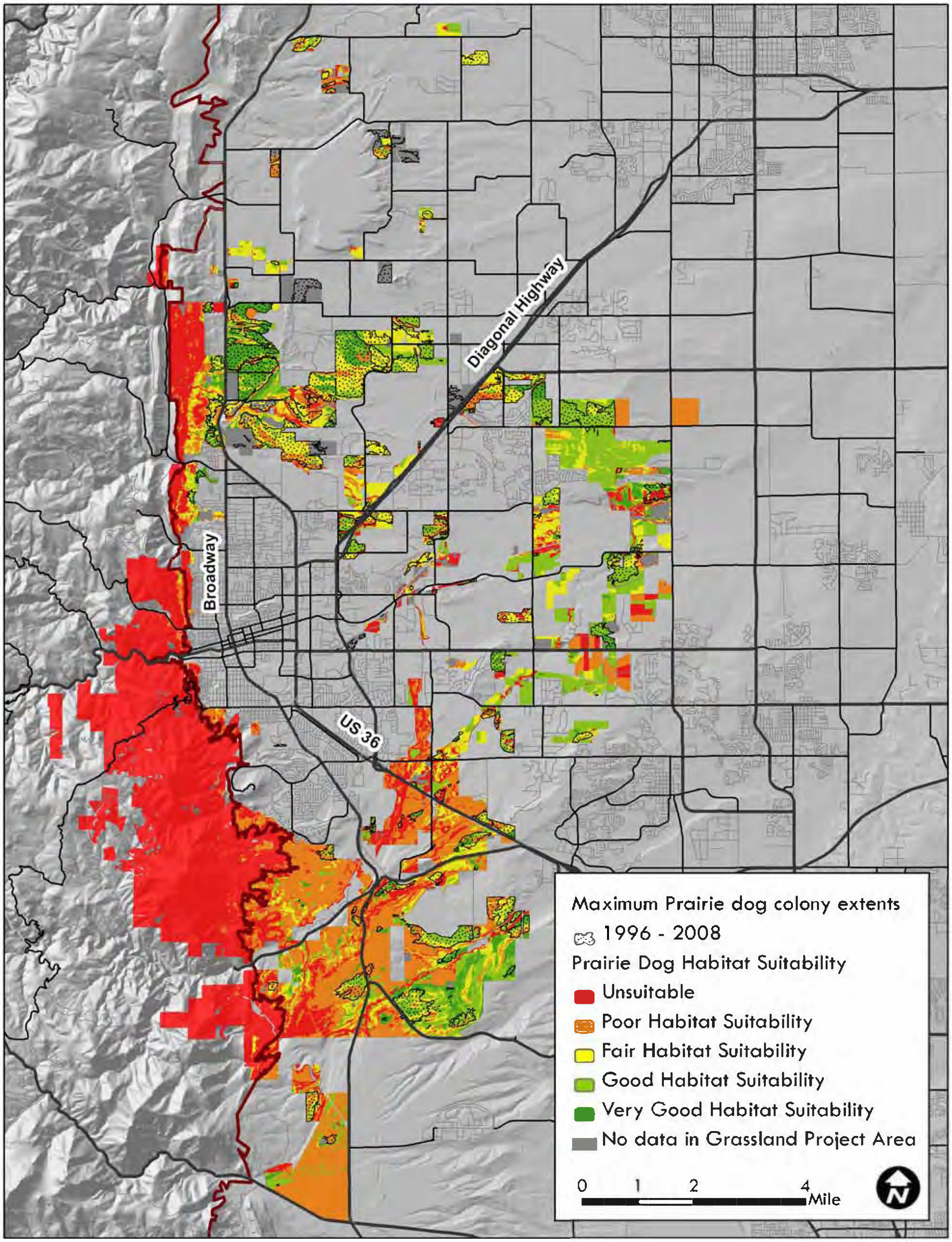

Figure H-3: Output of prairie dog Habitat Suitability Model
Cumulative distribution of prairie dogs on OSMP from 1996-2008 shown in hatching

APPENDIX I: Black-Tailed Prairie Dog Receiving Site Relocation Criteria

Relocation criteria represent a series of conditions that must be met before OSMP-managed lands can receive black-tailed prairie dogs through active relocation.

Prairie Dog Conservation Area (Basic Criteria)

1. Existing burrow structure or evidence of previous occupation
2. Relocation will follow regulations set out in City of Boulder's Wildlife Protection Ordinance and associated city policies
3. All appropriate state and federal permits obtained and conditions of permits followed

Grassland Preserves (Full Criteria)

1. Existing burrow structure or evidence of previous occupation
2. Relocation will follow regulations set out in City of Boulder's Wildlife Protection Ordinance and associated city policies
3. All appropriate state and federal permits obtained and conditions of permits followed
4. Grassland Preserve is below 10% threshold occupancy-as identified in Grassland Ecosystem Management Plan Black-tailed Prairie Dog and Associates viability standards
5. Vegetation and habitat within receiving site meets the following minimum standards based upon data from at least three transects within **each** habitat type on the receiving site:
    a. Average bare ground no more than 22% cover
    b. Average native species richness at least 18 species (with exception of non-native grassland patches)
    c. Average relative cover of perennial graminoid species at least 60%
    d. Average sensitive/conservative species richness at least 4 species (excepting non-native grassland patch types)
6. Majority of receiving site has been identified as exhibiting Good or Very Good Habitat Suitability in OSMP's prairie dog HSM. Relocation should begin in areas with highest suitability.

APPENDIX J: Best Opportunities to Conserve and Restore Wetland and Riparian Areas

Best Opportunities to Conserve

1. Coal Creek
   - restoration work done in the past has been successful (birds responding positively)
   - weeds remain an issue but are being managed
   - hydrology supports northern leopard frogs and discourages bullfrogs
   - significantly sized riparian corridor with continuity (unfragmented)
   - one of the only intermittent streams with significant riparian habitat

2. Leopard frog ponds
   - Dunn II
   - Moore-Robinson
   - Eggleston Reservoir #3
   - ERTL
   - Stratton
   - Bennett
   - Jewel Mountain

3. Bull Gulch
   - recommendations in Eldorado Mountain/Doudy Draw TSA plan (site in a Habitat Conservation Area which provides a higher level of protection from human disturbance)

4. Thomas-Hogan-Parrish (T.H.P.) pond and associated wetlands
   - Ute ladies-tresses orchid, *Eleocharis rostellata*, and native fish
   - recent removal of crack willow from pond

5. Native fish ponds (provide opportunities to conserve native fish)
   - ponds are too small to provide recreational fishing opportunities
   - evaluate similar ponds on OSMP for native fish potential

6. Tallgrass West exclosure
   - small grazing exclosure with remnant Ute ladies-tresses orchid stand

7. Schneider Draw
   - possible native fish refuge in pond
   - example of ephemeral riparian shrub drainage in good condition

8. Ryan wetlands

Best Opportunities to Restore

1. South Boulder Creek from South Boulder Road to Hwy 93 (including Rolling Rock property)
   - in state natural area
   - weeds (teasel) and bullfrogs of concern
   - Ute ladies-tresses orchid patches, Preble's meadow jumping mouse
   - floodplain management a concern
   - potential funding from Denver Water Board for aquatic restoration

- considerable work toward developing an instream flow water right
- past instream restoration work done in the past
- fish passage structures
- rare mayfly (*Baetis* sp.)

2. Eggleston Reservoir #3
    - hydrology can be managed for northern leopard frogs
    - bullfrogs present now

3. Jewel Mountain pond
    - grazing can be managed to improve shoreline habitat for shorebirds, turtles, reduce WQ impacts.
    - northern leopard frog, western painted turtle and shorebird habitat

4. Spring Brook
    - area of ongoing restoration
    - dwarf leadplant habitat
    - northern leopard frogs but no bullfrogs
    - resolve high trail/road density

5. Doudy Draw
    - current efforts to remove trails and trail crossings
    - weeds an issue

6. South Boulder Creek upstream Hwy 93
    - instream flow right – could use more
    - weeds
    - ownership
    - fish passage opportunities

7. Floodplain wet meadows north of South Boulder Road (Gebhardt, Burke, Burke II, Kentucky)
    - fragmented by development, trails
    - bobolink habitat, Ute ladies-tresses orchid, *Rotala*, American groundnut, Preble's meadow jumping mouse
    - evaluate status of frogs
    - teasel may be due to high levels of irrigation (?)

8. Dry Creek to 75th Street
    - dogs impacts to riparian areas on Klein
    - possible grazing management
    - low on the list of restoration sites
    - native fish
    - past and current restoration work

9. Sombrero Marsh
    - significant restoration efforts done in past
    - weeds
    - Boulder County Comprehensive Plan significant ecological resource

10. Confluence Area (Boulder Creek, South Boulder Creek)
    - part of confluence planning area
    - fill area and road grade present opportunities for restoration
    - weeds
    - high recreation area
    - prairie dogs
    - partnership opportunities with other city departments
    - Short-Milne passage (culvert road crossing and Green Ditch diversion, weeds)
    - augmentation plan required for Arapahoe Pit D

11. Lower Boulder Creek Habitat Conservation Area
    - only populations of large-flowered prairie gentian
    - Ute ladies-tresses orchid
    - bald eagle nesting
    - heronry
    - native bindweed
    - some of highest quality riparian bird habitat
    - managed as a Habitat Conservation Area
    - low trail density
    - Russian olive, teasel, crack willow removal
    - Culver wetland mitigation
    - cottonwood regeneration opportunities
    - fencing of riparian area

12. Hart Jones
    - example of few remaining (although low ranked) occurrence of G2 inland salt meadow
    - weeds
    - restore hydrology
    - protect more of the area
    - may be an opportunity to conserve instead of restore

13. Lousberg
    - unique groundwater fed system
    - restoration of native wetland communities
    - grazing and weed management
    - low ranked opportunity
    - native fish refugia

14. Mesa Reservoir
    - migratory bird habitat
    - ongoing restoration
    - native fish
    - consider potential importance of this pond as a water source for the grass bank/enhanced prescribed grazing strategy

15. Gallagher
    - restore irrigation to support wetlands

16. Papini
    - possible native fish and frog restoration

17. BLIP ponds
    - possible native fish refugia
    - northern leopard frog and bullfrogs
    - tiger salamander
    - manipulate water levels to support northern leopard frogs and native fish
    - consider potential importance of this pond as a water source for the grass bank/enhanced prescribed grazing strategy

18. Bennett pond
    - restore to native fish and northern leopard frog habitat
    - consider potential importance of this pond as a water source for the grass bank/enhanced prescribed grazing strategy

19. Stratton ponds
    - native fish restoration site
    - consider potential importance of this pond as a water source for the grass bank/enhanced prescribed grazing strategy

20. Andrea pond
    - native fish restoration site

21. Beech wetlands west of Lefthand Valley Reservoir
    - plug ditches to raise water table
    - weeds (teasel)

22. Axelson hillside seeps
    - *Lobelia* and *Eleocharis rostelata*
    - weeds include teasel and some purple loosestrife
    - opportunity to control weeds and restore native wet meadow

23. Boulder Valley Ranch
    - weed management and grazing management could improve wetland conditions
    - further investigations needed to determine best opportunities
    - low potential and priority

<u>Other General Opportunities</u>

Managing ditches to best support riparian function

Managing upper terrace wet meadows (Van Vleet-315, 331, Church, Yunker, Suitts, etc.)

- e.g. for bobolink habitat

APPENDIX K: Strategy Ranking Criteria and Methods (after TNC 2007)

The evaluation of strategies was based upon consideration of three broad categories—benefit, feasibility and cost. The components of benefit and feasibility are outlined below.

Benefit (**Higher** "Benefit" is preferable)
- How much does the strategy contribute toward achieving one or more conservation objectives?
- How many conservation issues does the strategy address?
- To what degree does the strategy improve target viability?
- How long lasting is the strategy?
- Will the strategy leverage other high-impact strategies?

Feasibility (**Higher** "Feasibility" is preferable)
- Are staff members or contractors with proven talent and relevant experience available to implement the strategy?
- How easily can the strategy be implemented?
- How will the implementation of the strategy affect Open Space and Mountain Parks' ability to deliver other key services, such as visitor access and recreation?
- Does the strategy appeal to public officials, landowners and interest groups whose involvement is critical to implementing the strategy?

Costs (**Lower** "Cost" is preferable)
- Looking ten years into the future, what is the cumulative cost of the strategy, including one-time and recurrent material and staffing costs?

Strategy ranking for the Grassland Plan used the Conservation Action Planning Workbook, an automated Microsoft Excel spreadsheet. Strategies were assigned a rating from "Low" to "Very High" as described below. The CAP Workbook used these ratings to compute the overall rank of each strategy.

Benefit

Contribution

The degree to which the proposed strategic action, if successfully implemented, will contribute to the achievement of the Grassland Plan's objective(s).

Very High: The strategic action, by itself, achieves one or more objectives.
High: The strategic action makes a substantial contribution towards achieving one or more objectives but is not by itself sufficient.
Medium: The strategic action makes an important contribution towards achieving one or more objectives.
Low: The strategic action makes a relatively small contribution towards achieving one or more objectives.

Duration of Outcome
The degree to which the proposed strategy, if successfully implemented, is likely to secure a long-lasting outcome.

Very High: The strategy, if successfully implemented, is likely to achieve an enduring, long-lasting outcome (e.g., acquisition of fee interest in land; an ongoing management practice; a very secure public policy).
High: The strategy, if successfully implemented, is likely to achieve an outcome with a relatively long (e.g., 10 years) duration (e.g., partial interest in land; solid but potentially vulnerable public policy change).
Medium: The strategy, if successfully implemented, is likely to achieve an outcome of moderate duration (e.g., 3-year management agreement).
Low: The strategy, if successfully implemented, is likely to achieve an outcome with a very short duration (e.g., handshake agreement; 1-year management plan; stopgap policy).

Leverage
The degree to which the strategy provides leverage for other highly-ranked strategies.

Very High: Immediate, visible, tangible results and high leverage towards another high-impact strategy.
High: Immediate, visible, tangible results or high leverage towards another high-impact strategy.
Medium: Moderate leverage.
Low: No apparent leverage.

Feasibility
Lead Individual / Institution
The availability of a lead individual with sufficient time, proven talent, relevant experience and good institutional support to implement the strategic action.

Very High: A lead individual ("champion') with sufficient time, proven talent, substantial relevant experience and institutional support is reasonably available and committed to lead implementation of the strategy.
High: An individual with sufficient time, promising talent, some relevant experience and institutional support is reasonably available and committed to lead implementation of the strategy.
Medium: An individual with promising talent and sufficient time is reasonably available but lacks relevant experience or institutional support.
Low: No lead individual currently available.

Ease of Implementation
Strategic actions that are less complex, have been successfully implemented previously and fit within the core competencies of the lead institution and for which funding is accessible have a higher likelihood of success than other actions.

Very High: Implementing the strategy is very straightforward; this type of strategy has been done often before.
High: Implementing the strategy is relatively straightforward but not certain; this type of strategy has been done before.
Medium: Implementing the strategy involves a fair number of complexities, hurdles and/or uncertainties; this type of strategy has rarely been done before.
Low: Implementing the strategy involves many complexities, hurdles and/or uncertainties; this type of strategy has never been done before.

Ability to Motivate
The degree to which key constituencies (e.g., landowners, public officials, interest groups) whose involvement is necessary to implementing the strategic action and their motives are understood and the action appeals to these key constituencies.

Very High: The key constituencies and their motives are well understood and the strategic action is likely to appeal to their key motives.
High: The key constituencies are well understood and the strategic action may appeal to their key motives.
Medium: The key constituencies are somewhat understood and the strategic action may appeal to their key motives.
Low: The key constituencies are not well understood and it is uncertain whether the strategic action will appeal to their key motives.

Cost
Total cost of implementing the strategy, including staff time -- in unrestricted or discretionary dollars (i.e. dollars that might be applied to other purposes)

Costs should be estimated for the time horizon of implementing the strategy but no longer than 10 years. Cost estimates should be focused on the use of discretionary or unrestricted dollars. The following four factors should be considered, as applicable:

- One Time Cost -- One-time direct cost, such as for land purchase.
- Annual Costs -- Labor and other costs. Consider the average number of staff and staff time required to implement the strategic action or action step and the average cost per person per year. Also, consider non-staff costs such as the average annual cost of an ongoing management strategy such as fire.
- Number of Years -- Consider the number of years the strategic action will require staff time or annual costs for implementation (maximum of 10 years).

Very High:	$100,000 or more.
High:	$50,000-$100,000
Medium:	$1,000-$50,000
Low:	up to $1,000

APPENDIX L: Strategy Descriptions

Strategies are numbered to correspond with their appearance in the body of the Grassland Plan.

Strategies Rated "Very High"

1. Develop a safe and effective prescribed fire program for the Grassland Planning Area

OSMP's grasslands are fire dependent systems. Because of its important ecological role, the use of prescribed fire has been identified repeatedly by OSMP as a priority strategy to manage grasslands. Fire management is a component of the Colorado Tallgrass Prairie Management Plan and both the North Boulder Valley and South Boulder Creek area management plans identified a variety of prescribed fire strategies as "Tier I" actions.

Fire plays several roles in the management of agricultural operations. It can be used as an effective tool for managing the distribution of livestock and improving forage quality. Ditch burns occur annually to maintain the irrigation water delivery system.

Any consideration of the use of fire to improve the ecological condition or agricultural productivity of OSMP must also consider appropriate fire suppression and fire prevention practices to address the negative impacts fire can have on the community—especially on adjacent lands and dwellings. Fire planning should identify existing and potential fire hazard mitigation projects in the Grassland Planning Area.

Implementation of a prescribed fire program will need to be integrated with other grassland plan strategies, especially grazing management and IPM to develop specific treatments for specific areas.

<u>Benefit:</u> Very High
Fire and grazing are the ecological processes that control grassland structure, composition and function. OSMP can use fire to help manage many of the key attributes of OSMP grasslands such as vegetation composition, vegetation structure, native plant cover and agricultural production. By favoring native species, fire can also be used to reduce the dominance and prevalence of weeds in the GPA.

Fire management is likely to be one of the few tools that OSMP can use to favor specific plant species and communities as climate and atmospheric chemistry changes affect the Grassland Planning Area.

<u>Feasibility:</u> High
Either OSMP will need to add staffing or use partnerships, consultants or contractors to develop and implement the grassland burn plans. In the past, OSMP has relied upon its partnerships with the Boulder Fire Department and other local fire protection districts to conduct grassland prescribed fires. Although grassland burns require technical understanding of weather, fuels and fire behavior and authorizations from a variety of jurisdictions, they are routinely implemented by experienced personnel. The use of prescribed fire as a management tool will need to involve collaboration with neighboring property owners and residents to address concerns over the

negative effects of fire and to build an appreciation for its ecological and wildfire mitigation benefits.

Cost: High
Training of existing staff, contracting with consultants and hiring seasonal crews represent significant costs for this strategy. OSMP will explore grant and partnership opportunities to reduce discretionary costs for this strategy.

2. Enhance prescribed grazing program through improvements to fencing, livestock watering facilities, stocking rate and seasonal use adjustments, and the establishment of one or more grass banks

Grazing is an important process structuring Grassland Plan targets. Increasing flexibility of livestock grazing gives OSMP greater ability to manage grasslands toward acceptable conditions of vegetative structure and composition. This strategy includes:

- Evaluating fencing alignments to allow OSMP to use rotational, deferred (rest rotation) and seasonal stocking systems in response to management needs
- Developing water sources to improve OSMP's flexibility in distributing livestock
- Evaluating the potential to manage selected OSMP lands as grass banks (grazing reserves)
- Adjusting stocking rates, timing and duration to achieve acceptable conditions

Implementation of changes to grazing management will be integrated with other grassland plan strategies, especially fire management and IPM to develop specific treatments for specific areas.

Benefit: Very High
By creating more targeted livestock grazing practices, OSMP is more likely to meet the current objectives of the Grassland Plan and will be better positioned to respond to changes resulting from prairie dog grazing and drought.

Feasibility: Very High
The staff is in place to support this strategy. The techniques for developing stocking systems, developing water sources and establishing grass banks are straightforward. There is general support for OSMP's agricultural operations, and there have only been supportive comments for this strategy during the development of the Grassland Plan.

Cost: Very High
The specific features of this strategy have not been developed, and consequently costs have not been calculated. Full implementation is likely to exceed available funding. It will be necessary to prioritize projects for implementation over the ten-year planning horizon. The specific projects implemented will be determined by reviewing the viability ratings in each Grassland Plan Implementation Area.

3. Manage agricultural activities to minimize soil erosion and protect soil fertility

Fertile soil is the foundation of sustainable agricultural production. Soil loss through wind or water erosion or depletion through overgrazing undermines the sustainability of agricultural operations as well as ecological systems. OSMP's best management practices for soil conservation are centered on practices that reduce soil surface disturbances, stimulate native plant growth, maintain or increase cover, maintain or increase organic matter in soils and cycle soil nutrients. Grazing plans allocate forage to livestock to achieve acceptable production while maintaining cover and litter levels necessary to protect soils. Stocking is timed so that grazing defoliation and removal of plant material encourages re-growth and to ensure sufficient residual vegetation is left to allow plants to prepare for winter dormancy. Staff use rotational, deferred (rest rotation) and seasonal stocking in response to the needs of the particular type of vegetation, as well as changing conditions caused by drought or prairie dog grazing. Disturbances to soil surfaces are minimized by the rotation of salt, mineral and supplemental feeding areas as well as careful management of stocking rates and duration.

In addition to balancing grazing/haying with plant production, OSMP staff uses other practices to manage soil stability and fertility in non-native pastures and hayfields. These include:

- Irrigation which stimulates plant growth and can help reduce the impact of soil compaction
- Pasture renovation (reseeding a pasture with or without plowing or tilling, often with alfalfa or other nitrogen-fixing legume)
- Fertilizer use (on OSMP, grazed pastures and hayfields are typically harrowed to break up and distribute manure; in some areas manure is spread onto the fields, and in other areas commercial fertilizers are applied)

OSMP agricultural practices are informed by informal periodic assessments of integrated measures of rangeland health. Staff is evaluating the value of formalizing OSMP's assessment of rangeland soil stability, hydrologic function, as well as structural and functional resilience to disturbance with multi-metric techniques (Gerrish 2004 and Pellant et al. 2000).

Benefits: Very High
Agricultural practices affect the majority of the planning area. Soil loss and decreases in soil fertility resulting from agricultural use could have far-reaching detrimental implications for agricultural and natural systems management. The use of these best management practices therefore provides considerable benefit across the Grassland Planning Area.

Feasibility: High
OSMP staff and lessees have been using these practices consistently for 40 years. Soil conservation practices are the subject of considerable on-going research and best practices are being developed, revised and disseminated by government agencies. There is strong public support for soil conservation.

Cost: Medium
The major cost is staff time for assessing conditions and working with lessees to make changes. In most cases, the non-personnel costs are borne by the lessee as part of their operating costs.

4. Minimize the adverse effects of trail development in areas of special conservation value or sensitivity within the Grassland Planning Area, as part of TSA planning

This strategy provides guidance to the TSA planning process, identifying sensitive habitats and areas with high conservation value. These areas include:

- Northern leopard frog habitat blocks

- Rare plant populations
- Prairie dog colonies within Grassland Preserves
- Prairie dog Multiple Objective Areas
- Wetlands and Riparian Areas (especially Best Opportunity Areas)
- Areas with low weed density
- Areas of high grassland bird nesting value[1] (in situations where seasonal protection measures are not feasible)

Benefit: Very High
If TSA planning is able to either avoid new trail development in these areas or mitigate the impacts of trails, the result will be to reduce the conservation issues facing several of the targets and avoid degradation of target viability.

Feasibility: Medium
While it is straightforward to make recommendations about avoiding impacts to certain areas, the outcomes of the TSA process are unpredictable. In some areas, it may not be possible to provide the community's desired recreational services without adverse impact to sensitive habitats. Decisions about how to reconcile OSMP's recreational management and ecological management objectives will be made through the TSA planning process.

Cost: Low
The costs associated with bringing direction from the Grassland Plan to TSA planning discussions are low.

5. Construct and maintain fish passage structures along South Boulder Creek and Boulder Creek

Fish passage structures provide habitat connectivity for fish, increasing the available habitat and reducing the impacts associated with diminished in-stream flows. Fish passage structures have been completed on South Boulder Creek (McGinn Ditch, South Boulder Canyon diversion and Shearer Ditch). These projects have opened fish migration range 3-4 miles from the Goodhue diversion downstream to Baseline and Valmont Reservoirs. The previous projects have also attracted an externally funded project to evaluate the success of fish passage structures at improving connectivity, particularly for native fish. Future projects include fish passage structures along South Boulder Creek at the Goodhue Ditch, and along Boulder Creek at the Green Ditch and at the culverted creek crossing on the Short-Milne property. Other localized modifications at drop structures and elsewhere will also be implemented when identified to improve fish passage. The Shearer Ditch fish passage structure has been identified for modification and repair.

Benefit: Very High
Riparian and aquatic habitats in South Boulder Creek are impaired because of the diversion structures that impede fish migration and spawning runs. Over 20 game and non-game warm and coldwater species have been surveyed in South Boulder Creek. These species and other riparian inhabitants would benefit immediately from diversion modifications for fish passage. Future work on South Boulder Creek would open approximately 6 miles for uninterrupted fish movement.

Feasibility: Very High
Open Space and Mountain Parks' past success in managing fish passage projects reflects the internal capacity, the "do-ability" of these projects, and their appeal to community interests. South Boulder Creek has excellent potential for fish to pass from Baseline and Valmont reservoirs upstream for wild spawning. South Boulder Creek is one of the few (if not only) transitional streams

[1] Locations to be determined based upon the results of inventory and monitoring.

on the Colorado Front Range with the potential for watershed-scale restoration projects. Because the creek lies almost entirely within existing public land, improvement efforts are not likely threatened by future changes in land use on adjoining properties.

Cost: Very High
OSMP staff has been very successful in attracting external funding to support the design and construction of past fish passage projects, typically reducing the City's cost by half. However, even with dedicated grant and partnership funding, OSMP's share has typically been significant.

6. Improve aquatic habitat in South Boulder Creek

This strategy is intended to improve in-stream aquatic habitat for native and sport fish that have better access to sections of the creek with recently completed fish passage projects. Existing habitat is in poor condition and does not provide adequate cover, especially during winter when creek flows are very low. Aquatic habitat improvement will include:

- Establishment of stream channel geometry in balance with the current flow regime by narrowing over-wide stream segments
- Construction of natural-appearing in-stream habitat features (boulder clusters, random boulder refuge habitat, woody debris, boulder deflectors) that support habitat needs of native and sport fish and protect riparian vegetation from further erosion
- Stabilization of eroding banks
- Planting of native riparian vegetation to provide shade, overhead cover and additional creek bank stabilization.

Benefit: Very High
If implemented, the restoration project will increase local populations of native and sport fish in the project area by improving the quality and quantity of aquatic habitat. Completion of this project will also significantly increase the over-winter habitat for all fish species leading to better reproduction, retention and growth. The project will also benefit the public by increasing recreational fishing opportunities for anglers in Boulder County and the greater Denver metropolitan area. Aesthetically speaking, the appearance of the creek will also improve significantly (natural sinuosity, pools, use of local rock materials, etc.).

Feasibility: Very High
OSMP has an experienced project manager committed to the project, as well as assistance from other experienced biologists, engineers and equipment operators. Although projects of this sort have not been conducted on OSMP before, they have been completed successfully elsewhere by the team members. Community members, granting agencies, other city programs and the Open Space Board of Trustees have indicated strong support for the project, indicating that it appeals to the motivations of the community.

Cost: Medium
While costly, external funding sources have been identified for aquatic habitat improvement projects in South Boulder Creek. Partners include the Colorado Division of Wildlife, Colorado Department of Transportation, the Denver Water Board, and Boulder Flycasters[2]. OSMP's share of the project will be between ten and fifty thousand dollars, mostly as in-kind participation of staff, materials and permit preparation.

[2] A chapter of Trout Unlimited involved in watershed restoration

7. Identify high-value grassland bird nesting areas and consider enacting seasonal protection measures through the TSA planning process, and, when necessary, prior to TSA planning

The TSA planning process has recognized the value of important grassland nesting bird habitat. Both the Eldorado Mountain/Doudy Draw and the Marshall Mesa/Southern Grassland TSA plans included the establishment of seasonal protections for grassland nesting bird habitat. One way OSMP currently protects the ecological function of high value grassland nesting bird habitat is by restricting human access. These seasonal restrictions do not prohibit visitors but require visitors to remain on designated trails and dogs to be leashed. Access by staff, lessees and contractors is also restricted. Approximately 1,100 acres (445 ha) are currently affected by these protection measures.

OSMP is conducting grassland bird monitoring in anticipation of future TSA planning to provide locations of important grassland nesting bird habitat. This information will be used to determine if and how seasonal protection measures can be used to achieve the Grassland Plan objectives, given the recreational and cultural resource objectives also being considered during TSA planning.

OSMP prefers to use the TSA planning process to integrate resource protection and visitor access and enjoyment. However, since TSA planning for portions of the GPA will not occur for several years, OSMP may institute seasonal protection measures when necessary to protect sensitive grassland nesting bird habitat **prior to the TSA planning process.**

The department will also continue its practice of establishing seasonal grassland raptor nesting protection measures, including restrictions on visitor access. This includes protections for nests of burrowing owl, northern harrier, ferruginous hawk and bald eagle. As part of this strategy, OSMP will work with airplane/glider pilots to reduce fly-by impacts to bald eagle nests.

Benefit: Very High
This strategy benefits several of the grassland plan targets by reducing the effects of people and dogs upon birds that nest on the ground or in low shrubs.

Feasibility: Medium
Merely developing recommendations is highly feasible. Actually instituting seasonal protection measures may be more difficult. Experience demonstrates that there is public acceptance for this strategy because it limits access restrictions to a critical time rather than establishing them year-round. However, acceptance is closely related to establishing protection measures in the most significant habitat and maintaining a reasonable balance between areas that are accessible and areas that are not. Currently, three percent of the grassland planning area is affected by grassland nesting bird protection measures (an additional 10 percent of the GPA is affected by seasonal raptor protections–mostly for bald eagle and osprey). There are OSMP staff members available to provide leadership for this project. Protection measures are relatively easy to implement, although there have been past difficulties successfully communicating seasonal access restrictions to visitors.

Cost: Medium
The costs associated with inventory fall within the medium range. Additional costs of providing this information to TSA planning discussions are negligible. However if it is determined that on-going monitoring is needed to inform the process, costs would be significantly higher. Should seasonal protection measures be established, there would be additional costs as well associated with rangers patrol ands signing.

8. Manage selected ponds as northern leopard frog breeding habitat

OSMP has assessed the ponds in the GPA for their suitability as northern leopard frog breeding habitat. Factors considered in the suitability assessment were:

- Presence of northern leopard frogs
- Presence of non-native predators of northern leopard frogs (bullfrogs, crayfish, predatory fish)
- Presence of *Batrachochytrium dendrobatidis* (Bd). Bd is a fungus responsible for a disease thought to be partly responsible for northern leopard frog population declines
- Water level control structures and their condition
- Pond size
- Proximity to trails/nature of visitor use
- Nature of livestock access
- Use as native fish refugia
- Level of recreational fishing
- Condition of habitat (vegetation) surrounding the pond and between the pond and the next nearest wetland/riparian area
- Proximity of nearest wetland/riparian area

Based on the assessment, OSMP has identified several sites as priorities for management to establish breeding areas for the northern leopard frog. Specific actions to be implemented at priority sites are:

- Excluding bullfrogs from ponds where they are absent
- Managing water levels in ponds with functioning water control devices to remove exotic predators while favoring leopard frogs and other native aquatic species
- Directly controlling of exotic predators
- Educating visitors who fish on OSMP about ways of avoiding the spread of Bd and the impacts of using bullfrogs as bait
- Evaluating restrictions on the use of bullfrogs as bait on OSMP
- Considering fishing restrictions in northern leopard frog breeding habitat (any restrictions on fishing would be vetted through a collaborative process with the fishing community)
- Establishing alternate or modified water sources for livestock
- Fencing ponds from livestock, dogs, visitors
- Restoring native vegetation around ponds
- Creating new wetlands as part of broader floodplain restoration strategies

<u>Benefit:</u> Very High
This strategy would provide long-term conservation of a species of concern facing significant threats in the Grassland Planning Area. The strategy reduces conservation issues and enhances viability of animal species composition for the Wetland and Riparian Areas targets.

<u>Feasibility:</u> Very High
OSMP has staff with the skills necessary to complete this strategy. Although the specific tasks associated with the strategy have not been done before on OSMP, they are straightforward. There is general support for the conservation of species facing local and regional extirpation. Community members may be concerned about non-target impacts resulting from temporarily draining ponds. OSMP will work to mitigate any such effects.

<u>Cost:</u> Medium
This project is likely to require significant staff and seasonal time and infrastructure improvements (which may be possible to integrate with improvements to the irrigation water delivery

infrastructure). OSMP will explore opportunities to work with volunteers and partner agencies such as the CDOW to reduce costs.

9. Manage Ute ladies-tresses orchid habitat with compatible grazing, haying and irrigation practices

OSMP staff coordinates agricultural management practices (irrigation, winter grazing, as well as the timing and distribution of hay cutting) with lessees in the South Boulder Creek floodplain. Coordinated management for Ute ladies-tresses orchid is focused on three fields where large populations are found but also includes other areas.

General management for the orchid was summarized in the South Boulder Creek Area Management Plan (City of Boulder 1998):

- Haying should occur prior to July 1 (or as soon after as possible) to avoid cutting of flowering stalks.
- In areas that are not hayed annually, prescribed fire or mowing should be conducted on a periodic basis (3 to 5 years). Fire or mowing should occur in tallgrass areas in March, April or October.
- Graze livestock after October 15 and before May 15 to avoid the most sensitive portion of the growing period (mid-May to mid-October). If orchid habitat is burned in the fall, grazing may need to be deferred until *after* the next growing season.
- Use moderate intensity or high intensity and short duration stocking during the late fall, winter and early spring.
- In irrigated meadows, water needs to be applied in the spring (April to June) before haying and again after haying (August, September) to maintain orchid and ground nesting bird habitat.
- Wetlands and orchid habitat are often created by leaky irrigation structures and ditches. Sensitive resources should be considered when construction or maintenance is proposed.

Benefit: Very High
Compatible agricultural management maintains habitat for this federally threatened plant species. This management also provides habitat for other associated, uncommon species and wetland plant communities. Although recently influenced by a better understanding of the orchid's biology, the basic agricultural management responsible for creating habitat for this species predates OSMP management (and description of the species) and is likely to persist into the future.

Feasibility: Very High
OSMP collaborates with lessees to develop grazing and haying plan. Lessees are responsible for irrigation, livestock management and haying operations. The practices are well established and supported by the community.

Cost: Low
Costs to OSMP are limited to time spent with the lessees in consultation. This strategy is largely implemented by lessees as part of their on-going agricultural operations.

10. Refrain from mowing the "Class A Bobolink Management Areas" until after bobolink fledging (July 15 unless otherwise determined)

In 2007, OSMP staff and volunteers detected bobolinks at 42% (70) of the hayfields sampled (165). Using abundance and density information from the hayfield bird monitoring program, staff chose four top-tier fields to be designated Class A Bobolink Management Areas where mowing would only occur after 15 July. The four top-tier fields are Church field 355, Burke II field 263, and two fields on the Van Vleet property (315 and 331). Waiting until after July 15 gives the bobolinks an opportunity to fledge before mowing operations destroy the nest and its contents.

Monitoring may indicate that it is preferable to delay mowing longer or acceptable to begin mowing earlier. Changes to the mowing date, as informed by monitoring results, will be developed by OSMP wildlife and agricultural staff.

Benefit: Medium
This strategy provides long-term reduction of the key conservation issue to a sensitive and uncommon nested target within the Agricultural Operations target.

Feasibility: Very High
OSMP wildlife and agricultural managers worked together with lessees to implement this strategy.

Cost: Low
There is no out of pocket cost to OSMP associated with the mowing of these fields. Lessees continue to provide lease payments to the department in exchange for the use of OSMP land, water and other facilities.

11. Develop a protocol to coordinate relocation of prairie dogs onto OSMP lands that is compatible with both the Urban Wildlife Management Plan and the Grassland Plan

Two of the prairie dog management designations in the Grassland Plan can serve as receiving sites for relocated prairie dogs. These are:

1. Areas within a Prairie Dog Conservation Area (PCAs) with an existing burrow structure and
2. Areas within a Grassland Preserve with an existing burrow structure, if the Grassland Preserve is below 10% total occupancy, vegetation within the receiving site meets the minimum standards established in the Grassland Plan, and the majority of the receiving site has been rated as exhibiting "Good" or "Very Good" habitat suitability.

Consequently, the extent of grassland available as receiving sites depends upon patterns of prairie dog occupancy and vegetative condition—both of which change seasonally. OSMP samples prairie dog occupancy during the fall and by late winter or early spring is able to map the location of active prairie dog colonies.

In an attempt to integrate the conservation objectives of the Grassland Plan with Council's direction on prairie dog management found in the Urban Wildlife Management Plan, OSMP and the Office of Environmental Affairs/Urban Wildlife Coordinator will develop an annual consultation process that will identify to what extent city-owned lands can reasonably accommodate the prairie dog removal needs of public agencies and private property owners affected by the Urban Wildlife Protection Ordinance and the Urban Wildlife Management Plan. Implementation of this strategy may require modifications to internal policies and rules affecting prairie dog relocation.

Benefit: High
Developing a shared understanding about the availability and use of relocation sites on OSMP lands will facilitate implementation of both the Urban Wildlife Management Plan and the Grassland Plan. Successful conservation of the Mixedgrass Prairie Mosaic, Xeric Tallgrass Prairie, and Agricultural Operations on OSMP relies upon the ability to remove prairie dogs from areas of incompatibility. The City's preference for prairie dog removal is relocation.

Feasibility: High
OSMP has the staff with the appropriate expertise assigned the responsibility of prairie dog management to implement this strategy. Developing a protocol to guide relocation onto OSMP is not a technically challenging task and can be completed relatively easily. Community support for coordination between the two plans is expected to be high; there is likely to be public interest in the details of how the priority of receiving site needs is determined.

Cost: Low
The costs for developing a protocol are estimated to be low and comprised primarily of staff time. There may also be costs associated with public process.

12. Establish specific indicators and acceptable ranges of variation to fill information gaps

OSMP staff identified the need to develop additional indicators that were not included in the Grassland Plan.

- Vegetation Height and Density (grassland bird habitat)
  An indicator of vegetation density measured as visual obstruction (Robel et al. 1970). This indicator is needed to describe the vegetation structure associated with diverse or abundant grassland bird populations. This indicator would be used as a tool to inform grazing and fire management, allowing managers to ensure adequate cover is available for grassland birds.

- Preble's Meadow Jumping Mouse
  An indicator of the viability of Preble's meadow jumping mouse (Preble's). Preble's was listed as a threatened species under the Endangered Species Act in 1998 and occurs in wetlands, riparian areas and other habitats near streams and ditches along Colorado's Front Range and in southeastern Wyoming. Preble's has been found in the Grassland Planning Area mostly around South Boulder Creek and OSMP lands are likely to be integral to the conservation of this species in Colorado.

- Range Site Condition
  This (or these) indicator would be developed as part of a rapid assessment protocol for use by agricultural managers to provide a preliminary evaluation of soil/site stability, hydrologic function and integrity of the biotic community. Such an indicator will help OSMP track areas that are potentially at risk of degradation and provide early warnings of potential problems and opportunities to alter management practices. Some examples of such indicators include the presence of erosion features (water flow patterns, gullies, wind scour, blowouts and litter movement), bare ground, dominance of various functional or structural groups of plants and annual production.

- Wetland and Riparian Hydrology
  OSMP has identified the altered hydrologic regime of the Wetland and Riparian Areas targets as a fundamental issue. However, the Grassland Plan proposes no way of describing current conditions or setting an acceptable future condition so that strategies can be developed to improve the situation. Determining the acceptable range of variation for hydrology is complicated by the highly developed and regulated use of water in Colorado and the flood issues affecting the developed areas that surround the Grassland Planning Area. Developing an indicator and an understanding of current and historic conditions will help OSMP work toward defining acceptable conditions for this highly modified ecosystem that are consistent with the purposes of OSMP and the objectives of the Grassland Plan.

Benefit: High
These indicators will provide OSMP with actionable information about significant viability concerns and important conservation issues. Establishing these indicators is likely to leverage more effective conservation action.

Feasibility: Very High
OSMP has staff with sufficient time and expertise identified to development these indicators and ranges of acceptable variation. None of these indicators is especially complex to develop, as there is considerable information available to inform each of them. The indicators are non-controversial and logical parts of the Grassland Plan framework.

Cost: Low
The costs associated with the development of these indicators are limited to staff time and should fall within the "Medium" range. The costs of implementing monitoring these indicators are not included in the cost assessment for this strategy.

Strategies Rated "High"

13. Treat non-native invasive species in the grassland planning area using appropriate integrated pest management techniques

In 2006 and 2007, OSMP mapped selected weed species in the Grassland Planning Area using methods developed by Utah State University and referred to as Rapid Assessment Mapping (RAM). The information from this inventory and recommendations of the authors of the first year's work (Dewey and Anderson 2006) has been used to formulate the approach used by OSMP to address invasive plant species.

Since the abundance of weeds in the Grassland Planning Area exceeds the resources available for control, OSMP prioritizes weed management. OSMP's prioritization centers on the invasiveness of the weeds as well as their abundance and distribution. OSMP gives special priority to weeds species for which the state requires control. OSMP's approach has been to devote some of its resources to each of the following objectives (Dewey and Anderson 2006):

- **Eradication of small infestations of highly invasive species** is a high priority for OSMP. These will grow if left unmanaged and become more costly and difficult to control in the future.
- The **containment and reduction of moderately sized infestations** is employed for somewhat larger weed populations that can be managed, but where eradication is unlikely.
- **Protecting non-infested areas from the spread of pervasive weeds** that are beyond the scope of containment and reduction.

Specific actions nested within this broad strategy include:

- Establishing "weed prevention areas" in areas with low weed diversity or the absence of certain weed species
- Working with conservation easement owners on treating invasive species on easements that border and contribute to the spread of weeds onto OSMP managed areas
- Forming a Cooperative Weed Management Areas for the Best Opportunity Areas in the northern and eastern portions of the planning area
- Supporting the biocontrol work done by universities and Boulder County to reduce diffuse knapweed
- Reclaiming or restoring localized disturbance areas that act as seed and propagule sources for surrounding areas

- Paying special attention to "hot spots" where new weeds are likely to become established due to on-going disturbances and numerous vectors (e.g., parking lots and trails)
- Analyzing hydrology data and irrigation use to promote desirable vegetation and discourage noxious weeds
- Using grazing goats in areas with high density of invasive species and low potential for impact on desirable species
- Reviewing and revising grazing management plans to ensuring that cattle are not moved from areas with Mediterranean sage to un-infested areas

Implementation of the IPM program will be integrated with other grassland plan strategies, especially grazing and fire management to develop specific treatments for specific areas.

Benefit: Very High
Successful IPM efforts will help abate one of the sources of stress most degrading the Grassland Plan targets.

Feasibility: High
OSMP has invested significantly in IPM, providing staffing and leadership. There is also strong community support for the program. While the mechanics of weed management are well understood and OSMP has effective means of implementing cultural, mechanical, biological and chemical controls, the department is unable to spread the available resources across the system to implement the necessary treatments. It is also unclear whether, in the presence of global environmental changes, IPM treatments will be effective in enhancing viability of the Grassland Plan targets.

Cost: Very High
OSMP's direct costs for system-wide IPM are approximately $250,000 per year. Costs associated with the GPA have not been calculated, but the majority of IPM treatments occur in the Grassland Planning Area. OSMP's IPM efforts are also supported by the activities of agricultural lessees and volunteers.

14. Establish, maintain, remove and exclude prairie dog colonies in accordance with prairie dog management designations

The Grassland Plan describes prairie dog management designations for the Grassland Planning Area. These designations were developed to provide opportunities for the conservation of prairie dog mediated grasslands, grasslands unaffected by prairie dogs and agricultural operations. The City of Boulder seeks to conserve prairie dogs and associated species, but because prairie dogs' digging and grazing activities are incompatible with the conservation of other targets, the management of prairie dogs colonies is an important strategy. This strategy includes:

- Tracking the extent of prairie dog activity on OSMP on at least an annual basis
- Assessing conditions of Grassland Preserves to determine suitability as sending or receiving sites for prairie dog relocation
  - Prairie dog removal from Grassland Preserves will be considered when occupation exceeds 26% and vegetation conditions are rated "Poor"
  - Relocation of prairie dogs to Grassland Preserves will be considered in accordance with the receiving site relocation criteria found in Appendix I
- Identifying and prioritizing removal and receiving sites
- Relocating prairie dogs as appropriate after obtaining the appropriate authorization from the City and the Colorado Division of Wildlife
- Obtaining necessary permits and removing prairie dogs via lethal control when necessary
- Sending site reclamation

- Coordinating with Boulder County Health on plague and other animal-borne disease
- Using tillage, irrigation and other practices to discourage prairie dogs from establishing colonies in removal and transition areas
- Working with community members, researchers and other land managers to develop innovative solutions prairie dog management

Prairie dog relocation criteria (Appendix I) were developed to provide for recovery of native plant communities and prairie dog habitat in Grassland Preserves after the death or removal of prairie dog colonies and to protect habitat for rare and sensitive plant species and communities.

This strategy requires that vacant colonies within Grassland Preserves be monitored to determine suitability for relocation. Because relocation needs may not be timed to coincide with ideal monitoring times, OSMP will need to identify potential relocation sites and decide how much monitoring is appropriate in a given year based upon the anticipated need for receiving sites by OSMP and others. OSMP will work with the Urban Wildlife Coordinator to integrate implementation of the Grassland Plan and the Urban Wildlife Management Plan.

Benefit: Very High
This strategy is crucial to allow OSMP to meet viability standards for the Black-Tailed Prairie Dog and Associates target. Implementation will ensure that sufficient acreage of prairie dog occupation is maintained on the OSMP land system to provide for long-term conservation of the black-tailed prairie dog and its associates.

Implementation of this strategy will also directly support the sustainability of OSMP's Agricultural Operations and viability of both the Mixedgrass Prairie Mosaic and Xeric Tallgrass Prairie targets. Demonstration of prairie dog management compatible with the conservation of other grassland types and agriculture may also leverage greater community support for the conservation of the Black-tailed Prairie Dog and Associates target.

Long-term occupation of prairie dog colonies affects vegetation composition and structure. Measurements of native plant species richness, native plant cover and cover by bare ground fall outside the range of acceptable variation in plots located within the Mixedgrass Prairie Mosaic on prairie dog colonies. Allowing vegetation to recover prior to reintroducing prairie dogs, as detailed in the prairie dog relocation criteria (Appendix I), is an essential component of managing for both prairie dogs and native communities in the relatively small and fragmented grasslands of the GPA.

Feasibility: Medium
Experienced staff members are available to conduct annual prairie dog mapping and assess the vegetation in Grassland Preserves (a prerequisite to relocation). There is currently no staff capacity identified to conduct relocation or other removal activities. While prairie dog relocation requires an understanding of prairie dog behavior, experience handling wild animals, and appropriate permits from the Colorado Division of Wildlife, it is routinely implemented by trained professionals. This strategy is consistent with the City Council-approved the Wildlife Protection Ordinance describing how prairie dogs should be managed in the city and on city-owned lands such as open space. OSMP has heard from community members who would like to have prairie dogs conserved in selected areas as well as those who would like to see more areas of native grassland and agricultural activity without prairie dogs. While staff has made adjustments to address a variety of perspectives while trying to maintain a workable approach, it is likely that some community members will feel that the strategy does not go far enough to meet their concerns. There are likely to be concerns from some members of the community that prairie dogs should be relocated to areas before the vegetation meets the relocation criteria or into areas not previously occupied by prairie dogs.

Cost: Very High
Annual prairie dog mapping is typically conducted by seasonal wildlife technicians and processed by GIS analysts. Vegetation readiness evaluations in Grassland Preserves can be conducted by either staff or contractors and are likely to take several days each for data collection and analysis. Prairie dog trapping success rates vary significantly from year to year and location to location making it difficult to predict the costs reliably. However, removing prairie dogs from the ground either by trapping or "flushing"[3] burrows is expensive whether conducted by staff or contractors. Once captured, there are additional costs associated with both relocating prairie dogs elsewhere or using lethal methods of control. If the number of prairie dogs that are retained at receiving site are figured into relocation costs the per-animal costs can be quite high (hundreds of dollars per animal).

Site restoration costs for sending sites are also highly variable. Some areas may be left untreated allowing the suppressed native vegetation to grow. Other areas may need to be treated for varying levels of invasive or non-native species. Agricultural areas such as irrigated pastures may need to be leveled and replanted.

The greatest efficiencies for OSMP are afforded when population levels in removal and transition areas are lowest.

15. Construct, repair, enhance and maintain irrigation delivery system

OSMP manages several miles of ditch laterals and approximately five hundred water supply structures (headgates, gauges, dams, developed springs, stock tanks etc.). Information about the water delivery system is managed using a proprietary water resources management database integrated with GIS. Combined, this information system allows staff to manage, store, query, retrieve and analyze tabular or geographic data for various water resources, including the water delivery infrastructure. This database has enabled OSMP to conduct an inventory and assessment of the function and condition of OSMP's irrigation facilities. The assessment produced several findings:

- A significant amount of the maintenance to the water delivery systems in the Grassland Planning Area has been deferred. While many irrigation structures on OSMP lands were old and in need of repair or replacement when the properties they serve were purchased by the department, others have deteriorated because of insufficient funding and staffing to maintain acceptable conditions. Staff used the inventory and assessment to identify, prioritize and estimate the costs and staffing needs for facility maintenance and capital improvements.

- OSMP needs a greater ability to measure water availability and use to manage its water resources effectively. Some measuring devices are available to quantify water use on OSMP properties. However, they are not sufficient in number or distribution, and there is insufficient staff time to visit these devices, which under current conditions cannot be monitored remotely.

- Some types of structures, such as junction boxes, and information (such as OSMP's operation, maintenance and replacement responsibility) are not yet part of the facility inventory.

- OSMP has a responsibility to avoid or minimize impacts from the maintenance and operation of the irrigation water delivery system to other OSMP resources.

Specific tasks under this strategy include:

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[3] Burrows are actually filled with foam, however prairie dogs typical response it to leave the burrow, presumably because they believe it is flooding.

- Inventorying the location of existing measuring devices that can support water management and quantify water use on Open Space properties.
- Monitoring water use at key locations.
- Identifying and prioritizing locations where water use information would be useful for management
- Installing measuring devices at priority unmeasured locations
- Installing measuring devices when headgates are replaced or repaired on both ditches and laterals, if the location will provide useful water use information
- Inventorying the locations of junction boxes that support OSMP's irrigation delivery system both on and off OSMP lands.
- Assessing the condition of the junction boxes and estimating the scope and timing of repairs or replacement
- Developing an ditch burning schedule to be integrated with the prescribed fire program
- Working with ditch companies that have written easements and prescriptive uses on OSMP land to encourage maintenance practices that minimize damage to other resources
- Working to ensure practices that minimize resource damage are followed according to program maintenance policies within constraints imposed by the by-laws of the ditch company in situations where OSMP is the primary or sole shareholder in a ditch company

Benefit: Very High
Addressing deferred maintenance issues will improve OSMP's ability manage the water the department owns supporting agricultural operations and the attendant biodiversity (e.g., Ute-ladies tresses orchid, bobolinks, and Preble's meadow jumping mouse as well as some wetlands and portions of the Mesic Bluestem Prairie). Improvements to the irrigation infrastructure will also help the department ensure long-term protection of those rights. The ability to track water more thoroughly will also provide OSMP greater flexibility and may bring understanding of how other targets might benefit from innovative applications of OSMP's water rights.

Feasibility: Medium
While OSMP has a staff knowledgeable and experienced in water resource management, the work to be done exceeds the available capacity. While requiring significant technical knowledge and expertise, the maintenance and repair projects are straightforward and many similar projects have been completed before by staff and contractors. There is strong public support for the maintenance of OSMP's infrastructure and water rights.

Cost: Very High
A significant amount of maintenance on the water delivery systems that serve OSMP lands has been deferred. These repair expenses will require a long-term commitment. Alternative funding sources, including participation by other water users, ditch companies and others, may be required where legally or financially appropriate and feasible.

16. Establish instream flows in South Boulder Creek and Coal Creek

Instream flow programs can improve the hydrologic variability and improve the ecological characteristics of the Riparian Areas target by establishing the minimum flows necessary to sustain aquatic life and prevent further deterioration of aquatic ecosystems.

Colorado law allows the Colorado Water Conservation Board (CWCB) to appropriate water without the requirement of diverting it from the natural watercourse—a so-called "instream" appropriation. Except for these instream appropriations, all other water decrees require that the water be diverted from the creek. New instream flow appropriations typically provide little benefit in most years because the rights are so junior and all the reliable water was fully appropriated long ago (MacDonnell 1991). The Colorado legislature has expanded the CWCB's ability to improve environmental conditions by allowing the acquisition of existing, decreed senior water rights for instream flow. Because water rights can now be "transferred" to instream appropriations without losing their seniority, instream appropriations can result in reliable flows in the creek.

The minimum instream flow needs for South Boulder Creek to sustain an adult trout population have been estimated (Hydrosphere1994) (Table L-1). This estimate was selected because it addressed the interest of key stakeholders and provided flows that would also support native fish and other aquatic life. With the exception of flows between Gross Reservoir and the town of Eldorado Springs during the irrigation season, minimum instream flows in South Boulder Creek are completely unaddressed by existing flow patterns.

Table L-1: Instream flow goals and instream flow deficits for South Boulder Creek (from Hydrosphere 1994)

Stream Reach	**Irrigation Season (April 15-October 31)**		**Storage Season (November 1-April 14)**	
	Instream Flow Goal	Instream Flow Deficit	Instream Flow Goal	Instream Flow Deficit
Gross Reservoir Outlet to Eldorado Springs (Community Ditch)	22.0 cubic feet/second	minor amounts	8.0 cubic feet/second	8.0 cubic feet/second
Eldorado Springs (Community Ditch) to Confluence w/Boulder Creek	6.0 cubic feet/second	6.0 cubic feet/second	2.5 cubic feet/second	2.5 cubic feet/second

Hydrosphere (1994) identifies management options to meet the minimum instream flow goals. The Denver Water Board's proposal to enlarge the capacity of Gross Reservoir and its need to mitigate for the environmental impacts of this expansion may provide an opportunity to progress towards providing instream flows for South Boulder Creek.

OSMP commissioned an instream flow planning study for Coal Creek to identify instream flow objectives and develop preliminary strategies to meet those objectives (Hydrosphere 2000). Rather than focus on conditions needed for a single species, the consultants proposed a model intended to provide conservation of the entire riparian and aquatic systems by incorporating more of the hydrologic variability inherent in natural creek systems (Richter et al. 1997). Although the Range of Variability (RVA) approach was not used by Hydrosphere, they did estimate monthly instream flow goals deficits based upon almost 40 years of flow data for Coal Creek (Table L-2). With the exception of the month of July, Coal Creek has an instream flow deficit throughout the year.

Table L-2: Preliminary model results instream flow goals and instream flow deficits for Coal Creek from Plainview to Superior (from Hydrosphere 2000)

	March	**April**	**May**	**June**	**July**	**Aug-Feb**
Instream Flow Goal	1.5	8	12	5	0.7	0.4
Instream Flow Deficit	0	3	5.5	3.9	0.7	0.3

Hydrosphere (2000) proposed and evaluated the general feasibility of several specific actions that would protect the existing flow regime and increase flows to meet the instream flow goals. These fall into the following categories:

- Establishing an instream flow right to protect the creek from the impact of appropriations that would divert additional flows from the creek
- Reducing diversions
- Increasing flows

While the city has proposed instream flow appropriations on Coal Creek to the CWCB, no instream flows have yet been appropriated. The City has not yet refined its management objectives or developed an RVA analysis of instream flow goals for Coal Creek. Those steps are needed before the OSMP can follow through on strategies to reduce diversions or increase flows.

Benefit: Very High
This strategy would make a significant contribution to the restoration of a fundamental process controlling one of the Grassland Plan targets.

Feasibility: High
City staff (OSMP and Utilities) has the experience and skills necessary to undertake this strategy and have been making progress for several years. Although establishing instream flows involves many complexities and uncertainties, this type of strategy has been accomplished before. The strategy is likely to find strong community support.

Cost: Very High
The water rights necessary to implement this strategy are extremely valuable. The CWCB would rely upon a donation from the City to establish an instream appropriation for South Boulder Creek. If that were to happen, the City would exchange the environmental benefit of the instream appropriation for the economic value of the water. Other options exist whereby the City could manipulate the location and timing of water storage and release in the upper and lower watershed to maintain minimum instream flows in the creek. The cost of implementing the strategy also includes considerable time of city staff, water resources consultants and water attorneys.

17. Collaborate with neighboring land management agencies to establish compatible land management practices

Regional coordination is a practical response to several management issues affecting all natural land managers in the area. These management issues include weed management, restoring habitat connectivity and agricultural management. There are four public agencies managing natural lands adjacent to the Grassland Planning Area, three of which are engaged in or committed to the development of management plans.

The US Fish and Wildlife Service manages the 6,200-acre (2,500-ha) Rocky Flats National Wildlife Refuge. The Comprehensive Conservation Plan (the Plan) for the refuge was approved in 2005. The Plan identifies the following strategies:

- Meet annually (at a minimum) with local governments and other adjacent landowners to coordinate habitat management and resource conservation strategies
- Work closely with surrounding open space and natural resource entities such as . . . City and County of Boulder . . . to develop resource management approaches for issues that cross refuge boundaries
- Within two years develop a vegetation management plan (this plan has not yet been developed due to funding limitation)
- Participate in regional Xeric Tallgrass Prairie conservation efforts

- Develop comprehensive integrated pest management plan
- Work with others to protect movement corridors [for deer and elk]

Boulder County Parks and Open Space (BCPOS) is currently in the process of developing a Grassland Management Policy and a management plan for 1,600 acres (650 ha) of grasslands adjacent to the southeast corner of the Grassland Planning Area. The BCPOS staff have made significant contributions to the development of the Grassland Plan and indicated that the Grassland Plan may provide useful information for their management planning efforts.

City of Boulder Parks and Recreation manages the approximately 300 acres (121 ha) around Boulder Reservoir and are currently engaged in the development of a management plan that will include resource management direction for the reservoir's natural areas. Open Space and Mountain Parks staff is participating in that planning effort.

United States Department of Commerce (DOC) National Oceanic and Atmospheric Administration (NOAA) owns Table Mountain in the northern portion of the Grassland Planning Area where they operate an experimental radio research site. While the DOC's focus at the 1,700-acre (690-ha) Table Mountain Field Site is not grassland conservation, the site offers considerable conservation potential. This strategy includes meeting with representatives from the DOC to understand their resource management practices and learn more about the vegetation and wildlife use of the site.

State, county and city transportation departments maintain rights-of-way adjacent to OSMP lands. Coordination of weed management, revegetation/plantings and rare plant management can help advance the individual and shared goals of OSMP and these agencies.

Benefit: High
Adjacent natural areas already confer significant habitat value to the Grassland Planning Area. However, coordinated approaches to weed management, and conservation of sensitive or uncommon species or natural systems could provide a long-term reduction of conservation issues and improve target viability. A management agreement with one agency could build support for other agreements.

Feasibility: Medium
Although OSMP staff members have the relevant experience, the department has not identified a lead individual with sufficient time to undertake this strategy. Developing management agreements with the County is very straightforward and has been done often. However, collaborative resource management with federal agencies can be complex, uncertain and require significant time devoted to process, though OSMP has occasionally entered into management agreements with federal agencies. There is likely to be strong public support for cooperation among government agencies to achieve compatible goals.

Cost: Medium
Staff time is the primary cost associated with meeting, information sharing and developing formal agreements.

18. Create a large block of conserved grassland in the northern portion of the OSMP land system through acquisitions and management agreements

OSMP's Acquisition Plan includes, among other aspects, two focal areas for acquisition on properties north of Neva Road and east of Broadway. The "Northern Tier" is centered on Table Mountain. An area surrounding this is identified as "Boulder County Partnerships". Specific actions for this strategy would be land acquisition, developing perpetual (or very long-term) management agreements with Boulder County, establishing land management objectives for conservation easements or other types of ownership agreement consistent with selected objectives of the Grassland Plan.

Benefit: Very High
In addition to the benefits of providing more conserved grassland, providing conservation management to large blocks of grassland habitat would offer protection to area sensitive species and provide additional areas for wide-ranging grassland species. OSMP's land acquisition and conservation easements are in perpetuity, so this strategy would be long lasting. OSMP acknowledges that purchasing land in poor condition has the potential to lower the rank for some key attributes (e.g., native plant cover).

Feasibility: Medium
OSMP staff includes property agents experienced in complex land negotiations who have already been actively involved in acquiring lands and property interests in this area, including several joint purchases with Boulder County. There is typically a large degree of community support for OSMP acquisitions and partnerships to conserve land. Any acquisitions would require the approval of the OSBT and the City Council. This strategy is consistent with board and council approved acquisition plan.

Cost: Very High
It is likely that this strategy would require the purchase of land. Consequently, it is a very high-cost strategy.

19. Promote conservation of the Grassland Plan targets by increasing awareness of grassland values and conservation issues

The Grassland Plan provides a framework for heightening public understanding and interest in OSMP grassland. Telling the "essential stories" of the Grassland Planning Area can increase people's understanding of connection with OSMP.

A better understanding of the ecological and agricultural services that OSMP provides to the community is likely to translate into greater appreciation of OSMP lands for those who visit and stronger general awareness and support for the OSMP program. Increased understanding of how the conservation targets "work" and the conservation issues they face has special relevance for many of the ways people enjoy OSMP lands. This understanding may lead to changes in behavior that will improve the viability of targets over time. Specific areas where greater understanding among community members and community groups can lead to significant impact are:

- Avoiding activities that spread weeds, the New Zealand mudsnail and zebra mussel
- Staying on trails, especially in sensitive areas or during times of sensitivity for grassland species
- Respecting seasonal protective measures
- Abiding by dog management requirements

OSMP has well-developed programs for community outreach, education and enforcement. Staff members are accustomed to and skillful at developing innovative and diverse programs to build connections by telling compelling stories and providing fun and meaningful experiences in the natural world. Programs range from trailside signs and a simple set of "Leave No Trace" principles to advanced naturalist training, long-term volunteer opportunities and a seasonal employment/educational program for teens. OSMP's priority for developing compatible behaviors is to provide opportunities for experience and understanding first, only using restrictions and regulations as complementary or backup strategies.

Benefit: High
OSMP relies upon public understanding and awareness of basic principles and laws to ensure compatible behaviors by visitors. This requires communicating these principles and rules along with information about the value of the resources and the objectives of management, and, most importantly, compatible ways to enjoy OSMP. OSMP believes that this approach is an effective means to promote compatible visitor behavior and confers significant conservation benefit. The effectiveness of these strategies is difficult and expensive to measure. While OSMP has invested some resources in measuring the effectiveness of our public engagement strategies, it has chosen to invest a greater share of resources in actual public engagement. This strategy is thought to improve the viability of all conservation targets and reduce conservation issues to some (unknown) degree.

Feasibility: High
OSMP has a staff capable and experienced in developing educational programs, community outreach and volunteerism. (More information about levels of service within the Grassland Planning Area is available in Appendix G.) These programs are under continual development and enhancement, and while sometimes complex, they represent a task that has been done repeatedly. There is strong community support and desire for these community services.

Cost: High
Based upon current levels of effort, staff time and other expenses for programs in the Grassland Planning Area over the ten-year planning horizon represent a "High" cost.

20. Protect Boulder Creek from the spread of New Zealand mudsnails by restricting access to the creek between 55th Street and 75th Street

The existing closure, established by regulation in 2005, includes informative ("Mud Snail Alert!") signs posted at nearby access points and periodic enforcement by rangers. It may also be necessary to conduct periodic outreach with local anglers to update them on the status of the mudsnail and the on-going need for the closure. A similar fishing access closure in the creek by the state of Colorado was rescinded in 2006.

Benefit: Medium
Because this remains one of only two known infestations in Colorado and the only one on OSMP, reducing human-borne transport of snails (attached to waders, shoes, in creels, etc.) can be an effective way to slow the spread of this species to other areas.

Feasibility: High
Anglers, the group most affected by this strategy, appear to support the closure and have demonstrated good compliance. Motivation to accept the closure was reduced somewhat by actions of the state of Colorado, creating confusion among some anglers about the different management approaches of the City and the State. Some members of the public who use the area for hiking and dog walking have expressed displeasure at the closure and anecdotal information suggests that a small number of users violate the closure.

Cost: Low
There are not significant discretionary costs associated with this strategy. Signs may need to be replaced periodically. Rangers enforce the regulation as part of their regular patrol schedule.

21. Continue Integrated Pest Management efforts to control Eurasian watermilfoil

Eurasian watermilfoil (EWM) is an aquatic invasive species that is getting a foothold in the Boulder Creek and St. Vrain Creek watersheds. In 2005, staff surveyed and managed this weed on a one-mile stretch of Boulder Creek and constructed experimental barrier fencing in Bear Creek to prevent further spread downstream. So far, OSMP has successfully managed to reduce infestations and contain this invasive species in Boulder Creek above 75th Street. If this level of containment is to be continued, OSMP will need to invest in on-going management. Under this strategy, OSMP would continue to increase public awareness of Eurasian watermilfoil and work with other city and county agencies, citizens and special interest groups to promote preventative methods such as an "Early Detection and Rapid Response" protocol. Staff will also play a role coordinating the control efforts of other city departments, the University of Colorado and County, State and private (ditch companies) interests.

Benefit: High
Control of this weed will help protect native aquatic habitat and irrigation infrastructure. Eurasian watermilfoil degrades native habitat in a variety of ways. It competes with native aquatic plants, deteriorates fish and macroinvertebrate habitat, leading to a loss of food sources for waterfowl and other wildlife, depletes dissolved oxygen, and increases water temperature, phosphorus levels, and nitrogen levels. It affects irrigation by clogging pipes and impeding the flow of water.

Feasibility: High
OSMP's management efforts to date have been effective at containing and reducing populations of EWM as well as increasing awareness of the threats posed by this species among water managers and members of the community. There is strong public support for removal efforts. Several control methods have been used effectively to contain EWM populations upstream of 75th Street.

Cost: High
Mechanical control of EWM is time consuming. Staff time for mechanical control, the installation and maintenance of physical controls, as well as materials and supplies are likely to fall in the \$50-\$100,000 range over the planning horizon. Volunteers have been willing to participate in mechanical control reducing, to some degree, personnel expenses.

22. Construct or maintain hunting perches near reservoirs and prairie dog colonies to encourage use by raptors

Benefit: Medium
If successfully implemented, this strategy will attract predators identified as prairie dog associates and improve the viability of the Black-tailed Prairie Dog and Associates target.

Feasibility: High
OSMP staff members have the expertise and availability to implement this strategy. It is also relatively straightforward and similar strategies (nesting platforms) have been implemented before. Attracting raptors typically appeals to the motivations of the community. However, some members of the community are opposed to the placement of tall structures in grasslands because of their aesthetic impacts and because they can provide locations from which cowbirds can detect nests to parasitize and could potentially increase predation on burrowing owls.

Cost: Low
Although the costs for this strategy are low even if borne by OSMP, partnerships with a public utility for perch pole placement could reduce costs further. The department has been successful in this regard in the past working to establish osprey-nesting platforms.

23. Construct and maintain alternate nesting structures for sensitive raptors in best opportunity sites

Historically, ferruginous hawks commonly nested on or near the ground. Since such locations are vulnerable to predation, nesting mortality has probably been high and ferruginous hawk populations low. Raptor biologists have experimented with artificial nest structures in an effort compensate for habitat destruction and human disturbances from mining, agriculture and development. Research has indicated that ferruginous hawks can be attracted to nest on artificial platforms and that these platforms can attract breeding pairs to nest in areas where no nesting had previously been recorded. Artificial platforms have been used successfully to provide nesting habitat in Alberta, Washington, Montana and south-central Wyoming.

Ferruginous hawks are common winter residents in the Grassland Planning Area and are occasionally seen during the breeding season. There are no records of ferruginous hawks nesting in Boulder County. OSMP will evaluate where artificial nest structures would be most likely to attract nesting ferruginous hawks.

In 2008, ten pairs of osprey nested in Boulder County. Four pairs nested on artificial structures on city-owned lands, all near Boulder Reservoir and two on Open Space and Mountain Parks. OSMP will evaluate opportunities for constructing additional osprey nest platforms in the Grassland Planning Area.

In 2008, five pairs of bald eagles nested in Boulder County, two pairs on OSMP lands in the GPA. So far, bald eagles have found suitable natural sites in the Grassland Planning Area. Their nests have been located in mature cottonwood trees in riparian areas with low levels of human activity. It is possible that the two bald eagle nests in the Grassland Planning Area have occupied the available habitat. OSMP is not proposing at this time to construct artificial structures to attract additional nesting by bald eagles. The Department is observing natural patterns of population expansion to learn more about the carrying capacity of the Grassland Planning Area for bald eagles.

Northern harriers (or marsh hawk) are known to nest in Boulder County. While there are no records of northern harrier nesting on OSMP lands, they do nest in marshes on adjacent city-owned lands near Boulder Reservoir. The northern harrier nests on the ground and is not known to use artificial nesting structures.

Benefit: Medium
This strategy currently benefits the osprey and has the potential to establish nesting by ferruginous hawks in Boulder County. Red-tailed hawks, a widespread raptor with sufficient existing nesting habitat, could appropriate artificial structures for their own use before ferruginous hawks begin nesting. Brown-headed cowbirds may also use these structures to locate and parasitize grassland songbird nests.

Feasibility: High
Staff with the appropriate skills and relevant experience is available to implement this strategy over the planning horizon. The construction, placement and maintenance of artificial nest structures are very straightforward and have been done before. There is typically strong public support for projects that support raptor population expansion. Some members of the community may be opposed to the construction of artificial structures on open space because of the aesthetic or potential ecological impacts.

Cost: Low
Although the costs for this strategy are low even if borne by OSMP, partnerships with a public utility for perch pole placement could reduce costs further. The Department worked successfully with Xcel Energy to erect osprey-nesting platforms.

24. Consider closing, restoring and discouraging the (re) establishment of undesignated trails in areas of special conservation value or sensitivity as part of the TSA planning process, and if necessary, prior to TSA planning

There are approximately 115 miles of undesignated trails within the Grassland Planning Area. One of the essential components of TSA plans is a set of recommendations about how undesignated trails (UDTs) will be managed. The management decision about UDTs typically determines that an UDT should either be **designated** by incorporation into new or existing designated trails or **closed and restored.** This strategy recommends that the TSA process consider the Grassland Plan recommendation to close and restore UDTs in places that meet the following criteria:

- Northern leopard frog habitat blocks
- Rare plant populations
- Prairie dog colonies within Grassland Preserves
- Prairie dog Multiple Objective Areas
- Wetlands and Riparian Areas (especially Best Opportunity Areas)
- Areas with low weed density
- Areas of high grassland bird nesting value[4] (in situations where seasonal protection measures are not feasible)

Given that undesignated trails will be closed for a variety of reasons, some unrelated to the Grassland Plan goals, this strategy also recommends that the TSA process consider prioritizing the closure of undesignated trails in these areas once undesignated trail management decisions have been made. Places that meet multiple criteria should be given a higher priority.

These recommendations are made with the understanding that they will be integrated with the recreational objectives of TSA plans.

This strategy also recommends that the TSA planning process consider closing UDTs in these areas first, once the decision has been made about which UDT's are to be closed. It is understood that several other considerations may factor into the prioritization of UDT closure.

OSMP prefers to use the TSA planning process to integrate resource protection and visitor access and enjoyment. However, since TSA planning for portions of the GPA will not occur for several years, OSMP may close undesignated trails when necessary to protect sensitive resources **prior to the TSA planning process.** TSA plans should also include a mechanism for responding to new information about sensitive resources allowing OSMP to enact protective measures after the TSA plan has been completed.

Benefit: High
The outcomes of TSA planning are unpredictable. The degree to which this strategy will successfully reduce the conservation issues associated with UDTs is unknown. Closing and restoring UDTs will benefit nested conservation targets that require large blocks of un-fragmented habitat and those that are sensitive to human and dog presence. Undesignated trails in and around

[4] Locations to be determined based upon the results of inventory and monitoring.

prairie dog colonies in Grassland Preserves and prairie dog MOAs reduce the otherwise significant potential of these areas to attract burrowing owls, horned larks and raptors.

This strategy also identifies the need for OSMP to protect sensitive resources by taking necessary actions prior to TSA planning, especially when the TSA process is far in the future.

Feasibility: Medium
There is staff available and capable of implementing this strategy. "Considering" closure of undesignated trails in areas of environmental sensitivity is not a complicated matter and has been done before. Closing UDT's prior to TSA planning may be more complicated, but has been done before. If adopted as part of the Grassland Plan, this strategy will provide direction and motivation for the planning team/community group to consider UDT closures in the best opportunity areas and sensitive habitats identified in the Grassland Plan. It is likely that some members of the community will not support resource protection measures that restrict visitor access prior to TSA planning.

Cost: Low
This is a low cost strategy, requiring some staff time during the TSA planning process. The closure and reclamation of many UDTs before TSA planning may increase the cost of this strategy.

25. Consider establishing on-leash requirements in areas of special conservation value or sensitivity as part of the TSA planning process, and, if necessary, prior to TSA planning

Dogs are allowed to be off leash if in sight and under voice control of their guardian throughout much of the Grassland Planning Area. TSA planning provides an opportunity for site-specific consideration of OSMP's dog management. This strategy recognizes that certain areas are either more vulnerable to the effects of dogs or pose a greater challenge to voice and sight control or both. It calls upon the TSA planning process to consider establishing leash requirements in those areas. This strategy recommends that the TSA process consider the Grassland Plan recommendation to require that dogs be leashed in places that meet the following criteria:

- Prairie dog colonies within Grassland Preserves
- Prairie dog Multiple Objective Areas
- Areas of high grassland bird nesting value[5] (in situations where seasonal protection measures are not feasible)

Prairie dog colonies in Grassland Preserves and prairie dog MOAs have been identified as the best opportunities to conserve prairie dogs and their associated species. Some of these species, like burrowing owls, horned larks and the prairie dogs themselves, are sensitive to disturbance by domestic dogs. The likelihood of disturbance by dogs in prairie dog colonies is elevated by the tendency of dogs to chase prairie dogs and the difficulty that many dog guardians face in gaining voice control of their dogs in this challenging situation.

While the Grassland Plan identifies seasonal on-designated trail and on-leash requirements as the preferred means to protect high-value grassland nesting bird habitat from the impacts of visitors and dogs, that approach may not be practical in all situations. A leash requirement would provide a lesser but potentially important way to reduce the negative effects of dogs traveling through these areas.

These recommendations are made with the understanding that they will be integrated with the recreational objectives of TSA plans.

[5] Locations to be determined based upon the results of inventory and monitoring.

OSMP prefers to use the TSA planning process to integrate resource protection and visitor access and enjoyment. However, since TSA planning for portions of the GPA will not occur for several years, OSMP may institute leash requirements when necessary to protect sensitive resources **prior to the TSA planning process.** TSA plans should also include a mechanism to responding to new information about sensitive resources allowing OSMP to enact protective measures after the TSA plan has been completed.

Benefit: High
The degree to which this strategy will successfully reduce the conservation issues associated with dogs in prairie dog colonies and high-value grassland bird habitat is unknown. Establishing leash requirements in MOAs and prairie dog colonies within Grassland Preserves will reduce the conservation issues associated with dogs traveling through these colonies and chasing prairie dogs. In high-value grassland bird nesting habitat applying a leash restriction would help reduce the area covered by dogs, reducing the likelihood of direct disturbance to nests or young.

This strategy also identifies the need for OSMP to protect sensitive resources by taking necessary actions prior to TSA planning, especially when the TSA process is far in the future.

Feasibility: Medium
The outcomes of TSA planning are unpredictable. There is staff available and capable of implementing this strategy. "Considering" leash requirements in areas of environmental sensitivity is not a complicated matter and has been done before. Establishing leash requirements prior to TSA planning may be more complicated but also has been done before. The greatest feasibility issue is associated with the difficult of identifying where the regulation is in effect. Boundaries of active prairie dog colonies might have to be generalized to existing fence lines or natural landmarks to ease notification and compliance. This strategy will provide direction and motivation for the planning team/community group to consider some leash restrictions. It is likely that some members of the community will not support implementation of leash requirements either as part of the TSA process or prior to TSA planning.

Cost: Low
This is a low cost strategy, requiring some staff time during the TSA planning process. The establishment of leash requirements before TSA planning may increase the cost of this strategy.

26. Consider providing additional no-dog opportunities to protect areas of conservation value and sensitivity as a part of TSA planning

One of the strategies in the VMP calls for is the establishment of additional no-dog opportunities on some trails using a collaborative process and suitability criteria. The Grassland Plan has identified a number of habitats where historic and current stresses present conservation challenges. These habitats or areas include riparian areas, leopard frog habitat blocks, wetlands, ponds, prairie dog MOAs, prairie dog colonies within Grassland Preserves and large blocks of grassland habitat. The effects of dogs are only a part of the challenge to managing these areas. As the TSA process seeks to identify additional no-dog opportunities, these areas of special conservation value and sensitivity should be considered as the most ecologically suitable places for dog access restrictions.

Benefit: High
As a proposal, this strategy has no direct effect on conservation. However, if implemented, this strategy would reduce the effects of dogs in areas of conservation value and ecological sensitivity. This would reduce the degree of conservation issues facing the targets and improve habitat effectiveness for many species such as ground nesting birds, northern leopard frogs, sensitive raptors and prairie dogs. This strategy is also likely to lead to long-lasting results.

Feasibility: Medium
The outcomes of TSA planning are unpredictable. The degree to which this strategy will successfully reduce the conservation issues associated with poorly managed dogs in unknown. OSMP staff is available and able to integrate these suitability criteria into TSA planning. The strategy is straightforward and has been done before with other ecological concerns. The concept of identifying areas for no-dog opportunities that provide ecological benefit is likely to make sense to the community.

Cost: Low
The costs associated with bringing direction from the Grassland Plan to TSA planning discussions are low.

Strategies Rated "Medium"

27. Consider changes to the VMP management area designation in part of the Gunbarrel/Heatherwood Passive Recreation Area to "Natural Area" as part of the TSA planning process, or prior to TSA planning

The VMP placed the lands in the Gunbarrel/Heatherwood area into two management area designations. OSMP north of Lookout Road was designated as a Natural Area; the area south of the road was designated as a Passive Recreation Area (PRA). The VMP notes that the two areas share many characteristics and that the major difference is the level of recreational access and activity, which is greater south of Lookout Road.

The VMP describes the Gunbarrel Hill/Heatherwood areas as a large contiguous block undergoing native grassland restoration with the intent of restoring a sustainable native grassland ecosystem. It also recognizes that the habitat values of the area support many native bird species and prairie dog colonies. The VMP also identifies seasonal closures or dog exclusions to protect nesting birds in both the PRA and Natural Area.

The Grassland Plan identifies a prairie dog Grassland Preserve that includes the part of the Gunbarrel/Heatherwood PRA north of the East Boulder/Gunbarrel Farm Trail. After a system-wide analysis, this was one of three areas identified where prairie dogs and their associated species are found as part of a relatively large and diverse grassland habitat block. Over the past several years, burrowing owls have nested in this area, and although grassland bird monitoring has not been completed in the area, the expansive grasslands and relatively low levels of use suggest that the area could make important contributions to OSMP's upland prairie bird grassland conservation objectives. In addition, the condition of restored native plant communities has improved in many areas, providing higher quality native grassland habitat beyond what existed at the time of VMP planning.

Staff recognizes that the VMP process established management area designations through a careful and deliberate public process and that it may be difficult to make changes because of interrelationship between the many components of the Visitor Master Plan. However, given the new information resulting from a system-wide analysis about the potential significance of the area for grassland conservation, staff recommends that OSMP propose re-designating the area north of the East Boulder/Gunbarrel Farm Trail to "Natural Area". Such a designation would not preclude the development of trails or use but would provide a context for access, use and grassland conservation strategies for the East TSA more in keeping with the ecological value of the area. The process for considering such a change should include involvement of relevant stakeholders, and could be integrated with the East TSA planning process. This would require a different approach from that used in the West TSA process where one of requirements was that VMP designations would not be changed. Because the East TSA planning process is probably several years away, staff could choose to engage in a process to consider this change prior to the development of the North TSA plan.

Benefit: Medium
While the outcomes of this strategy are uncertain, if successful this strategy would improve the likelihood that visitor access and activity development in the area are consistent with conservation strategies. Efforts to manage for prairie dog predators and commensals, species requiring large blocks of grassland habitat, are more consistent with the emphasis of the Natural Area designation.

Feasibility: Medium
OSMP is appropriately staffed to undertake this strategy. Although no management area designations have been considered for changes since the acceptance of the VMP, developing a process is straightforward. Given the need for all plans to be flexible to changing understanding and conditions, it will be useful to have a way to make changes to the VMP designations. However, there is likely to be concern among stakeholders about altering the delicate balance of management designations in the VMP.

Cost: Low
This strategy would require staff time and some costs for public meetings. If integrated into the East TSA plan, it would not represent any additional costs.

28. Identify and obtain water rights needed to support irrigated agriculture

OSMP has identified irrigated pastures and hayfields as the best opportunities for agricultural production. Without sufficient or sufficiently reliable water rights, the agricultural value of these properties is diminished. OSMP staff has developed a water rights database and associated GIS that allow an analysis of irrigation water requirements and availability. Related analyses of site conditions and water availability may also identify lands where irrigation is not cost effective because of soil quality, perennial maintenance issues or other factors that contribute to making on-going irrigation impractical and uneconomical. Water rights associated with these properties may be useful for supplementing irrigation on higher quality sites, establishing instream flow programs or supporting ecological conservation objectives.

This strategy includes continuing to refine irrigation water models and acquiring the water rights needed to support irrigated agriculture on OSMP lands.

Benefit: Medium
This strategy supports the viability of agricultural operations. It provides a framework to ensure sufficient reliable water for the long-term support of irrigated agriculture. This in turn establishes conditions that are likely to attract to potential lessees—thereby maintaining OSMP lands in agricultural use. There would be greater benefit of to this strategy if the focus were upon securing senior rights that would support additional conservation targets.

Feasibility: Very High
OSMP staff has contracted the development a water rights database that supports the analyses and has developed other tools in-house to use GIS and other tools to identify locations where irrigation water requirements and availability are imbalanced. Staff members with considerable experience in water rights acquisitions are also available to participate in this strategy. The analysis needed to identify the appropriate water rights for acquisition requires an understanding of how to both calculate irrigation water requirements and determine the availability and

reliability of water for a large number of sites. Staff has developed the tools necessary to undertake this analysis. The community, Open Space Board of Trustees and City Council have been supportive of OSMP's water rights acquisition. It is likely that targeted water rights acquisitions to improve agricultural sustainability will also be approved.

Cost: Very High
Water rights are expensive and their value tends to increase over time. While some irrigation water currently in use on other properties may be available to be redirected to higher quality sites in need of more water, it is likely that water will need to be purchased.

29. Establish and support the survival of plains cottonwoods and diverse and abundant shrub communities in riparian areas

Historic mining and agricultural uses of riparian areas compounded by water diversion and impoundment have altered riparian vegetation in the Grassland Planning Area. In order to improve understanding of riparian vegetation dynamics, OSMP hosted research projects that examined pathways of cottonwood and native willow establishment. Based upon the results of these studies staff has experimented with a variety of revegetation methods. A cottonwood regeneration project along Boulder Creek provided a successful example of artificially creating cottonwood forests in the absence of natural disturbances. This strategy applies this technique to increase the size and ecologic functioning of riparian areas on other OSMP properties. Other actions related to this strategy are:

- Controlling of exotic tree species (Russian olive, crack willow)
- Fencing riparian areas to control access by livestock, promote the growth of shrubs and protect young cottonwoods from grazing
- Planting trees and shrubs using traditional methods

Riparian planting is a component of integrated restoration projects identified along Boulder, South Boulder, Dry Creek (Carrier No. 2) and Coal creeks.

Benefit: High
This strategy makes fundamental improvements to the structure of one of the most highly degraded targets in the planning area. It directly addresses two key attributes (vegetation structure and composition) and will have cascading effects on animal species composition, habitat structure and water quality.

Feasibility: Medium
While OSMP staff includes individuals with expertise to implement this strategy, there is currently insufficient availability for staff to design and implement a project of this scale while managing on-going responsibilities and other project work. This project involves a fair number of complexities and uncertainties. Although it has been completed at a small scale, it has not been done over a large area before. There is likely to be a very high level of community support for the restoration of native riparian vegetation.

Cost: Very High
This strategy would require significant staff time, earth moving, the purchase or collection of shrubs and new fencing.

30. Remove trees from grasslands at 75% of best opportunity sites

Although prescribed fire will be an effective means to reduce woody plant invasions of Open Space and Mountain Parks, mechanical removal and herbicide treatments will be needed in areas where fire cannot be safely used or where mature or otherwise fire resistant trees persist after a grassland fire. This strategy would focus tree removal on best opportunity sites for the Xeric Tallgrass Prairie, Mixedgrass Prairie Mosaic, and Mesic Bluestem Prairie targets. A seasonal crew modeled on OSMP's forestry program may be the most effective way to implement this strategy.

Benefit: High
Woody plant invasion is a significant conservation issue for grassland birds. Reducing the scope of this stress would improve conditions in several of the dominant targets in the Grassland Planning Area.

Feasibility: Medium
People with expertise and experience are part of the OSMP staff and already committed to implementing a large proportion of this strategy. The forest ecologist and seasonal forestry crew, working under the guidance of the Forest Ecosystem Management Plan (FEMP), will reduce the tree density in ponderosa pine savannas at the margin of grasslands and forests. The IPM crew is committed to the removal of other trees in the Grassland Planning Area. OSMP has not yet assigned responsibility for the removal of ponderosa pine outside the stand boundaries of the FEMP. Tree cutting is straightforward although there may be some complexities associated with site access and wood removal and disposal. This strategy appears to be consistent with the motivations of the community. Some progress has been made on this strategy in the past as part of the FEMP and through IPM efforts to remove Russian olive and crack willow.

Cost: Very High
Trees are abundant and widespread across OSMP grasslands. It is likely to require a great deal of staff time to accomplish this strategy.

31. Treat wetlands dominated by non-native or invasive species using appropriate integrated pest management techniques.

The invasive plant species most affecting wetlands and wetland weed infestations were not as well identified by the RAM process as weeds elsewhere. Consequently, OSMP proposes a separate strategy for addressing wetland weeds.

Wetlands and wetland habitat for nested targets have been degraded or are threatened by several invasive species such as purple loosestrife, reed canarygrass and cattails. The dominance of these species can reduce the suitability of these areas as breeding habitat for waterfowl, shorebirds and northern leopard frogs. Russian olive degrades wetland habitats by replacing the native cottonwood and willow species. Russian olive is slower growing, has denser wood and is less susceptible to insect feeding compared to native trees. The result of Russian olive dominance is a reduction in the number and size of tree holes available for cavity nesters and the amount of food available for insectivores.

IPM techniques for treating non-native or invasive species include but are not limited to the use of fire, cattle or goat grazing, hand pulling, weed whipping, mowing, tree cutting and the use of herbicides. This strategy addresses several species that are not tracked through the RAM methodology. It is likely that OSMP would prioritize weed-dominated wetlands and riparian areas that have been identified as best opportunities for restoration.

Benefit: High
This strategy contributes to the abatement of one of the most significant sources of stress affecting wetland plant communities and wildlife habitat in wetlands. IPM efforts also help ensure compliance with state laws requiring control of certain weeds. Absent IPM efforts, the impact of invasive species on OSMP would increase over time.

Feasibility: Medium
Staff members experienced with weed management techniques are available to implement this strategy and have been doing so for several years. Though integrated management of numerous species involves a fair amount of complexity, OSMP has effectively reduced some populations of wetland and riparian weeds. Staff will rely upon their experience, the weed control literature and consultation with other weed management professionals to develop integrated approaches for the control of invasive species. There is typically strong public support for OSMP's integrated pest management activities and minimal use of herbicides. As with the general IPM strategy, OSMP capacity limits its ability to implement this strategy fully.

Cost: Very High
The costs associated with this strategy are very high. IPM requires significant amounts of manual labor to detect and treat weeds. Given the sensitivity of wetland and riparian areas, OSMP seeks to minimize the impact upon non-target vegetation by careful, selective application of herbicide. The costs of weed control can be reduced to some degree by enlisting volunteer assistance.

32. Participate in native fish recovery efforts with the Colorado Division of Wildlife

OSMP is interested in working with the CDOW and USFWS to assist in species recovery efforts. OSMP and fishery biologists from the CDOW have identified several opportunities to use ponds on OSMP as natural fish hatcheries. Native fish are released into predator-free ponds where they reproduce naturally. Once populations reach an acceptable level, fish are collected from the ponds and reintroduced into creeks and streams with low populations or from which the species has been extirpated. Starting in 2001, OSMP and CDOW have introduced creek chub, redbelly dace, common shiner, lake chub and greenback cutthroat trout in four OSMP ponds. OSMP has identified eight ponds (on the Papini, Bennett and Stratton properties) that could be reclaimed to support native fish refugia as needed.

Benefit: Low
OSMP anticipates that this strategy may improve the viability of the Riparian Areas target by improving the native fishery.

Feasibility: High
OSMP and CDOW staff have already collaborated to establish populations of four species in fish refugia on OSMP (creek chub did not survive). The project has been straightforward to implement and has been successfully implemented. The reintroduction of native fish is generally consistent with the motivations of the community and does not adversely affect any known community interest.

Cost: Low
Most of the non-personnel and some of the personnel costs are borne by the CDOW.

33. Evaluate the suitability of alternative agricultural practices for OSMP lands

Traditional agricultural activities (cow-calf operations, horse-hay production) continue to be attractive for those interested in leasing OSMP lands and water. OSMP agricultural staff members receive frequent requests about the availability of leases for these purposes. It is likely that traditional practices will continue to dominate agricultural operations during the ten-year planning period.

However, OSMP also has an interest in looking further into the future and assessing the benefit, feasibility and costs of other agricultural practices. Organic gardening and community-supported agriculture are currently expanding in the Boulder Valley. Boulder has historically been a center for organic and natural products industry and is working to enhance and publicize this community identity. If feasible and beneficial for the long-term sustainability of agriculture on OSMP, establishing or expanding natural and organic agricultural practices could also contribute to the city's efforts to enlarge and promote its reputation as a leader in organic and natural products.

A study on the feasibility of converting open space agricultural properties to organic and natural production operations was commissioned by the department fifteen years ago (Leleiwi 1994). A review of the study report would provide a good starting point for examining alternative agricultural operations.

An evaluation of alternatives may point in other directions or suggest that current agricultural practices are likely to be economically and ecologically sustainable into the future. Other ideas that have been identified in past planning efforts include:

- Increasing the use of native grass and forbs for hay production
- Establishing a native seed production operation
- Establishing a native plant nursery operation

Benefit: Low
This strategy does little to directly enhance viability or reduce the effect of identified conservation issues affecting agricultural operations, but it may leverage future opportunities. However this strategy may leverage continued community support for OSMP's agricultural program.

Feasibility: Very High
There are staff members available who are capable of completing this project or overseeing its completion by a consultant. Completion of this strategy requires an understanding of how to evaluate the OSMP land system, agricultural economics and trends in agricultural production. Consultants knowledgeable in these areas are likely to be available. Alternatively, a staff member could develop the necessary understanding while implementing this strategy.

Cost: Medium
This project could be scaled to the available funding. However, if a consultant were to be hired to complete the project, the project would probably require at least $10,000 and staff time to develop and oversee the consulting agreement.

34. Establish ten Class B Bobolink Management Areas and mow each area after bobolink fledging (July 15 unless otherwise determined) one year out of three

In 2007, OSMP staff and volunteers detected bobolinks at 42% (70) of the hayfields sampled (165). Using abundance and density information from the hayfield bird-monitoring program, staff identified 14 second-tier fields as candidates for consideration as "Class B Bobolink Management Areas". In each of these areas, mowing would be delayed (after July 15) in at least one of three years.

OSMP staff determined that 75% of the 14 fields identified as candidate Class B Bobolink Management Areas should be designated as such. So far, the five Class B Bobolink Management Areas that have been designated are: Gallagher field 133, Spicer field 260, Teller Farm North field 186 and two fields on the Bell II property (194 and 199). Agricultural production was identified as the appropriate priority management activity at four of the candidate sites. No determination has yet been made for the remaining five sites.

OSMP will attempt to create bobolink habitat outside of hayfields. Agricultural and wildlife staff will work with lessees to adjust stocking to achieve appropriate vegetation height and density conditions in irrigated pastures. Staff will also examine bobolink use of un-mowed habitats (i.e., wet meadows and wetlands) and may study fledging dates. Changes the preferred mowing date will be developed by OSMP wildlife and agricultural staff.

Benefit: Medium
This strategy provides long-term reduction of the key threat to a sensitive and uncommon nested target within the Agricultural Operations target.

Feasibility: Medium
OSMP staff with the skills and experience is available to implement this strategy. This strategy is operationally uncomplicated, and there is support for this approach in some sites. In three of the Class B areas, OSMP lessees already mow after July 15 as part of their agricultural practices. This management has been in effect for several years in these areas. It may be difficult to agree upon five additional Class B sites from among the candidates because of complexities in water availability, historic practices, lease agreements and other factors.

Cost: Low
There is no out of pocket cost to OSMP associated with the mowing of these fields. Lessees continue to provide lease payments to the department in exchange for the use of OSMP land, water and other facilities. It may be necessary to reduce lease payments to compensate lessees for decreased yields resulting from delayed mowing.

35. Assess changes to agricultural and water management in the Northern Grassland Preserve to achieve sustainability of numerous Grassland Plan targets.

Irrigated lands have been identified as OSMP's best opportunity to sustain agricultural operations. In an attempt to develop compatible strategies, prairie dogs may be excluded from irrigated areas within Grassland Preserves. An incompatibility emerges because Grassland Preserves were identified as areas that offer the best opportunity for conservation of prairie dogs and their associates in the context of lands unaffected by prairie dogs. Few opportunities are available on OSMP lands for this purpose. The northern Grassland Preserve is effectively bisected by and directly adjacent to irrigated agriculture, reducing the effective block size of area and continuing a longstanding incompatibility between wildlife management and agricultural operations in the area. Although the current situation is workable, it is not ideal. OSMP is interested in understanding the feasibility and desirability of modifying existing irrigation practices to allow for a more effective design for the northern Grassland Preserve.

Benefit: Medium
This strategy will have limited direct benefit on any of the conservation targets but could leverage an improved situation for the conservation of the Black-tailed Prairie Dog and Associates target. The further implementation of this strategy would only be considered a success if effects upon OSMP's Agricultural Operations were mitigated.

Feasibility: Medium
OSMP staff has the expertise and availability to implement this strategy. Integrating competing management objectives has many complexities and uncertainties. This sort of strategy has not been successfully implemented before.

Cost: Low
The assessment costs should be low, consisting primarily of staff time. The costs associated with actually changing irrigation practices could be very high when considering expenditures for legal services and reclamation, as well as the loss of lease revenue associated with the change in agricultural land use.

APPENDIX M: Monitoring Summary

Indicators	Priority	Methods	Frequency and Timing	Location	Lead	Who monitors	Status
Absolute cover bare ground	Very High	Point intercept method along 50 m transects plus complete species list from 100 m^2	Sampling season: July 15-August 31 Frequency: Annually for two years then three to five years break repeating pattern	System-wide	Grassland Ecologist	Plant Ecology staff, Monitoring staff, contractors	Planned
Native frog presence in suitable habitat	Very High	Visual encounter surveys augmented with aural breeding surveys	Aural sampling season: depends on species but generally late March through July Visual encounter sampling season: July through mid-September Frequency: Annual for both	System-wide	Wildlife Ecologist	Wildlife Ecology staff, Monitoring staff, Resource Information staff, volunteers	On-going
Native species relative cover	Very High	Point intercept method along 50 m transects plus complete species list from 100 m^2	Sampling season: July 15-August 31 Frequency: Annually for two years then three to five years break repeating pattern	System-wide	Grassland Ecologist	Plant Ecology staff, Monitoring staff, contractors	Planned
Native species richness	Very High	Point intercept method along 50 m transects plus complete species list from 100 m^2	Sampling season: July 15-August 31 Frequency: Annually for two years then three to five years break repeating pattern	System-wide	Grassland Ecologist	Plant Ecology staff, Monitoring staff, contractors	Planned

Indicators	Priority	Methods	Frequency and Timing	Location	Lead	Who monitors	Status
Percent of occupied land in Grassland Preserves, Multiple Objective Areas or Prairie Dog Conservation Areas.	Very High	GPS mapping of prairie dog colonies	Sampling season: August-November Frequency: Annual	System-wide	Wildlife Ecologist	Wildlife Ecology staff, Monitoring staff, Information Resource staff, volunteers	On-going
Percent of target with acceptable bird conservation score	Very High	Distance sampling of line transects	Sampling season: May 15-July 15 Frequency: TBD	System-wide	Wildlife Ecologist	Wildlife Ecology staff	Enhance
Proportion of habitat blocks over 100 ha with singing male grasshopper sparrows	Very High	Distance sampling line transects	Sampling season: May 15-July 15 Frequency: TBD	System-wide in blocks over 100 ha	Wildlife Ecologist	Wildlife Ecology staff	Enhance
Relative cover of host plants for skipper/butterfly species of concern (big bluestem and little bluestem)	Very High	Point intercept method along 50 m transects plus complete species list from 100 m^2	Sampling season: July 15-August 31 Frequency: Annually for two years then three to five years break repeating pattern	System-wide	Grassland Ecologist	Plant Ecology staff, Monitoring staff, contractors	Planned
Richness of selected conservative plant species	Very High	Point intercept method along 50 m transects plus complete species list from 100 m^2	Sampling season: July 15-August 31 Frequency: Annually for two years then three to five years break repeating pattern	System-wide	Grassland Ecologist	Plant Ecology staff, Monitoring staff, contractors	Planned
Abundance of black spleenwort	High	Population census	Sampling season: August Frequency: Once every five years	White Rocks	Grassland Ecologist	Plant Ecology staff, Monitoring staff, contractors	Planned

Indicators	Priority	Methods	Frequency and Timing	Location	Lead	Who monitors	Status
Acres in agricultural production	High	Database analysis	Annual report	System-wide	Agricultural Specialist	Agricultural Specialists, Resource Information staff	On-going
Average derived PIF score of sampled sites within selected drainages	High	Fixed distance point counts	Sampling season: May-July Frequency: Every other year or every third year	System-wide	Wildlife Ecologist	Wildlife Ecology staff, Resource Information staff, volunteers	Enhance
Grassland preserves with occupancy of prairie dogs between 10 and 26%	High	GPS mapping of prairie dog colonies	Sampling: August-November Frequency: Annual	Grassland Preserves	Wildlife Ecologist	Wildlife Ecology staff, Resource Information staff, volunteers	On-going
Fish index of biotic integrity (IBI)	High	Methods developed during recent EMAP project	Sampling: TBD Frequency: Once every five years	System-wide	Wetland/ Riparian Ecologist	Wetland/Riparian Ecology staff, Wildlife Ecology staff, Monitoring staff, CDOW	Planned
Impediments to fish passage	High	GIS analysis	Annual report	System-wide	Wetland/ Riparian Ecologist	Wetland/Riparian Ecology staff, Resource Information staff	On-going
Macroinvertebrate index of biotic integrity (IBI)	High	Methods developed during recent EMAP project	Sampling: Mid-summer Frequency: Once every five years	System-wide	Wetland/ Riparian Ecologist	Wetland/Riparian Ecology staff, Wildlife Ecology staff, Monitoring staff, CDOW, contractors	Planned

Indicators	Priority	Methods	Frequency and Timing	Location	Lead	Who monitors	Status
Management of Ute ladies-tresses orchid habitat	High	GIS and database analysis	Annual report	Two VanVleet parcels and Yunker	Monitoring Coordinator	Agricultural Specialists, Grassland Ecologist, Water Resources Administrator	Planned
Number of active bald eagle nest sites in the Grassland Planning Area	High	Visual observation	Sampling season: Nov. 1 through July 31 Frequency: Annual	System-wide	Wildlife Ecologist	Wildlife Ecology staff, Rangers, volunteers	On-going
Number of prairie dog colonies with successful nesting attempts by burrowing owls	High	Visual observation	Sampling season: March - October Frequency: Annual	System-wide at prairie dog colonies	Wildlife Ecologist	Wildlife Ecology staff, possibly volunteers	On-going
Percent of grazed areas in good condition according to an integrated measure of range quality	High	TBD	Season: When livestock leave a pasture Frequency: Annual	Leased lands	Agricultural Specialist	Agricultural Specialists	Planned
Percent of target area experiencing a 5-30 year fire return	High	GPS mapping and GIS analysis	Mapping will occur after fires. Analysis will occur on an annual basis.	System-wide	Resource Information coordinator	Resource Information staff, Monitoring staff, Grassland Ecology staff	On-going
Percent of target area experiencing a 5-10 year fire return	High	GPS mapping and GIS analysis	Mapping will occur after fires. Analysis will occur on an annual basis.	System-wide	Resource Information coordinator	Resource Information staff, Monitoring staff, Grassland Ecology staff	On-going

Indicators	Priority	Methods	Frequency and Timing	Location	Lead	Who monitors	Status
Percent of target dominated by exotic species (Rapid Assessment Mapping)	High	RAM	Sampling season: late June-early August Frequency: Once every five-ten years	System-wide	IPM Specialist	IPM staff	On-going
Percent of target with prevalence of exotic species (Rapid Assessment Mapping)	High	RAM	Sampling season: late June-early August Frequency: Once every five-ten years	System-wide	IPM Specialist	IPM staff	On-going
Physical instream and riparian habitat metric	High	Methods outlined in Barbour et al. 1999	Sampling season: June-October (growing season) Frequency: Once every five years.	System-wide	Wetland/ Riparian Ecologist	Wetland/ Riparian Ecology staff, Monitoring staff	Planned
Predator community composition/abundance	High	Visual observation	Sampling season: TBD Frequency: Annual	System-wide at prairie dog colonies	Wildlife Ecologist	Wildlife Ecology staff, volunteers	Desired
Presence of populations of Ute ladies-tresses orchid	High	Botanical inventory for presence	Season: second or third week of August Frequency: Annual	Two VanVleet parcels and Yunker	Grassland Ecologist	Plant Ecology staff, volunteers	Planned
Undesignated trail density within 200meters of northern leopard frog habitat blocks	High	GIS analysis	Sampling season: NA Frequency: Once every five years - on the same cycle as undesignated trail mapping	System-wide	Monitoring Coordinator	Resource information staff, Wetland/ Riparian Ecologist, Monitoring staff	On-going
Size distribution of large blocks	High	GIS analysis	Sampling season: NA Frequency: Once every five years	System-wide	Monitoring Coordinator	Resource information staff, Monitoring staff	On-going

Indicators	Priority	Methods	Frequency and Timing	Location	Lead	Who monitors	Status
Size of Bell's twinpod populations	High	CNHP/OSMP rare plant census methods	Season: May (late April possibly) Frequency: once every five years (minimum)	Shale barrens	Grassland Ecologist	Plant Ecology staff, volunteers	On-going
Size of dwarf leadplant populations	High	CNHP/OSMP rare plant census methods	Season: late May - mid June (ideal) through September (possible) Frequency: once every five years (minimum)	System-wide (concentrated at forest/grassland interface)	Grassland Ecologist	Plant Ecology staff, volunteers	On-going
Size of grassyslope sedge populations	High	CNHP/OSMP rare plant census methods	Season: June Frequency: once every five years (minimum)	Two known populations on pediments in southern part of the planning area	Grassland Ecologist	Plant Ecology staff, volunteers	On-going
Size of prairie violet/bird's foot violet populations	High	CNHP/OSMP rare plant census methods	Season: May (or late April) Frequency: once every five years (minimum)	System-wide (concentrated at forest/ grassland interface)	Grassland Ecologist	Plant Ecology staff, volunteers	On-going
Visual obstruction vegetation height-density (Robel pole measure)	High	Modified Robel pole or similar methodology	TBD	System-wide	Grassland Ecologist	Plant Ecology staff, contractors	Planned
Bobolink indicator	High	Aural surveys along transects	Sampling season: May-July Frequency: Annual	System-wide within hay fields or similar habitat	Wildlife Ecologist	Wildlife Ecology staff, volunteers	Enhance

Indicators	Priority	Methods	Frequency and Timing	Location	Lead	Who monitors	Status
Buffer width (vegetated area within 100 m of a creek)	Medium	Visual estimation or measurement	TBD	System-wide	Wetland/ Riparian Ecologist	Wetland/ Riparian Ecology staff, Monitoring staff	Planned
Buffer width (vegetated area within 100 m of the wetland)	Medium	Visual estimation or measurement	TBD	System-wide	Wetland/ Riparian Ecologist	Wetland/ Riparian Ecology staff, Monitoring staff	Planned
Cottonwood regeneration	Medium	Plots	TBD	System-wide	Wetland/ Riparian Ecologist	Wetland/ Riparian Ecology staff, Monitoring staff	Planned
Distance to nearest wetland or riparian area	Medium	GIS analysis	TBD	System-wide	Wetland/ Riparian Ecologist	Wetland/ Riparian Ecology staff, Monitoring staff, Resource Information staff	Planned
Irrigable land leased for agriculture	Medium	GIS and database analysis	Every other year	System-wide	Agricultural Specialist	Agricultural Specialist, Water Resources Administrator, Resource Information staff	Planned
Percent occurrence of CNHP-tracked grassland dependent butterflies and skipper species	Medium	TBD	Sampling season: May-August based on flight times which differ by species Frequency: Two consecutive years followed by three-seven years off repeating pattern	System-wide	Wildlife Ecologist	Wildlife Ecology staff, contractors	Desired

Indicators	Priority	Methods	Frequency and Timing	Location	Lead	Who monitors	Status
Percent occurrence of grassland dependent butterflies and skipper species	Medium	TBD	Sampling season: May-August based on flight times which differ by species Frequency: Two consecutive years followed by three-seven years off repeating pattern	System-wide	Wildlife Ecologist	Wildlife Ecology staff, contractors	Desired
Percent of colonies with territorial horned larks	Medium	Visual observation	Sampling season: May-July Frequency: Annual	System-wide at prairie dog colonies	Wildlife Ecologist	Wildlife Ecology staff, possibly volunteers	Desired
Percent soil organic matter	Medium	TBD	Sampling season: Growing season Frequency: Once every four years	Leased lands	Agricultural Specialist	Agricultural Specialists, lessees	Desired
Presence of full suite of rare species	Medium	Varies by species	Varies by species	White Rocks	Monitoring Coordinator	Wildlife Ecology staff, Plant Ecology staff, volunteers	Planned
Species richness of sensitive breeding birds	Medium	Point counts	Sampling season: May-July Frequency: TBD	System-wide in wetlands	Wildlife Ecologist	Wildlife Ecology staff, volunteers	Planned
Submerged aquatic nuisance species richness	Medium	Visual surveys	Sampling season: July-August Frequency: TBD	System-wide	IPM Specialist	IPM staff, Wetland/ Riparian Ecology staff, Wildlife Ecology staff	On-going
Dissolved oxygen (lotic--flowing water habitats)	Low	Dissolved oxygen meter	TBD	System-wide in flowing water	Wetland/ Riparian Ecologist	Wetland/ Riparian Ecology staff, Monitoring staff	Desired

Indicators	Priority	Methods	Frequency and Timing	Location	Lead	Who monitors	Status
Instream flows	Low	TBD	TBD	System-wide	Wetland/ Riparian Ecologist	Wetland/ Riparian Ecology staff, Monitoring staff	Desired
Number of over-bank flooding events during late May through June measured every 5-10 years	Low	TBD	When it occurs	System-wide	Wetland/ Riparian Ecologist	Wetland/ Riparian Ecology staff, Monitoring staff	Desired
Percent of area in conservation ownership	Low	GIS analysis	Annual report	White Rocks	Monitoring Coordinator	Resource Information staff, Monitoring staff	On-going
Percent of wetlands in each class with idealized/prescribed/proper hydrologic regime.	Low	TBD	TBD	System-wide	Wetland/ Riparian Ecologist	Wetland/ Riparian Ecology staff, Monitoring staff	Desired
Secchi disk depth (for ponds)	Low	Secchi disk sampling	TBD	System-wide in ponds	Wetland/ Riparian Ecologist	Wildlife Ecology staff, Wetland/ Riparian Ecology staff, Monitoring staff	Desired
Total phosphorus (for ponds)	Low	Grab and/or composite samples	TBD	System-wide in ponds	Wetland/ Riparian Ecologist	Wildlife Ecology staff, Wetland/ Riparian Ecology staff, Monitoring staff	Desired

Indicators	Priority	Methods	Frequency and Timing	Location	Lead	Who monitors	Status
Presence of breeding barn owls	Low	Nighttime broadcast call playbacks	Sampling season: May-June Frequency: Annual	White Rocks	Wildlife Ecologist	Wildlife Ecology staff, volunteers	Desired
Presence of six-lined racerunner	Low	Visual observation	Sampling season: May-August Frequency: Annual or every other year	White Rocks	Wildlife Ecologist	Wildlife Ecology staff, volunteers	Desired
Total phosphorus (lotic--flowing water habitats)	Low	Grab and/or composite samples	TBD	System-wide in flowing water	Wetland/ Riparian Ecologist	Wetland/ Riparian Ecology staff, Monitoring staff	Desired

APPENDIX N: Grassland Plan Implementation Area Characteristics

Implementation Area	Dominant and/or Distinctive Conservation Targets	Best Opportunity Areas; Grassland Preserves	Size	Landscape Context	Key Processes and Other Influences	Geology / Land Form	Non-Native Species Management Issues	Recreation Management	Agricultural Leases
1. Jewel Mountain / Van Vleet Jefferson County	Xeric Tallgrass Prairie (Rocky Flats version)*	Conservation: Upland Grassland Complex*	Large contiguous area	Large % surrounding land public or CE	Fire regime, cattle grazing	Rocky Flats alluvium – one of oldest surfaces in region*	Jefferson County jurisdiction*	Entirely HCA*- no trails currently; South TSA	Two thirds of area in one agricultural lease; one third of area intermittently leased
2. Southern Grasslands/ Davidson Mesa	Mixedgrass Prairie Mosaic*	Conservation and Restoration: Upland Grassland Complex, Black-tailed Prairie Dog and Associates, Riparian Areas; Grassland Preserve*	Large contiguous area	Large % surrounding land is OSMP fee or CE, other public or CE	Fire regime, cattle grazing, prairie dog colonies	Pediments and stream terraces	Similar across area	Large % HCA - low trail density, seasonal grassland bird closure in Natural Area, seasonal raptor closure in HCA*; South and East TSAs	One agricultural lease
3. Flatirons Vista/ Doudy Draw/ West Rudd/ Tallgrass West	Upland Grassland Complex	Conservation and Restoration: Upland Grassland Complex, Black-tailed Prairie Dog and Associates, Wetlands and Riparian Areas	Two large habitat blocks	Large % surrounding land is OSMP fee or CE; urban edge at north boundary	Fire regime, cattle grazing, prairie dog colonies	Pediments and stream terraces	Similar across area	Mostly Natural Area* - moderate to low trail density, seasonal grassland bird closures*; South and West TSAs	Two agricultural leases
4. Marshall Mesa (MM) Passive Rec. Area/ South Mesa Trailhead vicinity (SMTH)	Upland Grassland Complex	Restoration: Upland Grassland Complex	Two relatively small patches in a matrix of larger habitat blocks	Large % surrounding land is OSMP fee or CE	<u>MM</u>-fire regime, cattle grazing, prairie dog colonies, recreation* <u>SMTH-</u> floodplain hydrology, historic ranching*, recreation*	Pediment and floodplain	Concentration of priority weed species	Small blocks with high trail density and use surrounded by larger blocks Passive Recreation Area*; South and West TSA	<u>MM-</u> one agricultural lease <u>SMTH-</u> not leased

* Denotes particularly distinctive characteristics for a given area

Implementation Area	Dominant and/or Distinctive Conservation Targets	Best Opportunity Areas; Grassland Preserves	Size	Landscape Context	Key Processes and Other Influences	Geology / Land Form	Non-Native Species Management Issues	Recreation Management	Agricultural Leases
5. South Boulder Creek irrigated terraces	Mesic Bluestem Prairie*, Wetlands*, Agricultural Operations*	Conservation and Restoration: Mesic Bluestem Prairie*, Wetlands*, Agricultural Operations*	Large habitat block bisected by US 36; Cherryvale and South Boulder Road fragment block further	OSMP fee land to east and west; adjacent private lands are exurban	Fire regime, cattle grazing, irrigation*, haying*	Stream terraces	Native and non-native tree encroachment*	Large % HCA* - minimal trails, voluntary seasonal grassland bird closures; East TSA	Most of land in one agricultural lease
6. South Boulder Creek riparian corridor and floodplain	Riparian Areas*, Mesic Bluestem Prairie*, Wetlands*, Agricultural Operations*	Conservation and Restoration: Riparian Areas*, Mesic Bluestem Prairie*, Wetlands*, Agricultural Operations*	Riparian and floodplain corridor bisected by US 36; SH 93 & South Boulder Road additional interruptions	OSMP fee land along east edge; adjacent land is mostly exurban and CU property; north of Baseline suburban development is adjacent to east and west edges	Fire regime, cattle grazing, stream hydrology*, irrigation*, haying*	Floodplain and active stream	Native and non-native tree encroachment*, common teasel	Mostly Natural Area, So. Boulder Creek Trail lies within riparian corridor, dogs prohibited on about half the trail, voluntary seasonal grassland bird closures, seasonal leash requirements; East and West TSAs	One agricultural lease*
7. Grassland-forest ecotone at urban edge	Upland Grassland Complex	Conservation and Restoration: Upland Grassland Complex	Patches of high recreational use contiguous with large habitat blocks	Urban interface adjacent to the east	Variable fire regime, no grazing for last 20+ years, recreation*, historic ranching*	Pediments and valleys	Concentration of priority weed species, tree encroachment	Passive Recreation Area*; North and West TSAs	No agricultural leases*
8. Boulder Creek riparian corridor and floodplain- East	Riparian Areas*, Wetlands*, Agricultural Operations*	Restoration: Riparian Areas, Wetlands; Conservation: Agricultural Operations	Two separate areas form a large habitat block	OSMP fee land to north and south; adjacent private land is mostly exurban; suburban to the northwest	Fire regime, cattle grazing, stream hydrology*, irrigation*, haying*	Floodplain and stream terraces	Similar across area	HCA*, White Rocks Trail receives moderate visitation, dogs prohibited; East TSA	Multiple agricultural leases, Culver wetland not grazed

* Denotes particularly distinctive characteristics for a given area

Implementation Area	Dominant and/or Distinctive Conservation Targets	Best Opportunity Areas; Grassland Preserves	Size	Landscape Context	Key Processes and Other Influences	Geology / Land Form	Non-Native Species Management Issues	Recreation Management	Agricultural Leases
9. Gunbarrel Hill	Old agricultural field restoration*, Mixedgrass Prairie Mosaic*	Restoration: Mixedgrass Prairie Mosaic, Black-tailed Prairie Dog and Associates; Conservation: Grassland Preserve*	Large habitat block	OSMP fee land to north and south; suburban development lies to east and west	Historic agricultural management, restoration treatments*, prairie dog colonies, concentrated recreation, potential fire regime, cattle grazing	Pediment	Similar across area	Passive Recreation Area*, White Rocks Trail receives moderate visitation, dogs prohibited in southern part of trail; East TSA	One agricultural lease, most of area not leased
10. Beech / BVR/ Axelson	Upland Grassland Complex*, Black-tailed Prairie Dog and Associates*	Conservation and Restoration: Upland Grassland Complex*, Wetlands*, Grassland Preserve*	Large habitat block	Large % of surrounding land is suburban or exurban; large OSMP habitat block to west	Fire regime, cattle grazing, prairie dog colonies, concentrated recreation, agricultural and industrial history, geology	Six-mile fold geologic site and shale barrens*	Similar across area	Equally divided between Natural Area, Passive Recreation, and Agricultural Area with varying trail density, western portion part of HCA; North TSA	Leased land in one agricultural lease, ranch leased for horse livery and livestock grazing
11. West Beech grassland-forest ecotone	Upland Grassland Complex*	Conservation: Upland Grassland Complex*, Riparian Areas*	Large habitat block	Surrounding land is exurban to west and south; CE adjacent to north and northeast	Fire regime, agricultural and industrial history	Hogbacks, hill slopes and drainages	Similar across area	HCA*, with low trail density; North TSA	No agricultural leases*
12. Boulder Creek riparian corridor & floodplain- West	Riparian Areas*, Wetlands, Agricultural Operations	Restoration: Riparian Areas, Wetlands, Agricultural Operations	Patches embedded in urban matrix*	Urban/exurban	Stream hydrology*, recreation, adjacent urban activity, prairie dog colonies	Floodplain and active stream	Similar across area; concentration of priority weed species, ANS*	Mostly Natural Area*, Boulder Greenways Trail dominates; East TSA	Several agricultural leases in north

* Denotes particularly distinctive characteristics for a given area