# Noxious Weed Survey

# of the

# Pueblo Chemical Depot

# 2015

COLORADO NATURAL HERITAGE PROGRAM

April 2016

# Noxious Weed Survey of the Pueblo Chemical Depot

## 2015

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April 2016

*CNHP's mission is to preserve the natural diversity of life by contributing the essential scientific foundation that leads to lasting conservation of Colorado's biological wealth.*

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# EXECUTIVE SUMMARY

Pueblo Chemical Depot (PCD) includes approximately 36 square miles east of Pueblo in Pueblo County, Colorado. State-listed noxious weed species occur on the Depot and a systematic survey of the extent and degree of the infestations has not been completed since 2001 (Fayette Regier 2001). A noxious weed survey of the property is needed to comply with federal noxious weed laws and Executive Order 13112. In 2015, Colorado State University and the Colorado Natural Heritage Program (CNHP) mapped state-listed noxious weeds known to occur on the Depot. These data were used to prepare an updated weed map using GPS and GIS technology. In addition, representative photographs were taken of weeds and weed infestations. The methodology used to conduct this survey was based on similar weed surveys conducted by CNHP at the nearby U.S. Air Force Academy in 2002, 2007 and 2012; Peterson Air Force Base in 2003 and 2014; and Cheyenne Mountain Air Force Station in 2014. The use of repeatable data is important to facilitate comparisons of weed populations over time. This report and the spatial dataset will provide a useful tool to develop weed mitigation strategies and invasive species control plans to comply with noxious weed regulations.

Nine species of state listed noxious weeds were mapped at PCD in 2015 and assessed for their threat level based on coverage, plant biology, surrounding land use and their potential to spread. Each species is individually addressed in this report.

Three noxious weed species are considered to be at a high threat level (Russian knapweed, Canada thistle, and tamarisk) for PCD.

- Russian knapweed currently has a very small coverage at one localized occurrence and there is potential to eradicate this species at this stage of infestation.
- Tamarisk and Canada thistle occur at coverages that are large and widespread across the depot. Chemical control methods as they are being applied, appear to be exacerbating the spread of both species at PCD.

The remaining six species of mapped noxious weeds (chicory, field bindweed, bull thistle, puncturevine, common mullein, and Russian olive) are all considered to have a low threat level.

- Chicory, field bindweed, bull thistle and puncturevine have a very small cover and have declined or remained stable since the 2000-2001 survey.
- Common mullein covers wide areas but is almost always associated with disturbance and is an early successional species that tends to naturally decline over time.
- Russian olive is a tree species that has a low cover and appears to spread slowly at PCD. These trees can readily be removed if the proper treatment is used and surrounding disturbance is minimized.

In addition to noxious weeds, the Colorado Natural Heritage Program has documented 15 species that are considered elements of conservation concern at PCD (also known as Element Occurrences or EOs). The mapped EOs are used to construct Potential Conservation Areas (PCAs). PCAs

delineate land areas that provide habitat and ecological needs upon which a suite of elements (rare plants, and animals and plant communities) depend upon for continued existence. There are five PCAs that are found on PCD, two with very high biodiversity significance, two with high and one moderate biodiversity significance (CNHP 2015).

Recommendations include requiring a site plan before any type of treatment for high threat level species. Site plans should include:

1) A determination if treatments may be more detrimental than the presence of weed species;
2) A definitive treatment goal based on plant biology, size of the occurrence, and protection of natural resources in the area (wetlands, plants and animals);
3) A survey of weeds and native species in the treatment area;
4) Determination of the wetland status of the treatment area;
5) A plan for mitigating soil damage with native plant restoration immediately following proposed treatments;
6) Follow-up monitoring on weed treatments and plantings at appropriate intervals to determine if they are successful or need additional work.

# ACKNOWLEDGEMENTS

The authors would like to acknowledge Clark D. Jones, U.S. Fish and Wildlife Service (FWS) for assistance in the field and providing safety and other information on accessing areas at the Depot. In addition, the staff at the OC desk were helpful by providing radios and up to the minute updates for accessing areas on the site and providing other safety information.

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# 1.0 INTRODUCTION

A number of state-listed noxious weeds are already known to occur at Pueblo Chemical Depot (PCD) and weed surveys and weed treatments have been undertaken. A systematic survey of the extent and degree of the infestations was completed in 2001 (Fayette Regier 2001). The State of Colorado weed rules (USDA State of Colorado Code of Regulations 2014) have been revised since the last survey and there have been new changes, information and updates. To this end, in 2015, Colorado State University and the Colorado Natural Heritage Program (CNHP) mapped state-listed noxious weeds at PCD. Based on the survey data, a weed map and report were prepared to assist natural resource managers in controlling and monitoring weed infestations.

## 1.1 Purpose and Need

A noxious weed survey of the Pueblo Chemical Depot property is needed to comply with various federal, state and local noxious weed laws (Executive Order 13112 and State Department of Agriculture Code of Colorado Regulations 2014). Since the last noxious weed survey in 2001 (Fayette Regier), the Colorado State weed list has changed. Some target species specific to PCD have been added and others deleted based on new information. This updated report and spatial dataset are important tools for PCD staff to use in continuing to develop weed management strategies to meet noxious weed law requirements.

## 1.2 Management Area

The U. S. Army Pueblo Chemical Depot is located in Pueblo County, about 15 miles east of the Pueblo, Colorado (Figure 1) and includes approximately 23,000 acres of developed and undeveloped high plains landscapes. The non-developed areas include shortgrass prairie, sandsage shrublands, greasewood scrub, wetland and riparian vegetation (Rondeau 2013). Many disturbed lands are included within the non-developed areas. In addition, PCD houses a chemical weapons stockpile and The Pueblo Chemical Agent-Destruction Pilot Plant. The pilot plant and shooting range were not surveyed as part of this study. For detailed descriptions of the vegetation and a detailed history of the site see Rondeau (2013) and Rust International Inc. (1996). The focus for this survey was the non-developed prairie lands, riparian areas and wetlands with emphasis on previously reported occurrences and places with potential to have noxious weeds.

### 1.2.1 Climate

The Pueblo area has a cold semi-arid steppe climate that typically supports shrub and grassland vegetation. The climate is characterized by low humidity and low precipitation (average of 13 inches/year). This area has more sunny days than cloudy days, light winds are more common than high winds. For a detailed description of climate impacts on the vegetation at PCD see Rondeau et al. 2016.


**Figure 1. Vicinity Map for Pueblo Chemical Depot.**

### 1.2.2 Soils

The soils across the Depot range from dry sandy loams, loamy sands, gravelly sandy loams, clay loams, and silty clay loams to wet silty clays. Stoneham loam has the largest coverage and underlies much of the shortgrass prairie area (Figure 2). The permeability is moderate with a high available water capacity. This soil type tends to be mildly to moderately alkaline and supports mainly grasses (blue grama, galleta grass, sand dropseed) and cactus (USDA 1979, Rondeau 2013).

Soils are important to consider as indicators of flora and fauna that can inhabit specific areas. Soils with higher salinity or alkalinity tend to attract certain weed species. Past and current disturbances will dictate where noxious weeds may proliferate. Areas where soils have not been turned over, or where historical hydrology has not been impacted, are most resistant to weeds and support native systems on PCD. The soils are described in detail by Rondeau (2013).

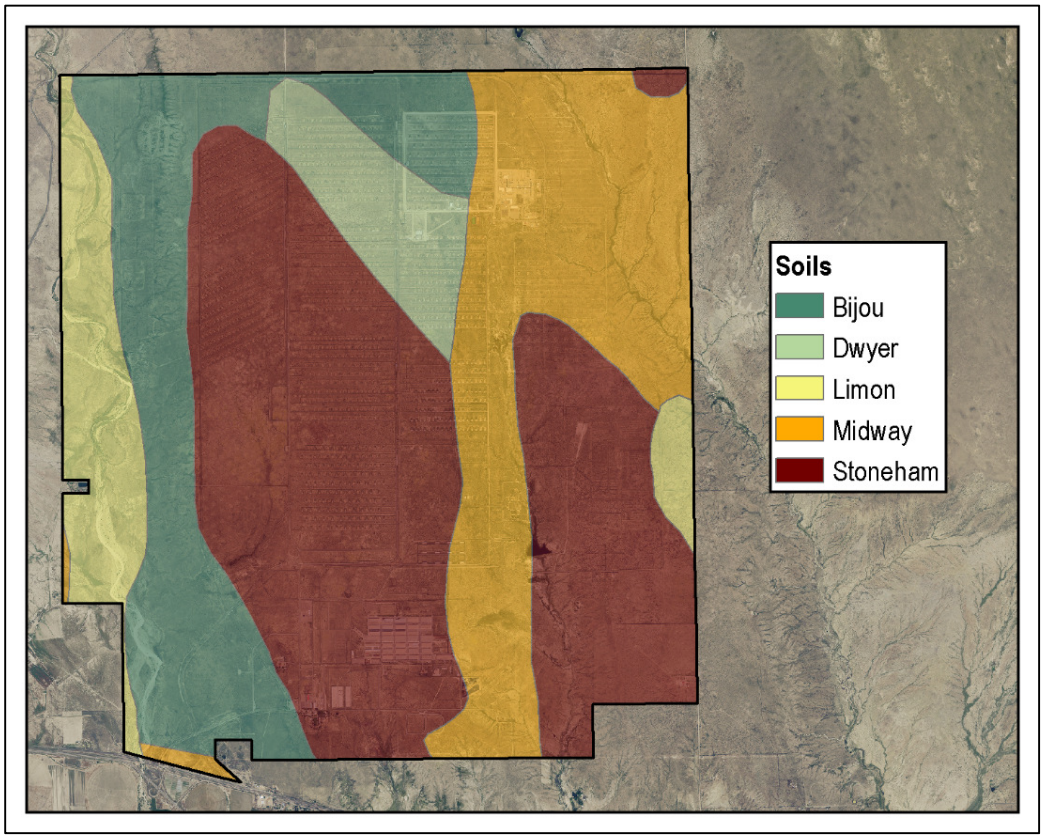


**Figure 2. Soils at Pueblo Chemical Depot.**

### 1.2.3 Surface water, wetlands, drainages and riparian areas

There are three major drainages that cross the PCD property: Chico Creek on the west side, Haynes Creek on the east side and Boone Creek in the central portion of the property (Figure 3).

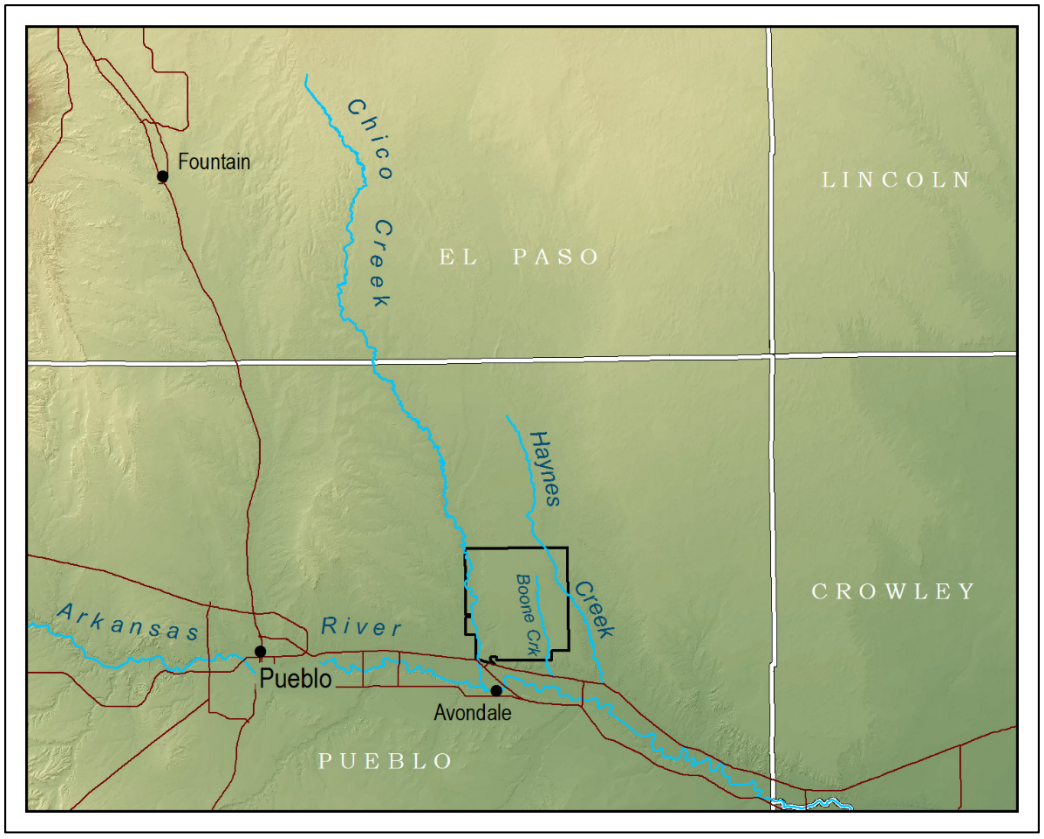


**Figure 3. Drainages at Pueblo Chemical Depot.**

***Chico Creek***

Chico Creek originates about 50 miles north of PCD in El Paso County. It is a tributary of the Arkansas River with the confluence near the town of Avondale, CO just to the south of PCD (Figure 3). The entire Chico Creek watershed reaches from the Black Forest to the Arkansas River, which includes over 580 square miles in El Paso and Pueblo counties. Chico Creek has intermittent flows throughout most of its length, and surface flow only reaches the Arkansas River after heavy precipitation. Seeps and springs create an extensive Great Plains wetland and riparian complex with perennially ponded portions in the south part of the Chico Creek watershed. Surface water is uncommon in the basin. There are 118 springs known from the entire length of Chico Creek and these springs are considered the most significant hydrologic feature of the entire basin (Romero 1992 as in Spackman Panjabi et al. 2003). Wetlands and riparian areas associated with Chico Creek are found in the west section of PCD.

***Haynes Creek***

Haynes Creek is a smaller drainage that originates north of PCD where springs are found on the Transportation Technology Center and private property. A section of Haynes Creek flows across PCD on the eastern side; it flows towards the Arkansas River to the south (Doyle et al. 2001). Compared to the other two drainages, Haynes Creek is less developed and less impacted by anthropogenic development and disturbances.

***Boone Creek***

Boone Creek is located entirely within PCD on the eastern side and also includes an impoundment where a small pond has formed (Doyle et al. 2001). The creek and pond are important areas for wildlife. Weeds and treatment activities are heavily impacting this drainage.

### 1.2.4 Vegetation

The vegetation cover at Pueblo Chemical Depot is divided into four main types: shortgrass prairie, northern sandhill prairie, greasewood shrubland and riparian vegetation (Rust International Inc. 1996, Rondeau 2013 – Figure 4). This matrix of vegetation is part of the high plains ecosystem, which is fragmented by developments including roads, train tracks, buildings, dam structures and parking lots. The shortgrass prairie occupies the largest natural land area, covering more than 11,000 acres and it is dominated by blue grama (*Bouteloua gracilis = Chondrosum gracile*) with lesser amounts of alkalai sacaton (*Sporobolus airoides*) or galleta grass (*Hilaria jamesii*). The sandhill prairie occupies about 4,000 acres at PCD and is dominated by sandsage (*Artemisia filifolia = Oligosporus filifolius*) with sparse ground cover and a matrix of grasses and forbs. Greasewood shrublands occupy about 2,400 acres on the PCD with the largest occurrence along Boone Creek (Rondeau 2013). Although the riparian areas cover the smallest amount of land area they are very important to the natural systems and wildlife. The wooded riparian areas of the west side of PCD are dominated by plains cottonwood (*Populus deltoides* ssp. *monilifera*), coyote willow (*Salix exigua*) and tamarisk (*Tamarix ramosissima*).

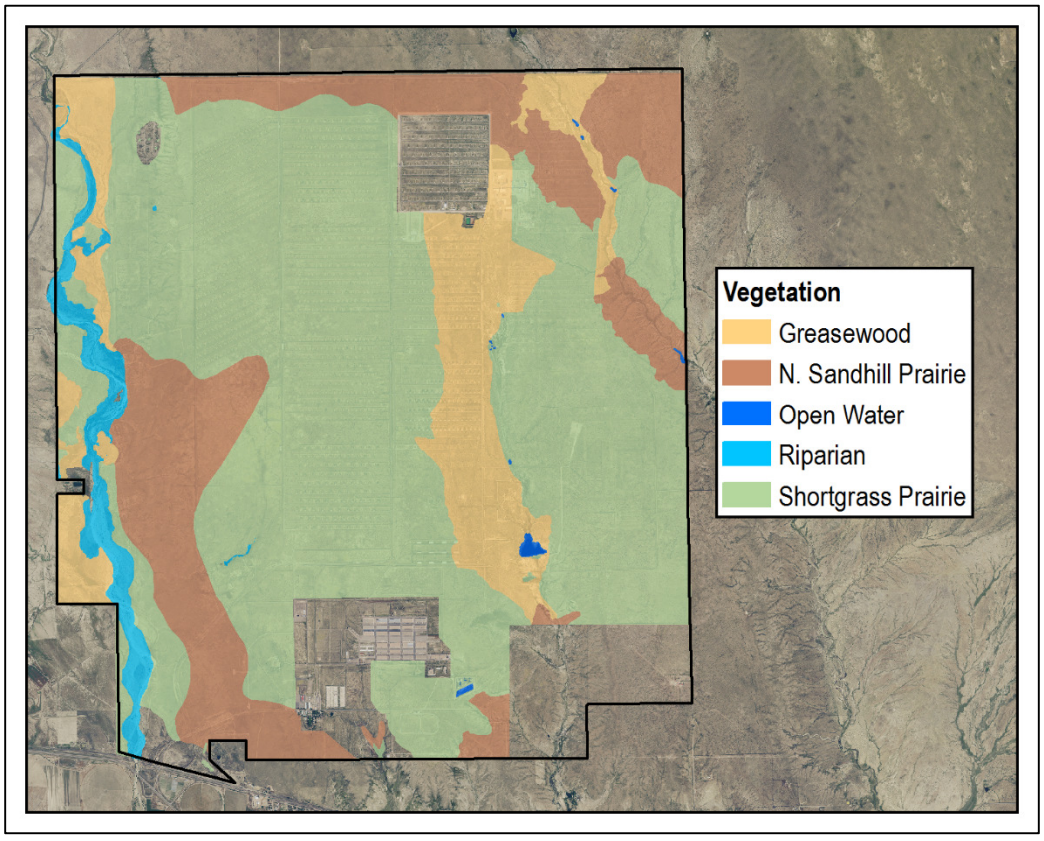


**Figure 4. Vegetation Cover at Pueblo Chemical Depot.**

### 1.2.5 History

Native American tribes and bison (*Bison bison*) were part of the history of the Pueblo area up until the 1870's. The introduction of horses and severe culling of the bison population occurred between 1840 and 1870 (Hornaday 1889). The Depot property was a mixture of private and state-owned parcels dominated by cattle ranching. Construction of the Depot began in 1942. The main functions for the next 52 years included storage, maintenance, distribution and disposal facility for munitions and other military equipment for the U.S. Army until 1994. Grazing of livestock on the property was terminated in 1998 for most of PCD, with the exception of a section in the NW corner. The majority of the land at PCD has been impacted by anthropogenic activities (Rondeau 2013).

Past biological surveys at the site have included:

- long-term vegetation monitoring (Rondeau 2016, 2013, 2003, 2001, Rondeau and Kettler 1999);
- ecological survey (Rust International Inc. 1996);
- small mammal surveys (Earth Tech 2001, Sovell et al. 2006);
- grasshopper monitoring (Sovell 2006, 2002, 2000 and Sovell and Schneider 2001); and
- noxious weed mapping (Fayette Regier 2001).

The vegetation, small mammal and grasshopper surveys were conducted to compare effects on recently grazed lands (up to 1998) and ungrazed lands (lands not grazed since 1942) at PCD.

### 1.2.6 Wildlife

Prairie dogs cover approximately 2,000 acres of land at PCD; however, the acreage varies with bouts of the plague which can change density of prairie dogs dramatically over the years. Rattlesnakes, frogs, roadrunners, jack rabbits, spotted ground squirrels, thirteen-lined ground squirrels, fox squirrels, deer mice, pocket mice, Ord's kangaroo rats, northern grasshopper mice, badgers, fox, coyote, elk, deer, and mountain lions are some of the wildlife known from the area. A variety of birds are attracted to the ponds and wetland areas as well as the upland habitats. Many state species of conservation concern are known from PCD (Table 1, Spackman Panjabi et al. 2003, CNHP 2015).

### 1.2.7 CNHP Potential Conservation Areas and Natural Heritage Element Occurrences

The Colorado Natural Heritage Program has documented 15 species that are considered elements of conservation concern at PCD (Table 1). The Masassauga rattlesnake (*Sistrurus catenatus*) is a state special concern, BLM Sensitive and USFS Sensitive species that is tracked by CNHP. This is a globally vulnerable, state imperiled (G3/S2) species. It has not been documented on the property. However, occurrences have been documented along the northern border near the test track and other areas with habitat similar to that found at PCD. Although this snake has not been documented on the Depot proper, it likely occurs as potential habitat exists on the PCD property (pers. comm. J. Siemers, CNHP 2016).

**Table 1. Rare animals, significant plant communities, and rare plants documented at the Pueblo Chemical Depot (CNHP 2015).** Species are listed by major group, and then according to global and state ranks. This table represents records in CNHP's database, and may not reflect the latest observations of PCD staff or contractors. (For rank and status definitions please see Appendix A.)

| Common Name | Scientific Name | Global Rank | State Rank | Federal Status | State Status | CNHP Last Obs |
|---|---|---|---|---|---|---|
| **Amphibians** | | | | | | |
| Couch's Spadefoot | *Scaphioupus couchii* | G5 | S1 | | SC | 2006 |
| Plains Leopard Frog | *Lithobates blairi* | G5 | S3 | BLM/USFS | SC | 2000 |
| **Birds** | | | | | | |
| Ferruginous Hawk | *Buteo regalis* | G4 | S3B | BLM/USFS | SC | 2003 |
| Lewis's Woodpecker | *Melanerpes lewis* | G4 | S4 | USFS | | 2003 |
| Mountain Plover[B] | *Charadrius montanus* | G3 | S2B | BLM/USFS | SC | 2002 |
| **Fish** | | | | | | |
| Southern Redbelly Dace | *Phoxinus erythrogaster* | G5 | S1 | USFS | SE | 1993 |
| **Reptiles** | | | | | | |
| Colorado Checkered Whiptail | *Aspidoscelis neotesselatus* | G2G3 | S2 | | | 2003 |
| Massasauga Rattlesnake* | *Sistrurus catenatus* | G3 | S2 | BLM/USFS | SC | 2001 N bord |
| **Mammals** | | | | | | |
| Black-tailed Prairie Dog[A] | *Cynomys ludoviciana* | G4 | S3 | BLM/USFS | | 2002 |
| Ord's Kangaroo Rat | *Dipodomys ordii* | | | | | |
| **Plant communities** | | | | | | |
| Bulrush Wet Meadow[B] | *Schoenoplectus pungens* Herbaceous Vegetation | G3G4 | S3 | | | 2000 |
| Plains Cottonwood /Alkalai Sacaton | *Populus deltoides/Sporobolus airoides* Forest | G3 | S2 | | | 2000 |
| Plains Cottonwood / Western Wheatgrass-Switchgrass | *Populus deltoides* / *Pascopyrum smithii – Panicum virgatum* Woodland | GNR | S2 | | | 2000 |
| Greasewood /Alkalai Sacaton | *Sarcobatus vermiculatus / Sporobolus airoides* Shrubland | G3? | S1 | | | 2000 |
| Saltgrass Saline Prairie[B] | *Distichlis spicata* Herbaceous Vegetation | G5 | S3 | | | 2000 |
| **Vascular plants** | | | | | | |
| Dwarf milkweed** | *Asclepias uncialis* | G3G4/ T3T2 | S2 | BLM/USFS | | 2000 |
| Sandhill goosefoot[A] | *Chenopodium cycloides* | G3G4 | S1 | USFS | | 2001 |
| | | | | | | |

[A] = At least one A ranked occurrence, [B] = at least one B ranked occurrence

*Documented in the vicinity and has potential to be present at PCD.

** Rust (2001)

Mapped elements of conservation concern are used to construct Potential Conservation Areas (PCAs). The goal of delineating PCAs is to identify a land area that can provide habitat and ecological needs upon which a particular element or suite of elements (rare plants, animals and plant communities) depends upon for continued existence. PCAs are ranked according to their biodiversity significance or B ranks (Table 2).

**Table 2. Biodiversity Ranks and Definitions**

| |
|---|
| **B1** Outstanding Significance (irreplaceable) |
| **B2** Very High Significance |
| **B3** High Significance |
| **B4** Moderate Significance |
| **B5** General or State-wide Biological Diversity Significance |

The Colorado Natural Heritage Program (CNHP 2015) has identified three PCAs for the protection of significant elements of concern at PCD (Table 3, Figure 5).

**Table 3. List of Potential Conservation Areas (PCAs) that are on or overlapping Pueblo Chemical Depot.**

| PCA Name | Biodiversity Rank | Biodiversity Significance |
|---|---|---|
| | | |
| Boone Creek | B4 | Moderate |
| Chico Creek | B3 | High |
| Haynes Creek | B3 | High |
| Small portions of these large PCAs overlap PCD and are not shown on Figure 5. | | |
| Chico Basin Shortgrass Prairie | B2 | Very High |
| Signal Rock Sandhills | B2 | Very High |
| | | |

See Appendix A for a detailed description of Natural Heritage Methodology Ranking system for elements of concern and Appendix B for a detailed information describing Potential Conservation Areas.

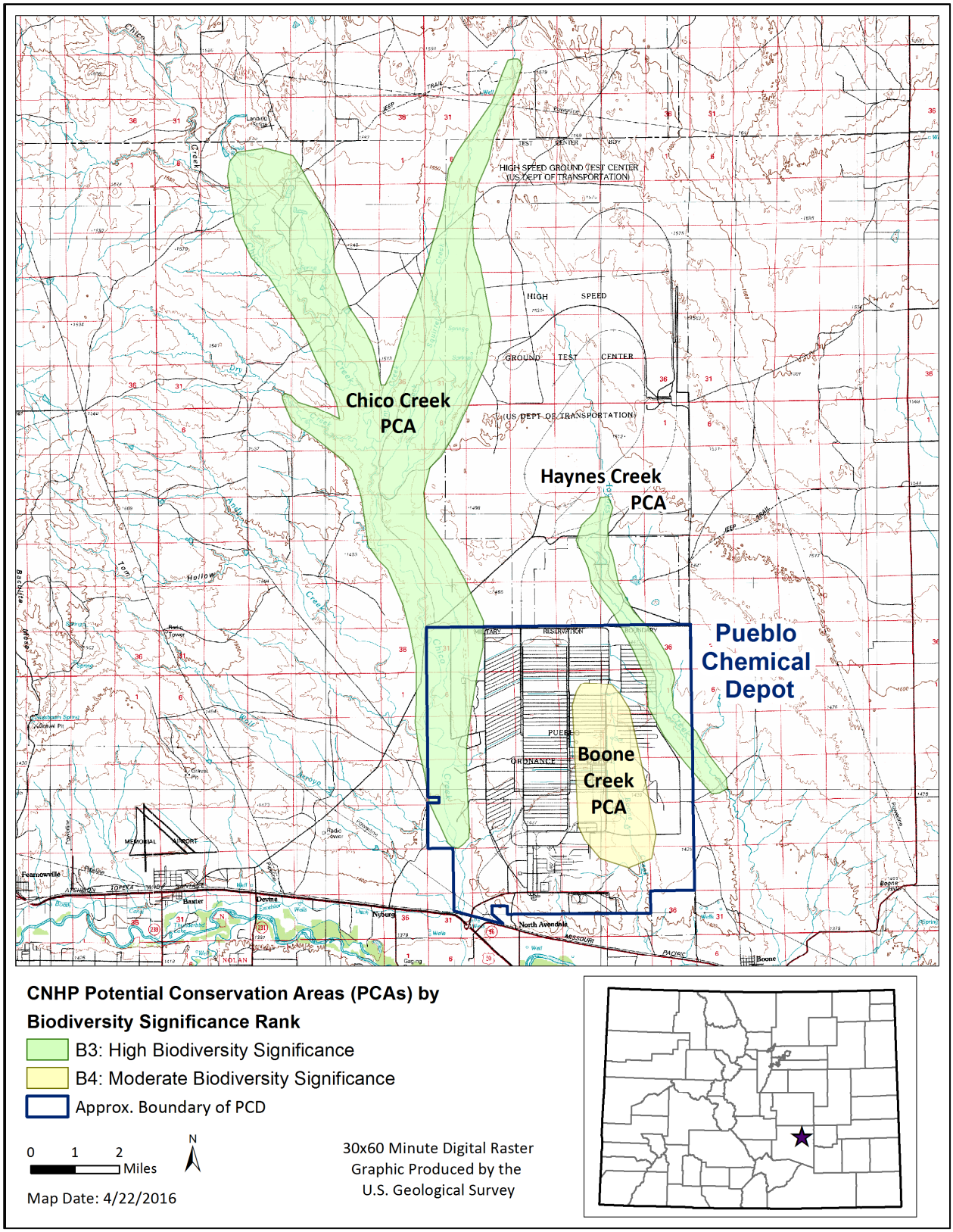


**Figure 5. CNHP Potential Conservation Areas at Pueblo Chemical Depot.**

# 2.0 METHODS

A list of target weed species for the 2015 weed survey was created from existing reports, the newly updated Colorado State Noxious Weed. The target list for 2015 was different from the 2000-2001 list (Table 4). Russian knapweed (*Acroptilon repens*) had not yet been discovered, or might not have been present, and was not mapped in 2000-2001. Russian olive has been considered a species of concern for PCD but was not listed as a State Noxious weed in 2000-2001. It is currently a List B species and was targeted for both surveys. Kochia and Russian thistle are not on the current noxious weed list but were targeted in 2000-2001. The populations were estimated in 2000-2001 using vegetation plots (Fayette Regier 2001). Due to their ubiquitous cover and the fact they do not tend to persist, these species were not targeted for survey in 2015. Buffalobur was considered a target weed species in 2001 since it has a tendency to be weedy in disturbed habitats and has been considered a problem to ranchers. This plant was not a target for the 2015 survey because it is a native species, it is not a state listed noxious weed, and the current cover is low (pers. comm. Georgia Doyle, CNHP). The white and yellow sweetclovers were mapped in 2000-2001 but were not mapped in 2015. These species are not on the current noxious weed list and the cover is too high to warrant treatment on a landscape scale. Cheatgrass is the only species on the noxious weed list that was not surveyed in 2015 due to the large and scattered cover across PCD.

The State Noxious Weed Act currently puts weeds into four different management lists: A, B, C and Watch List. Species status is included in Table 4.

**List A** species are invasive weeds that are either not known to occur in Colorado or are of very limited distribution and are required to be eradicated (completely eliminated).

**List B** species are invasive weeds with populations of varying distribution and densities within the state. The level of mandated control is based on local conditions. These weeds may require eradication within certain areas of the state.

**List C** species are widespread and common within the state. They may pose a risk to agricultural lands and may be required to be controlled.

**Watch List** species that are not known but that are expected to be found in Colorado and should be reported when found.

**Table 4. A Comparison of Weeds Targeted for Survey at the Pueblo Chemical Depot for 2000 and 2015 Surveys.**

| *Scientific Name* | *Common Name* | *Colorado Weed List Status (2014 Rule)* | *Mapped Weeds* | |
|---|---|---|---|---|
| | | | *2000-2001* | *2015* |
| *Acroptilon repens* | Russian knapweed | B | | √ |
| *Bromus tectorum* | cheatgrass | C | √ | |
| *Cichorium intybus* | chicory | C | √ | √ |
| *Cirsium arvense* | Canada thistle | B | √ | √ |
| *Cirsium vulgare* | bull thistle | B | | √ |
| *Convolvulus arvensis* | field bindweed | C | √ | √ |
| *Kochia scoparia* | kochia | n/a | √ | |
| *Elaeagnus angustifolia* | Russian olive | B | √ | √ |
| *Melilotus albus, M. officinalis* | white and yellow sweetclover | n/a | √ | |
| *Solanum rostratum* | buffalobur | n/a | √ | |
| *Salsola spp.* | Russian thistle | n/a | √ | |
| *Tamarix ramosissima* | tamarisk | B | √ | √ |
| *Tribulus terrestris* | puncturevine | C | √ | √ |
| *Verbascum thapsus* | common mullein | C | √ | √ |
| | | | | |

A systematic survey targeting previously mapped infestations was performed in the summer of 2015. In addition, CNHP searched for new species or target species in different potential habitats around PCD. GIS data were collected in the field using ESRI ArcPad software run on rugged Trimble units with built-in GPS capabilities. Mapping protocols followed those used for the U.S. Air Force Academy in 2012 (Lavender-Greenwell and Rondeau 2013) and are described in Appendix C. Field surveys were conducted through the summer months of August and September 2015, at phenologically appropriate times in order to increase the likelihood of identifying weed infestations. CNHP documented each weed infestation and delineated the boundary using a Global Positioning System (GPS). Quality control was ongoing during the fieldwork, and after completion of the fieldwork. Data were analyzed and compared with 2000-2001 infestations to assess the status and trends of weed occupancy within the study area. In addition, digital photographs were taken to show representative infestations of weed species.

# 3.0 RESULTS

No List A species (which are designated by the State Commissioner for eradication) were located during the 2015 survey. Five List B noxious weeds, which may require control, were mapped in 2015 and include Russian knapweed (*Acroptilon repens*), which is a new target weed species not present (or known to occur) during the 2000-2001 survey. The other four species (all mapped in both 2001 and 2015 surveys) include: Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium vulgare*), Russian-olive (*Elaeagnus angustifolia*) and tamarisk (*Tamarisk ramosissima*). List C species that were mapped in 2015 (and 2000-2001) include chicory (*Cichorium intybus*), field bindweed (*Convolvulus arvensis*), puncturevine (*Tribulus terrestris*) and common mullein (*Verbascum thapsus*). Cheatgrass, or downy brome (*Bromus tectorum*), was the only List C species that was mapped in 2000-2001 but not mapped in 2015. Kochia (*Kochia scoparia*), white and yellow sweetclover (*Melilotus alba, M. officinale*), Russian thistle (*Salsola* spp.) and buffalobur (*Solanum rostratum*) were all mapped in 2000-2001 but not in 2015 (Table 5).

Assessing the threat level of each weed species was accomplished by comparing the results of the 2000-2001 and 2015 survey data. A high threat level was assigned to three out of nine target species in 2015 (Table 5). The threat level assessment was based on the increase in cover and/or the potential for rapid spread at PCD. However, two of the three species identified as high threats (tamarisk and Canada thistle) are widespread and control will be difficult to achieve. Once a species that has the ability to reproduce from a deep root system, reaches an acre or more in coverage, and is dispersed across a landscape, it is approaching a level that may be impractical or impossible to eliminate (FEIS 2015). In addition, the likelihood of control or eradication is very low because the species are occupying a disturbed drainage with hydrology that has been significantly altered so that it no longer naturally supports a predominance of native species in some areas.

**Table 5. Results of Weed Survey with Threat Level/Action Summary.**

| *Scientific Name* | *Common Name* | *Colorado Weed List Status (2014 Rule)* | *Mapped Weeds* | | *Threat Level/Action Needed* |
|---|---|---|---|---|---|
| | | | *2000* | *2015* | |
| | | | | | |
| *Acroptilon repens* | Russian knapweed | B | | √ | **HIGH – Rapid Response** |
| *Bromus tectorum* | cheatgrass | C | √ | | **LOW** |
| *Cichorium intybus* | chicory | C | √ | √ | **LOW** |
| *Cirsium arvense* | Canada thistle | B | √ | √ | **HIGH – Site Plan** |
| *Cirsium vulgare* | bull thistle | B | √ | √ | **LOW** |
| *Convolvulus arvensis* | field bindweed | C | √ | √ | **LOW** |
| *Kochia scoparia* | kochia | n/a | √ | | **LOW** |
| *Elaeagnus angustifolia* | Russian-olive | B | √ | √ | **LOW** |
| *Melilotus albus, M. officinalis* | white and yellow sweetclover | n/a | √ | | **LOW** |
| *Solanum rostratum* | buffalobur | n/a | √ | | **LOW** |
| *Salsola spp.* | Russian thistle | n/a | √ | | **LOW** |
| *Tamarix ramosissima* | tamarisk | B | √ | √ | **HIGH – Site Plan** |
| *Tribulus terrestris* | puncturevine | C | √ | √ | **LOW** |
| *Verbascum thapsus* | common mullein | C | √ | √ | **LOW** |
| | | | | | |

Weed mapping spatial results for 2000 and 2015 is included in Figure 6. A direct comparison between the two maps is not possible because the mapping techniques differed for some of the species. In 2000, several areas were mapped more broadly to represent potential area of occupancy and not exact coverage. These areas are noted on the map. However, the point data collected in 2000 is comparable. Individual species results and recommendations are individually addressed in Section 4.0.

The location of weeds across PCD is correlated with development and soil disturbances. The riparian drainages, where many of the weed species are found, are also where many of the elements of conservation concern and PCAs are located. The soils and vegetation cover maps with the locations of weeds are provided in Figures 7 and 8.

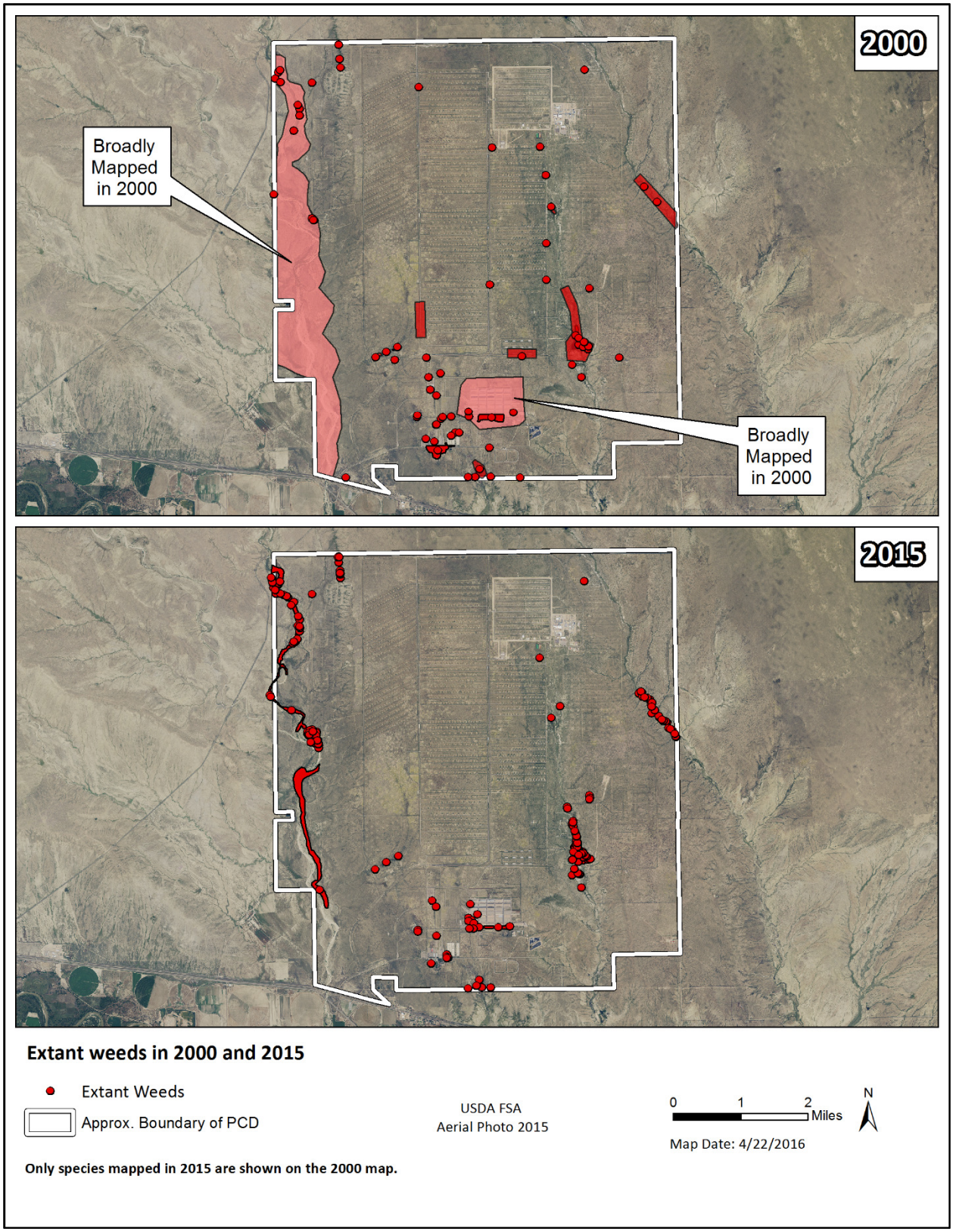


**Figure 6. Extant weed occurrences in 2000 and 2015.**

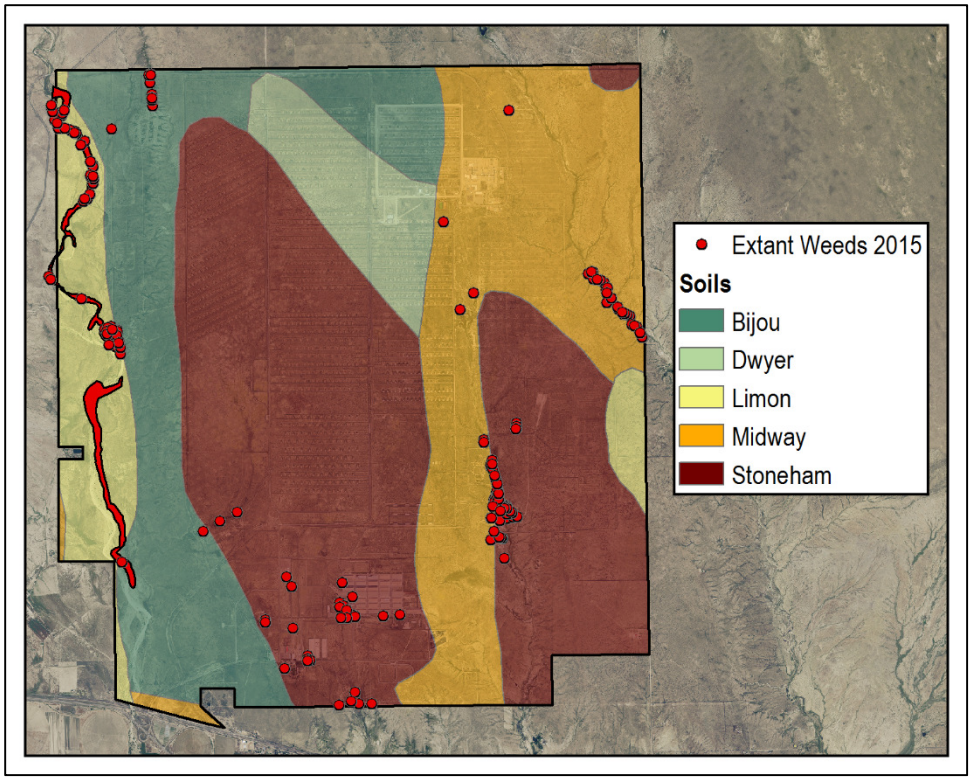


**Figure 7. Extant weed occurrences in 2015 with soils.**

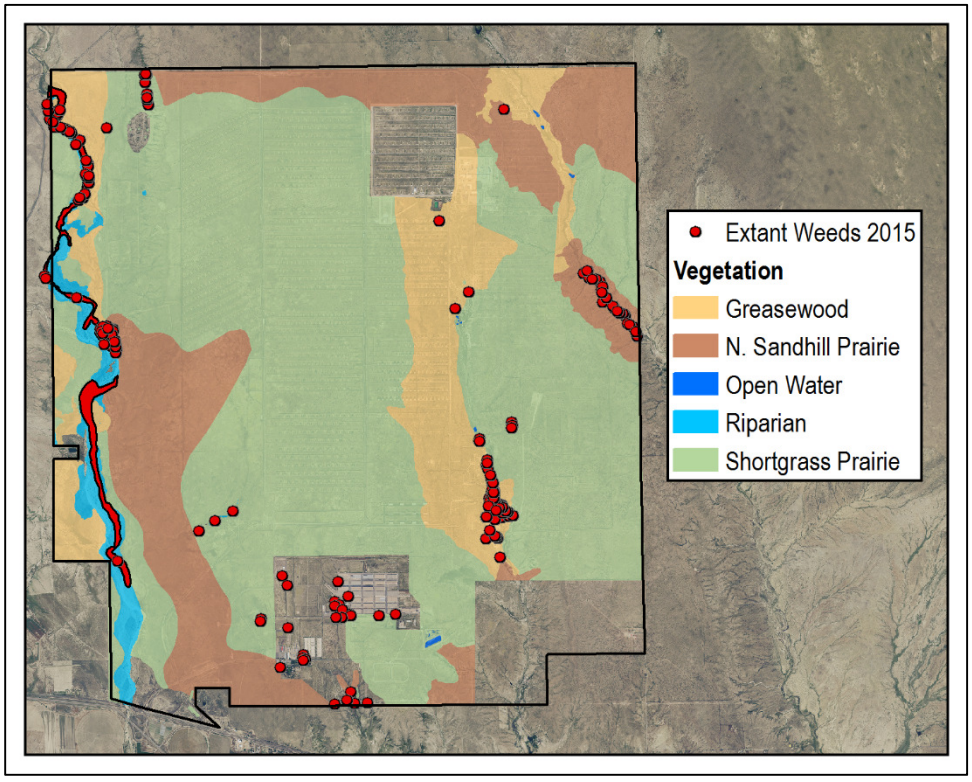


**Figure 8. Extant weed occurrences in 2015 with vegetation cover types.**

# 4.0 Monitoring Results by Species

Individual species are addressed in the following sections. Seed longevity is included to provide a guideline for post-treatment monitoring.

## 4.1 Russian Knapweed (*Acroptilon repens*)

State List B - Threat Level - potentially HIGH

- Perennial, spreading by lateral roots and from seeds
- Root buds active winter and spring
- Roots of newly established plants can expand rapidly and can be 8 ft deep (Beck 2008)
- Emerges early spring, bolts May – June, flowers into fall (CSU 2013)
- Rapid Response is still a viable treatment at the PCD
- Seed longevity: 5 years (Code of Colorado Regulations 2014)

**Photo: Russian knapweed flower, note papery non-spiny phyllaries (left) and lobed leaves with hairy stems (Photo CSU Extension JK Web).**

Russian knapweed was not previously mapped during the 2000-2001 survey (Fayette Regier 2001) and was not reported by Rust International Inc. (1996). This plant is known to be an aggressive invader with a very deep root system (8 feet deep) and is extremely difficult to control once it becomes established (Beck 2013). It spreads both vegetatively (by lateral roots) and by seed. There is currently only one known location of Russian knapweed at PCD (Figure 9). The location is already known by PCD staff and it has been treated in the past. It was observed during the 2015 survey; 200 plants were counted in a five meter radius in a shaded habitat (Table 6). All plants were in a vegetative state at the time of the survey with no flowering parts observed on September 15th.

**Table 6. Russian knapweed summary data, 2000 and 2015.**

| Russian knapweed | | | |
|---|---|---|---|
| ***Year*** | ***# Individuals*** | ***# Extant Features*** | ***Occupied Acres*** |
| 2000 | 0 | 0 | 0 |
| 2015 | 200 | 1 | Negligible (78.5 sq. meters) |
| | | | |

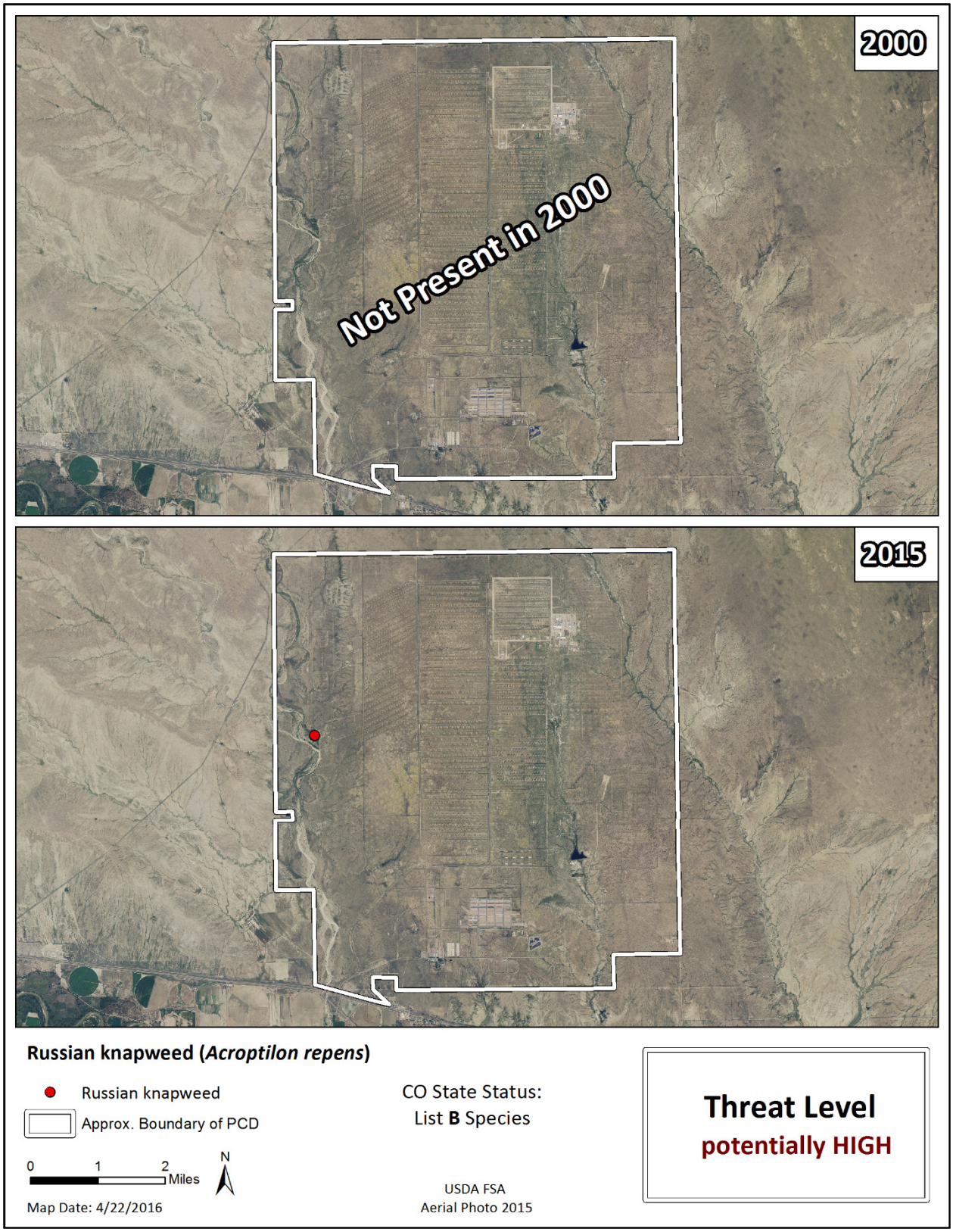


**Figure 9. Distribution of Russian knapweed at Pueblo Chemical Depot.**

Since population size and cover are both relatively small, elimination/eradication is possible and **highly recommended** because this species is extremely difficult to control once it becomes fully established. This is almost the ideal Early Detection Rapid Response scenario. However, control methods should minimize disturbances to prevent a re-establishment or an invasion by another weed species.

**A site plan should be created as soon as possible**. This plan should include:

1) A determination if treatments may be more detrimental than the presence of weed species;
2) A definitive treatment goal based on plant biology, size of the occurrence, and protection of natural resources in the area (wetlands, plants and animals);
3) A survey of weeds and native species in the treatment area;
4) Determination of the wetland status of the treatment area;
5) A plan for mitigating soil damage with native plant restoration immediately following proposed treatments;
6) Follow-up monitoring on weed treatments and plantings at appropriate intervals to determine if they are successful or need additional work.

A site plan is essential at this phase because this species has been present for more than a year and likely has had time to establish a substantial root system. Current research should be consulted when designing an integrated management plan. The time of year and the growth stage of the plants are important factors to consider for treatments as is the location of the site in a floodplain. A site survey to define the exact treatment boundary and avoid damage to surrounding native species is important to define, as native plant cover is thought to be the best defense against a re-invasion or spread (Beck 2013). Targeting treatment to individual plants (precise spot treatment vs. broadcast spray) is recommended for areas with natural resources (CPW 2013). Deep rooted plants often respond better to cut stem treatments, and although this is the most time consuming, it is the most effective method. Broadcast sprays can stimulate more root growth and subsequent spread of the plant by vegetative reproduction. In addition, non-target damage leaves open ground for more weeds. If treatments (this includes herbicides) result in bare soil patches, a plan to sow **an appropriate native seed mix that includes grasses is recommended**. Ideally, the seeds could be collected from native species near the site (Beck 2013). A combination of treatment strategies will be needed to effectively remove this population (pulling new sprouts, digging, herbicide, and native grass protection). Newly established plants can be removed mechanically (digging and hand-pulling). *This does not work with established plants because of the deep root system.* Russian knapweed is found to be very susceptible to fall-applied herbicides (Beck 2013).

Biological control is not yet available for Russian knapweed. Seed longevity is reported to be five years (Colorado Code of Regulations 2014), thus follow-up monitoring is recommended for at least five years after plants are eliminated. Monitoring post-treatment is important to determine if treatments and/or plantings are successful. Adaptive management strategies can then be determined based on the results.

## 4.2 Chicory (*Cichorium intybus*)

State List C – Threat Level - LOW

**Photo: chicory flower (CNHP 2000)**

Perennial forb native to Eurasia.

Flowers late spring into fall.

Basal rosette resembles a dandelion.

Produces a tap root.

Reproduction mainly by seeds, seed longevity is 4 years.
https://www.colorado.gov/pacific/agconservation/chicory

Prefers disturbed dry sites.

In 2000, there were four locations reported with chicory, each with only one individual, and all reported sites were in the Chico Creek drainage (Figure 10). In 2000, chicory was identified as a species to watch with a negligible coverage (Fayette Regier 2001) and this is also the case in 2015. Several plants documented in 2000 were not accessible in 2015 due to dense vegetation and were assumed extant (Table 7).

**Table 7. Chicory summary data, 2000 and 2015.**

| Chicory | | | |
|---|---|---|---|
| ***Year*** | ***# Individuals*** | ***# Extant Features*** | ***Occupied Acres*** |
| 2000 | 4 | 4 | Negligible |
| 2015 | 5 | 5* | Negligible (15.7 sq. meters) |

*Three sites documented in 2000 were not accessible in 2015 (dense vegetation) and assumed extant.

Although there are locations in Colorado where this plant can become invasive, it does not always become a problem and this appears to be the case currently at PCD. Chicory is more easily controlled than many other weed species (CSU Weed Fact Sheet http://www.colorado.gov/ag/weeds).

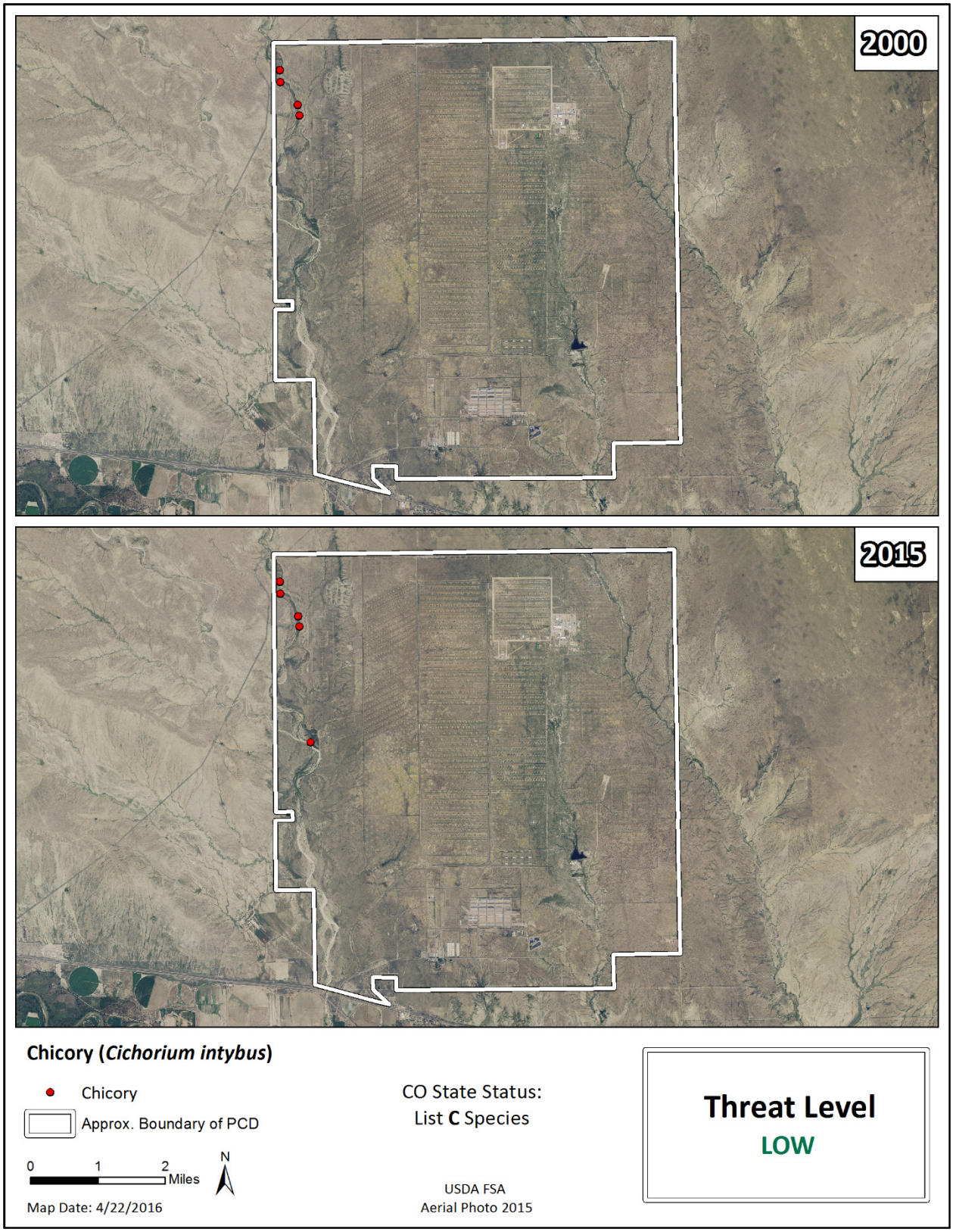


**Figure 10. Distribution of chicory at Pueblo Chemical Depot.**

## 4.3 Canada thistle (*Cirsium arvense*)

State List B -Threat Level- HIGH

- Perennial
- Horizontal and vertical root system
- Reproduction from root buds and seeds
- Seed longevity 22 years with deep burial promoting longevity (CSU 2013b)
- Susceptible to shading and inundation
- Biocontrol is available in Colorado

In 2015, there were 72 extant features that included thousands of plants with an estimated coverage of 5.6 acres. This appears to be a dramatic increase compared to the results from the 2000-2001 survey which reported a total of 13 small patches (Table 8).

**Table 8. Canada thistle summary data, 2000 and 2015.**

| Canada thistle | | | |
|---|---|---|---|
| ***Year*** | ***# Individuals*** | ***# Extant Features*** | ***Occupied Acres*** |
| 2000 | unknown | 13 | 0.5 |
| 2015 | 39,108 | 72 | 5.6 |
| | | | |

Many of the new occurrences of Canada thistle were located along Chico Creek and Boone Creek. Canada thistle was not found in the Haynes Creek drainage (Figure 11). Canada thistle is probably more common due to landscape wide hydrologic changes as well as more recent changes in the canopy vegetation. Changes in the hydrology that have occurred on the landscape can encourage the growth of non-native species because of the change in the water regime from the natural state.

Applying chemicals or using manual methods to remove weeds does not change this underlying disturbance. Recent applications of herbicide have top-killed a large percentage of mature tamarisk in Chico and Boone Creek drainages which had formed a shaded overstory. The treated areas correspond with dense areas of Canada thistle. Studies on the sudden removal of overstory species show resulting population shifts among an array of organisms, in addition to understory plants. A study conducted in Rocky Mountain National Park demonstrated that weed management practices including both chemical and mechanical treatments resulted in impacts to soils, soil biota and native plant species that were as damaging as the impacts from the Canada thistle (Pritekel et al. 2006). There is a distinctly different approach to handling weeds in natural areas versus an agricultural landscape. Unless pinpoint accuracy can be achieved, application of herbicides by aerial or broadcast methods in natural areas can damage native species and exacerbate the spread of weeds. This appears to be the case for Canada thistle. Future efforts to control Canada thistle should include the creation of a site plan before any treatment actions are taken in these areas.

This plan should include:

1) A determination if treatments may be more detrimental than the presence of weed species;
2) A definitive treatment goal based on plant biology, size of the occurrence, and protection of natural resources in the area (wetlands, plants and animals);
3) A survey of weeds and native species in the treatment area;
4) Determination of the wetland status of the treatment area;
5) A plan for mitigating soil damage with native plant restoration immediately following proposed treatments;
6) Follow-up monitoring on weed treatments and plantings at appropriate intervals to determine if they are successful or need additional work.

**Photo 1: A ring of dead vegetation produced by a broadcast method of chemical control at PCD.**

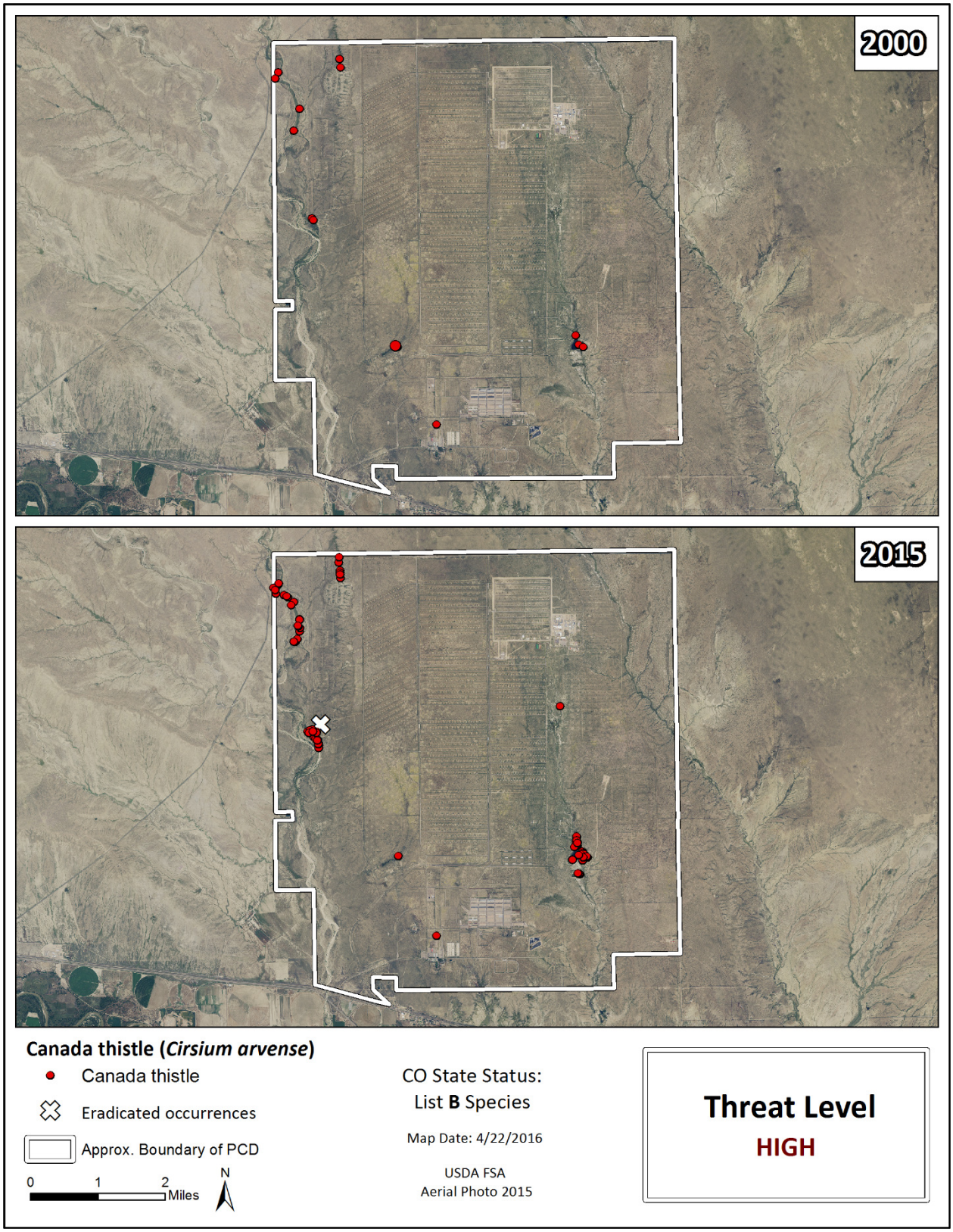


**Figure 11. Distribution of Canada thistle at Pueblo Chemical Depot.**

## 4.4 Bull thistle (*Cirsium vulgare*)

State List B - Threat level - LOW

Reproduction is only by seed

No rhizomes

Biennial forb

Often confused with native thistles

Seed longevity is thought to be relatively long when buried in the soil

Clipped flower heads can still produce seeds

**Photo: Bull thistle in flower** http://www.kingcounty.gov/environment/animalsAndPlants/noxious-weeds/weed-identification/bull-thistle.aspx

Bull thistle was reported from PCD by Rust International Inc. (1996) but was not found during the survey in 2000 (Fayette Regier 2001). Two extant features were mapped during the 2015 survey, with a total of seven individuals at two sites along an unnamed drainage east of Chico Creek in the northwestern section of PCD, near the north property boundary (Figure 12, Table 9). Native thistles were found with the bull thistle at these sites.

**Table 9. Bull thistle summary data, 2000 and 2015.**

| Bull thistle | | | |
|---|---|---|---|
| ***Year*** | ***# Individuals*** | ***# Extant Features*** | ***Occupied Acres*** |
| 2000 | 0 | 0 | Not found |
| 2015 | 7 | 2 | Negligible (31.4 sq. meters) |
| | | | |

The threat level is low for this species because of the small number of plants (<10 total) found in a small localized area. In addition, bull thistle is relatively easy to treat because it is a biennial without rhizomes or vegetative growth and spread is by seed. Bull thistle is a transitory species that does not tend to persist unless the area is continually disturbed. Preventing new infestations is key. Since the plants are in proximity to native thistle species, it is important to make sure the correct species are treated. However, treatment may not be the first choice. Currently, this population may not be threatening the local native plant populations (this can't be determined from a single visit) and continued monitoring and keeping the surrounding native vegetation intact is likely the best protective measure. If action is deemed necessary, then seed head removal (must be done more than once per growing season) or severing plant below the root crown (1 inch below soil surface) and removing seeds are recommended. Bull thistle seeds are thought to have a long life in the soil so top priority should be to avoid soil disturbances.

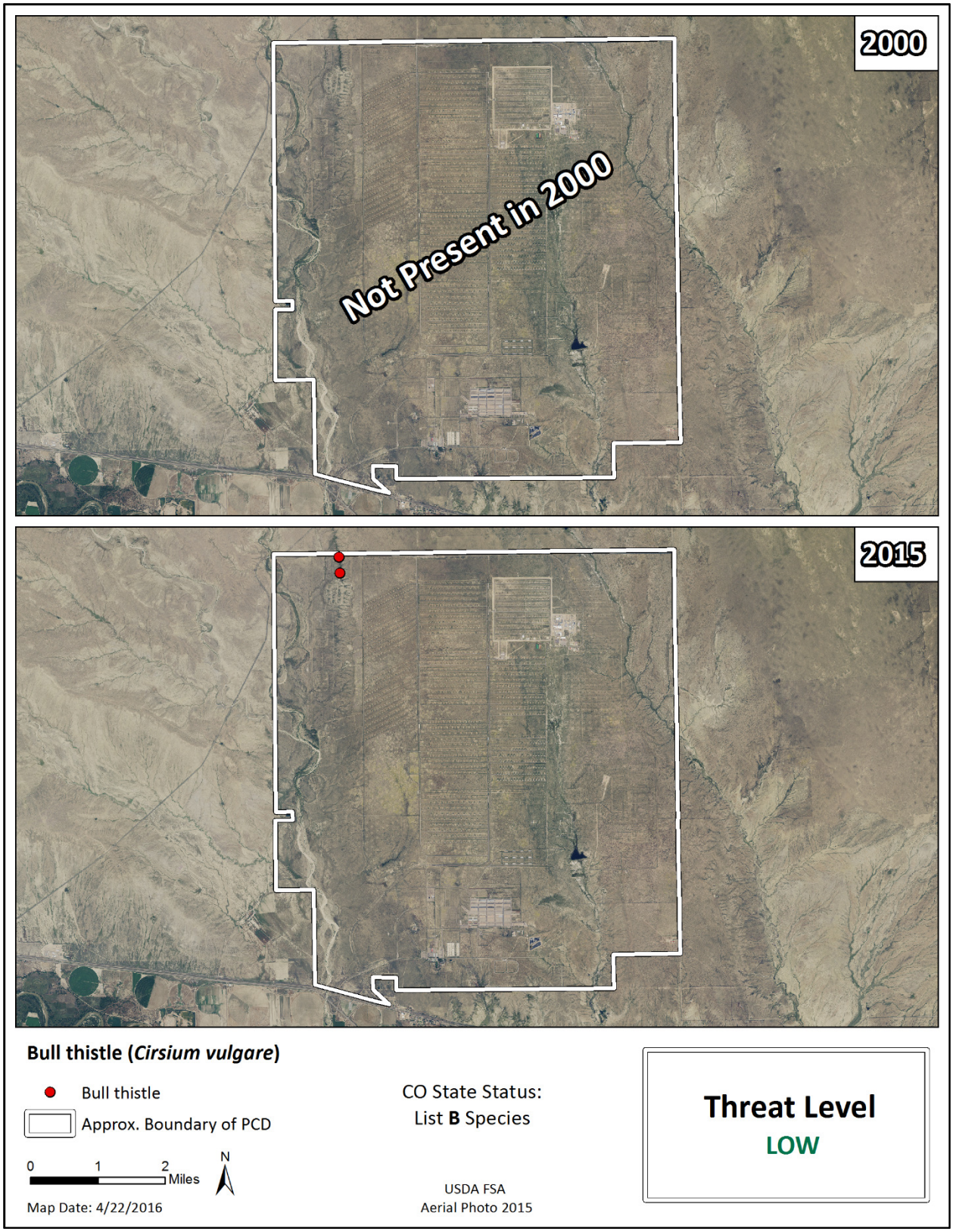


**Figure 12. Distribution of bull thistle at Pueblo Chemical Depot.**

## 4.5 Field bindweed (*Convolvulus arvensis*)

| State List C | Threat Level - LOW |
|---|---|

Perennial vine from deep, persistent spreading roots

Problematic for agriculture

Found in moist areas

Prefers bare soil

Reproduction by seed and vegetative reproduction by root buds

Seed longevity is 40 years https://www.colorado.gov/pacific/agconservation/field-bindweed

**Photo: Field bindweed flower, Michigan State University http//www.pestid.msu.eduwp-contentuploads201412Field-bindweed-flower.jpg**

At PCD, of the 15 extant features reported in 2000, only five were extant in 2015. Many of the sites were dry ditches which currently don't have moist habitat that would support field bindweed. All of the sites had much smaller occupied coverage than what was reported in the 2000 survey (Table 10, Figure 13).

**Table 10. Field bindweed summary data, 2000 and 2015.**

| Field bindweed | | | |
|---|---|---|---|
| ***Year*** | ***# Individuals*** | ***# Extant Features*** | ***Occupied Acres*** |
| 2000 | unknown | 15 | 59 |
| 2015 | 1,200 | 5 | 0.07 |
| | | | |

The most common habitat for field bindweed at PCD was roadside ditches. At this time, field bindweed does not appear to be a threat to higher quality grasslands or wetlands on the Depot. Any efforts to control this species would likely result in the spread of other non-native species (especially smooth brome) and plantings with native species could be difficult because of the disturbed nature of the extant sites. Overall, field bindweed appears to have declined since 2000 and the threat level appears to be very low at this time. Continued monitoring may be warranted in years with higher rainfall. However, no active treatments are recommended at this time.

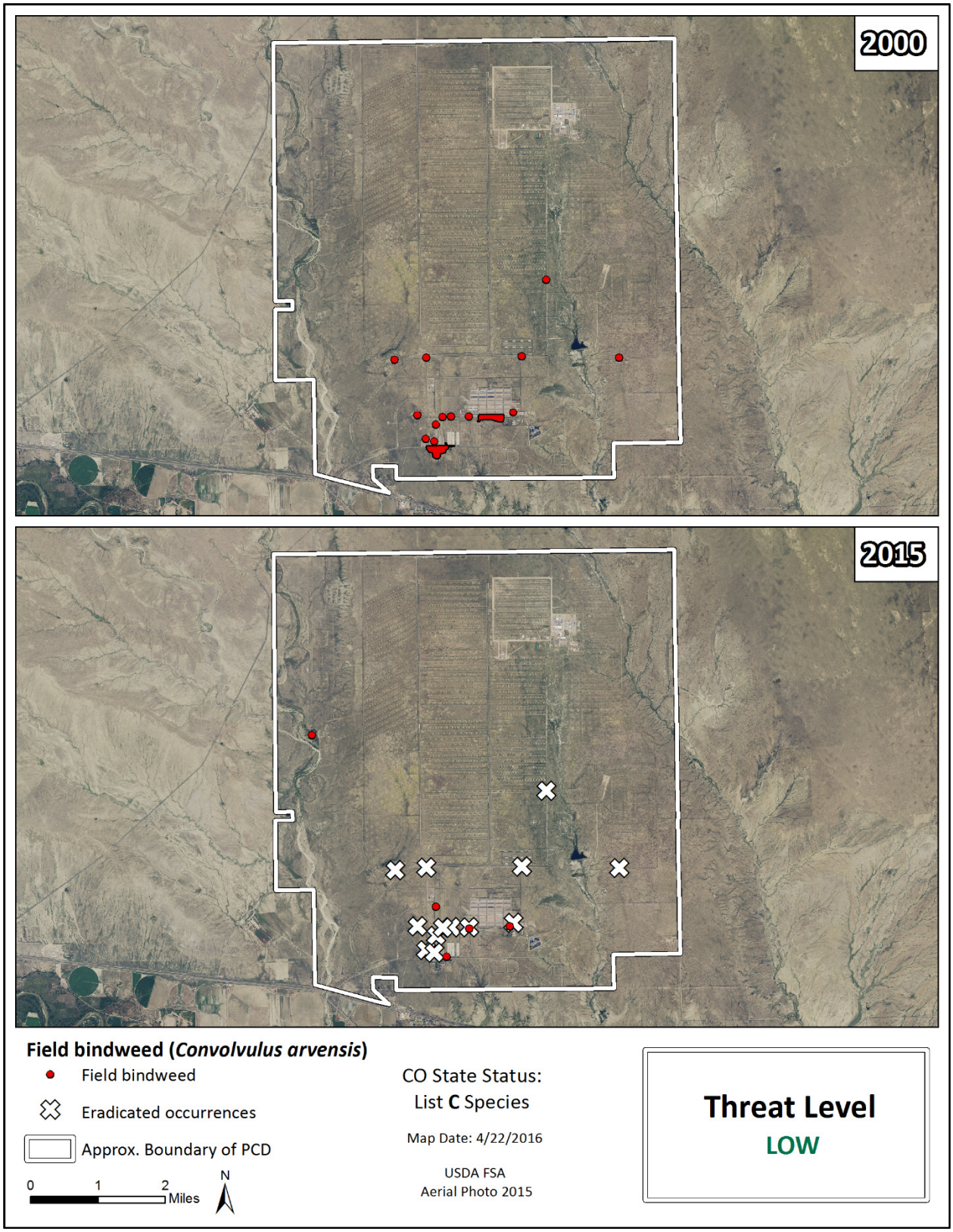


**Figure 13. Distribution of field bindweed at Pueblo Chemical Depot.**

## 4.6 Russian olive (*Elaeagnus angustifolia*)

State List B

Threat Level - LOW

Perennial multi-stemmed shrub or tree

Deep penetrating well-developed roots

Can be associated with N-fixing bacteria

Reproduction by seed and post injury sprouting – it can sprout from trunk, crown or roots after injury or top-kill (FEIS www.fs.fed.us )

Seeds can be viable for three years (na.fs.fed.us )

**Photo: Russian olive along Chico Creek 2015. P. Smith**

**Photo: Russian olive along Boone Reservoir, P. Smith**

In 2015, sixteen sites (representing 36 individuals) had Russian olive (Table 11). Two of the extant sites included trees that were dead standing trees with no sprouts (two points SW of Boone Reservoir). In 2000, six extant features were mapped (Figure 14).

**Table 11. Russian olive summary data, 2000 and 2015.**

| Russian Olive | | | |
|---|---|---|---|
| ***Year*** | ***# Individuals*** | ***# Extant Features*** | ***Occupied Acres*** |
| 2000 | unknown | 6 | unknown |
| 2015 | 36 | 16 | 0.4 |
| | | | |

Russian olive is not common at PCD and is at a level where elimination is an option. A plan should be in place to monitor all sites after treatments look for sprouting which could result in an increase in cover. If a plan is not in place for post-treatment monitoring, not treating trees could be a better choice. Also, an appropriate chemical that is approved for wetlands should be used as all occurrences are in riparian and wetland areas. (See Forest Invasive Plants Resource Center Fact Sheet http://na.fs.fed.us/spfo/invasiveplants/factsheets/pdf/autumn-and-russian-olive.pdf).

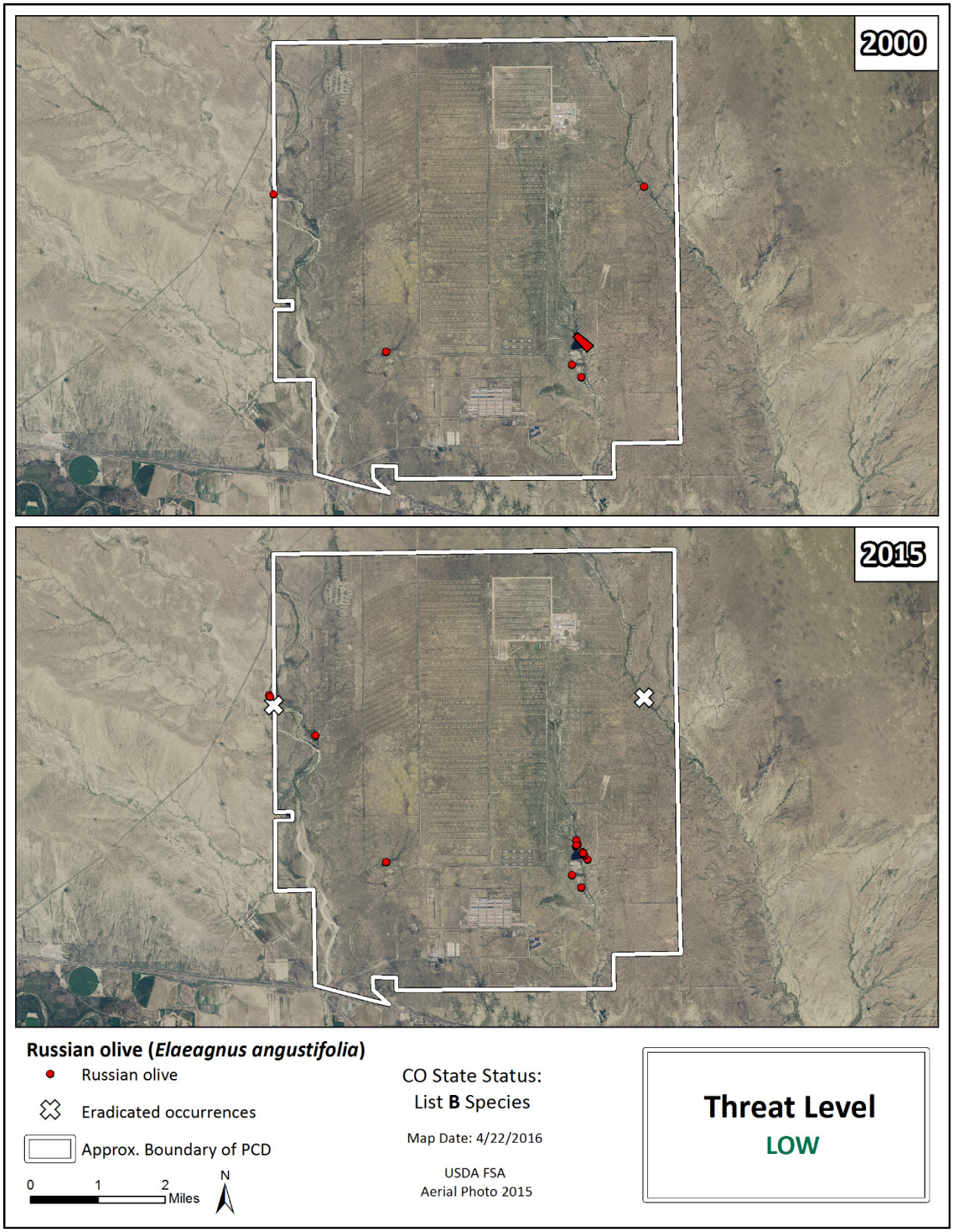


**Figure 14. Distribution of Russian olive at Pueblo Chemical Depot.**

## 4.7 Tamarisk (*Tamarix ramosissima*)

State List B - Threat level - HIGH

Shrub or small tree

Reproduction by submerged roots, stems and by seed

Seed longevity ~45 days

**Left Photo: Tamarisk at Boone Reservoir, P. Smith 2015; right photo: Inflorescence, Calphotos.berkely.edu**

Tamarisk, also known as salt cedar, is one of the most widespread weeds at PCD. It was mapped broadly in 2000 and has been refined in this survey. The occupied acres reported for 2000 likely reflect the entire area of potential habitat and not just the locations of the tamarisk (Table 12, Figure 15). Because this drainage was mapped so broadly it is difficult to determine whether the population of tamarisk has increased or decreased in Chico Creek since 2000. Currently, approximately 75% of Chico Creek on PCD has tamarisk in the drainage, with most of it sprouting from top-killed shrubs (Photo 2).

**Table 12. Tamarisk summary data, 2000 and 2015.**

| Tamarisk | | | |
|---|---|---|---|
| ***Year*** | ***# Individuals*** | ***# Extant Features*** | ***Occupied Acres*** |
| 2000 | unknown | 22 | 2,176* |
| 2015 | 1,284** | 83 | 237.7 |

*Broadly mapped in 2000, acreage reflects area of potential habitat
**Number of individuals in 2015 was extrapolated from exact counts at several sites

**Photo 2. Tamarisk in the Chico Creek drainage at PCD, P. Smith 2015.**

Aerial herbicide applications of tamarisk removed canopy cover and this appears to have exacerbated the growth of Canada thistle. Tamarisk is also found in other drainages and in isolated patches across PCD (Figure 15). The reasons tamarisk and the Canada thistle are common in the Chico Creek drainage is likely linked to hydrologic changes that support non-native species over the native cottonwoods and willows. Applying chemicals or using manual methods to remove these weeds does not change the disturbance in the water regime which likely occurred many years ago and upstream of PCD. In addition, the disturbance left by the chemical treatment of the tamarisk is wider than the initial tamarisk invasion and a corresponding increase in other noxious weed species has resulted. The majority (up to 90% in some areas) of the treated tamarisk that were top-killed are now re-sprouting. The overspray from the aerial application to non-target species has resulted in thick dense bands of non-native species with bare soils and kochia in the dryer riparian sites, and thick stands of Canada thistle in the wet areas (Photo 3). Aerial applications of herbicides are only recommended when there is a dense monoculture and not when tamarisk is mixed with riparian plant species because of the non-target harm to native vegetation and other organisms (Tamarisk Coalition 2008; Stromberg et al. 2005).

**Photo 3. Left gray band is sprouting top-killed tamarisk with dense understory of Canada thistle, central green band is dense cover of kochia and outer band is bare soil and dead kochia along northern section Chico Creek at PCD resulting from aerial application(s) of herbicide, P. Smith 2015.**

Although the threat level is high, tamarisk has been present for many years. It was reported as a dominant in 2000 at PCD (Fayette Regier 2001). It is difficult to treat tamarisk at PCD without addressing landscape wide impacts and considering restoration work that will encourage the growth of the cottonwoods and willows over the tamarisk. The most successful restorations are typically small sites (FEIS 2016).

Biocontrol has been widely used and there is sufficient cover to support it. However, no matter how the plants are removed from this system, if there are no changes other than removing the plant, the area will most likely fill in with noxious weeds. **A site plan is highly recommended for the Chico Creek drainage to determine how to move forward** without causing additional ecological disturbances to this drainage.

A site plan should include:

1) A determination if treatments may be more detrimental than the presence of weed species;
2) A definitive treatment goal based on plant biology, size of the occurrence, and protection of natural resources in the area (wetlands, plants and animals);
3) A survey of weeds and native species in the treatment area;
4) Determination of the wetland status of the treatment area;

5) A plan for mitigating soil damage with native plant restoration immediately following proposed treatments;
6) Follow-up monitoring on weed treatments and plantings at appropriate intervals to determine if they are successful or need additional work.

Aerial application of herbicide is not recommended for areas where there is not a monoculture of tamarisk and where precise application is not possible because of the effects to soil and non-target plants (Photo 3).

Isolated sites along Haynes Creek and other scattered locations (see Figure 15) can be treated with a cut stump method. Stumps need to be cut as close to the ground as possible and herbicide (triclopyr or imazapyr) should be applied immediately (within 1 minute) after cutting to the perimeter of the stem. Resprouts should be retreated 4 to 12 months later (CPW 2013) so a monitoring plan should be in place if treatments are conducted to check for re-sprouts.

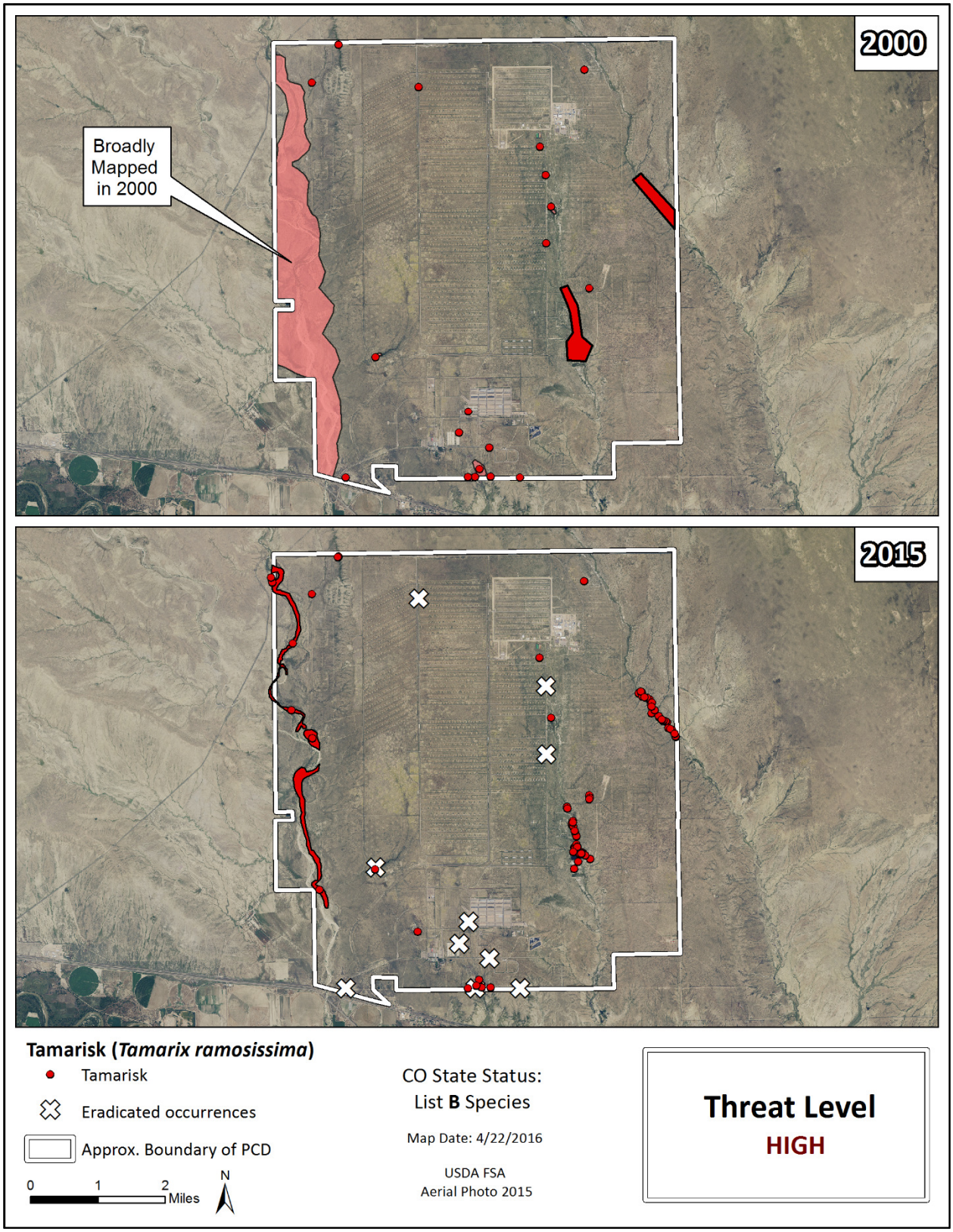


**Figure 15. Distribution of tamarisk at Pueblo Chemical Depot.**

## 4.8 Puncturevine (*Tribulus terrestris*)

State List C Threat Level - LOW

**Photos: Left leaves with spiny "goathead" shaped fruits P. Smith, top center fruit (invasives.org), top right flowers, Wikimedia Commons, right lower photo is sprawling nature of plant at PCD, P. Smith 2015.**

Summer annual forb with yellow flowers

Mat forming

Biocontrol organisms have been introduced in the US

Seeds are viable for 4-5 years

Puncturevine was not considered a noxious weed for the 2000-2001 survey (Fayette Regier 2001) but it was listed as one of the non-native species known from PCD by Rust International, Inc. (1996). The Noxious Weed List for Colorado currently recognizes this plant as a List C noxious weed and it was included on the target list for 2015. A single site was mapped at parking lot area on the south central section of PCD (Table 13, Figure 16).

Currently, the threat level is low because the population is very small. Puncturevine is an annual species with a shallow root system, so it is considered relatively easy to control. In addition, the threat level is low because of the location in a highly developed area.

If treatments are deemed necessary, mechanical removal is recommended. The invaded area at PCD is relatively small. Removing the seeds (in the spiny fruits) is the most important aspect of treatment. After plants are pulled, finding and removing the dropped fruits (patting the ground with a piece of carpet works well) is important for successful control (UC Davis IPM website: http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74128.html ). As with any soil disturbance, a follow-up planting is advised or more weeds will likely replace the puncturevine. Post-treatment follow-up monitoring to see if plants are returning should be continued for at least five years based on seed longevity (https://www.colorado.gov/pacific/agconservation/puncturevine ). Dispose of the seeds carefully to prevent growth in another area.

**Table 13. Puncturevine summary data, 2000 and 2015.**

| Puncturevine | | | |
|---|---|---|---|
| ***Year*** | ***Estimated # Individuals*** | ***# Extant Features*** | ***Occupied Acres*** |
| 2000 | Not mapped – not on target weed survey list | | |
| 2015 | 500 | 1 | 0.3 |
| | | | |

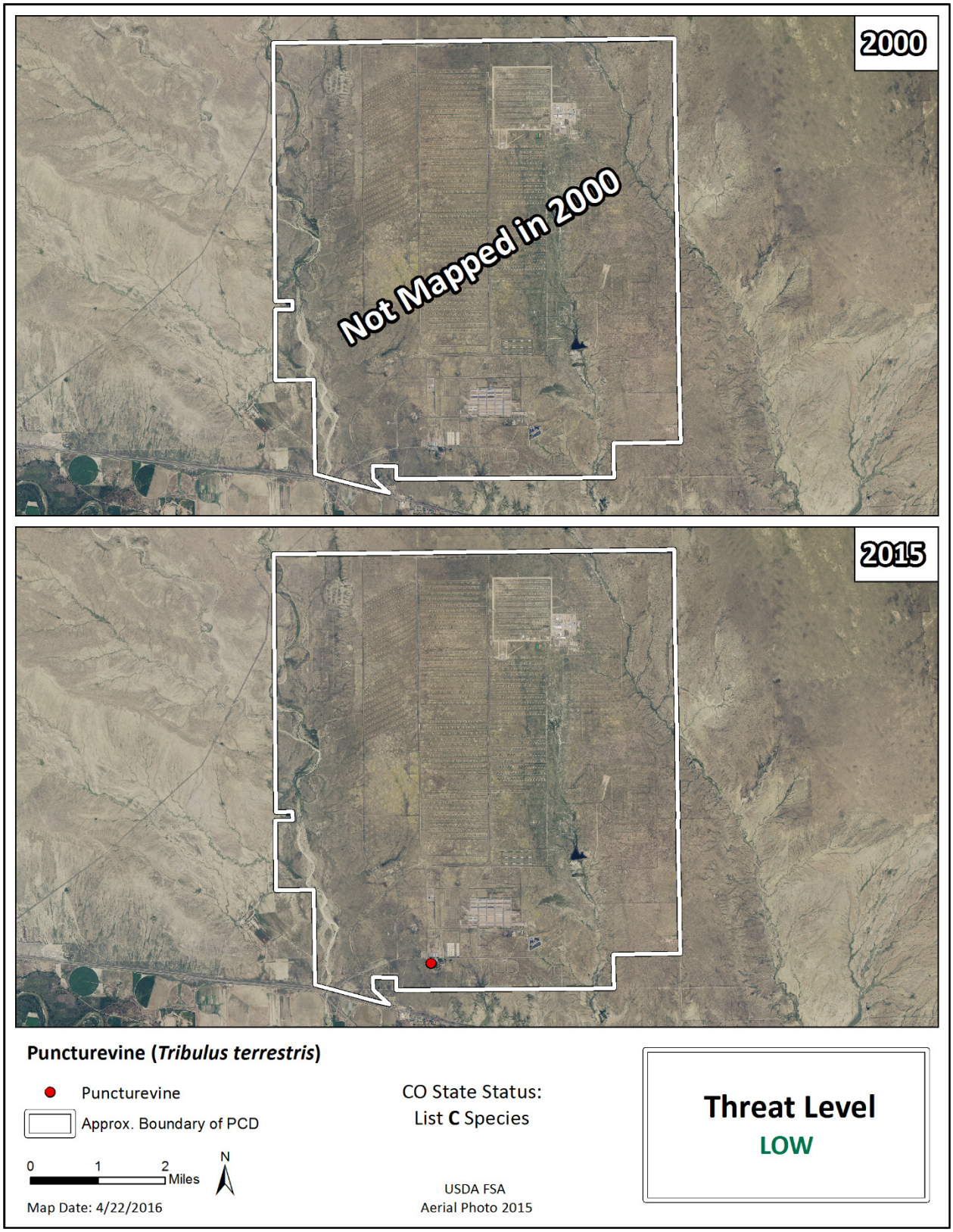


**Figure 16. Distribution of puncturevine at Pueblo Chemical Depot.**

## 4.9 Common mullein (*Verbascum thapsus*)

State List C - Threat Level LOW

**Photo top left: common mullein plant, © Dr. Alfred Brousseau, Saint Mary's College, top right close-up flowers, Wikimedia Commons, bottom right rosette, Wikimedia Commons.**

- Biennial that can exceed 2 meters in height, plant is densely wooly
- Reproduction is solely by seed, plants can be self-fertile or insect pollinated
- Seeds small and not adapted for long distance transport most fall within 3 m of plant (FEIS 2015)
- Seed longevity long-lived and persistent
- Plants are transitory and do not tend to persist
- Biocontrol has not been approved for Colorado

Common mullein was previously mapped at 15 sites at PCD. Fayette Regier (2001) calculated 472 acres of coverage, although occupied acres reported for 2000 likely reflect the entire area of potential habitat and not just the locations of mullein. In 2015, 16 extant features were mapped (Table 14, Figure 17)

**Table 14. Common mullein summary data, 2000 and 2015.**

| Common mullein | | | |
|---|---|---|---|
| ***Year*** | ***# Individuals*** | ***# Extant Features*** | ***Occupied Acres*** |
| 2000-2001 | unknown | 15 | 472* |
| 2015 | 2,203 | 16 | 13.2 |
| | | | |

*Broadly mapped in 2000, acreage reflects area of potential habitat

The most effective control is to minimize disturbance and prevent plants from colonizing new areas. Common mullein is eventually replaced by shrubs in natural landscapes. Decision making guidelines should be created on whether to actively manage the weeds for the following reasons: 1) common mullein is difficult to treat with chemicals due to dense hairs, 2) common mullein is an early succession plant and tends to fade with time and 3) at PCD, common mullein is typically found in developed and disturbed settings around buildings, roads and parking lots (Photo 4).

**Photo 4. Common mullein habitat at PCD, P. Smith 2015.**

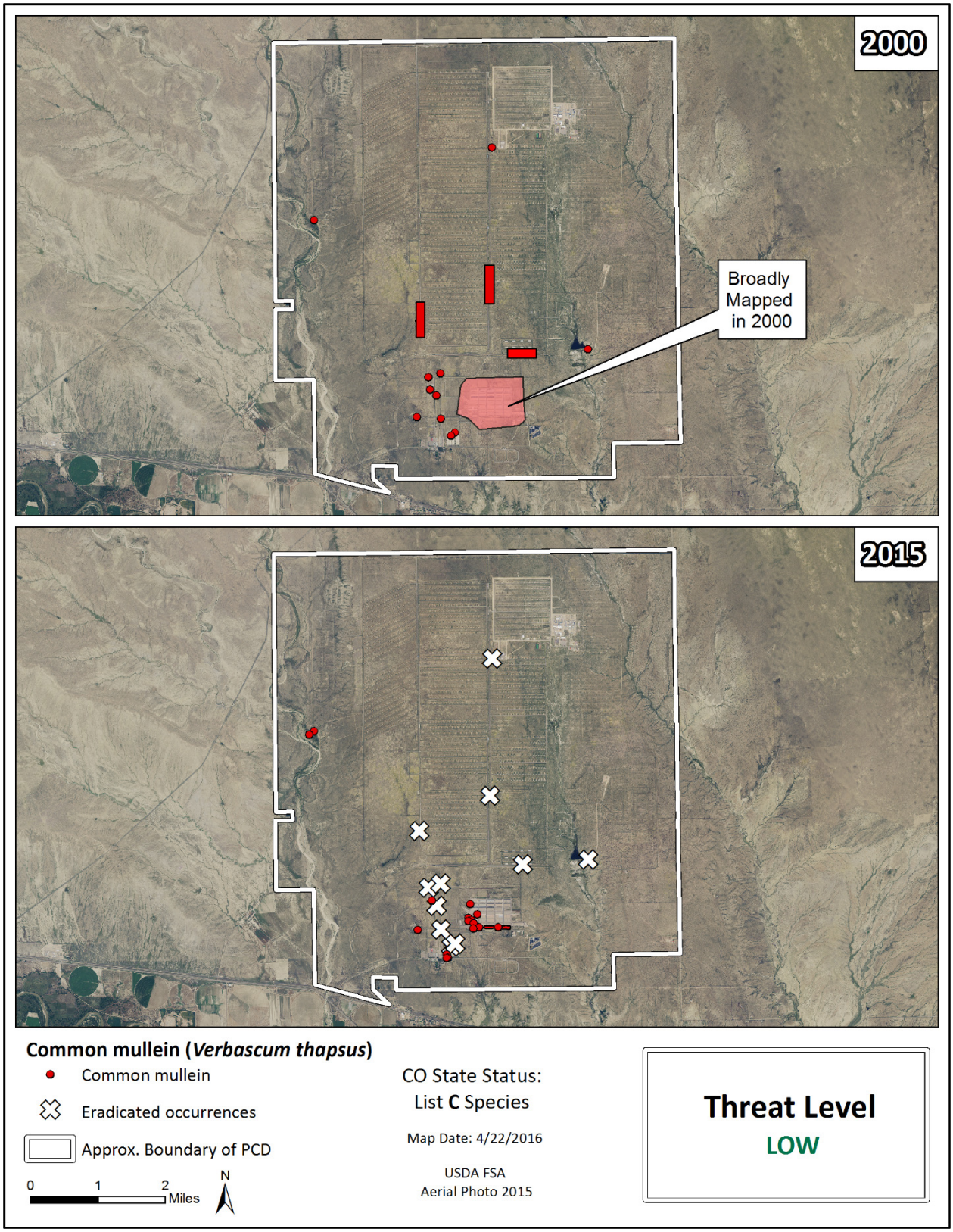


**Figure 17. Distribution of common mullein at Pueblo Chemical Depot.**

# 5.0 RECOMMENDATIONS FOR SPECIES NOT ON THE 2015 TARGET LIST

Kochia (*Kochia scoparia*), Russian thistle (*Salsola* spp.), cheatgrass (*Bromus tectorum*), white and yellow sweetclovers (*Melilotus albus, M. officinale*) and buffalobur (*Solanum rostratum*) were not mapped for the 2015 survey. All of these species were mapped in 2000 and were considered target species. Reasons for not mapping them in 2015 and recommendations for future management are included in the sections below.

## 5.1 Kochia and Russian thistle

Kochia and Russian thistle tend to move into highly disturbed sites and decline naturally over time. Although these species are widespread at PCD, they do not typically cause extensive problems and actually may serve as good cover until other species of the next seral stage can begin to move into disturbed areas. Seed longevity in soil is extremely short and both species are useful forage for wildlife. These two annual species are not currently listed as noxious weeds on the Colorado State Noxious Weed List. Therefore, the only action recommended at this time is to limit soil disturbances where possible and avoiding overspray when herbicides are applied.

## 5.2 Cheatgrass

Cheatgrass is widespread at PCD and across North America. This List C species is an annual grass that grows very early in the season ahead of many native grasses and can continue to sprout throughout the summer. Reasons for infestations are complicated but are often linked to disturbance. Currently, protecting existing native landscapes at PCD is one of the best ways to prevent cheatgrass invasions. New research may allow land managers to understand and potentially control cheatgrass and other non-native brome species on a site by site basis (Germino et al. 2015).

## 5.3 White and yellow sweetclovers

The sweetclovers are not currently on the Colorado list of noxious weeds. These species, which can act as annuals, biennials or perennials (USDA Plants) were intentionally introduced to the U.S. from Eurasia as livestock feed, for soil reclamation, food source for bees, wildlife forage, soil stabilization and for crop rotations https://en.wikipedia.org/wiki/Melilotus_officinalis. In addition, sweet clover cover can vary greatly from year to year making monitoring and treatments complicated. Although sweetclovers rapidly colonize bare, low nutrient soils, they rarely persist as a dominant (FEIS 2015). No actions are recommended at this time.

## 5.4 Buffalobur

Buffalobur is a native species with low cover and not a state listed noxious weed. Therefore, no actions are recommended at this time.

# 6.0 Weed Species Watch List

There are four species that are on the state noxious weed list that have been documented either in the vicinity or on the property at PCD (Rust International 1996, Fayette Regier 2001). None of these species were observed during the 2015 survey but should be on a watch list for PCD resource managers (Table 15).

**Table 15. Noxious weed species observed in the vicinity or on the property of PCD from previous surveys that were not observed in 2015.**

| *Scientific Name* | *Common Name* | *Colorado Weed List Status (2014 Rule)* | *Observation Location* | *Source* |
|---|---|---|---|---|
| | | | | |
| *Cardaria draba* | Whitetop (hoary cress) | B | Vicinity of PCD in riparian area | Fayette Regier 2001 |
| *Conium maculatum* | poison hemlock | C | PCD wetlands, riparian woodlands | Rust International Inc. 1996 |
| *Elytrigia (Elymus) repens* | quackgrass | C | PCD on shortgrass prairie, disturbed landscapes | Rust International Inc. 1996 |
| *Phragmites australis* | common reed | State Watch List | PCD wetlands, riparian woodlands | Rust International Inc. 1996 |

# 7.0 SUMMARY OF RECOMMENDATIONS

- **Protection of undisturbed sites is the best preventative measure** to prevent increases in weeds at PCD.
- Monitoring weeds may be a viable first step to determine if treatments are necessary.
- The impacts of any proposed treatment should be considered. All weed treatments have the potential to cause harm to soils, wildlife and native plant species.
- Before any weed treatments (biological, cultural or chemical) are commenced for the three High Threat Level species (Canada thistle, tamarisk and Russian knapweed), a **site plan** should be in place. If a site plan is not prepared, treatments are not recommended.
- Continue to monitor noxious weeds known from PCD yearly if possible to understand trends (increases or decreases).
- Refer to Section 4 for information on individual species.
- Survey for "watch list" species that have been previously documented at the site or in the vicinity.

# 8.0 REFERENCES


Beck, K.G. 2008. Russian knapweed fact sheet no. 3.111. Colorado State University Extension, Fort Collins, CO.

Beck, K.G. 2013. Fact Sheet 3.110. Colorado State University Extension. www.ext.colostate.edu

Code of Colorado Regulations. 2014. Secretary of State, State of Colorado, Department of Agriculture, Conservation Services Division. 8 CCR 1206-2 Rules Pertaining to the Administration and Enforcement of the Colorado Noxious Weed Act:

http://www.sos.state.co.us/CCR/GenerateRulePdf.do?ruleVersionId=6027&fileName=8%20CCR%201206-2

Colorado Natural Heritage Program (CNHP). 2015. Biodiversity Tracking and Conservation System. Fort Collins, CO: Colorado State University.

CPW. 2013. Colorado Parks and Wildlife; Weed management Techniques and Prevention BMPs. Colorado Natural Areas Program. http://cpw.state.co.us/aboutus/Pages/RS-NoxiousWeedsSpeciesProfiles.aspx

CSU 2013. Colorado State University Extension: Colorado Noxious Weed Fact Sheets Russian thistle. Website accessed 3/2015 http://www.ext.colostate.edu/pubs/natres/03111.html

CSU 2013b. Colorado State University Extension: Colorado Noxious Weed Fact Sheets: Canada thistle. Website accessed 3/2015 http://www.ext.colostate.edu/pubs/natres/03108.pdf

Doyle, G., J. Gionfriddo, D. Anderson and D. Culver. 2001. Survey of Critical Wetlands and Riparian Areas in El Paso and Pueblo Counties, Colorado. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO

Fayette Regier, K. 2001. Pueblo Noxious Weed Mapping. Produced for Department of the Army by the Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO

Fire Effects Information System (FEIS) 2015. USFS Sweetclovers, Common mullein
http://www.fs.fed.us/database/feis/plants/forb/melspp/all.html
http://www.fs.fed.us/database/feis/plants/forb/vertha/all.html

Fire Effects Information System (FEIS) 2016 Tamarisk
http://www.fs.fed.us/database/feis/plants/tree/tamspp/all.html

Germino, M.J., J.C. Chambers, C.S. Brown. eds. 2015. *Exotic Brome-Grasses in Arid and Semiarid Ecosystems of the Western US: Causes, Consequences, and Management Implications*. 1st Ed. 475 pp. Springer

Hornaday, W.T. 1998. The extermination of the American Bison, with a sketch of its discovery and life history. PP. 369-548 in Report of the National Museum, 1996-'87. Smithsonian Institution. United States National Museum, Washington, D.C.

Lavender-Greenwell, A. and R. Rondeau. 2013. Noxious Weed Survey of the U.S. Air Force Academy and Farish Outdoor Recreation Area – 2012. Produced for the U.S. Air Force Academy by the Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Pritekel, C., A. Whittemore-Olson, N. Snow, J. C. Moore. 2006. Impacts from invasive plant species and their control on the plant community and belowground ecosystem at Rocky Mountain National Park, USA. Applied Soil Ecology. 32(1):132-141.

Rondeau, R.J. and S.M. Kettler. 1999. Pueblo Chemical Depot vegetation monitoring: 1998 results. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Rondeau, R.J. 2001. Vegetation monitoring at Pueblo Chemical Depot 1998-2000. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Rondeau, R.J. 2003. Vegetation monitoring at Pueblo Chemical Depot 1998-2002. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Rondeau, R.J. 2013. Vegetation Monitoring at Pueblo Chemical Depot: 1999-2010. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Rondeau, R.J., G.A. Doyle and K. Decker. 2016. Vegetation Monitoring at Pueblo Chemical Depot 1999-2015. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO

Rust International Inc. 1996. Ecological Surveys at Pueblo Chemical Depot, Pueblo, Colorado: Vol. I. Engelwood CO.

Sovell, J. R. 2000. Pueblo Chemical Depot grasshopper monitoring: 1999 results. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Sovell, J.R. and S. Schneider. 2001. Pueblo Chemical Depot Grassshopper Monitoring: 2001 Results. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Sovell, J. R. 2002. Pueblo Chemical Depot grasshopper monitoring: 2002 results. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Sovell, J., B. Wunder, P. Lukacs, J. Gionfriddo, and J. Siemers. 2006. Population parameters and fat composition of small mammals on Pueblo Chemical Depot (2000-2003). Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Sovell, J. 2006. Grasshopper monitoring on Pueblo Chemical Depot (2001-2003). Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO

Spackman Panjabi, S., J. Sovell, G. Doyle, D. Culver and L. Grunau. 2003. Survey of Critical Biological Resources of Pueblo County, Colorado. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO

Stromberg, J., S. Lite and C. Paradzick. 2005. Tamarisk and River Restoration Along the San Pedro and Gila Rivers. USDA Forest Service Proceedings RMRS-P-36.

Tamarisk Coalition. 2008. Riparian Restoration: Assessment of Alternative Technologies for Tamarisk Control, Biomass Reduction and Revegetation. rev. July 2008.

U. S. Department of Agriculture (USDA) Soil Conservation Service. 1979. Soil survey of Pueblo Area, Colorado: parts of Pueblo and Custer Counties. 92 pp.

# APPENDIX A. THE NATURAL HERITAGE RANKING SYSTEM

Key to the functioning of Natural Heritage Programs is the concept of setting priorities for gathering information and conducting inventories. The number of possible facts and observations that can be gathered about the natural world is essentially limitless. The financial and human resources available to gather such information are not. Because biological inventories tend to be under-funded, there is a premium on devising systems that are both effective in providing information that meets users' needs and efficient in gathering that information. The cornerstone of Natural Heritage inventories is the use of a ranking system to achieve these twin objectives of effectiveness and efficiency.

Ranking species and ecological communities according to their imperilment status provides guidance for where Natural Heritage Programs should focus their information-gathering activities. For species and communities deemed secure, only general information needs to be maintained by Natural Heritage Programs. Fortunately, these constitute the majority of most groups of organisms. On the other hand, for those species and communities that are by their nature rare, more detailed information is needed. Because of their rarity, gathering comprehensive and detailed data can be less daunting than gathering similarly comprehensive information on more abundant species.

To determine the status of species within Colorado, CNHP gathers information on plants, animals, and plant communities. Each of these elements of natural diversity is assigned a rank that indicates its relative degree of imperilment on a five-point scale (for example, 1 = extremely rare/imperiled, 5 = abundant/secure). The primary criterion for ranking elements is the number of occurrences (in other words, the number of known distinct localities or populations). This factor is weighted more heavily than other factors because an element found in one place is more vulnerable to extinction than something found in twenty-one places. Also of importance are the size of the geographic range, the number of individuals, the trends in both population and distribution, identifiable threats, and the number of protected occurrences.

Element imperilment ranks are assigned both in terms of the element's degree of imperilment within Colorado (its State-rank or S-rank) and the element's imperilment over its entire range (its Global-rank or G-rank). Taken together, these two ranks indicate the degree of imperilment of an element. For example, the lynx, which is thought to be secure in northern North America but is known from less than five current locations in Colorado, is ranked G5 S1 (globally-secure, but critically imperiled in this state). The Rocky Mountain Columbine, which is known only in Colorado from about 30 locations, is ranked a G3 S3 (vulnerable both in the state and globally, since it only occurs in Colorado and then in small numbers). Further, a tiger beetle that is only known from one location in the world at the Great Sand Dunes National Monument is ranked G1 S1 (critically imperiled both in the state and globally, because it exists in a single location). CNHP actively collects, maps, and electronically processes specific occurrence information for animal and plant species considered extremely imperiled to vulnerable in the state (S1 - S3). Several factors, such as

rarity, evolutionary distinctiveness, and endemism (specificity of habitat requirements), contribute to the conservation priority of each species. Certain species are "watchlisted," meaning that specific occurrence data are collected and periodically analyzed to determine whether more active tracking is warranted.

Definition of Natural Heritage Imperilment Ranks:

| | |
|---|---|
| **G/S1** | Critically imperiled globally/state because of rarity (5 or fewer occurrences in the world/state; or 1,000 or fewer individuals), or because some factor of its biology makes it especially vulnerable to extinction. |
| **G/S2** | Imperiled globally/state because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make it very vulnerable to extinction throughout its range. |
| **G/S3** | Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals). |
| **G/S4** | Apparently secure globally/state, though it may be quite rare in parts of its range, especially at the periphery. Usually more than 100 occurrences and 10,000 individuals. |
| **G/S5** | Demonstrably secure globally/state, though it may be quite rare in parts of its range, especially at the periphery. |
| **G/SX** | Presumed extinct globally, or extirpated within the state. |
| **G#?** | Indicates uncertainty about an assigned global rank. |
| **G/SU** | Unable to assign rank due to lack of available information. |
| **GQ** | Indicates uncertainty about taxonomic status. |
| **G/SH** | Historically known, but usually not verified for an extended period of time. |
| **G#T#** | Trinomial rank (T) is used for subspecies or varieties. These taxa are ranked on the same criteria as G1-G5. |
| **S#B** | Refers to the breeding season imperilment of elements that are not residents. |
| **S#N** | Refers to the non-breeding season imperilment of elements that are not permanent residents. Where no consistent location can be discerned for migrants or non-breeding populations, a rank of SZN is used. |
| **SZ** | Migrant whose occurrences are too irregular, transitory, and/or dispersed to be reliably identified, mapped, and protected. |

| | |
|---|---|
| **SA** | Accidental in the state. |
| **SR** | Reported to occur in the state but unverified. |
| **S?** | Unranked. Some evidence that species may be imperiled, but awaiting formal rarity ranking. |

Note: Where two numbers appear in a state or global rank (for example, S2S3), the actual rank of the element is uncertain, but falls within the stated range.

This single rank system works readily for all species except those that are migratory. Those animals that migrate may spend only a portion of their life cycles within the state. In these cases, it is necessary to distinguish between breeding, non-breeding, and resident species. As noted in Table 1, ranks followed by a "B," for example S1B, indicate that the rank applies only to the status of breeding occurrences. Similarly, ranks followed by an "N," for example S4N, refer to non-breeding status, typically during migration and winter. Elements without this notation are believed to be year-round residents within the state.

# APPENDIX B. POTENTIAL CONSERVATION AREAS

In order to successfully protect populations or occurrences, it is helpful to delineate Potential Conservation Areas (PCAs). These PCAs focus on capturing the ecological processes that are necessary to support the continued existence of a particular element occurrence of natural heritage significance. Potential Conservation Areas may include a single occurrence of a rare element, or a suite of rare element occurrences or significant features.

The PCA is designed to identify a land area that can provide the habitat and ecological processes upon which a particular element occurrence, or suite of element occurrences, depends for its continued existence. The best available knowledge about each species' life history is used in conjunction with information about topographic, geomorphic, and hydrologic features; vegetative cover; and current and potential land uses. In developing the boundaries of a PCA, CNHP scientists consider a number of factors that include, but are not limited to:

- ecological processes necessary to maintain or improve existing conditions;
- species movement and migration corridors;
- maintenance of surface water quality within the PCA and the surrounding watershed;
- maintenance of the hydrologic integrity of the groundwater;
- land intended to buffer the PCA against future changes in the use of surrounding lands;
- exclusion or control of invasive exotic species; and
- land necessary for management or monitoring activities.

The boundaries presented are meant to be used for conservation planning purposes and have no legal status. The proposed boundary does not automatically recommend exclusion of all activity. Rather, the boundaries designate ecologically significant areas in which land managers may wish to consider how specific activities or land use changes within or near the PCA affect the natural heritage resources and sensitive species on which the PCA is based. Please note that these boundaries are based on our best estimate of the primary area supporting the long-term survival of targeted species and plant communities. A thorough analysis of the human context and potential stresses has not been conducted. However, CNHP's conservation planning staff is available to assist with these types of analyses where conservation priority and local interest warrant additional research.

***Off-Site Considerations***

Frequently, all necessary ecological processes cannot be contained within a PCA of reasonable size. For example, taken to the extreme, the threat of ozone depletion could expand every PCA to include the entire planet. The boundaries described in this report indicate the immediate, and therefore most important, area to be considered for protection. Continued landscape level conservation efforts that may extend far beyond PCA boundaries are necessary as well. This will involve regional efforts in addition to coordination and cooperation with private landowners, neighboring land planners, and state and federal agencies.

***Ranking of Potential Conservation Areas***

CNHP uses element and element occurrence ranks to assess the overall biological diversity significance of a PCA, which may include one or many element occurrences. Based on these ranks, each PCA is assigned a biological diversity rank (or B-rank).

Natural Heritage Program Biological Diversity Ranks and their Definitions:

| | |
|---|---|
| **B1** | Outstanding Significance (indispensable):<br>only known occurrence of an element<br>A-ranked occurrence of a G1 element (or at least C-ranked if best available occurrence)<br>concentration of A- or B-ranked occurrences of G1 or G2 elements (four or more) |
| **B2** | Very High Significance:<br>B- or C-ranked occurrence of a G1 element<br>A- or B-ranked occurrence of a G2 element<br>One of the most outstanding (for example, among the five best) occurrences rangewide (at least A- or B-ranked) of a G3 element.<br>Concentration of A- or B-ranked G3 elements (four or more)<br>Concentration of C-ranked G2 elements (four or more) |
| **B3** | High Significance:<br>C-ranked occurrence of a G2 element<br>A- or B-ranked occurrence of a G3 element<br>D-ranked occurrence of a G1 element (if best available occurrence)<br>Up to five of the best occurrences of a G4 or G5 community (at least A- or B-ranked) in an ecoregion (requires consultation with other experts) |
| **B4** | Moderate Significance:<br>Other A- or B-ranked occurrences of a G4 or G5 community<br>C-ranked occurrence of a G3 element<br>A- or B-ranked occurrence of a G4 or G5 S1 species (or at least C-ranked if it is the only state, provincial, national, or ecoregional occurrence)<br>Concentration of A- or B-ranked occurrences of G4 or G5 N1-N2, S1-S2 elements (four or more)<br>D-ranked occurrence of a G2 element |

| | |
|---|---|
| | At least C-ranked occurrence of a disjunct G4 or G5 element<br><br>Concentration of excellent or good occurrences (A- or B-ranked) of G4 S1 or G5 S1 elements (four or more) |
| **B5** | General or State-wide Biological Diversity Significance: good or marginal occurrence of common community types and globally secure S1 or S2 species. |

# APPENDIX C. MAPPING PROTOCOL

All weed infestations were mapped in the field using ArcPad version 10.2 (ESRI 1995-2015), a portable version of GIS software that allows the user to create and edit spatial data remotely using a tablet computer. ArcPad was installed on a Trimble Yuma rugged tablet with a Windows 7 operating system and a built-in GPS receiver module. The Yuma tablet has improved display capabilities, a rugged exterior to withstand adverse weather conditions, a stable operating system and hard drive, and a larger screen to help with navigation and data collection. The configuration of a built-in GPS receiver module prevented reoccurring loose connections that were problematic during previous weed mapping efforts. According to Trimble specifications, the GPS is generally accurate to within 2-5m using SBAS (Satellite-Based Augmentation System). To ensure data accuracy during the collection process, SBAS was activated and warning systems were enabled in ArcPad to notify the user when the PDOP (Positional Dilution of Precision) exceeded 6 and the EPE (Estimated Probable Error) exceeded 8. Twenty points were averaged at each location, and 10 vertices were averaged for lines and polygons.

Weeds were mapped as points, lines or polygons. Linear features were mapped as lines and assigned a buffer width to estimate area. Irregularly shaped features greater than approximately 900 square meters (30m x 30m) were mapped as polygons. All other features were mapped as points and assigned a radius. Since weeds are mobile from year to year, and the GPS has inherent inaccuracies, infestations within 5 meters of each other were mapped as one feature. If previously mapped infestations were not located, they were marked as eradicated, as opposed to deleted, in order to keep track of the soil seed bank and ensure future visits to historically infested areas. All features were collected using the GPS unless otherwise noted in the attribute table. Features that were inaccessible due to natural barriers or exclosures were digitized “heads-up” using the 2011 NAIP digital orthophoto quad for reference. Attributes were collected using customized field forms, designed to minimize user error by maximizing look-up tables and field auto-population techniques. One free text field was maintained to document any observations deemed important, such as nearby significant species or difficulties incurred in a specific area (e.g., dense oak thickets affecting the ability to map features or estimate individuals). The field botanist had the option to document number of individuals or density as number of individuals per square meter. If density was noted, the number of individuals was calculated in the office based on the assigned density and the size of the infestation.

Weed data were stored in a master geodatabase in ArcGIS v10.2 (ESRI 1999-2015). The following attributes were captured:

COLLECTDAT – Collection date

PLANSCODE – USDA plants code

SPECIES – Scientific name

COMMONNAME - Common name

NUMINDIV – Number of individuals

DENSITY – Density per square meter

BUFFDIST - Radius for point features; buffer width for line features; not applicable to polygon features

COVERCLASS – 0-1%, Trace; 1-5%, Low; 5-25%, Moderate; 25-75%, High; 75-100%, Very High

PATTERN – Continuous, Patchy, NA (for eradicated infestations)

COMMENT – Free text field

DATUM – Datum

FEATTYPE – Point, line or polygon

USOWNER – Federal land ownership

LOCALOWNER – Local land ownership

US_STATE – U.S. state

COUNTRY - Country

EXAMINER –Field observer

MAPAGENCY – Mapping agency

STATUS – Extant, Eradicated, Dead Standing, Sprouting, Other

Buffered points and lines were converted to polygons in the final weed geodatabase. See examples below.