City of Boulder
Open Space and Mountain Parks

West Trail Study Area
Natural Resource Inventory Report

Final Draft
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West TSA Natural Resource Inventory Report

Introduction

The West Trail Study Area is a complex and diverse mix of ecosystems, habitats, wildlife and plant species, and natural processes making this roughly 11,000 acres one of the most biologically rich areas in the Colorado Front Range. The TSA area contains two designated State Natural Areas that highlight the area's state-wide and regional significance and is home to 14 imperiled or critically imperiled plant species, over 1,000 acres of imperiled or critically imperiled vegetation associations, and a long list of wildlife species that are rare or sensitive according to the Colorado Natural Heritage Program, the US Forest Service, or the Colorado Division of Wildlife.

In addition to the discrete occurrences of rare species, the West TSA is made up of a broad mix of ecosystems. The larger matrix habitats in the TSA support a rich diversity of plant and animal species. Large contiguous blocks of ponderosa pine woodlands and mixed-conifer forests provide habitat for wide-ranging animals and allow for their movement across the landscape. Riparian areas and cliffs are much smaller in relative size but provide unique habitat for some of the rarest species on the OSMP system. Forest/grassland edges or ecotones support unique vegetation associations and virtually all the local wildlife species spend at least a portion of their lives in these openings and along these edges (Map 1).

The West TSA Natural Resource Inventory Report is a synthesis of the existing knowledge and data that relates to this portion of the OSMP system. The report integrates background information, data models and GIS, and recent monitoring data into an assessment of current conditions for targets, nested targets, attributes and indicators. The focus of this report is the newly developed TAIs for the forested portion of the system. Complete target descriptions as well as current conditions in the ***grassland portions*** of the TSA are described and detailed in the OSMP Grassland Ecosystem Management Plan (City of Boulder 2009).

Top: Wood lilly (*Lilium philadelphicum*)

Bottom: Peregrine falcon (*Falco peregrinus*)

This inventory report is also supplemented by a report prepared in the fall of 2008 by ERO Resources Corp. The ERO report focuses on nested targets or those species that are rare or sensitive and have unique conservation needs provided by the target. The report reviews recent research conducted on OSMP and other published works to describe some of the nested targets in the TSA and

provide spatial data for species occurrences. The report also provides a summary of research done on recreation and human impacts to wildlife. Much of this information is integrated into the Habitat Suitability Models of this report. While the ERO report provides background information on geology, soils, and vegetation, its focus is upon wildlife species of special concern.

Future West TSA planning will identify and describe:

- Desired Conditions
- Management Issues
- Recommended strategies to deliver a high quality visitor experience, sustainable visitor infrastructure and the conservation of resources

Parts of this Report

Target Descriptions and Current Conditions (Main Report)- The main body of this report gives an in-depth description of each natural resource target and reports out the current conditions of general target attributes as well as the current conditions for each indicator. The methods and specific data used to develop the current conditions are described in the following appendices.

Habitat Suitability Models and Trail Effects (Appendix A) - The wildlife indicators selected for the WTSA planning process focus on a subset of "umbrella species" that were selected because they have habitat needs within the specific target that also apply to a much broader suite of wildlife species. Theses indicator species were selected because there is sufficient baseline data to accurately model habitat needs on the system, there is a range of research on those habitat needs so the models could be appropriately refined, and the indicators are species that are sensitive to change due to visitor use.

This inventory report uses a technique called Habitat Suitability Modeling to map the potential habitat of the indicator species in each natural resource target. The models are based on a wide range of OSMP GIS data and incorporate species specific research and monitoring. Habitat models have obvious limitations and no model is perfect but they allow staff to get a system-wide perspective on resource values, provide an easily measured value of the status of habitat and inform future follow-up when finer scale management decisions are necessary. The habitat models are one tool being used at a coarse scale to identify areas in the West TSA where existing natural resource conditions could be improved. These coarse assessments will be followed by finer scale evaluations when specific

project areas are identified through the planning process. The models will allow for a more efficient and focused use of limited resources.

Existing literature and research was reviewed to identify human impacts related to each of the indicator species and these potential impacts were incorporated into the models. The trail and road effects portion of the models use the best available information to make general assumptions about potential effects. The models are limited by the amount of specific research that has been done for each species and, while the results of studies are not often conclusive, at the coarse level the modeled trail effects provide a tool to identify areas where natural resource values may be impacted and where changes to existing infrastructure could improve natural resource target conditions.

On-going Wildlife Monitoring Projects (Appendix A) - The methods and findings described in this section relate to on-going research and monitoring projects being conducted by OSMP staff in the West TSA. While many of these projects are not designed to specifically look at the impacts of trails or human use, they can inform the trail study area process. These studies can provide relatively current and discrete occurrence data for many nested target species and provide baseline information on species richness and abundance.

Rare Plant and Vegetation Monitoring (Appendix B) - This section of the report describes the monitoring methods used to track rare plants and communities across the OSMP system. Tables are included that report the numbers of subpopulations for each nested plant species and acres of each nested vegetation association.

Non-Native Species Mapping and Prioritization (Appendix C) - The final appendix in the report outlines OSMP's methods for mapping non-native vegetation. The rapid assessment weed mapping was used to develop the management priority weed indicator for each target. The appendix also includes a species prioritization developed by staff and based on associated habitats, ecological threat, difficulty of management, and state weed designations.

Conservation Target: Mixed Conifer Forests and Woodlands

Summary Statistics:

Total acres of the target in the entire OSMP system (fee properties): **4,242 acres**
Percentage of all OSMP vegetation in the target: **12.5 %**
Total acres of the target in the West TSA: **3,832 acres**
Percentage of the target in the West TSA: **90.3 %**

Miles of OSMP designated trails in the target: **18.4 miles**
Miles of undesignated trails in the target: **11.2 miles**

Background

Mixed conifer forests and woodlands form the largest target within the West TSA covering roughly 39% of the total area. Approximately 90% of all mixed conifer areas on the system occur within the TSA boundary. This focal target covers some of the steepest and most varied topography on the system and forms some of the largest intact habitat blocks in the forested areas on OSMP. Dense canopy, more mesic conditions, and relatively low levels of disturbance make this target a large contributor to the overall biological diversity of the OSMP system.

The majority of the Mixed Conifer target occurs west of the Mesa Trail on steep slopes. The soils that support this target are of the Judget and Fern Cliff series. These soils are generally coarse gravel or sandy loams with some large rock inclusions. These soils are well drained with moderate permeability and can be prone to erosion (Moreland and Moreland 1975).

Vegetation Composition (Attribute)

This target occurs within the lower and upper montane life zones from about 6,800 feet to roughly 8,500 ft on OSMP. Mixed Conifer forests and woodlands are recognized by canopy covers greater than 25%. On OSMP the dominant overstory species in this target are Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa subsp. scopulorum*), usually in equal proportions or dominated by Douglas-fir. In addition to these two common species there are also small scattered patches or individual occurrences of limber pine (*Pinus flexilis*), blue spruce (*Picea pungens*), lodgepole pine (*Pinus contorta*), Rocky Mountain juniper

(*Sabina scopulorum*), and quaking aspen (*Populus tremuloides*). Many of these stands favor the wetter, north-facing slopes of the mountain backdrop but can also be found on ridgelines and in draws and canyons.

In many mixed conifer areas understory growth can be greatly inhibited by the heavy canopy cover. Conditions favor more shade-tolerant species in the understory and the establishment of Douglas-fir seedlings. Shrub species like Rocky Mountain maple, ninebark (*Physocarpus monogynus*), and waxflower (*Jamesia americana*) can form thick stands within these forested areas. Other common understory plants include elk sedge (*Carex geyeri*), wild rye (*Leymus ambiguus*), ricegrass (*Piptatherum micranthum*), pipsissewa (*Chimaphila umbellata*), and one-sided wintergreen (*Orthilia secunda*). The moist, shaded conditions also support a unique suite of rare plants including picture-leaf wintergreen (*Pyrola picta*), wood lily (*Lilium philadelphicum*), Alaskan orchid (*Piperia unalascensis*), and western polypody (*Polypodium saximontanum*).

Current Conditions:

- 17% of the target area has been mapped for weeds, of this 0.4% of the target area has a weed canopy cover greater than 6%
- There are currently 9 known populations of rare plant species with a total of 26 subpopulations
- Potential high suitability Northern Goshawk habitat covers 5% of the West TSA. When trail effects are considered- highly suitable habitat is reduced to 3% of the WTSA

Indicator: Percentage of target with a prevalence of management priority weed species-
System-wide weed mapping data that includes species, percent cover, and patch size were used to identify areas in the TSA with relatively high weed cover. A list of the management priority weed species used in this target analysis and a description of the mapping methodology can be found in Appendix C. Approximately ***17% of the mixed conifer target in the TSA has been mapped for weeds****. Within the mapped portion of the mixed conifer target,* ***0.4% of the target area has a weed cover greater than 6%****. Mapping in 2009 will focus on mixed conifer forests to increase data on weed prevalence in this target. The low overall weed occurrence is likely the result of dense canopy cover and low levels of historic disturbance. Map 2 shows weed densities across the West TSA and areas of greater weed concentrations based on patch size and density.*

Indicator: Number of populations and subpopulations of local suite of rare species and communities-
Rare plant occurrences have been mapped across the OSMP land system. New occurrences are discovered each year. The values for this indicator are based on the most current information recognizing that new discoveries or environmental factors will likely cause changes in what rare plant species and the numbers that are found in the target. A list of the rare and sensitive plant species and communities that contribute to this indicator can be found in Appendix B. Within the mixed conifer target area ***there are currently nine known populations of rare plants with a total of 26 subpopulations and 36.5 acres of rare plant communities****. The known occurrences of rare plants and communities have been generalized on Map 3. Populations are all occurrences of a species within a distance of 2 km of each other when suitable habitat is present. Subpopulations are all individuals grouped within a distance of 50 m (NatureServe 2004).*

Wildlife and Habitat Effectiveness (Attribute)

The mixed conifer forests of OSMP provide essential habitat for interior wildlife species or those species that require blocks of intact, dense forest cover. Interior forests are defined as being more than 200 m from an ecotonal edge (Robbins et al. 1989, Bock et al. 1999) and higher basal area values are a good predictor for interior species use (Jones 1990). Interior bird species utilize the dense canopy of the mixed conifer target for foraging, nesting and breeding. There is a wide range of interior bird species that use OSMP lands including accipiters like Northern Goshawks and Cooper's Hawks and smaller species like Flammulated Owls, Hairy Woodpeckers, Red-breasted Nuthatches, and Hermit Thrushes. All of these bird species utilize the habitat that is provided by the dense patches of forest on OSMP.

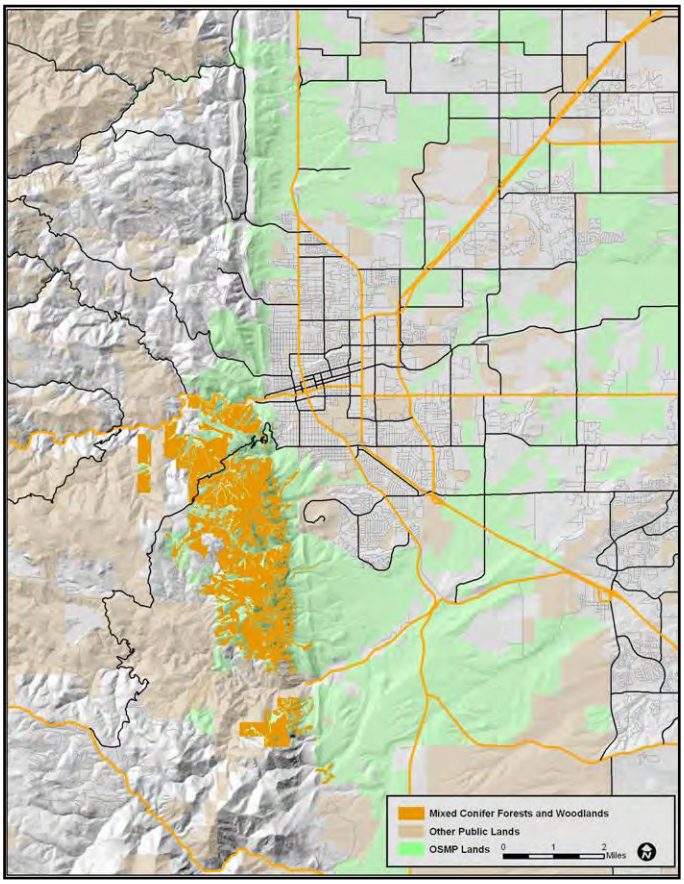
In addition to interior bird species, more generalist mammal species like mountain lions, black bears and bobcats use the mixed conifer forests. The dense canopy and rocky conditions provide areas for dens and day-bedding. The small patches of aspen that intermix with mixed conifer stands also provide forage for ungulates and ideal snags for cavity nesting birds and bats.

Indicator: Percent of West TSA with highly suitable Northern Goshawk habitat- *Northern Goshawk habitat was selected as an indicator for mixed conifer forests because it represents forest conditions that are ideal for a wide range of interior forest species and Northern Goshawks can be sensitive to human disturbance (ERO 2008). Northern Goshawk occurrences in the West TSA are uncommon and infrequent but more common species like Cooper's hawks are often found in very similar habitats. There is a wide range of research on Goshawk habitat needs which allowed OSMP staff to create a strong habitat model for this species. Highly suitable Northern Goshawk habitat represents areas in the TSA that have large, mature trees, high snag densities, and a dense forest structure usually dominated by Douglas-fir. The specifics of the Goshawk habitat model can be found in Appendix A.*

The habitat analysis in the West TSA was done in two steps. The first simply identified all potential suitable habitat based on the environmental variables in the model. All the data that was greater than one standard deviation above the mean was categorized as "highly" suitable. A minimum patch size of 10 ha (25 acres) was applied and patches smaller than this were removed from the highly suitable habitat. ***Five percent (5%) of the entire WTSA was categorized as potential highly suitable Northern Goshawk habitat*** *(Map 4). The second step was to incorporate existing trail and road influence into the model to map the current habitat conditions. A 6 meter (20 foot) buffer was put on voice and sight designated trails to account for people and dogs leaving the trail corridor and a 50 meter buffer was put on roads to account for road disturbance. All designated and undesignated trails were used to split potential habitat blocks. Patches of potentially highly suitable habitat smaller than 10 hectares (25 acres) were removed from consideration; patches greater than 10 hectares were considered to be highly suitable. The effect of trails and roads on the model was to reduce the amount of highly suitable goshawk habitat from five percent (5%) of the target to* ***three percent (3%) of the WTSA is currently highly suitable Northern Goshawk habitat*** *(Map 5).*

Ecological Processes

The high tree densities that are well-suited for interior wildlife species are a function of both the levels of moisture and soil conditions on the slopes the forests inhabit as well as a historic fire regime that was more intense and sporadic. Unlike the nearby ecotonal ponderosa stands, mixed conifer stands did not historically support high frequency-low intensity burns (Sherriff and Veblen 2004, Kaufmann et al 2007, Sherriff and Veblen 2007). Ecotonal ponderosa stands have heavy grass understorys and adjacent grasslands that are much more prone to ignition. In the mixed conifer forests moist conditions probably prevented widespread fires except under drought conditions. Heavy fuel loads accumulating during the longer period between fires in these areas also added to the fire severity when an ignition occurred (Kaufmann et al. 2006).



Fire scar evidence collected in Boulder County including samples from OSMP lands show that above about 6,900 feet most of the forested areas experienced less frequent fires of mixed or high severity (Sherriff and Veblen 2007). There is no evidence that frequent surface fires played a role in the fire history of these areas. Fire intervals in this target fall within the 30 to 100 year range.

Less frequent, more intense fires lead to more dense forest conditions and areas of even-aged cohorts in this target. While the higher elevation stands of the mixed conifer target have experienced the same levels of fire suppression over the past 100+ years as low elevation areas, the impact on the forest structure and function has been less striking compared to low elevations ponderosa forests. Historically, mixed conifer stands in the WTSA were denser and less diverse structurally. The time since fire suppression began is similar to the upper end of the natural interval between fire events.

Current high tree densities at higher elevations are probably a legacy of historic fire events and less a consequence of fire suppression of low severity fires. There is evidence to show that tree establishment has substantially increased, especially for Douglas-fir, in the last 30 years (Sherriff and Veblen 2004). This heavy overstory layer of trees can impact understory vegetation growth, aspen establishment, and decrease overall biodiversity. These forests also have higher fuel loads-a management

consideration as homes and people have encroached far into the wildland/urban interface.

Conservation Target: Ponderosa Pine Woodlands and Savannahs

Summary Statistics:

Total acres of the target in the entire OSMP system (fee properties): **3,461 acres**
Percentage of all OSMP vegetation in the target: **9.9%**
Total acres of the target in the West TSA: **2,964 acres**
Percentage of the target in the West TSA: **85.6%**

Miles of OSMP designated trails in the target: **22.8 miles**
Miles of undesignated trails in the target: **18.8 miles**

Background

Ponderosa pine woodlands and savannahs make-up the second largest conservation target in the West TSA and cover roughly 25% of the total TSA area. Ponderosa forms a common vegetation type across the eastern Front Range but OSMP's topography and its location at the very edge of the Great Plains and Rocky Mountains create a diversity of flora and fauna in this system not common elsewhere. This is also a vegetation type that has seen many changes over the last 150 to 200 years and is different now both structurally and functionally than it was in the past.

The soils and climate found along the foothills of OSMP contribute to perfect habitat for open ponderosa stands with a diverse understory. Deep, well-drained soils dominate the mesas where many of the ponderosa dominated stands are found on OSMP. The Goldvale rock outcrop complex (or stony coarse sandy loam) and Nederland series (very cobbly sandy loam) are the two soil series in the area and are defined by very coarse soils (Moreland and Moreland 1975). The coarse soils allow for the deep root penetration of ponderosa pine and allow for moderate to high water permeability.

Vegetation Composition (Attribute)

The majority of this target falls within the lower montane or transitional life zone on OSMP at or below 7,000 feet. This target is generally recognized by the low density of tree cover with canopy cover less than

25% for savannahs and between 25% and 60% for woodlands. The overstory of these stands is dominated by ponderosa pine (*Pinus ponderosa subsp. scopulorum*). Some areas of the system have relatively small components of Rocky Mountain juniper (*Sabina scopulorum*) on xeric sites and Douglas-fir (*Pseudotsuga menziesii*) on more mesic sites and in ravines. The open tree canopy often results in a diverse understory dominated by grasses, forbs and shrubs.

At the grassland/forest ecotone where ponderosa savannahs and woodlands dominate, the intermix of prairie grasslands and more montane forest types lead to a diverse and localized set of plant alliances and species. Xeric tallgrass plant communities dominated by big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and prairie dropseed

(*Sporobolus heterolepis*) intergrade with higher elevation species like mountain muhly (*Mulenbergia montana*) and sun sedge (*Carex pensylvanica*). This unique intersection of ecosystems and the open tree canopy leads to an exceptionally diverse forest understory. Nested target plant species found in this target and in adjacent grasslands include CNHP ranked dwarf leadplant (*Amorpha nana*), Rocky Mountain sedge (*Carex saximontana*), and birds-foot violet (*Viola pedatifida*). During inventories primarily done in low elevation ponderosa stands for the development of the Forest Ecosystem Management Plan, a total of 330 plant species in 232 genera were inventoried with an average richness of 48 species per 400 m^2 plot (City of Boulder 1999).

Current Indicator Conditions:

- 64% of this target has been mapped for weeds showing 6.2% of the target has a weed canopy cover greater than 6%
- There are currently 12 known populations of rare plant species with a total of 41 subpopulations
- Potential high suitability Abert's squirrel habitat covers 9% of the West TSA. When trail effects are considered- highly suitable habitat is reduced to 5% of the WTSA.

Indicator: Percentage of target with a prevalence of management priority weed species-
A list of the management priority weed species can be found in Appendix C. Approximately 64% of the ponderosa pine target in the West TSA has been mapped for priority weed species. Within the TSA, ***6.2% of the target area has a weed cover greater than 6%****. Many of the highest density weed patches are found in areas of historic disturbance (grazing, roads, etc) and areas with low tree canopy cover. Map 2 shows weed densities across the West TSA and areas of greater weed concentrations based on patch size, density and the proximity of other weed patches.*

Indicator: Number of populations and subpopulations of local suite of rare species and communities-
Within the ponderosa pine target area three species were used to evaluate the rare plant indicator. Rocky Mountain sedge (Carex saximontana), narrow-leaved milkweed (Asclepias stenophylla), and wavy-leaf stickleaf (Nuttallia sinuata) are all commonly found in the low elevation foothills and in open ponderosa pine stands and are all ranked as imperiled or critically imperiled in Colorado (CNHP 2009). Within the TSA ***there are currently 12 known populations of rare plants with a total of 41 subpopulations and 2.1 acres of rare plant communities*** *within the ponderosa pine woodlands and savannah target of the West TSA. The known occurrences of rare plants and communities have been generalized on Map 3.*

Wildlife and Habitat Effectiveness (Attribute)

The habitat and forest structure of OSMP's low elevation ponderosa stands result in a diverse mix of wildlife species. Ungulates such as mule deer and elk use the open savannah areas for forage and retreat to the more shaded woodlands for day-bedding and protection from predators. Large, dead ponderosas create ideal habitat for a suite of cavity nesting birds and bats as well as feeding areas for woodpeckers. Large, old trees create perch sites for forest raptors and turkeys. Denser stands are ideal habitat for Abert's squirrels and raptors such as Sharp-shinned Hawks.

There is potential for 38 different mammal species to occur in OSMP ponderosa woodlands (Jones 1990) and 1998 OSMP inventories recorded 61 different bird species in OSMP low-elevation forest stands (City of Boulder 1999).

Indicator: Percentage of West TSA with highly suitable Abert's squirrel habitat- *Abert's squirrels are the indicator species selected for the ponderosa pine target because they require patches of mature ponderosa pine in a mosaic of uneven-aged stands. This type of woodland has an overstory that provides habitat for many wildlife species, both common and rare. Highly suitable Abert's squirrel habitat is characterized by ponderosa pine with moderate tree densities and many large, mature trees. Many areas identified by the model have characteristics of mature forest stands with trees approaching old-growth. Specific variables used in the development of the Abert's habitat suitability model can be found in Appendix A.*

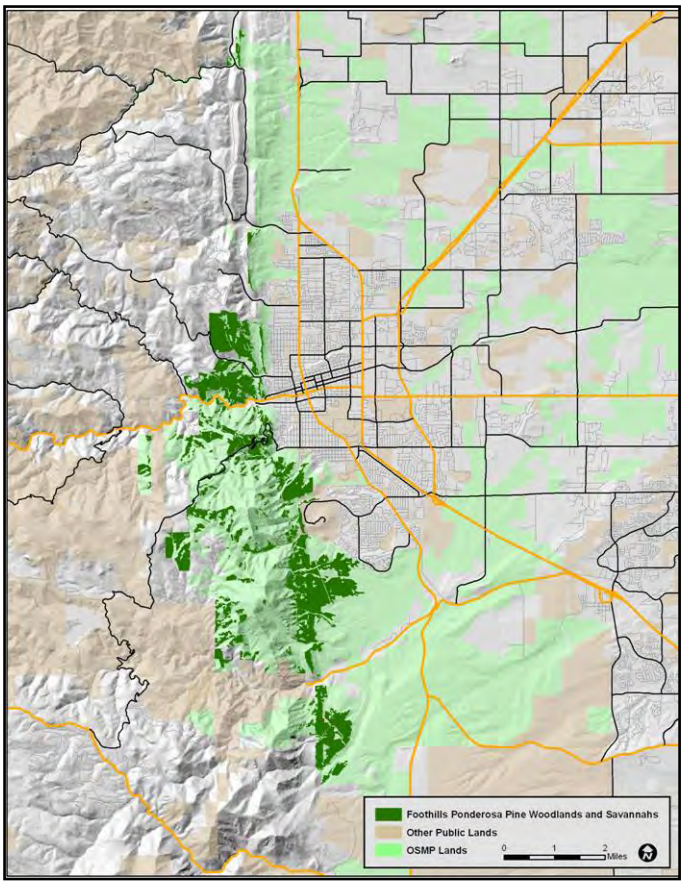
The habitat analysis in the West TSA was done in two steps. The first simply identified all potential suitable habitat based on the environmental variables in the model (all the model inputs and variables are described in Appendix A). A minimum patch size of 10 ha (25 acres) was applied to the model and areas smaller than this were removed from highly suitable habitat. ***Nine percent (9%) of the entire WTSA is potential highly suitable Abert's habitat*** *(Map 6). The second step was to incorporate existing trail and road influence into the model to map the current habitat conditions. A 6 meter (20 ft) buffer was put on voice and sight designated trails to account for people and dogs leaving the trail corridor and a 50 m (164 ft) buffer was put on roads to account for road disturbance. All designated and undesignated trails were used to split potential habitat blocks. Patches of potentially highly suitable habitat smaller than 10 hectares (25 acres) were removed from consideration; patches greater than 10 hectares remained highly suitable. The effect of trails on the model was to reduce the amount of highly suitable Abert's habitat from nine percent of the WTSA to* ***five percent (5%) of the West TSA is currently highly suitable Abert's habitat*** *(Map 7).*

Ecological Processes

Throughout their range, ponderosa pine forests are maintained and shaped by fire. Fire regimes in ponderosa forests tend to vary based on elevation and can range from very frequent fires of low severity at lower elevations to more mixed severity or even stand replacing fires at higher elevations (Kaufmann et al. 2006, Veblen 2004). In the lower elevations of the OSMP ponderosa target, analysis of fire scars has shown this area historically experienced high frequency, low intensity fires that

maintained open forest conditions (Veblen 1996, Sherriff and Veblen 2007). Below about 6,800 ft., ponderosa stands during and prior to the 19th century experienced mean fire return intervals of about 10 to 30 years (Kaufmann et al. 2006). These frequent fires killed a majority of the ponderosa regeneration and favored older, more fire resistant trees. The result was open stands of large trees and an understory dominated by grasses, shrubs and forbs. Frequent fires also resulted in transient canopy openings and perpetual low fuel loads reinforcing the pattern of low intensity fires.

Beginning in the late 19th and early 20th century fire went from being a frequent and regular occurrence to being almost completely excluded from the ponderosa pine system. More than 100 years of fire suppression has led to a dramatic shift in forest structure, especially in the low elevation ponderosa stands that make up the foothills ponderosa target. Fire suppression as well as the ground disturbance associated with historic grazing, mining, and logging has led to many years of favorable conditions for ponderosa establishment. The ease of access to low elevation stands also allowed for historic logging and the removal of larger and older trees which has resulted in less structural diversity. In comparison to historic conditions, ponderosa pine stands across the Front Range are denser, have fewer large trees and snags, and are more homogenous in tree age and size (Veblen and Donnegan 2005).



Like fire, another regular disturbance factor in the ponderosa target is insects and disease. Many of these biotic factors in ponderosa forests are native and cause limited mortality across the landscape in endemic levels. However, variables like drought or forest density can lead to larger epidemic outbreaks that can kill large portions of forest and change forest structures dramatically. Currently, the ponderosa target is facing fire suppressed, overly dense conditions that could lead to large bark beetle outbreaks in the near future. While a widespread outbreak of something like mountain pine beetles would cause a large amount of mortality in ponderosa forests it would also have ecological benefits. Beetles or other insects or pathogens can create diversity in tree ages and spacing, create snags and down trees that are important wildlife habitat, and open the canopy which can create a more diverse understory.

Conservation Target: Cliffs and Talus

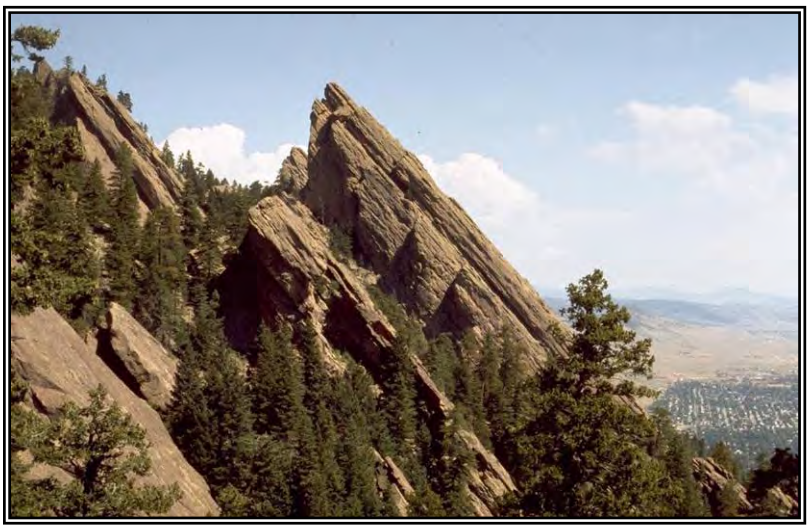
Summary Statistics:

Total acres of the target in the entire OSMP system (fee properties): **660 acres**
Percentage of all OSMP vegetation in the target: **1.9%**
Total acres of the target in the West TSA: **544 acres**
Percentage of the target in the West TSA: **82.4%**

Miles of OSMP designated trails in the target: **1.7 miles**
Miles of undesignated trails in the target: **1.8 miles**
Number of mapped climbing formations in the target: **132**

Background

Cliffs and talus are one of the smallest conservation targets in the TSA but they provide a habitat not found elsewhere. Despite the relatively small area of cliffs and talus this target consists of some of the most recognizable features in the mountain backdrop and have an ecological importance far greater than their extent would suggest. The Flatirons and the surrounding rock faces are *the* features that identify Boulder's natural setting.



The majority of this target occurs at higher elevations on the system west of the Mesa Trail and the Dakota Hogback. The most recognizable and obvious cliff features, including the Flatirons, are sedimentary sandstone rock from the Triassic, Permian, and Pennsylvanian periods (325 to 190 m. y. old) and include Lykins, Lyons, and Fountain formations. Smaller rocky cliffs and ledges can be found to the east of the Flatirons along the Dakota Ridge Hogback. This younger sedimentary rock dates to the Jurrassic and Cretaceous periods (190 to 65 m. y. old). Some of the oldest rock in the target area makes up the high peak tops and large talus fields. These areas are composed of igneous rocks of the Precambrian period (1,700 m. y. old) (Bilodeau et al. 1987).

Vegetation Composition (Attribute)

In the cliff and talus target the predominant cover is rock with a very small percentage, usually less than 20%, vegetation. Open cliff faces and large rocks tend to be excessively drained and vegetation favors relatively moist crevices and shelves in the rock (Bunin 1985). The sparse vegetation on the rocky substrate of this target is typically composed of shrubs such as wax currant (*Ribes cereum*), Rocky Mountain maple and waxflower. Tree cover is often sparse but Douglas fir, ponderosa pine and Rocky Mountain juniper can get established in cracks and crevices. In addition to common species, cliffs and talus can also support a suite of rare and sensitive species. Ferns and fern allies such as grassfern (*Asplenium septentrionale*), Wright's cliff brake (*Pellaea wrightiana*), and western polypody (Polypodium saximontanum) are only found on OSMP in the small crevices in rocks and cliffs. Weatherby's spikemoss (*Selaginella weatherbiana*) is a member of the club-moss family that is relatively common on rocky faces on OSMP but is ranked as vulnerable to extirpation or extinction both at the state level and globally.

Current Conditions:

- There are currently 5 known populations of rare plant species with a total of 7 subpopulations
- 44% of highly suitable potential falcon nest sites in the TSA are within an existing seasonal protection area

Indicator: Number of populations and subpopulations of local suite of rare species and communities -
Within the cliffs and talus target area four species were used to evaluate the rare plant indicator. Wright's cliffbrake (Pellaea wrightiana), grassfern (Asplenium septentrionale), Weatherby's spikemoss (Selaginella weatherbiana), and Western polypody (Polypodium saximontanum) are all commonly found in rock crevices and are all ranked as imperiled or vulnerable to extirpation across the state by CNHP. Across the TSA ***there are currently five known populations of rare plants with a total of seven subpopulations and no known occurrences of rare plant communities*** *within the cliffs and talus target. The known occurrences of rare plant subpopulations and communities have been generalized on Map 3.*

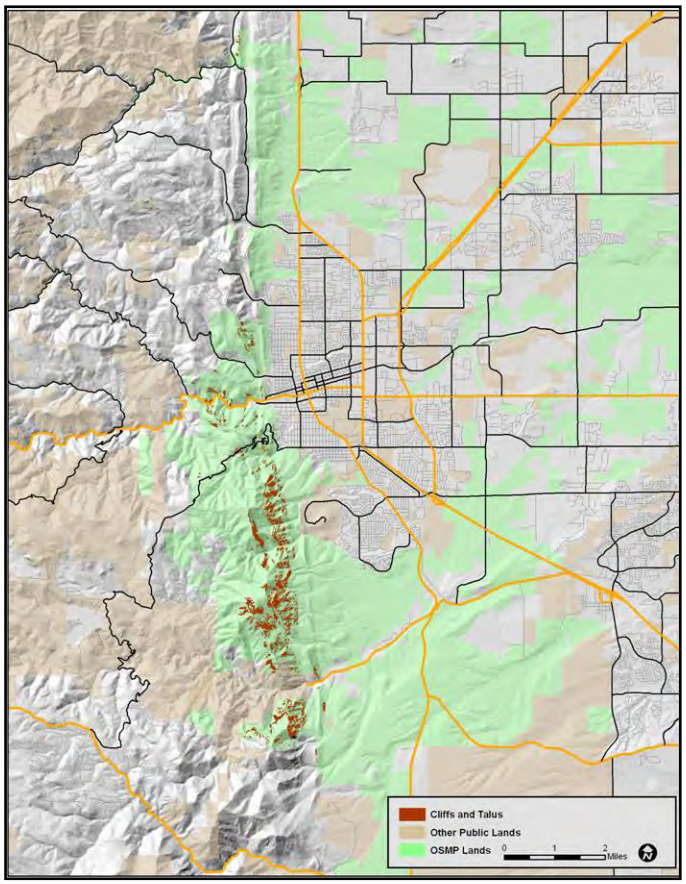
Wildlife and Habitat Effectiveness (Attribute)

The rock formations of the cliff and talus target provide some of the best habitat in the state for cliff-dependent wildlife species. Cliff nesting raptors like the Peregrine Falcon, Prairie Falcon, and Golden Eagle take advantage of the diverse cliff faces and nearby open spaces for nesting and hunting. OSMP cliffs support some of the highest densities of raptor nests in the state and consistently fledge young. The combination of large, tall cliffs, the proximity to open grasslands for hunting, and the annual disturbance protection measures established by OSMP create ideal conditions for cliff nesting raptors' success.

In addition to raptors, mammals of varying sizes use the cliff and talus target area across the OSMP system. Small caves and rock crevices provide ideal habitat and cool, protected areas for bat maternity and

bachelor roosts and hibernation sites. Townsend's big-eared bats (*Corynorhinus townsedii*) and fringed myotis (*Myotis thysonodes*) are two bat species that roost and hibernate in OSMP cliffs and rock faces. Both species are identified as species of conservation concern by CNHP. Larger mammals, such as bears and mountain lions, may also den or hibernate in caves or rocky outcrops in the cliff and talus target.

Indicator: ***Percent of highly suitable falcon nest sites protected-***
The cliff and talus target in the West TSA provides some of the best nesting habitat along the Front Range for both Prairie and Peregrine Falcons. Known falcon nest sites are protected seasonally by restricting seasonal access to decrease pressure on these species during key breeding and nesting periods. Suitable nest sites are cliffs with the steepest slopes and most southerly aspect. While falcons were chosen as the taxa of focus, Golden Eagles will sometimes choose nest sites with similar landscape characteristics (i.e., aspect, slope, etc.). All the data that was greater than one standard deviation above the mean was categorized as "highly" suitable. Specific variables used in the development of the habitat suitability model can be found in Appendix A.. Currently, ***44% of highly suitable potential falcon nest sites in the TSA are within an existing seasonal protection area*** *(Map 8).*



The dramatic rock formations of OSMP provide habitat for a wide variety of plants and animals as well as a unique recreational experience for climbers. With over 450 climbing formations and boulders in the WTSA, OSMP's cliffs have become a destination for climbers world-wide. In order to conserve critical raptor habitat, portions of the cliff and talus target are seasonally closed to protect nesting raptors and colonies of bats. There are a total of 14 protection areas in the mountain backdrop areas of OSMP and closures are in effect from February through July for raptors and April through October for bats.

Conservation Target: Foothills and Montane Riparian

Summary Statistics:

Total acres of the target in the entire OSMP system (fee properties): **269 acres**
Percentage of all OSMP vegetation in the target: **0.8%**
Total acres of the target in the West TSA: **241 acres**
Percentage of the target in the West TSA: **89.6%**

Miles of OSMP designated trails in the target: **4.1 miles**
Miles of undesignated trails in the target: **2.1 miles**

Background

Riparian woodlands and shrublands are known hotspots of biodiversity and support a disproportionate number of vertebrate species (Knopf 1985, Ohmart and Anderson 1982, Stromberg 1993). Riparian areas in the West TSA are particularly rich (Jones 1990) with a diverse flora and fauna, including many rare species. The Foothills and Montane Riparian Conservation Target is one of the smaller targets in the TSA, making up less than three percent of the land area. System-wide, 89% of this target falls within the West TSA.

Numerous streams and drainages cross the study area including Boulder Creek, South Boulder Creek, Bear Canyon Creek, Panther Canyon, Lost Gulch, Fern Canyon, Shadow Canyon, Long Canyon, Gregory Canyon, Greenman Canyon and Bluebell Canyon. These streams are joined by many smaller un-named tributaries with intermittent and ephemeral flow creating a complex network of riparian areas throughout the TSA.

Vegetation Composition (Attribute)

The diverse physiography in the West TSA supports diverse riparian vegetation. Stands of river birch (*Betula occidentalis*) occur at high elevations in a number of drainages including Bear, Long and Panther Canyons. In the sheltered channel bottoms hazelnut (*Corylus cornuta*) and alder (*Alnus incana*) frequently form a closed—almost impenetrable canopy.

In drainages with relatively cool, north facing exposures at low elevation, dense thickets of chokecherry (*Prunus virginiana*) are found. In these channel bottoms narrowleaf cottonwoods (*Populus angustifolia*) form an open canopy with blue-stem willow (*Salix irrorata*) overstory and graminoids populating the understory. South facing slopes in these

drainages are dominated by small trees and shrubs such as wax flower, chokecherry and hawthorn (*Crataegus macracantha*).

Current Conditions:

- 63% of this target has been mapped for weeds, of this 10.9% of the target area has a weed canopy cover greater than 6%
- There are currently 20 known populations of rare plant species with a total of 45 subpopulations
- 1% of the West TSA is potential highly suitable shrub-nesting bird habitat. When trail effects are considered- highly suitable habitat is reduced to 0.2% of the WTSA.
- Currently there are 61 feet/acre of designated trails and 30 feet/acre of undesignated trails in seasonally critical bear foraging habitat

A number of plant species of special concern are found in riparian areas in the TSA. Several of these species are eastern North American disjuncts and/or relictual species that may have persisted in the cool, moist mountain refugia of the TSA following post-Pleistocene warming (Weber 1965, Hogan 1993). Broad-lipped twayblade (*Listera convallaroides*) white adder's mouth orchid (*Malaxis monophyllos*), rattlesnake fern (*Botrypus virginianus*) and carrion flower (*Smilax lasioneuron*) are typically found at high elevations in cool, north facing drainages. Two relatively rare sedges, *Carex sprengelii* and *Carex torreyi* have been documented in unnamed drainages in Bear Canyon.

The most southerly stand of paper birch (*Betula papyrifera*) in the western U.S. and the only known stand south of the Black Hills of South Dakota is found in upper Long Canyon. This occurrence likely reflects the southern extension of boreal vegetation into this region during the Pleistocene.

Indicator: Percentage of target with a prevalence of management priority weed species-
A list of the management priority weed species can be found in Appendix C. Approximately 63% of the foothills and montane riparian target in the West TSA has been mapped for priority weed species. Within the mapped area, ***10.9% of the total target area has a weed cover greater than 6%****. Flowing water in riparian areas can serve as a vector for weed seed movement across the landscape and the high moisture levels and nutrient content in the soils make it ideal habitat for a wider range of species, both native and non-native. Map 2 shows weed densities across the West TSA and areas of greater weed concentrations based on patch size, density and the proximity of other weed patches.*

Indicator: Number of populations and subpopulations of local suite of rare species and communities -
Riparian areas in the West TSA support a diverse suite of rare plants and vegetation communities. Many of these species are ranked as critically imperiled by CNHP and some represent the only occurrences in the entire state. A list of the species used to evaluate this indicator can be found in Appendix B. Across the TSA ***there are currently 20 known populations of rare plants with a total of 45 subpopulations and 116.5 acres of rare plant communities*** *within the foothills and montane riparian target. The known occurrences of rare plants and communities have been generalized on Map 3.*

Wildlife and Habitat Effectiveness (Attribute)

Although riparian areas comprise less than two percent of the land cover in Colorado, they provide habitat for approximately 80 percent of birds, mammals, herptiles and fish (Knopf 1985). Many are species that depend almost entirely on these streamside and aquatic habitats for their survival. Wetlands in the TSA provide habitat for many animals including bears, mountain lions, songbirds, raptors, mule deer, elk, small mammals and herptiles.

The Preble's meadow jumping mouse is found in a number of drainages in the West TSA including Boulder Creek, South Boulder Creek, Bear Creek Canyon, Long Canyon and Gregory Canyon. As the Colorado Front Range has undergone rapid human development, Preble's habitat has been greatly impacted. This habitat loss and fragmentation led to the Federal listing of the mouse as threatened under the Endangered Species Act in 1998.

Northern leopard frogs occupy a variety of wetland and riparian types throughout Colorado. In the West TSA, potential habitat for the northern leopard frog includes South Boulder Creek and a few historic stock ponds. Populations of northern leopard frogs are declining throughout their western ranges. While population declines are not well understood, several factors have likely contributed including habitat loss and fragmentation, disease, pesticide use, and predation and competition by non-native fish and frogs. They are classified as a Sensitive Species by the U.S. Forest Service and Bureau of Land Management and a Species of Special Concern by the Colorado Division of Wildlife.

Riparian areas in the West TSA provide important breeding, nesting and foraging habitat for a variety of neo-tropical migratory songbirds. Yellow-breasted Chats (*Icteria virens*), Lazuli Buntings (*Passerina amoena*) and Gray Catbirds (*Dumetella carolinensis*) are just a few of the species that require healthy riparian areas for their habitat needs.

Indicator: Percentage of West TSA with highly suitable shrub-nesting bird habitat- *Shrub-nesting birds use areas of dense vegetation and shrub cover found along riparian areas during the breeding season. Riparian vegetation provides essential habitat for this suite of bird species and human disturbance can cause flushing, nest failure, or lower nest densities for shrub-nesting birds (Miller et. al., 2003). Suitable habitat for shrub-nesting birds consists of areas on the system with large blocks of riparian vegetation within close proximity of drainages and other continuous habitat blocks. Specific variables used in the development of the habitat suitability model can be found in Appendix A.*

The habitat analysis in the West TSA was done in two steps. The first simply identified all potential suitable habitat based on the environmental variables in the model. Analysis showed that ***one percent (1%) of the entire West TSA is potential highly suitable shrub-nesting bird habitat*** *(Map 9). The second step was to incorporate existing trail and road influence into the model to map the current habitat conditions. A 50 meter buffer was removed from each side of trails and roads to account for flushing distances associated with trail use (Miller et. al. 1998). An additional 6 meter (20 foot) buffer was added to voice and sight trails to account for people and dogs leaving the trail tread. The effect of trails on the model was to reduce the amount of highly suitable shrub-nesting bird habitat from 1% of the WTSA to* ***0.2% of the WTSA is currently highly suitable shrub-nesting bird habitat*** *(Map 10).*

Indicator: Trail density in critical bear foraging habitat-
Riparian areas in the West TSA provide essential habitat for black bears. In the fall, berry producing shrublands provide critical feeding areas allowing black bears to put on sufficient weight to bear young. The dense vegetation in riparian areas also provides cover for concealment, escape, and travel across the landscape. Areas of high human use may alter bear behavior shifting bear use from largely diurnal to nocturnal and may reduce bear use in areas with limited cover (Berry 1996; Beecham and Rohlman 1994). Human related impacts could decrease the effectiveness of riparian areas for essential bear fall feeding.

Critical bear foraging habitat consists of areas on the system dominated by berry producing shrubs, areas with dense shrub cover, and a close proximity to stream corridors for movement. Specific variables used in the development of the habitat suitability model can be found in Appendix A. Trail densities were calculated based on trail regulations in the fall to account for seasonal restrictions (many of these seasonal restrictions are in place in areas where bears feed every season). ***Currently there are 61 feet/acre of designated trails and 30 feet/acre of undesignated trails in seasonally critical bear foraging habitat****. A further breakdown of trail densities is available on Map 11.*

Ecological Processes

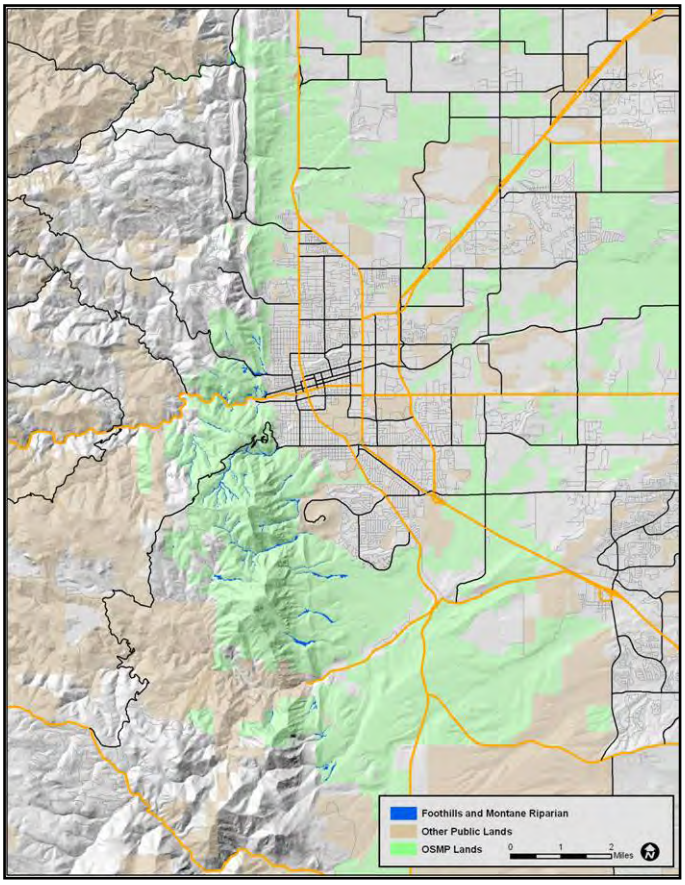
Like many snowmelt dominated systems in the west, peak stream discharges on Boulder Creek and South Boulder Creek occur in late May or June (Scott et al. 1993). Peak discharges and flooding can also occur as a result of intense localized summer thunderstorms. The natural hydrologic regime of these streams has been altered by numerous diversions and storage facilities that exist along much of their lengths including Gross Reservoir and Barker Reservoir, mainstem impoundments on South Boulder Creek and Boulder Creek, respectively.

The hydrology of the smaller riparian drainages in the TSA is complicated and difficult to characterize due to a lack of long-term hydrologic data. However, several generalizations can be made based on studies by D'Amico (1998) and Gerhardt and Johnson (1999).

Hydrology in most of the smaller drainages is largely driven by precipitation. Channels often remain dry for much of the summer, only flowing for brief periods after rain storms. This produces erratic flows with sudden sharp peaks and long periods when surface flow is absent and subsurface flow predominates.

Groundwater recharge and discharge rates are highly variable along stream reaches probably due to heterogeneity and fractures in the underlying bedrock. Streams can typically be seen flowing at one location, dry a short distance downstream and flowing again further downstream. Groundwater recharge is also rapid after storm events. Course soils and shallow bedrock allow for high infiltration rates.

Many streams in the West TSA do not exhibit typical riverine flow characteristics. Based on observations by Gerhardt and Johnson (1999), they do not "gain" or "lose" flow in a predictable pattern along their lengths. For example, in Bear Canyon, stream flow either decreased or remained constant along a study reach even though lateral input from adjacent springs and tributaries was prevalent.



Riparian areas in the TSA are influenced by a variety of other physical factors including soil type, elevation, exposure, slope and bedrock. Hydrology is influenced by or influences many of these factors and has been shown to be an important determinant of wetland and riparian structure and function.

A number of human activities have occurred in the TSA including livestock grazing and timber harvesting. While these anthropogenic disturbances no longer occur, their influence on the structure and function of the target likely still exists. In addition, fire suppression in the past century has increased tree density, interception and transpiration, resulting in decreased streamflow and overall size of riparian drainages along the Colorado Front Range (M. Kaufman, pers. comm.). Current forest management activities aimed at returning tree densities to historic ranges of variability may increase streamflow to historic levels where water diversion or impoundment has not significantly altered flows.

Sand and gravel from winter sanding operations on Flagstaff Road has affected several riparian drainages in the TSA, filling sections of Long Canyon and upper Gregory Canyon with sediment. Sedimentation of streams has been shown to affect channel dynamics (Malanson 1987), plant species regeneration (Cavalcanti and Lockaby 2006), and aquatic macroinvertebrate habitat and diversity (Wood and Armitage 1997, Wood et al. 2005).

All major drainages in the TSA have trails immediately adjacent to or directly within the riparian vegetation for much of their lengths. This pattern has implications for a number of ecosystem functions including wildlife habitat, sedimentation, soil compaction and erosion, and water quality. Trails planning in riparian areas must account for regulatory requirements in place to protect these systems. New trail construction

including reroutes or maintenance on existing trails in riparian areas may require additional clearances or permits. Map 12 displays areas on the system that are potential regulatory wetlands according to the City or Preble's Jumping Mouse occupied range according to the Colorado Division of Wildlife.

Conservation Target: Foothills and Montane Forest Openings

Summary Statistics:

Total acres of the target in the entire OSMP system (fee properties): **1,146 acres**
Percentage of all OSMP vegetation in the target: **3.3%**
Total acres of the target in the West TSA: **960 acres**
Percentage of the target in the West TSA: **85.6%**

Miles of OSMP designated trails in the target: **8.7 miles**
Miles of undesignated trails in the target: **6.7 miles**

Background

Forest openings on the OSMP system are a diverse mix of patch sizes and vegetation composition. They range from the larger ecotonal meadows at the grassland/forest edge to small open patches surrounded by trees in the forest interior. The grasslands and upland shrublands of this target provide habitat for a wide range of distinctive wildlife and plants.

This target spans the range of elevations in the forested part of OSMP. Forest openings are found from the Shanahan and Chautauqua areas at 5,700 feet to the west-side of the peaks at about 8,000 feet. Forest openings occur on a variety of soil types but tend to favor more gravelly or loamy sands on slopes of 5 to 20 percent. The most common soil types for this target are the Peyton and Juget soils series. Both of these soil types are gravelly and well drained and tend to have low to moderate water availability. The coarse texture allows for good root penetration and vegetation is often necessary to prevent erosion (Moreland and Moreland 1975).

Vegetation Composition (Attribute)

The forest openings target is made up of a diversity of vegetation types. This target includes upland shrublands, grasslands and areas of mixed

grasses, shrubs and trees. In general, these areas have a tree cover of less than 12%. Areas defined as shrublands have a cover of shrubs greater than 25%. The most common vegetation types in this target are big bluestem grasslands, and chokecherry, smooth sumac (*Rhus glabra*), buckbrush (*Ceanothus fendleri*) and Oregon-grape (*Mahonia repens*) shrublands. In addition to some of the more common vegetation types this target contains plant associations that are rare at both the state and global level. Vegetation types like the big bluestem communities tend to be locally abundant because of conservation efforts and locally favorable environmental factors but are globally imperiled due to human development and habitat conversion. Plant associations that include Parry's oatgrass (*Danthonia parryi*), mountain muhly/ needle and thread (*Muhlenbergia montana/ Hesperostipa comata*), and snowberry (*Symphoricarpos occidentalis*) shrublands are also considered by Colorado Natural Heritage Program as imperiled or vulnerable at the state and global scale.

Current Conditions:

- There are currently 5 known populations of rare plant species with a total of 45 subpopulations
- 60% of this target is mapped for weeds, of this 12.6% of the target area has a weed canopy cover greater than 6%
- Potential high suitability wild turkey habitat covers 4% of the West TSA. When trail effects are considered- highly suitable habitat is reduced to 1% of the WTSA.

A portion of the forest openings target in the TSA consists of ecotonal openings along the forest/grassland edge. These areas tend to be a mix of open ponderosa pine savannahs and large, open xeric tallgrass meadows. Many of these openings support a mix of both higher elevation species and Great Plains species. Most of the rare plants found within this target are species commonly associated with the Great Plains. Birds-foot violet (*Viola pedatifida*), dwarf leadplant (*Amorpha nana*), and frostweed (*Crocanthemum bicknellii*) are most commonly found in plains ecosystems and, in the TSA, most often occur along the very edge of grasslands and forests.

Indicator: ***Percentage of target with a prevalence of management priority weed species-***
A list of the management priority weed species can be found in Appendix C. Approximately 60% of the foothills and montane forest opening target in the West TSA has been mapped for priority weed species. Within the TSA, ***12.6% of this mapped area has a weed cover greater than 6%****. The relatively large area of the target with a prevalence of weeds can probably be attributed to the open growing conditions and historic disturbance. Many of the forest openings, especially at low elevations, were historically grazed and in some cases seeding with non-native grasses occurred for restoration. Map 2 shows weed densities across the West TSA and areas of greater weed concentrations based on patch size, density and the proximity of other weed patches.*

Indicator: ***Number of populations and subpopulations of local suite of rare species and communities -***
Within the forest openings target area three species were used to evaluate the rare plant indicator. Dwarf-leadplant (Amorpha nana), birds-foot violet (Viola pedatifida), and frostweed (Crocanthemum bicknellii) are all commonly found in forest openings and are all ranked as imperiled across the state by CNHP. Across the TSA ***there are currently five known populations of rare plants with a total of 45 subpopulations and 200 acres of rare plant communities*** *within the foothills and montane forest openings target. The known occurrences of rare plants and communities have been generalized on Map 3.*

Wildlife and Habitat Effectiveness (Attribute)

A wide range of wildlife species use forest openings for all or some of their lives. Upland shrublands are especially important and extremely rich avian habitat (Jones 1990). Nesting species include Gray Catbird, Lazuli Bunting, Virginia's Warbler and many others. These shrublands also provide food for bears and deer and cover for small mammals. Grassland openings are also important forage areas for deer and Wild Turkey and the edges between forests and grassland opening are essential for deer bedding, turkey roosts, and elk cover.

Indicator: Percentage of West TSA with highly suitable brood-rearing wild turkey habitat-

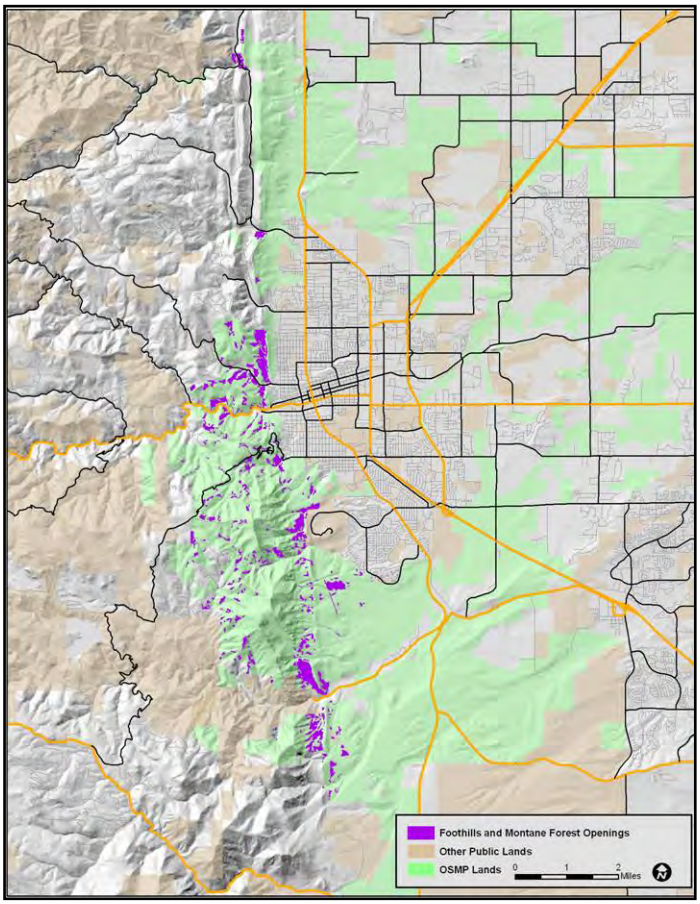
Effective habitat for Merriam's wild turkeys includes a combination of mature, open forests adjacent to forest openings. Patches of forest openings are essential to wild turkeys for foraging and successful reproduction and brood-rearing. Young turkey poults spend much of their time feeding in forest openings because they require a diet rich in insects. Wild turkeys and other galliformes can be sensitive to human use at their nesting sites (Lutz and Crawford, 1987; Rumble 1992; Thiel et al. 2007; M. Rumble pers. comm.) and to disturbance by dogs (Miller and Leopold, 1992). Highly suitable brood-rearing turkey habitat focuses on loafing and feeding habitat as well as this habitat's proximity to optimal roosting habitat which is represented by stands of large, mature ponderosa pines.

The habitat analysis in the West TSA was done in two steps. The first simply identified all potential suitable habitat based on the environmental variables in the model. All the data that was greater than one standard deviation above the mean was categorized as "highly" suitable (the variables used in the models are described in Appendix A). A minimum patch size of 7 ha (approx. 17 acres) was applied to the model and areas smaller than this were removed from the highly suitable habitat. ***Four percent (4%) of the entire WTSA is potential highly suitable brood-rearing wild turkey habitat*** *(Map 13). The second step was to incorporate existing trail and road influence into the model to map the current habitat conditions. A 31 meter buffer was added to voice and sight designated trails to account for people and dogs leaving the trail corridor(6 meters) and the flushing distance observed for similar species (25 meters according to Theil et al. 2007). A 50 meter buffer was put on roads to account for road disturbance. All designated and undesignated trails were used to split potential habitat blocks. Patches greater than 7 hectares (17 acres) (area suitable for breeding and raising young) remained highly suitable. With trail effects added to the model,* ***one percent (1%) of the WTSA is currently highly suitable wild turkey breeding habitat*** *(Map 14).*

Ecological Processes

Historically, forest openings were patches that shifted their size, shape and position in response to fire. As patches were burned, early successional grasses and shrubs moved in and as time went on they were replaced by later successional woody species (Keane et. al. 2002). In areas with frequent fire regimes these open patches were probably larger and were maintained by frequent surface fires over long periods. These shifting patches created a heterogeneous landscape and a diversity of habitats. During the late 19th century and early 20th century shifts in grazing and policies of fire exclusion led to a dramatic shift in patch dynamics.

The shift was especially dramatic in lower montane areas like the ones found on OSMP. These were areas of frequent low intensity fire that maintained open ponderosa stands and extensive grasslands and shrublands (Veblen and Donnegan 2005). In addition to low intensity burns, occasional patches of high severity fire resulted in canopy openings and dense shrub regeneration or grass growth. Without these frequent fire events tree establishment has slowly encroached into openings and replaced grasslands and shrublands with a tree overstory. Overall, on OSMP and across the Front Range there are fewer smaller forest openings today than there were when fires burned on a natural cycle.



Fire probably isn't the only disturbance that has shaped forest openings on OSMP. A history of grazing has had an impact on forest opening size and composition. Grazing may have promoted tree encroachment in lower montane grassland patches, both by reducing competition from grasses and forbs and by reducing fuels for fires. Heavy grazing can also expose bare mineral soil which is ideal for tree seedling establishment. Ranchers probably removed trees to improve grazing conditions, artificially creating patches on the landscape. Historic aerial photos show areas that may have been cleared for grazing. Some remain open today.

Based on historic aerial photos of Boulder County, forest openings are generally smaller and less common in the TSA compared to historic conditions. Fire suppression and grazing have led to a conversion to tree cover and, in many cases, the remaining forest openings now have a different composition of grasses than historically. Historic grazing and seeding related to forest or grazing operations have led to many of the current forest openings being dominated by non-native grass species like smooth brome (*Bromopsis inermis*), timothy (*Phleum pratense*) and other European pasture grasses. This composition shift makes the remaining forest openings dominated by native grasses like big bluestem, needle grasses, and mountain muhly that much rarer.

OSMP Grassland Ecosystem Conservation Targets

Summary Statistics:

Total acres of the target in the entire OSMP system (fee properties): **23,734 acres**
Percentage of all OSMP vegetation in grassland targets: **69%**
Total acres of grassland targets in the West TSA: **1,975 acres**
Percentage of the West TSA in grassland targets: **18.5%**

Miles of OSMP designated trails in West TSA grasslands: **15.0 miles**
Miles of undesignated trails in West TSA grasslands: **10.8 miles**

Approximately 17% of the West TSA falls within the scope of the OSMP Grassland Ecosystem Management Plan (Grassland Plan) (Map 1). In general, the grassland area in the WTSA (also referred to as Tallgrass West), includes representative areas of six grassland targets listed in table 1 below. In addition to having a mix of targets and vegetation types the Grassland Plan identifies a number of other key characteristics of this area. More in-depth target descriptions and viability analysis are available in the draft Grassland Plan (City of Boulder 2009) and will be used in the development of the West TSA plan.

Table 1: Grassland targets within the WTSA boundary

Grassland Target	Acres in the WTSA
Mesic Big Bluestem Prairie	**68**
Mixedgrass Prairie Mosaic	**427**
Plains/ Foothills Transitional Riparian	**212**
Wetlands	**108**
Xeric Tallgrass Prairie	**1,122**
Black-tailed Prairie Dog and Associated Species	**38**

Tallgrass West is one of the larger contiguous habitat blocks on the OSMP system. Larger habitat blocks have several advantages over smaller blocks including increased habitat diversity, greater plant and animal species richness, and a greater diversity of food plants and prey species. A habitat block is defined as contiguous habitat owned and managed by OSMP and not split by public roads.

Within the large habitat blocks in the grassland planning area, information on conservation and restoration potential was compiled to identify best opportunities for conservation on the system. Tallgrass West was identified as an area of best opportunity for conservation and restoration of the upland grassland mosaic. A portion of the West TSA grasslands along the South Boulder Creek drainage was also identified as a best opportunity for restoration of mesic bluestem prairie. As a large habitat block, Tallgrass West maintains habitat for interior grassland species such as Grasshopper Sparrows. Because of this and the diverse grassland habitat structure, this area was also identified as important bird habitat in the Grassland Plan. The Tallgrass West best opportunity areas also contain good examples of characteristic plant communities as well as the presence of rare/sensitive vegetation and a relatively low incidence of priority weeds.

In addition to the indicators outlined in this report, OSMP has developed a list of indicators for the grassland portions of the system that are outlined in the OSMP Grassland Ecosystem Management Plan. While not a system-wide indicator, OSMP has also developed a habitat suitability model for Grasshopper Sparrows in the grassland portions of the WTSA. Unlike the grassland indicators that are designed to assess grassland health as a whole, the Grasshopper Sparrow habitat model is meant to be an area specific tool to evaluate habitat effectiveness. Highly suitable Grasshopper Sparrow habitat represents large patches of mixed/tallgrass prairie far from a forest edge. The specific model inputs are outlined in Appendix A.

Similar to the other habitat models outlined in this report the habitat analysis for Grasshopper Sparrows was done in two steps. The first simply identified all potential suitable habitat based on the environmental variables in the model. Analysis shows that ***6% of the West TSA is potential highly suitable Grasshopper Sparrow habitat*** *(Map 15). The second step was to incorporate existing trail and road influence into the model to map the current habitat conditions. Two rankings were used to account for the proximity of suitable habitat to urban edges and roads and proximity to trails. Based on descriptions in Slater (2004) and Bock et al (1999), Grasshopper Sparrows prefer large patches of interior habitat greater than 200 meters from disturbances or edges. Suitable habitat areas within 200 meters of a road or urban edge were given a lower value. Areas within 100 meters of a designated or undesignated trail were also ranked lower. Patches of potentially highly suitable habitat smaller than 30 hectares were removed from consideration; patches greater than 30 hectares remained highly suitable. The effect of trails on the model was to reduce the amount of highly suitable Grasshopper Sparrow habitat from 6% of the WTSA to* ***2% of the WTSA is currently highly suitable Grasshopper Sparrow habitat*** *(Map 16).*

The West TSA process will work to use the grassland targets, attributes and indicators to inform the strategies developed in the West TSA plan. The grassland attributes and indicators selected for use in the WTSA planning process are a subset of all of the indicators used to assess the viability of the conservation targets in the Grassland Plan. The list of attributes and indicators utilized in the West TSA area may change slightly with the final version of the plan. Attributes that were selected are those for which attaining an acceptable, or viable, rating *could* affect

visitor use. For example, to attain an acceptable rating for the "habitat effectiveness" attribute of the mixedgrass prairie mosaic, visitor use *may* be directed away from the central portions of large habitat blocks. In latter stages, the West TSA plan will integrate strategies and management recommendations from the Grassland Plan.

The following table displays the current system-wide indicator ratings for grassland targets included in the West TSA. These ratings apply to the targets on a system-wide scale. The current viability status of the West TSA grasslands has not been assessed using these indicators. The rationale and justification for each indicator are included in Detailed Viability Assessment appendix of the Grassland Plan (City of Boulder 2009).

Table 2: Current grassland indicator viability rankings for targets in the West TSA

Key Attribute	Indicator	Rating
Target: **Mixedgrass Prairie Mosaic**		
Animal Species Composition	Percent of target with acceptable bird conservation score	Fair
Habitat Effectiveness	Proportion of habitat blocks over 100 hectares with singing male grasshopper sparrows	Not Rated
Vegetation Composition	Percent of target with prevalence of exotic species	Poor
Target: **Xeric Tallgrass Prairie**		
Animal Species Composition	Percent of target with acceptable bird conservation score	Fair
Vegetation Composition	Percent of target with prevalence of exotic species	Fair
Vegetation Composition	**Size of dwarf leadplant (*Amorpha nana*) populations**	**Good**
Vegetation Composition	**Size of prairie violet (*Viola pedatifida*) populations**	**Good**
Target: **Mesic Big Bluestem Prairie**		
Animal Species Composition	Species richness of sensitive breeding birds	Not Rated
Vegetation Composition	Percent of target with prevalence of exotic species	Poor
Target: **Wetlands**		
Connectivity	Buffer width (vegetated area within 100m of the wetland)	Fair
Vegetation Composition	Percent of target with prevalence of exotic species	Poor
Target: **Plains/ Foothills Transitional Riparian**		
Connectivity	Buffer width (vegetated area within 100m of a creek)	Fair
Habitat Structure	Physical instream and riparian habitat metric	Not Rated
Vegetation	Percent of target with prevalence of exotic species	Poor

Note: indicators in **bold** are considered within the acceptable range of variation. Indicators with a rating of "Not Rated" currently lack sufficient data to set a viability rating.

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Glossary of Terms

Accipiters: Hawks that inhabit deeply wooded areas. They have short rounded wings and long rudder-like tails which allow them to maneuver among the trees. Accipiters on OSMP include: Sharp-shinned hawk, Cooper's hawk, and Northern Goshawk.

Aspect: The direction a slope faces.

Attributes: Define key qualities or essential components of the targets, which, if they are not present or are severely compromised, result in unacceptable conditions or loss of the target.

Aspect: The full range of natural variety and variability within and among living organisms, and the ecological and environmental complexes in which they occur. It encompasses multiple levels of organization, including genes, species, communities and ecosystems.

Basal Area: The area of the cross section of a tree trunk near its base, usually 4 and ½ feet above the ground. Basal area is a way to measure how much of a site is occupied by trees. The term basal area is often used to describe the collective average basal area of an acre of forest.

Canopy: The part of any stand of trees represented by the tree crowns (usually refers to the uppermost layer of foliage).

Disjunct Species: Species that occur in two or more widely separated geographic areas.

Ecosystem: The dynamic complex of organisms and their environment contained within a specified area during a specified time. Systemic elements include interactions and feedbacks between components.

Ecotones / Ecotonal: A transitional zone between two biological communities containing the characteristics of each.

Endemic: a species that is native to or confined to a certain region; constantly present in a greater or less degree in one place

Epidemic: extremely prevalent, widespread

Ephemeral: Lasting a very short time; seasonal.

Extirpation: To remove or destroy totally from an area

Fire Regime: The characteristics of fire in a given ecosystem, such as the frequency, predictability, intensity, and seasonality of fire.

Foothills: The Foothills Zone has an elevational range between 6,000-8,000 feet in the east slope of the Front Range in Colorado. Geographically defined as gradual increases in hilly areas at the base of a mountain range. They are generally larger than hills, but not as tall as nearby mountains. Also referenced as the Lower Montane Zone.

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

Graminoid: grasses and grass like plants such as sedges and rushes

Habitat Connectivity: Patches of habitat across the landscape that are uninterrupted by barriers to movement.

Habitat Effectiveness: An area that meets a range of required characteristics, including environmental factors and lack of disturbance, and supports all stages of a species lifecycle.

Herptiles: A term used to refer to reptiles and amphibians as a group.

Indicators: Quantitative and qualitative measures of the attributes; they are what we measure to track conditions of the attributes.

Interior Habitat: Habitat some distance away from an edge, which is usually more ecologically productive due to edge effects and habitat fragmentation. Examples:
-Forest: Interior habitat = 200-400 meters (m) from forest edge (Robbins et al. 1989)

Management Priority Weed Species: Species of non-native plants that pose a threat to native species, ecosystems or overall habitat integrity. Priority is set as part of the integrated pest management program and is based on size of the population and threat to natural systems.

Montane: The Montane Zone has an elevational range between 8,000-10,000 feet in the east slope of the Front Range in Colorado. Of, relating to, growing in, or being the biogeographic zone of relatively moist cool upland slopes below timberline dominated by large coniferous trees. Also referenced as the Upper Montane Zone.

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

Non-Native Species: Also called alien or exotic species, these species have been introduced, by various means, into areas where they were not originally found.

Overstory: The higher vegetation layer in a forest, consisting of the upper canopy layer of trees.

Patch: An area of homogenous vegetation, in structure and composition.

Poult: A young fowl, as of the turkey, grouse, or other similar bird

Refugia: A small, isolated area that has escaped the extreme changes undergone by the surrounding area, as during a period of glaciation, allowing the survival of plants and animals from an earlier period.

Relictual Species: Species that have survived a given place while disappearing elsewhere.

Riparian Areas: Areas along streams and rivers, including related vegetation communities.

Snag: A standing dead tree. Snags are important as habitat for a variety of wildlife species and their prey.

Stand: A homogonous group of trees that occupy a specific area and are similar in species, age, and condition.

Strategy: A systematic long-term plan to deploy a sequence of actions toward achieving one of more goals and associated set of management objectives.

Talus: Broken rock piles found on mountain slopes and at the base of cliffs.

Targets: Define what we care about (the big picture). Targets define what we are planning for—those resources that we are trying to protect, provide, and manage.

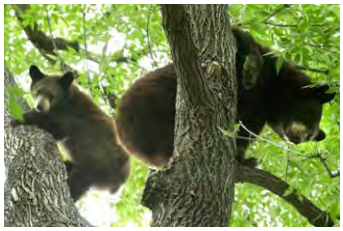
Understory: The lower vegetation layer in a forest found beneath the tree canopy. Includes grasses, forbs, trees, and woody shrubs growing beneath an overstory in a stand of trees.

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

Appendix A: Wildlife Resources

Habitat Suitability Models

For each of the natural resource forest targets in the TSA a representative or “umbrella” wildlife species was selected as an indicator. In general, the species selected have habitat needs within the specific target that also apply to a much broader suite of wildlife species. The indicator species were selected because there is sufficient baseline data to accurately model habitat needs on the system, there is a range of research on those habitat needs so the models could be appropriately refined, and the indicators are species that are sensitive to change due to visitor use.



Top: Abert’s squirrel

Middle: Northern Goshawk

Bottom: Black bear

Ideally OSMP staff would monitor and sample many of the nested wildlife targets (rare or sensitive species that occur within the targets) on a regular basis across the entire system. While this could help direct some management decisions, the time necessary and the resources required to conduct these types of projects make monitoring of many nested species unfeasible. Tools like habitat models are being used as an efficient means to identify the most important areas on the system for natural resources and inform broad scale management. Habitat models have obvious limitations but they allow staff to get a system-wide perspective on resource values, provide an easily measured value of the status of habitat and inform future follow-up when finer scale management decisions are necessary.

All of the habitat models were built using existing, system-wide GIS data. Datasets used include vegetation mapping, forest overstory inventories, stream data, digital elevation models, and existing trails infrastructure. Each model was run in two phases. The first identified all potentially suitable habitat for a species based solely on environmental characteristics. This potential habitat value represents the greatest amount of habitat that could be expected on the system given only environmental variables. The potential value could be changed through habitat manipulation like thinning or restoration but those types of management techniques are outside the scope of the TSA process.

The second phase of modeling attempted to account for impacts to wildlife and habitat related to visitor use and gives a current habitat value based on existing infrastructure and regulations. Existing literature and research was reviewed to identify human impacts related to each of the indicator species. In some cases specific management recommendations were outlined in the literature and in others staff used best professional judgment based on similar species’ flushing distances, breeding success, or using other general conservation biology concepts.

One of the greatest limitations in this phase of the modeling is a lack of accurate visitation data on all trails, both designated and undesignated. In

general, OSMP knows the areas that see heavier visitation on a qualitative level, but it's impossible to compare or categorize trail visitation accurately across the entire TSA. It is also difficult to predict use levels that may exist on the system in the future. Information like this could help refine the models and allow for variation in how visitation impacts are applied. This is especially true for undesignated trails that may get very heavy visitation or only infrequent visits.

The products of the habitat suitability models are intended to be just one tool for making management decisions. Ultimately, both the potential and current habitat acreages will be used to set desired future conditions realizing increasing habitat to its full potential is unlikely and the current condition is a guide to where management may need to focus. Highly suitable habitat will help inform where impacts may be focused and where the most effective management for natural resource protection could occur. This will help guide the department in finding a balance between visitor access and natural resource protection.

Northern Goshawk (Map 4 & Map 5)

Northern Goshawks were chosen as a wildlife indicator for the mixed conifer natural resource target. Goshawks are relatively infrequent visitors to the OSMP system but are known to nest in the upper elevations of the county; therefore, the OSMP system may provide suitable nesting habitat for this species. Goshawk nesting habitat usually consists of older, mature forest with a high density of large trees and high canopy closure (Reynolds et al., 1982; Greenwald et al., 2005). This type of dense, mature forest structure supports a wide range of other nested targets in the TSA including Cooper's Hawks, Northern Pygmy Owl, Flammulated Owls, and Williamson's Sapsucker.

Staff defined highly suitable habitat as areas that could support nesting Goshawks. These forest patches are dominated by dense forest canopies with large trees. The model also accounted for areas of mature forest, areas with high snag densities for perches, and northerly aspects with relatively gentle slopes. The highly suitable habitat also had to meet a minimum patch size to remain highly suitable. For Goshawks, patches smaller than 10 ha (approx. 25 acres) were eliminated prior to the trail effects modeling. Any patches that did not meet this minimum patch size were not considered highly suitable habitat in the indicator calculations but are displayed on the maps. The 10 ha cut-off was based on literature (Reynolds et al. 1992; Reynolds and Joy 1998) and expert opinion (R.T. Reynolds, personal communication: February 2009)

Northern Goshawks have shown sensitivity to human activity near their nesting sites. In this model as well as a number of the other models a 50 m

buffer was used along roads to account for disturbance from the road and passing traffic. This is a conservative estimate based on research that suggests road effects can impact a wide range of wildlife species and other ecological functions and the effects can extend outward from the road itself for up to 600 m (Forman and Deblinger 2000). Voice and sight trails as well as undesignated trails outside of HCAs were buffered by 6 m (20 ft.) to account for the width of the VMP-approved trail corridor. Forest patches were delineated using trails (and their buffers, if applied) and roads.

Table 3: Habitat suitability model inputs for Northern Goshawk

Variable	*Attributes*	*Ranks*	*Weights*
Preferred Forest Habitat Alliances	Douglas Fir Vegetation Alliances	9	1
	Ponderosa Pine - Douglas-fir Forest Alliance, Quaking Aspen - Douglas-fir Forest Alliance	9	1
	Lodgepole Pine Forest Alliance, Ponderosa Pine Forest Alliance, Quaking Aspen Forest Alliance	8	1
	Douglas-fir Woodland Alliance, Douglas-fir Temporarily Flooded Woodland Alliance	7	1
	Ponderosa Pine - Douglas-fir Woodland Alliance	6	1
	Ponderosa Pine Woodland Alliance, Ponderosa Pine Temporarily Flooded Woodland Alliance	5	1
	Narrowleaf Cottonwood Temporarily Flooded Forest Alliance	4	1
	Ponderosa Pine Wooded Mixed Herbaceous Alliance (Savannah), Ponderosa Pine Tallgrass Savannah Herbaceous Alliance, Box-elder Temporarily Flooded Forest Alliance	3	1
	Paper Birch Forest Alliance, Netleaf Hackberry Woodland Alliance, Water Birch Seasonally Flooded Shrubland Alliance	2	1
Topography	Aspect (degrees)	0 - 45, 315 - 360 = 9 45 - 135 = 7 225 - 315 = 5 135 - 225 = 3	1
	Slope (percent)	0 - 10, 20 - 35 = 9 10 - 20 = 7 35 - 50 = 5 > 50 = 0	1
Forest Stand Structure	Average Tree Diameter (inches)	> 17 = 9 13 - 17 = 5 9 - 13 = 3 0 - 9 = 0	1
	Mature Forest Stands (Stands with trees over 200 years old or an average stand age of 150 years)	8	1
	High Snag Forest Stands (Stands with 3 or more snags per acre)	5	1
	Average Basal Area (sq. ft./acre)	110 - 190 = 9 190 - 281, 80 - 110 = 5 7 - 80 = 3 0 - 7 = 0	1
Minimum Patch Size (applied before and after trail effects modeling)			
Only patches >= 10 hectares remain highly suitable			
Trail & Road Impacts			
Remove 20 feet on each side of V&S designated trails and undesignated trails outside an HCA Remove 50 meters on each side of roads Split polygons by all other designated trails and undesignated trails			

Abert's Squirrel (Map 6 & Map 7)

Abert's squirrels are the indicator species selected for the ponderosa pine target because they require patches of mature ponderosa pine in a mosaic of uneven-aged stand structures. This type of woodland represents an overstory structure that provides habitat for many wildlife species, both common and rare.

Highly suitable Abert's squirrel habitat represents areas on the system dominated by ponderosa pine with moderate tree densities and large, mature trees. Many areas identified by the model often have characteristics of mature forest stands with trees approaching old-growth. Mature, open ponderosa pine stands are limited across the Front Range and across their entire range. Historic fire suppression, grazing, and timber harvesting have led to much denser stands with large trees that are severely stressed by competition or have been removed altogether. In comparison to historic conditions, ponderosa pine stands across the Front Range are denser, have fewer large trees and snags, and are more homogenous in tree age and size (Veblen and Donnegan 2005).

Abert's are highly dependent on ponderosa pine stands for diet and nesting throughout the year. They feed almost exclusively on inner bark, seeds, and terminal buds of ponderosa and nest in clumps of large ponderosa trees (Fitzgerald et al., 1994). The habitat suitability model for this species accounted for the preference for larger, ponderosa trees. The model also factored in tree density (some interconnecting crowns are important for movement and protection from predators) and habitat block size (according to Fitzgerald et al. (1994) the mean home range for Abert's is about 10 hectares or approximately 25 acres). Habitat had to meet the minimum patch size of 10 hectares to remain highly suitable. This patch size is based on the average home range size of Abert's squirrels. The patch size filter was applied before trail effects were analyzed. In other words, patches of highly suitable habitat smaller than 10 ha don't factor into the indicator values of potential highly suitable habitat or highly suitable habitat with trail effect but they are displayed on the maps.

Trail impacts for this species were developed using existing research done across the US and in Boulder County. Research has shown impacts to Abert's and other small mammals related to dog activity on trails. Dogs can impact wildlife behaviors and distributions and small mammals are less active in areas visited by dogs (Sime, 1999; Lenth et al., 2008). Recreational trails that allow dogs can see a reduction in small mammal activity near the trail (Lenth et al., 2008). For these reasons a 20 foot buffer was removed from highly suitable Abert's habitat along voice and sight regulated trails. A 20 foot buffer width was chosen because that is

commonly used as the enforceable area of the “trail corridor” when dogs are not required on leash, but a voice and sight restriction exists.

Trails, both designated and undesignated, as well as roads were used to split highly suitable habitat into patches. Remaining patches smaller than the 20 hectare (approximately 50 acres) maximum home range of Abert’s (Fitzgerald et al. 1994) were removed from the highly suitable habitat. While one trail in a suitable habitat may or may not be a direct barrier to Abert’s movement the patch size variable will help identify where trails occur in highly suitable habitat and where trails management could improve habitat for wildlife.

Table 4: Habitat suitability model inputs for Abert’s squirrel

Variable	*Attributes*	*Ranks*	*Weights*
Preferred Forest Vegetation Alliances	Ponderosa Pine Forest Alliance, Ponderosa Pine Woodland Alliance	9	2
	Ponderosa Pine - Douglas-fir Forest Alliance, Ponderosa Pine - Douglas-fir Woodland Alliance	5	2
	Ponderosa Pine - Quaking Aspen Forest Alliance, Ponderosa Pine Temporarily Flooded Woodland Alliance, Ponderosa Pine Tallgrass Savannah Herbaceous Alliance, Ponderosa Pine Mixed Grass Savannah Herbaceous Alliance	3	2
Tree Size	Mean Tree Diameter of Ponderosa Pine Stands (inches)	> 15 = 9 9 - 15 = 7 7 - 9 = 5 4 - 7 = 3 0 - 4 = 1	1
Tree Density	Trees per acre over 5" in diameter	150 - 300 = 9 99 - 150 = 7 0 - 99 or > 300 = 0	1
Patch size	Preferred Forest Habitat Block Size (hectares)	<2= 0 2-10= 3 10-15= 6 15-20= 9	1
Topography	Elevation (ft)	6000 - 8528 = 9 5456 - 5999 = 6	1
Minimum Patch Size (applied before and after trail effects modeling)			
Only patches >= 10 hectares remain highly suitable			
Trail & Road Impacts			
Remove 20 feet on each side of V&S designated trails and undesignated trails outside an HCA Split polygons by all other designated trails and undesignated trails Remove 50 meters on each side of roads			

Prairie Falcon (Map 8)

Prairie falcons were chosen as an indicator wildlife species for the cliffs and talus target in the West TSA. Prairie and peregrine falcons have very similar nesting habitat requirements so this model applies to both of these cliff-nesting species. On OSMP, some golden eagle pairs have also chosen sites with similar landscape characteristics. Cliff-nesting raptors require diverse habitats for foraging and nesting. This model focuses on nesting habitat provided by the dramatic rock faces of the TSA. The close

proximity of these cliff faces to open grasslands to the east provides ideal breeding conditions for prairie and peregrine falcons.

Highly suitable falcon habitat focuses exclusively on cliffs and exposed rock faces as defined by the OSMP vegetation mapping. South facing ledges appear to be favored for nest sites (Enderson 1964) so higher ranks were given to south aspects derived from digital elevation models. Areas on the rock face with steep slopes are also favored for nesting locations, perhaps for protection from predators (BLM 1979).

The focus of this indicator is highly suitable nest sites that are protected throughout the TSA. Prairie and Pergrine Falcons require areas of limited disturbance to be successful and activities like rock climbing can cause disturbances that result in nest failure or abandonment (Richardson and Miller, 1997). OSMP has a number of seasonal raptor closures designed to protect existing nest locations during sensitive times of the year. Current closure boundaries were used to determine the percentage of suitable habitat that is currently protected.

Table 5: Habitat suitability model inputs for cliff nesting raptors

Variable	*Attributes*	*Ranks*	*Weights*
Topography of Nesting Habitat	Aspect (degrees)	138 – 180 (SE) = 9 180 – 270 (SW) = 7 22.5 – 138 (E), 270 - 337.5 (NW) = 5 0 - 22.5 (N), 337.5 – 360 (N) = 3	1
	Slope (degrees)	>= 60 = 9 50 - 60 = 7 40 - 50 = 5 30 - 40 = 3 0 - 30 = 0	1
Nesting Habitat Alliances	Cliffs and Talus vegetation alliance	9	1
Protection			
Total % of highly suitable that falls within existing seasonal closures			

Shrub-nesting birds (Map 9 & Map 10)

This model accounts for a suite of bird species that depend on the heavy shrub cover provided by the foothills and montane riparian target. Species like Gray Catbirds, Blue-gray Gnatcatchers, Yellow-breasted Chats, Black-headed Grosbeaks, Lazuli Bunting and Blue Grosbeaks are all nested targets that depend on riparian shrublands for nesting habitat. Shrub-nesters require areas of dense vegetation and tend to nest one to three meters above the ground (Harrison, 1979).

Shrub-nesting bird habitat in the TSA represents areas dominated by riparian shrubland vegetation. Larger shrub patches create more effective bird habitat and each patch was ranked based on overall patch size. In addition to patch size, shrublands within 75 meters of a stream were ranked higher than those beyond 75 meters. Interconnected patches within

stream corridors provide nesting habitat but also provide movement corridors across the landscape and connect blocks of habitat together. In addition, larger complexes of connected shrub habitat provide high quality foraging areas and increase the chances of multiple nesting species.

A number of studies have been conducted on both OSMP lands and in other areas that look at the impacts of trails on birds. Miller et al. (1998, 2001) found that grassland and forest bird species were more abundant away from trails and the abundance increased as the distance from trails increased. A study of riparian areas in Boulder County (Miller et al. 2003) showed that trail use affected riparian bird densities. Trail impacts were accounted for in this model by removing areas directly adjacent to existing trails. An area of 50 meters was removed from highly suitable habitat on both sides of existing trails. This was based on the 75 – 100 m area adjacent to trails where bird densities showed a decrease in the Miller study for grassland nesting birds. The number was reduced to account for differences in grassland and shrub habitats. An additional 20 feet was removed along trails with voice and sight regulations to account for dogs and people leaving the trail corridor.

Table 6: Habitat suitability model inputs for shrub-nesting birds

Variable	*Attributes*	*Ranks*	*Weights*
Habitat Block size (acres) created from merging these vegetation alliances	Prairie Cordgrass Temporarily Flooded Herbaceous Alliance, Western Wheatgrass Temporarily Flooded Herbaceous Alliance, Foxtail Barley Temporarily Flooded Herbaceous Alliance,Green Ash - (American Elm) Temporarily Flooded Forest Alliance, Quaking Aspen Temporarily Flooded Forest Alliance, Narrowleaf Cottonwood Temporarily Flooded Forest Alliance, Ponderosa Pine Temporarily Flooded Woodland Alliance, Douglas-fir Temporarily Flooded Woodland Alliance, Eastern Cottonwood Temporarily Flooded Woodland Alliance, Narrowleaf Cottonwood Temporarily Flooded Woodland, Box-elder Temporarily Flooded Woodland Alliance, Peachleaf Willow Temporarily Flooded Woodland Alliance, American Plum Shrubland Alliance, Crack Willow (introduced) Temporarily Flooded Woodland Alliance, Desert False Indigo Temporarily Flooded Shrubland Alliance, Non-Native Dominated Temporarily Flooded Woodland, Choke Cherry Shrubland Alliance, Wax Currant Shrubland Alliance, Skunkbush Intermittently Flooded Shrubland Alliance, (Coyote Willow, Sandbar Willow) Temporarily Flooded Shrubland Alliance, Rocky Mountain Maple Temporarily Flooded Shrubland Alliance, (Black Hawthorn, Fleshy Hawthorn) Temporarily Flooded Shrubland Alliance, Woods' Rose Temporarily Flooded Shrubland Alliance, Western Snowberry Temporarily Flooded Shrubland Alliance, Bluestem Willow Temporarily Flooded Shrubland Alliance, Water Birch Seasonally Flooded Shrubland Alliance	100 – 900 = 9 30 - 100 = 6 10 - 30 = 3 2 - 10 = 1	1
Riparian habitat blocks near other riparian habitat blocks	Riparian corridor habitat blocks (created from above vegetation alliances) >= 2 acres and <=75m from a perennial or intermittent stream	5	1
Trail & Road Impacts			
remove 20ft + 50m on each side of V&S designated trails remove 50m on each side of all other trails and roads			

Black Bear (Map 11)

Black Bears are one of two wildlife species chosen to identify highly suitable riparian wildlife habitat but represents the only terrestrial, wide-ranging large mammal indicator for the TSA. Black bears are one of the many species that use riparian areas for travel and seasonal feeding. Black bears are known to occur throughout the foothills and mountainous areas of Boulder County but riparian drainages provide essential seasonal feeding areas. Unsworth et al. (1989) found that bears fed and traveled in

riparian areas significantly more than steep slopes and exposed areas. In the fall, berry producing shrublands provide feeding areas allowing bears to put on sufficient weight to bear young and provide for the necessary pre-denning nutritional needs.

Critical bear foraging habitat on OSMP represents areas of the system within close proximity to streams and riparian vegetation that provide cover for movement and connections across the landscape. The habitat model also gave more weight to areas dominated by chokecherry, hawthorn and American plum; berry producing shrubs that are ideal food for black bears and dominate their scat content in fall (Berry, 1996; Johnson, 2000).

Trails and associated visitor activities in bear habitat may alter bear behavior without changing distributions. Bears in natural habitats are largely diurnal, while those in areas with heavy human activity were more nocturnal (Ayres et al., 1986), and human activity may reduce bear activity in areas of low vegetation cover (Berry, 1996). Black bears are less likely to be found < 50 m from secondary (dirt) roads (Unsworth et al., 1989), which means highly traveled, paved roads may have a more dramatic impact. No habitat was removed from the models based on existing trails; rather, existing trail densities in highly suitable habitat were calculated by trail category (such as voice and sight, undesignated, leash required, etc.). Each trails regulatory category was determined based on fall trail regulations to account for regulations currently in place for wildlife protection.

Table 7: Habitat suitability model inputs for black bear

Variable	*Attributes*	*Ranks*	*Weights*
Forest Vegetation	All forest and woodland vegetation alliances	1	1
High Berry Producing Shrubs	Choke Cherry Shrubland Alliance, Black Hawthorn/Fleshy Hawthorn Temporarily Flooded Shrubland Alliance, American Plum Shrubland Alliance	9	6
Riparian and Shrubland Vegetation	High quality habitat alliances (ERO defined): Prairie Cordgrass Temporarily Flooded Herbaceous Alliance, Western Wheatgrass Temporarily Flooded Herbaceous Alliance, Foxtail Barley Temporarily Flooded Herbaceous Alliance, Green Ash - (American Elm) Temporarily Flooded Forest Alliance, Box-elder Temporarily Flooded Forest Alliance, Quaking Aspen Temporarily Flooded Forest Alliance, Narrowleaf Cottonwood Temporarily Flooded Forest Alliance, Ponderosa Pine Temporarily Flooded Woodland Alliance, Douglas-fir Temporarily Flooded Woodland Alliance, Eastern Cottonwood Temporarily Flooded Woodland Alliance, Narrowleaf Cottonwood Temporarily Flooded Woodland, Box-elder Temporarily Flooded Woodland Alliance, Peachleaf Willow Temporarily Flooded Woodland Alliance, Crack Willow (introduced) Temporarily Flooded Woodland Alliance, Desert False Indigo Temporarily Flooded Shrubland Alliance, Non-Native Dominated Temporarily Flooded Woodland, Wax Currant Shrubland Alliance, Skunkbush Intermittently Flooded Shrubland Alliance, Coyote Willow, Sandbar Willow Temporarily Flooded Shrubland Alliance, Rocky Mountain Maple Temporarily Flooded Shrubland Alliance, Woods' Rose Temporarily Flooded Shrubland Alliance, Western Snowberry Temporarily Flooded Shrubland Alliance, Bluestem Willow Temporarily Flooded Shrubland Alliance, Water Birch Seasonally Flooded Shrubland Alliance	5	3
Movement Corridors	Distance from Perennial and Intermittent Streams (feet)	0 - 34 = 9 34 - 98 = 6 98 - 164 = 4 164 - 230 = 3 230 - 295 = 2 295 - 500 = 1 > 500 = 0	2
Trail & Road Impacts			
Calculate trail density by trail category in the fall to account for seasonal restrictions (leash, no dogs, V&S, undesignated, roads)			

Wild Turkey (Map 13 & Map 14)

Forest openings are essential habitat for Wild Turkey foraging and brood rearing. The forest openings target in the WTSA provides ideal habitat for turkeys as well as species that use grassland/ forest ecotones such as mule deer, elk, and many bird species. In particular, forest openings supply Wild Turkey hens rearing young the necessary food (i.e., insects) and escape cover to minimize predation. The local subspecies in Colorado, Merriam's Wild Turkey, is most often associated with forest openings within close proximity to mature forest patches with large, old trees that provide roost sites (Hoffman, 1968).

The Wild Turkey model accounts for both roosting sites (mature ponderosa forests) as well as feeding and loafing areas (openings) and ultimately identifies optimal forest openings based on the distance from the opening to suitable forest stands. For foraging habitat, higher ranks were given to openings closer to forest edges. These edges provide cover and protection for hens with poults which are less likely to stray beyond 50 meters from an edge and prefer areas within 25 meters (Hoffman et al. 1993). Roosting areas were identified in the model by ranking open ponderosa pine stands with large trees and an eastern aspect higher than other forest types. Areas where highly suitable foraging areas and highly suitable roosting areas occur in close proximity represent overall highly suitable Wild Turkey habitat. A minimum patch size of 7 hectares was applied to this model to eliminate habitat that is less desirable for hens with poults. This conservative value was based on literature (Rumble and Anderson 1993), expert opinion (M.A. Rumble, personal communication: June 2009), and staff knowledge of areas with brood hen use in the WTSA. The areas that did not exceed the patch size threshold were not considered highly suitable habitat but were displayed on the maps in red.

Increased use of trails in Wild Turkey habitat could lead to decreased turkey use or abandonment of an area (Wright and Speake, 1977) and turkeys are sensitive to disturbance at their nest sites (Lutz and Crawford, 1987). As a ground-nesting species, turkey populations can also be sensitive to dogs (Miller and Leopold, 1992). To account for the potential impacts of trail use, the turkey model integrated existing information on trails and roads. In this model as well as a number of the other models a 50 m buffer was used along roads to account for disturbance from the road and passing traffic. This is a conservative estimate based on research that suggests road effects can impact a wide range of wildlife species and other ecological functions and the effects can extend outward from the road itself for up to 600 m (Forman and Deblinger 2000). A buffer of 31 m was removed from highly suitable turkey habitat along trails with voice and sight regulations. This buffer was removed to account for dogs off-leash and people leaving the trail tread (6 m) and a 25 m flushing distance that

has been observed in a similar species, Capercaillie Grouse (*Tetrao urogallus*) (Thiel et al. 2007).

Table 8: Habitat suitability model inputs for Wild Turkey

Variable	*Attributes*	*Ranks*	*Weights*
Feeding and Loafing Habitat Created by Buffer Zones	Areas within 25 meters of grassland/ forest ecotones or forest openings	9	1
	Areas between 25 and 50 meters from grassland/ forest ecotones or forest openings	6	1
Topography	Slope of preferred habitat and feeding/loafing buffer zones	0 - 40 = 9 40 - 50 = 3 50 - 60 = 1 > 60 = 0	1
	Aspect of preferred habitat and feeding/loafing buffer zones	67.5 - 157.5 = 5 157.5 - 292.5 = 3 -1 - 67.5 = 2 -1, or 292.5 - 360 = 1	1
	% Slope of Foothills & Montane Forest Openings	0 - 40 = 9 40 - 50 = 3 50 - 60 = 1 > 60 = 0	2.5
Preferred Forest Vegetation Alliances	Ponderosa Pine Forest Alliance, Ponderosa Pine Woodland Alliance	9	1
	Ponderosa Pine Tallgrass Savannah Herbaceous Alliance, Ponderosa Pine Mixed Grass Savannah Herbaceous Alliance	7	1
	Ponderosa Pine - Douglas-fir Forest Alliance, Ponderosa Pine - Douglas-fir Woodland Alliance, Ponderosa Pine - Quaking Aspen Forest Alliance	5	1
	Douglas-fir Temporarily Flooded Woodland Alliance, Douglas Fir Forest Alliance, Quaking Aspen Forest Alliance, Quaking Aspen Temporarily Flooded Forest Alliance, Quaking Aspen - Douglas-fir Forest Alliance, Douglas-fir Woodland Alliance, Quaking Aspen Woodland Alliance (no polygons in this alliance)	3	1
Patch size	Preferred Habitat Block Size (hectares)	<2= 0 2-10= 3 10-20= 6 >20= 9	1
Distance to Roosting/ Foraging Habitat	Nearness of High Value Forest habitat to Forest Openings (feet)	0 - 25 = 9 25 - 50 = 6 50 - 100 = 3 > 100 = 0	2.5
Forest Stand Structure	Average Tree Diameter (inches)	> 15 = 9 9 - 15 = 7 7 - 9 = 5 4 - 7 = 3 0 - 4 = 1	1
	Average Basal Area (sq. ft./acre)	40 - 80 = 9 80 - 120 = 7 120 - 230 = 5 0 - 40, 230 - 281 = 3	1
Minimum Patch Size (applied before and after trail effects modeling)			
Only patches >= 7 hectares remain highly suitable			
Trail & Road Impacts			
Remove 6m + 25m on each side of V&S designated trails and undesignated trails outside of HCAs Split polygons by other designated trails and undesignated trails in HCAs Remove 50 meters on each side of roads			

Grasshopper Sparrow (Map 15 & Map 16)

The grassland portions of the West TSA provide habitat for a diverse mix of wildlife species. Although Grasshopper Sparrows are just one of the many bird and animal species that use this area, they were selected as an indicator species for the WTSA because of their need for large intact habitat blocks and their sensitivity to habitat fragmentation.

Although their average defended territory size is ≤2 ha (Dechant et al. 2003), the estimated minimum size requirement [defined as the area at which the probability of observing a species is 50% of its maximum (Robbins et al. 1989)] of Grasshopper Sparrows was 134 ha in mixed-grass habitats of Canada (Davis 2004) and 100 ha for grassland barrens in Maine (Vickery et al. 1994). Further, Wyoming Partners in Flight Best Management Practices recommends keeping grassland blocks >100 ha intact to benefit area-sensitive birds (Wyoming PIF 2002).

Within Boulder County, Thompson and Strauch (1986) found several breeding pairs of Grasshopper Sparrows on open space land and determined that the species is a regular breeder in the county. Breeding bird surveys in the Tallgrass West Area of the WTSA between 2005 and 2008 recorded the presence of Grasshopper Sparrow and the presence of females and singing males during surveys are assumed to represent breeding activity.

Highly suitable Grasshopper Sparrow habitat in the WTSA represents areas dominated by large patches of mixed or tall grass. Grasshopper Sparrows tend to avoid edges, which seem to be more vulnerable to predation and parasitism, and thus affect reproductive success (Delisle and Savidge 1996, Denchant et al. 2003).

Studies of grassland bird responses to recreational use have found that near trails, grassland nesting birds are less likely to nest, less abundant, and experience lower nesting success (Miller et al. 1998). Further, Bock et al. (1999) found this species to be significantly more abundant in interior grasslands than those near development.

Because of this, recreational trails were buffered in 50 m segments up to 100 m (i.e., two segments) and habitat quality was scored higher with increasing distance from the trail. Human development was buffered up to 200 m (i.e., four segments) and scored using similar methods.

A minimum patch size of 30 ha (~75 ac) was applied to this model to account for the area-sensitive nature of this species. Although most sources recommend conserving a ≥ 100 ha patch when managing for Grasshopper Sparrows, we chose a conservative threshold because

Tallgrass West represents much less acreage than studied / managed in these sources (Vickery et al. 1994, Wyoming PIF 2002, Davis 2004).

Table 9: Habitat suitability model inputs for Grasshopper Sparrow

Variable	*Attributes*	*Ranks*	*Weights*
Preferred Vegetation Alliances	Ill-scented Sumac / Big Bluestem Xeric Tallgrass Shrub Savannah, Big Bluestem Colorado Front Range Xeric Tallgrass Herbaceous Vegetation, Ill-scented Sumac Intermittently Flooded Shrubland, Big Bluestem - Little Bluestem Western Great Plains Herbaceous Vegetation, Big Bluestem - Prairie Dropseed Western Foothills Herbaceous Vegetation, Western Wheatgrass Herbaceous Vegetation, Western Wheatgrass - Blue Grama Herbaceous Vegetation, Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation, Western Wheatgrass - Green Needlegrass Herbaceous Vegetation, Little Bluestem - Sideoats Grama Western Great Plains Herbaceous Vegetation, Mountain Muhly Herbaceous Vegetation, Mountain Muhly - Needle-and-Thread Herbaceous Vegetation, Needle-and-Thread Colorado Front Range Herbaceous Vegetation, Green Needlegrass Herbaceous Vegetation, Parry's Oatgrass Herbaceous Vegetation, Woolly Sedge Herbaceous Vegetation, Western Wheatgrass - Needle-and-Thread Central Mixedgrass Herbaceous Vegetation, Needle-and-Thread - Blue Grama - Threadleaf Sedge Herbaceous Vegetation, Smooth Brome Cultivated Grass Hay, Yucca / Big Bluestem Xeric Tallgrass Shrub Savannah, Yucca / Needle-and-Thread Mixedgrass Shrub Savannah	9	3
	Three-leaved Sumac Upland Shrubland, Snakeweed Dwarf-shrubland Alliance, Prairie Cordgrass Temporarily Flooded Herbaceous Alliance, Baltic Rush Seasonally Flooded Herbaceous Alliance	4	3
Patch size	Acres of contiguous preferred vegetation	0-2= 1 2-8= 3 8-30= 5 30-100= 7 100-1500= 9	1
Grassland/ Forest edge	Distance (feet) from a forest stand	0-75= -7 75-150= -5 150-225= -3 225-300= -1	1
Minimum Patch Size (applied before and after trail effects modeling)			
Only patches >= 30 hectares remain highly suitable			
Trail & Road Impacts			
Habitat edges	Distance (feet) from urban edges and roads	0-150= -8 150-300= -6 300-450= -3 450-600= -1	1
Fragmentation edges	Distance (feet) from designated and undesignated trails	0-150= -6 150-300= -3	1

On-going OSMP Wildlife Studies and Monitoring

There are a number of on-going monitoring studies conducted by OSMP staff within the West TSA boundaries. All of these projects have been designed and implemented as a part of an existing management plan or to address a particularly rare or sensitive species or suite of species that occurs on the system. While many of these projects are not designed to specifically look at the impacts of trails or human use, they can inform the trail study area process. These studies can provide relatively current and discrete occurrence data for many nested target species and provide baseline information on species richness and abundance.

The following section provides short descriptions for the most current monitoring being conducted within the West TSA boundary. Monitoring sites are displayed on Map 17.

Forest Birds & Brown-headed Cowbird Monitoring

Background and Methods

In 1999, OSMP developed the Forest Ecosystem Management Plan to address the biologically degraded and fire-prone condition of coniferous forest and woodland areas on its lands. As mandated in the Plan, OSMP forestry staff began mechanically thinning Ponderosa pine (*Pinus ponderosa*) stands in 1999. Two primary goals were identified in the Plan: reduce risk of catastrophic wildfires while maintaining or improving ecosystem health and function.

Utilizing an adaptive management approach to forest stand restoration, OSMP staff developed a list of vegetative and wildlife variables believed to be key indicators of the effectiveness of restoration treatments. One such response variable was the abundance of forest-nesting songbirds as well as stand occupancy by Brown-headed Cowbirds (*Molothrus ater*). Brown-headed Cowbirds parasitize native songbird nests, reducing the overall populations of songbirds. They are edge specialists with increased activity along trails and natural openings.

To learn more about the effects of forest restoration on the abundance of landbirds in local Ponderosa pine forests and woodlands, OSMP used fixed-radius point counts to survey 17 control plots (i.e., not thinned) and 20 thinned forest plots three times each summer in 2007 and 2008. Boulder County Parks and Open Space also surveyed 10 plots in Ponderosa forests on Heil Ranch to expand sample size and improve inference (referred to as point count study below). Spot mapping was used to survey 2 control (forest conditions not requiring restoration treatment), 2 thin (slated for thinning treatment) and 2 burn +thin (slated for thinning and burning) in 2000-2001 (baseline data) and again in 2006 (following thinning treatment of 2 thin+burn plots).

<u>Point Count Study Methodology:</u> All points were ≥100 m from grassland/forest edge, points in untreated stands were ≥100 m from thinned stands, and all points were separated by ≥225 m. Surveys began at sunrise and continued until 1030. In order to account for possible differences in bird detectability in thinned vs. unthinned stands, only birds detected within 50 meters of plot center were analyzed. Each survey was 20 minutes in duration and consisted of two parts. The first part was a passive auditory survey (10 minute duration); this was followed by broadcasting recorded female cowbird chatter and male flight whistle calls with 10 – 15 second quiet intervals (10 minute duration). Staff calibrated the playback equipment such that broadcasts were detectable to approximately 75 m from plot center. OSMP staff employed broadcasting

(i.e., call playback) as a technique to increase the probability of cowbird detection in forest stands.

Spot Mapping Study Methodology: Spot mapping was completed according to standard spot mapping methodology, including using a 50 x 50 m grid system where all gridlines were walked 3 times during the early morning of the breeding season (June 1- July 15) and all bird activity was recorded on spatially explicit datasheets. Following field data collection, data was examined on an individual species level to assign territorial boundaries to the study sites. This information yielded a minimum number of territories for each species on each study plot. Additional data collection and analysis will be performed once all treatment (burning) is complete on the treatment plots.

Results and Discussion

Point Count Study: Staff detected significantly more bird species and more individuals per visit during surveys in thinned plots than in control plots (Figure 1). Numerically, staff detected 85% (n = 46) of forest bird species at greater numbers in thinned plots than in control plots (Table 10). Chipping Sparrows (*Spizella passerine*) and Plumbeous Vireos (*Vireo plumbeus)* were significantly more abundant in thinned plots (Figure 2). Both species are associated with open park-like forest stands and would seem to benefit from thinning events, which decrease canopy cover, as they consume insects on the ground or gleen insects from the foliage. Using our data as a guide, other species that may have benefited from opening of the forest canopy are Dusky Flycatcher (*Empidonax oberholseri*) and Pine Sisken (*Carduelis pinus*), both of which use open forests extensively.

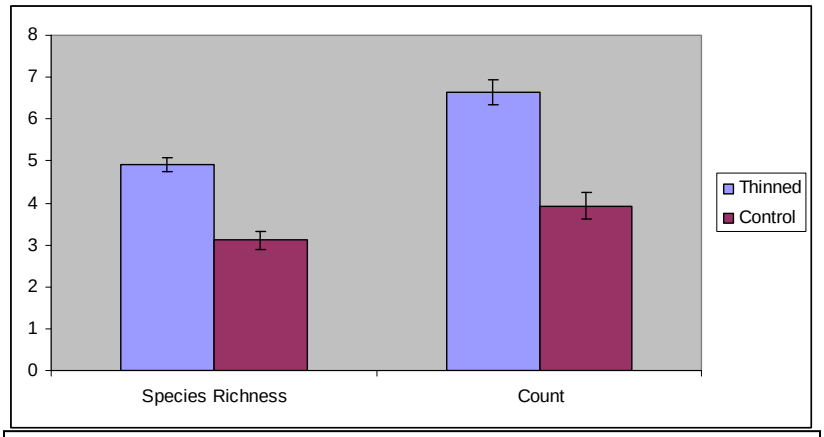


Figure 1. Mean (±SE) native species richness and count of individual native birds detected using passive auditory surveys within a 50 meter radius of control (n = 17) and thinned (n = 20) plots in Ponderosa pine forests on OSMP during 2007-08. Significantly more species and individuals were detected in thinned plots than in control plots ($p < 0.0001$).

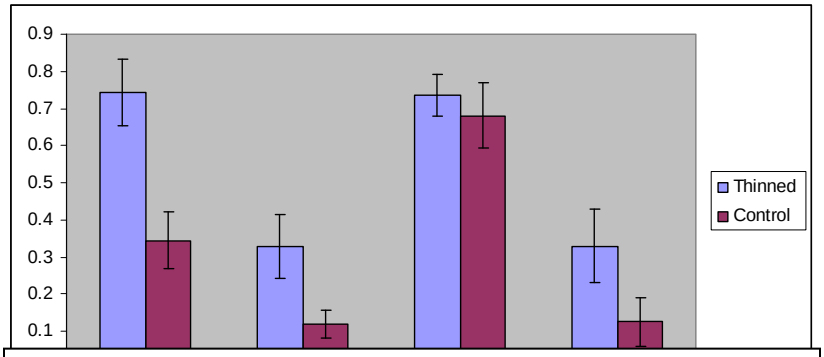


Figure 2. Mean abundance (±SE) for selected species of passerines detected within a 50 m radius of control (n = 17) and thinned (n = 20) plots in Ponderosa pine forests on OSMP during 2007-08. Chipping Sparrows (*Spizella passerine*, CHSP), Brown-headed Cowbirds (*Molothrus ater*, BHCO) and Plumbeous Vireos (*Vireo plumbeus*, PLVI) were significantly more abundant in thinned stands than in control stands ($p < 0.05$). Pygmy Nuthatches (*Sitta pygmaea*, PYNU) were not significantly more abundant in thinned stands ($p > 0.05$). Brown-headed Cowbird abundance was calculated using results from broadcast surveys as well as passive auditory surveys; other species' abundances were calculated using passive auditory surveys.

Brown-headed Cowbirds were significantly more abundant in thinned stands than in control stands (Figure 2). To date, little information is available describing

potential response of cowbirds to forest restoration. Cowbirds are: 1.) aggressive nest parasites, whose effect on host bird species has increased as sedentary domestic cattle have replaced wide-ranging buffalo herds; 2.) host-generalists with the potential to severely depress nesting success of forest bird species, most of whom have no evolved defense against nest parasitism; 3.) edge-specialists and have been documented using roads, powerlines, and other forest openings to access the nests of interior-nesting species.

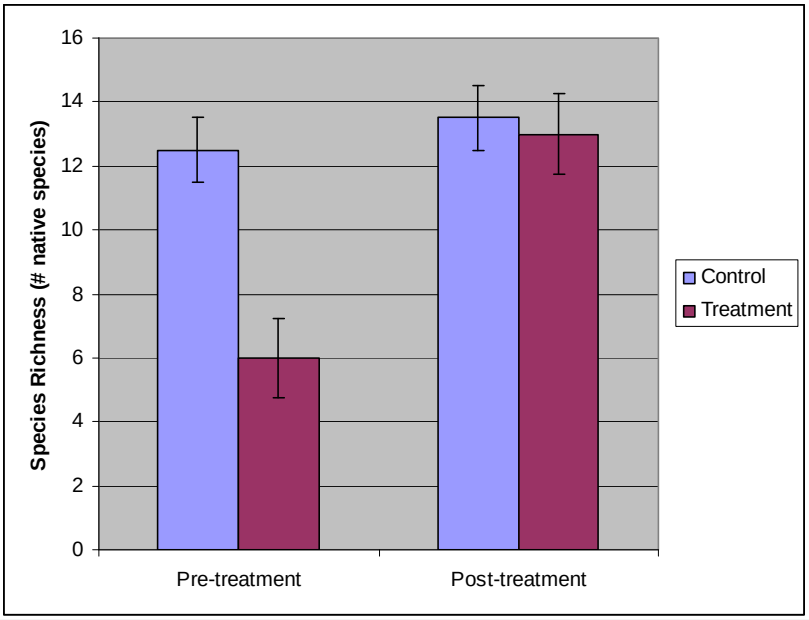


Figure 3. Mean native species richness (± SE) of native birds detected using spot mapping on control (untreated) plots (n = 2) and treatment Plots (n = 2) before (2000-2001) and after (2006) thinning of treatment plots. Species richness differed significantly before treatment (p= 0.04) but not following treatment (p= 0.25)

It is not clear whether forest restoration activities are reducing canopy cover to an extent that facilitates cowbird movement and parasitic behavior, or whether other factors, such as proximity to urban areas, or host abundance, act independently or cumulatively to affect cowbird abundance in these stands. Interestingly, staff detected more Plumbeous Vireos and Chipping Sparrows in thinned plots than in control plots and these are two species that cowbirds regularly parasitize. Finally, it is not known if cowbird abundance translates into depressed host nesting success in these particular forest stands (although this has been shown elsewhere). Future work in thinned and control forest stands should include research into the effects of forest restoration on cowbird parasitism rates, and host nesting success and productivity.

Spot Mapping Study: Because no burning has taken place on the treatment plots, results from this study are preliminary. However, in addition to 2 years of baseline data on all plots, we were able to collect one year of data on plots that were thinned as well as two control plots. Data collection on all plots and final analysis of the data will occur once treatment is complete on all treatment plots.

We found that species richness shifted dramatically in the two thinned plots in comparison to the control plots (Figure 3). Before treatment, species richness was significantly lower in untreated plots than in control plots (p= 0.04) and following thinning in treatment plots, species richness was similar between treatment and control plots (p= 0.25). This suggests that thinning has been successful in creating a habitat more like the control

plots which provide habitat for a wider range of species. Additional comparison will be made following treatment of all treatment plots and the implementation of controlled burns on burn treatment plots.

Table 10: Birds detected using passive auditory surveys within 50 meters of plot center for control (n =17) and thinned (n = 20) plots in Ponderosa pine forests on OSMP during 2007-08.

Common Name	Scientific Name	Control	Thinned
American Crow	*Corvus brachyrhynchos*	1	
American Goldfinch	*Carduelis tristis*	1	1
American Kestrel	*Falco sparverius*		1
American Robin	*Turdus migratorius*	16	55
Barn Swallow	*Hirundo rustica*		1
Blue-gray Gnatcatcher	***Polioptila caerulea***		3
Brown-headed Cowbird	*Molothrus ater*	5	6
Black-headed Grosbeak	*Pheucticus melanocephalus*		1
Blue Jay	*Cyanocitta cristata*		3
Broad-tailed Hummingbird	*Selasphorus platycercus*	34	58
Cassin's Finch	*Carpodacus cassinii*	1	2
Cedar Waxwing	*Bombycilla cedrorum*		3
Chipping Sparrow	*Spizella passerina*	37	108
Cordilleran Flycatcher	*Empidonax occidentalis*	1	1
Common Grackle	*Quiscalus quiscula*		5
Cooper's Hawk	***Accipiter cooperii***		2
Common Raven	*Corvus corax*	2	1
Dark-eyed Junco	*Junco hyemalis*	25	18
Dusky Flycatcher	*Empidonax oberholseri*	4	46
Eastern Bluebird	*Sialia sialis*	1	3
Hammond's Flycatcher	*Empidonax hammondii*	2	4
Hairy Woodpecker	*Picoides villosus*	7	23
Hermit Thrush	*Catharus guttatus*		1
House Finch	*Carpodacus mexicanus*	1	9
House Wren	*Troglodytes aedon*	10	39
Lazuli Bunting	***Passerina amoena***		2
Lesser Goldfinch	*Carduelis psaltria*	12	38
Long-eared Owl	***Asio otus***	3	
Mallard	*Anas platyrhynchos*	4	
Mountain Bluebird	***Sialia currucoides***		2
Mountain Chickadee	*Poecile gambeli*	28	48
Mourning Dove	*Zenaida macroura*	19	35
Northern Flicker	*Colaptes auratus*		4
Olive-sided Flycatcher	***Contopus cooperi***		1
Pine Siskin	*Carduelis pinus*	13	61
Plumbeous Vireo	*Vireo plumbeus*	10	50
Pygmy Nuthatch	***Sitta pygmaea***	75	109
Red-breasted Nuthatch	*Sitta canadensis*		5
Red Crossbill	*Loxia curvirostra*	10	28
Rock Wren	*Salpinctes obsoletus*	1	
Red-tailed Hawk	*Buteo jamaicensis*		1
Spotted Towhee	*Pipilo maculatus*	7	25

Steller's Jay	*Cyanocitta stelleri*	10	6
Townsend's Solitaire	*Myadestes townsendi*	8	3
Violet-green Swallow	*Tachycineta thalassina*		30
Virginia's Warbler	***Vermivora virginiae***	1	
Warbling Vireo	*Vireo gilvus*	1	1
White-breasted Nuthatch	*Sitta carolinensis*	6	24
Western Bluebird	***Sialia mexicana***	3	13
Western Tanager	***Piranga ludoviciana***	17	30
Western Wood-Pewee	*Contopus sordidulus*	11	37
Wilson's Warbler	*Wilsonia pusilla*		1
Yellow-breasted Chat	*Icteria virens*		1
Yellow-rumped Warbler	*Dendroica coronata*	7	19

*** Species in bold are nested targets**

Accipiter Surveys

Background and Methods

As part of the initial stages of the West TSA process a list of nested targets was created to identify rare and sensitive species that occur in the forests of OSMP. The Northern Goshawk is considered a sensitive species by the US Forest Service and vulnerable ("S3B") by the Colorado Natural Heritage Program. OSMP identified this species as a nested target and indicator species in the West TSA Plan. Thus, it is important for OSMP to locate potential breeding areas for recreational management plans such as Trails Study Areas. While some Cooper's Hawks and Sharp-shinned Hawks have shown an ability to adapt to human use, to fully protect these birds, actions should be taken to route human use away from known nesting sites. Accipiter surveys have not been conducted in the mountain backdrop since 1989. Therefore, current information on the presence and distribution of these species was the focus of 2008 surveys in the TSA.

The accipiter surveys followed methodologies described in Woodbridge and Hargis (2006) and Kennedy and Stahlecker (1993). Call stations were located 200 m apart along each transect and simultaneous surveys were conducted no closer than two transect widths apart to avoid identifying broadcasts from other surveyors. To elicit an accipiter response, staff broadcasted the Northern Goshawk juvenile begging call as well as the adult wail call using Sony SRS-A27 amplified speakers set to broadcast 110 dB at 1 meter distance. Staff did not survey under conditions such as high winds (greater than 15 mph) or rain that reduced ability to detect accipiter responses. Surveys began half an hour before sunrise and ceased half an hour before sunset.

When staff detected an accipiter, they attempted to locate the accipiter visually and determine the species and age (adult versus juvenile) of the responding individual. Staff also recorded compass bearing of any individual leaving the station to aid in locating potential nests.

Results and Discussion

OSMP staff surveyed six drainages at least once from 25 July to 5 August in 2008. Staff surveyed Gregory Canyon, Flagstaff, and Panther Canyon twice and Lost Gulch, North Draw, and Aspen Canyon once (Map 17). The latter areas were only surveyed once because ERO performed the other survey as part of the West TSA inventory process.

OSMP staff (as well as ERO) conducted accipiter surveys during late July and early August. This surveying timeframe was chosen to improve detectability of successful accipiter breeding attempts (juveniles and fledglings will often respond to broadcasts if present in the area). Staff detected two adult and two juvenile Cooper's Hawks and one juvenile Northern Goshawk during broadcast surveys in 2008. In Lost Gulch, staff located two Cooper's Hawk nests where successful breeding had taken place. In Aspen Canyon, staff observed two Cooper's Hawk fledglings close to a nesting site, although the use of this nest could not be confirmed. A juvenile Northern Goshawk responded to broadcasts at two stations in the Flagstaff study area on 27 July, but this individual was not detected during a subsequent survey. Thus, this individual may not have been resident or breeding but rather simply moving through the area.

While surveys conducted during late summer can detect successful accipiter nesting attempts, they do not provide any information on non-successful breeders. To learn more about the site choice and distribution of these individuals, dawn acoustical surveys (conducted in spring) are recommended. Increasing the number of dawn acoustical surveys may provide a more complete view of accipiter use of OSMP forests as well as identify some of the causes of nesting failures. Because it was evident that most of the successful breeding areas were located in areas with low human use, locating nesting attempts may help OSMP to manage for these species more effectively in the future.

Forest Owl Surveys

Background and Methods

The Flammulated owl is cavity-nesting species dependent on snags and mature mixed-conifer forest. It is considered a management indicator species for the US Forest Service and has been identified as a species of interest for future revisions of OSMP's Forest Ecosystem Management

Plan and a nested target in OSMP forests. Although Boulder County Audubon occasionally surveys for Flammulated Owls in Long Canyon, this species has not been formally surveyed for in OSMP forests for 20 years.

The forest owl surveys followed methods outlined by Cilimberg (2007). Staff used a stratified random sampling design to place call stations in good owl habitat. Broadcast stations (i.e., points) were located ≤ 500 m from each other, depending on terrain. Staff spent 10 minutes listening and calling for owls at each point. Surveying time was separated into five sections: two minutes of silent listening, 1 minute of broadcast calling, 3 minutes of post-broadcast listening, 1 minute calling, 3 minutes listening. For the 1 minute of broadcasting, staff played 15 seconds of a Flammulated Owl call series with caller pointed in each cardinal direction. Surveys were not conducted in poor weather (high wind, continuous rain, etc.). Surveys began approximately 15 minutes after published sunset and continued until the requisite stations had been surveyed.

Results and Discussion

In 2008, staff surveyed 26 stations in four drainages on three survey nights from 30 July to 13 August (Map 17). Staff detected Flammulated Owls on all three survey nights and recorded owl responses at eight stations. However, it was noted that one bird may have been detected at two stations and thus should only be counted once. Surveys in Gregory, Aspen/Shadow, and Panther Canyons produced three, three, and one Flammulated Owl responses, respectively. Staff also detected a Long-eared Owl in Shadow Canyon on 31 July.

Flammulated owl responses to con-specific playback may not be a reliable indicator of breeding because males will still call even if they have not found a mate. In some instances, the female will also respond, which increases the probability that breeding activity exists. This indicated one pair nesting in Shadow Canyon for the past three years, although a nest site has not been located. OSMP's forests are snag-deficient and this may be a limiting factor in Flammulated Owl abundance and distribution. To alleviate this, the revised FEMP should include measures to create more snags, as well as explore the possibility of installing artificial nest boxes in good owl habitat.

Cliff-nesting Raptor Monitoring

Background and Methods

Along the Front Range, cliff-nesting raptors are being adversely affected by habitat loss and disturbance to nesting sites and foraging areas. OSMP

manages for three cliff-nesting raptor species — Golden Eagle, Peregrine Falcon, and Prairie Falcon. All three of these species are either considered sensitive by federal agencies or rare by local organizations. In addition, all three species are protected by the Federal Migratory Bird Treaty Act and Golden Eagles are protected by the Federal Eagle Protection Act. OSMP staff identified these species as nested targets in the West TSA Plan and chose Prairie Falcons as a wildlife indicator species in the planning process. To minimize disturbance to these breeding birds, OSMP has established seasonal access restrictions to cliffs that are chosen as nest sites (Map 17).

Restrictions have been in effect since the mid 1980s and have generally been recognized and supported by OSMP visitors. Instituting these protective measures at nesting sites as well as managing for natural areas, which provide foraging opportunities for raptors, has helped OSMP maintain the densest breeding population of cliff-nesting raptors along the Front Range. The development of a volunteer raptor monitoring program in the 1990s has helped to record accurate data on breeding success and productivity and the program currently stands out as one of OSMP's most successful volunteer efforts.

Nest sites are monitored throughout the season using spotting scopes and binoculars to determine nesting success and productivity. Nestlings are assumed to be fledged after attaining 80% of their fledging age. This age differs between species. Closures are lifted when monitoring indicates that the fledglings have left the nest and are no longer susceptible to disturbance.

Results and Discussion

In 2008, there were seven nesting attempts by three species. All breeding attempts were successful. However, one nesting territory remained occupied without a nesting attempt (3rd Flatiron, occupied by Peregrine Falcons). In total, three Prairie Falcon pairs produced 15 fledglings, two Golden Eagle pairs fledged three young, and two Peregrine Falcon pairs fledged three young.

During the same year, 49 volunteers logged 587 site visits equaling ≥ 1,800 hrs of volunteer raptor monitoring. One new Golden Eagle nesting site was confirmed in 2008 and fledged one nestling. An additional Golden Eagle nesting site was suspected and this area was protected seasonally in 2009.

Known breeding attempts by cliff-nesting raptors on OSMP were distributed with similar density as those in the internationally-recognized Snake River Birds of Prey National Conservation Area (SRBOPNCA) in

southern Idaho. On the Snake River, Golden Eagles and Prairie Falcons nested as dense as 1 pair per 5-8 km and 1 pair per 2 km of river, respectively. On OSMP property in 2008, eagles and falcons nested as dense as 1 pair / 4 km and 1 pair / 2 km, respectively.

From 2000-2008, cliff-nesting raptors on OSMP have experienced high nesting success and productivity levels (Table 11), especially those choosing sites within the West TSA (Table 12). As a comparison, Steenhof (1998) recorded a 64% nesting success rate and 2.5 fledglings per nesting attempt during a long-term study (n = 573 broods) of Prairie Falcons in the SRBOPNCA. Kochert et al. (2002) calculated a 60% nesting success rate, which yielded 1.6 fledglings per attempt during a 23 year long study on Golden Eagles in the SRBOPNCA. White et al. (2002) collated breeding data on Peregrine Falcons from 6 US states and found a 75% nesting success rate and 1.5 fledglings per nesting attempt.

Importantly, breeding parameters (nesting success and productivity) of these three species on OSMP exceeds those published elsewhere in protected and semi-protected natural areas. Management actions aimed to protect nesting raptors as well as their foraging areas should be continued in the future to maintain these reproductive levels.

Table 11. Mean nesting success and productivity (# of fledglings / nesting attempt [n]) for cliff-nesting raptor species on OSMP from 2000-2008.

	2000-2008		
	n	Nesting Success (%)	Productivity
Prairie Falcon	34	88	3.15
Peregrine Falcon	19	84	2.32
Golden Eagle	18	78	1.05

Table 12. Breeding parameters for three cliff-nesting raptor species by site in the West Trail Study Area of OSMP, 2000-2008.

Site	2000-2008			
	Species	n	Nesting Success (%)	Productivity
Gregory Amphiteater	Falcon	3	67	2.67
Bear Creek Spire	Falcon	9	100	4.22
Fern Canyon	Falcon	9	78	2.11
Flagstaff	Eagle	1	100	1
Mickey Mouse Wall	Falcon	8	88	2
Mt. Sanitas	Falcon	6	100	4.17
Shadow	Falcon	11	91	2.73
Skunk	Eagle	8	100	1.38
3rd Flatiron	Falcon	7	71	2.14

Northern Leopard Frog Monitoring

Background and Methods

The decline of northern leopard frogs (*Rana pipiens*) has been documented throughout the Western United States and Canada (Smith and Keinath, 2007). Despite the lack of federal protection status, many states in the Western U.S. have listed the northern leopard frog as endangered or of special concern. The Colorado Division of Wildlife has listed this frog as a "species of special concern".

Leopard frog populations on City of Boulder Open Space and Mountain Parks (OSMP) property face similar threats that affect many other Western U.S. populations. The most apparent threats are habitat loss and destruction, disease, and predation from non-native species. Habitat degradation can arise from: reduced shoreline vegetation and shoreline erosion by cattle, dogs and humans, and grassy vegetation reduction from competition with Russian olive and cattails. Further threats to northern leopard frog populations include bullfrogs and introduced predaceous fish such as trout, largemouth bass, common carp, and sunfish. These species prey on leopard frog larvae, eggs, and adults, as well as compete with leopard frogs for resources.

To learn more about the abundance and distribution of this frog and others on OSMP, staff and volunteers began to survey wetlands and other wet areas throughout the grasslands and foothills in spring 2006 using visual encounter surveys. Upon arriving at a survey site, the individual established a starting point to begin the survey. The surveyor would then slowly walk the perimeter of the wetland, searching for and recording any amphibian species that were found. Special attention was paid to areas of high quality habitat (low emergent vegetation or floating algae mats) during the survey. Staff and/or volunteers surveyed the site three times, evenly spaced, throughout the season. Volunteers that were involved with the visual encounter surveys were given a morning of field training to aid in the visual identification of local amphibian species. After the survey was complete, all equipment including footwear was disinfected using a 10% bleach solution to minimize the potential for spreading disease between wetlands surveyed.

Results and Discussion

In the West TSA, eight sites were surveyed for Northern Leopard Frogs from 2006-2008 (Map 17). Leopard frogs were observed at one of these sites in 2006 and two of these sites in 2007 (Table 13). Because some of these sites were not sampled every year, determining trends is difficult. The northern leopard frog is a nested target in the draft Grassland

Ecosystem Management Plan and thus this species will continue to be monitored as funding allows. Sites where Northern Leopard frogs are observed should be protected in accordance to strategies outlined in the Grassland Plan.

Table 13: Results of visual encounter surveys for Northern Leopard Frogs in the West TSA. Recorded as presence (1) or absence (0), sites with NA were not sampled in the associated year.

Site Name	2006	2007	2008
Middle/North Fork Junction	NA	0	0
Bluestem Connector	NA	1	0
W. of Lehigh Connector	NA	1	0
N. Watertank	NA	0	0
Neuhauser Pond	1	0	0
Bear Canyon Creek	NA	NA	0
Gregory Canyon Creek	NA	NA	0
Sunshine Canyon	0	NA	NA

Bat Monitoring

Background and Methods

Bats are among the most intensely feared and relentlessly persecuted animals on earth. In North America, nearly 40 percent of all bat species are included on state or federal threatened, endangered, or sensitive species lists or are candidates for listing. Vandalism and repeated disturbance in roosting caves are primary causes for these declines (Western Bat Working Group).

In partnership with the Colorado Division of Wildlife and the Colorado Bat Society, the OSMP bat monitoring program began in 1995 and is overseen by volunteer services, ecological resources staff, and ranger naturalists. There are three main components of the program involving volunteer monitoring efforts, collaboration with professional researchers, and protection efforts through seasonal wildlife closures. On average 20-40 volunteers spend 400 hours/year conducting auditory and visual counts at water holes. Volunteers also perform exit counts at other known roost sites such as the Amphitheatre rock formation. Volunteers and staff monitor wildlife closures for 2 imperiled species, the Fringed Myotis (*Myotis thysonodes*) at Der Zerkle and the Townsend's Big Eared Bat (*Corynorhinus townsedii*) at Harmon and Mallory Caves.

Water Hole Trend Surveys: Bat monitors venture out at dusk to ponds for two hour surveys. They perform auditory and visual population counts for two consecutive nights a month, June through September at 41 possible locations across OSMP property, 7 of which are in the WTSA. Repeated

yearly surveys at traditional sites provide us with trend information and possible warning of changes in activity. However, because not all of the sites were sampled every year, determining trends is difficult for some locations.

Roost surveys: Each year, bat monitors visit 4 known bat roosts of verified species to count actual numbers of bats as they exit roost sites. Seasonal closures of sensitive areas for imperiled maternity colonies are the direct result of observation, monitoring and research. The Department has a good working relationship with climbing and hiking advocacy groups who help ensure that these closures are respected. The cooperation of the public, and the work of volunteer monitors, helps us to protect the bats while they are raising their young.

Results and Discussion

The 2008 sampling of water sources for bats on OSMP properties gives us a 13 year record of data for many of these sites. In 2008, the ratio of captures of adult females (39) and adult males (35) was very close to 50:50. The number of subadults captured (first-year young nearing adulthood) was 12, with 11 of these being females. Generally speaking, our records have been showing a decline in the female/male sex ratio over the years and it was encouraging to see this even ratio in 2008. However, the numbers of nonreproductive females in the Boulder County foothills remains high. Sampling in 2007 marked the highest incidence of nonreproductive females captured in any single season over the last 13 years (52%). 2008 marked the second highest incidence of nonreproductive females with 44%.

In both 2007 and 2008, the *Eptesicus fuscus* (big brown bat) maternity colony abandoned their rock-crevice roost on the ampitheater and the colony fractured into several different roost sites including under a large boulder (R. Adams, pers. comm.).

Table 14: Range of total bats sampled during sampling years at watering holes located in the West TSA

Water Hole Trend Sites	Years Sampled	Range for # of Bats Sampled
Abbey Pond	1996-97,2004	3-268
Bear Pool	1995-96,2004,07,08	1-305
Flagstaff Summit	1995	1-350
Gregory Canyon	1995-96,2001,07,08	0-23
Sanitas Valley	1995,97-99,2008	0-48
Shanahan Pond	1996-97,2003-04,07-08	0-423
Stockton Cabin Pool	1997,2003-04,08	2-765

Table 15: Range of total bats sampled during sampling years at roosting sites located in the West TSA

Roost Sites	Years Sampled	Range for # of Bats Sampled
Amphitheater	2001-04,06-08	2-60
Der Zerkle	2004,06-08	2-266
Harmon Cave	2004,07-08	0-220
Mallory Cave	2004,06-08	3-112

Tallgrass West Bird Monitoring

Background and Methods

Tallgrass West (area of grassland habitat west of Hwy 93 between Shanahan Ridge to north and Eldorado Springs Drive to south) is an area of regional importance characterized by locally rare big bluestem communities that provide habitat for many grassland nesting birds species of conservation concern. This area contains three designated recreational trails and was part of a long term grazing lease for 20 years. To maximize health of the vegetation and wildlife communities, the grazing regime was re-examined and modified in 2005. Following the expiration of the long-term lease in 2006, a new, experimental four-year grazing rotation was put in place. To track changes associated with this grazing change, we began a monitoring project in 2005 to capture the responses of the bird community.

We first stratified the study area on three variables: plant community, grazing regime, and proximity to recreational trails. Plant community categories included riparian, upland, and forest edge. In each of these areas we randomly located points in areas that are grazed, or ungrazed (under the new grazing regime) and near trail (within 50m) and distant from trails (greater than 200m)- recreational stratification is not included in below discussions as sample size is low and changes to recreational use have been minimal over the study period. We established a total of 22 transects distributed among these treatments:

	Riparian		Upland		Forest Edge	
	Near	Far	Near	Far	Near	Far
Grazed	1	1	3	3	3	2
Ungrazed		1	4	3	4	6

Wildlife transects were 200 m long, at least 200 m apart, and either ran parallel to a trail (all near trail transects) or at a 45˚ angle from roads and property lines (far from trail category).

We surveyed birds along each transect twice during each of four breeding seasons (early-June to mid-July, 2005-2008). We used distance sampling (Buckland et al. 1993), which provides estimates of bird densities without assuming all birds have an equal probability of detection or that every bird present during the survey is detected. We recorded all bird species seen or heard along the transect and estimated their distance to the nearest meter, calibrated with a laser rangefinder (Bushnell Corporation, Overland Park, Kansas). We also measured the sighting angle from the transect line with

a large protractor. Sampling occurred between sunrise and 3 hours after sunrise and was not conducted in inclement weather.

Results and Discussion

Due to the preliminary status of the data, full analysis using program DISTANCE has not been completed. For the purposes of this summary, species richness was measured and defined as number of native species. In addition, for examination of grassland specialist species (Grasshopper Sparrow, Lark Sparrow, Savannah Sparrow, Vesper Sparrow, Western Meadowlark), we calculated relative abundance as defined by average number of individuals of each species per transect within a given treatment.

Following completion of the study period (summer 2009 for grazing regime focus), data will be analyzed using the program DISTANCE (Thomas et al. 1998) to generate estimates of bird density (birds per hectare) in each treatment category. First for all species and then for grassland specialists (Grasshopper Sparrow, Lark Sparrow, Vesper Sparrow, Western Meadowlark), we will model a detection function, based on exact distance values, with the robust models suggested by Buckland et al. (2001). We will select the best model based on Akaike's information criterion corrected for small sample sizes (AICc) (Burnham & Anderson 2002) and by inspecting probability density functions and χ^2 goodness-of-fit statistics (Buckland et al. 1993). We will then obtain density estimates in each treatment by re-running the best model for the species of interest and stratifying by treatment. We will perform pair wise comparisons of specific density estimates of interest with a *z* test (Ott & Longnecker 2001). We have established an α of 0.05 *a priori* for all analyses to minimize Type I error.

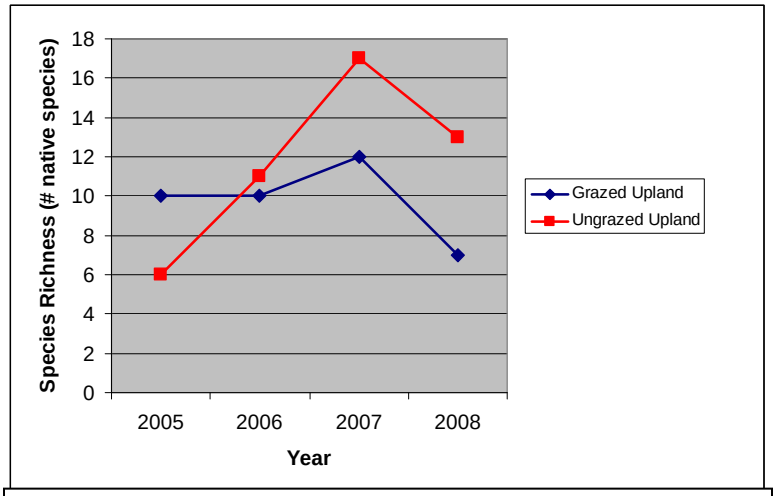


Figure 4. Species richness on grazed and ungrazed upland plots between 2005 and 2008 on Tallgrass West.

Over the four years of study completed, we detected 51 species of birds at our Tallgrass West study sites. Of these, 49 were native and five are considered grassland specialists. Both grazed and ungrazed transects had 41 species detected (grazed = 40 native, ungrazed = 39 native). However, the species detected differed between the two treatments (Table 16). All five grassland specialists were detected at grazed transects and all but Savannah Sparrow were detected at ungrazed transects. Numbers of

detections for Lark Sparrows and Savannah Sparrows were too low to allow further analysis.

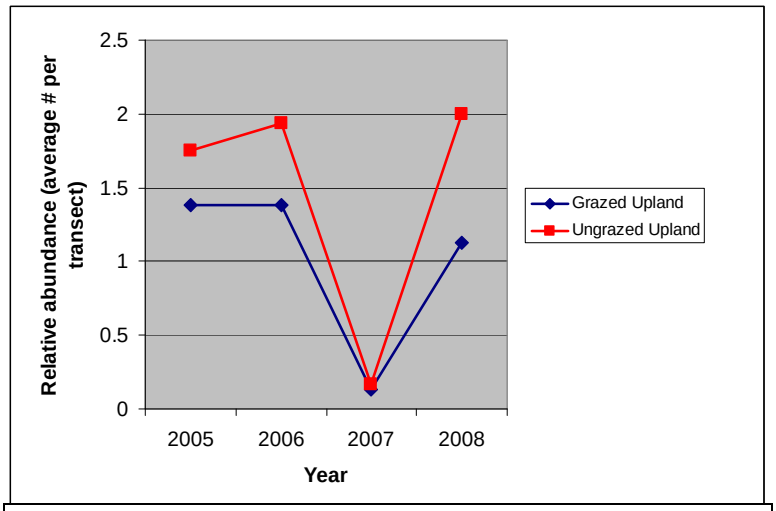


Figure 5. Relative abundance of Grasshopper Sparrows on grazed and ungrazed upland plots between 2005-2008 on Tallgrass West.

Trends when all habitat types were pooled to examine grazed vs. ungrazed transects showed large annual variation and no detectable difference between treatments. This annual variation seems to be responsible for most if not all of the variation in the data. However, examination of grazed upland transects and ungrazed upland transects shows a detectable although not statistically significant (p = .44) trend toward increases in species richness on ungrazed upland plots (Figure 4). Similarly, examinations of individual grassland specialist species show an increasing trend on ungrazed upland transects as compared to grazed upland transects. Of the three species examined, (Grasshopper Sparrow- Figure 5, Vesper Sparrow- Figure 6 and Western Meadowlark- Figure 7), only Grasshopper Sparrow showed a marginally significant difference between grazed upland and ungrazed upland transects (p = .077) (Figure 5). It should be noted that ungrazed upland plots had more Grasshopper Sparrow detections prior to a shift in grazing regime (2005). As discussed in relation to combined analysis of all three habitat types, annual variation within the species numbers was quite high, making it difficult to detect any significant trends in response to grazing changes.

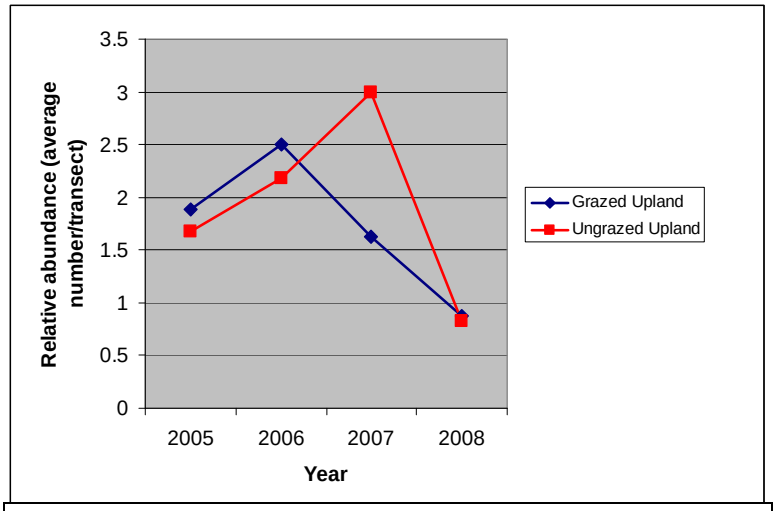


Figure 6. Relative abundance of Vesper Sparrows on grazed and ungrazed upland plots between 2005-2008 on Tallgrass West.

Trends related to shifts in grazing regime were weak, although when we focused on upland habitats only, indications of increased species richness and abundance of grassland specialists existed, although significance in these trends was only detected for Grasshopper Sparrow. Low sample sizes make it difficult to detect significance with 4 summers of data (3 since changes in grazing took place). We will re-analyze the data using more sensitive statistical tests and metrics (density) following completion of the full study (2009).

Annual variation in numbers of individuals within a species suggest that changes from year-to-year unrelated to grazing management of the area may make it difficult to detect trends over a relatively short study timeframe (4 years). Longer-term datasets may be necessary to detect any trends above the annual variation that exists. In addition, it is likely that habitat changes resulting from grazing regime shifts are likely to take some time to affect meaningful changes to the vegetation community and nesting habitat available to ground nesting birds. As a result, following completion of the initial study phase (2009), we will continue to monitor birds in the area on a periodic basis (perhaps every 2-3 years if feasible) to examine longer term trends in numbers resulting from changes in grazing and potential future shifts in recreation.

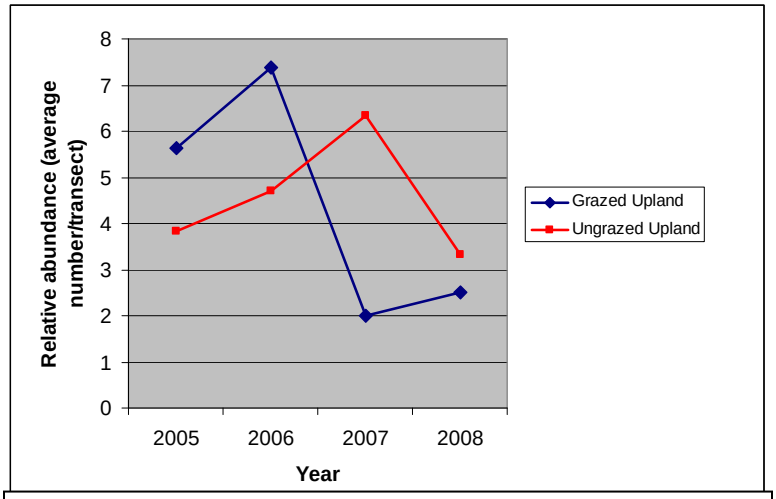


Figure 7. Relative abundance of Western Meadowlarks on grazed and ungrazed upland plots between 2005-2008 on Tallgrass West.

Recreation (near vs. far from trail) will be included as a variable in future analysis of the data. This may provide additional insight to the bird community present, and their response to grazing changes. In addition, our data provide a bird community baseline that compliments previous studies done in the area (Bock et al. 1999, Bock 2000, Bock unpublished data, Haire et al. 2000) that can be used to detect future changes in the bird community related to habitat management, grazing management and recreational use.

Table 16. Common name, scientific name and presence/absence of birds detected using distance sampling along transects in grassland habitats of tallgrass west on OSMP during 2005-08.

Common Name	*Scientific Name*	Grazed Transects	Ungrazed Transects	Grazed Upland	Ungrazed Upland
American Goldfinch	*Carduelis tristis*	X	X		X
American Kestrel	*Falco sparverius*	X	X	X	X
American Crow	*Corvus brachyrhynchos*	X		X	
American Robin	*Turdus migratorius*	X	X	X	X
Barn Swallow	*Hirundo rustica*	X	X	X	X
Black-billed Magpie	*Pica pica*	X	X	X	X
Black-capped Chickadee	*Parus atricapillus*	X			
Blue-gray Gnatcatcher	*Polioptila caerulea*	X	X		X
Brown-headed Cowbird	*Molothrus ater*	X	X	X	X
Brewer's Blackbird	*Euphagus cyanocephalus*	X	X	X	X
Blue Jay	*Cyanocitta cristata*	X		X	
Broad-tailed Hummingbird	*Selasphorus platycercus*	X	X		X
Chipping Sparrow	*Spizella passerina*	X	X	X	X
Cliff Swallow	*Hirundo pyrrhonota*	X	X	X	
Common Grackle	*Quiscalus quiscula*	X	X	X	
Common Nighthawk	*Chordeiles minor*	X	X	X	X
Common Raven	*Corvus corax*	X	X		
Downy Woodpecker	*Picoides pubescens*		X		
European Starling*	*Sturnus vulgaris*	X	X	X	X
Grasshoppper Sparrow**	*Ammodramus savannarum*	X	X	X	X

Great-Horned Owl	*Bubo virginianus*		X		X
House Finch	*Carpodacus mexicanus*	X	X		X
Lark Sparrow**	*Chondestes grammacus*	X	X		X
Lesser Goldfinch	*Carduelis psaltria*	X	X		
Mourning Dove	*Zenaida macroura*	X	X		X
Mountain Chickadee	*Poecile gambeli*	X	X		
Northern Flicker	*Colaptes auratus*		X		X
Plumbeous Vireo	*Vireo plumbeus*	X			
Pygmy Nuthatch	*Sitta pygmaea*	X			
Red Crossbill	*Loxia curvirostra*	X			
Rock Dove*	*Columba livia*		X		X
Red-tailed Hawk	*Buteo jamaicensis*	X		X	
Red-winged Blackbird	*Agelaius phoeniceus*	X	X	X	
Savannah Sparrow**	*Passerculus sandwichensis*	X		X	
Spotted Towhee	*Pipilo maculatus*	X	X		X
Steller's Jay	*Cyanocitta stelleri*	X	X		
Scrub Jay	*Aphelocoma coerulescens*	X			
Swainson's Hawk	*Buteo swainsoni*		X		
Turkey Vulture	*Cathartes aura*	X	X		
Vesper Sparrow**	*Pooecetes gramineus*	X	X	X	X
White-breasted Nuthatch	*Sitta carolinensis*		X		X
Western Kingbird	*Tyrannus verticalis*	X	X	X	X
Western Meadowlark**	*Sturnella neglecta*	X	X	X	X
Western Wood-pewee	*Contopus sordidulus*	X	X		
Yellow-breasted Chat	*Icteria virens*	X	X		
Bullock's Oriole	*Icterus bullockii*	X	X		X
House Wren	*Troglodytes aedon*		X		X
Lazuli Bunting	*Passerina amoena*		X		X
Mountain Bluebird	*Sialia currucoides*		X		X
Violet-green Swallow	*Tachycineta thalassina*		X		X
Western Tanager	*Piranga ludoviciana*	X			

Species in bold are forest or grassland nested targets
* non-native species ** ground nesting grassland specialist

Appendix B: Rare Plants and Vegetation Communities

Rare and Sensitive Vegetation

Top: White adders-mouth orchid (*Malaxis monophyllos ssp. brachypoda*)

Middle: Birds-foot violet (*Viola pedatifida*)

Bottom: Dwarf leadplant (*Amorpha nana*)

One of the City of Boulder's Open Space and Mountain Parks Department (OSMP) charter purposes is the preservation of rare and sensitive native plant species. In order to achieve this objective, staff must maintain current and accurate information on the location, distribution, ecology, and conservation status of these species.

The Colorado Natural Heritage Program (CNHP) has developed state conservation status ranks (S-Ranks) to best characterize the relative rarity or endangerment of a species or community element within the state. These assessments provide an estimate of extinction risk on a scale of one to five, where S1 rankings indicate critical imperilment and S5 rankings signify the species is demonstrably secure. All pertinent factors, including abundance, distribution, short- and long-term population trends, environmental specificity and range extent, and threats may be used to assign this ranking . Likewise, OSMP Plant Ecologists used similar quantitative and qualitative factors to identify additional sensitive species.

Previously documented rare plant species locations are inventoried on a regular basis across the OSMP system using a standardized methodology. Staff has determined that all known subpopulations should be resurveyed every 5 years to best maintain accurate resource information. Surveys for additional rare plant occurrences are conducted in conjunction with routine inventories, or as part of specific projects. Newly discovered rare plant occurrences are added to the OSMP GIS rare plant database and the regular monitoring cycle.

During each rare plant field survey a GPS unit is used to record a number of characteristics about the subpopulation. The surveys are intended to provide a snapshot in time and allow staff to track occurrence size, general habitat characteristics, demographic information, and threats to each subpopulation. The following characteristics are recorded for each occurrence during the surveys:

- Species
- Dimensions of the subpopulation
- Number of individuals
- Life stage
- Plant distribution within the area
- Soil conditions
- Associated species
- Threats to the subpopulation

Rare plant communities are mapped on OSMP as part of the Vegetation Mapping project following the standards and methodology detailed in the

International Vegetation Classification system (Grossman et al. 1998). All plant communities on OSMP are mapped to a minimum mapping unit of a tenth (to a quarter) of an acre at the alliance or finer-scale association level within the classification hierarchy. Rare vegetation types are those associations that have been evaluated and subsequently ranked by CNHP as S1 to S3, indicating they are critically imperiled to vulnerable. Within the forested areas of OSMP, rare vegetation associations may not be identified because OSMP mapping is done to the alliance level, which focuses solely on the dominant or diagnostic tree species in the uppermost stratum. Additional diagnostic species in the understory strata necessary for association level classification weren't always detailed in the mapping effort. Therefore, while many of the associations listed in the forest nested target list could be expected on the OSMP system, only the rare vegetation associations in table14 have been officially mapped on the system.

Map 3 displays the rare plant and vegetation types currently mapped in the TSA. For this report, the discrete rare plant locations have been generalized to protect the resources. Individual plant points have been displayed as the polygons of the surrounding vegetation. More precise location data exists for each of the known occurrences and will be used for finer scale planning.

Table 16: Rare plant species currently inventoried in the West TSA

Common Name	Scientific Name	Ranking	Populations**	Subpopulations**	Target
Wright's cliffbrake	*Pellaea wrightiana*	**S2/G5**	**1**	**1**	Cliffs & talus
Grassfern	*Asplenium septentrionale*	**S3S4/G4G5**	**2**	**2**	Cliffs & talus
Weatherby's spikemoss	*Selaginella weatherbiana*	**S3S4/G3G4**	**1**	**1**	Cliffs & talus
Western polypody	*Polypodium saximontanum*	**S3/G3**	**1**	**3**	Cliffs & talus
			5	**7**	
Alaskan orchid	*Piperia unalascensis*	**OSMP**	**1**	**2**	Mixed conifer
Malefern	*Dryopteris filix-mas*	**OSMP**	**1**	**1**	Mixed conifer
Wood lilly	*Lilium philadelphicum*	**S3S4/G5**	**2**	**5**	Mixed conifer
Fairy slipper	*Calypso bulbosa*	**OSMP**	**2**	**3**	Mixed conifer
Pictureleaf wintergreen	*Pyrola picta*	**S3S4/G4G5**	**2**	**10**	Mixed conifer
Spring coralroot	*Corallorhiza wisteriana*	**OSMP**	**1**	**5**	Mixed conifer
			9	**26**	
Birds-foot violet*	*Viola pedatifida*	**S2/G5**	**2**	**20**	Forest openings
Dwarf leadplant*	*Amorpha nana*	**S2S3/G5**	**1**	**22**	Forest openings
Frostweed*	*Crocanthemum bicknellii*	**S2/G5**	**2**	**3**	Forest openings
			5	**45**	
Rocky Mountain sedge	*Carex saximontana*	**S1/G5**	**6**	**9**	Ponderosa pine
Narrow-leaved Milkweed*	*Asclepias stenophylla*	**S2/G4G5**	**5**	**27**	Ponderosa pine
Wavy-leaf stickleaf*	*Nuttallia sinuata*	**S2/G3**	**1**	**5**	Ponderosa pine
			12	**41**	
Sprengel's sedge	*Carex sprengelii*	**S2S3/G5**	**1**	**1**	Riparian
White adders-mouth orchid	*Malaxis monophyllos* ssp. *brachypoda*	**S1/G4**	**1**	**2**	Riparian
Broadlipped twayblade	*Listera convallarioides*	**S2/G5**	**2**	**19**	Riparian
Paper birch	*Betula papyrifera*	**S1/G5**	**1**	**1**	Riparian
Rattlesnake fern	*Botrypus virginianus* ssp. *europaeus*	**S1/G5**	**1**	**1**	Riparian
Wild sarsaparilla	*Aralia nudicaulis*	**OSMP**	**1**	**2**	Riparian
Torrey's sedge	*Carex torreyi*	**S1/G4**	**2**	**2**	Riparian
Snakeroot	*Sanicula marilandica*	**OSMP**	**3**	**3**	Riparian
Carrionflower	*Smilax lasioneuron*	**S3S4/G5**	**5**	**10**	Riparian
Wild hops	*Humulus lupulus* ssp. *americanus*	**OSMP**	**3**	**4**	Riparian
			20	**45**	

***These species primarily occur in the forest/grassland ecotone and could be considered prairie species. To account for occurrences that occur in the forest as well as in the grasslands all subpopulations in the TSA boundary have been grouped into the above targets.**

Ranking Descriptions

The Colorado Natural Heritage Program designates conservation status with a number from 1 to 5, preceded by a letter that reflects the scale of the assessment (**G= global, S= subnational**)

1= critically imperiled

2= imperiled

3= vulnerable to extirpation or extinction

4= apparently secure

5= demonstrably widespread, abundant and secure

OSMP= identified by staff or local experts as sensitive, threatened or declining at a local level or important to the overall integrity of the system (many of these species have yet to be evaluated by CNHP)

**Populations and subpopulations are grouped based on guidelines developed by NatureServe (2004). Populations are all occurrences of a species within a distance of 2 km from each other when suitable habitat is present. Subpopulations are species occurrences within a distance of 50 m

Table 17: Rare vegetation associations currently inventoried in the West TSA

Common Name	Scientific Name	Rank	Acres in the TSA	Target
Douglas-fir / Rocky Mountain Maple Forest	*Pseudotsuga menziesii / Acer glabrum Forest*	**S1/G4?**	**34.2**	Mixed conifer
Quaking Aspen / Beaked Hazelnut Forest	*Populus tremuloides / Corylus cornuta Forest*	**S1/G3**	**0.3**	Mixed conifer
			34.5	
Ponderosa Pine / Sun Sedge Woodland	*Pinus ponderosa / Carex inops ssp. heliophila Woodland*	**S2/G3G4**	**2.1**	Ponderosa Pine
			2.1	
Choke Cherry - (American Plum) Shrubland	*Prunus virginiana - (Prunus americana) Shrubland*	**S3/G4**	**11.0**	Riparian
Douglas-fir / Water Birch Woodland	*Pseudotsuga menziesii / Betula occidentalis Woodland*	**S3/G3?**	**13.9**	Riparian
Eastern Cottonwood - (Peachleaf Willow) / (Coyote Willow, Sandbar Willow) Woodland	*Populus deltoides - (Salix amygdaloides) / Salix (exigua, interior) Woodland*	**S3/G3G4**	**0.8**	Riparian
Ill-scented Sumac Intermittently Flooded Shrubland	*Rhus trilobata Intermittently Flooded Shrubland*	**S2/G2**	**10.1**	Riparian
Narrowleaf Cottonwood / Water Birch Woodland	*Populus angustifolia / Betula occidentalis Woodland*	**S3/G3**	**9.3**	Riparian
Quaking Aspen / Beaked Hazelnut Forest	*Populus tremuloides / Corylus cornuta Forest*	**S1/G3**	**46.5**	Riparian
Quaking Aspen / Rocky Mountain Maple Forest	*Populus tremuloides / Acer glabrum Forest*	**S2/G1G2**	**0.6**	Riparian
Quaking Aspen / Water Birch Forest	*Populus tremuloides / Betula occidentalis Forest*	**S2/G3**	**2.8**	Riparian
Western Snowberry Shrubland	*Symphoricarpos occidentalis Shrubland*	**S3/G4G5**	**7.5**	Riparian
			102.6	
Big Bluestem - Prairie Dropseed Western Foothills Herbaceous Vegetation	*Andropogon gerardii - Sporobolus heterolepis Western Foothills Herbaceous Vegetation*	**S1S2/G2**	**133.6**	Forest openings
Big Bluestem - Yellow Indiangrass Western Great Plains Herbaceous Vegetation	*Andropogon gerardii - Sorghastrum nutans Western Great Plains Herbaceous Vegetation*	**S1S2/G2**	**1.5**	Forest openings
Choke Cherry - (American Plum) Shrubland	*Prunus virginiana - (Prunus americana) Shrubland*	**S3/G4Q**	**13.3**	Forest openings
Ill-scented Sumac Intermittently Flooded Shrubland	*Rhus trilobata Intermittently Flooded Shrubland*	**S2/G2**	**3.4**	Forest openings
Mountain Muhly - Needle-and-Thread Herbaceous Vegetation	*Muhlenbergia montana - Hesperostipa comata Herbaceous Vegetation*	**S1S2/G1G2**	**7.4**	Forest openings
Mountain Muhly Herbaceous Vegetation	*Muhlenbergia montana Herbaceous Vegetation*	**S2? /G3G4**	**2.9**	Forest openings
Mountain-mahogany / Needle-and-Thread Shrubland	*Cercocarpus montanus / Hesperostipa comata Shrubland*	**S2/G2**	**1.3**	Forest openings
Parry's Oatgrass Herbaceous Vegetation	*Danthonia parryi Herbaceous Vegetation*	**S3/G3**	**2.7**	Forest openings
Quaking Aspen / Northern Bracken Forest	*Populus tremuloides / Pteridium aquilinum Forest*	**S3S4/G4**	**0.4**	Forest openings
Western Snowberry Shrubland	*Symphoricarpos occidentalis Shrubland*	**S3/G4G5**	**16.4**	Forest openings
			182.9	
Big Bluestem - Yellow Indiangrass Western Great Plains Herbaceous Vegetation	*Andropogon gerardii - Sorghastrum nutans Western Great Plains Herbaceous Vegetation*	S1S2/G2	**68.1**	Mesic bluestem
			68.1	
Western Wheatgrass - Green Needlegrass Herbaceous Vegetation	*Pascopyrum smithii - Nassella viridula Herbaceous Vegetation*	S2/G3G4	**15.2**	Mixed Grass
Choke Cherry - (American Plum) Shrubland	*Prunus virginiana - (Prunus americana) Shrubland*	S3/G4Q	**1.3**	Mixed Grass
			16.5	

Western Snowberry Shrubland	*Symphoricarpos occidentalis Shrubland*	S3/G4G5	**5.7**	Plains riparian
Ill-scented Sumac Intermittently Flooded Shrubland	*Rhus trilobata Intermittently Flooded Shrubland*	S2/G2	**52.7**	Plains riparian
Choke Cherry - (American Plum) Shrubland	*Prunus virginiana - (Prunus americana) Shrubland*	S3/G4Q	**5.4**	Plains riparian
Eastern Cottonwood - (Peachleaf Willow) / (Coyote Willow, Sandbar Willow) Woodland	*Populus deltoides - (Salix amygdaloides) / Salix (exigua, interior) Woodland*	S3/G3G4	**2.9**	Plains riparian
			66.7	
Emory Sedge Herbaceous Vegetation	*Carex emoryi Herbaceous Vegetation*	S2/G2?	**0.6**	Wetlands
Prairie Cordgrass Herbaceous Vegetation	*Spartina pectinata Western Herbaceous Vegetation*	S3/G3?	**7.0**	Wetlands
Nebraska Sedge Herbaceous Vegetation	*Carex nebrascensis Herbaceous Vegetation*	S3/G4	**4.7**	Wetlands
Western Snowberry Shrubland	*Symphoricarpos occidentalis Shrubland*	S3/G4G5	**2.8**	Wetlands
Clustered Field Sedge Herbaceous Vegetation	*Carex praegracilis Herbaceous Vegetation*	S2/G3G4	**2.3**	Wetlands
			17.4	
Big Bluestem - Little Bluestem Western Great Plains Herbaceous Vegetation	*Andropogon gerardii - Schizachyrium scoparium Western Great Plains Herbaceous Vegetation*	S2/G2?	**14.9**	Xeric tallgrass
Big Bluestem - Yellow Indiangrass Western Great Plains Herbaceous Vegetation	*Andropogon gerardii - Sorghastrum nutans Western Great Plains Herbaceous Vegetation*	S1S2/G2	**164.6**	Xeric tallgrass
Big Bluestem - Prairie Dropseed Western Foothills Herbaceous Vegetation	*Andropogon gerardii - Sporobolus heterolepis Western Foothills Herbaceous Vegetation*	S1S2/G2	**357.0**	Xeric tallgrass
			536.5	

***Ranking Descriptions**

The Colorado Natural Heritage Program designates conservation status with a number from 1 to 5, preceded by a letter that reflects the scale of the assessment (**G= global, S= subnational**)

1= critically imperiled
2= imperiled
3= vulnerable to extirpation or extinction
4= apparently secure
5= demostrably widespread, abundant and secure
an S or G rank followed by a "?" denotes a questionable rank because sufficient information doesn't exist

Appendix C: Priority Weed Species

Non-native Vegetation Mapping

Non-native species pose a significant threat to many natural systems in the West Trail Study Area. Weedy species can out-compete or replace native species, decrease overall native biodiversity, degrade wildlife habitat, change natural fire regimes, and decrease the overall aesthetic value of an area. The management of non-native species on OSMP lands is a key focus of the department and integrated pest management considerations factor into almost all management decisions (Table 15). A key to effective weed management is having accurate and consistent mapping of weed occurrences across the system. The "Coverage of Weeds" map in this appendix is a visual representation of weed densities in mapped areas of the West TSA.

Top: Canada thistle (*Breea arvensis*)

Middle: Jointed goatgrass (*Cylindropyrum cylindricum*)

Bottom: Myrtle spurge (*Tithymalus myrsinites*)

In 2006 staff began mapping weeds across the OSMP system using methods developed by Utah State University and referred to as Rapid Assessment Mapping or RAM. The primary objective of this project is to document the distribution and abundance of targeted invasive non-native plant species across the range of native habitats and areas of management within Boulder OSMP lands. The information from this inventory will be useful in the City's ongoing efforts to improve strategic planning and to increase the effectiveness of field operations associated with invasive plant management and conservation efforts.

Weed mapping in 2008 focused on large portions of the West Trail Study Area in anticipation of the TSA planning process. The 2008 RAM inventory was conducted between June and August. Staffing and timing restrictions limited the amount of mapping that was possible so staff focused efforts on low elevation forest stands along the forest/ grassland edge, and in areas with existing high recreation use and along existing designated and undesignated trails west of the Mesa Trail. The lower grasslands in the TSA, south of Shanahan Ridge, were mapped in 2006 in advance of planning efforts for the Grassland Management Plan. Additional portions of the forested areas of OSMP will be mapped during the 2009 field season. Much of this work will focus on the denser, mixed conifer forests that have yet to be inventoried.

Field searches were conducted at the finest scale required to be confident that 90 percent or more of all targeted invasive plant infestations 0.01 acre or larger within the inventory area were detected. Mapping consisted of walking transects from one side of a property to the other covering the entire unit. Transect swaths varied in width based on topography, vegetation cover, and target species. Widths ranged from less than 25 meters in denser riparian areas to 100 meters in open grasslands. All designated trails and some undesignated trails west of the Mesa Trail were surveyed for 50 meters on each side to get a quick assessment of weed occurrences along existing trails. Geo XT GPS units were used to navigate along inventory transects and to collect data related to each weed occurrence using a RAM specific data dictionary. For each weed patch the staff member recorded the species name, size of the infestation, and a percent cover in five categories ranging from a trace (less

than one percent) to a majority (51%-100%). Scattered patches separated by less than 50 meters were considered one distinct patch.

Map 2 displays a weighted density of all the RAM weed inventory data currently completed on the OSMP system. To account for the size of the infestation and the percent cover an importance value, or weight, was assigned to each mapped weed occurrence. The importance value was calculated as acreage multiplied by percent cover and then multiplied by a constant value to assure all cells had an integer value. The density analysis was performed using a 500 foot search radius to obtain the value of each cell in the map. The spectrum of low to high weed densities on the map represents areas with increasingly higher non-native cover and larger infestation sizes. The density could be attributed to one individual species or a combination of multiple species occurrences. It's important to note that this map displays all the RAM data collected to date. Large portions of the WTSA are still to be mapped and will be a focus in the upcoming field season. Current indicator conditions are based on the best available data and may change as additional mapping is completed.

Table 17: OSMP priority non-native species list

SPECIES			Associated Habitats										
			FOOTHILLS						PLAINS				
Designation	Common Name	Scientific Name	Forest / Woodland	Shrubland	Grassland	Riparian / Wetland / Aquatic	Forest / Grassland Interface	Grassland/ Forest Edge	Shrubland	Native Grassland	Non-Native Grassland	Restoration Areas	Riparian / Wetland / Aquatic
OSMP	Absinth wormwood	*Artemisia absinthium*	M										
OSMP	Bladder senna	*Colutea arborescens*	M	M	M		M						
B	Bouncing bet	*Saponaria officinalis*	L		L	M	M					L	L
B / OSMP	Buckthorn	*Rhamnus cathartica*	L	H		H	M						
B	Canada thistle	*Breea arvensis*	L	M	M	M	L			M	H	H	H
C	Cheat grass	*Anisantha tectorum*	M	L	H	L	L		L	M	M	M	H
B	Common tansy	*Tanacetum vulgare*											M
B	Common teasel	*Dipsacus fullonum*				M	L					H	H
OSMP	Crown vetch	*Securigera varia*			L		M						M
B / OSMP	Cut-leaf teasel	*Dipsacus laciniatus*					L						H
B	Dalmatian toadflax	*Linaria genistifolia*	L	L	M		H			H	L		L
B	Dame's rocket	*Hesperis matronalis*				H							M
B	Diffuse knapweed	*Acosta diffusa*	M	L	M	L	M		M	H	H	H	L
B	Eurasian watermilfoil	*Myriophyllum spicatum*											H
	Garlic Mustard	*Alliaria petiolata*				M							M
B	Hoary cress	*Cardaria draba*								L	H	M	M
B	Houndstongue	*Cynoglossum officinale*	L	L	L	M	L			L	L	L	L
	Japanese knotweed	*Reynoutria japonica*									M		H
C	Jointed goatgrass	*Cylindropyrum cylindricum*	H		H		H			H		H	
B	Leafy spurge	*Tithymalus uralensis*	H		H		H						
A	Mediterranean sage	*Salvia aethiopis*					**H**			**H**		**H**	
B	Musk thistle	*Carduus nutans*	L	L	L	L	L			L	M	L	L
A	Myrtle spurge	*Tithymalus myrsinites*	**H**	**H**	**H**		**H**			**H**			**H**
A	Orange hawkweed	*Hieracium aurantiacum*	**H**										
B	Oxeye daisy	*Leucanthemum vulgare*									H		H

B	Perennial pepperweed	*Cardaria latifolia*					L				L	M	M
OSMP	Perennial sweetpea	*Lathyrus latifolius*		M	H	M	M						L
A	Purple loosestrife	*Lythrum salicaria*				**H**							**H**
OSMP	Queen of the Meadow	*Filipendula ulmaria*											H
B	Russian knapweed	*Acroptilon repens*					L				H	H	
B	Russian olive	*Elaeagnus angustifolia*				H	L			H	L	L	H
B	Scotch thistle	*Onopordum acanthium*					M			M	M	H	M
OSMP	Smooth brome	*Bromopsis inermis*	M	M	H	H	H			L		M	H
B+	Spotted knapweed	*Acosta maculosa*	**H**								**H**		
B	Sulfur cinquefoil	*Potentilla recta*	M	L	H	M	H			H		H	M
OSMP	Tall oatgrass	*Arrhenatherum elatius*			H		H						
B+	Tamarisk	*Tamarix ramosissima*									**H**	**H**	**H**
OSMP	White campion	*Melandrium dioicum*			L		L						H
B	Yellow toadflax	*Linaria vulgaris*	M		M	H	M			M	H		M

H	= **HIGH** priority as designated by State of CO as List A or B+
H	= **HIGH** priority per OSMP
M	= **MODERATE** priority per OSMP
L	= **LOW** priority per OSMP

= ignore; species not known or expected in this habitat

= Watch out; may be on the way and we should be looking for it in these habitats

State Noxious Weed Designations

List A Species- Designated by the CO Department of Agriculture for eradication

List B Species- are species for which the Department of Ag, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, develops and implements state noxious weed management plans designed to stop the continued spread of these species. Species designated as "B+" are targeted for eradication on OSMP lands.

List C Species- are species for which the Department of Ag, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, will develop and implement state noxious weed management plans designed to support the efforts of local governing bodies to facilitate more effective integrated weed management on private and public lands. The goal of such plans will not be to stop the continued spread of these species but to provide additional education, research, and biological control resources to jurisdictions that choose to require management of List C species.

Map 1 West TSA - Natural Resource Targets

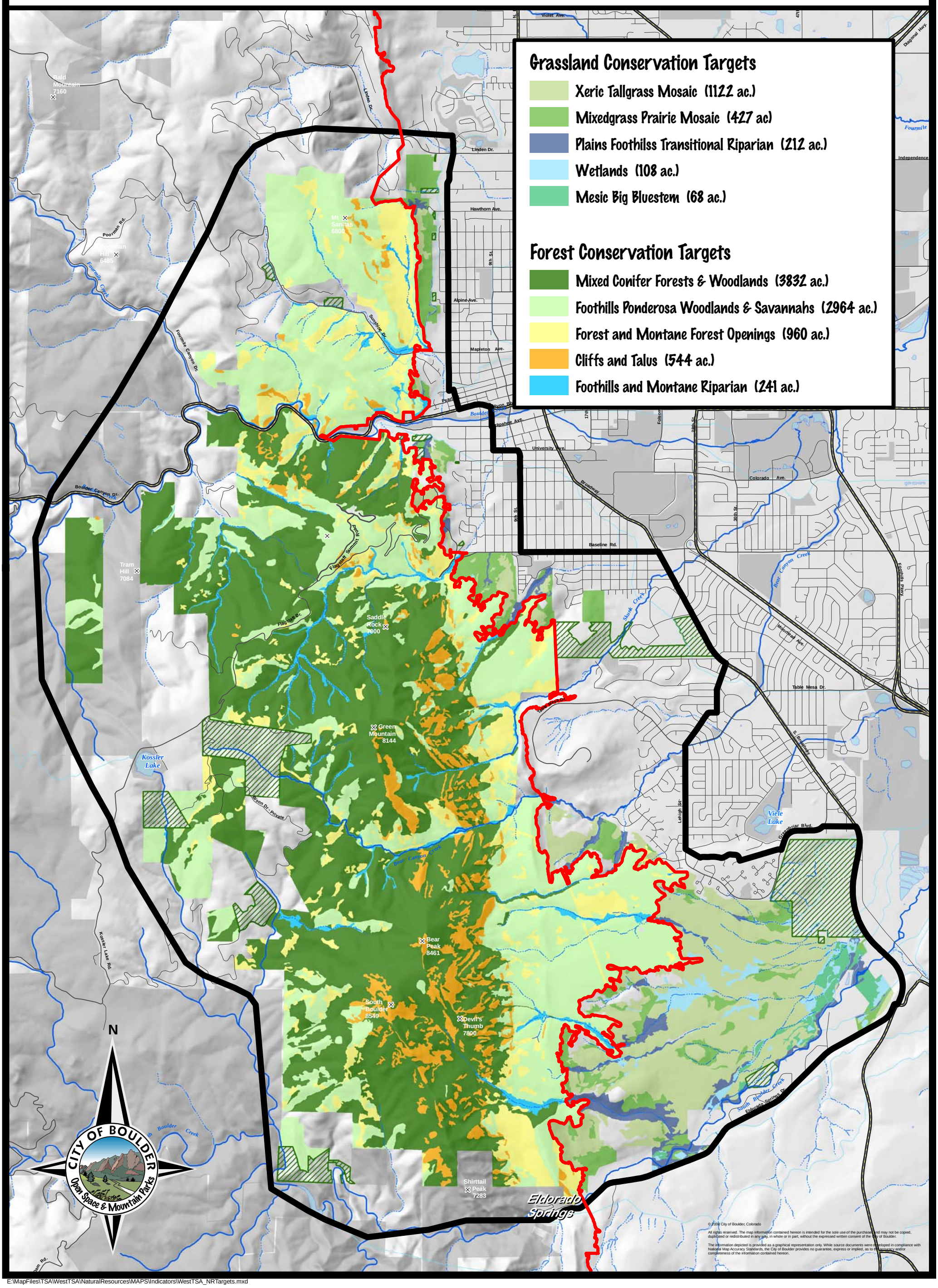
West TSA Boundary

Forest/Grassland Edge

OSMP Conservation Easement

0 0.5 1
Miles

revised 7/20/2009



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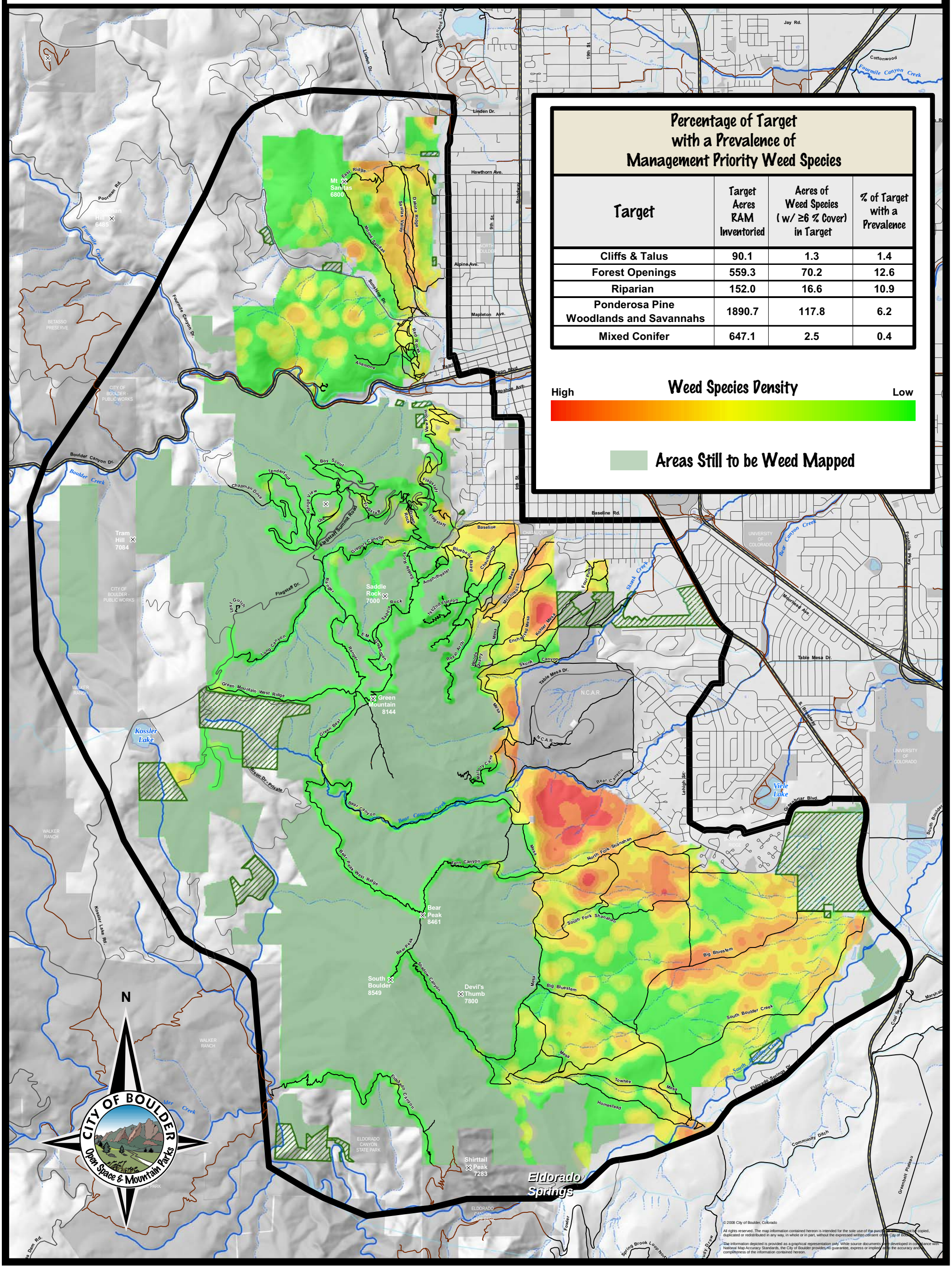
Map 2 West TSA - Coverage of Weeds

West TSA Boundary
Other Government Land
OSMP Conservation Easement
Trail Managed By OSMP
Trail Not Managed By OSMP

0 0.5 1
Miles

revised: 4/21/2009



Percentage of Target with a Prevalence of Management Priority Weed Species

Target	Target Acres RAM Inventoried	Acres of Weed Species (w/ ≥6 % Cover) in Target	% of Target with a Prevalence
Cliffs & Talus	90.1	1.3	1.4
Forest Openings	559.3	70.2	12.6
Riparian	152.0	16.6	10.9
Ponderosa Pine Woodlands and Savannahs	1890.7	117.8	6.2
Mixed Conifer	647.1	2.5	0.4

Weed Species Density

High — Low

Areas Still to be Weed Mapped

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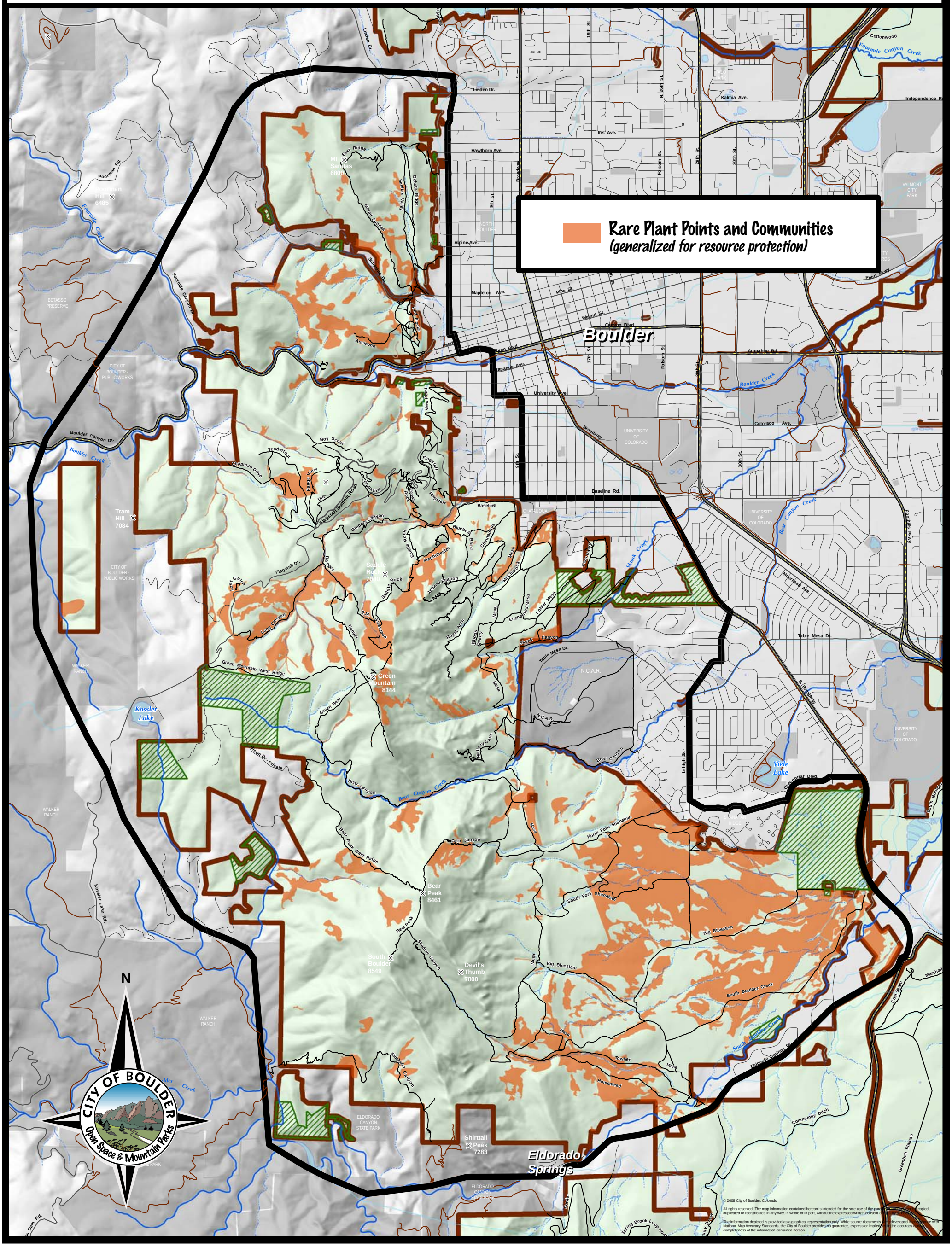
Map 3 West TSA - Rare Plants and Communities

West TSA Boundary
Other Government Land
OSMP Conservation Easement
OSMP Land
Trail Managed By OSMP
Trail Not Managed By OSMP

revised: 4/30/2009

0 0.5 1
Miles



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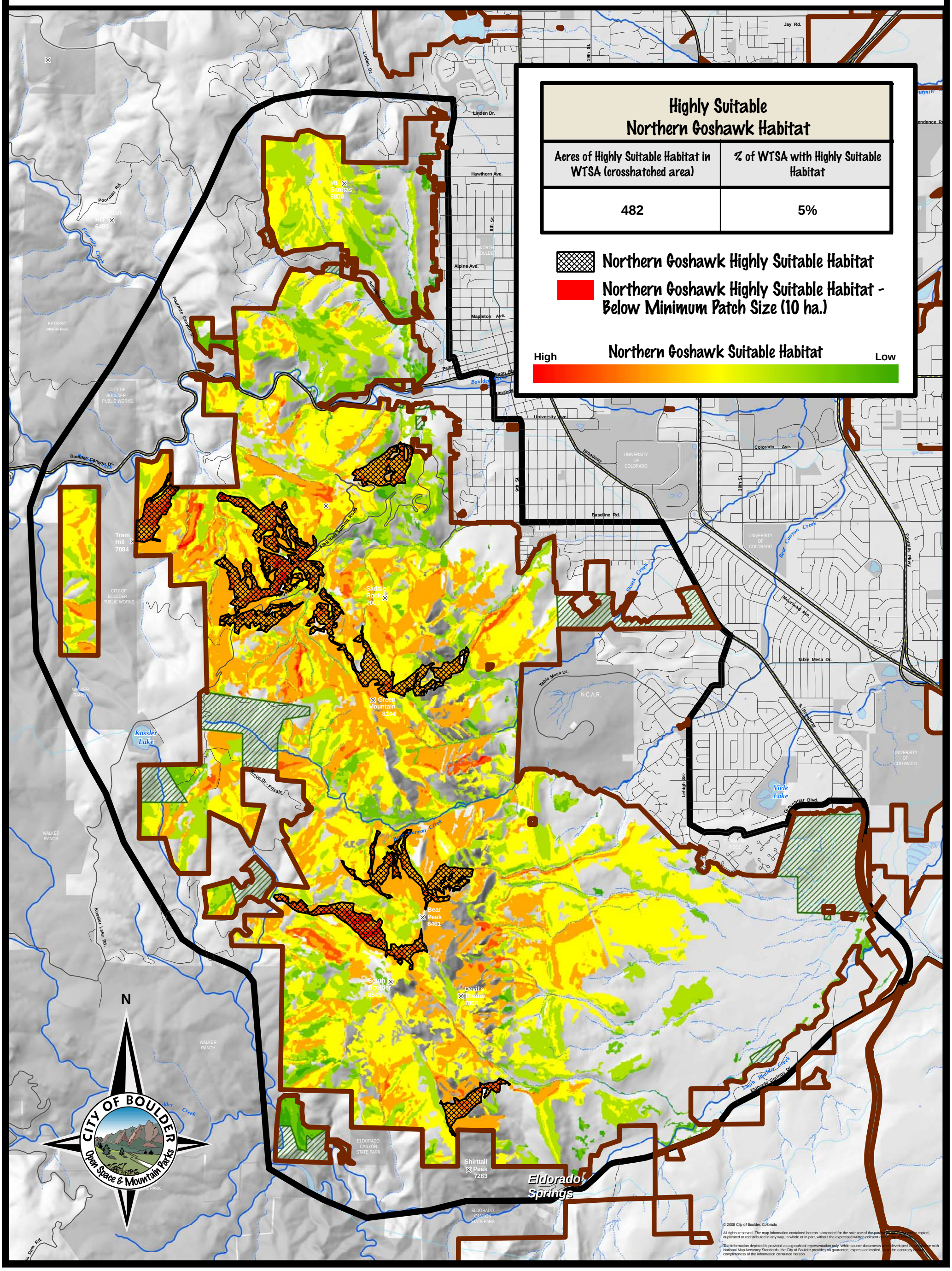
Map 4 West TSA - Northern Goshawk Potential Habitat

West TSA Boundary | Other Government Land | OSMP Land | OSMP Conservation Easement

revised: 7/20/2009

0 0.5 1
Miles



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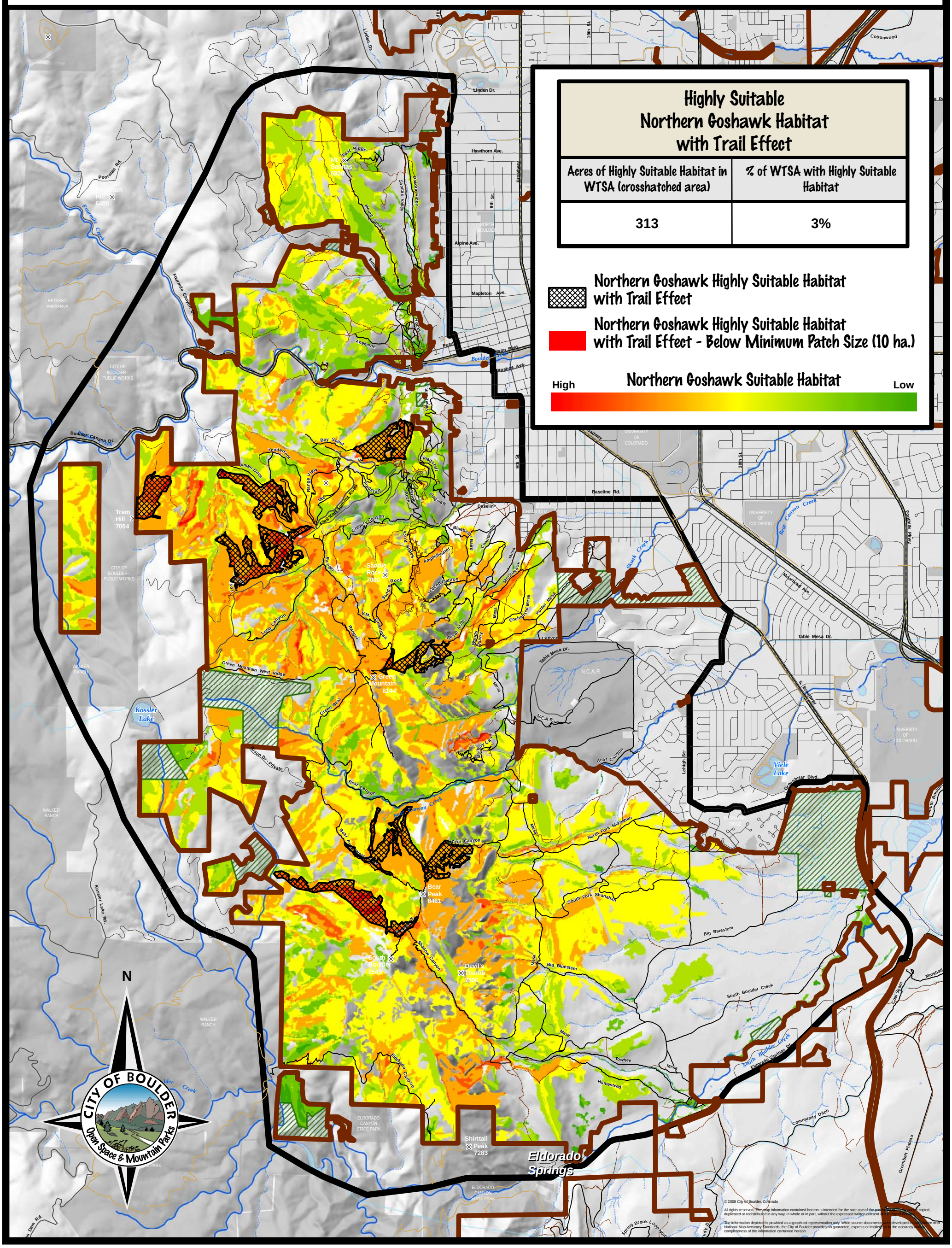
Map 5 West TSA - Northern Goshawk Potential Habitat with Trail Effect

West TSA Boundary
Other Government Land
OSMP Land
OSMP Conservation Easement
Trail Managed By OSMP
Undesignated Trails
Trail Not Managed By OSMP

0 0.5 1
Miles

revised: 7/20/2009



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Map 6 West TSA - Abert's Squirrel Potential Habitat

West TSA Boundary

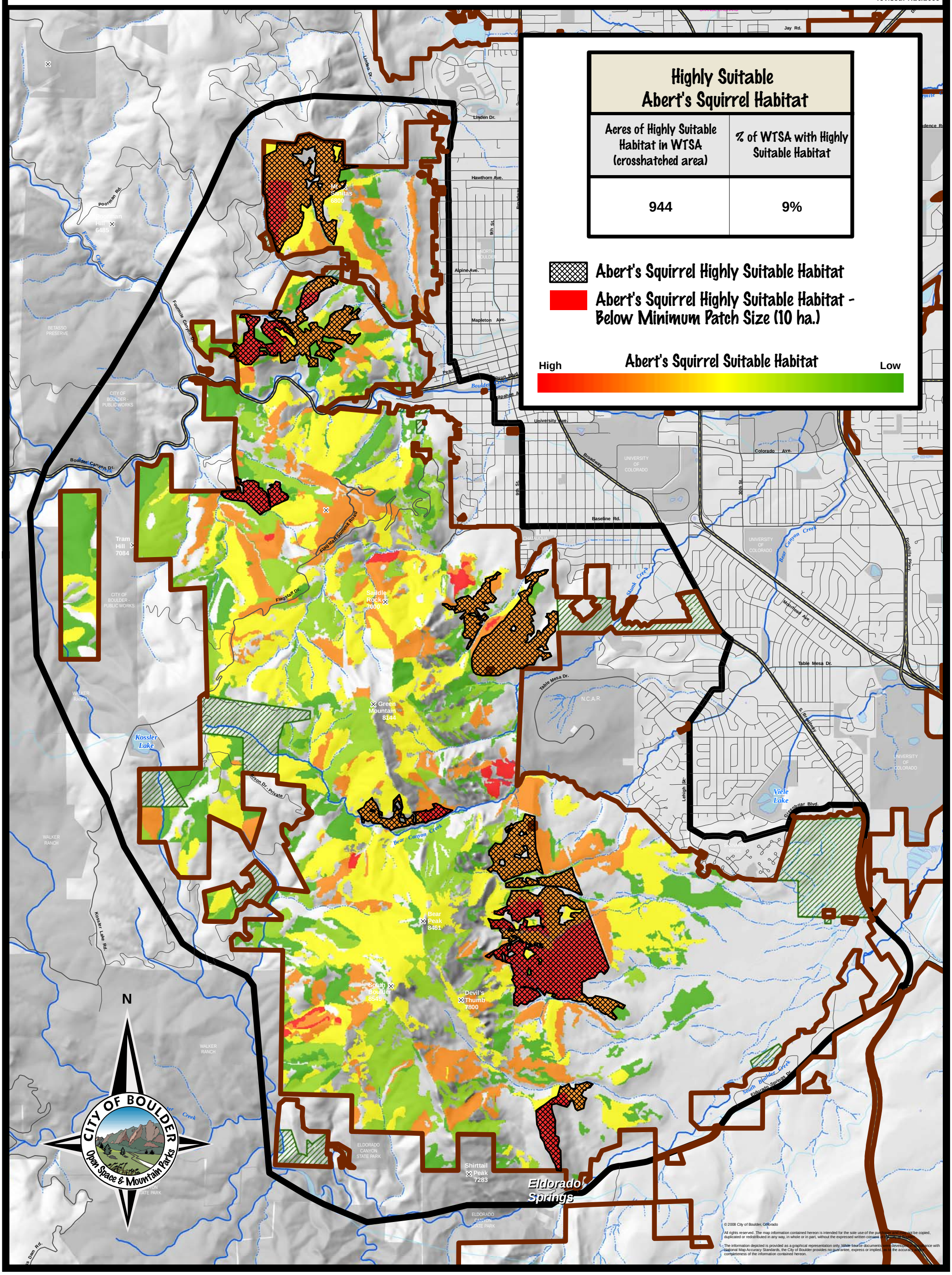
Other Government Land

OSMP Land

OSMP Conservation Easement

0 0.5 1
Miles

revised: 7/20/2009



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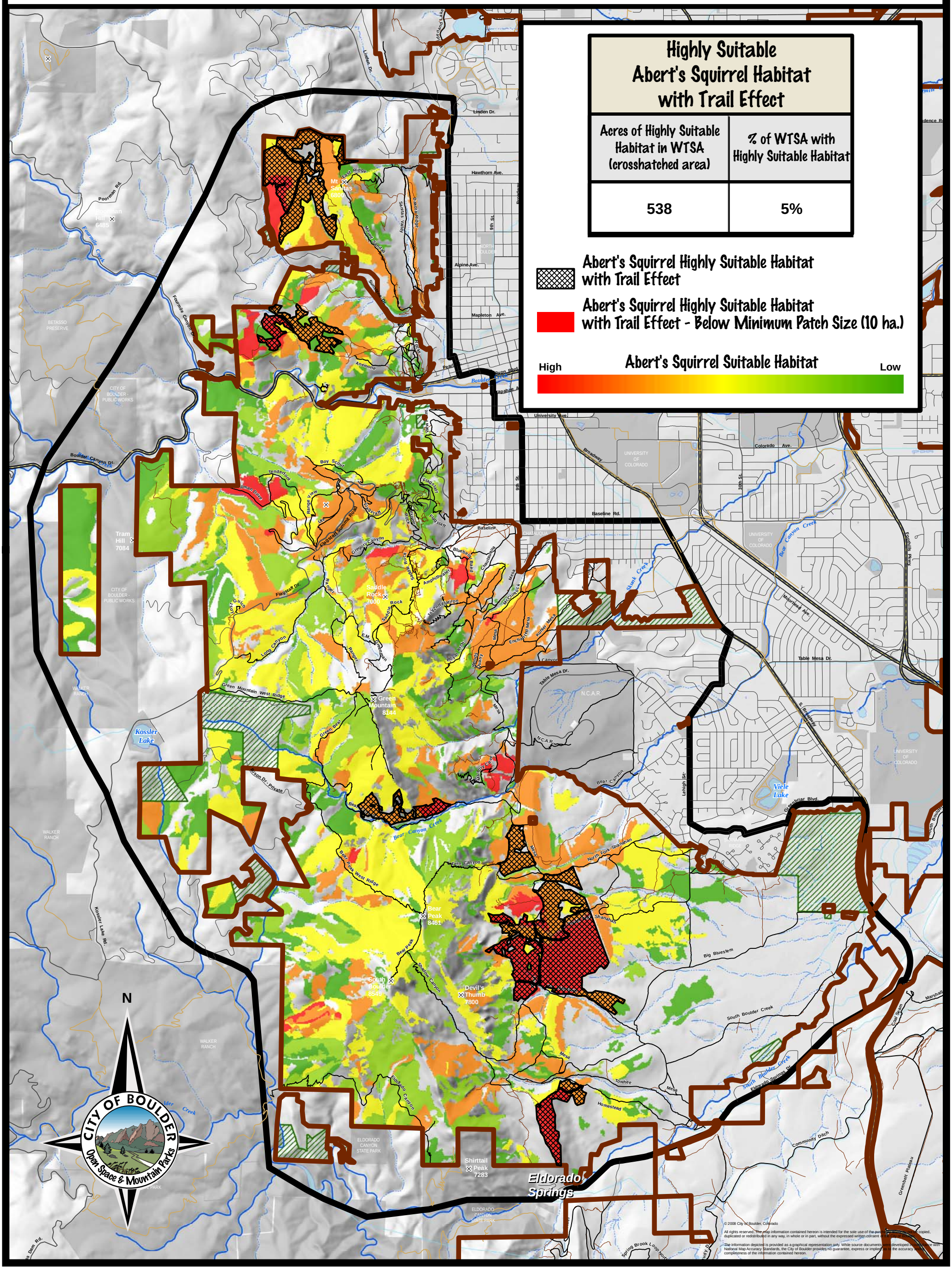
Map 7 West TSA - Abert's Squirrel Habitat with Trail Effect

West TSA Boundary
Other Government Land
OSMP Land
OSMP Conservation Easement
Trail Managed By OSMP
Undesignated Trails
Trail Not Managed By OSMP

0 0.5 1
Miles

revised:7/20/2009



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Map 8 West TSA - Protection of Cliff Nesting Raptor Sites

West TSA Boundary

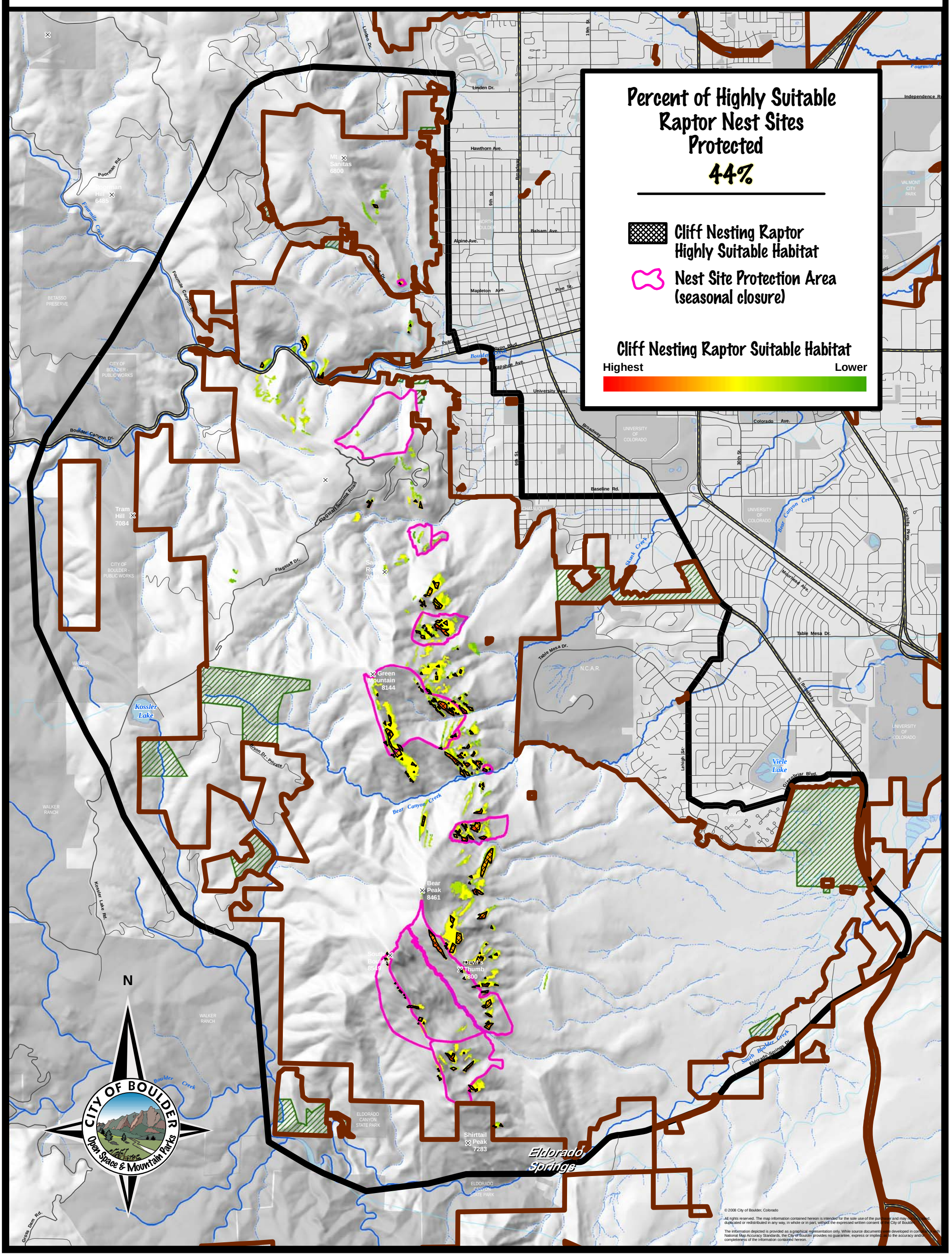
Other Government Land

OSMP Land

OSMP Conservation Easement

0 0.5 1
Miles

revised: 4/30/2009



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Map 9 West TSA - Shrub-Nesting Bird Potential Habitat

West TSA Boundary | Other Government Land | OSMP Land | OSMP Conservation Easement

0 0.5 1
Miles

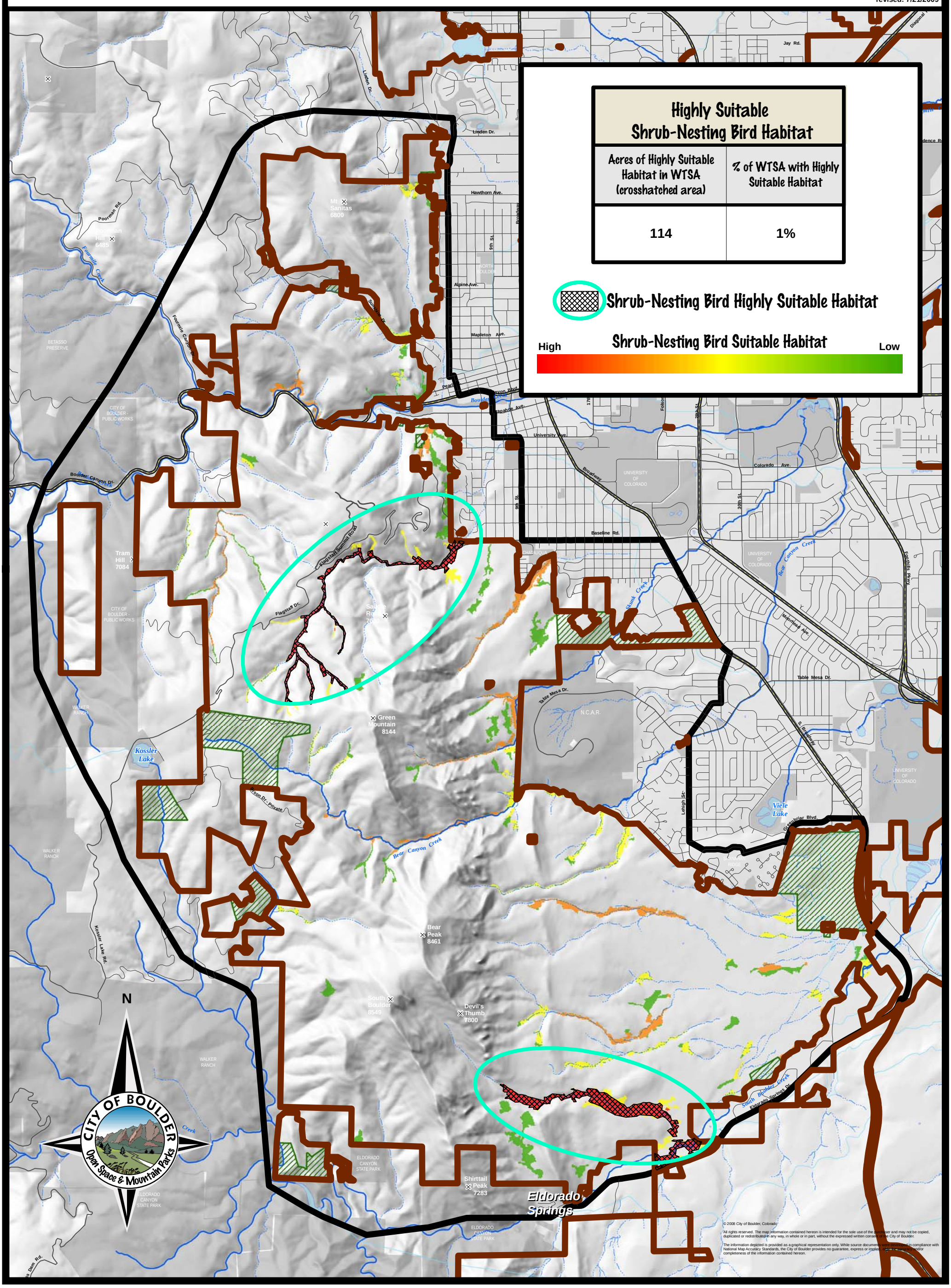
revised: 7/21/2009

Highly Suitable Shrub-Nesting Bird Habitat	
Acres of Highly Suitable Habitat in WTSA (crosshatched area)	% of WTSA with Highly Suitable Habitat
114	1%

Shrub-Nesting Bird Highly Suitable Habitat

Shrub-Nesting Bird Suitable Habitat

High — Low



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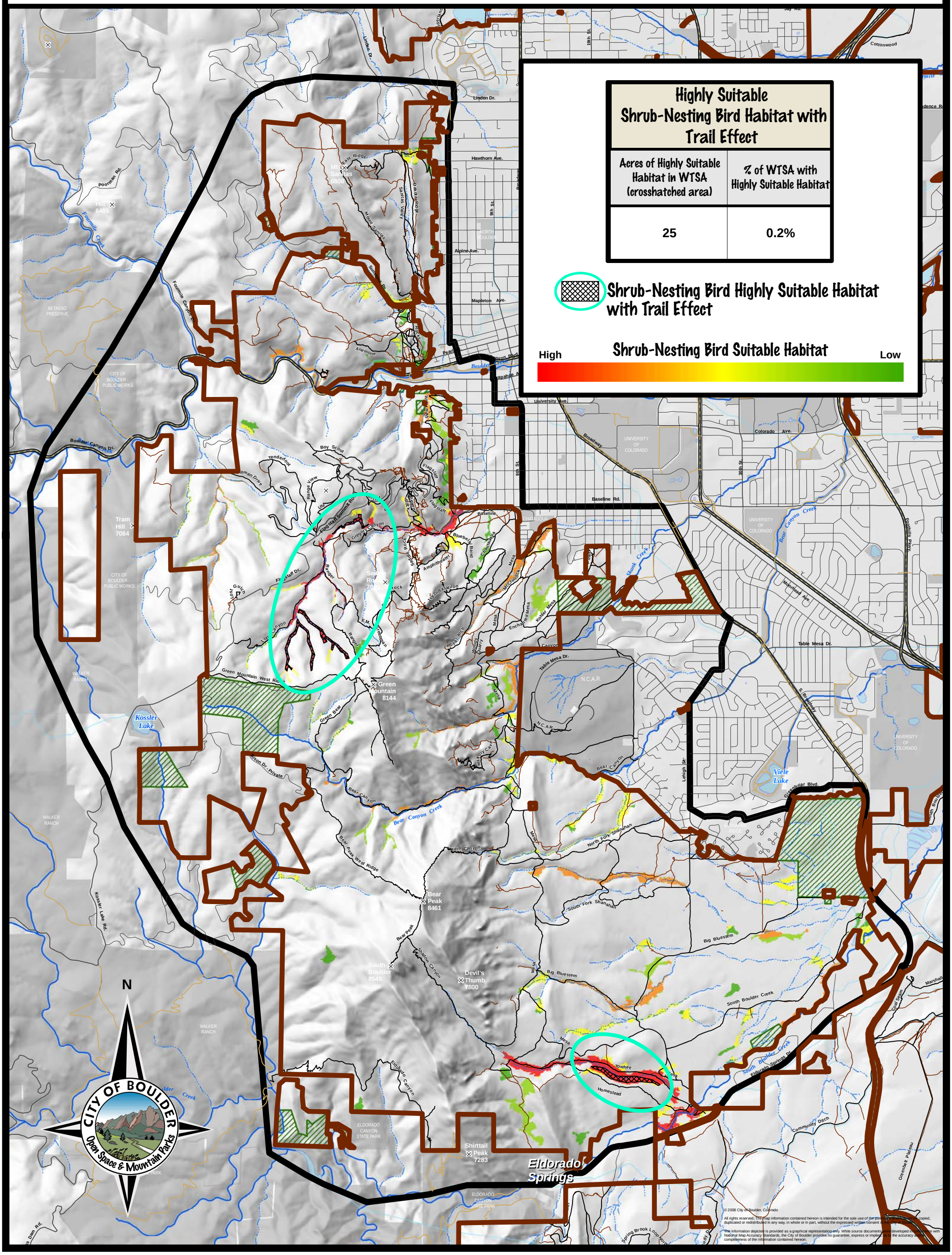
Map 10 West TSA - Shrub-Nesting Bird Habitat with Trail Effect

West TSA Boundary
Other Government Land
OSMP Land
OSMP Conservation Easement
Trail Managed By OSMP
Undesignated Trails
Trail Not Managed By OSMP

0 0.5 1
Miles

revised: 7/21/2009



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Map 11 West TSA - Bear Habitat Quality

West TSA Boundary

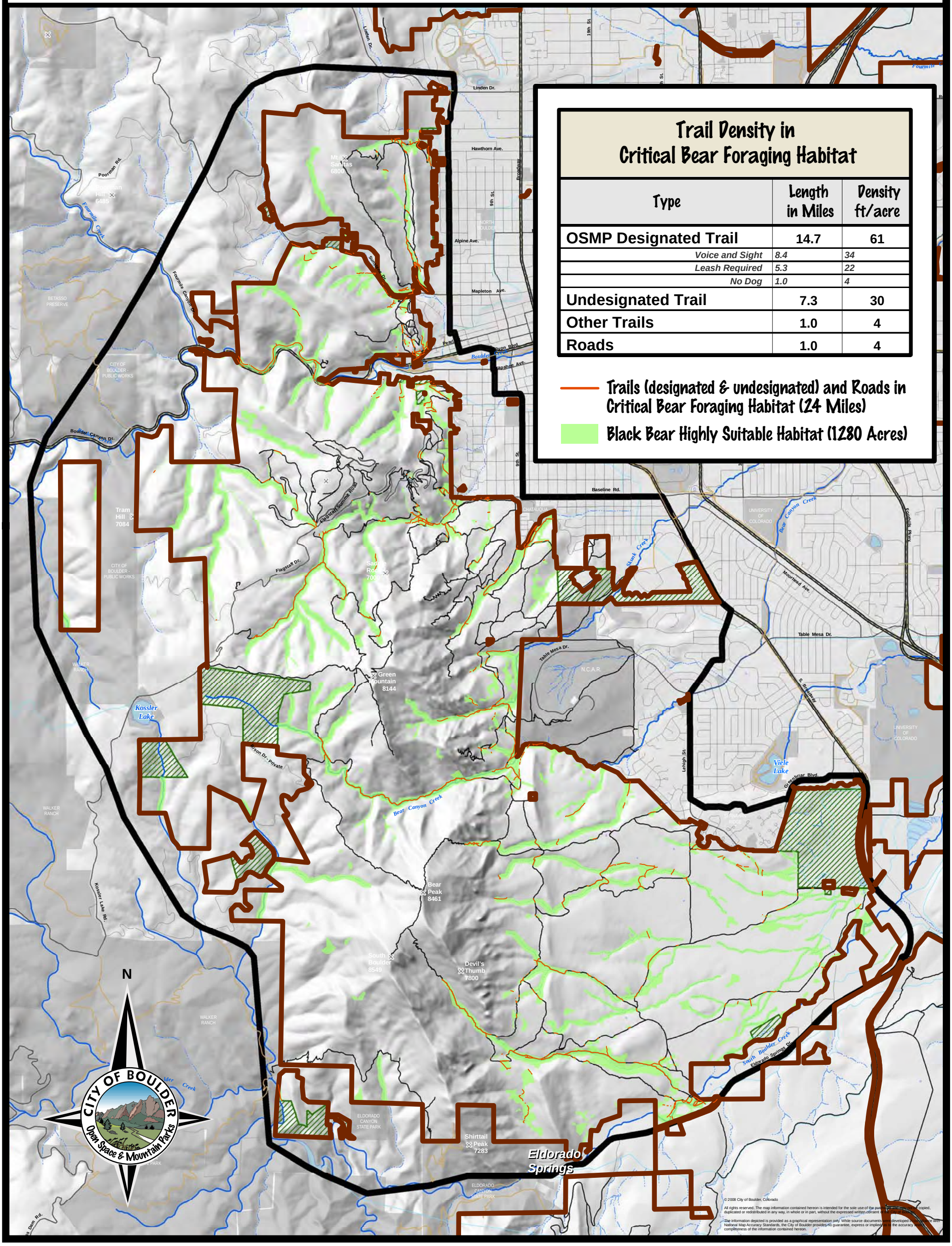
Other Government Land

OSMP Land

OSMP Conservation Easement

0 0.5 1
Miles

revised: 7/17/2009



Trail Density in Critical Bear Foraging Habitat

Type	Length in Miles	Density ft/acre
OSMP Designated Trail	**14.7**	**61**
Voice and Sight	*8.4*	*34*
Leash Required	*5.3*	*22*
No Dog	*1.0*	*4*
Undesignated Trail	**7.3**	**30**
Other Trails	**1.0**	**4**
Roads	**1.0**	**4**

Trails (designated & undesignated) and Roads in Critical Bear Foraging Habitat (24 Miles)

Black Bear Highly Suitable Habitat (1280 Acres)

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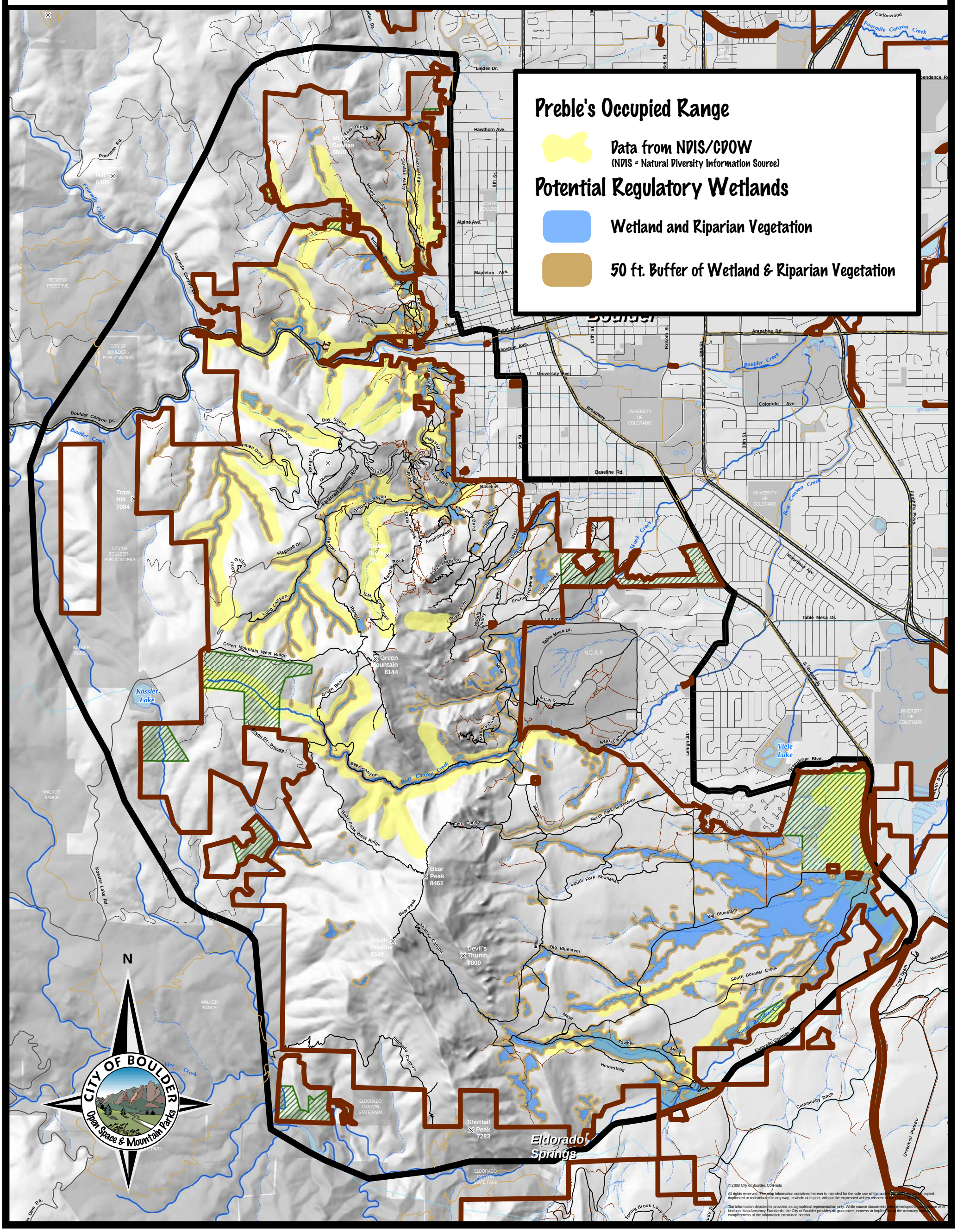
Map 12 West TSA - Preble's Meadow Jumping Mouse Habitat & Potential Regulatory Wetlands

West TSA Boundary
Other Government Land
OSMP Land
OSMP Conservation Easement
Trail Managed By OSMP
Undesignated Trails
Trail Not Managed By OSMP

0 0.5 1
Miles

revised: 4/30/2009



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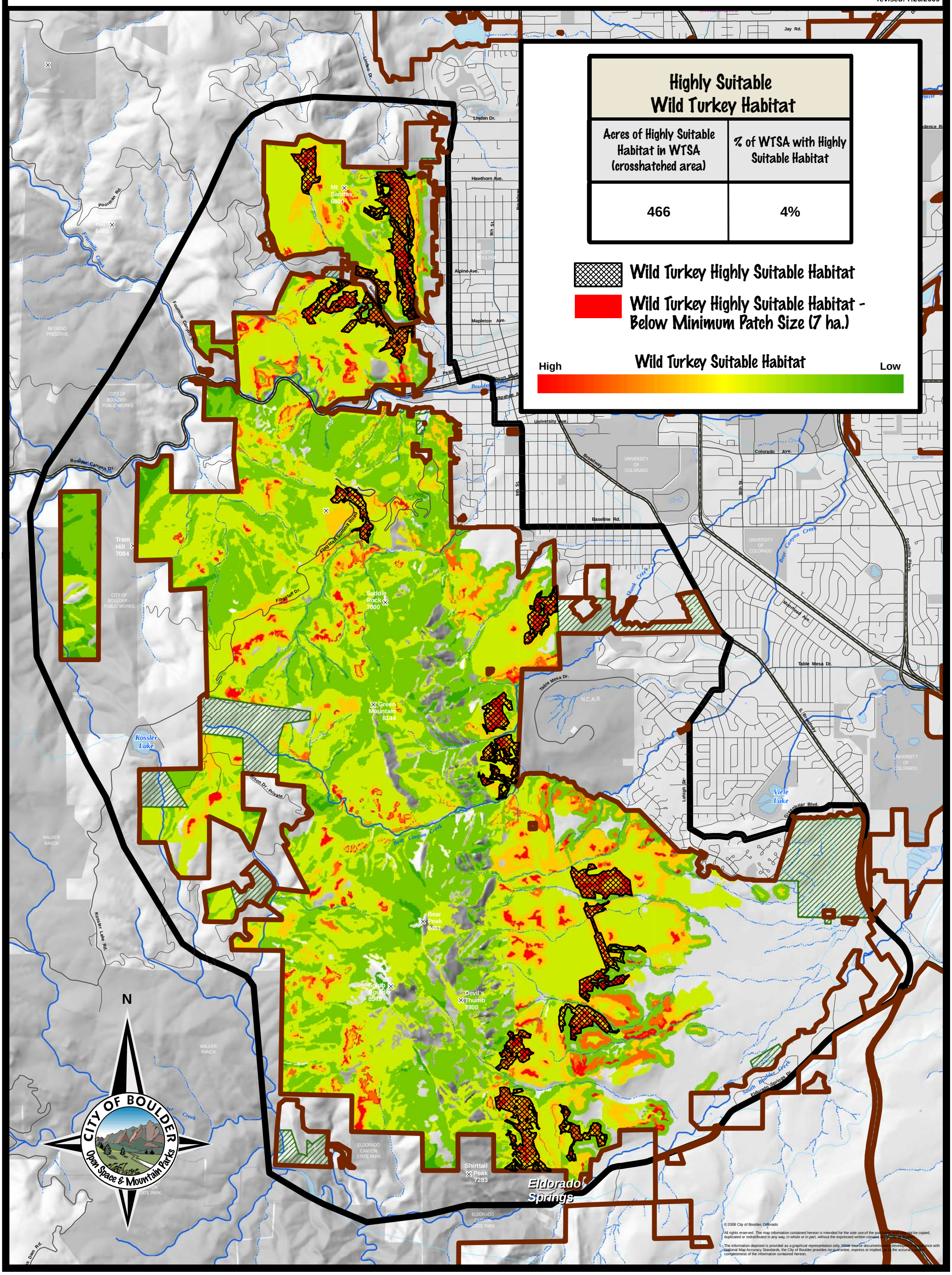
Map 13 West TSA - Wild Turkey Potential Habitat

West TSA Boundary | Other Government Land | OSMP Land | OSMP Conservation Easement

0 0.5 1
Miles

revised: 7/20/2009



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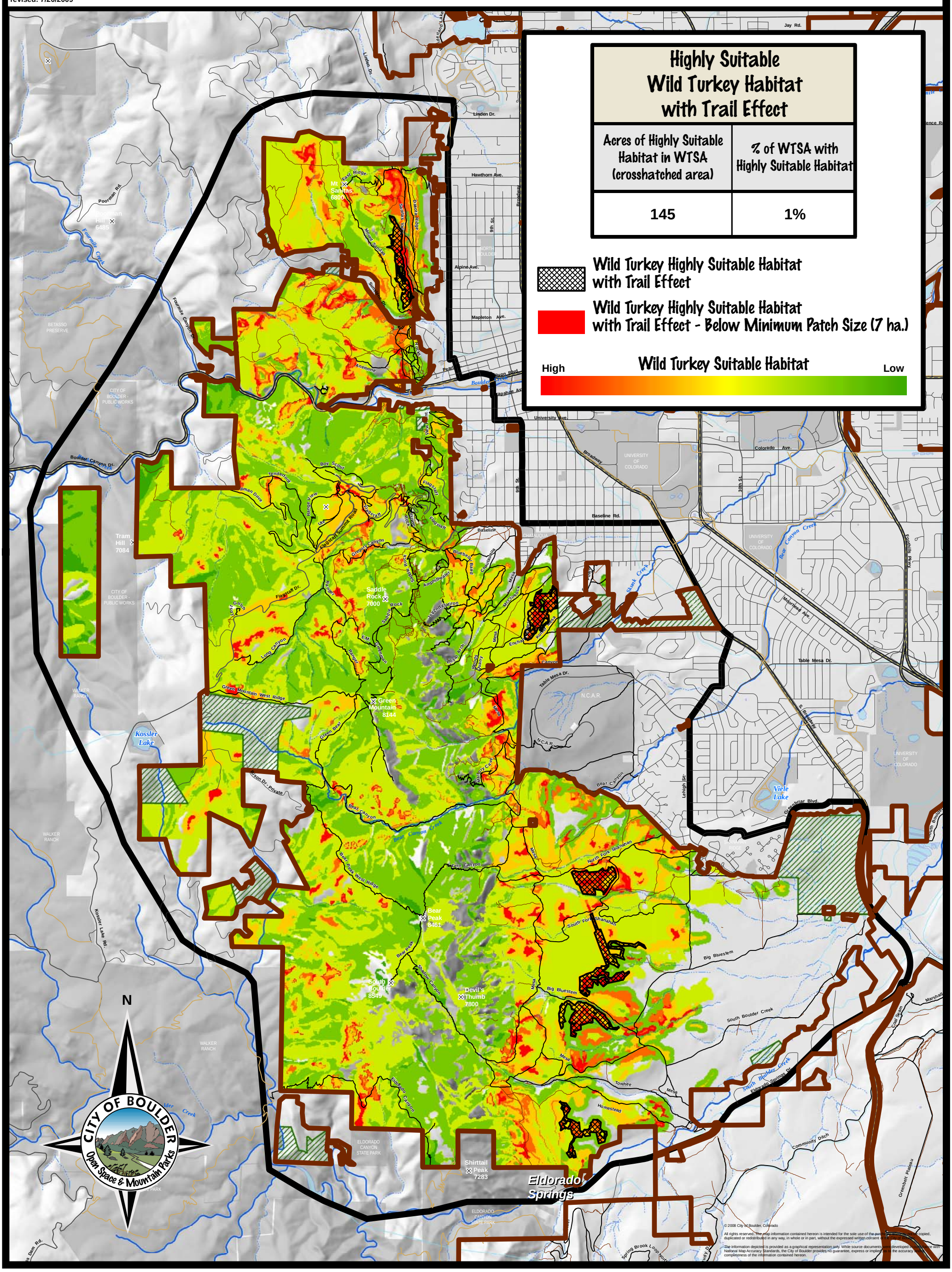
Map 14 West TSA - Wild Turkey Habitat with Trail Effect

West TSA Boundary
Other Government Land
OSMP Land
OSMP Conservation Easement
Trail Managed By OSMP
Undesignated Trails
Trail Not Managed By OSMP

0 0.5 1
Miles

revised: 7/20/2009



Acres of Highly Suitable Habitat in WTSA (crosshatched area)	% of WTSA with Highly Suitable Habitat
145	1%

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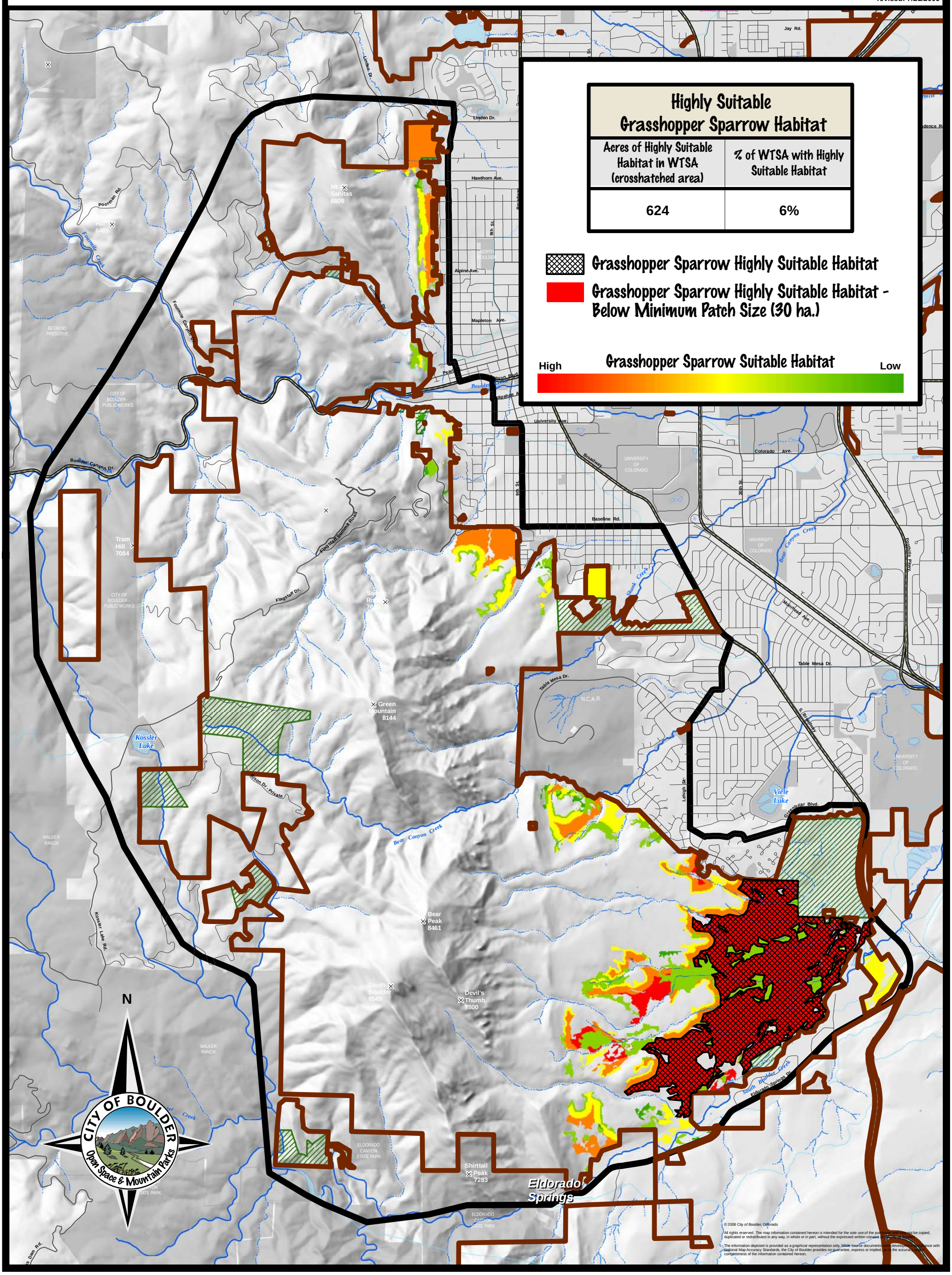
Map 15 West TSA - Grasshopper Sparrow Potential Habitat

West TSA Boundary | Other Government Land | OSMP Land | OSMP Conservation Easement

0 0.5 1
Miles

revised: 7/21/2009



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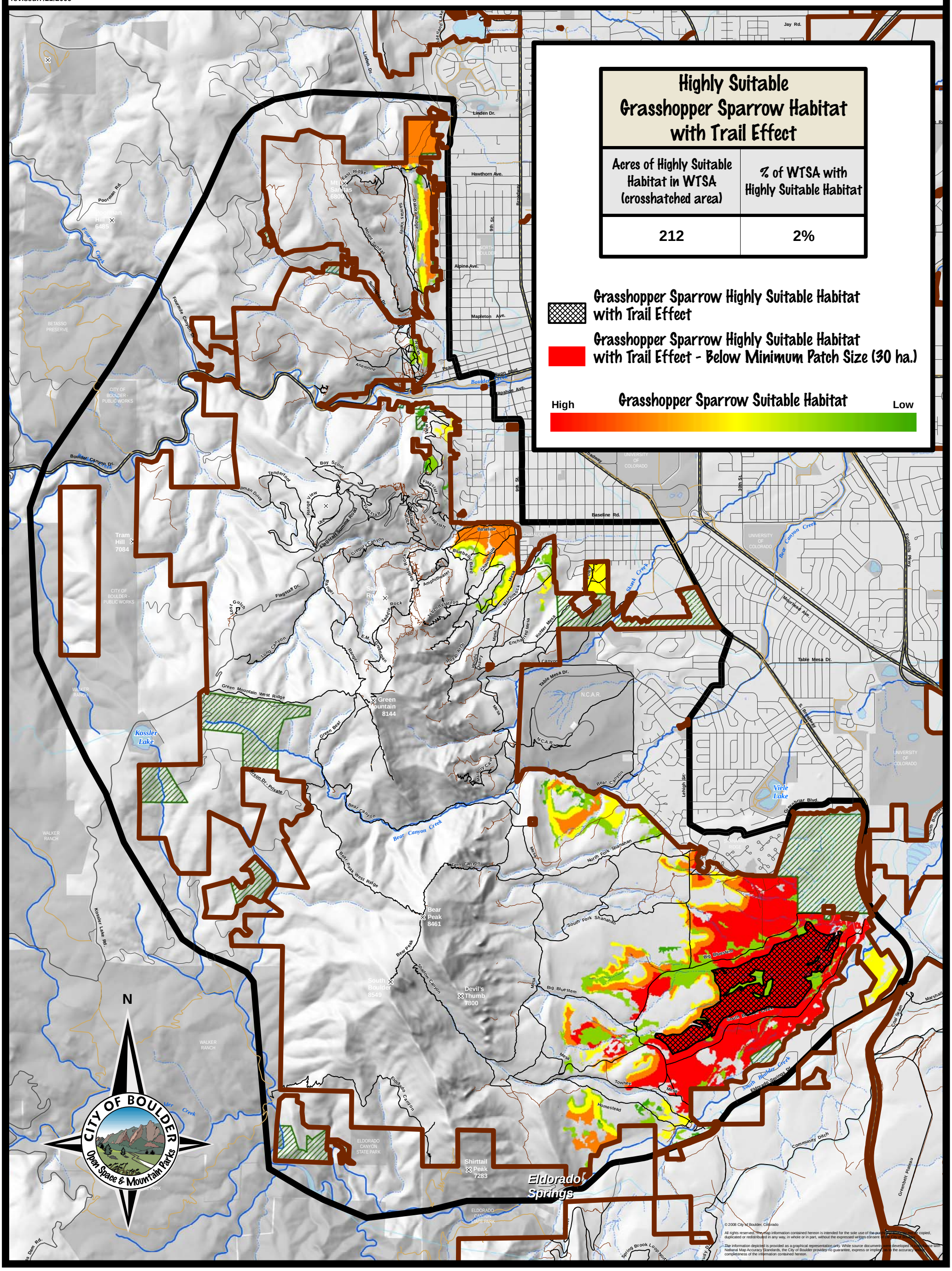
Map 16 West TSA - Grasshopper Sparrow Habitat with Trail Effect

West TSA Boundary
Other Government Land
OSMP Land
OSMP Conservation Easement
Trail Managed By OSMP
Undesignated Trails
Trail Not Managed By OSMP

0 0.5 1
Miles

revised:7/21/2009



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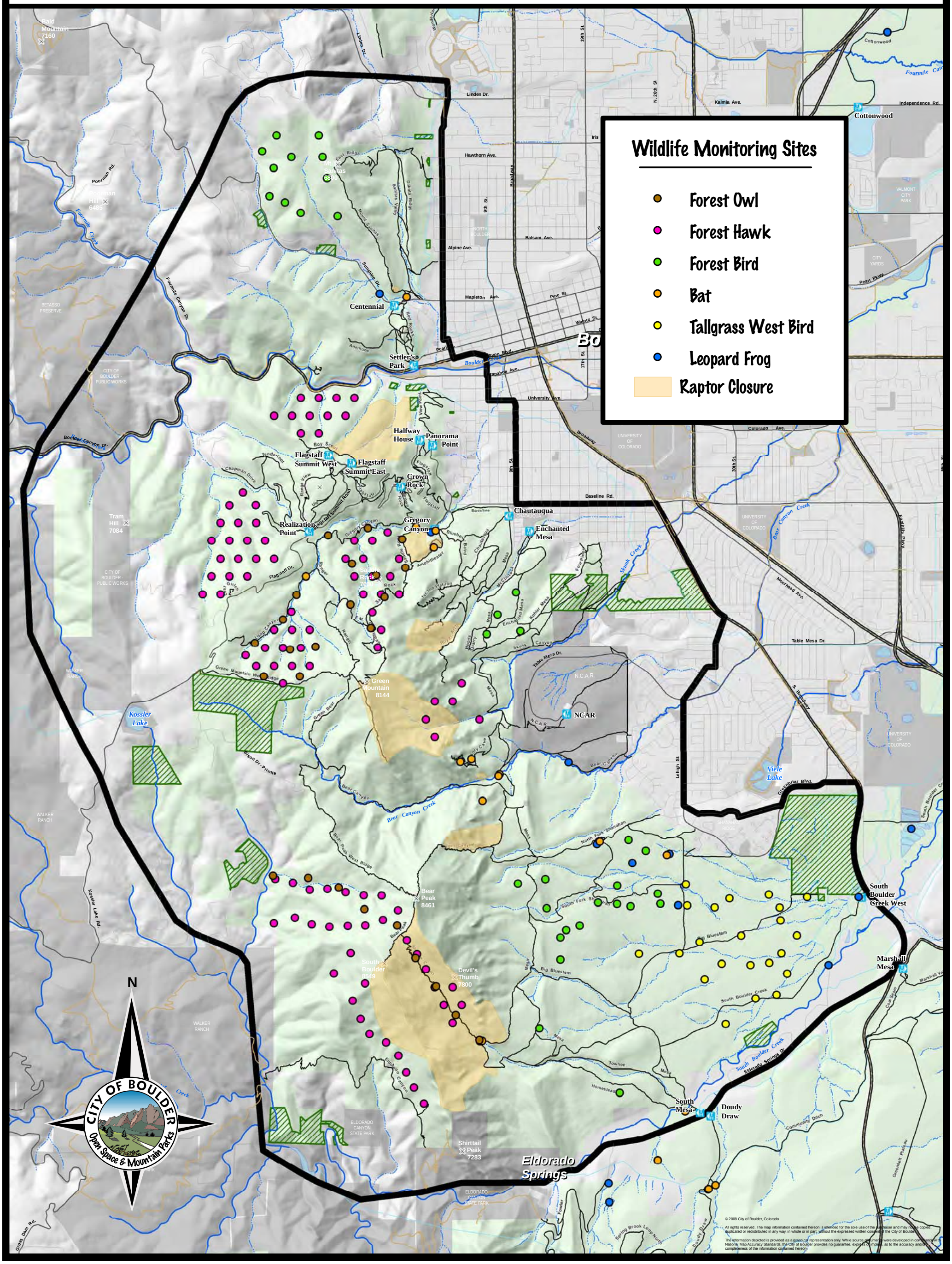
Map 17 West TSA - Wildlife Monitoring Sites

West TSA Boundary
Other Government Land
OSMP Land
OSMP Conservation Easement
Trailhead
Trails Managed By OSMP
Trail Not Managed By OSMP

0 0.5 1
Miles

revised: 4/21/2009



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