CITY OF FORT COLLINS
NATURAL AREAS DEPARTMENT

RESTORATION PLAN

2016-2025

City of Fort Collins Natural Areas

naturally yours

Contents

Chapter 1: Introduction 1

A. A Case for Ecological Restoration 1

B. Purpose and Scope of this Plan 1

C. Supporting Plans and Policies 2

Chapter 2: Review of the 2004 Comprehensive Restoration Plan and Progress toward Native Plant Communities and Habitats 5

A. Review of the 2004 Comprehensive Restoration Plan 5

B. Restoration Progress 2005 – 2014 6

C. Progress and Current Conditions Based on Vegetation Monitoring 6

D. Current Conditions Based on Avian Indicator Species 13

Chapter 3: Overarching Restoration Goals for Natural Areas 2016 - 2025 17

A. Restoration Vision for the 10-year period 2016 – 2025 17

Chapter 4: Restoration Needs for Rare Plants, Rare Plant Communities, and Wildlife Habitat 21

A. Conservation of Rare Plants and Rare Communities 21

B. Restoration Considerations for Wildlife 23

Chapter 5: Managing Local Ecosystems in the Face of Climate Change 27

A. Expected Future Conditions 27

B. The City of Fort Collins Climate Action Plan and Vulnerability Assessment 27

C. Effects on Specific Habitat Types as Assessed by Colorado Natural Heritage Program 28

D. Management Implications for Anticipated Changes 29

Chapter 6: Ecosystem Specific Restoration Actions 2016-2025 33

A. Introduction to Geographic Zones and Ecosystems 33

B. Zone 1: Lower Poudre River (Taft Hill Road to Interstate 25) 36

C. Zone 2: Southwest and Fossil Creek Grasslands 42

D. Zone 3: Foothills 48

E. Zone 4: Poudre River Canyon 53

F. Zone 5: Soapstone Prairie 57

Chapter 7: Measurable Outcomes for Restoration Projects 63

A. Current Management and Restoration Measures 63

B. Improvements and New Measures Going Forward 63

C. The Monitoring Matrix 66

D. Synchronizing with the River Health Assessment Framework 66

Chapter 8: Priorities and 10-Year Budget Estimate 69
A. Budget Review 2005 – 2014 (Actuals) 69
B. Prioritization of Restoration Activities 2016 - 2025 69
C. Summary by Restoration Zone 70
Chapter 9: Collaborations and Partnerships 75

Appendices

A. City of Fort Collins Natural Areas Plant Species and Plant Communities of Interest
B. City of Fort Collins Natural Areas Wildlife Species of Interest
C. River and Floodplain Restoration Monitoring Framework and Metrics

Photographic Note: All images were supplied by City of Fort Collins Natural Areas Department staff unless otherwise noted. Additional images were supplied by individual photographers, whom we thank for their generosity and support of the Natural Areas Department

Chapter 1: Introduction

A. A Case for Ecological Restoration
B. Purpose and Scope of this Plan
C. Supporting Plans and Policies

A. A Case for Ecological Restoration

Ecological restoration is an essential part of the Natural Areas Department's long-term commitment toward rehabilitating sites to a natural condition and maintaining the ecological value of the City's regional habitat as part of a network of conserved lands. In 2002, Fort Collins voters extended funding for the Natural Areas Department by passing the "Open Space Yes!" ballot measure. The ballot language specifically defined "*Land Conservation Activities*" to include "*improving acquired lands by restoring and enhancing native plant and animal communities*." Ecological restoration also fits squarely within the Natural Areas mission statement to, *"conserve and enhance lands with natural resource, agricultural and scenic values, while providing meaningful education and appropriate recreation opportunities."*

The Society of Ecological Restoration defines ecological restoration as "*the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed."* Properties acquired by the Natural Areas Department vary in ecological condition ranging from relatively natural foothill sites with few weed problems, to highly degraded lands adjacent to the Poudre River that historically were used for gravel mining. Restoration of degraded ecosystems can create important refuge for wildlife, plants, and people in a landscape otherwise highly altered by agricultural and urban development. Fort Collins natural areas provide this important refuge.

The Natural Areas Department (NAD or the Department) has made much restoration progress since the first Natural Areas Restoration Plan was written in 2004. There has been a marked increase in acres dominated by native plant cover in urban natural areas, from 19% to 26%. Correspondingly, areas dominated by non-native plant cover declined from 44% to 29%. One of the Department's long term goals is to graduate 50% of urban natural area acres into a fully restored condition by 2030 (a 2% annual movement in total acreage per year). In addition to grassland restoration there were 4 major Poudre River and wetland restorations that were initiated in 2011 and completed by 2015. The Natural Areas Department plans to continue to restore valuable natural resources and increase the pace of restorations initiated over the next 10 years.

B. Purpose and Scope of this Plan

The purpose of the Comprehensive Restoration Plan Update is to:

1. Describe the current conditions of natural areas and review progress over the last 10 years;
2. Consolidate team knowledge to target priority native* species and habitats – and create a Species of Interest list specific to the City of Fort Collins Natural Areas Department;
3. Prioritize restoration needs relative to targeted native species and habitats;
4. Outline the scope, scale, and magnitude of costs associated with restoration efforts over the next 10-year period (2016 – 2025);
5. Consider the influence of climate changes for future restoration and native habitat conservation; and
6. Identify relevant performance metrics for restoration projects.

*For the purposes of this plan, native species and native plant and animal communities are those that occurred in the Fort Collins area before European settlement.

The scope of this Comprehensive Restoration Update includes all natural areas. However, the Department determined that natural areas in the Upper Poudre River Canyon as well as Soapstone Prairie are not in need of restoration but rather a focus on monitoring and vegetation management, respectively. As part of this restoration planning effort, all existing site management plans were reviewed by the Department to incorporate specific management and restoration goals for each site.

C. Supporting Plans and Policies

Open Space Yes! Ballot measure Guidance (2002)

Interpretation of the 2002 Open Space Yes! Ballot measure allows "resource management activities" (land restoration) to fall under the auspices of "land conservation activities" which is allotted 80% of the revenues collected. This ballot language required that no less than 80% of the tax revenue generated by the ballot measure be dedicated to land conservation activities. Land conservation activities are defined, in part, as the act of restoring and enhancing native plant and animal communities, including all aspects of restoration planning, permitting, monitoring, and implementation activities not limited to site cleanup, demolition, soil amending, soil preparation, seeding, planting, weed control, and prescribed burning . Basic noxious weed control and ongoing native plant maintenance are classified as operations and maintenance activities. For more information: http://www.fcgov.com/naturalareas/pdf/definition-rm.pdf

Natural Areas Master Plan (2014)

The Natural Areas Master Plan, rooted in the 2011 community planning effort known as City Plan Fort Collins, establishes priorities for conservation and stewardship for the years 2014-2024. The plan identifies how the Department will continue to fulfill the desires of the community as established in the 2002 Open Space Yes! Ballot language. This plan lists broad initiatives through a 10-year period, including a commitment to high quality ecological restoration.

Natural Areas Department Strategic Plan (2015)

The Natural Areas Department's 2015 Strategic Plan sets forth a series of objectives toward achieving the goal *of supporting and enhancing ecological function and diversity on natural area properties*. The plan establishes objectives that:

1. *Protect, develop, and maintain aquatic and riparian connectivity within the Poudre River and its tributaries.*
2. *Implements a robust ecological stewardship program that restores native plant communities, wildlife, and ecological processes.*
3. *Implements habitat enhancements that promote the recovery of native rare, endangered, or extirpated species.*
4. *Protects natural resources via responsible public access planning and management.*

Within the context of the 10-year Natural Areas Master Plan and 2015 Natural Areas Strategic Plan, it is imperative to measure progress of restoration efforts toward achieving the outcomes outlined for all restoration activities, especially the four objectives listed above.

Vegetation Management Guidelines (2015)

The Natural Areas Department established Vegetation Management Guidelines in 2004 that were updated in 2015. These guidelines outline restoration techniques that include prescribed burning, mowing, prescribed grazing, forest and shrubland thinning, and weed control including chemical, cultural, and biological means. The 2015 update included information on the Department's increased use of prescribed fire as a management tool for the purposes of controlling weeds, initiating grassland restoration, or providing a natural disturbance regime. Additionally, prescriptive grazing on natural areas for the purposes of promoting ecological and agricultural objectives will continue to provide managers another tool for vegetation management.

Wildlife Management Guidelines (2007)

The Wildlife Management Guidelines establish a framework to inform wildlife management decisions made by the Natural Areas Department. The guidelines outline how the Department approaches the management of prairie dog colonies in the urban setting, conflicts with wildlife, non-native species management, habitat protection, and inventory and monitoring efforts through which the quality and diversity of wildlife habitat may be assessed.

This document supplanted a 1998 City Council adopted policy that solely focused on black-tailed prairie dog management. The 2007 Guidelines provide a broader, holistic ecological direction by taking a multi-species approach to ecosystem health. Additionally, these guidelines considered the possibility of long-term species recovery efforts for black-footed ferret (*Mustela nigripes*), plains sharp-tailed grouse (*Tympanuchus phasianellus jamesii*), and American bison (*Bison bison*). The Natural Areas Department, in cooperation with the United States Fish and Wildlife Service and Colorado Parks and Wildlife, reintroduced black-footed ferrets in 2014 and genetically native bison in 2015, to Soapstone Prairie.

Fire Management Plan (2012)

The Natural Areas Fire Management Plan provides contextual information on how the Department uses prescribed fire as a vegetation and wildlife habitat management tool. The Fire Management Plan identifies and prioritizes specific areas where prescribed fire is an integral step in the revegetation process. Since 2004, the Department has conducted a combination of 53 agricultural and prescribed burns totaling 986 acres.

Natural Areas Agricultural Position Statement (2011)

The 2002 Open Space Yes! ballot initiative included new direction for the Natural Areas Department to acquire, operate, and maintain important agricultural lands. The Agricultural Position Statement, administratively adopted, by the Department in 2011, clarifies the role the Department will fill in the acquisition and management of agricultural lands. The Natural Areas Department will work with willing landowners to protect agricultural lands through fee simple and conservation easement purchases. Although the Department will not be the primary operators of agricultural lands, the Department will manage farming and grazing leases and utilize cattle grazing when demonstrated to benefit habitat improvement projects.

For access to plans and policies, go to: http://www.fcgov.com/naturalareas/plans-policies.php (unless listed otherwise).

Chapter 2: Review of the 2004 Comprehensive Restoration Plan and Progress toward Native Plant Communities and Habitats

A. Review of the 2004 Comprehensive Restoration Plan
B. Restoration Progress 2005 – 2014
C. Progress and Current Conditions Based on Vegetation Monitoring
D. Current Conditions Based on Avian Indicator Species

A. Review of the 2004 Comprehensive Restoration Plan

In 2004 the Natural Areas Department embarked on its first systemic effort to develop plans and priorities for ecological restoration. The 2004 Comprehensive Restoration Plan was an effort to look forward from stewardship efforts that were primarily focused on weed control and maintaining the status quo to taking a more proactive role in restoring degraded lands.

The purpose of the 2004 Comprehensive Restoration Plan was threefold:

1. Identify restoration priorities for the 2005 – 2014 time period;
2. Develop projected costs based on generic restoration prescriptions; and
3. Develop a database for tracking restoration efforts and costs.

While the prioritization effort considered a variety of factors, those areas with existing native vegetation, undisturbed soils, and functioning wildlife habitat ranked high for management actions to improve, maintain, or expand these higher quality habitats. Another factor included the size of the natural area (larger, contiguous sites were given more priority than smaller, isolated sites). Sites along the Poudre River (a major corridor) and along the foothills (the City's visual backdrop and its adjacency to other open and protected areas) also ranked high. In 2004, regional sites such as Bobcat Ridge Natural Area and Soapstone Prairie Natural Area were considered "moderate" restoration priorities as Bobcat Ridge was a newly acquired site, comparatively large, and warranted in-depth planning. Soapstone Prairie's almost 23,000 acres comprises the best example of native grassland and functional grassland habitat. This area does not require restoration rather only on-going weed treatment, grazing, and/or fire to maintain the site in its high quality condition. Most natural areas that were considered low priority in 2004 were smaller or located in isolated urban areas.

The restoration priorities identified by the plan were the following:

1. Large, contiguous prairies in the Fort Collins/Loveland community separator
2. Riparian woodlands, shrublands, and grasslands along the Poudre River
3. Large, contiguous foothills grassland and woodlands
4. Regional natural areas (Bobcat Ridge and Soapstone Prairie)
5. Natural areas along the Poudre River on the southeast side of Fort Collins
6. Natural areas in the vicinity of Fossil Creek
7. Small or isolated urban sites with limited ecological potential

Once restoration priorities were identified, restoration costs were projected (for the years 2005 – 2014) using generic prescriptions per habitat type. Although generic prescriptions allowed for a reasonable means of comparison, experience demonstrated that most sites were unique and costs varied greatly depending on services contracted compared to projects completed by Natural Areas staff. The 2004 plan helped establish a base budget for restoration at $250,000 annually and provided solid footing

through the 10-year period. A review of actual expenditures through the last 10 years is provided in Chapter 8.

Finally, as part of the 2004 comprehensive restoration plan, natural areas staff used Geographic Information Systems (GIS) to create a map of planning-based restoration units. Units were delineated using natural area boundaries, aerial imagery, and vegetation delineations of cover types. A restoration unit was defined as an area of contiguous land with similar substrate and vegetative conditions that would warrant a similar management treatment. Each polygon unit was assigned a unique identifier so that all management actions and associated costs could be tracked. Ultimately, the "Resource Management Information System" (RMIS) was developed to provide the desired long-term tracking of management actions. A field visit to all urban RMIS units is conducted at least once every three years to characterize the quality of the natural vegetation and monitor the progress of restoration action on the units. At this time only urban RMIS units are monitored as they require the most intensive management. Results of the on-going monitoring are summarized below in Section C.

B. Restoration Progress 2005 – 2014

The decade from 2005 through 2014 is aptly characterized as a decade of knowledge growth, experimentation, and evolution of restoration methods. The earlier part of the decade was devoted to the "triage" of existing and newly acquired properties that required immediate weed treatments, soil erosion control, demolition of buildings, and general cleanup. Examples of these efforts included significant noxious weed outbreaks, hyper-overgrazing on prairie dog colonies, removal of remnant infrastructure, and two-track road obliteration.

The decade's significant accomplishments and growth in restoration of resource management include:

2003 - First Prescribed Burn and grassland restoration begins at Kingfisher Point Natural Area.
2004 - Comprehensive Restoration Plan written.
2005 - All actions and data recorded in a GIS database.
2006 - Utilization of livestock to improve grassland habitat.
2007 – New wildlife management guidelines and grassland health approach to prairie dog management. Floodplain improvements were completed at Riverbend Ponds Natural Area.
2008 - GIS models are used for rare plant surveys.
2009 - Breeding bird surveys for the Poudre River corridor and foothills properties begin.
2010 - River and floodplain restoration begins. Grassland restoration at Coyote Ridge Natural Area was initiated.
2011 - Targeted assessment and reduction of herbicides. McMurry gravel pond restoration.
2012 - Poudre River Ecological Response Model used to guide river restoration actions.
2013 - Floristic Quality Assessments utilized to assess status of native plant communities.
2014 - Three major river and floodplain restorations are initiated including McMurry, North Shields Ponds, and Homestead natural areas.

C. Progress and Current Conditions Based on Vegetation Monitoring

The Natural Areas Department tracks progress and effort toward restoring land to native-plant dominated communities. Restoration progress and current conditions are tracked using vegetation monitoring methods and include restoration status categories, existing conditions within active restoration sites, vegetation cover monitoring, floristic quality data, and photo point monitoring. All of

these methods of tracking progress will continue in the future which is discussed in further details in Chapter 7.

Two measures are used to report on current status of urban natural areas for City-wide performance measures. The first measure is a categorization of restoration units into one of three restoration effort categories: Pre-Restoration, Active Restoration, and Post-Restoration. This is termed "Restoration Status." The next measure takes the "active restoration" category and describes it in terms of percentages of native plant cover. That measure is termed "Existing Condition within Active Restoration Sites." The two measures are described below.

Restoration Status - (Figure 1)

All natural areas are broken into restoration units and each unit is categorized by a Restoration Status to indicate the level of management or restoration activity. The three categories are: *Pre-Restoration, Active Restoration, and Post-Restoration*. *Pre-Restoration* areas typically lack native plant composition and diversity, and are managed only for invasive weeds. The acres in this category are maintained until they are moved into the active restoration category. *Active Restoration* status indicates that the Natural Areas Department has been actively working on restoring the area with a recent planting of native seeds or plants. This category generally encompasses 1,000 -2,000 acres annually and is monitored on an annual basis. *Post-Restoration* areas are places where the vegetation is greater than 75% native, with a diversity of grasses, forbs and structure, and are functionally stable (also considered great condition). This category includes areas that are naturally in great condition as well as areas converted to great condition through restoration efforts.

The Department's long range goal is to graduate 50% of urban natural area acres into a fully restored condition by 2030 (a 2% annual movement into *Post-Restoration* per year). This is represented on the graph as *Post-Restoration* acres increasing and *Pre-Restoration* acres decreasing. As new lands are acquired the exact acreage changes; hence acres are represented as percentages for tracking over time. Between 2010 and 2013, 9% of urban acres moved to *Post-Restoration* status with a corresponding decrease in the number of *Active* and/or *Pre-Restoration* acres (Figure 1). For the purposes of this metric and plan, urban natural areas are all areas within the urban envelope of Fort Collins and exclude regional natural areas (i.e., Bobcat Ridge, Soapstone Prairie, and Gateway natural areas).

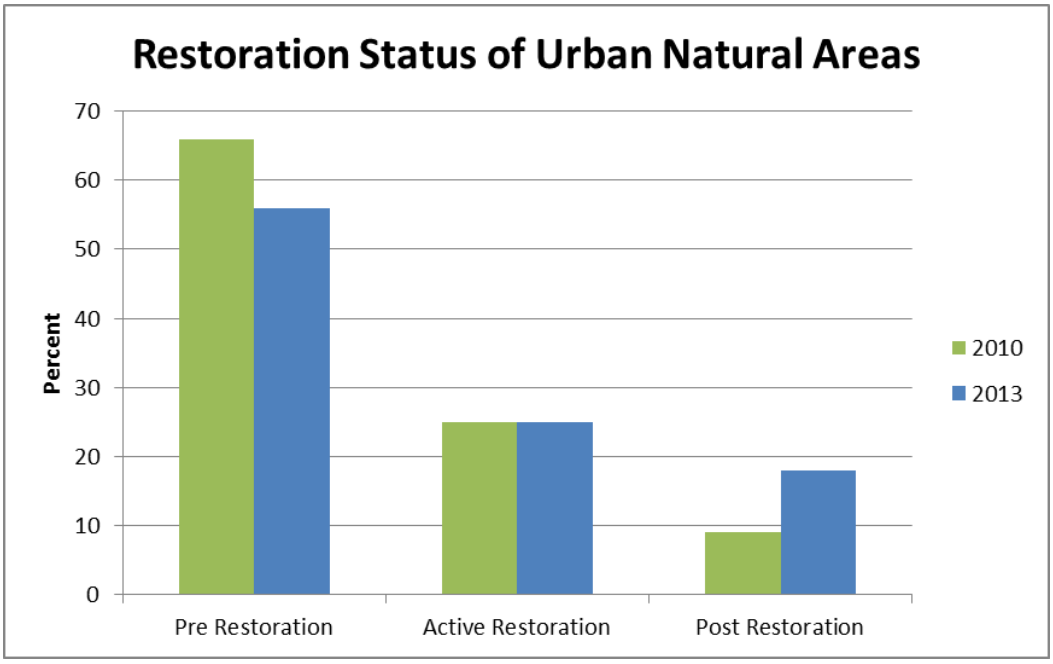


Figure 1. Restoration Status of Urban Natural Areas

Existing Condition within Active Restoration Sites – (Figure 2)

Each year between 1,000 and 2,000 acres of natural areas within the urban setting are managed intensely as *Active* Restoration areas. These areas are monitored annually to determine adaptive management actions based on changes to the condition of the vegetation. Once the vegetation in the restoration unit is documented as greater than 75% native, diverse, and stable, the area is graduated to *Post-Restoration.* This ecological process can take many years given past land uses and ever changing environmental conditions. Hence while several *Active Restoration* units are in >75% native vegetation condition, they remain on the annual monitoring list for several years. The general description of poor to great condition is based off of the percent native vegetation cover, which is broken down into these three categories: <25% native (poor), 25-75% native (okay/good), and >75% native (great)(also see diagram below). This measure merely presents a snapshot of the year-end condition of *Active Restoration* units and fluctuates each year as new sites move in or out of the category. In conjunction with the above measure, this shows the work in progress on an annual basis to convert natural areas to native, diverse and stable vegetation conditions that then functions as quality habitat for wildlife (Figure 2).

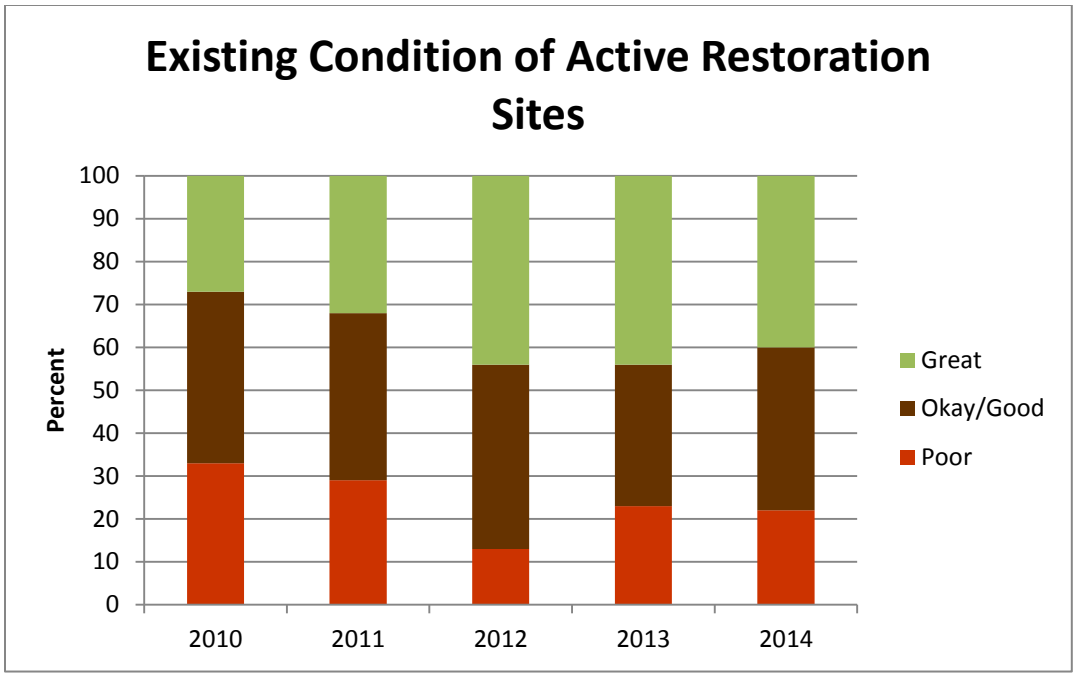
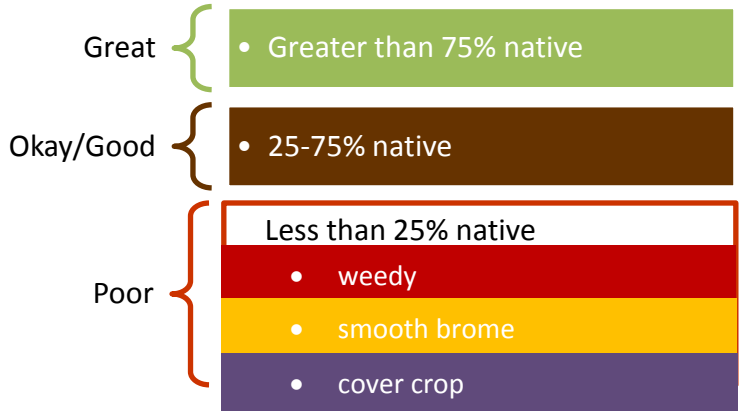


Figure 2. Existing Condition of Sites in Active Restoration 2010 – 2014.

Vegetation Cover – (Figure 3)

Every three years a quantitative assessment is conducted at all urban natural areas to document changes in the existing condition of vegetation communities within each restoration unit (currently over 400 units). Along with other information, existing condition for the entire unit (ranging in size from 0.5 – 300 acres) is estimated based on percent native cover. The categories include:



These broad existing condition categories help determine what types of management effort or restoration actions are needed. Conditions can change due to natural variations in year to year weather, natural progression through seral stages of vegetation, or management and restoration activities implemented by staff.

Units that are in the poor category are all less than 25% native cover and then are further categorized as weedy, cover crop, or smooth brome (*Bromus inermis*). Each of these conditions requires a different strategy to convert to good or great vegetation cover as well as varying degrees of urgency. Smooth

brome fields are considered stable, which lowers the urgency for restoration. Areas with cover crop are likely already in the beginning stages of restoration, or being leased for agricultural uses until restoration takes place. This leaves weedy areas as a higher priority to restore. Natural areas in 25-75% native vegetation are generally considered in okay/good condition for the urban setting. The effort to convert a unit to this category can be the initial restoration phase and may be adequate to support moderate quality or early seral stage habitat. However, it can take a greater effort and significantly more time to convert a unit from good to great. Additionally, units categorized as greater than 75% native vegetation either may have already been in great condition or management actions helped restore them to great condition. These areas will likely still need some management to maintain the diversity of native vegetation, and habitat quality.

The following map and pie-chart (Figure 3) are based on 2013 field data and demonstrate that 26% of the urban natural areas acreage is in greater than 75% native vegetation. Some of these areas are still considered *Active Restoration* as they are determined to be insufficiently diverse or lack stability to graduate into the *Post-Restoration* category. Finally, 38% of the urban natural areas acreage was categorized as 25-75% native vegetation cover, which is positive considering the high levels of disturbance and past land uses.

Vegetation cover data shows that much progress has made between 2004 and 2013. In that decade, there has been a marked increase in acres dominated by native plant cover in urban natural areas from 19% to 26% (in the greater than 75% native cover). Correspondingly, areas dominated by non-native plant cover declined from 44% to 29% during that same time period. Vegetation cover data for urban natural areas is updated every three years and the next update will be in 2016.

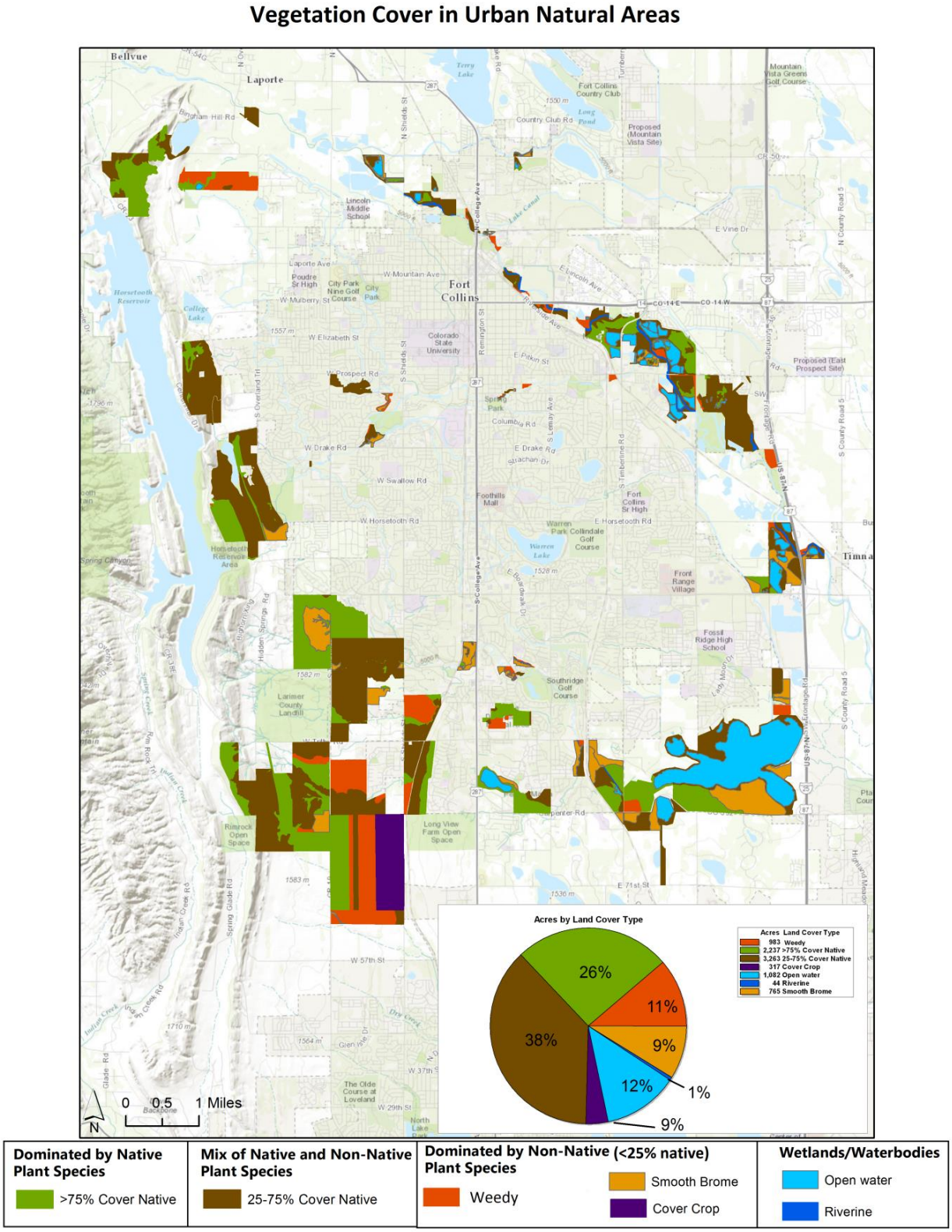


Figure 3. Vegetation Cover (2013) in Urban Natural Areas with pie chart showing percentages of acres by land cover type.

Floristic Quality of Fort Collins Natural Areas

The Natural Areas Department has also begun tracking floristic condition across the majority of the urban Natural Areas using the Floristic Quality Assessment (FQA) method. A Floristic Quality Indices (FQI) is a measure of vegetation quality based on plant cover and composition. The sum of these two factors produces a score to reflect the vegetation quality of a site. Adjusted FQI scores are often used in urban areas where introduced species are more prevalent, and scores under 30 are generally indicative of low quality sites with high disturbance (Miller and Wardrop 2006). Most relatively intact uplands and wetlands in Colorado with limited anthropogenic stressors and fragmentation FQI receive scores ranging from 40-60 (Lemly and Gilligan, CNHP pers. comm. 2015).

Adjusted FQI scores calculated for natural areas within the urban core of Fort Collins range from 23 to 44 and with an average of 34. While these scores reflect the pressures from the urban setting (relative to Soapstone Prairie condition), these scores are higher than those found in a wetland study along Colorado's northern Front Range, where scores were 17 to 30, with an average score of 29 (Lemly et al. 2013). Adjusted FQI scores from a study of urban wetlands in Denver County ranged from 16 to 30, with an average score of 25 (Smith and Kuhn 2015). While the Front Range and Denver studies examined only wetland sites, and varied in study area size, they offer a relative comparison for scores for Fort Collins urban natural areas. Natural Areas' FQI scores are considerably higher on average than those found along the Front Range and urban Denver, suggesting that plant communities within natural areas are in good condition and have the capacity to support the wildlife occupying the areas.

Repeat Photo Point Monitoring

An additional measure of restoration progress is made through employing the method of repeat photography. Repeat photography utilizes a system of "photo points" that are geographically distributed throughout areas undergoing vegetation management related to restoration. Photo points allow managers to create a visual record of changes in plant communities and create an on-going baseline of directional change.

Current efforts consist of 171 geo-located points that have been photographed every other year since 2005. Photographs are visually evaluated and scored into three categories: improvement, degradation, or no change. This qualitative analysis informs the effect of management treatments through several years. If points demonstrate a lack of vegetative improvement for two consecutive monitoring periods then management treatments are reevaluated, determinations are made relative to causal factors, and future treatments are modified.

Results of this effort indicate clear evidence that current efforts are successful at controlling noxious weed populations and increasing native plant cover. As management efforts continue the evaluation of the photographs become increasingly difficult to determine direction of change as changes become increasingly subtle. For example, it may be easy to detect the removal of Canada thistle (*Cirsium arvense*) in a photograph, but it becomes more difficult to detect a subtle conversion from non-native grasses to native grasses at the same site. As a ratio of photographs showing improvement to photographs showing degradation, values have moved from 7:1 in 2007, to 1:1 in 2013. Early analysis indicates that 2015 values should improve to 2:1. These measurements will continue to assist the Department in monitoring management and restoration success.

Photo Point CFP03, located at Cathy Fromme Prairie Natural Area

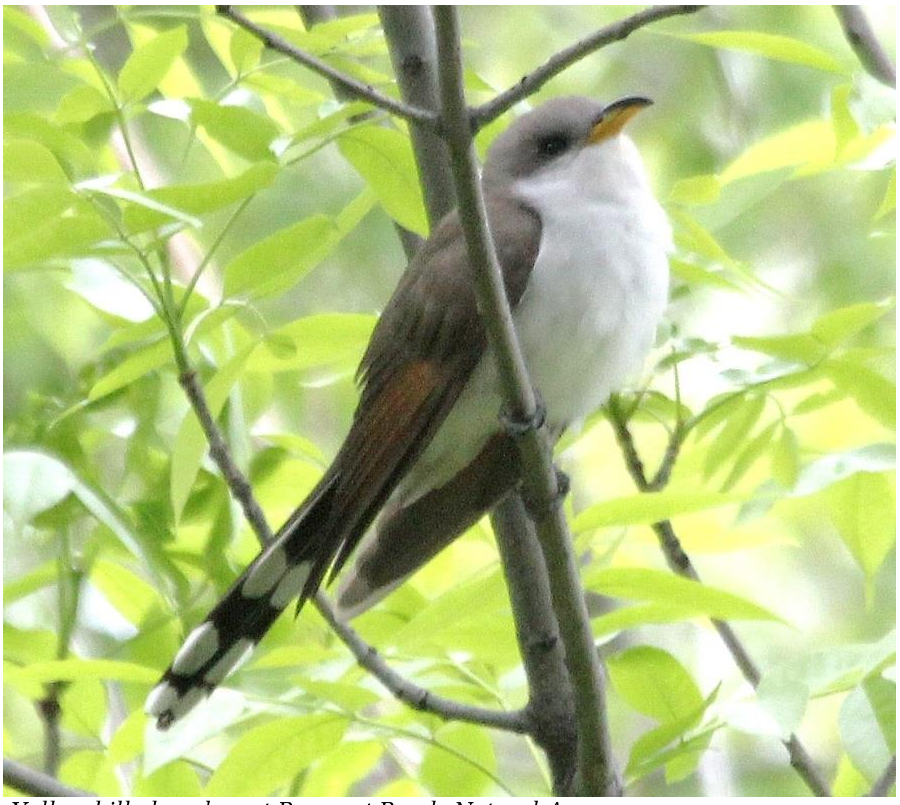
D. Current Conditions Based on Avian Indicator Species

Poudre River Bird Survey Summary

Initial avian surveys began in 2009 and demonstrate the utility of birds as important indicators of habitat quality and the influence of restoration efforts along the Poudre River. Baseline data of species presence and absence, diversity, and spatial variability inform management on habitat quality for both existing condition and desired future condition. In fact, early surveys demonstrate that the missing fruit-bearing shrubs and willow habitat component in the understory of the cottonwood forests can benefit from targeted plantings during restoration efforts.

The habitat structure of intact lowland riparian forests along Colorado's Front Range is characteristically heterogeneous. This ecosystem is capable of supporting species that utilize a variety of habitat, but some species are more closely associated with specific habitat features. Natural areas along the Poudre River host many of the species considered representative of lowland riparian ecosystems. Indicator species that are absent from the surveys are associated with riparian shrub thickets that are not currently well represented. This under-represented habitat characteristic is critical for foraging and nesting (Miller et al. 2003).

Riparian shrub indicator birds require a dense, mid-story riparian shrub community in order to thrive. Shrub communities form thickets attractive to a variety of native birds. Due to historical land use that prevented the river access to the natural floodplain, this habitat type/structure is not well represented along the Poudre River. These mid-story thickets were shaped by annual flooding events that provided a continual disturbance regime creating canopy gaps and transforming the forest in a horizontal and vertical manner. When quality shrub habitat is present, it is normally composed of wild plum (*Prunus americana*), snowberry (*Symphoricarpos occidentalis*), chokecherry (*Prunus virginiana ssp. melanocarpa*), skunkbush sumac (*Rhus trilobata*) hawthorn (*Crataegus* spp.), boxelder (*Acer negundo*), and native willows (*Salix* spp.). Grey catbird (*Dumetella carolinensis*), brown thrasher (*Toxostoma rufum*), yellow-breasted chat (*Icteria virens*), and yellow-billed cuckoo (*Coccyzus americanus*) are species that utilize this habitat for nesting and forage.



Yellow-billed cuckoo at Prospect Ponds Natural Area

Grasslands Bird Survey Summary

Results from initial breeding bird surveys, in 2011, indicate that grassland restorations have been successful in creating native plant communities important to grassland bird habitat. Shortgrass prairie ecosystems exhibit lower avian diversity, which is a result of a variety of environmental conditions that create more uniform habitat structure (VerCauteren and Gillihan 2004). Avian species associated with the Great Plains are aligned with three primary habitat types: short vegetation structure created by frequent drought conditions and intensive herbivory; grasslands with more varied structure in areas with greater precipitation; and, grasslands punctuated with the presence of wetland habitats. Birds with preferences for heavily grazed areas generally do not require vegetation structure to support the attraction of mates. These species have evolved to depend on forb seed production and an invertebrate prey base created by herbivory. Birds that generally exhibit a preference for habitat with structural diversity (grass height, some bare ground, and a shrub component) utilize the tallest elements to broadcast songs, attract mates, and defend territories. Nest sites are typically selected within shrubs, grasses, or forbs; or immediately adjacent to them and bare ground provides areas for foraging and dust bathing. Wetland habitat provides nesting sites and foraging opportunities for birds whose life history is closely tied to this environment.

The Natural Areas Department has selected five indicator species that align with the diverse grassland vegetation structure and habitat characteristics as described above and include: vesper sparrow *(Pooecetes gramineus),* grasshopper sparrow *(Ammodramus savannarum),* lark sparrow *(Chondestes grammacus),* Brewer's sparrow *(Spizella breweri),* and Cassin's sparrow *(Aimophila cassinii)*. The distribution of these species across survey areas reveals a pattern of areas hosting high-quality grassland habitat as well as areas requiring habitat improvement. Older grassland restorations (approximately 15 years since initial management action) host many of these grassland indicator species. Newer grassland

restoration efforts on dryland farm fields (McKee sections of Coyote Ridge, east of Taft Hill Road) quickly show improved habitat quality for indicator species. Vesper sparrows and grasshopper sparrows are found to be the most widely distributed, but still require a degree of habitat diversity. Distribution of the other three indicator species suggests a strong tie to a shrub component or greater habitat diversity. Where bare ground, diverse grass and forb height, and shrubs are present, all indicator species are found suggesting the highest quality bird habitat. Currently, this habitat condition is limited, patchy, and fragmented by adjacent degraded areas. Additionally, these indicator bird species may not be found on smaller more isolated natural areas as there isn't sufficient natural landscape to support a population. Moving forward these indicator species will serve as markers of success as additional grassland restorations mature through the years. The Department will continue surveys every other year as a monitoring strategy through the life of this 10 year restoration plan.

Literature Cited

Lemly, J. and J. Rocchio. 2009. Field Testing of the Subalpine-montane Riparian Shrublands Ecological Integrity Assessment (EIA) in the Blue River Watershed, Colorado. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

Lemly, J., J.B. Johnson, L. Gilligan, and E. Carlson. 2013. Setting Mitigation in the Watershed Context: Demonstration and Description of Colorado's Watershed Approach to Compensatory Wetland Mitigation. Colorado Natural Heritage Program. Report. Final Draft, April 2013.

Miller, J.R., Wiens, J.A., Hobbs, T., and Theobald, D. M. 2003. Effects of Human Settlement on Bird Communities in Lowland Riparian Areas of Colorado. *Ecol. Applic.,* 13(4): 1041-1059.

Miller, S.J. and D.H. Wardrop. 2006. Adapting the Floristic Quality Assessment Index to Indicate Anthropogenic Disturbance in Central Pennsylvania Wetlands. *Ecol. Indic.* 6: 313–326.

Rocchio, J. 2009. Floristic Quality Assessment Indices of Colorado Plant Communities. Unpublished report prepared for Colorado Department of Natural Resources, and U.S. Environmental Protection Agency, Region VIII. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

Smith, P. and B. Kuhn. 2015. Survey and Assessment of Critical Urban Wetlands: City and County of Denver. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

VerCauteren, T., and Gillihan, S. W. 2004. Integrating Bird Conservation into Range Management Rocky Mountain Bird Observatory, Brighton, Colorado.

Chapter 3: Overarching Restoration Goals for Natural Areas 2016 - 2025

A. Restoration Vision for the 10-year period 2016 – 2025
B. Overarching Goals and Identification of Priority Restoration Areas

A. Restoration Vision for the 10-year period 2016 – 2025

As stated in the 2014 Natural Areas Master Plan, future restoration efforts will strive for increased sophistication at an ambitious pace to create high quality habitats within the urban natural areas. To accomplish this, the Department will identify targeted plant communities and habitats that support diverse and abundant wildlife populations, act to recover imperiled or rare species, and maintain supportive conditions through natural disturbance, which acts to restart the ecological succession process. This vision is thought of by the Resource Management work team as an effort to create "Wilderness in the City."

B. Overarching Goals and Identification of Priority Restoration Areas

The overarching goals, listed below, are intended to provide general guidance to restoration activities and are supported by detailed habitat zone specific goals in Chapter 6. Included in this list are two of the goals that were highlighted in the 2014 Master Plan to address an accelerated pace of restoration.

Overarching Goals for Comprehensive Restoration Plan Update 2015

1. Continue a high pace of restoration – initiate restoration on the Southern grasslands by 2019 and natural areas along the Poudre River by 2025 (target priority restoration areas).

2. Create restoration goals that include specific plant community composition and target wildlife and plant Species of Interest habitat needs (see Fort Collins Species of Interest list in Appendix A and B).

3. Increase monitoring efforts to improve measures of habitat quality and restoration success on natural areas (see indicator species in chapter 7).

4. Consider future climatic scenarios in restoration efforts as a necessary consideration for long-term viability (see Chapter 5).

Furthermore, in planning for this Restoration Plan update, it became clear that achieving restored plant communities should continue at a high pace as regional climate changes are likely underway. Initiating restoration efforts in advance of significant climate changes allows plant communities to mature and acquire a level of adaptability necessary to withstand more variable and extreme swings in climate. In particular, locally adapted species may have a narrowing ecological niche as the climate changes, which warrants broadening the diversity of species to accommodate a range of climatic conditions.

Given a relative urgency to maintain a high pace of ecological restoration, the Natural Areas Department created a City of Fort Collins Natural Areas list of species of interest (Chapter 4) and identified "Priority Restoration Areas."

The first tier prioritization of future restoration efforts utilized a number of sources to derive areas of opportunity in terms of locations and species of interest. The Colorado Natural Heritage Program (CNHP) has identified more than 1,800 Potential Conservation Areas (PCAs) across the state, 15 of which

occur on or in the vicinity of Fort Collins natural areas (Figure 4). PCAs are those areas that CNHP has identified as quality habitat and important to conservation of imperiled species or plant communities. All regional areas (Bobcat Ridge, Soapstone Prairie and Gateway) fall within at least one PCA and are considered quality habitat with relatively less need for restoration. The most significant exception would be the grasslands and ponderosa pine forests within Bobcat Ridge Natural Area that have been altered by agriculture and wildfire, respectively.

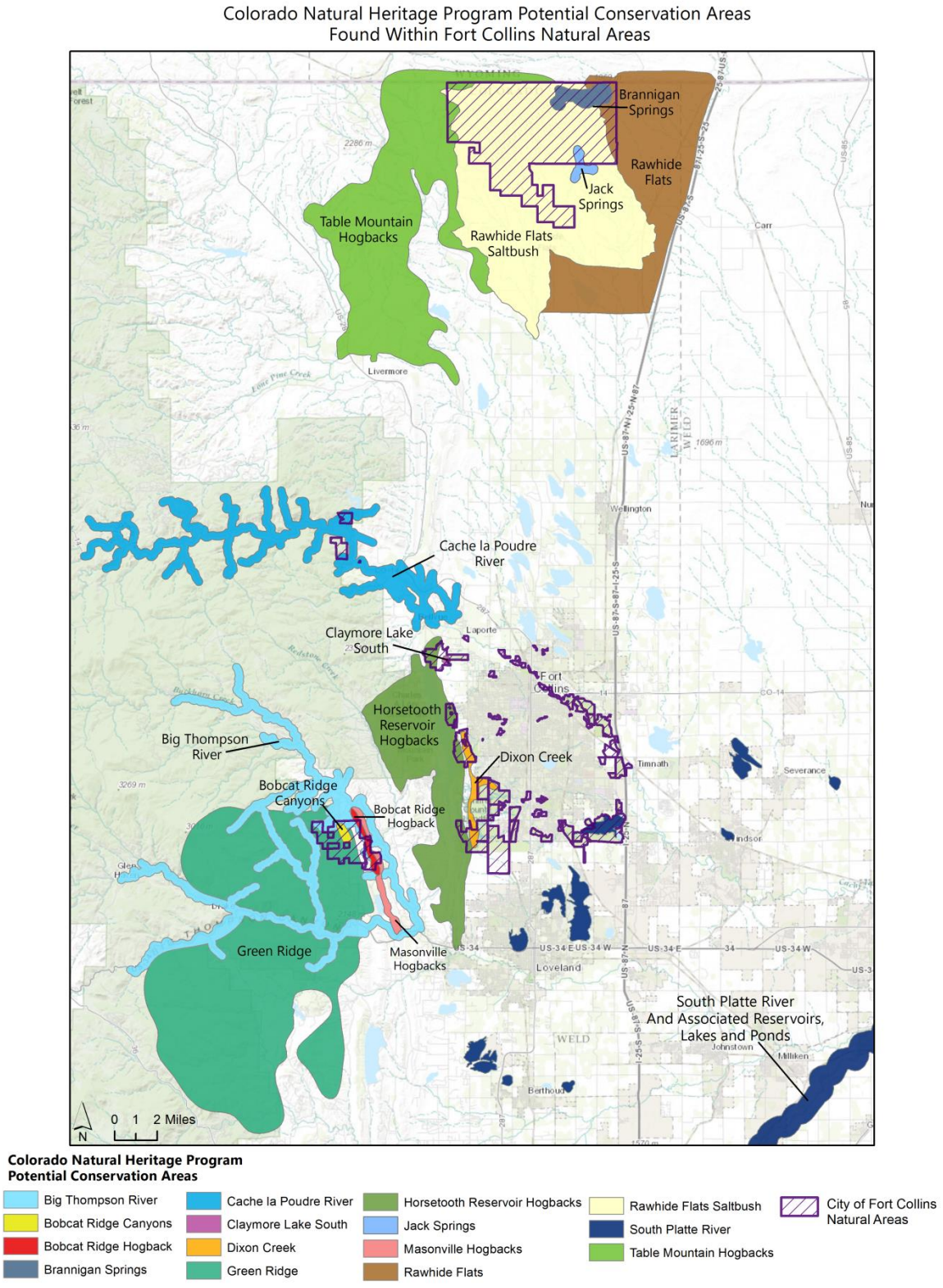


Figure 4. Potential Conservation Areas (PCAs) as identified by Colorado Natural Heritage Program

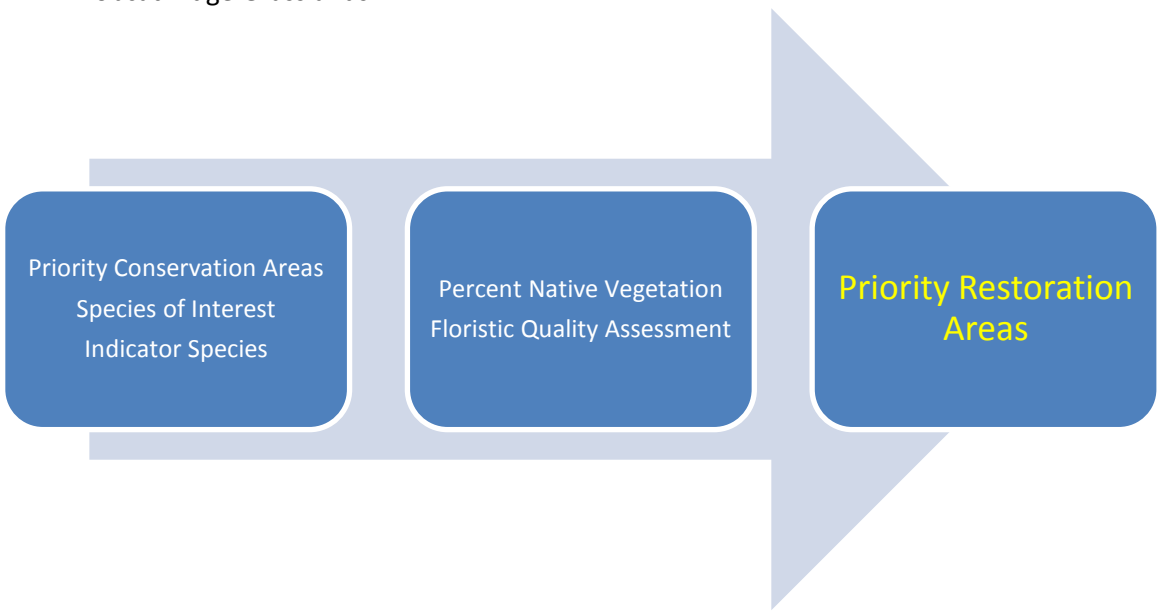
A second-tier prioritization for restoration areas is determined using other factors such as the presence of species of interest or the absence of an indicator species for a given habitat. Staff is working on methods to combine these factors to better prioritize across urban natural areas using GIS analysis. In order to accomplish this, a spatial database could be maintained in order to track species of interest and indicator species locations. These data, combined with percent native vegetation cover and Floristic Quality Assessment data, would lend themselves to a GIS analysis showing restoration priorities on a finer scale (Figure 5). Until this GIS analysis can be performed, staff will further prioritize units based on current datasets and knowledge of species of interest and indicator species locations. Species location data will improve over time; therefore, further priorities can be determined on an annual basis during the work plan and budget process.

Based on the above analysis, floodplains along the Poudre River corridor are a high priority for restoration with the goal of re-introducing the natural flooding disturbance regime. The ability for the river to spill over its banks during spring snowmelt is a primary driver for ecological processes that many plant and wildlife communities depend upon. To make an even stronger case, this already highly-altered riparian system will be difficult to maintain as a healthy and resilient Poudre River (a goal clearly articulated at a City Plan level), even in the absence of compounding impacts from climate change. To that end, all areas within the Poudre River corridor are considered priority restoration areas.

Similarly, the grasslands at the southern edge of Fort Collins and along the base of the foothills are adjacent to PCAs and face challenges in light of climate change. Restored, higher quality grasslands will be more resilient to the potential future conditions of extreme heat and drought. As referenced in Chapter 2 by recent breeding bird surveys, grasslands restored by the Natural Areas Department have proven to host high-quality habitat indicator species. To that end this 10 year restoration plan sets forth the intent to initiate restoration on all remaining grasslands by 2019.

Currently the 3 restoration priorities through 2016-2025 are:

- ✓ Lower Poudre River Corridor
- ✓ Southern Grasslands (southwest and Fossil Creek)
- ✓ Bobcat Ridge Grasslands



.
Figure 5. Determining priority restoration areas for natural areas.

Chapter 4: Restoration Needs for Rare Plants, Rare Plant Communities, and Wildlife Habitat

A. Conservation of Rare Plants and Rare Communities
B. Restoration Considerations for Wildlife

Fort Collins is located in a unique convergence of two ecoregions: the Central Shortgrass Prairie and the Rocky Mountain ecoregion (Chapman et al. 2006). As a result, a wide diversity of ecosystems is present and creates a variety of plant and wildlife communities. In spite of urban pressures, natural areas in the City of Fort Collins are biologically rich, diverse, and support a host of rare species. Still, many areas require some level of restoration with the goal of improving the quality of plant communities and wildlife habitat. This chapter outlines species and habitats of interest as well as associated restoration goals and actions.

A. Conservation of Rare Plants and Rare Communities

Fort Collins natural areas are floristically diverse with approximately 1,000 species of plants documented. Due to the geographic location and number of unique ecosystems, the natural areas harbor plants and plant communities considered rare both globally and locally by the Colorado Natural Heritage Program (CNHP). In coordination with CNHP the Natural Areas Department has compiled a list of plant species and communities of interest for the Fort Collins area (Appendix A). This list includes plants that are documented or have the potential to occur on natural areas and are:

1) Plants that are tracked by the Colorado Natural Heritage Program;
2) Plants that are uncommon in Colorado and/or Larimer County; and
3) Plants once common in the shortgrass prairie or foothills shrublands that are threatened by development along the Front Range.

A total of 157 plants are ranked as Species of Interest by the City of Fort Collins Natural Areas Department. Of these species, 54 occur on natural areas and 103 are likely to occur due to the presence of suitable habitat. Likewise, 17 rare plant communities occur within the natural areas portfolio. These plant communities, tracked by CNHP, encompass one or more dominant or co-dominant native plant species, in conjunction with a characteristic set of associated native plant species, habitat conditions, and physiognomy.

Bell's twinpod (Physaria bellii) is found only in the northern front range of Colorado. Several natural areas provide refuge for this rare plant.

Many of the documented or potentially occurring rare plants and plant communities are at the western edge of their range and were once common in the shortgrass prairie ecosystem. Today, much of the shortgrass prairie in Colorado has been significantly altered by agriculture and urban use. Lands owned by the City of Fort Collins Natural Areas Department function as refugia to native flora and some of the rarest plants in the state of Colorado.

The Natural Areas Department has developed five conservation goals and associated actions for rare plants and rare plant communities and are listed in Table 1.

Table 1. Rare plant conservation goals and actions for City of Fort Collins natural areas.

Rare Plant Conservation Goals	Rare Plant Conservation Actions
Protect and conserve existing populations of rare plants and rare plant communities	✓ Identify known and potential threats to each species of rare plant ✓ Provide detailed maps of rare plant locations to field staff to limit herbicide application or damage from maintenance activities ✓ Limit recreation users from accessing and damaging rare plants ✓ Provide appropriate disturbance regimes for habitat management including prescribed fire and grazing ✓ Periodically monitor populations ✓ Regularly monitor Threatened and Endangered plants and use adaptive management techniques when appropriate to avoid population declines
Continue to look for and document populations of rare plants based on potential suitable habitats	✓ Survey for new populations of rare plant species
Encourage expansion of rare plant populations and rare plant communities by improving and restoring adjacent habitat to known occurrences	✓ Expand existing populations of American black currant (*Ribes americanum*), bearded flatsedge (*Cyperus squarrosus*), slender false foxglove (*Agalinis tenuifolia*) and slender flatsedge (*Cyperus bipartitus*) in urban natural areas
Consider reintroduction of rare plants and plant communities in areas where historical occurrences have been documented	✓ Continue to identify priority rare plant species and habitats where reintroduction is appropriate
Explore ex situ conservation for priority rare plant species in natural areas with suitable habitat	✓ Explore potential ex situ conservation for nine priority rare plants listed in Appendix A ✓ Collaborate with plant researchers at CSU and other institutions to better understand propagation techniques for ex situ species ✓ Develop protocols for site selection, seed collection, aftercare, and monitoring of ex situ sites ✓ For any ex situ conservation efforts, NAD staff will use only locally collected seed sources or plant material from Denver Botanic Gardens or the National Center for Genetic Resources Preservation

B. Restoration Considerations for Wildlife

Wildlife habitat across the Front Range of Colorado is becoming increasingly fragmented by rapid urban growth in the last several decades. Threats to wildlife habitat on natural areas include non-native species, lack of natural disturbance (flooding, wildfire, grazing), habitat fragmentation, climate change, and human disturbance. Even where there is quality wildlife habitat, disturbance regimes such as burning, grazing, or flooding are needed to restart successional processes that support habitat diversity and in turn benefit native wildlife. Wildlife habitat restoration goals can focus on providing habitat for a range of common species and the conservation of rare species. While the Natural Areas Department will prioritize rare species when appropriate, it is important to underscore the improvement and persistence of common plant community characteristics within the region.

With the assistance of CNHP, the Natural Areas Department has compiled a list of native wildlife Species of Interest for Fort Collins natural areas (Appendix B). This list includes wildlife that are documented or have the potential to occur on natural areas and are:

1) Considered species of greatest conservation need (SGCN) in the 2015 State Wildlife Action Plan (SWAP) (Colorado Parks and Wildlife (CPW) 2015); and/or
2) Tracked by CNHP.

Some species on this list may warrant further investigation to determine if they occur on natural areas properties and presence/absence surveys may be considered when data gaps exist in areas that are believed to be suitable habitat. Wildlife goals and actions are outlined in Table 2 as well as Chapter 6.

Grasshopper Sparrow (photo by Cole Wild)

Habitats of importance for wildlife species of interest include shortgrass prairie, tallgrass and mixed-grass prairie, riparian forest and shrubland, wetlands, foothills shrubland/rock outcrop, and ponderosa pine forest. Specific habitat structure and plant composition required by wildlife of interest will be incorporated into restoration actions where these species are known to occur or could occur. Some areas may host more than one wildlife species of interest and there may be conflicting habitat needs. In these cases, management for one species may have higher priority or management that has a greater positive impact overall may be selected. Ideally, a mosaic of habitat will be achieved benefitting most species present in an area. The SWAP contains information for SGCNs and habitat qualities and can be referenced to inform restoration planning.

The Natural Areas Department will prioritize species of interest where they occur, with the caveat that many urban natural areas are unable to support some species due to small size, isolation, or pressures

from the urban environment. In these cases, lands may be managed for a suite of common species that occur in a particular habitat. An example of this is the lowland riparian habitat along the Cache la Poudre River corridor. This ecosystem type is a ribbon of habitat that hosts the richest avian diversity in the state, but riparian habitat only represents 3% of the Colorado landscape (Kingery 1998). Although many of the species utilizing lowland riparian habitat are considered common, improving riparian habitat for migratory birds and other wildlife is a priority across the state and the arid west. Additionally, urban grasslands may not provide habitat for many rare species, but a suite of grassland birds and other wildlife can be managed for and their presence can indicate that a healthy grassland habitat was established through restoration.

Restoration efforts may also include wildlife reintroductions where there is quality habitat but the species are no longer present for other reasons (e.g., disease or urban growth). Similarly, wildlife may be reintroduced once degraded habitat is restored. Reintroduction of four wildlife species of interest has already taken place on City of Fort Collins natural areas. Black-footed ferrets were reintroduced beginning in October 2014 and genetically native bison* were reintroduced to Soapstone Prairie Natural Area, in November 2015. Northern redbelly dace and plains topminnow have been reintroduced into Spottlewood Creek at Soapstone Prairie Natural Area. Future reintroductions of three native fish species of interest (plains topminnow, brassy minnow and northern redbelly dace) are scheduled for introduction into to a wetland restoration site on the newly acquired Topminnow Natural Area. Additional reintroduction projects could include the northern leopard frog, Preble's meadow jumping mouse, and sharp-tailed grouse, with the creation of suitable habitat. The City will continue to work with Colorado Parks and Wildlife and the U.S. Fish and Wildlife Service to help guide appropriate wildlife reintroductions.
*Genetically native bison contain only original genetics from bison at Yellowstone National Park.

Table 2. Wildlife restoration goals and actions for City of Fort Collins natural areas.

Wildlife Conservation Goals	Wildlife Conservation Actions
Understand where wildlife species of interest occur and protect existing populations	✓ Survey for wildlife species of interest in appropriate habitat as needed ✓ Document incidental observations of wildlife species of interest and consider a new database for record keeping ✓ Limit recreation disturbance to wildlife species of interest populations
Manage and restore wildlife habitat for wildlife of interest and to keep common species common	✓ Manage and restore plant communities to the most appropriate condition where possible ✓ Provide habitat structure through appropriate disturbance regimes such as prescribed fire and grazing ✓ Include targeted wildlife habitat goals where wildlife of interest exist or could be reintroduced ✓ Protect and restore important habitat features for wildlife of interest (snags, perches, nesting cavities/sites, roosting caves, etc.)
Consider reintroducing wildlife species of interest as appropriate	✓ Cooperate with CPW and U.S. Fish and Wildlife Service (USFWS) to reintroduce wildlife species of interest to appropriate habitat

Literature Cited

Chapman, S.S., G.E. Griffith, J.M. Omernik, A.B. Price, J. Freeouf, and D.L. Schrupp. 2006. Ecoregions of Colorado. (Map Scale 1:1,200,000). U.S. Geological Survey, Reston, Virginia.

Colorado Parks and Wildlife. 2015 (*In Review*). State Wildlife Action Plan: A Strategy for Conserving Wildlife in Colorado. Denver, Colorado.

Kingery, Hugh E., editor. 1998, *Colorado Breeding Bird Atlas*, Colorado Bird Atlas Partnership, Colorado Division of Wildlife, Denver, Colorado.

Chapter 5: Managing Local Ecosystems in the Face of Climate Change

A. Expected Future Conditions
B. The City of Fort Collins' Climate Action Plan and Vulnerability Assessment
C. Effects on Specific Habitat Types as Assessed by Colorado Natural Heritage Program
D. Management Implications for Anticipated Changes

A. Expected Future Conditions

It is important to examine the potential future climate conditions for Northern Colorado and the potential effects it will have on ecosystems and habitats the Natural Areas Department manages. This information will guide modifications to restoration goals and the way biological resources are managed. A plethora of studies have been conducted that model future climate change both globally, regionally, and specifically for the Poudre River watershed. Existing climate models for the region anticipate increases in temperature in all seasons, potentially up to 6^{o} F by mid-21st century, depending on future greenhouse gas emissions (Geos Institute 2013). Precipitation changes are more difficult to predict, therefore future restoration planning will need to anticipate both wetter and drier scenarios (Woodbury et al. 2012). In the likely scenario of expected warming, a greater percentage of winter precipitation will fall as rain rather than snow, impacting current hydrologic regimes in the Poudre River and Fort Collins' stream networks. These modified hydrologic regimes will be further exacerbated by increasing water demand and systems of water storage.

An overall warmer climate also means extended frost-free periods and fewer cold snaps. Cold snaps and frost currently serve to hinder the persistence of insect and disease outbreaks such as pine beetle, and West Nile Virus. The timing of the Poudre River's spring runoff could shift up to 18 days earlier by mid-21st century (Woodbury et al. 2012), which will affect many ecological processes that have co-evolved with peak river flows. The ability for fish hatching and cottonwood seed dispersal to adapt to this new timing is unclear. Earlier springs also increase the length of hot summers; that together will increase river temperatures, reduce soil moisture over the growing season, and increase frequency of wildfire during drought conditions. Current habitat stressors, such as invasive species, will be exacerbated by the changing climate (Geos Institute 2013). Furthermore, competing societal demand for water and instream flows for the ecosystem will be one of the many challenges faced by the Fort Collins community.

B. The City of Fort Collins Climate Action Plan and Vulnerability Assessment

The City recently adopted a revised Climate Action Plan with some of the most ambitious goals in the nation to reduce community greenhouse gas emissions (20% below 2005 levels by 2020, 80% below 2005 levels by 2030, and carbon neutral by 2050). Currently, an inter-departmental City staff team is drafting an implementation plan to meet these goals, focusing on strategies to reduce carbon emissions (mitigation).

Two mitigation strategies identified in the Climate Action Plan include carbon sequestration through land and soil conservation and encouraging local food/urban agriculture. Both strategies align with the mission and on-going efforts of the Natural Areas Department. The Climate Action Plan also identified the NAD's land conservation and restoration efforts as tactics to protect vulnerable lands with high soil carbon storage potential.

Along with climate mitigation strategies, the City is also working on adaptation strategies to prepare for the expected changes. Through a vulnerability assessment done in 2014, key concerns for the City's services and operations that may need adaptation strategies were identified. Vulnerabilities directly related to the Natural Areas Department were habitat conservation, vegetation stewardship, riparian zones restoration and conservation, water supply for a healthy and resilient Poudre River, and agricultural conservation. This Restoration Plan Update examines how restoration and resource management actions can (or currently do) assist with adapting to the effects of future climate change.

C. Effects on Specific Habitat Types as Assessed by Colorado Natural Heritage Program

At a state level, vulnerabilities of each of Colorado's habitat types have been examined by the Colorado Natural Heritage Program (Decker and Fink 2014) for the State's Wildlife Action Plan. The vulnerability assessments examine the exposure and sensitivity of a habitat to predicted climate change, and the ability for the habitat to adapt to changes. These assessments consider factors including condition of the habitat, the habitat's climactic range, dispersal and growth forms, and other stressors that could be exacerbated by climate change. Habitats experiencing current stressors and exhibiting lower resilience generally rank higher (more vulnerable) than those with less pressure and a higher degree of resiliency. CNHP assessed the vulnerability of 13 Colorado habitats, all modeled for a moderate emissions scenario for the mid-21st century. The results for the five habitats found within Fort Collins natural areas are shown below.

Highly Vulnerable	Moderately Vulnerable	Less Vulnerable
•Shortgrass prairie •Foothill grasslands	•Ponderosa pine •Wetlands	•Riparian*

* Natural Areas has determined that the Lower Poudre River area is highly vulnerable.

Soil moisture level is a determining factor in the distribution of shortgrass prairies and a major factor in determining its vulnerability to climate change. While the shortgrass prairie is well adapted to be drought tolerant, it is expected to experience more droughts with the anticipated temperature increases which will decrease soil moisture levels. Especially important for recharging soil moisture are the large, yet rare, rain events. It can be said that a loss in soil moisture can result in a plant community shift that would likely be characterize by woody plants such as cholla (*Opuntia* spp.), yucca (*Yucca* spp.) and snakeweed (*Gutierrezia* spp.) that favor increased CO2 and have tap roots that can reach deeper soil water.

With warmer and possibly drier conditions, foothill grassland species composition could also change to more drought tolerant shrubs, forbs, and bare-ground mix resembling a semi-desert grassland. As with many local habitats, foothill grasslands are generally considered highly altered, making them susceptible to future changes and open to invasive species.

Ponderosa pine forests like those found at Bobcat Ridge and many of the foothills natural areas occupy a climate (montane) zone receiving at least 13 inches of precipitation per year. Along the Front Range, episodic recruitment of ponderosa pines is associated with high spring and fall precipitation during El Nino years. If future conditions are drier, the regeneration capability of ponderosa pine stands may be jeopardized. As a result, existing ponderosa forests at Bobcat Ridge, Pineridge, Maxwell, and other foothills sites may shift upslope by midcentury with the potential for extirpation in the long-term.

Similarly, increased drought conditions will likely permit increased insect and disease outbreaks (e.g., pine beetle and mistletoe) in addition to severe wildfire.

Wetlands depend on water from precipitation, groundwater, surface flow, or artificial seeps from irrigation practices. Even with uncertain future precipitation patterns, the most significant threat will likely come from changing water use patterns through societal consumption in the warmer/drier scenario. Already considered heavily impacted habitats, wetland occurrences are typically small and isolated. Similarly the lack of connectivity creates challenges for species dispersal and greatly hinders wetland adaptive capacity.

For snowmelt river systems such as the Poudre River, warmer winter and spring temperatures will change the timing and amount of peak runoff to earlier in the spring. The river is also anticipated to exhibit lower late summer and fall flows, increasing the heat stress for aquatic organisms and drought stress for riparian vegetation. For smaller streams such as Spring Creek and Fossil Creek, changes in precipitation patterns could have a significant effect. Large rainfall events and subsequent erosion will impact both environmental and urban infrastructure concerns. Riparian habitats are somewhat adaptable due to the diversity of plant communities; however, they are likely to constrict in size as reduced streamflow and increased drought manifest.

CNHP's report acknowledges that both wetland and riparian systems are likely more vulnerable to climate change than the broad-scale assessment methods can capture, likely due to the relatively small size of these habitats across the state-wide landscape. When compared to the relative importance of these habitats in the arid environment along the Front Range and the fact that they are already so highly altered, it is difficult to imagine that these habitat types are not highly vulnerable. The lower Poudre River riparian area is considered highly vulnerable by the Natural Areas Department for reasons described above.

In summary, by mid-century currently occupied habitat ranges for City of Fort Collins natural areas will be warmer, but still within the range of tolerance for most species. Habitat-type ranges may begin to shift in location (elevation) and plant community compositions may begin to shift as well, however, drastic habitat shifts or novel ecosystems are not likely to be formed by mid-21st century. Resilient habitats are needed to withstand the anticipated effects of climate change. Along with other factors, this has caused the Natural Areas Department to prioritize accelerating the pace of restoring shortgrass prairie, foothill grassland, riparian, and wetland habitat types on the natural areas (per Chapter 3-Overarching Goals).

D.Management Implications for Anticipated Changes

Several natural resource adaptation measures are being discussed and becoming practice for some natural resource management agencies (Gonzalez 2010 and Capon et al. 2013). The Natural Areas Department has begun to and is considering implementing some of these adaptation strategies. The strategies include planning and on the ground management considerations.

At a planning level, the vulnerability analyses help to identify higher-threat areas or habitats as well as possible refugia locations. This can help guide new habitat/land conservation areas and prioritize existing protected areas for adaptive management including restoration. Through the vulnerability assessments summarized above, the Natural Areas Department is finding grasslands and riparian habitats to be of special concern, and is designating these habitats as priority restoration areas.

With many uncertainties of the effects of climate change on ecosystems world-wide, information gathering, monitoring, and sharing will have multi-agency and landscape-scale benefits. Landscape Conservation Cooperatives (LCC's) have been developed to assist with multiple agency communication and partnerships in natural resource management in the light of climate change. Participating in the Great Plains and Southern Rockies LCC's will help Natural Areas gain and share the most current and helpful information on expected changes for specific management actions in our region.

At a more specific and on-the-ground level, restoration and management goals that focus on habitat type and function, rather than a specific species or historic conditions, will allow for a greater number of species to benefit from those efforts and resources. This goal represents a philosophy shift from targeting historic conditions to paradigms considering the suite of new species adapted to new climate conditions.

Recent riparian restoration projects along the Poudre River are examples of restoring the ecological process of flooding on the floodplain to benefit the riparian habitat. Continued efforts to lower banks and promote floodplain inundation during low-flow years acts an "insurance policy" against impaired hydrologic regimes of the future.

Acquiring and restoring wildlife movement corridors supports "micro-niches" permitting native wildlife and plant communities to evolve within a narrow habitat range for some types and species. The Department will continue to re-establish and maintain habitat corridors through restoration and land conservation efforts as well as across agencies and the private/public sectors. On-going restoration within the large grassland complex between Fort Collins and Loveland and up and down the Poudre River will play a key role of providing "elasticity" within a habitat complex. Lastly, land conservation efforts in key areas such as the Laramie Foothills provide migration and dispersal corridors from the mountains to plains.

The Natural Areas Department is also working to establish in-stream flow rights within the Poudre River to secure water to support the riparian ecosystem and in-stream habitat. In conjunction with this effort, in-stream habitat connectivity is being improved by seeking partnerships with water diversion companies to modify structures to allow fish passage as well as working on the timing of water diversions and releases to maintain a base flow in the Poudre River. This work will continue to be critical as temperatures rise in northern Colorado.

Restoration with climate-adapted plant species involves identifying, conserving, and planting native plants adapted to projected climate conditions. This involves conserving and propagating genetic diversity, especially where plants are at the edge of their current natural range. For NAD that means species and genetic ecotypes well adapted to severe heat and drought conditions especially in grassland habitats. Work in this area is beginning with a better understanding of which species are most in need of genetic preservation through the Southern Rockies Seed Network organized by multiple local natural resource agencies.

A final consideration is concern for migratory wildlife and the mismatched timing with natural food availability. The Natural Areas Department can consider identifying the most important food sources for migratory wildlife and their potential to be altered due to projected climate changes. Conserving or potentially propagating these food sources for this migratory wildlife may be another way to assist in perpetuating such species. Along those lines are other mistimed ecological events such as peak spring runoff in riparian system timed with cottonwood seed dispersal and fish spawning. The timing of the

spring runoff for the Poudre River is predicted to be 2-18 days earlier by mid-century (Woodbury et al. 2012). Situations like this will continue to be monitored and studied to see how natural ecological adaptation processes will keep up with the pace of climate change.

Natural Areas Department Actions as a Result of Climate Considerations

- Continue to monitor climate change science and seek out credible downscaled information especially for precipitation and the Poudre River watershed
- Continue to pursue instream flow rights
- Participate with regional Landscape Conservation Cooperatives (LCC)
- Focus restoration goals on:
    - Habitat connectivity
    - Ecosystem processes vs. historic conditions
    - Mimicking natural disturbances with prescribed fire, flooding, and grazing
- Identify native plants requiring genetic preservation (collect seed when appropriate)
- Increase the pace of restoration efforts to allow habitats time to become established and resilient in advance of severe climate changes
- Research potential upcoming invasive species by comparing expected new climate to predicted reference locations (Albuquerque, New Mexico is Fort Collins' reference location)

Literature Cited

Capon, S. et al. 2013. Riparian Ecosystems in the 21st Century: Hotspots for Climate Change Adaptation? Ecosystems 16: 359-381.

Decker, K. and Fink, M. 2014. Colorado Wildlife Action Plan Enhancement: Climate Change Vulnerability Assessment. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

Geos Institute. 2013. Climate Change Primer for Fort Collins, Colorado. Geo Institute, Ashland, Oregon.

Gonzalez, P. 2010. Impacts of climate change on terrestrial ecosystems and adaptation measures for natural resource management. Chapter in book: J. Dodson (Ed.) Changing Climates, Earth Systems and Society. Springer, Dordrecht, Netherlands.

Woodbury, M., Baldo, M., Yates, D, and Kaatz, L. 2012. Joint Front Range Climate Change Vulnerability Study. Water Research Foundation, Denver, Colorado.

Chapter 6: Ecosystem Specific Restoration Actions 2016-2025

A. Introduction to Geographic Zones and Ecosystems
B. Zone 1: Lower Poudre River
C. Zone 2: Grasslands
D. Zone 3: Foothills
E. Zone 4: Poudre River Canyon
F. Zone 5: Soapstone Prairie

A. Introduction to Geographic Zones and Ecosystems

To facilitate restoration planning, Natural Areas designated five restoration zones based on geographic location, eco-regional classification (Chapman et al. 2006), and existing plant communities (Figure 6, Table 3). These five zones are

- Zone 1: Lower Poudre River
- Zone 2: Southwest and Fossil Creek Grasslands
- Zone 3: Foothills
- Zone 4: Poudre River Canyon
- Zone 5: Soapstone Prairie

A brief description of the ecological systems found within each zone is provided below. Additional information on the stressors, restoration goals, and actions is provided.

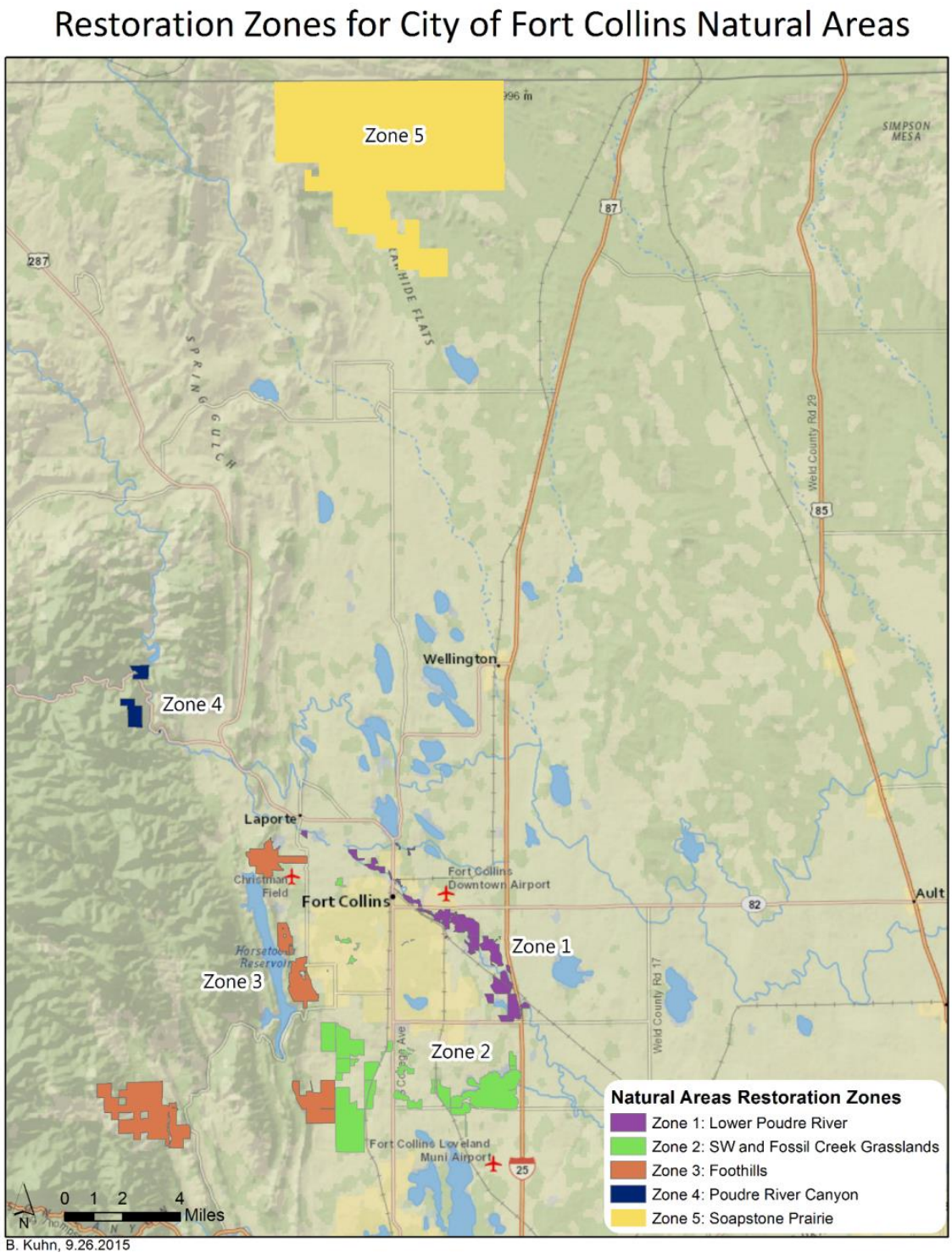


Figure 6. Overview map of the Natural Areas Restoration Zones.

ZONE 1: Lower Poudre River	
Natural Areas Included	**Size (acres)**
Arapaho Bend Natural Area	463.8
Butterfly Woods Natural Area	24.1
Cattail Chorus Natural Area	104.7
Cottonwood Hollow Natural Area	88.1
Gustav Swanson Natural Area	10.4
Homestead Natural Area	38.7
Kingfisher Point Natural Area	178.1
Magpie Meander Natural Area	24.2
McMurry Natural Area	44.8
North Shields Ponds Natural Area	53.8
Prospect Ponds Natural Area	46.4
Redwing Marsh Natural Area	22.9
Riverbend Ponds Natural Area	218.1
River's Edge Natural Area	9.5
Running Deer Natural Area	361.5
Salyer Natural Area	24.2
Springer Natural Area	19.4
Topminnow Natural Area	48.0
Udall Natural Area	26.2
Williams Natural Area	1.4
Zone 1 Total Acres	**1,808.3**

ZONE 2: Southwest and Fossil Creek Grasslands	
Natural Areas Included	**Size (acres)**
#09SC1	1.0
Cathy Fromme Prairie Natural Area	1,070.1
Colina Mariposa Natural Area	206.6
Coyote Ridge Natural Area (East Portion)	1,229.9
Eagle View Natural Area	85.9
Fischer Natural Area	11.7
Fossil Creek Reservoir Natural Area	1,518.3
Fossil Creek Wetlands Natural Area	220.2
Hazaleus Natural Area	163.5
Mallard's Nest Natural Area	6.6
Pelican Marsh Natural Area	157.4
Prairie Dog Meadow Natural Area	84.3
Red Fox Meadows Natural Area	40.7
Redtail Grove Natural Area	51.6
Ross Natural Area	26.5
#13IS1	37.4
The Coterie Natural Area	3.7
Two Creeks Natural Area	29.7
Zone 2 Total Acres	**4,945.1**

Zone 3: Foothills	
Natural Areas Included	**Size (acres)**
Bobcat Ridge Natural Area	2,603.7
Coyote Ridge Natural Area (West portion)	974.8
Maxwell Natural Area	289.8
Pineridge Natural Area	676.7
Reservoir Ridge Natural Area	765.3
Zone 3 Total Acres	**5,310.3**

ZONE 4: Poudre River Canyon	
Natural Areas Included	**Size (acres)**
Gateway Natural Area	170.2
Picnic Rock Natural Area	324.1
Zone 4 Total Acres	**494.3**

ZONE 5: Soapstone Prairie	
Natural Areas Included	**Size (acres)**
Soapstone Prairie	22,237.3
Zone 5 Total Acres	**22,237.3**

Table 3. List of natural areas included in each of the five restoration zones.

B. Zone 1: Lower Poudre River (Taft Hill Road to Interstate 25)

Zone 1 encompasses 21 natural areas and a total of 1,812 acres (Figure 7). These natural areas are located along the urban reach of the Poudre River as it emerges from the foothills north of Fort Collins onto the High Plains and flows toward Greeley.

Four major ecological systems (listed below) are present in Zone 1:

- Lotic Riparian Shrublands
- Lotic Riparian Forests
- Floodplain Ponds and Wetlands
- Grasslands

Prior to European settlement, the Poudre River experienced high spring flows and periodic flooding (Poudre River Technical Advisory Group 2008). Since the 1860s, water from the Poudre River has been diverted for use in agriculture, municipal supply, and industry, thus resulting in changes in the quantity, duration, and timing of flows. While the importance of maintaining base and peak flows to support ecosystem function is of critical importance to the present and future ecological function of the Poudre River, managing flows is beyond the scope of this document. For more information on river channel and flow management, see the Poudre River Health Assessment Framework (2015). Instead, this plan focuses on restoring wetlands and uplands that are adjacent to the Poudre River. Re-establishing the river-floodplain connection also acts to reset elevations that enable the flooding function to occur under the altered flows the river currently experiences.

Wetland restoration before (left, 5-2-2011) and after (right, 9-2-2012) at McMurry Natural Area

Zone 1 is dominated by cottonwood forests lacking diversity in the understory. Much of the understory is dominated by smooth brome and reed canary grass. Other land cover types include open water, fields of non-native smooth brome, and riverine wetlands. The Poudre River prior to the mid-19th century likely hosted a mosaic of riparian forests and shrublands, with patches of emergent wetlands. Today, small areas of cottonwood gallery forests and coyote willow shrublands persist despite a significant reduction in size and extent due to urban and agricultural development.

Restored Wetland and Adjacent Cottonwood Riparian forest at McMurry Natural Area.

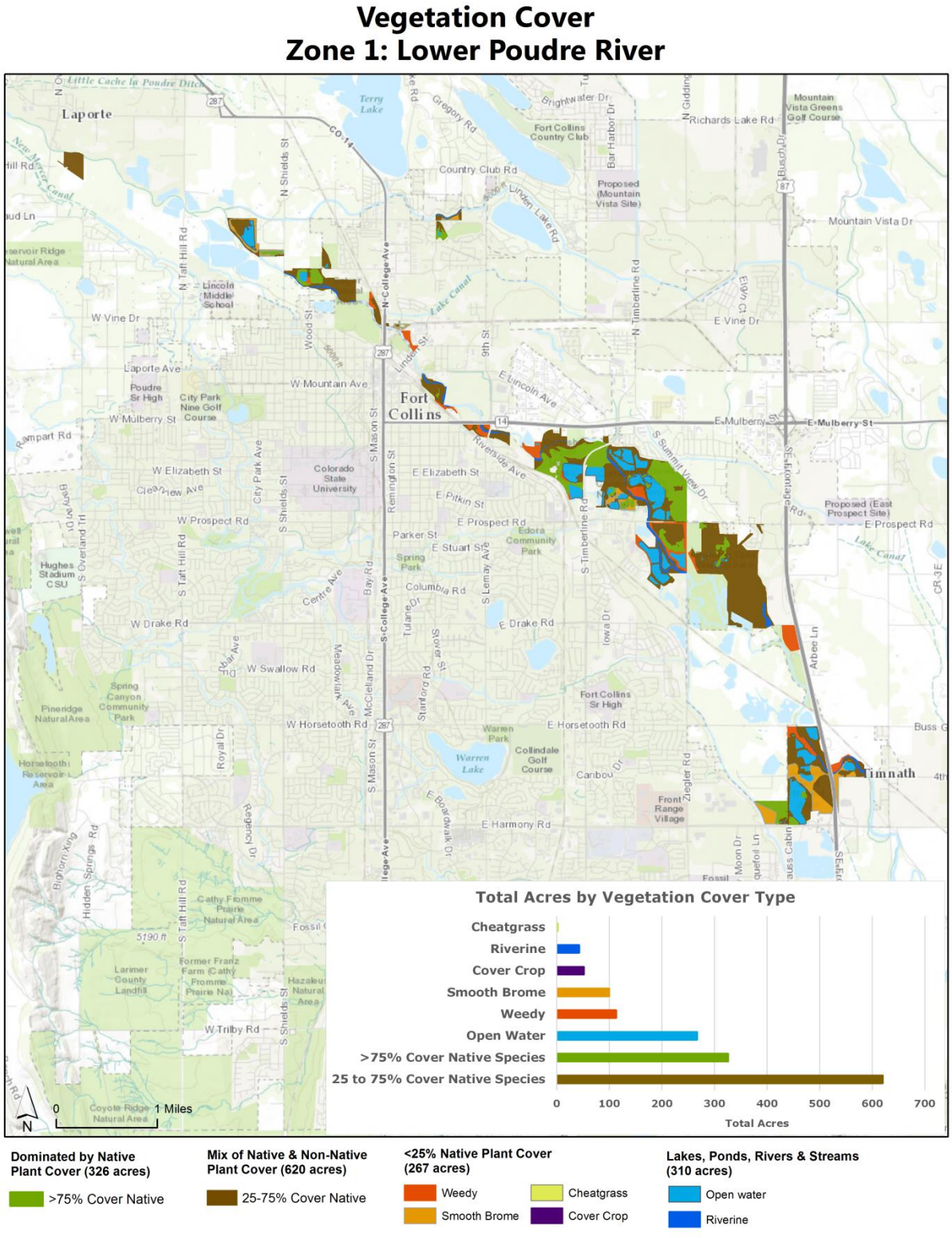


Figure 7. Vegetation cover and acreage totals for each land cover category in Zone 1: Lower Poudre River. Note: land cover has not been documented for all natural area parcels in Zone 1.

Areas dominated by woody cover along the Poudre River are classified as Lotic Riparian Shrublands and Lotic Riparian Forests. Although degraded along the urban areas of the Poudre River, Lotic Riparian Shrublands are often dominated by native shrubs including coyote willow (*Salix exigua*), chokecherry (*Prunus virginiana* ssp. *melanocarpa*), boxelder (*Acer negundo*), wild plum (*Prunus americana*), and snowberry (*Symphoricarpos occidentalis*). Lotic Riparian Forests are dominated by native trees such as plains cottonwood (*Populus deltoides* ssp. *monilifera*), narrowleaf cottonwood (*Populus angustifolia*), peachleaf willow (*Salix amygdaloides*), and non-natives including crack willow (*Salix fragilis*), Russian olive (*Eleagnus angustifolia*) and Siberian elm (*Ulmus* spp.).

Ponds and associated wetlands are generally novel ecological systems that did not exist along the Poudre River prior to gravel mining. Excavation along the river's floodplain has resulted in the creation of abandoned gravel ponds in Zone 1, such as those at North Shields Ponds, McMurry, Riverbend Ponds, Arapaho Bend, and other natural areas. Despite their anthropogenic origins, most ponds contain a thin band of cattails (*Typha* spp.) and bulrushes (*Schoenoplectus* spp.). In some areas the ponds have filled in with enough sediment to create wetlands that provide habitat for waterfowl, marsh birds, amphibians, and invertebrates within the urban landscape. The shorelines of these ponds are often heavily trampled by visitors, resulting in bare ground.

Lastly, Floodplain Grasslands occur in areas adjacent to the Poudre River. Dominant vegetation types in the Zone 1 Grasslands vary from smooth brome fields to smaller areas hosting native plants (Figure 7). Despite the history of agricultural use and persistence of non-native plant species in many of these grasslands, they provide important upland habitat and act as an ecologically important buffer between the river and the urban envelope of Fort Collins.

The lowland riparian ecosystem of the Lower Poudre River provides important habitat for a myriad of wildlife species. The river and surrounding wetlands and ponds provide habitat for semi-aquatic mammals such as beaver, muskrat, and mink. Natural areas in this zone provide a mostly contiguous landscape that is unique in an urban context. This allows for movement and cover for large mammals, such as mule and white-tailed deer. Habitat structure can be diverse in this ecosystem and host a great variety of species, especially avian species. Bird species that utilize specific components of habitat in this zone provide a perspective on the overall habitat condition and quality. This zone is important for sport fish populations and non-sport fish native to Colorado. Rare butterflies, such as the two-spotted skipper (*Euphyes bimacula*) and smoky eyed brown (*Satryodes eurydice fumosa*) have been detected in this zone as well.

Stressors within Zone 1 include:

- Altered flows that cause a cascade of effects on the physical, chemical and biological properties of the river;
- Lack of connectivity between the floodplain and river;
- Increased water temperatures due to lack of shading and reduced river flows;
- Lack of appropriate vegetation structure and complexity necessary to support diverse native wildlife;
- Fragmentation of landscape/ dispersal corridors and small habitat patch size in the riparian zone;
- Non-natives including domestic and feral cats, bullfrogs, Siberian elm, Canada thistle, and smooth brome;
- Disturbed pond margins and riverbanks due to recreation use; and
- Earlier spring river runoff due to climate warming.

Restoration Goals and Specific Actions

In order to alleviate and/or mitigate the above mentioned stressors, the Natural Areas Department has identified the following restoration goals and their associated specific actions. The relative success of these restoration actions should be measured with the urban context of Zone 1 in mind.

GOAL - Increase lateral connectivity between the river and its floodplain:

- ✓ Lower channel banks and re-contour floodplain to allow spring floods to access the floodplain.
- ✓ Continue removing non-critical concrete rip-rap and unnatural armoring from Poudre River bank.
- ✓ Increase the use of bio-engineering approaches when bank stabilization is required.
- ✓ Promote establishment of emergent wetland vegetation such as willows, sedges, and bulrushes for water retention and sediment filtration.

GOAL - Promote native floodplain vegetation:

- ✓ Create optimal physical habitat conditions to support natural cottonwood regeneration. Assist cottonwood establishment in the floodplain through planting, watering, protection from beaver, pruning, thinning, and other forest management techniques.
- ✓ Increase cover of native wetland plants including bulrushes (*Schoenoplectus* spp.), rushes (*Juncus* spp.), spikerush (*Eleocharis* spp.) and sedges (*Carex* spp.) along riparian corridors and pond margins to provide food and cover for mammals, amphibians, and waterfowl.
- ✓ Consider reestablishing native aquatic macrophytes such as pondweeds (*Potamogeton* spp.) for aquatic macroinvertebrate habitat in ponds.
- ✓ Alleviate recreation pressure by evaluating pond margins for vegetation trampling and soil compaction and implement best practices such as elevated walkways, rerouting trails, and providing designated access points.
- ✓ Promote tree and shrub growth along river and pond banks to increase or re-establish shade to keep water temperatures cool in the warming climate.
- ✓ When possible, protect existing stands of older cottonwood trees during restoration.
- ✓ Continue to explore effective means of reducing coverage of reed canary grass and smooth brome.

GOAL - Support native wildlife:

- ✓ Reference CNHP guidelines for plant composition and structure for Zone 1 plant communities including: lotic riparian shrublands, lotic riparian forests, lakes, ponds and associated wetlands, and grasslands.

- ✓ Seek assistance and reference documents from CPW and Bird Conservancy of the Rockies for wildlife habitat recommendations.

- ✓ Establish higher cover of native upland and wetland forbs along the Poudre River corridor for pollinators and rare butterflies. Establish plants such as milkweeds (*Asclepias speciosa* and *Asclepias incarnata)* in restored areas.

- ✓ Restore and protect appropriate upland nesting habitat for waterfowl near waterbodies.

- ✓ When removing exotic trees, replace with native tree/shrub cover where appropriate and space the timing and location of exotic removals to maintain decent wildlife habitat structure and cover.

- ✓ Identify and implement management techniques that allow beaver to exist in urban waterways of Fort Collins, where appropriate.

- ✓ Work with the City's Planning Department to prohibit use of plastic erosion control matting on any river or pond shoreline and replace with coconut fiber or other biodegradable materials on City and private projects.

- ✓ Continue planting fruit bearing shrubs and willows for the missing mid-story indicator birds (gray catbird, brown thrasher, yellow-breasted chat, and yellow-billed cuckoo).

- ✓ Work with CPW to continue to improve fish habitats in ponds and river channel for the purpose of native fish conservation. Provide habitat using practices such as: bio-engineered bank stabilization with woody-toe, dredging ponds, placing root wads and branches in ponds, removing dams and restructuring water diversions to be fish passible.

- ✓ Fire or grazing will be prescribed by project, or on an as needed basis. Once grasslands are restored to greater than 75% native cover, a regular, more natural fire or grazing regime is warranted.

GOAL - Protect/expand populations of plant and wildlife species of interest within Zone 1 (Appendix A and B). Highlights include:

- ✓ Manage habitat for and consider reintroduction of northern leopard frog, plains topminnow, common shiner, and brassy minnow. Consider Boxelder Creek at Running Deer Natural Area for a possible fish re-introduction site.

- ✓ Protect and expand populations of two-spotted skipper and orangespotted sunfish (*Lepomis humilis*).

- ✓ Restoration priorities (augmentation, reintroduction and ex situ conservation) for plant species of interest include the following species (see also Appendix A): *Azolla mexicana, Ruppia cirrhosa, Sparganium eurycarpum, Wolffia columbiana, Ribes americanum, Humulus lupulus* var.

neomexicanus, Smilax lasioneura, Acorus calamus, Carex atherodes, Carex sprengelii, Cyperus squarrosus, Dichanthelium acuminatum var. *sericeum, Agalinis tenuifolia, Agrimonia striata, Calystegia sepium, Eustoma exaltatum* ssp. *russellianum, Gaura neomexicana* ssp. *coloradensis, Glaux maritima, Lobelia siphilitica* var. *ludoviciana, Lysimachia ciliata, Lysimachia thyrsiflora,* and *Spiranthes diluvialis*

GOAL - Continue and establish wildlife monitoring programs before and following restoration

- ✓ Collaborate with Bird Conservancy of the Rockies to monitor secretive marsh birds as indicator species of wetland health and restoration success (Table 4, page 54).
- ✓ Continue and expand existing amphibian monitoring program along the Poudre River and at floodplain ponds.
- ✓ Continue Poudre River breeding bird surveys using indicator species to measure riparian health and restoration success (Table 4). Desire is to achieve abundance/densities that indicate healthy habitat.
- ✓ Collaborate with Colorado Parks and Wildlife and/or the American Fisheries Society to monitor native prairie fish as indicator species to measure wetland health and restoration success on a five year cycle (Table 4).

C. Zone 2: Southwest and Fossil Creek Grasslands

Zone 2 encompasses a total of 18 natural areas and 4,941 acres. The majority of these natural areas are located near the southern boundary of the City of Fort Collins.

A total of five ecological systems are found within Zone 2:

- Grasslands
- Foothill Shrublands
- Lotic Riparian Shrublands
- Lotic Riparian Forests
- Lakes, Ponds, and Associated Wetlands

These properties range from 1 acre (#09SC01) in size to 1,518 acres (Fossil Creek Reservoir). The majority of these parcels were historically used as rangeland or hay production prior to the acquisition by the City of Fort Collins. Many of these areas are undergoing restoration with the goal of transforming weedy crop fields to native grasslands. High levels of soil disturbance from past agricultural use and existing recreational use have resulted in the introduction of non-native plant species in the grassland ecosystems of Zone 2. The lack of fire has likely led to changes in plant species composition such as an increase in woody plants and a decrease in herbaceous dicots (McPherson 1995). Despite the presence of cropland and high non-native cover, the lands in Zone 2 are ecologically valuable as they provide the most expansive areas of undeveloped habitat adjacent to the habitats in the foothills south and west of Fort Collins. A total of 1,117 acres within Zone 2 are dominated by native plant species cover (Figure 8).

This represents 26% of the 4,343 acres of monitored units within Zone 2. A mix of native and non-native plant species comprise 30% of monitored units in Zone 2, and 44% is dominated by non-native plant species.

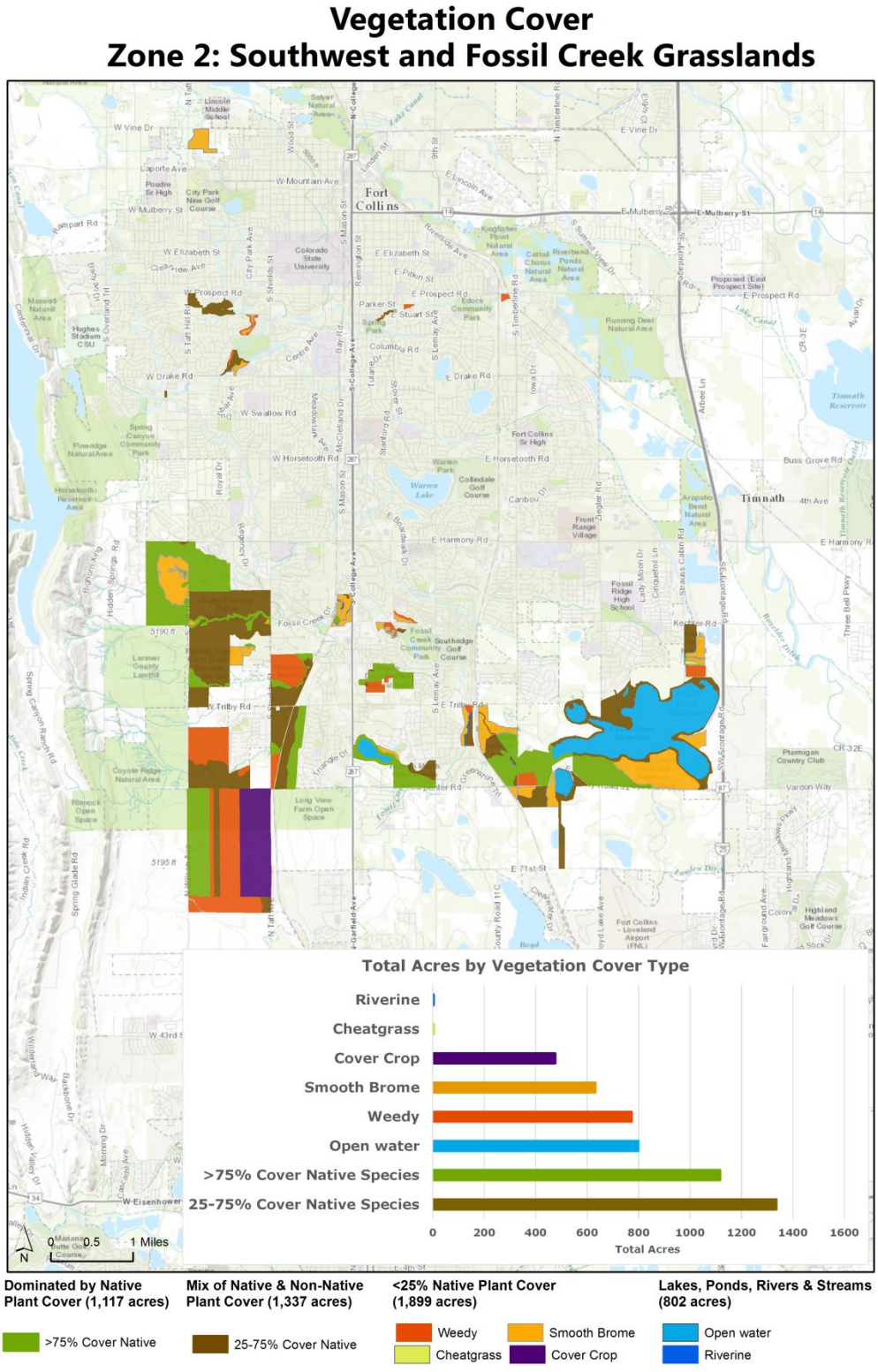


Figure 8. Vegetation cover and acreage totals for each land cover category in Zone 2: Southwest and Fossil Creek Grasslands. Note: land cover has not been documented for all Natural Area parcels in Zone 2.

Grasslands in Zone 2 vary from areas with greater than 75% native cover, to smooth brome fields. Some of these grasslands contain plant species common in the shortgrass prairie ecosystem, such as blue grama (*Bouteloua gracilis*) and three-awn (*Aristida purpurea*). On the western edge of Zone 2 closer to the foothills, mid-height and tall grasses are common including needle-and-thread (*Hesperostipa comata*), switchgrass (*Panicum virgatum*), bluestem (*Andropogon gerardii*), and little bluestem (*Schizachyrium scoparium*). Small areas of Foothills Shrublands also dot the western edge of Zone 2. However, the larger extent of this ecological system is represented in Zone 3 (next section). Dominant overstory species found in the Foothills Shrubland are mountain mahogany (*Cercocarpus montanus*), rabbitbrush (*Chrysothamnus nauseosus*), and skunkbush sumac (*Rhus trilobata*). Mail Creek and Fossil Creek contain stretches of Lotic Riparian Shrublands and Lotic Riparian Forests. The former is dominated by coyote willow (*Salix exigua*) and chokecherry (*Prunus virginiana*), while plains cottonwood (*Populus angustifolia*), narrowleaf cottonwood (*Populus deltoides*), peachleaf willow (*Salix amygdaloides*), and the non-native crack willow (*Salix* x *fragilis*); dominate the overstory of the Lotic Riparian Forests. Lastly, Pelican Marsh Natural Area is an example of the Lakes, Ponds, and Associated Wetlands ecological system, and it provides important open water for waterfowl.

Grassland at Cathy Fromme Prairie Natural Area (Photo by Aran Meyer)

Zone 2 landscapes host a variety of wildlife due to the diversity of habitat types. Waterbodies (lakes/ponds) support migratory non-resident and migratory resident waterfowl as well as other groups of birds. Mink and muskrat have been observed in Fossil Creek along with evidence of beaver dams and lodges. Grasslands in Zone 2 support grassland bird species that are excellent indicators of grassland

condition and health, and species of interest. Small mammals including vole, mice, and ground squirrels act to burrow and churn through the soil releasing nutrients and benefiting plant growth. Small mammals are also an important prey source for predators. Restoration goals aim to create conditions that promote a diversity of small mammals. Disturbance activities including grazing and fire act to restart the successional process and create habitat diversity.

Stressors within Zone 2 are:

- High cover of non-native species;
- Lack of structural diversity in vegetation;
- Overgrazing by prairie dogs resulting in bare ground and increases in non-native plants;
- Lack of disturbance such as fire, grazing, and large insect events;
- Prior land use (e.g. soil, water and carbon depletion, erosion, etc.);
- Fragmentation of habitat by roads and other urban infrastructure;
- Disturbance by placement and maintenance of underground utility infrastructure; and
- Increasing severity and frequency of drought due to climate change.

Restoration Goals

The goals and actions listed below largely focus on restoring former agricultural lands to create improved habitat for wildlife and plant species. The success of these actions may require extensive efforts for long periods of time, and may be dependent on climate variables such as drought. The goals and restoration actions for Zone 2 are listed below.

GOAL - Accelerate the pace of restoration to better prepare for impacts of climate change by establishing resilient and diverse habitats

- ✓ Initiate all grassland restoration on SW sites by 2019.
- ✓ Initiate all grassland restoration at all Fossil Creek sites by 2025.

GOAL - Manage for structural and native plant diversity

- ✓ Implement a variety of treatments that mimic natural disturbance regimes within the grassland ecosystem. Treatments may include prescribed burning, prescribed grazing, and mechanical treatments such as mowing and haying.
- ✓ Burn 10% of restored grasslands per year according to the goal in the Natural Areas Master Plan.
- ✓ Target <25% native cover areas such as smooth brome and crested wheatgrass monocultures as restoration priorities.
- ✓ Monitor for non-native plants along at-risk trails.
- ✓ Manage prairie dog populations consistent with the Wildlife Management Guidelines.

GOAL - Support suite of grassland wildlife

- ✓ Reference CNHP's guidelines for plant composition and structure for Zone 2 plant communities including: Grasslands, Foothill Shrublands, Lotic Riparian Shrublands, Lotic Riparian Forests, Lakes, Ponds and Associated Wetlands.
- ✓ Seek assistance and reference documents from CPW and Bird Conservancy of the Rockies for wildlife habitat recommendations.
- ✓ Create structural diversity for native grassland wildlife by planting shrubs and forbs, and create patch disturbances with prescribed burns and grazing.
- ✓ Establish higher cover of native upland and wetland forbs for pollinator habitat in restored areas. Include important larval hosts and adult nectar plants in restoration seed mixes (big bluestem, little bluestem, and a diversity of native forbs).
- ✓ Maintain snags and large trees for raptor perches, and shrub pockets for predator habitat.

GOAL – Improve wetland habitat and riparian habitat along grassland associated creeks

- ✓ Identify possible grassland creek reference sites and determine ideal future condition.
- ✓ Collaborate with the Stormwater Utility to restore grassland creeks and swales.
- ✓ Support waterfowl, muskrat, mink, and beaver expansion into unoccupied areas of the Fossil Creek watershed. Support efforts to identify areas not currently occupied.

GOAL - Accommodate for climate changes

- ✓ Set restoration goals for ecosystem function under future hotter conditions, not pre-settlement conditions.
- ✓ Identify, conserve, and propagate local plant ecotypes to accommodate for climate change.
- ✓ Maintain soil carbon levels by minimizing ground disturbance during restoration efforts.

GOAL - Protect/expand populations of plant and wildlife species of interest within Zone 2 (Appendix A and B). Highlights include:

- ✓ Consider the re-introduction of bison on Coyote Ridge Natural Area as well as the re-introduction of northern leopard frog and plains fishes of interest to Fossil Creek.
- ✓ Protect and expand populations of grasshopper sparrow, Brewer's sparrow, Cassin's sparrow, lark sparrow, and vesper sparrow through habitat management.
- ✓ Restoration priorities (augmentation, reintroduction and ex situ conservation) for plant species of interest include the following species (see also Appendix A): *Ruppia cirrhosa, Sparganium*

eurycarpum, Wolffia columbiana, Acorus calamus, Calystegia sepium, Eustoma exaltatum ssp. *russellianum, Lysimachia ciliata,* and *Spiranthes diluvialis*.

GOAL - Establish and continue grassland wildlife monitoring programs

- ✓ Continue grassland breeding bird surveys, using indicator species, to measure grassland health and restoration success (Table 4). Utilize published abundance and density objectives for bird indicator species as they become available.
- ✓ Consider small mammal monitoring using a suite of species, as a measure of grassland health and restoration success.
- ✓ Consider expansion of existing amphibian monitoring program.
- ✓ Survey for butterfly indicator species in grasslands to monitor habitat functionality and restoration success (Table 4): Arogos skipper (*Atrytone arogos*), Ottoe's skipper (*Hesperia ottoe*), crossline skipper (*Polites origenes*), and regal frittilary (*Speyeria idalia*).

D. Zone 3: Foothills

Zone 3 encompasses six natural areas and approximately 5,310 acres (Figure 9), including Reservoir Ridge, Maxwell, Pineridge, Coyote Ridge, Bobcat Ridge, and Foothills Trail. This area has a history of agriculture and ranching prior to acquisition as public natural area. Zone 3 is dominated by native plants (Figure 10), but shows areas dominated by invasive weeds or remnant agricultural crops.

Three major ecological systems are present in Zone 3:

- Foothills Shrublands
- Grasslands
- Ponderosa Pine Forests

Foothills Shrubland at Reservoir Ridge Natural Area (Photo by Norm Keally)

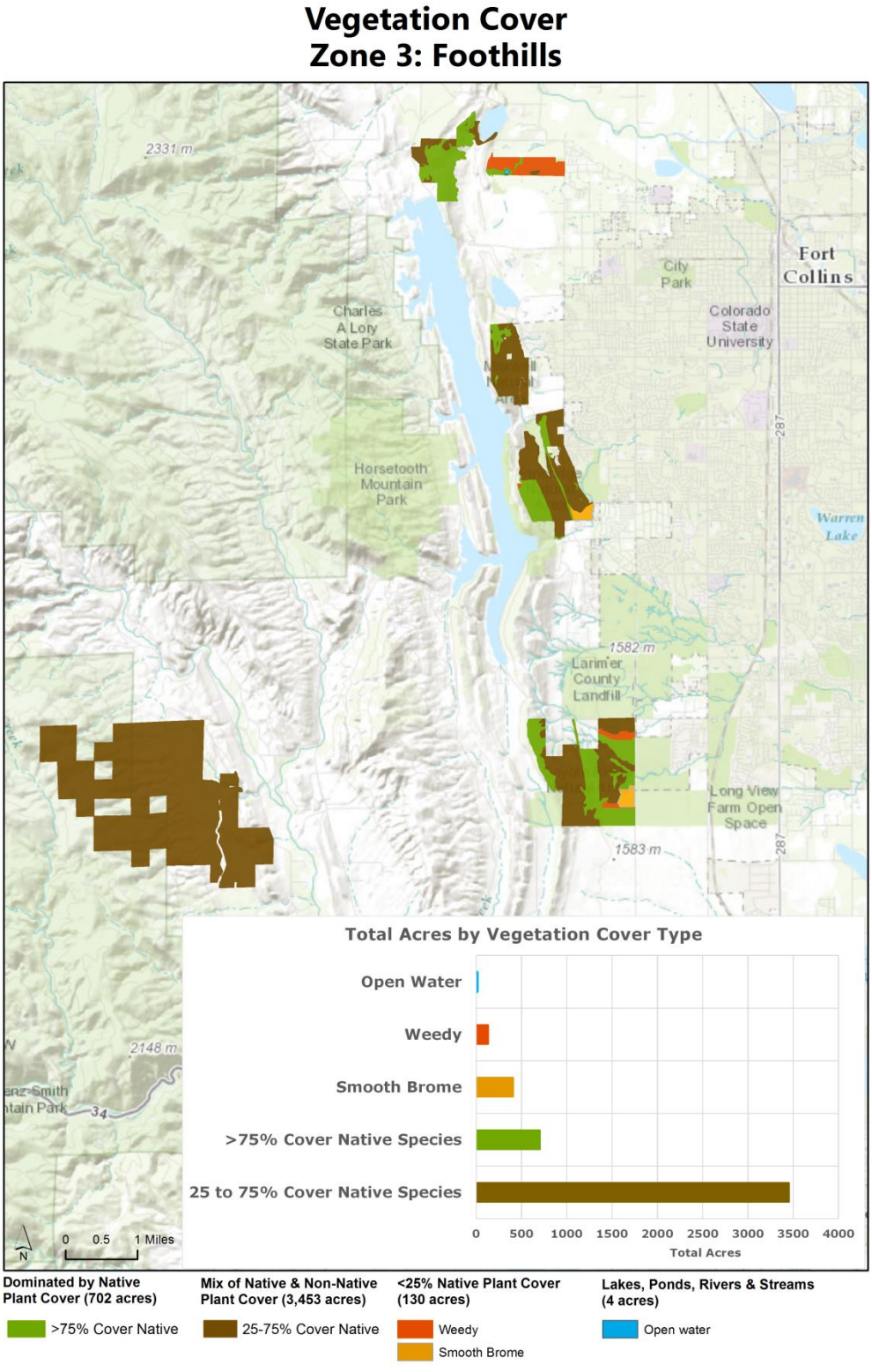
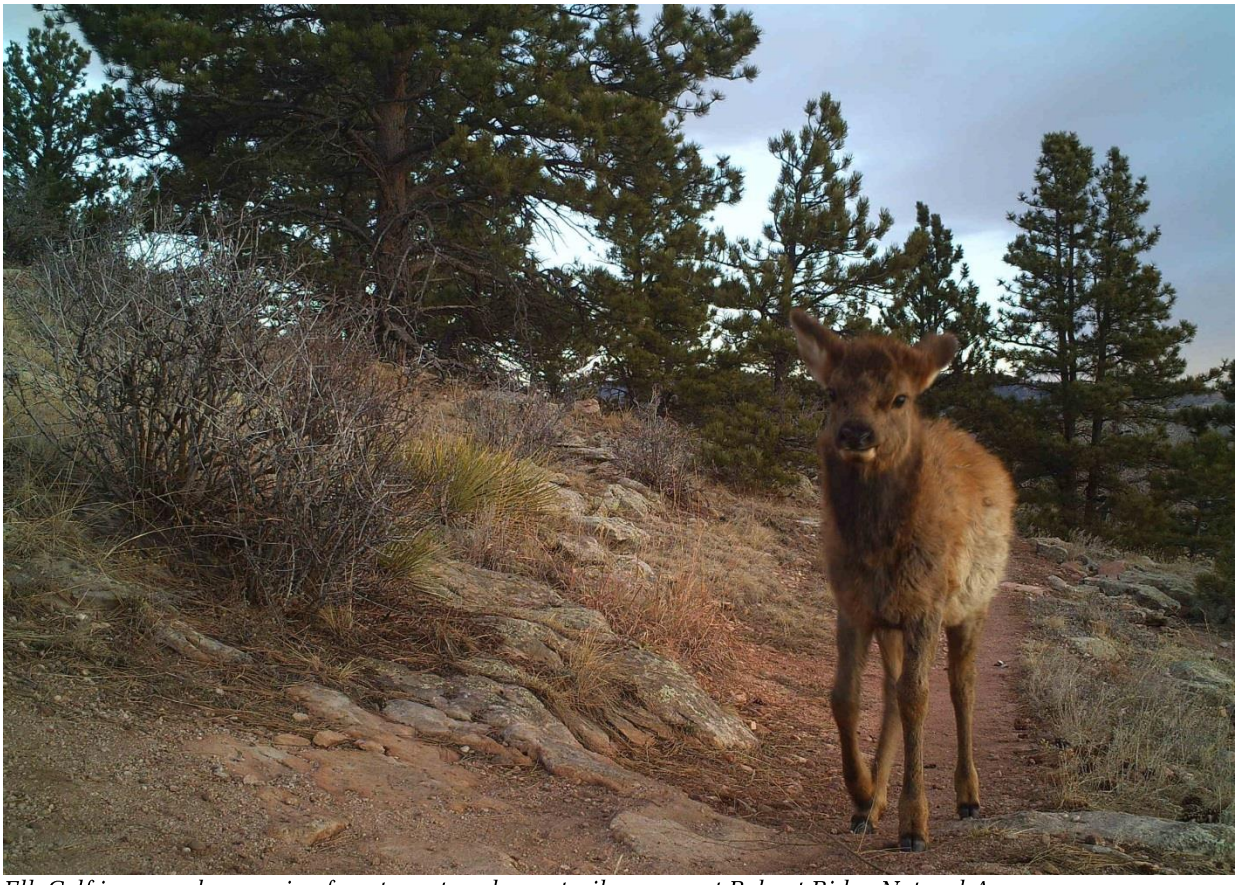


Figure 9. Vegetation cover and acreage totals for each land cover category in Zone 3: Foothills. Note: land cover has not been documented for all Natural Area parcels in Zone 3.

Foothills Shrublands include such species as mountain mahogany (*Cercocarpus montanus*), rabbitbrush (*Chrysothamnus nauseosus*), and skunkbush sumac (*Rhus trilobata*), with drainages of wild rose (*Rosa woodsii*), and American plum (*Prunus americana*). Ponderosa pine (*Pinus ponderosa*) forestlands are dominated by ponderosa pine, with aggressive non-natives such as cheatgrass (*Bromus tectorum*), Japanese brome (*Bromus arvensis*), and smooth brome (*Bromus inermis*) dominating the understory. Various sage (*Artemisia* spp.), goldenrod (*Solidago* spp.), and currant (*Ribes* spp.) represent the dominant natives in this system. Grasslands in this zone vary with some areas having considerable smooth brome coverage to others containing plant species common in the shortgrass prairie ecosystem, such as blue grama (*Bouteloua gracilis*) and three awn (*Aristida purpurea*). In Zone 3, mid-height and tall grasses are common including needle-and-thread (*Hesperostipa comata*), switchgrass (*Panicum virgatum*), big bluestem (*Andropogon gerardii*), and little bluestem (*Schizachyrium scoparium*).

These habitats are prime areas for ungulate populations including elk and mule deer, but are also home to some of Colorado's most charismatic large predators, including black bear, mountain lion, bobcat, and coyote. Rare species, such as Preble's meadow jumping mouse, could be found in select riparian areas that intersect the Foothills and its plant communities. This zone also supports species of grassland, shrubland, and forest breeding birds unique to these habitats. Grasslands in this zone play the same role as they do in Zone 2 with regards to grassland birds and mammals. Plant species in the foothills are important hosts for butterfly species as well and should be conserved and expanded.



Elk Calf in a ponderosa pine forest, captured on a trail camera at Bobcat Ridge Natural Area

Stressors

- Non-native plant invasion (specifically cheatgrass)
- Lack of natural disturbance
- Prairie dog grazing pressure with resulting increase in non-natives
- Susceptibility to catastrophic fire impacts

Restoration Goals

Goal - Restore native vegetation diversity, composition, and structure

- ✓ Reference CNHP's guidelines for plant composition and structure in Zone 3 plant communities including, ponderosa pine forest, foothill shrubland, grassland.
- ✓ Seek assistance and reference documents from CPW and Bird Conservancy of the Rockies for wildlife habitat recommendations.
- ✓ Initiate restoration on 600 acres of grassland at Bobcat Ridge by 2025.
- ✓ Control non-native vegetation (e.g., cheatgrass, toadflax) and restore native vegetation through burning, grazing, aerial spraying, backpack spraying, planting native forbs, and hand-pulling as required.
- ✓ Conduct prescribed fires on an as needed basis. Once areas are restored, a regular more natural fire rotation may be implemented.
- ✓ Assess ponderosa pine forests for natural seedling recruitment and consider supplemental planting as necessary at Bobcat Ridge and any other burned forest areas. Consult with the Colorado State Forest Service for recommended pine densities.
- ✓ Continue to monitor ponderosa pine for impacts from pine beetles and take appropriate management actions.

GOAL - Support native wildlife

- ✓ Identify and improve movement corridors for wildlife with wide ranges including deer and elk. Collaborate with the Colorado State University and CPW to better understand these populations.
- ✓ Support habitat needs for rare species such as Ute's ladies tresses orchid and Preble's meadow jumping mouse.
- ✓ Establish higher cover of native upland and wetland forbs for pollinator habitat in restored areas.
- ✓ Understand and include snag density goals for wildlife habitat.

GOAL - Protect/expand populations of plant and wildlife species of interest within Zone 3 (Appendix A and B). Highlights include:

- ✓ Manage riparian vegetation for, and consider reintroduction of, Preble's meadow jumping mouse.

- ✓ Protect and expand populations of arogos skipper, Ottoe's skipper, crossline skipper and regal fritillary through habitat management. Include important larval hosts and adult nectar plants in restoration seed mixes (big bluestem, little bluestem, and a diversity of native forbs).

- ✓ Restoration priorities (augmentation, reintroduction and ex situ conservation) for plant species of interest include the following species (see also Appendix A): *Humulus lupulus* var. *neomexicanus, Eustoma exaltatum* ssp. *russellianum, Lysimachia ciliata, Physaria bellii, Spiranthes diluvialis, Triodanis leptocarpa,* and *Triodanis perfoliata*

GOAL - Continue existing and establish new wildlife monitoring programs as resources allow

- ✓ Continue surveys for bird indicator species on foothills grasslands and shrublands in order to monitor habitat functionality and restoration success (Table 4).

- ✓ Survey for butterfly indicator species in foothills grasslands to monitor habitat functionality and restoration success (Table 4).

- ✓ Expand the Bobcat Ridge breeding bird surveys in order to detect bird indicator species in the ponderosa pine forests (Table 4). Consider similar surveys at other natural areas with small stands of ponderosa pine forests.

- ✓ Continue and expand the existing amphibian monitoring program in order to monitor a suite of species and detect the presence of northern leopard frog.

E. Zone 4: Poudre River Canyon

Zone 4 includes Gateway and Picnic Rock natural areas (Figure 10). Gateway was the home to a water treatment facility at the confluence of the Cache la Poudre River and North Fork of the Cache la Poudre River. The treatment facility was closed in the 1980s and was opened to the public in 2002 as Gateway Mountain Park, but was renamed Gateway Natural Area when the site was transferred to the Natural Areas Department. The intense public use area of the natural area has a significant footprint with a park-like setting of solitary trees and turf grass. Away from the high use area, the 2013 High Park Fire consumed a large portion of the natural area, leaving numerous snags and bare soils subject to erosion.

Four major ecological systems are present in Zone 3.

- Foothills Shrublands
- Mixed Conifer
- Ponderosa Pine Forests
- Lotic Riparian Forests

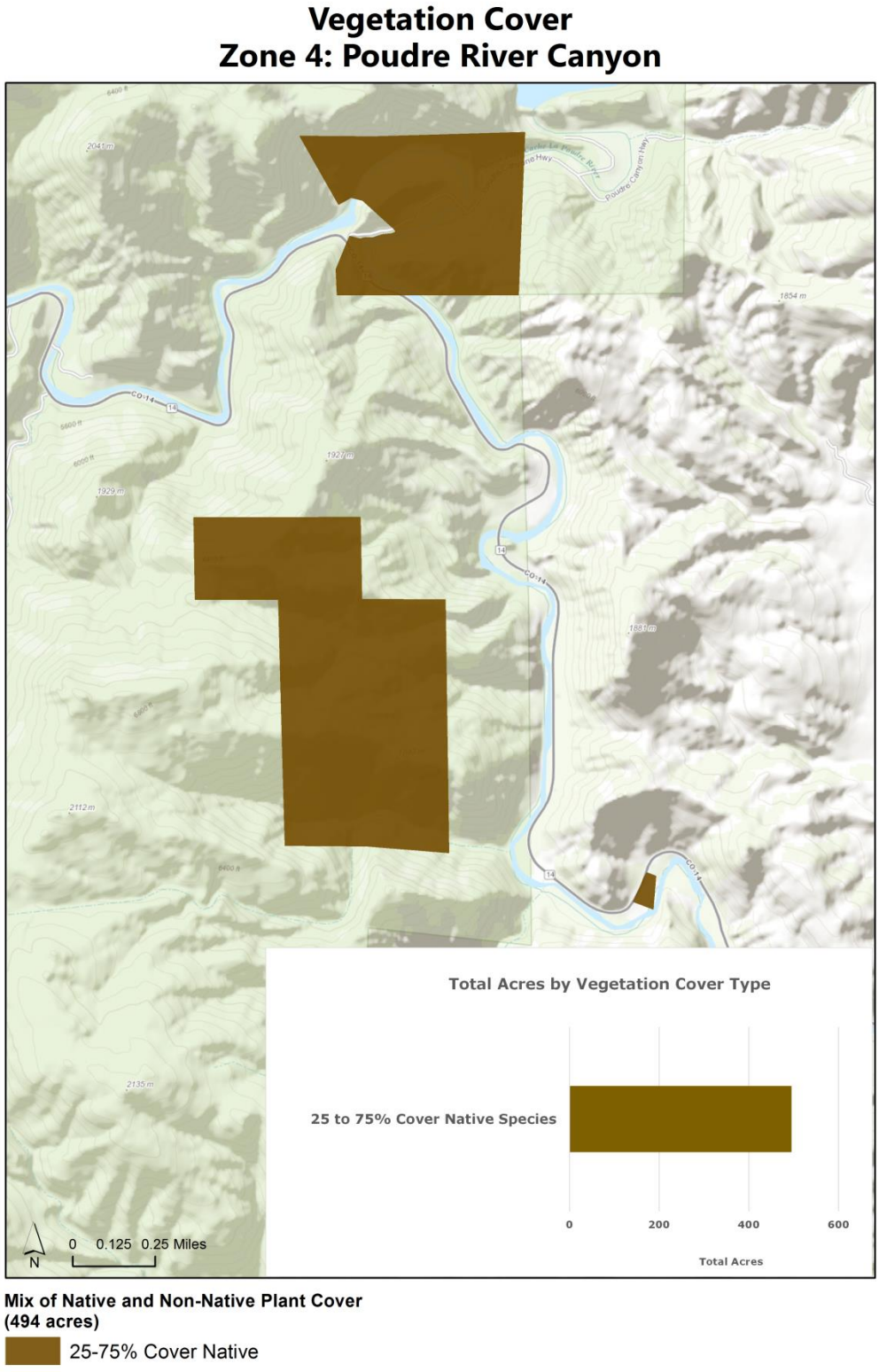


Figure 10. Vegetation cover and acreage totals for each land cover category in Zone 4: Poudre River Canyon.

Foothills Shrublands include such species as mountain mahogany (*Cercocarpus montanus*), rabbitbrush (*Chrysothamnus nauseosus*), and skunkbush sumac (*Rhus trilobata*), with drainages of wild rose (*Rosa woodsii*), American plum (*Prunus americana*), and snowberry (*Symphoricarpos occidentalis*). Ponderosa Pine Forestlands are dominated by ponderosa pine, with cheatgrass (*Bromus tectorum*), Japanese brome (*Bromus japonicas*), smooth brome (*Bromus inermis*), various sage (*Artemisia* spp.), goldenrod (*Solidago* spp.), and currant (*Ribes* spp.). The Mixed Conifer Forests are a mix of Douglas fir (*Pseudotsuga menziesii*) and white fir (*Abies concolor*) with some ponderosa pine (*Pinus ponderosa*), aspen (*Populus tremuloides*), and spruce (*Picea* spp.) intermixed. Lotic Riparian Forests are dominated by native tree species such as the plains cottonwood (*Populus deltoides*), narrowleaf cottonwood (*Populus angustifolia*), peachleaf willow (*Salix amygdaloides*), coyote willow (*Salix exigua*), and the non-native crack willow (*Salix fragilis*), alder (*Alnus tenufolia*), Russian olive (*Eleagnus angustifolia*), and elm (*Ulmus* spp.).

Poudre River Canyon (photo by Ken Eis)

Like the Foothills, the ecological systems in Zone 4 host elk, mule deer, black bear, mountain lion, bobcat, and coyote. River otter are present in the upper watershed and may use areas managed by the Natural Areas Department. Additionally, semi-aquatic mammals such as beaver, muskrat, and mink are present in this zone. Rare species, such as Preble's meadow jumping mouse, could be found in select riparian areas along the river while the fringed myotis bat and Abert's squirrel have been documented in this zone. Bird species assemblages can change in this zone relative to the lowland riparian forest found within the City of Fort Collins, but continue to be excellent indicators of habitat condition and quality.

Stressors
The primary stressors located within Zone 4 include:

- Non-native plants (especially toadflax)
- Impacts from recent wildland fires (soil erosion, non-native vegetation following fire)
- Recreation use impacts

Restoration Goals
In order to alleviate stressors mentioned above, the Natural Areas Department will focus on efforts to minimize soil erosion, maintain weed control, and establish monitoring programs for forest health and selected wildlife. The complete list of goals and actions are:

GOAL - Promote native plant communities to support habitat needs of native wildlife

- ✓ Reference CNHP's guidelines for plant composition and structure for Zone 4 plant communities including: foothill shrublands, lotic riparian forests, mixed conifer forests, and ponderosa pine forests.
- ✓ Seek assistance and reference documents from CPW and Bird Conservancy of the Rockies for wildlife habitat recommendations.
- ✓ Monitor forest recovery from the High Park Fire and determine if/when actions are required to reduce weed infestations and control soil erosion.
- ✓ Consider alternative methods of restoration and vegetation management in the steep mountain terrain.

GOAL - Protect/expand populations of plant and wildlife species of interest within Zone 4 (Appendix A and B). Highlights include:

- ✓ Manage habitat for, and consider reintroduction, of Preble's meadow jumping mouse.
- ✓ Enable healthy populations of the fringed myotis bat and Abert's squirrel to persist.
- ✓ Restoration priorities (augmentation, reintroduction, and ex situ conservation) for plant species of interest include the following species (see also Appendix A): *Humulus lupulus* var. *neomexicanus* and *Spiranthes diluvialis*.

GOAL- Establish new wildlife monitoring programs as resources allow

- ✓ Establish a bird indicator species monitoring program to monitor the functionality of riparian, ponderosa pine, and mixed-conifer forests (Table 4).
- ✓ Conduct surveys for Preble's meadow jumping mouse in appropriate habitat before major riparian disturbance or restoration. Consider a baseline presence/absence survey within Preble's habitat.

F. Zone 5: Soapstone Prairie

Soapstone Prairie Natural Area (Soapstone Prairie hereafter), nearly 23,000 acres, is the only City natural area found within the Moderate Relief Plains of the High Plains Ecoregion (Chapman et al. 2006). It is the largest City natural area and is located approximately 25 miles north of the City of Fort Collins. Soapstone Prairie is considered its own restoration zone due to its large size, vast expanses of native shortgrass prairie and foothill shrubland, and its relative geographic isolation from the core concentration of Fort Collins natural areas (Figure 11).

Five ecological systems occur at Soapstone Prairie:

- Grasslands
- Foothills Shrublands
- Lotic Riparian Shrublands
- Lotic Riparian Forests
- Groundwater-Fed Prairie Wetlands

Together, this mix of upland and wetland systems supports a diverse flora of approximately 450 plant taxa. For more detailed information on Soapstone Prairie, see the Soapstone Prairie Natural Areas Management Plan (2007).

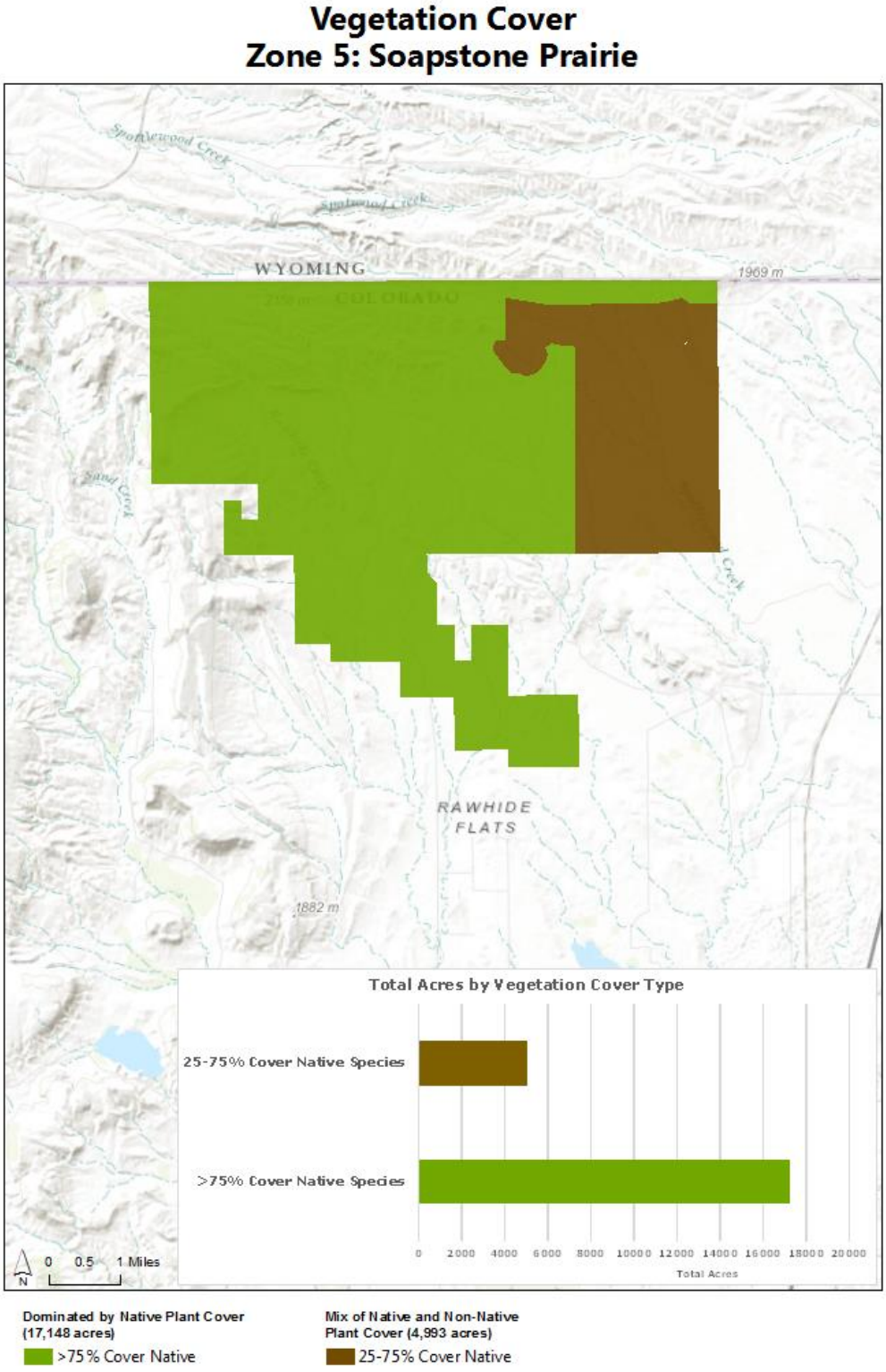


Figure 11. Vegetation cover and acreage totals for each land cover category in Zone 5: Soapstone Natural Area. Note: land cover has not been documented for all Natural Area parcels in Zone 5.

The Grassland ecological system at Soapstone Prairie is largely comprised of native shortgrass prairie. Dominated by buffalo grass (*Buchloe dactyloides*), blue grama (*Bouteloua gracilis*), and sideoats grama (*Bouteloua curtipendula*), shortgrass prairie covers approximately 70% of Soapstone Prairie. It contains important habitat for both common and rare grassland species that have experienced severe habitat loss in the last century. A total of sixteen plants identified as Species of Interest by the NAD have been documented in the shortgrass prairie at Soapstone Prairie Natural Area (see Appendix A). Three rare plant communities also occur in the shortgrass prairie at Soapstone: blue grama/buffalo grass, needle-and-thread grass/blue grama, and winterfat/western wheatgrass/blue grama (see Soapstone Management Plan for more details). Many more rare plants and animals have not been documented, but could potentially occur at Soapstone. These are included in the comprehensive Natural Areas Species of Interest list in Appendix A and B.

The Foothills Shrublands ecological system at Soapstone contains rocky upland areas with thin soils dominated by shrubs such as mountain mahogany (*Cercocarpus montanus*) and skunkbush sumac (*Rhus trilobata*), as well as pockets with deeper soils that support mid-height prairie grasses such as needle-and-thread grass (*Hesperostipa comata*) and New Mexico feathergrass (*Hesperostipa neomexicana*). Historically, mountain mahogany shrublands covered much of the foothills along Colorado's Front Range. However, many of these shrublands have disappeared due to development, or have been severely fragmented. Soapstone Prairie contains mountain mahogany shrublands that are large in size, intact, and dominated by native plants.

Groundwater supported Prairie Wetlands at Soapstone include springs, wet meadows, fens, and other small wetlands. The largest examples of these are Brannigan Springs and Jack Springs. Both of these springs support large wetlands that contain Rocky Mountain blazing star (*Liatris ligulistylis*) and pale blue-eyed grass (*Sisyrinchium pallidum*). They also contain rare plant communities, and provide important wildlife habitat in an otherwise arid landscape. Brannigan Springs and Jack Springs have been identified as Potential Conservation Areas by the Colorado Natural Heritage Program.

Riparian areas at Soapstone are located along Graves Creek, Rawhide Creek, Sand Creek, and Spottlewood Creek. These creeks maintain a natural hydrologic pattern, flowing through a mosaic of upland and riparian shortgrass prairie plant communities. They support a diversity of common and rare native species. Two ecological systems are found along these creeks: Lotic Riparian Shrublands and Lotic Riparian Forests. The Lotic Riparian Shrublands are dominated by coyote willow (*Salix exigua*), while the Lotic Riparian Forests contain stands of narrowleaf cottonwood (*Populus angustifolia*), plains cottonwood (*Populus deltoides*), and peachleaf willow (*Salix amygdaloides*).

Soapstone prairie provides valuable habitat for numerous wildlife species, many of which are considered Species of Interest by the NAD. It is an important reintroduction site for black-footed ferrets, bison, red-belly dace, and plains topminnow. Soapstone also provides important winter range for pronghorn antelope, mule deer and elk. Other rare wildlife species can be found in this zone such as swift fox, leopard frog, ferruginous hawk, peregrine falcon, and mountain plover.

Black-footed ferret at Soapstone Prairie Natural Area (Photo by Mathew Holzwarth)

Stressors

Soapstone Prairie is a biologically diverse site, with large expanses of undeveloped shortgrass prairie. However, stressors such as noxious weeds and lack of natural fire regime all have potential to diminish the quality of the Soapstone Prairie ecosystem. The primary stressors include:

- Non-native/invasive plant species
- Lack of natural disturbance such as fire
- Uncertain impacts from climate change
- Wildlife plague epizootics (outbreaks)

Restoration Actions

Soapstone Prairie is a prime location for conservation and re-introduction efforts, given its large size and relatively intact ecosystem. The NAD has already reintroduced populations of black-footed ferrets in 2014, and bison in late 2015. A large part of these wildlife restorations will involve on-going monitoring and adaptive management as needed. A complete list of goals and actions is detailed below.

GOAL- Use natural disturbance and grazing to support ecological function

- ✓ Use bison, cattle, and black-tailed prairie dogs to promote a natural grazing regime in the prairie ecosystem.

- ✓ Conduct prescribed burning to periodically restart plant community succession of grasslands.

GOAL- Support a suite of native grassland plant communities and wildlife

- ✓ Reference CNHP's guidelines for plant composition and structure in Zone 5 plant communities including, grasslands, foothills shrublands, lotic riparian shrublands, lotic riparian forests, and groundwater-supported prairie streams and wetlands.
- ✓ Seek assistance and reference documents from CPW and Bird Conservancy of the Rockies for wildlife habitat recommendations.
- ✓ Use on-site seed sources to preserve local ecotype genetics.
- ✓ Restore eastern portions of Soapstone Prairie to >75% native cover by restoring native appropriate shortgrass prairie species with local (Soapstone-sourced) ecotypes.
- ✓ Continue management efforts to control plague in black-tailed prairie dog colonies and black-footed ferret locations.
- ✓ Continue on-going experimental efforts to control plague with partnered research institutions.
- ✓ Expand bare ground habitat for mountain plover.
- ✓ Implement formal monitoring along trails for invasive plants.
- ✓ Continue efforts to protect stream flow and riparian areas within the grassland ecosystem.

GOAL- Plan for climate change

- ✓ Install groundwater wells at major springs to monitor and understand hydrologic patterns in the face of a changing climate.
- ✓ Maintain soil carbon levels by minimizing ground disturbance during restoration efforts.

GOAL - Protect/expand populations of plant and wildlife species of interest within Zone 5 (Appendix A and B). Highlights include:

- ✓ Consider reintroductions of sharp-tailed grouse and continue to support current reintroduction efforts for bison, black-footed ferrets, plains topminnow, and redbelly dace.
- ✓ Restoration priorities (augmentation, reintroduction, and ex situ conservation) for plant species of interest include the following species (see also Appendix A): *Sparganium eurycarpum, Humulus lupulus* var. *neomexicanus, Eleocharis atropurpurea, Gaura neomexicana* ssp. *coloradensis,* and *Spiranthes diluvialis*.

GOAL- Support and continue wildlife monitoring programs

- ✓ Continue monitoring and supporting the reintroduced black-footed ferret population.
- ✓ Create a grassland bird monitoring plan on a 3-year cycle targeting CPW's Tier 1 and Tier 2 species (Appendix B).

Literature Cited

Chapman, S.S., G.E. Griffith, J.M. Omernik, A.B. Price, J. Freeouf, and D.L. Schrupp. 2006. Ecoregions of Colorado. (Map Scale 1:1,200,000). U.S. Geological Survey, Reston, Virginia.

City of Fort Collins, 2015. River Health Assessment Framework, Poudre River. Final Report, August 2015. City of Fort Collins, Natural Areas Department. Available upon request.

Colorado Natural Heritage Program. 2005. Ecological System Descriptions and Viability Guidelines for Colorado. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

McPherson, G.R. 1995. The role of fire in desert grasslands. Pp 130-151. The Desert Grassland, (M.P. McClaran and T.R. Van Devender, [eds.]). University of Arizona Press, Tucson, Arizona.

Poudre River Technical Advisory Group. 2008. Characterizing the Cache la Poudre River: Past, Present, and Future. Final Report, April 2008. Available upon request.

Chapter 7: Measurable Outcomes for Restoration Projects

A. Current Management and Restoration Measures
B. Improvements and New Measures Going Forward
C. The Monitoring Matrix
D. Synchronizing with the River Health Assessment Framework (RHAF)

A. Current Management and Restoration Measures

The City has improved efforts to measure outcomes of requested budgets including those for restoration projects. Through the years a number of metrics have been utilized by the Department in an attempt to establish meaningful measures of the Department's restoration efforts. The following have been established and utilized to report our progress in this plan (Chapter 2) as well as several other forums. The Department will continue to use these measures in addition to the new measures discussed in this chapter.

1. *Restoration Status (Pre-restoration, Active, Post-restoration) in Urban Natural Areas;*
2. *Existing condition (progress conversion to native vegetation) in Active Restoration Areas;*
3. *Percent native vegetation on all urban natural areas;*
4. *Qualitative photo point score on vegetation community condition;*
5. *Breeding bird surveys as indicator of habitat quality; and*
6. *River floodplain acreage brought into the 5-year inundation zone over a 3-year rolling period.*

B. Improvements and New Measures Going Forward

Over the next 10-year period, the Department will continually improve upon current restoration measures while incorporating new measures specific to projects or areas.

New Restoration Status Categories

During this restoration plan update it became evident that the original three categories for restoration status (maintenance, active restoration, and post restoration) were insufficient for our internal understanding of existing conditions and progress for our restorations efforts. The new categories refine the category for "Maintenance/Pre-restoration" as truly maintenance areas that are yet to be restored versus areas where restoration is being initiated. Next, the "Active Restoration" areas are more aptly named "native planting & establishment period" more aptly describes areas that were recently re-planted and are intensely managed and monitored. As such, the new restoration status categories are:

1) Maintenance or pre-restoration
2) Restoration Initiated
3) Native planting establishment period
4) Restored
5) Naturally great condition

Additional Indicator Species

In addition to the avian species that have emerged as indicators of quality grassland and riparian habitat, the Department has identified additional potential indicator species by habitat type. The table below (Table 4) outlines both current and potential indicator species. This list is a culmination of expertise from CNHP, The Bird Conservancy of the Rockies, and the Natural Areas Department.

Recommended indicator species for several plant communities are available in the CNHP Ecological System Descriptions and Viability Guidelines for Colorado (2005) and were adopted by the Natural Areas Department.

For restoration monitoring purposes, indicator species are those that are responsive to management actions and would signal change in habitat condition. Additionally, indicator species exhibit habitat requirements that are representative of other wildlife within that habitat type. Likewise, indicator species can be used to measure restoration success only if that species has the potential to be present on a restoration site and has a preference for the desired conditions. Urban habitats may not have the ability to host some indicator species, therefore the urban grasslands and Soapstone Prairie grasslands are divided in the list below.

Resources to conduct monitoring efforts are currently limited; however, through this planning effort, additional monitoring program goals and budget have been identified and will be implemented as time and funding allow (Chapters 3, 6, and 8).

Table 4. Wildlife Indicator Species by habitat type (restoration zone).

Wildlife Species or Group	**Urban Grasslands** Zone 2	**Foothill & Piedmont Grassland** Zone 3	**Ponderosa Pine** Zones 3,4	**Wetlands** Zones 1,2,3,5	**Riparian** Zones 1,2,3,4,5	**Soapstone Shortgrass Prairie** Zone 5
Vesper sparrow	X					
Lark sparrow	X					
Brewer's sparrow	X					
Cassin's sparrow	X					
Grasshopper sparrow	X					
Pygmy nuthatch			X			
Lewis' woodpecker			X		X	
Plumbeous vireo			X			
Long-billed curlew						X
Mountain plover						X
McCown's longspur						X
Short-eared owl						X
Ferruginous hawk						X
Prairie falcon						X
Golden eagle						X
Burrowing owl						X
Sora				X		
American bittern				X		
Virginia rail				X		
Green heron				X		
Grey Catbird					X	
Brown thrasher					X	
Yellow-breasted chat					X	
Yellow-billed cuckoo					X	
Eastern screech owl					X	
Arogos skipper		X				
Ottoe's skipper		X				
Crossline skipper		X				
Regal frittilary		X				X
Native prairie fish					X	
Short-horned lizard						X
Northern leopard frog				X	X	
Native prairie amphibians				X	X	
Preble's meadow jumping mouse					X	
Native small mammals	X					
Swift fox						X
Black-footed ferret						X
Pronghorn						X
Black-tailed prairie dog complexes						X

Eastern screech owl (Megascops asio), a natural areas riparian indicator species (Photo by Aran Meyer)

C. The Monitoring Matrix

As part of this plan, a new process was developed to determine which attributes of a restoration will be monitored on a project specific basis. Attributes of a restored ecosystem should be selected based on the ability to indicate achievement of specific desired goals. For the purposes of evaluating specific river and floodplain restoration projects within natural areas, various components of five different protocols were compiled to create a Monitoring Matrix based on existing literature, which is included in Appendix C (Woolsey et al. 2007, Lewis et al. 2009, Palmer et al. 2011, Duncan 2012, Johnson et al. 2013).

The matrix is a simple spreadsheet intended for a project manager to identify project goals during the design phase. In general, pre- and post-construction monitoring would aim to characterize the project site relative to pre-selected goals. Though the monitoring matrix was developed with a heavy emphasis towards river and floodplain restoration, it may be easily adapted to restoration projects outside the river corridor.

D. Synchronizing with the River Health Assessment Framework

The City of Fort Collins Natural Areas Department and Utilities Service Area have developed a River Health Assessment Framework (RHAF) to clearly define the City's vision for a healthy and resilient Poudre River. This vision includes aspirations for improving the Poudre River's health as well as sustaining current ecosystem function. The RHAF will help guide and inform the City's efforts to support watershed services and river management efforts. The scope of the RHAF encompasses the entire Poudre River as it affects the city, from its headwaters to Windsor, but with greater emphasis on the reach extending from the mouth of the Poudre Canyon to I-25.

The RHAF is based on a recently developed river assessment methodology that has been refined and customized to fit the specific context of the Poudre River. This methodology is built around ten indicators that represent the essential physical, chemical, and biological elements of the river ecosystem. Each health indicator is described by several metrics that are measurable or observable aspects of the river ecosystem, such as water chemistry or the number of bird species detected. Evaluation of the restoration outcomes of river and floodplain restoration efforts will require close incorporation of these indicators and metrics with the ones described above. Cross-reporting of indicator metrics will inform the broader effort to measure the health of the river, while providing important specific input to help guide the design and functional outcomes of restoration efforts.

Literature Cited

City of Fort Collins, 2015. River Health Assessment Framework, Poudre River. Final Report. City of Fort Collins Natural Areas Department, Fort Collins, Colorado.

Colorado Natural Heritage Program. 2005. Ecological System Descriptions and Viability Guidelines for Colorado. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

Duncan, A. 2012. A Functional Approach to Riparian Restoration in Austin, Texas. City of Austin, Watershed Protection Department, Environmental Resource Management. Austin, Texas.

Johnson, B., M. Beardsley, and J. Doran. 2013. Functional Assessment of Colorado Wetlands (FACWet) Method – Version 3.0. Colorado State University, Fort Collins, Colorado.

Lewis, D., M. Lennox, and S. Nossaman, 2009. Developing a Monitoring Program for Riparian Revegetation Projects. University of California, Division of Agriculture and Natural Resources, Davis California, Publication #8363: 16.

Palmer, M. A., L. Wainger, L. Craig, C. Febria, J. Hosen, and K. Politano. 2011. Promoting Successful Restoration through Effective Monitoring in the Chesapeake Bay Watershed. Prepared for the National Fish and Wildlife Foundation, Washington, DC. 24 pp.

Woolsey, S., F. Capelli, T. Gonser, E. Hoehn, M. Hostmann, B. Junker, and A. Peter, 2007. A strategy to assess river restoration success. Freshwater Biology, 52(4), 752–769. http://doi.org/10.1111/j.1365-2427.2007.01740.x

Chapter 8: Priorities and 10-Year Budget Estimate

A. Budget Review 2005 – 2014 (Actuals)

B. Prioritization of Restoration Activities 2016 – 2025

C. Summary by Restoration Zone

D. Proposed Schedule and Estimated Budget through 2025

A. Budget Review 2005 – 2014 (Actuals)

Between 2005 and 2014, the Natural Areas Department spent an average of $498,770 per year on restoration-related activities with a median of $374,156 (Table 5). Larger expenditures represented below account for costs from large river restorations which require a significant capital expenditure on planning, permitting, earthwork, planting and plant materials, and follow-up. In those cases it has been necessary to "bank" several years funding to raise sufficient capital to complete the project. The "Keep Fort Collins Great" (KFCG) city-wide sales tax in part has funded river restoration projects since 2011. That funding proved critical in matching Natural Areas funding to implement several highly visible river restoration projects.

Table 5. Natural areas restoration budget 2005-2014.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	
Tree Removal	$ 3,000	$ 16,045	$ 7,075	$ -	$ -	$ 52,883	$ 13,963	$ 25,596	$ 10,340	$ 5,176	**$ 134,078**
Planting	$ 3,400	$ 39,263	$ 50	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 42,713**
Prescribed Burn	$ 4,639	$ 5,627	$ 23,641	$ 3,303	$ 4,538	$ -	$ 3,767	$ -	$ -	$ 3,268	**$ 48,783**
Demolition	$ 11,256	$ 2,385	$ -	$ 21,971	$ 52,383	$ 22,044	$ 3,935	$ 5,004	$ 10,225	$ 5,000	**$ 134,203**
Mowing	$ 24,268	$ 20,055	$ 29,098	$ 4,986	$ 6,125	$ 4,458	$ 4,600	$ 3,940	$ 4,590	$ 5,520	**$ 107,640**
Plant Materials	$ 22,033	$ 4,070	$ 14,391	$ 3,812	$ 15,166	$ 42,768	$ 40,007	$ 29,564	$ 31,042	$ 32,346	**$ 235,199**
Chemicals	$ 15,893	$ 9,829	$ 18,462	$ 10,047	$ 6,403	$ 22,927	$ 17,245	$ 10,744	$ 14,023	$ 7,673	**$ 133,246**
Capital Restoration	$ 192,112	$ 109,541	$ 552,780	$ 202,289	$ 574,286	$ 30,845	$ 241,143	$ 10,955	$ 880,034	$ 505,568	**$ 3,299,553**
KFCG Restoration	$ -	$ -	$ -	$ -	$ -	$ -	$ 147,050	$ 83,470	$ 167,112	$ 454,657	**$ 852,289**
Total	**$276,601**	**$206,815**	**$645,497**	**$246,408**	**$658,901**	**$175,925**	**$471,710**	**$169,273**	**$1,117,366**	**$1,019,208**	**$ 4,987,704**

Not listed in the tabulated calculations shown above is the significant river and floodplain restoration initiated on 31 acres of Homestead Natural Area (formerly the Woodward Governor property) in 2014. The $3.15 million cost of the restoration and improvements were provided by Woodard Governor as part of the Woodward Technology Center development agreement with the City.

B. Prioritization of Restoration Activities 2016 - 2025

Using a combination of Priority Conservation Areas and Ecosystem Specific Restoration Actions (Chapters 3 and 6), the NAD has identified Zones 1, 2, and 3 (Lower Poudre River, Southwest and Fossil Creek Grasslands, and Foothills) as top priority zones through the 2016-2025 period. While the Soapstone Prairie area (Zone 5) is perhaps the most biologically significant natural area, it requires almost no active restoration but rather a focus on maintaining a diverse grassland system through on-going disturbance regimes. Likewise, the Poudre River Canyon (Zone 4) is stable with a greater requirement for on-going monitoring rather than active restoration.

Restoration of Zones 1, 2, and 3 will require significantly different approaches. Relatively speaking, grassland restoration is less complex than river and floodplain restoration. Similarly, restoration in the Foothills presents an equally significant challenge due to steep slopes and dense mountain mahogany obscuring non-native grasses lying below. Zone 2 grassland restoration offers the lowest restoration cost with the highest value (management impact) relative to cost. The Foothills Zone restoration (non-native grass conversion) requires intensive weed control, with reliance upon native grass recovery

rather than active planting or reseeding. Finally, river and floodplain restoration within Zone 1 (Lower Poudre River) is the most costly and requires extensive planning, permitting, and earthmoving. While river restoration will be a high priority, it will be necessary to bank several years of capital restoration funding while also seeking additional funding mechanisms.

In addition to active, on-the-ground restoration, this plan proposes an intensified monitoring effort for biological impacts and effects of restoration. As part of the overall 10-year budget, a small amount of funding relative to the capital cost of the project is designated for up to three years of follow-up and evaluation. In addition to the funding to assist with external contracts as necessary, on-going support will be needed from natural areas field staff.

C. Summary by Restoration Zone

Zone 1 – Lower Poudre River ($5.2 million) 2016 - 2025

Restoration of the Poudre River and its floodplain will be a priority over the 10-year period of this plan. Beginning in 2016 through 2018 the Department's efforts will focus on the restoration of Kingfisher Point including in-channel restoration, wetland creation, and floodplain contouring. NAD is scheduling an extensive restoration at Running Deer Natural Area, and includes neighboring sections of Prospect Ponds and the Environmental Learning Center. This project estimated at $2.5 million will require partnerships and/or additional funding sources. Likewise, NAD anticipates the kickoff of a major restoration at Arapaho Bend in 2024, concluding by 2026. Finally, as part of a broader City effort to revitalize the Poudre River through the City's downtown, NAD will contribute $1,000,000 toward the Downtown River Project.

Zone 2 – SW and Fossil Creek Grasslands ($450,000) 2016 - 2023

Grassland restoration efforts in Zone 2 will represent a significant and high priority effort through 2019 and beyond. The Natural Areas' goal is to complete all initial entries into Zone 2 grassland on the southwest side of Fort Collins by 2019. Likewise, grasslands in the Fossil Creek area are scheduled for all initial entries by 2020 through 2023. Currently, initial grassland restoration with follow up actions is estimated at $500 per acre at current prices (2015).

Zone 3 – Foothills ($379,000) 2016 - 2025

Restoration efforts in the Foothills Ecosystem remain complex due to topography and the intermix of grasslands, shrublands, and open ponderosa pine forests. The priority for these areas is to reduce the coverage and abundance of cheatgrass and other exotic grasses. While there is no easy way to do this on a large scale, a 2015 experiment was conducted using an aerial herbicide application on a 20-acre test plot and could become the primary method of restoration in the foothills region. Based on pricing from the 2015 experimental exercise, the NAD estimates a cost of $50/acre for this method. Thus for estimation purposes we are targeting 200 acres/year at a cost of $10,000 per year beginning in 2016 and continuing for approximately 7 years for a conservative total of 1,400 acres.

At Bobcat Ridge Natural Area the NAD has identified the restoration of 600 acres (maximum) of grassland in Bobcat's valley as a high restoration priority. The NAD anticipates that effort will begin slowly and ramp up after 2018. If the $500/acre cost is applied to this effort it is expect that costs could rise to $300,000 through 2025. Given the high cost, our initial actions on site will be gradual, and spread over the 10-year cycle of this plan.

Zone 4 – Poudre River Canyon ($0)
Barring significant disturbance events (flooding and wildfire), the Upper Poudre River properties including Gateway Natural Area, Picnic Rock Natural Area, and future acquisitions will likely require on-going monitoring rather than any specific restoration treatments. However, in the event of a significant disturbance the Department may need to engage in erosion control, removal of hazard trees, or other activities. These needs are difficult to anticipate both in terms of specific events, and responsibility for response that typically falls to the U.S. Forest Service, Larimer County, and other agencies as project leads.

Zone 5 – Soapstone Prairie ($5,000 per year)
Soapstone Prairie Natural Area represents an example of a pristine shortgrass and mixed-grass prairie ecosystems. The focus of management of the area in the next 10 years will be on maintaining disturbance regimes through black-tailed prairie dog management, periodic prescribed burning, as well as cattle and bison grazing. A $5,000 per year budget is retained to address short-term needs to ensure small needs for restoration can be met. This may include reclamation of trail disturbance, road decommissioning, and seed collection. No large capital projects are anticipated.

D. Proposed Schedule and Estimated Budget through 2025

Over the 10-year period from 2016 – 2025 a restoration schedule and anticipated annual budget is proposed as shown in Table 6 below. Over the course of 10 years, restoration costs are estimated at $6.4 million. Presented throughout the 10–year time period are on-going costs carried as contingency for small unanticipated projects, rare plant conservation work, and wildlife surveys.

A summary of the overall schedule for 2016 – 2025 is as follows:

2016
Requested Budget: $562,500
1. Completion of Phase I Kingfisher Restoration (Gadwall Pond wetlands).
2. Udall capital restoration in coordination with Stormwater and Engineering Departments.
3. Initiation of 175 acres of grassland restoration in the southwest grasslands.
4. Initial control of up to 200 acres of cheatgrass and other non-native grasses in the Foothills Zone.
5. Funding for unanticipated minor projects.

2017
Requested Budget: $482,500
1. Completion of Phase II of the Kingfisher Restoration (river and floodplain).
2. Contingency work associated with the Udall Restoration.
3. Initiation of an additional 175 acres of grassland restoration in the southwest grasslands.
4. Initial control of an additional 200 acres of cheatgrass and other non-natives in the Foothills Zone.
5. Funding for unanticipated minor projects.
6. $500,000 contribution to the Downtown River Project (not calculated in requested budget).

2018
Requested Budget: $217,500
1. Initiation of an additional 175 acres of grassland restoration in the southwest grasslands.

2. Initial control of an additional 200 acres of cheatgrass and other non-natives in the Foothills Zone.
3. Initiation of 75 acres of grassland restoration in the valley of Bobcat Ridge.
4. Funding for unanticipated minor projects.
5. $500,000 contribution to the Downtown River Project (not calculated in requested budget).

2019
Requested Budget: $290,000
1. Initiation of the final 175 acres of grassland restoration in the southwest grasslands.
2. Initial control of an additional 200 acres of cheatgrass and other non-natives in the Foothills Zone.
3. Initiation of an additional 75 acres of grassland restoration in the valley of Bobcat Ridge.
4. Initial planning, design, and permitting for the Running Deer capital restoration.
5. Funding for unanticipated minor projects.

2020
Requested Budget: $857,500
1. Initial control of an additional 200 acres of cheatgrass and other non-native grasses in the Foothills Zone.
2. Initiation of an additional 75 acres of grassland restoration in the valley of Bobcat Ridge.
3. Initial construction of the Running Deer capital restoration.
4. Initial grassland restoration of 50 acres of the Fossil Creek grasslands.
5. Funding for unanticipated minor projects.

2021
Requested Budget: $877,500
1. Initial control of an additional 200 acres of cheatgrass and other non-natives in the Foothills Zone.
2. Initiation of an additional 75 acres of grassland restoration in the valley of Bobcat Ridge.
3. Completed construction of the Running Deer capital restoration.
4. Initial grassland restoration of an additional 50 acres of the Fossil Creek grasslands.
5. Funding for unanticipated minor projects.

2022
Requested Budget: $862,500
1. Final control of 200 acres of cheatgrass and other non-natives in the Foothills Zone.
2. Initiation of an additional 75 acres of grassland restoration in the valley of Bobcat Ridge.
3. Completed construction of the Running Deer capital restoration.
4. Initial grassland restoration of an additional 50 acres of the Fossil Creek grasslands.
5. Funding for unanticipated minor projects.

2023
Requested Budget: $175,500
1. Contingency follow-up to Running Deer restoration if necessary.
2. Initiation of an additional 75 acres of grassland restoration in the valley of Bobcat Ridge.
3. (Final) Grassland restoration of an additional 50 acres of the Fossil Creek grasslands.
4. Funding for unanticipated minor projects.

2024

Requested Budget: $190,500

1. Initiation of an additional 75 acres of grassland restoration in the valley of Bobcat Ridge.
2. Initial planning, design, and permitting for the Arapaho Bend capital restoration.
3. Funding for unanticipated minor projects.

2025

Requested Budget: $860,500

1. (Final) Initiation of an additional 75 acres of grassland restoration in the valley of Bobcat Ridge.
2. Initial construction of Arapaho Bend capital restoration.
3. Funding for unanticipated minor projects.

Table 6. Natural areas projected restoration budget 2016-2025.

Zone 1 - Lower Poudre River		Project cost	Years	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Udall Capital Project	Project Cost	$ 112,000	2016 -2017	$ 100,000	$ 10,000	$ 2,000							
Kingfisher Capital Project	Project Cost	$ 700,000	2017 - 2019	$ -	$ 325,000	$ 325,000	$ 50,000	$ 5,000	$ 5,000	$ 5,000			
Downtown River Project	NA Contribution	$ 1,000,000	2017 - 2018		$ 500,000	$ 500,000							
Running Deer Capital Project	Project Cost	$ 2,420,000	2019 - 2023	$ -			$ 100,000	$ 750,000	$ 750,000	$ 750,000	$ 50,000	$ 10,000	$ 10,000
McDowell (80ac grassland)	Project Cost	$ 40,000	2022 - 2025							$ 10,000	$ 10,000	$ 10,000	$ 10,000
Arapaho Bend Capital Project	Project Cost	$ 600,000	2024 - 2025									$ 100,000	$ 750,000
Zone 2 - SW & FC Grasslands	**Per Acre**	**Acres**	**Rate**										
Southwest Grasslands	$ 500	700	175ac/yr	$ 87,500	$ 87,500	$ 87,500	$ 87,500						
Fossil Creek Grasslands	$ 500	200	50ac/yr					$ 25,000	$ 25,000	$ 25,000	$ 25,000		
Zone 3 - Foothills Ecosystem	**Per Acre**	**Acres**	**Rate**										
Cheatgrass Control	$ 50	1,400	200ac/yr	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 3,000	$ 3,000	$ 3,000
Bobcat Valley Grasslands	$ 500	600	75ac/yr		$ -	$ 37,500	$ 37,500	$ 37,500	$ 37,500	$ 37,500	$ 37,500	$ 37,500	$ 37,500
				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Zone 4 - Upper Poudre River				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Zone 5 - Soapstone Prairie		Contingency for small projects		$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000
Budget for All Zones		Unanticipated minor capital projects		$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000
		Rare Plant Cons/Restoration		$ 5,000	$ 10,000	$ -	$ 10,000	$ -	$ 10,000		$ 10,000		$ 10,000
		Wildlife Surveys/Restoration		$ 5,000	$ 10,000	$ -	$ 10,000	$ -	$ 10,000		$ 10,000		$ 10,000
						1st Budget Cycle		2nd Budget Cycle		3rd Budget Cycle		4th Budget Cycle	5th Budget
				2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
		Annual Restoration Plan Total		$ 137,500	$ 982,500	$ 992,000	$ 335,000	$ 857,500	$ 877,500	$ 867,500	$ 175,500	$ 190,500	$ 860,500
		Budget Cycle Total		**$237,500**		**$1,974,500**		**$1,192,500**		**$ 1,745,000**		**$ 366,000**	**$ 860,500**

*Red text indicates monitoring/followup

*Blue Text is follow up Treatment

$ 6,376,000	**Total Proposed Expenditure 2016 - 2025**
$ 3,500,000.00	NA Restoration Budget 2016 - 2025
$ 2,876,000.00	Difference

Chapter 9: Collaborations and Partnerships

Restoration in the City's Natural Areas would not be possible without the support, assistance, and advice from internal and external partners. While it is impossible to be 100% comprehensive, below is a sample of how collaborations further the Department's mission to restore and connect habitats throughout the city and surrounding area.

Different work groups and programs within the Department continue to make important contributions to restoration efforts as it is part of the Department's mission. The NAD Education Program incorporates restoration into education programs and outreach materials. Natural Areas Rangers continue to monitor restored areas or restorations in progress as well as educate the public regarding restoration projects. The Public improvements work group assists with restoration efforts by re-routing trails to improve public access and to protect restored areas. Volunteer coordinators have brought numerous agencies, individuals, and local businesses to assist with restoration projects creating an exceptional connection with the public. Not only do these activities assist staff with meeting restoration goals but also helps maintain public support for the Department. The Natural Areas Enhancement Fund Program provides financial assistance to steward and restore privately-owned natural spaces within the community.

Several internal City departments are also integral to restoring habitats within the City and include Parks, Park Planning and Development, Stormwater, Forestry, and the Planning Departments. These types of partnerships include sharing expertise on native seed mixes, wildlife friendly fencing, or erosion control methods with Parks, Stormwater and Forestry Departments. Multiple departments assist with river restoration efforts by providing peer review on specific restoration site plans. Most notably, review by Stormwater managers ensuring protection of citizens and infrastructure through implementation of the City's floodplain regulations. The Natural Areas Department advises the Planning Department on how to consider habitat connectivity while conducting development reviews. The City's mitigation policy for development has resulted in funds and plant material contributions for several restoration projects.

The Natural Areas Department cooperates with many outside agencies and organizations as well. There are too many to list all of them here, but some of the most common organizations include: Larimer County Parks and Open Lands, Colorado Parks and Wildlife, Poudre Fire Authority, Colorado Natural Heritage Program, U.S. Fish and Wildlife Service, Colorado Water Trust, The Bird Conservancy of the Rockies, Colorado Water Trust, and the Environmental Learning Center. In addition to these partners, special projects such as river restoration or species of interest reintroductions can foster many other beneficial relationships with both public and private entities, many of which are crucial to project completion.

Appendix A

City of Fort Collins Natural Areas Plant Species and Plant Communities of Interest

List of plant taxa documented in the Fort Collins Natural Areas. Synonymy follows USDA, NRCS. 2015. The PLANTS Database (http://plants.usda.gov, 21 December 2015). National Plant Data Team, North Carolina. * Includes augmentation, reintroduction, and ex-situ conservation.

Scientific Name	Common Name	Global Rank	State Rank	Tracked by CNHP?	ESA Status	FC Natural Areas Status	Priorities for Restoration*
Fern and Fern Allies							
Argyrochosma fendleri	Fendler's false cloak fern	G3	S3S4	Y		Documented	
Azolla mexicana	Mexican mosquitofern	G5	S4	N		Documented	Zone 1
Marsilea vestita	Hairy waterclover	G5	S4	N		Documented	
Aquatics (Submerged or Floating)							
Callitriche heterophylla	Two-headed water-starwort	G5	S1	Y		Documented	
Hippuris vulgaris	Common mare's tail	G5	SNR	N		Documented	
Lemna minuta	Least duckweed	G4	SNR	N		Documented	
Ruppia cirrhosa	Spiral ditchgrass	G5	SNR	N		Documented	Zone 1, 2
Sparganium eurycarpum	Broadfruit bur-reed	G5	S2	Y		Documented	Zone 1, 2, 5
Wolffia columbiana	Columbian watermeal	G5	S4	N		Documented	Zone 1, 2
Shrubs and Trees							
Ribes americanum	American black currant	G5	S2	Y		Documented	Zone 1
Opuntia phaeacantha	Tulip prickly pear	G5	SNR	N		Documented	
Vines							
Humulus lupulus var. *neomexicanus*	Common hop	G5	SNR	N		Documented	Zone 1, 3, 4, 5
Smilax lasioneura	Blue ridge carrionflower	G5	S3S4	W		Documented	Zone 1
Grass and Grass-like							
Acorus calamus	Sweetflag	G4?	S1	Y		Documented	Zone 1, 2
Aristida basiramea	Forked three-awn grass	G5	S1	Y		Documented	

Scientific Name	Common Name	Global Rank	State Rank	Tracked by CNHP?	ESA Status	FC Natural Areas Status	Priorities for Restoration*
Carex atherodes	Wheat sedge	G5	SNR	N		Documented	Zone 1
Carex bebbii	Bebb's sedge	G5	SNR	N		Documented	
Carex crawei	Crawe's sedge	G5	S1	Y		Documented	
Carex lasiocarpa	Slender sedge	G5	S1	Y		Documented	
Carex sprengelii	Sprengel's sedge	G5	S2	Y		Documented	
Cyperus bipartitus	Slender flatsedge	G5	SNR	N		Documented	Zone 1
Cyperus lupulinus	Great plains flatsedge	G5	SNR	N		Documented	
Cyperus squarrosus	Bearded flatsedge	G5	SNR	N		Documented	Zone 1
Dichanthelium acuminatum var. *sericeum*	Tapered rosette grass	G5TNR	S1	Y		Documented	Zone 1
Eleocharis atropurpurea	Purple spikerush	G4G5	SNR	N		Documented	Zone 5
Lipocarpha aristulata	Smallflower halfchaff sedge	G5?	SNR	N		Documented	
Sporobolus heterolepis	Prairie dropseed	G5	SNR	N		Documented	
Wildflowers and Forbs							
Agalinis tenuifolia	Slender false foxglove	G5	SNR	N		Documented	Zone 1
Agrimonia striata	Roadside agrimony	G5	SNR	N		Documented	Zone 1
Ammannia robusta	Grand redstem	G5	SNR	N		Documented	
Besseya wyomingensis	Wyoming coral-drops	G5	S1	Y		Documented	
Calystegia sepium	Hedge false bindweed	G5	SNR	N		Documented	Zone 1, 2
Cirsium flodmanii	Flodman's thistle	G5	SNR	N		Documented	
Eustoma exaltatum ssp. *russellianum*	Prairie gentian	G5	S3S4	W		Documented	Zone 1, 2, 3
Gaura neomexicana ssp. *coloradensis*	Colorado butterfly plant	G3T2	S1	Y	LT	Documented	Zone 1, 5
Glaux maritima	Sea milkwort	G5	SNR	N		Documented	Zone 1
Liatris ligulistylis	Rocky mountain blazing star	G5?	S2	Y		Documented	
Lobelia siphilitica var. *ludoviciana*	Great blue lobelia	G5T5?	SNR	N		Documented	Zone 1
Lysimachia ciliata	Fringed loosestrife	G5	SNR	N		Documented	Zone 1, 2, 3
Lysimachia thyrsiflora	Water loosestrife	G5	S1	Y		Documented	Zone 1

Scientific Name	Common Name	Global Rank	State Rank	Tracked by CNHP?	ESA Status	FC Natural Areas Status	Priorities for Restoration*
Mentzelia speciosa	Jeweled blazingstar	G3	S3	Y		Documented	
Musineon tenuifolium	Slender wild parlsey	G4	S2	Y		Documented	
Osmorhiza longistylis	Smooth sweet-cicely	G5	SNR	N		Documented	
Pediomelum esculentum	Large Indian breadroot	G5	SNR	N		Documented	
Penstemon eriantherus	Crested-tongue beardtongue	G4	S1	Y		Documented	
Phacelia denticulata	Rocky mountain phacelia	G3	SU	Y		Documented	
Physaria bellii	Front Range twinpod	G2G3	S2S3	Y		Documented	Zone 3
Sisyrinchium pallidum	Pale blue-eyed grass	G3	S2	Y		Documented	
Sium suave	Hemlock waterparsnip	G5	SNR	N		Documented	
Oligoneuron album	Prarie goldenrod	G5	S1	Y		Documented	
Spiranthes diluvialis	Ute lady's tresses	G2G3	S2	Y	LT	Documented	Zone 1, 2, 3, 4, 5
Stephanomeria runcinata	Desert wire lettuce	G5	SNR	N		Documented	
Triodanis leptocarpa	Slimpod venus' looking-glass	G5?	S1	Y		Documented	Zone 3
Triodanis perfoliata	Clasping Venus' looking-glass	G5	SNR	N		Documented	Zone 3

List of plant taxa that could potentially occur in Fort Collins Natural Areas based on the presence of suitable habitat. Synonymy follows USDA, NRCS. 2015. The PLANTS Database (http://plants.usda.gov, 21 December 2015). National Plant Data Team, Greensboro, NC 27401-4901 USA.

Scientific Name	Common Name	Authority	Global Rank	State Rank	Tracked by CNHP?	ESA Status	FC Natural Areas Status
Fern and Fern Allies							
Asplenium adiantum-nigrum	Black spleenwort	*(L.) A. Nelson*	*G5*	*S1*	*Y*		*Potential*
Asplenium septentrionale	Forked spleenwort	*(L.) Hoffman*	*G4G5*	*S3S4*	*W*		*Potential*
Botrychium campestre	Prarie dunewort	*W.H. Wagner & Farrar*	*G3G4*	*S1*	*Y*		*Potential*
Botrychium lineare	Narrowleaf grapefern	*W.H. Wagner*	*G2G3*	*S2S3*	*Y*		*Potential*
Botrychium multifidum	Leathery grapefern	*(S.G. Gmel.) Trev*	*G5*	*S1S2*	*Y*		Potential

Scientific Name	Common Name	Authority	Global Rank	State Rank	Tracked by CNHP?	ESA Status	FC Natural Areas Status
Botrychium virginianum	Rattlesnake fern	*(L.) Sw.*	*G5*	*S1*	*Y*		Potential
Dryopteris filix-mas	Male fern	*(L.) Schott*	*G5*	*SNR*	*N*		Potential
Equisetum variegatum var. variegatum	Variegated horsetail	*Schleich Ex, F. Weber & D. Mohr*	*G5*	*S1*	*Y*		Potential
Goodyera repens	Lesser rattlesnake plantain	*(L.) R. BR*	*G5*	*S3S4*	*W*		Potential
Gymnocarpium dryopteris	Western oakfern	*(L.) Newman,*	*G5*	*S2S3*	*N*		Potential
Pellaea atropurpurea	Purple cliffbrake	*(L.) Link*	*G5*	*S2S3*	*N*		Potential
Pellaea glabella ssp. occidentalis	Western dwarf cliffbrake	*(E.Nels.) Windham*	*G5T4*	*SNR*	*N*		Potential
Pellaea glabella ssp. simplex	Simple cliffbrake	*(Butters) A. & D. Love*	*G5T4?*	*S2*	*Y*		Potential
Polypodium saximontanum	Rocky mountain polypody	*Windham*	*G3?*	*S3S4*	*Y*		Potential
Selaginella weatherbiana	Weatherby's spikemoss	*R. Tryon*	*G3G4*	*S3S4*	*W*		Potential
Aquatics (Submerged or Floating)							
Elatine triandra	Threestamen waterwort	*Schkuhr*	*G5*	*S2*	*Y*		Potential
Heteranthera limosa	Blue mudplantain	*(Sw.) Willd.,*	*G5*	*SNR*	*N*		Potential
Myriophyllum verticillatum	Whorled water milfoil	*L.*	*G5*	*S1*	*Y*		Potential
Potamogeton diversifolius	Waterthread pondweed	*Raf.*	*G5*	*S1*	*Y*		Potential
Sagittaria brevirostra	Shortbeak arrowhead	*Mackenzie & Bush,*	*G5*	*S2?*	*N*		Potential
Sagittaria calycina var. calycina	Hooded arrowhead	*Engelm.*	*G5T5?*	*S1*	*Y*		Potential
Stuckenia vaginata	Sheathed pondweed	*(Turcz.) Holub*	*G5*	*SNR*	*N*		Potential
Utricularia minor	Lesser bladderwort	*L.*	*G5*	*S2*	*Y*		Potential
Wolffia borealis	Northern watermeal	*(Engelm. Ex Hegelm.) Landolt ex Landolt & Wildi*	*G5*	*SNR*	*N*		Potential
Shrubs and Trees							
Amorpha nana	Dwarf false indigo	*Nutt.*	*G5*	*S2*	*Y*		Potential
Betula papyrifera var. papyrifera	Paper birch	*Marshall*	*G5*	*S1*	*Y*		Potential
Crataegus chrysocarpa	Fireberry hawthorn	*Ashe*	*G5*	*S1*	*Y*		Potential
Salix serissima	Autumn willow	*(L.H. Bailey) Fernald*	*G4*	*S1*	*Y*		Potential

Scientific Name	Common Name	Authority	Global Rank	State Rank	Tracked by CNHP?	ESA Status	FC Natural Areas Status
Grass and Grass-like							
Achnatherum contractum	Contracted ricegrass	*(B.L. Johnson) Barkworth*	*G3G4*	*SU*	*Y*		Potential
Carex conoidea	Field sedge	*Schkuhr ex Willd*	*G5*	*S1*	*Y*		Potential
Carex oreocharis	Grassy slope sedge	*T. Holm*	*G3*	*S2*	*Y*		Potential
Carex peckii	Peck's sedge	*Howe*	*G5*	*S1*	*Y*		Potential
Carex sartwellii	Sartwell's sedge	*Dewey*	*G4G5*	*S1*	*Y*		Potential
Carex saximontana	Rocky mountain sedge	*Mack*	*G5*	*S1*	*Y*		Potential
Carex torreyi	Torrey's sedge	*Tuck.*	*G4*	*S1*	*Y*		Potential
Cyperus acuminatus	Tapertip flatsedge	*Torr. & Hook. ex Torr.*	*G5*	*SNR*	*N*		Potential
Juncus brachycephalus	Smallhead rush	*(Engelm.) Buchenau*	*G5*	*S1*	*Y*		Potential
Juncus brevicaudatus	Narrowpanicle rush	*(Engelm.) Fernald*	*G5*	*S1*	*Y*		Potential
Juncus tweedyi	Tweedy's rush	*Rydb.*	*G3Q*	*S1*	*Y*		Potential
Juncus vaseyi	Vasey's rush	*Engelm.*	*G5?*	*S1*	*Y*		Potential
Schizachne purpurascens	False melic	*(Torr.) Swallen,*	*G5*	*SNR*	*N*		Potential
Schoenoplectus saximontanus	Rocky mountain bulrush	*(Fernald) Raynal*	*G5*	*S1*	*Y*		Potential
Wildflowers and Forbs							
Agastache foeniculum	Blue giant hyssop	*(Pursh) Kuntze*	*G4G5*	*S1*	*Y*		Potential
Aletes humilis	Colorado aletes	*Coult & Rose*	*G2G3*	*S2S3*	*Y*		Potential
Anagallis minima	Chaffweed	*(L.) Krause*	*G5*	*S1*	*Y*		Potential
Anemone virginiana var. alba	Virginia anemone	*L., (Oakes) Alph. Wood*	*G5*	*SNR*	*N*		Potential
Apios americana	Groundnut	*Medik.*	*G5*	*S1*	*Y*		Potential
Aquilegia chrysantha var. rydbergii	Golden columbine	*A. Gray, Munz*	*G4T1Q*	*S1*	*Y*		Potential
Aralia nudicaulis	Wild sarsaparilla	*L.*	*G5*	*S2*	*N*		Potential
Asclepias hallii	Hall's milkweed	*A. Gray*	*G3*	*S3*	*Y*		Potential
Asclepias stenophylla	Slimleaf milkweed	*A. Gray*	*G4G5*	*S2*	*Y*		Potential
Asclepias uncialis ssp. uncialis	Greene's milkweed	*Greene*	*G3G4T2T3*	*S2*	*Y*		Potential
Astragalus americanus	American milkvetch	*(Hook) M.E. Jones*	*G5*	*SH*	*Y*		Potential

Scientific Name	Common Name	Authority	Global Rank	State Rank	Tracked by CNHP?	ESA Status	FC Natural Areas Status
Astragalus bodinii	Bodin's milkvetch	*Sheldon*	*G4*	*S2*	*Y*		Potential
Astragalus gilviflorus	Plains milkvetch	*Sheldon*	*G5*	*S1*	*Y*		Potential
Astragalus plattensis	Platte river milkvetch	*Nutt.*	*G5*	*S1*	*Y*		Potential
Astragalus sparsiflorus	Front range milkvetch	*A. Gray*	*G2*	*S2*	*Y*		Potential
Campanula aparinoides	Marsh bellflower	*Pursh*	*G5*	*SH*	*Y*		Potential
Chenopodium cycloides	Sandhill goosefoot	*A. Nelson*	*G3G4*	*S1*	*Y*		Potential
Claytonia rubra	Redstem springbeauty	*(Howell) Tidestr.*	*G5*	*S1*	*Y*		Potential
Crassula aquatica	Water pygmyweed	*(L.) Schoenl.*	*G5*	*SH*	*Y*		Potential
Cryptantha cana	Mountain cat's eye	*(A. Nelson) Payson*	*G5*	*S2*	*Y*		Potential
Cypripedium parviflorum var. pubescens	Yellow lady's slipper	*Salisb., (Willd.) Knight*	*G5*	*S2*	*Y*		Potential
Desmodium obtusum	Stiff-tick trefoil	*(Muhl. Ex Willd.) DC*	*G4G5*	*S4*	*N*		Potential
Erigeron nematophyllus	Needleleaf fleabane	*Rydb.*	*G3*	*S2*	*Y*		Potential
Eriogonum exilifolium	Dropleaf buckwheat	*Reveal*	*G3*	*S2*	*Y*		Potential
Gentiana andrewsii	Closed bottle gentian	*Griseb.*	*G5?*	*SNR*	*N*		Potential
Geranium bicknellii	Bicknell's cranesbill	*Britton*	*G5*	*S2*	*Y*		Potential
Helianthemum bicknellii	Hoary frostweed	*Fernald*	*G5*	*S1*	*Y*		Potential
Lesquerella alpina var. alpina	Alpine bladderpod	*(Nutt.) S. Watson*	*G5T4*	*SNR*	*Y*		Potential
Lesquerella arenosa var. argillosa	Secund bladderpod	*Rollins and Shaw*	*G5T4*	*S1*	*Y*		Potential
Lewisia rediviva var. rediviva	Bitterroot	*Pursh*	*G5*	*S2*	*Y*		Potential
Lewisia triphylla	Threeleaf lewisia	*(S. Watson) B.L. Rob*	*G4?*	*S2*	*Y*		Potential
Liatris lancifolia	Lanceleaf blazing star	*(Greene)Kittell*	*G4*	*S1*	*Y*		Potential
Lilium philadelphicum	Wood lily	*L.*	*G5*	*S3S4*	*W*		Potential
Listera borealis	Northern twayblade	*Morong*	*G4*	*S2*	*Y*		Potential
Listera convallarioides	Broad-leaved twayblade	*(Sw.) Nutt. Ex Elliott*	*G5*	*S2*	*Y*		Potential
Lomatium nuttallii	Nuttall's desert-parsley	*(A. Gray) J.F. Macbr*	*G3*	*S1*	*N*		Potential
Machaeranthera coloradoensis	Colorado tansy-aster	*(A. Gray) Osterhout*	*G3*	*S3*	*Y*		Potential
Malaxis brachypoda	White adder's-mouth orchid	*(A. Gray) Fernald*	*G4Q*	*S1*	*Y*		Potential

Scientific Name	Common Name	Authority	Global Rank	State Rank	Tracked by CNHP?	ESA Status	FC Natural Areas Status
Mertensia humilis	Rocky mountain bluebells	*Rydb.*	*G2*	*S1*	*Y*		Potential
Mimulus gemmiparus	Weber's monkeyflower	*W.A.*	*G1*	*S1*	*Y*		Potential
Mimulus ringens	Square-stem monkeyflower	*L.*	*G5*	*SH*	*Y*		Potential
Oenothera grandis	Showy evening primrose	*(Britton) Smyth*	*G5?*	*S1*	*Y*		Potential
Oonopsis wardii	Ward's false goldenweed	*(A. Gray) Greene*	*G3*	*S1*	*Y*		Potential
Packera debilis	Weak groundsel	*(Nutt.) Weber & A. Love*	*G4*	*S1*	*Y*		Potential
Parthenium alpinum	Alpine fever-few	*(Nutt.) Torr. & A. Gray*	*G3*	*S3*	*Y*		Potential
Pediomelum cuspidatum	Largebract indian breadroot	*(Pursh) Rydb*	*G4*	*S1*	*Y*		Potential
Penstemon gracilis	Slender beardtongue	*Nutt.*	*G5*	*SNR*	*N*		Potential
Penstemon laricifolius ssp. exilifolius	Larch-leaf beardtongue	*Hook. & Arn., (A. Nelson) D.D. Keck*	*G4T3Q*	*S2*	*Y*		Potential
Penstemon radicosus	Mat-root beardtongue	*A. Nelson*	*G5*	*S1*	*Y*		Potential
Potentilla ambigens	Southern rocky mountain cinquefoil	*Greene*	*G3*	*S2*	*Y*		Potential
Potentilla rupincola	Rock cinquefoil	*Osterh.*	*G2*	*S2*	*Y*		Potential
Psoralidium argophyllum	Silverleaf scurf pea	*(Pursh) Rydberg*	*G5*	*SNR*	*N*		Potential
Rotala ramosior	Lowland rotala	*(L.) Koehne*	*G5*	*S1*	*Y*		Potential
Silphium integrifolium Michx. var laeve	Wholeleaf rosinweed	*Torr. & A. Gray*	*G5*	*SH*	*Y*		Potential
Silphium laciniatum	Compass plant	*L.*	*G5*	*SH*	*Y*		Potential
Sisyrinchium demissum	Stiff blue-eyed grass	*Greene*	*G5*	*S2*	*Y*		Potential
Suckleya suckleyana	Poison suckleya	*(Torr.) Rydb.*	*G5*	*SNR*	*N*		Potential
Symphyotrichum novae-angliae	New England aster	*(L.) G.L. Nesom*	*G5*	*S1*	*Y*		Potential
Trillium ovatum	Pacific trillium	*Pursh*	*G5*	*S3S4*	*W*		Potential
Viola pedatifida	Prairie violet	*G. Don*	*G5*	*S2*	*Y*		Potential
Viola selkirkii	Selkirk's violet	*Pursh ex Goldie*	*G5?*	*S1*	*Y*		Potential

List of rare plant communities tracked by the Colorado Natural Heritage Program that occur in Fort Collins Natural Areas.

Scientific Name	Common Name	Global Rank	State Rank	Tracked by CNHP?	ESA Status	FC Natural Areas Status
Atriplex canescens / *Bouteloua gracilis* Shrubland	Shortgrass Prairie	G3	S2	Y		Documented
Bouteloua gracilis - *Buchloe dactyloides* Herbaceous Vegetation	Shortgrass Prairie	G4	S2?	P		Documented
Carex nebrascensis Herbaceous Vegetation	Wet Meadows	G4	S3	P		Documented
Carex simulata Herbaceous Vegetation	Wet Meadow	G4	S3	P		Documented
Carex utriculata Herbaceous Vegetation	Beaked Sedge Montane Wet Meadows	G5	S4	P		Documented
Catabrosa aquatica - *Mimulus* ssp. Spring Wetland	Spring Wetland	GU	S2	Y		Documented
Cercocarpus montanus - *Rhus trilobata* / *Andropogon gerardii* Shrubland	Mountain Mahogany - Skunkbush / Big Bluestem Shrubland	G2G3	S2	Y		Documented
Cercocarpus montanus / *Achnatherum scribneri* Shrubland	Foothills Shrubland	G3	S2	Y		Documented
Cercocarpus montanus / *Elymus lanceolatus* ssp. *lanceolatus* Shrubland	Mountain Mahogany/Griffith's Wheatgrass Shrubland	GU	S2	Y		Documented
Cercocarpus montanus / *Hesperostipa comata* Shrubland	Mixed Foothill Shrublands	G2	S2	Y		Documented
Cercocarpus montanus / *Hesperostipa neomexicana* Shrubland	Foothills Shrubland	G2G3	S2	Y		Documented
Distichlis spicata Herbaceous Vegetation	Salt Meadows	G5	S3	P		Documented
Krascheninnikovia lanata / *Pascopyrum smithii* - *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation	Western Slope Grasslands	G4	S1	Y		Documented
Pinus ponderosa / *Cercocarpus montanus* / *Andropogon gerardii* Wooded Herbaceous Vegetation	Foothills Ponderosa Pine Scrub Woodlands	G2	S2	Y		Documented
Populus deltoides / *Carex pellita* Woodland	Plains Cottonwood Riparian Woodland	G2	S2	Y		Documented
Hesperostipa comata - *Bouteloua gracilis* - *Carex filifolia* Herbaceous Vegetation	Montane Grasslands	G5	S2	Y		Documented
Typha (*latifolia*, *angustifolia*) Western Herbaceous Vegetation	Narrow-leaf Cattail Marsh	G5	S4	P		Documented

Appendix B

City of Fort Collins Natural Areas Wildlife Species of Interest

*Documented or potentially occurring on natural areas, *ESA- Endangered Species Act or federal listing status, *State- state listing status

Common Name	*Scientific Name*	Global Rank	State Rank	Documented or Potential*	Tracked by CNHP/CPW?	ESA*	State*
Mammals							
Abert's squirrel	*Sciurus aberti*	G5	S5	Documented	SWAP Tier 2		
Bighorn sheep	*Ovis canadensis*	G4	S4	Documented	SWAP Tier 2		
Bison	*Bison bison*	G4	SX	Documented/ reintroduced	SWAP Tier 2		
Black-footed ferret	*Mustela nigripes*	G1	S1	Documented/ reintroduced	CNHP full/ SWAP Tier 1	E	SE
Black-tailed prairie dog	*Cynomys ludovicianus*	G4	S3	Documented	CNHP partial/ SWAP Tier 2		SC
Dwarf shrew	*Sorex nanus*	G4	S2	Potential	CNHP full/ SWAP Tier 2		
Fringed myotis	*Myotis thysanodes*	G4	S3	Documented	CNHP full/ SWAP Tier 1		
Hoary bat	*Lasiurus cinereus*	G5	S5B	Documented	SWAP Tier 2		
Northern pocket gopher	*Thomomys talpoides agrestis*	G5T3	S3	Potential	CNHP partial		
Olive-backed pocket mouse	*Perognathus fasciatus*	G5	S3	Potential	CNHP full/ SWAP Tier 1		
Preble's meadow jumping mouse	*Zapus hudsonius preblei*	G5T2	S1	Documented (historic)	CNHP full/ SWAP Tier 1	T	ST
River otter	*Lontra canadensis*	G5	S3S4	Documented	SWAP Tier 2		ST
Sagebrush vole	*Lemmiscus curtatus*	G5	S1	Potential	CNHP full/ SWAP Tier 2		
Swift fox	*Vulpex velox*	G3	S3	Documented	CNHP full/ SWAP Tier 2		SC
Townsend's big-eared bat	*Coryhnorhinus townsendii pallescens*	G3T3	S2	Documented	CNHP full/ SWAP Tier 1		SC
Birds							
American bittern	*Botaurus lentiginosus*	G4	S3S4B	Documented	SWAP Tier 2		
American peregrine falcon	*Falco peregrinus anatum*	G4T4	S2B	Documented	CNHP full/ SWAP Tier 2	Delisted	SC
American white pelican	*Pelecanus erythrorhynchos*	G4	S1B	Documented	CNHP full/ SWAP Tier 2		
Bald eagle	*Haliaeetus leucocephalus*	G5	S1B, S3N	Documented	CNHP full/ SWAP Tier 2	Delisted	SC
Barrow's goldeneye	*Bucephala islandica*	G5	S2B	Documented	CNHP full/ SWAP Tier 2		
Black tern	*Chlidonias niger*	G5	S2B	Documented	SWAP Tier 2		

Common Name	*Scientific Name*	Global Rank	State Rank	Documented or Potential*	Tracked by CNHP/CPW?	ESA*	State*
Black-necked stilt	*Himantopus mexicanus*	G5	S3B	Documented	CNHP full		
Bobolink	*Dolichonyx oryzivorus*	G5	S3B	Documented	CNHP watch/ SWAP Tier 2		
Brewer's sparrow	*Spizella breweri*	G5	S4B	Documented	SWAP Tier 2		
Burrowing owl	*Athene cunicularia*	G4	S4B	Documented	CNHP watch/ SWAP Tier 1		ST
Cassin's finch	*Peucaea cassinii*	G5	S5	Documented	SWAP Tier 2		
Cassin's sparrow	*Aimophila cassinii*	G5	S4B	Documented	CNHP watch/ SWAP Tier 2		
Chestnut-collared longspur	*Calcarius ornatus*	G5	S1B	Documented	CNHP full/ SWAP Tier 2		
Ferruginous hawk	*Buteo regalis*	G4	S3B, S4N	Documented	CNHP full/ SWAP Tier 2		SC
Flammulated owl	*Otus flammeolus*	G4	S4	Documented	SWAP Tier 2		
Forester's tern	*Sterna forsteri*	G5	S2B, S4N	Documented	CNHP full		
Golden eagle	*Aquila chrysaetos*	G5	S3S4B, S4N	Documented	SWAP Tier 1		
Grasshopper sparrow	*Ammodramus savannarum*	G5	S3S4B	Documented	SWAP Tier 2		
Greater sandhill crane	*Grus canadensis tabida*	G5T4	S2B, S4N	Potential	CNHP full/ SWAP Tier 1		SC
Lark bunting	*Calamospiza melanocorys*	G5	S4	Documented	SWAP Tier 2		
Lazuli bunting	*Passerina amoena*	G5	S5B	Documented	SWAP Tier 2		
Least tern	*Sterna antillarum*	G4	S1B	Documented	CNHP full/ SWAP Tier 2	E	SE
Lewis's woodpecker	*Melanerpes lewis*	G4	S4	Documented	CNHP full/ SWAP Tier 2		
Loggerhead shrike	*Lanius ludovicianus*	G4	S3S4B	Documented	SWAP Tier 2		
Long-billed curlew	*Numenius americanus*	G5	S2B	Documented	CNHP full/ SWAP Tier 2		SC
McCown's longspur	*Calcarius mccownii*	G4	S2B	Documented	CNHP full/ SWAP Tier 2		
Mountain plover	*Charadrius montanus*	G3	S2B	Documented	CNHP full/ SWAP Tier 1		SC
Northern bobwhite*	*Colinus virginianus*	G5	S4	Documented	SWAP Tier 2		
Northern goshawk	*Accipiter gentilis*	G5	S3B	Documented	CNHP watch/ SWAP Tier 2		
Northern harrier	*Circus cyaneus*	G5	S3B	Documented	SWAP Tier 2		
Northern pygmy owl	*Glaucidium gnoma*	G4G5	S3B	Documented	CNHP watch		
Olive-sided flycatcher	*Contopus cooperi*	G4	S3S4B	Documented	SWAP Tier 2		
Ovenbird	*Seiurus aurocapilla*	G5	S2B	Documented	CNHP full		
Pinyon jay	*Gymnorhinus cyanocephalus*	G5	S5	Documented	SWAP Tier 2		
Piping plover	*Charadrius melodus*	G3	S1B	Documented	CNHP full/ SWAP Tier 2	T	ST
Plains sharp-tailed grouse	*Tympanuchus phasianellus jamesi*	G4T4	S1	Potential reintroduction	CNHP full		SC

Common Name	*Scientific Name*	Global Rank	State Rank	Documented or Potential*	Tracked by CNHP/CPW?	ESA*	State*
Prairie falcon	*Falco mexicanus*	G5	S4	Documented	CNHP watch/ SWAP Tier 2		
Rufous hummingbird	*Selasphorus rufus*	G5	SNA	Documented	SWAP Tier 2		
Short-eared owl	*Asio flammeus*	G5	S2B	Documented	CNHP full/ SWAP Tier 2		
Snowy egret	*Egretta thula*	G5	S2B	Documented	CNHP full		
Swainson's hawk	*Buteo swainsoni*	G5	S5B	Documented	SWAP Tier 2		
Upland sandpiper	*Bartramia longicauda*	G5	S3B	Documented	SWAP Tier 2		
Veery	*Catharus fuscescens*	G5	S3B	Documented	CNHP watch/ SWAP Tier 2		
Virginia's warbler	*Oreothlypis virginiae*	G5	S5	Documented	SWAP Tier 2		
Western snowy plover	*Charadrius alexandrinus nivosus*	G3T3	SB1	Documented	CNHP full	T	SC
White-faced ibis	*Plegadis chihi*	G5	S2B	Documented	CNHP full/ SWAP Tier 2		
Willet	*Catoptrophorus semipalmatus*	G5	S1B	Documented	CNHP full		
Willow flycatcher	*Empidonax trailii*	G5	S4B	Potential	CNHP watch		
Wilson's pharalope	*Phalaropus tricolor*	G5	S4B, S4N	Documented	CNHP full		
Fish							
Brassy minnow	*Hybognathus hankinsoni*	G5	S3	Documented	CNHP full/ SWAP Tier 1		ST
Common shiner	*Notropis cornutus*	G5	S2	Documented	CNHP full/ SWAP Tier 1		ST
Iowa darter	*Etheostoma exile*	G5	S3	Documented	CNHP full		SC
Northern redbelly dace	*Phoxinus eos*	G5	S1	Documented	CNHP full/ SWAP Tier 1		SE
Orangespotted sunfish	*Lepomis humilis*	G5	S5	Documented	SWAP Tier 1		
Plains topminnow	*Fundulus sciadicus*	G4	S4	Documented	SWAP Tier 1		
Reptiles and Amphibians							
Northern leopard frog	*Lithobates pipiens*	G5	S3	Documented (historic)	CNHP full/ SWAP Tier 1		SC
Common garter snake	*Thamnophis sirtalis*	NA	NA	Documented	SWAP Tier 2		SC
Lined snake	*Tropicdoclonion lineatum*	G5	S3	Documented	CNHP watch		
Milksnake	*Lampropeltis triangulum*	G5	S2	Documented	SWAP Tier 2		
Ornate box turtle	*Terrapene ornata*	NA	NA	Documented	NA		
Painted turtle	*Chrysemys picta*	G5	S5	Documented	CNHP partial		
Short-horned lizard	*Phrynosoma hernandesi*	G5	S5	Documented	CNHP watch		
Invertebrates							
Arapahoe snowfly	*Capnia arapahoe*	G1	S1	Potential	CNHP full		

Common Name	*Scientific Name*	Global Rank	State Rank	Documented or Potential*	Tracked by CNHP/CPW?	ESA*	State*
Arogos skipper	*Atrytone arogos*	G3	S2	Documented	CNHP full		
Autumn springfly	*Pictetiella expansa*	G3	S2	Potential	CNHP full		
Backswimmer	*Notonecta unifasciata*	GNR	S1	Documented	CNHP full		
Colorado blue	*Eupholies rita coloradensis*	G3T3	S2	Potential	CNHP full		
Crossline skipper	*Polites origenes*	G5	S3	Documented	CNHP full		
Dusted skipper	Atrytonopsis hianna	G4	S2	Potential	CNHP full		
Hairy sallfly	*Alloperla pilosa*	G3	S2	Potential	CNHP full		
Hops blue	*Celastrina humulus*	G2	S2	Documented	CNHP full		
Larimide sallfly	*Suwallia wardi*	G3	S2	Potential	CNHP full		
Lusk's pinemoth	*Coloradia luski*	G4	S1	Potential	CNHP full		
Modest sphinx moth	*Pachysphinx modesta*	G4	S2	Potential	CNHP full		
Morrison's skipper	*Stinga morrisoni*	G4	S3	Potential	CNHP full		
Moss' elfin	*Calliphorys mossii schryveri*	G4T3	S2	Documented	CNHP full		
Mottled dusky wing	*Erynnis martialis*	G3	S2	Potential	CNHP full		
Ottoe's skipper	*Hesperia ottoe*	G3	S2	Documented	CNHP full		
Plains snowfly	*Mesocapnia frisoni*	G5	S1	Potential	CNHP full		
Regal frittilary	*Speyeria idalia*	G3	S1	Documented	CNHP full		
Rhesus skipper	*Polites rhesus*	G4	S2	Documented	CNHP full		
Sandhill fritillary	*Boloria selene sabulocollis*	G5T2	S1	Potential	CNHP full		
Simius roadside skipper	*Amblyscirtes simius*	G4	S3	Potential	CNHP full		
Smoky eyed brown	*Satryodes eurydice fumosa*	G5T3	S1	Documented	CNHP full		
Stevens' torticid moth	*Decodes stevensi*	GNR	S1	Potential	CNHP full		
Two-banded skipper	*Pyrgus ruralis*	G5	S3	Potential	CNHP full		
Two-spotted skipper	*Euphyes bimacula*	G4	S2	Documented	CNHP full		

*****Northern Bobwhite- There is uncertainty if the birds seen in the area are native as there were reintroductions across the state historically.

Appendix C

River and Floodplain Restoration Monitoring Framework and Metrics

		Project Goals and Objectives											
		Service to Society		River Ecosystem Attributes							Implementation		
Indicator Category	Indicator	Sustainable supply of drinking water	Provision of high recreational value	Morphological and hydraulic variability	Flood attenuation	Near-natural temperature regime	Longitudinal Connectivity	Lateral Connectivity	Near-natural abundance and diversity of floodplain vegetation/habitat	Near-natural abundance and diversity of fauna	Cycling of organic matter	Project implemented as designed	Project accpetance by stakeholders and greater public	Stakeholder participation
Project acceptance	Acceptance by interest group		x										X	X
	Acceptance by entire public		x										X	X
	Acceptance by project work group		x										X	X
Stakeholder participation	Satisfaction of interest groups with the design of the particiation process		x										X	X
	Satisfaction of the public with participation opportunities		x										X	X
	Satisfaction of interest groups with participation opportunities		x										X	X
Recreational use	Number of visitors		x										X	X
	Variety of recreational opportunities		x										X	X
	Public site accessibility for recreation		x										X	X
stream hydrology	Average Discharge	x		X		X								
	Maximum discharge	x		X	X	X								
	Minimum discharge	x		X		X								
	Downstream discharge	x		X	X	X								
Stream channel morphology	Variability of wetted channel width			X		X		X			X			
	Variability of flow velocity			X		X								
	Depth variability at bankfull discharge			X	X	X		X			X			
	Bank Stability			X		X		X				X		
	Longitudinal connectivity (Barrier free migration for fish)		x	X		X	X							
	Maximum or mean pool depth			X		X								
	Bankfull width to depth ratio			X	X	X						X		
Riparian/Floodplain hydrogeomorphology	Ratio of flooded area to stream length at peak river flow	x	x	X	X	X		X			X	X		
	Riparian zone width		x	X		X						X		
	Ratio of floodplain width to average tree height (from USDA database)					X								
	Groundwater elevation in floodplain										X	X		
	Floodplain sediment accretion			X				X			X			
Riparian hydrology	Riparian flood extent	x		X	X	X		X			X	X		
	Riparian flood duration	x		X	X	X		X			X			
	Riparian flood frequency (annual frequency)	x		X	X	X		X			X	X		
Vegetation	Percent survival of planted individuals											X		
	Size, vigor, and growth of planted individuals											X		
	Presence of typical floodplain species		x			X			X		X			
	Recruitment and succession of native plant species on floodplains		x			X		X	X					
	Native woody species regeneration		x			X		X	X					
	Composition of floodplain plant communities		x						X		X			
	Tree or shrub cover and composition		x			X			X					
	Herbaceous cover; herbaceous composition		x						X		X			
	Hardwood demography					X			X					
	Structural diversity		x						X		X			
	Noxious weeds		x						X					
	Exotic species coverage		x						X					
	Aggressive native cover								X					
	Species composition (Mean C value of riparian vegetation)								X					
	Habitat patchiness and interspersion		x						X	X				
	Quantity and spatial extent of habitat types								X	X				
	Temporal changes in the quantity and spatial extent of habitat types								X	X				
Fish Habitat	Percent cover from shoreline vegetation	x	x			X			X	X	X	X		
	Number of instream structures					X				X		X		
Biota	Richness and density of terrestrial riparian arthropods									X				
	Taxonomic composition of macroinvertebrate community									X				
	Presence of amphibian species in the groundwater									X				
	Habitat use or population estimates of species of interest		x							X				
	Species Lists									X				
	% Sensitive Taxa									X				

Common goals and objectives (columns) are assessed using commonly utilized monitoring metrics (rows) that correspond with specific goals and objectives.

Duncan, A. 2012. A Functional Approach to Riparian Restoration in Austin, Texas. City of Austin, Watershed Protection Department, Environmental Resource Management. Austin, Texas.

Recognizing the need to document and quantify the impacts of restoration activities on natural systems, the city of Austin, Texas created a monitoring framework to assess the improved ecological condition of their urban riparian systems. The assessment is predicated on the idea that functional riparian systems will have improved water quality and aquatic life, increased cover and structural diversity of floodplain vegetation, a dominant hardwood community, minimal soil disturbance, a wide and continuous riparian buffer, limited channelization, improved bank stability, and in stream aquatic habitat.

Measured Metrics

- Macro-algae cover
- Diatoms
- Canopy cover
- Plant cover and structural diversity
- Hardwood demography
- Recruitment/succession
- Riparian zone width
- Ratio of riparian zone width to SPTH
- Gap frequency
- Entrenchment ratio
- Bank stability
- Large woody debris
- Soil Moisture
- Soil pH
- Soil compaction

Johnson, B., M. Beardsley, and J. Doran. 2013. Functional Assessment of Colorado Wetlands (FACWet) Method – Version 3.0. Colorado State University, Fort Collins, Colorado.

FACWet/FACStream/Poudre River Health Assessment Framework

FACWet is based on Hydrogeomorphic theory, and is a weight of evidence approach. It is a rapid assessment, so is meant to be quick and inexpensive in personnel time. It is stressor based, making the assumption that more stressors on a system will lower the provisioning of functions. This is done by rating 8 “state variables” that are assumed to correlate with specific wetland functions. As it is a rapid assessment, no quantitative data are collected during the site visit. State variables are placed within three primary attribute groups, related to Buffer and Landscape, Hydrology, and Abiotic and Biotic Condition.

The assessment is conducted by rating 8 "state variables" that are assumed to correlate with specific wetland functions. As it is a rapid assessment, no quantitative data are collected during the site visit. State variables are placed within three primary attribute groups, related to Buffer and Landscape, Hydrology, and Abiotic and Biotic Condition.

State Variables

- Habitat Connectivity
- Contributing Area
- Water Source
- Water Distribution
- Water Outflow
- Geomorphology
- Chemical Environment
- Vegetation Structure and Complexity

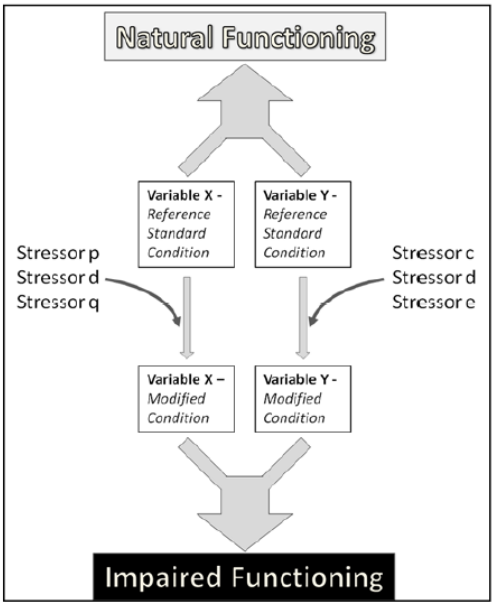


Figure 1. Schematic illustration of the FACWet model. State Variables interact to create the natural or characteristic functions associated with a wetland. Stressors modify the form of State Variables and consequently alter functioning. Notice that the stressors present in a wetland may or may not affect multiple variables.

FACWet is currently being expanded into FACStream, which was also used to create an assessment framework for the entire Poudre River in Fort Collins. Though not created for individual restoration project assessment, the Poudre River Health Assessment Framework (RHAF) does include some commonly used metrics for restoration assessment. It is important to note that both FACWet and the RHAF compares the conditions noted in the field to conditions expected in a reference site, necessitating a common understanding of what the reference condition of an urban system would be.

RHAF Metrics

- Tree shrub and herb coverage
- Noxious weeds and exotic species coverage
- Species composition
- Habitat heterogeneity
- Native woody species regeneration

Lewis, D., M. Lennox, and S. Nossaman 2009. Developing a Monitoring Program for Riparian Revegetation Projects. *University of Californa Division of Agriculture and Natural Resources*.

This document outlines the general framework to be followed when creating a new monitoring program for riparian restoration projects. There are clear steps in identifying project goals, and creating monitoring parameters that specifically address the project goals. Goals, as strongly stated in the document, should be directly connected to the goals and objectives of the revegetation project, and should be clearly articulated from the beginning of the project's development. Once goals are articulated, the two simple steps to creating monitoring parameters are to select the attribute that matches particular goals, and then set a target for that attribute to achieve. Monitoring can be qualitative or quantitative, and can be designed to provide feedback on each

step of a project. The pre-project assessment identifies a baseline and defines the management actions required. Implementation monitoring can ensure the project was carried out as specified. Effectiveness monitoring assesses the post project impacts to the site, beyond simply the physical specifications. A robust list of monitoring attributes are provided, along with the suggested methodology for each metric.

The need for project feedback to improve long term results and meet contractual requirements supports the essential role of riparian revegetation monitoring. Restoration monitoring entails the systematic collection and analysis of data that provides information useful for measuring project performance at a variety of scales (locally, regionally, and nationally), determining when modification of efforts is necessary, and building long-term public support for habitat protection and restoration. Monitoring objectives should be directly tied to goals and objectives of the project. Ecological success cannot be determined without clear project objectives from the start and the subsequent evaluation of its achievement. Goals should be specific, measureable, achievable, relevant, and time based. **The Process:** First, select an attribute (plant species composition), then set a target (>90% natives). Other attributes: bank cover, canopy, and channel width-to-depth, tree and shrub abundance, canopy cover, stream bank stability, stream channel shape, utilization by wildlife. Photo point monitoring is a useful qualitative technique. If a primary goal of a project is to increase native woody cover on the target stream bank, then the parameters to be sampled would be native tree and shrub cover and species composition. **Assessing plant survival:** a universal objective for planting riparian veg is plant survival. They advocate direct counts if at all possible. Along with direct counts (census), notes should be taken on plant vigor, cover estimates, and other factors applicable to your projects objectives. **Control sites:** when chosen correctly control and reference sites can provide a useful context for interpreting project success and evaluating how soon the trajectory of each attribute will reach the desired outcome.

<u>Monitoring Metrics</u>

- Plant survival and establishment
- Tree or shrub cover
- Herbaceous cover
- Canopy cover
- Stream channel morphology
- Bank stability
- Woody debris
- Maximum or mean pool depth
- Water quantity
- Habitat use or population estimates

Table 1. Fundamental monitoring types with principal questions that riparian revegetation project monitoring can answer

Principal monitoring question	Type of monitoring
1. What are the existing site conditions and the reasons for implementing a project at the site?	**PREPROJECT ASSESSMENT:** Documentation of current site conditions and how they support project selection and design.
2. Was the project installed according to design specifications, permits, and landowner agreements?	**IMPLEMENTATION:** Monitoring to confirm that the project was implemented according to the approved designs, plans, and permits. In other words, determining whether the agreed upon work was completed as planned. This is also a critical moment to identify any potential threats to project success so they can be addressed.
3. Did attributes and components at the project site change in magnitude as expected over the appropriate time frame?	**EFFECTIVENESS:** Monitoring to assess postproject site conditions and to document changes resulting from the implemented project. This is done through comparison with preproject conditions to establish trends in the condition of resources at the site. Accordingly, effectiveness monitoring needs to occur over a sufficient period of time to allow conditions to change as a result of the vegetation treatment. Also, similar to implementation monitoring, effectiveness monitoring is a critical moment in the project timeline to identify and address threats to project success.
4. Did fish, wildlife, or water quality respond to the changes in physical or biological attributes or components brought about by the revegetation project?	**VALIDATION:** Monitoring to confirm the cause and effect relationship between the project and biotic (wildlife) or physical (water quality) response. For example, this includes the change in use, presence, or abundance of desired salmon and steelhead trout or migratory songbirds at the project site. Similar to effectiveness monitoring, validation monitoring needs to occur over a sufficient period of time for wildlife use to change as a result of the vegetation treatment. This is predicated on the availability and proximity of targeted wildlife to the project site.

Source: Adapted from Roni 2005.

Table 2. Recommended monitoring methods based on attributes sampled

Attribute monitored	Quantitative method	References	Time*	Skill†
survival and establishment	direct count	See the section "Assessing Survival of Planted Vegetation"	—	—
	plot method	See the section "Assessing Survival of Planted Vegetation"	—	—
tree or shrub cover	line intercept transects	Harris et al. 2005‡ Coulloudon et al. 1996	L	L
tree or shrub composition	line intercept transects	Harris et al. 2005‡ Coulloudon et al. 1996	L	M
	floodplain forest composition plots	Harris et al. 2005‡	M	H
herbaceous cover; herbaceous composition	gap intercept	Herrick et al. 2005 vol. 1	L	L
	line-point intercept	Herrick et al. 2005 vol. 1	M	M–H
	step-point method	Coulloudon et al. 1996		
canopy cover; solar radiation	spherical densiometer	Flosi et al. 1998	L	L
	solar pathfinder	Harris et al. 2005‡	M	M
stream channel morphology	bankfull width-to-depth ratio	Rosgen 1996	L	M
	cross section	Harrelson et al. 1994	M	M
	longitudinal profile	Gerstein 2005 Harrelson et al. 1994	M	M
bank stability	line intercept transects	Gerstein and Harris 2005‡	L	L
	cross section	Harrelson et al. 1994	H	M
woody debris	woody debris survey	Gerstein 2005 Flosi et al. 1998	L	M
maximum or mean pool depth	residual pool depth	Lisle 1987	L	M
	longitudinal profile	Gerstein 2005 Harrelson et al. 1994	M	H
water quantity	stream flow	SWRCB 2001 Tate 1995a, b	M	H
	groundwater elevation	Nielsen 1991 Freeze and Cherry 1979	H	H
habitat use or population estimates	birds	Ralph et al. 1993	M	H
	benthic macroinvertebrates	Barbour et al. 1999	M	H
	salmon or steelhead	Duffy 2005 Dolloff et al. 1993	H	H

APPENDIX A
MONITORING PLAN WORKSHEET, INSTRUCTIONS, AND EXAMPLE

Monitoring Plan Worksheet

Project Name: **Implementation Date:**

Project Goals and Objectives
1. Project goals and objectives: 2. Attribute(s): 3. Targets (Include expected recovery timeline or number of years needed to achieve target):

Project Funding and Resources
1. Contract termination date: 2. Length of contract: 3. Monitoring required by contract? ☐ Yes ☐ No 4. Contractually required monitoring duration: 5. Duration of monitoring desired for attribute and trajectory: 6. Monitoring funds included in grant? ☐ Yes ☐ No Amount: 7. Monitoring funds from other sources? ☐ Yes ☐ No Source and amount: 8. Total monitoring funds available:

Monitoring Types			
___Preproject			Comments:
___Implementation	___Qualitative	___Quantitative	
___Effectiveness	___Qualitative	___Quantitative	
___Validation	___Qualitative	___Quantitative	

Monitoring Objective(s)

Monitoring Methods
1. Method(s) and reference(s): 2. Method documents obtained and reviewed? ☐ Yes ☐ No 3. Estimated time required at each site: 4. Estimated equipment costs, if any: 5. Control site employed: ☐ Yes ☐ No 6. Reference site employed: ☐ Yes ☐ No

COMPLETED WORKSHEET FOR EXAMPLE SITE

Project Name: Parsons Creek Willow Wall **Implementation Date:** 10/2003

Project Goals and Objectives

1. Project goals and objectives:
   a) stabilize eroding streambank to reduce fine sediment in channel
   b) increase woody vegetative cover on bank
   c) increase canopy cover over channel
2. Attribute(s):
   a) stability
   b) woody species cover
   c) canopy cover
3. Targets (Include expected recovery timeline or number of years needed to achieve target):
   a) stability ≥ 90% (after 3 years)
   b) establish woody veg cover (> 3 ft tall) to 30% (after 10 years)
   c) canopy cover ≥ 70% (after 10 years)

Project Funding and Resources

1. Contract termination date: 3/31/04
2. Length of contract: 3 years
3. Monitoring required by contract? ☑ Yes ☐ No
4. Contractually required monitoring duration: 3 years
5. Duration of monitoring desired for attribute and trajectory: 3 and 10 years
6. Monitoring funds included in grant? ☐ Yes ☑ No Amount:
7. Monitoring funds from other sources? ☐ Yes ☑ No Source and amount:
8. Total monitoring funds available: 0$ volunteers only

Monitoring Types

✓ Preproject			Comments:
✓ Implementation	✓ Qualitative	✓ Quantitative	
✓ Effectiveness	✓ Qualitative	✓ Quantitative	
___ Validation	___ Qualitative	___ Quantitative	

Monitoring Objective(s)

Quantitatively evaluate proposed increases in bank stability from current conditions to > 90% within 3 years.
Quantitatively evaluate proposed increases in woody vegetation cover from current conditions to 30% within 10 years.
Quantitatively evaluate proposed increases in canopy cover over channel from current conditions to 70% within 10 years.

Monitoring Methods

1. Method(s) and reference(s):
   a) line intercept transect at bankfull (Gerstein and Harris 2005)
   b) line intercept transect at bankfull and top of bank (Harris et al. 2005)
   c) spherical densiometer (Flosi et al. 1998)
2. Method documents obtained and reviewed? ☑ Yes ☐ No
3. Estimated time required at each site: 2 hours per visit
4. Estimated equipment costs, if any: none
5. Control site employed: ☐ Yes ☑ No
6. Reference site employed: ☐ Yes ☑ No

Palmer, M. A., L. Wainger, L. Craig, C. Febria, J. Hosen, and K. Politano. 2011. Promoting Successful Restoration through Effective Monitoring in the Chesapeake Bay Watershed. Prepared for the National Fish and Wildlife Foundation, Washington, D.C.: 24pp.

This report was prepared for the National Fish and Wildlife Foundation in Washington, DC in an effort to create a scientifically robust monitoring protocol for management of the Chesapeake Bay Watershed. This protocol is broad enough to be employed in many situations, though is created specifically for streams and adjacent riparian areas. Based on their literature review, they split the monitoring metrics into five categories: Hydrologic, Geomorphic, Biotic, Riparian Vegetation, and Physico-chemical.

There are major constraints on the success of restoration projects, as restoration often takes place at a reach scale, though rivers are generally impacted over the watershed scale. Changes to any particular reach may not lead to measurable changes in things like water quality. In a vague sense, restoration can be deemed successful if it leads to a self-sustaining system that over time closely

resembles the natural condition in terms of structure and function (Palmer et al 2005). There is often a need to balance goals with recognized limitations. Indicators of progress should be measureable, detectable within the first few years, and should indicate whether the reach is on the right trajectory. Because system processes interact in complex ways, a suite of monitoring metrics used together is often the best approach for understanding progress towards goals and to evaluate any tradeoffs between goals. **Implementation Verification Metrics** are used to confirm the proposed project was executed according to the planned design. **Monitoring metrics** provide evidence that the ecological functions of the site have been restored and are used to suggest adaptive management needs to reach the projects full potential. Reference sites are needed to accurately compare monitoring metric data to. Monitoring metrics can be structural (quantify spatial conditions and patterns, often at a single point in time) or functional (quantify dynamic processes over time). Structural metrics are the most common to monitor, as measuring dynamic processes can be time consuming and expensive. It is hoped/assumed that certain structural metrics act as proxies for specific functional metrics. **Hydrogeomorphic metrics:** discharge and sediment influence every aspect of stream ecology. Daily discharge at the site, measuring pool/riffle sequence through the stretch, and annual cross sections to detect aggradation or degradation. **Biotic Metrics**: Aquatic biotic metrics are generally poor indicators of restoration success as they are a function of the larger system more than that single reach. **Riparian Vegetation metrics:** "The single most important factor for restoring a stream is to establish healthy, native riparian vegetation along the streambanks." % Native vegetation and % cover of them are both important metrics. Canopy cover is highly correlated to basal food availability, allochthonous inputs, water temperature, large woody debris, and biotic composition. Riparian vegetation is also important habitat for birds, bats, spiders, and other terrestrial species.

<u>Monitoring Metrics</u>

Hydrologic

- Discharge

Geomorphic

- Substrate particle size
- % Fines on streambed
- Floodplain connectivity
- Streambed armoring

Biotic

- Species list
- % Sensitive
- Fish size structure

Riparian Vegetation

- % Native vegetation
- Vegetation composition and size

Physico-chemical

- Water chemistry
- Temperature
- Oxygen

Table 2. Implementation Verification Metrics for Streams

Metric Category	Metric	Description
Structural	Built features (during construction)	Step pools, floodplain re-connection, or other built elements should have photos or site inspections to document that design elements were followed by contractors and disturbance to the riparian zone was minimized
	Built features (post-construction)	Built elements match design in extent, placement, and type of material – should be reassessed after one flood season
	Topography	Site slope matches design
	Natural structures	Coir logs, woody debris additions, or other natural structural elements meet all design specifications
Non-Structural	Riparian plantings	Verify that specified planting was conducted through photo documentation or on-site inspection
	Vegetated and non-vegetated areas and basic channel form	Measure/estimate area of pools, riffles, riparian corridor width; Use of GIS, Google maps, Lidar or other appropriate technology is desirable for documenting pre vs. post presence and extent of non-structural features including basic channel form. Detailed channel morphometric surveys (e.g., x-section and longitudinal profiles) are not necessary unless channel stability is a project goal.

Woolsey, S., Capelli, F., Gonser, T., Hoehn, E., Hostmann, M., Junker, B., Peter, A. 2007. A strategy to assess river restoration success. *Freshwater Biology 52*(4): 752–769.

A robust effort from Switzerland to restore significant sections of the country's streams and rivers led to the creation of a monitoring assessment framework in which project managers could choose monitoring attributes that fit their specific goals. Because reference reaches of rivers in industrialized nations rarely exist, rather than comparing the restored rivers to reference reaches, the protocol urges all attributes to be assessed prior to restoration implementation. The measured change in each attribute following restoration is what indicates a successful project. Success can be related to social, economic, or environmental metrics. Each indicator provided in their protocol is associated both with an indicator category as well as a variety of possible project objectives. For instance, within the indicator category of "vegetation," a specific indicator is "succession and rejuvenation of plant species on floodplains" which can be used to indicate success of the project objectives "lateral connectivity" as well as "near natural abundance and diversity of floodplain vegetation."