

**ASSESSMENT OF CONSERVATION TARGETS, VIABILITY,
AND IMPACTS TO BIOLOGICAL DIVERSITY
ON THE LOWRY RANGE**



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**Colorado
State
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Knowledge to Go Places

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EXECUTIVE SUMMARY

The Lowry Range offers a unique opportunity to conserve a functioning prairie ecosystem in close proximity to an expanding urban environment, and to advance understanding of how native biodiversity is influenced by development. The vision of the State Board of Land Commissioners (SBLC) for the Lowry Range is to create a contained development environment which can interact with the natural habitat through sustainable design principles, so as to maintain the inherent values associated within a shortgrass prairie ecosystem, as well as to meet the fiduciary responsibilities constitutionally mandated for the SBLC.

The Range currently supports a mosaic of habitats and several species of conservation concern. Future land-use and management plans include contained (housing or urban) development, water resource development, conservation easements, and revenue-generating leases for a variety of activities such as mining, grazing, and recreation. The SBLC and the Colorado Natural Heritage Program (CNHP) studied the interplay between various land-use activities and existing natural systems to identify management strategies that could balance biodiversity conservation with opportunities for the SBLC to meet its fiduciary mandate on The Range. Proper management combined with the appropriate placement of areas developed for commercial, residential, and conservation uses should allow for realization of both the economic and ecological potential of The Range.

Conservation Targets

The Range is currently home to a suite of native prairie species and habitats, which together make up the living landscape of The Range. Specific conservation targets were selected from among these species and habitats to help focus species viability and impact analyses, and to guide management decisions. The targets chosen include the ecological systems that support the diversity of species inhabiting the site, as well as species that may be lost without special attention. The *macrotis* subspecies of the northern pocket gopher is of highest conservation significance on The Range, because it is extremely limited in distribution and highly threatened in most places where it lives. By protecting key habitats on The Range, the SBLC has an opportunity to make a significant contribution to the conservation of this species. Pronghorn, myriad grassland bird species, and the prairie dog animal community (including associated species Burrowing Owl, Mountain Plover, Ferruginous Hawk, and swift fox) are all present on The Range, and are indicators of healthy and functioning prairie ecosystems. Piedmont grasslands, riparian corridors, and wetlands make up the other habitats that support these and other native prairie species. Though each of these species and systems are unique, they are intricately linked through complex ecological patterns and processes that operate at a landscape scale. Long-term maintenance of these targets on The Range will require collaborative regional planning and cooperation among the SBLC, neighbors, local governments, and conservation partners.

Overall, the health of the species and ecological systems on The Range can be categorized as good. Condition of the pocket gopher population and the Box Elder Creek

riparian corridor is good, though weeds are problematic along most of the Box Elder corridor. Coal Creek is also in good condition north of East Quincy Avenue, but stretches of this creek to the south are severely degraded by past mining and grazing activities. Condition of the piedmont grassland system, habitat for some grassland birds, and wetlands has also been degraded by continuous, year-round grazing. The prairie dog animal community and the pronghorn population are currently in fair condition, but long-term viability on The Range may be compromised by loss of surrounding habitat.

Threats

Though siting, design, and methods of implementation may help minimize and mitigate impacts, it is an unavoidable truth that human activities such as development and resource extraction result in some level of stress to other species and natural systems. Stresses that are significant enough to degrade the health of populations and reduce the ability of species and natural systems to persist are considered threats. Activities that have potential to threaten the biological diversity on The Range, depending on how these activities are implemented, include:

- Housing and urban development
- Reservoirs
- Mining (sand and gravel; oil and gas)
- Incompatible grazing
- Groundwater pumping
- Recreation
- Utility infrastructure (pipelines and wells)
- Unexploded ordnance clearance.

Of these, the most significant are housing/urban development and reservoirs. Each of these activities results in permanent destruction of habitat, as well as an array of potential indirect impacts associated with disturbance of hydrologic regimes and alteration of species composition (both flora and fauna). Development and reservoirs are likely to have some level of impact on all conservation targets on The Range, but have the most potential for high or very high degrees of impact on riparian systems, native grasslands, and pronghorn.

Other significant threats include sand/gravel mining, incompatible grazing, and groundwater pumping. The only target currently affected by sand and gravel mining is the riparian corridor of Coal Creek. However, past impacts have been severe enough to compromise the function of this hydrologic system, which reduces the overall potential of The Range for biological diversity value. Past incompatible grazing has altered vegetation composition and degraded streambank condition along the riparian corridors of Coal and Box Elder Creeks, and altered the structure and function of the piedmont grasslands. Groundwater pumping is a potential future threat associated with housing/urban development and reservoirs. If enough groundwater is pumped to lower the water table, there could be significant implications for the riparian corridors and wetlands, including loss of vegetation (especially trees and shrubs), and reduction or loss

of animal populations that depend on these habitats. Other threats acting alone are not expected to have significant levels of impact on conservation targets, but may contribute to the cumulative effects of larger threats.

Strategies

Maintaining the full suite of biological resources that currently occupy the Lowry Range will require a two-pronged approach to conservation: 1) on-site management, and 2) regional collaboration. On-site management can be implemented at the discretion of SBLC staff, and at least preliminary results can be achieved over short timeframes. Regional collaboration is a long-term approach that requires the cooperation of others beyond SBLC staff. Regional strategies presented in this document are not prescriptions for what the SBLC should do, but rather suggestions for management approaches that would conserve the biological diversity values that make The Range so significant.

Important areas of focus for on-site management are proper planning and implementation of future development activities, and restoration of degraded targets. Ground disturbance should be minimized within potential habitat for the pocket gopher, and should be avoided to the maximum extent practicable within occupied habitat. Development of residential areas, reservoirs, and recreation facilities should address the needs of conservation targets in siting, design, and construction. Reducing the intensity of grazing will help species characteristic of the piedmont grassland system recover, and improve the condition of the wetlands. Temporary elimination of grazing within riparian corridors may be necessary in order to restore damage to vegetation and stream banks in these areas. An integrated weed management plan is needed to improve the vegetation composition of native communities across The Range. There are many unknowns associated with managing complex ecological systems, so flexibility in responding to unexpected consequences of management actions is important. Additional research on thresholds and impacts of groundwater depletion and surface flow diversions would help define policies for future mining and development. An appropriately designed monitoring program can help quantify adverse impacts from development activities, and highlight needed changes in management approach and priority.

Management activities within direct control of SBLC staff can improve the condition of these targets on The Range, but overall results will be diminished without the acknowledgement, support, and cooperation of neighbors and partners. In particular, habitat outside The Range that is suitable for movement and dispersal of pronghorn and prairie dogs between The Range and the open prairie to the east is needed. These targets exist on a landscape scale, and The Range is not large enough to support viable populations within its boundaries. If these animals lose their ability to move across the landscape, future management options for the SBLC will be greatly complicated, and may be limited to the resource-intensive strategies necessary for maintaining small populations within confined spaces. In addition, the riparian corridors along Coal and Box Elder Creeks begin and end beyond the boundaries of The Range, and can easily be adversely affected by offsite activities.

In summary, proper management for the benefit of conservation targets, combined with appropriate design and placement of areas developed for commercial, residential, and conservation activities, should allow for realization of both the economic and ecological potential of The Range. By using the data in this report for additional analysis, the SBLC will be able to better meet the dual objectives of conservation and long-term revenue generation on the Lowry Range.

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INTRODUCTION

Background and Purpose of the Project

The Colorado State Board of Land Commissioners (SBLC) contracted with the Colorado Natural Heritage Program (CNHP) to conduct a field inventory of significant biological resources on the Lowry Range (The Range) during the summer of 2005. The results of the inventory were summarized in Lowry Range Biological Survey 2005 (Sovell et al. 2006). This report is a follow-up to that effort. In this second phase of the Lowry Range project, CNHP and SBLC staff conducted species viability and threat analyses to expand upon information gathered in the biological survey. The purpose of these analyses was to evaluate the relationship between potential development scenarios and conservation of significant biological resources on The Range. The vision of the SBLC for the Lowry Range is a challenging one: to create a contained development environment which can interact with the natural habitat through sustainable design principles, so as to maintain the inherent values associated within a Shortgrass Prairie Ecosystem, as well as to meet the fiduciary responsibilities constitutionally mandated for the SBLC. The goals of this Phase II project were to assist the SBLC in achieving their vision by:

1. Identifying target species and habitats of highest priority for conservation
2. Evaluating targets for viability and determining conditions that would affect viability
3. Examining basic conservation and land-use strategies for the property and surrounding area from a biological standpoint.

Planning Process

CNHP biologists and planners collaborated with staff from the SBLC on each step in the planning process. The process used to conduct the viability and threat analyses is based on a well-tested method developed by The Nature Conservancy for site planning. This method, commonly referred to as Conservation Action Planning (CAP), was designed to help conservation practitioners and managers develop strategies, take action, measure success, and adapt and learn overtime (The Nature Conservancy 2005). The CAP method focuses on these questions:

- What *systems* warrant conservation attention (i.e., “conservation targets”), and what is the status (viability) of their populations?
- What *stresses* and *sources of stress* (threats) are impairing condition or function of conservation targets?
- What *strategies* are necessary to alleviate stresses and achieve conservation goals?
- How will *success* be evaluated and measured?

This project focused on the first two questions – Systems (targets and viability) and Stresses and Sources of Stress (threats). While this report provides basic guidelines for future conservation efforts on The Range, this project did not include detailed development of strategies, implementation plans, and measures of success. Rather, the

SBLC will be contracting with development and conservation partners to design and implement detailed development and conservation objectives, using the information compiled during this process.

A custom Excel-based software program was developed by The Nature Conservancy to facilitate the CAP process, automate the roll-up of summary results, and serve as a repository for planning information (The Nature Conservancy 2005). Detailed results for viability and threats analyses from the CAP workbook for the Lowry Range are included in Appendix A and B, respectively.

Conservation Goal / Vision Statement for the Lowry Range

The Lowry Range is one of the largest and most visible parcels of land held in trust by the Colorado State Land Board. As such, the goals for future management of this property are based on the prior use of the land, as well as the current natural values. The Lowry Range is included in the Stewardship Trust, which is designed to "...protect and enhance the beauty, natural values, open space and wildlife habitat thereof." As previously mentioned, the SBLC also has the charge as mandated by the Colorado Constitution to "prudently manage the property it holds in trust in order to produce reasonable and consistent income over time." In order to comply with both the mandate of the Colorado Constitution, as well as to hold the tenants of the Stewardship Trust, the overall vision for the Lowry Range is to create a long-term management goal of open space and conservation plans, integrated with compatible revenue producing activities on The Range.

CONSERVATION TARGETS AND VIABILITY

Purpose of Identifying Conservation Targets

When conservation of biological diversity is a management goal but resources are limited, it is crucial to clearly articulate which biological values (generally individual species or ecological systems) are the highest priorities for conservation attention. These are referred to as the site's conservation targets. Identification of conservation targets is necessary to accurately define the condition that management is supposed to achieve, evaluate threats that need to be acted upon, and identify management actions needed. Selection of conservation targets is based on scientific information, and highlights ecological systems that support the diversity of species inhabiting the site, as well as species that may be lost without special attention (e.g., those that are particularly rare or threatened).

Each species or ecological system at a site is characterized by different habitat or physical parameters, patterns of distribution, life history/ecology, etc. Likewise, threats at the site may have different impacts on different species and systems. However, the needs and responses of species and ecological systems are all bound together in complex and intricate ways. In order to manage the site such that important species and systems remain present and functioning over the long-term (i.e., remain viable at the site), appropriate strategies are needed to maintain the health of populations and to abate stresses that could reduce viability. This is best achieved by managing species and systems as an integrated whole within a regional context.

Assessing Viability

In general terms, "viability" refers to the likelihood that a species or ecological system will still be present and functioning at a site over some future timeframe (usually 20-100 years). Estimates of viability for each conservation target are based on three characteristics: size, condition, and landscape context. Size is a quantitative measure of abundance or area of occupancy. Condition is an estimate of the relative quality of each target *within* the site or target occurrence. For species, condition is a measure of the health of populations (successful reproduction, vigor, evidence of disease, etc.). For systems, condition is a measure of species composition and structure (presence of exotics, etc.), development (e.g, early successional stage, old growth), and function of ecological processes such as hydrology. Landscape context is an estimate of the relative quality and connectivity of the habitats and ecological systems *surrounding* the site or target occurrence, and the degree to which the surrounding area may affect conservation targets on the site (NatureServe 2002).

Conservation Targets Identified for the Lowry Range

Eight conservation targets have been identified for the Lowry Range. These are: northern pocket gopher (*macrotis* subspecies), black-tailed prairie dog animal community, plains riparian systems (Coal Creek and Box Elder Creek), piedmont

grasslands, wetlands, pronghorn, and grassland birds (Figure 1). In addition, 13 “nested targets” that are closely associated with the eight conservation targets have been identified. Nested targets are species or systems that co-occur on the landscape, require similar ecological processes, have similar threats – and therefore require similar conservation strategies as the primary targets they are nested under. Management plans designed to conserve the eight primary conservation targets should also conserve the nested targets on The Range. Table 1 lists the eight primary conservation targets for the Lowry Range, and their associated nested targets. Table 2 summarizes viability ratings for each target.

Table 1. Primary and nested conservation targets.

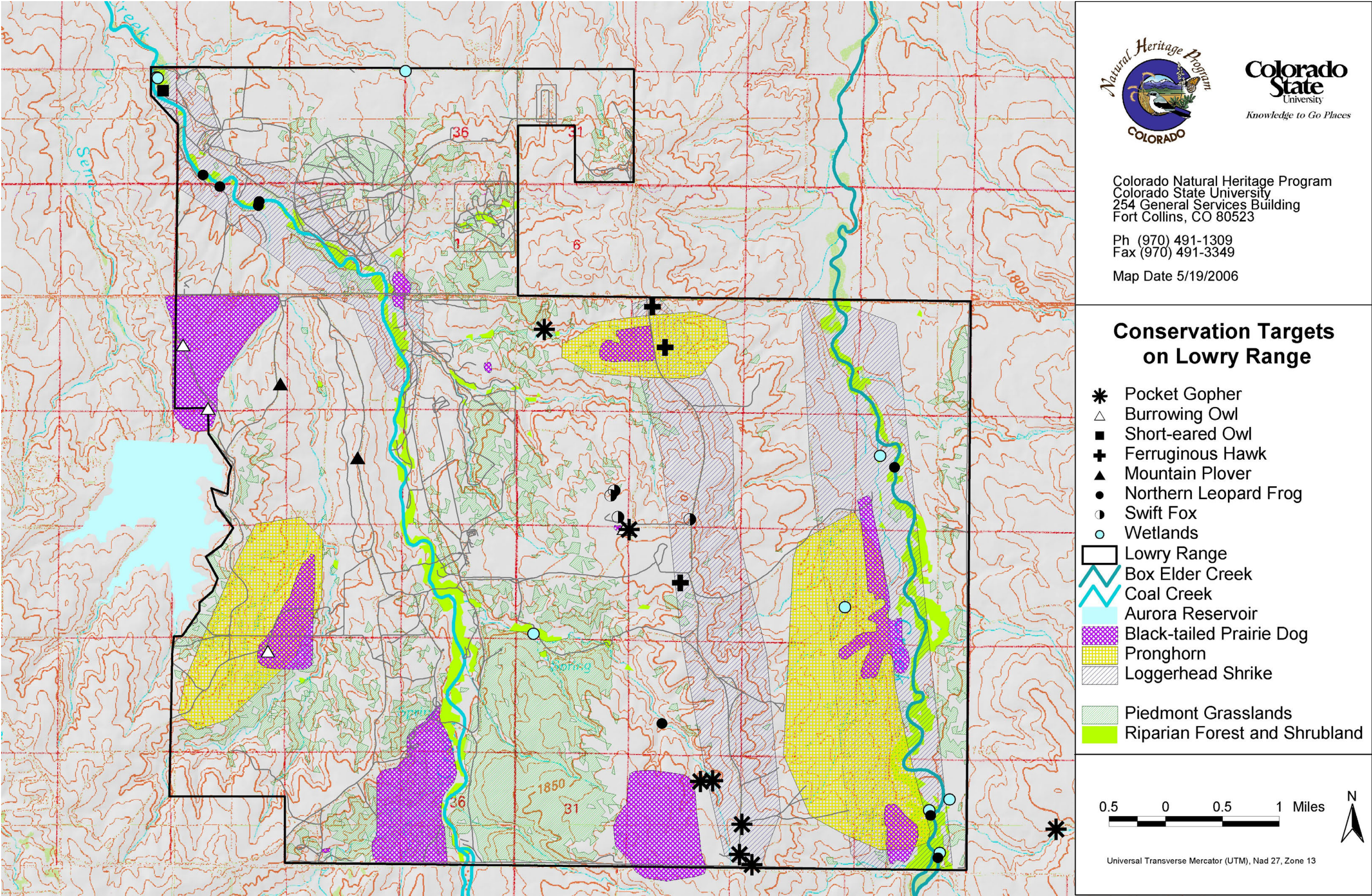
Conservation Targets for Lowry Range	Nested Conservation Targets
Northern pocket gopher (<i>macrotis</i> subspecies)	
Black-tailed prairie dog animal community	Burrowing Owl, Mountain Plover, Ferruginous Hawk, Swift Fox
Plains riparian system – Coal Creek	Northern Leopard Frog, Cottonwood Trees, Short-eared Owl
Plains riparian system – Box Elder Creek	Northern leopard frog, Cottonwood Trees, Short-eared Owl
Piedmont grassland	Swift Fox, Loggerhead Shrike, Grasshopper Sparrow
Wetlands	Native amphibians
Pronghorn	
Grassland birds	Lark Bunting, Vesper Sparrow, Western Meadowlark, Horned Lark

Northern Pocket Gopher (macrotis subspecies)

Target Significance

The northern pocket gopher subspecies (*Thomomys talpoides macrotis*) is the highest priority conservation target on The Range. The known global distribution of this subspecies is restricted to 10 populations in Douglas and Arapahoe Counties in Colorado. Of these ten known locations, the future viability of the nine populations outside of The Range is uncertain, primarily due to threats from expanding urban development. The Range can provide most, if not all, of this subspecies’ ecological requirements, including enough area to support a population, suitable habitat (proper soils, drainage, and soil moisture), and forage availability. The *macrotis* population on The Range offers the SBLC an important opportunity to contribute to vital conservation of this subspecies.

Figure 1. Conservation targets on the Lowry Range.



Target Viability

Based on the information that is available, the *macrotis* population on The Range is considered to be among the best known occurrences for this subspecies. Records of earlier observations on adjacent land as well as museum collections from the area around The Range suggest that gophers have been persistent in this area for a long time. This subspecies is able to persist in relatively small patches, with individual animals requiring as little as 1/20th of an acre to complete their life cycle (Hansen and Reid 1973). Given estimated territory sizes this small, there is more than enough suitable habitat on The Range to support a self-sustaining population of this subspecies. Available suitable habitat within two miles of this occurrence is undisturbed, composed primarily of native vegetation, and generally free from significant threats. Evidence of long-term persistence in the area, combined with availability of suitable habitat in a high quality landscape setting, indicates that estimated viability of this target is currently good, and could be very good if the population expands. Additional information on abundance and density of gophers at The Range would help confirm this assessment.

Black-tailed Prairie Dog Animal Community

Target Significance

The black-tailed prairie dog (*Cynomys ludovicianus*) is a keystone species of the shortgrass prairie ecosystem (Kotliar et al. 1999; Hoogland 2006). As a keystone species, prairie dogs provide habitat for a suite of other prairie species. Black-tailed prairie dog colonies on The Range support four of these associated species – Burrowing Owl (*Athene cunicularia*), Mountain Plover (*Charadrius montanus*), Ferruginous Hawk (*Buteo regalis*), and swift fox (*Vulpes velox*). All of these species are of conservation concern, primarily due to loss and degradation of habitat. Black-tailed prairie dog populations have experienced significant reductions in habitat and abundance from historic levels, and populations of Burrowing Owls and Mountain Plovers are believed to be declining as well. Lethal control of prairie dogs is on-going throughout much of their range, due primarily to real or perceived conflicts with the agricultural and construction industries. Because of these conflicts, as well as the fact that prairie dogs are still classified as a pest in many counties where they occur, large-scale conservation of prairie dogs is not always well-received. However, over 90% of remaining prairie dog habitat is on non-federal lands, so taking advantage of opportunities where they exist to pursue conservation of this animal community is important.

Target Viability

Estimated viability of the black-tailed prairie dog animal community on The Range is fair overall. Size and condition of potential habitat within The Range is good, with almost 23,000 acres of potentially suitable habitat¹ and over 70% cover of native vegetation.

¹ Suitable habitat defined as acres with <10 degrees slope, and grassland vegetation (i.e., not shrubs, trees, wetlands, or water), based on GIS calculation using Colorado Division of Wildlife's Basinwide landcover data.

Quality of landscape context has been reduced by urban development in the surrounding area (especially on the western boundary of The Range), which has eliminated formerly suitable habitat. Continuing development on all sides of The Range will further reduce habitat available for future expansion, and will likely result in indirect impacts to existing populations on The Range. From a landscape scale perspective, the size of the occupied prairie dog towns on The Range is poor. There are currently approximately 1,700 acres of active prairie dog towns on The Range. Prairie dog towns of this size may support individuals of one or more associated species, some breeding pairs, etc., but do not provide population level benefits to the full suite of associated species. However, the prairie dog colonies on The Range are part of a larger complex that occurs in a scattered distribution across approximately 22,000 acres of surrounding landscape. Available information indicates that The Range supports approximately 31% of the prairie dog colonies within this complex (11 of 37 total), and approximately 50% of the occupied acres (~1,863 of a total 3,690)² If connectivity could be maintained between The Range and the surrounding landscape, estimated viability of this target would be improved.

Plains Riparian Systems – Coal Creek and Box Elder Creek

Target Significance

In the semi-arid environment of the Great Plains, the water and cover provided by riparian corridors are significant habitat features for the majority of species who inhabit or migrate through the plains. However, in terms of lands that could be considered “protected,” low elevation riparian systems in Colorado are under-represented. This is primarily because these systems mostly occur on privately owned lands that are favored by humans for development and agriculture. For these reasons, protection of plains riparian systems can make a disproportionately large contribution to conservation of prairie species.

Target Viability

Overall estimated viability is fair for Coal Creek, and good for Box Elder Creek. The length of unmodified stream segments (i.e., not dammed or diverted) with intact hydrological function is very good for both creeks. Along Coal Creek, the quality of the surrounding uplands is variable across The Range, but is good to very good in most places. However, the local hydrologic regime of this stream corridor has been adversely impacted by roads and sand/gravel mining, and cottonwood trees in some areas are dead. In addition, Coal Creek has been heavily used by cattle. Excess erosion and cutbanks are problematic in some areas along Coal Creek and its tributaries, probably due to mining or to cumulative impacts from mining and cattle grazing. Non-native pasture grasses and dense patches of leafy spurge reduce the quality of some drier areas along Coal Creek.

² The prairie dog complex is defined by mapped occurrences of prairie dog colonies, combined with a habitat permeability model. The model groups all colonies within dispersal distance for prairie dogs that are connected by “permeable habitat” – i.e., habitat that an individual prairie dog could successfully travel through. Thus, the model serves as a surrogate for identifying a complex of prairie dog colonies that are presumably linked via emigration/immigration, and constitute a single population.

However, the stretch of Coal Creek north of East Quincy Avenue is in good condition, with good cottonwood regeneration and apparently healthy bird populations. Cottonwoods are also regenerating along Coal Creek near the southern boundary of The Range.

Overall, Box Elder Creek is in better condition than Coal Creek. This creek has not been used for mining, and there has been little modification of the local hydrologic regime. Some of this riparian corridor is dominated by native species, with understory shrubs present and streambanks generally in good condition. However, in many areas of Box Elder Creek the understory is dominated by weeds and shrubs are absent, probably as a result of heavy grazing use.

Piedmont Grassland

Target Significance

The piedmont grassland ecological system can be characterized as a mixed-grass to tallgrass prairie that occurs in a narrow band along the Rocky Mountain Front Range and out onto the Palmer Divide. Species composition of the grasslands on The Range is consistent with typical piedmont grasslands. However, these grasslands are functioning biologically and structurally as a shortgrass prairie, probably due to past grazing practices. Different management regimes could be implemented to encourage dominance of either piedmont or shortgrass species. However, shortgrass prairies (which occur across the western Great Plains from Canada to Mexico) are considerably more widespread and common than piedmont grasslands, which occur in a comparatively restricted distribution. Threats to grassland systems from land conversion are epidemic across the plains, and affect both piedmont and shortgrass prairie systems. However, the comparative degree of threat to piedmont systems along the rapidly urbanizing Front Range, combined with the higher percentage of ecological system affected, suggest a higher priority for conservation of piedmont grasslands than for shortgrass systems. Thus, the piedmont grassland was chosen as a conservation target for The Range to encourage a management approach suited to expression of the piedmont over the shortgrass prairie.

Target Viability

Overall viability of the piedmont grassland on The Range is good, primarily because of its size and the fact that it has not been degraded by encroachment of woody plants (trees and shrubs). Size is very good, with the grasslands forming a matrix community over approximately 15,000 acres. This is a large enough area to support the prairie butterflies and birds typical of this system. Current condition of this target is fair. Past grazing pressure has encouraged dominance of shortgrass vegetation over piedmont grasses, but species typical of piedmont grasslands are still present and could be restored by altering the grazing regime. There are some large patches of invasive weeds, including cheatgrass, leafy spurge, and musk thistle. Quality of the landscape context is degraded by development of essentially all the former prairie to the west. However, development

is still relatively scattered to the east, north, and south, and connectivity to the open prairie to the east is still intact.

Wetlands

Target Significance

Wetlands occur in small patches throughout The Range. These wetlands are distinguished from the riparian corridors of Coal and Box Elder Creeks in that they are maintained by groundwater rather than surface flow. These isolated ponds support a variety of amphibians and aquatic insects, indicating that the hydrologic systems on The Range are healthy and functioning.

Target Viability

Estimated viability of the wetlands on The Range is fair. The quality of the surrounding uplands is good, with very little evidence of hydrologic alteration (e.g., groundwater pumping) and vegetation dominated by native species. Species composition is highly variable, with some drier areas severely impacted by weeds such as smooth brome, Canada thistle, and leafy spurge. Water quality is currently poor due to nutrient loading from livestock waste, which has resulted in a high percentage of algae.

Pronghorn

Target Significance

Historically, the pronghorn (*Antilocapra americana*) was considerably more abundant than it is today. Populations that once numbered in the tens of millions were threatened with extinction by the 1900s (Fitzgerald et al. 1994). Consequent protection efforts helped numbers increase, and today this species is one of the few native grazers that still occurs on the Great Plains in wild populations. Pronghorn are an indicator of overall prairie health, and presence of pronghorn on The Range is visible indication that the native prairie ecosystem there is intact and functioning. In addition, pronghorn are among the most easily recognizable animals on The Range, and have social and cultural significance to visitors and surrounding communities.

Target Viability

Overall viability is currently good. Habitat on The Range is healthy, and connectivity between The Range and the open prairie to the east is still intact. However, continued development to the south and potential for development to north will eliminate pronghorn from The Range unless steps are taken to protect connectivity to open prairie to the east. This species functions at a landscape scale – the Lowry Range alone is not large enough to support a self-sustaining population.

Grassland Birds

Target Significance

Grassland birds are of conservation concern because so many species are declining. According to Knopf (1996), North American Breeding Bird Survey (BBS) data suggest that grassland birds have experienced steeper, more consistent, and more geographically widespread declines than any other ecological or behavioral guild of North American species. Though these species are still relatively widespread and abundant, BBS data from 1966 to 2004 indicate that Horned Larks, Lark Buntings, Vesper Sparrows, and Western Meadowlarks have all experienced statistically significant declines survey-wide (Sauer et al. 2005). Grassland bird targets of particular concern are Lark Bunting and Vesper Sparrow. The breeding range of Lark Buntings is restricted to only a few ecoregions of the western Great Plains – thus opportunities to conserve this species are limited to those areas. The Vesper Sparrow is an indicator of piedmont grassland habitats. Management strategies designed for conservation of the Vesper Sparrow will also benefit the piedmont grassland target.

Target Viability

Viability of grassland birds is fair overall. Available data are not sufficient to quantify abundance, but observations from the 2005 field season suggest that size of these populations is likely fair, based on numbers of Lark Buntings and Horned Larks observed. Landscape context is compromised by disturbance from agriculture and residential development. Habitat condition is good for birds that require very short grass, but for birds that require more structure and taller grass (such as the Vesper Sparrow), current conditions are poor. The majority of grasses are less than 15cm in height due to past grazing pressure. Change in grazing management could easily improve viability for this target.

Table 2. Summary of viability for conservation targets on The Lowry Range. See Appendix A for details.

Conservation Targets		Landscape Context		Condition		Size		Viability Rank
		Grade	Weight	Grade	Weight	Grade	Weight	
1	Northern Pocket Gopher, macrotis subsp.	Good	1	-	1	Good	1	Good
2	Black-tailed Prairie Dog animal community	Fair	1	Good	1	Poor	1	Fair
3	Plains Riparian System - Coal Creek	Fair	1	Fair	1	Very Good	0.25	Fair
4	Plains Riparian System - Box Elder Creek	Good	1	Fair	1	Very Good	0.25	Good
5	Piedmont Grassland	Fair	1	Good	1	Very Good	1	Good
6	Wetlands	Good	1	Poor	1	-	1	Fair
7	Pronghorn	Good	1	Good	1	-	1	Good
8	Grassland Birds	Fair	1	Poor	1	Fair	1	Fair
Site Biodiversity Health Rank								Good

STRESSES AND THREATS

At any given time, there are a variety of human and natural processes (e.g., extractive or consumptive land uses, natural disturbance) operating on The Range, and these processes influence each other and the conservation targets in different ways. Processes that impair the viability of the conservation targets (e.g., excessive erosion, weed invasion, habitat destruction) are referred to as “stresses.” Activities that cause stresses (i.e., “sources of stress”) are considered threats. There may be a great deal of overlap between threats, stresses, and targets. One threat may cause multiple stresses to different targets, and a single stress may be caused by multiple threats. In addition, the severity and scope of any particular stress may be variable from one target to another. Also, for any given stress, how much a particular threat contributes to that stress, and the ease with which adverse impacts can be reversed, is variable from one threat to another. The more complex this situation is, the more difficult it can be to decide what kind of action is necessary to improve the condition of conservation targets and their overall viability. Accurate identification of threats, and articulation of the stresses that these threats cause for each target, is helpful in pinpointing efficient and effective conservation/management strategies.

The following discussion offers a brief summary of each threat (including current threats and likely future threats) identified on The Range. Table 3 presents severity ratings for each threat by conservation target. See Appendix B for additional detail.

Housing and Urban Development

On The Range, housing and urban development is one of the highest priority threats, and has some level of impact on all of the conservation targets. When realized, planned future development on The Range north of East Quincy Avenue will eliminate roughly 10-15% of the existing native habitat. Much of the land adjacent to the western boundary of The Range is already developed or identified as a future residential growth area by the City of Aurora (City of Aurora 2005). Development pressure is also being felt on the north, east, and south, though development in these areas is relatively scattered and lower density for now. It is uncertain whether development pressure to the north of The Range will come from the cities of Aurora or Watkins, or both, but much of this land is owned by developers, and conversion of this area to residential and/or commercial development is probably inevitable. The Comprehensive Land Use Plan for Arapahoe County identifies unincorporated land to the east of The Range as a rural area, but there is some exurban development, particularly along the southeast boundary.

Conversion of land from natural ecological systems to housing and urban development permanently destroys habitat for many native species, and is essentially irreversible. In addition, there are many indirect impacts that may stress targets in adjacent areas. Depending on density, design, and placement of developments, stresses from indirect impacts may include:

- Habitat loss or degradation from associated infrastructure (roads, utility corridors, etc.)

- Alteration of local hydrologic patterns (increase in impervious surfaces, flood control measures, wells for water supply)
- Altered flora/fauna communities (weeds, increased mortality from non-native predators such as domestic pets and red foxes, abandonment of the area by native animal species)
- Fragmentation of formerly connected habitat patches.

Adverse impacts from housing and urban development are likely to be most significant for the pronghorn and the riparian communities of Coal and Box Elder Creeks, followed by the piedmont grasslands, and the prairie dog community.

Pronghorn can acclimate to the presence of people in general, but they require wide, open vistas in order to detect predators. They are very sensitive to visual obstructions such as those posed by buildings. Disruption of sight lines fragments corridors, disrupts pronghorns' willingness to use or move through corridors, and renders habitat unsuitable. Once surrounding development reaches a certain point (this threshold is as yet unknown), habitat may appear to be in good condition, but it will not be occupied by pronghorn.

The primary concern for Coal Creek is habitat conversion from proposed development north of East Quincy Avenue. The stretch of Coal Creek that flows through this section of The Range is in much better condition than upstream reaches south of Quincy. Current plans for The Range call for the entire area along this segment of Coal Creek to be converted to residential development. If not done in a sensitive and compatible manner, development here could seriously degrade the healthiest part of this creek.

A second concern for Coal Creek, and the primary concern for Box Elder Creek, is the potential alteration of the local hydrologic regime. Excess runoff from an increase in impermeable surfaces may alter stream flows and increase sedimentation and erosion. In addition, water quality may be degraded by pollution from fertilizers and pesticides commonly used for horticultural landscaping. Pollution and nutrient enrichment would stress leopard frogs and other amphibians, and native fishes. These impacts may have a more direct impact on Coal Creek because developed areas will likely be directly adjacent to the riparian corridor. Development occurring around the southeast boundary of The Range is upstream of Box Elder Creek, so these stresses could degrade the downstream segments of this creek that flow through The Range. The limited, low density housing currently present will have less impact than higher density development would, but the potential for continuing future development in the area is high. Box Elder Creek is generally in good condition at the present time, but this target could easily be compromised if threats increase.

The most significant impact on the piedmont grassland is expected to be direct habitat loss and replacement of native grasslands with horticultural landscaping in developed areas north of East Quincy Avenue. Weed infestations may affect the composition of the grasslands south of Quincy, as a result of surface disturbance in adjacent areas and escaped garden plants. This impact can be manifested a considerable distance away from the original source. In addition, the animal community may change due to the

introduction or proliferation of non-native predators such as domestic pets and red foxes. Increased predation and disturbance from greater human presence in the area could result in the grassland habitat becoming a sink for bird populations³, and/or these species may abandon these habitats altogether.

The primary concern for the prairie dog community is reduced ability to support associated species. Prairie dogs and Burrowing Owls are able to adapt to surrounding development, but Ferruginous Hawks, Mountain Plovers, and swift fox are much more sensitive to human encroachment. These species are more likely to abandon the area if density and proximity of development is too high. Also, prairie dogs are already occupying much of the available habitat on The Range. As development proceeds around the boundary, prairie dogs will lose their options for dispersal and colonization of new areas.

Reservoirs

Water development is a potential future use for The Range that would serve two purposes: provide revenue to meet the SBLC's fiduciary mandate, and provide water to surrounding developments and communities. The City of Aurora and Rangeview Metropolitan District have each proposed potential reservoir sites on The Range. Likelihood of implementation, timeframe, and source of water for reservoirs are unknown. If the proposed City of Aurora reservoir is built, it would be filled using water piped in from outside The Range. If the adjudicated Rangeview reservoirs are built, they would be filled with some combination of groundwater, surface flows, and event flows on The Range. Rangeview currently holds a lease which allows movement of 40% of their allocation to be diverted off The Range to another location if their proposed reservoirs are not built. The four proposed reservoir sites are on the west side of The Range, and overlap with areas currently occupied by the prairie dog community and pronghorn.

Completion of either reservoir project could result in inundation of over 1,000 acres of native habitat, directly impacting pronghorn, piedmont grasslands, and prairie dogs. Direct habitat disturbance or loss from construction and maintenance of additional infrastructure (dams, pipelines, wells) would also impact Box Elder and Coal Creeks. Proposed plans from Rangeview Metropolitan District include provisions for diverting surface flows from Box Elder Creek via pipelines to the reservoirs (see following sections on Groundwater Pumping and Surface Flow Diversion, and Utility Infrastructure). However, the most significant impact of reservoir development is likely to be additional degradation of the hydrologic regime of Coal Creek. If dams associated with reservoirs are constructed in the drainages that flow into Coal Creek, the altered flows may further depress the ability of this system to recover from existing stresses caused by mining and excess grazing.

³ In simple terms, habitat functions as a population sink when it appears to be high quality – and thus animals are attracted to it – but threats are high, resulting in population decline due to failed reproduction, increased mortality, decreased recruitment, or all three. In this situation, the population is unable to sustain itself without continual input of new individuals immigrating from other populations.

Groundwater Pumping and Surface Flow Diversion

Groundwater pumping and surface flow diversions are associated with water resource development (construction of reservoirs) and housing and urban development (wells for water supply). Lowering of the water table and reducing instream flows can alter the composition of native vegetation, potentially leading to loss of riparian and wetland vegetation in nearby areas, as well as reduction or loss of animal populations that depend upon those habitats. Degree of impact could be highly variable, depending on amount of water pumped or diverted, as well as timing and location(s). Site-specific studies and detailed development and diversion plans would be needed to quantify potential impacts, but they could be substantial. Construction of infrastructure (pipelines, wells) can also result in destruction of vegetation, spread of weeds, and temporary disturbance to local animal populations (see following Utility Infrastructure discussion). Stresses associated with groundwater pumping and surface flow diversion are likely to be most significant for Box Elder and Coal Creeks, and wetlands.

Mining

Sand and Gravel

There is an existing lease in place to mine sand and gravel from the central portion of the Coal Creek basin. Many of the cottonwood trees in this area are dead or dying, presumably due to impacts from mining activities (e.g., lowering of the water table, damage in the root zone). Sand and gravel mining destroys riparian vegetation when it occurs directly in the floodplain, and degrades riparian communities by intercepting the water table and disrupting runoff and ground water flow into stream channels. This, in turn, reduces the amount of water available to riparian vegetation, ultimately leading to decline and death of the vegetation. When vegetation is lost, the ground loses its ability to stay intact, and the rate of erosion increases. Once excessive erosion has begun, headstream erosion continues to work its way upstream. There are areas of severe erosion on tributaries to Coal Creek, and this is probably what has happened in these areas (pers. comm., Mike Scott, USGS wetland ecologist to Renee Rondeau). Even though Coal Creek is the only conservation target currently impacted by sand and gravel mining, this is considered a significant threat for biodiversity on The Range overall. Because the condition of the Coal Creek riparian corridor is already compromised, this target is less able to accommodate continuing stresses that further impair ecological function.

Oil and Gas

Oil and gas exploration activities are currently taking place in a few limited areas on The Range. The field under The Range appears to be diminishing, so future oil and gas development is not expected to increase greatly.⁴ Overall, oil and gas mining is not

⁴ Oil and gas production is closely tied to the economic efficiency of extracting the resource, which can change markedly over time. Fields that are considered “diminishing” when sale prices are low compared to the costs of extraction may be considered “productive” if sale prices rise enough.

currently considered a significant threat across The Range, and these activities have not had significant adverse impacts on any of the conservation targets to date. However, there is some concern for potential impacts to the *macrotis* pocket gopher in areas where occupied and potential habitat overlap with existing and potential mining sites.

Construction of pads and access roads would destroy habitat, and weeds associated with ground disturbance may alter the local vegetation community. Not enough is known about the ecology of this subspecies to ascertain whether or not altering the vegetation community would have a direct negative impact. However, weed proliferation degrades habitat overall from an ecological standpoint, and could reduce food resources for the gopher.

Incompatible Grazing

The grassland system on The Range evolved with grazing animals. Grazing is an important ecological process that is necessary to maintain the grassland and prevent encroachment of trees and shrubs. Grazing animals, stocking rates, seasonality, and duration of grazing pressure affect grassland systems differently. Many animals and plants tend to become scarce under intense grazing, while others thrive. Under intense grazing, the composition of grasslands and riparian areas tend to change over time, with the forage plants preferred by livestock being reduced or eliminated. Current stocking rates, timing, and/or length of grazing season on The Range appear to be incompatible if the management goal is restoration of the piedmont grassland and riparian areas.

Currently, the piedmont grassland community on The Range is not being expressed to its full potential, probably because heavy grazing by livestock has caused a decline in the grasses native to this ecological system. Reverting to a less intensive grazing regime could gradually increase the abundance of those species that have declined and enable grasses characteristic of the piedmont grassland to recover, and improve habitat for the grassland birds that require higher structure. In addition, reducing the intensity of grazing could help increase density of pocket gophers due to overlap in dietary needs between pocket gophers and cattle – that is, there would potentially be more forbs available for the gophers (Cameron 2000).

Composition of the herbaceous riparian plant communities along Coal and Box Elder Creeks have also been degraded through intense grazing, resulting in a groundcover change from native plant species to communities dominated by weeds. In addition, trampling of streambanks and vegetation has led to increased erosion.

Recreation

Concern relative to recreation is associated with the potential future development of a trail system on The Range. Stresses most likely to result from construction of a trail system are indirect effects, including spread of weeds and disturbance from increased human access into the area. Miller et al. (1998) identified a zone of influence approximately 250 feet from trails where grassland birds were less likely to nest, and if they did nest, were more likely to experience lower nest survival rates. If trail systems fragment large areas of habitat into small patches, effects of human disturbance will be

more pronounced. Other related impacts include trampling of vegetation in the vicinity of trails, and habitat loss from trail construction. Though impacts from recreation are low to medium compared to other stresses operating on The Range, there is potential for this threat to stress all conservation targets except possibly wetlands.

Utility Infrastructure (Water Pipelines)

Construction and maintenance of utility infrastructure is associated with housing and urban development, and water resource development. Concerns are direct loss of habitat and spread of weeds typically associated with ground disturbance (see previous section Groundwater Pumping and Surface Flow Diversions for discussion of impacts to hydrologic regimes). Water resource development proposals from the Rangeview Metropolitan District include provisions for piping surface flows from Box Elder Creek via pipelines to fill reservoirs proposed for the west side of The Range. Pipelines could be constructed within the creek corridor, as well as across uplands. Concerns include destruction of existing riparian vegetation (in the uplands, along the creek channel and in the floodplain, or both), soil disturbance and increased erosion, and spread of weeds from construction. These impacts, as well as habitat fragmentation, would be increased if the utility corridor(s) included construction of roads to facilitate ongoing maintenance. Construction across the uplands would pose additional concerns for the pocket gopher. This population is in good condition, and is not significantly threatened at this point. However, this population could be vulnerable to comparatively low level threats because it is a single population that is relatively isolated. Given the high significance of this target, extra care is warranted.

Unexploded Ordnance Clearance

Before being acquired by the SBLC, The Range was used as a bombing target site by the military for training pilots. There are eight former bombing sites on The Range that have yet to be cleared for unexploded ordnance. Some degree of surface disturbance is expected at each of these sites, but the scope and severity are unknown. Levels of stress are likely to be highly variable from site to site, but may be temporary and reversible. The overall impact from this threat is not expected to be significant, but may contribute to cumulative impacts from other stresses. Given the current distribution of conservation targets and bombing sites, Box Elder Creek, prairie dogs, pronghorn, and the majority of grasslands may experience low to medium stress. Much of the native grassland north of East Quincy Avenue has already been lost.

Table 3. Summary of threats on by conservation target. See Appendix B for details.

Threats Across Systems		Northern Pocket Gopher, macrotis subsp.	Black-tailed Prairie Dog animal community	Plains Riparian System - Coal Creek	Plains Riparian System - Box Elder Creek	Piedmont Grassland	Wetlands	Pronghorn	Grassland Birds	Overall Threat Rank
<i>Project-specific threats</i>										
1	Housing & Urban Development	Low	Medium	Very High	Very High	High	Medium	Very High	Medium	Very High
2	Natural System Modifications - reservoirs	Low	Medium	Very High	High	High	High	High	Medium	Very High
3	Groundwater Pumping and Surface Flow Diversions	-	-	Very High	High	-	High	-	-	High
4	Mining - sand and gravel	-	-	Very High	-	-	-	-	-	High
5	Grazing & Ranching - incompatible grazing	-	-	High	High	Medium	Medium	-	Medium	High
6	Human-Powered Recreation - potential for future trail development and volume of use	Low	Low	Medium	Medium	Low	-	Medium	Medium	Medium
7	Utility Infrastructure - water pipelines	Low	-	Medium	Medium	-	-	-	-	Medium
8	Unexploded Ordnance Clearance	-	Low	-	Medium	Low	-	Low	-	Low
9	Mining - oil and gas	Low	-	-	-	-	-	-	-	Low
Threat Status for Targets and Site		Low	Medium	Very High	Very High	High	High	High	Medium	Very High

STRATEGIES FOR MAINTAINING VIABILITY AND ABATING THREATS

Maintaining the full suite of biological resources that currently occupy the Lowry Range will require a two-pronged approach to conservation: 1) on-site management, and 2) regional collaboration. On-site management can be implemented at the discretion of SBLC staff, and at least preliminary results can be achieved over short timeframes. Areas of highest priority for implementing on-site management strategies for the benefit of the conservation targets are shown in Figure 2. Regional collaboration is a long-term approach that requires the cooperation of others beyond SBLC staff. Maximizing the likelihood of long-term persistence for some conservation targets – particularly pronghorn, but also the prairie dog animal community – requires more area than The Range can provide. Other targets, such as the riparian systems, are easily influenced by impacts from off-site activities. Maintaining viability and abating stresses to these targets require strategies that operate on a regional or landscape scale. Collaboration with local governments, neighbors, conservation partners, and others who have influence over land use in the area, will be necessary to implement landscape scale strategies.

Regional strategies presented in this document are not prescriptions for what the SBLC should do, but rather suggestions for management approaches that would conserve the biological diversity values that make The Range so significant.

On-Site Management

1. ***Avoid disturbance within pocket gopher habitat.*** The pocket gopher population appears to be in good condition, so management for this species should focus on avoiding manifestation of potential threats. The most important goal for gopher management is to minimize surface disturbance within the Potential Conservation Area (Sovell et al. 2006). If possible, no more than 10% of potential habitat should experience surface or subsurface disturbance. Disturbance within occupied habitat should be avoided altogether if possible.
2. ***Reduce cattle access to riparian areas and wetlands.*** The most effective approach for immediate results is to fence cattle out of riparian areas and wetlands. A few small access points could be left along creeks if necessary, but restoration would be more successful if all grazing were eliminated for the near term. Once the vegetation has been restored, additional access can be allowed, but heavy year-round grazing in the riparian zones will not be sustainable. Any fences installed on The Range should be designed to allow passage by pronghorn. If fencing cattle out is not a feasible option, an alternative approach would be to reduce the number of head and the length of use. Reducing use during summer months (June, July, August), when trees and shrubs are regenerating, will be necessary to restore community structure. Weed control and planting with appropriate native species is needed to restore herbaceous vegetation. Restoration of Box Elder Creek will have the most immediate and significant impact on overall biodiversity value of The Range, because reducing the impacts of grazing would eliminate the majority of threats currently being realized in this area.

3. ***Manage sand and gravel mining to reduce impacts to Coal Creek and avoid impacts to the pocket gopher.*** Avoid introducing disturbance to the east side of Coal Creek, which is currently free of mining impacts. On the west side, concentrate mining to areas above the cottonwood gallery forest. If possible, restrict mining in sections 18, 19, 30, and 31 to avoid potential pocket gopher habitat.
4. ***Manage grazing to support a mosaic of habitats suitable for the full suite of upland conservation targets.*** Some conservation targets require short grasses (e.g., Mountain Plover), while others prefer grasslands with taller structure (targeted grassland birds). Prairie dogs can occur in either shortgrass or piedmont grasslands; in piedmont grasslands, their grazing and clipping activities will result in a short grass structure. Grazing is a necessary ecological process for maintaining grassland systems. When using grazing to manage for piedmont grasslands, the number of head, timing, and length of the grazing season should be considered. Some or all of these components of the grazing regime need to be reduced to allow regeneration of decreasers⁵ and improve vegetation structure (i.e., height of the grass). While restoration is in progress, winter grazing would be ideal. If possible, avoid grazing during the growing season for piedmont species (May, June, July). If grazing cannot be avoided during the growing season, grazing pressure should be as light as possible, and should be managed according to current conditions in terms of the health of the grasses and precipitation. A detailed grazing management plan is needed to achieve a mosaic of shorter and taller grasses.
5. ***Develop and implement an integrated weed management plan.*** Proliferation of weeds is affecting most targets on The Range, so this one strategy can have a significant effect on condition of biodiversity on The Range. Note that there is potential for some weed control activities, such as spraying of herbicides, to have adverse impacts on native plants and animals. Care should be taken to protect native species.
6. ***Design and manage trail system to minimize impacts to conservation targets.*** Important aspects of trail management include: maintaining a low density network of trails, constructing the majority of trails outside riparian corridors; avoiding occupied pocket gopher habitat; providing interpretation to encourage users to stay on trails and keep pets leashed; and controlling weeds. The majority of trails are planned for the developed area north of East Quincy Avenue. Any trails constructed south of East Quincy Avenue should be limited in scope and designed to avoid impacts to conservation targets.
7. ***Encourage neighbors and residents to use native plants for landscaping.*** Use of native species for landscaping reduces risk of expansion of non-native species (weeds and horticultural plants) into native ecosystems, requires less water to be diverted from native systems to support non-native vegetation, and reduces the need for use of

⁵ Decreasers are native plants that are palatable to cattle, and therefore decrease in abundance under heavy grazing as cattle selectively remove these species.

chemical fertilizers and pesticides to support introduced species. Xeriscaping is suggested for all contained developments.

8. ***Sponsor additional research to fill information gaps.*** Additional information is needed on how future land-use and management activities may affect conservation targets. Specifically, site-specific data are needed to quantify:
 - how groundwater depletion and surface flow diversion may impact riparian areas, wetlands, and dependent animal communities, under current and proposed plans; and
 - likely impacts from future sand and gravel mining in new areas along Coal Creek, and how those activities may affect the potential for successful restoration of this system.
9. ***Develop and implement a monitoring plan.*** Housing and urban development both on and around The Range, as well as water resource development and increased recreational opportunities on The Range, will all have some level of impact on the conservation targets. An appropriately designed monitoring plan can help identify adverse impacts as development proceeds, and highlight needed changes in management approach and priority.

Regional Collaboration

10. ***Maintain the ability of pronghorn to move between habitat patches on and off of The Range.*** The Colorado Division of Wildlife has identified an area along West Bijou Creek due east of The Range as a pronghorn concentration area (see map in Sovell et al. 2006). There are also smaller concentration areas to the north and south of The Range. At a minimum, enough open habitat to allow movement of pronghorn between The Range and West Bijou Creek should be maintained. If future land use changes such that The Range becomes an island of native habitat surrounded by development, different strategies for managing small populations would become necessary. However, these strategies would be very resource intensive, and the pronghorn population would not retain full ecological function under these conditions. Concerted efforts to protect habitat connectivity to the eastern plains and avoid hemming The Range in on all sides will greatly enhance the SBLC's contribution to prairie conservation, benefit all of the conservation targets, and retain more options for future management.
11. ***Coordinate with neighbors and partners on a regional approach to prairie dog management.*** Increasing the number of acres occupied by prairie dogs would provide enhanced support for the associated birds and improve the overall viability of the animal community. Protection of existing occupied habitat on The Range, as well as connectivity among colonies on The Range and in the surrounding landscape, is important. Ideally, prairie dog animal communities would be distributed among small towns and large towns that, together, form large complexes. In order to accommodate movement of prairie dogs between colonies, towns should be within five kilometers (approximately three miles) of each other, and surrounded by habitat

that individual animals could successfully traverse (e.g., not multi-lane highways, etc.).

Maintaining connectivity among prairie dog colonies on and off The Range would also help reduce potential need for future lethal control. If prairie dogs become restricted within an area, they will eventually eat all of the vegetation and the only remaining plants will be weeds. Once degraded to this extent, it may be difficult to fully restore functioning prairie. For instance, if all the blue grama grass in an area dies, it is extremely difficult to regenerate from seed. Pursuing housing and water resource development on The Range and on-going development of surrounding lands could combine to constrain the prairie dogs' options for moving among habitat patches. Use of control as a management tool may ultimately become necessary on some areas of The Range if prairie dogs lose their ability to move.

12. ***Work with adjacent landowners, developers, and local authorities to minimize adverse impacts to the hydrologic regimes of Coal and Box Elder Creeks, and to maintain the water table.*** Influences from housing and water resource development can have significant impacts on the riparian corridors on The Range. These activities can reduce water quality, destroy or degrade riparian vegetation, stress amphibians and other associated species, constrain the creeks' ability to meander, and alter amount and timing of instream flows. These impacts can be minimized by encouraging protection of the floodplains, use of appropriate setbacks, landscaping with native vegetation, avoiding the use of chemicals, and minimizing damming, pumping, and diversion of surface flows and groundwater as much as possible. To maintain and enhance the quality of the riparian corridors on The Range, it is important to protect the upstream reaches to the south. Avoid lowering the water table to protect wetlands and associated species.

13. ***Work with Arapahoe County to integrate a region-wide weed management plan.*** Effectiveness of weed control efforts on The Range could be reduced if weeds are prevalent on adjacent properties. In particular, leafy spurge is extremely difficult to control once infestations become established. A coordinated, regional approach to controlling the more invasive exotics will improve likelihood of a successful outcome. Consult with the Colorado Department of Agriculture and the local Colorado State University Extension Office for assistance on weed control programs.

CONCLUSION

The Lowry Range offers a unique opportunity to conserve a functioning prairie ecosystem in close proximity to an expanding urban environment, and to advance understanding of how development influences native biodiversity at a local scale. The Range is currently home to a suite of native prairie species and habitats, which together make up the living landscape of The Range. Though each of these species and systems are unique, they are intricately linked through complex ecological patterns and processes that operate at a landscape scale. Long-term maintenance of these targets on The Range

will require collaborative regional planning and cooperation among the SBLC, neighbors, local governments, and conservation partners.

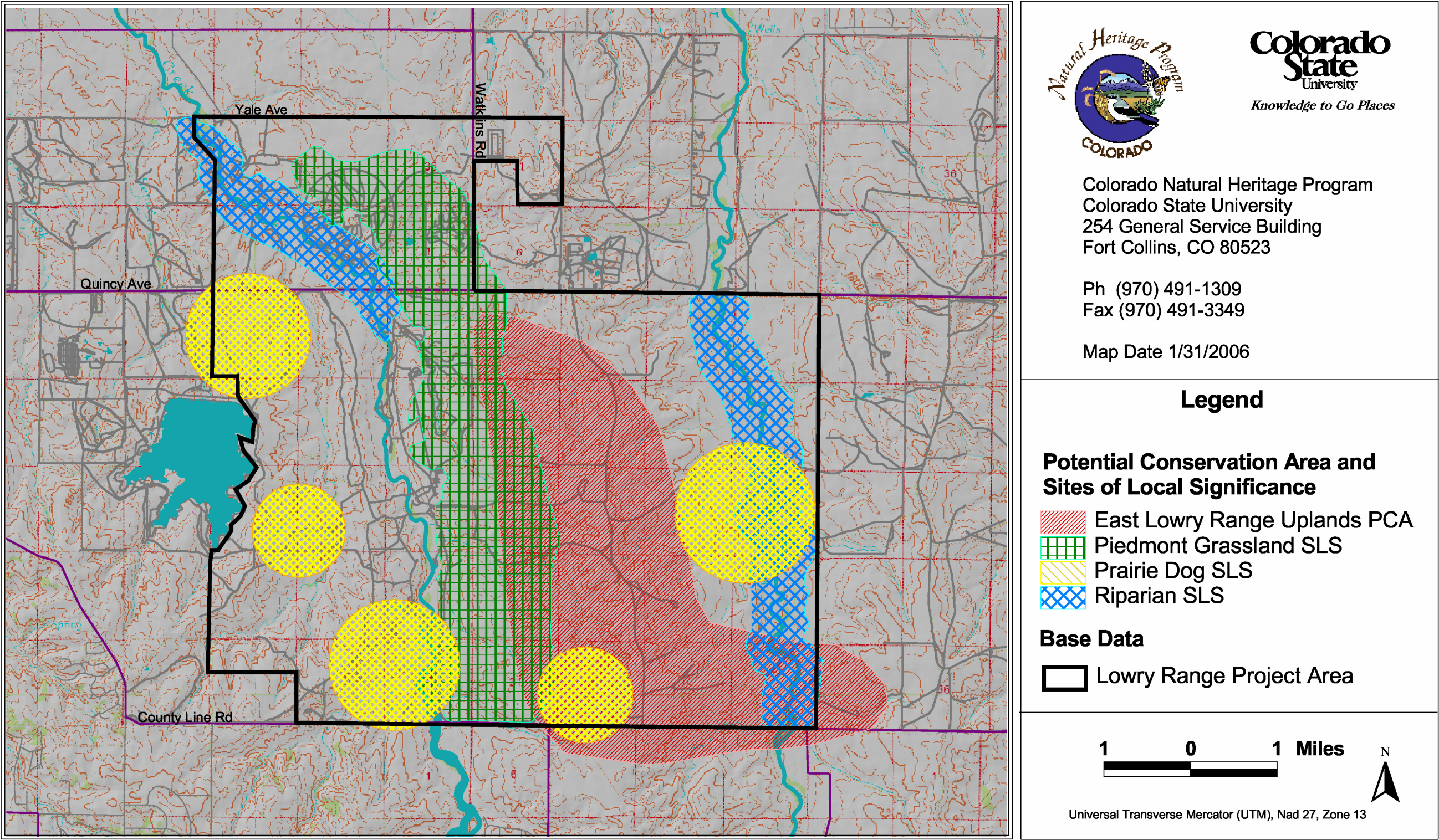
Planned and potential future land uses on The Range and in the vicinity may threaten the biodiversity values on The Range. Of these, the most significant are housing/urban development and reservoir development. Each of these activities results in permanent destruction of habitat, as well as an array of potential indirect impacts associated with disturbance of hydrologic regimes and alteration of species composition (both flora and fauna). Other significant threats are sand/gravel mining, incompatible grazing, and groundwater pumping. The only target currently affected by sand and gravel mining is the riparian corridor of Coal Creek. However, past impacts have been severe enough to compromise the function of this hydrologic system, which reduces the overall potential of The Range for biological diversity value. Past incompatible grazing has altered vegetation composition and degraded streambank condition along the riparian corridors of Coal and Box Elder Creeks, and altered the structure and function of the piedmont grasslands. Groundwater pumping is a potential future threat associated with housing/urban development and reservoirs. If enough groundwater is pumped to lower the water table, there could be significant implications for the riparian corridors and wetlands, including loss of vegetation (especially trees and shrubs), and reduction or loss of animal populations that depend on these habitats.

Maintaining the full suite of biological resources that currently occupy the Lowry Range will require a two-pronged approach to conservation: 1) on-site management, and 2) regional collaboration. Regional collaboration will be required for long-term maintenance of pronghorn and species associated with the prairie dog animal community on The Range. Important areas of focus for on-site management are proper planning and implementation of future development activities, and restoration of degraded targets. Ground disturbance should be minimized within potential habitat for the pocket gopher, and should be avoided to the maximum extent practicable within occupied habitat. Development of residential areas, reservoirs, and recreation facilities should address the needs of conservation targets in siting, design, and construction. Reducing the intensity of grazing will help species characteristic of the piedmont grassland system recover, and improve the condition of the wetlands. Temporary elimination of grazing within riparian corridors may be necessary in order to restore damage to vegetation and stream banks in these areas. An integrated weed management plan, implemented in conjunction with a compatible grazing plan, is needed to improve the vegetation composition of native communities across The Range.

There are many unknowns associated with managing complex ecological systems, so flexibility in responding to unexpected consequences of management actions is important. Additional research on thresholds and impacts of groundwater depletion and surface flow diversions would help define policies for future mining and development. An appropriately designed monitoring program can help quantify adverse impacts from development activities, and highlight needed changes in management approach and priority.

In conclusion, proper management for the benefit of conservation targets, combined with appropriate design and placement of areas developed for commercial, residential, and conservation activities, should allow for realization of both the economic and ecological potential of The Range. By using the data in this report for additional analysis, the SBLC will be able to better meet the dual objectives of conservation and long-term revenue generation on the Lowry Range.

Figure 2. Management zones of highest priority for conservation targets (reprinted from Sovell et al. 2006).



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APPENDIX A – VIABILITY ANALYSIS

Viability was evaluated for each conservation target on the Lowry Range based on three categories: size, condition, and landscape context. Each target's status relative to these categories was rated on a scale of Poor to Very Good according to "key ecological attributes" and "indicators" (defined below). Indicators were rated for current condition and desired future condition. Where desired future condition is better than current condition, management strategies are needed to enhance or restore that ecological attribute. Where desired future condition and current condition are the same, but less than Very Good, management strategies may be needed to avoid further degradation.

Unless cited otherwise, the source for the following definitions is: The Nature Conservancy. 2005. Conservation Action Planning Workbook User Manual, Version 4.b, August 2005, The Nature Conservancy, Arlington, VA.

Key Ecological Attribute – critical components of a conservation target's life history, physical processes, community interaction, habitat or interaction with other species that most clearly define or characterize the conservation target, limit its distribution, or determine its variation over space and time. These are characteristics that, if degraded or missing, would seriously jeopardize the target's ability to persist over time.

Indicator – measurable characteristics used to assess status and trend of key ecological attributes.

Indicator Rating – ranges of variation in an indicator that define quality categories from Poor to Very Good, to provide consistent and objective basis for evaluating the status of an indicator.

Very Good: The indicator is functioning within an ecologically desirable status, requiring little human intervention for maintenance with the natural range of variation.

Good: The indicator is functioning within its range of acceptable variation, although it may require some human intervention for maintenance.

Fair: The indicator lies outside of its range of acceptable variation and requires human intervention for maintenance. If unchecked, the target will be vulnerable to serious degradation.

Poor: Allowing the indicator to remain in this condition for an extended period will make restoration or prevention of extirpation of the target practically impossible (e.g., it will be too complicated, costly, and/or uncertain to reverse the alteration.)

CONSERVATION TARGET: NORTHERN POCKET GOPHER, *macrotis* subsp.

Category: Landscape Context

Key Attribute: Landscape pattern (mosaic) & structure

Indicator: Percent natural land cover

Indicator Ratings:

Poor: >75% surrounding area converted to non-native cover or land use

Fair: >50% surrounding area disturbed or non-native vegetation

Good: Predominantly native vegetation within 1/2 mile

Very Good: Native vegetation dominant within 1 mile

Indicator ratings comment: Surrounding area <25% developed. City of Aurora is developing the majority of the western boundary. Some lands bordering northern boundary for sale; Aurora leading candidate to annex for development. None of the undeveloped area within 2 miles is tilled.

Current Indicator Status: Most suitable habitat undisturbed and composed of native vegetation. Development pressure west and north of Lowry Range. Not tilled within 2 miles.

Current Rating: Good

Date of Current Rating: 9/15/2005

Current rating comment: Most suitable habitat is currently undisturbed and composed of native species.

Desired Rating: Very Good

Category: Size

Key Attribute: Population size & dynamics

Indicator: number of individuals

Indicator Ratings:

Poor: <1,500 individuals

Fair: at least 1,500 individuals

Good: at least 3,000 individuals

Very Good: >5,000 individuals

Indicator ratings comment: Quantitative basis for assessing not available. Current assessment based on qualitative evaluation by experienced field observer. Based on earlier observations on adjacent land as well as museum collections from this area, gophers have been persistent in this area for a long time. Based on persistence, condition of habitat, and very good local landscape context, assume condition of population is very good. Additional data needed to confirm.

Survey confirmed presence but did not produce data sufficient to estimate density or abundance. Based on observations of diggings, we hypothesize that the density of existing population is no more than 12/ha (Reid 1973) (i.e., on the low end of the densities documented in literature).

Current Indicator Status: Present on Lowry Range. Among the best known occurrences for this T1 subspecies.

Current Rating: Good

Date of Current Rating: 9/15/2005

Desired Rating: Very Good

Category: Size

Key Attribute: Size / extent of characteristic communities / ecosystems - occupied habitat

Indicator: Acres of occupied habitat

Key attribute and indicator comment: Able to persist in relatively small patches. From Center for Native Ecosystems et al. petition for emergency listing: territory size is small and does not fluctuate substantially. Citing Hansen and Reid 1973, surface area of single burrow system = 2,000 sq. ft. (0.05 ac), with recaptures within 120 feet of original capture site. Their conclusion was that individuals live out life in 1/20 of an acre.

Densities reported: for northern pocket gopher, >50/ha (Armstrong 1987); 91/ha (Miller 1964); 12-25/ha (Reid 1973).

Armstrong, David M. 1987. Rocky Mountain Mammals. Colorado Associated University Press. Pp. 107-109.

Hansen, Richard M. and Vincent H. Reid. 1973. Distribution and adaptations of pocket gophers." In Pocket Gophers and Colorado Mountain Rangeland. Experiment Station Bulletin, Colorado State University, Fort Collins, CO.

Miller, Richard S. 1964. "Ecology and distribution of pocket gophers (Geomyidae) in Colorado." Ecology 45(2):256-272.

Reid 1973. "Population biology of the northern pocket gopher." In Pocket Gophers and Colorado Mountain Rangeland. Experiment Station Bulletin, Colorado State University, Fort Collins, CO.

Indicator Ratings:

Poor: <125 acres

Fair: 125 - 249 acres

Good: 250 - 415 acres

Very Good: >416 acres

Indicator ratings comment: Based on calculation of number of acres that would be needed to support 5,000 adults, using the low density estimate of 12/ha. This is the conservative approach. Survey confirmed presence but did not produce data sufficient to estimate density or abundance. Based on observations of diggings, we hypothesize that the density of existing population is no more than 12/ha (i.e., on the low end of the densities documented in literature).

Current Indicator Status: Present on Lowry Range, and on adjacent lands. Estimate approx. 300 acres currently occupied with scattered distribution.

Current Rating: Good

Date of Current Rating: 3/6/2006

Desired Rating: Very Good

Category: Size

Key Attribute: Size / extent of characteristic communities / ecosystems - suitable habitat

Indicator: Acres of suitable habitat

Indicator Ratings:

Poor: <500 acres

Fair: 500 - 999 acres

Good: 1,000 - 1,663 acres

Very Good: at least 1,664 acres

Indicator ratings comment: Numbers based on the assumption that ideally suitable, unoccupied habitat would be approximately 4 times the amount of occupied habitat

Current Indicator Status: No data to quantify, but important that suitable habitat to support population growth/ dynamics is available. Estimate that there is 5,000-7,000 acres on Lowry Range.

Current Rating: Very Good

Date of Current Rating: 3/6/2006

Desired Rating: Very Good

CONSERVATION TARGET: BLACK-TAILED PRAIRIE DOG ANIMAL COMMUNITY

Category: Landscape Context

Key Attribute: Landscape pattern (mosaic) & structure

Indicator: Percent tilled and developed land

Indicator Ratings:

Poor: >50% tilled; >10% exurban; >5% urban

Fair: 25-50% tilled; 5-10% exurban; 1-5% urban

Good: <25% tilled; 1-5% exurban; <1% urban

Very Good: <5% tilled; <1% exurban; 0% urban

Indicator ratings comment: Surrounding area <25% developed. City of Aurora developing majority of western boundary. Some lands bordering northern boundary for sale; Aurora leading candidate to annex for development. None of the undeveloped area within 2 miles of existing prairie dog complex is tilled.

Current Indicator Status: <25% developed. None of the land within 2 miles of existing prairie dog colony is tilled.

Current Rating: Fair

Date of Current Rating: 9/30/2005

Desired Rating: Good

Category: Condition

Key Attribute: Potential for population expansion

Indicator: Number of acres with appropriate slope

Indicator Ratings:

Poor: <5,000 acres

Fair: 5,000 - 10,000 acres

Good: 10,000 - 25,000 acres

Very Good: >25,000 acres

Indicator ratings comment: Based on CNHP's Element Occurrence rank specifications for black-tailed prairie dog grassland complex, November 2005. Calculation of potential expansion acres based on 30m NED slope and CDOW Basinwide landcover.

Lowry Range currently has over 20,000 acres of potentially suitable habitat for prairie dogs, but the majority of those acres is unoccupied. Depending on future land-use and

management, the amount of suitable habitat is expected to be less (i.e., managing some grasslands for taller grasses, construction of reservoirs, trails, etc.).

Current Indicator Status: 22,700 acres <10 degrees slope that is not in shrubs, trees, wetlands, or water.

Current Rating: Good

Date of Current Rating: 4/6/2006

Desired Rating: Good

Category: Condition

Key Attribute: Species composition / dominance

Indicator: Percent landcover native species

Indicator Ratings:

Poor: <50% native vegetation

Fair: 50 - 69% native vegetation

Good: 70 - 79% native vegetation

Very Good: >80% native vegetation

Current Indicator Status: >70% contains native vegetation.

Current Rating: Good

Date of Current Rating: 11/1/2005

Desired Rating: Good

Category: Condition

Key Attribute: Species composition / dominance

Indicator: Presence of associated species

Indicator Ratings:

Poor: Associated species not present

Fair: Some associated species present, but not all

Good: Mountain Plover, Ferruginous Hawk, Burrowing Owl, swift fox all present and breeding

Very Good: Full suite of associated species, including black-footed ferrets, are present.

Indicator ratings comment: For the purposes of this project, associated species are black-footed ferret, Burrowing Owl, Mountain Plover, Ferruginous Hawk, swift fox (Kotliar et al. 1999). Kotliar et al. defined 4 criteria for dependence of associated species, and identified nine species that meet at least one criterion: black-footed ferret (met all four criteria), Burrowing Owl (met 3), Mountain Plover (met 3), Ferruginous

Hawk, Golden Eagle, swift fox, Horned Lark, deer mouse, and grasshopper (met 1 each). In 2005, Swift fox, Burrowing Owl, Ferruginous Hawk, Northern Harrier, Prairie Falcon were present on Lowry Range.

Kotliar, N.B., B.W. Baker, A.D. Whicker, and G. Plumb. 1999. A critical review of assumptions about the prairie dog as a keystone species. *Environmental Management* 24(2):177-192.

Current Indicator Status: Diverse animal assemblage present. Connection to open prairie to east necessary for viability.

Current Rating: Fair

Date of Current Rating: 11/1/2005

Desired Rating: Fair

Desired rating comment: Lowry Range is not big enough to support viable occurrences of associated species without maintaining connectivity to open prairie to the east.

Category: Size

Key Attribute: Size / extent of characteristic communities / ecosystems - occupied habitat

Indicator: Acres of occupied habitat

Indicator Ratings:

Poor: <5,000 acres

Fair: 5,000 - 10,000 acres

Good: 10,000 - 25,000 acres

Very Good: >25,000 acres

Indicator ratings comment: Indicator ratings based on CNHP's Element Occurrence rank specifications for black-tailed prairie dog grassland complex, November 2005. Rank specifications based on needs of black-footed ferrets according to Forrest et al. 1985. Current size of prairie dog complex on Lowry Range is poor, but would be fair if the entire complex that includes the surrounding area was considered (based on CNHP's permeability model for prairie dog complexes).

Forrest, S. C., T. W. Clark, L. Richardson, T. M. Campbell III. 1985. Black-footed Ferret Habitat: Some Management and Reintroduction Considerations. Wyoming BLM Wildlife Technical Bulletin No.2.

Current Indicator Status: ~1,700 occupied acres on Lowry Range. Extent of larger complex in surrounding area outside of Lowry Range is ~22,000 acres.

Current Rating: Poor

Date of Current Rating: 9/30/2005

Desired Rating: Fair

Desired rating comment: Lowry Range is not big enough to support "Good" or "Very Good" size within its boundary.

CONSERVATION TARGET: PLAINS RIPARIAN SYSTEM – COAL CREEK

Category: Landscape Context

Key Attribute: Landscape pattern (mosaic) & structure

Indicator: Percent natural land cover

Key attribute and indicator comment: Based on CNHP's ecological systems description for Western Great Plains Riparian Woodland, Shrubland and Herbaceous systems, Sept 2005.

Indicator Ratings:

Poor: Surrounding uplands mostly converted to agricultural or urban uses. Riparian occurrence may be reduced to narrow strip with much edge effect.

Fair: Uplands surrounding occurrence, or upstream watershed, are fragmented by urban or agricultural use, but still 20-60% natural.

Good: Uplands and watershed largely unaltered by urban or agricultural uses, with 60-90% natural land cover. Much connectivity is retained, and uplands are not intensively cropped by center-pivot irrigation, dryland farming, or numerous roads.

Very Good: Surrounding uplands and watershed largely unaltered, with >90% natural land cover, and distance to nearest cropped, mowed, or developed land is >1mi.

Current Indicator Status: Uplands within Lowry Range are variable, but generally good to very good. Coal Creek impacted by roads and mining. Condition outside of Lowry Range are disturbed by urban development.

Current Rating: Fair

Date of Current Rating: 11/5/2005

Desired Rating: Fair

Category: Condition

Key Attribute: Disturbance

Indicator: Local hydrologic regime

Indicator Ratings:

Poor: Not restorable; system remains fundamentally compromised despite restoration of some processes.

Fair: Natural hydrologic regime altered by upstream dams, local drainage, filling/digging/ dredging. Alteration is extensive, but potentially restorable over several decades.

Good: Intact or slightly altered by local drainage, flood control, irrigation canals, livestock grazing, digging, vehicle use, roads, etc. Alteration is easily restorable by ceasing such activities.

Very Good: Intact, including unaltered floodplain. Little or no evidence of alteration due to flood control, drainage, irrigation canals, livestock grazing, digging, berming, vehicle use, etc.

Current Indicator Status: Impacted by sand/gravel mining. Cottonwood trees are dead.

Current Rating: Fair

Date of Current Rating: 11/5/2005

Desired Rating: Fair

Category: Condition

Key Attribute: Disturbance

Indicator: Stream bank condition

Indicator Ratings:

Poor: Not restorable; system remains fundamentally compromised despite restoration of some processes.

Fair: Stream banks severely altered; disturbance significant enough to have notable impact on species composition; soil compaction, and excessive erosion.

Good: Stream banks may show some local deleterious effects.

Very Good: Stream banks are not overly steepened and have not been stripped of vegetation.

Current Indicator Status: Impacted by sand/gravel mining. Also heavily used by cattle. Mining and cattle have led to excess erosion and some cutbank areas, but streambanks are generally well vegetated.

Current Rating: Fair

Date of Current Rating: 11/5/2005

Desired Rating: Fair

Category: Condition

Key Attribute: Species composition / dominance

Indicator: Non-natives

Indicator Ratings:

Poor: May be dominant over significant portions of area, with little potential for control.

Fair: May be widespread but potentially manageable with restoration of most natural processes.

Good: Few exotic species, and low potential for their expansion if restoration occurs.

Very Good: <3% canopy cover of non-natives, with little potential for expansion.

Current Indicator Status: Overall fair, but there are some sites that are poor, based on dense leafy spurge and pasture grasses. Condition in wettest areas good.

Current Rating: Fair

Date of Current Rating: 11/5/2005

Desired Rating: Fair

Category: Size

Key Attribute: Size / extent of characteristic communities / ecosystems

Indicator: Linear miles of riparian system

Indicator Ratings:

Poor: <0.5 miles

Fair: 0.5-1 miles

Good: 1-1.5 miles

Very Good: >1.5 miles

Current Indicator Status: Coal Creek longer than 5 miles on Lowry Range.

Current Rating: Very Good

Date of Current Rating: 11/5/2005

Desired Rating: Very Good

CONSERVATION TARGET: PLAINS RIPARIAN SYSTEM – BOX ELDER CREEK

Category: Landscape Context

Key Attribute: Landscape pattern (mosaic) & structure

Indicator: Percent natural land cover

Key attribute and indicator comment: Based on CNHP's ecological systems description for Western Great Plains Riparian Woodland, Shrubland and Herbaceous systems, Sept 2005.

Indicator Ratings:

Poor: Surrounding uplands mostly converted to agricultural or urban uses. Riparian occurrence may be reduced to narrow strip with much edge effect.

Fair: Uplands surrounding occurrence, or upstream watershed, are fragmented by urban or agricultural use, but still 20-60% natural.

Good: Uplands and watershed largely unaltered by urban or agricultural uses, with 60-90% natural land cover. Much connectivity is retained, and uplands are not intensively cropped by center-pivot irrigation, dryland farming, or numerous roads.

Very Good: Surrounding uplands and watershed largely unaltered, with >90% natural land cover, and distance to nearest cropped, mowed, or developed land is >1mi.

Current Indicator Status: Current condition good, but it will take some work to keep it there. Can't achieve very good.

Current Rating: Good

Date of Current Rating: 11/5/2005

Desired Rating: Good

Category: Condition

Key Attribute: Community architecture

Indicator: Community structure

Indicator Ratings:

Poor:

Fair: Noticeably altered by disturbance.

Good: Although species composition is primarily native species, the physiognomic structure is less diverse than in A-ranked occurrences.

Very Good: Community is composed primarily of native species and has a diverse physiognomic structure.

Current Indicator Status: Overall, native species dominate and understory shrubs are present. Not very good due to some areas with weeds and reduced shrub understory.

Current Rating: Good

Date of Current Rating: 11/5/2005

Desired Rating: Very Good

Category: Condition

Key Attribute: Disturbance

Indicator: Local hydrologic regime

Indicator Ratings:

Poor: Not restorable; system remains fundamentally compromised despite restoration of some processes.

Fair: Natural hydrologic regime altered by upstream dams, local drainage, filling/digging/ dredging. Alteration is extensive but potentially restorable over several decades.

Good: Intact or slightly altered by local drainage, flood control, irrigation canals, livestock grazing, digging, vehicle use, roads, etc. Alteration is easily restorable by ceasing such activities.

Very Good: Intact, including unaltered floodplain. Little or no evidence of alteration due to flood control, drainage, irrigation canals, livestock grazing, digging, berming, vehicle use, etc.

Current Indicator Status: Little hydrologic modification upstream, but there is some residential development.

Current Rating: Good

Date of Current Rating: 11/5/2005

Desired Rating: Good

Category: Condition

Key Attribute: Disturbance

Indicator: Stream bank condition

Indicator Ratings:

Poor: Not restorable; system remains fundamentally compromised despite restoration of some processes.

Fair: Stream banks severely altered; disturbance significant enough to have notable impact on species composition, soil compaction, and excessive erosion.

Good: Stream banks may show some local deleterious effects.

Very Good: Stream banks are not overly steepened and have not been stripped of vegetation.

Current Indicator Status: Some local impacts, but generally in good condition.

Current Rating: Good

Date of Current Rating: 11/5/2005

Desired Rating: Very Good

Category: Condition

Key Attribute: Species composition / dominance

Indicator: Non-natives

Key attribute and indicator comment: Based on CNHP's Ecological Systems description Western Great Plains Riparian Woodland, Shrubland, and Herbaceous systems, Sept 2005.

Indicator Ratings:

Poor: May be dominant over significant portions of area, with little potential for control.

Fair: May be widespread but potentially manageable with restoration of most natural processes.

Good: Few exotic species, and low potential for their expansion if restoration occurs.

Very Good: <3% canopy cover of non-natives, with little potential for expansion.

Current Indicator Status: Some areas are in good condition, but in many areas non-natives dominate in understory.

Current Rating: Fair

Date of Current Rating: 11/5/2005

Desired Rating: Good

Other comments: Invasive exotics are those that have major potential to alter structure and composition (e.g., non-native thistle, cheatgrass, leafy spurge). Native increasers are native species that increase in cover/abundance with grazing (e.g, fringed sage).

Category: Size

Key Attribute: Size / extent of characteristic communities / ecosystems

Indicator: Acres of occupied habitat

Key attribute and indicator comment: Based on CNHP's Ecological Systems description Western Great Plains Riparian Woodland, Shrubland, and Herbaceous systems, Sept 2005.

Indicator Ratings:

Poor: <0.5 miles

Fair: 0.5-1 miles

Good: 1-1.5 miles

Very Good: >1.5 miles

Current Indicator Status: Box Elder Creek longer than 5 miles on Lowry Range.

Current Rating: Very Good

Date of Current Rating: 11/5/2005

Desired Rating: Very Good

CONSERVATION TARGET: PIEDMONT GRASSLAND

Category: Landscape Context

Key Attribute: Landscape pattern (mosaic) & structure

Indicator: Percent natural land cover

Key attribute and indicator comment: Based on CNHP's Ecological Systems description for Western Great Plains Foothill and Piedmont Grassland system, September 2005.

Indicator Ratings:

Poor: Major human-caused alteration of surrounding landscape. Adjacent systems are mostly converted to agricultural or urban uses.

Fair: Surrounding landscape a mosaic of agricultural or semi-developed areas, with >50% natural or semi-natural vegetation. Some non-natural barriers present; significant disturbance but easily restorable.

Good: Surrounding landscape at least 75% natural or semi-natural vegetation, with little urban development within or adjacent to occurrence.

Very Good: At least 90% native and unaltered landscape, with very little to no urban development or agriculture.

Current Indicator Status: Area to west completely developed, but to east, south, and north development is relatively light and scattered (for now). Still retaining connectivity to grasslands to east.

Current Rating: Fair

Date of Current Rating: 11/5/2005

Desired Rating: Fair

Category: Condition

Key Attribute: Species composition / dominance

Indicator: Community structure

Indicator Ratings:

Poor: Native grassland species <10% cover and 20% relative cover. Alteration of vegetation is extensive and restoration potential is low.

Fair: Trees and shrubs may have seedlings, juveniles or saplings present. Alteration is extensive but potentially restorable over several decades.

Good: If trees are present, they are widely scattered and mature. Species richness high; grasses (non-increasers) are dominant.

Very Good: If trees are present, they are widely scattered and mature. Species richness high; native bunch grasses are dominant.

Current Indicator Status: Only a few shrubs present (yucca).

Current Rating: Very Good

Date of Current Rating: 11/5/2005

Desired Rating: Very Good

Category: Condition

Key Attribute: Species composition / dominance

Indicator: Non-natives

Indicator Ratings:

Poor: Non-natives are dominant.

Fair: Invasive exotics may be prominent but still controllable. Other non-natives >10% cover.

Good: Invasive exotics may be present but in low abundance. Other non-natives <10% cover, with native species dominant.

Very Good: Invasive exotics absent. Other non-natives <5% cover, with native species dominant.

Indicator ratings comment: A few large patches of invasive exotics found in grasslands, including scattered patches of cheatgrass, leafy spurge and musk thistle. Grazing pressure has led to blue grama dominating, rather than being co-dominant with sideoats grama, stipas, and western wheatgrass.

Current Indicator Status: A few large patches of invasive exotics found in grasslands. Scattered patches of cheatgrass, leafy spurge, and musk thistle.

Current Rating: Fair

Date of Current Rating: 11/5/2005

Desired Rating: Good

Category: Condition

Key Attribute: Species composition / dominance

Indicator: Species composition

Indicator Ratings:

Poor:

Fair: Native increasers dominant to co-dominant with native species.

Good: Native increasers <10% cover.

Very Good: Native increasers <3% cover.

Indicator ratings comment: Currently, the grassland on Lowry Range is a homogenous, monoculture of blue grama. Ideally, there would be a mosaic of patches of blue grama interspersed with a variety of other prairie grasses, including sideoats grama, western wheatgrass, needle-and-thread grasses, and little bluestem. The current condition is a result of sustained grazing pressure, leading to increased cover of blue grama at the expense of these other grasses.

Current Indicator Status: Grazing pressure has led to blue grama dominating, rather than being co-dominant with sideoats grama, stipas, and western wheatgrass.

Current Rating: Fair

Date of Current Rating: 11/5/2005

Desired Rating: Good

Category: Size

Key Attribute: Size / extent of characteristic communities / ecosystems

Indicator: Acres of occupied habitat

Indicator Ratings:

Poor: <1,000 acres

Fair: 1,000 - 2,000 acres

Good: 2,000 - 5,000 acres

Very Good: >5,000 acres. Large enough to support A-ranked occurrences of disjunct butterflies and skippers, grassland birds, and mosaic of plant associations.

Current Indicator Status: This is the matrix community on Lowry Range, and covers majority of the 26,000 acre site (probably about 15,000 acres).

Current Rating: Very Good

Date of Current Rating: 11/5/2005

Desired Rating: Very Good

CONSERVATION TARGET: WETLANDS

Category: Landscape Context

Key Attribute: Hydrologic regime - (timing, duration, frequency, extent)

Indicator: Local hydrologic regime

Key attribute and indicator comment: Based on CNHP's Ecological Systems description for North American Arid West Emergent Marsh system, Sept 2005.

Indicator Ratings:

Poor: Restoration is not feasible within reason. System remains fundamentally compromised despite restoration of some processes.

Fair: Natural processes have been altered by local drainage, clearing or mining, excessive livestock grazing. Restoration is feasible over several decades.

Good: Some hydrological alteration may occur within watershed but has only minor influence on natural water levels. Alteration from local drainage, clearing or mining, livestock grazing is easily restorable by ceasing such activities.

Very Good: No hydrological alterations are in place that pump groundwater. Little or no evidence of alteration from increased or decreased drainage, excessive livestock grazing, anthropogenic nutrient input, mining, or other human impacts.

Current Indicator Status: There is some drawdown in the vicinity, especially to support cattle grazing. Livestock grazing is the only existing impact.

Current Rating: Good

Date of Current Rating: 11/5/2005

Desired Rating: Good

Category: Landscape Context

Key Attribute: Landscape pattern (mosaic) & structure

Indicator: Percent natural land cover

Key attribute and indicator comment: Based on CNHP's Ecological Systems description for North American Arid West Emergent Marsh system, Sept 2005.

Indicator Ratings:

Poor: Surrounding uplands are mostly converted to agricultural or urban uses.

Fair: Surrounding uplands are 20-60% natural vegetation. Uplands are fragmented by urban or agricultural alteration.

Good: Surrounding uplands are 60-90% natural vegetation. Uplands within 1/4 mile have moderate urban or agricultural alteration, but retain much connectivity, or uplands are heavily managed.

Very Good: Surrounding uplands have >90% natural vegetation. Uplands within 1 mile are largely unaltered by urban or agricultural uses, and include few to no cropped fields, roads, mines or quarries, developments, or excessively grazed pastures.

Current Indicator Status: Uplands within Lowry Range are variable, but generally good to very good.

Current Rating: Good

Date of Current Rating: 11/5/2005

Desired Rating: Good

Category: Condition

Key Attribute: Species composition / dominance

Indicator: Species composition

Key attribute and indicator comment: Based on CNHP's Ecological Systems description for North American Arid West Emergent Marsh system, Sept 2005.

Indicator Ratings:

Poor: Exotic species (such as Canada thistle, redtop, kochia) prominent to dominant.

Native species that increase with changes in hydrology or nutrients may be dominant.

Fair: Exotics may be widespread, but are potentially manageable with restoration of most natural processes. Native species that increase with changes in hydrology or nutrients may be very prominent.

Good: Few exotics, with little potential for expansion if restoration occurs. Native species that increase with changes in hydrology or nutrients absent, low in abundance, or restricted to high-nutrient microsites.

Very Good: None or very few exotic species present, with no potential for expansion.

Native species that increase with disturbance to changes in hydrology or nutrients are absent or low in abundance.

Current Indicator Status: Highly variable. Wettest areas are in best condition, with native species. Some areas severely impacted by smooth brome, Canada thistle, leafy spurge. Some have spadefoot toads and other unidentified tadpoles.

Current Rating: Fair

Date of Current Rating: 11/5/2005

Desired Rating: Good

Category: Condition

Key Attribute: Water quality

Indicator: Percent algae cover

Indicator Ratings:

Poor: Excessive nutrient loading from anthropogenic sources, such as septic systems, livestock, etc.

Fair:

Good:

Very Good: No or little evidence of anthropogenic nutrient input, mining, or other human impacts.

Current Indicator Status: Currently very little dissolved oxygen, as evidenced by high algae cover. Primary cause is nutrient loading from livestock waste.

Current Rating: Poor

Date of Current Rating: 11/15/2005

Desired Rating: Very Good

CONSERVATION TARGET: PRONGHORN

Category: Landscape Context

Key Attribute: Landscape pattern (mosaic) & structure

Indicator: Percent natural land cover

Key attribute and indicator comment: Based on CNHP's Ecological Systems description for Western Great Plains Shortgrass Prairie system, Sept 2005.

Indicator Ratings:

Poor: Surrounding landscape almost entirely dominated by lands converted to agriculture or urban uses. Ability of pronghorn to move through landscape is eliminated.

Fair: 20-50% natural vegetation. Surrounding landscape is mosaic of agricultural or semi-developed areas. Pronghorn movement is severely compromised.

Good: 50-80% natural vegetation. Surrounding landscape has had some land conversion, but in general is still ecologically connected with many of the adjacent natural communities. Pronghorn movement is predominantly unaffected.

Very Good: Surrounding vegetation is at least 80% natural, unaltered vegetation, and is generally surrounded by other high-quality natural communities.

Indicator ratings comment: Smaller reservoirs may not adversely impact pronghorn if they do not have associated recreational development and high levels of human activity.

Current Indicator Status: Currently good. However, continued development to south and potential for development to north will eliminate pronghorn from Lowry Range unless steps are taken to protect connectivity to open prairie to the east.

Current Rating: Good

Date of Current Rating: 11/5/2005

Desired Rating: Good

Category: Condition

Key Attribute: Community architecture

Indicator: Community structure

Key attribute and indicator comment: Based on CNHP's Ecological Systems description for Western Great Plains Shortgrass Prairie, Condition (community structure for pronghorn and endemic grassland birds), Sept 2005.

Indicator Ratings:

Poor: Habitat has been highly altered from natural conditions, and even with intense management, may never completely recover. Unlikely to ever support a diverse fauna of Great Plains species.

Fair: Natural vegetation conditions are still sufficient to support some Great Plains mammal species, but impacts from human activities are heavy, and intense management or long time periods maybe needed to restore the area to natural conditions.

Good: Natural vegetation is still sufficient to support Great Plains mammal species.

Very Good: Habitat includes patchiness on a variety of scales, from bare ground and very short grass to mixed and taller grass/shrub patches and ungrazed areas. Includes strong forb component (25-35%), high-quality winter browse, and mixture of native grasses.

Current Indicator Status: Current habitat is suitable for pronghorn, but viability of pronghorn on Lowry Range dependent on landscape context (see comment above).

Current Rating: Good

Date of Current Rating: 11/5/2005

Desired Rating: Very Good

Category: Size

Key Attribute: Population size & dynamics

Indicator: Number of individuals

Indicator Ratings:

Poor: <1,000 individuals

Fair: at least 1,000 individuals

Good:

Very Good: at least 2,000 individuals

Indicator ratings comment: Based on Pojar et al. 1995. This study looked at methods to estimate density of pronghorn in eastern Colorado. The study was done in habitat that is comparable to Lowry outside of Limon, CO. All three methods found existing densities of approx 0.004 pronghorn/ac (about 1 pronghorn per sq km). We assumed that this estimate is representative of average population size for the Lowry Range area.

Pojar, Thomas M., David C. Bowden, and R. Bruce Gill. 1995. Aerial counting experiments to estimate pronghorn density and herd structure. *Journal of Wildlife Management* 59(1): 117-128.

Current Indicator Status: Lowry Range alone is not large enough to support a population, but it contributes to the larger population inhabiting the area. Viability of that population is at least fair or good, but only because connectivity among habitat patches is in place.

Current rating comment: The Lowry Range is the wrong scale to discuss viability of pronghorn. This species functions at a landscape scale. Considering the surrounding landscape, viability is probably fair to good as long as connectivity with the open prairie

to the east is retained. Lowry's contribution to this population will diminish in proportion to loss of connectivity if severed.

Category: Size

Key Attribute: Size / extent of characteristic communities / ecosystems

Indicator: Acres of occupied habitat

Indicator Ratings:

Poor:

Fair: 125,000 acres (to support 1,000 animals)

Good:

Very Good: 465,000 acres to support 2,000 individuals

Indicator ratings comment: Calculations based on adult male territory size reported in Fitzgerald et al. 1994.

Fitzgerald, James P., Carron A. Meaney, and David M. Armstrong. 1994. Mammals of Colorado. Denver Museum of Natural History and University Press of Colorado. Niwot, Colorado. 467pp.

Current Indicator Status: Contribution to big picture is approx. 15-20% of habitat necessary for "very good." Greater landscape supporting pronghorn now. Connectivity to support unrestricted movement in landscape required to maintain pronghorn on Lowry Range.

Date of Current Rating: 11/5/2005

Current rating comment: The Lowry Range is the wrong scale to discuss viability of pronghorn. This species functions at a landscape scale. Considering the surrounding landscape, viability is probably fair to good as long as connectivity with the open prairie to the east is retained. Lowry's contribution to this population will diminish in proportion to loss of connectivity if severed.

CONSERVATION TARGET: GRASSLAND BIRDS

Category: Landscape Context

Key Attribute: Landscape pattern (mosaic) & structure

Indicator: Percent natural land cover

Key attribute and indicator comment: Based on CNHP's draft Element Occurrence rank specifications for Lark Bunting (in process, J. Sovell, CNHP), November 2005.

Indicator Ratings:

Poor: Surrounding landscape almost entirely dominated by lands converted to agriculture or urban uses.

Fair: 20-50% natural vegetation; surrounding landscape is mosaic of agricultural or semi-developed areas.

Good: 50-80% natural vegetation. Surrounding landscape has had some land conversion, but in general is still ecologically connected with many of the adjacent natural communities.

Very Good: Surrounding vegetation is at least 80% natural, unaltered vegetation, and is generally surrounded by other high-quality natural communities.

Current Indicator Status: Current status is fair. Surrounding area includes disturbance from agriculture and residential development. Need cooperation of surrounding landowners to maintain fair rating.

Current Rating: Fair

Date of Current Rating: 11/5/2005

Desired Rating: Fair

Category: Condition

Key Attribute: Community architecture

Indicator: Community structure

Key attribute and indicator comment: Sparks, R.A., D.J. Hanni, and M. McLachlan. 2005. Section-based monitoring of breeding birds within the Shortgrass Prairie Bird Conservation Region (BCR 18). Rocky Mountain Bird Observatory, Brighton, CO. From Vesper Sparrow data. Of the four species identified as nested targets, Vesper Sparrow has the most restrictive requirements, hence the criteria is based on Vesper Sparrow.

Indicator Ratings:

Poor: Shrub cover 10% or greater. Majority (more than 30%) of grasses are >15cm tall.

Fair: Predominantly native grassland with no shrub cover or shrub cover greater than 10%. Percent cover of grasses greater than 15cm is less than 20% or more than 30%.

Good: Native grassland with shrub cover 3% or less, less than 30% of grass cover is taller than 15 cm.

Very Good: Native grassland with shrub cover 3% or less, percent cover of grasses greater than 15 cm is between 20-30%.

Current Indicator Status: Existing shrub cover is fine, but majority of grasslands are <15cm due to past grazing pressure.

Current Rating: Poor

Date of Current Rating: 3/6/2006

Desired Rating: Good

Category: Size

Key Attribute: Population size & dynamics

Indicator: Density

Key attribute and indicator comment: Based on CNHP's draft Element Occurrence rank specifications for Lark Bunting (in process, J. Sovell, CNHP), November 2005.

Indicator Ratings:

Poor: Abundance less than 600 pairs over 3 consecutive years, or densities of <0.1 pairs/ha.

Fair: Abundance between approx 600 and 1,500 pairs over multiple years in appropriate midgrass vegetation, or densities between 0.5 pair/ha and 0.75 pair/ha on less than 2,500 ha in a single year.

Good: Abundance between approx 1,500 and 3,000 pairs in at least 2,500 ha over multiple years, or densities between 0.75/ha and 1 pair/ha on at least 2,500 ha in a single year.

Very Good: Abundance of 3,000 pairs for greater than/equal to 2 years, in at least 5,000 ha midgrass habitat that are maintained through native disturbance regimes, or densities >1pair/ha on at least 5,000 ha in a single year.

Indicator ratings comment: Existing populations of Horned Larks, Western Meadowlarks, Lark Buntings are numerous on Lowry Range.

Current Indicator Status: Data not sufficient to quantify, but observations from one field season (2005) suggest condition likely fair (based on numbers of Lark Buntings observed).

Current Rating: Fair

Date of Current Rating: 11/1/2005

Desired Rating: Good

APPENDIX B – STRESSES AND THREATS

Stresses and threats (i.e., sources of stress) were ranked on a scale of low to very high in order to help identify where management actions are most needed. Categories ranked in the following table are defined below. Unless cited otherwise, the source for these definitions is:

The Nature Conservancy. 2005. Conservation Action Planning Workbook User Manual, Version 4.b, August 2005, The Nature Conservancy, Arlington, VA.

STRESS – an altered key ecological attribute that impairs a conservation target’s viability.

Severity – the level of damage to the conservation target at the site than can reasonably be expected within 10 years under current circumstances.

Very High: The stress is likely to destroy or eliminate the target over some portion of the target’s occurrence at the site.

High: The stress is likely to seriously degrade the target over some portion of the target’s occurrence at the site.

Medium: The stress is likely to moderately degrade the target over some portion of the target’s occurrence at the site.

Low: The stress is likely to only slightly impair the target over some portion of the target’s occurrence at the site.

Scope – the geographic scope of impact on the conservation target at the site that can reasonably be expected within 10 years under current circumstances.

Very High: The stress is likely to be very widespread or pervasive in its scope, and affect the target throughout the target’s occurrence at the site.

High: The stress is likely to be widespread in its scope, and affect the target at many of its locations at the site.

Medium: The stress is likely to be localized in scope, and affect the target at some of the target’s locations at the site.

Low: The stress is likely to be very localized in its scope, and affect the target at a limited portion of the target’s location at the site.

THREAT (SOURCE OF STRESS) – the activity or condition that causes a stress.

Contribution – the expected contribution of the source, acting alone, to the full expression of a stress under current circumstances.

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.

Irreversibility – the reversibility of the stress caused by the source of stress.

Very High: The source produces a stress that is not reversible.

High: The source produces a stress that is reversible, but not practically affordable.

Medium: The source produces a stress that is reversible with a reasonable commitment of resources.

Low: The source produces a stress that is easily reversible at a relatively low cost.

Blue-shading in the following tables indicate that comments are associated with those cells.

1	Northern Pocket Gopher, <i>macrotis</i> subsp.
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Viability Summary	Landscape Context	Condition	Size	Viability Rank
	Good	-	Good	Good

Stresses - Altered Key Ecological Attributes	Severity	Scope	Stress Rank
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1	Landscape pattern (mosaic) & structure - reduced natural landcover	Low	Low	Low
2	Population structure & recruitment - reduced survival	Low	Medium	Low
3	Size / extent of characteristic communities / ecosystems - reduced occupied habitat	Low	Low	Low
4	Size / extent of characteristic communities / ecosystems - reduced suitable habitat	Low	Low	Low

1. Northern Pocket Gopher, *macrotis* subsp., continued

Threats – Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Population structure & recruitment - reduced survival	Size / extent of characteristic communities / ecosystems - reduced occupied habitat	Size / extent of characteristic communities / ecosystems - reduced suitable habitat
Stress Rank	Low	Low	Low	Low

1. Human-Powered Recreation - potential for future trail development and volume of use Threat to System Rank: Low

Contribution	High	High	Medium	Low
Irreversibility	Low	Low	Low	Low
Threat Rank (override)				
Threat Rank	Low	Low	-	-

2. Natural System Modifications - reservoirs

Threat to System Rank: Low

Contribution	Low	Low	Medium	Low
Irreversibility	High	High	High	High
Threat Rank (override)				
Threat Rank	Low	Low	Low	Low

3. Housing & Urban Development

Threat to System Rank: Low

Contribution	Medium	Medium	Low	Low
Irreversibility	Very High	Very High	Very High	Very High
Threat Rank (override)				
Threat Rank	Low	Low	Low	Low

1. Northern Pocket Gopher, *macrotis* subsp., continued

Threats - Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Population structure & recruitment - reduced survival	Size / extent of characteristic communities / ecosystems - reduced occupied habitat	Size / extent of characteristic communities / ecosystems - reduced suitable habitat
Stress Rank	Low	Low	Low	Low

4. Mining - oil and gas

Contribution	High	High	Very High	Medium
Irreversibility	Medium	Medium	Medium	Medium
Threat Rank (override)				
Threat Rank	Low	Low	Low	Low

Threat to System Rank: Low

5. Utility Infrastructure - water pipelines

Contribution	High	High	Very High	Medium
Irreversibility	Medium	Medium	Medium	Medium
Threat Rank (override)				
Threat Rank	Low	Low	Low	Low

Threat to System Rank: Low

6. Unexploded Ordnance Clearance

Contribution	Low	Low	Low	Low
Irreversibility	Low	Low	Low	Low
Threat Rank (override)				
Threat Rank	-	-	-	-

Threat to System Rank: -

2	Black-tailed Prairie Dog animal community
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Viability Summary	Landscape Context	Condition	Size	Viability Rank
	Fair	Good	Poor	Fair

Stresses - Altered Key Ecological Attributes	Severity	Scope	Stress Rank
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1	Landscape pattern (mosaic) & structure - reduced natural landcover	Medium	High	Medium
2	Species composition / dominance - weeds	Medium	High	Medium
3	Species composition / dominance - potential loss of associated spp.	Medium	High	Medium
4	Population size - size of colonies within Lowry are too small to constitute a complex.	Medium	Very High	Medium

Stresses - Altered Key Ecological Attributes comment: Current severity rank is medium for prairie dog stresses, but has real potential for moving to high as surrounding area develops. We predict that Burrowing Owl will do fine with some development in the surrounding area, but Ferruginous Hawk and swift fox may be more sensitive to development. Won't take much development to further reduce size of colonies, thus reducing ability to support associated species. Prairie dogs are already occupying much of the available habitat on The Range. As development proceeds around the boundary, the prairie dogs will lose their options for dispersal and colonization of new areas.

2. Black-tailed Prairie Dog animal community, continued

Threats - Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Species composition / dominance - weeds	Species composition / dominance - potential loss of associated spp.	Population size - size of colonies within Lowry are too small to constitute a complex.
Stress Rank	Medium	Medium	Medium	Medium

1. Housing & Urban Development

Contribution	Very High	Very High	Very High	Very High
Irreversibility	Very High	Medium	High	Very High
Threat Rank (override)				
Threat Rank	Medium	Medium	Medium	Medium

Threat to System Rank: Medium

2. Natural System Modifications - reservoirs

Contribution	Medium	-	Medium	Medium
Irreversibility	Very High	-	High	High
Threat Rank (override)				
Threat Rank	Medium	-	Low	Low

Threat to System Rank: Medium

3. Human-Powered Recreation - potential for future trail development and volume of use

Contribution	Medium	High	High	Medium
Irreversibility	Low	Medium	Low	Low
Threat Rank (override)				
Threat Rank	Low	Low	Low	Low

Threat to System Rank: Low

2. Black-tailed Prairie Dog animal community, continued

Threats - Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Species composition / dominance - weeds	Species composition / dominance - potential loss of associated spp.	Population size - size of colonies within Lowry are too small to constitute a complex.
Stress Rank	Medium	Medium	Medium	Medium

4. Unexploded Ordnance Clearance

Contribution	Low	Low	Low	-
Irreversibility	Low	High	Low	-
Threat Rank (override)				
Threat Rank	Low	Low	Low	-

Threat to System Rank: Low

3	Plains Riparian System - Coal Creek
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Viability Summary	Landscape Context	Condition	Size	Viability Rank
	Fair	Fair	Very Good	Fair

Stresses - Altered Key Ecological Attributes	Severity	Scope	Stress Rank
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1	Landscape pattern (mosaic) & structure - reduced natural landcover	High	Medium	Medium
2	Species composition / dominance - weeds	High	High	High
3	Disturbance - hydrologic regime	Very High	Very High	Very High
4	Disturbance - stream bank condition	Medium	Medium	Medium
5	Species composition / dominance - altered animal community	Medium	Medium	Medium

Stresses - Altered Key Ecological Attributes comment: Ranks for severity on hydrological condition assume future pumping of groundwater and containment of surface water to fill proposed reservoirs.

3. Plains Riparian System - Coal Creek, continued

Threats - Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Species composition / dominance - weeds	Disturbance - hydrologic regime	Disturbance - stream bank condition	Species composition / dominance - altered animal community
Stress Rank	Medium	High	Very High	Medium	Medium

1. Natural System Modifications - reservoirs

Threat to System Rank: Very High

Contribution	High	High	Very High	Medium	Medium
Irreversibility	Very High	High	Very High	Very High	Medium
Threat Rank (override)					
Threat Rank	Medium	High	Very High	Medium	Low

2. Mining - sand and gravel

Threat to System Rank: Very High

Contribution	High	High	High	Very High	Low
Irreversibility	High	High	High	High	Medium
Threat Rank (override)					
Threat Rank	Medium	High	Very High	Medium	Low

3. Housing & Urban Development

Threat to System Rank: Very High

Contribution	High	High	High	Medium	High
Irreversibility	High	High	High	Medium	High
Threat Rank (override)					
Threat Rank	Medium	High	Very High	Low	Medium

3. Plains Riparian System - Coal Creek, continued

Threats - Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Species composition / dominance - weeds	Disturbance - hydrologic regime	Disturbance - stream bank condition	Species composition / dominance - altered animal community
Stress Rank	Medium	High	Very High	Medium	Medium

4. Grazing & Ranching - incompatible grazing

Threat to System Rank: High

Contribution	High	High	Low	Medium	-
Irreversibility	Low	High	Low	High	-
Threat Rank (override)					
Threat Rank	Low	High	Medium	Low	-

5. Human-Powered Recreation - potential for future trail development and volume of use

Threat to System Rank: Medium

Contribution	Low	Medium	-	-	Low
Irreversibility	Low	High	-	-	Low
Threat Rank (override)					
Threat Rank	Low	Medium	-	-	Low

6. Groundwater Pumping and Surface Flow Diversions

Threat to System Rank: Very High

Contribution	High	Low	Very High	High	-
Irreversibility	Very High	High	Very High	High	-
Threat Rank (override)					
Threat Rank	Medium	Medium	Very High	Medium	-

3. Plains Riparian System - Coal Creek, continued

Threats - Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Species composition / dominance - weeds	Disturbance - hydrologic regime	Disturbance - stream bank condition	Species composition / dominance - altered animal community
Stress Rank	Medium	High	Very High	Medium	Medium

7. Utility Infrastructure - water pipelines

Threat to System Rank: Medium

Contribution	Low	Medium	Low	Low	-
Irreversibility	Low	High	Low	Low	-
Threat Rank (override)					
Threat Rank	Low	Medium	Medium	Low	-

4	Plains Riparian System - Box Elder Creek
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Viability Summary	Landscape Context	Condition	Size	Viability Rank
	Good	Fair	Very Good	Good

Stresses - Altered Key Ecological Attributes	Severity	Scope	Stress Rank
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1	Landscape pattern (mosaic) & structure - reduced natural landcover	Medium	Medium	Medium
2	Species composition / dominance - weeds	High	High	High
3	Disturbance - hydrologic regime	High	High	High
4	Disturbance - stream bank condition	Medium	Medium	Medium
5	Species composition / dominance - altered animal community	High	High	High

Stresses - Altered Key Ecological Attributes comment: Ranks for severity on hydrological condition assume future pumping of groundwater and containment of surface water to fill proposed reservoirs.

4. Plains Riparian System - Box Elder Creek, continued

Threats - Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Species composition / dominance - weeds	Disturbance - hydrologic regime	Disturbance - stream bank condition	Species composition / dominance - altered animal community
Stress Rank	Medium	High	High	Medium	High

1. Natural System Modifications - reservoirs

Threat to System Rank: High

Contribution	Medium	Low	High	-	-
Irreversibility	High	Low	High	-	-
Threat Rank (override)					
Threat Rank	Low	Low	High	-	-

2. Groundwater Pumping and Surface Flow Diversions

Threat to System Rank: High

Contribution	High	Low	Very High	High	-
Irreversibility	Very High	High	Very High	High	-
Threat Rank (override)					
Threat Rank	Medium	Medium	High	Medium	-

3. Housing & Urban Development

Threat to System Rank: Very High

Contribution	High	High	High	Medium	High
Irreversibility	High	High	High	Medium	High
Threat Rank (override)					
Threat Rank	Medium	High	High	Low	High

4. Plains Riparian System - Box Elder Creek, continued

Threats - Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Species composition / dominance - weeds	Disturbance - hydrologic regime	Disturbance - stream bank condition	Species composition / dominance - altered animal community
Stress Rank	Medium	High	High	Medium	High

4. Grazing & Ranching - incompatible grazing

Threat to System Rank: High

Contribution	High	High	Low	Medium	-
Irreversibility	Low	High	Low	High	-
Threat Rank (override)					
Threat Rank	Low	High	Low	Low	-

5. Human-Powered Recreation - potential for future trail development and volume of use

Threat to System Rank: Medium

Contribution	Low	Medium	-	-	High
Irreversibility	Low	High	-	-	Medium
Threat Rank (override)					
Threat Rank	Low	Medium	-	-	Medium

6. Unexploded Ordnance Clearance

Threat to System Rank: Medium

Contribution	Low	Low	-	-	-
Irreversibility	Low	High	-	-	-
Threat Rank (override)					
Threat Rank	Low	Medium	-	-	-

4. Plains Riparian System - Box Elder Creek, continued

Threats - Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Species composition / dominance - weeds	Disturbance - hydrologic regime	Disturbance - stream bank condition	Species composition / dominance - altered animal community
Stress Rank	Medium	High	High	Medium	High

7. Utility Infrastructure - water pipelines

Threat to System Rank: Medium

Contribution	Low	Medium	Low	Low	-
Irreversibility	Low	High	Low	Low	-
Threat Rank (override)					
Threat Rank	Low	Medium	Low	Low	-

Threats - Sources of Stress comment: Current plans do not call for an adjudicated reservoir site along Box Elder Creek. However, threat ranking could change if additional water storage facilities were developed. Current ratings based on assumption that proposed reservoirs would be filled by pumping groundwater.

5	Piedmont Grassland
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Viability Summary	Landscape Context	Condition	Size	Viability Rank
	Fair	Good	Very Good	Good

Stresses - Altered Key Ecological Attributes	Severity	Scope	Stress Rank
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1	Landscape pattern (mosaic) & structure - reduced natural landcover	High	High	High
2	Community architecture - increase in shrubs and trees	High	High	High
3	Species composition / dominance - altered animal community	Medium	High	Medium
4	Species composition / dominance - weeds	High	Medium	Medium

Stresses - Altered Key Ecological Attributes comment: Current severity rank is medium for prairie dog stresses, but has real potential for moving to high as surrounding area develops. We predict that Burrowing Owl will do fine with some development in the surrounding area, but Ferruginous Hawk and swift fox may be more sensitive to development. Won't take much development to further reduce size of colonies, thus reducing ability to support associated species. Prairie dogs are already occupying much of the available habitat on The Range. As development proceeds around the boundary, the prairie dogs will lose their options for dispersal and colonization of new areas.

5. Piedmont Grassland, continued

Threats - Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Community architecture - increase in shrubs and trees	Species composition / dominance - altered animal community	Species composition / dominance - weeds
Stress Rank	High	High	Medium	Medium

1. Housing & Urban Development

Contribution	Very High	Very High	Very High	Medium
Irreversibility	Very High	High	High	High
Threat Rank (override)				
Threat Rank	High	High	Medium	Low

Threat to System Rank: High

2. Natural System Modifications - reservoirs

Contribution	Medium	High	Medium	Medium
Irreversibility	Very High	High	High	High
Threat Rank (override)				
Threat Rank	High	High	Low	Low

Threat to System Rank: High

3. Human-Powered Recreation - potential for future trail development and volume of use

Contribution	Low	Low	High	Medium
Irreversibility	Low	Low	Low	High
Threat Rank (override)				
Threat Rank	Low	Low	Low	Low

Threat to System Rank: Low

5. Piedmont Grassland, continued

Threats - Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Community architecture - increase in shrubs and trees	Species composition / dominance - altered animal community	Species composition / dominance - weeds
Stress Rank	High	High	Medium	Medium

4. Grazing & Ranching - incompatible grazing

Contribution	High	Low	Medium	Medium
Irreversibility	Low	Low	Low	High
Threat Rank (override)				
Threat Rank	Medium	Low	Low	Low

Threat to System Rank: Medium

5. Unexploded Ordnance Clearance

Contribution	Low	-	-	Low
Irreversibility	Low	-	-	High
Threat Rank (override)				
Threat Rank	Low	-	-	Low

Threat to System Rank: Low

6	Wetlands
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Viability Summary	Landscape Context	Condition	Size	Viability Rank
	Good	Poor	-	Fair

Stresses - Altered Key Ecological Attributes	Severity	Scope	Stress Rank
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1	Hydrologic regime - (timing, duration, frequency, extent) - altered local hydrologic regime	High	High	High
2	Landscape pattern (mosaic) & structure - reduced natural landcover	Low	Low	Low
3	Water quality	High	Medium	Medium
4	Species composition / dominance - weeds	High	Medium	Medium

Stresses - Altered Key Ecological Attributes comment: Rank based on assumption that proposed reservoirs are built.

6. Wetlands, continued

Threats - Sources of Stress	Hydrologic regime - (timing, duration, frequency, extent) - altered local hydrologic regime	Landscape pattern (mosaic) & structure - reduced natural landcover	Water quality	Species composition / dominance - weeds
Stress Rank	High	Low	Medium	Medium

1. Grazing & Ranching - incompatible grazing

Contribution	Low	Low	Very High	High
Irreversibility	Low	Low	Low	High
Threat Rank (override)				
Threat Rank	Low	-	Medium	Medium

Threat to System Rank: Medium

2. Natural System Modifications - reservoirs

Contribution	High	High	Low	Medium
Irreversibility	High	High	High	High
Threat Rank (override)				
Threat Rank	High	Low	Low	Low

Threat to System Rank: High

3. Groundwater Pumping and Surface Flow Diversions

Contribution	High	-	-	-
Irreversibility	High	-	-	-
Threat Rank (override)				
Threat Rank	High	-	-	-

Threat to System Rank: High

6. Wetlands, continued

Threats - Sources of Stress	Hydrologic regime - (timing, duration, frequency, extent) - altered local hydrologic regime	Landscape pattern (mosaic) & structure - reduced natural landcover	Water quality	Species composition / dominance - weeds
Stress Rank	<i>High</i>	<i>Low</i>	<i>Medium</i>	<i>Medium</i>

4. Housing & Urban Development

Contribution	-	-	Very High	High
Irreversibility	-	-	Medium	High
Threat Rank (override)				
Threat Rank	-	-	Medium	Medium

Threat to System Rank: Medium

7	Pronghorn
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Viability Summary	Landscape Context	Condition	Size	Viability Rank
	Good	Good	-	Good

Stresses - Altered Key Ecological Attributes	Severity	Scope	Stress Rank
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1	Landscape pattern (mosaic) & structure - reduced natural landcover	Very High	High	High
2	Fragmentation and patch size	Very High	Very High	Very High

7. Pronghorn, continued

Threats - Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Fragmentation and patch size
Stress Rank	<i>High</i>	<i>Very High</i>

1. Housing & Urban Development

Contribution	Very High	Very High
Irreversibility	Very High	Very High
Threat Rank (override)		
Threat Rank	High	Very High

Threat to System Rank: Very High

2. Natural System Modifications - reservoirs

Contribution	High	-
Irreversibility	Very High	-
Threat Rank (override)		
Threat Rank	High	-

Threat to System Rank: High

3. Human-Powered Recreation - potential for future trail development and volume of use

Contribution	Low	Low
Irreversibility	Low	Medium
Threat Rank (override)		
Threat Rank	Low	Medium

Threat to System Rank: Medium

7. Pronghorn, continued

Threats - Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Fragmentation and patch size
Stress Rank	<i>High</i>	<i>Very High</i>

4. Unexploded Ordnance Clearance

Contribution	Low	-
Irreversibility	Low	-
Threat Rank (override)		
Threat Rank	Low	-

Threat to System Rank: Low

8	Grassland Birds
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Viability Summary	Landscape Context	Condition	Size	Viability Rank
	Fair	Poor	Fair	Fair

Stresses - Altered Key Ecological Attributes	Severity	Scope	Stress Rank
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1	Landscape pattern (mosaic) & structure - reduced natural landcover	Medium	High	Medium
2	Community architecture - increase in shrubs and trees	Medium	High	Medium
3	Population size & dynamics - reduced density	Medium	High	Medium
4	Species composition / dominance - weeds	High	Medium	Medium

8. Grassland Birds, continued

Threats - Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Community architecture - increase in shrubs and trees	Population size & dynamics - reduced density	Species composition / dominance - weeds
Stress Rank	Medium	Medium	Medium	Medium

1. Housing & Urban Development

Contribution	Very High	Very High	Very High	High
Irreversibility	Very High	High	High	High
Threat Rank (override)				
Threat Rank	Medium	Medium	Medium	Medium

Threat to System Rank: Medium

2. Natural System Modifications - reservoirs

Contribution	Medium	High	Medium	Low
Irreversibility	Very High	High	High	High
Threat Rank (override)				
Threat Rank	Medium	Medium	Low	Low

Threat to System Rank: Medium

3. Human-Powered Recreation - potential for future trail development and volume of use

Contribution	Low	Low	High	High
Irreversibility	Low	Low	Low	High
Threat Rank (override)				
Threat Rank	Low	Low	Low	Medium

Threat to System Rank: Medium

8. Grassland Birds, continued

Threats - Sources of Stress	Landscape pattern (mosaic) & structure - reduced natural landcover	Community architecture - increase in shrubs and trees	Population size & dynamics - reduced density	Species composition / dominance - weeds
Stress Rank	<i>Medium</i>	<i>Medium</i>	<i>Medium</i>	<i>Medium</i>

4. Grazing & Ranching - incompatible grazing

Contribution	High	Low	High	High
Irreversibility	Low	Low	Low	High
Threat Rank (override)				
Threat Rank	Low	Low	Low	Medium

Threat to System Rank: Medium