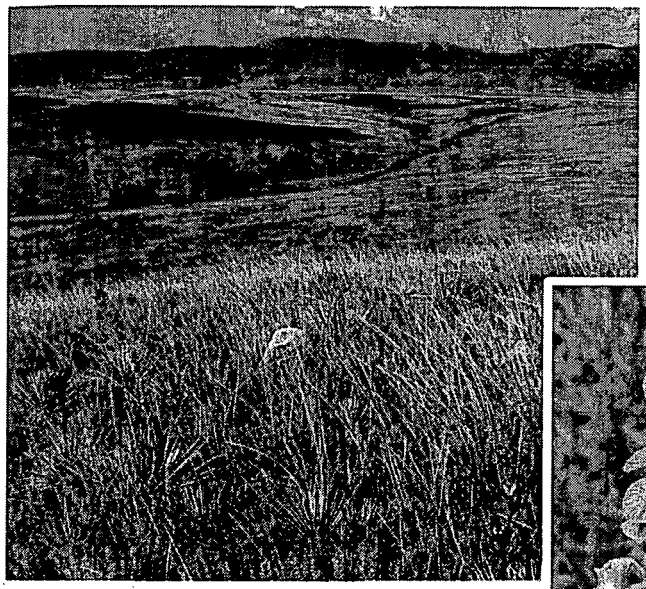
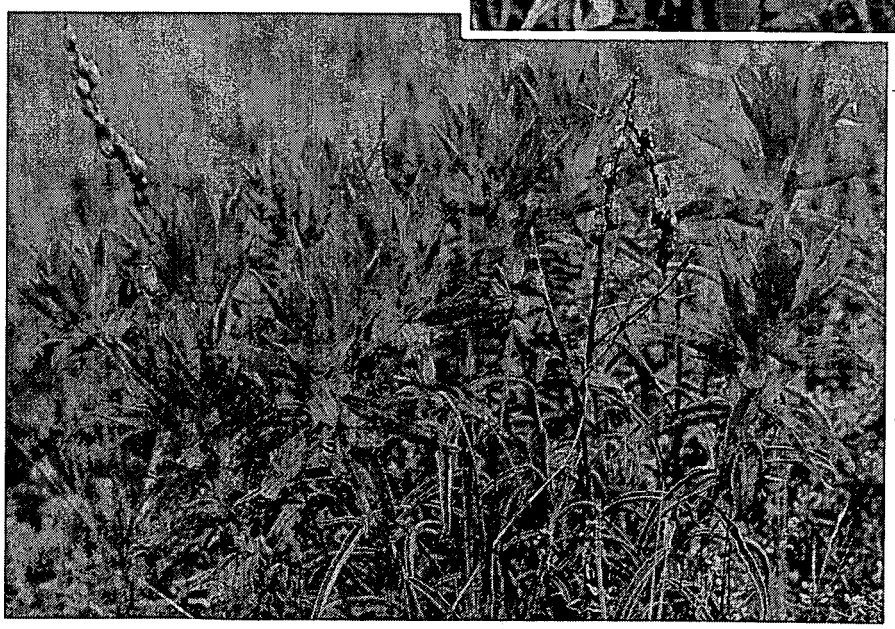
ECOLOGY

# 1999 Annual Vegetation Report for the Rocky Flats Environmental Technology Site





SW-A-005614

# 1999 Annual Vegetation Report for the Rocky Flats Environmental Technology Site

Kaiser-Hill, LLC
Rocky Flats Environmental Technology Site
Golden, Colorado 80402-0464

June 2000

ADMIN RECORD

SW-A-005614

# Contents


| | Page |
|---|---|
| List of Figures | iv |
| List of Tables | vii |
| Acronyms and Abbreviations | ix |
| Executive Summary | E-1 |
| 1. Introduction | 1 |
| 2. Methods | 2 |
| 2.1 High-Value Vegetation Surveys | 2 |
| 2.1.1 Species Richness Surveys | 2 |
| 2.1.2 Weed Mapping Surveys | 3 |
| 2.1.3 Photographic Documentation Surveys | 3 |
| 2.1.4 Qualitative Habitat Assessment and Rare Plant Surveys | 4 |
| 2.2 Quantitative Vegetation Monitoring Techniques | 4 |
| 2.2.1 Belt Transects | 5 |
| 2.2.2 Point-Intercept Transects | 5 |
| 2.2.3 Quadrats | 5 |
| 2.3 Data Analyses | 6 |
| 3. Results and Discussion | 7 |
| 3.1 Mesic Mixed Grassland | 7 |
| 3.2 Pre-Burn Monitoring for Prescribed Burn | 10 |
| 3.3 Great Plains Riparian Woodland | 13 |
| 3.4 Wetlands | 14 |
| 3.5 Rare Plants | 15 |
| 3.6 Site Flora | 15 |
| 3.7 Weeds and Weed Control | 16 |
| 3.7.1 1999 Weed Control Efforts at the Site | 16 |
| 3.7.2 Weed Monitoring | 18 |

3.8 Photographic Monitoring 24

3.9 Disturbances 24

4. Conclusions 25

5. References 26

6. Glossary 28

Figures

Tables

Appendices are found on the enclosed CD-ROM

Appendix A – Technical Reports

Appendix B – 1999 Rocky Flats Plant Species List

Appendix C – Revegetation Information and Photographs

## List of Figures

*Figures are found in a separate section after the text.*


Figure 1 Location of the Rocky Flats Environmental Technology Site

Figure 2 Great Plains riparian woodland management units

Figure 3 Wetland management units

Figure 4 Permanent vegetation monitoring locations at Rocky Flats Environmental Technology Site

Figure 5 Cool-season versus warm-season graminoid cover: 1993–1995, 1999

Figure 6 1992–1999 monthly precipitation means for Rocky Flats Environmental Technology Site

Figure 7 Diffuse knapweed growing on a dry, elevated stream terrace with coyote willow and leadplant in the Rock Creek drainage

Figure 8 Canada thistle just beginning to establish along the riparian corridor in Walnut Creek in 1997

Figure 9 Canada thistle infestation at the same location as shown above (Figure 8) in Walnut Creek two years later in 1999

Figure 10 Continued streambank erosion below the B-4 dam spillway in Walnut Creek is causing the loss of riparian shrubland essential as Preble's meadow jumping mouse habitat

Figure 11 Streambank erosion along the woodlands below the B-4 dam in Walnut Creek

Figure 12 Rare and imperiled plants distribution, Colorado Natural Heritage Program species of concern

Figure 13 1999 revegetation and restoration locations

Figure 14 FY1999 road grading and mowing operations for weed control

Figure 15 FY1999 ground and aerial herbicide application locations using Tordon 22K

Figure 16 Helicopter conducting aerial herbicide application at Rocky Flats Environmental Technology Site

Figure 17 Helicopter refueling and refilling herbicide tanks during aerial herbicide application operations at Rocky Flats Environmental Technology Site

Figure 18 Photos of diffuse knapweed–infested area in 1997 and 1999

Figure 19 Photos of musk thistle–infested area in 1997 and 1999

Figure 20 Photos of common mullein–infested area in 1997 and 1999

Figure 21 1999 diffuse knapweed (*Centaurea diffusa*) distribution

Figure 22 1999 musk thistle (*Carduus nutans*) distribution

Figure 23 1999 dalmatian toadflax (*Linaria dalmatica*) distribution

Figure 24 1999 mullein (*Verbascum thapsus*) distribution

Figure 25 1999 scotch thistle, russian knapweed, dame's rocket, and annual rye distribution

Figure 26 1999 jointed goatgrass (*Aegilops cylindrica*) distribution

Figure 27 Photo of dalmation toadflax–infested area in 1999

Figure 28 1998 diffuse knapweed pre–aerial herbicide application distribution

Figure 29 1999 diffuse knapweed post–aerial herbicide application distribution

Figure 30 Comparison of 1998 and 1999 diffuse knapweed pre– and post–aerial herbicide application

Figure 31 Diffuse knapweed infestation near the AS-2 monitoring plot in 1997

Figure 32 The same area near the AS-2 monitoring plot in 1999 after the aerial herbicide spraying

Figure 33 Control plot quadrat locations covered with plastic prior to aerial herbicide application

Figure 34 Diffuse knapweed cover in the control and treatment plots, pre- and post-treatment by aerial herbicide application

Figure 35 Diffuse knapweed frequency in control and treatment plots pre- and post-treatment by aerial herbicide application

Figure 36 1997–1999 species richness totals at the control and treatment plots by sampling event

Figure 37 1997–1999 mean number of species/quadrat at control and treatment plots by sampling event

Figure 38 1997–1999 Shannon-Weaver diversity indices at the control and treatment plots by sampling event

Figure 39 Diffuse knapweed densities at control and treatment plots by sampling event

Figure 40 Total foliar vegetation cover at the control and treatment plots by sampling event

Figure 41 Total forb relative foliar cover at the control and treatment plots by sampling event

Figure 42 Total non-native forb relative foliar cover at the control and treatment plots by sampling event

Figure 43 Total native forb relative foliar cover at the control and treatment plots by sampling event

Figure 44 Total graminoid relative foliar cover at the control and treatment plots by sampling event

Figure 45 Total warm-season graminoid relative foliar cover at the control and treatment plots by sampling event

Figure 46 Total cool-season graminoid relative foliar cover at the control and treatment plots by sampling event

Figure 47 Photos of diffuse knapweed–infested area in 1997 and 1999

Figure 48 Unauthorized off-road driving in the Buffer Zone creates disturbances and ruts in the plant communities that often become infested with weeds

Figure 49 Spinning tires by unauthorized off-road driving has become an increasing problem in the Buffer Zone

## List of Tables

*Figures are found in a separate section after the text.*


Table 1 1993–1995, and 1999 mesic mixed grassland species richness

Table 2 1993–1995, and 1999 mesic mixed grassland foliar cover by community

Table 3 1993–1995, and 1999 mesic mixed grassland foliar cover at TR02

Table 4 1993–1995, and 1999 mesic mixed grassland foliar cover at TR04

Table 5 1993–1995, and 1999 mesic mixed grassland foliar cover at TR11

Table 6 1999 prescribed burn pre-burn species richness

Table 7 1999 prescribed burn pre-burn foliar cover summary

Table 8 1999 prescribed burn pre-burn frequency summary

Table 9 1997 and 1999 Great Plains riparian woodland species richness comparison

Table 10 1997 and 1999 wetland species richness comparison

Table 11 1999 estimated weed infestation acreage summary for Rocky Flats Environmental Technology Site

Table 12 Comparison of 1997, 1998, and 1999 weed infestation extents at Rocky Flats Environmental Technology Site

Table 13 Comparison of 1998 and 1999 diffuse knapweed pre– and post–aerial herbicide application infestation levels at Rocky Flats Environmental Technology Site

Table 14 1997–1999 diffuse knapweed herbicide monitoring species richness summary

Table 15 1997–1999 diffuse knapweed herbicide monitoring foliar cover summary – control data

Table 16 1997–1999 diffuse knapweed herbicide monitoring foliar cover summary – treatment data

Table 17 1997–1999 diffuse knapweed monitoring species frequency data summary

## Acronyms and Abbreviations

| | |
|---|---|
| CNHP | Colorado Natural Heritage Program |
| DOE | Department of Energy |
| GPS | global positioning system |
| K-H | Kaiser-Hill Company, LLC |
| QA/QC | quality assurance and quality control |
| Site | Rocky Flats Environmental Technology Site |

# Executive Summary

The Kaiser-Hill Company (K-H) Ecology Group conducts ecological monitoring of the Site's natural resources to ensure regulatory compliance and to preserve and protect those resources during cleanup and closure operations. Ecological monitoring is an integral aspect of determining whether the management objectives and goals for the plant communities at the Site are being achieved. One component of the ecological monitoring program is annual vegetation monitoring, the goal of which is to assess the status and quality of the plant communities on the Site, document any trends, and assess the effectiveness of various management techniques. This report summarizes the results of the vegetation monitoring that was conducted at the Rocky Flats Environmental Technology Site (Site) during 1999.

At an elevation of approximately 6,000 feet, the Site contains a unique ecotonal mixture of mountain and prairie plant species resulting from the topography of the area and its proximity to the mountain front. The Buffer Zone, the area surrounding the Industrial Area, is one of the largest remaining undeveloped areas of its kind along the Colorado Piedmont. A number of plant communities present at the Site have been identified as increasingly rare and unique by the Colorado Natural Heritage Program (CNHP). These communities include the xeric tallgrass prairie, tall upland shrubland, wetlands, and Great Plains riparian woodland communities. Many of these communities support populations of increasingly rare animals as well, including the federally protected Preble's meadow jumping mouse, and other uncommon species such as the grasshopper sparrow, loggerhead shrike, Merriam's shrew, black crowned night heron, and Hops blue and Arogos skipper butterflies.

Vegetation monitoring is conducted at the Site using several methods to meet the monitoring objectives. During 1999, these objectives included species richness inventories, noxious weed and rare plant species mapping, photographic documentation, qualitative habitat assessment surveys, quantitative monitoring of long-term plant community changes, and quantitative assessments of the effectiveness of herbicide applications and potential associated impacts to the native plant communities.

During 1999, species richness inventories were conducted in the Great Plains riparian woodland and wetland management units at the Site. A total of 350 vascular plant species were recorded in the Great Plains riparian woodland, and of these, 77 percent were native species. In the wetlands, a total of 246 plant species were recorded, 76 percent of which were native species. Comparison to past inventories showed little change in the species richness found in either plant community. Qualitative habitat assessments continue to indicate that the management issue of greatest concern in both communities is noxious weeds. In both communities, Canada thistle is present at many locations. Along many of the drier stream terraces, particularly in Rock Creek, diffuse knapweed has become abundant. Other noxious weeds such as bouncingbet and dame's

rocket have also become established at some stream locations. Streambank erosion was identified as a potential problem at a location in Walnut Creek below the B-4 pond, where high-water events have continued to erode the steep streambank sections. Aside from these concerns, however, the riparian woodlands and wetlands in general appeared healthy. No visible signs of disease, predation, injury, or die-off of any of the dominant plant species was observed, and most appeared to have flowered and produced fruit during 1999. Comparison of the permanent photo-point photographs from 1997 and 1999 showed no substantial changes in the riparian and wetland vegetation during this time frame.

As a result of the 1999 field work, a total of ten new records of vascular plant species are reported for the Site. This increase brings the total number of plant species known to occur on the Site to 585. None of the new species recorded on the Site in 1999 is a rare species or state-listed noxious weed. Of the plant species of concern listed by the CNHP as rare or imperiled, the species recorded previously on the Site were observed again in 1999. Populations of mountain-loving sedge, forktip three-awn, carrionflower greenbriar, and dwarf wild indigo were visited and evaluated. All four species were observed in vegetative, flowering, and fruiting condition, and their populations appeared to be doing well.

The mesic mixed grassland was monitored during 1999 to evaluate the quality of the grassland and to document any changes in species composition at permanent sampling locations. Locations were monitored for species richness, cover, and species frequency. Monitoring results continued to document the generally high quality of this plant community on the Site. Total community species richness in 1999 (141 species) was the same as measured in 1994 and 1995 (143 and 141 species, respectively). Total foliar cover and species diversity in 1999 were not substantially different from past measurements.

One measure that has changed substantially from past measurements is the cool-season versus warm-season graminoid composition of the mesic mixed grassland. In the past, cool-season graminoids, primarily dominated by Japanese brome (commonly known as cheatgrass, a non-native grass), provided the highest amounts of vegetation cover in the community. However, data from 1999 show that Japanese brome decreased substantially and that the native grasses blue grama and side-oats grama had increased. This is a positive change for the grassland, because cheatgrass-infested areas typically have lower species richness and diversity, less ecosystem stability, increased potential for soil erosion, more frequent wildfires, and lower wildlife and livestock utilization. One issue however, is whether the results from 1999 are simply transitory, in response to a single year's environmental factors, or in fact, represent a longer-term change. Because monitoring is not conducted in this plant community annually—the last monitoring was in 1995—it is being recommended that another year of data be collected during 2000 to help answer this question.

During 1999, several activities were conducted under the Vegetation Management Program to actively manage the ecological resources at the Site. A number of large

projects disturbed native and previously reclaimed grasslands on the Site in 1999. After the projects were completed, disturbed areas were revegetated and treated for weed control, as required by Site policies, resulting in approximately 23 revegetated acres. As part of an effort to prevent weeds from becoming established in previously unrevegetated areas, an abandoned firebreak road (approximately 2.3 acres) in the south Buffer Zone was revegetated in the fall of 1999. Observations in spring 2000 have shown that some of the seeding is coming up. Physical and mechanical weed control measures at the Site in 1999 consisted of grading, mowing, and selective hand control. Grading was done on 18 miles of Buffer Zone firebreak roads, and approximately 113 acres were mowed along these roadside edges to keep the weeds down. Hand control, consisting of hand pulling, using sickles or sling blades, and spot herbicide spraying, was conducted at several locations to control localized infestations of scotch thistle, annual rye, and dame's rocket. Herbicide applications of Tordon 22K were used to control several hundred acres of noxious weed–infested grasslands at the Site during 1999. Primary target species were diffuse knapweed, musk thistle, and mullein; however, other less aggressive exotic species such as goatsbeard, curly-top gumweed, alyssum, wild lettuce, small-seeded false flax, and some of the tansymustards were also controlled. Approximately 72 acres were treated on the ground, while almost 1,500 acres were treated with a helicopter.

Monitoring results from the aerial herbicide application of Tordon 22K showed that diffuse knapweed was effectively controlled at locations sprayed in 1999. Diffuse knapweed cover dropped to less than 1 percent, and diffuse knapweed frequency was reduced substantially in the sprayed areas. Weed-mapping of the aerial spray locations showed that the total amount of diffuse knapweed was reduced by 683 acres, from 878 acres in 1998 to 195 acres in 1999. This represents a 78 percent reduction in the total number of diffuse knapweed–infested acres in the areas that were sprayed in 1999. In practical terms, this means that essentially no adult diffuse knapweed plants were present in the areas that received herbicide treatment. The elimination of adult plants from these areas in 1999 means that no additional seed was added to the seed bank, and no plants were available to blow away from these areas, further infesting other areas.

Drift card results from the aerial herbicide application showed that a small amount of undesirable drift was observed at some locations during 1999, but observations of the plants in these areas throughout the growing season showed no chlorosis, wilting, or death of the sensitive native species in these areas. Thus, no impact resulted from the drift. However, because drift is not desired, the use of drift cards will continue during future aerial herbicide applications.

Monitoring also continued during 1999, at plots set up in 1997, to evaluate the effect of Tordon 22K on diffuse knapweed and native plant species in the xeric tallgrass prairie. Results revealed that diffuse knapweed density was significantly reduced after the herbicide treatment and continues to remain far below original levels three growing seasons after treatment. However, an increase in diffuse knapweed frequency was observed in 1999, suggesting that diffuse knapweed is beginning to come back into the area. Weed mapping also suggests that diffuse knapweed is beginning to increase in the area around the study plots. Data gathered in 1998 showed that there were impacts to

species other than diffuse knapweed. There were initially declines in species richness, species diversity, forb cover, and cactus density. Data from 1999, however, showed that this trend was reversed for all of these measures, with the exception of cactus density, which remained low. In 1999, overall species richness in the treatment plot had essentially returned to pre-treatment levels. The use of a similarity index showed that both the control and treatment plots had essentially the same species composition as was present in 1997, further indicating that the herbicide application had not affected overall species richness in the long term. Species diversity in 1999 reversed its downward trend in the treatment plot and was no longer statistically different from the control plot, although numerically it still remained below its original level. Similar trends were observed for overall forb cover, native forb cover, and non-native forb cover, which had all shown initial declines, but in 1999 were returning toward pre-treatment levels. Each of these forb measures in 1999 was no longer statistically different from that in the control plots.

Associated with the initial loss of forb cover was an increase in graminoid cover in the treatment plot that kept the total foliar cover essentially parallel to that in the control plot. Thus, although some initial declines in abundance were apparent for non-target forbs, they have begun to return to normal abundance levels and over the next year or so should return to pre-treatment levels. These Site data are in general agreement with studies conducted elsewhere that have shown similar effects on other grassland communities after treatment with Tordon 22K. Those studies showed that long-term impacts to the native species were negligible and disappeared after a few years. It is expected that similar results will be seen at the Site. Continued monitoring of the plots will assess the long-term effects, and will also determine how long the herbicide controls the diffuse knapweed before reapplication is necessary, given the specific conditions at the Site. Additional control measures are being recommended for evaluation in 2000 to attempt to extent the length of effective control after large-scale spraying efforts.

Weed mapping (by density categories) continued to indicate that the most serious threat to the xeric tallgrass prairie and other plant communities on the Site is from noxious weeds. The most widespread noxious weed species in 1999 was dalmatian toadflax, which covered nearly 2,507 acres, followed by diffuse knapweed (2,295 acres), musk thistle (1,353 acres), and common mullein (1,068 acres). This reflects a change from the past, when diffuse knapweed was the most abundant noxious weed on the Site. From 1998 to 1999, the total acreage Site-wide infested by diffuse knapweed and musk thistle decreased by 618 and 332 acres, respectively, largely due to the aerial herbicide application conducted in May 1999. Common mullein acreage for the Site increased due to a large increase in the scattered density category; however, the high-, medium-, and-low density categories decreased, largely because of the aerial spraying. Dalmatian toadflax acreage showed an increase of more than 500 acres from 1998 to 1999. The cause of this large increase is unknown, although qualitative observations suggested that 1999 was apparently a bumper-crop year for dalmatian toadflax at the Site. This information will prove helpful as the Vegetation Management Program continues to actively control weeds and manage the ecological resources at the Site.

In conclusion, vegetation monitoring in 1999 continued to document the generally high quality of the native plant communities at the Site. The ecological resources at the Site continue to provide an important island of biodiversity in a region where much of the native diversity is being lost to urbanization. However, the results also continue to underscore the serious issues that threaten the quality and long-term sustainability of the Site's ecological resources. These threats come primarily from noxious weeds, human disturbances, and plant litter build up, the latter of which has resulted from an absence of wildfires and/or grazing. However, the data indicate that, beneath the sometimes visually dominant weedy appearance, the native plant communities are still present and viable. In fact, management actions such as weed control have improved the condition of the grasslands at the Site. Continued active management of these native communities is necessary if they are to survive over the long term and maintain their ecological value. Through good stewardship and use of best management practices, the Site's current ecological resource management plan and vegetation management program provide direction for managing the resources in a sustainable manner. As stewards of the ecological resources at the Site, Kaiser-Hill and DOE continue to strive to preserve and maintain these unique resources into the future.

# 1. Introduction

Rocky Flats Environmental Technology Site (Site) is a U.S. Department of Energy (DOE) facility located on the Colorado Piedmont east of the Front Range between Boulder and Golden, Colorado. The Site is located in Jefferson County, approximately 16 miles northwest of downtown Denver (Figure 1). In production from 1951 through 1989, the Site manufactured nuclear weapons components for the Cold War. Since shutdown, it has been classified as a Superfund site and is currently undergoing cleanup and closure. One of the DOE's goals for natural resource management has been to preserve the unique ecological resources found at the Site (K-H 1997a).

At an elevation of approximately 6,000 feet, the Site contains a unique ecotonal mixture of mountain and prairie plant species, resulting from the topography and proximity to the mountain front. The Buffer Zone, the area surrounding the Industrial Area, is one of the largest remaining undeveloped areas of its kind along the Colorado Piedmont (approx. 5,600 acres; K-H 1997b). A number of plant communities at the Site have been identified as increasingly rare and unique by the Kaiser-Hill Company (K-H) Ecology Group and the Colorado Natural Heritage Program (CNHP). These communities include the xeric tallgrass prairie, tall upland shrubland, wetlands, and Great Plains riparian woodland communities (CNHP 1994; 1995). Many of these communities support populations of increasingly rare animals as well, including the federally protected Preble's meadow jumping mouse and other uncommon species such as the grasshopper sparrow, loggerhead shrike, Merriam's shrew, black crowned night heron, and Hops blue and Arogos skipper butterflies (CNHP 1994; 1995).

The K-H Ecology Group conducts ecological monitoring of the Site's natural resources to ensure regulatory compliance and to preserve and protect those resources during cleanup and closure operations. The goal of vegetation monitoring is to assess the status and quality of the plant communities on the Site, document any trends, and assess the effectiveness of various management techniques. Ecological monitoring provides integral data for determining whether the management objectives and goals for the plant communities at the Site are being achieved (K-H 1997a,b). Annual reports are produced to synthesize and interpret the information, providing the DOE with important and timely information necessary for wise stewardship and best management of the Site's ecological resources.

This report summarizes the results of the vegetation monitoring conducted during 1999. Several monitoring techniques were used to evaluate the status and condition of the plant communities on the Site. General descriptions of the methods used are outlined in the following section, with summaries of the monitoring results presented in subsequent sections. Detailed technical reports for each of the specific monitoring activities conducted in 1999 are found in Appendix A.

# 2. Methods

Vegetation monitoring is conducted at the Site using several methods designed to meet the monitoring objectives. During 1999, monitoring included: species richness inventories, noxious weed and rare plant species mapping, photographic documentation, qualitative habitat assessment surveys, quantitative monitoring of long-term plant community changes, and quantitative assessments to determine the effectiveness of herbicide applications and potential associated impacts to the native plant communities.

## 2.1 High-Value Vegetation Surveys

The goal of the high-value vegetation monitoring is to qualitatively assess the status and condition of the high-value plant communities (xeric tallgrass prairie, tall upland shrubland, selected wetlands, and Great Plains riparian woodland) on the Site and to document any changes in these areas. The high-value plant communities at the Site are those identified by the K-H Ecology Group and the CNHP as containing significant or rare ecological resources at both the local and regional scale (K-H 1997b; CNHP 1994, 1995).

The objectives of the high-value vegetation monitoring are to qualitatively:

- Assess the species richness of the plant communities
- Identify any rare plant populations
- Document the locations and continued presence of any rare plant populations
- Identify and document any infestations of noxious weeds
- Document the effectiveness of weed control applications
- Assess the impacts of disturbance on the plant communities
- Provide a general assessment of the overall status and quality of the plant communities at the Site.

### 2.1.1 Species Richness Surveys

The Great Plains riparian woodland and selected wetlands were monitored in 1999 as part of the rotating schedule for monitoring high-value vegetation communities on the Site. These communities were previously monitored in 1997, when all the high-value vegetation communities were monitored for the first time. Species richness was inventoried in each of the ten Great Plains riparian woodland units and three wetland management units (Figures 2 and 3). Inventories were conducted by traversing each

management unit twice during the growing season (in spring and late summer) and recording all vascular plant species observed. Attempts were made to visit, as completely as possible, all areas and microhabitats of each specified plant community that occur within each management unit.

### 2.1.2 Weed Mapping Surveys

Sitewide weed mapping continued for selected species as a means of monitoring the distribution of specific noxious weed species on the Site, identifying high-priority treatment areas, and tracking the effectiveness of weed control efforts. Weed mapping was conducted on foot during the high-value vegetation surveys in the Great Plains riparian woodland and wetlands, and from a vehicle using binoculars for the remainder of the Site. Species were mapped during their respective flowering periods and/or when they were most visible. The species mapped during 1999 included diffuse knapweed (*Centaurea diffusa*), musk thistle (*Carduus nutans*), dalmatian toadflax (*Linaria dalmatica*), common mullein (*Verbascum thapsus*), Russian knapweed (*Centaurea repens*), annual rye (*Secale cereale*), Scotch thistle (*Onopordum acanthium*), dame's rocket (*Hesperis matronalis*), and jointed goatgrass (*Aegilops cylindrica*). Canada thistle (*Cirsium arvense*) was not mapped because it is common throughout most of the wetlands on the Site, and the wetlands map would therefore provide a good indication of the infested areas.

Four species—diffuse knapweed, musk thistle, dalmatian toadflax, and common mullein—were mapped based on infestation densities. The other species listed above were mapped by presence/absence only. Infestation areas were classified in general density categories of high, medium, low, and scattered, based on a subjective interpretation of the extent, visual density, need for control, and aggressive nature of the species. In general, a high-density category indicated an area that was dominated by a nearly solid infestation and/or very high cover of the species. A medium-density category was used where the infestation provided less cover and was less homogeneous in the distribution of the species. The low-density category was used where the species was present in fewer numbers and did not visually dominate the landscape, but was beginning to establish a foothold in the community and was in need of control. The scattered-density category indicated a sporadic occurrence of the species. The noxious weed populations and distributions were drawn in the field on 44×34-inch sitewide base maps. It should be noted that the boundaries shown on the maps are approximate and are based on professional judgement. They should not be interpreted as a precise outline of the distribution of these species, because no surveying or global positioning system (GPS) equipment was used to locate boundary edges, nor do the maps necessarily represent every location of the species on the Site.

### 2.1.3 Photographic Documentation Surveys

Photographs were taken at all permanent high-value vegetation photo-point locations during 1999. Woody vegetation photographs were taken at selected photo points during

the winter months in 1999, and summer photographs were taken at all photo points during the summer of 1999. Photographs were taken in the same compass directions as past photographs from these photo points. Comparisons were made to past photographs to evaluate changes in the plant communities.

### 2.1.4 Qualitative Habitat Assessment and Rare Plant Surveys

Qualitative habitat assessments were made in each of the high-value vegetation community management units on the Site during 1999. Assessment objectives dealt primarily with habitat loss, threats to the plant community, weed issues, rare plant species, the health of dominant plant species in the community, and general community quality. Attempts were also made to revisit each of the locations where CNHP-listed plant species of special concern are known to occur. These species include the mountain-loving sedge (*Carex oreocharis*), forktip three-awn (*Aristida basiramea*), dwarf wild indigo (*Amorpha nana*), and carrionflower greenbriar (*Smilax herbacea* var. *lasioneuron*). Population locations were mapped during the 1997 field season. Locations were revisited in 1999 to confirm the continued presence of these species on the Site and to evaluate any concerns regarding them.

Further details on the qualitative methods used in 1999 are found in the document *High-Value Vegetation Survey Plan for the Rocky Flats Environmental Technology Site* (K-H 1997c) and *The Environmental Management Department Operating Procedures Manual* (DOE 1995a).

## 2.2 Quantitative Vegetation Monitoring Techniques

The objectives of the quantitative vegetation monitoring are to assess plant community changes over time (i.e., trends) and/or changes in response to management actions (e.g., herbicide application, prescribed fire). In 1999, quantitative vegetation monitoring was used for evaluating long-term trends on the mesic mixed grassland, evaluating the effects of herbicide applications on the noxious weed diffuse knapweed and on native prairie species, and gathering pre-burn data on the xeric tallgrass prairie at locations scheduled to be burned in spring 2000.

Quantitative methods used to assess plant communities included:

- Belt transects (species richness and woody plant and cactus density)
- Point-intercept transects (foliar and basal cover)
- Quadrats (species frequency and selected plant densities).

### 2.2.1 Belt Transects

Species richness was measured in a 2-m-wide belt centered along each permanent 50-m transect. Every plant species rooted within the 100-$m^2$ area was recorded. In addition, the densities of woody plant and cactus stems were counted by species for the 100-$m^2$ area and recorded. Species richness was sampled in both the spring and late summer, while woody plant and cactus density in the belt transects was measured only in the spring.

### 2.2.2 Point-Intercept Transects

Basal cover and foliar cover estimates were made using a point-intercept method along each of the 50-m transects. A 2-m-long rod, with a 6-mm diameter, was dropped vertically at 50-cm increments along the transect to record a total of 100 intercept points. Two types of hits were recorded:

- Basal cover hits indicated what material the rod contacted at the ground surface. Hits could be vegetation (live plants), litter (fallen dead material), rock (pebbles and cobbles that were greater than the rod diameter), bare ground, or water, in the order of priority based on the protection from erosion provided by each type of cover. A basal vegetation hit was recorded only if the rod was touching the stem or crown of the plant where the plant entered the ground.
- Foliar vegetation hits (defined as a portion of a plant touching the rod) were recorded in three categories, as defined by height and growth form. The topmost hit of each growth form was recorded. The growth forms measured were herbaceous, woody <2 m in height, and woody >2 m in height.

Cover was sampled in the late summer only, when plant growth was at its maximum.

### 2.2.3 Quadrats

Frequency information by species was gathered by randomly locating five 1-$m^2$ quadrats along each transect and recording all species present in each plot. Density counts were made of selected weed species (which varied depending on the individual study) within each of the quadrats. Quadrats were sampled in both the spring and late summer.

For more detailed information on the quantitative methods used in 1999 for specific projects, refer to the technical reports in Appendix A or the *Environmental Monitoring Department Operating Procedures Manual* (DOE 1995a) and the *High Value Vegetation Survey Plan for the Rocky Flats Environmental Technology Site* (K-H 1997c).

## 2.3 Data Analyses

Prior to analysis, all data were checked for quality assurance and quality control (QA/QC), following previously accepted and applied steps for ecological data at the Site (K-H 1997d). Descriptive and graphical comparisons and summaries of the data were prepared for most data sets. Appropriate statistical analyses were also conducted on the data where feasible. Further details on the specific analyses conducted on particular data sets are found in the technical reports in Appendix A.

# 3. Results and Discussion

## 3.1 Mesic Mixed Grassland

During 1999, three permanent monitoring sites (TR02, TR04, and TR11) in the mesic mixed grassland community, last monitored in 1995, were monitored again to reassess and document any change (Figure 4; DOE 1995b; K-H 1997b). Species richness, cover, and frequency were monitored at all three sites. Species richness and frequency were monitored both in the spring and late summer 1999. Cover was monitored only in late summer 1999. Monitoring results from 1999 were compared to past data to determine whether any changes had taken place.

Total community species richness in 1999 (141 species) was the same as measured in 1994 and 1995 (143 and 141 species, respectively). Total species richness at sites TR04 and TR11 in 1999 was only slightly higher than past values, indicating that little change had occurred at these sites (Table 1). At TR02, however, a decrease of 15 species was noted from the 1995 species richness values (Table 1). Most of these species were forbs, which were likely impacted by the aerial herbicide application that was done at this site in May 1999. Of those not present in 1999, 80 percent were native species and 20 percent were non-native species. Based on studies elsewhere on the Site that are examining the impact of herbicide treatments on non-target species, it is expected that this decline in species richness will return to pre-treatment levels in the next year or two. It should also be noted that, in many cases, these species were missing from the monitoring transects themselves, but they could often be found outside the transect boundaries. Therefore, they were not eliminated from the grassland. Future monitoring will document the return of these species to these transects. The percentage of native species at each site remained consistent with past measurements (Table 1).

Litter cover in mesic mixed grassland in 1999 (71 percent) was substantially higher than that documented in 1995 (59 percent; K-H 1997b). The high litter amounts continue to underscore the need for prescribed fire and/or grazing to help remove the built-up dead plant matter on the grasslands at the Site. Planning for a spring 2000 prescribed burn on some of the grasslands at the Site is underway and will help address this problem. Fire will reduce litter loads (reducing the chance of a catastrophic wildfire) and recycle tied-up nutrients, thus increasing the vigor and health of many of the native species.

Total foliar vegetation cover for the mesic mixed grassland community in 1999 was not substantially different from past measurements (Table 2). Additionally, total graminoid cover and total forb cover across all sites combined were within previously measured amounts, suggesting that no changes in the community structure have occurred (Table 2). Species diversity (Shannon-Weaver; Brower and Zar 1977), a measure of species richness and abundance, changed little and actually increased slightly from past measures. The percent of cover from native plant species increased in 1999 compared to past measurements, which had shown continuing declines for the years 1993–1995 at all

three sites and in the community as a whole (Tables 2–5). This reversal suggests some improvement in the mesic mixed grassland community, which may be at lease partially explained by the changes in cool-season versus warm-season graminoid cover, discussed below. While total non-native foliar cover decreased in the community, non-native forb cover remained little changed across all sites combined, indicating that the weeds are still a problem in general (Table 2). However, at TR02 where the aerial herbicide application was conducted, declines in both native and non-native forb cover were observed (Table 3). The declines in native forb cover were expected, and these species should return to pre-treatment levels over the next few years, based on other studies where Tordon 22K has been sprayed (Rice and Toney 1996; Rice et al. 1997).

One measure that has changed substantially from past measurements is the cool- versus warm-season graminoid composition of the mesic mixed grassland. In the past, cool-season graminoids accounted for approximately 70 percent of the total foliar cover on the mesic mixed grassland at the Site, while warm-season graminoids accounted for 5–14 percent (Table 2). In 1999, cool-season graminoid cover dropped significantly to about 50 percent of the total cover, while warm-season graminoid cover increased significantly to approximately 32 percent (Table 2; Figure 5). The loss of cool-season graminoid cover is due largely to the 26-percent reduction in the cover of Japanese brome (non-native) and 6 percent loss of western wheatgrass (native) observed from 1995 to 1999 (Table 2). Although relative cover values are mentioned here because these are best used to describe the actual species composition of the vegetation present, the absolute or actual cover of these species also declined by similar amounts, meaning that the changes are real (Table 2).

Previously, Japanese brome had the highest cover of all species on the mesic mixed grassland. As an annual grass, large fluctuations in Japanese brome cover are possible because of annual fluctuations in the timing of precipitation events (Rosentreter 1994). This fact, combined with a lack of cover data for the years 1996–1998, makes interpretation of the 1999 results difficult. Maybe the low cover of Japanese brome and other cool-season graminoids observed in 1999 is part of a normal cyclical fluctuation in response to environmental conditions, or it may be part of a continual decline that has been occurring over the past several years. The lack of a continuous data set (i.e., three years of missing data) and other biotic and abiotic measurements makes it difficult to say for sure. The fact remains, however, that in 1999, Japanese brome and cool-season graminoids in general accounted for substantially less cover than had been observed in the past on the mesic mixed grassland.

With respect to the large increase in warm-season graminoid cover, it is important to note that it was not just a mathematical reversal in terms of relative foliar cover (i.e., loss of relative cover of one thing [cool-season graminoids] does not automatically mean an increase in something else). There were substantial increases in the absolute or actual cover of the warm-season graminoid species blue grama and sideoats grama, both of which are native grasses to the region (Table 2). One possible explanation for this shift in composition may have to do with the timing and amounts of precipitation received in different years. In 1999, above-average summer precipitation appeared to have benefited

many of the other warm-season graminoid species at the Site. Species like big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), indiangrass (*Sorghastrum nutans*), and mountain muhly (*Muhlenbergia montana*) all flowered profusely on the Site in 1999. In addition, examination of the Site precipitation data for the last eight years showed that, for three out of the past four years, the Site has received above-average precipitation for the July through September time frame (Figure 6). This could account for some of the noticed increase in warm-season cover, because the summer precipitation would be most beneficial to the warm-season species. It is also interesting to note, however, that no similar decreases in spring precipitation were apparent that might account for the cool-season species decreases over the same time period (Figure 6). Without data on the warm-season graminoid cover for the years 1996–1998, it is difficult to arrive at a more definitive answer. There are no data that support the hypothesis that a continual increase in cover has occurred since 1995, or alternatively, that this was simply a change seen in 1999 alone. This issue illustrates one of the problems that arises when monitoring is not done on an annual basis: when changes are noted between data sets, interpretation becomes difficult because the intermediate information that is necessary to determine trends is missing.

Taken separately, the individual sites also demonstrated these differences, although with some variation. The change in cool-season versus warm-season graminoid composition was most pronounced at TR02, where the warm-season graminoids actually became the dominant species in 1999. Relative foliar cover of warm-season graminoids at TR02 increased from 8 percent in 1995 to just over 50 percent in 1999, with most of this increase coming from blue grama and sideoats grama (Table 3). Relative foliar cover of cool-season graminoids decreased from 66 percent to 40 percent during the same time period (Table 3). In addition to the increased summer precipitation mentioned above as a possible reason for this change in composition, this site also received the aerial herbicide treatment of Tordon 22K that was applied in mid-May 1999. By the time the herbicide was applied, most of the cool-season graminoid species would have been growing and getting ready to flower. Thus, by the time the herbicide actually affected the target species and some of the non-target species, the ability of the cool-season graminoid species to take advantage of the reduced competition would have passed. Instead, the warm-season graminoid species, which would have just started their growth period, would have been able to take advantage of the reduced competition and increased summer precipitation, thus perhaps accounting for much of the increase in cover.

Similar large changes in cool- versus warm-season graminoid cover were also observed at TR04, however, which received no herbicide treatment (Table 4). At TR11, increased warm-season and decreased cool-season graminoid cover was also observed, but the differences were much smaller (Table 5). Thus, although there was a substantial shift in composition across all sites combined, the magnitude of the shift varied among the sites. This variability may be due to microsite differences and, at TR02, the herbicide treatment. From a management standpoint, the shift in graminoid composition observed in 1999 is a beneficial one. Japanese brome and downy brome, commonly referred to as cheatgrasses, are both non-native species that have taken over millions of acres across the western United States (Pellant and Hall, 1994). Areas infested by these cool-season

annual grasses often have lower species richness and diversity, less ecosystem stability, increased potential for soil erosion, more frequent wildfires, and lower wildlife and livestock utilization (Rosentreter 1994). This issue has been mentioned previously as a potential management concern for the Site (DOE 1995b). The reduction of these species in the mesic mixed grassland, as seen in the 1999 data, and a shift to a more perennial, warm-season graminoid composition lessens the potential for these adverse effects.

Based on these results and the criteria mentioned in the Integrated Monitoring Plan (K-H 1999a), when a substantial change is noted in any of the measured variables, an evaluation is recommended to determine whether the management goals are being achieved. The large decrease in cover of Japanese brome and increase of warm-season perennial native grasses, as mentioned above, is a beneficial change. However, from a management standpoint, it is important to know whether this was simply an annual fluctuation observed in 1999, or part of a longer-term trend. Therefore, it is suggested that monitoring the mesic grassland sites again during 2000 be considered. A second year of continuous data would help answer this question.

The detailed technical report for the mesic mixed grassland monitoring conducted in 1999 is found in Appendix A.

## 3.2 Pre-Burn Monitoring for Prescribed Burn

Prescribed burning is an important tool for native grassland management. To maintain the health and vigor of the native plant species, reduce plant litter and the potential for wildfire, and help with weed control, the use of prescribed burns is being planned to help manage the grassland communities at the Site. As with all land management actions, monitoring is an integral part of determining whether the management objectives and goals for a particular management technique are being achieved. During 1999, a prescribed burn was proposed for the xeric tallgrass prairie plant community, to be conducted in the spring of 2000. To evaluate the effect of the prescribed burn on the plant community, a monitoring program was instituted to provide quantitative monitoring data for the following questions of interest:

1. How will a prescribed burn affect the species richness and species diversity of the xeric tallgrass prairie?
2. What impact will a prescribed burn have on the foliar cover of the xeric tallgrass prairie? Specifically, what impact is there to the following categories of foliar cover: overall cover, native cover, non-native cover, forb cover, overall graminoid cover, warm-season graminoid cover, and cool-season graminoid cover?
3. What impact will a prescribed burn have on the frequency of individual plant species on the xeric tallgrass prairie?
4. What impact will a prescribed burn have on specific weed species?

5. How does the fire response of the xeric tallgrass prairie at the Site compare to the response of the tallgrass prairie of the eastern great plains, or to that of the more mesic tallgrass prairie found on City of Boulder open space?

6. What recommendations can be made with regard to the use of prescribed burns for management of the xeric tallgrass prairie at the Site?

Three control plots (no burn; BC1, BC2, and TR01) and three treatment plots (burn; BT1, BT2, and BT3) were monitored in 1999 (Figure 4). At each plot, five randomly located 50-m transects were sampled for species richness, cover, and frequency. Sampling was conducted from September 9 through 24, 1999. Due to the timing of the decision to pursue conducting a controlled burn, it was not possible to collect any pre-burn spring data for the xeric tallgrass prairie. Thus, the study will evaluate only the late-summer effects on the prairie. Additionally, in May 1999, all six sites were sprayed by helicopter with Tordon 22K to help control the noxious weed diffuse knapweed (*Centaurea diffusa*).

Pre-burn results indicate a high measure of similarity between the control and treatment areas for most of the variables measured. Little difference was noted in terms of species richness or overall foliar vegetation cover between the control and treatment areas. A total of 103 species was recorded at all control and treatment locations monitored in 1999 (Table 6). The control areas had a total of 89 species, while the treatment areas had 86 species (Table 6). Total foliar vegetation cover was 80.2 percent in the control areas, compared to 76.1 percent in the treatment areas (Table 7). Overall forb and graminoid cover amounts were also essentially equal at both the control and treatment locations. Forb cover was somewhat low (5–7 percent, Table 7) in the control and treatment areas, compared to past monitoring at other locations on the xeric tallgrass prairie where relative forb cover amounts have ranged from 10 to 39 percent (K-H 1999b). Additionally, graminoid cover was higher in the control and treatment areas (9395 percent, Table 7), compared to past measurements at other locations that have ranged from 61 to 90 percent (K-H 1999b). The lower forb and higher graminoid cover is to be expected however, as a result of the herbicide treatment that these areas received in the spring of 1999.

The control and treatment locations were dominated by big bluestem, mountain muhly, and Canada bluegrass (Table 7). Although the order of dominance differed between the control and treatment locations, all three species are the dominant graminoid species on the xeric tallgrass prairie at the Site. Warm-season and cool-season grasses accounted for nearly equal amounts of relative foliar cover at the control and treatment locations, and this is one of the measures that it is hoped would be changed by a prescribed burn. The two predominant cool-season grasses at the control and treatment locations are Kentucky bluegrass (*Poa pratensis*) and Canada bluegrass, both non-native species. One of the objectives for a spring prescribed burn is to reduce the amount of exotic cool-season graminoid cover and increase the native warm-season graminoids. Thus, a spring prescribed burn would have the greatest impact on the cool-season grasses, particularly

Kentucky bluegrass and Canada bluegrass, and should reduce the foliar cover of both species.

A prescribed burn will also reduce the high litter amounts found on the xeric tallgrass prairie. Seventy-seven percent of the ground surface was covered with dead plant litter in the treatment areas. Pre-burn monitoring of the prescribed burn area, in spring 2000, showed total biomass amounts of 465 g/m$^2$ (4152 lbs/acre). The high litter amounts on the prairie at the Site contribute substantially to the potential for wildfires. In addition, the litter ties up nutrients that are currently unavailable for plant growth. Part of the goal of a prescribed burn is to remove much of this litter, thereby reducing the potential for catastrophic wildfire and also recycling nutrients. Monitoring after the prescribed fire will determine to what degree this goal has been accomplished.

Of the measurements that differed between the control and treatment locations, cactus densities were higher at the treatment locations. Twistspine prickly pear (*Opuntia macorhiza*) density was 1.2 stems/m$^2$ in the treatment areas and 0.36 stems/m$^2$ in the control areas. Hedgehog cacti (*Echinocereous viridiflorus*) density was 1.1 stems/m$^2$ in the treatment areas and 0.93 stems/m$^2$ in the control areas. Individual species frequencies differed considerably between the control and treatment areas for many species (Table 8). This is understandable for many of the less frequently encountered species on the xeric tallgrass prairie. However, even for the dominant graminoid species—big bluestem, mountain muhly, and Canada bluegrass—frequency values differed by 20–30 percent between the control and treatment areas. Monitoring in 1998 showed a similar pattern of high variability on the xeric tallgrass prairie in general (K-H 1999b). Because frequency is a measure of both the evenness and commonness of a species across the landscape, these data reveal the heterogeneous nature of the species distribution of the xeric tallgrass prairie at the Site. The combination of bunchgrasses, like big bluestem and mountain muhly, and rhizome or turf grasses like Canada bluegrass, creates a mosaic pattern of species distribution. Such a pattern is common in natural communities because of variations in microclimate and microtopography that influence such factors as light, temperature, soil moisture, and soil type.

The 1999 xeric tallgrass prairie monitoring data have provided a good baseline of information for both control and treatment locations prior to the prescribed burn slated for spring 2000. The data also reveal the heterogeneous nature of the species distribution and species composition of the xeric tallgrass prairie community at the Site. These results will provide useful information to evaluate how the use of prescribed burning as a management tool will affect the species composition and structure of the xeric tallgrass prairie at the Site.

The detailed technical report for the prescribed fire monitoring conducted in 1999 is found in Appendix A.

## 3.3 Great Plains Riparian Woodland

A total of 350 plant species were recorded during surveys in the Great Plains riparian woodland at the Site during 1999 (Table 9). Of these, 77 percent were native species. This was an increase of 14 species, compared to the 1997 Site inventory, which found 274 species in the community. Four of these species were new to the Site species list: alkali bluegrass (*Poa juncifolia* Scribn.), rough bugleweed (*Lycopus asper* Greene), common gooseberry (*Ribes inerme* Rydb.), and hedge bindweed (*Calystegia sepium* (L.) R. Br. ssp. *angulata*). A Sorensen similarity index (an index to evaluate species richness similarity between locations; Brower and Zar 1977) using presence/absence data from the two years yielded a value of 0.88, indicating a high floristic similarity between years, as would be expected. Examination of the species lists from both years (Table 9) shows no substantial difference in the inventory results. The different species observed during the two years are mostly a result of the slight differences in routes used to traverse the management units and of the natural variability in abundance of individual species.

Examination of the qualitative habitat assessment data from the Great Plains riparian woodland management units in 1999 revealed concerns similar to those reported previously (K-H 1998). The biggest management issue in the Great Plains riparian woodland, as well as the biggest threat, is from weeds—especially diffuse knapweed and Canada thistle. Diffuse knapweed is especially prevalent in the Rock Creek and Woman Creek drainages at many locations. The dry, rocky, disturbed conditions on old stream terraces in these drainages are especially conducive to diffuse knapweed establishment. At many of these locations, diffuse knapweed occurs in abundance in the canopy openings between the trees and shrubs, making control difficult (Figure 7). Canada thistle is present along most of the stream reaches on the Site and is increasing at many locations. Comparison of riparian woodland permanent photo-point photographs from 1997 and 1999 shows how Canada thistle has increased at this location in Walnut Creek (Figures 8 and 9).

At many locations, other weed species—such as Dame's rocket, bouncingbet (*Saponaria officinalis*), chicory (*Chicorium intybus*), stinging nettle (*Urtica dioica*), musk thistle, dalmatian toadflax, annual rye, common mullein, and numerous other less aggressive species—are also problems in the riparian community. During 1999, control of the noxious weed Dame's rocket was initiated at a woodland location west of the A-1 pond in Walnut Creek. Once the plants flowered, all the plants found along the stream had their tops cut off, using a sickle, to prevent seed set. Visits were made throughout the rest of the summer to cut the tops off of any additional flowering plants. It is hoped that similar efforts over the next few years will prevent further seed set in the drainage and stress the plants to the point where they will eventually die. The small size of the population makes mechanical control a viable tool to eradicate the weed at this, the only known population location on the Site. Similar control is recommended for other small, isolated noxious weed populations in the Great Plains riparian woodland on the Site to prevent larger problems from developing.

Streambank erosion was noted as a concern along the reach of Great Plains riparian woodland between the B-4 and B-5 ponds. In this area, the stream cuts down to bedrock

in several places, and during high-water events, has begun to cut horizontally, removing large pieces of the streambank. Several locations have been washed away, resulting in streambank collapse during 1999 (Figures 10 and 11). If left unattended, it is likely that some of the trees and shrubs growing along the stream will eventually be lost as they are undercut and fall over. This is of concern at this location because the area is a known Preble's meadow jumping mouse population location, and the loss of trees and shrubland could reduce the quality and amount of available habitat for the mouse.

Aside from these concerns, the Great Plains riparian woodland in general appeared healthy and continues to provide valuable habitat for numerous wildlife species at the Site. No visible signs of disease, predation, injury, or die off of any of the dominant riparian trees and shrubs were observed. Most appeared to have flowered and produced fruit during 1999. Comparison of the permanent photo-point photographs of the Great Plains riparian woodlands in 1997 and 1999 showed no substantial changes in the riparian vegetation during this time frame.

## 3.4 Wetlands

A total of 246 plant species were recorded during surveys at the three wetlands monitored during 1999 (Table 10). This was a decrease of 14 species, compared to the 1997 Site inventory, which found 260 species in the community. Of these, 76 percent were native species. One of the species (water parsnip [*Berula erecta* (Huds.) Cov. var. *incisum*]) found at the wetlands in 1999 was a new record for the Site. A Sorensen similarity index using presence/absence data from the two years yielded a value of 0.83, indicating a high floristic similarity between years, as would be expected. Examination of the species lists from both years (Table 10) shows no substantial difference in the inventory results. The different species observed during the two years are mostly a result of the slight differences in routes used to traverse the management units, and of the natural annual variability in the abundance of individual species.

Examination of the qualitative habitat assessment data from the wetland management units also revealed concerns similar to those reported previously (K-H 1998). The management issue of greatest concern in the wetlands, as well as the biggest threat, is from weeds, particularly Canada thistle. Canada thistle was present at moderate to high infestation levels at all three wetlands monitored on Site in 1999. Another noxious thistle, bull thistle (*Cirsium vulgare*), also seemed to be present in higher amounts than were noted previously. Butter-and-eggs (*Linaria vulgare*), another state-listed noxious weed, was found growing in the Antelope Springs wetland, near locations where it had been found previously growing only in mesic grassland/wet meadow ecotonal areas. The issue of weed control at the Site is discussed in greater detail later in this report.

Aside from the weed management concerns in the wetlands, the community appeared healthy and continues to provide habitat for a variety of wildlife on the Site. No visible signs of disease, predation, injury, or die off of any of the dominant wetland species were observed. Comparison of the permanent photo-point photographs of the wetlands in

1997 and 1999 showed no substantial changes in the wetland vegetation during this time frame.

A substantial amount of litter (dead plant material) was present at all three monitored wetlands. The use of prescribed burning would help reduce this litter load and return tied-up nutrients to the plants, increasing the vigor and health of the community. Currently, the prescribed burn planned for spring 2000 is slated to burn across most of the Antelope Springs wetland in the south Buffer Zone, which would help alleviate this problem at that location.

## 3.5 Rare Plants

Observations were made during 1999 of each of the plant species of concern listed by the CNHP as rare or imperiled that occur on the Site. Populations of mountain-loving sedge, forktip three-awn, carrionflower greenbriar, and dwarf wild indigo were visited and evaluated. All four species were observed in vegetative, flowering, and fruiting condition, and their populations appeared to be doing well. Figure 12 shows the known locations where these species have been observed on the Site.

## 3.6 Site Flora

As a result of the 1999 field work, a total of ten new records of vascular plant species are reported for the Site. Plant nomenclature follows that of GPFA (1986), Weber (1976), and Weber (1990), in that order of determination. The new plant species reported for the Site flora are:

| | |
|---|---|
| *Poa juncifolia* Scribn. | Alkali Bluegrass |
| *Berula erecta* (Huds.) Cov. var. *incisum* | Water Parsnip |
| *Lycopus asper* Greene | Rough Bugleweed |
| *Astragalus lotiflorus* Hook. | Lotus Milk-Vetch |
| *Ribes inerme* Rydb. | Common Gooseberry |
| *Calystegia sepium* (L.) R. Br. ssp. *angulata* | Hedge Bindweed |
| *Coronilla varia* L. | Crown Vetch |
| *Trifolium repens* L. | White Clover |
| *Ceanothus fendleri* A. Gray | Buckbrush |
| *Lolium perenne* L. var. *aristatum* Willd. | Italian Ryegrass |
| *Lolium perenne* L. var. *perenne* | Perennial Ryegrass |

None of the new species recorded on Site in 1999 is a rare species or state-listed noxious weed. The complete list of plant species known to occur at Rocky Flats as of the end of the 1999 field season is found in Appendix B. Voucher specimens of these species are maintained in the Site herbarium.

## 3.7 Weeds and Weed Control

At present, the most serious threat to the native plant communities on the Site is from noxious weed infestations. Although many species of weeds exist in the plant communities at the Site, most are not especially problematic. However, under the Colorado Noxious Weed Act (CRS 1996), a number of particularly noxious weeds must be controlled by property owners to prevent their spread to surrounding lands. Some of these weeds pose a significant threat to the plant communities at the Site. During 1999, the Site's weed control program used a variety of methods to address these problems. In addition, monitoring was conducted to ascertain the effectiveness of ground and aerial herbicide applications on diffuse knapweed, and to assess any associated impacts to native species, in addition to mapping the distribution of various weed species. Weed control efforts and results from the monitoring conducted in 1999 are discussed in general below. Detailed technical reports outlining the Site's weed control efforts in 1999, and more detailed results of the weed control monitoring, can be found in Appendix A.

### 3.7.1 1999 Weed Control Efforts at the Site

During 1999, the integrated weed management program at the Site continued to work toward controlling infestations of several noxious weed species in the Buffer Zone. Several methodologies were applied to control current infestations and prevent new ones from starting. These included the use of administrative and cultural controls, physical and mechanical methods, biological controls, and chemical controls. Strides were made in controlling several large infestations of diffuse knapweed, musk thistle, and mullein, in addition to other smaller infestations of scotch thistle, annual rye, and dame's rocket.

Cultural and administrative controls were used during 1999 for several large projects that disturbed native and previously reclaimed grasslands on the Site (Figure 13). After project completion, revegetation and weed control of the disturbed areas was required by Site policies (K-H 1999c). The total acreage revegetated in project areas in 1999 was approximately 23 acres. As required by the 1999 weed control plan (K-H 1999c), each of the projects used weed-free topsoil, seed, and mulch. In addition, the seed mix used for revegetation was approved by and/or provided by the K-H Ecology Group to preclude the introduction of undesirable species to the Site.

As part of an effort to prevent weeds from becoming established in previously unremediated areas, an abandoned firebreak road in the south Buffer Zone was revegetated in the fall of 1999 (Figure 13). Because the road crossed through two different plant communities, xeric tallgrass prairie and mesic mixed grassland, it was seeded with native species to match the surrounding plant communities at specific locations. Approximately 2.3 acres were seeded. Additional information and photographs of the project and road revegetation efforts are available on the CD-ROM found in Appendix C of this report.

Physical and mechanical controls used at the Site in 1999 consisted of mowing, grading, and selective hand control. Mowing was done along the margins of the main east and west access roads, in addition to several miles of firebreak roads in the Buffer Zone, to prevent the roadside weeds from going to seed and spreading further (Figure 14). Approximately 113 acres were mowed along these roadsides during 1999. Grading was conducted along approximately 18 miles of firebreak roads in the Buffer Zone to maintain the roads and also to prevent roadside weeds from going to seed and spreading further (Figure 14). Approximately 66 acres of road were graded in 1999. Hand control in 1999 was conducted at several locations to control localized infestations of scotch thistle, annual rye, and dame's rocket. Hand control consisted of hand pulling, using sickles or sling blades, and spot herbicide spraying.

No new biological controls (insects) were introduced on the Site during 1999. However, several species that were released previously to control musk thistle, St. John's-wort (*Hypericum perforatum*), dalmatian toadflax, and diffuse knapweed continue to do a good job of containing infestations of musk thistle and St. John's-wort. They have been much less effective at controlling infestations of dalmatian toadflax and diffuse knapweed, however.

Herbicides were used to control several hundred acres of noxious weed–infested grasslands at the Site during 1999. Figure 15 shows the locations of ground and aerial applications of the herbicide Tordon 22K in 1999. Primary target species were diffuse knapweed, musk thistle, and mullein; however, other less aggressive exotic species such as goatsbeard (*Tragopogon dubius*), curly-top gumweed (*Grindelia squarrosa*), alyssum (*Alyssum minus*), wild lettuce (*Lactuca serriola*), small-seeded false flax (*Camelina microcarpa*), and some of the tansymustards (*Descurania* ssp.) were also controlled. Approximately 72 acres were treated on the ground, while almost 1,500 acres were treated with a helicopter (Figures 16 and 17). Excellent control of the diffuse knapweed, musk thistle, and mullein was achieved at most locations treated (Figures 18–20). The residual effect of the Tordon 22K is expected to help provide continuing control of these species for the next few years, precluding the need for annual retreatment at these locations.

As part of the ongoing integrated weed management program, the sharing of information and planning strategies with other local agency weed coordinators and resource managers is an important component, because coordinated efforts among land owners is essential for long-term control. During 1999, two specific weed tours were conducted in the Buffer Zone, sponsored by different groups at the Site. The K-H Ecology Group brought ecologists from the City of Boulder Mountain Parks and City of Boulder Open Space departments to the Site to view firsthand the effects of the aerial and ground herbicide applications. The DOE, in coordination with the Colorado Weed Network, sponsored a tour with the assistance of Site ecologists, to show 55 local weed coordinators and resource managers the effects of large-scale ground and aerial herbicide applications for controlling diffuse knapweed in the Buffer Zone. These tours provided an opportunity to show the public some of the resource management actions being conducted to preserve the ecological resources at the Site. The K-H Ecology Group also disseminated

information to Site personnel through meetings, personal communication, and Site newspaper articles. In addition, K-H ecologists attended regional weed control meetings and the annual 1999 Colorado Weed Management Association conference to keep up to date with the most recent knowledge and advances in weed control.

### 3.7.2 Weed Monitoring

#### 3.7.2.1 Weed Mapping

The 1999 weed distribution maps for diffuse knapweed, musk thistle, dalmatian toadflax, and common mullein are shown in Figures 21 through 24, respectively. Five additional species—annual rye, Russian knapweed, Scotch thistle, dame's rocket, and jointed goatgrass—were mapped in 1999 because of their aggressive nature and their recent appearance at various locations on the Site. The distributions of these species are shown in Figures 25 and 26. After being entered into the Site Geographic Information System (GIS), the overall extent of these species across the Site was estimated by species and by infestation level using the GIS coverages. Table 11 contains the estimated total acreage and acreage-by-density category for each of the species, based on the maps. The species with the greatest extent on the Site in 1999 was dalmatian toadflax, covering nearly 2,507 acres, followed by diffuse knapweed (2,295 acres), musk thistle (1,353 acres), and common mullein (1,068 acres). (The Site covers approximately 6,485 acres in total [K-H 1997b]). Table 11 also lists the total number of acres for annual rye, Russian knapweed, Scotch thistle, dame's rocket, and jointed goatgrass. It should be noted that all these acreages are only approximate and should not be interpreted as exact areas. Also, these values represent known locations for these species. It is possible that unmapped infestations are present as well.

Table 12 shows the total infested acreages for diffuse knapweed, dalmatian toadflax, musk thistle, and common mullein for 1997, 1998, and 1999. Most of the large increases in infestation acreages for dalmatian toadflax, musk thistle, and common mullein from 1997 to 1998 were a result of the time of year in which mapping was conducted. Mapping in 1997 was conducted in August for each of the species. Beginning in 1998, weed mapping was conducted for each species when that species was in flower and/or most visible. Therefore, the higher visibility of the species allowed more accurate estimates of their infestation levels in 1998 and 1999, which produced the higher acreage estimates.

From 1998 to 1999, the total acreage site-wide infested by diffuse knapweed and musk thistle decreased by 618 and 332 acres, respectively, largely due to the aerial herbicide application conducted in May 1999. Common mullein acreage was also decreased for the high, medium, and low density levels largely because of the aerial spraying. Overall common mullein acreage for the Site increased, however, due to the large increase in the scattered category. Dalmatian toadflax acreage showed an increase of more than 500 acres from 1998 to 1999. The reasons for this large increase are unknown, although qualitative observations suggested that 1999 was a bumper-crop year for the species. The increase may have resulted from a high amount of flowering in 1999 (Figure 27), which

increased the visibility of the species in areas where it had not been observed previously. Whatever the reason, the substantial amount of dalmatian toadflax present at the Site presents a control challenge, because no effective control methods are available at present for large-scale dalmatian toadflax infestations. Certain herbicides applied at high rates can kill dalmatian toadflax, but the high rates also kill all the other forbs on the grassland. Therefore, this is not an acceptable method, given the management objectives at the Site.

#### 3.7.2.2 Aerial Herbicide Application Monitoring

During May 1999, the herbicide Tordon 22K was applied from a helicopter to control diffuse knapweed and other noxious weeds on approximately 1,500 acres at the Site. Figures 28 and 29 show the locations of the aerial herbicide application in 1999 and the pre- and post-treatment diffuse knapweed densities at these locations in 1998 and 1999, respectively. Comparison of the maps demonstrates the dramatic effect of the spraying. At the aerial herbicide application locations, the total amount of diffuse knapweed present was reduced by 683 acres, from 878 acres in 1998 to 195 acres in 1999 (Table 13, Figure 30). This represents a 78 percent reduction in the total number of diffuse knapweed–infested acres in the areas that were sprayed in 1999. In practical terms, this means there were essentially no adult diffuse knapweed plants observed at these locations, which means that no additional seed was added to the seed bank and no plants were available to blow away from these infestations, to further infest other areas. Figures 31 and 32 illustrate visually the dramatic decrease in diffuse knapweed that was observed at most of the treatment locations.

In addition to the mapping effort, the effectiveness of the 1999 aerial herbicide application of Tordon 22K on diffuse knapweed was evaluated using a set of 30 control plots and 30 treatment plots (0.5×1.0 m). The sites used were AS-1, AS-2, and AS-3 (Figure 4). Diffuse knapweed cover was estimated visually at each plot. Control plots were covered after initial monitoring to prevent the herbicide from reaching the plants and surface of the ground (Figure 33).

Results from the plots showed that the aerial herbicide application of Tordon 22K by helicopter was very effective at controlling diffuse knapweed. Diffuse knapweed cover dropped significantly, to less than 1 percent, in the sprayed plots (Figure 34). This was in sharp contrast to the significant increases observed in the control plot (Figure 34). Additionally, diffuse knapweed frequency was reduced significantly in the sprayed areas (Figure 35). Qualitative observations elsewhere indicated similar success at most treatment areas on the xeric tallgrass prairie, except where small spots were missed inadvertently. The aerial application most effectively controlled diffuse knapweed on the flat areas on top of the pediment, where the application was consistent and even. The residual effect of Tordon 22K is such that similar effectiveness should be seen in these areas for the next 3 to 4 years.

Diffuse knapweed remained only along a few flight lines where areas were accidentally missed (Figure 29; southwest areas of Site). Control on one of the hillsides in northern Rock Creek was less consistent, however, and overall diffuse knapweed densities were

reduced less (Figure 29; northern-most locations on Site). It is unknown why control was not as effective on this particular hillside.

Both ground and aerial herbicide applications of Tordon 22K have been shown to be effective at controlling diffuse knapweed at the Site. Observations indicate that its effectiveness is similar through aerial application is similar to that of ground application.

Drift cards were used to detect herbicide drift beyond the specified spray areas where sensitive habitats (i.e., shrublands, streams, wetlands, and woodlands) were present. Drift cards were typically located in two parallel lines along the edges of the spray areas. The drift cards detected small amounts of herbicide at a few locations, but observations of the sensitive native plants in these areas throughout the growing season showed no chlorosis, wilting, or death. Although no undesirable impact resulted from the herbicide that went beyond the spray areas, drift is not desired, and drift cards will be used in future aerial herbicide applications. Additionally, aerial applicators will continue to be educated about the importance of maintaining appropriate buffer areas. As necessary, more detailed maps and flagging of spray boundaries in the field should be considered for better delineation of buffer-area boundaries in sensitive areas.

The detailed technical report for the aerial herbicide monitoring conducted in 1999 is found in Appendix A.

#### 3.7.2.3 Ground Herbicide Application Monitoring on Diffuse Knapweed and Native Plant Species

In 1997, an investigation was begun to evaluate the effectiveness of ground applications of the herbicide Tordon 22K on diffuse knapweed, and to document any resulting impacts on native species. The study was conducted at sites DKC and DKT, northwest of the Industrial Area at the Site (Figure 4). Overall species richness in the treatment area declined by 12 species immediately after the herbicide application in 1997, but by 1999, overall species richness had almost completely returned (only one species less than the original number in 1999; Table 14, Figure 36). A Sorensen coefficient of similarity index (an index used to evaluate species similarity between locations) was used to evaluate the species richness similarity within the control and treatment plots from spring 1997 to summer 1999. An index value of 0.83 resulted for both plots, indicating high similarity between pre- and post-treatment. An additional comparison of similarity between the control plot and the treatment plot for spring 1997 and summer 1999, showed essentially no difference either, indicating no long-term loss of species richness as a result of the herbicide application.

At a finer scale, using quadrat data, the number of species per quadrat was significantly lower in the treatment plot, as compared to the control plot, only immediately after the herbicide application during summer 1997 (Figure 37). After this, the treatment plot response paralleled that of the control plot, indicating no substantial change in species richness at this scale. Therefore, although there was some slight initial depression of

species richness in response to the herbicide application, after three growing seasons, it essentially returned to pre-treatment levels.

Species diversity (a measure of species richness and abundance; Shannon-Weaver index) declined immediately after the herbicide application in the treatment plot (Figure 38). It reached its lowest level in summer 1998, when it was significantly different from the control plot, before beginning to return toward pre-treatment levels in 1999. Although the species diversity in the treatment plot still remains below its initial level and that of the control plot, the diversity indices in 1999 were no longer significantly different from those of the control plot. Continued monitoring will evaluate how long it takes for species diversity on the xeric tallgrass prairie at the Site to fully return to pre-treatment levels.

The response of diffuse knapweed, the primary target species of the herbicide application, has been dramatic. The herbicide application reduced the diffuse knapweed in the treatment plot to a densities far below the original value, and that level of control was maintained in 1999 (Figure 39). Diffuse knapweed cover also remains at less than 1 percent of the total relative foliar cover (Tables 15 and 16). In the control plot, however, spring diffuse knapweed densities have increased by a factor of five, and summer densities have also increased (Figure 39). The ongoing control of diffuse knapweed observed in the treatment plot is critical, because it reduces the number of adult plants that are available to produce additional seed and to blow across the landscape spreading the seed. It is important to note, however, that with time, diffuse knapweed density will begin to increase again in the treatment plot, as a result of seed still remaining in the seed bank and from immigration of new seed from off-site sources (i.e. grasslands and mining areas to the west). If no further control measures are taken, the density could reach and potentially exceed pre-treatment levels in a few years.

Although diffuse knapweed density continues to be maintained at a low level, frequency data for the treatment plot showed that after bottoming out at 20 percent in 1998, diffuse knapweed frequency increased to 44 percent in 1999 (Table 17). Additionally, in the larger area surrounding the treatment plot, which received the same herbicide application, weed mapping results have begun to show a return of diffuse knapweed. Thus, although the herbicide continues to control the diffuse knapweed in the treatment plot, long-term integrated weed control using multiple methods is necessary to sustainable this control. This is especially important because of the potential long-term impacts that the native plants in the community could experience in response to repeated long-term herbicide applications. Cooperative weed control in conjunction with surrounding land owners would help address the issue of seed being transported onto the Site.

The responses of the non-target species on the xeric tallgrass prairie varied, but fell within generally expected parameters. One of the non-target species groups that was most affected was the cacti, particularly the twistspine cactus. Twistspine cactus density was reduced by 87 percent, from approximately 79 stems/100 $m^2$ in 1997 to 10 stems/100 $m^2$ in 1999. This decrease was statistically significant. Most of these cacti turned yellow initially after the herbicide application and later died. The hedgehog cactus, the other

common species on the xeric tallgrass prairie, was less severely affected and, while showing a numerical loss of just over 50 percent, the loss was not statistically significant. Continued monitoring will document whether the cacti begin to return to the treatment plot, but any return will be gradual because cacti are slow-growing plants.

Total absolute (actual) cover on the xeric tallgrass prairie was not substantially affected by the herbicide treatment—changes in the treatment plot mostly paralleled changes observed in the control plot (Figure 40). This statistic is important, because it demonstrates that no large unvegetated areas were created on the prairie as a result of the herbicide application. Instead, other species (graminoids) expanded, filling in the canopy where other species were reduced as a result of the spraying.

The forb, or broadleaf, non-grass component of the prairie, both non-native and native, was affected by the herbicide treatment. This effect was expected though, because Tordon 22K, though most injurious to certain plant families, is still a broadleaf herbicide. Total relative forb cover declined for the first two field seasons after treatment, reaching its lowest point in summer 1998. By 1999, the third season after treatment, it was no longer significantly different from the control plot and was returning to pre-treatment levels (Figure 41). Non-native relative forb cover was eliminated from the treatment plot during 1998, the second growing season after treatment, but began to return again in 1999 (Figure 42). Diffuse knapweed relative cover accounted for less than half of the returning non-native forb cover in 1999 and was itself less than 1 percent of the total relative cover at the treatment plot.

Native relative forb cover dropped initially after the herbicide application and reached its lowest point during the summer of the second season after treatment. In the third season, native relative forb cover was no longer significantly different from the control plot and was returning to pre-treatment levels (Figure 43). Continued monitoring will determine how long it takes for native forb cover to fully return to pre-treatment levels. This is important because it is not desirable to re-treat the area with a broad-spectrum, broadleaf herbicide if the native forb component of the community has not shown that it can return to its pre-treatment level of abundance . Repeated broadcast applications with a broad-spectrum herbicide, without allowing appropriate time for the native forbs to rebound, could potentially stress them to the point of elimination from the grassland, which would be an undesirable result.

A broadcast application of a more species-specific herbicide such as Transline, which controls diffuse knapweed very effectively with little impact to other species, might be useful as a follow-up a few years after a Tordon 22K application. One drawback to Transline, however, is its lack of a multi-year residual effect—it would have to be applied annually to remain effective. The use of selective wick applications and/or hand control is planned for FY2000, to evaluate the effectiveness of these methods for extending the interval between applications of Tordon 22K.

The loss of relative forb cover was offset by an increase in relative graminoid cover, in response to reduced competition from forb species (Figure 44). The increase in relative

graminoid cover in the treatment plot began after the herbicide application and continued through 1999, three growing seasons after the herbicide treatment (Figure 44). The warm-season grasses responded to the herbicide application by increasing their relative cover. This increase was most pronounced immediately after the treatment (Figure 45), although the changes were not significant. This effect most likely resulted from applying the herbicide in mid-June 1997, thereby reducing the competition of forbs for much of the rest of the growing season and giving the warm-season species the greatest benefit. The cool-season graminoid response was delayed until the following season, when it was able to take advantage of the reduced forb competition and showed increases as well (Figure 46), some of which were significant. By 1999, it was apparent that much of the graminoid community was returning to normal. The treatment plot cool-season graminoids had returned to the level of the control plot in summer 1999, and the treatment plot warm-season species had returned to the control plot level in spring 1999. The warm-season increase, above that of the control in summer 1999, is most likely due to the higher precipitation received during summer 1999 and the continued reduced forb competition. Monitoring during 2000 will confirm whether the overall graminoid cover response returns to pre-treatment levels and remains essentially equal to that of the control plot.

Data from the Site are consistent with the data from other studies that have shown an initial decline of species diversity, loss of forb and weed cover, and increase in graminoid vigor and cover after spraying with Tordon 22K. Rice and Toney (1996) reported decreases in forb cover due to herbicide treatments on native prairie in Montana. They reported that these responses were transitory, however, and that forb values returned to pre-treatment levels after about three years. Rice et al. (1997) found that species diversity also declined after spraying with Tordon 22K, but recovered after 2–3 years. Both of these studies also indicated that, as a result of lost weed and forb cover (i.e., reduced competition), the graminoid component of the community responded vigorously. In the Lolo National Forest in Montana, Henry (1998) reported that two years after spraying with Tordon 22K, a mountain grassland community had a 95 percent reduction in weed biomass and an 86 percent decrease in forb biomass. Associated with this was a 714 percent increase in grass biomass.

The only substantial difference between the Site data and the data from these other studies is in the recovery time for some of the measures. The Montana study on native plant communities had recovery times of 2–3 years (Rice and Toney,1996; Rice et al., 1997), whereas some measures in the Site treatment plot have not returned numerically to pre-treatment levels after three growing seasons, although most measures in the treatment plot are no longer statistically different from those in the control plot. Continued monitoring will document the time needed for complete recovery under the specific conditions of the xeric tallgrass prairie at the Site. This information will be useful in improving weed control strategies and better managing the Site's grassland communities for the long term.

## 3.8 Photographic Monitoring

Photographic monitoring at permanent photo point locations during 1999 showed varying degrees of change in comparison to photographs taken in 1997. At many locations, little or no change was evident in the plant communities. At other locations, however, large differences were apparent, often as a result of management actions (i.e., weed control efforts) or because noxious weeds had become more dominant on the landscape. Figures 8 and 9 show an area in Walnut Creek where Canada thistle increased dramatically over a 2-year period. Diffuse knapweed infestations were dramatically reduced where an aerial herbicide application was applied on the xeric tallgrass prairie (Figure 47) and on a hillside in Rock Creek (Figure 18). A map of the permanent photo-point locations that has been linked to pairs of comparison photographs taken in 1997 and 1999 is available on the CD-ROM in Appendix C of this report.

## 3.9 Disturbances

During 1999, several projects disturbed approximately 23acres of the native plant communities at different locations in the Buffer Zone (Figure 13). Most of this disturbance was in the mesic mixed grassland, reclaimed grassland, and a small amount of Great Plains riparian woodland. At the conclusion of each project, the disturbed areas were revegetated using certified weed-free native seed mixes and weed-free mulch. Photographs and maps of the project areas and revegetation efforts are found on the CD-ROM in Appendix C.

Other disturbances to the native plant communities on the Site came primarily from unauthorized off-road driving (Figure 48). Several off-road locations showed evidence that spinning tires that had removed the vegetation entirely, creating bare spots (Figure 49). From a resource management standpoint, these incidents create two problems. First, unauthorized off-road driving spreads weed seeds from the Buffer Zone road edges further into undisturbed areas of the native prairie. Second, the bare spots created by spinning tires create disturbance patches in the previously undisturbed native prairie, and these patches then become islands of weeds that then spread seed into the native prairie. Given the weed control issues at the Site, unauthorized off-road driving is inconsistent with the Buffer Zone resource management policy of preserving and maintaining the high-quality ecological resources found at the Site. Administrative measures were taken during 1999, and continue at present, to address and eliminate this problem.

# 4. Conclusions

Vegetation monitoring in 1999 continued to document the generally high quality of the native plant communities at the Site. The Site continues to provide a haven for many increasingly rare plant communities that are disappearing rapidly from the Front Range of Colorado. The results, however, also continue to underscore the issues that threaten the quality and long-term sustainability of the Site's ecological resources. These threats come primarily from weeds, human disturbances, and plant litter build up. Active resource management being practiced at the Site has helped alleviate some of these threats. Aerial and ground herbicide applications have dramatically reduced the amount of diffuse knapweed and other weeds on the prairie, enhanced the vigor and health of many native graminoid species, and improved the aesthetic appearance of the grasslands. The reintroduction of prescribed burning for prairie management has been pursued, and a prescribed burn is scheduled for spring 2000. Project disturbances have been revegetated with native species to return these areas to native prairie. These resource management efforts are having a positive effect on the native plant communities.

Although recent herbicide applications have successfully controlled diffuse knapweed in the treated areas, with minimal impact on other prairie species, long-term control will require the integration of other methods to help maintain the lower diffuse knapweed levels in the treated areas. Without this integrated control approach, diffuse knapweed levels will return to pre-treatment levels, requiring additional herbicide applications. Long-term reliance on herbicides is not a practical solution, because repeated applications are likely to be detrimental to many of the native prairie species, not to mention the prohibitive costs associated with this type of management. Additionally, coordinated efforts with off-site agencies and property owners are needed to prevent the constant reintroduction of weed seed into treated areas from off site.

Despite these concerns, however, the data indicate that beneath the sometimes visually dominant weedy appearance, the native plant communities are still present. The Site represents some of the last remaining strongholds for many of the rare plant communities that were once more common along the base of the Front Range. Monitoring results indicate that management actions are having their desired effects. Continued active management of these native communities should provide a lasting legacy for future generations.

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# 6. Glossary

Annual – A plant that lives its entire life cycle during the course of a single growing season.

Biocontrol – A method of weed control that uses insects or fungi to stress, damage, or destroy the plant tissue of undesirable species.

Biodiversity – The existence of a wide range of different types of organisms in a given place at a given time.

Biomass – A measure of the productivity of a community, usually measured by clipping the vegetation and obtaining the dry weight of the vegetation expressed per unit area (grams/square meter).

Control – The plot, quadrat, transect, site, or location, that receives no treatment or management action (e.g., weed control, prescribed burning, mowing). It serves as an unaffected plot that can be compared to the treatment plot to evaluate whether or not the treatment had any impact.

Cool-season graminoids – Grasses that green up early in the growing season (March–May) and produce mature fruits by late June or early July.

Cover – Vegetation cover is a measure of abundance for individual plant species in a specified area. The cover of different species can be grouped and summed to provide the cover for that grouping of species (e.g., graminoid cover or forb cover).

Density – A measure of the number of individuals per unit area.

Diversity – A measure of the number of species present and their relative abundance in a community.

Dominant plant species – One or more species that occur in the greatest abundance (usually based on cover or biomass) in a given plant community.

Ecotonal – An ecotone is the boundary area between two different plant communities.

Forbs – Herbaceous, broad-leaved, non-woody plant species.

Graminoids – Grasses, sedges, or rushes.

Litter – Dead plant matter that has accumulated on the surface of the ground.

Management units – Arbitrary divisions of the different plant communities at the Site used to facilitate vegetation sampling. Roads, fence lines, and streams were often used as boundaries.

Perennial – A plant that lives its lifecycle over the course of multiple years.

Prescribed burns or fire – A prescribed, controlled fire, intentionally set to burn off the vegetation to meet a set of management objectives.

Relict – Persistent remnants of a pre-existing, once more widespread flora or fauna that now exist in more restricted or isolated areas.

Riparian – Pertaining to, or on the banks of a stream (e.g., riparian vegetation or riparian woodland).

Species richness – The complete list and number of species found in a given area.

Species richness similarity – A mathematical coefficient that quantifies how similar or dissimilar the species composition of two communities is. A common coefficient is the Sorensen coefficient of similarity index, which is an index that compares species lists between two areas by taking into account the total number of species present in each community and the number in common between them.

Target species – Species specifically chosen for weed control (e.g., diffuse knapweed or musk thistle).

Treatment – The plot, quadrat, transect, site, or location, that receives a specific management action (e.g. weed control, prescribed burn , mowing).

Vascular plants – Plants that have xylem and phloem (i.e., conductive tissue) for internal movement of water, minerals, and nutrients. This excludes plants such as mosses, liverworts, and hornworts that have no such tissues.

Warm-season graminoids – Grasses that green up later in the growing season (late May–June) and don't produce mature fruits until September.

Wick application – A method of applying herbicide by direct contact to selected individuals of the target species.

Xeric – Dry or characterized by scant moisture; tolerating or adapted to arid conditions.

# Figures

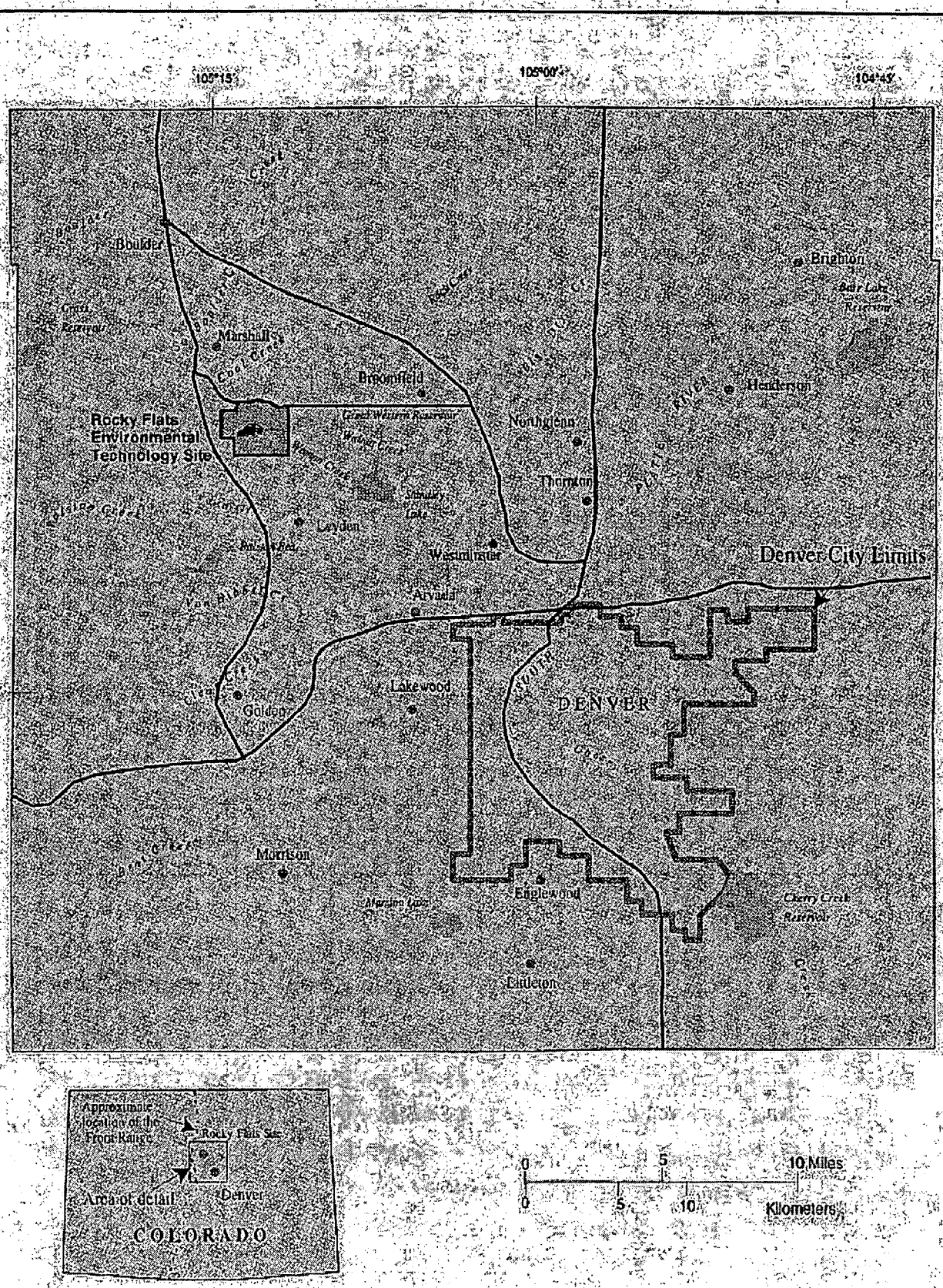
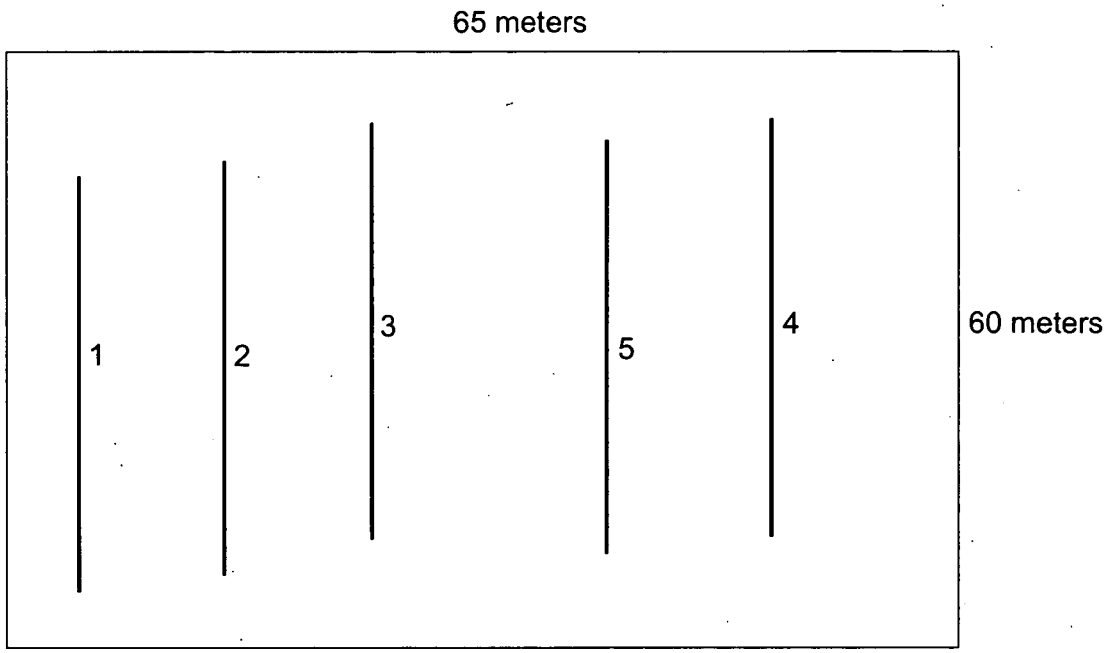
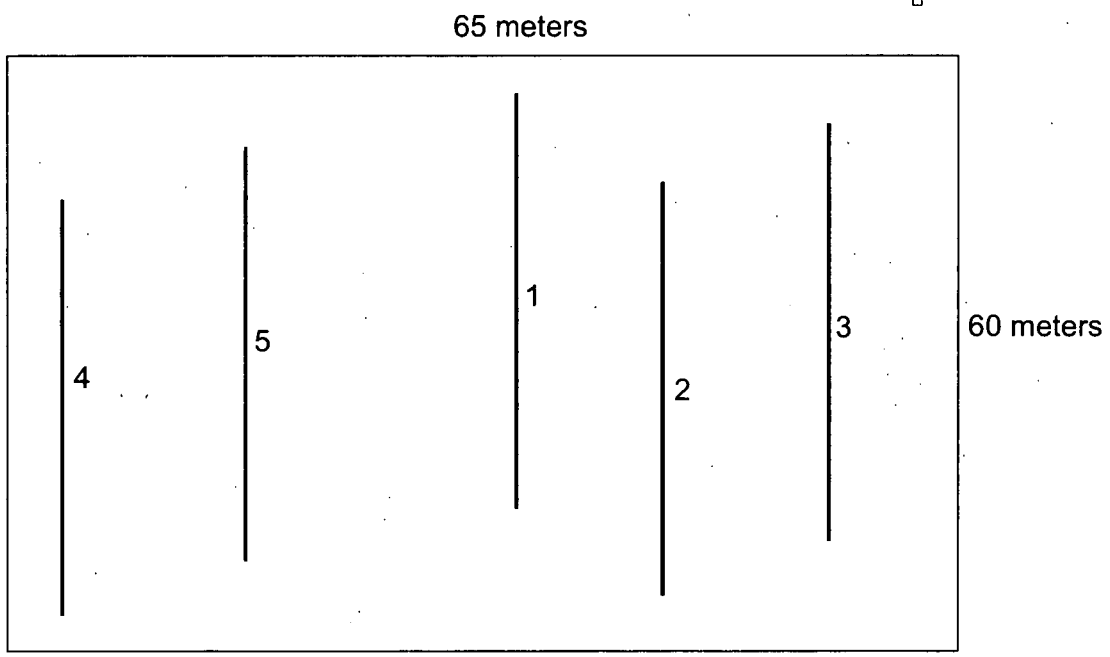



Figure 1

LOCATION OF THE ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE



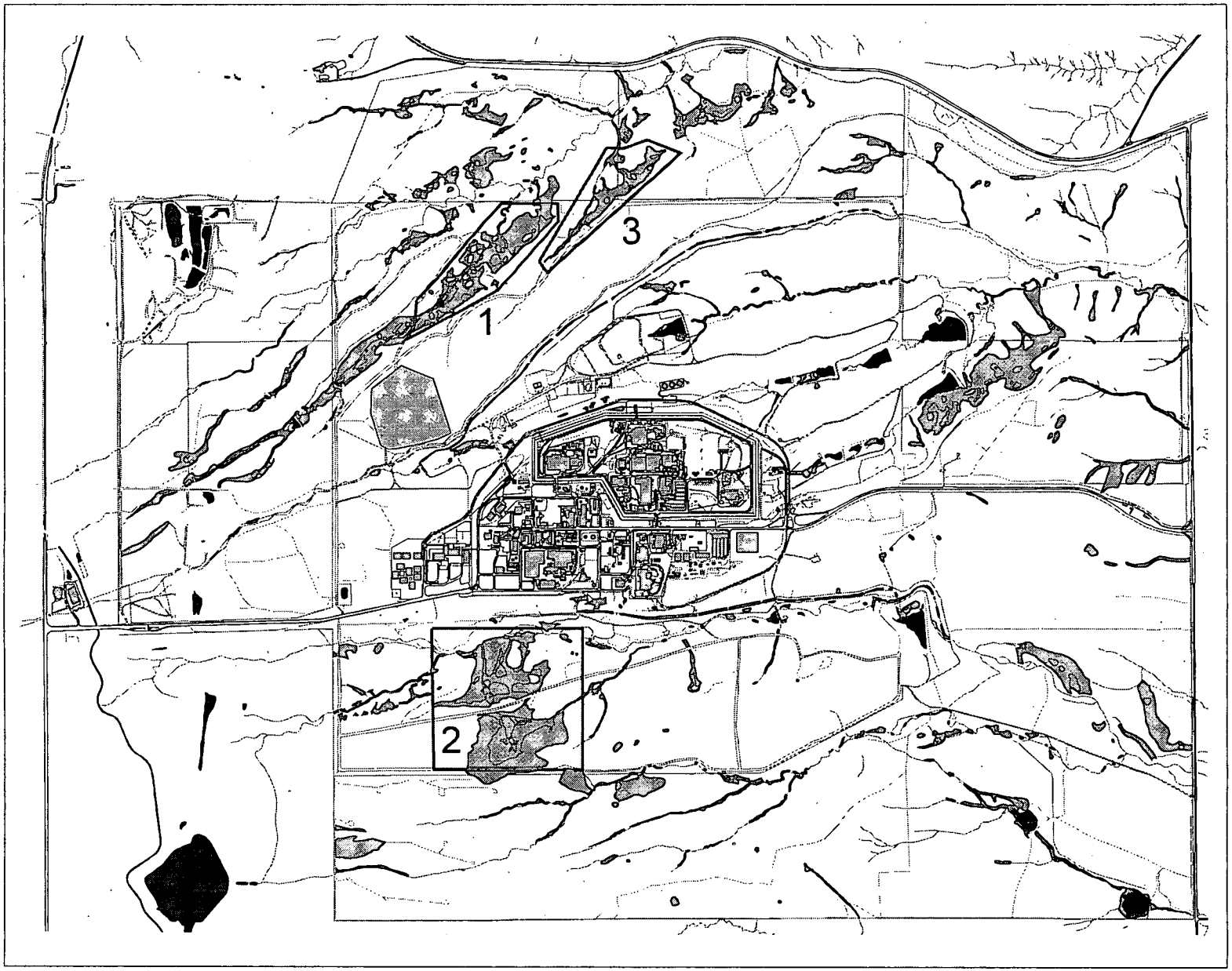

**Control Plot-DKC**




**Treatment Plot-DKT**

Figure 2. Diffuse knapweed monitoring plot and transect locations.

*\\Boulder1\Data\Groups\Graphics\Projects\1454\knapweed mon plot.fh8 p 1 & 2 03-29-00 CO*




# Wetland Management Units

Figure 3

## MAP LEGEND

Wetlands (Combined Wet Meadow/Marsh, Short Marsh, and Tall Marsh Habitat Types)

Wetland Management Units

### Standard Map Features

- New Landfill
- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads

DATA SOURCE:
Management Unit and wetland boundaries provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1/85
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**
These locations approximate the boundaries of the Management Units. The boundaries are not exact and should not be treated as such.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

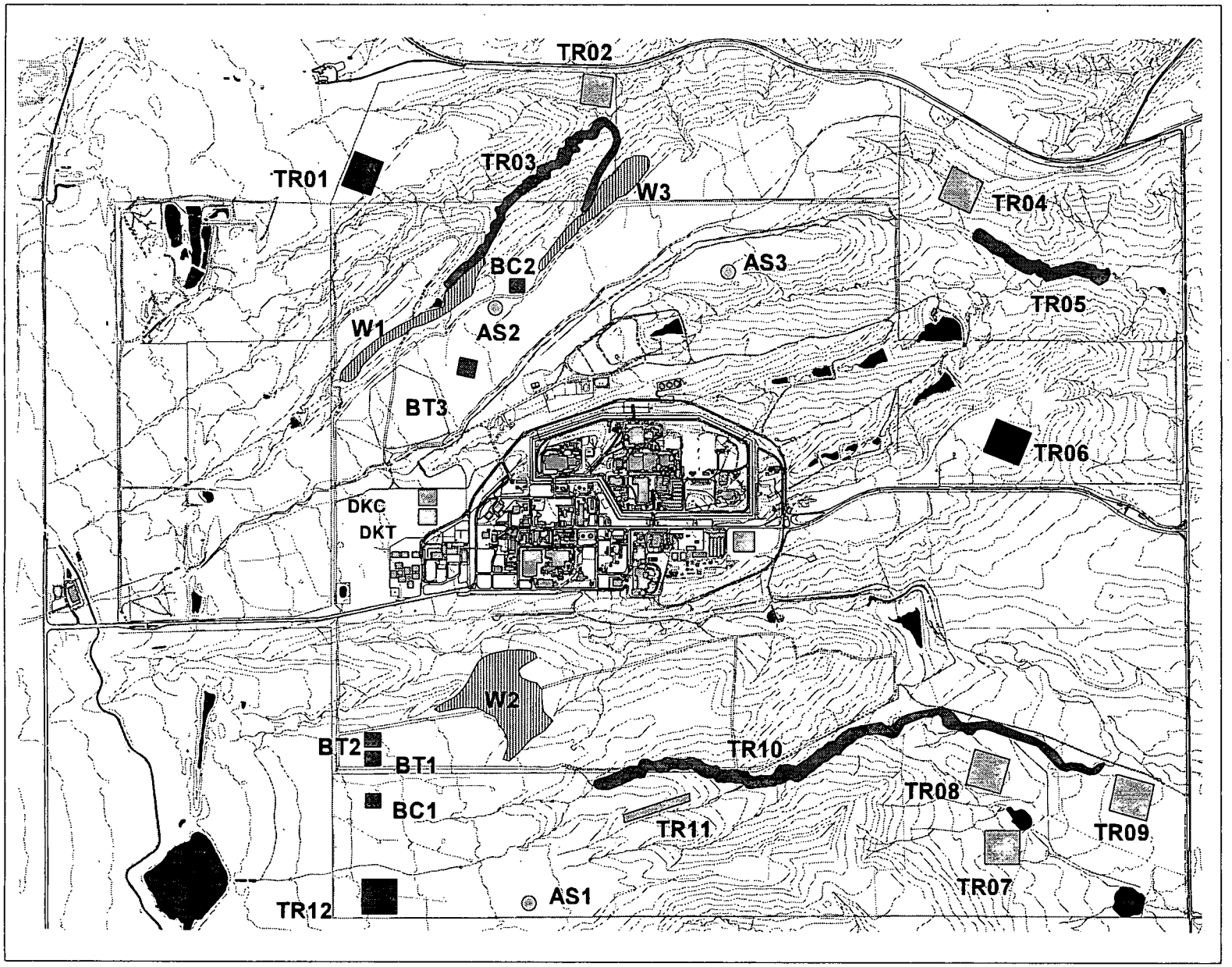
Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID. 2k-0158

March 14, 2000

\\GlobalGIS\ECO-projects\Projects\32-0158\management units a.apr\Wetland Management Unit view




# Permanent Vegetation Monitoring Locations at Rocky Flats Environmental Technology Site

Figure 4

## MAP LEGEND

- Diffuse Knapweed Herbicide Monitoring
- Prescribed Burn Monitoring
- Aerial Herbicide Monitoring

Long-Term Monitoring Locations

- Xeric Mixed Grassland
- Mesic Mixed Grassland
- Reclaimed Grassland
- Riparian Community
- Wetland Community

Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
Permanent vegetation monitoring locations provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial flyover data captured by EG&G R&L, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Note:

Monitoring locations are approximate. Permanent transects endpoints are marked with rebar.

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0038

November 22, 1999

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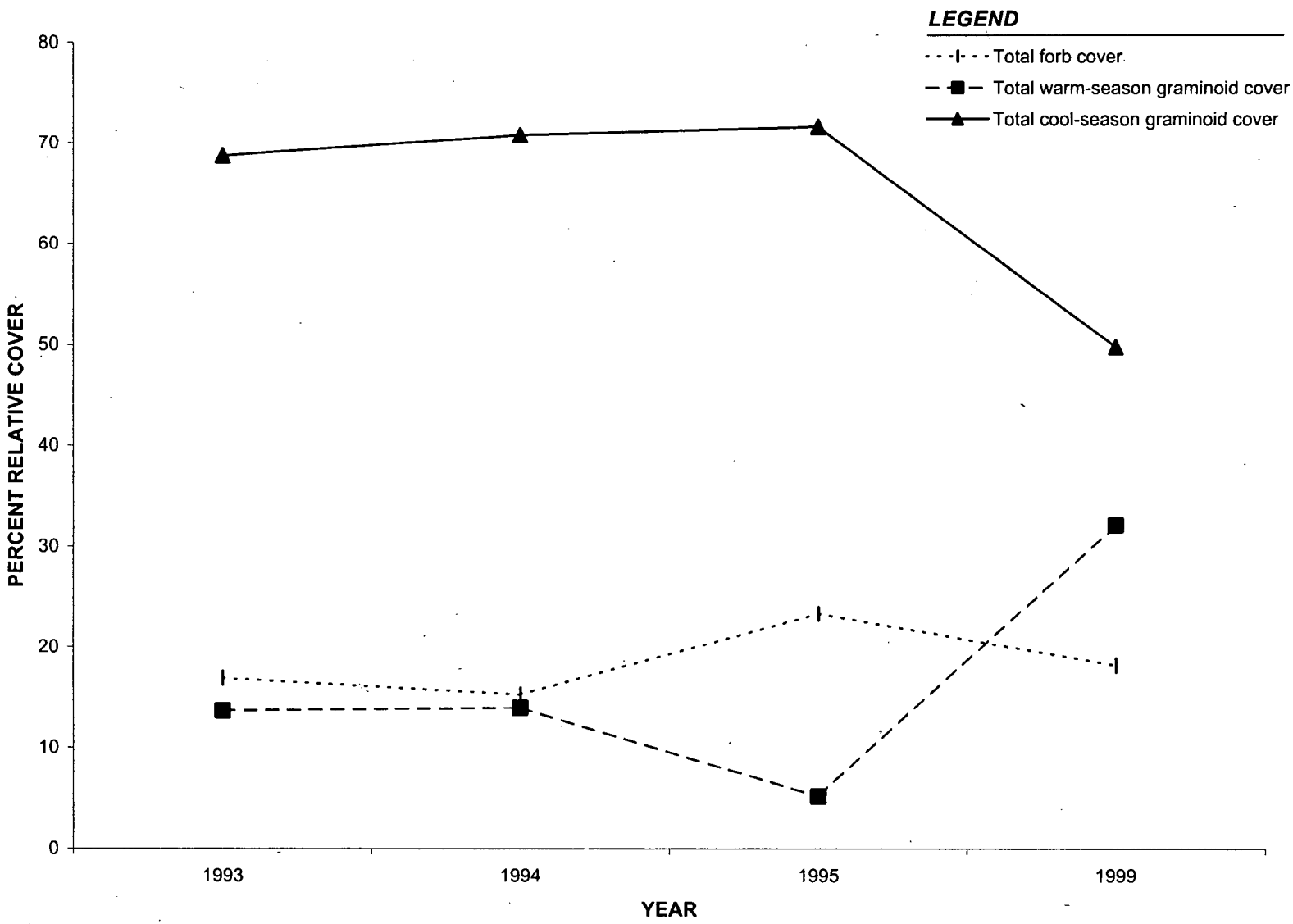



Figure 5. Cool-season versus warm-season graminoid cover: 1993-1995, 1999.

*Boulder1\data\groups\graphics\projects\1454\5/23/00 11:14 AM (MesicFinalTables for report.xls Figure 2)*

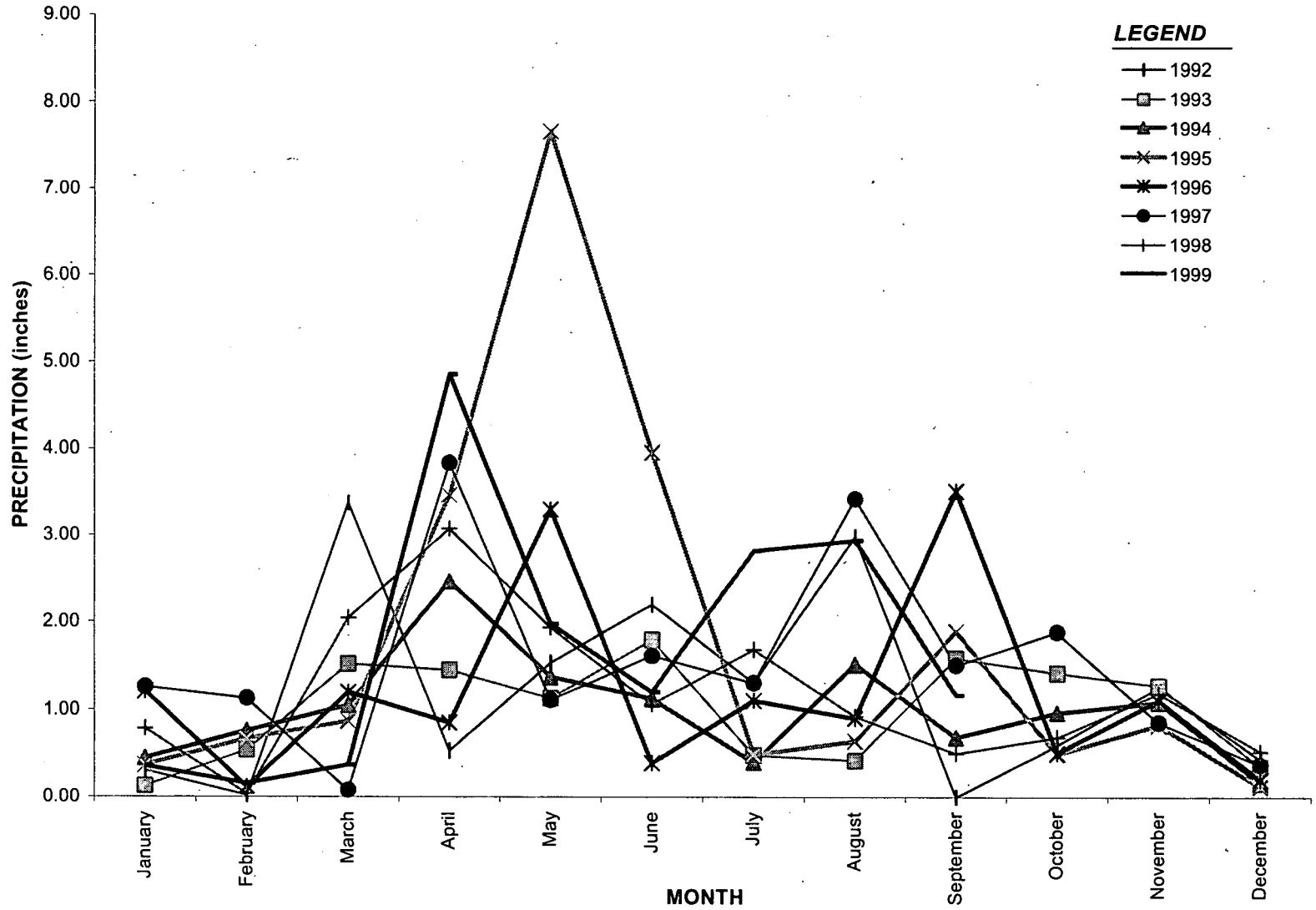



Figure 6. 1992-1999 monthly precipitation means for Rocky Flats Environmental Technology Site.

*Boulder1\data\groups\graphics\1454\5/23/00 11:11 AM (1992-99 Climate Summary for report.xls Chart1)*

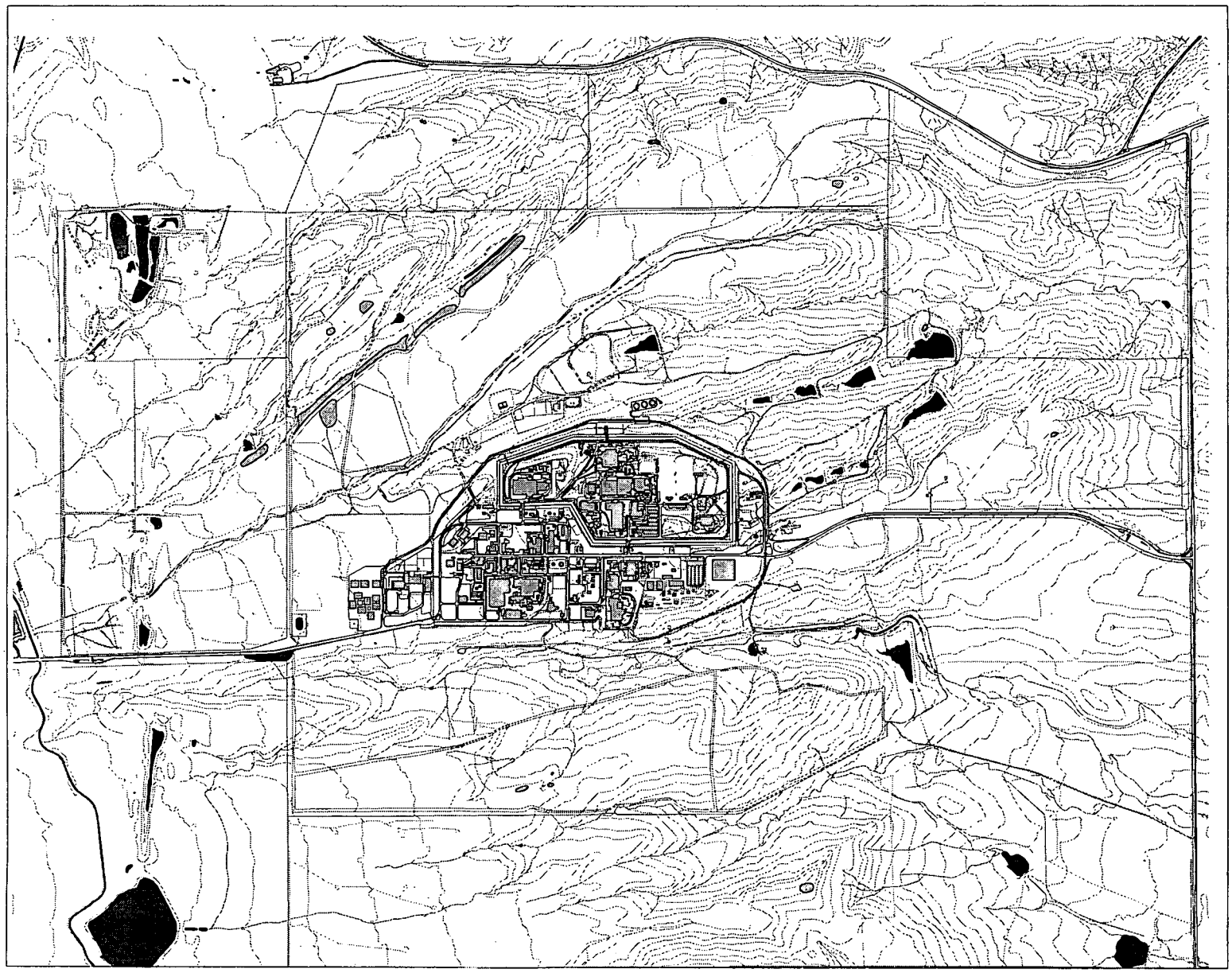
Figure 7. Diffuse knapweed growing on a dry, elevated stream terrace with coyote willow and leadplant in the Rock Creek drainage.

Figure 8. Canada thistle just beginning to establish along the riparian corridor in Walnut Creek in 1997. Photograph below shows how the infestation increased over a two year period.

Figure 9. Canada thistle infestation at the same location as shown above (Figure 1-5) in Walnut Creek two years later in 1999.

Figure 10. Continued streambank erosion below the B-4 dam spillway in Walnut Creek is causing the loss of riparian shrubland essential as Preble's meadow jumping mouse habitat.

Figure 11. Streambank erosion along the woodlands below the B-4 dam in Walnut Creek.



# Rare and Imperiled Plants Distribution
## Colorado Natural Heritage Program Species of Concern

Figure 12

### MAP LEGEND

- Dwarf Wild Indigo (Amorpha nana)
- Forktip Three-awn (Aristida basiramea)
- Mountain-Loving Sedge (Carex oreocharis)
- Carrionflower Greenbriar (Smilax herbacea)

### Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
Plant distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

**Note:**

The boundaries for the rare plant locations are not exact and should not be treated as such. These areas may not represent all populations on Site.

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent™

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MAP ID: K2-0074

March 14, 2000

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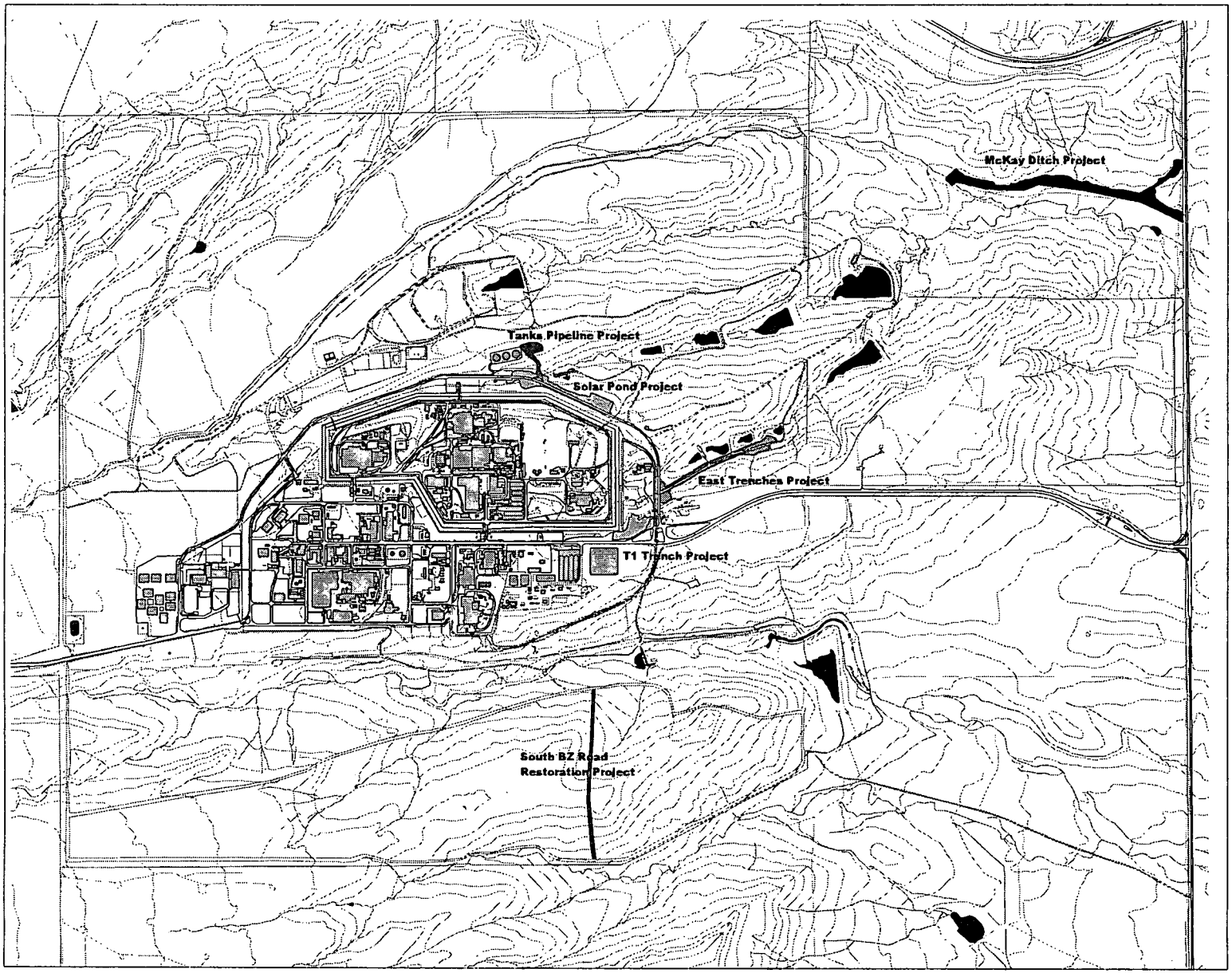


# 1999 Revegetation and Restoration Locations

Figure 13

## MAP LEGEND

- McKay Ditch Project
- Solar Pond Project
- East Trenches Project
- T-1 Trench Project
- Tanks Pipeline Project
- South BZ Road Restoration Project

## Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
Locations provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**
Project boundaries obtained using GPS equipment, except for the South BZ road restoration location which is based on the roads coverage.

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Rocky Flats Environmental Technology Site

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For: Kaiser-Hill Company, LLC

MAP ID: K2-0057

March 14, 2000

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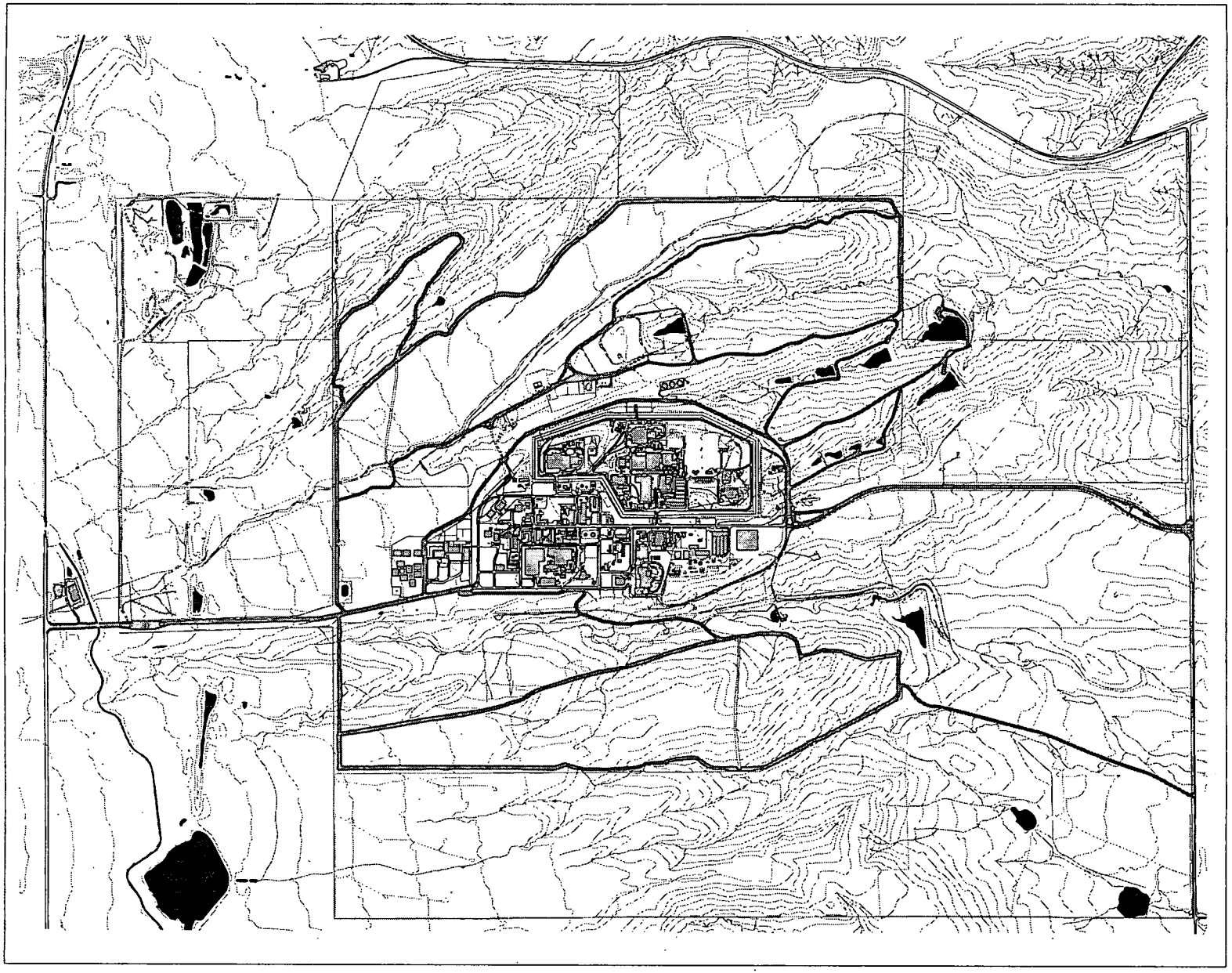

# FY1999 Road Grading and Mowing Operations for Weed Control

Figure 14

MAP LEGEND

- Road Grading and Roadside Mowing
- Roadside Mowing Only

Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial flyover data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent™

For: Kaiser-Hill Company, LLC

MAP ID: K2-0051

March 14, 2000

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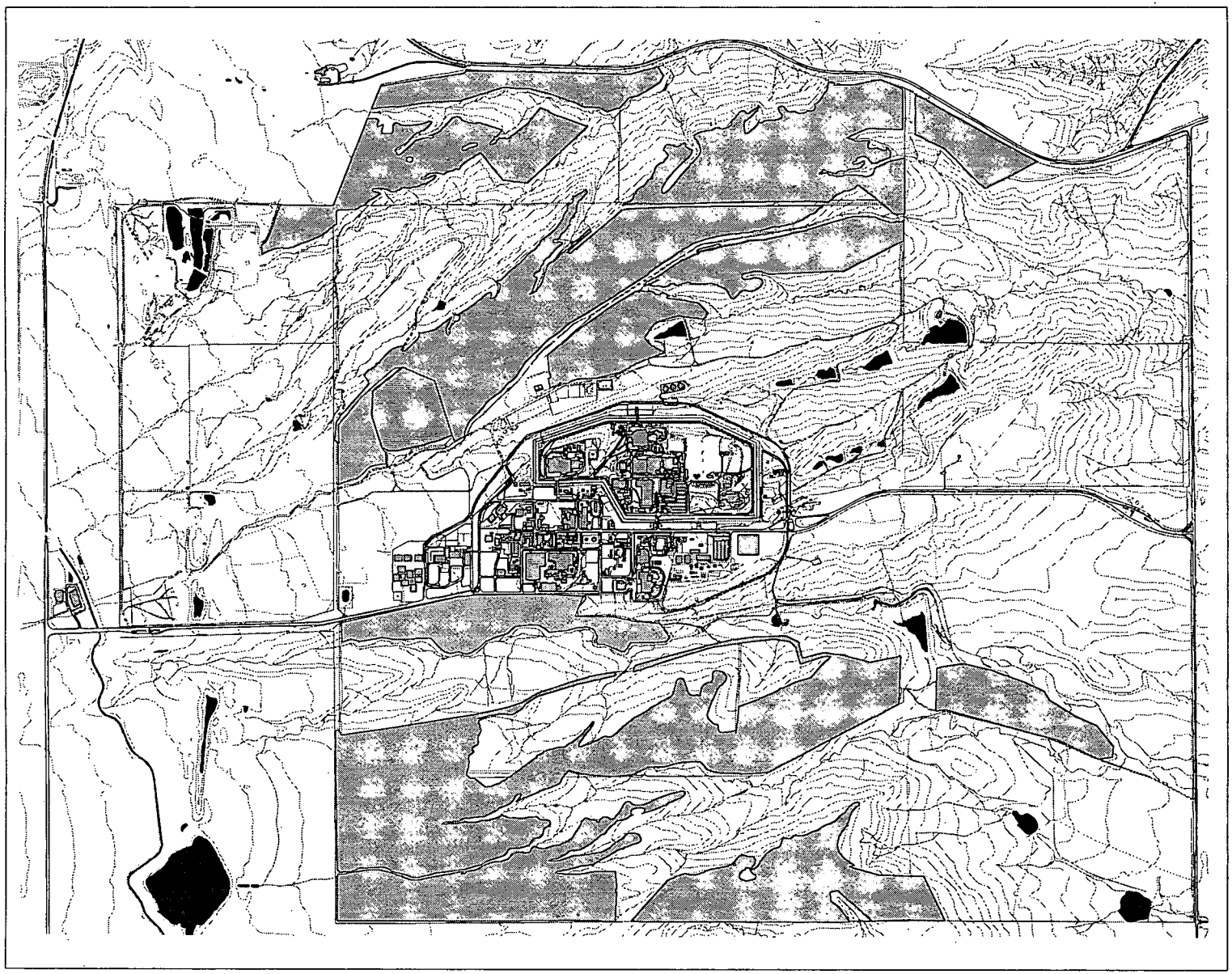

# FY1999 Ground and Aerial Herbicide Application Locations Using Tordon 22K

## Figure 15

### MAP LEGEND

- Aerial Herbicide Application Locations
- Ground Herbicide Application Locations

### Standard Map Features

- New Landfill
- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)
- Power Lines

DATA SOURCE:
Ground and Aerial Herbicide Locations provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G REL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**
These locations are approximate.

N

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0016

March 14, 2000

\\Gaurv\GIS\ECO-projects\projects\k2-0016\aerial\herbicide\k2k_apr\1999 Ground and Aerial Herbicide Application Locations

Figure 16. Helicopter conducting aerial herbicide application at Rocky Flats Environmental Technology Site.

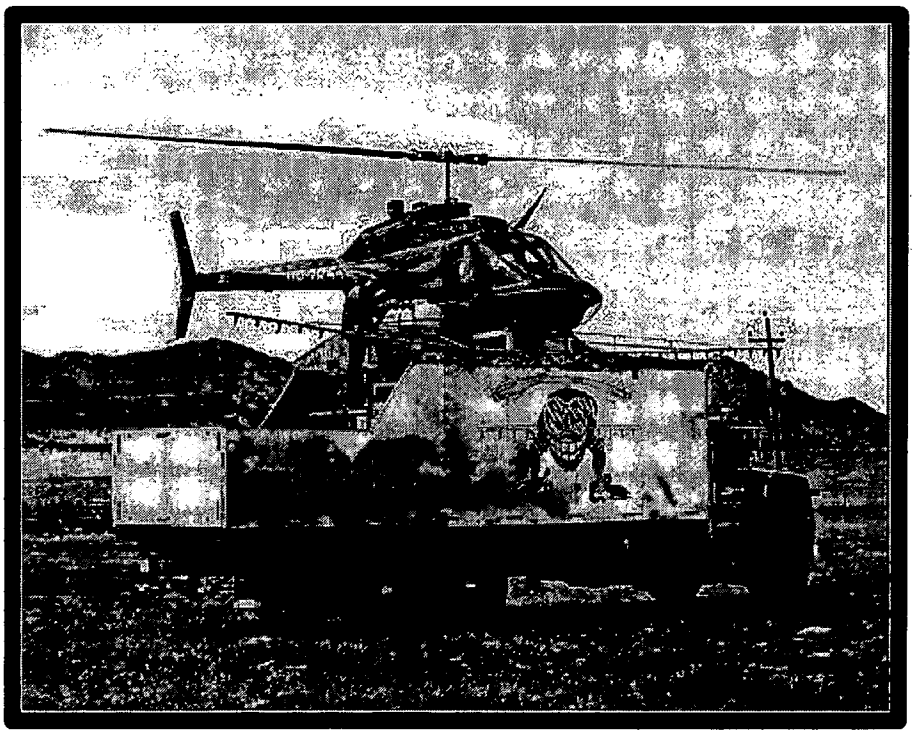
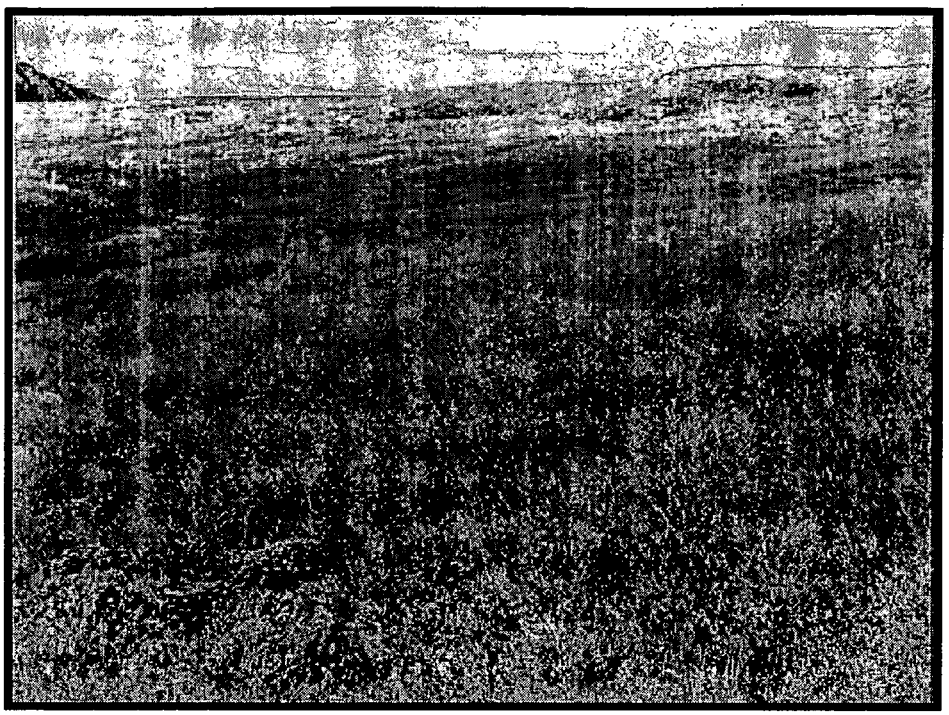
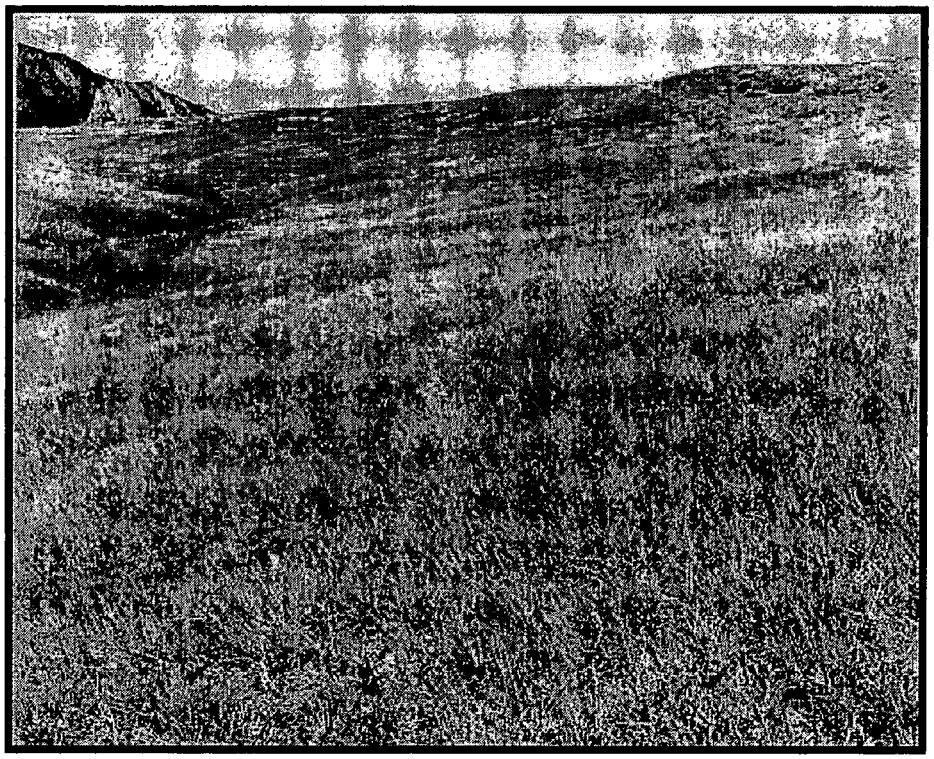


Figure 17. Helicopter refueling and refilling herbicide tanks during aerial herbicide application operations at Rocky Flats Environmental Technology Site.

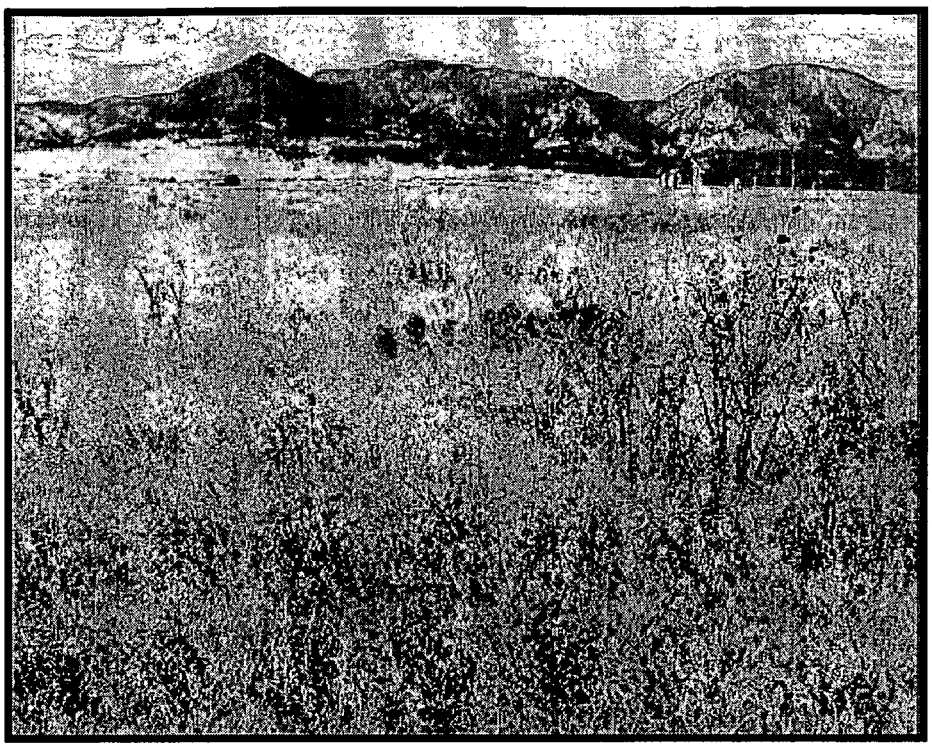


1997

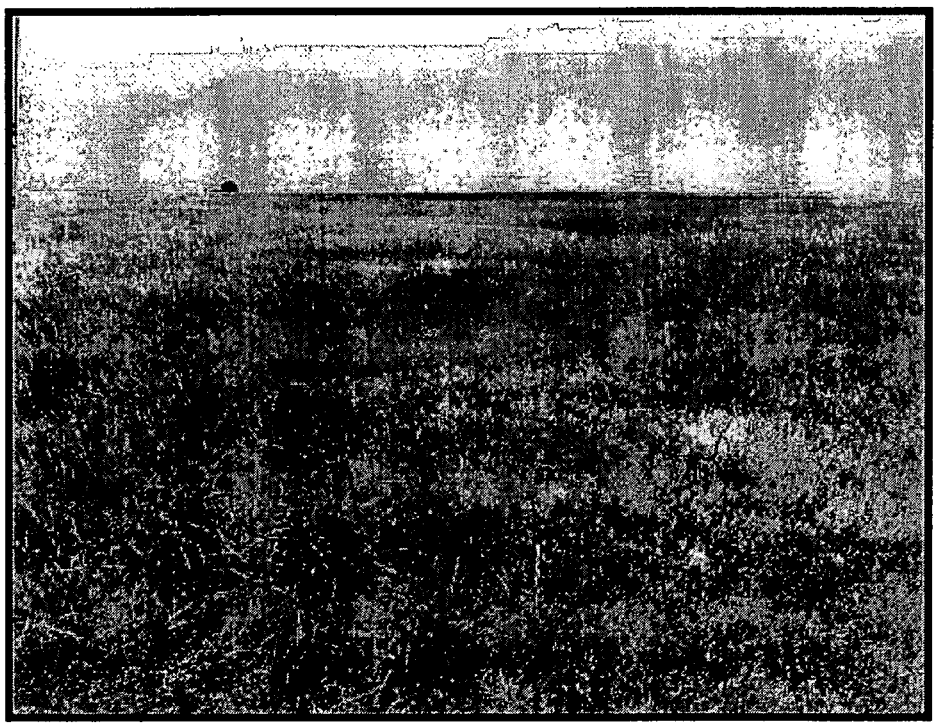


1999

Figure 18. The top photograph taken in 1997 shows a substantial diffuse knapweed infestation (brown areas) on this hillside at the Site. The bottom photograph was taken in 1999 approximately three months after the hillside was treated with Tordon 22K, applied by helicopter.

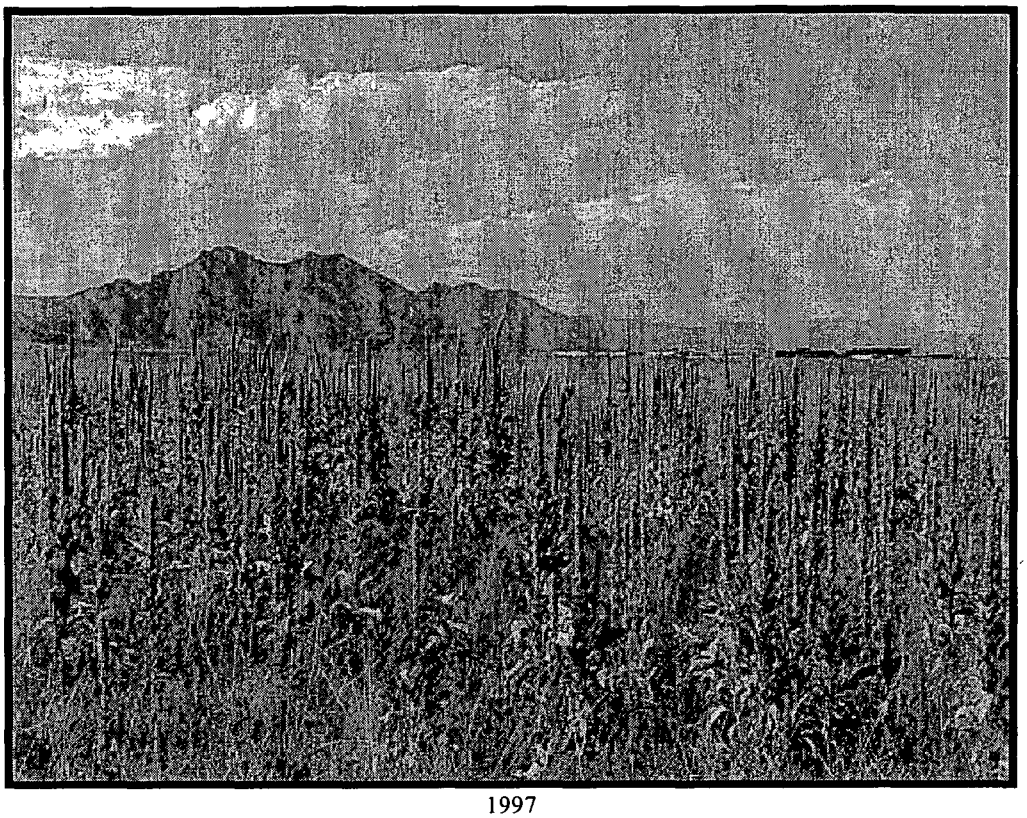


1997

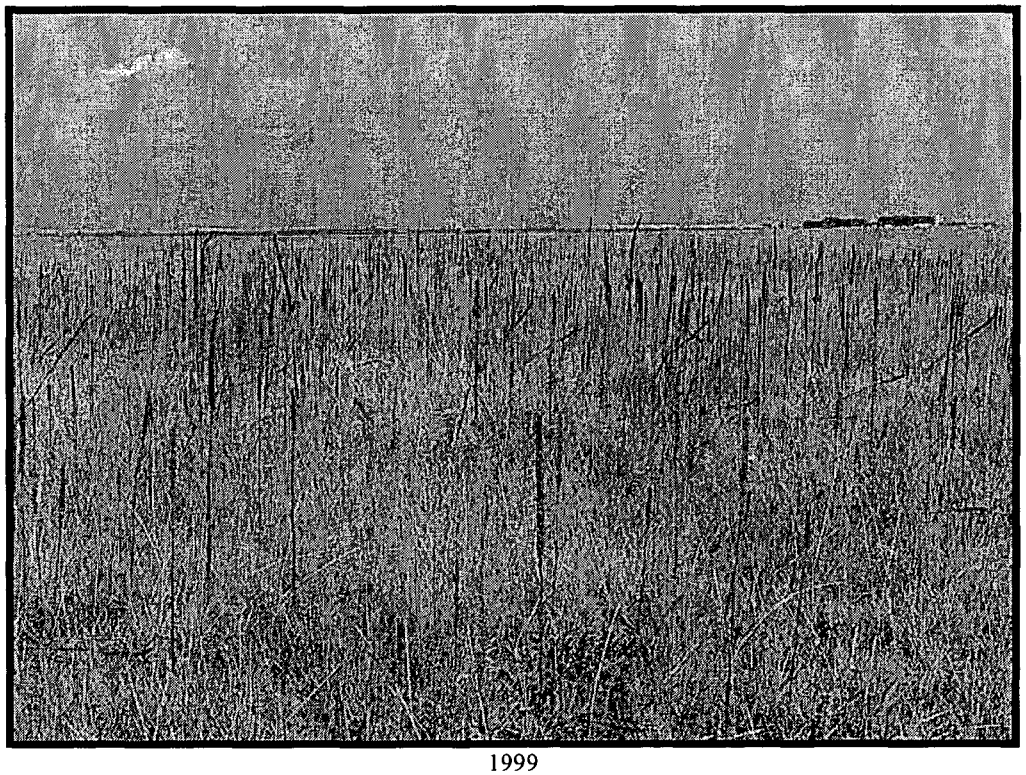


1999

Figure 19. Note the abundance of musk thistle in the top photograph taken in 1997 (the tall plant in the right foreground and scattered across the prairie in the background). In addition to controlling diffuse knapweed which was spreading into this area, the aerial herbicide application also controlled the musk thistle. The bottom photograph was taken approximately 3 months after the application of Tordon 22K.

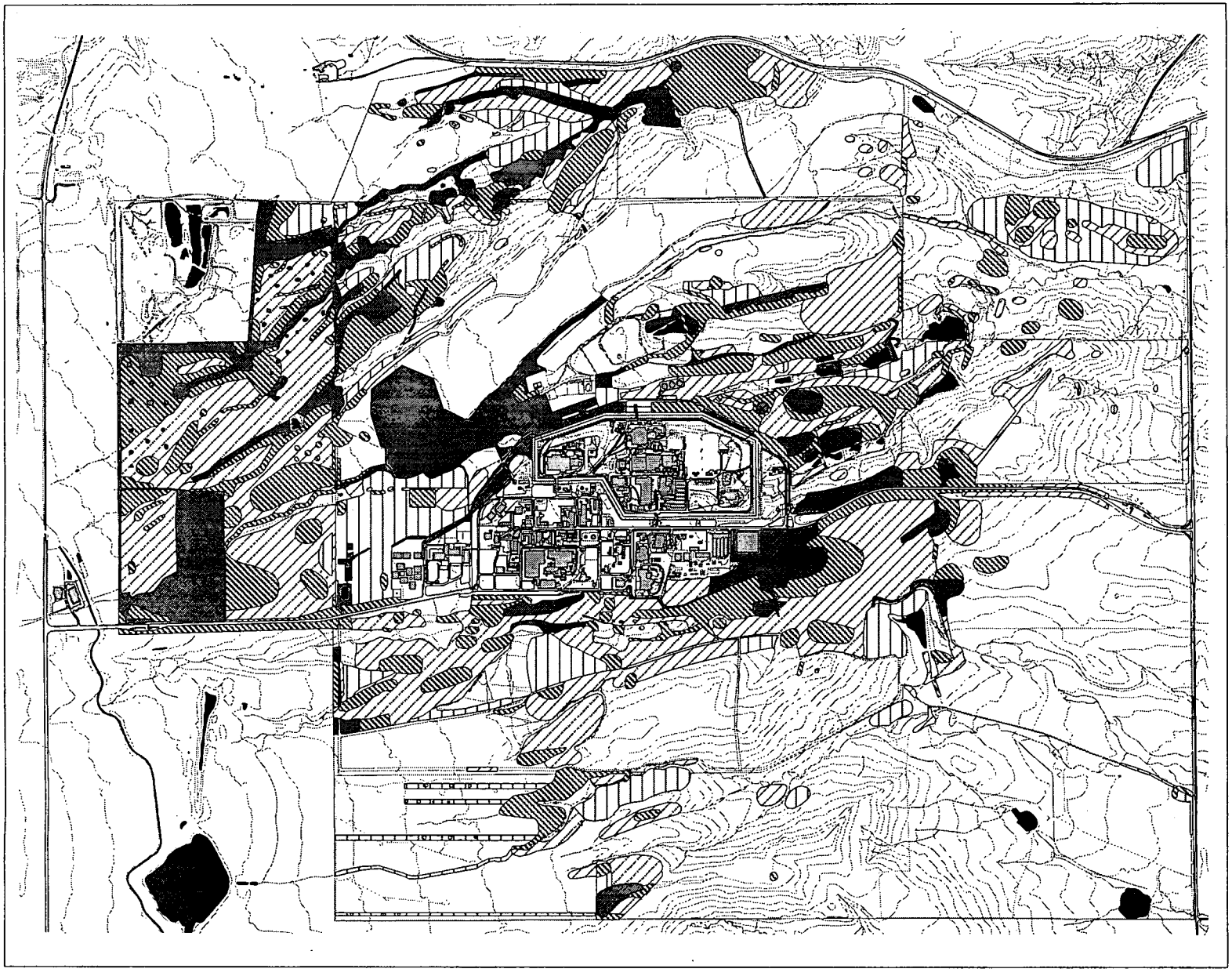


1997



1999

Figure 20. In 1999, an aerial herbicide application of Tordon 22K (applied by helicopter) was done to control diffuse knapweed across portions of the xeric tallgrass prairie at the Site. In addition to controlling diffuse knapweed, another noxious weed, common mullein, seen in the 1997 photograph as a virtual "forest" was also controlled. Only the dead stalks from previous years are seen in the 1999 photograph taken approximately 3 months after spraying.



# 1999 Diffuse Knapweed (Centaurea diffusa) Distribution

Figure 21

## MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

### Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial flyover data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**

These locations approximate the boundaries of infestation areas. The boundaries are not exact and should not be treated as such. These areas may not represent all populations on Site.

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1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

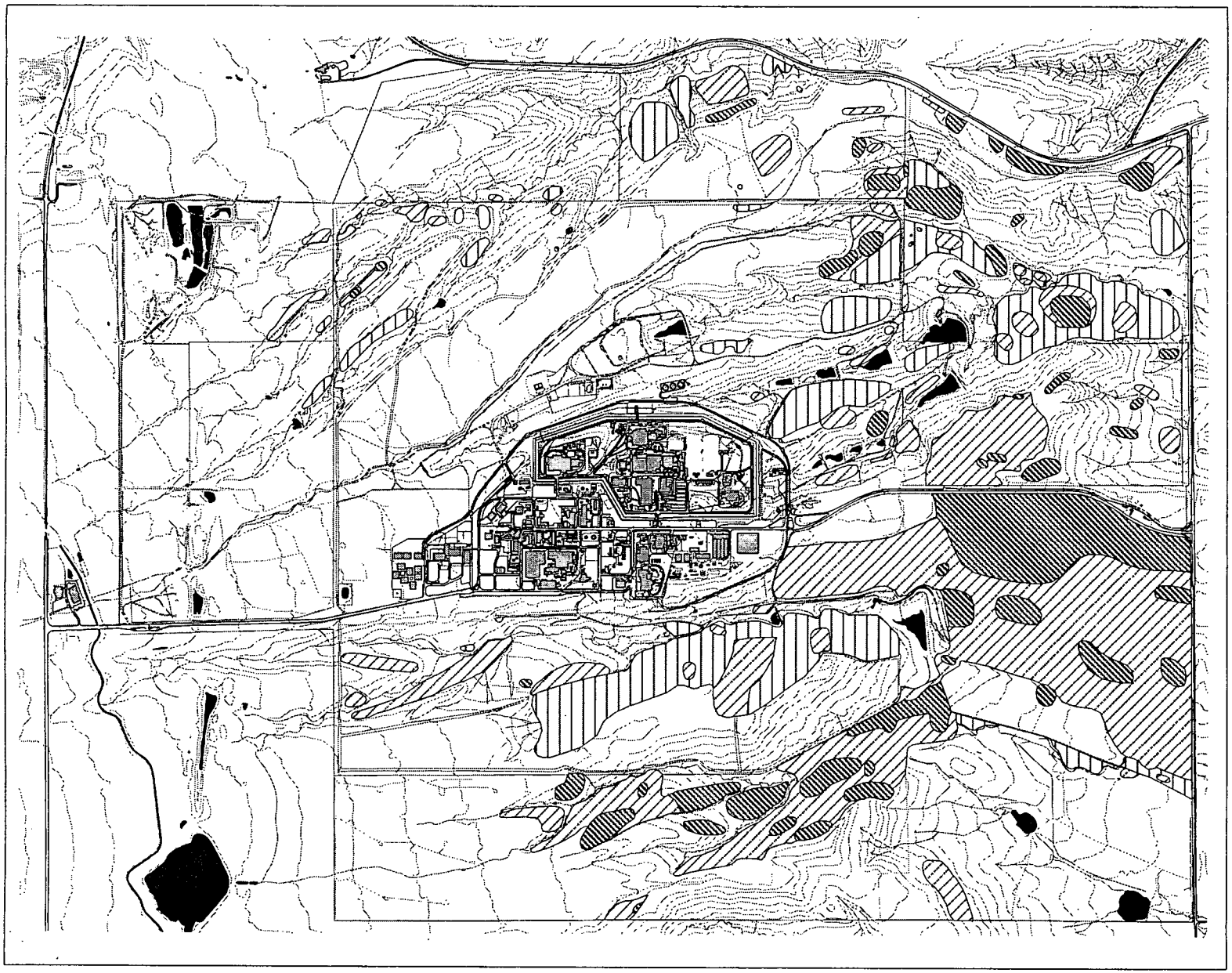
Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0017

March 14, 2000

\\Kaiser\GIS\ECO-proj\ecoprojects\k2-0017\esd\99 apr\1999 Diffuse Knapweed Distribution.view



# 1999 Musk Thistle (Carduus nutans) Distribution

Figure 22

## MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

## Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

**Note:**

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N

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1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent™

For: Kaiser-Hill Company, LLC

MAP ID: K2-0019

March 14, 2000

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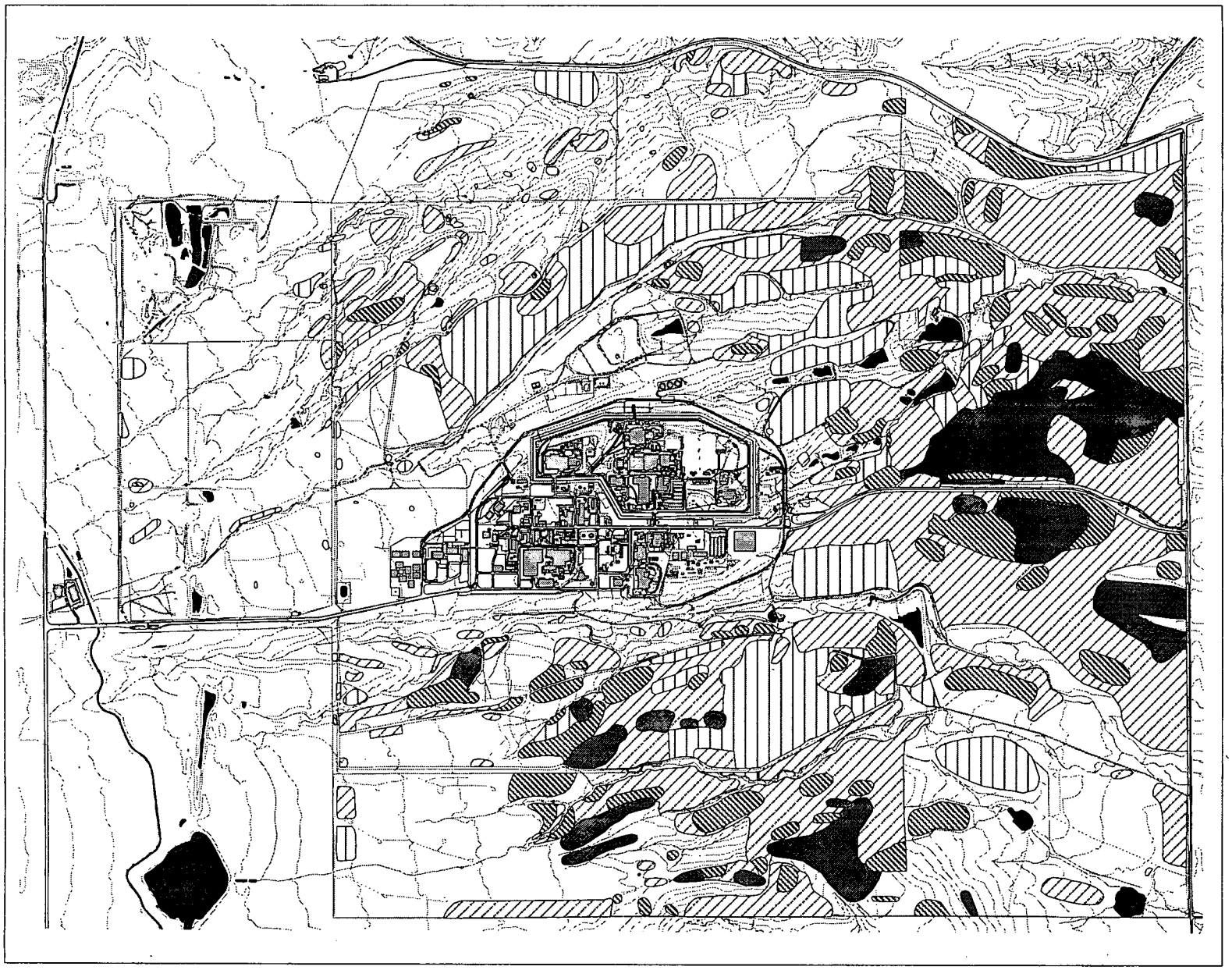

# 1999 Dalmatian Toadflax (Linaria dalmatica) Distribution

Figure 23

## MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

## Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial flyover data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/85
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**

These locations approximate the boundaries of infestation areas. The boundaries are not exact and should not be treated as such. These areas may not represent all populations on Site.

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1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

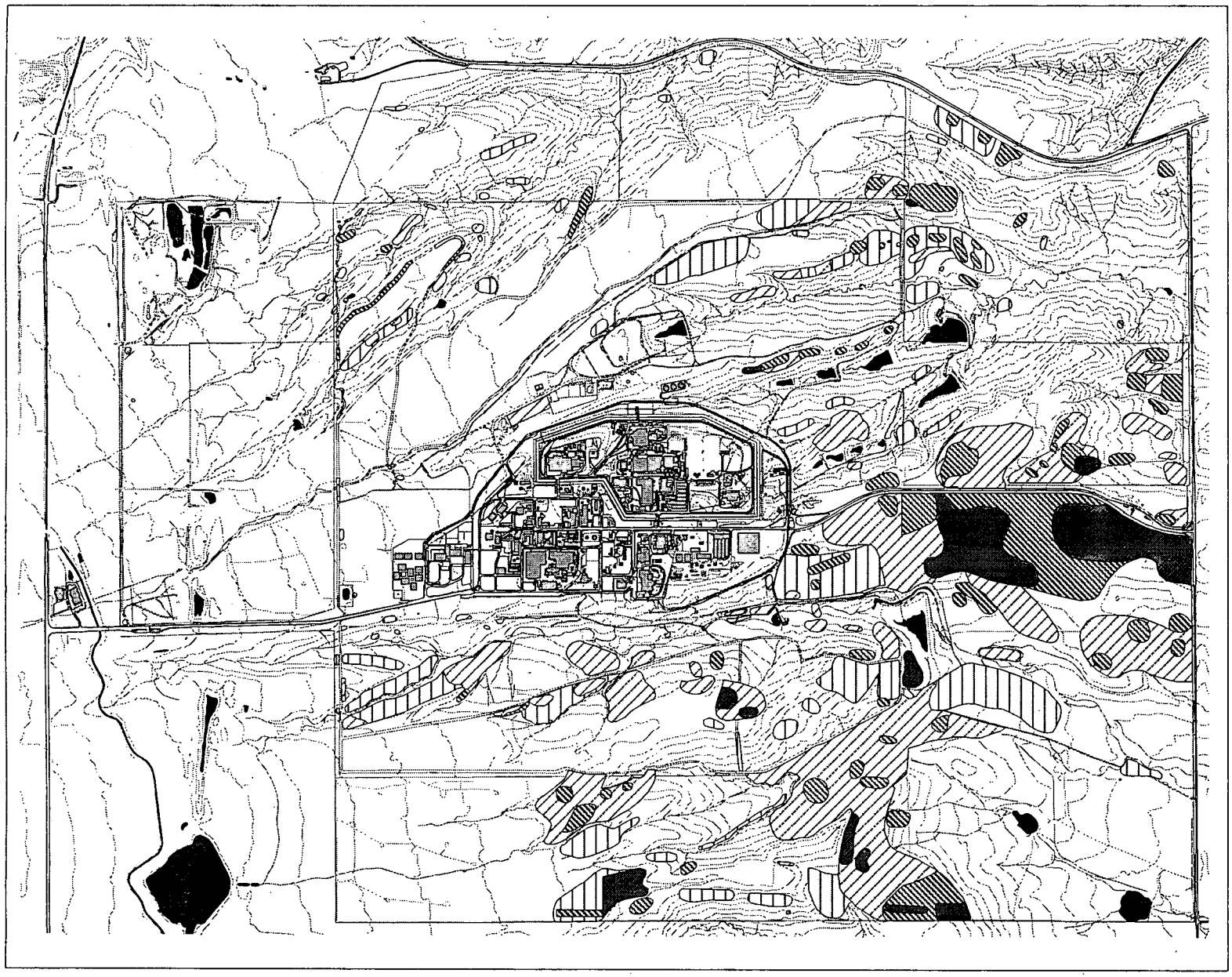
U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0018

March 14, 2000



# 1999 Mullein (Verbascum thapsus) Distribution

Figure 24

## MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

### Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial flyover data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**

These locations approximate the boundaries of infestation areas. The boundaries are not exact and should not be treated as such. These areas may not represent all populations on Site.

N

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1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0020

March 14, 2000

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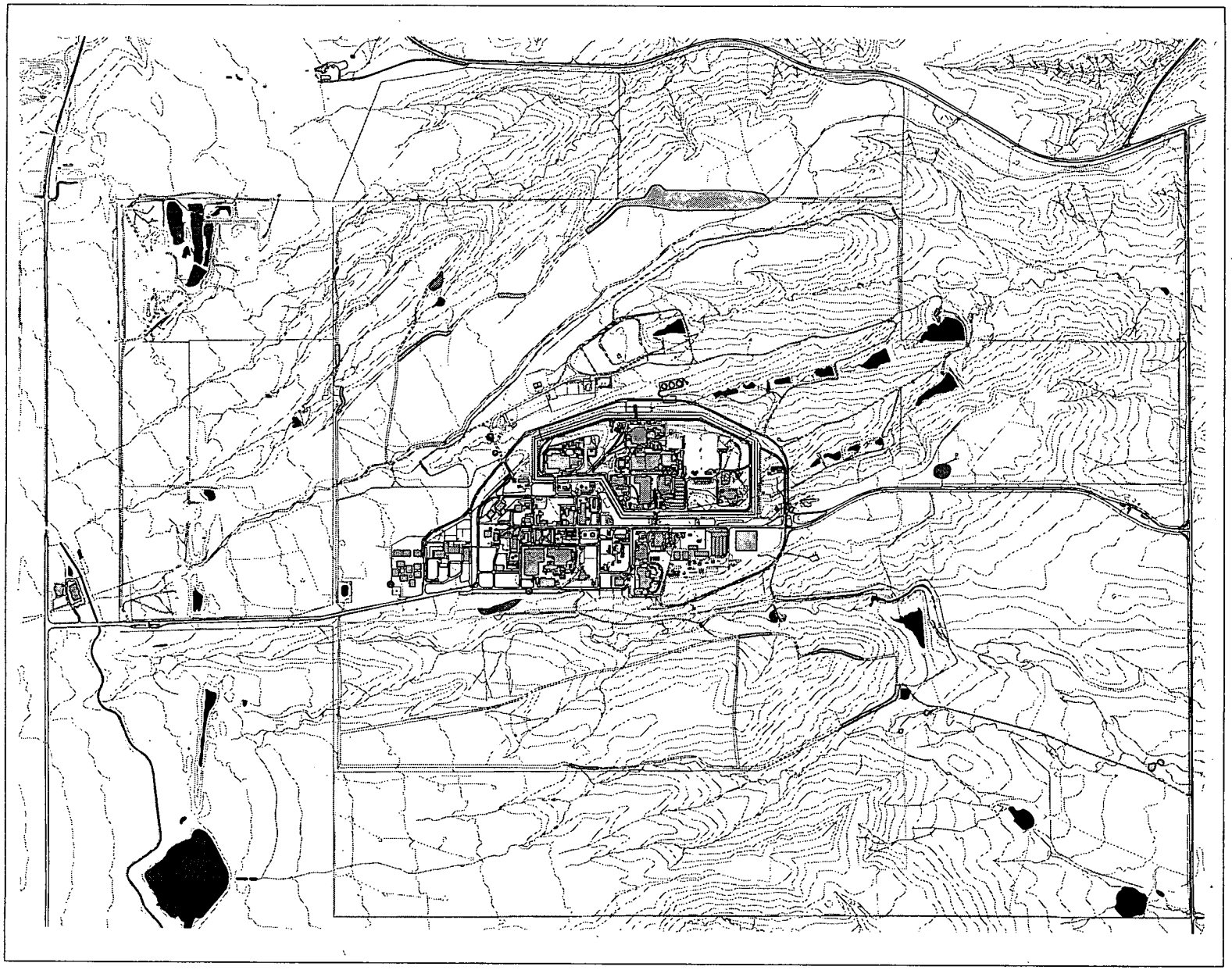

# 1999 Scotch Thistle (Onopordum acanthium), Russian Knapweed (Centaurea repens), Dame's Rocket (Hesperis matronalis), and Annual Rye (Secale cereale) Distribution

Figure 25

## MAP LEGEND

- Scotch Thistle Infestations
- Russian Knapweed Infestations
- Dame's Rocket Infestations
- Annual Rye Infestations

### Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

**Note:**

These locations approximate the boundaries of infestation areas. The boundaries are not exact and should not be treated as such. These areas may not represent all populations on Site.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent™

For: Kaiser-Hill Company, LLC

MAP ID: K2-0043

March 14, 2000

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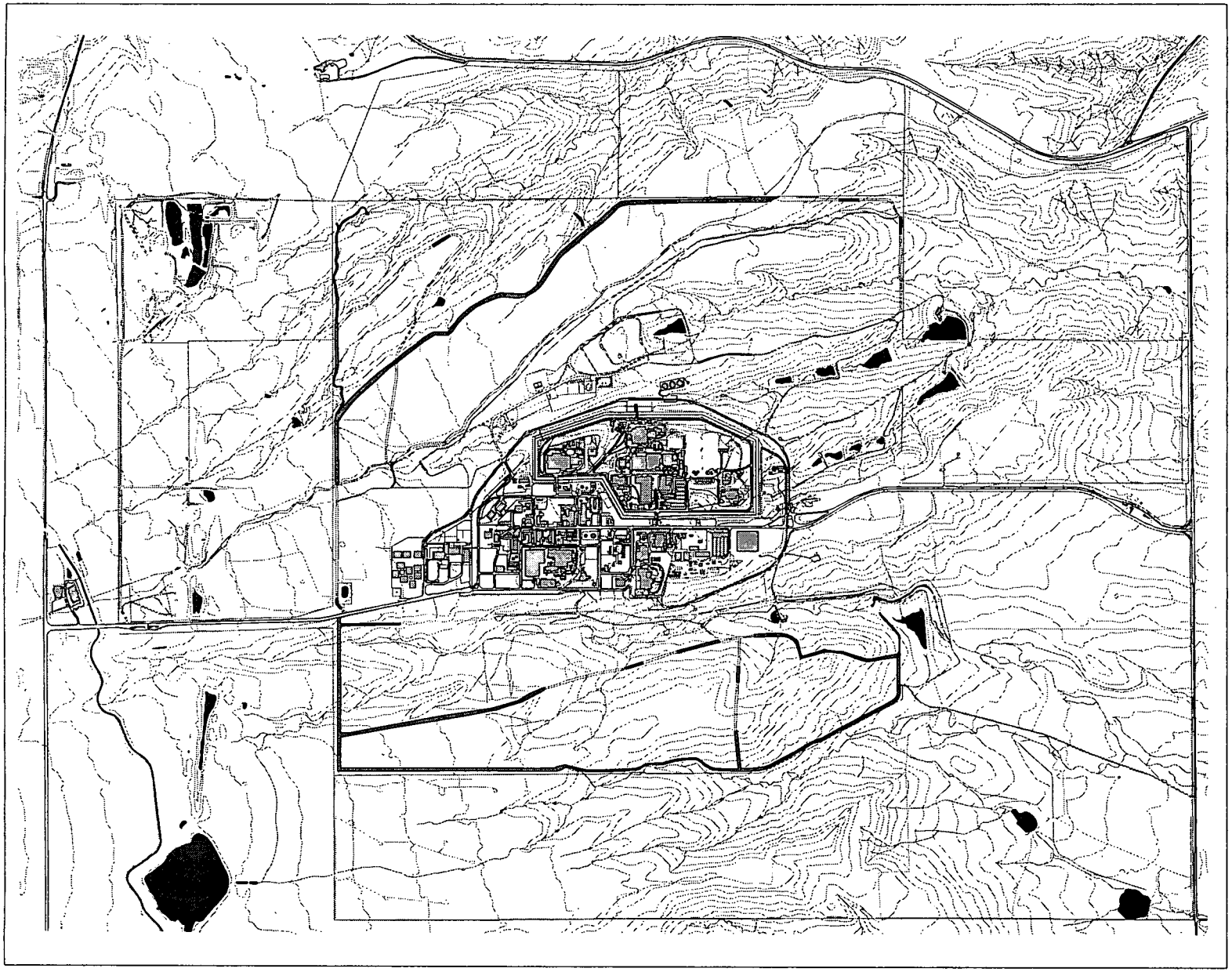

# 1999 Jointed Goatgrass (Aegilops cylindrica) Distribution

Figure 26

## MAP LEGEND

Jointed Goatgrass Infestations

### Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

**Note:**

These locations approximate the boundaries of infestation areas. The boundaries are not exact and should not be treated as such. These areas may not represent all populations on Site.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0042

March 14, 2000

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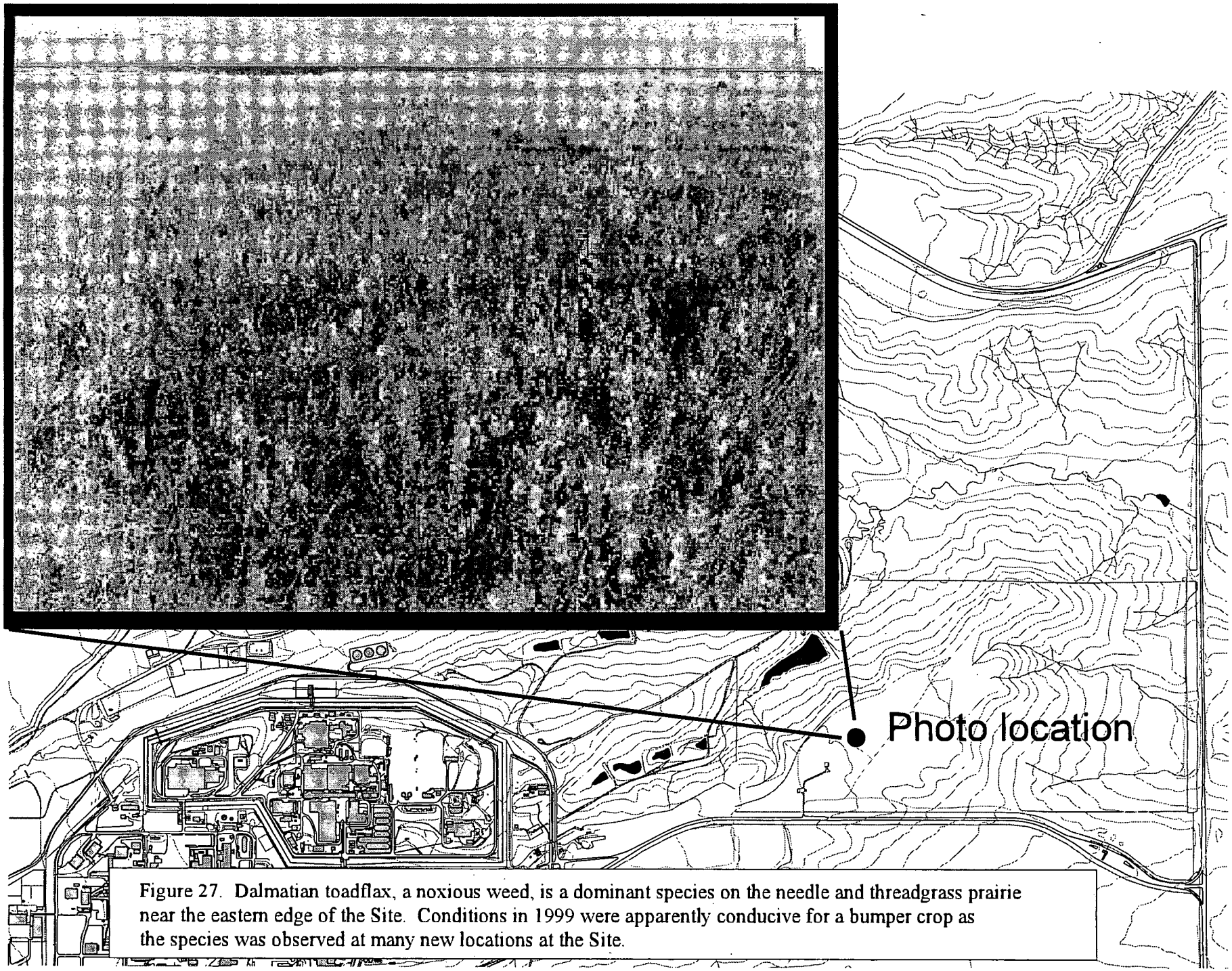
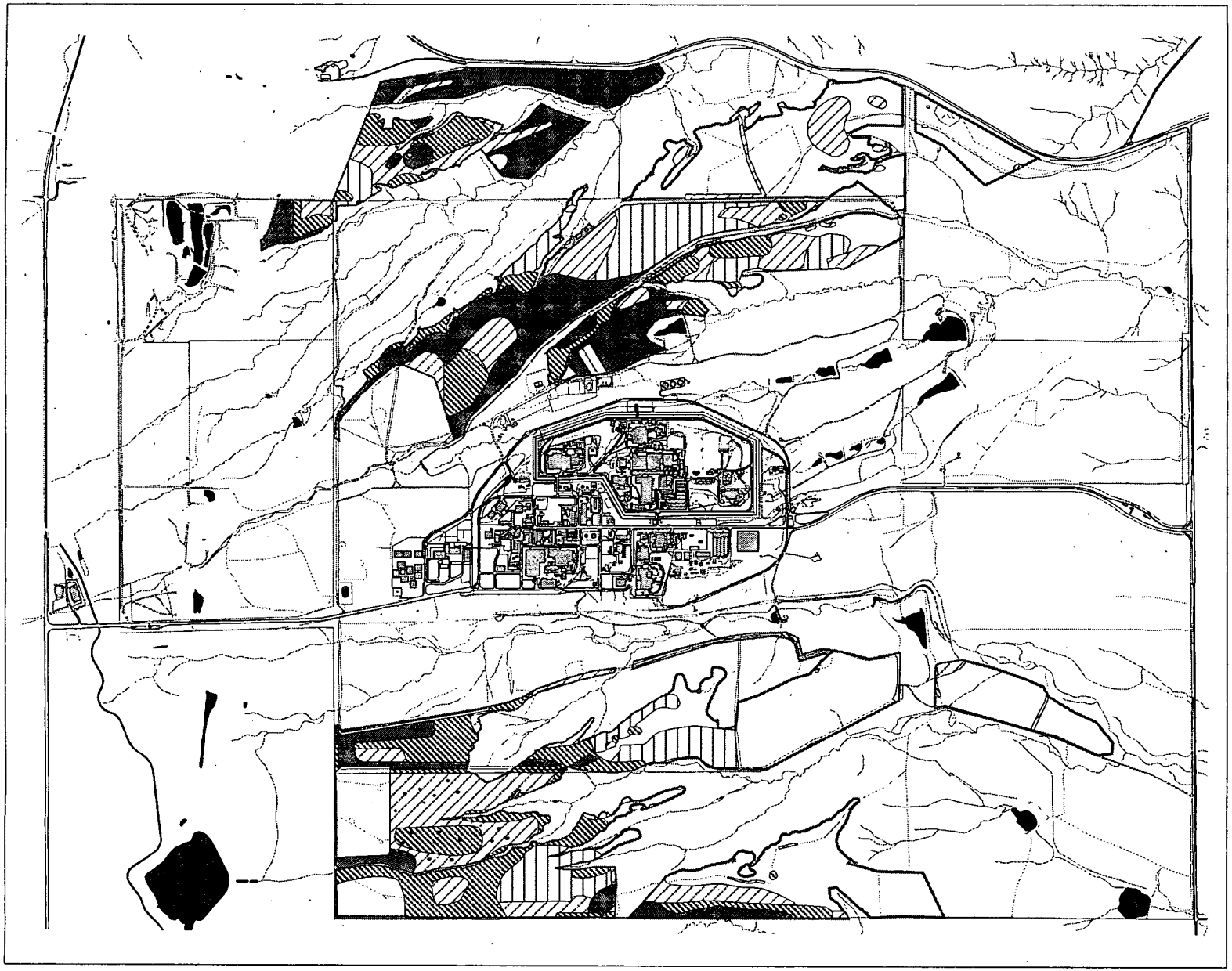



Figure 27. Dalmatian toadflax, a noxious weed, is a dominant species on the needle and threadgrass prairie near the eastern edge of the Site. Conditions in 1999 were apparently conducive for a bumper crop as the species was observed at many new locations at the Site.



# 1998 Diffuse Knapweed Pre-Aerial Herbicide Application Distribution

Figure 28

## MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas
- 1999 Aerial Spray Areas

## Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- New landfill

DATA SOURCE:
1998 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial flyover data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**

These locations approximate the boundaries of infestation areas. Infestation areas shown on this map only represent those that overlapped with the aerial herbicide application locations (i.e. this map does not represent the extent of diffuse knapweed at the Site).

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

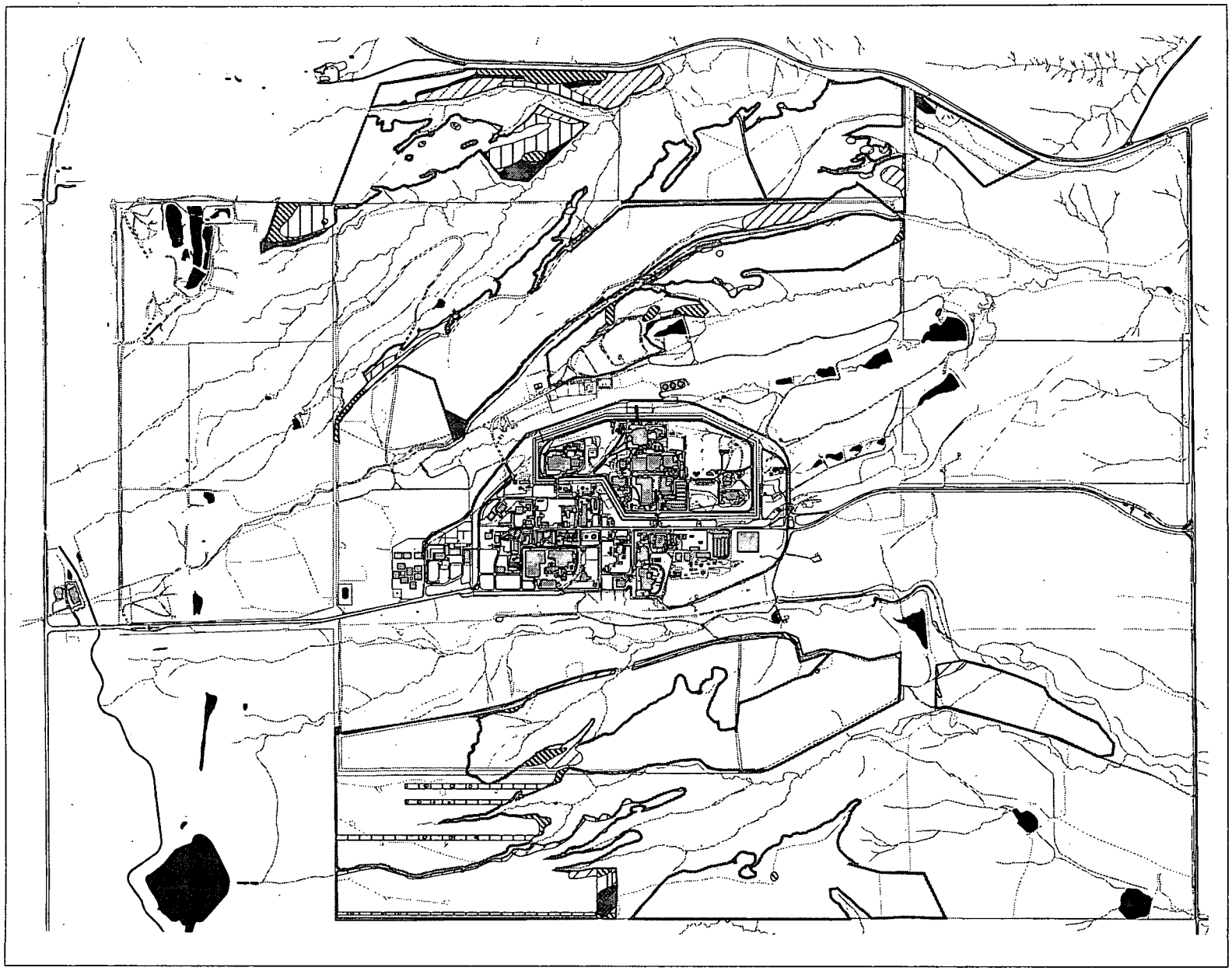
Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0017

March 14, 2000

\\Kaiser-Hill\GIS\EC0-project\bmprojects\k2-0017\cad\039 apr1998 Diffuse Knapweed Pre-Herbicide Application



# 1999 Diffuse Knapweed Post-Aerial Herbicide Application Distribution

Figure 29

## MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas
- 1999 Aerial Spray Areas

## Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- New landfill

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/85
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**
These locations approximate the boundaries of infestation areas. Infestation areas shown on this map only represent those that overlapped with the aerial herbicide application locations (i.e. this map does not represent the extent of diffuse knapweed at the Site).

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0017

March 20, 2000

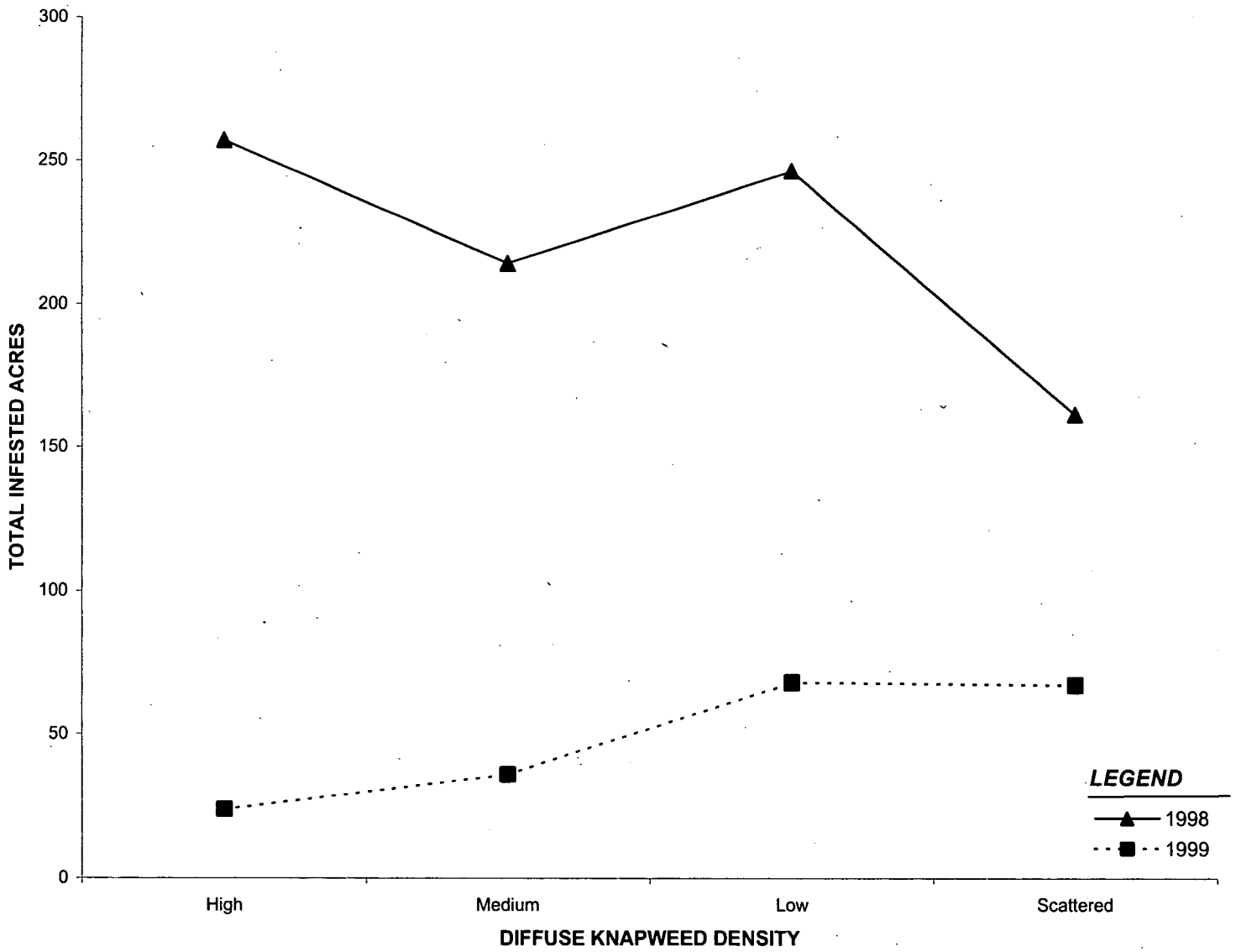



Figure 30. Comparison of 1998 and 1999 diffuse knapweed pre- and post-aerial herbicide application.

*Boulder1\data\groups\graphics\projects\1454\5/23/00 10:44 AM (HVVTables for report.xls Chart1)*

Figure 31. Diffuse knapweed infestation near the AS-2 monitoring plot in 1997. Notice the high density of diffuse knapweed (reddish colored plant) in the foreground.

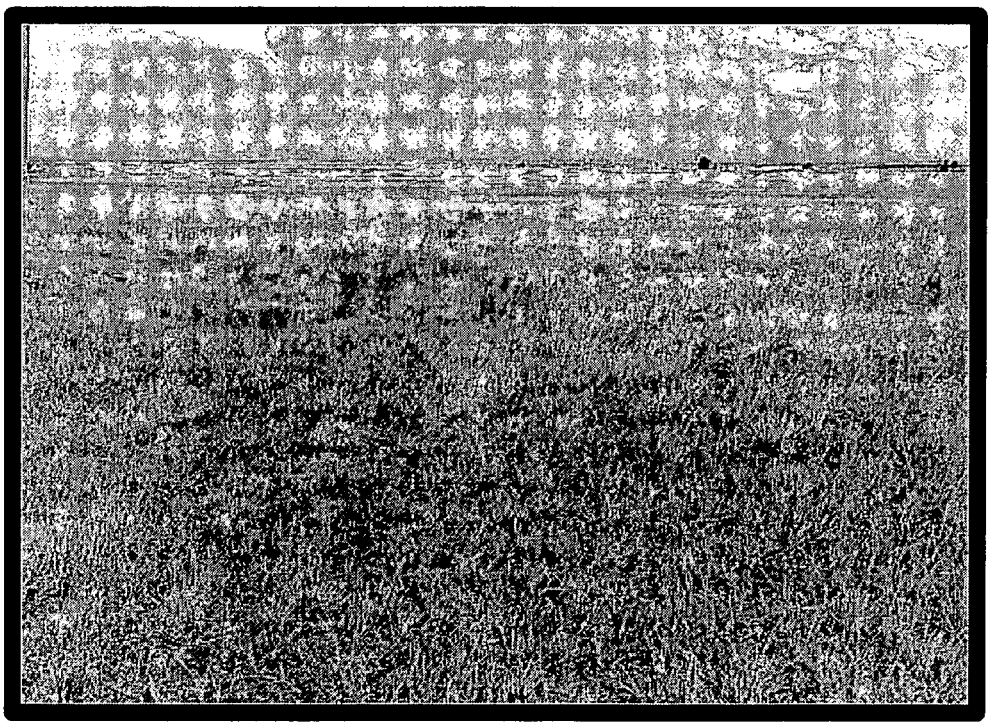


Figure 32. The same area near the AS-2 monitoring plot in 1999 after the aerial herbicide spraying. Only the remains of the previous year's dead knapweed stalks remain. Otherwise the area is devoid of adult diffuse knapweed plants, thus preventing seed set in the area during 1999 and reducing the chance of infestation spread.

Figure 33. Control plot quadrat locations covered with plastic prior to aerial herbicide application. Notice all the previous year's dead diffuse knapweed plants (light brown plants) scattered about.

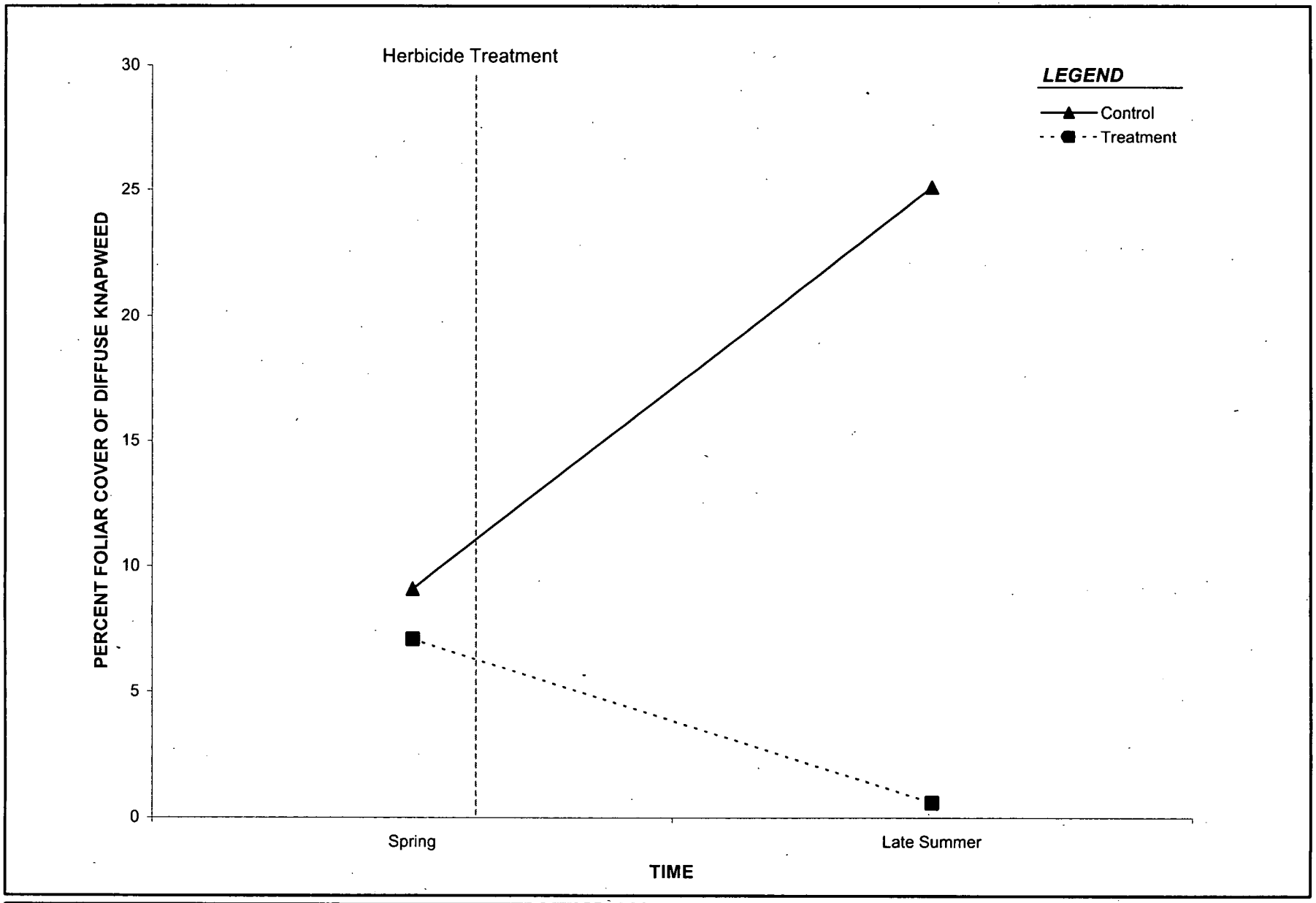



Figure 34. Diffuse knapweed cover in the control and treatment plots, pre- and post-treatment by aerial herbicide application.

*Boulder1\data\groups\graphics\projects\1454\5/23/00 11:01 AM (Figure 5 for report.xls Chart1)*

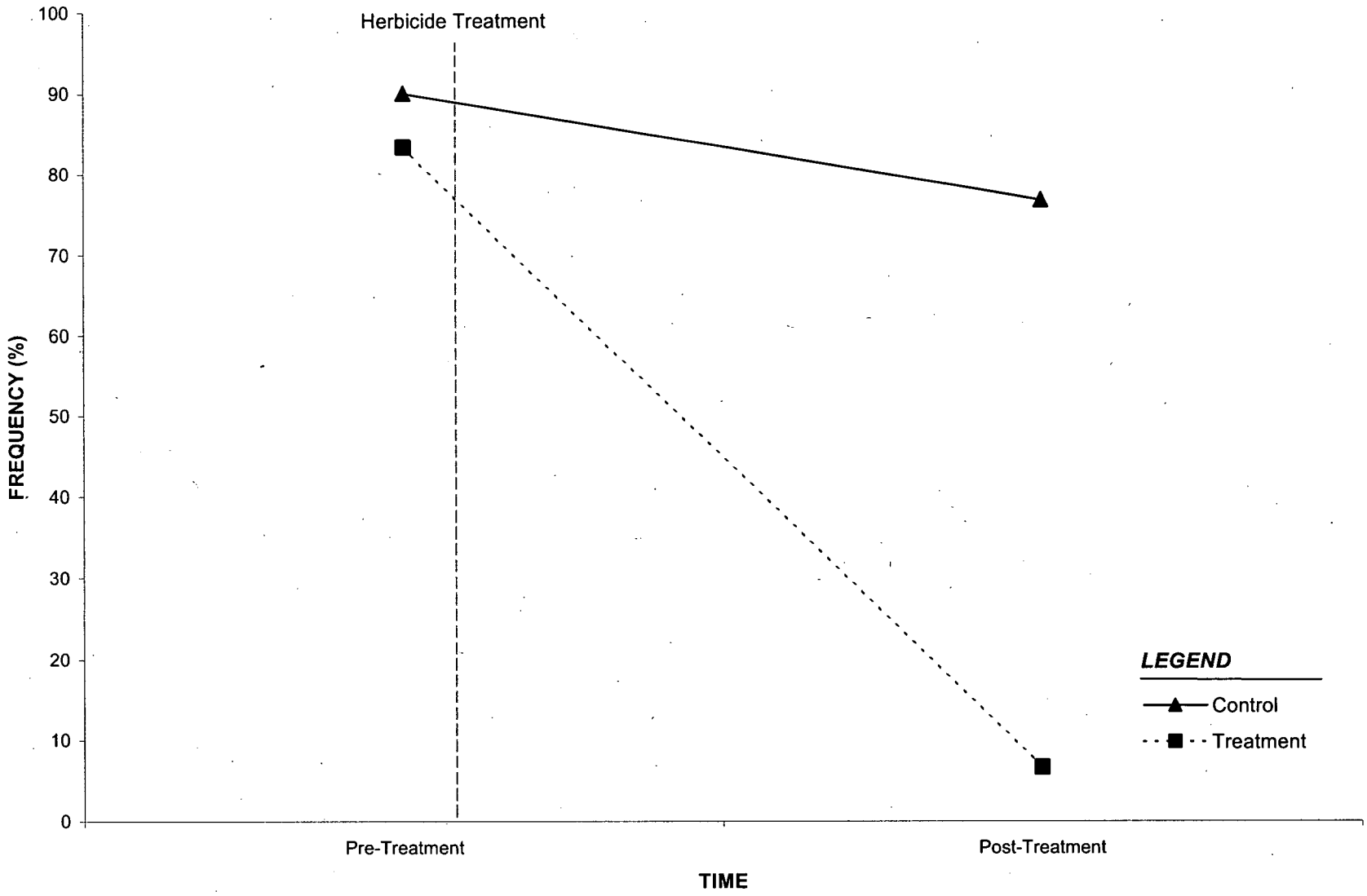



Figure 35. Diffuse knapweed frequency in control and treatment plots pre- and post-treatment by aerial herbicide application.

Boulder1\data\groups\graphics\projects\1454\5/23/00 11:00 AM (summary for report.xls figure 6)

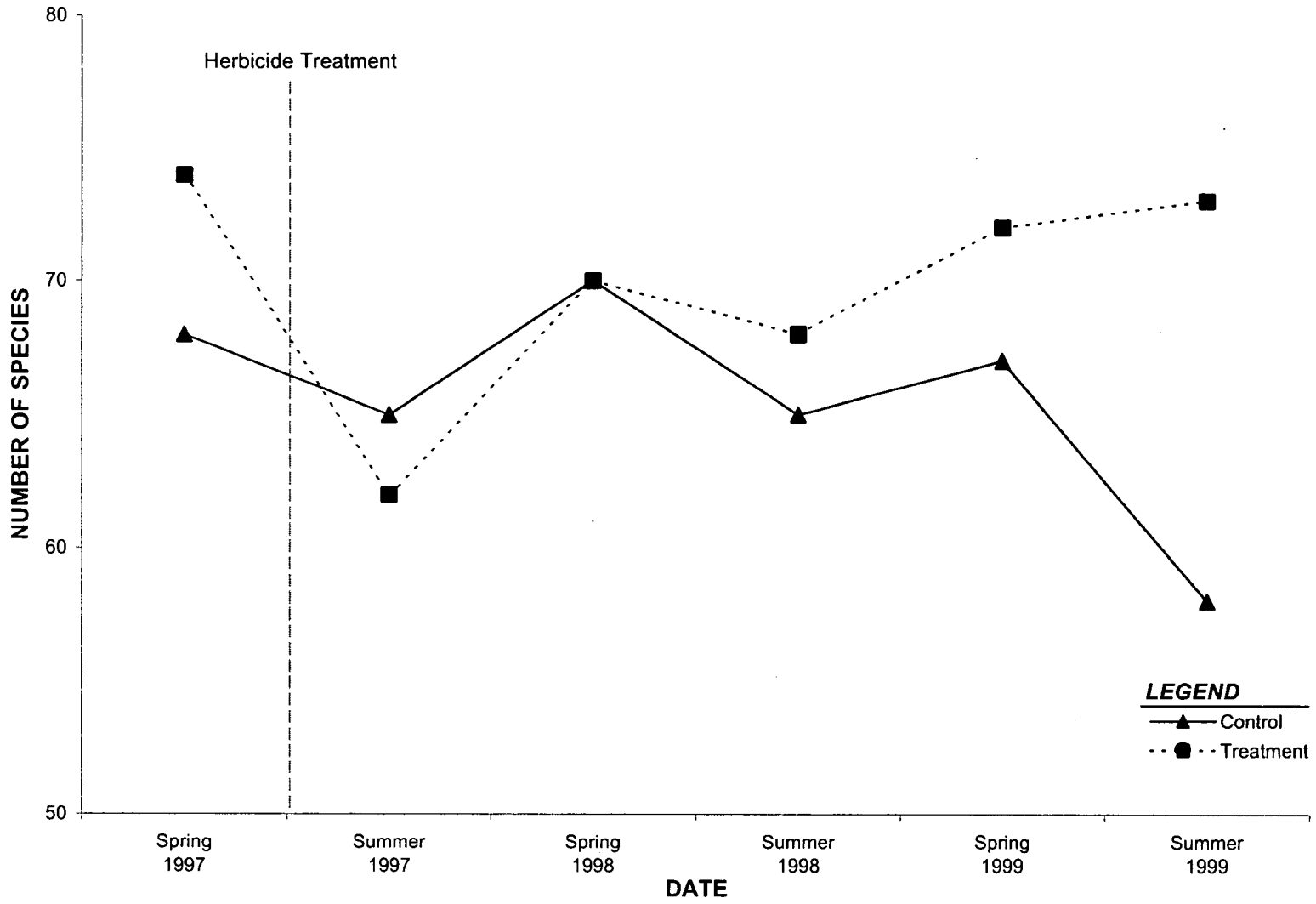



Figure 36. 1997-1999 species richness totals at the control and treatment plots by sampling event.

*Boulder1\data\groups\graphics\projects\1454\5/23/00 11:05 AM (CEDI Tables and Figures FORMATED for report.xls Figure 3)*

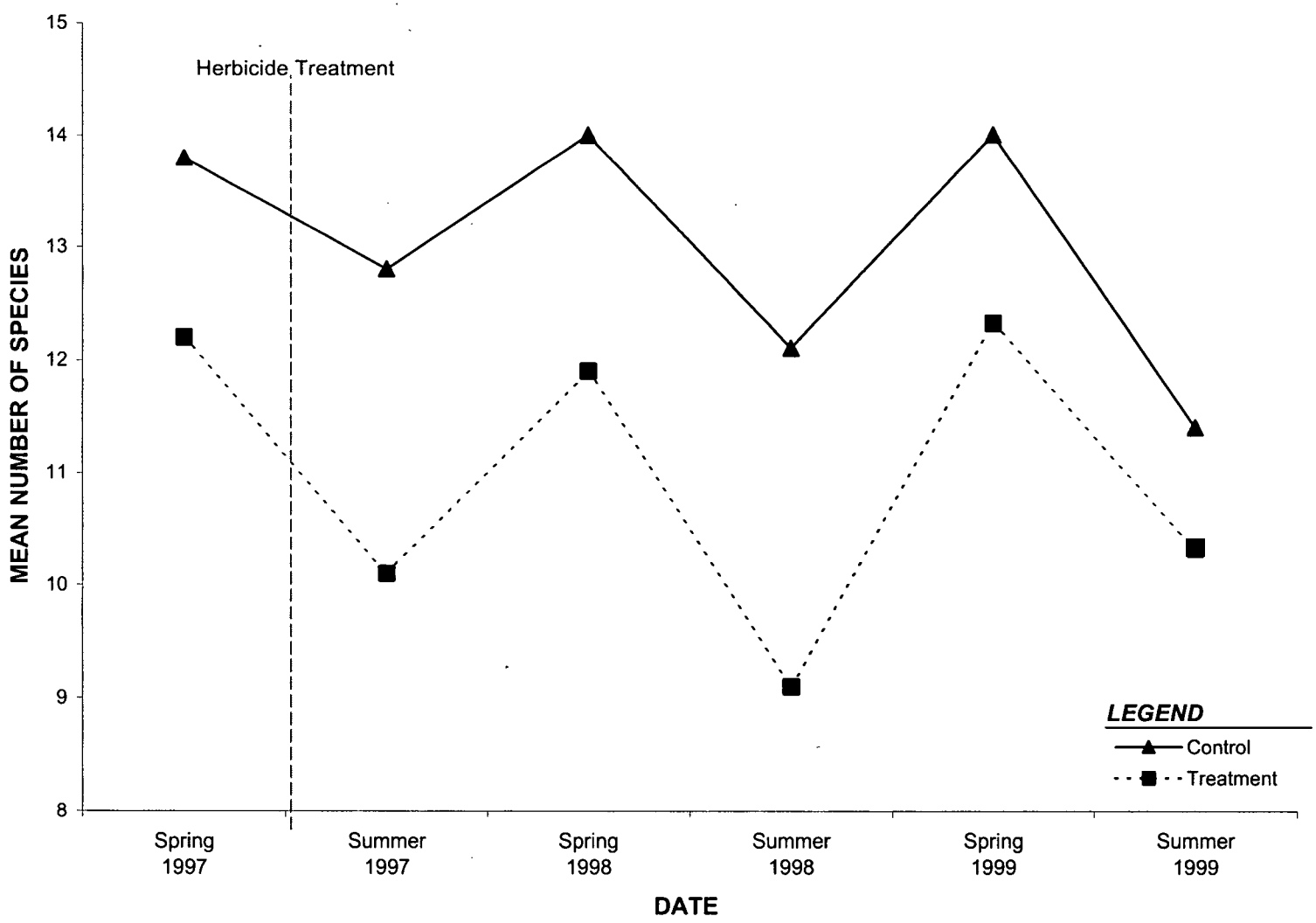



Figure 37. 1997-1999 mean number of species/quadrat at control and treatment plots by sampling event.

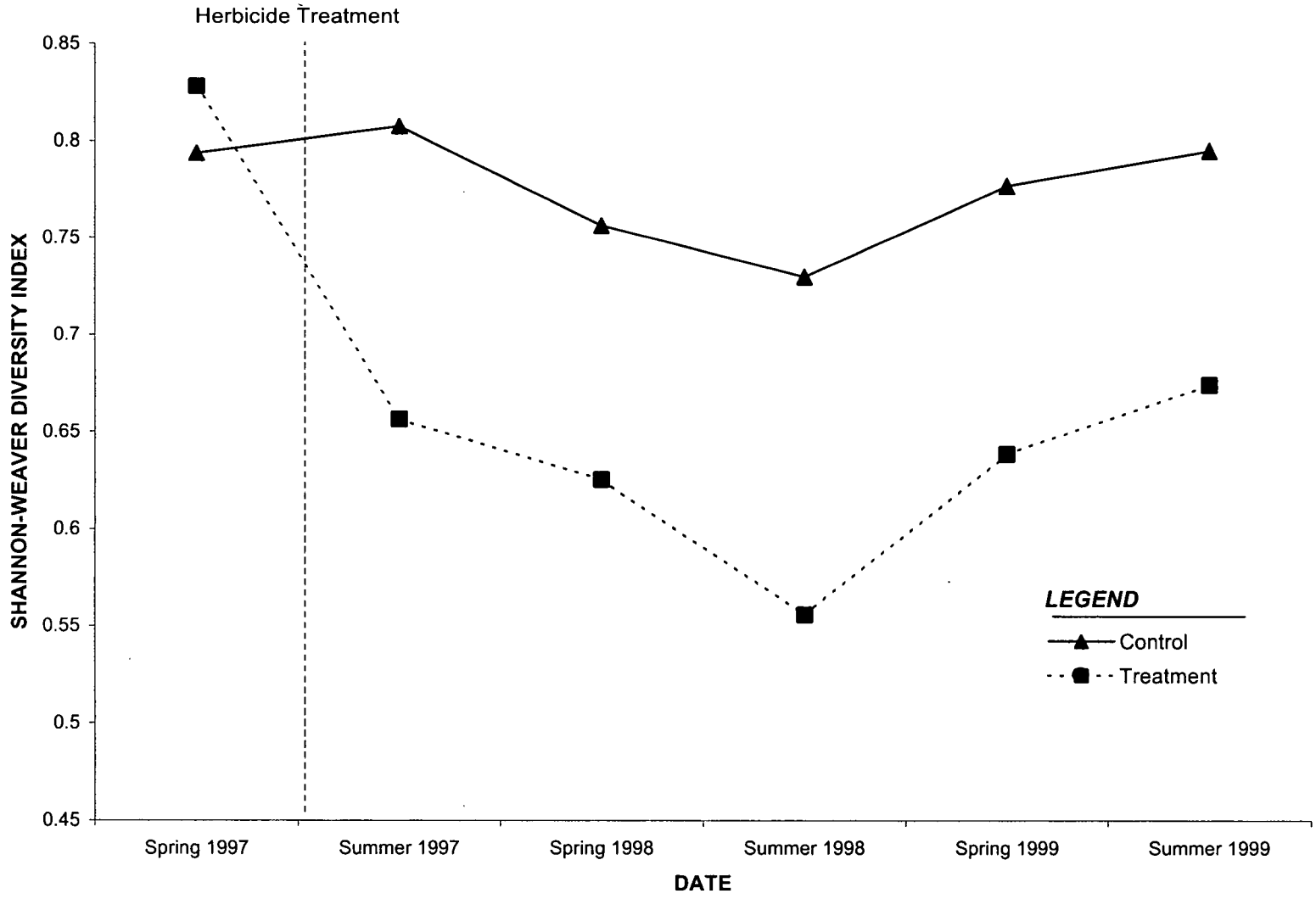



Figure 38. 1997-1999 Shannon-Weaver diversity indices at the control and treatment plots by sampling event.

*Boulder1\data\groups\graphics\projects\1454\5/23/00 11:13 AM (Figure 81for report.xls Figure 8)*

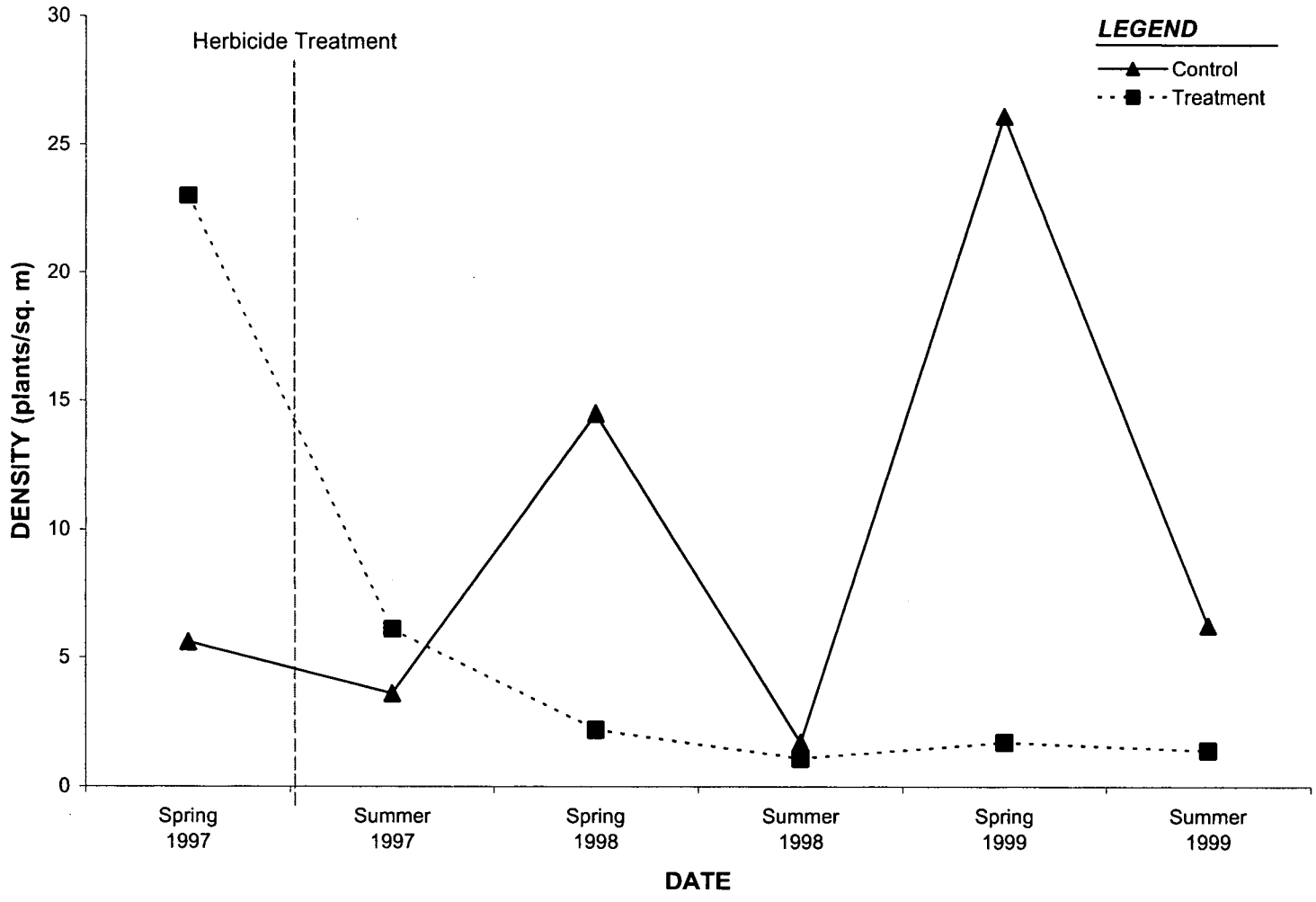



Figure 39. Diffuse knapweed densities at control and treatment plots by sampling event.

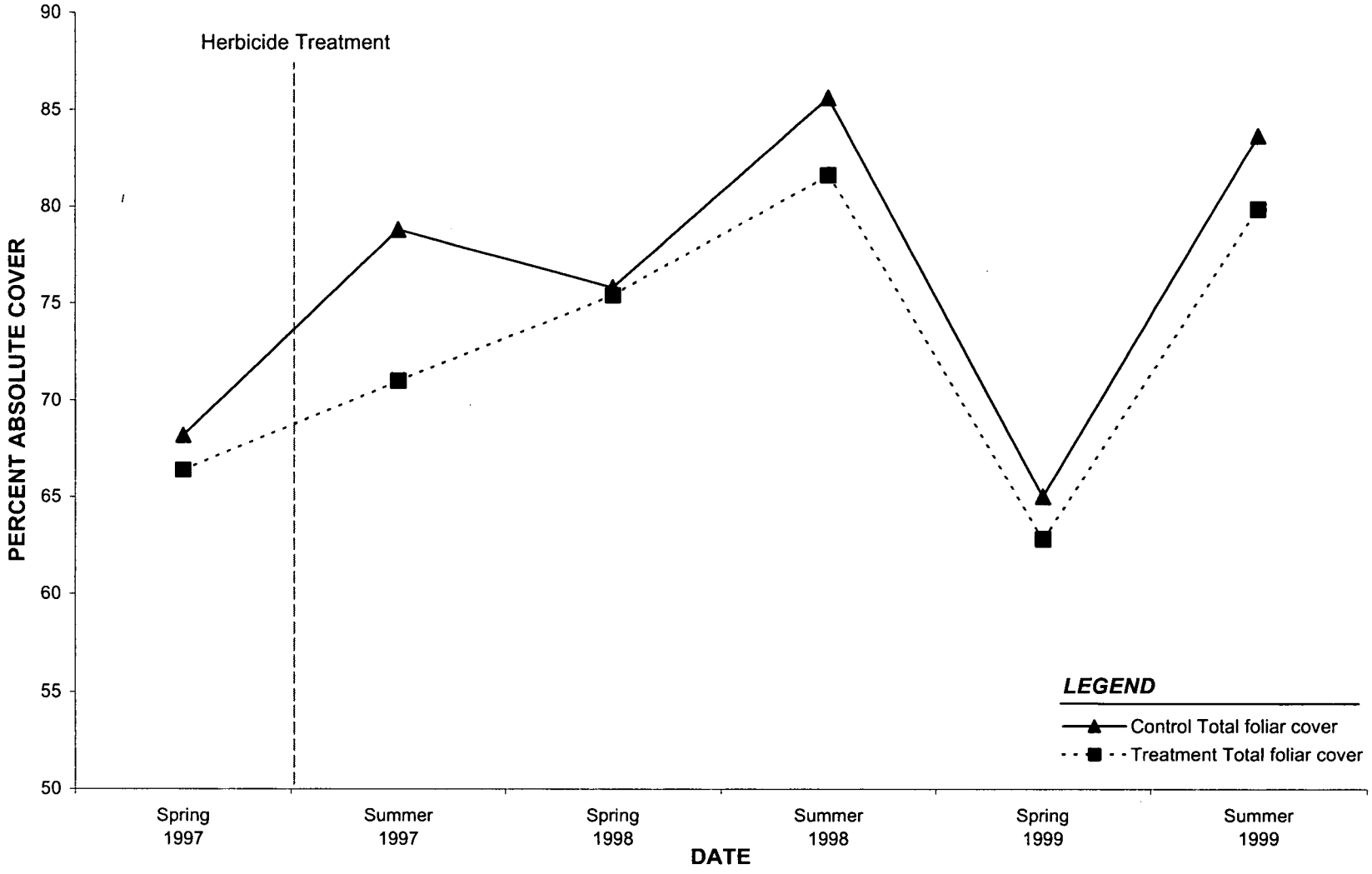



Figure 40. Total foliar vegetation cover at the control and treatment plots by sampling event.

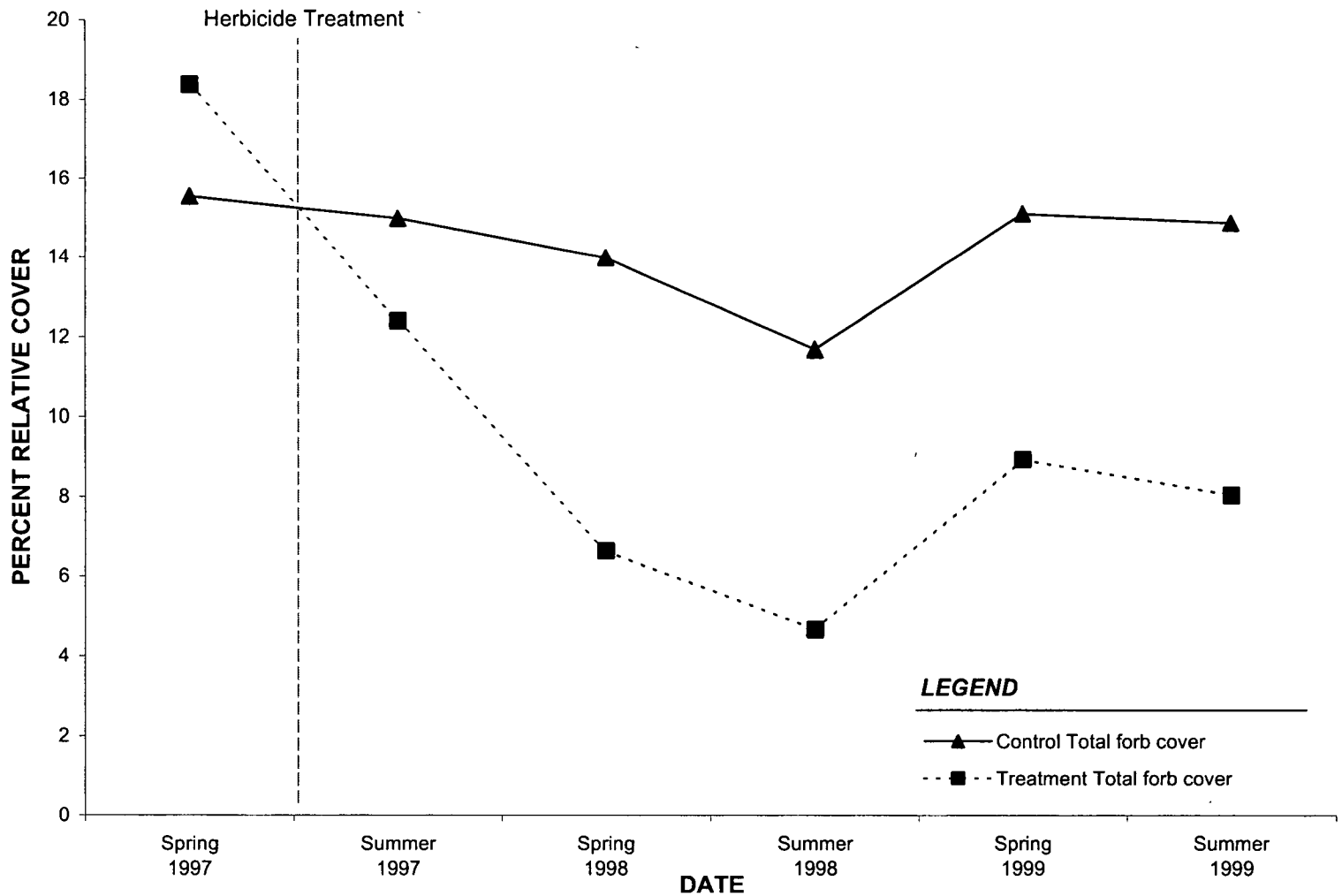



Figure 41. Total forb relative foliar cover at the control and treatment plots by sampling event.

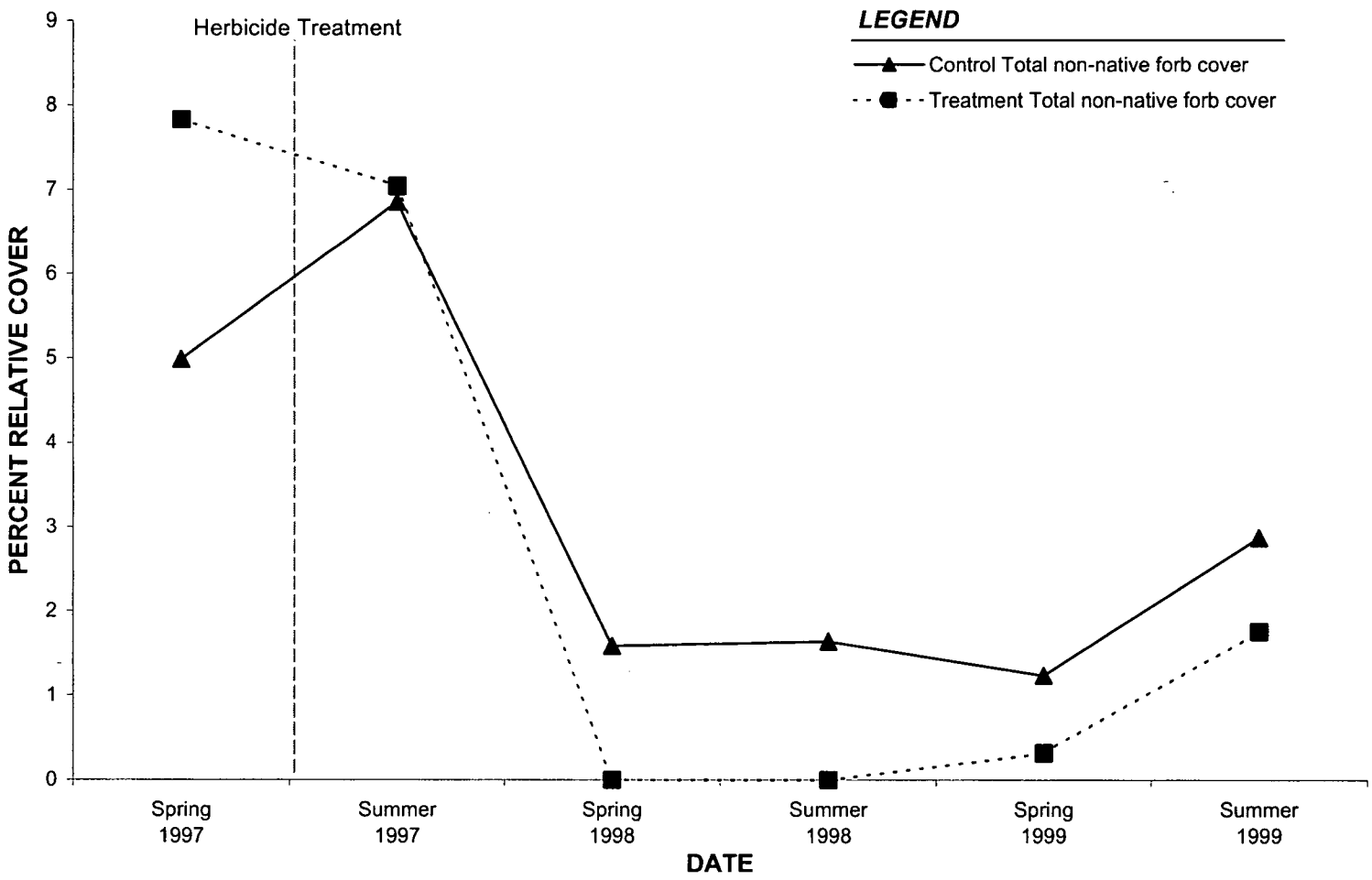



Figure 42. Total non-native forb relative foliar cover at the control and treatment plots by sampling event.

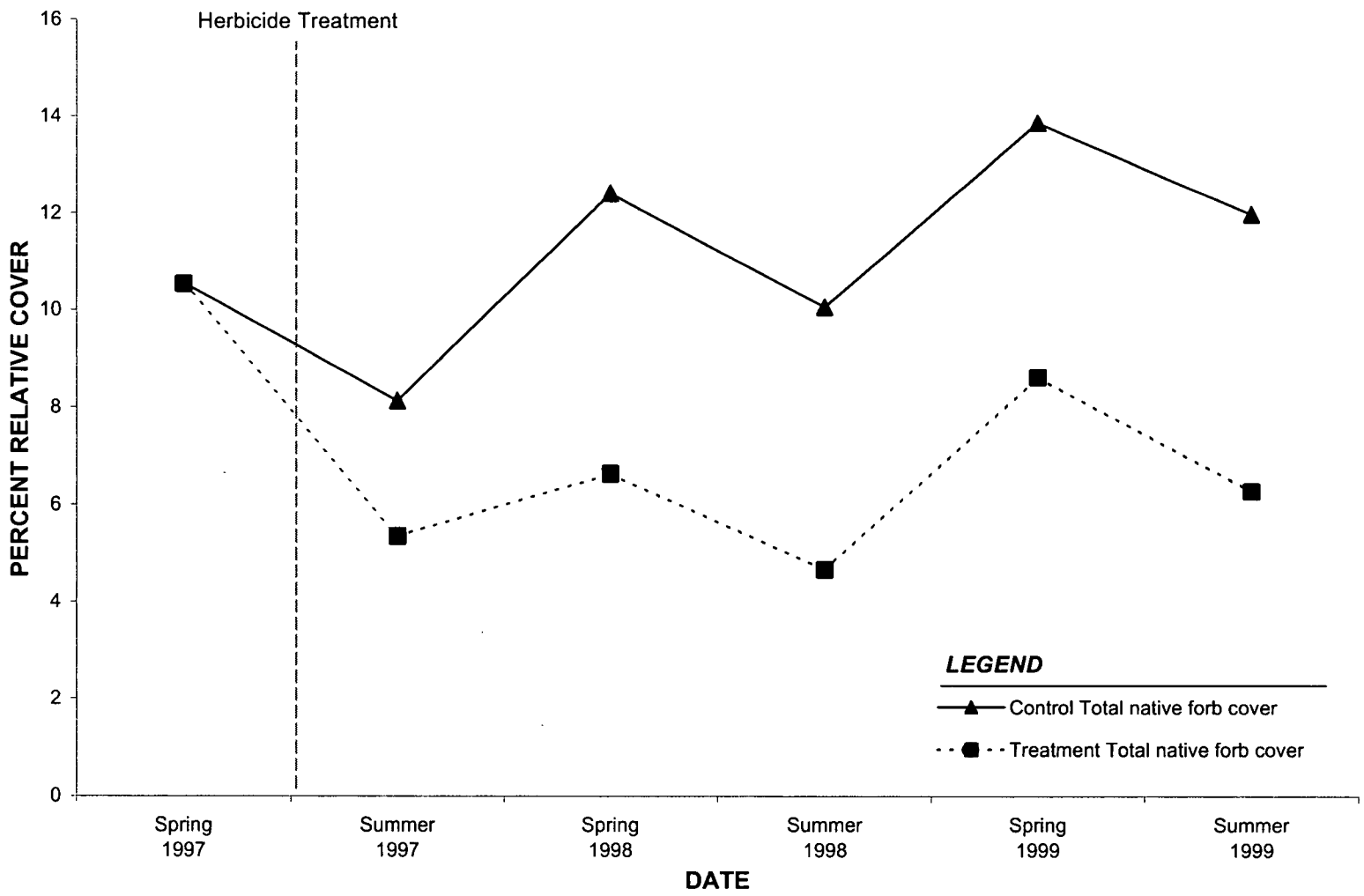



Figure 43. Total native forb relative foliar cover at the control and treatment plots by sampling event.

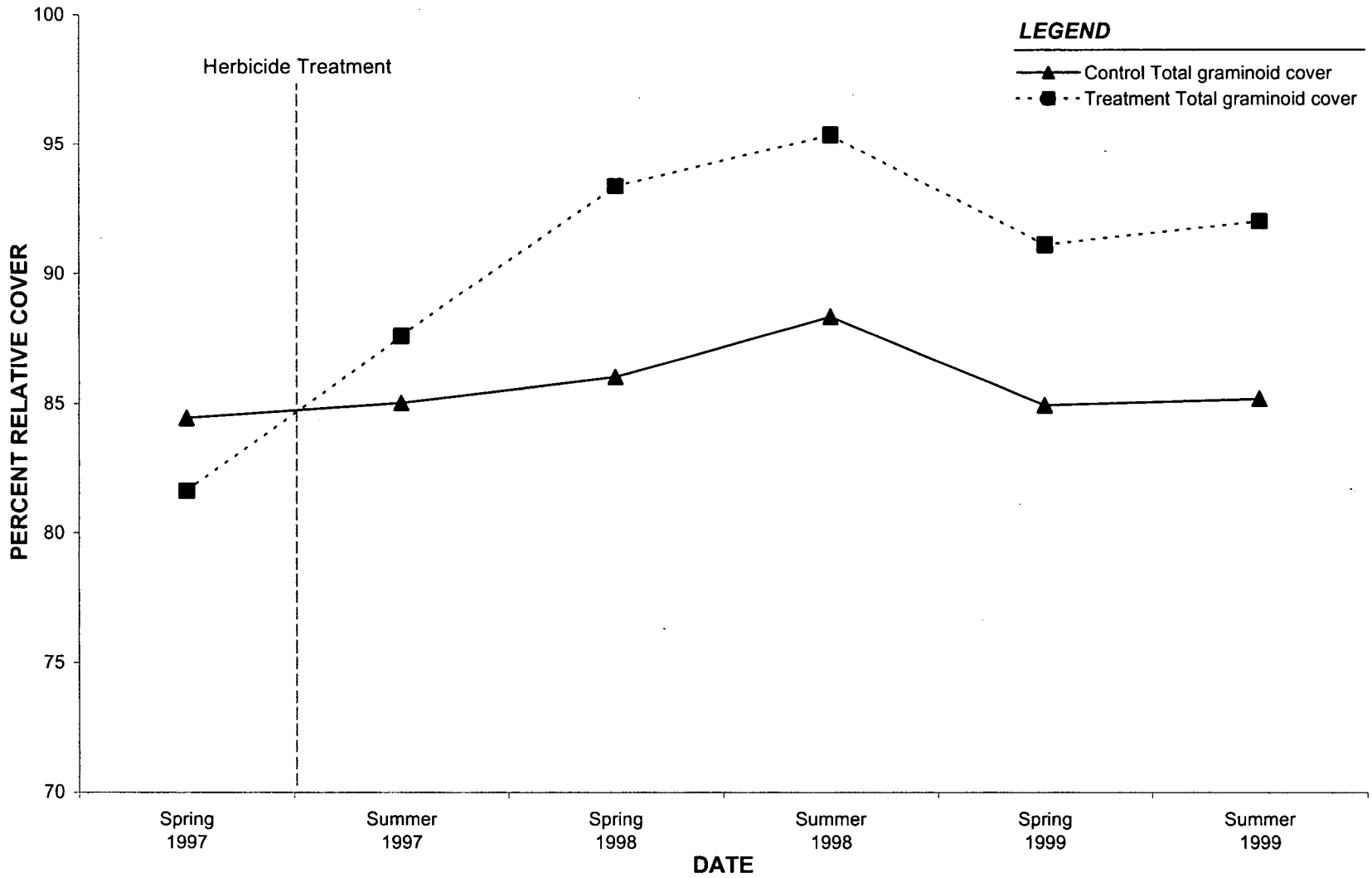



Figure 44. Total graminoid relative foliar cover at the control and treatment plots by sampling event.

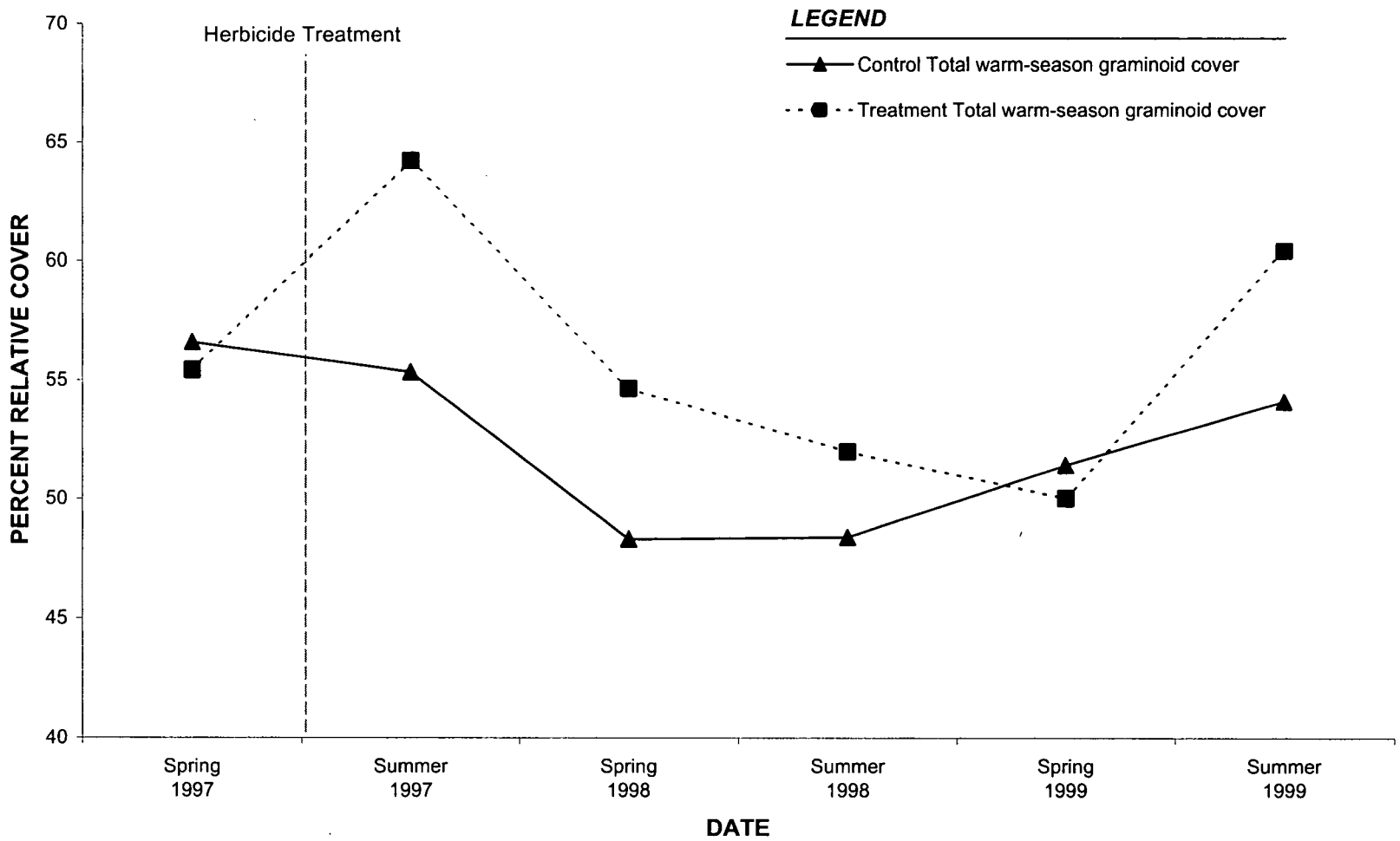



Figure 45. Total warm-season graminoid relative foliar cover at the control and treatment plots by sampling event.

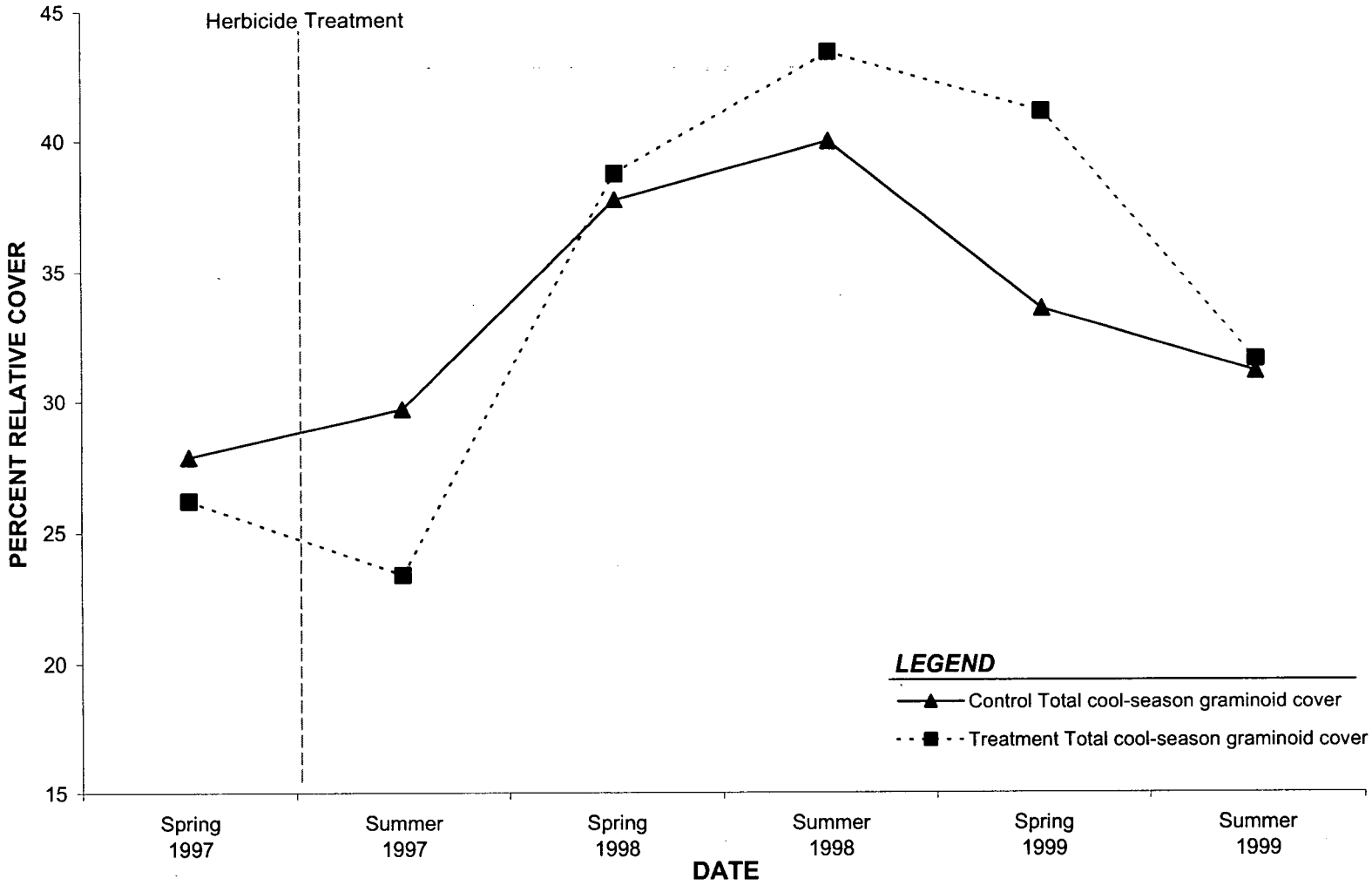
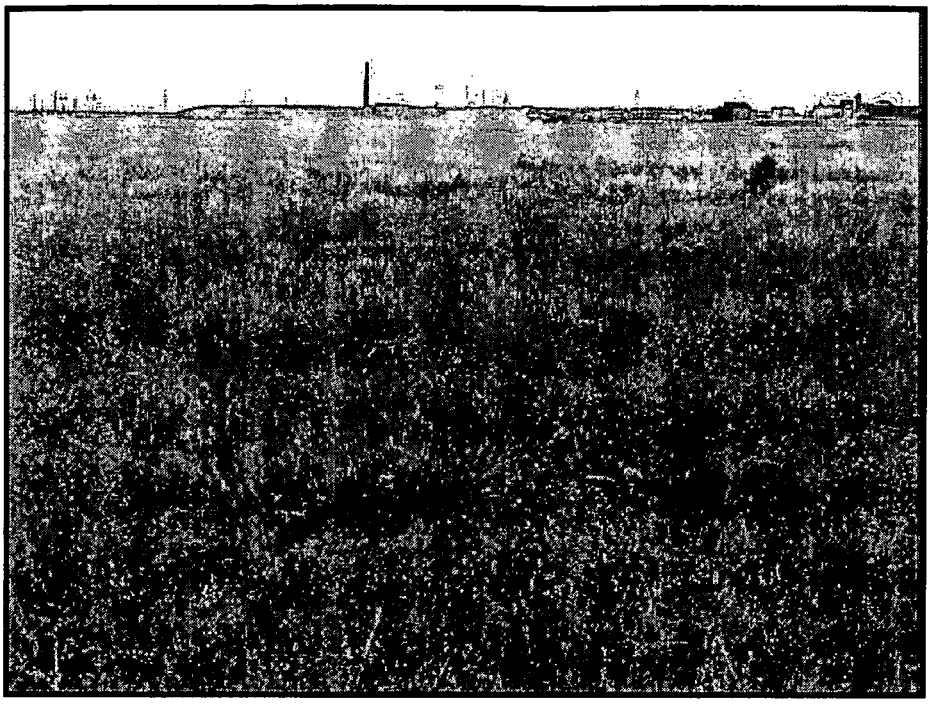
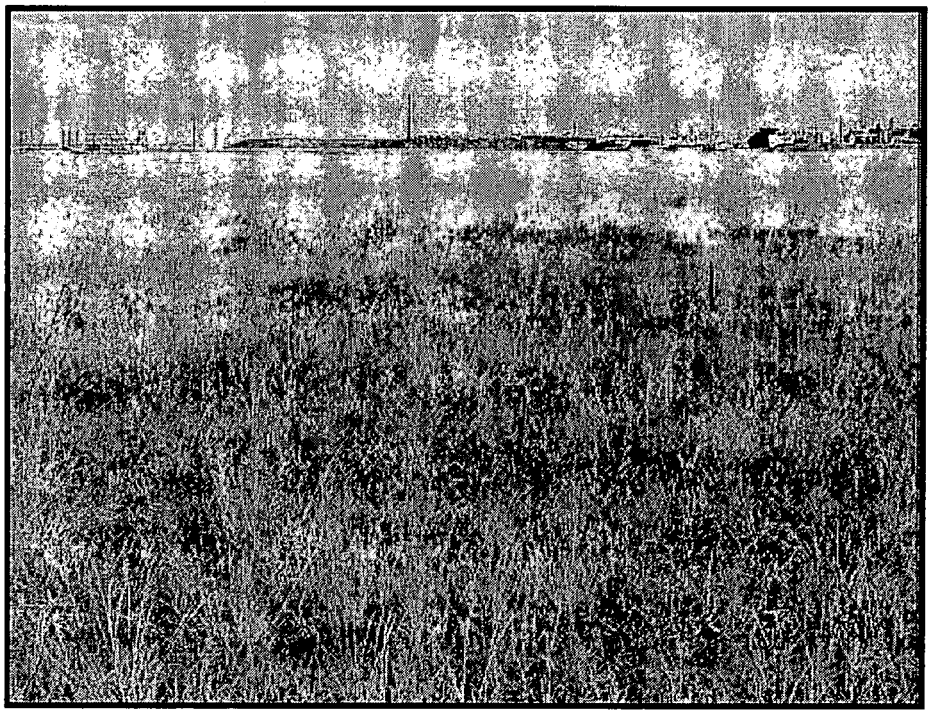



Figure 46. Total cool-season graminoid relative foliar cover at the control and treatment plots by sampling event.



1997



1999

Figure 47. Lots of diffuse knapweed (the bushy plants with tiny white flowers in the foreground of the top photograph) was present on the xeric tallgrass prairie at this location in the north Buffer Zone in 1997. The May 1999 aerial herbicide application provided excellent control of diffuse knapweed as can be seen in the lower photograph taken approximately 3 months after the application.

Figure 48. Unauthorized off-road driving in the Buffer Zone creates disturbances and ruts in the plant communities that often become infested with weeds. The striped quadrat (1 m x 0.5 m) between the ruts provides scale in this photograph.

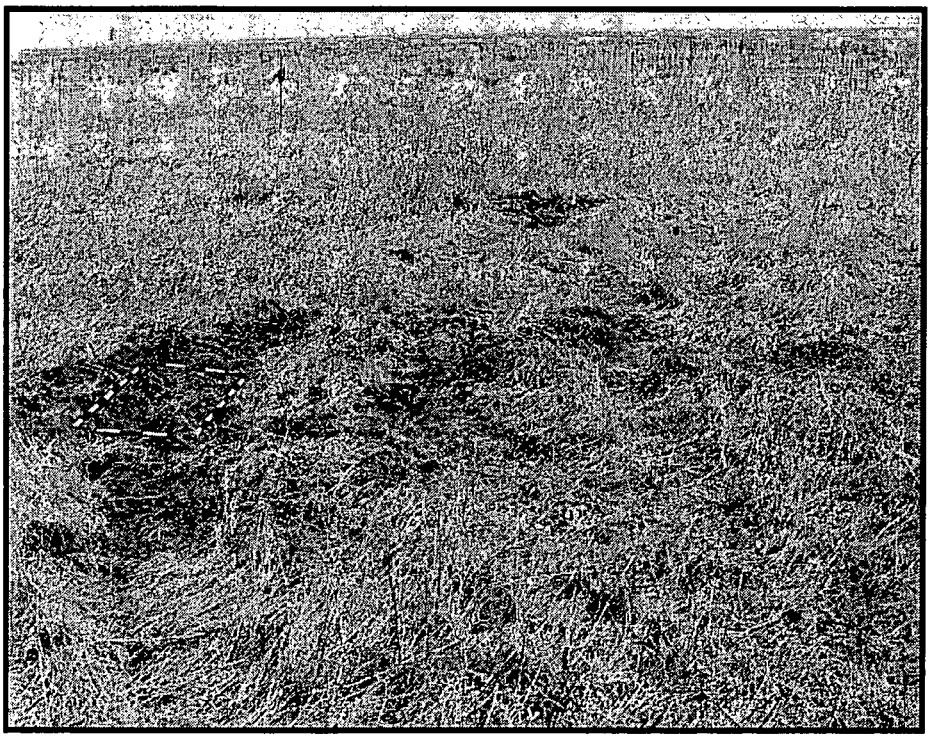


Figure 49. Spinning tires by unauthorized off-road driving has become and increasing problem in the Buffer Zone. The bare ground created at this location will need reseeding and weed control to prevent the establishment of noxious weeds. The striped quadrat (1 m x 0.5 m) provides some scale to the amount of disturbance created at this location.

# Tables

**Table 1. 1993-1995, And 1999 Mesic Mixed Grassland Species Richness**

| | | | | TR02 | | | | TR04 | | | | TR11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Native | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| AGAVACEAE | Yucca glauca Nutt. | YUGL1 | Y | X | X | X | X | | | | | X | X | X | X |
| APIACEAE | Astragalus lotiflorus Hook. | ASLO1 | Y | | | | | | | | X | | | | |
| APIACEAE | Harbouria trachypleura (Gray) C. & R. | HATR1 | Y | X | | | | | | | | | | | |
| APIACEAE | Lomatium orientale Coult. & Rose | LOOR1 | Y | | X | X | X | | X | X | X | | X | X | X |
| APIACEAE | Musineon divaricatum (Pursh.) Nutt. var. hookeri T. & G. | MUDI1 | Y | | X | X | X | | X | X | X | | X | X | X |
| ASCLEPIADACEAE | Asclepias pumila (Gray) Vail | ASPU1 | Y | X | X | X | X | | | | | | | | |
| ASCLEPIADACEAE | Asclepias speciosa Torr. | ASSP1 | Y | | | | | | | | | X | | X | X |
| ASCLEPIADACEAE | Asclepias viridiflora Raf. | ASVI1 | Y | | | | | | | X | | | | X | |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | ACMI1 | Y | | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Ambrosia psilostachya DC. | AMPS1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Arnica fulgens Pursh. | ARFU1 | Y | | | | | | X | | | | X | X | X |
| ASTERACEAE | Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem. | ARCA1 | Y | | | | X | X | | | X | | | | X |
| ASTERACEAE | Artemisia dracunculus L. | ARDR1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Artemisia frigida Willd. | ARFR1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Aster falcatus Lindl. | ASFA1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Aster porteri Gray | ASPO1 | Y | X | X | X | X | | | | X | X | X | X | X |
| ASTERACEAE | Aster sp. | AST1 | | | | | | X | X | | | | | | |
| ASTERACEAE | Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | CANU1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Centaurea diffusa Lam. | CEDI1 | N | X | X | X | X | X | | X | X | | | X | X |
| ASTERACEAE | Chrysopsis fulcrata Greene | CHFU1 | Y | X | | | X | | | | | X | X | X | X |
| ASTERACEAE | Chrysopsis villosa Pursh. | CHVI1 | Y | X | X | X | X | X | X | X | X | | | X | X |
| ASTERACEAE | Cirsium arvense (L.) Scop. | CIAR1 | N | | X | | | X | X | X | X | X | X | X | X |
| ASTERACEAE | Cirsium undulatum (Nutt.) Spreng. | CIUN1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Crepis occidentalis Nutt. | CROC1 | Y | | | | | | | | | | X | | |
| ASTERACEAE | Erigeron divergens T. & G. | ERDI1 | Y | X | X | X | X | X | X | X | X | | X | | X |
| ASTERACEAE | Erigeron flagellaris A. Gray | ERFL1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Gutierrezia sarothrae (Pursh.) Britt. & Rusby | GUSA1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Helianthus annuus L. | HEAN1 | Y | | | X | | | | | X | | X | X | |
| ASTERACEAE | Helianthus petiolaris Nutt. | HEPE1 | Y | | | | X | | | X | X | | | X | X |
| ASTERACEAE | Helianthus pumilus Nutt. | HEPU1 | Y | X | X | X | X | X | X | | | X | X | | |
| ASTERACEAE | Helianthus sp. | HEL1 | | | | X | | | | X | | | X | | |
| ASTERACEAE | Hymenopappus filifolius Hook. var. cinereus (Rydb.) I. M. Johnst. | HYFI1 | Y | X | | X | X | | | | | X | | | |
| ASTERACEAE | Kuhnia chlorolepis Woot. & Standl. | KUCH1 | Y | | | X | X | X | | | | X | | X | X |
| ASTERACEAE | Kuhnia eupatorioides L. | KUEU1 | Y | X | X | X | X | X | X | X | X | | X | X | X |
| ASTERACEAE | Kuhnia sp. | KUH1 | | | | | | | X | | | | X | | |
| ASTERACEAE | Lactuca serriola L. | LASE1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Liatris punctata Hook. | LIPU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Microseris cuspidata (Pursh.) Sch. Bip. | MICU1 | Y | | X | X | X | | X | X | | | X | X | X |
| ASTERACEAE | Picradeniopsis oppositifolia (Nutt.) Rydb. | PIOP1 | Y | | | | | | | | | | X | X | X |
| ASTERACEAE | Ratibida columnifera (Nutt.) Woot. & Standl. | RACO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Scorzonera laciniata L. | SCLA1 | N | X | X | X | X | X | X | X | X | | X | X | X |

Table 1. (cont.)

| | | | | TR02 | | | | TR04 | | | | TR11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Native | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| ASTERACEAE | Senecio integerrimus Nutt. | SEIN1 | Y | | X | | | | X | X | X | | X | | |
| ASTERACEAE | Senecio plattensis Nutt. | SEPL1 | Y | | X | X | X | | X | | | | X | X | X |
| ASTERACEAE | Senecio spartioides T. & G. | SESP1 | Y | X | X | X | X | | | | | X | X | X | X |
| ASTERACEAE | Solidago missouriensis Nutt. | SOMI1 | Y | | | | | X | X | X | X | X | X | X | X |
| ASTERACEAE | Solidago mollis Bart. | SOMO1 | Y | | | | | X | | | | | | | |
| ASTERACEAE | Solidago rigida L. | SORI1 | Y | | X | X | X | | | | | | | | |
| ASTERACEAE | Solidago sp. | SOL2 | | | | | | | X | | | | X | | |
| ASTERACEAE | Sonchus asper (L.) Hill | SOAS1 | N | | | | | | | | X | | | | |
| ASTERACEAE | Taraxacum laevigatum (Willd.) DC. | TALA1 | N | | | X | | | | | | | | | |
| ASTERACEAE | Taraxacum officinale Weber | TAOF1 | N | X | X | X | X | X | X | X | X | | X | X | X |
| ASTERACEAE | Thelesperma megapotanicum (Spreng.) O. Ktze. | THME1 | Y | | | X | | | | | | | | | |
| ASTERACEAE | Tragopogon dubius Scop. | TRDU1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| BORAGINACEAE | Lappula redowskii (Hornem.) Greene | LARE1 | Y | | X | X | X | | X | X | | | X | X | X |
| BORAGINACEAE | Lithospermum incisum Lehm. | LIIN1 | Y | | X | | X | | | | X | X | X | X | X |
| BORAGINACEAE | Onosmodium molle Michx. var. occidentale (Mack.) Johnst. | ONMO1 | Y | X | X | X | X | | | | X | | | | |
| BRASSICACEAE | | BR1 | | | | X | | | | | | | X | | |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| BRASSICACEAE | Arabis fendleri (S. Wats.) Greene var. fendleri | ARFE3 | Y | | | | | | | | | | X | | |
| BRASSICACEAE | Arabis glabra (L.) Bernh. | ARGL1 | N | | | | | | X | X | X | | | | |
| BRASSICACEAE | Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins | ARHI1 | Y | | | | | | | | X | | | | |
| BRASSICACEAE | Arabis sp. | ARA1 | | | X | | | | | | | | | | |
| BRASSICACEAE | Camelina microcarpa Andrz. ex DC. | CAMI1 | N | | X | X | | X | X | X | X | X | X | X | X |
| BRASSICACEAE | Descurainia pinnata (Walt.) Britt. | DEPI1 | Y | | X | X | X | | X | X | X | | X | X | X |
| BRASSICACEAE | Descurainia richardsonii (Sweet) Schultz | DERI1 | Y | | | | | | X | X | X | | X | X | X |
| BRASSICACEAE | Descurainia sophia (L.) Webb ex Prantl. | DESO1 | N | | | | | | | | | X | | | |
| BRASSICACEAE | Descurainia sp. | DES1 | | | | | | | X | | | | | | |
| BRASSICACEAE | Draba reptans (Lam.) Fern. | DRRE1 | Y | | X | X | | | X | X | X | | X | X | X |
| BRASSICACEAE | Erysimum capitatum (Nutt.) DC. | ERCA2 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| BRASSICACEAE | Erysimum repandum L. | ERRE1 | N | | | | | | X | X | X | | | | |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | LECA1 | N | | | | X | | | | X | | | | |
| BRASSICACEAE | Lepidium densiflorum Schrad. | LEDE1 | Y | | | X | | | X | X | | | | | |
| BRASSICACEAE | Lepidium sp. | LEP1 | | | | | | | X | | | | X | X | |
| BRASSICACEAE | Lesquerella montana (A. Gray) Wats. | LEMO1 | Y | X | X | X | X | | | | | X | X | X | X |
| BRASSICACEAE | Sisymbrium altissimum L. | SIAL1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| BRASSICACEAE | Thlaspi arvense L. | THAR1 | N | | | X | | | X | X | | | | | |
| CACTACEAE | Coryphantha missouriensis (Sweet) Britt. & Rose | COMI1 | Y | | X | X | X | | X | X | X | | X | X | |
| CACTACEAE | Echinocereus viridiflorus Engelm. | ECVI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| CACTACEAE | Opuntia fragilis (Nutt.) Haw. | OPFR1 | Y | X | X | X | | X | X | X | X | X | X | X | X |
| CACTACEAE | Opuntia macrorhiza Engelm. | OPMA1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| CACTACEAE | Opuntia polyacantha Haw. | OPPO1 | Y | | | | | X | | | | | | | |
| CACTACEAE | Pediocactus simpsonii (Engelm.) Britt. & Rose | PESI1 | Y | | X | | | | | | | | | | |
| CAMPANULACEAE | Triodanis leptocarpa (Nutt.) Nieuw. | TRLE1 | Y | | | X | | | | | | | | | |
| CAMPANULACEAE | Triodanis sp. | TRI2 | | | X | | | | X | | | | | | |

Table 1. (cont.)

| | | | | TR02 | | | | TR04 | | | | TR11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Native | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| CARYOPHYLLACEAE | Paronychia jamesii T. & G. | PAJA1 | Y | | X | | | | | | | | | | |
| CARYOPHYLLACEAE | *Silene antirrhina* L. | SIAN1 | Y | | X | X | | | X | X | X | | X | X | X |
| CARYOPHYLLACEAE | Silene drummondii Hook. | SIDR1 | Y | | | X | | | | | | | X | | X |
| CHENOPODIACEAE | | CH1 | | | | X | | | | | | | | | |
| CHENOPODIACEAE | Chenopodium album L. | CHAL1 | N | | | | X | | | | | | | | |
| CHENOPODIACEAE | Chenopodium leptophyllum Nutt. ex Moq. | CHLE2 | Y | X | X | X | | X | X | X | X | X | X | X | |
| CLUSIACEAE | Hypericum perforatum L. | HYPE1 | N | X | X | X | X | X | X | | X | X | X | X | X |
| COMMELINACEAE | Tradescantia occidentalis (Britt.) Smyth | TROC1 | Y | | X | X | X | | X | X | X | | X | X | X |
| CONVOLVULACEAE | Convolvulus arvensis L. | COAR1 | N | X | X | X | X | | | | | | | X | X |
| CONVOLVULACEAE | Evolvulus nuttallianus R. & S. | EVNU1 | Y | X | X | X | X | X | | X | X | X | X | X | X |
| CYPERACEAE | Carex sp. | CAR1 | | | | | | | X | | | | | | |
| CYPERACEAE | Carex eleocharis Bailey | CAEL1 | Y | X | X | X | | X | X | X | X | X | | | X |
| CYPERACEAE | Carex heliophila Mack. | CAHE1 | Y | | X | X | X | | X | | X | | X | X | X |
| CYPERACEAE | Carex interior Bailey | CAIN1 | Y | | | | | | | | | | X | | |
| CYPERACEAE | Carex oreocharis Holm. | CAOR1 | Y | | X | | | | | | | X | | | |
| EUPHORBIACEAE | Euphorbia dentata Michx. | EUDE1 | Y | | | | | | | | | | X | | X |
| EUPHORBIACEAE | Euphorbia marginata Pursh. | EUMA1 | Y | | | X | | | | | | | | X | |
| EUPHORBIACEAE | Euphorbia robusta (Engelm.) Small | EURO1 | Y | | X | X | | | | | | | | X | |
| EUPHORBIACEAE | Euphorbia spathulata Lam. | EUSP1 | Y | | X | X | X | | X | X | X | | X | X | X |
| FABACEAE | Astragalus agrestis Dougl. ex G. Don | ASAG1 | Y | | X | | | X | X | X | X | | X | | X |
| FABACEAE | Astragalus crassicarpus Nutt. | ASCR1 | Y | | X | X | | | X | X | X | | | | |
| FABACEAE | Astragalus drummondii Dougl. ex Hook. | ASDR1 | Y | | | | | X | X | X | | | | | |
| FABACEAE | Astragalus flexuosus (Hook.) G. Don | ASFL1 | Y | X | X | X | X | | | | X | | | | |
| FABACEAE | Astragalus shortianus Nutt. ex T.&G. | ASSH1 | Y | | X | X | | | X | | | | X | X | X |
| FABACEAE | Astragalus sp. | AST2 | | | X | | | | | | | | | | |
| FABACEAE | Astragalus tridactylicus Gray | ASTR1 | Y | | X | | | | | | | | | | |
| FABACEAE | Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinners. | DACA1 | Y | X | | X | X | | | X | | X | X | X | X |
| FABACEAE | Dalea purpurea Vent | DAPU1 | Y | X | X | X | X | | | X | X | X | X | X | X |
| FABACEAE | Lathyrus eucosmus Butters and St. John | LAEU1 | Y | | | | | | | | | | | | X |
| FABACEAE | Melilotus officinalis (L.) Pall. | MEOF1 | N | | | | | X | | | | | | | |
| FABACEAE | Oxytropis lambertii Pursh. | OXLA1 | Y | | X | X | X | | | | | | | X | X |
| FABACEAE | Psoralea tenuiflora Pursh. | PSTE1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| FABACEAE | Trifolium sp. | TRI1 | | | | | | | | | | | X | | |
| FABACEAE | Vicia americana Muhl. ex Willd. | VIAM1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| GERANIACEAE | Erodium cicutarium (L.) L'Her. | ERCI1 | N | | X | X | X | | X | X | X | | | X | X |
| HYDROPHYLLACEAE | Phacelia heterophylla Pursh. | PHHE1 | Y | | X | | | | | | | X | X | X | X |
| JUNCACEAE | Juncus dudleyi Wieg. | JUDU1 | Y | | | | | | | | | | | X | |
| JUNCACEAE | Juncus interior Wieg. | JUIN1 | Y | | | | | | | | | | | | X |
| LAMIACEAE | Hedeoma hispidum Pursh. | HEHI1 | Y | | | | | X | | | | X | | | |
| LAMIACEAE | *Nepeta cataria* L. | NECA1 | N | | | X | | | | | | | | | |
| LAMIACEAE | Scutellaria brittonii Porter | SCBR1 | Y | | | | | | | | | | X | | X |
| LILIACEAE | Allium textile A. Nels. & Macbr. | ALTE1 | Y | X | X | X | X | | X | X | | X | X | X | X |
| LILIACEAE | Calochortus gunnisonii S. Wats. | CAGU1 | Y | | | | | | | X | | X | | X | |

Table 1. (cont.)

| | | | | TR02 | | | | TR04 | | | | TR11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Native | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| LILIACEAE | Leucocrinum montanum Nutt. | LEMO2 | Y | | X | X | X | | | X | X | | X | X | X |
| LINACEAE | Linum perenne L. var. lewisii (Pursh.) Eat. & Wright | LIPE1 | Y | X | X | X | X | X | X | X | X | | | | X |
| LINACEAE | Linum pratense (Nort.) Small | LIPR1 | Y | | | | | | | | X | | | | |
| MALVACEAE | Sphaeralcea coccinea (Pursh.) Rydb. | SPCO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| NYCTAGINACEAE | Mirabilis linearis (Pursh.) Heimerl | MILI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ONAGRACEAE | Epilobium paniculatum Nutt. | EPPA1 | Y | X | | | | | | X | | | | | |
| ONAGRACEAE | Gaura coccinea Pursh. | GACO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ONAGRACEAE | Oenothera howardii (A. Nels.) W. L. Wagner | OEHO1 | Y | | | | | | X | X | X | | | | |
| OROBANCHACEAE | Orobanche fasciculata Nutt. | ORFA1 | Y | | | | | | | X | X | | X | X | X |
| PLANTAGINACE | Plantago lanceolata L. | PLLA1 | N | | | | | X | X | | X | | | | |
| PLANTAGINACE | Plantago patagonica Jacq. | PLPA1 | Y | | | | | X | | X | X | | | X | |
| POACEAE | | PO1 | | - | | X | | | | | | | | | |
| POACEAE | Agropyron intermedium (Host) Beauv. | AGIN1 | N | | | | | X | X | | | | | | |
| POACEAE | Agropyron smithii Rydb. | AGSM1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Andropogon gerardii Vitman | ANGE1 | Y | X | X | X | X | | | X | X | X | X | X | X |
| POACEAE | Andropogon scoparius Michx. | ANSC1 | Y | X | X | X | X | | | | | X | X | X | X |
| POACEAE | Aristida purpurea Nutt. var. longiseta (Steud.) Vasey | ARFE1 | Y | X | X | X | | X | X | X | | X | X | X | |
| POACEAE | Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Aristida sp. | ARI1 | | | | | | | X | | | | | | |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | BOCU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bouteloua hirsuta Lag | BOHI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bouteloua sp. | BOU1 | | | | | | | X | | | | | | |
| POACEAE | Bromus inermis Leyss. ssp. inermis | BRIN1 | N | X | X | X | X | | | | | | | | |
| POACEAE | Bromus japonicus Thunb. ex Murr. | BRJA1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bromus tectorum L. | BRTE1 | N | X | | X | | X | X | X | X | X | X | X | X |
| POACEAE | Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | Y | X | X | X | X | X | X | X | X | | X | X | X |
| POACEAE | Festuca octoflora Walt. | FEOC1 | Y | | | | | | | | | | | X | |
| POACEAE | Festuca pratensis Huds. | FEPR1 | Y | | | | X | | | | X | | | | |
| POACEAE | Hordeum jubatum L. | HOJU1 | Y | | | | | X | | X | X | | X | | |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | KOPY1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | Y | | | | | X | X | | | | | X | |
| POACEAE | Muhlenbergia wrightii Vasey | MUWR1 | Y | | X | | | X | | X | X | X | X | X | X |
| POACEAE | Poa compressa L. | POCO1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Poa pratensis L. | POPR1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Schedonnardus paniculatus (Nutt.) Trel. | SCPA2 | N | | | | | | | | X | | | | |
| POACEAE | Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | Y | X | X | X | X | X | | | | X | | X | X |
| POACEAE | Sporobolus asper (Michx.) Kunth | SPAS1 | Y | | | | X | | | | | | | | X |
| POACEAE | Sporobolus cryptandrus (Torr.) A. Gray | SPCR1 | Y | X | X | | | | | | X | | | | |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | Y | | | | | | | | | | X | X | X |
| POACEAE | Stipa comata Trin. & Rupr. | STCO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Stipa sp. | STI1 | | | | | | | | | | | X | | |
| POACEAE | Stipa viridula Trin. | STVI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |

Table 1. (cont.)

| | | | | TR02 | | | | TR04 | | | | TR11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Native | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| POACEAE | Triticum aestivum L. | TRAE1 | N | | | | | | X | | | | | | |
| POLEMONIACEAE | Collomia linearis Nutt. | COLI1 | Y | | X | | | | | X | | | X | X | |
| POLEMONIACEAE | Microsteris gracilis (Hook.) Greene | MIGR1 | Y | | | | | | X | X | X | | | | |
| POLYGONACEAE | Eriogonum alatum Torr. | ERAL1 | Y | X | X | X | X | | | | | X | | | X |
| POLYGONACEAE | Polygonum aviculare L. | POAV1 | N | | | | | X | | | | | | | |
| POLYGONACEAE | Polygonum ramosissimum Michx. | PORA1 | Y | | | | | | | | X | | | | |
| POLYGONACEAE | Polygonum sawatchense Small | POSA1 | Y | | | X | | | X | X | | | | | |
| POLYGONACEAE | Polygonum sp. | POL1 | | | | X | | | | | | | | | |
| RANUNCULACEAE | Delphinium nuttalianum Pritz. ex Walpers | DENU1 | Y | | | | | | | | | | | | X |
| RANUNCULACEAE | Delphinium sp. | DEL1 | | | | | | | X | | | | X | | |
| RANUNCULACEAE | Delphinium virescens Nutt. ssp. penardii (Huth) Ewan | DEVI1 | Y | | | | | | | X | | | | X | X |
| ROSACEAE | Rosa acicularis Lindl. | ROAC1 | Y | X | | | | X | | | | X | | X | |
| ROSACEAE | Rosa arkansana Porter | ROAR1 | Y | | X | X | X | | X | X | X | | X | X | X |
| SANTALACEAE | Comandra umbellata (L.) Nutt. | COUM1 | Y | | X | X | | | X | | X | | X | | X |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | LIDA1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| SCROPHULARIACEAE | Penstemon angustifolius Nutt. ex Pursh | PEAN1 | Y | | X | | | | | | | | | | |
| SCROPHULARIACEAE | Penstemon secundiflorus Benth. | PESE1 | Y | | | X | X | | | | | | X | X | X |
| SCROPHULARIACEAE | Penstemon virens Penn. | PEVI1 | Y | | X | X | | | | | | | X | X | X |
| SCROPHULARIACEAE | Penstemon virgatus Gray ssp. asa-grayi Crosswhite | PEVI2 | Y | | | | | | | | | | | | X |
| SCROPHULARIACEAE | Verbascum blattaria L. | VEBL1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| SCROPHULARIACEAE | Verbascum thapsus L. | VETH1 | N | | X | | | | | | | X | X | | X |
| SCROPHULARIACEAE | Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren | VEPE1 | Y | | | | | | | X | | | | | |
| SOLANACEAE | Physalis heterophylla Nees | PHHE2 | Y | | | | | | | | | X | | | |
| SOLANACEAE | Physalis sp. | PHY1 | | | | | | | X | | | | | | |
| SOLANACEAE | Physalis virginiana P. Mill. | PHVI2 | Y | | | | | | | X | | | | | |
| TYPHACEAE | Typha latifolia L. | TYLA1 | Y | | | | | X | X | | | | | | |
| VERBENACEAE | Verbena bracteata Lag. & Rodr. | VEBR1 | Y | | | | | | X | | X | | | | |
| VIOLACEAE | Hybanthus verticillatus (Ort.) Baill. | HYVE1 | Y | | X | X | X | | | | | | X | X | X |
| VIOLACEAE | Viola nuttallii Pursh. | VINU1 | Y | | | X | X | | | X | | | X | X | X |
| | Total Number of Species | | | 75 | 107 | 108 | 93 | 75 | 95 | 97 | 100 | 76 | 106 | 110 | 111 |
| | Percent Native Species | | | 77 | 81 | 80 | 80 | 72 | 76 | 79 | 76 | 79 | 83 | 83 | 82 |

Table 2. 1993-1995, And 1999 Mesic Mixed Grassland Foliar Cover by Community

| | | | | | Absolute Cover (%) | | | | Relative Cover (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Native | Form | Cool/ Warm Season | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| Opuntia macrorhiza Engelm. | OPMA1 | Y | C | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | N | F | | 0.9 | 2.1 | 2.1 | 2.5 | 1.2 | 2.2 | 2.2 | 2.9 |
| Camelina microcarpa Andrz. ex DC. | CAMI1 | N | F | | 0.3 | 1.3 | 1.0 | 0.1 | 0.3 | 1.4 | 1.0 | 0.1 |
| Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | CANU1 | N | F | | 1.0 | 0.1 | 1.4 | 0.1 | 1.3 | 0.1 | 1.4 | 0.1 |
| Centaurea diffusa Lam. | CEDI1 | N | F | | 0.1 | 0.2 | 0.5 | 0.5 | 0.2 | 0.2 | 0.5 | 0.7 |
| Cirsium arvense (L.) Scop. | CIAR1 | N | F | | 0.1 | 0.0 | 0.0 | 0.3 | 0.1 | 0.0 | 0.0 | 0.3 |
| Convolvulus arvensis L. | COAR1 | N | F | | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 |
| Hypericum perforatum L. | HYPE1 | N | F | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Lactuca serriola L. | LASE1 | N | F | | 0.1 | 0.0 | 0.5 | 0.3 | 0.1 | 0.0 | 0.6 | 0.3 |
| Linaria dalmatica (L.) Mill. | LIDA1 | N | F | | 0.5 | 1.0 | 0.9 | 0.4 | 0.6 | 1.1 | 0.9 | 0.5 |
| Scorzonera laciniata L. | SCLA1 | N | F | | 0.5 | 1.5 | 1.8 | 2.3 | 0.7 | 1.7 | 1.8 | 2.8 |
| Sisymbrium altissimum L. | SIAL1 | N | F | | 0.2 | 0.3 | 0.6 | 0.0 | 0.2 | 0.3 | 0.6 | 0.0 |
| Tragopogon dubius Scop. | TRDU1 | N | F | | 0.9 | 0.1 | 1.3 | 0.5 | 1.3 | 0.2 | 1.4 | 0.6 |
| Verbascum thapsus L. | VETH1 | N | F | | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.6 |
| Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | ACMI1 | Y | F | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Ambrosia psilostachya DC. | AMPS1 | Y | F | | 0.3 | 0.1 | 0.1 | 0.3 | 0.3 | 0.1 | 0.1 | 0.3 |
| Artemisia dracunculus L. | ARDR1 | Y | F | | 0.1 | 0.3 | 0.7 | 0.7 | 0.1 | 0.3 | 0.7 | 0.8 |
| Artemisia frigida Willd. | ARFR1 | Y | F | | 0.2 | 0.3 | 0.3 | 0.1 | 0.3 | 0.3 | 0.3 | 0.1 |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | Y | F | | 1.5 | 0.6 | 1.4 | 0.3 | 1.8 | 0.6 | 1.5 | 0.3 |
| Aster falcatus Lindl. | ASFA1 | Y | F | | 0.8 | 0.3 | 0.7 | 0.8 | 1.1 | 0.3 | 0.7 | 0.9 |
| Astragalus flexuosus (Hook.) G. Don | ASFL1 | Y | F | | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.2 | 0.1 | 0.1 |
| Aster porteri Gray | ASPO1 | Y | F | | 0.1 | 0.0 | 0.3 | 0.0 | 0.1 | 0.0 | 0.3 | 0.0 |
| Chrysopsis villosa Pursh. | CHVI1 | Y | F | | 0.5 | 0.2 | 0.1 | 0.0 | 0.8 | 0.2 | 0.1 | 0.0 |
| Cirsium undulatum (Nutt.) Spreng. | CIUN1 | Y | F | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Comandra umbellata (L.) Nutt. | COUM1 | Y | F | | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 |
| Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinners. | DACA1 | Y | F | | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 |
| Dalea purpurea Vent | DAPU1 | Y | F | | 0.1 | 0.2 | 0.0 | 0.0 | 0.1 | 0.2 | 0.0 | 0.0 |
| Descurainia pinnata (Walt.) Britt. | DEPI1 | Y | F | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Descurainia richardsonii (Sweet) Schultz | DERI1 | Y | F | | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 |
| Eriogonum alatum Torr. | ERAL1 | Y | F | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Erysimum capitatum (Nutt.) DC. | ERAS1 | Y | F | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Erigeron divergens T. & G. | ERDI1 | Y | F | | 0.1 | 0.1 | 0.0 | 0.1 | 0.2 | 0.1 | 0.0 | 0.1 |
| Erigeron flagellaris A. Gray | ERFL1 | Y | F | | 0.3 | 0.5 | 0.2 | 0.5 | 0.4 | 0.5 | 0.2 | 0.5 |

Table 2. (cont.)

| Scientific Name | Speccode | Native | Form | Cool/ Warm Season | Absolute Cover (%) 1993 | 1994 | 1995 | 1999 | Relative Cover (%) 1993 | 1994 | 1995 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Evolvulus nuttallianus R. & S. | EVNU1 | Y | F | | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 |
| Gaura coccinea Pursh. | GACO1 | Y | F | | 0.0 | 0.2 | 0.1 | 0.0 | 0.0 | 0.2 | 0.1 | 0.0 |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | Y | F | | 0.1 | 0.2 | 1.0 | 0.2 | 0.2 | 0.2 | 1.0 | 0.2 |
| Gutierrezia sarothrae (Pursh.) Britt. & Rusby | GUSA1 | Y | F | | 0.1 | 0.3 | 0.5 | 0.8 | 0.1 | 0.3 | 0.5 | 0.9 |
| Helianthus petiolaris Nutt. | HEPE1 | Y | F | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Helianthus pumilus Nutt. | HEPU1 | Y | F | | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 |
| Kuhnia chlorolepis Woot. & Standl. | KUCH1 | Y | F | | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Kuhnia eupatorioides L. | KUEU1 | Y | F | | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 |
| Lesquerella montana (A. Gray) Wats. | LEMO1 | Y | F | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Lepidium sp. | LEP1 | Y | F | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Linum perenne L. var. lewisii (Pursh.) Eat. & Wright | LIPE1 | Y | F | | 0.2 | 0.5 | 0.0 | 0.0 | 0.3 | 0.5 | 0.0 | 0.0 |
| Liatris punctata Hook. | LIPU1 | Y | F | | 0.1 | 0.1 | 0.6 | 0.0 | 0.2 | 0.1 | 0.6 | 0.0 |
| Lomatium orientale Coult. & Rose | LOOR1 | Y | F | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Mirabilis linearis (Pursh.) Heimerl | MILI1 | Y | F | | 0.2 | 0.2 | 0.1 | 0.1 | 0.3 | 0.2 | 0.1 | 0.2 |
| Phacelia heterophylla Pursh. | PHHE1 | Y | F | | 0.1 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 |
| Polygonum sawatchense Small | POSA1 | Y | F | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Psoralea tenuiflora Pursh. | PSTE1 | Y | F | | 2.5 | 2.2 | 4.8 | 2.9 | 3.3 | 2.4 | 4.9 | 3.3 |
| Ratibida columnifera (Nutt.) Woot. & Standl. | RACO1 | Y | F | | 0.4 | 0.1 | 0.5 | 0.4 | 0.6 | 0.1 | 0.5 | 0.5 |
| Solidago missouriensis Nutt. | SOMI1 | Y | F | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Sphaeralcea coccinea (Pursh.) Rydb. | SPCO1 | Y | F | | 0.3 | 0.2 | 0.1 | 0.5 | 0.4 | 0.2 | 0.1 | 0.6 |
| Vicia americana Muhl. ex Willd. | VIAM1 | Y | F | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Agropyron intermedium (Host) Beauv. | AGIN1 | N | G | C | 0.8 | 0.0 | 0.0 | 0.0 | 1.1 | 0.0 | 0.0 | 0.0 |
| Bromus inermis Leyss. ssp. inermis | BRIN1 | N | G | C | 0.1 | 0.1 | 0.2 | 1.1 | 0.2 | 0.2 | 0.2 | 1.4 |
| Bromus japonicus Thunb. ex Murr. | BRJA1 | N | G | C | 14.5 | 29.1 | 37.1 | 10.5 | 19.6 | 31.8 | 38.2 | 12.0 |
| Bromus tectorum L. | BRTE1 | N | G | C | 0.3 | 3.9 | 3.7 | 4.7 | 0.3 | 4.2 | 3.8 | 5.2 |
| Poaceae sp. | PO1 | N | G | C | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Poa compressa L. | POCO1 | N | G | C | 1.4 | 0.9 | 1.2 | 1.8 | 1.8 | 1.0 | 1.2 | 2.0 |
| Poa pratensis L. | POPR1 | N | G | C | 2.9 | 2.6 | 1.0 | 4.6 | 3.6 | 2.8 | 1.0 | 5.2 |
| Schedonnardus paniculatus (Nutt.) Trel. | SCPA2 | N | G | C | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.2 |
| Agropyron smithii Rydb. | AGSM1 | Y | G | C | 21.7 | 18.1 | 20.2 | 12.1 | 29.7 | 20.1 | 20.8 | 14.8 |
| Aristida purpurea Nutt. var. longiseta (Steud.) Vasey | ARFE1 | Y | G | C | 0.1 | 0.2 | 0.0 | 0.0 | 0.1 | 0.2 | 0.0 | 0.0 |
| Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | Y | G | C | 1.1 | 0.5 | 0.8 | 0.6 | 1.4 | 0.6 | 0.8 | 0.7 |
| Carex eleocharis Bailey | CAEL1 | Y | G | C | 2.9 | 0.1 | 0.2 | 0.1 | 3.9 | 0.1 | 0.2 | 0.2 |

**Table 2. (cont.)**

| Scientific Name | Speccode | Native | Form | Cool/ Warm Season | Absolute Cover (%) 1993 | 1994 | 1995 | 1999 | Relative Cover (%) 1993 | 1994 | 1995 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Carex heliophila Mack. | CAHE1 | Y | G | C | 0.0 | 4.1 | 2.2 | 2.5 | 0.0 | 4.5 | 2.3 | 3.0 |
| Carex oreocharis Holm. | CAOR1 | Y | G | C | 1.1 | 0.0 | 0.0 | 0.0 | 1.3 | 0.0 | 0.0 | 0.0 |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | Y | G | C | 0.1 | 0.1 | 0.0 | 0.4 | 0.2 | 0.1 | 0.0 | 0.5 |
| Stipa comata Trin. & Rupr. | STCO1 | Y | G | C | 3.9 | 3.1 | 1.2 | 2.1 | 4.7 | 3.3 | 1.3 | 2.4 |
| Stipa viridula Trin. | STVI1 | Y | G | C | 0.7 | 1.7 | 1.5 | 1.9 | 0.8 | 1.9 | 1.6 | 2.2 |
| Andropogon gerardii Vitman | ANGE1 | Y | G | W | 3.2 | 1.7 | 1.8 | 2.7 | 4.0 | 1.9 | 1.9 | 3.1 |
| Andropogon scoparius Michx. | ANSC1 | Y | G | W | 0.1 | 0.2 | 0.0 | 0.2 | 0.2 | 0.2 | 0.0 | 0.2 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | Y | G | W | 1.6 | 2.4 | 0.9 | 7.1 | 2.2 | 2.7 | 1.0 | 8.8 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | Y | G | W | 4.4 | 6.5 | 2.1 | 14.4 | 6.2 | 7.3 | 2.1 | 17.6 |
| Bouteloua hirsuta Lag | BOHI1 | Y | G | W | 0.4 | 0.9 | 0.1 | 0.1 | 0.6 | 1.0 | 0.1 | 0.1 |
| Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | Y | G | W | 0.1 | 0.5 | 0.1 | 1.8 | 0.2 | 0.6 | 0.1 | 2.1 |
| Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | Y | G | W | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Muhlenbergia wrightii Vasey | MUWR1 | Y | G | W | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 |
| Sporobolus cryptandrus (Torr.) A. Gray | SPCR1 | Y | G | W | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | Y | G | W | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 |
| Rosa arkansana Porter | ROAR1 | Y | S | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Yucca glauca Nutt. | YUGL1 | Y | S | | 0.4 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 |
| Total foliar cover | | | | | 74.7 | 91.3 | 97.0 | 84.7 | 99.9 | 100.0 | 100.0 | 100.0 |
| Total forb cover | | | | | 12.7 | 13.9 | 22.6 | 15.6 | 16.9 | 15.2 | 23.3 | 18.1 |
| Total native forb cover | | | | | 8.1 | 7.3 | 12.3 | 8.1 | 10.9 | 8.0 | 12.6 | 9.3 |
| Total non-native forb cover | | | | | 4.6 | 6.7 | 10.3 | 7.5 | 6.0 | 7.3 | 10.7 | 8.8 |
| Total graminoid cover | | | | | 61.5 | 77.3 | 74.4 | 69.1 | 82.4 | 84.7 | 76.7 | 81.9 |
| Total native cover | | | | | 50.1 | 47.9 | 43.4 | 54.3 | 67.2 | 52.8 | 44.7 | 65.1 |
| Total non-native cover | | | | | 24.6 | 43.4 | 53.6 | 30.3 | 32.7 | 47.2 | 55.3 | 34.9 |
| Total warm-season graminoid cover | | | | | 10.0 | 12.5 | 5.0 | 26.4 | 13.6 | 13.9 | 5.2 | 32.1 |
| Total cool-season graminoid cover | | | | | 51.5 | 64.8 | 69.4 | 42.7 | 68.8 | 70.8 | 71.6 | 49.7 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (1500).

Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).

All cover values presented are means (n = 15).

Native categories: Y = Native, N = Non-Native

Form categories: C = Cactus, F = Forb, G = Graminoid

Cool/Warm Season categories: C = Cool season species, W = Warm season species

Table 3. 1993-1995, And 1999 Mesic Mixed Grassland Foliar Cover at TR02

| | | | | | TR02 - Frequency (%) | | | | TR02 - Absolute Cover (%) | | | | TR02 - Relative Cover (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | F | N | | 20 | 40 | 60 | 80 | 0.8 | 1.6 | 2.0 | 2.0 | 1.2 | 1.8 | 2.1 | 2.6 |
| Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | CANU1 | F | N | | | | | | | | | | | | | |
| Centaurea diffusa Lam. | CEDI1 | F | N | | 20 | 60 | 60 | 60 | 0.4 | 0.6 | 1.6 | 1.4 | 0.6 | 0.7 | 1.6 | 1.8 |
| Convolvulus arvensis L. | COAR1 | F | N | | | | 20 | 20 | | | 0.2 | 0.2 | | | 0.2 | 0.3 |
| Hypericum perforatum L. | HYPE1 | F | N | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Lactuca serriola L. | LASE1 | F | N | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Scorzonera laciniata L. | SCLA1 | F | N | | | 100 | 80 | 40 | | 1.8 | 1.6 | 1.2 | | 2.0 | 1.6 | 1.6 |
| Sisymbrium altissimum L. | SIAL1 | F | N | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Tragopogon dubius Scop. | TRDU1 | F | N | | 60 | 20 | 80 | | 1.2 | 0.4 | 3.0 | | 1.8 | 0.5 | 3.1 | |
| Ambrosia psilostachya DC. | AMPS1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Artemisia dracunculus L. | ARDR1 | F | Y | | | | | | | | | | | | | |
| Artemisia frigida Willd. | ARFR1 | F | Y | | 40 | 60 | 40 | | 0.4 | 0.8 | 0.6 | | 0.6 | 0.9 | 0.6 | |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 20 | 20 | 40 | | 0.4 | 0.4 | 0.4 | | 0.6 | 0.5 | 0.4 | |
| Aster falcatus Lindl. | ASFA1 | F | Y | | 60 | 20 | 40 | 20 | 0.6 | 0.2 | 0.4 | 0.2 | 0.9 | 0.2 | 0.4 | 0.3 |
| Aster porteri Gray | ASPO1 | F | Y | | 20 | | 40 | | 0.2 | | 0.6 | | 0.3 | | 0.6 | |
| Astragalus flexuosus (Hook.) G. Don | ASFL1 | F | Y | | | 20 | 20 | | | 0.4 | 0.2 | | | 0.5 | 0.2 | |
| Chrysopsis villosa Pursh. | CHVI1 | F | Y | | 80 | 20 | 20 | | 1.4 | 0.4 | 0.4 | | 2.1 | 0.5 | 0.4 | |
| Cirsium undulatum (Nutt.) Spreng. | CIUN1 | F | Y | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinners. | DACA1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Erigeron divergens T. & G. | ERDI1 | F | Y | | 20 | | | | 0.4 | | | | 0.6 | | | |
| Erigeron flagellaris A. Gray | ERFL1 | F | Y | | 20 | 40 | 20 | | 0.4 | 0.4 | 0.4 | | 0.6 | 0.5 | 0.4 | |
| Eriogonum alatum Torr. | ERAL1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Erysimum capitatum (Nutt.) DC. | ERAS1 | F | Y | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Evolvulus nuttallianus R. & S. | EVNU1 | F | Y | | 20 | | | | 0.2 | | | | 0.3 | | | |
| Gaura coccinea Pursh. | GACO1 | F | Y | | | 20 | 20 | | | 0.2 | 0.2 | | | 0.2 | 0.2 | |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | F | Y | | 20 | 20 | 60 | | 0.2 | 0.2 | 1.2 | | 0.3 | 0.2 | 1.2 | |
| Gutierrezia sarothrae (Pursh.) Britt. & Rusby | GUSA1 | F | Y | | | | 60 | 20 | | | 0.6 | 0.2 | | | 0.6 | 0.3 |
| Helianthus pumilus Nutt. | HEPU1 | F | Y | | | | | 20 | | | | 0.2 | | | | 0.3 |
| Lesquerella montana (A. Gray) Wats. | LEMO1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Liatris punctata Hook. | LIPU1 | F | Y | | 20 | 20 | 40 | | 0.2 | 0.2 | 1.8 | | 0.3 | 0.2 | 1.9 | |
| Linum perenne L. var. lewisii (Pursh.) Eat. & Wright | LIPE1 | F | Y | | | 40 | | | | 1.2 | | | | 1.4 | | |
| Mirabilis linearis (Pursh.) Heimerl | MILI1 | F | Y | | 20 | 40 | | | 0.2 | 0.4 | | | 0.3 | 0.5 | | |
| Psoralea tenuiflora Pursh. | PSTE1 | F | Y | | 80 | 60 | 100 | 80 | 2.4 | 2.2 | 7.6 | 1.4 | 3.5 | 2.5 | 7.8 | 1.8 |
| Ratibida columnifera (Nutt.) Woot. & Standl. | RACO1 | F | Y | | 80 | | 80 | 20 | 1.2 | | 1.2 | 0.2 | 1.8 | | 1.2 | 0.3 |
| Sphaeralcea coccinea (Pursh.) Rydb. | SPCO1 | F | Y | | 20 | 20 | 20 | 40 | 0.6 | 0.6 | 0.4 | 0.4 | 0.9 | 0.7 | 0.4 | 0.5 |
| Bromus inermis Leyss. ssp. inermis | BRIN1 | G | N | C | 20 | 20 | 20 | 40 | 0.4 | 0.4 | 0.6 | 3.2 | 0.6 | 0.5 | 0.6 | 4.1 |
| Bromus japonicus Thunb. ex Murr. | BRJA1 | G | N | C | 100 | 100 | 100 | 100 | 5.6 | 18.4 | 27.6 | 3.8 | 8.2 | 20.9 | 28.4 | 4.9 |
| Poa compressa L. | POCO1 | G | N | C | 40 | 40 | 20 | 20 | 1.0 | 0.4 | 0.2 | 0.4 | 1.5 | 0.5 | 0.2 | 0.5 |
| Poa pratensis L. | POPR1 | G | N | C | 20 | 20 | | 20 | 0.2 | 0.2 | | 0.2 | 0.3 | 0.2 | | 0.3 |
| Agropyron smithii Rydb. | AGSM1 | G | Y | C | 100 | 100 | 100 | 100 | 27.6 | 29.0 | 30.6 | 18.2 | 40.5 | 33.0 | 31.5 | 23.5 |
| Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | G | Y | C | 60 | 20 | 40 | 40 | 1.2 | 0.6 | 0.4 | 0.6 | 1.8 | 0.7 | 0.4 | 0.8 |

Table 3. (cont.)

| | | | | | TR02 - Frequency (%) | | | | TR02 - Absolute Cover (%) | | | | TR02 - Relative Cover (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| Carex eleocharis Bailey | CAEL1 | G | Y | C | 40 | | 20 | | 3.4 | | 0.2 | | 5.0 | | 0.2 | |
| Carex heliophila Mack. | CAHE1 | G | Y | C | | 40 | 20 | 40 | | 3.6 | 2.8 | 3.2 | | 4.1 | 2.9 | 4.1 |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | | | | 40 | | | | 0.4 | | | | 0.5 |
| Stipa comata Trin. & Rupr. | STCO1 | G | Y | C | 40 | 40 | 20 | 20 | 1.8 | 1.0 | 0.6 | 0.2 | 2.6 | 1.1 | 0.6 | 0.3 |
| Stipa viridula Trin. | STVI1 | G | Y | C | 20 | 40 | 40 | 80 | 0.2 | 0.6 | 1.0 | 1.0 | | 0.7 | 1.0 | 1.3 |
| Andropogon gerardii Vitman | ANGE1 | G | Y | W | 40 | 40 | 40 | 40 | 2.2 | 1.4 | 1.8 | 1.6 | 3.2 | 1.6 | 1.9 | 2.1 |
| Andropogon scoparius Michx. | ANSC1 | G | Y | W | 40 | 20 | | 20 | 0.4 | 0.2 | | 0.4 | 0.6 | 0.2 | | 0.5 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 80 | 80 | 40 | 80 | 3.2 | 4.8 | 2.6 | 14.8 | 4.7 | 5.5 | 2.7 | 19.1 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 80 | 100 | 60 | 100 | 6.8 | 11.8 | 2.8 | 20.6 | 10.0 | 13.4 | 2.9 | 26.6 |
| Bouteloua hirsuta Lag | BOHI1 | G | Y | W | 60 | 60 | | | 1.2 | 2.0 | | | 1.8 | 2.3 | | |
| Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | G | Y | W | 40 | 60 | 20 | 80 | 0.4 | 1.0 | 0.2 | 1.4 | 0.6 | 1.1 | 0.2 | 1.8 |
| Sporobolus cryptandrus (Torr.) A. Gray | SPCR1 | G | Y | W | 20 | | | | 0.2 | | | | 0.3 | | | |
| Poaceae sp. | PO1 | G | | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Yucca glauca Nutt. | YUGL1 | S | Y | | 20 | | | | 1.2 | | | | 1.8 | | | |
| Total foliar cover | | | | | | | | | 68.2 | 88.0 | 97.2 | 77.4 | 99.7 | 100.0 | 100.0 | 100.0 |
| Total forb cover | | | | | | | | | 11.2 | 12.6 | 25.6 | 7.4 | 16.4 | 14.3 | 26.3 | 9.6 |
| Total native forb cover | | | | | | | | | 8.8 | 8.0 | 16.8 | 2.6 | 12.9 | 9.1 | 17.3 | 3.4 |
| Total non-native forb cover | | | | | | | | | 2.4 | 4.6 | 8.8 | 4.8 | 3.5 | 5.2 | 9.1 | 6.2 |
| Total graminoid cover | | | | | | | | | 55.8 | 75.4 | 71.6 | 70.0 | 81.5 | 85.7 | 73.7 | 90.4 |
| Total native cover | | | | | | | | | 58.6 | 64.0 | 59.8 | 65.0 | 85.6 | 72.7 | 61.5 | 84.0 |
| Total non-native cover | | | | | | | | | 9.6 | 24.0 | 37.2 | 12.4 | 14.1 | 27.3 | 38.3 | 16.0 |
| Total warm-season graminoid cover | | | | | | | | | 14.4 | 21.2 | 7.4 | 38.8 | 21.1 | 24.1 | 7.6 | 50.1 |
| Total cool-season graminoid cover | | | | | | | | | 41.4 | 54.2 | 64.0 | 31.2 | 60.4 | 61.6 | 65.8 | 40.3 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (500).

Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).

All cover values presented are means (n = 5).

Native categories: Y = Native, N = Non-Native

Form categories: C = Cactus, F = Forb, G = Graminoid

Cool/Warm Season categories: C = Cool season species, W = Warm season species

Table 4. 1993-1995, And 1999 Mesic Mixed Grassland Foliar Cover at TR04

| | | | | | TR04 - Frequency (%) | | | | TR04 - Absolute Cover (%) | | | | TR04 - Relative Cover (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| Opuntia macrorhiza Engelm. | OPMA1 | C | Y | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | F | N | | 40 | 40 | 40 | 60 | 0.8 | 1.8 | 1.4 | 2.6 | 1.1 | 2.0 | 1.4 | 3.0 |
| Camelina microcarpa Andrz. ex DC. | CAMI1 | F | N | | 20 | 60 | 60 | | 0.2 | 1.2 | 1.2 | | 0.3 | 1.3 | 1.2 | |
| Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | CANU1 | F | N | | 60 | 40 | 40 | | 1.4 | 0.4 | 2.0 | | 2.0 | 0.4 | 2.0 | |
| Lactuca serriola L. | LASE1 | F | N | | | | 20 | - | | | 0.2 | | | | 0.2 | |
| Linaria dalmatica (L.) Mill. | LIDA1 | F | N | | 20 | 80 | 60 | 40 | 0.6 | 0.8 | 1.4 | 0.6 | 0.8 | 0.9 | 1.4 | 0.7 |
| Scorzonera laciniata L. | SCLA1 | F | N | | 60 | 60 | 100 | 100 | 1.4 | 2.8 | 3.8 | 5.6 | 2.0 | 3.1 | 3.9 | 6.5 |
| Sisymbrium altissimum L. | SIAL1 | F | N | | | 40 | 20 | | | 0.4 | 0.6 | | | 0.4 | 0.6 | |
| Tragopogon dubius Scop. | TRDU1 | F | N | | 40 | | 60 | 60 | 0.6 | | 0.8 | 1.4 | 0.8 | | 0.8 | 1.6 |
| Ambrosia psilostachya DC. | AMPS1 | F | Y | | 20 | 20 | | | 0.4 | 0.2 | | | 0.6 | 0.2 | | |
| Artemisia dracunculus L. | ARDR1 | F | Y | | 20 | 40 | 80 | 40 | 0.2 | 0.8 | 1.8 | 2.0 | 0.3 | 0.9 | 1.8 | 2.3 |
| Artemisia frigida Willd. | ARFR1 | F | Y | | 20 | | | 20 | 0.2 | | | 0.2 | 0.3 | | | 0.2 |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 20 | | 20 | | 0.2 | | 0.6 | | 0.3 | | 0.6 | |
| Aster falcatus Lindl. | ASFA1 | F | Y | | 60 | 40 | 80 | 80 | 1.4 | 0.6 | 1.8 | 1.8 | 2.0 | 0.7 | 1.8 | 2.1 |
| Astragalus flexuosus (Hook.) G. Don | ASFL1 | F | Y | | | | | 20 | | | | 0.2 | | | | 0.2 |
| Chrysopsis villosa Pursh. | CHVI1 | F | Y | | 20 | 20 | | | 0.2 | 0.2 | | | 0.3 | 0.2 | | |
| Descurainia pinnata (Walt.) Britt. | DEPI1 | F | Y | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Erigeron divergens T. & G. | ERDI1 | F | Y | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Erigeron flagellaris A. Gray | ERFL1 | F | Y | | 20 | 20 | 20 | 20 | 0.2 | 0.6 | 0.2 | 1.0 | 0.3 | 0.7 | 0.2 | 1.2 |
| Evolvulus nuttallianus R. & S. | EVNU1 | F | Y | | | | | 20 | | | | 0.2 | | | | 0.2 |
| Gaura coccinea Pursh. | GACO1 | F | Y | | | 40 | 20 | | | 0.4 | 0.2 | | | 0.4 | 0.2 | |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | F | Y | | 20 | 20 | 60 | 60 | 0.2 | 0.4 | 1.4 | 0.6 | 0.3 | 0.4 | 1.4 | 0.7 |
| Gutierrezia sarothrae (Pursh.) Britt. & Rusby | GUSA1 | F | Y | | 20 | 40 | 40 | 60 | 0.2 | 0.6 | 0.6 | 1.2 | 0.3 | 0.7 | 0.6 | 1.4 |
| Lepidium sp. | LEP1 | F | | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Linum perenne L. var. lewisii (Pursh.) Eat. & Wright | LIPE1 | F | Y | | 20 | 20 | | | 0.6 | 0.2 | | | 0.8 | 0.2 | | |
| Mirabilis linearis (Pursh.) Heimerl | MILI1 | F | Y | | 20 | 20 | 20 | 40 | 0.2 | 0.2 | 0.2 | 0.4 | 0.3 | 0.2 | 0.2 | 0.5 |
| Polygonum sawatchense Small | POSA1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Psoralea tenuiflora Pursh. | PSTE1 | F | Y | | 80 | 80 | 100 | 100 | 1.4 | 2.4 | 3.6 | 4.2 | 2.0 | 2.6 | 3.7 | 4.9 |
| Ratibida columnifera (Nutt.) Woot. & Standl. | RACO1 | F | Y | | | 20 | 40 | 20 | | 0.4 | 0.4 | 0.2 | | 0.4 | 0.4 | 0.2 |
| Sphaeralcea coccinea (Pursh.) Rydb. | SPCO1 | F | Y | | 20 | | | 60 | 0.2 | | | 1.2 | 0.3 | | | 1.4 |
| Vicia americana Muhl. ex Willd. | VIAM1 | F | Y | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Agropyron intermedium (Host) Beauv. | AGIN1 | G | N | C | 20 | | | | 2.4 | | | | 3.4 | | | |
| Bromus japonicus Thunb. ex Murr. | BRJA1 | G | N | C | 100 | 100 | 100 | 100 | 26.8 | 44.6 | 46.6 | 10.2 | 37.6 | 48.7 | 47.3 | 11.9 |
| Bromus tectorum L. | BRTE1 | G | N | C | | 40 | 40 | 40 | | 4.2 | 3.0 | 2.4 | | 4.6 | 3.0 | 2.8 |
| Poa compressa L. | POCO1 | G | N | C | 60 | 60 | 80 | 80 | 0.8 | 0.8 | 1.6 | 1.2 | 1.1 | 0.9 | 1.6 | 1.4 |
| Poa pratensis L. | POPR1 | G | N | C | 60 | 80 | 40 | 80 | 2.0 | 1.6 | 1.2 | 6.8 | 2.8 | 1.7 | 1.2 | 7.9 |
| Schedonnardus paniculatus (Nutt.) Trel. | SCPA2 | G | N | C | | | | 20 | | | | 0.6 | | | | 0.7 |
| Agropyron smithii Rydb. | AGSM1 | G | Y | C | 100 | 100 | 100 | 100 | 20.4 | 14.4 | 19.0 | 11.8 | 28.6 | 15.7 | 19.3 | 13.7 |
| Aristida purpurea Nutt. var. longiseta (Steud.) Vasey | ARFE1 | G | Y | C | 20 | 20 | | | 0.2 | 0.2 | | | 0.3 | 0.2 | | |
| Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | G | Y | C | | 20 | 20 | 20 | | 0.2 | 0.4 | 0.2 | | 0.2 | 0.4 | 0.2 |
| Carex eleocharis Bailey | CAEL1 | G | Y | C | 40 | 20 | 20 | 20 | 1.8 | 0.4 | 0.4 | 0.4 | 2.5 | 0.4 | 0.4 | 0.5 |

Table 4. (cont.)

| | | | | | TR04 - Frequency (%) | | | | TR04 - Absolute Cover (%) | | | | TR04 - Relative Cover (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| Carex heliophila Mack. | CAHE1 | G | Y | C | | | | 20 | | | | 0.2 | | | | 0.2 |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | 20 | 20 | | | 0.2 | 0.2 | | | 0.3 | 0.2 | | |
| Stipa comata Trin. & Rupr. | STCO1 | G | Y | C | | 20 | | 20 | | 0.2 | | 0.2 | | 0.2 | | 0.2 |
| Stipa viridula Trin. | STVI1 | G | Y | C | | 40 | 40 | 40 | | 0.6 | 0.8 | 0.4 | | 0.7 | 0.8 | 0.5 |
| Andropogon gerardii Vitman | ANGE1 | G | Y | W | | | | 20 | | | | 0.2 | | | | 0.2 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 40 | 40 | 20 | 40 | 0.4 | 1.6 | 0.2 | 4.0 | 0.6 | 1.7 | 0.2 | 4.7 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 80 | 80 | 80 | 100 | 5.4 | 6.2 | 2.6 | 20.4 | 7.6 | 6.8 | 2.6 | 23.7 |
| Bouteloua hirsuta Lag | BOHI1 | G | Y | W | | 20 | 20 | 20 | | 0.4 | 0.2 | 0.2 | | 0.4 | 0.2 | 0.2 |
| Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | G | Y | W | | 20 | | 100 | | 0.6 | | 3.4 | | 0.7 | | 4.0 |
| Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | G | Y | W | 20 | | | | 0.2 | | | | 0.3 | | | |
| Muhlenbergia wrightii Vasey | MUWR1 | G | Y | W | | | 20 | | | | 0.2 | | | | 0.2 | |
| Total foliar cover | | | | | | | | | 71.2 | 91.6 | 98.6 | 86.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Total forb cover | | | | | | | | | 10.6 | 15.2 | 22.4 | 23.4 | 14.9 | 16.6 | 22.7 | 27.2 |
| Total native forb cover | | | | | | | | | 5.6 | 7.6 | 11.0 | 13.2 | 7.9 | 8.3 | 11.2 | 15.3 |
| Total non-native forb cover | | | | | | | | | 5.0 | 7.4 | 11.4 | 10.2 | 7.0 | 8.1 | 11.6 | 11.9 |
| Total graminoid cover | | | | | | | | | 60.6 | 76.2 | 76.2 | 62.6 | 85.1 | 83.2 | 77.3 | 72.8 |
| Total native cover | | | | | | | | | 34.2 | 32.6 | 34.8 | 54.6 | 48.0 | 35.6 | 35.3 | 63.5 |
| Total non-native cover | | | | | | | | | 37.0 | 58.6 | 63.8 | 31.4 | 52.0 | 64.0 | 64.7 | 36.5 |
| Total warm-season graminoid cover | | | | | | | | | 6.0 | 8.8 | 3.2 | 28.2 | 8.4 | 9.6 | 3.2 | 32.8 |
| Total cool-season graminoid cover | | | | | | | | | 54.6 | 67.4 | 73.0 | 34.4 | 76.7 | 73.6 | 74.0 | 40.0 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (500).

Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).

All cover values presented are means (n = 5).

Native categories: Y = Native, N = Non-Native

Form categories: C = Cactus, F = Forb, G = Graminoid

Cool/Warm Season categories: C = Cool season species, W = Warm season species

Table 5. 1993-1995, And 1999 Mesic Mixed Grassland Foliar Cover at TR11

| | | | | | TR11 - Frequency (%) | | | | TR11 - Absolute Cover (%) | | | | TR11 - Relative Cover (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | F | N | | 60 | 60 | 60 | 80 | 1.2 | 2.8 | 3.0 | 2.8 | 1.4 | 3.0 | 3.2 | 3.1 |
| Camelina microcarpa Andrz. ex DC. | CAMI1 | F | N | | 20 | 60 | 40 | 20 | 0.6 | 2.8 | 1.8 | 0.2 | 0.7 | 3.0 | 1.9 | 0.2 |
| Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | CANU1 | F | N | | 60 | | 60 | 20 | 1.6 | | 2.2 | 0.2 | 1.9 | | 2.3 | 0.2 |
| Centaurea diffusa Lam. | CEDI1 | F | N | | | | | 20 | | | | 0.2 | | | | 0.2 |
| Cirsium arvense (L.) Scop. | CIAR1 | F | N | | 20 | | | 20 | 0.2 | | | 0.8 | 0.2 | | | 0.9 |
| Convolvulus arvensis L. | COAR1 | F | N | | 20 | | | | 0.2 | | | | 0.2 | | | |
| Lactuca serriola L. | LASE1 | F | N | | 20 | | 80 | 60 | 0.2 | | 1.2 | 0.8 | 0.2 | | 1.3 | 0.9 |
| Linaria dalmatica (L.) Mill. | LIDA1 | F | N | | 40 | 40 | 60 | 60 | 0.8 | 2.2 | 1.2 | 0.6 | 0.9 | 2.3 | 1.3 | 0.7 |
| Scorzonera laciniata L. | SCLA1 | F | N | | | | | 20 | | | | 0.2 | | | | 0.2 |
| Sisymbrium altissimum L. | SIAL1 | F | N | | 20 | 20 | 20 | | 0.6 | 0.2 | 1.2 | | 0.7 | 0.2 | 1.3 | |
| Tragopogon dubius Scop. | TRDU1 | F | N | | 60 | | 20 | 20 | 1.0 | | 0.2 | 0.2 | 1.2 | | 0.2 | 0.2 |
| Verbascum thapsus L. | VETH1 | F | N | | | | | 40 | | | | 1.6 | | | | 1.8 |
| Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | ACMI1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Ambrosia psilostachya DC. | AMPS1 | F | Y | | 20 | 20 | 20 | 40 | 0.4 | 0.2 | 0.2 | 0.8 | 0.5 | 0.2 | 0.2 | 0.9 |
| Artemisia dracunculus L. | ARDR1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Artemisia frigida Willd. | ARFR1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 100 | 60 | 100 | 60 | 3.8 | 1.4 | 3.2 | 0.8 | 4.5 | 1.5 | 3.4 | 0.9 |
| Aster falcatus Lindl. | ASFA1 | F | Y | | 40 | | | 40 | 0.4 | | | 0.4 | 0.5 | | | 0.4 |
| Aster porteri Gray | ASPO1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Comandra umbellata (L.) Nutt. | COUM1 | F | Y | | | | | 20 | | | | 0.2 | | | | 0.2 |
| Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinners. | DACA1 | F | Y | | | 20 | | 20 | | 0.2 | | 0.4 | | 0.2 | | 0.4 |
| Dalea purpurea Vent | DAPU1 | F | Y | | 20 | 40 | | | 0.2 | 0.6 | | | 0.2 | 0.6 | | |
| Descurainia pinnata (Walt.) Britt. | DEPI1 | F | Y | | | | | | | | | | | | | |
| Descurainia richardsonii (Sweet) Schultz | DERI1 | F | Y | | | 40 | 20 | | | 0.4 | 0.2 | | | 0.4 | 0.2 | |
| Erigeron divergens T. & G. | ERDI1 | F | Y | | | | | 20 | | | | 0.2 | | | | 0.2 |
| Erigeron flagellaris A. Gray | ERFL1 | F | Y | | 40 | 20 | | 40 | 0.4 | 0.4 | | 0.4 | 0.5 | 0.4 | | 0.4 |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | F | Y | | | | 40 | | | | 0.4 | | | | 0.4 | |
| Gutierrezia sarothrae (Pursh.) Britt. & Rusby | GUSA1 | F | Y | | | 20 | 20 | 20 | | 0.2 | 0.2 | 1.0 | | 0.2 | 0.2 | 1.1 |
| Helianthus petiolaris Nutt. | HEPE1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Kuhnia chlorolepis Woot. & Standl. | KUCH1 | F | Y | | 20 | | | | 0.2 | | | | 0.2 | | | |
| Kuhnia eupatorioides L. | KUEU1 | F | Y | | | 20 | 20 | 20 | | 0.4 | 0.4 | 0.4 | | 0.4 | 0.4 | 0.4 |
| Liatris punctata Hook. | LIPU1 | F | Y | | 20 | | | | 0.2 | | | | 0.2 | | | |
| Lomatium orientale Coult. & Rose | LOOR1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Mirabilis linearis (Pursh.) Heimerl | MILI1 | F | Y | | 20 | | | | 0.2 | | | | 0.2 | | | |
| Phacelia heterophylla Pursh. | PHHE1 | F | Y | | 20 | | | | 0.4 | | | | 0.5 | | | |
| Psoralea tenuiflora Pursh. | PSTE1 | F | Y | | 100 | 100 | 100 | 80 | 3.8 | 2.0 | 3.2 | 3.0 | 4.5 | 2.1 | 3.4 | 3.3 |
| Ratibida columnifera (Nutt.) Woot. & Standl. | RACO1 | F | Y | | | | | 60 | | | | 0.8 | | | | 0.9 |
| Solidago missouriensis Nutt. | SOMI1 | F | Y | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Bromus japonicus Thunb. ex Murr. | BRJA1 | G | N | C | 100 | 100 | 100 | 100 | 11.0 | 24.4 | 37.2 | 17.4 | 13.0 | 25.8 | 39.1 | 19.2 |
| Bromus tectorum L. | BRTE1 | G | N | C | 40 | 60 | 80 | 80 | 0.8 | 7.6 | 8.0 | 11.6 | 0.9 | 8.1 | 8.4 | 12.8 |
| Poa compressa L. | POCO1 | G | N | C | 40 | 40 | 40 | 40 | 2.4 | 1.6 | 1.8 | 3.8 | 2.8 | 1.7 | 1.9 | 4.2 |

Table 5. (cont.)

| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | TR11 - Frequency (%) | | | | TR11 - Absolute Cover (%) | | | | TR11 - Relative Cover (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| Poa pratensis L. | POPR1 | G | N | C | 60 | 80 | 80 | 60 | 6.6 | 6.0 | 1.8 | 6.8 | 7.8 | 6.4 | 1.9 | 7.5 |
| Agropyron smithii Rydb. | AGSM1 | G | Y | C | 100 | 80 | 100 | 80 | 17.0 | 11.0 | 11.0 | 6.4 | 20.1 | 11.7 | 11.6 | 7.1 |
| Aristida purpurea Nutt. var. longiseta (Steud.) Vasey | ARFE1 | G | Y | C | | 40 | | | | 0.4 | | | | 0.4 | | |
| Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | G | Y | C | 40 | 40 | 60 | 40 | 2.0 | 0.8 | 1.6 | 1.0 | 2.4 | 0.8 | 1.7 | 1.1 |
| Carex eleocharis Bailey | CAEL1 | G | Y | C | 40 | | | | 3.6 | | | | 4.3 | | | |
| Carex heliophila Mack. | CAHE1 | G | Y | C | | 100 | 100 | 100 | | 8.8 | 3.8 | 4.2 | | 9.3 | 4.0 | 4.6 |
| Carex oreocharis Holm. | CAOR1 | G | Y | C | 60 | | | | 3.2 | | | | 3.8 | | | |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | 20 | | | 40 | 0.2 | | | 0.8 | 0.2 | | | 0.9 |
| Stipa comata Trin. & Rupr. | STCO1 | G | Y | C | 100 | 60 | 80 | 60 | 9.8 | 8.2 | 3.0 | 6.0 | 11.6 | 8.7 | 3.2 | 6.6 |
| Stipa viridula Trin. | STVI1 | G | Y | C | 20 | 60 | 60 | 40 | 2.0 | 4.0 | 2.8 | 4.4 | 2.4 | 4.2 | 2.9 | 4.9 |
| Andropogon gerardii Vitman | ANGE1 | G | Y | W | 80 | 60 | 60 | 80 | 7.4 | 3.8 | 3.6 | 6.4 | 8.7 | 4.0 | 3.8 | 7.1 |
| Andropogon scoparius Michx. | ANSC1 | G | Y | W | | 40 | | 20 | | 0.4 | | 0.2 | | 0.4 | | 0.2 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 40 | 40 | | 60 | 1.2 | 0.8 | | 2.4 | 1.4 | 0.8 | | 2.6 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 40 | 100 | 60 | 80 | 1.0 | 1.6 | 0.8 | 2.2 | 1.2 | 1.7 | 0.8 | 2.4 |
| Bouteloua hirsuta Lag | BOHI1 | G | Y | W | | 20 | | | | 0.2 | | | | 0.2 | | |
| Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | G | Y | W | | | | 40 | | | | 0.6 | | | | 0.7 |
| Muhlenbergia wrightii Vasey | MUWR1 | G | Y | W | | 20 | | | | 0.4 | | | | 0.4 | | |
| Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | G | Y | W | | 20 | | 20 | | 0.4 | | 0.4 | | 0.4 | | 0.4 |
| Total foliar cover | | | | | | | | | 84.6 | 94.4 | 95.2 | 90.6 | 100.0 | 100.0 | 100.0 | 100.0 |
| Total forb cover | | | | | | | | | 16.4 | 14.0 | 19.8 | 16.0 | 19.4 | 14.8 | 20.8 | 17.7 |
| Total native forb cover | | | | | | | | | 10.0 | 6.0 | 9.0 | 8.4 | 11.8 | 6.4 | 9.5 | 9.3 |
| Total non-native forb cover | | | | | | | | | 6.4 | 8.0 | 10.8 | 7.6 | 7.6 | 8.5 | 11.3 | 8.4 |
| Total graminoid cover | | | | | | | | | 68.2 | 80.4 | 75.4 | 74.6 | 80.6 | 85.2 | 79.2 | 82.3 |
| Total native cover | | | | | | | | | 57.4 | 46.8 | 35.6 | 43.4 | 67.8 | 49.6 | 37.4 | 47.9 |
| Total non-native cover | | | | | | | | | 27.2 | 47.6 | 59.6 | 47.2 | 32.2 | 50.4 | 62.6 | 52.1 |
| Total warm-season graminoid cover | | | | | | | | | 9.6 | 7.6 | 4.4 | 12.2 | 11.3 | 8.1 | 4.6 | 13.5 |
| Total cool-season graminoid cover | | | | | | | | | 58.6 | 72.8 | 71.0 | 62.4 | 69.3 | 77.1 | 74.6 | 68.9 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (500).

Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).

All cover values presented are means (n = 5).

Native categories: Y = Native, N = Non-Native

Form categories: C = Cactus, F = Forb, G = Graminoid

Cool/Warm Season categories: C = Cool season species, W = Warm season species

**Table 6. 1999 Prescribed Burn Pre-Burn Species Richness**

| Family | Scientific Name | Speccode | Native | Control | Treatment |
|---|---|---|---|---|---|
| AGAVACEAE | Yucca glauca Nutt. | YUGL1 | Y | X | X |
| ANACARDIACEAE | Rhus aromatica Ait. var. trilobata (Nutt.) A. Gray | RHAR1 | Y | X | |
| APIACEAE | Lomatium orientale Coult. & Rose | LOOR1 | Y | X | X |
| ASCLEPIADACEAE | Asclepias speciosa Torr. | ASSP1 | Y | X | X |
| ASCLEPIADACEAE | Asclepias stenophylla A. Gray | ASST1 | Y | X | X |
| ASCLEPIADACEAE | Asclepias viridiflora Raf. | ASVI1 | Y | X | X |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | ACMI1 | Y | X | |
| ASTERACEAE | Ambrosia psilostachya DC. | AMPS1 | Y | X | X |
| ASTERACEAE | Antennaria parvifolia Nutt. | ANPA1 | Y | X | X |
| ASTERACEAE | Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem. | ARCA1 | Y | | X |
| ASTERACEAE | Artemisia dracunculus L. | ARDR1 | Y | X | |
| ASTERACEAE | Artemisia frigida Willd. | ARFR1 | Y | X | X |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | Y | X | X |
| ASTERACEAE | Aster porteri Gray | ASPO1 | Y | X | X |
| ASTERACEAE | Centaurea diffusa Lam. | CEDI1 | N | X | X |
| ASTERACEAE | Chrysopsis fulcrata Greene | CHFU1 | Y | X | X |
| ASTERACEAE | Chrysopsis villosa Pursh. | CHVI1 | Y | X | X |
| ASTERACEAE | Cirsium arvense (L.) Scop. | CIAR1 | N | X | |
| ASTERACEAE | Cirsium undulatum (Nutt.) Spreng. | CIUN1 | Y | X | X |
| ASTERACEAE | Erigeron divergens T. & G. | ERDI1 | Y | X | X |
| ASTERACEAE | Gaillardia aristata Pursh. | GAAR1 | Y | X | X |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | Y | X | X |
| ASTERACEAE | Helianthus pumilus Nutt. | HEPU1 | Y | X | X |
| ASTERACEAE | Helianthus rigidus (Cass.) Desf. ssp. subrhomboideus (Rydb.) Heiser | HERI1 | Y | X | |
| ASTERACEAE | Kuhnia chlorolepis Woot. & Standl. | KUCH1 | Y | X | |
| ASTERACEAE | Kuhnia eupatorioides L. | KUEU1 | Y | X | |
| ASTERACEAE | Lactuca serriola L. | LASE1 | N | X | X |
| ASTERACEAE | Liatris punctata Hook. | LIPU1 | Y | X | X |
| ASTERACEAE | Ratibida columnifera (Nutt.) Woot. & Standl. | RACO1 | Y | X | X |
| ASTERACEAE | Senecio plattensis Nutt. | SEPL1 | Y | X | X |
| ASTERACEAE | Senecio spartioides T. & G. | SESP1 | Y | X | X |
| ASTERACEAE | Solidago mollis Bart. | SOMO1 | Y | X | X |
| ASTERACEAE | Taraxacum officinale Weber | TAOF1 | N | X | X |
| ASTERACEAE | Tragopogon dubius Scop. | TRDU1 | N | X | X |
| BORAGINACEAE | Cryptantha virgata (Porter) Payson | CRVI1 | Y | | X |
| BORAGINACEAE | Lithospermum incisum Lehm. | LIIN1 | Y | X | X |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | N | X | X |
| BRASSICACEAE | Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins | ARHI1 | Y | X | X |
| BRASSICACEAE | Camelina microcarpa Andrz. ex DC. | CAMI1 | N | | X |
| BRASSICACEAE | Erysimum capitatum (Nutt.) DC. | ERCA2 | Y | X | X |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | LECA1 | N | X | X |
| BRASSICACEAE | Lepidium densiflorum Schrad. | LEDE1 | Y | | X |
| BRASSICACEAE | Lesquerella montana (A. Gray) Wats. | LEMO1 | Y | X | X |
| CACTACEAE | Echinocereus viridiflorus Engelm. | ECVI1 | Y | X | X |
| CACTACEAE | Opuntia macrorhiza Engelm. | OPMA1 | Y | X | X |
| CARYOPHYLLACEAE | Arenaria fendleri A. Gray | ARFE2 | Y | X | X |
| CARYOPHYLLACEAE | Paronychia jamesii T. & G. | PAJA1 | Y | X | X |
| CARYOPHYLLACEAE | Silene drummondii Hook. | SIDR1 | Y | X | |
| CLUSIACEAE | Hypericum perforatum L. | HYPE1 | N | X | X |
| CRASSULACEAE | Sedum lanceolatum Torr. | SELA1 | Y | | X |
| CYPERACEAE | Carex heliophila Mack. | CAHE1 | Y | X | X |
| EUPHORBIACEAE | Euphorbia robusta (Engelm.) Small | EURO1 | Y | X | X |
| FABACEAE | Astragalus agrestis Dougl. ex G. Don | ASAG1 | Y | | X |
| FABACEAE | Astragalus shortianus Nutt. ex T.&G. | ASSH1 | Y | X | |
| FABACEAE | Dalea purpurea Vent | DAPU1 | Y | X | X |
| FABACEAE | Oxytropis lambertii Pursh. | OXLA1 | Y | | X |
| FABACEAE | Psoralea tenuiflora Pursh. | PSTE1 | Y | X | X |
| GERANIACEAE | Erodium cicutarium (L.) L'Her. | ERCI1 | N | X | X |
| HYDROPHYLLACEAE | Phacelia heterophylla Pursh. | PHHE1 | Y | X | |
| JUNCACEAE | Juncus interior Wieg. | JUIN1 | Y | X | X |
| LILIACEAE | Allium textile A. Nels. & Macbr. | ALTE1 | Y | X | X |
| NYCTAGINACEAE | Mirabilis linearis (Pursh.) Heimerl | MILI1 | Y | X | X |

**Table 6. (cont.)**

| Family | Scientific Name | Speccode | Native | Control | Treatment |
|---|---|---|---|---|---|
| ONAGRACEAE | Calylophus serrulatus (Nutt.) Raven | CASE2 | Y | X | |
| ONAGRACEAE | Gaura coccinea Pursh. | GACO1 | Y | X | |
| OROBANCHACEAE | Orobanche fasciculata Nutt. | ORFA1 | Y | X | |
| PLANTAGINACE | Plantago lanceolata L. | PLLA1 | N | | X |
| POACEAE | Aegilops cylindrica Host | AECY1 | N | | X |
| POACEAE | Agropyron smithii Rydb. | AGSM1 | Y | X | X |
| POACEAE | Andropogon gerardii Vitman | ANGE1 | Y | X | X |
| POACEAE | Andropogon scoparius Michx. | ANSC1 | Y | X | X |
| POACEAE | Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | Y | X | X |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | BOCU1 | Y | X | X |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | Y | X | X |
| POACEAE | Bouteloua hirsuta Lag | BOHI1 | Y | X | X |
| POACEAE | Bromus japonicus Thunb. ex Murr. | BRJA1 | N | X | X |
| POACEAE | Bromus tectorum L. | BRTE1 | N | X | X |
| POACEAE | Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | Y | X | |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | KOPY1 | Y | X | X |
| POACEAE | Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | Y | X | X |
| POACEAE | Muhlenbergia wrightii Vasey | MUWR1 | Y | X | X |
| POACEAE | Panicum capillare L. | PACA1 | Y | | X |
| POACEAE | Poa compressa L. | POCO1 | N | X | X |
| POACEAE | Poa pratensis L. | POPR1 | N | X | X |
| POACEAE | Setaria viridis (L.) Beauv. | SEVI1 | N | | X |
| POACEAE | Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | Y | X | X |
| POACEAE | Sorghastrum nutans (L.) Nash | SONU1 | Y | X | X |
| POACEAE | Sporobolus asper (Michx.) Kunth | SPAS1 | Y | | X |
| POACEAE | Sporobolus cryptandrus (Torr.) A. Gray | SPCR1 | Y | X | X |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | Y | X | X |
| POACEAE | Stipa comata Trin. & Rupr. | STCO1 | Y | X | X |
| POLEMONIACEAE | Ipomopsis spicata (Nutt.) V. Grant ssp. spicata | IPSP1 | Y | X | |
| POLYGONACEAE | Eriogonum alatum Torr. | ERAL1 | Y | X | X |
| POLYGONACEAE | Eriogonum umbellatum Torr. | ERUM1 | Y | X | X |
| PORTULACACEAE | Talinum parviflorum Nutt. | TAPA1 | Y | X | X |
| ROSACEAE | Potentilla fissa Nutt. | POFI1 | Y | X | X |
| ROSACEAE | Potentilla hippiana Lehm. | POHI1 | Y | X | |
| ROSACEAE | Rosa arkansana Porter | ROAR1 | Y | | X |
| SANTALACEAE | Comandra umbellata (L.) Nutt. | COUM1 | Y | X | X |
| SCROPHULARIACEAE | Castilleja sessiliflora Pursh. | CASE3 | Y | X | X |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | LIDA1 | N | X | X |
| SCROPHULARIACEAE | Penstemon secundiflorus Benth. | PESE1 | Y | X | |
| SCROPHULARIACEAE | Penstemon virens Penn. | PEVI1 | Y | X | X |
| SCROPHULARIACEAE | Verbascum thapsus L. | VETH1 | N | | X |
| | Total Number of Species/Treatment | | | 89 | 86 |
| | Total Number of Species/Combined | | | 103 | |
| | Sorenson Similarity Index | | | 0.82 | |

Table 7. 1999 Prescribed Burn Pre-Burn Foliar Cover Summary

| | | | | | | Control | | | Treatment | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Form | Native | Cool/Warm Season | Frequency | Absolute Cover | Relative Cover | Frequency | Absolute Cover | Relative Cover |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | F | N | | 33 | 1.60 | 2.00 | 33 | 1.00 | 1.31 |
| ASTERACEAE | Centaurea diffusa Lam. | CEDI1 | F | N | | | | | 7 | 0.07 | 0.09 |
| GERANIACEAE | Erodium cicutarium (L.) L'Her. | ERCI1 | F | N | | 13 | 0.20 | 0.25 | | | |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | LIDA1 | F | N | | 20 | 0.27 | 0.33 | 7 | 0.07 | 0.09 |
| ASTERACEAE | Ambrosia psilostachya DC. | AMPS1 | F | Y | | | | | 7 | 0.27 | 0.35 |
| CARYOPHYLLACEAE | Arenaria fendleri A. Gray | ARFE2 | F | Y | | 13 | 0.13 | 0.17 | 7 | 0.07 | 0.09 |
| ASTERACEAE | Artemisia frigida Willd. | ARFR1 | F | Y | | 7 | 0.07 | 0.08 | 7 | 0.07 | 0.09 |
| BRASSICACEAE | Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins | ARHI1 | F | Y | | 7 | 0.07 | 0.08 | | | |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 7 | 0.07 | 0.08 | 27 | 0.27 | 0.35 |
| ASTERACEAE | Aster porteri Gray | ASPO1 | F | Y | | 7 | 0.20 | 0.25 | | | |
| ASTERACEAE | Chrysopsis villosa Pursh. | CHVI1 | F | Y | | 13 | 0.13 | 0.17 | 7 | 0.07 | 0.09 |
| SANTALACEAE | Comandra umbellata (L.) Nutt. | COUM1 | F | Y | | | | | 7 | 0.07 | 0.09 |
| POLYGONACEAE | Eriogonum alatum Torr. | ERAL1 | F | Y | | 7 | 0.13 | 0.17 | | | |
| ASTERACEAE | Kuhnia eupatorioides L. | KUEU1 | F | Y | | 7 | 0.07 | 0.08 | | | |
| ASTERACEAE | Liatris punctata Hook. | LIPU1 | F | Y | | 80 | 1.87 | 2.33 | 67 | 1.20 | 1.58 |
| APIACEAE | Lomatium orientale Coult. & Rose | LOOR1 | F | Y | | | | | 7 | 0.07 | 0.09 |
| SCROPHULARIACEAE | Penstemon virens Penn. | PEVI1 | F | Y | | 7 | 0.07 | 0.08 | 7 | 0.07 | 0.09 |
| FABACEAE | Psoralea tenuiflora Pursh. | PSTE1 | F | Y | | 40 | 0.53 | 0.67 | 13 | 0.20 | 0.26 |
| ASTERACEAE | Solidago mollis Bart. | SOMO1 | F | Y | | 7 | 0.07 | 0.08 | | | |
| POACEAE | Aegilops cylindrica Host | AECY1 | G | N | C | | | | 7 | 0.07 | 0.09 |
| POACEAE | Bromus japonicus Thunb. ex Murr. | BRJA1 | G | N | C | 53 | 1.07 | 1.33 | 60 | 1.20 | 1.58 |
| POACEAE | Bromus tectorum L. | BRTE1 | G | N | C | 47 | 1.73 | 2.16 | 20 | 0.40 | 0.53 |
| POACEAE | Poa compressa L. | POCO1 | G | N | C | 93 | 13.47 | 16.79 | 100 | 20.47 | 26.91 |
| POACEAE | Poa pratensis L. | POPR1 | G | N | C | 80 | 6.53 | 8.15 | 73 | 5.20 | 6.84 |
| POACEAE | Agropyron smithii Rydb. | AGSM1 | G | Y | C | 7 | 0.07 | 0.08 | 7 | 0.27 | 0.35 |
| POACEAE | Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | G | Y | C | 67 | 0.93 | 1.16 | 13 | 0.13 | 0.18 |
| CYPERACEAE | Carex heliophila Mack. | CAHE1 | G | Y | C | 93 | 4.80 | 5.99 | 87 | 2.93 | 3.86 |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | 87 | 2.93 | 3.66 | 60 | 0.93 | 1.23 |
| JUNCACEAE | Juncus interior Wieg. | JUIN1 | G | Y | C | 7 | 0.07 | 0.08 | | | |
| POACEAE | Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | G | Y | C | 13 | 0.13 | 0.17 | 7 | 0.07 | 0.09 |
| POACEAE | Stipa comata Trin. & Rupr. | STCO1 | G | Y | C | 87 | 4.73 | 5.90 | 87 | 4.93 | 6.49 |
| POACEAE | Andropogon gerardii Vitman | ANGE1 | G | Y | W | 100 | 15.07 | 18.79 | 100 | 12.67 | 16.65 |

Table 7. (cont.)

| | | | | | | Control | | | Treatment | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Form | Native | Cool/Warm Season | Frequency | Absolute Cover | Relative Cover | Frequency | Absolute Cover | Relative Cover |
| POACEAE | Andropogon scoparius Michx. | ANSC1 | G | Y | W | 47 | 1.33 | 1.66 | 67 | 1.40 | 1.84 |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 87 | 3.47 | 4.32 | 47 | 1.40 | 1.84 |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 93 | 3.13 | 3.91 | 80 | 1.80 | 2.37 |
| POACEAE | Bouteloua hirsuta Lag | BOHI1 | G | Y | W | 40 | 0.73 | 0.91 | 40 | 0.40 | 0.53 |
| POACEAE | Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | G | Y | W | 7 | 0.07 | 0.08 | | | |
| POACEAE | Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | G | Y | W | 73 | 12.47 | 15.54 | 100 | 17.13 | 22.52 |
| POACEAE | Muhlenbergia wrightii Vasey | MUWR1 | G | Y | W | 7 | 0.07 | 0.08 | | | |
| POACEAE | Sorghastrum nutans (L.) Nash | SONU1 | G | Y | W | 53 | 1.53 | 1.91 | 33 | 1.07 | 1.40 |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | G | Y | W | 20 | 0.40 | 0.50 | 7 | 0.13 | 0.18 |
| Total foliar cover | | | | | | | 80.20 | 100.00 | | 76.07 | 100.00 |
| Total forb cover | | | | | | | 5.47 | 6.82 | | 3.47 | 4.56 |
| Total native forb cover | | | | | | | 3.40 | 4.24 | | 2.33 | 3.07 |
| Total non-native forb cover | | | | | | | 2.07 | 2.58 | | 1.13 | 1.49 |
| Total graminoid cover | | | | | | | 74.73 | 93.18 | | 72.60 | 95.44 |
| Total native cover | | | | | | | 55.33 | 68.99 | | 47.60 | 62.58 |
| Total non-native cover | | | | | | | 24.87 | 31.01 | | 28.47 | 37.42 |
| Total warm-season graminoid cover | | | | | | | 38.27 | 47.71 | | 36.00 | 47.33 |
| Total cool-season graminoid cover | | | | | | | 36.47 | 45.47 | | 36.60 | 48.12 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (1500).

Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).

All cover values presented are means (n = 15).

Native categories: Y = Native, N = Non-Native

Form categories: C = Cactus, F = Forb, G = Graminoid

Cool/Warm Season categories: C = Cool season species, W = Warm season species

Frequency values are in percent (n = 15).

**Table 8. 1999 Prescribed Burn Pre-Burn Frequency Summary**

| | | | Frequency (%) | |
|---|---|---|---|---|
| Family | Scientific Name | Speccode | Control | Treatment |
| APIACEAE | Lomatium orientale Coult. & Rose | LOOR1 | 12.0 | 24.0 |
| ASCLEPIADACEAE | Asclepias viridiflora Raf. | ASVI1 | 1.3 | |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | ACMI1 | 4.0 | |
| ASTERACEAE | Ambrosia psilostachya DC. | AMPS1 | 9.3 | 5.3 |
| ASTERACEAE | Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem. | ARCA1 | | 1.3 |
| ASTERACEAE | Artemisia dracunculus L. | ARDR1 | 1.3 | |
| ASTERACEAE | Artemisia frigida Willd. | ARFR1 | 8.0 | 8.0 |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | 6.7 | 34.7 |
| ASTERACEAE | Aster porteri Gray | ASPO1 | 20.0 | 8.0 |
| ASTERACEAE | Centaurea diffusa Lam. | CEDI1 | 2.7 | 5.3 |
| ASTERACEAE | Chrysopsis fulcrata Greene | CHFU1 | 5.3 | 1.3 |
| ASTERACEAE | Chrysopsis villosa Pursh. | CHVI1 | 20.0 | 1.3 |
| ASTERACEAE | Cirsium arvense (L.) Scop. | CIAR1 | 1.3 | |
| ASTERACEAE | Cirsium undulatum (Nutt.) Spreng. | CIUN1 | 1.3 | 1.3 |
| ASTERACEAE | Erigeron divergens T. & G. | ERDI1 | 1.3 | 2.7 |
| ASTERACEAE | Gaillardia aristata Pursh. | GAAR1 | 5.3 | 12.0 |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | | 5.3 |
| ASTERACEAE | Helianthus pumilus Nutt. | HEPU1 | 1.3 | 1.3 |
| ASTERACEAE | Kuhnia chlorolepis Woot. & Standl. | KUCH1 | 1.3 | |
| ASTERACEAE | Kuhnia eupatorioides L. | KUEU1 | 1.3 | |
| ASTERACEAE | Liatris punctata Hook. | LIPU1 | 69.3 | 45.3 |
| ASTERACEAE | Ratibida columnifera (Nutt.) Woot. & Standl. | RACO1 | 1.3 | |
| ASTERACEAE | Senecio plattensis Nutt. | SEPL1 | 4.0 | 4.0 |
| ASTERACEAE | Senecio spartioides T. & G. | SESP1 | 1.3 | |
| ASTERACEAE | Solidago mollis Bart. | SOMO1 | 4.0 | |
| ASTERACEAE | Taraxacum officinale Weber | TAOF1 | | 1.3 |
| ASTERACEAE | Tragopogon dubius Scop. | TRDU1 | 2.7 | 2.7 |
| BORAGINACEAE | Lithospermum incisum Lehm. | LIIN1 | 2.7 | |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | 38.7 | 37.3 |
| BRASSICACEAE | Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins | ARHI1 | 5.3 | 5.3 |
| BRASSICACEAE | Erysimum capitatum (Nutt.) DC. | ERCA2 | 4.0 | 4.0 |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | LECA1 | 12.0 | 1.3 |
| BRASSICACEAE | Lesquerella montana (A. Gray) Wats. | LEMO1 | 29.3 | 46.7 |
| CACTACEAE | Echinocereus viridiflorus Engelm. | ECVI1 | 53.3 | 58.7 |
| CACTACEAE | Opuntia macrorhiza Engelm. | OPMA1 | 34.7 | 60.0 |
| CARYOPHYLLACEAE | Arenaria fendleri A. Gray | ARFE2 | 21.3 | 13.3 |
| CARYOPHYLLACEAE | Paronychia jamesii T. & G. | PAJA1 | 14.7 | 2.7 |
| CLUSIACEAE | Hypericum perforatum L. | HYPE1 | 2.7 | 1.3 |
| CRASSULACEAE | Sedum lanceolatum Torr. | SELA1 | | 4.0 |
| CYPERACEAE | Carex heliophila Mack. | CAHE1 | 90.7 | 77.3 |
| FABACEAE | Astragalus agrestis Dougl. ex G. Don | ASAG1 | | 2.7 |
| FABACEAE | Dalea purpurea Vent | DAPU1 | 9.3 | 4.0 |
| FABACEAE | Psoralea tenuiflora Pursh. | PSTE1 | 22.7 | 18.7 |
| GERANIACEAE | Erodium cicutarium (L.) L'Her. | ERCI1 | 8.0 | |
| HYDROPHYLLACEAE | Phacelia heterophylla Pursh. | PHHE1 | 2.7 | |
| JUNCACEAE | Juncus interior Wieg. | JUIN1 | 2.7 | 5.3 |
| LILIACEAE | Allium textile A. Nels. & Macbr. | ALTE1 | 2.7 | 4.0 |
| NYCTAGINACEAE | Mirabilis linearis (Pursh.) Heimerl | MILI1 | 1.3 | 1.3 |
| ONAGRACEAE | Gaura coccinea Pursh. | GACO1 | 1.3 | |
| OROBANCHACEAE | Orobanche fasciculata Nutt. | ORFA1 | 1.3 | |
| POACEAE | Agropyron smithii Rydb. | AGSM1 | 5.3 | 2.7 |
| POACEAE | Andropogon gerardii Vitman | ANGE1 | 58.7 | 80.0 |
| POACEAE | Andropogon scoparius Michx. | ANSC1 | 41.3 | 34.7 |
| POACEAE | Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | 17.3 | 6.7 |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | BOCU1 | 66.7 | 49.3 |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | 74.7 | 60.0 |
| POACEAE | Bouteloua hirsuta Lag | BOHI1 | 45.3 | 18.7 |

**Table 8. (cont.)**

| | | | Frequency (%) | |
|---|---|---|---|---|
| **Family** | **Scientific Name** | **Speccode** | **Control** | **Treatment** |
| POACEAE | Bromus japonicus Thunb. ex Murr. | BRJA1 | 20.0 | 38.7 |
| POACEAE | Bromus tectorum L. | BRTE1 | 21.3 | 8.0 |
| POACEAE | Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | 1.3 | |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | KOPY1 | 45.3 | 34.7 |
| POACEAE | Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | 50.7 | 82.7 |
| POACEAE | Muhlenbergia wrightii Vasey | MUWR1 | 1.3 | |
| POACEAE | Poa compressa L. | POCO1 | 54.7 | 73.3 |
| POACEAE | Poa pratensis L. | POPR1 | 40.0 | 33.3 |
| POACEAE | Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | 21.3 | 6.7 |
| POACEAE | Sorghastrum nutans (L.) Nash | SONU1 | 16.0 | |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | 5.3 | |
| POACEAE | Stipa comata Trin. & Rupr. | STCO1 | 49.3 | 56.0 |
| POLYGONACEAE | Eriogonum alatum Torr. | ERAL1 | 25.3 | 16.0 |
| PORTULACACEAE | Talinum parviflorum Nutt. | TAPA1 | 2.7 | 2.7 |
| ROSACEAE | Potentilla fissa Nutt. | POFI1 | 1.3 | 1.3 |
| ROSACEAE | Potentilla hippiana Lehm. | POHI1 | 1.3 | |
| SANTALACEAE | Comandra umbellata (L.) Nutt. | COUM1 | 4.0 | 9.3 |
| SCROPHULARIACEAE | Castilleja sessiliflora Pursh. | CASE3 | 2.7 | |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | LIDA1 | 12.0 | 2.7 |
| SCROPHULARIACEAE | Penstemon virens Penn. | PEVI1 | 5.3 | 4.0 |
| SCROPHULARIACEAE | Verbascum thapsus L. | VETH1 | | 1.3 |

Frequency values based on n = 75.

**Table 9. 1997 and 1999 Great Plains Riparian Woodland Species Richness Comparison**

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| ACERACEAE | Acer negundo L. var. interius (Britt.) Sarg. | Y | ACNE1 | X | X |
| AGAVACEAE | Yucca glauca Nutt. | Y | YUGL1 | X | X |
| ALISMATACEAE | Alisma trivale Pursh | Y | ALTR1 | X | X |
| ALISMATACEAE | Sagittaria latifolia Willd. | Y | SALA1 | X | X |
| AMARANTHACEAE | Amaranthus graecizans L. | Y | AMGR1 | X | |
| ANACARDIACEAE | Rhus aromatica Ait. var. trilobata (Nutt.) A. Gray | Y | RHAR1 | X | X |
| ANACARDIACEAE | Toxicodendron rydbergii (Small) Greene | Y | TORY1 | X | X |
| APIACEAE | Cicuta maculata L. var. angustifolia Hook. | Y | CIMA1 | X | X |
| APIACEAE | Conium maculatum L. | N | COMA1 | X | X |
| APIACEAE | Heracleum sphondylium L. ssp. montanum (Schleich.) Briq. | Y | HESP1 | X | X |
| APIACEAE | Lomatium orientale Coult. & Rose | Y | LOOR1 | X | X |
| APIACEAE | Musineon divaricatum (Pursh.) Nutt. var. hookeri T. & G. | Y | MUDI1 | X | X |
| APIACEAE | Osmorhiza chiliensis H. & A. | Y | OSCH1 | X | X |
| APIACEAE | Osmorhiza longistylis (Torr.) DC var. longistylis | Y | OSLO1 | X | X |
| APOCYNACEAE | Apocynum cannabinum L. | Y | APCA1 | X | X |
| ASCLEPIADACEAE | Asclepias incarnata L. | Y | ASIN1 | X | X |
| ASCLEPIADACEAE | Asclepias speciosa Torr. | Y | ASSP1 | X | X |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | Y | ACMI1 | X | X |
| ASTERACEAE | Ambrosia psilostachya DC. | Y | AMPS1 | X | X |
| ASTERACEAE | Ambrosia trifida L. | Y | AMTR1 | X | X |
| ASTERACEAE | Antennaria parvifolia Nutt. | Y | ANPA1 | | X |
| ASTERACEAE | Arctium minus Bernh. | Y | ARMI1 | X | X |
| ASTERACEAE | Arnica fulgens Pursh. | Y | ARFU1 | X | X |
| ASTERACEAE | Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem. | Y | ARCA1 | X | X |
| ASTERACEAE | Artemisia dracunculus L. | Y | ARDR1 | X | X |
| ASTERACEAE | Artemisia frigida Willd. | Y | ARFR1 | X | X |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | Y | ARLU1 | X | X |
| ASTERACEAE | Aster falcatus Lindl. | Y | ASFA1 | X | X |
| ASTERACEAE | Aster hesperius A. Gray var. hersperius | Y | ASHE1 | X | X |
| ASTERACEAE | Aster laevis L. var. geyeri A. Gray | Y | ASLA1 | | X |
| ASTERACEAE | Aster porteri Gray | Y | ASPO1 | X | X |
| ASTERACEAE | Bidens frondosa L. | Y | BIFR1 | X | X |
| ASTERACEAE | Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | N | CANU1 | X | X |
| ASTERACEAE | Centaurea diffusa Lam. | N | CEDI1 | X | X |
| ASTERACEAE | Chrysanthemum leucanthemum L. | N | CHLE1 | X | X |
| ASTERACEAE | Chrysopsis fulcrata Greene | Y | CHFU1 | X | X |
| ASTERACEAE | Chrysopsis villosa Pursh. | Y | CHVI1 | X | X |
| ASTERACEAE | Chrysothamnus nauseosus (Pall.) Britt. ssp. graveolens (Nutt.) Piper | Y | CHNA1 | X | X |
| ASTERACEAE | Chrysothamnus nauseosus (Pall.) Britt. ssp. nauseosus | Y | CHNA2 | X | X |
| ASTERACEAE | Cichorium intybus L. | N | CIIN1 | X | X |
| ASTERACEAE | Cirsium arvense (L.) Scop. | N | CIAR1 | X | X |
| ASTERACEAE | Cirsium undulatum (Nutt.) Spreng. | Y | CIUN1 | X | X |
| ASTERACEAE | Cirsium vulgare (Savi) Ten. | N | CIVU1 | X | X |
| ASTERACEAE | Conyza canadensis (L.) Cronq. | Y | COCA1 | X | X |
| ASTERACEAE | Erigeron divergens T. & G. | Y | ERDI1 | X | X |
| ASTERACEAE | Erigeron flagellaris A. Gray | Y | ERFL1 | X | X |
| ASTERACEAE | Erigeron strigosus Muhl. ex Willd. | Y | ERST1 | X | X |
| ASTERACEAE | Gaillardia aristata Pursh. | Y | GAAR1 | X | |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | Y | GRSQ1 | X | X |
| ASTERACEAE | Gutierrezia sarothrae (Pursh.) Britt. & Rusby | Y | GUSA1 | X | X |
| ASTERACEAE | Helianthus annuus L. | Y | HEAN1 | X | X |
| ASTERACEAE | Helianthus maximilianii Schrad. | Y | HEMA1 | X | X |
| ASTERACEAE | Helianthus nuttallii T. & G. | Y | HENU1 | X | X |
| ASTERACEAE | Helianthus petiolaris Nutt. | Y | HEPE1 | X | X |
| ASTERACEAE | Helianthus pumilus Nutt. | Y | HEPU1 | X | X |
| ASTERACEAE | Heliomeris multiflora Nuttall | Y | HEMU1 | X | X |
| ASTERACEAE | Iva axillaris Pursh. | Y | IVAX1 | X | |
| ASTERACEAE | Kuhnia chlorolepis Woot. & Standl. | Y | KUCH1 | X | |

Table 9. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| ASTERACEAE | Kuhnia eupatorioides L. | Y | KUEU1 | X | X |
| ASTERACEAE | Lactuca oblongifolia Nutt. | Y | LAOB1 | X | X |
| ASTERACEAE | Lactuca serriola L. | N | LASE1 | X | X |
| ASTERACEAE | Liatris punctata Hook. | Y | LIPU1 | X | X |
| ASTERACEAE | Ratibida columnifera (Nutt.) Woot. & Standl. | Y | RACO1 | X | X |
| ASTERACEAE | Scorzonera laciniata L. | N | SCLA1 | X | X |
| ASTERACEAE | Senecio integerrimus Nutt. | Y | SEIN1 | X | X |
| ASTERACEAE | Senecio plattensis Nutt. | Y | SEPL1 | X | X |
| ASTERACEAE | Senecio spartioides T. & G. | Y | SESP1 | X | X |
| ASTERACEAE | Solidago canadensis L. | Y | SOCA1 | X | |
| ASTERACEAE | Solidago gigantea Ait. | Y | SOGI1 | X | X |
| ASTERACEAE | Solidago missouriensis Nutt. | Y | SOMI1 | X | X |
| ASTERACEAE | Solidago rigida L. | Y | SORI1 | X | X |
| ASTERACEAE | Sonchus arvensis L. ssp. uglinosus (Bieb.) Nyman | N | SOAR2 | X | X |
| ASTERACEAE | Sonchus asper (L.) Hill | N | SOAS1 | X | X |
| ASTERACEAE | Stephanomeria pauciflora (Torr.) A. Nels. | Y | STPA1 | X | |
| ASTERACEAE | Taraxacum officinale Weber | N | TAOF1 | X | X |
| ASTERACEAE | Tragopogon dubius Scop. | N | TRDU1 | X | X |
| ASTERACEAE | Xanthium strumarium L. | Y | XAST1 | X | X |
| BERBERIDACEAE | Berberis repens Lindl. | Y | BERE1 | X | X |
| BETULACEAE | Alnus incana (L.) Moench ssp. tenuifolia (Nuttall) Breitung | Y | ALIN1 | X | X |
| BETULACEAE | Betula occidentalis Hook. | Y | BEOC1 | | X |
| BORAGINACEAE | Asperugo procumbens L. | N | ASPR1 | | X |
| BORAGINACEAE | Cynoglossum officinale L. | N | CYOF1 | X | X |
| BORAGINACEAE | Lithospermum incisum Lehm. | Y | LIIN1 | X | X |
| BORAGINACEAE | Mertensia lanceolata (Pursh.) A. DC. | Y | MELA1 | X | X |
| BORAGINACEAE | Onosmodium molle Michx. var. occidentale (Mack.) Johnst. | Y | ONMO1 | X | X |
| BRASSICACEAE | Alyssum alyssoides (L.) L. | N | ALAL1 | X | X |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | N | ALMI1 | X | X |
| BRASSICACEAE | Arabis glabra (L.) Bernh. | N | ARGL1 | X | X |
| BRASSICACEAE | Barbarea vulgaris R. Br. | N | BAVU1 | X | X |
| BRASSICACEAE | Camelina microcarpa Andrz. ex DC. | N | CAMI1 | X | X |
| BRASSICACEAE | Cardaria chalepensis (L.) Hand-Mazz | N | CACH1 | | X |
| BRASSICACEAE | Conringia orientalis (L.) Dum. | N | COOR1 | X | |
| BRASSICACEAE | Descurainia pinnata (Walt.) Britt. | Y | DEPI1 | X | X |
| BRASSICACEAE | Descurainia richardsonii (Sweet) Schultz | Y | DERI1 | X | X |
| BRASSICACEAE | Descurainia sophia (L.) Webb ex Prantl. | N | DESO1 | X | X |
| BRASSICACEAE | Erysimum repandum L. | N | ERRE1 | X | X |
| BRASSICACEAE | Hesperis matronalis L. | N | HEMA2 | X | |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | N | LECA1 | X | X |
| BRASSICACEAE | Lesquerella montana (A. Gray) Wats. | Y | LEMO1 | | X |
| BRASSICACEAE | Nasturtium officinale R. Br. | N | NAOF1 | X | X |
| BRASSICACEAE | Physaria vitulifera Rydb. | Y | PHVI1 | X | X |
| BRASSICACEAE | Rorippa palustris (L.) Bess. ssp. hispida (Desv.) Jonsell | Y | ROPA1 | | X |
| BRASSICACEAE | Sisymbrium altissimum L. | N | SIAL1 | X | X |
| BRASSICACEAE | Thlaspi arvense L. | N | THAR1 | X | X |
| CACTACEAE | Coryphantha missouriensis (Sweet) Britt. & Rose | Y | COMI1 | X | X |
| CACTACEAE | Echinocereus viridiflorus Engelm. | Y | ECVI1 | X | X |
| CACTACEAE | Opuntia fragilis (Nutt.) Haw. | Y | OPFR1 | X | X |
| CACTACEAE | Opuntia macrorhiza Engelm. | Y | OPMA1 | X | X |
| CACTACEAE | Opuntia polyacantha Haw. | Y | OPPO1 | | X |
| CACTACEAE | Pediocactus simpsonii (Engelm.) Britt. & Rose | Y | PESI1 | X | |
| CANNABACEAE | Humulus lupulus L. var. lupuloides E. Small | Y | HULU1 | X | X |
| CAPRIFOLIACEAE | Symphoricarpos occidentalis Hook. | Y | SYOC1 | X | X |
| CAPRIFOLIACEAE | Symphoricarpos oreophilus Gray | Y | SYOR1 | X | X |
| CARYOPHYLLACEAE | Cerastium arvense L. | Y | CEAR1 | X | X |
| CARYOPHYLLACEAE | Cerastium vulgatum L. | N | CEVU1 | X | X |
| CARYOPHYLLACEAE | Paronychia jamesii T. & G. | Y | PAJA1 | X | X |

Table 9. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| CARYOPHYLLACEAE | Saponaria officinalis L. | N | SAOF1 | X | X |
| CARYOPHYLLACEAE | Silene antirrhina L. | Y | SIAN1 | X | |
| CARYOPHYLLACEAE | Silene drummondii Hook. | Y | SIDR1 | X | X |
| CARYOPHYLLACEAE | Silene pratensis (Raf.)Godr. & Gren | N | SIPR1 | X | X |
| CARYOPHYLLACEAE | Vaccaria pyramidata Medic. | N | VAPY1 | X | X |
| CERATOPHYLLACEAE | Ceratophyllum demersum L. | Y | CEDE1 | X | X |
| CHENOPODIACEAE | Chenopodium album L. | N | CHAL1 | X | X |
| CHENOPODIACEAE | Chenopodium fremontii S. Wats. | Y | CHFR1 | | X |
| CHENOPODIACEAE | Kochia scoparia (L.) Schrad. | N | KOSC1 | X | X |
| CHENOPODIACEAE | Salsola iberica Senn. & Pau. | N | SAIB1 | X | X |
| CLUSIACEAE | Hypericum perforatum L. | N | HYPE1 | X | X |
| COMMELINACEAE | Tradescantia occidentalis (Britt.) Smyth | Y | TROC1 | X | X |
| CONVOLVULACEAE | Calystegia sepium (L.) R. Br. ssp. angulata Brummitt | Y | CASE1 | | X |
| CONVOLVULACEAE | Convolvulus arvensis L. | N | COAR1 | X | X |
| CONVOLVULACEAE | Evolvulus nuttallianus R. & S. | Y | EVNU1 | X | X |
| CRASSULACEAE | Sedum lanceolatum Torr. | Y | SELA1 | X | X |
| CUPRESSACEAE | Juniperus scopulorum Sarg. | T | JUSC1 | X | X |
| CYPERACEAE | Carex athrostachya Olney | Y | CAAT1 | | X |
| CYPERACEAE | Carex aurea Nutt. | Y | CAAU1 | | X |
| CYPERACEAE | Carex brevior (Dew.) Mack. ex Lunell. | Y | CABR1 | X | X |
| CYPERACEAE | Carex douglasii F. Boott. | Y | CADO1 | | X |
| CYPERACEAE | Carex eleocharis Bailey | Y | CAEL1 | X | X |
| CYPERACEAE | Carex emoryi Dew. | Y | CAEM1 | | X |
| CYPERACEAE | Carex heliophila Mack. | Y | CAHE1 | X | X |
| CYPERACEAE | Carex hystericina Muhl. ex Willd. | Y | CAHY1 | X | X |
| CYPERACEAE | Carex lanuginosa Michx. | Y | CALA1 | X | X |
| CYPERACEAE | Carex nebrascensis Dew. | Y | CANE1 | X | X |
| CYPERACEAE | Carex praegracilis W. Boott. | Y | CAPR1 | X | X |
| CYPERACEAE | Carex scoparia Schkuhr. ex Willd. | Y | CASC1 | X | X |
| CYPERACEAE | Carex simulata Mack. | Y | CASI1 | X | X |
| CYPERACEAE | Carex stipata Muhl. | Y | CAST1 | X | X |
| CYPERACEAE | Carex vulpinoidea Michx. | Y | CAVU1 | X | X |
| CYPERACEAE | Eleocharis acicularis (L.) R. & S. | Y | ELAC1 | X | |
| CYPERACEAE | Eleocharis compressa Sulliv. | Y | ELCO1 | X | |
| CYPERACEAE | Eleocharis macrostachya Britt. | Y | ELMA1 | X | X |
| CYPERACEAE | Scirpus pallidus (Britt.) Fern | Y | SCPA1 | X | X |
| CYPERACEAE | Scirpus pungens Vahl | Y | SCPU1 | | X |
| CYPERACEAE | Scirpus pungens Vahl | Y | SCAM1 | X | |
| CYPERACEAE | Scirpus validus Vahl. | Y | SCVA1 | X | X |
| ELAEAGNACEAE | Elaeagnus angustifolia L. | N | ELAN1 | X | X |
| EQUISETACEAE | Equisetum arvense L. | Y | EQAR1 | X | X |
| EQUISETACEAE | Equisetum laevigatum A. Br. | Y | EQLA1 | X | X |
| EUPHORBIACEAE | Euphorbia dentata Michx. | Y | EUDE1 | X | X |
| EUPHORBIACEAE | Euphorbia marginata Pursh. | Y | EUMA1 | | X |
| EUPHORBIACEAE | Euphorbia serpyllifolia Pers. | Y | EUSE1 | X | |
| EUPHORBIACEAE | Tragia ramosa Nutt. | Y | TRRA1 | | X |
| FABACEAE | Amorpha fruticosa L. | Y | AMFR1 | X | X |
| FABACEAE | Astragalus agrestis Dougl. ex G. Don | Y | ASAG1 | X | X |
| FABACEAE | Astragalus canadensis L. | Y | ASCA1 | X | X |
| FABACEAE | Astragalus crassicarpus Nutt. | Y | ASCR1 | X | X |
| FABACEAE | Astragalus drummondii Dougl. ex Hook. | Y | ASDR1 | X | X |
| FABACEAE | Astragalus flexuosus (Hook.) G. Don | Y | ASFL1 | X | X |
| FABACEAE | Astragalus shortianus Nutt. ex T.&G. | Y | ASSH1 | X | |
| FABACEAE | Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinners. | Y | DACA1 | X | X |
| FABACEAE | Dalea purpurea Vent | Y | DAPU1 | X | X |
| FABACEAE | Glycyrrhiza lepidota Pursh. | Y | GLLE1 | X | X |
| FABACEAE | Lathyrus eucosmus Butters and St. John | Y | LAEU1 | X | X |
| FABACEAE | Lupinus argenteus Pursh ssp. ingratus (Greene) Harmon | Y | LUAR2 | X | X |

Table 9. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| FABACEAE | Lupinus argenteus Pursh var. argenteus | Y | LUAR1 | X | X |
| FABACEAE | Medicago lupulina L. | N | MELU1 | X | X |
| FABACEAE | Medicago sativa L. ssp. sativa | N | MESA1 | X | X |
| FABACEAE | Melilotus alba Medic. | N | MEAL1 | X | X |
| FABACEAE | Melilotus officinalis (L.) Pall. | N | MEOF1 | X | X |
| FABACEAE | Oxytropis lambertii Pursh. | Y | OXLA1 | X | X |
| FABACEAE | Psoralea tenuiflora Pursh. | Y | PSTE1 | X | X |
| FABACEAE | Thermopsis rhombifolia var. divaricarpa (Nels.) Isely | Y | THRH1 | X | X |
| FABACEAE | Trifolium pratense L. | N | TRPR1 | | X |
| FABACEAE | Vicia americana Muhl. ex Willd. | Y | VIAM1 | X | X |
| GENTIANACEAE | Gentiana affinis Griseb. | Y | GEAF1 | X | |
| GENTIANACEAE | Swertia radiata (Kell.) O. Ktze. | Y | SWRA1 | | X |
| GERANIACEAE | Erodium cicutarium (L.) L'Her. | N | ERCI1 | X | X |
| GERANIACEAE | Geranium caespitosum James ssp. caespitosum | Y | GECA1 | X | X |
| GROSSULARIACEAE | Ribes aureum Pursh | Y | RIAU1 | X | X |
| GROSSULARIACEAE | Ribes cereum Dougl. | Y | RICE1 | X | X |
| GROSSULARIACEAE | Ribes inerme Rydb. | Y | RIIN1 | | X |
| HYDROPHYLLACEAE | Hydrophyllum fendleri (Gray) Heller | Y | HYFE1 | X | X |
| HYDROPHYLLACEAE | Phacelia heterophylla Pursh. | Y | PHHE1 | X | X |
| IRIDACEAE | Iris missouriensis Nutt. | Y | IRMI1 | X | X |
| IRIDACEAE | Sisyrinchium montanum Greene | Y | SIMO1 | X | X |
| JUNCACEAE | Juncus articulatus L. | Y | JUAR1 | | X |
| JUNCACEAE | Juncus balticus Willd. | Y | JUBA1 | X | X |
| JUNCACEAE | Juncus dudleyi Wieg. | Y | JUDU1 | X | X |
| JUNCACEAE | Juncus ensifolius Wikst. var. montanus (Englm.) C. L. Hitchc. | Y | JUEN1 | X | X |
| JUNCACEAE | Juncus interior Wieg. | Y | JUIN1 | X | |
| JUNCACEAE | Juncus longistylis Torr. | Y | JULO1 | X | X |
| JUNCACEAE | Juncus nodosus L. | Y | JUNO1 | X | X |
| JUNCACEAE | Juncus torreyi Cov. | Y | JUTO1 | X | X |
| JUNCACEAE | Juncus tracyi Rydb. | Y | JUTR1 | | X |
| LAMIACEAE | Lycopus americanus Muhl. ex Barton | Y | LYAM1 | X | X |
| LAMIACEAE | Lycopus asper Greene | Y | LYAS1 | | X |
| LAMIACEAE | Marrubium vulgare L. | N | MAVU1 | X | X |
| LAMIACEAE | Mentha arvensis L. | Y | MEAR1 | X | X |
| LAMIACEAE | Monarda fistulosa L. var. menthifolia (Grah.) Fern. | Y | MOFI1 | X | X |
| LAMIACEAE | Nepeta cataria L. | N | NECA1 | X | X |
| LAMIACEAE | Prunella vulgaris L. | Y | PRVU1 | X | X |
| LAMIACEAE | Scutellaria brittonii Porter | Y | SCBR1 | X | X |
| LAMIACEAE | Stachys palustris L. ssp. pilosa (Nutt.) Epling | Y | STPA2 | X | X |
| LEMNACEAE | Lemna minor L. | Y | LEMI1 | X | X |
| LILIACEAE | Allium cernuum Roth | Y | ALCE1 | | X |
| LILIACEAE | Allium geyeri S. Wats. | Y | ALGE1 | X | X |
| LILIACEAE | Allium textile A. Nels. & Macbr. | Y | ALTE1 | X | X |
| LILIACEAE | Asparagus officinalis L. | N | ASOF1 | X | X |
| LILIACEAE | Calochortus gunnisonii S. Wats. | Y | CAGU1 | X | X |
| LILIACEAE | Leucocrinum montanum Nutt. | Y | LEMO2 | X | |
| LILIACEAE | Smilacina stellata (L.) Desf. | Y | SMST1 | X | X |
| LILIACEAE | Zigadenus venenosus Wats. var. gramineus (Rydb.) Walsh ex Peck | Y | ZIVE1 | X | |
| LINACEAE | Linum perenne L. var. lewisii (Pursh.) Eat. & Wright | Y | LIPE1 | X | X |
| LINACEAE | Linum pratense (Nort.) Small | Y | LIPR1 | | X |
| LYTHRACEAE | Lythrum alatum Pursh. | Y | LYAL1 | X | |
| MALVACEAE | Malva neglecta Wallr. | N | MANE1 | | X |
| MALVACEAE | Sidalcea candida Gray | Y | SICA1 | X | X |
| MALVACEAE | Sphaeralcea coccinea (Pursh.) Rydb. | Y | SPCO1 | X | X |
| NYCTAGINACEAE | Mirabilis hirsuta (Pursh.) MacM. | Y | MIHI1 | X | X |
| NYCTAGINACEAE | Mirabilis linearis (Pursh.) Heimerl | Y | MILI1 | X | X |
| NYCTAGINACEAE | Mirabilis nyctaginea (Michx.) MacM. | Y | MINY1 | X | X |
| ONAGRACEAE | Epilobium ciliatum Raf. ssp. glandulosum (Lehm.) Hock & Raven | Y | EPCI1 | X | X |

Table 9. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| ONAGRACEAE | Epilobium paniculatum Nutt. | Y | EPPA1 | X | X |
| ONAGRACEAE | Gaura coccinea Pursh. | Y | GACO1 | X | X |
| ONAGRACEAE | Gaura parviflora Dougl. | Y | GAPA1 | X | X |
| ONAGRACEAE | Oenothera howardii (A. Nels.) W. L. Wagner | Y | OEHO1 | X | X |
| ONAGRACEAE | Oenothera villosa Thunb. ssp. strigosa (Rydb.) Dietrich & Raven | Y | OEVI1 | X | X |
| ORCHIDACEAE | Habenaria hyperborea (L.) R. Br. | Y | HAHY1 | X | X |
| OXALIDACEAE | Oxalis dillenii Jacq. | N | OXDI1 | X | X |
| PAPAVERACEAE | Argemone polyanthemos (Fedde) G. Ownbey | Y | ARPO1 | X | X |
| PINACEAE | Pinus ponderosa Laws | Y | PIPO1 | X | X |
| PLANTAGINACE | Plantago lanceolata L. | N | PLLA1 | X | X |
| PLANTAGINACE | Plantago major L. | N | PLMA1 | X | X |
| POACEAE | Agropyron caninum (L.) Beauv. ssp. majus (Vasey) C. L. Hitchc. | Y | AGCA1 | X | X |
| POACEAE | Agropyron cristatum (L.) Gaertn. | N | AGCR1 | X | X |
| POACEAE | Agropyron dasystachyum (Hook.) Scribn. | Y | AGDA1 | X | |
| POACEAE | Agropyron desertorum (Fisch.) Schult. | N | AGDE1 | X | X |
| POACEAE | Agropyron intermedium (Host) Beauv. | N | AGIN1 | X | X |
| POACEAE | Agropyron repens (L.) Beauv. | N | AGRE1 | X | X |
| POACEAE | Agropyron smithii Rydb. | Y | AGSM1 | X | X |
| POACEAE | Agrostis stolonifera L. | N | AGST1 | X | X |
| POACEAE | Andropogon gerardii Vitman | Y | ANGE1 | X | X |
| POACEAE | Andropogon scoparius Michx. | Y | ANSC1 | X | X |
| POACEAE | Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | Y | ARLO1 | X | X |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | Y | BOCU1 | X | X |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | Y | BOGR1 | X | X |
| POACEAE | Bouteloua hirsuta Lag | Y | BOHI1 | X | X |
| POACEAE | Bromus inermis Leyss. ssp. inermis | N | BRIN1 | X | X |
| POACEAE | Bromus japonicus Thunb. ex Murr. | N | BRJA1 | X | X |
| POACEAE | Bromus tectorum L. | N | BRTE1 | X | X |
| POACEAE | Buchloe dactyloides (Nutt.) Engelm. | Y | BUDA1 | X | X |
| POACEAE | Ceratochloa marginata (Nees ex Stued.) Jackson | Y | CEMA1 | | X |
| POACEAE | Dactylis glomerata L. | N | DAGL1 | X | X |
| POACEAE | Dichanthelium oligosanthes (Schultz) Gould var. scribnerianum (Nash) G | Y | DIOL1 | X | X |
| POACEAE | Echinochloa crusgallii (L.) Beauv. | N | ECCR1 | X | X |
| POACEAE | Elymus canadensis L. | Y | ELCA1 | X | X |
| POACEAE | Festuca octoflora Walt. | Y | FEOC1 | X | |
| POACEAE | Festuca ovina L. var. rydbergii St. Yves | Y | FEOV1 | X | X |
| POACEAE | Festuca pratensis Huds. | Y | FEPR1 | X | X |
| POACEAE | Glyceria grandis S. Wats. ex A. Gray | Y | GLGR1 | X | X |
| POACEAE | Glyceria striata (Lam.) Hitchc. | Y | GLST1 | X | X |
| POACEAE | Hordeum brachyantherum Nevski | Y | HOBR1 | | X |
| POACEAE | Hordeum jubatum L. | Y | HOJU1 | X | X |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | Y | KOPY1 | X | X |
| POACEAE | Leersia oryzoides (L.) Sw. | Y | LEOR1 | X | X |
| POACEAE | Muhlenbergia asperifolia (Nees. & Mey.) Parodi | Y | MUAS1 | | X |
| POACEAE | Muhlenbergia filiformis (Thurb.) Rydb. | Y | MUFI1 | | X |
| POACEAE | Muhlenbergia montana (Nutt.) Hitchc. | Y | MUMO1 | X | |
| POACEAE | Muhlenbergia racemosa (Michx.) B. S. P. | Y | MURA1 | X | X |
| POACEAE | Muhlenbergia wrightii Vasey | Y | MUWR1 | | X |
| POACEAE | Panicum capillare L. | Y | PACA1 | X | X |
| POACEAE | Panicum virgatum L. | Y | PAVI1 | X | X |
| POACEAE | Phalaris arundinacea L. | Y | PHAR1 | X | X |
| POACEAE | Phleum pratense L. | N | PHPR1 | X | X |
| POACEAE | Poa canbyi (Scribn.) Piper | Y | POCA1 | | X |
| POACEAE | Poa compressa L. | N | POCO1 | X | X |
| POACEAE | Poa juncifolia Scribn. | Y | POJU1 | | X |
| POACEAE | Poa palustris L. | N | POPA1 | X | |
| POACEAE | Poa pratensis L. | N | POPR1 | X | X |
| POACEAE | Polypogon monspeliensis (L.) Desf. | N | POMO1 | X | |

Table 9. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| POACEAE | Schedonnardus paniculatus (Nutt.) Trel. | N | SCPA2 | | X |
| POACEAE | Secale cereale L. | N | SECE1 | X | X |
| POACEAE | Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | Y | SIHY1 | X | X |
| POACEAE | Sorghastrum nutans (L.) Nash | Y | SONU1 | X | X |
| POACEAE | Spartina pectinata Link | Y | SPPE1 | X | X |
| POACEAE | Sporobolus asper (Michx.) Kunth | Y | SPAS1 | X | X |
| POACEAE | Sporobolus cryptandrus (Torr.) A. Gray | Y | SPCR1 | X | X |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | Y | SPHE1 | X | X |
| POACEAE | Stipa comata Trin. & Rupr. | Y | STCO1 | X | X |
| POACEAE | Stipa viridula Trin. | Y | STVI1 | X | X |
| POACEAE | X Agrohordeum macounii (Vasey) Lepage | N | AGMA1 | X | |
| POLYGONACEAE | Eriogonum alatum Torr. | Y | ERAL1 | X | X |
| POLYGONACEAE | Eriogonum effusum Nutt. | Y | EREF1 | X | X |
| POLYGONACEAE | Eriogonum umbellatum Torr. | Y | ERUM1 | X | X |
| POLYGONACEAE | Polygonum arenastrum Jord. ex Bor. | N | POAR1 | | X |
| POLYGONACEAE | Polygonum convolvulus L. | N | POCO2 | X | X |
| POLYGONACEAE | Polygonum douglasii Greene | Y | PODO1 | X | |
| POLYGONACEAE | Polygonum lapathifolium L. | N | POLA1 | X | X |
| POLYGONACEAE | Polygonum pensylvanicum L. | Y | POPE1 | | X |
| POLYGONACEAE | Polygonum persicaria L. | N | POPE2 | | X |
| POLYGONACEAE | Polygonum ramosissimum Michx. | Y | PORA1 | | X |
| POLYGONACEAE | Rumex acetosella L. | N | RUAC1 | X | X |
| POLYGONACEAE | Rumex crispus L. | N | RUCR1 | X | X |
| POLYGONACEAE | Rumex obtusifolius L. | N | RUOB1 | X | X |
| POLYGONACEAE | Rumex salicifolius Weinm. ssp. triangulivalvis Danser | Y | RUSA1 | X | X |
| PORTULACACEAE | Talinum parviflorum Nutt. | Y | TAPA1 | X | X |
| PRIMULACEAE | Androsace occidentalis Pursh. | Y | ANOC1 | X | |
| PRIMULACEAE | Lysimachia ciliata L. | Y | LYCI1 | X | X |
| RANUNCULACEAE | Clematis ligusticifolia Nutt. | Y | CLLI1 | X | X |
| RANUNCULACEAE | Delphinium nuttalianum Pritz. ex Walpers | Y | DENU1 | X | |
| RANUNCULACEAE | Delphinium virescens Nutt. ssp. penardii (Huth) Ewan | Y | DEVI1 | X | X |
| RANUNCULACEAE | Ranunculus macounii Britt. | Y | RAMA1 | X | X |
| RANUNCULACEAE | Ranunculus trichophyllus Chaix | Y | RATR1 | X | X |
| RANUNCULACEAE | Thalictrum dasycarpum Fisch. & Ave-Lall | Y | THDA1 | X | X |
| ROSACEAE | Agrimonia striata Michx. | Y | AGST2 | X | X |
| ROSACEAE | Crataegus erythropoda Ashe | Y | CRER1 | X | X |
| ROSACEAE | Crataegus succulenta Link var. occidentalis (Britton) E. J. Palm. | Y | CRSU1 | | X |
| ROSACEAE | Geum aleppicum Jacq. | Y | GEAL1 | X | X |
| ROSACEAE | Geum macrophyllum Willd. | Y | GEMA1 | X | X |
| ROSACEAE | Potentilla arguta Pursh | Y | POAR2 | X | |
| ROSACEAE | Potentilla fissa Nutt. | Y | POFI1 | X | X |
| ROSACEAE | Potentilla gracilis Dougl. ex Hook. var. glabrata (Lehm.) C. L. Hitchc. | Y | POGR1 | X | X |
| ROSACEAE | Potentilla hippiana Lehm. | Y | POHI1 | X | X |
| ROSACEAE | Potentilla norvegica L. | Y | PONO1 | X | |
| ROSACEAE | Potentilla paradoxa Nutt. | Y | POPA2 | | X |
| ROSACEAE | Potentilla pulcherrima x hippiana | Y | POPU1 | X | X |
| ROSACEAE | Prunus americana Marsh. | Y | PRAM1 | X | X |
| ROSACEAE | Prunus virginiana L. var. melanocarpa (A. Nels.) Sarg. | Y | PRVI1 | X | X |
| ROSACEAE | Pyrus malus L. | N | PYMA1 | X | X |
| ROSACEAE | Rosa acicularis Lindl. | Y | ROAC1 | X | X |
| ROSACEAE | Rosa arkansana Porter | Y | ROAR1 | X | X |
| ROSACEAE | Rosa woodsii Lindl. | Y | ROWO1 | X | X |
| ROSACEAE | Rubus deliciosus Torr. | Y | RUDE1 | | X |
| ROSACEAE | Rubus idaeus L. ssp. sachalinensis (Levl.) Focke var. sachalinensis | Y | RUID1 | X | X |
| ROSACEAE | Sanguisorba minor Scop. | N | SAMI1 | | X |
| ROSACEAE | Sorbus scopulina Greene | Y | SOSC1 | | X |
| RUBIACEAE | Galium aparine L. | Y | GAAP1 | X | X |
| RUBIACEAE | Galium septentrionale Roemer & Schultes | Y | GASE1 | X | X |

Table 9. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| SALICACEAE | Populus alba L. | Y | POAL1 | X | X |
| SALICACEAE | Populus angustifolia James | Y | POAN3 | X | X |
| SALICACEAE | Populus deltoides Marsh. ssp. monilifera (Ait.) Eckenw. | Y | PODE1 | X | X |
| SALICACEAE | Populus x acuminata Rydb. | Y | POAC1 | X | X |
| SALICACEAE | Salix amygdaloides Anderss. | Y | SAAM1 | X | X |
| SALICACEAE | Salix exigua Nutt. ssp. interior (Rowlee) Cronq. | Y | SAEX1 | X | X |
| SALICACEAE | Salix fragilis L. | N | SAFR1 | X | |
| SALICACEAE | Salix irrorata Andersson | Y | SAIR1 | X | X |
| SALICACEAE | Salix lutea Nutt. | Y | SALU1 | X | X |
| SANTALACEAE | Comandra umbellata (L.) Nutt. | Y | COUM1 | X | X |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | N | LIDA1 | X | X |
| SCROPHULARIACEAE | Penstemon secundiflorus Benth. | Y | PESE1 | X | X |
| SCROPHULARIACEAE | Penstemon virens Penn. | Y | PEVI1 | X | X |
| SCROPHULARIACEAE | Penstemon virgatus Gray ssp. asa-grayi Crosswhite | Y | PEVI2 | X | X |
| SCROPHULARIACEAE | Scrophularia lanceolata Pursh. | Y | SCLA2 | X | X |
| SCROPHULARIACEAE | Verbascum blattaria L. | N | VEBL1 | X | X |
| SCROPHULARIACEAE | Verbascum thapsus L. | N | VETH1 | X | X |
| SCROPHULARIACEAE | Veronica americana (Raf.) Schwein. ex Benth. | Y | VEAM1 | X | |
| SCROPHULARIACEAE | Veronica anagallis-aquatica L. | N | VEAN1 | X | X |
| SCROPHULARIACEAE | Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren | Y | VEPE1 | X | |
| SMILACACEAE | Smilax herbacea L. var. lasioneura (Small) Rydb.. | Y | SMHE1 | | X |
| SOLANACEAE | Physalis heterophylla Nees | Y | PHHE2 | X | X |
| SOLANACEAE | Physalis virginiana P. Mill. | Y | PHVI2 | X | X |
| TYPHACEAE | Typha angustifolia L. | Y | TYAN1 | X | X |
| TYPHACEAE | Typha latifolia L. | Y | TYLA1 | X | X |
| ULMACEAE | Ulmus pumila L. | N | ULPU1 | X | X |
| URTICACEAE | Parietaria pensylvanica Muhl. ex Willd. | Y | PAPE1 | | X |
| URTICACEAE | Urtica dioica L. ssp. gracilis (Ait.) Seland. | Y | URDI1 | X | X |
| VERBENACEAE | Lippia cuneifolia (Torr.) Steud. | Y | LICU1 | X | X |
| VERBENACEAE | Verbena bracteata Lag. & Rodr. | Y | VEBR1 | X | X |
| VERBENACEAE | Verbena hastata L. | Y | VEHA1 | X | X |
| VIOLACEAE | Hybanthus verticillatus (Ort.) Baill. | Y | HYVE1 | | X |
| VIOLACEAE | Viola scopulorum (Gray) Greene | Y | VISC1 | | X |
| VIOLACEAE | Viola sororia Willd. | Y | VISO1 | X | X |
| VITACEAE | Vitis riparia Michx. | Y | VIRI1 | X | X |
| | Unknown species | | UNKN | | X |
| | Total # Species | | | 336 | 350 |
| | Sorenson Similarity Index | | | 0.88 | |

**Table 10. 1997 and 1999 Wetland Species Richness Comparison**

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| ACERACEAE | Acer negundo L. var. interius (Britt.) Sarg. | Y | ACNE1 | X | |
| AGAVACEAE | Yucca glauca Nutt. | Y | YUGL1 | X | X |
| ALISMATACEAE | Alisma trivale Pursh | Y | ALTR1 | X | |
| ALISMATACEAE | Sagittaria latifolia Willd. | Y | SALA1 | X | X |
| ANACARDIACEAE | Rhus aromatica Ait. var. trilobata (Nutt.) A. Gray | Y | RHAR1 | X | X |
| ANACARDIACEAE | Toxicodendron rydbergii (Small) Greene | Y | TORY1 | X | X |
| APIACEAE | Berula erecta (Huds.) Cov. var. incisum | Y | BEER1 | | X |
| APIACEAE | Cicuta maculata L. var. angustifolia Hook. | Y | CIMA1 | X | X |
| APIACEAE | Conium maculatum L. | N | COMA1 | X | X |
| APIACEAE | Heracleum sphondylium L. ssp. montanum (Schleich.) Briq. | Y | HESP1 | X | X |
| APIACEAE | Lomatium orientale Coult. & Rose | Y | LOOR1 | X | X |
| APIACEAE | Osmorhiza chiliensis H. & A. | Y | OSCH1 | | X |
| APOCYNACEAE | Apocynum cannabinum L. | Y | APCA1 | X | X |
| ASCLEPIADACEAE | Asclepias incarnata L. | Y | ASIN1 | X | X |
| ASCLEPIADACEAE | Asclepias speciosa Torr. | Y | ASSP1 | X | X |
| ASCLEPIADACEAE | Asclepias stenophylla A. Gray | Y | ASST1 | X | |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | Y | ACMI1 | X | X |
| ASTERACEAE | Ambrosia artemisiifolia L. | Y | AMAR1 | X | |
| ASTERACEAE | Ambrosia psilostachya DC. | Y | AMPS1 | X | X |
| ASTERACEAE | Ambrosia trifida L. | Y | AMTR1 | | X |
| ASTERACEAE | Arctium minus Bernh. | Y | ARMI1 | X | X |
| ASTERACEAE | Arnica fulgens Pursh. | Y | ARFU1 | X | X |
| ASTERACEAE | Artemisia frigida Willd. | Y | ARFR1 | X | |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | Y | ARLU1 | X | X |
| ASTERACEAE | Aster falcatus Lindl. | Y | ASFA1 | X | X |
| ASTERACEAE | Aster hesperius A. Gray var. hersperius | Y | ASHE1 | X | X |
| ASTERACEAE | Aster laevis L. var. geyeri A. Gray | Y | ASLA1 | X | X |
| ASTERACEAE | Aster porteri Gray | Y | ASPO1 | X | X |
| ASTERACEAE | Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | N | CANU1 | X | X |
| ASTERACEAE | Centaurea diffusa Lam. | N | CEDI1 | X | X |
| ASTERACEAE | Chrysopsis fulcrata Greene | Y | CHFU1 | X | X |
| ASTERACEAE | Chrysopsis villosa Pursh. | Y | CHVI1 | X | X |
| ASTERACEAE | Cirsium arvense (L.) Scop. | N | CIAR1 | X | X |
| ASTERACEAE | Cirsium vulgare (Savi) Ten. | N | CIVU1 | X | X |
| ASTERACEAE | Conyza canadensis (L.) Cronq. | Y | COCA1 | X | X |
| ASTERACEAE | Crepis runcinata (James) T. & G. | Y | CRRU1 | X | |
| ASTERACEAE | Erigeron divergens T. & G. | Y | ERDI1 | X | X |
| ASTERACEAE | Erigeron flagellaris A. Gray | Y | ERFL1 | | X |
| ASTERACEAE | Gaillardia aristata Pursh. | Y | GAAR1 | X | X |
| ASTERACEAE | Gnapthalium chilense Spreng. | Y | GNCH1 | X | X |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | Y | GRSQ1 | X | X |
| ASTERACEAE | Gutierrezia sarothrae (Pursh.) Britt. & Rusby | Y | GUSA1 | X | X |
| ASTERACEAE | Helianthus annuus L. | Y | HEAN1 | X | X |
| ASTERACEAE | Helianthus nuttallii T. & G. | Y | HENU1 | X | X |
| ASTERACEAE | Helianthus petiolaris Nutt. | Y | HEPE1 | X | X |
| ASTERACEAE | Helianthus pumilus Nutt. | Y | HEPU1 | | X |
| ASTERACEAE | Helianthus rigidus (Cass.) Desf. ssp. subrhomboideus (Rydb.) Heiser | Y | HERI1 | X | X |
| ASTERACEAE | Kuhnia eupatorioides L. | Y | KUEU1 | X | X |
| ASTERACEAE | Lactuca oblongifolia Nutt. | Y | LAOB1 | | X |
| ASTERACEAE | Lactuca serriola L. | N | LASE1 | X | X |
| ASTERACEAE | Liatris punctata Hook. | Y | LIPU1 | X | X |
| ASTERACEAE | Onopordum acanthium L. | N | ONAC1 | | X |
| ASTERACEAE | Ratibida columnifera (Nutt.) Woot. & Standl. | Y | RACO1 | X | X |
| ASTERACEAE | Scorzonera laciniata L. | N | SCLA1 | X | X |
| ASTERACEAE | Senecio integerrimus Nutt. | Y | SEIN1 | | X |
| ASTERACEAE | Senecio plattensis Nutt. | Y | SEPL1 | X | X |
| ASTERACEAE | Senecio spartioides T. & G. | Y | SESP1 | | X |
| ASTERACEAE | Solidago canadensis L. | Y | SOCA1 | X | X |

Table 10. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| ASTERACEAE | Solidago gigantea Ait. | Y | SOGI1 | X | X |
| ASTERACEAE | Solidago missouriensis Nutt. | Y | SOMI1 | X | X |
| ASTERACEAE | Solidago rigida L. | Y | SORI1 | X | X |
| ASTERACEAE | Sonchus arvensis L. ssp. uglinosus (Bieb.) Nyman | N | SOAR2 | | X |
| ASTERACEAE | Sonchus asper (L.) Hill | N | SOAS1 | X | X |
| ASTERACEAE | Taraxacum officinale Weber | N | TAOF1 | X | X |
| ASTERACEAE | Tragopogon dubius Scop. | N | TRDU1 | X | X |
| ASTERACEAE | Tragopogon porrifolius L. | N | TRPO1 | X | |
| BORAGINACEAE | Cynoglossum officinale L. | N | CYOF1 | X | X |
| BORAGINACEAE | Lithospermum multiflorum Torr. | Y | LIMU1 | | X |
| BORAGINACEAE | Mertensia lanceolata (Pursh.) A. DC. | Y | MELA1 | X | X |
| BORAGINACEAE | Onosmodium molle Michx. var. occidentale (Mack.) Johnst. | Y | ONMO1 | X | X |
| BRASSICACEAE | Alyssum alyssoides (L.) L. | N | ALAL1 | X | X |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | N | ALMI1 | X | X |
| BRASSICACEAE | Arabis glabra (L.) Bernh. | N | ARGL1 | X | X |
| BRASSICACEAE | Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins | Y | ARHI1 | X | |
| BRASSICACEAE | Barbarea vulgaris R. Br. | N | BAVU1 | X | X |
| BRASSICACEAE | Camelina microcarpa Andrz. ex DC. | N | CAMI1 | X | X |
| BRASSICACEAE | Descurainia pinnata (Walt.) Britt. | Y | DEPI1 | X | X |
| BRASSICACEAE | Descurainia richardsonii (Sweet) Schultz | Y | DERI1 | X | X |
| BRASSICACEAE | Descurainia sophia (L.) Webb ex Prantl. | N | DESO1 | X | X |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | N | LECA1 | X | X |
| BRASSICACEAE | Nasturtium officinale R. Br. | N | NAOF1 | X | X |
| BRASSICACEAE | Sisymbrium altissimum L. | N | SIAL1 | X | X |
| BRASSICACEAE | Thlaspi arvense L. | N | THAR1 | X | X |
| CACTACEAE | Opuntia fragilis (Nutt.) Haw. | Y | OPFR1 | X | X |
| CACTACEAE | Opuntia macrorhiza Engelm. | Y | OPMA1 | X | X |
| CACTACEAE | Pediocactus simpsonii (Engelm.) Britt. & Rose | Y | PESI1 | X | |
| CAMPANULACEAE | Campanula rotundifolia L. | Y | CARO1 | X | X |
| CAMPANULACEAE | Lobelia siphilitica L. var. ludoviciana A. DC. | Y | LOSI1 | X | X |
| CANNABACEAE | Humulus lupulus L. var. lupuloides E. Small | Y | HULU1 | X | X |
| CAPRIFOLIACEAE | Symphoricarpos occidentalis Hook. | Y | SYOC1 | X | X |
| CAPRIFOLIACEAE | Viburnum opulus L. var. americanum Ait | N | VIOP1 | X | |
| CARYOPHYLLACEAE | Arenaria fendleri A. Gray | Y | ARFE2 | X | |
| CARYOPHYLLACEAE | Cerastium arvense L. | Y | CEAR1 | X | X |
| CARYOPHYLLACEAE | Cerastium vulgatum L. | N | CEVU1 | X | |
| CARYOPHYLLACEAE | Silene antirrhina L. | Y | SIAN1 | X | X |
| CARYOPHYLLACEAE | Silene drummondii Hook. | Y | SIDR1 | | X |
| CARYOPHYLLACEAE | Silene pratensis (Raf.)Godr. & Gren | N | SIPR1 | X | X |
| CARYOPHYLLACEAE | Stellaria longifolia Muhl. ex Willd. | Y | STLO1 | X | X |
| CERATOPHYLLACEAE | Ceratophyllum demersum L. | Y | CEDE1 | X | X |
| CHENOPODIACEAE | Chenopodium album L. | N | CHAL1 | X | X |
| CLUSIACEAE | Hypericum majus (A. Gray) Britt. | Y | HYMA1 | X | X |
| CLUSIACEAE | Hypericum perforatum L. | N | HYPE1 | X | X |
| COMMELINACEAE | Tradescantia occidentalis (Britt.) Smyth | Y | TROC1 | X | X |
| CONVOLVULACEAE | Calystegia macouni (Greene) Brummitt | Y | CAMA1 | | X |
| CONVOLVULACEAE | Calystegia sepium (L.) R. Br. ssp. angulata Brummitt | Y | CASE1 | | X |
| CONVOLVULACEAE | Convolvulus arvensis L. | N | COAR1 | X | X |
| CYPERACEAE | Carex aurea Nutt. | Y | CAAU1 | | X |
| CYPERACEAE | Carex brevior (Dew.) Mack. ex Lunell. | Y | CABR1 | X | X |
| CYPERACEAE | Carex douglasii F. Boott. | Y | CADO1 | | X |
| CYPERACEAE | Carex eleocharis Bailey | Y | CAEL1 | X | X |
| CYPERACEAE | Carex heliophila Mack. | Y | CAHE1 | X | |
| CYPERACEAE | Carex hystericina Muhl. ex Willd. | Y | CAHY1 | X | X |
| CYPERACEAE | Carex interior Bailey | Y | CAIN1 | X | X |
| CYPERACEAE | Carex lanuginosa Michx. | Y | CALA1 | X | X |
| CYPERACEAE | Carex nebrascensis Dew. | Y | CANE1 | X | X |
| CYPERACEAE | Carex praegracilis W. Boott. | Y | CAPR1 | X | X |

Table 10. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| CYPERACEAE | Carex scoparia Schkuhr. ex Willd. | Y | CASC1 | X | |
| CYPERACEAE | Carex simulata Mack. | Y | CASI1 | X | X |
| CYPERACEAE | Eleocharis acicularis (L.) R. & S. | Y | ELAC1 | X | |
| CYPERACEAE | Eleocharis compressa Sulliv. | Y | ELCO1 | X | |
| CYPERACEAE | Eleocharis macrostachya Britt. | Y | ELMA1 | X | X |
| CYPERACEAE | Scirpus pallidus (Britt.) Fern | Y | SCPA1 | X | X |
| CYPERACEAE | Scirpus pungens Vahl | Y | SCAM1 | X | |
| CYPERACEAE | Scirpus pungens Vahl | Y | SCPU1 | | X |
| CYPERACEAE | Scirpus validus Vahl. | Y | SCVA1 | X | X |
| ELAEAGNACEAE | Elaeagnus angustifolia L. | N | ELAN1 | X | X |
| EQUISETACEAE | Equisetum laevigatum A. Br. | Y | EQLA1 | X | X |
| EUPHORBIACEAE | Euphorbia serpyllifolia Pers. | Y | EUSE1 | X | |
| FABACEAE | Amorpha fruticosa L. | Y | AMFR1 | X | X |
| FABACEAE | Astragalus agrestis Dougl. ex G. Don | Y | ASAG1 | X | X |
| FABACEAE | Astragalus drummondii Dougl. ex Hook. | Y | ASDR1 | X | |
| FABACEAE | Astragalus flexuosus (Hook.) G. Don | Y | ASFL1 | X | X |
| FABACEAE | Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinners. | Y | DACA1 | X | X |
| FABACEAE | Dalea purpurea Vent | Y | DAPU1 | X | X |
| FABACEAE | Glycyrrhiza lepidota Pursh. | Y | GLLE1 | X | X |
| FABACEAE | Lathyrus eucosmus Butters and St. John | Y | LAEU1 | X | X |
| FABACEAE | Lupinus argenteus Pursh var. argenteus | Y | LUAR1 | X | X |
| FABACEAE | Medicago lupulina L. | N | MELU1 | X | |
| FABACEAE | Melilotus alba Medic. | N | MEAL1 | X | |
| FABACEAE | Melilotus officinalis (L.) Pall. | N | MEOF1 | | X |
| FABACEAE | Oxytropis lambertii Pursh. | Y | OXLA1 | X | |
| FABACEAE | Psoralea tenuiflora Pursh. | Y | PSTE1 | X | X |
| FABACEAE | Thermopsis rhombifolia var. divaricarpa (Nels.) Isely | Y | THRH1 | X | X |
| FABACEAE | Vicia americana Muhl. ex Willd. | Y | VIAM1 | X | X |
| GENTIANACEAE | Gentiana affinis Griseb. | Y | GEAF1 | X | X |
| GENTIANACEAE | Swertia radiata (Kell.) O. Ktze. | Y | SWRA1 | X | X |
| GERANIACEAE | Erodium cicutarium (L.) L'Her. | N | ERCI1 | X | |
| GERANIACEAE | Geranium caespitosum James ssp. caespitosum | Y | GECA1 | X | X |
| GROSSULARIACEAE | Ribes aureum Pursh | Y | RIAU1 | X | X |
| HALORAGACEAE | Myriophyllum exalbescens Fern. | Y | MYEX1 | X | X |
| HYDROPHYLLACEAE | Hydrophyllum fendleri (Gray) Heller | Y | HYFE1 | X | X |
| HYDROPHYLLACEAE | Phacelia heterophylla Pursh. | Y | PHHE1 | X | X |
| IRIDACEAE | Iris missouriensis Nutt. | Y | IRMI1 | X | X |
| IRIDACEAE | Sisyrinchium montanum Greene | Y | SIMO1 | X | X |
| JUNCACEAE | Juncus articulatus L. | Y | JUAR1 | | X |
| JUNCACEAE | Juncus balticus Willd. | Y | JUBA1 | X | X |
| JUNCACEAE | Juncus dudleyi Wieg. | Y | JUDU1 | X | X |
| JUNCACEAE | Juncus ensifolius Wikst. var. montanus (Englm.) C. L. Hitchc. | Y | JUEN1 | X | X |
| JUNCACEAE | Juncus interior Wieg. | Y | JUIN1 | X | |
| JUNCACEAE | Juncus longistylis Torr. | Y | JULO1 | X | X |
| JUNCACEAE | Juncus nodosus L. | Y | JUNO1 | X | X |
| JUNCACEAE | Juncus torreyi Cov. | Y | JUTO1 | X | X |
| LAMIACEAE | Lycopus americanus Muhl. ex Barton | Y | LYAM1 | X | X |
| LAMIACEAE | Mentha arvensis L. | Y | MEAR1 | X | X |
| LAMIACEAE | Monarda fistulosa L. var. menthifolia (Grah.) Fern. | Y | MOFI1 | X | X |
| LAMIACEAE | Nepeta cataria L. | N | NECA1 | X | X |
| LAMIACEAE | Prunella vulgaris L. | Y | PRVU1 | X | X |
| LEMNACEAE | Lemna minor L. | Y | LEMI1 | X | X |
| LILIACEAE | Allium cernuum Roth | Y | ALCE1 | X | |
| LILIACEAE | Allium geyeri S. Wats. | Y | ALGE1 | | X |
| LILIACEAE | Allium textile A. Nels. & Macbr. | Y | ALTE1 | X | X |
| LILIACEAE | Asparagus officinalis L. | N | ASOF1 | X | X |
| LILIACEAE | Calochortus gunnisonii S. Wats. | Y | CAGU1 | X | X |
| LILIACEAE | Smilacina stellata (L.) Desf. | Y | SMST1 | X | X |

**Table 10. (cont.)**

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| LILIACEAE | Zigadenus venenosus Wats. var. gramineus (Rydb.) Walsh ex Peck | Y | ZIVE1 | X | X |
| LINACEAE | Linum perenne L. var. lewisii (Pursh.) Eat. & Wright | Y | LIPE1 | X | X |
| LYTHRACEAE | Lythrum alatum Pursh. | Y | LYAL1 | X | X |
| NYCTAGINACEAE | Mirabilis hirsuta (Pursh.) MacM. | Y | MIHI1 | X | |
| NYCTAGINACEAE | Mirabilis nyctaginea (Michx.) MacM. | Y | MINY1 | X | |
| ONAGRACEAE | Epilobium ciliatum Raf. ssp. glandulosum (Lehm.) Hock & Raven | Y | EPCI1 | X | X |
| ONAGRACEAE | Epilobium paniculatum Nutt. | Y | EPPA1 | X | X |
| ONAGRACEAE | Gaura coccinea Pursh. | Y | GACO1 | X | X |
| ONAGRACEAE | Gaura parviflora Dougl. | Y | GAPA1 | X | X |
| ONAGRACEAE | Oenothera villosa Thunb. ssp. strigosa (Rydb.) Dietrich & Raven | Y | OEVI1 | X | X |
| OXALIDACEAE | Oxalis dillenii Jacq. | N | OXDI1 | X | X |
| PINACEAE | Pinus ponderosa Laws | Y | PIPO1 | | X |
| PLANTAGINACE | Plantago lanceolata L. | N | PLLA1 | X | X |
| PLANTAGINACE | Plantago major L. | N | PLMA1 | | X |
| POACEAE | Aegilops cylindrica Host | N | AECY1 | | X |
| POACEAE | Agropyron caninum (L.) Beauv. ssp. majus (Vasey) C. L. Hitchc. | Y | AGCA1 | | X |
| POACEAE | Agropyron cristatum (L.) Gaertn. | N | AGCR1 | X | X |
| POACEAE | Agropyron dasystachyum (Hook.) Scribn. | Y | AGDA1 | X | X |
| POACEAE | Agropyron desertorum (Fisch.) Schult. | N | AGDE1 | X | |
| POACEAE | Agropyron intermedium (Host) Beauv. | N | AGIN1 | X | X |
| POACEAE | Agropyron repens (L.) Beauv. | N | AGRE1 | X | X |
| POACEAE | Agropyron smithii Rydb. | Y | AGSM1 | X | X |
| POACEAE | Agrostis scabra Willd. | Y | AGSC1 | X | X |
| POACEAE | Agrostis stolonifera L. | N | AGST1 | X | X |
| POACEAE | Alopecurus geniculatus L. | Y | ALGE2 | X | |
| POACEAE | Andropogon gerardii Vitman | Y | ANGE1 | X | X |
| POACEAE | Andropogon scoparius Michx. | Y | ANSC1 | X | X |
| POACEAE | Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | Y | ARLO1 | X | |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | Y | BOCU1 | X | |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | Y | BOGR1 | X | X |
| POACEAE | Bouteloua hirsuta Lag | Y | BOHI1 | X | |
| POACEAE | Bromus inermis Leyss. ssp. inermis | N | BRIN1 | X | X |
| POACEAE | Bromus japonicus Thunb. ex Murr. | N | BRJA1 | X | X |
| POACEAE | Bromus tectorum L. | N | BRTE1 | X | X |
| POACEAE | Calamagrostis stricta (Timm.) Koel | Y | CAST2 | | X |
| POACEAE | Ceratochloa marginata (Nees ex Stued.) Jackson | Y | CEMA1 | X | X |
| POACEAE | Dactylis glomerata L. | N | DAGL1 | X | X |
| POACEAE | Elymus canadensis L. | Y | ELCA1 | X | X |
| POACEAE | Festuca pratensis Huds. | Y | FEPR1 | X | X |
| POACEAE | Glyceria grandis S. Wats. ex A. Gray | Y | GLGR1 | X | |
| POACEAE | Glyceria striata (Lam.) Hitchc. | Y | GLST1 | X | X |
| POACEAE | Hordeum jubatum L. | Y | HOJU1 | X | X |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | Y | KOPY1 | X | X |
| POACEAE | Leersia oryzoides (L.) Sw. | Y | LEOR1 | | X |
| POACEAE | Muhlenbergia filiformis (Thurb.) Rydb. | Y | MUFI1 | X | X |
| POACEAE | Muhlenbergia racemosa (Michx.) B. S. P. | Y | MURA1 | X | X |
| POACEAE | Panicum virgatum L. | Y | PAVI1 | X | X |
| POACEAE | Phleum pratense L. | N | PHPR1 | X | X |
| POACEAE | Poa compressa L. | N | POCO1 | X | X |
| POACEAE | Poa palustris L. | N | POPA1 | X | |
| POACEAE | Poa pratensis L. | N | POPR1 | X | X |
| POACEAE | Sorghastrum nutans (L.) Nash | Y | SONU1 | X | X |
| POACEAE | Spartina pectinata Link | Y | SPPE1 | X | X |
| POACEAE | Sporobolus cryptandrus (Torr.) A. Gray | Y | SPCR1 | X | |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | Y | SPHE1 | X | X |
| POACEAE | Stipa comata Trin. & Rupr. | Y | STCO1 | X | X |
| POACEAE | Stipa viridula Trin. | Y | STVI1 | X | X |
| POLEMONIACEAE | Collomia linearis Nutt. | Y | COLI1 | X | X |

Table 10. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| POLYGONACEAE | Eriogonum umbellatum Torr. | Y | ERUM1 | | X |
| POLYGONACEAE | Polygonum arenastrum Jord. ex Bor. | N | POAR1 | | X |
| POLYGONACEAE | Polygonum convolvulus L. | N | POCO2 | X | X |
| POLYGONACEAE | Polygonum douglasii Greene | Y | PODO1 | X | |
| POLYGONACEAE | Polygonum hydropiper L. | N | POHY1 | | X |
| POLYGONACEAE | Polygonum pensylvanicum L. | Y | POPE1 | X | X |
| POLYGONACEAE | Polygonum persicaria L. | N | POPE2 | X | |
| POLYGONACEAE | Polygonum ramosissimum Michx. | Y | PORA1 | | X |
| POLYGONACEAE | Polygonum sawatchense Small | Y | POSA1 | X | |
| POLYGONACEAE | Rumex acetosella L. | N | RUAC1 | | X |
| POLYGONACEAE | Rumex crispus L. | N | RUCR1 | X | X |
| POLYGONACEAE | Rumex obtusifolius L. | N | RUOB1 | X | X |
| POLYGONACEAE | Rumex salicifolius Weinm. ssp. triangulivalvis Danser | Y | RUSA1 | X | |
| PORTULACACEAE | Portulaca oleracea L. | N | POOL1 | X | |
| POTAMOGETONACEAE | Potamogeton foliosus Raf. | Y | POFO1 | X | |
| POTAMOGETONACEAE | Potamogeton natans L. | Y | PONA1 | X | |
| PRIMULACEAE | Androsace occidentalis Pursh. | Y | ANOC1 | X | |
| PRIMULACEAE | Lysimachia ciliata L. | Y | LYCI1 | X | X |
| RANUNCULACEAE | Ranunculus macounii Britt. | Y | RAMA1 | X | X |
| RANUNCULACEAE | Ranunculus scleratus L. | Y | RASC1 | | X |
| RANUNCULACEAE | Ranunculus trichophyllus Chaix | Y | RATR1 | X | X |
| RANUNCULACEAE | Thalictrum dasycarpum Fisch. & Ave-Lall | Y | THDA1 | X | X |
| ROSACEAE | Agrimonia striata Michx. | Y | AGST2 | X | X |
| ROSACEAE | Crataegus erythropoda Ashe | Y | CRER1 | X | X |
| ROSACEAE | Crataegus succulenta Link var. occidentalis (Britton) E. J. Palm. | Y | CRSU1 | | X |
| ROSACEAE | Geum aleppicum Jacq. | Y | GEAL1 | X | X |
| ROSACEAE | Geum macrophyllum Willd. | Y | GEMA1 | X | X |
| ROSACEAE | Physocarpus monogynus (Torr.) Coult. | Y | PHMO1 | | X |
| ROSACEAE | Potentilla arguta Pursh | Y | POAR2 | X | |
| ROSACEAE | Potentilla gracilis Dougl. ex Hook. var. glabrata (Lehm.) C. L. Hitchc. | Y | POGR1 | X | X |
| ROSACEAE | Potentilla norvegica L. | Y | PONO1 | X | X |
| ROSACEAE | Prunus americana Marsh. | Y | PRAM1 | X | X |
| ROSACEAE | Prunus pumila L. var. besseyi (Bailey) Gl. | Y | PRPU1 | X | |
| ROSACEAE | Prunus virginiana L. var. melanocarpa (A. Nels.) Sarg. | Y | PRVI1 | X | X |
| ROSACEAE | Pyrus malus L. | N | PYMA1 | | X |
| ROSACEAE | Rosa acicularis Lindl. | Y | ROAC1 | X | |
| ROSACEAE | Rosa arkansana Porter | Y | ROAR1 | X | X |
| ROSACEAE | Rosa woodsii Lindl. | Y | ROWO1 | X | X |
| RUBIACEAE | Galium aparine L. | Y | GAAP1 | X | X |
| RUBIACEAE | Galium septentrionale Roemer & Schultes | Y | GASE1 | X | X |
| SALICACEAE | Populus deltoides Marsh. ssp. monilifera (Ait.) Eckenw. | Y | PODE1 | X | X |
| SALICACEAE | Salix amygdaloides Anderss. | Y | SAAM1 | X | X |
| SALICACEAE | Salix exigua Nutt. ssp. interior (Rowlee) Cronq. | Y | SAEX1 | X | X |
| SANTALACEAE | Comandra umbellata (L.) Nutt. | Y | COUM1 | X | X |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | N | LIDA1 | X | X |
| SCROPHULARIACEAE | Linaria vulgaris Hill | N | LIVU1 | X | X |
| SCROPHULARIACEAE | Mimulus glabratus H. B. K. var. fremontii (Benth.) A. L. Grant | Y | MIGL1 | X | X |
| SCROPHULARIACEAE | Penstemon secundiflorus Benth. | Y | PESE1 | X | X |
| SCROPHULARIACEAE | Penstemon virens Penn. | Y | PEVI1 | X | |
| SCROPHULARIACEAE | Penstemon virgatus Gray ssp. asa-grayi Crosswhite | Y | PEVI2 | X | X |
| SCROPHULARIACEAE | Scrophularia lanceolata Pursh. | Y | SCLA2 | X | X |
| SCROPHULARIACEAE | Verbascum blattaria L. | N | VEBL1 | X | X |
| SCROPHULARIACEAE | Verbascum thapsus L. | N | VETH1 | X | X |
| SCROPHULARIACEAE | Veronica americana (Raf.) Schwein. ex Benth. | Y | VEAM1 | X | |
| SCROPHULARIACEAE | Veronica anagallis-aquatica L. | N | VEAN1 | X | X |
| SOLANACEAE | Physalis heterophylla Nees | Y | PHHE2 | X | X |
| SOLANACEAE | Physalis virginiana P. Mill. | Y | PHVI2 | X | X |
| TYPHACEAE | Typha latifolia L. | Y | TYLA1 | X | X |

**Table 10. (cont.)**

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| ULMACEAE | Ulmus pumila L. | N | ULPU1 | X | X |
| URTICACEAE | Urtica dioica L. ssp. gracilis (Ait.) Seland. | Y | URDI1 | X | X |
| VERBENACEAE | Verbena bracteata Lag. & Rodr. | Y | VEBR1 | X | |
| VERBENACEAE | Verbena hastata L. | Y | VEHA1 | X | X |
| VIOLACEAE | Viola sororia Willd. | Y | VISO1 | X | X |
| | Total # Species | | | 260 | 246 |
| | Sorenson Similarity Index | | | 0.83 | |

**Table 11. 1999 Estimated Weed Infestation Acreage Summary for Rocky Flats Environmental Technology Site**

| | 1999 Acreage (Estimated) | | | | |
|---|---|---|---|---|---|
| | | Density Level | | | |
| **Common Name** | **Site Total** | **High** | **Medium** | **Low** | **Scattered** |
| Dalmatian Toadflax | 2507 | 341 | 389 | 1240 | 537 |
| Diffuse Knapweed | 2295 | 466 | 613 | 873 | 343 |
| Musk Thistle | 1353 | 1 | 311 | 684 | 357 |
| Mullein | 1068 | 130 | 204 | 450 | 284 |
| Jointed Goatgrass | 57 | NA | NA | NA | NA |
| Annual Rye | 30 | NA | NA | NA | NA |
| Scotch Thistle | 6 | NA | NA | NA | NA |
| Russian Knapweed | 1 | NA | NA | NA | NA |
| Dame's Rocket | 1 | NA | NA | NA | NA |

NA = Data not collected by density level.

**Table 12. Comparison of 1997, 1998, and 1999 Weed Infestation Extents at Rocky Flats Environmental Technology Site**

| | | | Density Level | | | |
|---|---|---|---|---|---|---|
| **Weed Species** | **Year** | **Site Total** | **High** | **Medium** | **Low** | **Scattered** |
| Diffuse Knapweed | 1997 | 2678 | 696 | 893 | 658 | 431 |
| | 1998 | 2913 | 761 | 778 | 987 | 388 |
| | 1999 | 2295 | 466 | 613 | 873 | 343 |
| Dalmatian Toadflax | 1997 | 422 | 135 | 205 | 82 | 0 |
| | 1998 | 1934 | 313 | 273 | 989 | 359 |
| | 1999 | 2507 | 341 | 389 | 1240 | 537 |
| Musk Thistle | 1997 | 474 | 2 | 270 | 202 | 0 |
| | 1998 | 1685 | 32 | 515 | 1035 | 102 |
| | 1999 | 1353 | 1 | 311 | 684 | 357 |
| Mullein | 1997 | 575 | 117 | 238 | 203 | 17 |
| | 1998 | 867 | 168 | 225 | 460 | 13 |
| | 1999 | 1068 | 130 | 204 | 450 | 284 |

All values are acreages.

See text for density level descriptions.

**Table 13. Comparison of 1998 and 1999 Diffuse Knapweed Pre- and Post-Aerial Herbicide Application Infestation Levels at Rocky Flats Environmental Technology Site**

| | | Diffuse Knapweed Density Level | | | |
|---|---|---|---|---|---|
| Year | Total | High | Medium | Low | Scattered |
| 1998 | 878 | 257 | 214 | 246 | 161 |
| 1999 | 195 | 24 | 36 | 68 | 67 |
| Change | -683 | -233 | -178 | -178 | -94 |
| Percent Change | -78 | -91 | -83 | -72 | -58 |

Values are approximate number of acres.

Total area sprayed by helicopter with Tordon 22K in 1999 was approximately 1500 acres.

**Table 14. 1997-1999 Diffuse Knapweed Herbicide Monitoring Species Richness Summary**

| | | | | DKC - Control | | | | | | DKT - Treatment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Native | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| APIACEAE | Lomatium orientale Coult. & Rose | LOOR1 | Y | X | X | X | X | X | | X | X | X | X | X | X |
| ASCLEPIADACEAE | Asclepias stenophylla A. Gray | ASST1 | Y | X | X | X | X | X | X | X | | | X | X | X |
| ASCLEPIADACEAE | Asclepias viridiflora Raf. | ASVI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | ACMI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Ambrosia psilostachya DC. | AMPS1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Antennaria parvifolia Nutt. | ANPA1 | Y | X | X | X | | X | X | X | X | X | X | X | X |
| ASTERACEAE | Arnica fulgens Pursh. | ARFU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem. | ARCA1 | Y | X | X | | X | | | X | X | X | | | |
| ASTERACEAE | Artemisia frigida Willd. | ARFR1 | Y | | | | | | | X | | | | | |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Aster porteri Gray | ASPO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | CANU1 | N | X | X | X | X | | | X | | | | | X |
| ASTERACEAE | Centaurea diffusa Lam. | CEDI1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Chrysopsis fulcrata Greene | CHFU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Chrysopsis villosa Pursh. | CHVI1 | Y | | | X | X | | | | | X | X | | |
| ASTERACEAE | Cirsium arvense (L.) Scop. | CIAR1 | N | | | | | | | X | | X | | X | |
| ASTERACEAE | Conyza canadensis (L.) Cronq. | COCA1 | Y | | | | | | | | | | | | X |
| ASTERACEAE | Erigeron divergens T. & G. | ERDI1 | Y | | | | X | X | | X | X | | X | X | |
| ASTERACEAE | Erigeron flagellaris A. Gray | ERFL1 | Y | X | X | X | X | | X | X | X | X | | | |
| ASTERACEAE | Gaillardia aristata Pursh. | GAAR1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Lactuca serriola L. | LASE1 | N | X | X | X | X | X | X | X | X | | X | X | X |
| ASTERACEAE | Liatris punctata Hook. | LIPU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Microseris cuspidata (Pursh.) Sch. Bip. | MICU1 | Y | X | | X | | X | | X | | X | | X | |
| ASTERACEAE | Scorzonera laciniata L. | SCLA1 | N | X | X | X | | X | | X | X | | | | |
| ASTERACEAE | Senecio plattensis Nutt. | SEPL1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Senecio spartioides T. & G. | SESP1 | Y | | | | | | | | X | | X | X | X |
| ASTERACEAE | Solidago mollis Bart. | SOMO1 | Y | X | X | X | X | X | X | X | X | X | X | | X |
| ASTERACEAE | Solidago rigida L. | SORI1 | Y | | X | X | X | X | X | | | | | | |
| ASTERACEAE | Taraxacum officinale Weber | TAOF1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Tragopogon dubius Scop. | TRDU1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| BORAGINACEAE | Lithospermum incisum Lehm. | LIIN1 | Y | X | X | X | | X | | | | | | | |
| BORAGINACEAE | Mertensia lanceolata (Pursh.) A. DC. | MELA1 | Y | | | X | | X | | X | | | | | |
| BRASSICACEAE | Alyssum alyssoides (L.) L. | ALAL1 | N | | | X | | | | X | | | | | |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| BRASSICACEAE | Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins | ARHI1 | Y | | | X | X | | | X | X | | | X | X |
| BRASSICACEAE | Barbarea vulgaris R. Br. | BAVU1 | N | | | | | | | X | X | X | | X | X |
| BRASSICACEAE | Camelina microcarpa Andrz. ex DC. | CAMI1 | N | X | X | X | X | X | X | X | | X | X | X | X |
| BRASSICACEAE | Draba reptans (Lam.) Fern. | DRRE1 | Y | X | X | X | | X | | | | | X | | |
| BRASSICACEAE | Erysimum capitatum (Nutt.) DC. | ERCA2 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | LECA1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| BRASSICACEAE | Lepidium densiflorum Schrad. | LEDE1 | Y | X | X | | | | | X | X | X | X | | X |
| BRASSICACEAE | Lesquerella montana (A. Gray) Wats. | LEMO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| BRASSICACEAE | Sisymbrium altissimum L. | SIAL1 | N | X | X | | | | | | | X | | X | X |
| CACTACEAE | Coryphantha missouriensis (Sweet) Britt. & Rose | COMI1 | Y | X | | | | X | | X | | | | | |
| CACTACEAE | Echinocereus viridiflorus Engelm. | ECVI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| CACTACEAE | Opuntia macrorhiza Engelm. | OPMA1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| CARYOPHYLLACEAE | Arenaria fendleri A. Gray | ARFE2 | Y | X | X | X | X | X | X | X | X | X | X | X | X |

Table 14. (cont.)

| | | | | DKC - Control | | | | | | DKT - Treatment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Native | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| CARYOPHYLLACEAE | Paronychia jamesii T. & G. | PAJA1 | Y | X | | | X | | | X | X | X | X | X | X |
| CARYOPHYLLACEAE | Silene antirrhina L. | SIAN1 | Y | X | X | X | | X | | X | X | X | X | X | X |
| CLUSIACEAE | Hypericum perforatum L. | HYPE1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| COMMELINACEAE | Tradescantia occidentalis (Britt.) Smyth | TROC1 | Y | X | | | | | | X | | X | X | X | X |
| CRASSULACEAE | Sedum lanceolatum Torr. | SELA1 | Y | | | | | | | X | X | X | X | X | X |
| CYPERACEAE | Carex heliophila Mack. | CAHE1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| CYPERACEAE | Eleocharis compressa Sulliv. | ELCO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| FABACEAE | Dalea purpurea Vent | DAPU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| FABACEAE | Medicago lupulina L. | MELU1 | N | | | | | | | X | | | | | |
| FABACEAE | Oxytropis lambertii Pursh. | OXLA1 | Y | X | | | | | X | | | | | | |
| FABACEAE | Psoralea tenuiflora Pursh. | PSTE1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| HYDROPHYLLACEAE | Phacelia heterophylla Pursh. | PHHE1 | Y | | | | | | | | X | X | X | X | X |
| JUNCACEAE | Juncus interior Wieg. | JUIN1 | Y | | X | X | X | X | X | | | X | X | X | X |
| LAMIACEAE | Hedeoma hispidum Pursh. | HEHI1 | Y | | | | | | | | | X | | | |
| LILIACEAE | Allium textile A. Nels. & Macbr. | ALTE1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| LILIACEAE | Leucocrinum montanum Nutt. | LEMO2 | Y | X | | X | | X | | | | | | | |
| ONAGRACEAE | Oenothera villosa Thunb. ssp. strigosa (Rydb.) Dietrich & Raven | OEVI1 | Y | X | X | X | X | X | X | | | | | X | X |
| OROBANCHACEAE | Orobanche fasciculata Nutt. | ORFA1 | Y | X | | | | X | | | X | X | X | X | |
| PLANTAGINACE | Plantago lanceolata L. | PLLA1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| PLANTAGINACE | Plantago patagonica Jacq. | PLPA1 | Y | | | | | | | X | | | | | |
| POACEAE | Agropyron smithii Rydb. | AGSM1 | Y | X | | | | | | | | X | | X | |
| POACEAE | Andropogon gerardii Vitman | ANGE1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Andropogon scoparius Michx. | ANSC1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | Y | | X | | | | X | | | | | | X |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | BOCU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bouteloua hirsuta Lag | BOHI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bromus inermis Leyss. ssp. inermis | BRIN1 | N | X | X | X | X | X | X | | | | | | |
| POACEAE | Bromus japonicus Thunb. ex Murr. | BRJA1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bromus tectorum L. | BRTE1 | N | | | | | | | X | X | X | X | X | X |
| POACEAE | Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | Y | | | | | | | X | X | | X | X | X |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | KOPY1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Muhlenbergia wrightii Vasey | MUWR1 | Y | | | | | | | | | X | X | X | |
| POACEAE | Panicum capillare L. | PACA1 | Y | | | | | | | | | | | | X |
| POACEAE | Poa compressa L. | POCO1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Poa pratensis L. | POPR1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | Y | X | X | | X | X | X | X | X | | X | X | X |
| POACEAE | Sorghastrum nutans (L.) Nash | SONU1 | Y | | X | X | X | | X | | X | X | X | | X |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Stipa comata Trin. & Rupr. | STCO1 | Y | | | | X | | X | | | X | | | |
| POLEMONIACEAE | Collomia linearis Nutt. | COLI1 | Y | | | | | | | X | | X | X | X | X |
| POLYGONACEAE | Eriogonum alatum Torr. | ERAL1 | Y | | | X | X | | | X | X | X | X | X | X |
| POLYGONACEAE | Polygonum arenastrum Jord. ex Bor. | POAR1 | N | | | | | | | | | | | X | |
| POLYGONACEAE | Polygonum convolvulus L. | POCO2 | N | | | X | | | | | | | | | |
| POLYGONACEAE | Polygonum ramosissimum Michx. | PORA1 | Y | | | X | X | | | | | X | X | X | X |
| POLYGONACEAE | Rumex crispus L. | RUCR1 | N | | | | | | | X | | X | X | X | X |
| PORTULACACEAE | Talinum parviflorum Nutt. | TAPA1 | Y | | X | X | X | X | X | X | | | | X | X |

Table 14. (cont.)

| | | | | DKC - Control | | | | | | DKT - Treatment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Native | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| ROSACEAE | Potentilla gracilis Dougl. ex Hook. var. glabrata (Lehm.) C. L. Hitchc. | POGR1 | Y | | | | | | | X | | | | | |
| ROSACEAE | Prunus virginiana L. var. melanocarpa (A. Nels.) Sarg. | PRVI1 | Y | X | X | X | X | X | X | | | | | | |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | LIDA1 | N | | | | | X | | | | | | | |
| SCROPHULARIACEAE | Penstemon virens Penn. | PEVI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| SCROPHULARIACEAE | Verbascum blattaria L. | VEBL1 | N | X | X | X | X | X | X | | | | | | |
| SCROPHULARIACEAE | Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren | VEPE1 | Y | | | X | X | X | | | | X | X | X | X |
| VIOLACEAE | Viola nuttallii Pursh. | VINU1 | Y | | | | | X | | | | | | | |
| | | UNKN | | | | | | | | | | | | | X |
| | # Plant Families | | | 18.0 | 18.0 | 19.0 | 18.0 | 20.0 | 16.0 | 20.0 | 17.0 | 21.0 | 20.0 | 22.0 | 22.0 |
| | # Species | | | 68.0 | 65.0 | 70.0 | 65.0 | 67.0 | 58.0 | 74.0 | 62.0 | 70.0 | 68.0 | 72.0 | 73.0 |
| | % Natives | | | 75.0 | 74.0 | 74.0 | 77.0 | 76.0 | 76.0 | 73.0 | 77.0 | 77.0 | 79.0 | 75.0 | 76.0 |

**Table 15. 1997-1999 Diffuse Knapweed Herbicide Monitoring Foliar Cover Summary - Control Data**

| | | | | | Frequency | | | | | | Absolute Foliar Cover (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| Camelina microcarpa Andrz. ex DC. | CAMI1 | F | N | | | | | 20 | | | | | | 0.2 | | |
| Centaurea diffusa Lam. | CEDI1 | F | N | | 100 | 100 | 40 | 80 | 20 | 60 | 2.6 | 4.8 | 0.4 | 1 | 0.6 | 2 |
| Hypericum perforatum L. | HYPE1 | F | N | | | 20 | | | | | | 0.2 | | | | |
| Lepidium campestre (L.) R. Br. | LECA1 | F | N | | 20 | 20 | 20 | 20 | | 20 | 0.4 | 0.2 | 0.2 | 0.2 | | 0.2 |
| Tragopogon dubius Scop. | TRDU1 | F | N | | 40 | 20 | 60 | | 20 | 20 | 0.4 | 0.2 | 0.6 | | 0.2 | 0.2 |
| Allium textile A. Nels. & Macbr. | ALTE1 | F | Y | | | | | | | | | | | | | |
| Ambrosia psilostachya DC. | AMPS1 | F | Y | | 60 | 60 | 100 | 80 | 80 | 60 | 1.2 | 0.6 | 1.2 | 1.4 | 1.8 | 1.4 |
| Arenaria fendleri A. Gray | ARFE2 | F | Y | | 40 | 20 | | 40 | 20 | 40 | 0.4 | 0.2 | | 0.4 | 0.6 | 0.4 |
| Arnica fulgens Pursh. | ARFU1 | F | Y | | 20 | | 20 | | | 20 | 0.2 | | 0.2 | | | 0.2 |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 100 | 20 | 40 | 40 | 40 | 40 | 1 | 0.2 | 0.6 | 0.4 | 0.6 | 0.4 |
| Asclepias stenophylla A. Gray | ASST1 | F | Y | | 20 | 20 | | | | 40 | 0.2 | 0.2 | | | | 0.4 |
| Aster porteri Gray | ASPO1 | F | Y | | 100 | 100 | 100 | 100 | 100 | 100 | 2.6 | 2 | 5.4 | 4.6 | 4.6 | 5.6 |
| Dalea purpurea Vent | DAPU1 | F | Y | | | 20 | 20 | | 20 | 20 | | 0.2 | 0.2 | | 0.2 | 0.2 |
| Erigeron divergens T. & G. | ERDI1 | F | Y | | | | | | 40 | | | | | | 0.4 | |
| Erigeron flagellaris A. Gray | ERFL1 | F | Y | | | 20 | 20 | | | | | 0.2 | 0.2 | | | |
| Gaillardia aristata Pursh. | GAAR1 | F | Y | | | 20 | | | 20 | | | 0.2 | | | 0.2 | |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | F | Y | | 40 | 80 | | 20 | | | 0.4 | 1.2 | | 0.2 | | |
| Liatris punctata Hook. | LIPU1 | F | Y | | 20 | | | | | | 0.2 | | | | | |
| Lomatium orientale Coult. & Rose | LOOR1 | F | Y | | | | 60 | | 40 | | | | 0.8 | | 0.4 | |
| Psoralea tenuiflora Pursh. | PSTE1 | F | Y | | 40 | 80 | 40 | 80 | 20 | 100 | 0.8 | 1.4 | 0.8 | 1.6 | 0.2 | 1.4 |
| Silene antirrhina L. | SIAN1 | F | Y | | 20 | | | | | | 0.2 | | | | | |
| Poa compressa L. | POCO1 | G | N | C | 100 | 100 | 100 | 100 | 100 | 100 | 17.2 | 20.8 | 25.4 | 31.8 | 19.2 | 24.2 |
| Poa pratensis L. | POPR1 | G | N | C | 20 | 40 | 40 | 20 | | | 0.4 | 0.6 | 0.8 | 0.2 | | |
| Carex heliophila Mack. | CAHE1 | G | Y | C | 60 | 100 | 80 | 80 | 60 | 60 | 0.6 | 1.6 | 2 | 2 | 2 | 1.2 |
| Eleocharis compressa Sulliv. | ELCO1 | G | Y | C | 20 | | 20 | | | 20 | 0.4 | | 0.2 | | | 0.2 |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | 40 | 20 | 20 | 20 | 40 | 40 | 0.4 | 0.2 | 0.2 | 0.2 | 0.4 | 0.4 |
| Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | G | Y | C | | 20 | | | 20 | | | 0.2 | | | 0.2 | |
| Andropogon gerardii Vitman | ANGE1 | G | Y | W | 100 | 100 | 100 | 100 | 100 | 100 | 8.6 | 11 | 7.2 | 12.2 | 6.6 | 12 |
| Andropogon scoparius Michx. | ANSC1 | G | Y | W | 20 | 20 | 20 | | | 60 | 0.4 | 0.2 | 0.2 | | | 0.6 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 40 | 80 | 40 | 80 | 40 | 60 | 0.4 | 1.8 | 1 | 0.8 | 1.2 | 2 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 20 | | | 20 | 20 | 20 | 0.4 | | | 0.2 | 0.2 | 0.4 |
| Bouteloua hirsuta Lag | BOHI1 | G | Y | W | | | 20 | | 20 | 40 | | | 0.2 | | 0.2 | 0.4 |
| Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | G | Y | W | 100 | 100 | 100 | 100 | 100 | 100 | 23.2 | 24.4 | 23.2 | 22.2 | 19.6 | 23.4 |
| Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | G | Y | W | 100 | 100 | 100 | 100 | 100 | 100 | 5.6 | 6.2 | 4.8 | 6 | 5.6 | 6.4 |
| Total foliar cover | | | | | | | | | | | 68.2 | 78.8 | 75.8 | 85.6 | 65.0 | 83.6 |
| Total forb cover | | | | | | | | | | | 10.6 | 11.8 | 10.6 | 10.0 | 9.8 | 12.4 |
| Total native forb cover | | | | | | | | | | | 7.2 | 6.4 | 9.4 | 8.6 | 9.0 | 10.0 |
| Total non-native forb cover | | | | | | | | | | | 3.4 | 5.4 | 1.2 | 1.4 | 0.8 | 2.4 |
| Total graminoid cover | | | | | | | | | | | 57.6 | 67.0 | 65.2 | 75.6 | 55.2 | 71.2 |
| Total native cover | | | | | | | | | | | 47.2 | 52.0 | 48.4 | 52.2 | 45.0 | 57.0 |
| Total non-native cover | | | | | | | | | | | 21.0 | 26.8 | 27.4 | 33.4 | 20.0 | 26.6 |
| Total warm-season graminoid cover | | | | | | | | | | | 38.6 | 43.6 | 36.6 | 41.4 | 33.4 | 45.2 |
| Total cool-season graminoid cover | | | | | | | | | | | 19.0 | 23.4 | 28.6 | 34.2 | 21.8 | 26.0 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (500).
Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).
All cover values presented are means (n = 5).
Native categories: Y = Native, N = Non-Native
Form categories: C = Cactus, F = Forb, G = Graminoid
Cool/Warm Season categories: C = Cool season species, W = Warm season species

Table 15. (cont.)

| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | Relative Foliar Cover (%) Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| Camelina microcarpa Andrz. ex DC. | CAMI1 | F | N | | | | | 0.2 | | |
| Centaurea diffusa Lam. | CEDI1 | F | N | | 3.8 | 6.1 | 0.5 | 1.2 | 0.9 | 2.4 |
| Hypericum perforatum L. | HYPE1 | F | N | | | 0.3 | | | | |
| Lepidium campestre (L.) R. Br. | LECA1 | F | N | | 0.6 | 0.3 | 0.3 | 0.2 | | 0.2 |
| Tragopogon dubius Scop. | TRDU1 | F | N | | 0.6 | 0.3 | 0.8 | | 0.3 | 0.2 |
| Allium textile A. Nels. & Macbr. | ALTE1 | F | Y | | | | | | | |
| Ambrosia psilostachya DC. | AMPS1 | F | Y | | 1.8 | 0.8 | 1.6 | 1.6 | 2.8 | 1.7 |
| Arenaria fendleri A. Gray | ARFE2 | F | Y | | 0.6 | 0.3 | | 0.5 | 0.9 | 0.5 |
| Arnica fulgens Pursh. | ARFU1 | F | Y | | 0.3 | | 0.3 | | | 0.2 |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 1.5 | 0.3 | 0.8 | 0.5 | 0.9 | 0.5 |
| Asclepias stenophylla A. Gray | ASST1 | F | Y | | 0.3 | 0.3 | | | | 0.5 |
| Aster porteri Gray | ASPO1 | F | Y | | 3.8 | 2.5 | 7.1 | 5.4 | 7.1 | 6.7 |
| Dalea purpurea Vent | DAPU1 | F | Y | | | 0.3 | 0.3 | | 0.3 | 0.2 |
| Erigeron divergens T. & G. | ERDI1 | F | Y | | | | | | 0.6 | |
| Erigeron flagellaris A. Gray | ERFL1 | F | Y | | | 0.3 | 0.3 | | | |
| Gaillardia aristata Pursh. | GAAR1 | F | Y | | | 0.3 | | | 0.3 | |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | F | Y | | 0.6 | 1.5 | | 0.2 | | |
| Liatris punctata Hook. | LIPU1 | F | Y | | 0.3 | | | | | |
| Lomatium orientale Coult. & Rose | LOOR1 | F | Y | | | | 1.1 | | 0.6 | |
| Psoralea tenuiflora Pursh. | PSTE1 | F | Y | | 1.2 | 1.8 | 1.1 | 1.9 | 0.3 | 1.7 |
| Silene antirrhina L. | SIAN1 | F | Y | | 0.3 | | | | | |
| Poa compressa L. | POCO1 | G | N | C | 25.2 | 26.4 | 33.5 | 37.1 | 29.5 | 28.9 |
| Poa pratensis L. | POPR1 | G | N | C | 0.6 | 0.8 | 1.1 | 0.2 | | |
| Carex heliophila Mack. | CAHE1 | G | Y | C | 0.9 | 2.0 | 2.6 | 2.3 | 3.1 | 1.4 |
| Eleocharis compressa Sulliv. | ELCO1 | G | Y | C | 0.6 | | 0.3 | | | 0.2 |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | 0.6 | 0.3 | 0.3 | 0.2 | 0.6 | 0.5 |
| Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | G | Y | C | | 0.3 | | | 0.3 | |
| Andropogon gerardii Vitman | ANGE1 | G | Y | W | 12.6 | 14.0 | 9.5 | 14.3 | 10.2 | 14.4 |
| Andropogon scoparius Michx. | ANSC1 | G | Y | W | 0.6 | 0.3 | 0.3 | | | 0.7 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 0.6 | 2.3 | 1.3 | 0.9 | 1.8 | 2.4 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 0.6 | | | 0.2 | 0.3 | 0.5 |
| Bouteloua hirsuta Lag | BOHI1 | G | Y | W | | | 0.3 | | 0.3 | 0.5 |
| Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | G | Y | W | 34.0 | 31.0 | 30.6 | 25.9 | 30.2 | 28.0 |
| Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | G | Y | W | 8.2 | 7.9 | 6.3 | 7.0 | 8.6 | 7.7 |
| Total foliar cover | | | | | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Total forb cover | | | | | 15.5 | 15.0 | 14.0 | 11.7 | 15.1 | 14.8 |
| Total native forb cover | | | | | 10.6 | 8.1 | 12.4 | 10.0 | 13.8 | 12.0 |
| Total non-native forb cover | | | | | 5.0 | 6.9 | 1.6 | 1.6 | 1.2 | 2.9 |
| Total graminoid cover | | | | | 84.5 | 85.0 | 86.0 | 88.3 | 84.9 | 85.2 |
| Total native cover | | | | | 69.2 | 66.0 | 63.9 | 61.0 | 69.2 | 68.2 |
| Total non-native cover | | | | | 30.8 | 34.0 | 36.1 | 39.0 | 30.8 | 31.8 |
| Total warm-season graminoid cover | | | | | 56.6 | 55.3 | 48.3 | 48.4 | 51.4 | 54.1 |
| Total cool-season graminoid cover | | | | | 27.9 | 29.7 | 37.7 | 40.0 | 33.5 | 31.1 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (500).
Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).
All cover values presented are means (n = 5).
Native categories: Y = Native, N = Non-Native
Form categories: C = Cactus, F = Forb, G = Graminoid
Cool/Warm Season categories: C = Cool season species, W = Warm season species

**Table 16. 1997-1999 Diffuse Knapweed Herbicide Monitoring Foliar Cover Summary - Treatment Data**

| | | | | | Frequency | | | | | | Absolute Foliar Cover (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | F | N | | | | | | 20 | 20 | | | | | 0.2 | 0.2 |
| Centaurea diffusa Lam. | CEDI1 | F | N | | 100 | 100 | | | | 20 | 4.4 | 4.8 | | | | 0.6 |
| Hypericum perforatum L. | HYPE1 | F | N | | 20 | 20 | | | | | 0.2 | 0.2 | | | | |
| Lactuca serriola L. | LASE1 | F | N | | | | | | | 20 | | | | | | 0.2 |
| Lepidium campestre (L.) R. Br. | LECA1 | F | N | | 20 | | | | | | 0.2 | | | | | |
| Plantago lanceolata L. | PLLA1 | F | N | | 20 | | | | | | 0.2 | | | | | |
| Tragopogon dubius Scop. | TRDU1 | F | N | | 20 | | | | | 40 | 0.2 | | | | | 0.4 |
| Allium textile A. Nels. & Macbr. | ALTE1 | F | Y | | 20 | 20 | 20 | | | | 0.2 | 0.2 | 0.2 | | | |
| Ambrosia psilostachya DC. | AMPS1 | F | Y | | 80 | | | | | 20 | 1.6 | | | | | 0.2 |
| Arenaria fendleri A. Gray | ARFE2 | F | Y | | 20 | | | | | | 0.4 | | | | | |
| Arnica fulgens Pursh. | ARFU1 | F | Y | | 60 | 20 | 20 | 40 | 40 | | 0.6 | 0.2 | 0.4 | 0.4 | 0.8 | |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 20 | 60 | | 60 | | 60 | 0.4 | 1 | | 0.6 | | 0.6 |
| Asclepias stenophylla A. Gray | ASST1 | F | Y | | 20 | | | 20 | | | 0.2 | | | 0.2 | | |
| Aster porteri Gray | ASPO1 | F | Y | | 80 | 100 | 60 | 60 | 60 | 80 | 2 | 2 | 1.8 | 2.6 | 2.6 | 3.2 |
| Dalea purpurea Vent | DAPU1 | F | Y | | | 20 | 20 | | | | | 0.2 | 0.2 | | | |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | F | Y | | 60 | 20 | 20 | | 20 | | 0.6 | 0.2 | 0.2 | | 0.2 | |
| Lesquerella montana (A. Gray) Wats. | LEMO1 | F | Y | | | | | | | 20 | | | | | | 0.2 |
| Liatris punctata Hook. | LIPU1 | F | Y | | 20 | | 20 | | | 40 | 0.2 | | 0.2 | | | 0.6 |
| Lomatium orientale Coult. & Rose | LOOR1 | F | Y | | 60 | | 80 | | 80 | | 0.8 | | 1.6 | | 1.2 | |
| Penstemon virens Penn. | PEVI1 | F | Y | | | | 20 | | | | | | 0.2 | | | |
| Senecio plattensis Nutt. | SEPL1 | F | Y | | | | 20 | | | | | | 0.2 | | | |
| Senecio spartioides T. & G. | SESP1 | F | Y | | | | | | | 20 | | | | | | 0.2 |
| Tradescantia occidentalis (Britt.) Smyth | TROC1 | F | Y | | | | | | 20 | | | | | | 0.4 | |
| Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren | VEPE1 | F | Y | | | | | | 20 | | | | | | 0.2 | |
| Bromus japonicus Thunb. ex Murr. | BRJA1 | G | N | C | 60 | 80 | 40 | 60 | 40 | 40 | 2.2 | 2.4 | 2 | 2.2 | 1.2 | 0.8 |
| Bromus tectorum L. | BRTE1 | G | N | C | 20 | | 40 | 40 | | 20 | 1.8 | | 1.2 | 0.6 | | 0.6 |
| Poa compressa L. | POCO1 | G | N | C | 100 | 100 | 100 | 100 | 100 | 100 | 12.2 | 12.4 | 25 | 31.6 | 23.8 | 22.8 |
| Poa pratensis L. | POPR1 | G | N | C | 20 | 20 | 20 | | | | 0.2 | 0.4 | 0.2 | | | |
| Carex heliophila Mack. | CAHE1 | G | Y | C | 60 | 40 | 60 | 40 | 40 | 40 | 0.8 | 1.2 | 0.8 | 0.8 | 0.6 | 0.8 |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | 40 | 20 | | | 20 | | 0.2 | 0.2 | | | 0.2 | |
| Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | G | Y | C | | | | 20 | | 20 | | | | 0.2 | | 0.2 |
| Andropogon gerardii Vitman | ANGE1 | G | Y | W | 80 | 100 | 80 | 100 | 100 | 100 | 5 | 8.2 | 5.4 | 7.8 | 4.6 | 10.2 |
| Andropogon scoparius Michx. | ANSC1 | G | Y | W | 80 | 60 | 80 | 60 | 40 | 40 | 1.6 | 1 | 1 | 1 | 0.8 | 1.4 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 60 | 40 | 60 | 20 | 60 | 80 | 0.8 | 0.4 | 1.4 | 0.2 | 1.6 | 2 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 40 | 20 | 80 | | | 80 | 0.6 | 0.2 | 1.2 | | | 0.8 |
| Bouteloua hirsuta Lag | BOHI1 | G | Y | W | 80 | | | 20 | 40 | | 0.8 | | | 0.2 | 0.6 | |
| Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | G | Y | W | 100 | 100 | 100 | 100 | 100 | 100 | 26.4 | 35.2 | 31.6 | 32.6 | 23 | 32.6 |
| Sorghastrum nutans (L.) Nash | SONU1 | G | Y | W | | | | | | 20 | | | | | | 0.2 |
| Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | G | Y | W | 60 | 20 | 40 | 40 | 40 | 40 | 1.6 | 0.6 | 0.6 | 0.6 | 0.8 | 1 |
| Total foliar cover | | | | | | | | | | | 66.4 | 71.0 | 75.4 | 81.6 | 62.8 | 79.8 |
| Total forb cover | | | | | | | | | | | 12.2 | 8.8 | 5.0 | 3.8 | 5.6 | 6.4 |
| Total native forb cover | | | | | | | | | | | 7.0 | 3.8 | 5.0 | 3.8 | 5.4 | 5.0 |
| Total non-native forb cover | | | | | | | | | | | 5.2 | 5.0 | 0.0 | 0.0 | 0.2 | 1.4 |
| Total graminoid cover | | | | | | | | | | | 54.2 | 62.2 | 70.4 | 77.8 | 57.2 | 73.4 |

Table 16. (cont.)

| | | | | | Frequency | | | | | | Absolute Foliar Cover (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| Total native cover | | | | | | | | | | | 44.8 | 50.8 | 47.0 | 47.2 | 37.6 | 54.2 |
| Total non-native cover | | | | | | | | | | | 21.6 | 20.2 | 28.4 | 34.4 | 25.2 | 25.6 |
| Total warm-season graminoid cover | | | | | | | | | | | 36.8 | 45.6 | 41.2 | 42.4 | 31.4 | 48.2 |
| Total cool-season graminoid cover | | | | | | | | | | | 17.4 | 16.6 | 29.2 | 35.4 | 25.8 | 25.2 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (500).
Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).
All cover values presented are means (n = 5).
Native categories: Y = Native, N = Non-Native
Form categories: C = Cactus, F = Forb, G = Graminoid
Cool/Warm Season categories: C = Cool season species, W = Warm season species

Table 16. (cont.)

| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | Relative Foliar Cover (%) Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | F | N | | | | | | 0.3 | 0.3 |
| Centaurea diffusa Lam. | CEDI1 | F | N | | 6.6 | 6.8 | | | | 0.8 |
| Hypericum perforatum L. | HYPE1 | F | N | | 0.3 | 0.3 | | | | |
| Lactuca serriola L. | LASE1 | F | N | | | | | | | 0.3 |
| Lepidium campestre (L.) R. Br. | LECA1 | F | N | | 0.3 | | | | | |
| Plantago lanceolata L. | PLLA1 | F | N | | 0.3 | | | | | |
| Tragopogon dubius Scop. | TRDU1 | F | N | | 0.3 | | | | | 0.5 |
| Allium textile A. Nels. & Macbr. | ALTE1 | F | Y | | 0.3 | 0.3 | 0.3 | | | |
| Ambrosia psilostachya DC. | AMPS1 | F | Y | | 2.4 | | | | | 0.3 |
| Arenaria fendleri A. Gray | ARFE2 | F | Y | | 0.6 | | | | | |
| Arnica fulgens Pursh. | ARFU1 | F | Y | | 0.9 | 0.3 | 0.5 | 0.5 | 1.3 | |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 0.6 | 1.4 | | 0.7 | | 0.8 |
| Asclepias stenophylla A. Gray | ASST1 | F | Y | | 0.3 | | | 0.2 | | |
| Aster porteri Gray | ASPO1 | F | Y | | 3.0 | 2.8 | 2.4 | 3.2 | 4.1 | 4.0 |
| Dalea purpurea Vent | DAPU1 | F | Y | | | 0.3 | 0.3 | | | |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | F | Y | | 0.9 | 0.3 | 0.3 | | 0.3 | |
| Lesquerella montana (A. Gray) Wats. | LEMO1 | F | Y | | | | | | | 0.3 |
| Liatris punctata Hook. | LIPU1 | F | Y | | 0.3 | | 0.3 | | | 0.8 |
| Lomatium orientale Coult. & Rose | LOOR1 | F | Y | | 1.2 | | 2.1 | | 1.9 | |
| Penstemon virens Penn. | PEVI1 | F | Y | | | | 0.3 | | | |
| Senecio plattensis Nutt. | SEPL1 | F | Y | | | | 0.3 | | | |
| Senecio spartioides T. & G. | SESP1 | F | Y | | | | | | | 0.3 |
| Tradescantia occidentalis (Britt.) Smyth | TROC1 | F | Y | | | | | | 0.6 | |
| Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren | VEPE1 | F | Y | | | | | | 0.3 | |
| Bromus japonicus Thunb. ex Murr. | BRJA1 | G | N | C | 3.3 | 3.4 | 2.7 | 2.7 | 1.9 | 1.0 |
| Bromus tectorum L. | BRTE1 | G | N | C | 2.7 | | 1.6 | 0.7 | | 0.8 |
| Poa compressa L. | POCO1 | G | N | C | 18.4 | 17.5 | 33.2 | 38.7 | 37.9 | 28.6 |
| Poa pratensis L. | POPR1 | G | N | C | 0.3 | 0.6 | 0.3 | | | |
| Carex heliophila Mack. | CAHE1 | G | Y | C | 1.2 | 1.7 | 1.1 | 1.0 | 1.0 | 1.0 |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | 0.3 | 0.3 | | | 0.3 | |
| Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | G | Y | C | | | | 0.2 | | 0.3 |
| Andropogon gerardii Vitman | ANGE1 | G | Y | W | 7.5 | 11.5 | 7.2 | 9.6 | 7.3 | 12.8 |
| Andropogon scoparius Michx. | ANSC1 | G | Y | W | 2.4 | 1.4 | 1.3 | 1.2 | 1.3 | 1.8 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 1.2 | 0.6 | 1.9 | 0.2 | 2.5 | 2.5 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 0.9 | 0.3 | 1.6 | | | 1.0 |
| Bouteloua hirsuta Lag | BOHI1 | G | Y | W | 1.2 | | | 0.2 | 1.0 | |
| Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | G | Y | W | 39.8 | 49.6 | 41.9 | 40.0 | 36.6 | 40.9 |
| Sorghastrum nutans (L.) Nash | SONU1 | G | Y | W | | | | | | 0.3 |
| Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | G | Y | W | 2.4 | 0.8 | 0.8 | 0.7 | 1.3 | 1.3 |
| Total foliar cover | | | | | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Total forb cover | | | | | 18.4 | 12.4 | 6.6 | 4.7 | 8.9 | 8.0 |
| Total native forb cover | | | | | 10.5 | 5.4 | 6.6 | 4.7 | 8.6 | 6.3 |
| Total non-native forb cover | | | | | 7.8 | 7.0 | 0.0 | 0.0 | 0.3 | 1.8 |
| Total graminoid cover | | | | | 81.6 | 87.6 | 93.4 | 95.3 | 91.1 | 92.0 |

Table 16. (cont.)

| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | Relative Foliar Cover (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| Total native cover | | | | | 67.5 | 71.5 | 62.3 | 57.8 | 59.9 | 67.9 |
| Total non-native cover | | | | | 32.5 | 28.5 | 37.7 | 42.2 | 40.1 | 32.1 |
| Total warm-season graminoid cover | | | | | 55.4 | 64.2 | 54.6 | 52.0 | 50.0 | 60.4 |
| Total cool-season graminoid cover | | | | | 26.2 | 23.4 | 38.7 | 43.4 | 41.1 | 31.6 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (500).
Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).
All cover values presented are means (n = 5).
Native categories: Y = Native, N = Non-Native
Form categories: C = Cactus, F = Forb, G = Graminoid
Cool/Warm Season categories: C = Cool season species, W = Warm season species

**Table 17. 1997-1999 Diffuse Knapweed Monitoring Species Frequency Data Summary**

| | | | Frequency (%) at DKC - Control | | | | | | Frequency (%) at DKT - Treatment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| APIACEAE | Lomatium orientale Coult. & Rose | LOOR1 | 92 | | 92 | 48 | 100 | | 80 | 8 | 92 | 72 | 92 | 24 |
| ASCLEPIADACEAE | Asclepias stenophylla A. Gray | ASST1 | 8 | 4 | | | 4 | 4 | | | | | | |
| ASCLEPIADACEAE | Asclepias viridiflora Raf. | ASVI1 | 8 | 12 | 8 | 8 | 12 | 12 | | | | | | |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | ACMI1 | 8 | 8 | 8 | 4 | 8 | 4 | | | | | | |
| ASTERACEAE | Ambrosia psilostachya DC. | AMPS1 | 72 | 68 | 64 | 68 | 64 | 60 | 32 | 32 | 12 | 16 | 16 | 12 |
| ASTERACEAE | Arnica fulgens Pursh. | ARFU1 | 36 | 16 | 40 | 28 | 40 | 12 | 16 | 12 | 16 | 12 | 20 | 8 |
| ASTERACEAE | Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem. | ARCA1 | | | | | | | 4 | 4 | 4 | | | |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | 68 | 68 | 68 | 64 | 68 | 64 | 36 | 36 | 32 | 16 | 24 | 16 |
| ASTERACEAE | Aster porteri Gray | ASPO1 | 76 | 76 | 84 | 76 | 76 | 76 | 80 | 84 | 80 | 72 | 80 | 72 |
| ASTERACEAE | Centaurea diffusa Lam. | CEDI1 | 76 | 76 | 76 | 60 | 96 | 64 | 80 | 60 | 52 | 20 | 44 | 44 |
| ASTERACEAE | Chrysopsis fulcrata Greene | CHFU1 | 8 | 8 | 8 | 4 | 4 | 4 | | | | | 4 | 4 |
| ASTERACEAE | Erigeron divergens T. & G. | ERDI1 | | | | | 4 | | 4 | | | | | |
| ASTERACEAE | Erigeron flagellaris A. Gray | ERFL1 | 4 | 4 | 4 | 4 | | 4 | | 4 | | | | |
| ASTERACEAE | Gaillardia aristata Pursh. | GAAR1 | 12 | 4 | 8 | 4 | 12 | 8 | 8 | 4 | | 4 | 4 | 4 |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | 56 | 48 | 68 | 40 | 40 | 32 | 20 | 16 | 12 | | 12 | 4 |
| ASTERACEAE | Lactuca serriola L. | LASE1 | 12 | 12 | 28 | 8 | 20 | 4 | 20 | 8 | | | 28 | 16 |
| ASTERACEAE | Liatris punctata Hook. | LIPU1 | 16 | 20 | 20 | 28 | 24 | 24 | 20 | 20 | 28 | 20 | 28 | 24 |
| ASTERACEAE | Microseris cuspidata (Pursh.) Sch. Bip. | MICU1 | 4 | | 8 | | 4 | | 4 | | 4 | | 8 | |
| ASTERACEAE | Scorzonera laciniata L. | SCLA1 | | | | | | | 4 | 4 | | | | |
| ASTERACEAE | Senecio plattensis Nutt. | SEPL1 | 8 | 4 | 4 | | 16 | 4 | 24 | 12 | 20 | 4 | 12 | 4 |
| ASTERACEAE | Solidago mollis Bart. | SOMO1 | 24 | 24 | 28 | 28 | 28 | 24 | | | | | | |
| ASTERACEAE | Taraxacum officinale Weber | TAOF1 | | | | | | | 4 | | | | | |
| ASTERACEAE | Tragopogon dubius Scop. | TRDU1 | 8 | 16 | 44 | 32 | 32 | 20 | 12 | 8 | | 4 | 8 | 4 |
| BORAGINACEAE | Lithospermum incisum Lehm. | LIIN1 | 4 | 4 | | | | | | | | | | |
| BORAGINACEAE | Mertensia lanceolata (Pursh.) A. DC. | MELA1 | | | 4 | | | | 4 | | | | | |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | 28 | 20 | 12 | 16 | 20 | 8 | 4 | 4 | 16 | 4 | 8 | 4 |
| BRASSICACEAE | Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins | ARHI1 | | | | | | | 4 | | | | 4 | 4 |
| BRASSICACEAE | Barbarea vulgaris R. Br. | BAVU1 | | | | | | | 4 | | | | | |
| BRASSICACEAE | Camelina microcarpa Andrz. ex DC. | CAMI1 | 8 | | | | 8 | 4 | | | | | 4 | |
| BRASSICACEAE | Draba reptans (Lam.) Fern. | DRRE1 | 16 | 4 | 4 | | 12 | | | | | 4 | | |
| BRASSICACEAE | Erysimum capitatum (Nutt.) DC. | ERCA2 | 8 | 4 | 8 | | 4 | | 4 | | | | 8 | 8 |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | LECA1 | | 4 | 4 | 4 | 12 | 8 | 16 | 8 | 16 | 12 | 20 | 12 |
| BRASSICACEAE | Lepidium densiflorum Schrad. | LEDE1 | 4 | 4 | | | | | 12 | 8 | | | | |
| BRASSICACEAE | Lesquerella montana (A. Gray) Wats. | LEMO1 | 8 | 8 | 12 | 16 | 28 | 16 | 12 | 16 | 12 | 12 | 20 | 20 |
| CACTACEAE | Echinocereus viridiflorus Engelm. | ECVI1 | 16 | 16 | 20 | 8 | 8 | 4 | 40 | 36 | 28 | 32 | 28 | 24 |
| CACTACEAE | Opuntia macrorhiza Engelm. | OPMA1 | 40 | 40 | 40 | 40 | 36 | 32 | 64 | 76 | 20 | 32 | 24 | 28 |
| CARYOPHYLLACEAE | Arenaria fendleri A. Gray | ARFE2 | 32 | 44 | 20 | 44 | 32 | 36 | 52 | 40 | 28 | 28 | 28 | 24 |
| CARYOPHYLLACEAE | Paronychia jamesii T. & G. | PAJA1 | | | | | | | 12 | 12 | 4 | 4 | 4 | 4 |
| CARYOPHYLLACEAE | Silene antirrhina L. | SIAN1 | 8 | 8 | 4 | | 12 | | 4 | | 28 | | 24 | 8 |
| CLUSIACEAE | Hypericum perforatum L. | HYPE1 | 52 | 64 | 44 | 16 | 24 | 16 | 16 | 8 | 72 | 12 | 36 | 24 |
| COMMELINACEAE | Tradescantia occidentalis (Britt.) Smyth | TROC1 | | | | | | | 4 | | 4 | | 4 | 4 |
| CYPERACEAE | Carex heliophila Mack. | CAHE1 | 64 | 72 | 72 | 68 | 56 | 60 | 32 | 40 | 52 | 40 | 36 | 28 |
| FABACEAE | Dalea purpurea Vent | DAPU1 | 8 | 4 | 8 | 8 | 8 | 8 | 12 | 12 | 8 | 12 | 12 | 12 |
| FABACEAE | Psoralea tenuiflora Pursh. | PSTE1 | 32 | 40 | 44 | 36 | 36 | 44 | 20 | 8 | 16 | 16 | 12 | 16 |
| JUNCACEAE | Juncus interior Wieg. | JUIN1 | | 4 | | 4 | | 4 | | | | 4 | | |

Table 17. (cont.)

| | | | Frequency (%) at DKC - Control | | | | | | Frequency (%) at DKT - Treatment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| LILIACEAE | Allium textile A. Nels. & Macbr. | ALTE1 | 20 | 4 | 8 | | 8 | | 36 | 12 | 24 | 12 | 28 | 16 |
| ONAGRACEAE | Oenothera villosa Thunb. ssp. strigosa (Rydb.) Dietrich & Raven | OEVI1 | | | 4 | | | | | | | | 4 | 4 |
| OROBANCHACEAE | Orobanche fasciculata Nutt. | ORFA1 | | | | | 4 | | | 4 | 4 | 4 | 20 | |
| POACEAE | Andropogon gerardii Vitman | ANGE1 | 88 | 88 | 88 | 84 | 88 | 92 | 68 | 64 | 64 | 64 | 64 | 68 |
| POACEAE | Andropogon scoparius Michx. | ANSC1 | 28 | 28 | 20 | 24 | 16 | 36 | 20 | 40 | 20 | 20 | 20 | 28 |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | BOCU1 | 36 | 40 | 28 | 28 | 40 | 40 | 8 | 32 | 28 | 12 | 24 | 32 |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | | 16 | 8 | 8 | 8 | 20 | 16 | 28 | 16 | 24 | 36 | 48 |
| POACEAE | Bouteloua hirsuta Lag | BOHI1 | 16 | 16 | 16 | 28 | 16 | 20 | 16 | | | 4 | 8 | 20 |
| POACEAE | Bromus japonicus Thunb. ex Murr. | BRJA1 | | | 4 | 4 | 4 | | 36 | 32 | 32 | 36 | 40 | 24 |
| POACEAE | Bromus tectorum L. | BRTE1 | | | | | | | 8 | 4 | 12 | 8 | | 12 |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | KOPY1 | 40 | 32 | 28 | 20 | 28 | 24 | 36 | 20 | 28 | 20 | 20 | 32 |
| POACEAE | Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | 100 | 100 | 96 | 100 | 96 | 100 | 96 | 96 | 92 | 92 | 96 | 100 |
| POACEAE | Poa compressa L. | POCO1 | 92 | 100 | 100 | 100 | 100 | 96 | 96 | 96 | 100 | 100 | 100 | 100 |
| POACEAE | Poa pratensis L. | POPR1 | 8 | 8 | 8 | 8 | 4 | 4 | | | 4 | 4 | 8 | 4 |
| POACEAE | Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | 8 | 12 | | | 8 | 12 | | | | | | 4 |
| POACEAE | Sorghastrum nutans (L.) Nash | SONU1 | | 4 | 4 | 4 | | 4 | | | | 4 | | 4 |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | 20 | 20 | 20 | 24 | 20 | 20 | | | | | | |
| POACEAE | Stipa comata Trin. & Rupr. | STCO1 | | | | 4 | | 4 | | | | | | |
| POLEMONIACEAE | Collomia linearis Nutt. | COLI1 | | | | | | | 4 | | 4 | 4 | 4 | 4 |
| POLYGONACEAE | Polygonum ramosissimum Michx. | PORA1 | | | | 8 | | | | | 4 | 8 | 8 | 4 |
| POLYGONACEAE | Rumex crispus L. | RUCR1 | | | | | | | 4 | | | | | |
| PORTULACACEAE | Talinum parviflorum Nutt. | TAPA1 | | 4 | 4 | | 8 | 4 | | | | | 12 | 28 |
| SCROPHULARIACEAE | Penstemon virens Penn. | PEVI1 | 4 | | 4 | 4 | 4 | 4 | 16 | | 28 | 12 | 28 | 24 |
| SCROPHULARIACEAE | Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren | VEPE1 | | | 4 | | | | | | 72 | 32 | 60 | 16 |
| | Unknown | UNKN | | | | | | | | | | | | 4 |

Note: Frequency values are percentages (n = 25).

# Appendix A

## Report 1

## 1999 High-Value Vegetation Surveys

# 1. 1999 High-Value Vegetation Surveys

## 1.1 Introduction

The goal of the high-value vegetation monitoring is to qualitatively assess the status and quality of the high-value plant communities (xeric tallgrass prairie, tall upland shrubland, selected wetlands, and Great Plains riparian woodland) at the Rocky Flats Environmental Technology Site (the Site) and to document any changes. These qualitative surveys evaluate conditions at a community-wide scale across the Site as a whole. This qualitative information, coupled with other quantitative monitoring data gathered at specific locations within the plant communities, provides important information at appropriate scales for resource management. The high-value plant communities at the Site are those identified by Site ecologists and the Colorado Natural Heritage Program (CNHP) as containing significant or rare ecological resources at both the local and regional scale (Kaiser-Hill [K-H] 1997a; CNHP 1994, 1995).

Objectives of the high-value vegetation monitoring are to qualitatively:

- Assess the species richness of the plant communities
- Identify any rare plant populations, and document the locations and continued presence of any rare plant populations
- Identify and document any infestations of noxious weeds
- Document the effectiveness of weed-control efforts
- Assess the impacts of disturbance on the plant communities
- Provide a general assessment of the overall status and quality of the plant communities.

## 1.2 Methods

### 1.2.1 Species Richness Inventory

As part of the rotating schedule for monitoring high-value vegetation communities on the Site, the Great Plains riparian woodland and wetland communities were monitored in 1999. Species richness was inventoried in each of the ten Great Plains riparian woodland management units and three wetland management units (Figures 1-1 and 1-2). Inventories were conducted by traversing each management unit twice during the growing season (spring and late summer) and recording all vascular plant species observed. Attempts were made to visit, as completely as possible, all areas and microhabitats that occur within each management unit.

### 1.2.2 Weed Mapping

Sitewide weed mapping continued for selected species as a means of identifying high-priority treatment areas, monitoring the distribution of specific noxious weed species, and tracking the effectiveness of weed control. Weed mapping was conducted on foot during the high-value vegetation surveys and from a vehicle using binoculars for the remainder of the Site. Species were mapped during their respective flowering periods and/or when they were most visible. The species mapped in 1999 included diffuse knapweed (*Centaurea diffusa*), musk thistle (*Carduus nutans*), dalmatian toadflax (*Linaria dalmatica*), common mullein (*Verbascum thapsus*), Russian knapweed (*Centaurea repens*), annual rye (*Secale cereale*), Scotch thistle (*Onopordum acanthium*), Dame's rocket (*Hesperis matronalis*), and jointed goatgrass (*Aegilops cylindrica*). Canada thistle (*Cirsium arvense*) was not mapped, because it is common throughout most of the wetlands and riparian corridors on the Site, and therefore, the wetlands map would provide a good indication of the infested areas.

Infestation areas of the four dominant noxious weeds mapped (diffuse knapweed, musk thistle, dalmatian toadflax, and mullein) were classified into general density categories of high, medium, low, and scattered, based on a subjective interpretation of the extent, visual density, need for control, and aggressive nature of the species. The other five species were mapped for presence/absence. In general, a high-density category indicated that an area that was dominated by a nearly solid infestation and/or very high cover of the species. A medium-density category was used where the infestation provided less cover and was less homogeneous in the distribution of the species. The low-density category was used where the species were present in fewer numbers and were not visually dominating the landscape, but were beginning to establish a foothold in the community and were in need of control. The scattered-density category was used only in a few cases and indicated a sporadic occurrence of the species. The noxious weed populations and distributions for the four dominant species mapped were drawn in the field on 44- × 34-inch sitewide base maps. The distributions of the other species were drawn on 11- × 17-inch sitewide base maps. With regard to the resulting maps, it should be noted that the boundaries shown on the maps are only approximate and are based on professional judgement. They should not be interpreted as a precise outline of the distribution of these species, because no surveying or global positioning system (GPS) equipment was used to locate boundary edges, nor do the maps necessarily represent every location of the species on the Site. Attempts were made to visit the entire Site, but some infestations may still have been missed.

Dalmatian toadflax mapping was modified in 1999 because several large infestation areas on the Site were treated with Tordon 22K (applied from a helicopter) in May 1999. Observations after spraying showed that flowering of the species was depressed in June 1999, but the plants had not been killed. Because mapping for the species is done primarily based on the presence of flowering individuals (because non-flowering plants are difficult to see from a distance) it was assumed that infestation levels had not changed in the sprayed areas since 1998. As a result, the infestation locations and density

categories recorded in 1998 were used to represent the infestations of dalmatian toadflax in 1999 at the sprayed locations. Any changes resulting from the aerial herbicide spraying will be documented during the 2000 mapping effort.

### 1.2.3 Photographic Documentation

Photographs were taken at all 46 permanent photo points during the summer of 1999 (Figure 1-3). Winter photographic documentation was conducted at the shrubland and woodland photo points during the winter of 1999 to document the condition of these areas when the leaves were off the plants. Photographs were taken from established photo points in the same compass directions as past photographs. Photographs were then compared to those taken in 1997.

### 1.2.4 Qualitative Habitat Assessments

Qualitative habitat assessments were made in all of the high-value vegetation community management units on the Site during 1999. Assessment objectives dealt primarily with habitat loss, threats to the plant community, weed issues, rare plant species, dominant plant species health in the community, and general community quality. Attempts were also made to revisit populations of CNHP–listed plant species of special concern that are known to occur on the Site. These species include the mountain-loving sedge (*Carex oreocharis*), forktip three-awn (*Aristida basiramea*), dwarf wild indigo (*Amorpha nana*), and carrionflower greenbriar (*Smilax herbacea* var. *lasioneuron*). Population locations were mapped during the 1997 field season. Most locations were revisited to confirm the continued presence of these species on the Site and to evaluate any concerns about them. Further details on the methods used are found in the document *High-Value Vegetation Survey Plan for the Rocky Flats Environmental Technology Site* (K-H 1997b), the *Environmental Management Department Operating Procedures Manual* (DOE 1995), and *1999 Ecological Field Monitoring Plans for the Rocky Flats Environmental Technology Site* (K-H 1999).

## 1.3 Results and Discussion

### 1.3.1 Site Flora

As a result of the 1999 fieldwork, a total of ten new records of vascular plant species are reported for the Site. Plant nomenclature follows that of GPFA (1986), Weber (1976), and Weber (1990), in that order of determination. The new plant species reported for the Site are:

| | |
|---|---|
| *Poa juncifolia* Scribn. | Alkali Bluegrass |
| *Berula erecta* (Huds.) Cov. var. *incisum* | Water Parsnip |
| *Lycopus asper* Greene | Rough Bugleweed |
| *Astragalus lotiflorus* Hook. | Lotus Milk-Vetch |

| | |
|---|---|
| *Ribes inerme* Rydb. | Common Gooseberry |
| *Calystegia sepium* (L.) R. Br. ssp. *angulata* | Hedge Bindweed |
| *Coronilla varia* L. | Crown Vetch |
| *Trifolium repens* L. | White Clover |
| *Ceanothus fendleri* A. Gray | Buckbrush |
| *Lolium perenne* L. var. *aristatum* Willd. | Italian Ryegrass |
| *Lolium perenne* L. var. *perenne* | Perennial Ryegrass |

None of the new species recorded on Site in 1999 is a rare species or state-listed noxious weed. The complete list of plant species known to occur at Rocky Flats as of the end of the 1999 field season is found in Appendix B of the 1999 Annual Vegetation Report for the Rocky Flats Environmental Technology Site. Voucher specimens of these species are maintained in the Site herbarium.

### 1.3.2 Great Plains Riparian Woodland

A total of 350 plant species were recorded in the Great Plains riparian woodland at the Site during 1999 (Table 1-1). Of these, 77 percent were native species. This was an increase of 14 species, compared to the 1997 Site inventory, which found 274 species in the community. Four of these species were new to the Site species list: alkali bluegrass, rough bugleweed, common gooseberry, and hedge bindweed. A Sorensen similarity index (Brower and Zar 1977) using presence/absence data from the two years yielded a value of 0.88, indicating a high floristic similarity between years, as would be expected. Examination of the species lists from both years (Table 1-1) shows no substantial difference in the inventory results. The different species observed during the two years are mostly a result of the slight differences in routes used to traverse the management units and of the natural variability in abundance of individual species.

Examination of the qualitative habitat assessment data from the Great Plains riparian woodland management units in 1999 revealed concerns similar to those reported previously (K-H 1998). The biggest management issue in the Great Plains riparian woodland, as well as the biggest threat, is from weeds, especially diffuse knapweed and Canada thistle. Diffuse knapweed is especially prevalent at many locations in the Rock Creek and Woman Creek drainages. The dry, rocky, disturbed conditions on old stream terraces in these drainages are especially conducive to diffuse knapweed establishment. At many of these locations, diffuse knapweed occurs in abundance in the canopy openings between the trees and shrubs, making control difficult (Figure 1-4). Canada thistle is present along most of the stream reaches on the Site and is increasing at many locations. Comparison of riparian woodland permanent photo point photographs from 1997 and 1999 shows how Canada thistle has increased at this location (Figures 1-5 and 1-6). At many locations, other weed species—such as Dame's rocket, bouncingbet (*Saponaria officinalis*), chicory (*Chicorium intybus*), stinging nettle (*Urtica dioica*), musk thistle, dalmatian toadflax, annual rye, common mullein, and numerous other less aggressive species—are also problems in the riparian community. During 1999, control of the noxious weed Dame's rocket was initiated at the woodland locations west of the A-1 ponds in Walnut Creek. Once the plants flowered, a sickle was used to cut the tops

off of all the plants along the stream, to prevent seed set. Visits were made throughout the rest of the summer to cut the tops off of any new plants that were flowering. It is hoped that similar efforts over the next few years will prevent further seed set in the drainage and stress the plants to the point where they will eventually die. The small size of the population makes mechanical control a viable tool to eradicate the population at this, the only known population location on the Site. Similar control is recommended for other small, isolated noxious weed populations on the Site to prevent larger problems from developing. Further discussion concerning weed control is found later in this technical report.

Streambank erosion was noted as a concern along the reach of Great Plains riparian woodland between the B-4 and B-5 ponds. The stream at this location cuts down to bedrock at several locations and, during high-water events, has begun to cut horizontally, removing large pieces of the streambank. Several locations were washed away, resulting in streambank collapse during 1999 (Figures 1-7 and 1-8). If left unattended, it is likely that some of the trees and shrubs growing along the stream will eventually be lost as they are undercut and fall over. This is a concern at this location, because the area is a known Preble's meadow jumping mouse population location, and the loss of trees and shrubland could reduce the quality and amount of available Preble's habitat.

Aside from these concerns, the riparian woodlands in general appeared healthy. No visible signs of disease, predation, injury, or die-off of any of the dominant riparian trees and shrubs was observed. Most appeared to have flowered and produced fruit during 1999. Comparison of the permanent photo-point photographs from 1997 and 1999 showed no substantial changes in the riparian vegetation during this time frame.

### 1.3.3 Wetlands

A total of 246 plant species were recorded at the three wetlands monitored at the Site during 1999 (Table 1-2). Of these, 76 percent were native species. This was a decrease of 14 species, compared to the 1997 Site inventory, which found 260 species in the community. One of the species (water parsnip) found at the wetlands in 1999 was a new record for the Site. A Sorensen similarity index (Brower and Zar 1977) using presence/absence data from the two years yielded a value of 0.83, indicating a high floristic similarity between years, as would be expected. Examination of the species lists from both years (Table 1-2) shows no substantial difference in the inventory results. The different species observed during the two years are mostly a result of the slight differences in routes used to traverse the management units, and of the natural annual variability in abundance of individual species.

Examination of the qualitative habitat assessment data from the wetland management units revealed concerns similar to those reported previously (K-H 1998). The management issue of greatest concern in the wetlands, as well as the biggest threat, is from weeds, particularly Canada thistle. Canada thistle was present at moderate to high infestation levels at all three wetlands monitored on Site in 1999. Another noxious thistle, bull thistle (*Cirsium vulgare*), also seemed to be present in higher amounts than

previously noticed. Butter-and-eggs (*Linaria vulgare*), another state-listed noxious weed, was found growing in the Antelope Springs wetland, near locations where it previously had only been found growing in mesic grassland/wet meadow ecotonal areas. The issue of weed control is discussed in greater detail later in this report.

Aside from the weed management concerns in the wetlands, the community appeared healthy. No visible signs of disease, predation, injury, or die-off of any of the dominant wetland species were observed. Comparison of the permanent photo-point photographs from 1997 and 1999 showed no substantial changes in the wetland vegetation during this time frame. A substantial amount of litter (dead plant material) was present at all three monitored wetlands. The use of prescribed burning would help reduce the amount of litter and return tied-up nutrients to the plants, increasing the vigor and health of the community. The prescribed burn planned for spring 2000 is slated to burn across most of the Antelope Springs wetland in the south Buffer Zone, which would help alleviate this problem at that location.

### 1.3.4 Rare-Plant Monitoring

Of the plant species of concern listed by the CNHP as rare or imperiled, the species recorded previously on the Site were observed again in 1999. Populations of mountain-loving sedge, forktip three-awn, carrionflower greenbriar, and dwarf wild indigo were visited and evaluated. All four species were observed in vegetative, flowering, and fruiting condition, and their populations appeared to be doing well. Figure 1-9 shows the known locations where these species have been observed on the Site.

### 1.3.5 Photographic Documentation

Photographs were taken at all 46 permanent photo points during the summer of 1999 (Figure 1-3). Winter photographic documentation was conducted at the shrubland and woodland photo points during the winter of 1999 to document the condition of these areas when the leaves were off the plants. Comparison of the 1999 photographs to 1997 photographs taken at the different plant communities on the Site showed that, for most locations, little change has occurred in the dominant species or structure of the plant communities. In a number of cases, however, the photographs have proven useful for evaluating changes in weed populations at specific locations on the Site. The photographs show how untreated weed populations have expanded at some locations, and where herbicide applications have been made, show the effectiveness of weed control treatments. These results and examples are discussed and illustrated in the various sections of this report where weeds are discussed. Additional examples of the permanent photo-point photographs taken in 1997 and again in 1999, along with interpretation, are found on the CD-rom (HVV Photo Point Photos directory) in Appendix C of the 1999 Annual Vegetation Report for the Rocky Flats Environmental Technology Site.

### 1.3.6 Plant Community Disturbance in 1999

During 1999, several projects disturbed the native plant communities at different locations in the Buffer Zone at the Site (Figure 1-10). A total of approximately 22.6 acres of plant community was disturbed in the Buffer Zone in 1999. Most of this disturbance was in the mesic mixed grassland, reclaimed grassland, and a small amount of Great Plains riparian woodland. At the conclusion of each project, the disturbed areas were revegetated using certified weed-free, native seed mixes and weed-free mulch. Photographs and maps of the project areas and revegetation efforts are found on the CD-ROM in Appendix C of the 1999 Annual Vegetation Report for the Rocky Flats Environmental Technology Site.

Other disturbances to the native plant communities on Site came primarily from unauthorized off-road driving. Several off-road locations showed evidence of spinning tires removing the vegetation entirely, creating bare spots. From a resource management standpoint, these incidents create two problems. Unauthorized off-road driving spreads weed seeds from the Buffer Zone road edges further into undisturbed areas of the native prairie. The bare spots created by spinning tires creates disturbance patches in the previously undisturbed native prairie, which then become islands of weeds that spread seed into the native prairie. Given the weed control issues at the Site, unauthorized off-road driving is inconsistent with the Buffer Zone resource management policy, which is trying to preserve and maintain the high-quality ecological resources found at the Site. Administrative efforts were taken during 1999, and continue at present, to address and eliminate this problem.

### 1.3.7 Weed Mapping

The 1999 weed distribution maps for diffuse knapweed, musk thistle, dalmatian toadflax, and common mullein are shown in Figures 1-11 through 1-14, respectively. Five additional species—annual rye, Russian knapweed, Scotch thistle, dame's rocket, and jointed goatgrass—were mapped in 1999 because of their aggressive nature and their recent appearance at various locations on the Site. The distributions of these species are shown in Figures 1-15 and 1-16. After being entered into the Site Geographic Information System (GIS), the overall extent of these species across the Site was estimated by species and by infestation level using the GIS coverages. Table 1-3 contains the estimated total acreage and acreage-by-density category for each of the species, based on the maps. The species with the greatest extent on the Site was dalmatian toadflax, covering nearly 2,507 acres, followed by diffuse knapweed (2,295 acres), musk thistle (1,353 acres), and common mullein (1,068 acres). The total acreage of the Site is approximately 6,485 acres (K-H 1997c). The total numbers of acres are also shown in Table 1-3 for annual rye, Russian knapweed, Scotch thistle, dame's rocket, and jointed goatgrass. It should be noted that all these acreages are only approximate and should not be interpreted as exact areas. These values are also only representative of known locations for these species. It is possible that unmapped infestations are present as well.

Table 1-4 shows the total infested acreages for diffuse knapweed, dalmatian toadflax, musk thistle, and common mullein for 1997, 1998, and 1999. Most of the large increases in infestation acreages from 1997 to 1998 were a result of the time of year in which mapping was conducted. Mapping in 1997 was conducted in August for each of the species. Beginning in 1998, weed mapping was conducted for each species when that species was in flower and/or most visible. Therefore, the higher visibility of the species allowed more accurate estimates of their infestation levels in 1998 and 1999, and thus the resulting higher acreages.

From 1998 to 1999, the total Site acreage infested by diffuse knapweed and musk thistle decreased by 618 and 332 acres, respectively, largely due to the aerial herbicide application conducted in May 1999. Common mullein acreage also decreased for the high-, medium-, and low-density levels, largely because of the aerial spraying. Overall, however, common mullein acreage for the Site increased due to the large increase in the scattered category.

Dalmatian toadflax acreage showed an increase of over 500 acres from 1998 to 1999. It is now the noxious weed with the largest extent at the Site, replacing diffuse knapweed as the leader. What accounted for this large increase is unknown, although qualitative observations suggested that 1999 was apparently a bumper-crop year for the species. Observations at previously known locations of dalmatian toadflax showed that the species was extremely visible during 1999 (Figure 1-17), so the increase may have resulted from a high amount of flowering that increased the visibility of the species in areas where it had not been observed previously. The fact remains, however, that there is a substantial amount of dalmatian toadflax present at the Site. This is challenging from a control standpoint, because no effective control methods are available for large-scale dalmatian toadflax infestations. Certain herbicides applied at high rates can kill dalmatian toadflax, but at the high application rates, all the other forbs on the grassland are killed, too. Given the management objectives at the Site, this would not be an acceptable result.

Figures 1-18 and 1-19 show the locations of the aerial herbicide application in 1999 and the pre- and post-treatment diffuse knapweed densities at these locations in 1998 and 1999, respectively. Approximately 1500 acres were treated by helicopter with Tordon 22K in 1999. The maps show the dramatic response of the diffuse knapweed to the spraying. At the aerial herbicide application locations, the total amount of diffuse knapweed present was reduced by 683 acres, from 878 acres in 1998 to 195 acres in 1999 (Table 1-5, Figure 1-20). This represents a 78 percent reduction in the total number of diffuse knapweed–infested acres in the areas that were sprayed in 1999. In practical terms, this means there were essentially no adult diffuse knapweed plants observed at these locations. The elimination of adult plants from these areas in 1999 means no additional seed was added to the seed bank and no plants were available to blow away from these infestations, further infesting other areas. Figures 1-21 and 1-22 illustrate the substantial decrease in diffuse knapweed that was observed at most of the treatment locations.

Control was best on the flat areas on top of the pediment where the herbicide was applied most evenly. Diffuse knapweed remained only along a few flight lines where areas were accidentally missed (Figure 1-11; southwest areas of Site). Control on one of the hillsides in northern Rock Creek was less consistent, however, and overall densities were reduced less (Figures 1-18 and 1-19; northern-most locations on Site). It is unknown why control was not as effective on this particular hillside. Overall, the aerial application of Tordon 22K for control of diffuse knapweed and other noxious weed species was beneficial and generally improved the quality and appearance of the Site's grasslands. The initial response has been increased vigor, health, and flowering of the grasses, reduced abundance of diffuse knapweed and other weeds, and an initial decline in the abundance of some native forbs. (For more specific information on the longer-term effects of Tordon 22K on the grasslands at the Site, from both aerial and ground-based applications, see the Technical Reports in Appendix A of the 1999 Annual Vegetation Report for the Rocky Flats Environmental Technology Site).

## 1.4 Impact of Tordon 22K on Prairie Plants

The impacts of herbicide spraying on both target species and non-target (i.e., native) species are an important management concern at the Site. Although weed control is an essential tool for natural resource management, and in some cases, herbicides must be used due to the scale of the problem, it is desirable to know what impacts can be expected as a result of using a particular compound. Over the past three field seasons, qualitative observations have documented many of the impacts of Tordon 22K on different plant species in the grasslands at the Site. Table 1-6 summarizes these impacts. These results are based on observations made during several visits to sprayed areas, with the timeframe for the visits ranging from a week or two after initial application to a year or more after application. Observations have been made in areas treated by both ground and aerial (helicopter) application equipment at an application rate of 1 pint/acre. Four types of observations have been recorded.

- NE (no effect)—used where individuals of a given species showed no impact from the spraying
- C (chlorosis)—used where individuals of a given species showed chlorosis (yellowing of the plant) after spraying
- W (wilting)—used where individuals of a given species began to wilt or show structural deformities after spraying
- D (death)—used where individuals of a given species died after spraying.

It should be noted that, in many cases, each species has demonstrated multiple effects within the treated areas. No attempts have been made to determine what percentage of a species experienced the different effects. In many instances, the differences in how a species responded to the herbicide application appear to be attributable to variations in

herbicide application method, timing of application, vegetation density during application, spraying evenness (resulting from wind fluctuations or areas having been missed), soil differences, or other unknown factors. Although many species exhibited multiple effects, it was apparent that even the most herbicide-sensitive species were never completely eliminated from a given area. There were always individuals of each species that remained, creating a mosaic effect in many places for most species. This is similar to the effects of a prescribed fire in which some areas are hit harder than others. No observations of graminoids are included in Table 1-6 because no impacts were observed to these species, with the exception of squirreltail grass (*Sitanion hystrix*), which occasionally showed some structural deformity in the inflorescence.

The preceding represents qualitative observations of the effects of Tordon 22K on various native and non-native species, given the conditions at Rocky Flats and the application methods. No claim is made that these observations are complete or that other results may be observed at other locations under different conditions. In evaluating the effects of the herbicide on prairie plants, it should also be noted that impacts from the 1997 spraying are no longer apparent, and the plant communities do not appear to have suffered long-term adverse effects.

## 1.5 Conclusions

Qualitative monitoring of the high-value plant communities during 1999 revealed both positive and negative findings. Floristically, the Great Plains riparian woodland and wetland communities remain diverse and have not changed substantially since they were last monitored. No new noxious weeds were found at the Site during 1999. The rare and imperiled plant species populations (as listed by the CNHP) at the Site appear to be healthy; all four rare species were observed in vegetative and flowering condition during 1999. Although monitoring suggests that the plant communities appear to be doing well in general, several management concerns are apparent. The threat of weeds continues to be the highest priority. Several weed species continue to degrade the quality of the Great Plains riparian woodland and wetland areas on the Site. Diffuse knapweed and Canada thistle are the most significant problems in the Great Plains riparian woodland, while Canada thistle is the predominant problem in the wetlands. The Site's weed management program has applied various methods to control weeds on the Site (see the Technical Reports in Appendix A of the 1999 Annual Vegetation Report for the Rocky Flats Environmental Technology Site for a summary of the 1999 Weed Control Program at the Site). Although most of these efforts have focused on the weed problems in the grasslands in recent years, the weed problem continues to grow along the streams and wetlands and thus needs to be addressed there as well. Litter buildup continues to be a problem in the plant communities at the Site, and the use of prescribed burning will help alleviate this. The Department of Energy's (DOE's) shift toward a more active ecological resource management program at the Site in recent years continues to address these issues. As cleanup and closure of the Site proceeds, it will be important to maintain the desire and commitment to preserve and maintain the high quality of the Site's unique ecological resources for future generations.

## 1.6 References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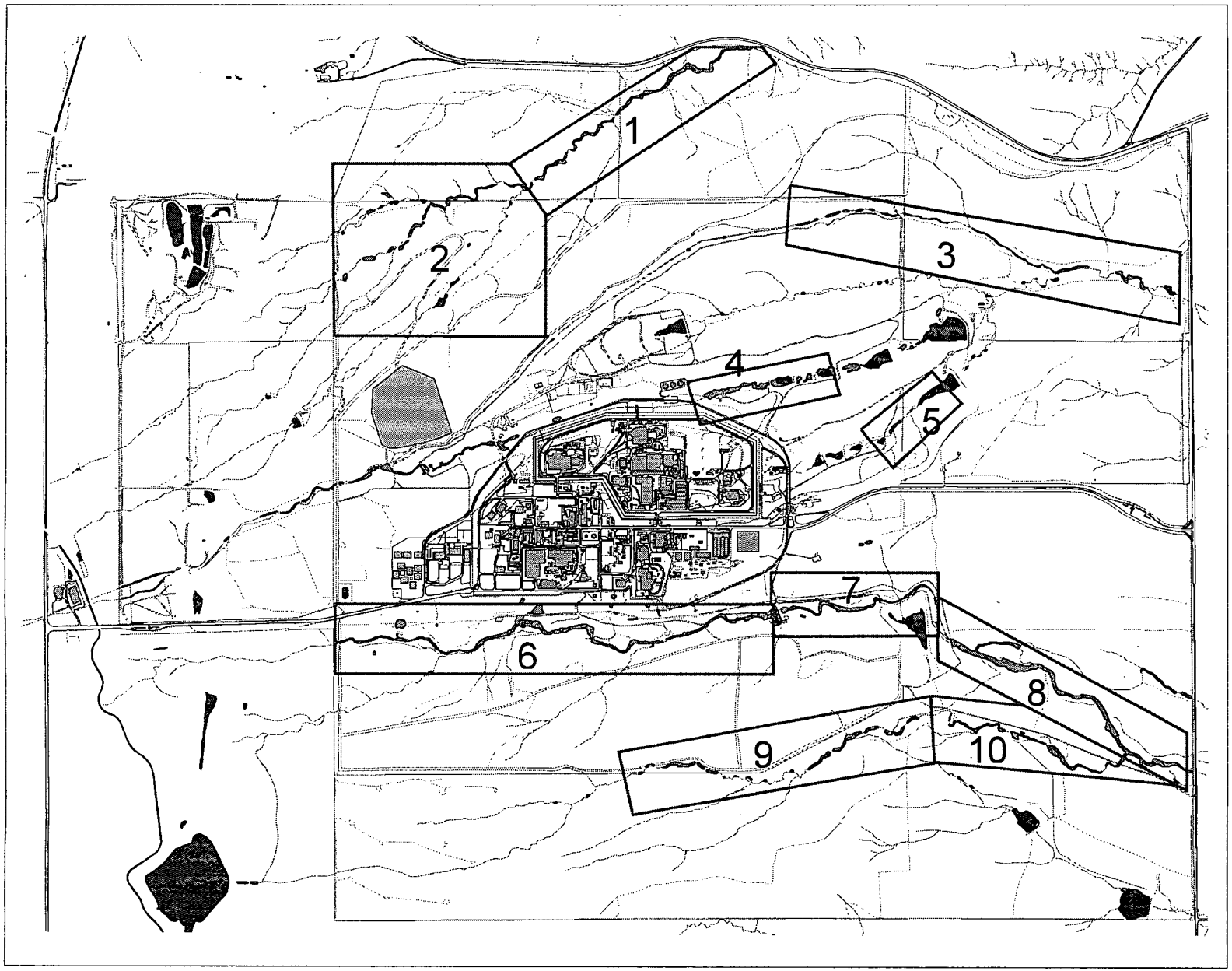
# Figures




# Great Plains Riparian Woodland Management Units

Figure 1-1

MAP LEGEND

- Great Plains Riparian Woodland (Combined Riparian Woodland, Willow Shrubland, and Leadplant Shrubland Habitat Types)
- Great Plains Riparian Woodland Management Units

Standard Map Features

- New Landfill
- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads

DATA SOURCE:
Management Unit and wetland boundaries provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**
These locations approximate the boundaries of the Management Units. The boundaries are not exact and should not be treated as such.

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

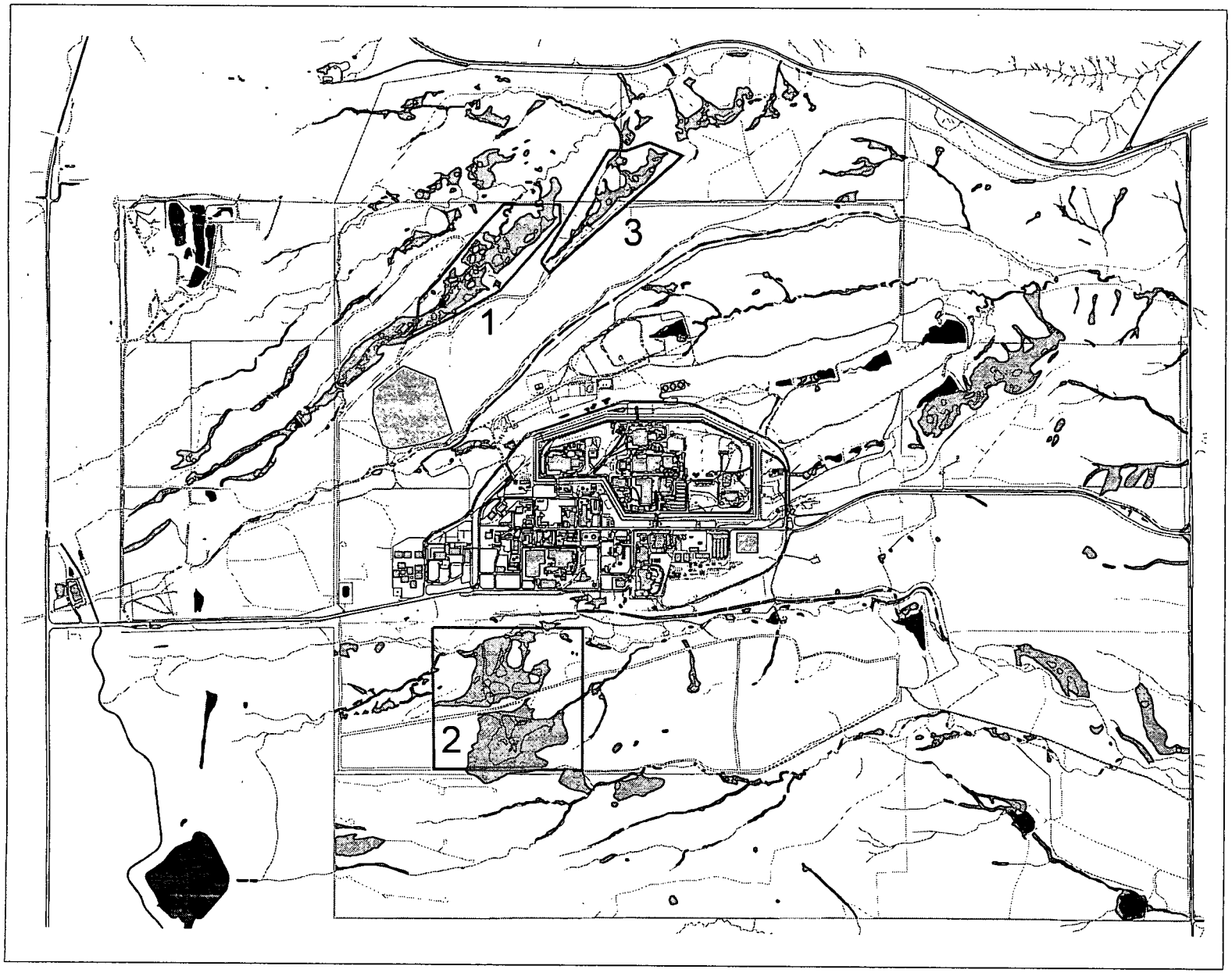
U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: 2k-0158

March 14, 2000




# Wetland Management Units

Figure 1-2

## MAP LEGEND

Wetlands (Combined Wet Meadow/Marsh, Short Marsh, and Tall Marsh Habitat Types)

Wetland Management Units

## Standard Map Features

- New Landfill
- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads

DATA SOURCE:
Management Unit and wetland boundaries provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

**Note:**
These locations approximate the boundaries of the Management Units. The boundaries are not exact and should not be treated as such.

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

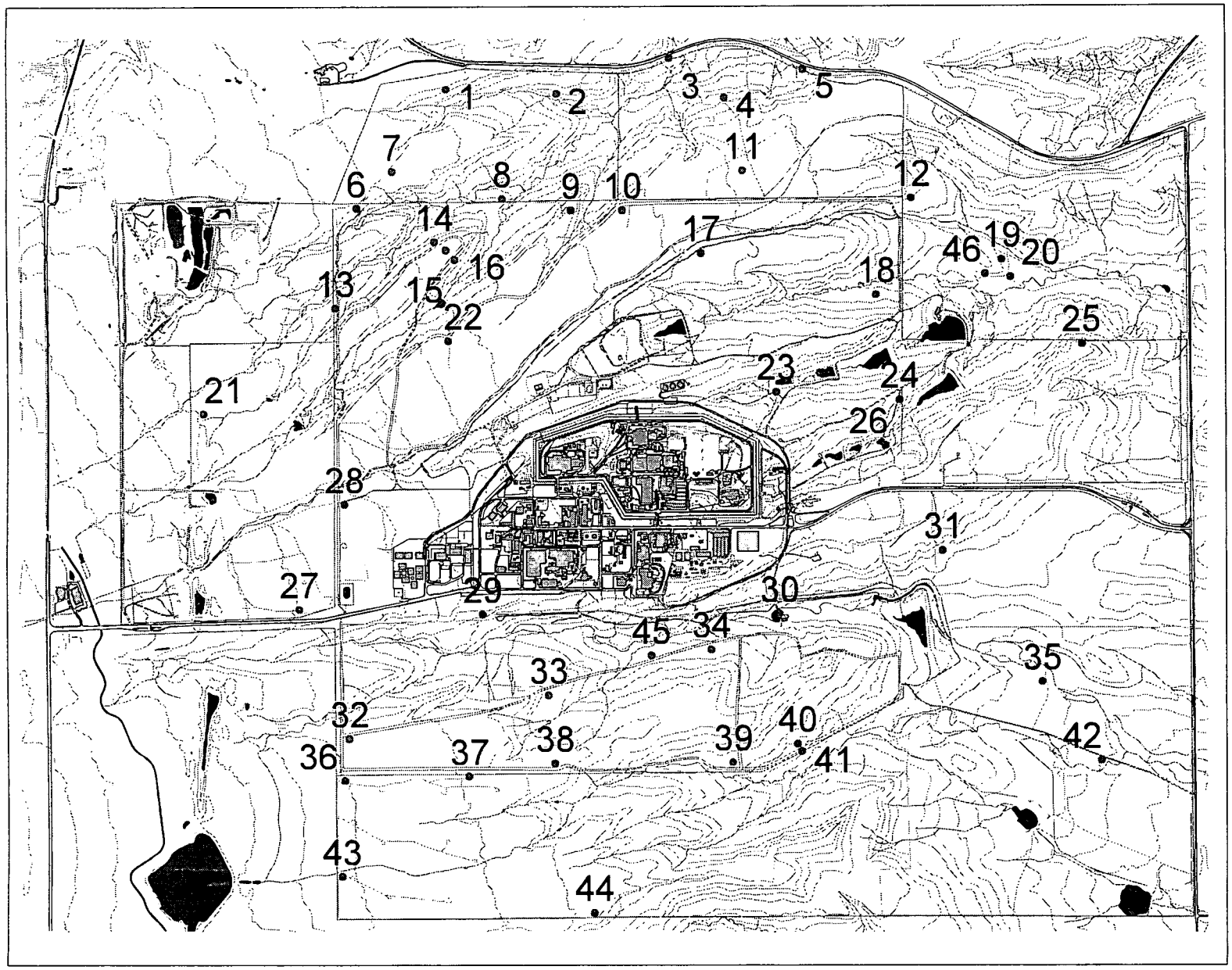
Prepared by: Exponent™

For: Kaiser-Hill Company, LLC

MAP ID: 2k-0158

March 14, 2000

\\Gisserv\GIS\EDO-projects\projects\2k-0158\management units-xy\Wetland Management Unit view




# 1999 Permanent Photo Point Locations

Figure 1-3

MAP LEGEND

- Permanent Photo Point Locations

Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (25 ft)

DATA SOURCE:
Permanent photo point locations provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Note:
Photo point locations are approximate. Locations are staked with rebar on the ground.

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0025

March 14, 2000

Figure 1-4. Diffuse knapweed growing on a dry, elevated stream terrace with coyote willow and leadplant in the Rock Creek drainage.

Figure 1-5. Canada thistle just beginning to establish along the riparian corridor in Walnut Creek in 1997. Photograph below shows how the infestation increased over a two year period.

Figure 1-6. Canada thistle infestation at the same location as shown above (Figure 1-5) in Walnut Creek two years later in 1999.

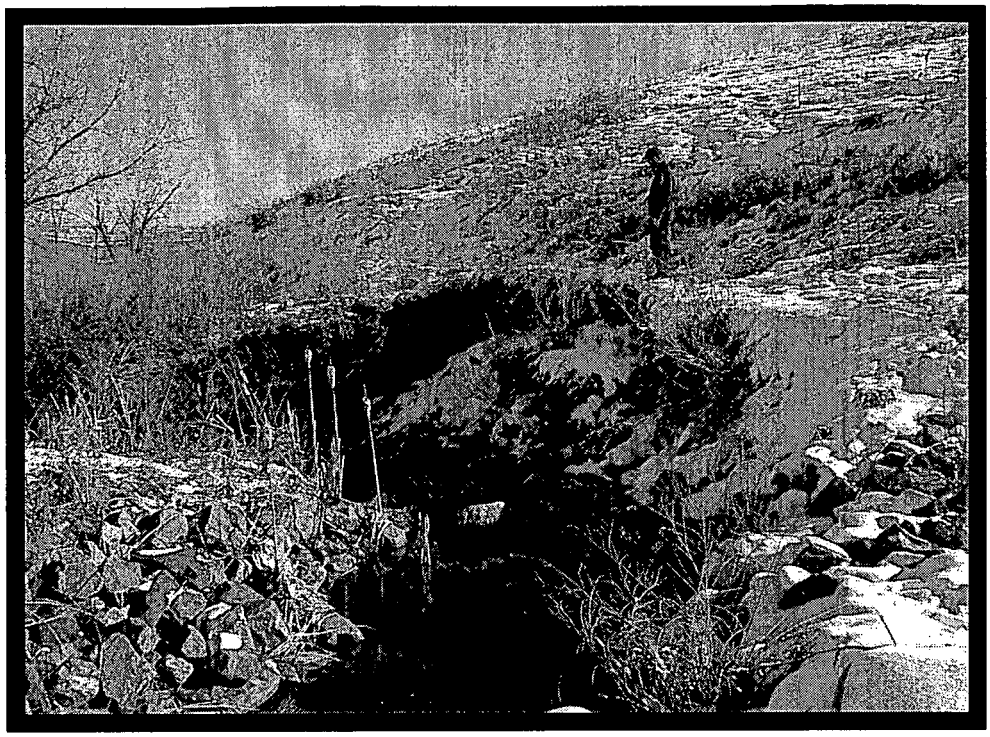
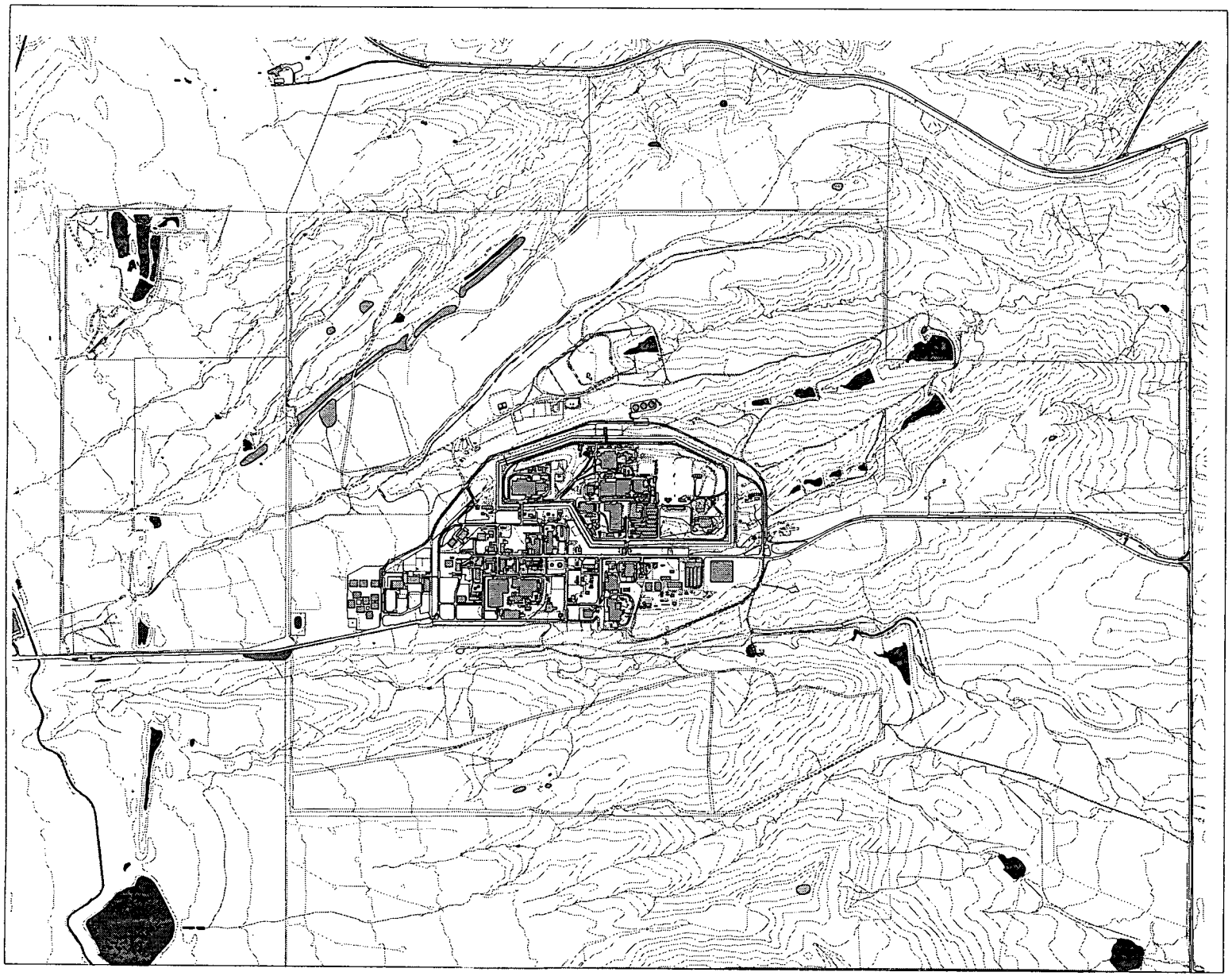


Figure 1-7. Continued streambank erosion below the B-4 dam spillway in Walnut Creek is causing the loss of riparian shrubland essential as Preble's meadow jumping mouse habitat.

Figure 1-8. Streambank erosion along the woodlands below the B-4 dam in Walnut Creek.



# Rare and Imperiled Plants Distribution
## Colorado Natural Heritage Program Species of Concern

Figure 1-9

### MAP LEGEND

- Dwarf Wild Indigo (Amorpha nana)
- Forktip Three-awn (Aristida basiramea)
- Mountain-Loving Sedge (Carex oreocharis)
- Carrionflower Greenbriar (Smilax herbacea)

### Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
Plant distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

**Note:**

The boundaries for the rare plant locations are not exact and should not be treated as such. These areas may not represent all populations on Site.

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent™

For: Kaiser-Hill Company, LLC

MAP ID: K2-0074

March 14, 2000

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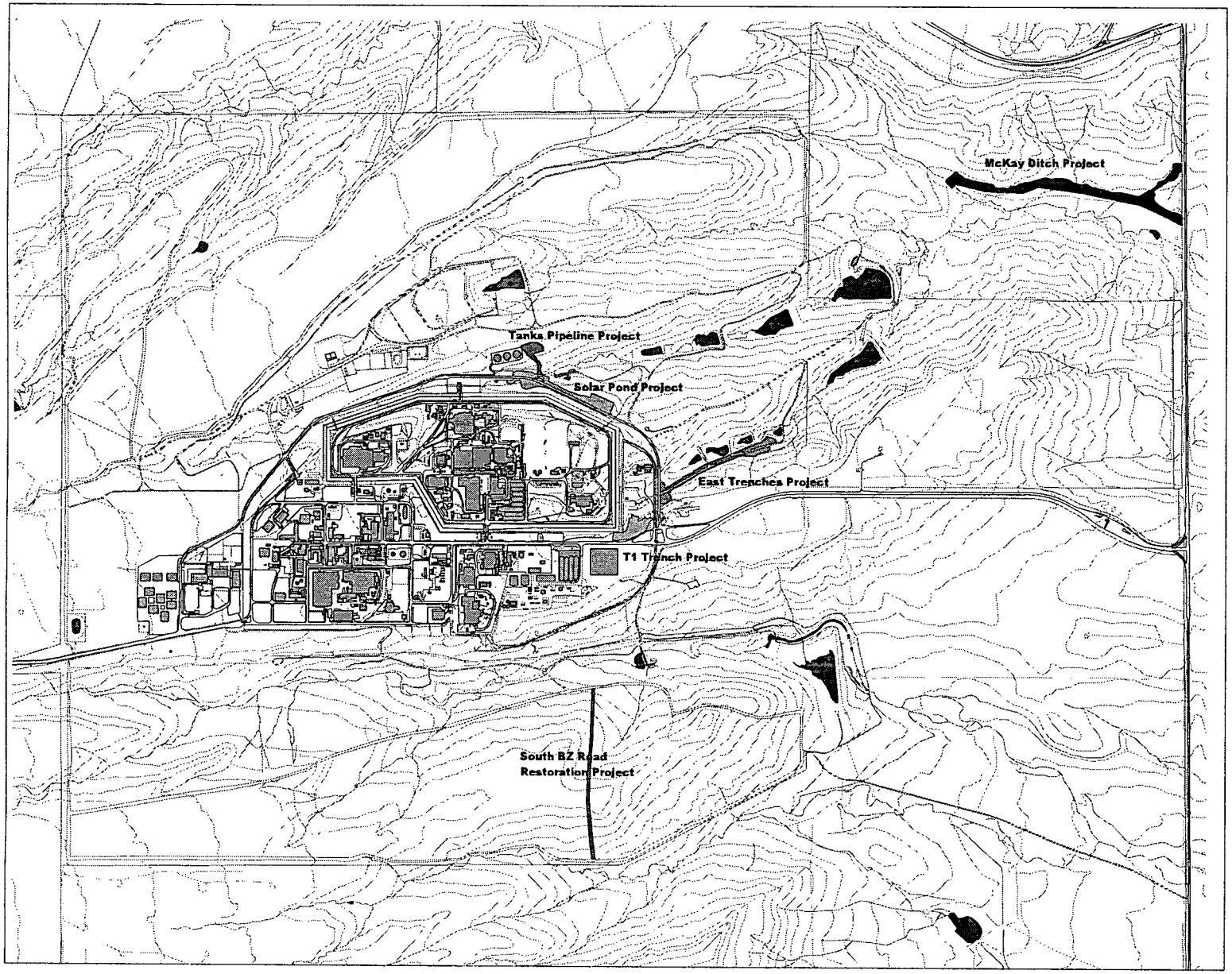


# 1999 Revegetation and Restoration Locations

Figure 1-10

## MAP LEGEND

- McKay Ditch Project
- Solar Pond Project
- East Trenches Project
- T-1 Trench Project
- Tanks Pipeline Project
- South BZ Road Restoration Project

## Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
Locations provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**
Project boundaries obtained using GPS equipment, except for the South BZ road restoration location which is based on the roads coverage.

N

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1000 0 1000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0057

March 14, 2000

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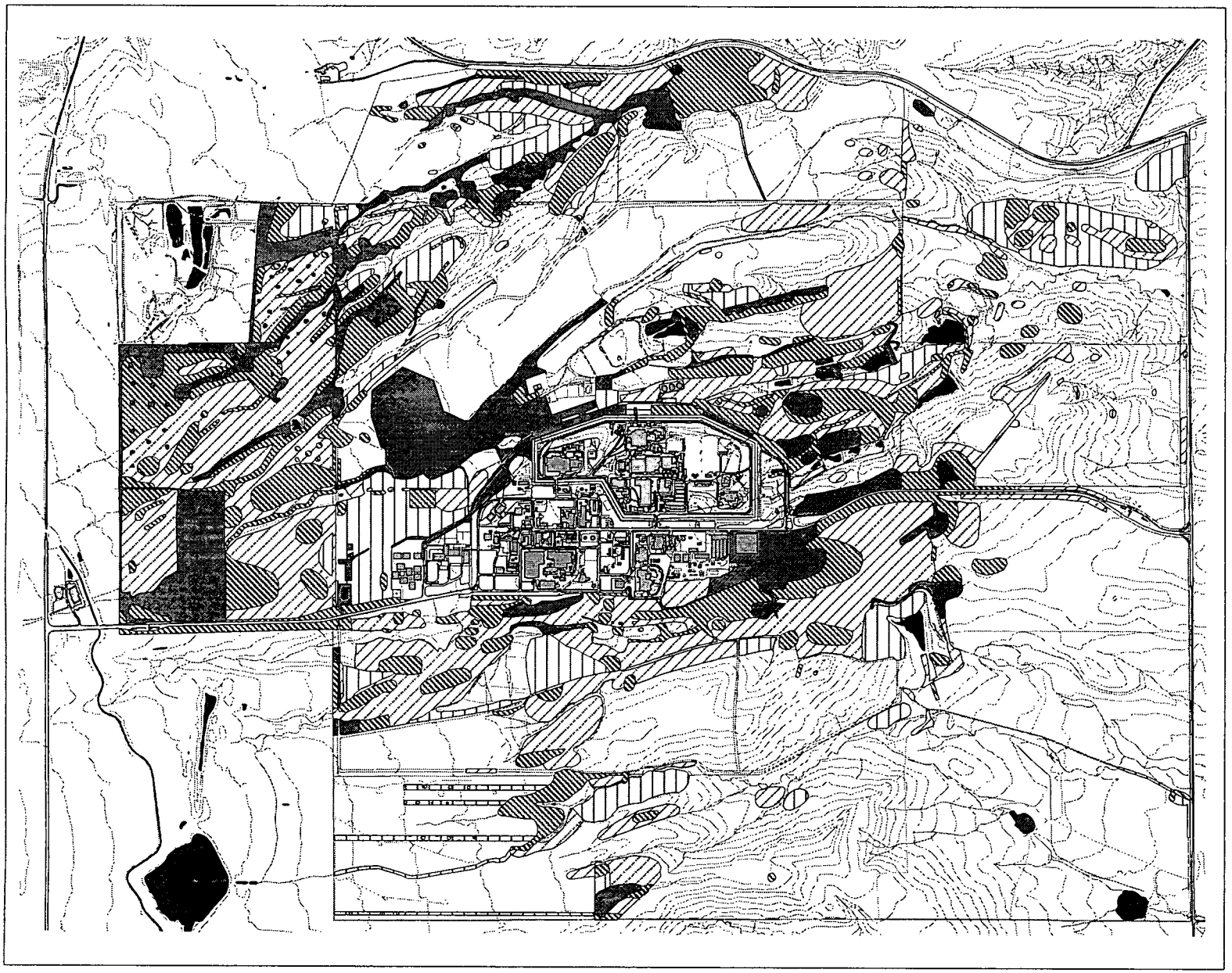

# 1999 Diffuse Knapweed (Centaurea diffusa) Distribution

Figure 1-11

## MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

### Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial flyover data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

**Note:**

These locations approximate the boundaries of infestation areas. The boundaries are not exact and should not be treated as such. These areas may not represent all populations on Site.

N

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1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0017

March 14, 2000

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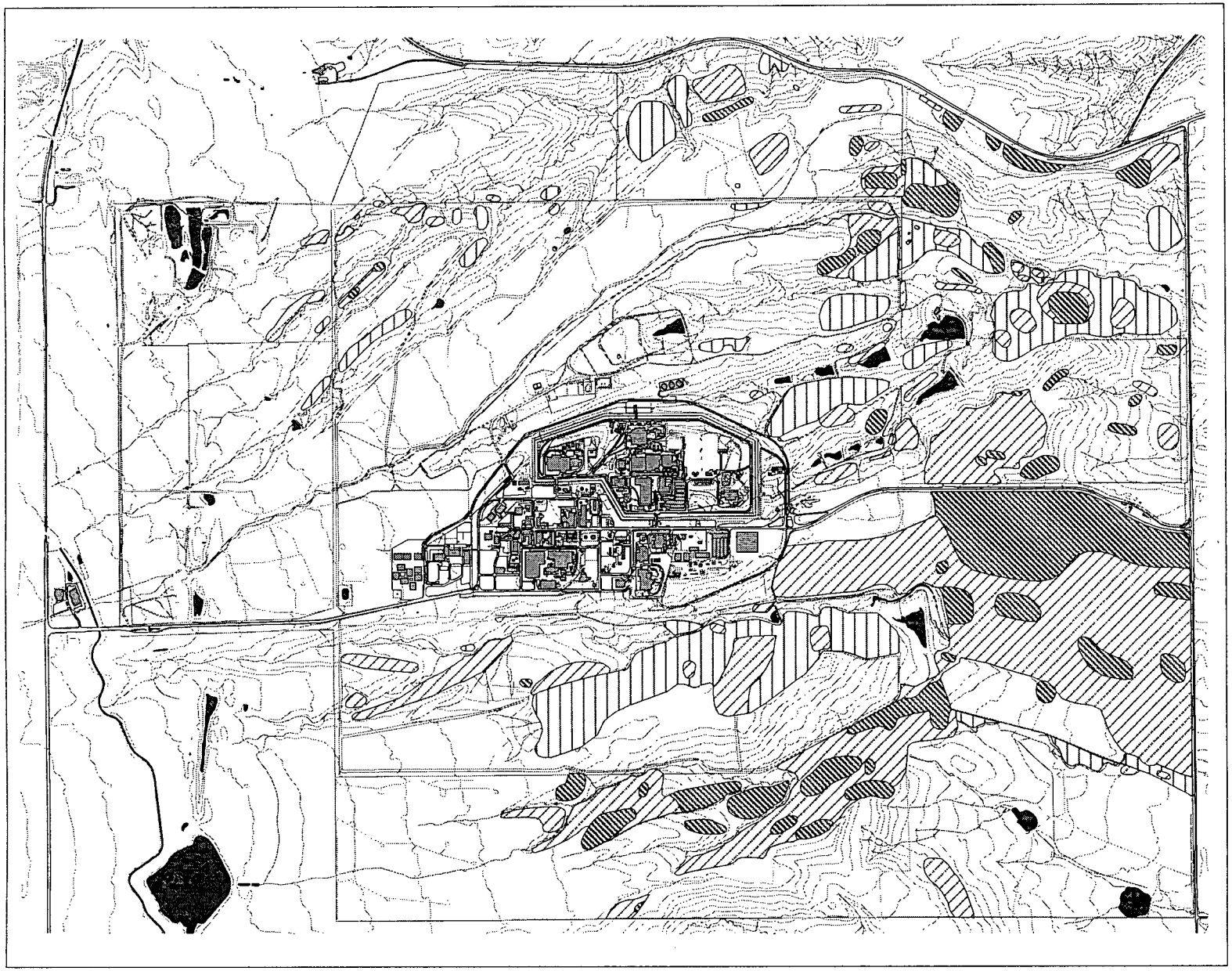

# 1999 Musk Thistle (Carduus nutans) Distribution

Figure 1-12

## MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

## Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

**Note:**

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0019

March 14, 2000

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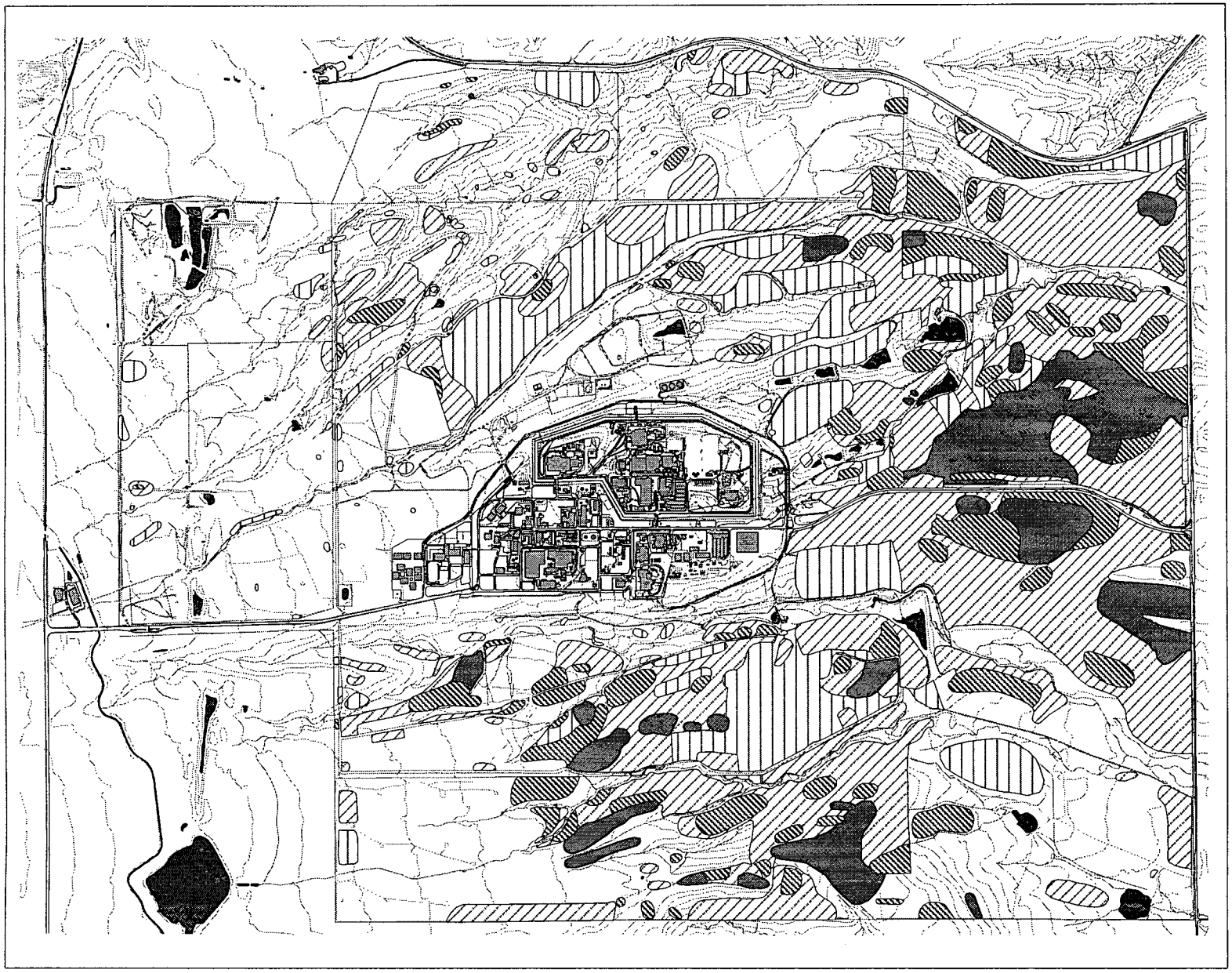

# 1999 Dalmatian Toadflax (Linaria dalmatica) Distribution

Figure 1-13

## MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

### Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial flyover data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

**Note:**

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0018

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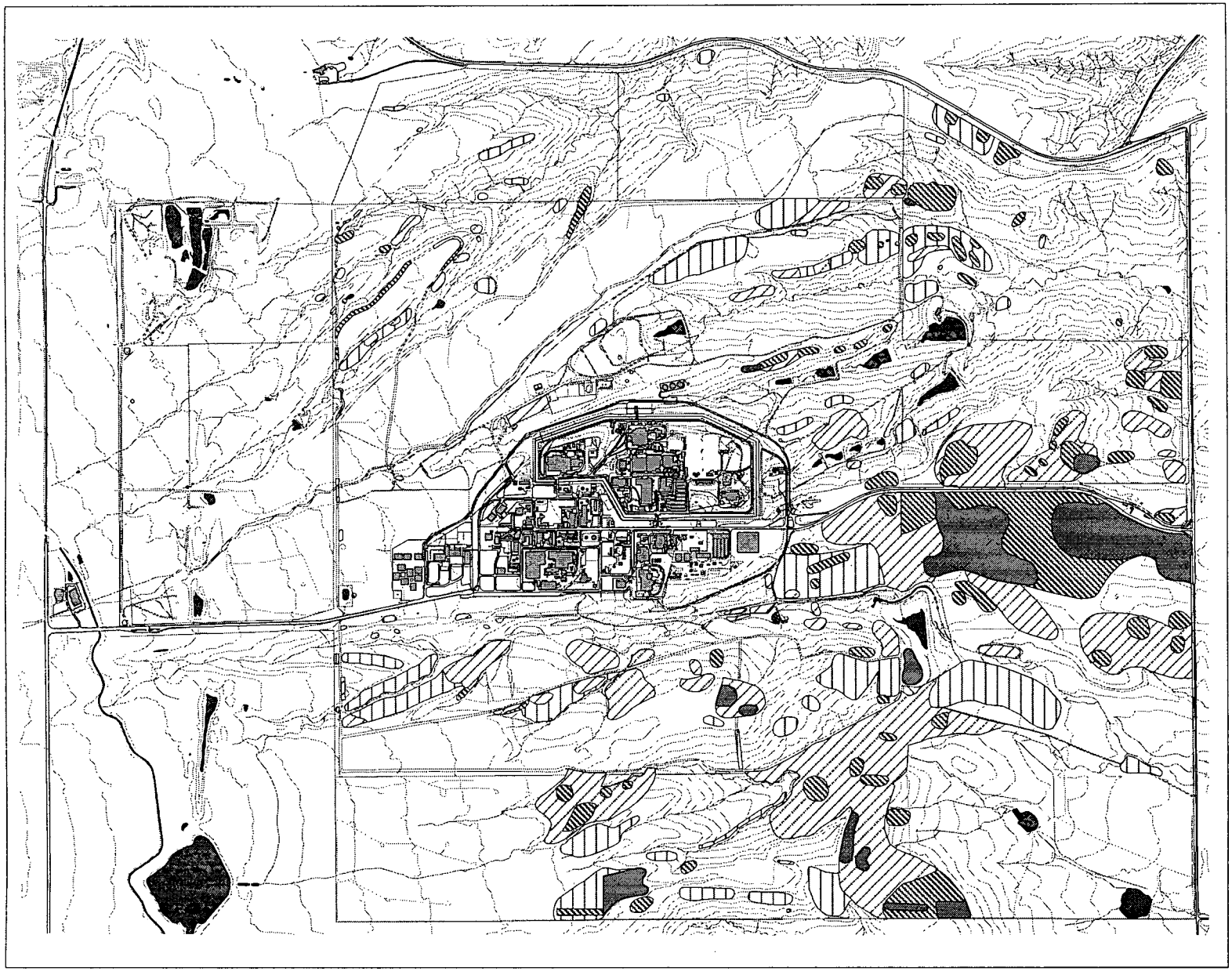

# 1999 Mullein (Verbascum thapsus) Distribution

Figure 1-14

## MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

### Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/85
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**

These locations approximate the boundaries of infestation areas. The boundaries are not exact and should not be treated as such. These areas may not represent all populations on Site.

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

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March 14, 2000

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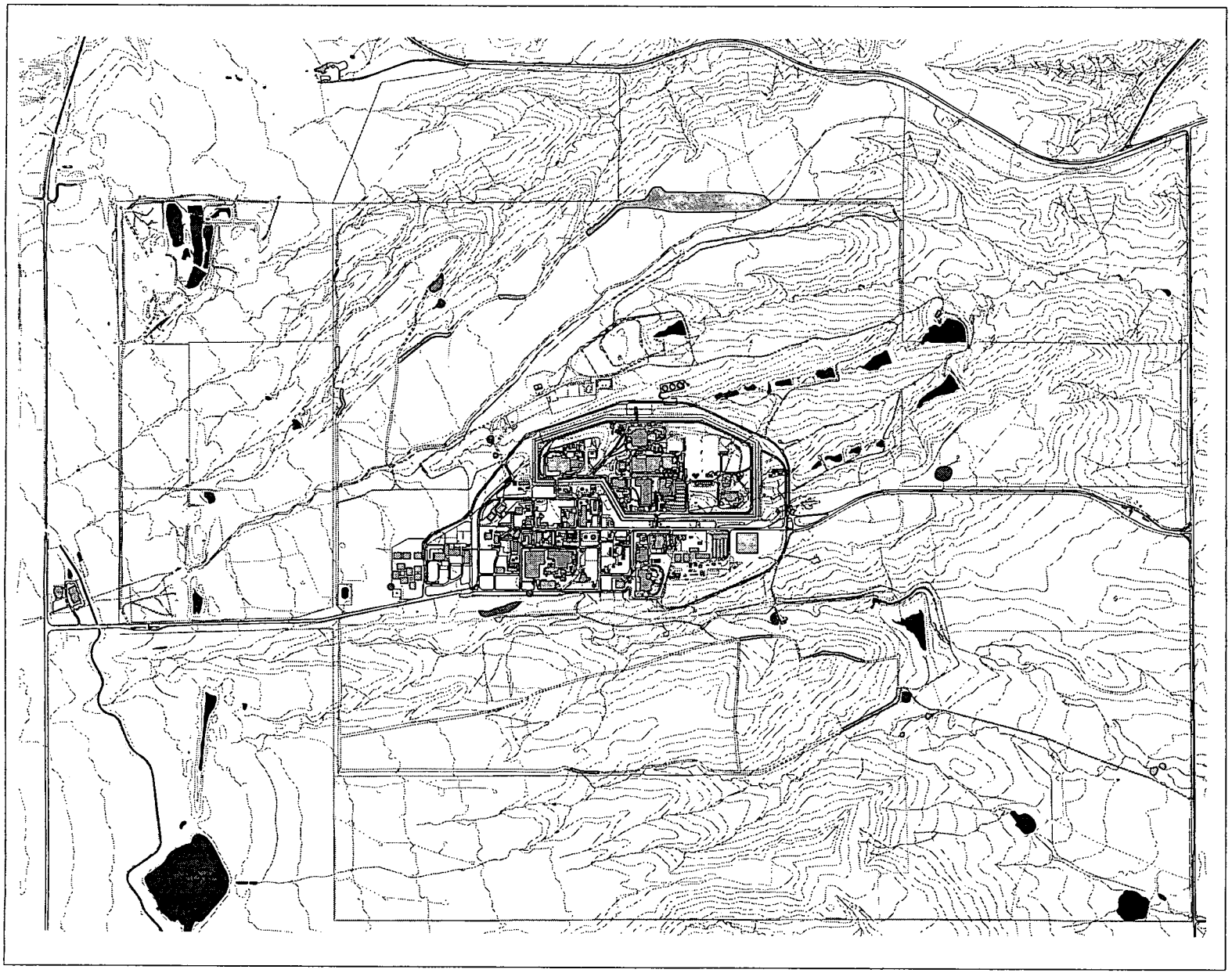

# 1999 Scotch Thistle (Onopordum acanthium), Russian Knapweed (Centaurea repens), Dame's Rocket (Hesperis matronalis), and Annual Rye (Secale cereale) Distribution

Figure 1-15

## MAP LEGEND

- Scotch Thistle Infestations
- Russian Knapweed Infestations
- Dame's Rocket Infestations
- Annual Rye Infestations

### Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial flyover data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**

These locations approximate the boundaries of infestation areas. The boundaries are not exact and should not be treated as such. These areas may not represent all populations on Site.

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent™

For: Kaiser-Hill Company, LLC

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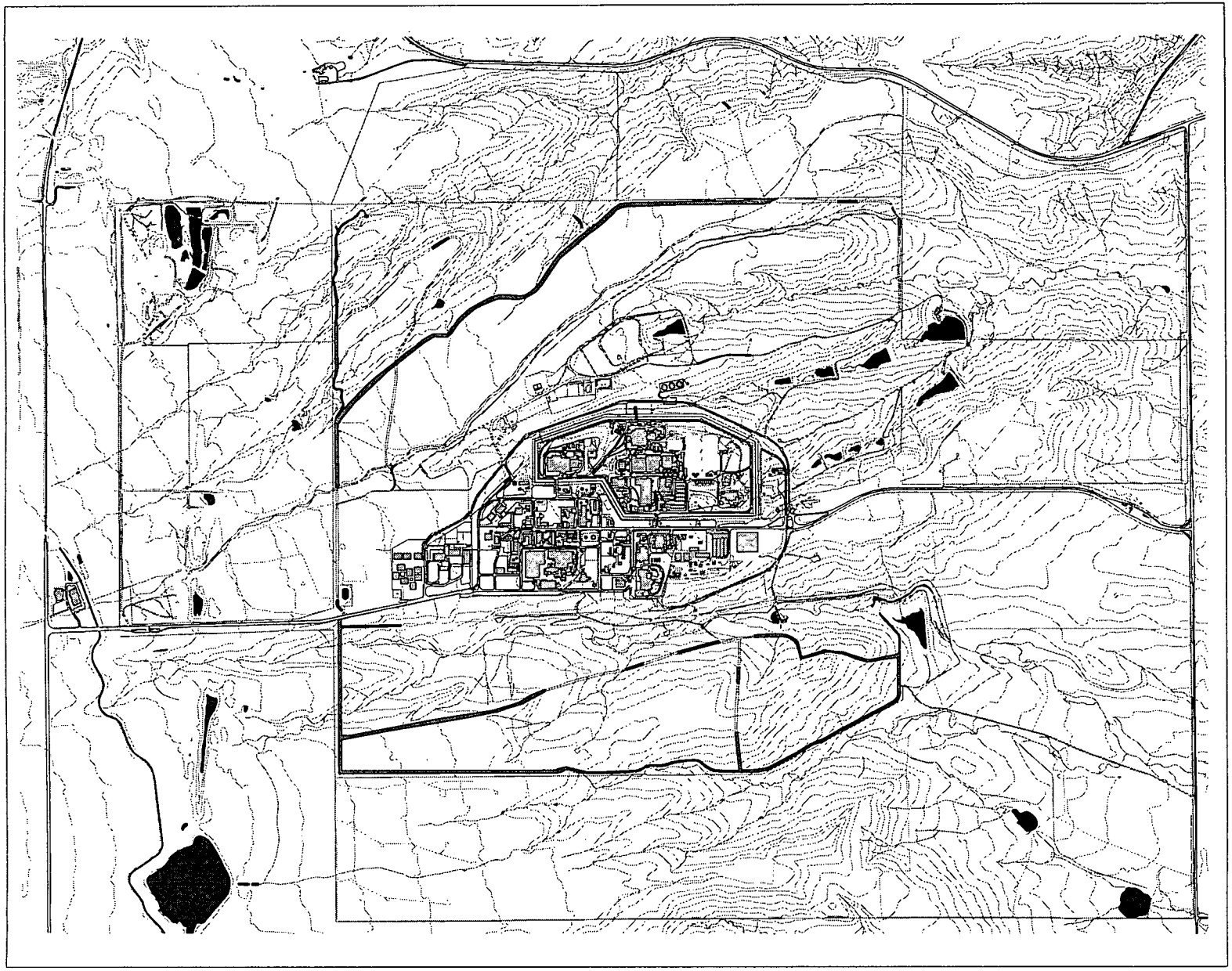

# 1999 Jointed Goatgrass (Aegilops cylindrica) Distribution

Figure 1-16

## MAP LEGEND

Jointed Goatgrass Infestations

### Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/85
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**

These locations approximate the boundaries of infestation areas. The boundaries are not exact and should not be treated as such. These areas may not represent all populations on Site.

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent™

For: Kaiser-Hill Company, LLC

MAP ID: K2-0042

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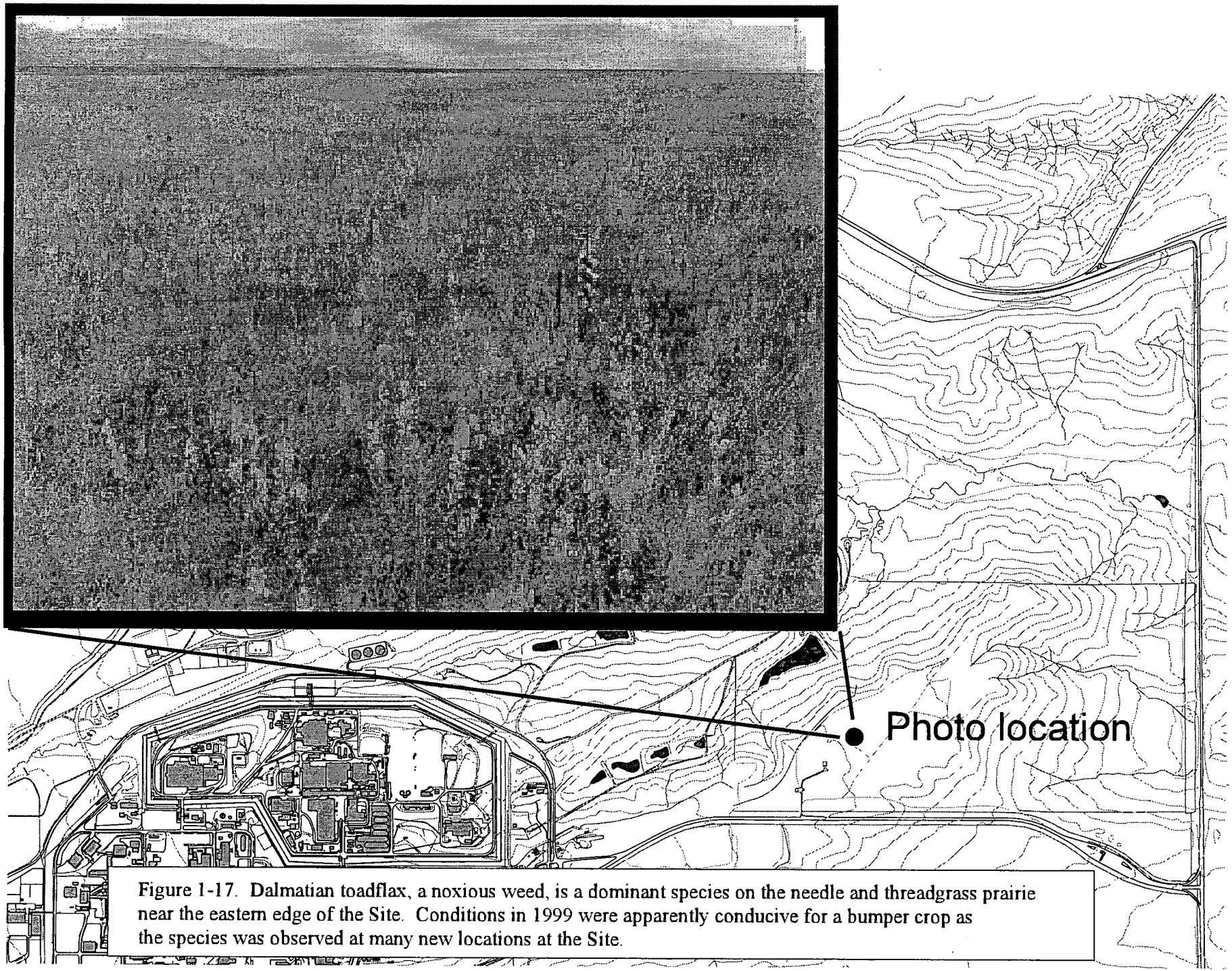
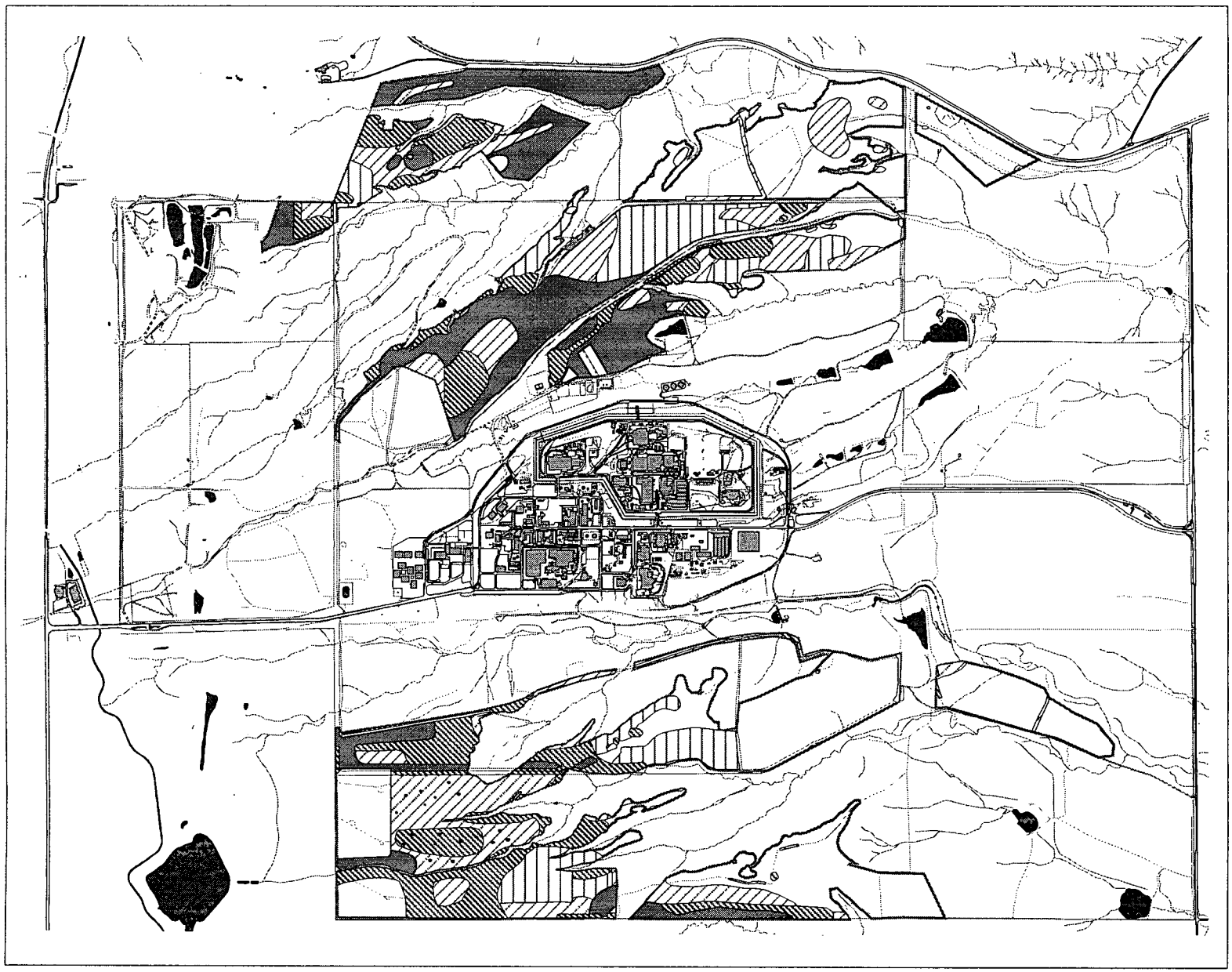



Figure 1-17. Dalmatian toadflax, a noxious weed, is a dominant species on the needle and threadgrass prairie near the eastern edge of the Site. Conditions in 1999 were apparently conducive for a bumper crop as the species was observed at many new locations at the Site.



# 1998 Diffuse Knapweed Pre-Aerial Herbicide Application Distribution

Figure 1-18

## MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas
- 1999 Aerial Spray Areas

## Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- New landfill

DATA SOURCE:
1998 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab. Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**

These locations approximate the boundaries of infestation areas. Infestation areas shown on this map only represent those that overlapped with the aerial herbicide application locations (i.e. this map does not represent the extent of diffuse knapweed at the Site).

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent™

For: Kaiser-Hill Company, LLC

MAP ID: K2-0017

March 14, 2000

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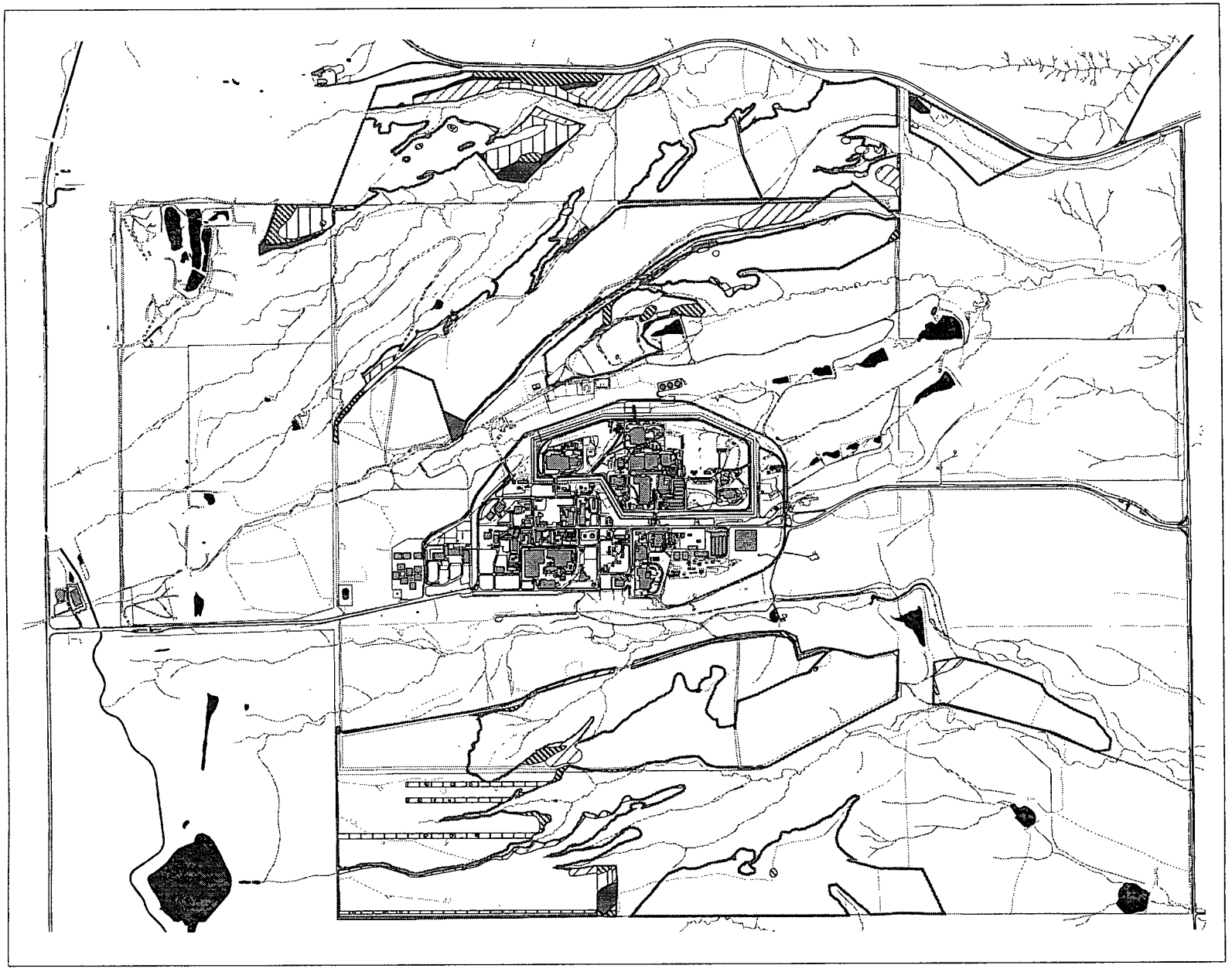

# 1999 Diffuse Knapweed Post-Aerial Herbicide Application Distribution

Figure 1-19

MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas
- 1999 Aerial Spray Areas

Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- New landfill

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G R&L, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**
These locations approximate the boundaries of infestation areas. Infestation areas shown on this map only represent those that overlapped with the aerial herbicide application locations (i.e. this map does not represent the extent of diffuse knapweed at the Site).

N

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1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0017

March 20, 2000

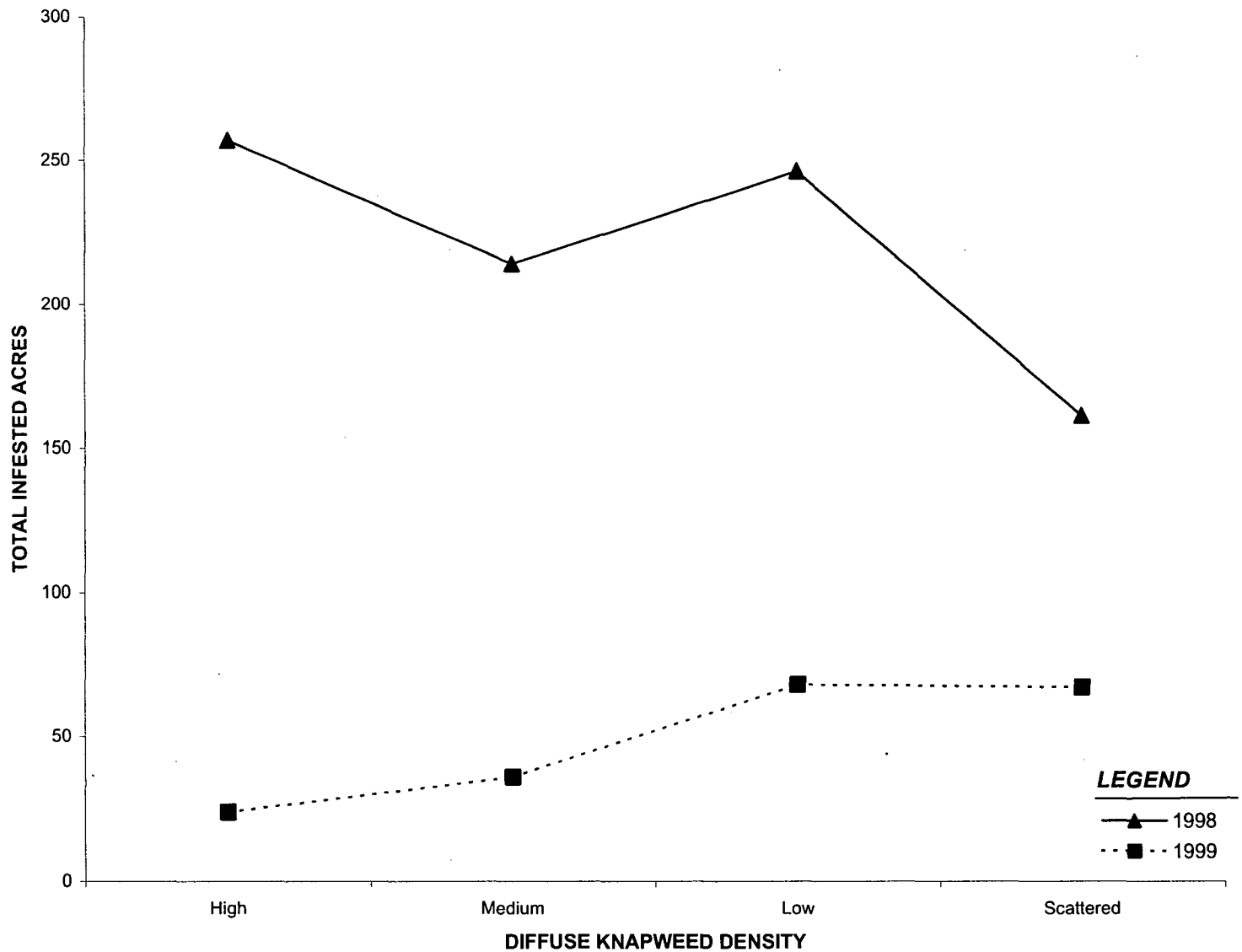


Figure 1-20. Comparison of 1998 and 1999 diffuse knapweed pre- and post-aerial herbicide application.

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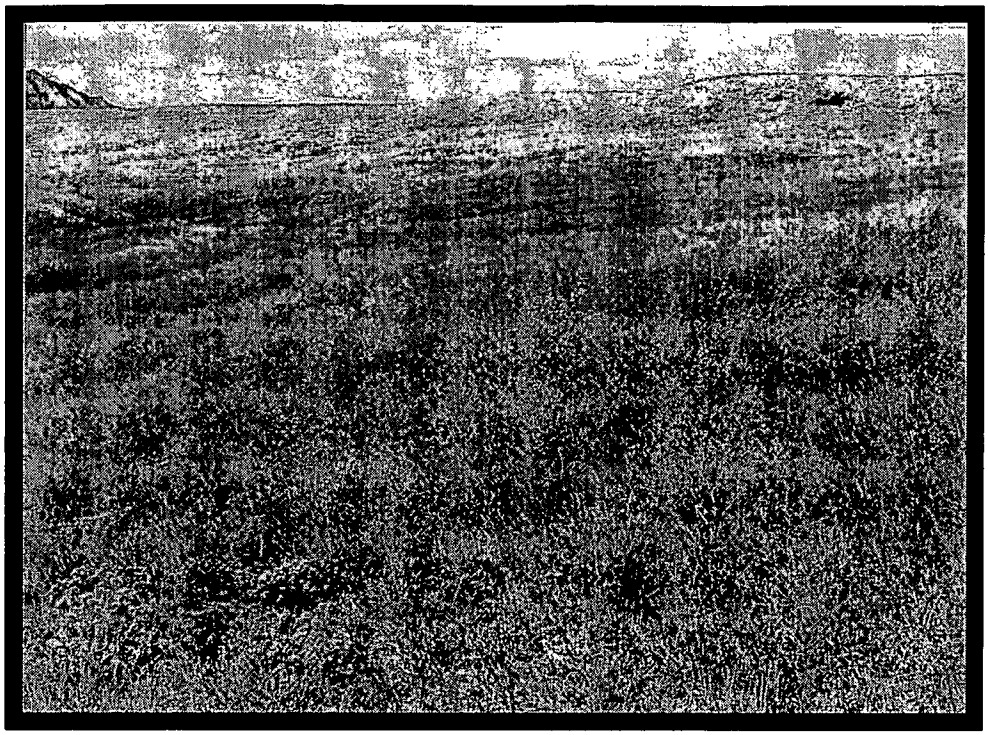


Figure 1-21. Diffuse knapweed covering a hillside in the Rock Creek drainage in 1997.

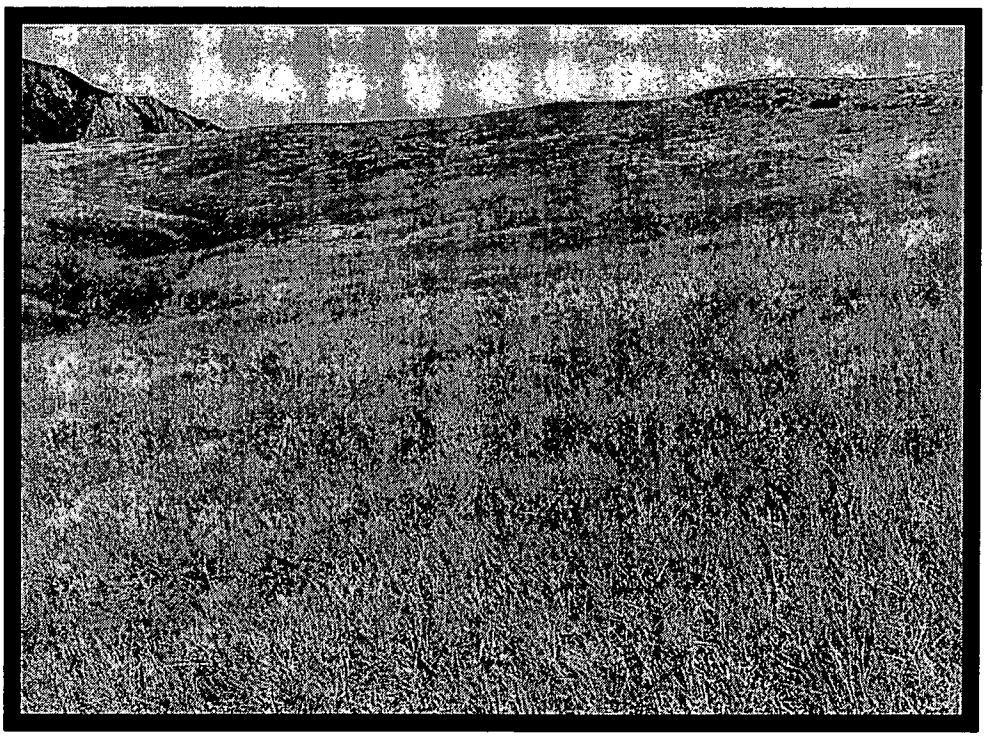


Figure 1-22. The same hillside in Rock Creek as shown above in Figure 20 after being treated with Tordon 22K applied by helicopter in 1999.

# Tables

**Table 1-1. 1997 and 1999 Great Plains Riparian Woodland Species Richness Comparison**

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| ACERACEAE | Acer negundo L. var. interius (Britt.) Sarg. | Y | ACNE1 | X | X |
| AGAVACEAE | Yucca glauca Nutt. | Y | YUGL1 | X | X |
| ALISMATACEAE | Alisma trivale Pursh | Y | ALTR1 | X | X |
| ALISMATACEAE | Sagittaria latifolia Willd. | Y | SALA1 | X | X |
| AMARANTHACEAE | Amaranthus graecizans L. | Y | AMGR1 | X | |
| ANACARDIACEAE | Rhus aromatica Ait. var. trilobata (Nutt.) A. Gray | Y | RHAR1 | X | X |
| ANACARDIACEAE | Toxicodendron rydbergii (Small) Greene | Y | TORY1 | X | X |
| APIACEAE | Cicuta maculata L. var. angustifolia Hook. | Y | CIMA1 | X | X |
| APIACEAE | Conium maculatum L. | N | COMA1 | X | X |
| APIACEAE | Heracleum sphondylium L. ssp. montanum (Schleich.) Briq. | Y | HESP1 | X | X |
| APIACEAE | Lomatium orientale Coult. & Rose | Y | LOOR1 | X | X |
| APIACEAE | Musineon divaricatum (Pursh.) Nutt. var. hookeri T. & G. | Y | MUDI1 | X | X |
| APIACEAE | Osmorhiza chiliensis H. & A. | Y | OSCH1 | X | X |
| APIACEAE | Osmorhiza longistylis (Torr.) DC var. longistylis | Y | OSLO1 | X | X |
| APOCYNACEAE | Apocynum cannabinum L. | Y | APCA1 | X | X |
| ASCLEPIADACEAE | Asclepias incarnata L. | Y | ASIN1 | X | X |
| ASCLEPIADACEAE | Asclepias speciosa Torr. | Y | ASSP1 | X | X |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | Y | ACMI1 | X | X |
| ASTERACEAE | Ambrosia psilostachya DC. | Y | AMPS1 | X | X |
| ASTERACEAE | Ambrosia trifida L. | Y | AMTR1 | X | X |
| ASTERACEAE | Antennaria parvifolia Nutt. | Y | ANPA1 | | X |
| ASTERACEAE | Arctium minus Bernh. | Y | ARMI1 | X | X |
| ASTERACEAE | Arnica fulgens Pursh. | Y | ARFU1 | X | X |
| ASTERACEAE | Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem. | Y | ARCA1 | X | X |
| ASTERACEAE | Artemisia dracunculus L. | Y | ARDR1 | X | X |
| ASTERACEAE | Artemisia frigida Willd. | Y | ARFR1 | X | X |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | Y | ARLU1 | X | X |
| ASTERACEAE | Aster falcatus Lindl. | Y | ASFA1 | X | X |
| ASTERACEAE | Aster hesperius A. Gray var. hersperius | Y | ASHE1 | X | X |
| ASTERACEAE | Aster laevis L. var. geyeri A. Gray | Y | ASLA1 | | X |
| ASTERACEAE | Aster porteri Gray | Y | ASPO1 | X | X |
| ASTERACEAE | Bidens frondosa L. | Y | BIFR1 | X | X |
| ASTERACEAE | Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | N | CANU1 | X | X |
| ASTERACEAE | Centaurea diffusa Lam. | N | CEDI1 | X | X |
| ASTERACEAE | Chrysanthemum leucanthemum L. | N | CHLE1 | X | X |
| ASTERACEAE | Chrysopsis fulcrata Greene | Y | CHFU1 | X | X |
| ASTERACEAE | Chrysopsis villosa Pursh. | Y | CHVI1 | X | X |
| ASTERACEAE | Chrysothamnus nauseosus (Pall.) Britt. ssp. graveolens (Nutt.) Piper | Y | CHNA1 | X | X |
| ASTERACEAE | Chrysothamnus nauseosus (Pall.) Britt. ssp. nauseosus | Y | CHNA2 | X | X |
| ASTERACEAE | Cichorium intybus L. | N | CIIN1 | X | X |
| ASTERACEAE | Cirsium arvense (L.) Scop. | N | CIAR1 | X | X |
| ASTERACEAE | Cirsium undulatum (Nutt.) Spreng. | Y | CIUN1 | X | X |
| ASTERACEAE | Cirsium vulgare (Savi) Ten. | N | CIVU1 | X | X |
| ASTERACEAE | Conyza canadensis (L.) Cronq. | Y | COCA1 | X | X |
| ASTERACEAE | Erigeron divergens T. & G. | Y | ERDI1 | X | X |
| ASTERACEAE | Erigeron flagellaris A. Gray | Y | ERFL1 | X | X |
| ASTERACEAE | Erigeron strigosus Muhl. ex Willd. | Y | ERST1 | X | X |
| ASTERACEAE | Gaillardia aristata Pursh. | Y | GAAR1 | X | |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | Y | GRSQ1 | X | X |
| ASTERACEAE | Gutierrezia sarothrae (Pursh.) Britt. & Rusby | Y | GUSA1 | X | X |
| ASTERACEAE | Helianthus annuus L. | Y | HEAN1 | X | X |
| ASTERACEAE | Helianthus maximilianii Schrad. | Y | HEMA1 | X | X |
| ASTERACEAE | Helianthus nuttallii T. & G. | Y | HENU1 | X | X |
| ASTERACEAE | Helianthus petiolaris Nutt. | Y | HEPE1 | X | X |
| ASTERACEAE | Helianthus pumilus Nutt. | Y | HEPU1 | X | X |
| ASTERACEAE | Heliomeris multiflora Nuttall | Y | HEMU1 | X | X |
| ASTERACEAE | Iva axillaris Pursh. | Y | IVAX1 | X | |
| ASTERACEAE | Kuhnia chlorolepis Woot. & Standl. | Y | KUCH1 | X | |

Table 1-1. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| ASTERACEAE | Kuhnia eupatorioides L. | Y | KUEU1 | X | X |
| ASTERACEAE | Lactuca oblongifolia Nutt. | Y | LAOB1 | X | X |
| ASTERACEAE | Lactuca serriola L. | N | LASE1 | X | X |
| ASTERACEAE | Liatris punctata Hook. | Y | LIPU1 | X | X |
| ASTERACEAE | Ratibida columnifera (Nutt.) Woot. & Standl. | Y | RACO1 | X | X |
| ASTERACEAE | Scorzonera laciniata L. | N | SCLA1 | X | X |
| ASTERACEAE | Senecio integerrimus Nutt. | Y | SEIN1 | X | X |
| ASTERACEAE | Senecio plattensis Nutt. | Y | SEPL1 | X | X |
| ASTERACEAE | Senecio spartioides T. & G. | Y | SESP1 | X | X |
| ASTERACEAE | Solidago canadensis L. | Y | SOCA1 | X | |
| ASTERACEAE | Solidago gigantea Ait. | Y | SOGI1 | X | X |
| ASTERACEAE | Solidago missouriensis Nutt. | Y | SOMI1 | X | X |
| ASTERACEAE | Solidago rigida L. | Y | SORI1 | X | X |
| ASTERACEAE | Sonchus arvensis L. ssp. uglinosus (Bieb.) Nyman | N | SOAR2 | X | X |
| ASTERACEAE | Sonchus asper (L.) Hill | N | SOAS1 | X | X |
| ASTERACEAE | Stephanomeria pauciflora (Torr.) A. Nels. | Y | STPA1 | X | |
| ASTERACEAE | Taraxacum officinale Weber | N | TAOF1 | X | X |
| ASTERACEAE | Tragopogon dubius Scop. | N | TRDU1 | X | X |
| ASTERACEAE | Xanthium strumarium L. | Y | XAST1 | X | X |
| BERBERIDACEAE | Berberis repens Lindl. | Y | BERE1 | X | X |
| BETULACEAE | Alnus incana (L.) Moench ssp. tenuifolia (Nuttall) Breitung | Y | ALIN1 | X | X |
| BETULACEAE | Betula occidentalis Hook. | Y | BEOC1 | | X |
| BORAGINACEAE | Asperugo procumbens L. | N | ASPR1 | | X |
| BORAGINACEAE | Cynoglossum officinale L. | N | CYOF1 | X | X |
| BORAGINACEAE | Lithospermum incisum Lehm. | Y | LIIN1 | X | X |
| BORAGINACEAE | Mertensia lanceolata (Pursh.) A. DC. | Y | MELA1 | X | X |
| BORAGINACEAE | Onosmodium molle Michx. var. occidentale (Mack.) Johnst. | Y | ONMO1 | X | X |
| BRASSICACEAE | Alyssum alyssoides (L.) L. | N | ALAL1 | X | X |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | N | ALMI1 | X | X |
| BRASSICACEAE | Arabis glabra (L.) Bernh. | N | ARGL1 | X | X |
| BRASSICACEAE | Barbarea vulgaris R. Br. | N | BAVU1 | X | X |
| BRASSICACEAE | Camelina microcarpa Andrz. ex DC. | N | CAMI1 | X | X |
| BRASSICACEAE | Cardaria chalepensis (L.) Hand-Mazz | N | CACH1 | | X |
| BRASSICACEAE | Conringia orientalis (L.) Dum. | N | COOR1 | X | |
| BRASSICACEAE | Descurainia pinnata (Walt.) Britt. | Y | DEPI1 | X | X |
| BRASSICACEAE | Descurainia richardsonii (Sweet) Schultz | Y | DERI1 | X | X |
| BRASSICACEAE | Descurainia sophia (L.) Webb ex Prantl. | N | DESO1 | X | X |
| BRASSICACEAE | Erysimum repandum L. | N | ERRE1 | X | X |
| BRASSICACEAE | Hesperis matronalis L. | N | HEMA2 | X | |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | N | LECA1 | X | X |
| BRASSICACEAE | Lesquerella montana (A. Gray) Wats. | Y | LEMO1 | | X |
| BRASSICACEAE | Nasturtium officinale R. Br. | N | NAOF1 | X | X |
| BRASSICACEAE | Physaria vitulifera Rydb. | Y | PHVI1 | X | X |
| BRASSICACEAE | Rorippa palustris (L.) Bess. ssp. hispida (Desv.) Jonsell | Y | ROPA1 | | X |
| BRASSICACEAE | Sisymbrium altissimum L. | N | SIAL1 | X | X |
| BRASSICACEAE | Thlaspi arvense L. | N | THAR1 | X | X |
| CACTACEAE | Coryphantha missouriensis (Sweet) Britt. & Rose | Y | COMI1 | X | X |
| CACTACEAE | Echinocereus viridiflorus Engelm. | Y | ECVI1 | X | X |
| CACTACEAE | Opuntia fragilis (Nutt.) Haw. | Y | OPFR1 | X | X |
| CACTACEAE | Opuntia macrorhiza Engelm. | Y | OPMA1 | X | X |
| CACTACEAE | Opuntia polyacantha Haw. | Y | OPPO1 | | X |
| CACTACEAE | Pediocactus simpsonii (Engelm.) Britt. & Rose | Y | PESI1 | X | |
| CANNABACEAE | Humulus lupulus L. var. lupuloides E. Small | Y | HULU1 | X | X |
| CAPRIFOLIACEAE | Symphoricarpos occidentalis Hook. | Y | SYOC1 | X | X |
| CAPRIFOLIACEAE | Symphoricarpos oreophilus Gray | Y | SYOR1 | X | X |
| CARYOPHYLLACEAE | Cerastium arvense L. | Y | CEAR1 | X | X |
| CARYOPHYLLACEAE | Cerastium vulgatum L. | N | CEVU1 | X | X |
| CARYOPHYLLACEAE | Paronychia jamesii T. & G. | Y | PAJA1 | X | X |

**Table 1-1. (cont.)**

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| CARYOPHYLLACEAE | Saponaria officinalis L. | N | SAOF1 | X | X |
| CARYOPHYLLACEAE | Silene antirrhina L. | Y | SIAN1 | X | |
| CARYOPHYLLACEAE | Silene drummondii Hook. | Y | SIDR1 | X | X |
| CARYOPHYLLACEAE | Silene pratensis (Raf.)Godr. & Gren | N | SIPR1 | X | X |
| CARYOPHYLLACEAE | Vaccaria pyramidata Medic. | N | VAPY1 | X | X |
| CERATOPHYLLACEAE | Ceratophyllum demersum L. | Y | CEDE1 | X | X |
| CHENOPODIACEAE | Chenopodium album L. | N | CHAL1 | X | X |
| CHENOPODIACEAE | Chenopodium fremontii S. Wats. | Y | CHFR1 | | X |
| CHENOPODIACEAE | Kochia scoparia (L.) Schrad. | N | KOSC1 | X | X |
| CHENOPODIACEAE | Salsola iberica Senn. & Pau. | N | SAIB1 | X | X |
| CLUSIACEAE | Hypericum perforatum L. | N | HYPE1 | X | X |
| COMMELINACEAE | Tradescantia occidentalis (Britt.) Smyth | Y | TROC1 | X | X |
| CONVOLVULACEAE | Calystegia sepium (L.) R. Br. ssp. angulata Brummitt | Y | CASE1 | | X |
| CONVOLVULACEAE | Convolvulus arvensis L. | N | COAR1 | X | X |
| CONVOLVULACEAE | Evolvulus nuttallianus R. & S. | Y | EVNU1 | X | X |
| CRASSULACEAE | Sedum lanceolatum Torr. | Y | SELA1 | X | X |
| CUPRESSACEAE | Juniperus scopulorum Sarg. | T | JUSC1 | X | X |
| CYPERACEAE | Carex athrostachya Olney | Y | CAAT1 | | X |
| CYPERACEAE | Carex aurea Nutt. | Y | CAAU1 | | X |
| CYPERACEAE | Carex brevior (Dew.) Mack. ex Lunell. | Y | CABR1 | X | X |
| CYPERACEAE | Carex douglasii F. Boott. | Y | CADO1 | | X |
| CYPERACEAE | Carex eleocharis Bailey | Y | CAEL1 | X | X |
| CYPERACEAE | Carex emoryi Dew. | Y | CAEM1 | | X |
| CYPERACEAE | Carex heliophila Mack. | Y | CAHE1 | X | X |
| CYPERACEAE | Carex hystericina Muhl. ex Willd. | Y | CAHY1 | X | X |
| CYPERACEAE | Carex lanuginosa Michx. | Y | CALA1 | X | X |
| CYPERACEAE | Carex nebrascensis Dew. | Y | CANE1 | X | X |
| CYPERACEAE | Carex praegracilis W. Boott. | Y | CAPR1 | X | X |
| CYPERACEAE | Carex scoparia Schkuhr. ex Willd. | Y | CASC1 | X | X |
| CYPERACEAE | Carex simulata Mack. | Y | CASI1 | X | X |
| CYPERACEAE | Carex stipata Muhl. | Y | CAST1 | X | X |
| CYPERACEAE | Carex vulpinoidea Michx. | Y | CAVU1 | X | X |
| CYPERACEAE | Eleocharis acicularis (L.) R. & S. | Y | ELAC1 | X | |
| CYPERACEAE | Eleocharis compressa Sulliv. | Y | ELCO1 | X | |
| CYPERACEAE | Eleocharis macrostachya Britt. | Y | ELMA1 | X | X |
| CYPERACEAE | Scirpus pallidus (Britt.) Fern | Y | SCPA1 | X | X |
| CYPERACEAE | Scirpus pungens Vahl | Y | SCPU1 | | X |
| CYPERACEAE | Scirpus pungens Vahl | Y | SCAM1 | X | |
| CYPERACEAE | Scirpus validus Vahl. | Y | SCVA1 | X | X |
| ELAEAGNACEAE | Elaeagnus angustifolia L. | N | ELAN1 | X | X |
| EQUISETACEAE | Equisetum arvense L. | Y | EQAR1 | X | X |
| EQUISETACEAE | Equisetum laevigatum A. Br. | Y | EQLA1 | X | X |
| EUPHORBIACEAE | Euphorbia dentata Michx. | Y | EUDE1 | X | X |
| EUPHORBIACEAE | Euphorbia marginata Pursh. | Y | EUMA1 | | X |
| EUPHORBIACEAE | Euphorbia serpyllifolia Pers. | Y | EUSE1 | X | |
| EUPHORBIACEAE | Tragia ramosa Nutt. | Y | TRRA1 | | X |
| FABACEAE | Amorpha fruticosa L. | Y | AMFR1 | X | X |
| FABACEAE | Astragalus agrestis Dougl. ex G. Don | Y | ASAG1 | X | X |
| FABACEAE | Astragalus canadensis L. | Y | ASCA1 | X | X |
| FABACEAE | Astragalus crassicarpus Nutt. | Y | ASCR1 | X | X |
| FABACEAE | Astragalus drummondii Dougl. ex Hook. | Y | ASDR1 | X | X |
| FABACEAE | Astragalus flexuosus (Hook.) G. Don | Y | ASFL1 | X | X |
| FABACEAE | Astragalus shortianus Nutt. ex T.&G. | Y | ASSH1 | X | |
| FABACEAE | Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinners. | Y | DACA1 | X | X |
| FABACEAE | Dalea purpurea Vent | Y | DAPU1 | X | X |
| FABACEAE | Glycyrrhiza lepidota Pursh. | Y | GLLE1 | X | X |
| FABACEAE | Lathyrus eucosmus Butters and St. John | Y | LAEU1 | X | X |
| FABACEAE | Lupinus argenteus Pursh ssp. ingratus (Greene) Harmon | Y | LUAR2 | X | X |

Table 1-1. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| FABACEAE | Lupinus argenteus Pursh var. argenteus | Y | LUAR1 | X | X |
| FABACEAE | Medicago lupulina L. | N | MELU1 | X | X |
| FABACEAE | Medicago sativa L. ssp. sativa | N | MESA1 | X | X |
| FABACEAE | Melilotus alba Medic. | N | MEAL1 | X | X |
| FABACEAE | Melilotus officinalis (L.) Pall. | N | MEOF1 | X | X |
| FABACEAE | Oxytropis lambertii Pursh. | Y | OXLA1 | X | X |
| FABACEAE | Psoralea tenuiflora Pursh. | Y | PSTE1 | X | X |
| FABACEAE | Thermopsis rhombifolia var. divaricarpa (Nels.) Isely | Y | THRH1 | X | X |
| FABACEAE | Trifolium pratense L. | N | TRPR1 | | X |
| FABACEAE | Vicia americana Muhl. ex Willd. | Y | VIAM1 | X | X |
| GENTIANACEAE | Gentiana affinis Griseb. | Y | GEAF1 | X | |
| GENTIANACEAE | Swertia radiata (Kell.) O. Ktze. | Y | SWRA1 | | X |
| GERANIACEAE | Erodium cicutarium (L.) L'Her. | N | ERCI1 | X | X |
| GERANIACEAE | Geranium caespitosum James ssp. caespitosum | Y | GECA1 | X | X |
| GROSSULARIACEAE | Ribes aureum Pursh | Y | RIAU1 | X | X |
| GROSSULARIACEAE | Ribes cereum Dougl. | Y | RICE1 | X | X |
| GROSSULARIACEAE | Ribes inerme Rydb. | Y | RIIN1 | | X |
| HYDROPHYLLACEAE | Hydrophyllum fendleri (Gray) Heller | Y | HYFE1 | X | X |
| HYDROPHYLLACEAE | Phacelia heterophylla Pursh. | Y | PHHE1 | X | X |
| IRIDACEAE | Iris missouriensis Nutt. | Y | IRMI1 | X | X |
| IRIDACEAE | Sisyrinchium montanum Greene | Y | SIMO1 | X | X |
| JUNCACEAE | Juncus articulatus L. | Y | JUAR1 | | X |
| JUNCACEAE | Juncus balticus Willd. | Y | JUBA1 | X | X |
| JUNCACEAE | Juncus dudleyi Wieg. | Y | JUDU1 | X | X |
| JUNCACEAE | Juncus ensifolius Wikst. var. montanus (Englm.) C. L. Hitchc. | Y | JUEN1 | X | X |
| JUNCACEAE | Juncus interior Wieg. | Y | JUIN1 | X | |
| JUNCACEAE | Juncus longistylis Torr. | Y | JULO1 | X | X |
| JUNCACEAE | Juncus nodosus L. | Y | JUNO1 | X | X |
| JUNCACEAE | Juncus torreyi Cov. | Y | JUTO1 | X | X |
| JUNCACEAE | Juncus tracyi Rydb. | Y | JUTR1 | | X |
| LAMIACEAE | Lycopus americanus Muhl. ex Barton | Y | LYAM1 | X | X |
| LAMIACEAE | Lycopus asper Greene | Y | LYAS1 | | X |
| LAMIACEAE | Marrubium vulgare L. | N | MAVU1 | X | X |
| LAMIACEAE | Mentha arvensis L. | Y | MEAR1 | X | X |
| LAMIACEAE | Monarda fistulosa L. var. menthifolia (Grah.) Fern. | Y | MOFI1 | X | X |
| LAMIACEAE | Nepeta cataria L. | N | NECA1 | X | X |
| LAMIACEAE | Prunella vulgaris L. | Y | PRVU1 | X | X |
| LAMIACEAE | Scutellaria brittonii Porter | Y | SCBR1 | X | X |
| LAMIACEAE | Stachys palustris L. ssp. pilosa (Nutt.) Epling | Y | STPA2 | X | X |
| LEMNACEAE | Lemna minor L. | Y | LEMI1 | X | X |
| LILIACEAE | Allium cernuum Roth | Y | ALCE1 | | X |
| LILIACEAE | Allium geyeri S. Wats. | Y | ALGE1 | X | X |
| LILIACEAE | Allium textile A. Nels. & Macbr. | Y | ALTE1 | X | X |
| LILIACEAE | Asparagus officinalis L. | N | ASOF1 | X | X |
| LILIACEAE | Calochortus gunnisonii S. Wats. | Y | CAGU1 | X | X |
| LILIACEAE | Leucocrinum montanum Nutt. | Y | LEMO2 | X | |
| LILIACEAE | Smilacina stellata (L.) Desf. | Y | SMST1 | X | X |
| LILIACEAE | Zigadenus venenosus Wats. var. gramineus (Rydb.) Walsh ex Peck | Y | ZIVE1 | X | |
| LINACEAE | Linum perenne L. var. lewisii (Pursh.) Eat. & Wright | Y | LIPE1 | X | X |
| LINACEAE | Linum pratense (Nort.) Small | Y | LIPR1 | | X |
| LYTHRACEAE | Lythrum alatum Pursh. | Y | LYAL1 | X | |
| MALVACEAE | Malva neglecta Wallr. | N | MANE1 | | X |
| MALVACEAE | Sidalcea candida Gray | Y | SICA1 | X | X |
| MALVACEAE | Sphaeralcea coccinea (Pursh.) Rydb. | Y | SPCO1 | X | X |
| NYCTAGINACEAE | Mirabilis hirsuta (Pursh.) MacM. | Y | MIHI1 | X | X |
| NYCTAGINACEAE | Mirabilis linearis (Pursh.) Heimerl | Y | MILI1 | X | X |
| NYCTAGINACEAE | Mirabilis nyctaginea (Michx.) MacM. | Y | MINY1 | X | X |
| ONAGRACEAE | Epilobium ciliatum Raf. ssp. glandulosum (Lehm.) Hock & Raven | Y | EPCI1 | X | X |

Table 1-1. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| ONAGRACEAE | Epilobium paniculatum Nutt. | Y | EPPA1 | X | X |
| ONAGRACEAE | Gaura coccinea Pursh. | Y | GACO1 | X | X |
| ONAGRACEAE | Gaura parviflora Dougl. | Y | GAPA1 | X | X |
| ONAGRACEAE | Oenothera howardii (A. Nels.) W. L. Wagner | Y | OEHO1 | X | X |
| ONAGRACEAE | Oenothera villosa Thunb. ssp. strigosa (Rydb.) Dietrich & Raven | Y | OEVI1 | X | X |
| ORCHIDACEAE | Habenaria hyperborea (L.) R. Br. | Y | HAHY1 | X | X |
| OXALIDACEAE | Oxalis dillenii Jacq. | N | OXDI1 | X | X |
| PAPAVERACEAE | Argemone polyanthemos (Fedde) G. Ownbey | Y | ARPO1 | X | X |
| PINACEAE | Pinus ponderosa Laws | Y | PIPO1 | X | X |
| PLANTAGINACE | Plantago lanceolata L. | N | PLLA1 | X | X |
| PLANTAGINACE | Plantago major L. | N | PLMA1 | X | X |
| POACEAE | Agropyron caninum (L.) Beauv. ssp. majus (Vasey) C. L. Hitchc. | Y | AGCA1 | X | X |
| POACEAE | Agropyron cristatum (L.) Gaertn. | N | AGCR1 | X | X |
| POACEAE | Agropyron dasystachyum (Hook.) Scribn. | Y | AGDA1 | X | |
| POACEAE | Agropyron desertorum (Fisch.) Schult. | N | AGDE1 | X | X |
| POACEAE | Agropyron intermedium (Host) Beauv. | N | AGIN1 | X | X |
| POACEAE | Agropyron repens (L.) Beauv. | N | AGRE1 | X | X |
| POACEAE | Agropyron smithii Rydb. | Y | AGSM1 | X | X |
| POACEAE | Agrostis stolonifera L. | N | AGST1 | X | X |
| POACEAE | Andropogon gerardii Vitman | Y | ANGE1 | X | X |
| POACEAE | Andropogon scoparius Michx. | Y | ANSC1 | X | X |
| POACEAE | Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | Y | ARLO1 | X | X |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | Y | BOCU1 | X | X |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | Y | BOGR1 | X | X |
| POACEAE | Bouteloua hirsuta Lag | Y | BOHI1 | X | X |
| POACEAE | Bromus inermis Leyss. ssp. inermis | N | BRIN1 | X | X |
| POACEAE | Bromus japonicus Thunb. ex Murr. | N | BRJA1 | X | X |
| POACEAE | Bromus tectorum L. | N | BRTE1 | X | X |
| POACEAE | Buchloe dactyloides (Nutt.) Engelm. | Y | BUDA1 | X | X |
| POACEAE | Ceratochloa marginata (Nees ex Stued.) Jackson | Y | CEMA1 | | X |
| POACEAE | Dactylis glomerata L. | N | DAGL1 | X | X |
| POACEAE | Dichanthelium oligosanthes (Schultz) Gould var. scribnerianum (Nash) G | Y | DIOL1 | X | X |
| POACEAE | Echinochloa crusgallii (L.) Beauv. | N | ECCR1 | X | X |
| POACEAE | Elymus canadensis L. | Y | ELCA1 | X | X |
| POACEAE | Festuca octoflora Walt. | Y | FEOC1 | X | |
| POACEAE | Festuca ovina L. var. rydbergii St. Yves | Y | FEOV1 | X | X |
| POACEAE | Festuca pratensis Huds. | Y | FEPR1 | X | X |
| POACEAE | Glyceria grandis S. Wats. ex A. Gray | Y | GLGR1 | X | X |
| POACEAE | Glyceria striata (Lam.) Hitchc. | Y | GLST1 | X | X |
| POACEAE | Hordeum brachyantherum Nevski | Y | HOBR1 | | X |
| POACEAE | Hordeum jubatum L. | Y | HOJU1 | X | X |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | Y | KOPY1 | X | X |
| POACEAE | Leersia oryzoides (L.) Sw. | Y | LEOR1 | X | X |
| POACEAE | Muhlenbergia asperifolia (Nees. & Mey.) Parodi | Y | MUAS1 | | X |
| POACEAE | Muhlenbergia filiformis (Thurb.) Rydb. | Y | MUFI1 | | X |
| POACEAE | Muhlenbergia montana (Nutt.) Hitchc. | Y | MUMO1 | X | |
| POACEAE | Muhlenbergia racemosa (Michx.) B. S. P. | Y | MURA1 | X | X |
| POACEAE | Muhlenbergia wrightii Vasey | Y | MUWR1 | | X |
| POACEAE | Panicum capillare L. | Y | PACA1 | X | X |
| POACEAE | Panicum virgatum L. | Y | PAVI1 | X | X |
| POACEAE | Phalaris arundinacea L. | Y | PHAR1 | X | X |
| POACEAE | Phleum pratense L. | N | PHPR1 | X | X |
| POACEAE | Poa canbyi (Scribn.) Piper | Y | POCA1 | | X |
| POACEAE | Poa compressa L. | N | POCO1 | X | X |
| POACEAE | Poa juncifolia Scribn. | Y | POJU1 | | X |
| POACEAE | Poa palustris L. | N | POPA1 | X | |
| POACEAE | Poa pratensis L. | N | POPR1 | X | X |
| POACEAE | Polypogon monspeliensis (L.) Desf. | N | POMO1 | X | |

Table 1-1. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| POACEAE | Schedonnardus paniculatus (Nutt.) Trel. | N | SCPA2 | | X |
| POACEAE | Secale cereale L. | N | SECE1 | X | X |
| POACEAE | Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | Y | SIHY1 | X | X |
| POACEAE | Sorghastrum nutans (L.) Nash | Y | SONU1 | X | X |
| POACEAE | Spartina pectinata Link | Y | SPPE1 | X | X |
| POACEAE | Sporobolus asper (Michx.) Kunth | Y | SPAS1 | X | X |
| POACEAE | Sporobolus cryptandrus (Torr.) A. Gray | Y | SPCR1 | X | X |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | Y | SPHE1 | X | X |
| POACEAE | Stipa comata Trin. & Rupr. | Y | STCO1 | X | X |
| POACEAE | Stipa viridula Trin. | Y | STVI1 | X | X |
| POACEAE | X Agrohordeum macounii (Vasey) Lepage | N | AGMA1 | X | |
| POLYGONACEAE | Eriogonum alatum Torr. | Y | ERAL1 | X | X |
| POLYGONACEAE | Eriogonum effusum Nutt. | Y | EREF1 | X | X |
| POLYGONACEAE | Eriogonum umbellatum Torr. | Y | ERUM1 | X | X |
| POLYGONACEAE | Polygonum arenastrum Jord. ex Bor. | N | POAR1 | | X |
| POLYGONACEAE | Polygonum convolvulus L. | N | POCO2 | X | X |
| POLYGONACEAE | Polygonum douglasii Greene | Y | PODO1 | X | |
| POLYGONACEAE | Polygonum lapathifolium L. | N | POLA1 | X | X |
| POLYGONACEAE | Polygonum pensylvanicum L. | Y | POPE1 | | X |
| POLYGONACEAE | Polygonum persicaria L. | N | POPE2 | | X |
| POLYGONACEAE | Polygonum ramosissimum Michx. | Y | PORA1 | | X |
| POLYGONACEAE | Rumex acetosella L. | N | RUAC1 | X | X |
| POLYGONACEAE | Rumex crispus L. | N | RUCR1 | X | X |
| POLYGONACEAE | Rumex obtusifolius L. | N | RUOB1 | X | X |
| POLYGONACEAE | Rumex salicifolius Weinm. ssp. triangulivalvis Danser | Y | RUSA1 | X | X |
| PORTULACACEAE | Talinum parviflorum Nutt. | Y | TAPA1 | X | X |
| PRIMULACEAE | Androsace occidentalis Pursh. | Y | ANOC1 | X | |
| PRIMULACEAE | Lysimachia ciliata L. | Y | LYCI1 | X | X |
| RANUNCULACEAE | Clematis ligusticifolia Nutt. | Y | CLLI1 | X | X |
| RANUNCULACEAE | Delphinium nuttalianum Pritz. ex Walpers | Y | DENU1 | X | |
| RANUNCULACEAE | Delphinium virescens Nutt. ssp. penardii (Huth) Ewan | Y | DEVI1 | X | X |
| RANUNCULACEAE | Ranunculus macounii Britt. | Y | RAMA1 | X | X |
| RANUNCULACEAE | Ranunculus trichophyllus Chaix | Y | RATR1 | X | X |
| RANUNCULACEAE | Thalictrum dasycarpum Fisch. & Ave-Lall | Y | THDA1 | X | X |
| ROSACEAE | Agrimonia striata Michx. | Y | AGST2 | X | X |
| ROSACEAE | Crataegus erythropoda Ashe | Y | CRER1 | X | X |
| ROSACEAE | Crataegus succulenta Link var. occidentalis (Britton) E. J. Palm. | Y | CRSU1 | | X |
| ROSACEAE | Geum aleppicum Jacq. | Y | GEAL1 | X | X |
| ROSACEAE | Geum macrophyllum Willd. | Y | GEMA1 | X | X |
| ROSACEAE | Potentilla arguta Pursh | Y | POAR2 | X | |
| ROSACEAE | Potentilla fissa Nutt. | Y | POFI1 | X | X |
| ROSACEAE | Potentilla gracilis Dougl. ex Hook. var. glabrata (Lehm.) C. L. Hitchc. | Y | POGR1 | X | X |
| ROSACEAE | Potentilla hippiana Lehm. | Y | POHI1 | X | X |
| ROSACEAE | Potentilla norvegica L. | Y | PONO1 | X | |
| ROSACEAE | Potentilla paradoxa Nutt. | Y | POPA2 | | X |
| ROSACEAE | Potentilla pulcherrima x hippiana | Y | POPU1 | X | X |
| ROSACEAE | Prunus americana Marsh. | Y | PRAM1 | X | X |
| ROSACEAE | Prunus virginiana L. var. melanocarpa (A. Nels.) Sarg. | Y | PRVI1 | X | X |
| ROSACEAE | Pyrus malus L. | N | PYMA1 | X | X |
| ROSACEAE | Rosa acicularis Lindl. | Y | ROAC1 | X | X |
| ROSACEAE | Rosa arkansana Porter | Y | ROAR1 | X | X |
| ROSACEAE | Rosa woodsii Lindl. | Y | ROWO1 | X | X |
| ROSACEAE | Rubus deliciosus Torr. | Y | RUDE1 | | X |
| ROSACEAE | Rubus idaeus L. ssp. sachalinensis (Levl.) Focke var. sachalinensis | Y | RUID1 | X | X |
| ROSACEAE | Sanguisorba minor Scop. | N | SAMI1 | | X |
| ROSACEAE | Sorbus scopulina Greene | Y | SOSC1 | | X |
| RUBIACEAE | Galium aparine L. | Y | GAAP1 | X | X |
| RUBIACEAE | Galium septentrionale Roemer & Schultes | Y | GASE1 | X | X |

Table 1-1. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| SALICACEAE | Populus alba L. | Y | POAL1 | X | X |
| SALICACEAE | Populus angustifolia James | Y | POAN3 | X | X |
| SALICACEAE | Populus deltoides Marsh. ssp. monilifera (Ait.) Eckenw. | Y | PODE1 | X | X |
| SALICACEAE | Populus x acuminata Rydb. | Y | POAC1 | X | X |
| SALICACEAE | Salix amygdaloides Anderss. | Y | SAAM1 | X | X |
| SALICACEAE | Salix exigua Nutt. ssp. interior (Rowlee) Cronq. | Y | SAEX1 | X | X |
| SALICACEAE | Salix fragilis L. | N | SAFR1 | X | |
| SALICACEAE | Salix irrorata Andersson | Y | SAIR1 | X | X |
| SALICACEAE | Salix lutea Nutt. | Y | SALU1 | X | X |
| SANTALACEAE | Comandra umbellata (L.) Nutt. | Y | COUM1 | X | X |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | N | LIDA1 | X | X |
| SCROPHULARIACEAE | Penstemon secundiflorus Benth. | Y | PESE1 | X | X |
| SCROPHULARIACEAE | Penstemon virens Penn. | Y | PEVI1 | X | X |
| SCROPHULARIACEAE | Penstemon virgatus Gray ssp. asa-grayi Crosswhite | Y | PEVI2 | X | X |
| SCROPHULARIACEAE | Scrophularia lanceolata Pursh. | Y | SCLA2 | X | X |
| SCROPHULARIACEAE | Verbascum blattaria L. | N | VEBL1 | X | X |
| SCROPHULARIACEAE | Verbascum thapsus L. | N | VETH1 | X | X |
| SCROPHULARIACEAE | Veronica americana (Raf.) Schwein. ex Benth. | Y | VEAM1 | X | |
| SCROPHULARIACEAE | Veronica anagallis-aquatica L. | N | VEAN1 | X | X |
| SCROPHULARIACEAE | Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren | Y | VEPE1 | X | |
| SMILACACEAE | Smilax herbacea L. var. lasioneura (Small) Rydb.. | Y | SMHE1 | | X |
| SOLANACEAE | Physalis heterophylla Nees | Y | PHHE2 | X | X |
| SOLANACEAE | Physalis virginiana P. Mill. | Y | PHVI2 | X | X |
| TYPHACEAE | Typha angustifolia L. | Y | TYAN1 | X | X |
| TYPHACEAE | Typha latifolia L. | Y | TYLA1 | X | X |
| ULMACEAE | Ulmus pumila L. | N | ULPU1 | X | X |
| URTICACEAE | Parietaria pensylvanica Muhl. ex Willd. | Y | PAPE1 | | X |
| URTICACEAE | Urtica dioica L. ssp. gracilis (Ait.) Seland. | Y | URDI1 | X | X |
| VERBENACEAE | Lippia cuneifolia (Torr.) Steud. | Y | LICU1 | X | X |
| VERBENACEAE | Verbena bracteata Lag. & Rodr. | Y | VEBR1 | X | X |
| VERBENACEAE | Verbena hastata L. | Y | VEHA1 | X | X |
| VIOLACEAE | Hybanthus verticillatus (Ort.) Baill. | Y | HYVE1 | | X |
| VIOLACEAE | Viola scopulorum (Gray) Greene | Y | VISC1 | | X |
| VIOLACEAE | Viola sororia Willd. | Y | VISO1 | X | X |
| VITACEAE | Vitis riparia Michx. | Y | VIRI1 | X | X |
| | Unknown species | | UNKN | | X |
| | Total # Species | | | 336 | 350 |
| | Sorenson Similarity Index | | | 0.88 | |

**Table 1-2. 1997 and 1999 Wetland Species Richness Comparison**

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| ACERACEAE | Acer negundo L. var. interius (Britt.) Sarg. | Y | ACNE1 | X | |
| AGAVACEAE | Yucca glauca Nutt. | Y | YUGL1 | X | X |
| ALISMATACEAE | Alisma trivale Pursh | Y | ALTR1 | X | |
| ALISMATACEAE | Sagittaria latifolia Willd. | Y | SALA1 | X | X |
| ANACARDIACEAE | Rhus aromatica Ait. var. trilobata (Nutt.) A. Gray | Y | RHAR1 | X | X |
| ANACARDIACEAE | Toxicodendron rydbergii (Small) Greene | Y | TORY1 | X | X |
| APIACEAE | Berula erecta (Huds.) Cov. var. incisum | Y | BEER1 | | X |
| APIACEAE | Cicuta maculata L. var. angustifolia Hook. | Y | CIMA1 | X | X |
| APIACEAE | Conium maculatum L. | N | COMA1 | X | X |
| APIACEAE | Heracleum sphondylium L. ssp. montanum (Schleich.) Briq. | Y | HESP1 | X | X |
| APIACEAE | Lomatium orientale Coult. & Rose | Y | LOOR1 | X | X |
| APIACEAE | Osmorhiza chiliensis H. & A. | Y | OSCH1 | | X |
| APOCYNACEAE | Apocynum cannabinum L. | Y | APCA1 | X | X |
| ASCLEPIADACEAE | Asclepias incarnata L. | Y | ASIN1 | X | X |
| ASCLEPIADACEAE | Asclepias speciosa Torr. | Y | ASSP1 | X | X |
| ASCLEPIADACEAE | Asclepias stenophylla A. Gray | Y | ASST1 | X | |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | Y | ACMI1 | X | X |
| ASTERACEAE | Ambrosia artemisiifolia L. | Y | AMAR1 | X | |
| ASTERACEAE | Ambrosia psilostachya DC. | Y | AMPS1 | X | X |
| ASTERACEAE | Ambrosia trifida L. | Y | AMTR1 | | X |
| ASTERACEAE | Arctium minus Bernh. | Y | ARMI1 | X | X |
| ASTERACEAE | Arnica fulgens Pursh. | Y | ARFU1 | X | X |
| ASTERACEAE | Artemisia frigida Willd. | Y | ARFR1 | X | |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | Y | ARLU1 | X | X |
| ASTERACEAE | Aster falcatus Lindl. | Y | ASFA1 | X | X |
| ASTERACEAE | Aster hesperius A. Gray var. hersperius | Y | ASHE1 | X | X |
| ASTERACEAE | Aster laevis L. var. geyeri A. Gray | Y | ASLA1 | X | X |
| ASTERACEAE | Aster porteri Gray | Y | ASPO1 | X | X |
| ASTERACEAE | Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | N | CANU1 | X | X |
| ASTERACEAE | Centaurea diffusa Lam. | N | CEDI1 | X | X |
| ASTERACEAE | Chrysopsis fulcrata Greene | Y | CHFU1 | X | X |
| ASTERACEAE | Chrysopsis villosa Pursh. | Y | CHVI1 | X | X |
| ASTERACEAE | Cirsium arvense (L.) Scop. | N | CIAR1 | X | X |
| ASTERACEAE | Cirsium vulgare (Savi) Ten. | N | CIVU1 | X | X |
| ASTERACEAE | Conyza canadensis (L.) Cronq. | Y | COCA1 | X | X |
| ASTERACEAE | Crepis runcinata (James) T. & G. | Y | CRRU1 | X | |
| ASTERACEAE | Erigeron divergens T. & G. | Y | ERDI1 | X | X |
| ASTERACEAE | Erigeron flagellaris A. Gray | Y | ERFL1 | | X |
| ASTERACEAE | Gaillardia aristata Pursh. | Y | GAAR1 | X | X |
| ASTERACEAE | Gnapthalium chilense Spreng. | Y | GNCH1 | X | X |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | Y | GRSQ1 | X | X |
| ASTERACEAE | Gutierrezia sarothrae (Pursh.) Britt. & Rusby | Y | GUSA1 | X | X |
| ASTERACEAE | Helianthus annuus L. | Y | HEAN1 | X | X |
| ASTERACEAE | Helianthus nuttallii T. & G. | Y | HENU1 | X | X |
| ASTERACEAE | Helianthus petiolaris Nutt. | Y | HEPE1 | X | X |
| ASTERACEAE | Helianthus pumilus Nutt. | Y | HEPU1 | | X |
| ASTERACEAE | Helianthus rigidus (Cass.) Desf. ssp. subrhomboideus (Rydb.) Heiser | Y | HERI1 | X | X |
| ASTERACEAE | Kuhnia eupatorioides L. | Y | KUEU1 | X | X |
| ASTERACEAE | Lactuca oblongifolia Nutt. | Y | LAOB1 | | X |
| ASTERACEAE | Lactuca serriola L. | N | LASE1 | X | X |
| ASTERACEAE | Liatris punctata Hook. | Y | LIPU1 | X | X |
| ASTERACEAE | Onopordum acanthium L. | N | ONAC1 | | X |
| ASTERACEAE | Ratibida columnifera (Nutt.) Woot. & Standl. | Y | RACO1 | X | X |
| ASTERACEAE | Scorzonera laciniata L. | N | SCLA1 | X | X |
| ASTERACEAE | Senecio integerrimus Nutt. | Y | SEIN1 | | X |
| ASTERACEAE | Senecio plattensis Nutt. | Y | SEPL1 | X | X |
| ASTERACEAE | Senecio spartioides T. & G. | Y | SESP1 | | X |
| ASTERACEAE | Solidago canadensis L. | Y | SOCA1 | X | X |

Table 1-2. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| ASTERACEAE | Solidago gigantea Ait. | Y | SOGI1 | X | X |
| ASTERACEAE | Solidago missouriensis Nutt. | Y | SOMI1 | X | X |
| ASTERACEAE | Solidago rigida L. | Y | SORI1 | X | X |
| ASTERACEAE | Sonchus arvensis L. ssp. uglinosus (Bieb.) Nyman | N | SOAR2 | | X |
| ASTERACEAE | Sonchus asper (L.) Hill | N | SOAS1 | X | X |
| ASTERACEAE | Taraxacum officinale Weber | N | TAOF1 | X | X |
| ASTERACEAE | Tragopogon dubius Scop. | N | TRDU1 | X | X |
| ASTERACEAE | Tragopogon porrifolius L. | N | TRPO1 | X | |
| BORAGINACEAE | Cynoglossum officinale L. | N | CYOF1 | X | X |
| BORAGINACEAE | Lithospermum multiflorum Torr. | Y | LIMU1 | | X |
| BORAGINACEAE | Mertensia lanceolata (Pursh.) A. DC. | Y | MELA1 | X | X |
| BORAGINACEAE | Onosmodium molle Michx. var. occidentale (Mack.) Johnst. | Y | ONMO1 | X | X |
| BRASSICACEAE | Alyssum alyssoides (L.) L. | N | ALAL1 | X | X |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | N | ALMI1 | X | X |
| BRASSICACEAE | Arabis glabra (L.) Bernh. | N | ARGL1 | X | X |
| BRASSICACEAE | Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins | Y | ARHI1 | X | |
| BRASSICACEAE | Barbarea vulgaris R. Br. | N | BAVU1 | X | X |
| BRASSICACEAE | Camelina microcarpa Andrz. ex DC. | N | CAMI1 | X | X |
| BRASSICACEAE | Descurainia pinnata (Walt.) Britt. | Y | DEPI1 | X | X |
| BRASSICACEAE | Descurainia richardsonii (Sweet) Schultz | Y | DERI1 | X | X |
| BRASSICACEAE | Descurainia sophia (L.) Webb ex Prantl. | N | DESO1 | X | X |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | N | LECA1 | X | X |
| BRASSICACEAE | Nasturtium officinale R. Br. | N | NAOF1 | X | X |
| BRASSICACEAE | Sisymbrium altissimum L. | N | SIAL1 | X | X |
| BRASSICACEAE | Thlaspi arvense L. | N | THAR1 | X | X |
| CACTACEAE | Opuntia fragilis (Nutt.) Haw. | Y | OPFR1 | X | X |
| CACTACEAE | Opuntia macrorhiza Engelm. | Y | OPMA1 | X | X |
| CACTACEAE | Pediocactus simpsonii (Engelm.) Britt. & Rose | Y | PESI1 | X | |
| CAMPANULACEAE | Campanula rotundifolia L. | Y | CARO1 | X | X |
| CAMPANULACEAE | Lobelia siphilitica L. var. ludoviciana A. DC. | Y | LOSI1 | X | X |
| CANNABACEAE | Humulus lupulus L. var. lupuloides E. Small | Y | HULU1 | X | X |
| CAPRIFOLIACEAE | Symphoricarpos occidentalis Hook. | Y | SYOC1 | X | X |
| CAPRIFOLIACEAE | Viburnum opulus L. var. americanum Ait | N | VIOP1 | X | |
| CARYOPHYLLACEAE | Arenaria fendleri A. Gray | Y | ARFE2 | X | |
| CARYOPHYLLACEAE | Cerastium arvense L. | Y | CEAR1 | X | X |
| CARYOPHYLLACEAE | Cerastium vulgatum L. | N | CEVU1 | X | |
| CARYOPHYLLACEAE | Silene antirrhina L. | Y | SIAN1 | X | X |
| CARYOPHYLLACEAE | Silene drummondii Hook. | Y | SIDR1 | | X |
| CARYOPHYLLACEAE | Silene pratensis (Raf.)Godr. & Gren | N | SIPR1 | X | X |
| CARYOPHYLLACEAE | Stellaria longifolia Muhl. ex Willd. | Y | STLO1 | X | X |
| CERATOPHYLLACEAE | Ceratophyllum demersum L. | Y | CEDE1 | X | X |
| CHENOPODIACEAE | Chenopodium album L. | N | CHAL1 | X | X |
| CLUSIACEAE | Hypericum majus (A. Gray) Britt. | Y | HYMA1 | X | X |
| CLUSIACEAE | Hypericum perforatum L. | N | HYPE1 | X | X |
| COMMELINACEAE | Tradescantia occidentalis (Britt.) Smyth | Y | TROC1 | X | X |
| CONVOLVULACEAE | Calystegia macouni (Greene) Brummitt | Y | CAMA1 | | X |
| CONVOLVULACEAE | Calystegia sepium (L.) R. Br. ssp. angulata Brummitt | Y | CASE1 | | X |
| CONVOLVULACEAE | Convolvulus arvensis L. | N | COAR1 | X | X |
| CYPERACEAE | Carex aurea Nutt. | Y | CAAU1 | | X |
| CYPERACEAE | Carex brevior (Dew.) Mack. ex Lunell. | Y | CABR1 | X | X |
| CYPERACEAE | Carex douglasii F. Boott. | Y | CADO1 | | X |
| CYPERACEAE | Carex eleocharis Bailey | Y | CAEL1 | X | X |
| CYPERACEAE | Carex heliophila Mack. | Y | CAHE1 | X | |
| CYPERACEAE | Carex hystericina Muhl. ex Willd. | Y | CAHY1 | X | X |
| CYPERACEAE | Carex interior Bailey | Y | CAIN1 | X | X |
| CYPERACEAE | Carex lanuginosa Michx. | Y | CALA1 | X | X |
| CYPERACEAE | Carex nebrascensis Dew. | Y | CANE1 | X | X |
| CYPERACEAE | Carex praegracilis W. Boott. | Y | CAPR1 | X | X |

Table 1-2. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| CYPERACEAE | Carex scoparia Schkuhr. ex Willd. | Y | CASC1 | X | |
| CYPERACEAE | Carex simulata Mack. | Y | CASI1 | X | X |
| CYPERACEAE | Eleocharis acicularis (L.) R. & S. | Y | ELAC1 | X | |
| CYPERACEAE | Eleocharis compressa Sulliv. | Y | ELCO1 | X | |
| CYPERACEAE | Eleocharis macrostachya Britt. | Y | ELMA1 | X | X |
| CYPERACEAE | Scirpus pallidus (Britt.) Fern | Y | SCPA1 | X | X |
| CYPERACEAE | Scirpus pungens Vahl | Y | SCAM1 | X | |
| CYPERACEAE | Scirpus pungens Vahl | Y | SCPU1 | | X |
| CYPERACEAE | Scirpus validus Vahl. | Y | SCVA1 | X | X |
| ELAEAGNACEAE | Elaeagnus angustifolia L. | N | ELAN1 | X | X |
| EQUISETACEAE | Equisetum laevigatum A. Br. | Y | EQLA1 | X | X |
| EUPHORBIACEAE | Euphorbia serpyllifolia Pers. | Y | EUSE1 | X | |
| FABACEAE | Amorpha fruticosa L. | Y | AMFR1 | X | X |
| FABACEAE | Astragalus agrestis Dougl. ex G. Don | Y | ASAG1 | X | X |
| FABACEAE | Astragalus drummondii Dougl. ex Hook. | Y | ASDR1 | X | |
| FABACEAE | Astragalus flexuosus (Hook.) G. Don | Y | ASFL1 | X | X |
| FABACEAE | Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinners. | Y | DACA1 | X | X |
| FABACEAE | Dalea purpurea Vent | Y | DAPU1 | X | X |
| FABACEAE | Glycyrrhiza lepidota Pursh. | Y | GLLE1 | X | X |
| FABACEAE | Lathyrus eucosmus Butters and St. John | Y | LAEU1 | X | X |
| FABACEAE | Lupinus argenteus Pursh var. argenteus | Y | LUAR1 | X | X |
| FABACEAE | Medicago lupulina L. | N | MELU1 | X | |
| FABACEAE | Melilotus alba Medic. | N | MEAL1 | X | |
| FABACEAE | Melilotus officinalis (L.) Pall. | N | MEOF1 | | X |
| FABACEAE | Oxytropis lambertii Pursh. | Y | OXLA1 | X | |
| FABACEAE | Psoralea tenuiflora Pursh. | Y | PSTE1 | X | X |
| FABACEAE | Thermopsis rhombifolia var. divaricarpa (Nels.) Isely | Y | THRH1 | X | X |
| FABACEAE | Vicia americana Muhl. ex Willd. | Y | VIAM1 | X | X |
| GENTIANACEAE | Gentiana affinis Griseb. | Y | GEAF1 | X | X |
| GENTIANACEAE | Swertia radiata (Kell.) O. Ktze. | Y | SWRA1 | X | X |
| GERANIACEAE | Erodium cicutarium (L.) L'Her. | N | ERCI1 | X | |
| GERANIACEAE | Geranium caespitosum James ssp. caespitosum | Y | GECA1 | X | X |
| GROSSULARIACEAE | Ribes aureum Pursh | Y | RIAU1 | X | X |
| HALORAGACEAE | Myriophyllum exalbescens Fern. | Y | MYEX1 | X | X |
| HYDROPHYLLACEAE | Hydrophyllum fendleri (Gray) Heller | Y | HYFE1 | X | X |
| HYDROPHYLLACEAE | Phacelia heterophylla Pursh. | Y | PHHE1 | X | X |
| IRIDACEAE | Iris missouriensis Nutt. | Y | IRMI1 | X | X |
| IRIDACEAE | Sisyrinchium montanum Greene | Y | SIMO1 | X | X |
| JUNCACEAE | Juncus articulatus L. | Y | JUAR1 | | X |
| JUNCACEAE | Juncus balticus Willd. | Y | JUBA1 | X | X |
| JUNCACEAE | Juncus dudleyi Wieg. | Y | JUDU1 | X | X |
| JUNCACEAE | Juncus ensifolius Wikst. var. montanus (Englm.) C. L. Hitchc. | Y | JUEN1 | X | X |
| JUNCACEAE | Juncus interior Wieg. | Y | JUIN1 | X | |
| JUNCACEAE | Juncus longistylis Torr. | Y | JULO1 | X | X |
| JUNCACEAE | Juncus nodosus L. | Y | JUNO1 | X | X |
| JUNCACEAE | Juncus torreyi Cov. | Y | JUTO1 | X | X |
| LAMIACEAE | Lycopus americanus Muhl. ex Barton | Y | LYAM1 | X | X |
| LAMIACEAE | Mentha arvensis L. | Y | MEAR1 | X | X |
| LAMIACEAE | Monarda fistulosa L. var. menthifolia (Grah.) Fern. | Y | MOFI1 | X | X |
| LAMIACEAE | Nepeta cataria L. | N | NECA1 | X | X |
| LAMIACEAE | Prunella vulgaris L. | Y | PRVU1 | X | X |
| LEMNACEAE | Lemna minor L. | Y | LEMI1 | X | X |
| LILIACEAE | Allium cernuum Roth | Y | ALCE1 | X | |
| LILIACEAE | Allium geyeri S. Wats. | Y | ALGE1 | | X |
| LILIACEAE | Allium textile A. Nels. & Macbr. | Y | ALTE1 | X | X |
| LILIACEAE | Asparagus officinalis L. | N | ASOF1 | X | X |
| LILIACEAE | Calochortus gunnisonii S. Wats. | Y | CAGU1 | X | X |
| LILIACEAE | Smilacina stellata (L.) Desf. | Y | SMST1 | X | X |

Table 1-2. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| LILIACEAE | Zigadenus venenosus Wats. var. gramineus (Rydb.) Walsh ex Peck | Y | ZIVE1 | X | X |
| LINACEAE | Linum perenne L. var. lewisii (Pursh.) Eat. & Wright | Y | LIPE1 | X | X |
| LYTHRACEAE | Lythrum alatum Pursh. | Y | LYAL1 | X | X |
| NYCTAGINACEAE | Mirabilis hirsuta (Pursh.) MacM. | Y | MIHI1 | X | |
| NYCTAGINACEAE | Mirabilis nyctaginea (Michx.) MacM. | Y | MINY1 | X | |
| ONAGRACEAE | Epilobium ciliatum Raf. ssp. glandulosum (Lehm.) Hock & Raven | Y | EPCI1 | X | X |
| ONAGRACEAE | Epilobium paniculatum Nutt. | Y | EPPA1 | X | X |
| ONAGRACEAE | Gaura coccinea Pursh. | Y | GACO1 | X | X |
| ONAGRACEAE | Gaura parviflora Dougl. | Y | GAPA1 | X | X |
| ONAGRACEAE | Oenothera villosa Thunb. ssp. strigosa (Rydb.) Dietrich & Raven | Y | OEVI1 | X | X |
| OXALIDACEAE | Oxalis dillenii Jacq. | N | OXDI1 | X | X |
| PINACEAE | Pinus ponderosa Laws | Y | PIPO1 | | X |
| PLANTAGINACE | Plantago lanceolata L. | N | PLLA1 | X | X |
| PLANTAGINACE | Plantago major L. | N | PLMA1 | | X |
| POACEAE | Aegilops cylindrica Host | N | AECY1 | | X |
| POACEAE | Agropyron caninum (L.) Beauv. ssp. majus (Vasey) C. L. Hitchc. | Y | AGCA1 | | X |
| POACEAE | Agropyron cristatum (L.) Gaertn. | N | AGCR1 | X | X |
| POACEAE | Agropyron dasystachyum (Hook.) Scribn. | Y | AGDA1 | X | X |
| POACEAE | Agropyron desertorum (Fisch.) Schult. | N | AGDE1 | X | |
| POACEAE | Agropyron intermedium (Host) Beauv. | N | AGIN1 | X | X |
| POACEAE | Agropyron repens (L.) Beauv. | N | AGRE1 | X | X |
| POACEAE | Agropyron smithii Rydb. | Y | AGSM1 | X | X |
| POACEAE | Agrostis scabra Willd. | Y | AGSC1 | X | X |
| POACEAE | Agrostis stolonifera L. | N | AGST1 | X | X |
| POACEAE | Alopecurus geniculatus L. | Y | ALGE2 | X | |
| POACEAE | Andropogon gerardii Vitman | Y | ANGE1 | X | X |
| POACEAE | Andropogon scoparius Michx. | Y | ANSC1 | X | X |
| POACEAE | Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | Y | ARLO1 | X | |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | Y | BOCU1 | X | |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | Y | BOGR1 | X | X |
| POACEAE | Bouteloua hirsuta Lag | Y | BOHI1 | X | |
| POACEAE | Bromus inermis Leyss. ssp. inermis | N | BRIN1 | X | X |
| POACEAE | Bromus japonicus Thunb. ex Murr. | N | BRJA1 | X | X |
| POACEAE | Bromus tectorum L. | N | BRTE1 | X | X |
| POACEAE | Calamagrostis stricta (Timm.) Koel | Y | CAST2 | | X |
| POACEAE | Ceratochloa marginata (Nees ex Stued.) Jackson | Y | CEMA1 | X | X |
| POACEAE | Dactylis glomerata L. | N | DAGL1 | X | X |
| POACEAE | Elymus canadensis L. | Y | ELCA1 | X | X |
| POACEAE | Festuca pratensis Huds. | Y | FEPR1 | X | X |
| POACEAE | Glyceria grandis S. Wats. ex A. Gray | Y | GLGR1 | X | |
| POACEAE | Glyceria striata (Lam.) Hitchc. | Y | GLST1 | X | X |
| POACEAE | Hordeum jubatum L. | Y | HOJU1 | X | X |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | Y | KOPY1 | X | X |
| POACEAE | Leersia oryzoides (L.) Sw. | Y | LEOR1 | | X |
| POACEAE | Muhlenbergia filiformis (Thurb.) Rydb. | Y | MUFI1 | X | X |
| POACEAE | Muhlenbergia racemosa (Michx.) B. S. P. | Y | MURA1 | X | X |
| POACEAE | Panicum virgatum L. | Y | PAVI1 | X | X |
| POACEAE | Phleum pratense L. | N | PHPR1 | X | X |
| POACEAE | Poa compressa L. | N | POCO1 | X | X |
| POACEAE | Poa palustris L. | N | POPA1 | X | |
| POACEAE | Poa pratensis L. | N | POPR1 | X | X |
| POACEAE | Sorghastrum nutans (L.) Nash | Y | SONU1 | X | X |
| POACEAE | Spartina pectinata Link | Y | SPPE1 | X | X |
| POACEAE | Sporobolus cryptandrus (Torr.) A. Gray | Y | SPCR1 | X | |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | Y | SPHE1 | X | X |
| POACEAE | Stipa comata Trin. & Rupr. | Y | STCO1 | X | X |
| POACEAE | Stipa viridula Trin. | Y | STVI1 | X | X |
| POLEMONIACEAE | Collomia linearis Nutt. | Y | COLI1 | X | X |

Table 1-2. (cont.)

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| POLYGONACEAE | Eriogonum umbellatum Torr. | Y | ERUM1 | | X |
| POLYGONACEAE | Polygonum arenastrum Jord. ex Bor. | N | POAR1 | | X |
| POLYGONACEAE | Polygonum convolvulus L. | N | POCO2 | X | X |
| POLYGONACEAE | Polygonum douglasii Greene | Y | PODO1 | X | |
| POLYGONACEAE | Polygonum hydropiper L. | N | POHY1 | | X |
| POLYGONACEAE | Polygonum pensylvanicum L. | Y | POPE1 | X | X |
| POLYGONACEAE | Polygonum persicaria L. | N | POPE2 | X | |
| POLYGONACEAE | Polygonum ramosissimum Michx. | Y | PORA1 | | X |
| POLYGONACEAE | Polygonum sawatchense Small | Y | POSA1 | X | |
| POLYGONACEAE | Rumex acetosella L. | N | RUAC1 | | X |
| POLYGONACEAE | Rumex crispus L. | N | RUCR1 | X | X |
| POLYGONACEAE | Rumex obtusifolius L. | N | RUOB1 | X | X |
| POLYGONACEAE | Rumex salicifolius Weinm. ssp. triangulivalvis Danser | Y | RUSA1 | X | |
| PORTULACACEAE | Portulaca oleracea L. | N | POOL1 | X | |
| POTAMOGETONACEAE | Potamogeton foliosus Raf. | Y | POFO1 | X | |
| POTAMOGETONACEAE | Potamogeton natans L. | Y | PONA1 | X | |
| PRIMULACEAE | Androsace occidentalis Pursh. | Y | ANOC1 | X | |
| PRIMULACEAE | Lysimachia ciliata L. | Y | LYCI1 | X | X |
| RANUNCULACEAE | Ranunculus macounii Britt. | Y | RAMA1 | X | X |
| RANUNCULACEAE | Ranunculus scleratus L. | Y | RASC1 | | X |
| RANUNCULACEAE | Ranunculus trichophyllus Chaix | Y | RATR1 | X | X |
| RANUNCULACEAE | Thalictrum dasycarpum Fisch. & Ave-Lall | Y | THDA1 | X | X |
| ROSACEAE | Agrimonia striata Michx. | Y | AGST2 | X | X |
| ROSACEAE | Crataegus erythropoda Ashe | Y | CRER1 | X | X |
| ROSACEAE | Crataegus succulenta Link var. occidentalis (Britton) E. J. Palm. | Y | CRSU1 | | X |
| ROSACEAE | Geum aleppicum Jacq. | Y | GEAL1 | X | X |
| ROSACEAE | Geum macrophyllum Willd. | Y | GEMA1 | X | X |
| ROSACEAE | Physocarpus monogynus (Torr.) Coult. | Y | PHMO1 | | X |
| ROSACEAE | Potentilla arguta Pursh | Y | POAR2 | X | |
| ROSACEAE | Potentilla gracilis Dougl. ex Hook. var. glabrata (Lehm.) C. L. Hitchc. | Y | POGR1 | X | X |
| ROSACEAE | Potentilla norvegica L. | Y | PONO1 | X | X |
| ROSACEAE | Prunus americana Marsh. | Y | PRAM1 | X | X |
| ROSACEAE | Prunus pumila L. var. besseyi (Bailey) Gl. | Y | PRPU1 | X | |
| ROSACEAE | Prunus virginiana L. var. melanocarpa (A. Nels.) Sarg. | Y | PRVI1 | X | X |
| ROSACEAE | Pyrus malus L. | N | PYMA1 | | X |
| ROSACEAE | Rosa acicularis Lindl. | Y | ROAC1 | X | |
| ROSACEAE | Rosa arkansana Porter | Y | ROAR1 | X | X |
| ROSACEAE | Rosa woodsii Lindl. | Y | ROWO1 | X | X |
| RUBIACEAE | Galium aparine L. | Y | GAAP1 | X | X |
| RUBIACEAE | Galium septentrionale Roemer & Schultes | Y | GASE1 | X | X |
| SALICACEAE | Populus deltoides Marsh. ssp. monilifera (Ait.) Eckenw. | Y | PODE1 | X | X |
| SALICACEAE | Salix amygdaloides Anderss. | Y | SAAM1 | X | X |
| SALICACEAE | Salix exigua Nutt. ssp. interior (Rowlee) Cronq. | Y | SAEX1 | X | X |
| SANTALACEAE | Comandra umbellata (L.) Nutt. | Y | COUM1 | X | X |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | N | LIDA1 | X | X |
| SCROPHULARIACEAE | Linaria vulgaris Hill | N | LIVU1 | X | X |
| SCROPHULARIACEAE | Mimulus glabratus H. B. K. var. fremontii (Benth.) A. L. Grant | Y | MIGL1 | X | X |
| SCROPHULARIACEAE | Penstemon secundiflorus Benth. | Y | PESE1 | X | X |
| SCROPHULARIACEAE | Penstemon virens Penn. | Y | PEVI1 | X | |
| SCROPHULARIACEAE | Penstemon virgatus Gray ssp. asa-grayi Crosswhite | Y | PEVI2 | X | X |
| SCROPHULARIACEAE | Scrophularia lanceolata Pursh. | Y | SCLA2 | X | X |
| SCROPHULARIACEAE | Verbascum blattaria L. | N | VEBL1 | X | X |
| SCROPHULARIACEAE | Verbascum thapsus L. | N | VETH1 | X | X |
| SCROPHULARIACEAE | Veronica americana (Raf.) Schwein. ex Benth. | Y | VEAM1 | X | |
| SCROPHULARIACEAE | Veronica anagallis-aquatica L. | N | VEAN1 | X | X |
| SOLANACEAE | Physalis heterophylla Nees | Y | PHHE2 | X | X |
| SOLANACEAE | Physalis virginiana P. Mill. | Y | PHVI2 | X | X |
| TYPHACEAE | Typha latifolia L. | Y | TYLA1 | X | X |

**Table 1-2. (cont.)**

| Family | Scientific Name | Native | Speccode | 1997 | 1999 |
|---|---|---|---|---|---|
| ULMACEAE | Ulmus pumila L. | N | ULPU1 | X | X |
| URTICACEAE | Urtica dioica L. ssp. gracilis (Ait.) Seland. | Y | URDI1 | X | X |
| VERBENACEAE | Verbena bracteata Lag. & Rodr. | Y | VEBR1 | X | |
| VERBENACEAE | Verbena hastata L. | Y | VEHA1 | X | X |
| VIOLACEAE | Viola sororia Willd. | Y | VISO1 | X | X |
| | Total # Species | | | 260 | 246 |
| | Sorenson Similarity Index | | | 0.83 | |

**Table 1-3. 1999 Estimated Weed Infestation Acreage Summary for Rocky Flats Environmental Technology Site**

| | 1999 Acreage (Estimated) | | | | |
|---|---|---|---|---|---|
| | | Density Level | | | |
| **Common Name** | **Site Total** | **High** | **Medium** | **Low** | **Scattered** |
| Dalmatian Toadflax | 2507 | 341 | 389 | 1240 | 537 |
| Diffuse Knapweed | 2295 | 466 | 613 | 873 | 343 |
| Musk Thistle | 1353 | 1 | 311 | 684 | 357 |
| Mullein | 1068 | 130 | 204 | 450 | 284 |
| Jointed Goatgrass | 57 | NA | NA | NA | NA |
| Annual Rye | 30 | NA | NA | NA | NA |
| Scotch Thistle | 6 | NA | NA | NA | NA |
| Russian Knapweed | 1 | NA | NA | NA | NA |
| Dame's Rocket | 1 | NA | NA | NA | NA |

NA = Data not collected by density level.

**Table 1-4. Comparison of 1997, 1998, and 1999 Weed Infestation Extents at Rocky Flats Environmental Technology Site**

| | | | Density Level | | | |
|---|---|---|---|---|---|---|
| **Weed Species** | **Year** | **Site Total** | **High** | **Medium** | **Low** | **Scattered** |
| Diffuse Knapweed | 1997 | 2678 | 696 | 893 | 658 | 431 |
| | 1998 | 2913 | 761 | 778 | 987 | 388 |
| | 1999 | 2295 | 466 | 613 | 873 | 343 |
| Dalmatian Toadflax | 1997 | 422 | 135 | 205 | 82 | 0 |
| | 1998 | 1934 | 313 | 273 | 989 | 359 |
| | 1999 | 2507 | 341 | 389 | 1240 | 537 |
| Musk Thistle | 1997 | 474 | 2 | 270 | 202 | 0 |
| | 1998 | 1685 | 32 | 515 | 1035 | 102 |
| | 1999 | 1353 | 1 | 311 | 684 | 357 |
| Mullein | 1997 | 575 | 117 | 238 | 203 | 17 |
| | 1998 | 867 | 168 | 225 | 460 | 13 |
| | 1999 | 1068 | 130 | 204 | 450 | 284 |

All values are acreages.

See text for density level descriptions.

**Table 1-5. Comparison of 1998 and 1999 Diffuse Knapweed Pre- and Post-Aerial Herbicide Application Infestation Levels at Rocky Flats Environmental Technology Site**

| | | Diffuse Knapweed Density Level | | | |
|---|---|---|---|---|---|
| Year | Total | High | Medium | Low | Scattered |
| 1998 | 878 | 257 | 214 | 246 | 161 |
| 1999 | 195 | 24 | 36 | 68 | 67 |
| Change | -683 | -233 | -178 | -178 | -94 |
| Percent Change | -78 | -91 | -83 | -72 | -58 |

Values are approximate number of acres.

Total area sprayed by helicopter with Tordon 22K in 1999 was approximately 1500 acres.

**Table 1-6. Observed Impacts on Plants Sprayed with Tordon 22K**

| Family | Scientific Name | No Effect | Chlorosis | Wilting | Dead |
|---|---|---|---|---|---|
| AGAVACEAE | Yucca glauca Nutt. | NE | C | W | |
| ANACARDIACEAE | Rhus aromatica Ait. var. trilobata (Nutt.) A. Gray | NE | | W | |
| APIACEAE | Harbouria trachypleura (Gray) C. & R. | | | W | |
| APIACEAE | Lomatium orientale Coult. & Rose | NE | | W | |
| ASCLEPIADACEAE | Asclepias viridiflora Raf. | NE | | | |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | | C | W | D |
| ASTERACEAE | Ambrosia psilostachya DC. | NE | | | D |
| ASTERACEAE | Antennaria parvifolia Nutt. | NE | C | W | D |
| ASTERACEAE | Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem. | NE | C | W | D |
| ASTERACEAE | Artemisia dracunculus L. | NE | | W | D |
| ASTERACEAE | Artemisia frigida Willd. | NE | C | W | D |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | NE | | W | D |
| ASTERACEAE | Aster falcatus Lindl. | NE | C | W | |
| ASTERACEAE | Aster porteri Gray | NE | C | W | D |
| ASTERACEAE | Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | | | W | D |
| ASTERACEAE | Centaurea diffusa Lam. | | C | W | D |
| ASTERACEAE | Chrysopsis fulcrata Greene | NE | | W | |
| ASTERACEAE | Chrysopsis villosa Pursh. | NE | C | W | D |
| ASTERACEAE | Chrysothamnus nauseosus (Pall.) Britt. ssp. graveolens (Nutt.) Piper | | | W | |
| ASTERACEAE | Chrysothamnus nauseosus (Pall.) Britt. ssp. nauseosus | NE | | W | |
| ASTERACEAE | Cirsium arvense (L.) Scop. | NE | | W | D |
| ASTERACEAE | Cirsium undulatum (Nutt.) Spreng. | | | W | D |
| ASTERACEAE | Erigeron divergens T. & G. | | | W | D |
| ASTERACEAE | Gaillardia aristata Pursh. | NE | C | W | |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | | C | W | D |
| ASTERACEAE | Gutierrezia sarothrae (Pursh.) Britt. & Rusby | NE | C | W | D |
| ASTERACEAE | Helianthus annuus L. | NE | | | |
| ASTERACEAE | Helianthus pumilus Nutt. | NE | | W | |
| ASTERACEAE | Helianthus rigidus (Cass.) Desf. ssp. subrhomboideus (Rydb.) Heiser | | | W | |
| ASTERACEAE | Lactuca serriola L. | NE | | | |
| ASTERACEAE | Leucelene ericoides (Torr.) Greene | NE | | | |
| ASTERACEAE | Liatris punctata Hook. | NE | C | W | |
| ASTERACEAE | Microseris cuspidata (Pursh.) Sch. Bip. | | | W | |
| ASTERACEAE | Ratibida columnifera (Nutt.) Woot. & Standl. | | | W | |
| ASTERACEAE | Scorzonera laciniata L. | | | W | D |
| ASTERACEAE | Senecio plattensis Nutt. | NE | C | W | |
| ASTERACEAE | Senecio spartioides T. & G. | | C | W | |
| ASTERACEAE | Solidago missouriensis Nutt. | | | W | |
| ASTERACEAE | Solidago mollis Bart. | NE | | W | D |
| ASTERACEAE | Taraxacum officinale Weber | NE | | W | |
| ASTERACEAE | Thelesperma megapotanicum (Spreng.) O. Ktze. | NE | | | |
| ASTERACEAE | Tragopogon dubius Scop. | NE | C | W | |
| BORAGINACEAE | Lithospermum incisum Lehm. | NE | C | | |
| BORAGINACEAE | Lithospermum multiflorum Torr. | NE | | | |
| BORAGINACEAE | Mertensia lanceolata (Pursh.) A. DC. | | | W | |
| BORAGINACEAE | Onosmodium molle Michx. var. occidentale (Mack.) Johnst. | NE | | | |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | NE | | W | D |
| BRASSICACEAE | Camelina microcarpa Andrz. ex DC. | NE | | W | |
| BRASSICACEAE | Descurainia richardsonii (Sweet) Schultz | NE | | W | |
| BRASSICACEAE | Erysimum capitatum (Nutt.) DC. | NE | | W | D |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | NE | | | |
| BRASSICACEAE | Lesquerella montana (A. Gray) Wats. | NE | | | |
| CACTACEAE | Echinocereus viridiflorus Engelm. | NE | | | |
| CACTACEAE | Opuntia macrorhiza Engelm. | NE | C | | D |
| CAPRIFOLIACEAE | Symphoricarpos occidentalis Hook. | NE | | W | D |
| CARYOPHYLLACEAE | Arenaria fendleri A. Gray | NE | C | W | |
| CARYOPHYLLACEAE | Cerastium arvense L. | | C | W | |
| CARYOPHYLLACEAE | Paronychia jamesii T. & G. | NE | C | W | |

**Table 1-6. (cont.)**

| Family | Scientific Name | No Effect | Chlorosis | Wilting | Dead |
|---|---|---|---|---|---|
| CARYOPHYLLACEAE | Silene drummondii Hook. | | | W | |
| CHENOPODIACEAE | Kochia scoparia (L.) Schrad. | NE | | | |
| CHENOPODIACEAE | Salsola iberica Senn. & Pau. | | | | D |
| CONVOLVULACEAE | Convolvulus arvensis L. | NE | | | |
| CONVOLVULACEAE | Evolvulus nuttallianus R. & S. | NE | | | |
| CRASSULACEAE | Sedum lanceolatum Torr. | NE | | W | |
| EUPHORBIACEAE | Euphorbia robusta (Engelm.) Small | NE | | | |
| FABACEAE | Astragalus crassicarpus Nutt. | | C | W | |
| FABACEAE | Astragalus drummondii Dougl. ex Hook. | NE | C | W | D |
| FABACEAE | Astragalus shortianus Nutt. ex T.&G. | NE | | W | |
| FABACEAE | Astragalus tridactylicus Gray | NE | | W | |
| FABACEAE | Dalea purpurea Vent | NE | | | |
| FABACEAE | Lupinus argenteus Pursh var. argenteus | NE | | | |
| FABACEAE | Oxytropis lambertii Pursh. | | C | W | |
| FABACEAE | Psoralea tenuiflora Pursh. | NE | | W | |
| FABACEAE | Thermopsis rhombifolia var. divaricarpa (Nels.) Isely | | | W | |
| FABACEAE | Vicia americana Muhl. ex Willd. | | | W | |
| GERANIACEAE | Erodium cicutarium (L.) L'Her. | NE | | | |
| GERANIACEAE | Geranium caespitosum James ssp. caespitosum | | | W | |
| HYDROPHYLLACEAE | Phacelia heterophylla Pursh. | NE | | W | |
| LAMIACEAE | Monarda fistulosa L. var. menthifolia (Grah.) Fern. | NE | | W | |
| LILIACEAE | Allium textile A. Nels. & Macbr: | NE | | | |
| LILIACEAE | Calochortus gunnisonii S. Wats. | NE | | | |
| LILIACEAE | Leucocrinum montanum Nutt. | NE | | | |
| MALVACEAE | Sphaeralcea coccinea (Pursh.) Rydb. | NE | | | |
| NYCTAGINACEAE | Mirabilis linearis (Pursh.) Heimerl | | | W | |
| ONAGRACEAE | Calylophus serrulatus (Nutt.) Raven | NE | | W | D |
| OXALIDACEAE | Oxalis dillenii Jacq. | NE | | | |
| PAPAVERACEAE | Argemone polyanthemos (Fedde) G. Ownbey | NE | | | |
| PINACEAE | Pinus ponderosa Laws | NE | | | |
| POLEMONIACEAE | Ipomopsis spicata (Nutt.) V. Grant ssp. spicata | NE | | W | |
| POLYGONACEAE | Eriogonum alatum Torr. | NE | C | W | D |
| RANUNCULACEAE | Delphinium virescens Nutt. ssp. penardii (Huth) Ewan | NE | | W | |
| ROSACEAE | Potentilla fissa Nutt. | NE | | W | D |
| ROSACEAE | Potentilla hippiana Lehm. | NE | | W | |
| ROSACEAE | Prunus virginiana L. var. melanocarpa (A. Nels.) Sarg. | | | W | |
| ROSACEAE | Rosa arkansana Porter | NE | | W | |
| RUBIACEAE | Galium septentrionale Roemer & Schultes | | C | | |
| SANTALACEAE | Comandra umbellata (L.) Nutt. | NE | C | W | |
| SCROPHULARIACEAE | Castilleja integra A. Gray | NE | | | |
| SCROPHULARIACEAE | Castilleja sessiliflora Pursh. | NE | | W | |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | NE | C | W | D |
| SCROPHULARIACEAE | Penstemon secundiflorus Benth. | NE | C | W | |
| SCROPHULARIACEAE | Penstemon virens Penn. | NE | | W | |
| SCROPHULARIACEAE | Verbascum blattaria L. | NE | C | W | |
| SCROPHULARIACEAE | Verbascum thapsus L. | NE | C | W | D |
| SOLANACEAE | Physalis virginiana P. Mill. | NE | | | |
| VERBENACEAE | Lippia cuneifolia (Torr.) Steud. | NE | | | |
| VIOLACEAE | Viola nuttallii Pursh. | | | W | |

NE = No observed impact to some individuals of the species.
C = Chlorosis or yellowing of the leaves observed on some individuals of the species.
W = Wilting or withering on some individuals of the species observed. This could vary greatly from a few leaves withered to the flower stalk being twisted and contorted.
D = Death of some individuals of the species.
NOTE: Each species often had multiple effects observed on different individuals within the population. No attempt was done to determine what percentage of each species' population received which impact. However, no species was eradicated from the grassland.

# Appendix A

## Report 2

## Summary of the 1999 Vegetation Management Program at the Rocky Flats Environmental Technology Site

# 2. Summary of the 1999 Vegetation Management Program at the Rocky Flats Environmental Technology Site

## 2.1 Introduction

The vegetation management program at the Rocky Flats Environmental Technology Site (the Site) continued to direct a multi-faceted attack on the noxious weeds at the Site during 1999. The regulatory framework governing weed control at the Site includes (K-H 1997a):

- Federal Noxious Weed Act, Section 15—Management of Undesirable Plants on Federal Lands
- Federal Noxious Weed Act, Title 7—Agriculture, Chapter 61—Noxious Weeds
- Colorado Weed Management Act, § 35-5.5-115, C.R.S. (1996 Supp.)
- Jefferson County, Colorado, Undesirable Plant Management Plan
- Memorandum of Understanding for the Establishment of a Federal Interagency Committee for the Management of Noxious and Exotic Weeds.

The Site vegetation management program is guided by the Integrated Weed Control Strategy plan (K-H 1997a), and by the annual vegetation management plans (previously called annual weed control plans; K-H 1997b, 1999a) that specify weed control applications for each year. The integrated strategy for the Site includes the use of administrative and cultural, mechanical and physical, biological, and chemical control methods. This report summarizes, by method, the weed control and revegetation/ reclamation activities conducted at the Site during FY1999.

## 2.2 Administrative and Cultural Controls

During 1999, several large projects disturbed native and previously reclaimed grasslands on the Site (Figure 2-1). After the projects were completed, revegetation and weed control of the disturbed areas was required by Site policies (K-H 1999a). The total acreage revegetated in project areas in 1999 was approximately 23 acres. As required by the 1999 weed control plan, each of the projects used weed-free topsoil, seed, and mulch. In addition, the seed mix used for revegetation was approved by and/or provided by the K-H Ecology Group to preclude the introduction of undesirable species to the Site.

As part of an effort to prevent weeds from becoming established in previously unrevegetated areas, an abandoned firebreak road in the south Buffer Zone was revegetated in the fall of 1999 (Figure 2-1). Because the road crossed two different plant communities, the xeric tallgrass prairie and mesic mixed grassland, it was seeded with native species to match the surrounding plant communities at specific locations. A total of approximately 2.3 acres were seeded.

For each of the projects listed above, photo monitoring was initiated and will continue in order to evaluate the effectiveness of the revegetation efforts and to continue learning what works best for conditions at the Site. Additional monitoring conducted in 1999, related to weed control, consisted of mapping the distribution of several weed species on the Site, including diffuse knapweed (*Centaurea diffusa*), musk thistle (*Carduus nutans*), dalmatian toadflax (*Linaria dalmatica*), common mullein (*Verbascum thapsus*), dame's rocket (*Hesperis matronalis*), annual rye (*Secale cereale*), jointed goatgrass (*Aegilops cylindrica*), and scotch thistle (*Onopordum acanthium*). Other monitoring included both qualitative and quantitative monitoring of herbicide impacts to native and target species. Several of these monitoring efforts are summarized in Appendix C of the 1999 Annual Vegetation Report (K-H 2000).

## 2.3 Physical and Mechanical Controls

Physical and mechanical controls used at the Site in 1999 consisted of mowing, grading, and selective hand control. Mowing was done along the margins of the main east and west access roads, in addition to several miles of firebreak roads in the Buffer Zone, to prevent the roadside weeds from going to seed and spreading further (Figure 2-2). Approximately 113 acres were mowed along these roadsides during 1999.

Grading was conducted along approximately 18 miles of firebreak roads in the Buffer Zone to maintain these firebreak roads and prevent roadside weeds from going to seed and spreading further (Figure 2-2). Approximately 66 acres of road were graded in 1999.

Hand control in 1999 was conducted at several locations to control localized infestations of scotch thistle, annual rye, and dame's rocket. Hand control consisted of hand pulling, using sickles or sling blades, and spot herbicide spraying.

## 2.4 Biological Control

No new biological controls were introduced on the Site during 1999. However, several species that were released previously continued to work. Biological control insects were released previously at the Site to control musk thistle, St. John's-wort (*Hypericum perforatum*), dalmatian toadflax, and diffuse knapweed. The insects continue to do a good job of containing infestations of musk thistle and St. John's-wort. They have been much less effective at controlling infestations of dalmatian toadflax and diffuse knapweed, however.

## 2.5 Chemical Control

Herbicide applications were used to control several hundred acres of noxious weed-infested grasslands at the Site during 1999. Figure 2-3 shows the locations of ground and aerial applications of the herbicide Tordon 22k in 1999. Primary target species were diffuse knapweed, musk thistle, and mullein; however, other less aggressive exotic species such as goatsbeard (*Tragopogon dubius*), curly-top gumweed (*Grindelia squarrosa*), alyssum (*Alyssum minus*), wild lettuce (*Lactuca serriola*), small-seeded false flax (*Camelina microcarpa*), and some of the tansymustards (*Descurania* ssp.) were also controlled. Approximately 72 acres were treated on the ground, while almost 1,500 acres were treated with a helicopter (Figures 2-4 and 2-5). Excellent control of the diffuse knapweed, musk thistle, and mullein was achieved at most locations treated (Figures 2-5 through 2-7).

The residual effect of the Tordon 22K is expected to help provide continuing control of these species for the next few years, precluding the need for annual retreatment at these locations. However, because diffuse knapweed (a primary target species) can and likely will return to pre-treatment levels if nothing else is done at these locations, feasibility studies are planned to evaluate using maintenance methods to keep infestations at these locations from returning as quickly. Now that the initial infestation levels of diffuse knapweed have been substantially reduced in these areas, the use of methods such as selective hand control and/or spot herbicide treatments may keep the returning infestations under control, extending the effectiveness of the large-scale herbicide treatments. In addition to the cost savings that could be realized by extending the interval between large-scale herbicide applications, the ability of current ecological monitoring efforts to document the effectiveness of weed control maintenance efforts (K-H 1998, 1999b, 2000) would also offer economic advantages.

## 2.6 Education

As part of the ongoing vegetation management program, the sharing of information and planning strategies with other local agency weed coordinators and resource managers is important because coordinated efforts between land owners is essential for long-term control. During 1999, two specific weed tours were conducted in the Buffer Zone, sponsored by different groups at the Site. The K-H Ecology Group brought ecologists from the City of Boulder Mountain Parks and City of Boulder Open Space departments to view firsthand the effects of the aerial and ground herbicide applications. The DOE, in coordination with the Colorado Weed Network, sponsored a tour with the assistance of Site ecologists, to show 55 local weed coordinators and resource managers the effects of large-scale ground and aerial herbicide applications for controlling diffuse knapweed in the Buffer Zone. Both tours provided an opportunity to show the public some of the resource management actions being conducted to preserve the ecological resources at the Site. The K-H Ecology Group also disseminated information to onsite personnel, through meetings, personal communication, and Site newspaper articles. In addition, K-H Ecologists attended regional weed control meetings and the annual 1999 Colorado Weed

Management Association conference to keep up to date with the most recent knowledge and advances in weed control.

## 2.7 Conclusion

During 1999, the vegetation management program at the Site continued to work toward controlling infestations of several noxious weed species in the Buffer Zone. Several methods were applied to control current infestations and prevent new ones. These included the use of administrative and cultural controls, physical and mechanical methods, biological controls, and chemical controls. Strides were made in controlling several large infestations of diffuse knapweed, musk thistle, and mullein, in addition to other smaller infestations of scotch thistle, annual rye, and dame's rocket. In addition, several disturbed areas and an abandoned road were revegetated during 1999. Using the knowledge gained from onsite monitoring of the current efforts, and by keeping in contact with other local agency weed coordinators and resource managers, improvements will continue to be made to the vegetation management program at the Site.

## 2.8 References

K-H. 1997a. Integrated weed control strategy for Rocky Flats Environmental Technology Site. Kaiser-Hill Company, LLC, Rocky Flats Environmental Technology Site, Golden, CO.

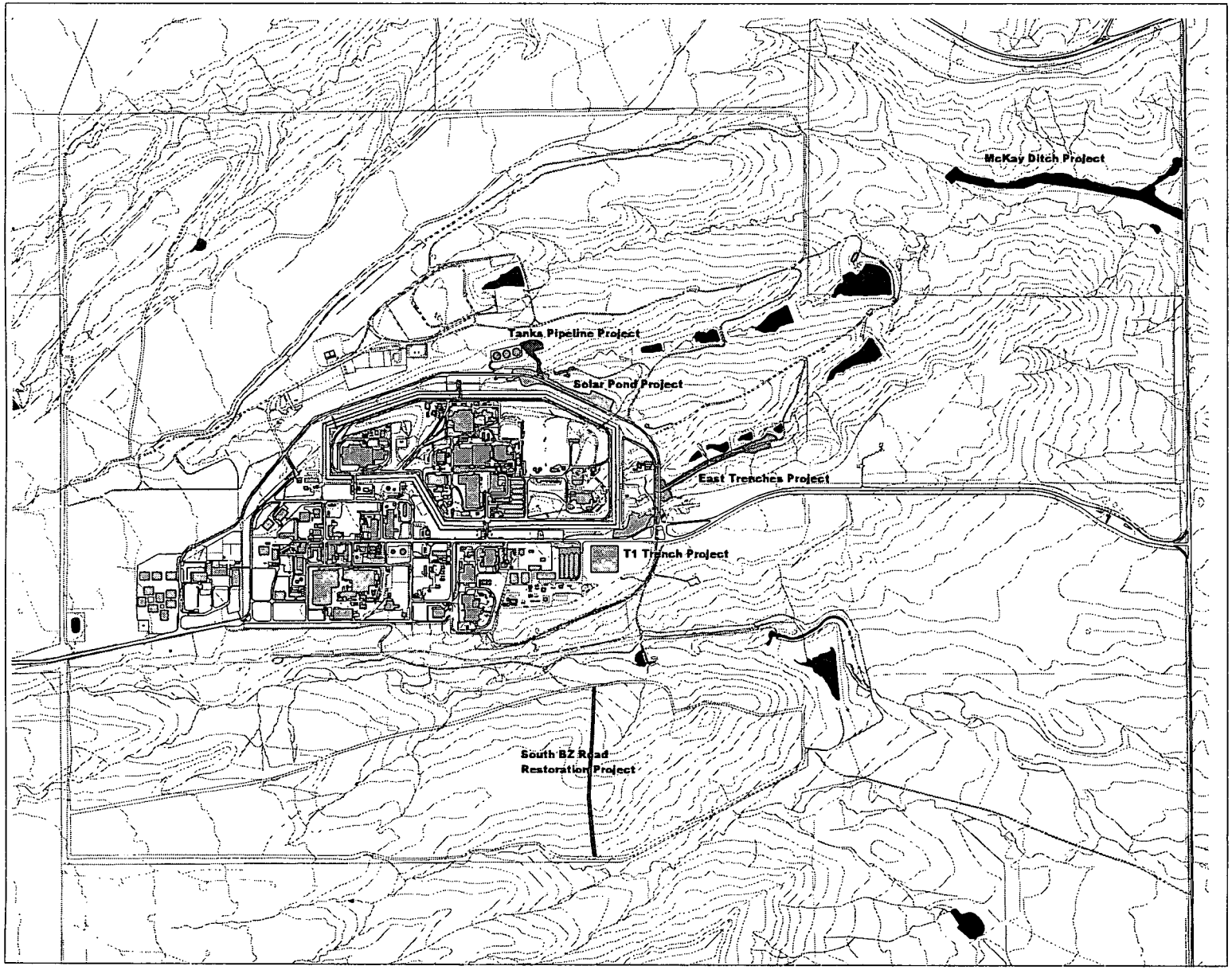
K-H. 1997b. Integrated weed control plan for the Rocky Flats Environmental Technology Site for FY97. Kaiser-Hill Company, LLC, Rocky Flats Environmental Technology Site, Golden, CO.

K-H. 1998. 1997 annual vegetation report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, LLC, Rocky Flats Environmental Technology Site, Golden, CO.

K-H. 1999a. 1999 annual weed control plan for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, LLC, Rocky Flats Environmental Technology Site, Golden, CO.

K-H. 1999b. 1998 annual vegetation report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, LLC, Rocky Flats Environmental Technology Site, Golden, CO.

K-H. 2000. 1999 annual vegetation report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, LLC, Rocky Flats Environmental Technology Site, Golden, CO.




# 1999 Revegetation and Restoration Locations

Figure 2-1

## MAP LEGEND

- McKay Ditch Project
- Solar Pond Project
- East Trenches Project
- T-1 Trench Project
- Tanks Pipeline Project
- South BZ Road Restoration Project

## Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
Locations provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**
Project boundaries obtained using GPS equipment, except for the South BZ road restoration location which is based on the roads coverage.

N

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1000 0 1000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent™

For: Kaiser-Hill Company, LLC

MAP ID: K2-0057

March 14, 2000

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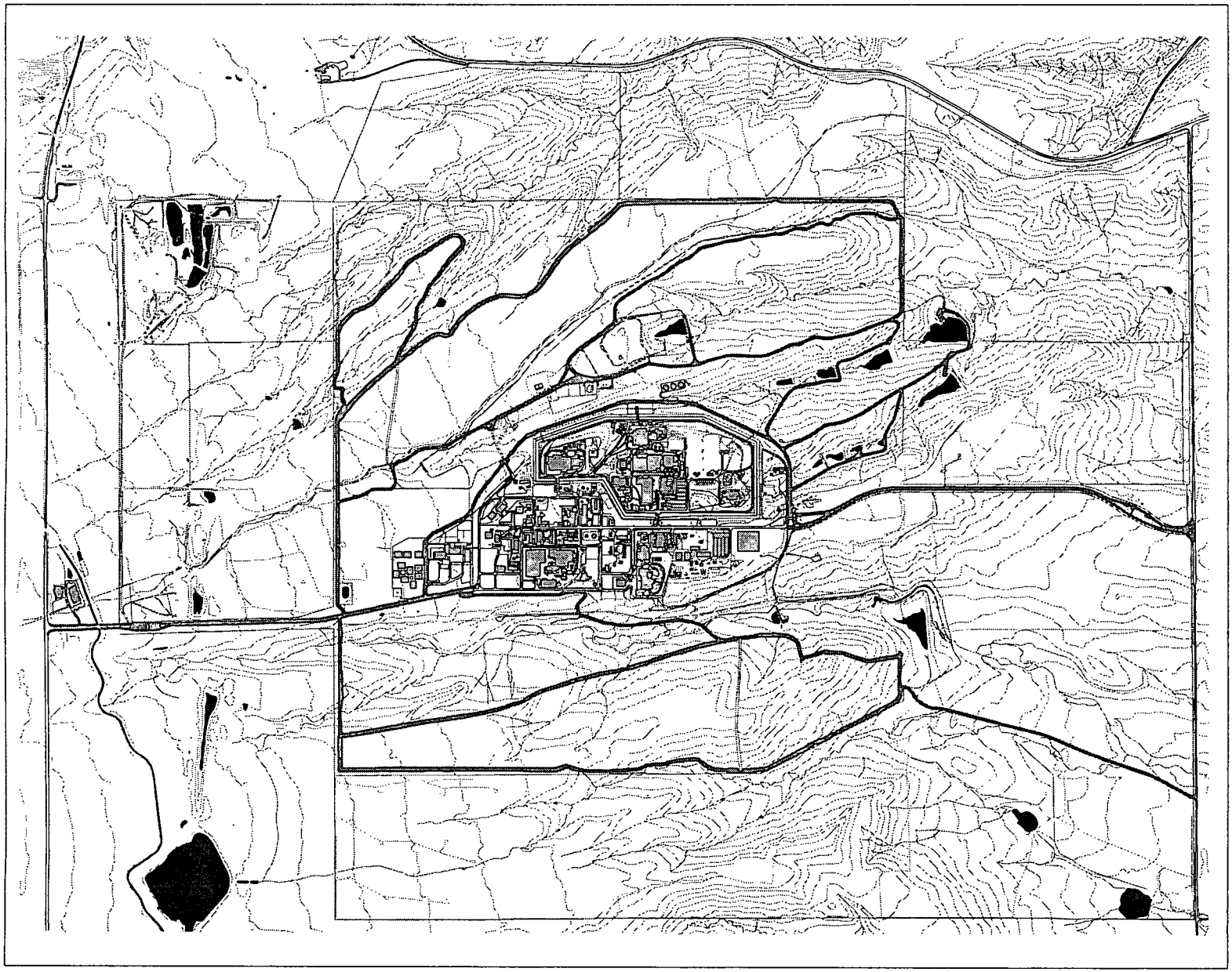

# FY1999 Road Grading and Mowing Operations for Weed Control

Figure 2-2

## MAP LEGEND

- Road Grading and Roadside Mowing
- Roadside Mowing Only

## Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1/85
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

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1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

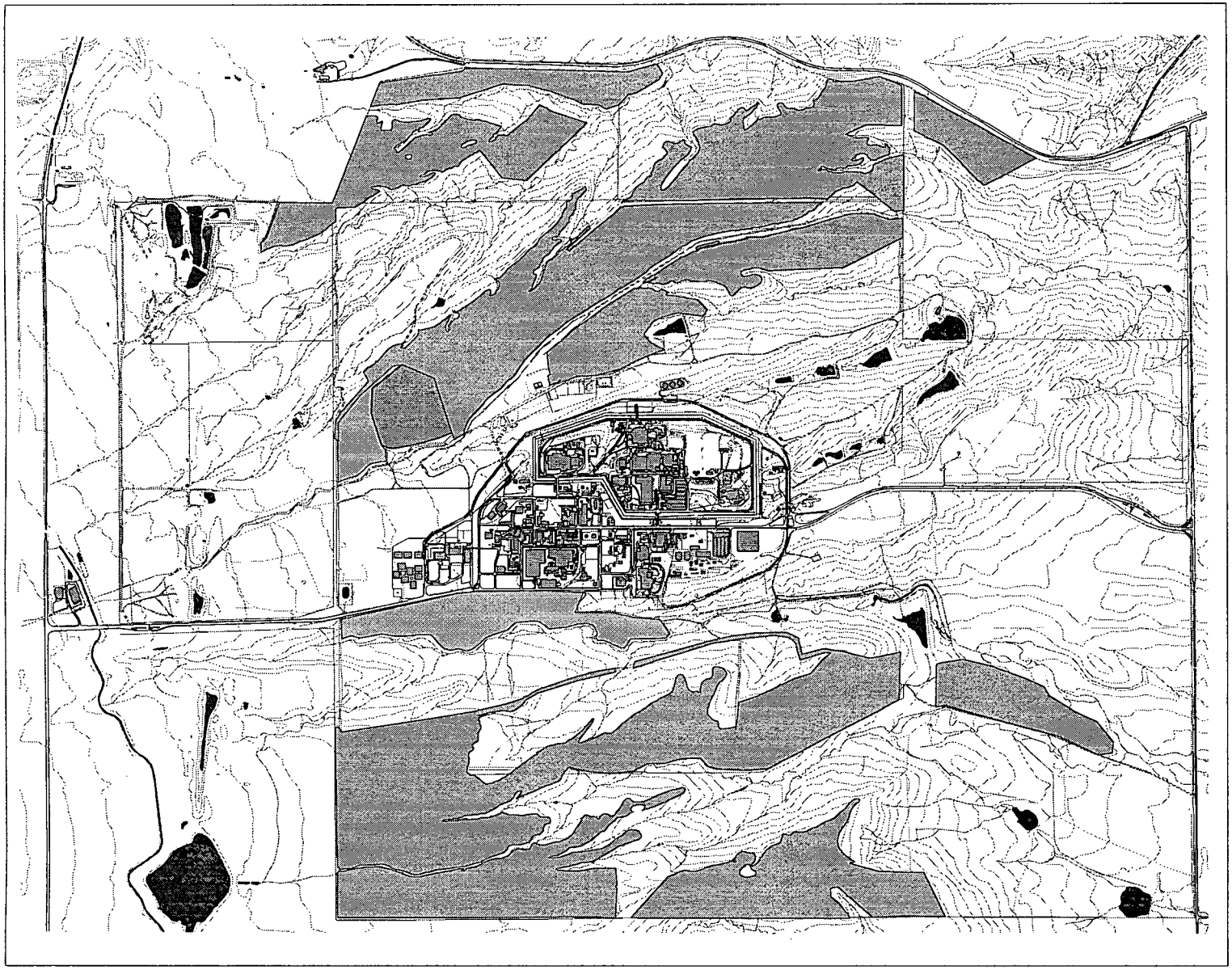
Prepared by: Exponent™

For: Kaiser-Hill Company, LLC

MAP ID: K2-0051

March 14, 2000

\\Kaiser-Hill\GIS\EDO-projects\plates\K2-0051\weed\plan\maps a.jpg\99 weed effort figure 2



# FY1999 Ground and Aerial Herbicide Application Locations Using Tordon 22K

## Figure 2-3

### MAP LEGEND

- Aerial Herbicide Application Locations
- Ground Herbicide Application Locations

**Standard Map Features**

- New Landfill
- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)
- Power Lines

DATA SOURCE:
Ground and Aerial Herbicide Locations provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G REL, Las Vegas.
Digitized from the orthophotographs, 1/85
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

**Note:**
These locations are approximate.

N

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1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

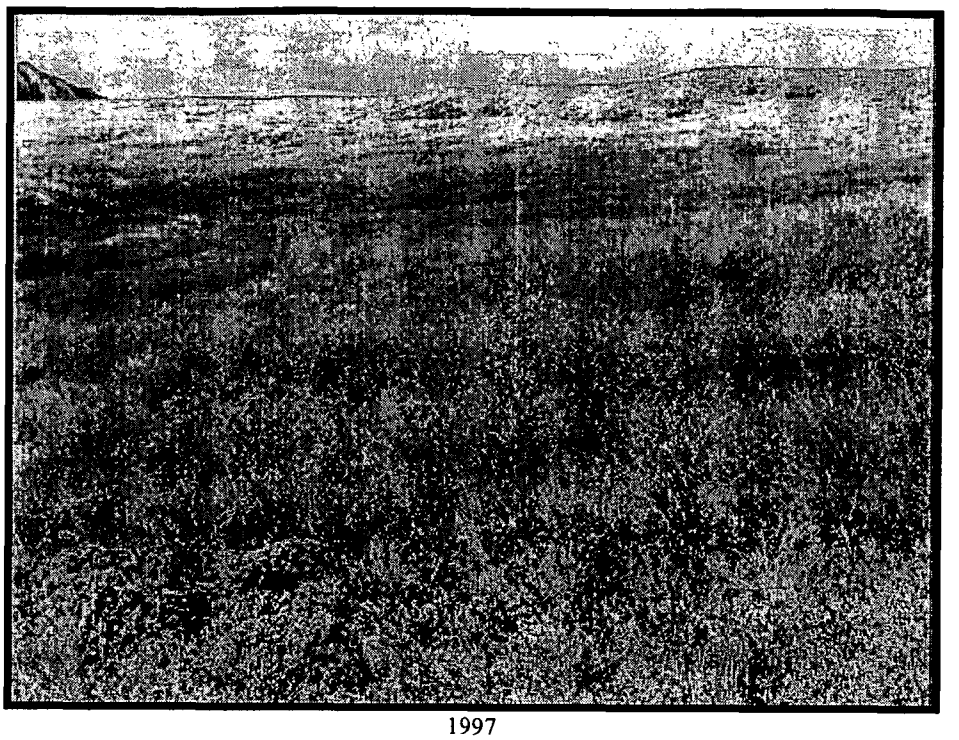
MAP ID: K2-0016

March 14, 2000

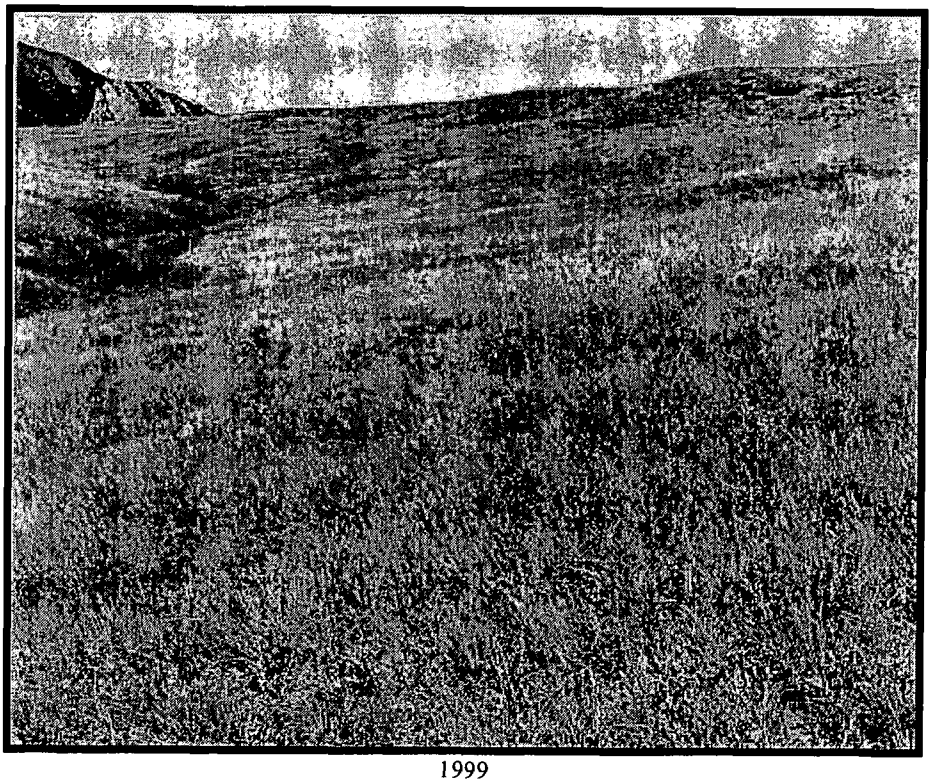
W:\Gis\arc\GIS\ECO-projects\boraxcsts\k2-0016\aerialherbapp2k apr\1999 Ground and Aerial Herbicide Application Locations

Figure 2-4. Aerial herbicide application being conducted for weed control at the Site during May 1999. The application equipment delivers a carefully controlled rate of herbicide.

Figure 2-5. Refueling and refilling of the herbicide tanks during aerial herbicide application in 1999.

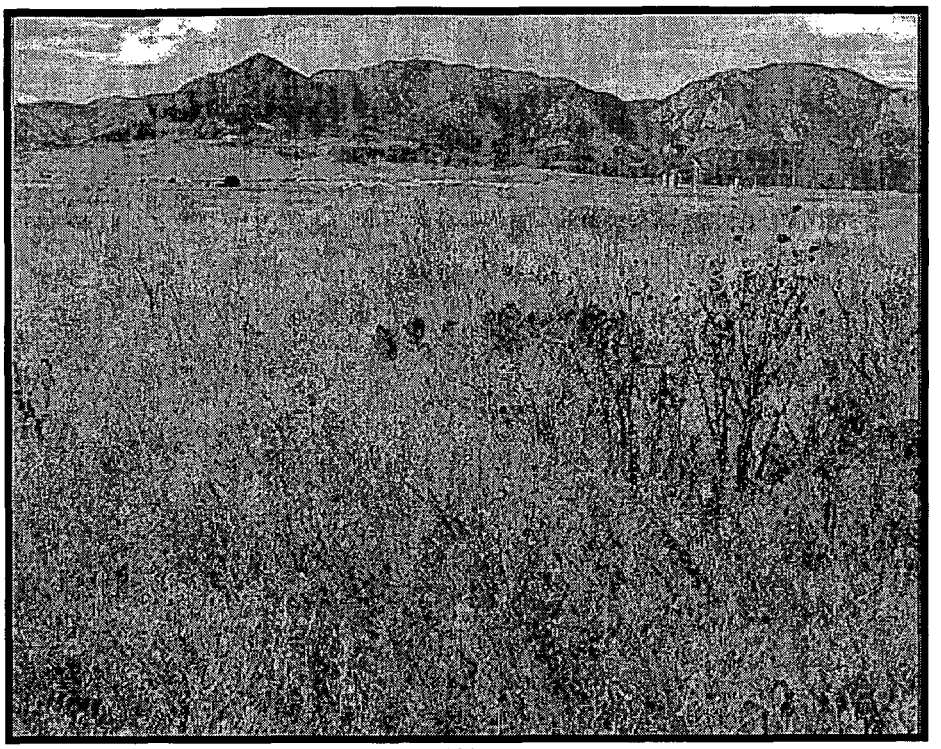


1997

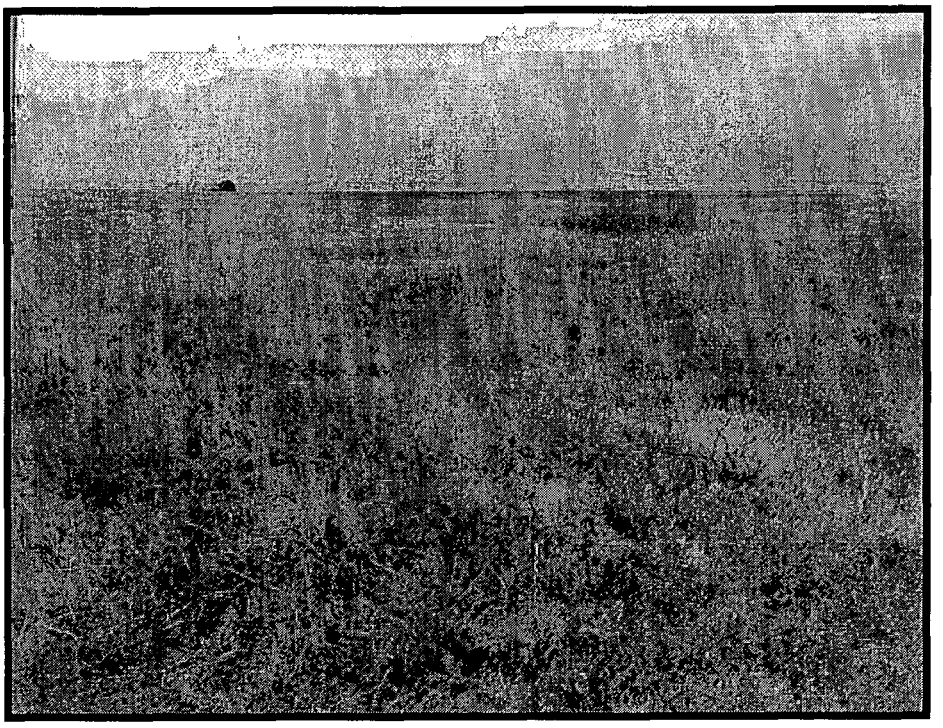


1999

Figure 2-6. The top photograph taken in 1997 shows a substantial diffuse knapweed infestation (brown areas) on this hillside at the Site. The bottom photograph was taken in 1999 approximately three months after the hillside was treated with Tordon 22K, applied by helicopter.

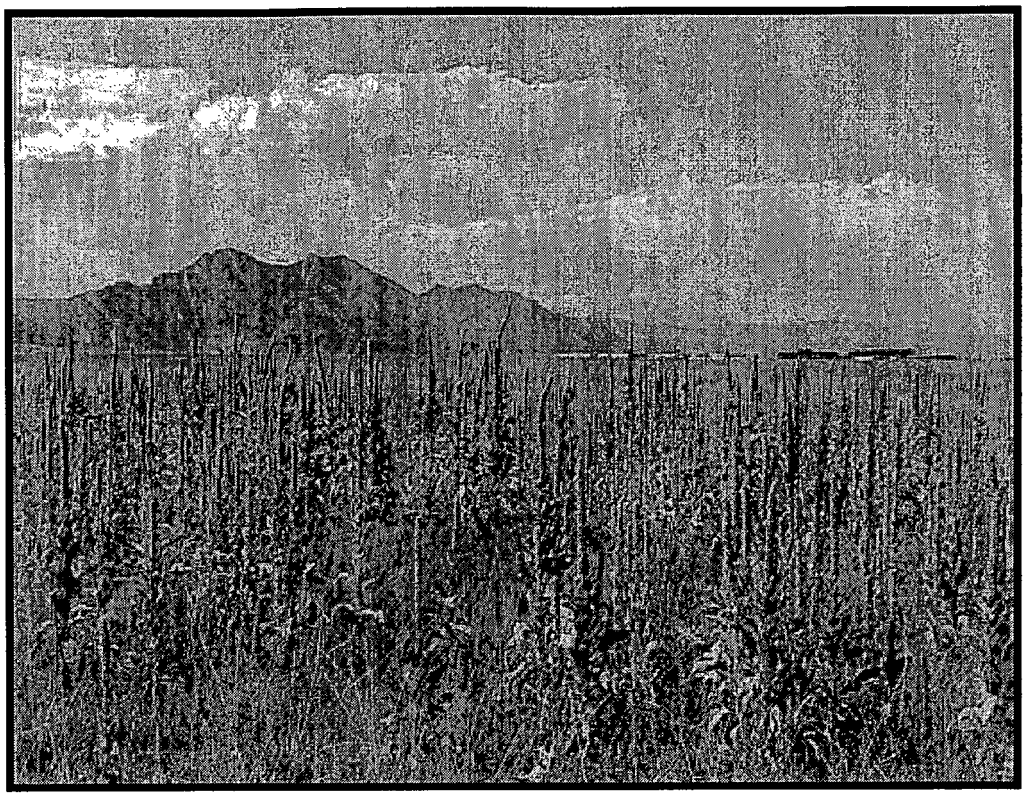


1997



1999

Figure 2-7. Note the abundance of musk thistle in the top photograph taken in 1997 (the tall plant in the right foreground and scattered across the prairie in the background). In addition to controlling diffuse knapweed which was spreading into this area, the aerial herbicide application also controlled the musk thistle. The bottom photograph was taken approximately 3 months after the application of Tordon 22K.



1997

1999

Figure 2-8. In 1999, an aerial herbicide application of Tordon 22K (applied by helicopter) was done to control diffuse knapweed across portions of the xeric tallgrass prairie at the Site. In addition to controlling diffuse knapweed, another noxious weed, common mullein, seen in the 1997 photograph as a virtual "forest" was also controlled. Only the dead stalks from previous years are seen in the 1999 photograph taken approximately 3 months after spraying.

# Appendix A

## Report 3

## 1999 Aerial Herbicide Application Monitoring

# 3. 1999 Aerial Herbicide Application Monitoring

## 3.1 Introduction

During May 1999, the herbicide Tordon 22K was applied from a helicopter to control diffuse knapweed (*Centaurea diffusa*) and other noxious weeds on approximately 1500 acres at the Rocky Flats Environmental Technology Site (Site). To evaluate the effectiveness of the aerial herbicide application on diffuse knapweed, the primary target species, a monitoring effort was undertaken.

The following questions were proposed for investigation:

1. Is the aerial herbicide application effective at reducing the frequency and cover of diffuse knapweed?
2. How does the aerial herbicide application compare to previous ground applications for controlling diffuse knapweed at the same application rates?
3. Is there evidence of undesirable drift or other unintentional application outside the specified application areas? If so, what were the impacts?

This report presents and summarizes the results of the 1999 monitoring.

## 3.2 Methods

The study was conducted at three replicated circular plots (AS-1, AS-2, and AS-3) chosen subjectively for their high infestation of diffuse knapweed in the xeric tallgrass prairie at the Site (Figure 3-1). Each plot was 30 m in diameter, and the center of each plot was permanently staked with rebar. Using randomly generated X (distance from center stake) and Y (aspect) coordinates, a total of 20 quadrats (0.5 × 1 m; 10 control and 10 treatment) were located in each plot. No overlapping of quadrats was allowed. The southwest corner of each quadrat location was permanently staked, assigned a number, and tagged. Quadrats were aligned north-south and east-west, using a compass, with the 1-m side of the quadrat running east-west and the southwest corner of the quadrat touching the stake. Quadrats were sampled in mid-May on the day before and morning of the aerial herbicide application, and again in August of 1999. At each quadrat, diffuse knapweed cover was estimated using the cover class system shown in Table 3-1. Only live diffuse knapweed plants were used to estimate cover. It should be noted therefore that the spring (pre-treatment) cover data represent only seedling and rosette cover, while the summer (post-treatment) data represents the cover of seedling, rosette, and adult plants. At each plot, photographs were taken of five control and five treatment quadrats. Photographs were taken with a single-lens reflex (SLR) camera with a 35-mm lens.

Photographs were taken looking straight down on the center of each quadrat from eye level (approximately 1.5 m), while standing facing south so that the permanent stake is in the upper right hand corner of the photograph.

After the initial monitoring of the quadrats, but prior to the aerial herbicide application, the 10 control quadrats at each plot were covered with black plastic that was weighted down to hold it in place during spraying. This was done to prevent the herbicide from reaching the plants and surface of the ground (Figure 3-2). The aerial herbicide application was conducted on May 12 and 13, 1999. The black plastic was removed within a few hours after the aerial herbicide application had taken place. Figures 3-3 and 3-4 show the equipment used for conducting the aerial herbicide application.

Drift cards were used to evaluate whether herbicide drifted beyond the specified spray areas. Drift cards were placed along the edges of several spray areas where sensitive habitat (i.e. shrublands, streams, wetlands, and woodlands) were present. Drift cards were typically located in two parallel lines along the edges of several spray areas. One line was positioned along the actual edge of the intended spray area, and the other line was positioned 10—15 m outside the spray area. Drift cards were placed within 1–2 hours prior to spraying and were picked up for evaluation 1–3 hours after spraying was completed. There was no precipitation during this period. At one location where the single population of a rare plant—dwarf wild indigo (*Amorph nana*; a rare and imperiled species that is tracked by the Colorado Natural Heritage Program)—is known to occur, the plant was covered with plastic to prevent the herbicide from contacting the plant and soil at its base.

Diffuse knapweed cover was summarized for the control and treatment areas during each sampling session. The midpoint of each cover class was used for the cover analyses (Table 3-1), and all 30 quadrats for the control and treatment analyses, respectively, were summarized together by type. Statistical comparisons were made between and within the control and treatment areas for each sample session and across time (pre- and post-treatment) using non-parametric tests because the data failed normality tests. Independent samples (control versus treatment) were tested using a Mann-Whitney rank sum test, and dependent samples (spring versus summer within treatments) were tested with a Wilcoxon signed rank test (SigmaStat 1997). Frequency analyses were conducted using a McNemar test (Sheskin 1997).

## 3.3 Results

Initial cover amounts for diffuse knapweed (seedlings and rosettes) at the control and treatment plots prior to aerial herbicide application were not statistically different, averaging approximately 7 and 9 percent, respectively (Figure 3-5; Mann-Whitney rank sum test, $U = 891.5$, $P = 0.734$). However, approximately 3 months after the herbicide application, diffuse knapweed cover amounts (seedlings, rosettes, and adults) were statistically different between the late summer control and treatment plots, averaging 25 and less than 1 percent, respectively (Figure 3-5; Mann-Whitney rank sum test, $U = 1244.5$, $P < 0.001$). Additionally, comparison of the pre-application versus post-

application diffuse knapweed cover amounts for the control and treatment plots showed statistically significant changes. At the control plots, diffuse knapweed cover increased from a mean of 9 percent to 25 percent from May to August (Figure 3-5; Wilcoxon signed rank test, $T = 10$, $P < 0.001$). During the same time frame at the treatment plots, diffuse knapweed cover decreased from 7 percent to less than 1 percent cover (Figure 3-5; Wilcoxon signed rank test, $T = 0.0$, $P < 0.001$). Diffuse knapweed frequency in the control plots decreased only slightly and was not significantly different (Figure 3-6). In the treatment plots, however, the frequency of diffuse knapweed dropped substantially, from 83 percent before treatment to 7 percent after treatment (Figure 3-6; McNemar test, $X^2 = 10.3$, $df = 1$, $P < 0.01$). Photographs of several of the control and treatment quadrats, both pre- and post-herbicide application, are shown in Figures 3-7 through 3-10. Figures 3-11 and 3-12 show the diffuse knapweed infestation in the area at the AS-2 plot before and after herbicide application.

Drift-card results showed that no substantial herbicide drift was observed in any sensitive habitats adjacent to the spray areas. At some locations, slight drift was noticed on a few cards in the row outside the edge of the spray area, but observations throughout the growing season showed no impacts to plants. No chlorosis, wilting, or death was observed to any of the plants of concern in these areas. Neither was any impact noted to the dwarf wild indigo plant that was covered during the aerial application. It flowered and fruited normally during 1999.

## 3.4 Discussion

The aerial herbicide application of Tordon 22K by helicopter was shown to effectively control diffuse knapweed at the Site where it was sprayed in 1999. Diffuse knapweed cover dropped to less than 1 percent in the sprayed areas where monitoring was conducted. Additionally, diffuse knapweed frequency was reduced substantially in the sprayed areas. Qualitative observations elsewhere indicated similar success at most treatment areas on the xeric tallgrass prairie. At most of these locations, essentially no adult diffuse knapweed plants were observed in 1999, except where small spots were missed inadvertently. Therefore, the annual seed set in these areas has been reduced to near zero, and little spread of diffuse knapweed will occur from these areas because no adult plants are available to blow across the landscape. Given the residual effect of Tordon 22K, similar effectiveness should be seen in these areas for the next 3 to 4 years.

Although direct comparisons between aerial and ground herbicide application methods are not possible due to the different monitoring methods and experimental designs used, as well as the difference in the timing of the application, ground application data showed that diffuse knapweed abundance dropped considerably; from 23 plants/m$^2$ in spring 1997 to 1 plant/m$^2$ in late summer 1998 in the treatment areas (K-H 1999). Additionally, qualitative observations in the areas treated using ground application equipment showed that virtually no adult diffuse knapweed plants were present at many treated locations during the first two growing seasons after initial application. Therefore, ground application and aerial application appear to work equally well. Either method provides effective control, and the aerial application is more cost effective over large areas, as well

as more suitable on rough terrain where ground application would be impractical. The reduction in the number of adult plants in treated areas by either application method has effectively reduced annual seed set and reduced the rate of infestation spread.

Although a small amount of undesirable drift was observed at some locations during 1999, observations of the plants in these areas throughout the growing season showed no chlorosis, wilting, or death of the sensitive native species in these areas. Thus, no impact resulted from the drift. However, because drift is not desired, drift will continue to be monitored using drift cards during future aerial herbicide applications. Additionally, the concern of maintaining appropriate buffer areas should continue to be communicated to the herbicide applicator prior to aerial application. As necessary, more detailed maps and actual flagging of spray boundaries in the field should be considered for better delineation of buffer area boundaries in sensitive areas.

## 3.5 Conclusions

In summary, the 1999 aerial herbicide application of Tordon 22K effectively controlled diffuse knapweed on the xeric tallgrass prairie at the Site. Qualitative and quantitative results indicated that by late summer virtually no adult diffuse knapweed plants were present in the areas treated, except at a few locations that were missed during spraying. Therefore, annual seed set at these locations has been reduced to near zero, and the chance of these infestations spreading from treated areas in 1999 is greatly reduced because no adult plants are available to tumble across the landscape. Ground versus aerial application methods revealed no apparent differences in the ability of Tordon 22K to control diffuse knapweed. Both methods have been shown to be effective. Improvements will continue to be made in the protocols for aerial application of herbicides at the Site to continue to protect sensitive habitats and undesired drift, while proactively managing the Site's ecological resources.

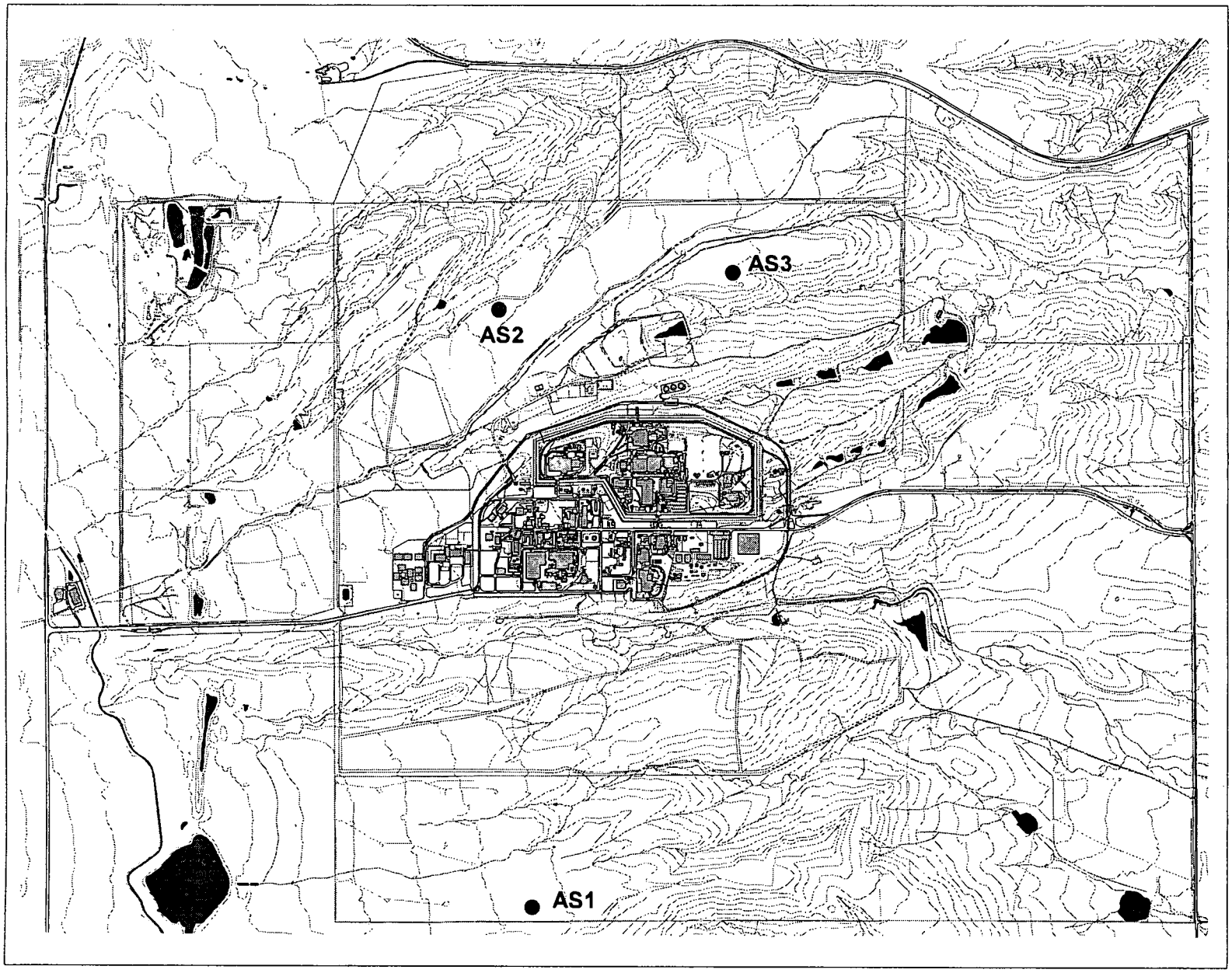
## 3.6 References

K-H. 1999. 1998 Annual vegetation report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, LLC, Rocky Flats Environmental Technology Site, Golden, CO.

Sheskin, D.J. 1997. Handbook of parametric and nonparametric statistical procedures. CRC Press, Boca Raton, FL.

SigmaStat. 1997. SigmaStat Statistical Software, Version 2.0. SPSS Inc./Marketing Department, Chicago, IL.

# Figures




# Aerial Herbicide Monitoring Plot Locations

Figure 3-1

MAP LEGEND

● Aerial Herbicide Monitoring Plots

Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
Permanent vegetation monitoring locations provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Note:

Monitoring locations are approximate. Permanent transects endpoints are marked with rebar.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0038

March 14, 2000

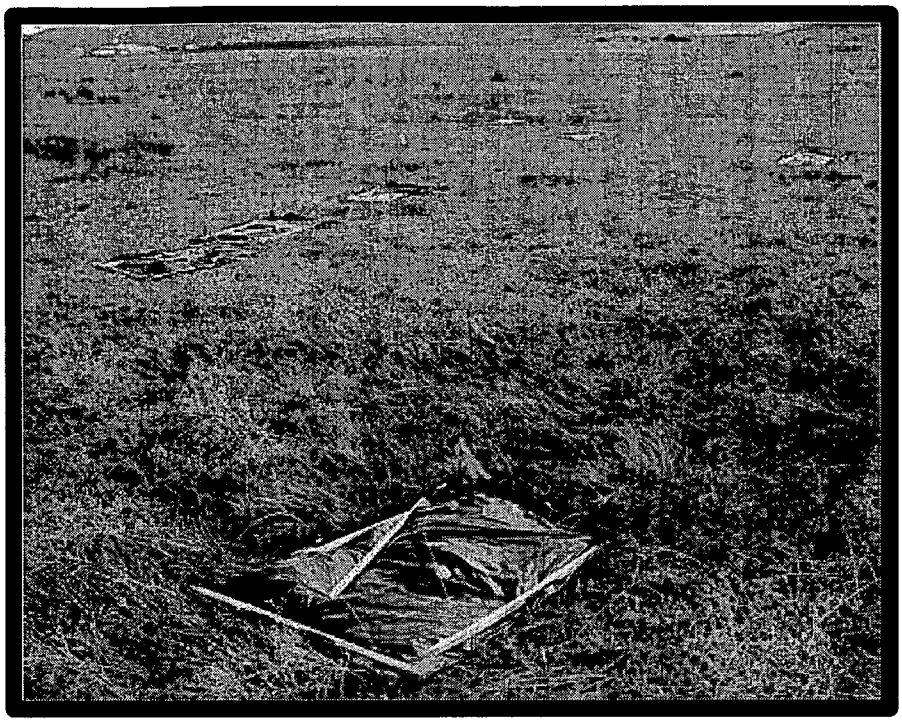


Figure 3-2. Control plot quadrat locations covered with plastic prior to aerial herbicide application. Notice all the previous year's dead diffuse knapweed plants (light brown plants) scattered about.

Figure 3-3. Helicopter conducting aerial herbicide application at Rocky Flats Environmental Technology Site.

Figure 3-4. Helicopter refueling and refilling herbicide tanks during aerial herbicide application operations at Rocky Flats Environmental Technology Site.

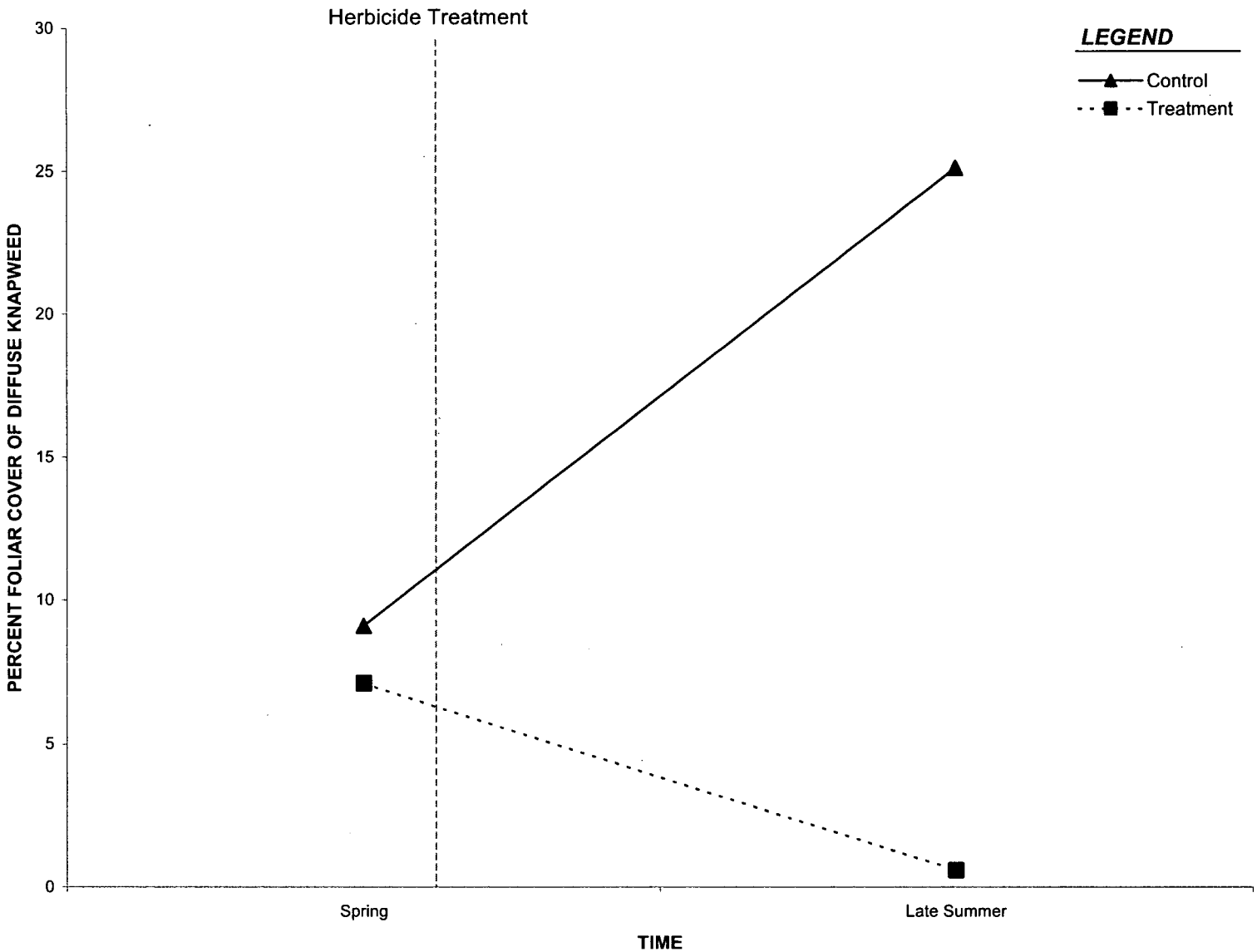



Figure 3-5. Diffuse knapweed cover in the control and treatment plots, pre- and post-treatment by aerial herbicide application.

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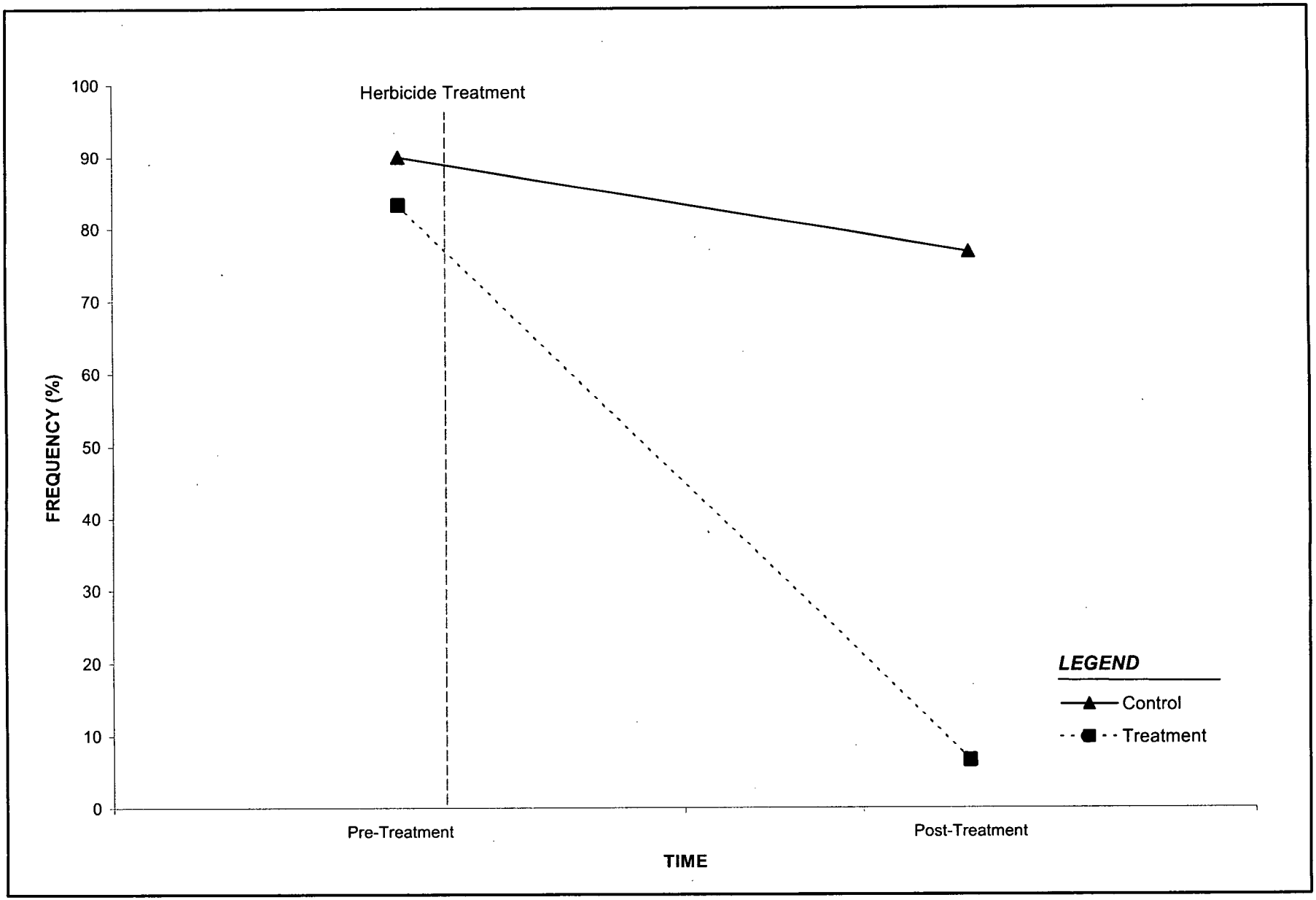


Figure 3-6. Diffuse knapweed frequency in control and treatment plots pre- and post-treatment by aerial herbicide application.

Boulder1\data\groups\graphics\projects\1454\5/23/00 10:59 AM (summary.xls figure 6)

Figure 3-7. Diffuse knapweed rosettes at control plot AS-3, quadrat 8 prior to aerial herbicide spraying. Most of the green non-grass material is diffuse knapweed. This plot was not sprayed with Tordon 22K. See photo below for comparison. Photograph date: 5/11/99.

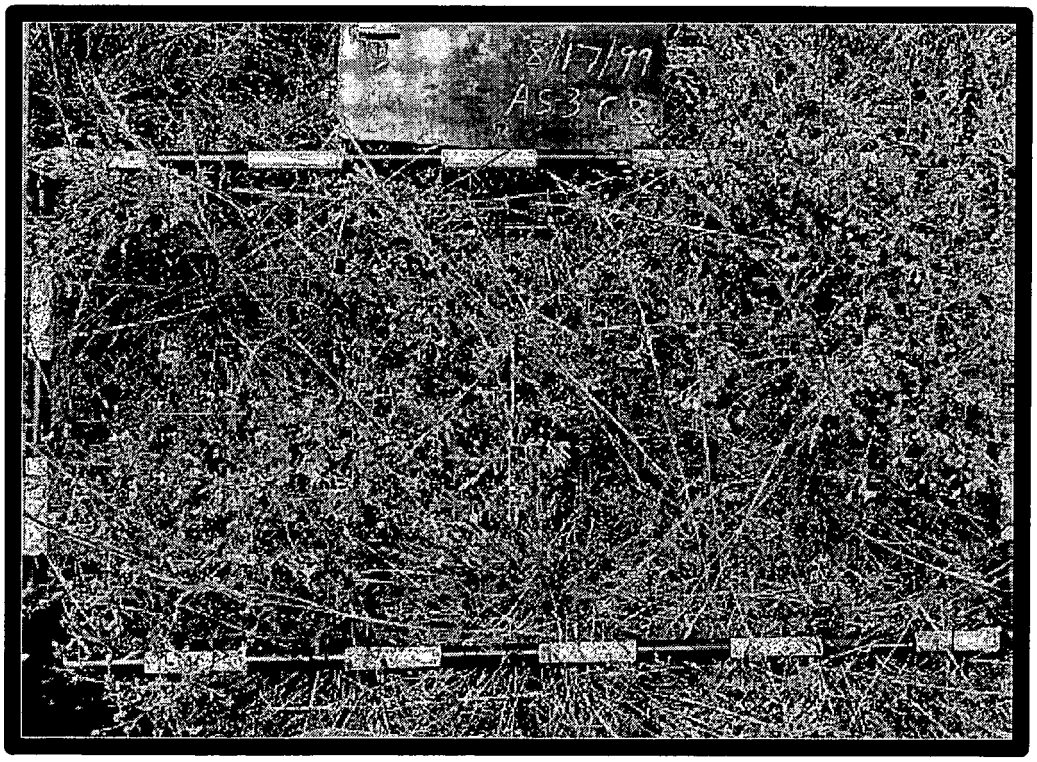


Figure 3-8. Diffuse knapweed at control plot AS-3, quadrat 8 three months later. Note the multiple adult diffuse knapweed plants across most of the quadrat. Compare these control plot photographs with those of a treatment plot (Figures 8 and 9). Photograph date: 8/17/99.

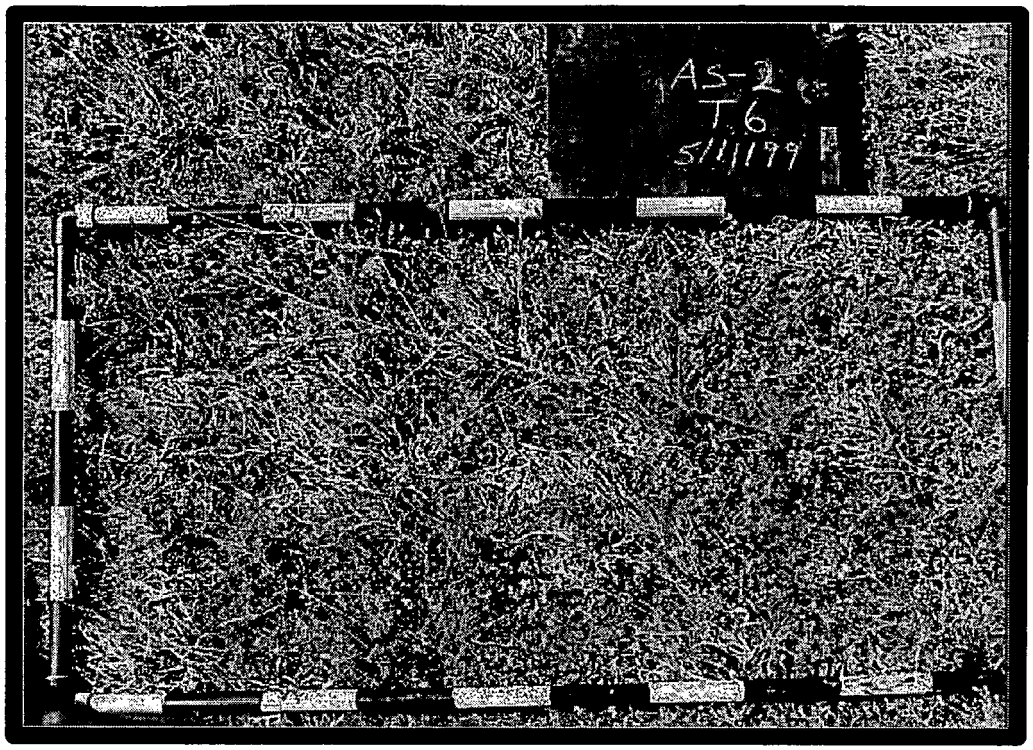


Figure 3-9. Diffuse knapweed at treatment plot AS-2, quadrat 6 prior to herbicide treatment in 1999. Most of the green non-grass plants in the photo are diffuse knapweed along with some alyssum (another weed). Compare to the photograph below taken 3 months later and to control plots (Figures 6 and 7) that received no treatment. Photograph date: 5/11/99.

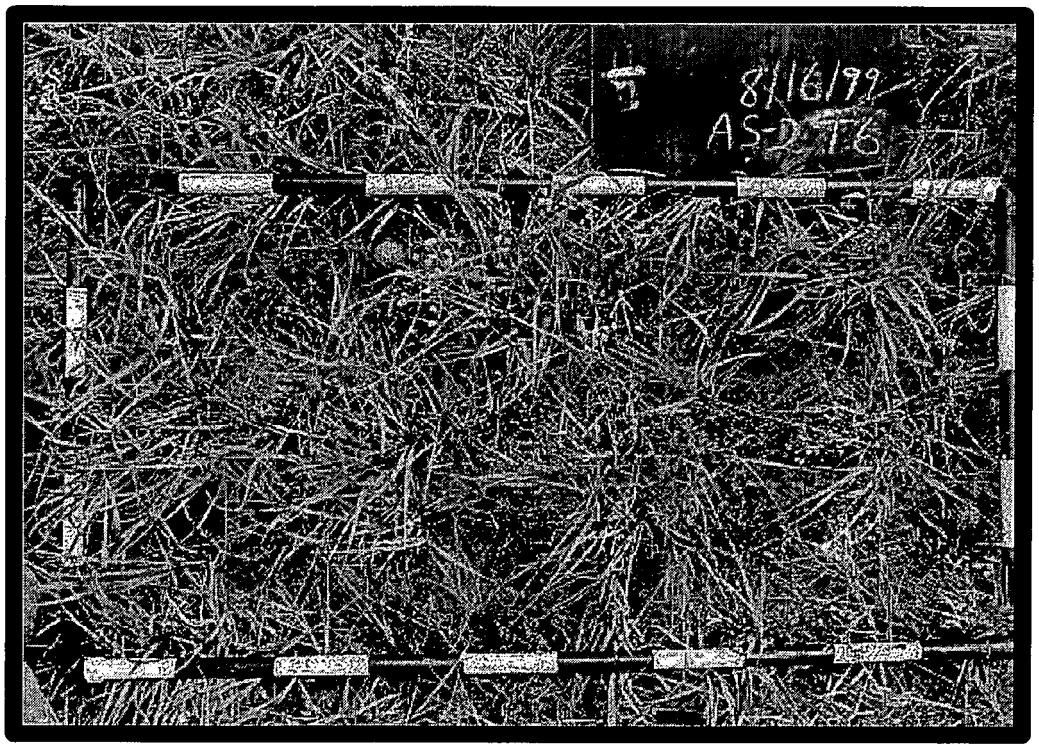


Figure 3-10. Treatment plot AS-2, quadrat 6, three months after herbicide treatment with Tordon 22K. The only diffuse knapweed visible are some old dead stalks from last year. The rosettes present in the spring photograph above have all been killed. Photograph date: 5/11/99.

Figure 3-11. Diffuse knapweed infestation near the AS-2 monitoring plot in 1997. Notice the high density of diffuse knapweed (reddish colored plant) in the foreground.

Figure 3-12. The same area near the AS-2 monitoring plot in 1999 after the aerial herbicide spraying. Only the remains of the previous year's dead knapweed stalks remain. Otherwise the area is devoid of adult diffuse knapweed plants, thus preventing seed set in the area during 1999 and reducing the chance of infestation spread.

# Tables

**Table 3-1. Cover Class System**

| Cover Class | Visually Estimated Cover Range | Midpoint |
|---|---|---|
| 1 | <5% | 2.50% |
| 2 | 5-25% | 15.00% |
| 3 | 26-50% | 37.50% |
| 4 | 51-75% | 62.50% |
| 5 | >76% | 87.50% |

# Appendix A

## Report 4

## Monitoring Summary for Diffuse Knapweed Control Study

# 4. Monitoring Summary for Diffuse Knapweed Control Study

## 4.1 Introduction

Diffuse knapweed (*Centaurea diffusa*) is a noxious weed that has become increasingly widespread across the Front Range of Colorado. Over the past several years, the spread of this species has become a serious threat with regard to managing the natural resources in the Buffer Zone at the Rocky Flats Environmental Technology Site (the Site). Under the Colorado Noxious Weed Act, diffuse knapweed is listed as a noxious weed that must be controlled by property owners, and it is listed as one of the top ten prioritized species for control in the state (CRS 1996).

Diffuse knapweed is a very aggressive competitor in dry conditions such as those found at the Site. Studies elsewhere have shown that it rapidly invades overgrazed range lands, disturbed sites, and even undisturbed plant communities, often becoming a dominant species and altering the species composition of the plant community (Powell 1990; FEIS 1996; Sheley et al. 1998). Studies have also shown that diffuse knapweed–infested lands exhibit increased soil erosion, degraded water quality, lower wildlife habitat value, reduced grazing capacity, and less aesthetic and recreational value (Sheley et al. 1997, 1998).

At the Site, one of the rare plant communities that is increasingly affected by the spread of diffuse knapweed is the relict xeric tallgrass prairie. The Site contains a significant portion of what has been identified as the largest remaining stand of this plant community known to occur in Colorado, and potentially in all of North America (CNHP 1995). The herbicide Tordon 22K (trademark of DowElanco [picloram]) is one of the more effective chemicals used for treatment of diffuse knapweed infestations, because its multi-year residual effect can prevent the species from germinating for several years after application (Beck 1994). Because this is an important plant community, the issue of what effect the spraying of Tordon 22K might have on the native species in the xeric tallgrass prairie is a management concern. A study was begun on the Site in 1997 to evaluate the effectiveness of Tordon 22K in controlling diffuse knapweed on the Site and to identify any potential effects on desirable species in the xeric tallgrass prairie. This report summarizes the three years of data collected thus far.

The following general questions were proposed for investigation:

- How effective is Tordon 22K on controlling diffuse knapweed under Site conditions?
- How long is a single application of Tordon 22K effective in controlling diffuse knapweed?

- How does Tordon 22K affect species richness, cover, and individual species abundance on the xeric tallgrass prairie?

## 4.2 Study Site Location and Characteristics

The study site is located north of the T130 trailer complex, west of the Industrial Area (Figure 4-1). The xeric tallgrass prairie at the Site is located primarily on the pediment, which is underlain by Rocky Flats Alluvium (SCS 1980). The soils are classified as Flatirons very cobbly sandy loams (SCS 1980). The study site is essentially flat, with only a 1° slope to the northeast. The area was chosen because it was large enough for placement of both control and treatment plots (each 60 × 65 m), and an abundance of diffuse knapweed was present where the two plots would be located.

## 4.3 Methods

A control plot (no herbicide applied) and a treatment plot (herbicide applied) were established. Within both the control and treatment plots, five parallel, randomly located, 50-m transects were established from a baseline using X and Y coordinates generated by a computerized random number generator (Figure 4-2). Transects were permanently marked, assigned numbers, and labeled. Although it would have been preferable to collect a full year's worth of data prior to herbicide application in 1997, logistics and the required time frame only allowed for a single spring sampling prior to herbicide application. Sampling during 1997 was conducted on June 16–19 and again on September 2–4. In 1998, sampling was conducted on June 17–19 and August 24–27. In 1999, sampling was conducted on June 14–18 and August 30–September 1. The treatment plot was sprayed with Tordon 22K, applied at a rate of 1 pint/acre, on June 23–24, 1997, using a truck-mounted spray unit with a 16.75-m (55-ft) boom. The boom was held approximately 0.6–1.0 m (2–3 ft) above the vegetation. A uniform application rate was obtained across the area using a computerized spray system that regulated the application pressure rate according to the speed of the truck. Some diffuse knapweed plants had already bolted and were in the bud stage at the time the spraying occurred, but many rosettes were still present.

Species richness was determined in a 2-m-wide belt centered along the length of each 50-m transect. Every plant species rooted within the 100-$m^2$ area was recorded. In addition, the numbers of woody plant stems and cactus stems were counted for the 100-$m^2$ area and recorded. Basal cover and foliar cover estimates were made using a point-intercept method along each of the 50-m transects. A 2-m-long rod, with a 6-mm diameter, was dropped vertically at 50-cm increments along the transect to record a total of 100 intercept points. Two categories of hits were recorded, basal and foliar. Basal cover hits indicated what material the rod contacted at the ground surface. Hits could be vegetation (live plants), litter (fallen dead material), rock (pebbles and cobbles that were greater than the rod diameter), bare ground, or water, in that order of priority based on the protection from erosion each type of cover provided. Basal vegetation hits were recorded

by species only if the rod was touching the stem or crown of the plant where the plant entered the ground. Foliar vegetation hits (defined as a portion of a plant touching the rod) were recorded by species in three categories as defined by height and growth form. The topmost hit of each growth form was recorded. The growth forms measured were herbaceous, woody <2 m in height, and woody >2 m in height.

Frequency information by species was gathered by randomly locating 25 1-$m^2$ quadrats (5 per transect) in each of the control and treatment plots and recording all species present in each plot. Stem density counts for diffuse knapweed also were made using these same quadrats. No distinctions were made during counts between seedlings, rosettes, or adult plants. More detailed summaries of these specific methods are found in the *Environmental Monitoring Department Operating Procedures Manual* (DOE 1995), the *High Value Vegetation Survey Plan for the Rocky Flats Environmental Technology Site* (K-H 1997), and the *1999 Ecological Field Monitoring Plans for the Rocky Flats Environmental Technology Site* (K-H 1999a).

Species richness data were summarized by generating species lists for the control and treatment plots for each sampling period. In addition, other species richness variables were calculated from the species lists. Basal cover data were reported as total percent cover of vegetation, litter, rock, and bare ground. Foliar cover data were reported as frequency, absolute cover, and relative cover for each species encountered. Frequency from the cover data was defined as the percent of point-intercept transects in which a species occurred, out of the total five possible sampled per plot. Absolute foliar cover was the percentage of the number of hits on a species out of the total number of hits possible at a plot (500). This value is the actual cover of a species. Relative foliar cover was the number of hits on a species relative to the total number of vegetative hits recorded per plot (i.e., the percent of total vegetative cover [100 percent] represented by the species).

Both absolute and relative foliar cover values are means averaged over the five transects. Frequency based on quadrats (n=25) was defined as the number of quadrats in which a species was recorded, divided by 25 (the total number of quadrats possible), multiplied by 100. Density count data were summarized as the mean number of stems per square meter based on the 25 quadrats sampled within each plot (n=25).

For most results, descriptive comparisons were made between the control and treatment plots from the three years of data to examine potential changes over time—pre-treatment to post-treatment. Summaries of species richness, cover, and frequency were summarized by combining data from the five control transects and five treatment transects for each sampling event, respectively. A Sorensen coefficient of similarity was used to assess the species richness similarity between the control and treatment data (Brower and Zar 1977). A Shannon-Weaver diversity index was used to calculate diversity and was conducted using the relative foliar cover data (Brower and Zar 1977). Statistical analysis of the results was conducted only when mean values were different enough to suggest a meaningful interpretation. Where normality, variance, and dependence requirements were met, parametric tests were used to compare results. Nonparametric tests were used for all analyses where normality, variance, and

independence requirements were not met. Independent samples (i.e., the control and treatment plots) were compared using one-way analysis of variance (ANOVA), t-tests, or Mann-Whitney U tests (SigmaStat 1997; Fowler and Cohen 1990; Sheskin 1997). Dependent sample comparisons (i.e., within treatment over time) were done using Wilcoxon's test for matched pairs and Friedmans 2-way ANOVA (SigmaStat 1997; Fowler and Cohen 1990; Sheskin 1997). Where applicable, a Tukey test was used for pairwise multiple comparison procedures to isolate groups that differed from one another (SigmaStat 1997). Frequency analyses were done using a McNemar test (Sheskin 1997).

## 4.4 Results

### 4.4.1 Species Richness

Overall species richness in the treatment plot initially declined by 12 species after the herbicide application in 1997, but over the two years since treatment, species richness has returned to near pre-treatment levels (Tables 4-1 and 4-2, Figure 4-3). Species richness in the control plot during the same time period has remained stable, with some seasonal fluctuation, except for a drop in summer 1999 (Tables 4-1 and 4-2, Figure 4-3).

Examination of the mean number of species per quadrat showed parallel seasonal responses in both the control and treatment plots from 1997-1999 (Tables 4-1 and 4-2, Figure 4-4). The treatment plot had fewer species per quadrat than the control plot initially and during all subsequent sampling events. Although significant statistical changes in the mean number of species per quadrat were observed for some of the spring-to-summer fluctuations in both the control and treatment plots from 1997–1999, same-season comparisons (i.e., spring to spring and summer to summer; the more meaningful comparisons) for the same time frame were not statistically significant in either the control plot or the treatment plot (Friedmans 2-Way ANOVA by Ranks, $X^2 = 41.5$, df = 5, $P < 0.05$). Additionally, the treatment plot had a lower number of species per quadrat initially in spring 1997. However, only in summer 1997 was the difference compared to the control plot significant, following the trend shown in the overall species richness results (Figure 4-4; Friedmans 2-Way ANOVA by Ranks, $X^2 = 85.064$, df = 5, $P < 0.001$).

A Sorensen coefficient of similarity was use to compare initial 1997 species richness to that in 1999 for both the control and treatment plots. Comparing spring 1997 to summer 1999 resulted in a Sorensen index value of 0.83 for both the control and treatment plots, indicating no substantial difference in species richness in the treatment plot, three growing seasons after the herbicide application. The spring 1997 control-versus-treatment Sorenson index value was 0.80, and for the same comparison in summer 1999, a value of 0.78 was obtained. Thus three growing seasons after the herbicide application, essentially no difference was apparent in species richness between the control and treatment plots.

### 4.4.2 Diffuse Knapweed Response

Diffuse knapweed densities declined significantly in the treatment plot after the herbicide application and continued to remain at low levels in 1999, three growing seasons after the herbicide application (Table 4-1, Figure 4-5; Friedmans 2-Way ANOVA by Ranks, $X^2 = 49.0$, df = 5, $P < 0.05$). In the treatment plot, spring diffuse knapweed densities (a measure of seedling and rosette density) decreased significantly after herbicide treatment, from 23 plants/m$^2$ in 1997 to 1.7 plants/m$^2$ in 1999 (Table 4-1, Figure 4-6; Friedmans 2-Way ANOVA by Ranks, $X^2 = 49.0$, df = 5, $P < 0.05$). Late-summer diffuse knapweed densities in the treatment plot (largely a measure of adult plants), while not statistically significant, showed declines from 6.2 plants/m$^2$ in 1997 to 1.1 plants/m$^2$ in 1998 after herbicide treatment, and remained at 1.4 plants/m$^2$ in 1999 (Table 4-1, Figure 4-6). (Note: The late-summer 1997 diffuse knapweed density data are considered here as "pre-treatment" values, because by the time the herbicide was applied in 1997, the plants had already bolted and started to flower. Therefore, these values are representative of the adult diffuse knapweed densities prior to the impact of the herbicide.)

Large seasonal fluctuations were observed in diffuse knapweed densities in the control plot (Table 4-1, Figure 4-5). Spring diffuse knapweed density showed a statistically significant increase in the control plot, from 5.6 plants/m$^2$ in 1997 to 26.1 plants/m$^2$ in 1999 (Table 4-1, Figure 4-6; Friedmans 2-Way ANOVA by Ranks, $X^2 = 59.1$, df = 5, $P < 0.05$). Late-summer diffuse knapweed densities in the control plot were not statistically different, but decreased initially from 3.6 plants/m$^2$ in 1997 to 1.7 plants/m$^2$ in 1998, and then increased to 6.2 plants/m$^2$ in 1999 (Table 4-1, Figure 4-6).

Diffuse knapweed frequency decreased slightly in the control plot, from 76 percent in 1997 to 64 percent in 1999 (Table 4-3). In the treatment plot, during the same time period, diffuse knapweed frequency declined considerably, from 80 percent before herbicide treatment in 1997 to 20 percent in summer 1998, but increased back to 44 percent in summer 1999 (Table 4).

### 4.4.3 Cactus Density Response

Cactus densities in the control plot for twistspine prickly pear (*Opuntia macorhiza*) and hedgehog cacti (*Echinocereus viridiflorus*) remained generally stable, showing only a slight increase from 1997 to 1999 (Table 4-1; Figure 4-7). In the treatment plot, however, densities for these two species both declined after the herbicide treatment (Table 4-1; Figure 4-7). The twistspine prickly pear density decreased significantly by 87 percent (Figure 4-7; Friedmans 2-Way ANOVA by Ranks, $X^2 = 10$, df = 2, $P < 0.001$). The frequency of the twistspine prickly pear also decreased, significantly by more than 50 percent (Table 4-3; McNemar test, $X^2 = 8.1$, df = 1, $P < 0.01$). Hedgehog cactus density and frequency, although declining, did not decrease significantly (Tables 4-1 and 4-3; $P > 0.05$). There is no indication of a reversal of the loss of cactus density in the treatment plot three years after the herbicide application. Continued monitoring will detect when and if the cacti begin to return to these areas.

### 4.4.4 Diversity Response

Shannon-Weaver diversity indices for the control and treatment plots are shown, by sampling event, in Table 4-1 and Figure 4-8. No significant changes were observed in the control plot from 1997 through 1999 (Figure 4-8). In the treatment plot, a significant loss of diversity was observed from spring 1997 to summer 1998 as a result of the herbicide treatment (Figure 4-8; Friedmans 2-Way ANOVA by Ranks, $X^2 = 12.429$, df = 5, P = 0.029). In 1999, however, diversity began to increase and return to pre-treatment levels, and was no longer statistically different from the control plot (Figure 4-8; P>0.05). Further numerical increases in diversity are needed at the treatment plot before a complete return to pre-treatment levels is reached.

### 4.4.5 Plant Frequency Response

Individual species frequencies measured during each sampling event are presented in Table 4-3 for both the control and treatment plots. Taking into account changes that occurred from spring 1997 to spring 1999 in the control plot (i.e., assumed to be natural variability in species frequency), those species in the treatment plot that showed the greatest change in frequency are shown in Table 4-4. Only those species that showed changes of 12 percent or more (negative or positive) are listed, because the presence of a species in a single quadrat represents 4 percent (n = 25). Changes of 8 percent or less are as likely explained by chance as by any response to the herbicide application, given the natural variability of species on the prairie. The species showing the greatest decrease was diffuse knapweed, which decreased by 56 percent in the treatment plot compared to the control plot. Of the other seven species listed as having experienced declines in frequency, six were native species and one was non-native (Table 4-4). Several species also showed increases in frequency in the treatment plot versus control plot analysis (Table 4-4).

### 4.4.6 Vegetation Cover Response

Basal cover amounts for total basal vegetation, rock, bare ground, and litter cover did not change by any meaningful amounts in either the control or treatment plots from 1997 to 1999 (Table 4-1). The apparent loss of bare ground cover in both the control and treatment plots was offset by similar increases in plant litter cover and is likely a result of sampling bias.

Foliar cover results, by species and species groupings, for the control and treatment plots for 1997 to 1999, by sampling session, are presented in Tables 4-5 and 4-6. Change in species composition (relative cover) and actual cover (absolute cover) were evaluated by examining changes in the amounts of foliar cover provided by different species or groups of species. Examination of the cover data showed seasonal shifts in cover amounts for many of the species groupings (Tables 4-5 and 4-6). Total foliar cover, total native foliar cover, and total non-native foliar cover values for both the control and treatment plots

showed essentially parallel responses from 1997 through 1999 (Tables 4-5 and 4-6; Figure 4-9). The only fluctuation in total absolute foliar cover in the treatment plot compared to the control plot occurred in summer 1997, and most of this resulted from the loss of non-native foliar cover (Tables 4-5 and 4-6). Thus the total absolute cover present on the grassland was not substantially affected by the herbicide treatment. Species composition was affected though. Total relative forb cover in the control plot changed little from 1997 through 1999, fluctuating only about four percent around an average of approximately 14 percent (Figure 4-10). Total relative forb cover in the treatment plot, however, dropped significantly—from more than 18 percent initially in 1997 to a low of less than 5 percent in summer 1998—in response to the herbicide (Figure 4-10; Friedmans 2-Way ANOVA by Ranks, $X^2 = 17.9$, df = 5, $P < 0.05$). In 1998, the treatment plot relative forb cover was significantly lower than the control plot (Figure 4-10; spring 1998, Mann-Whitney Rank Sum test, T = 40, $P < 0.05$; summer 1998, T-test, t = 3.211, df = 8, $P < 0.05$). During 1999, relative forb cover began to recover and increased to nearly 9 percent, although a similar parallel increase was observed in the control plot (Figure 4-10). However, the difference in total forb cover between the control and treatment plots was no longer significant in 1999 (Figure 4-10; $P>0.05$). Thus, the loss of overall forb cover was transitory, and although the differences between the control and treatment plots are no longer statistically significant, the numbers indicate that the treatment plot still has not yet recovered to pre-treatment levels.

Examination of both native and non-native relative forb cover data showed that both were reduced in the treatment plot by the herbicide application (Tables 4-5 and 4-6, Figures 4-11 and 4-12). Non-native relative forb cover dropped significantly, from approximately 8 to zero percent cover from 1997 through 1998 (Figure 4-12; Friedmans 2-Way ANOVA by Ranks, $X^2 = 22.5$, df = 5, $P < 0.001$). Although similar drops in non-native relative forb cover were observed in the control plot, significant differences were present between the control and treatment plots for spring and summer 1998 (Figure 4-12, spring 1998, Mann-Whitney Rank Sum test, T = 40, $P < 0.05$; summer 1998, T-test, t = 5.854, df = 8, $P < 0.001$), indicating that the herbicide had depressed non-native relative forb cover beyond the natural decline seen in the control plot. In 1999, however, although non-native relative forb cover in the treatment plot remained below that in the control plot, it was no longer statistically different (Figure 4-12; $P>0.05$).

Native relative forb cover in the control plot increased slightly each year from 1997 to 1999, although the increases were not statistically significant (Figure 4-11; $P>0.05$). In the treatment plot, native relative forb cover declined after the herbicide treatment, but the decreases were not statistically significant (Figure 4-11; $P>0.05$). However, due to the natural increases in native relative forb cover documented in the control plot during 1998, the native relative forb cover in the treatment plot throughout 1998 was significantly less than that in the control plot, indicating that the herbicide treatment had depressed the native relative forb cover compared to increases in the control plot (Figure 4-11, spring 1998, Mann-Whitney Rank Sum test, T = 40, $P < 0.05$; summer 1998, T-test, t = 2.409, df = 8, $P < 0.05$). By summer 1999, although native relative forb cover remained less than that in the control plot, it was no longer significantly different (Figure 4-11; $P>0.05$). Therefore, the loss of native relative forb cover was transitory;

however, while the differences between the control and treatment plots are no longer statistically significant, there are still some numerical gains to be achieved before pre-treatment levels are reached.

Absolute (actual) graminoid cover increased at both the control and treatment plots from 1997 through 1999 (Tables 4-5 and 4-6, Figure 4-13). Initially, the control plot had more absolute graminoid cover, but after herbicide application, the treatment plot had slightly more absolute graminoid cover than the control plot. Relative graminoid cover, an indicator of species composition, increased slightly in the control plot, but the change was not statistically significant (Figure 4-14; $P>0.05$). In the treatment plot, however, relative graminoid cover increased significantly from 1997 to summer 1998 (Figure 4-14; Friedmans 2-Way ANOVA by Ranks, $X^2 = 17.89$, $df = 5$, $P = 0.003$), thus changing the species composition of the treatment plot. As a result of the herbicide application, relative graminoid cover was significantly higher in the treatment plot than in the control plot throughout 1998 (Figure 4-14, spring 1998, Mann-Whitney Rank Sum test, $T = 15$, $P < 0.05$; summer 1998, T-test, $t = -3.211$, $df = 8$, $P < 0.05$). By 1999, however, treatment plot relative graminoid cover was beginning to return toward pre-treatment amounts and was no longer statistically different from the control plot (Figure 4-14; $P>0.05$).

Warm-season graminoid and cool-season graminoid cover showed differing responses to the herbicide treatment (Tables 4-5 and 4-6, Figures 4-15 and 4-16). In the control plot, cool-season graminoid relative cover increased in 1998 and declined in 1999, but the changes were not significant (Figure 4-16; $P>0.05$). Cool-season graminoid relative cover in the treatment plot was initially lower than in the control plot, but it declined in summer 1997 after the herbicide application. In spring 1998, it increased significantly and was greater than that in the control plot; it remained so until summer 1999 (Figure 4-16; Friedmans 2-Way ANOVA by Ranks, $X^2 = 17.89$, $df = 5$, $P = 0.002$). At no point, however, were the cool-season graminoid relative cover amounts significantly different between the control and treatment plots for a given sampling event (Figure 4-16; $P>0.05$). Warm-season graminoid relative cover in the control plot declined in 1998 and increased slightly in 1999 (Figure 4-15). In the treatment plot, however, warm-season graminoid relative cover increased immediately after the herbicide application and remained higher than that in the control plot until spring 1999 (Figure 4-15). No observed changes within or between the control and treatment plots were significantly different, however (Figure 4-15; $P>0.05$).

## 4.5 Discussion

The effect of the herbicide Tordon 22K on diffuse knapweed and other species in the xeric tallgrass prairie was examined to provide important information for weed control and resource management activities at the Site. In 1998, the second growing season after the initial herbicide application, a number of measured plant community variables continued to show declines as a result of the herbicide application. In addition to diffuse knapweed, forbs in general were affected; overall forb cover decreased considerably, and species richness, cactus density, and species diversity all declined initially (K-H 1999b).

Data from the 1999 field season (three growing seasons after the herbicide application), however, began to show the expected reversal of many of these initial responses.

Although overall species richness in the treatment area declined by 12 species immediately after the herbicide application in 1997, overall species richness had almost completely returned by 1999 (only one species less than the original number; Figure 4-3). A Sorensen coefficient of similarity index (an index used to evaluate species similarity between locations), was used to evaluate the species richness similarity within the control and treatment plots from spring 1997 to summer 1999. An index value of 0.83 resulted for both plots, indicating high similarity between pre- and post-treatment. An additional comparison of similarity between the control plot and the treatment plot, for spring 1997 and summer 1999, showed essentially no difference either, thus indicating that no long-term loss of species richness occurred as a result of the herbicide application. At a finer scale, using quadrat data, the number of species per quadrat was significantly lower in the treatment plot than in the control only immediately after the herbicide application during summer 1997 (Figure 4-4). After this, the treatment plot response paralleled that of the control plot, indicating no substantial change in species richness at this scale. Therefore, although there was some slight initial depression of species richness in response to the herbicide application, after three growing seasons, it had essentially returned to pre-treatment levels.

Species diversity (Shannon-Weaver) declined immediately after the herbicide application in the treatment plot (Figure 4-8). It reached its lowest level in summer 1998, when it was significantly different from the control plot, before beginning to return to pre-treatment levels in 1999. Although the species diversity in the treatment plot remains below its initial level and that of the control plot, the diversity indices in 1999 were no longer significantly different from the control plot. Continued monitoring will reveal how long it takes for species diversity on the xeric tallgrass prairie at the Site to fully return to pre-treatment levels.

The response of diffuse knapweed, the primary target species of the herbicide application, has been dramatic. The herbicide application reduced and continues to control the diffuse knapweed in the treatment plot, where diffuse knapweed densities remain far below their original values (Figure 4-5). Diffuse knapweed cover also remains at less than 1 percent of the total relative foliar cover (Table 4-6). In the control plot, however, spring diffuse knapweed densities have increased by a factor of five, and summer densities have also increased (Figures 4-5 and 4-6).

The effective control of diffuse knapweed observed in the treatment plot is critical, because the longer the control continues, the fewer adult plants there are present to produce additional seeds and blow across the landscape spreading the seeds. Thus, the control of diffuse knapweed documented from 1997 through 1999 in the treatment plot has and continues to reduce diffuse knapweed seed production in the area and has substantially reduced the chances for spread of the species from this site.

Both of these criteria are considered important for controlling diffuse knapweed. Another important consideration however, is that with time, diffuse knapweed density will begin to increase again in the treatment plot as a result of the seed bank that remains, and from immigration of new seed from offsite sources (e.g., grasslands and mining areas to the west). If no further control measures are taken, the densities will reach and could potentially exceed pre-treatment levels in a few years. In fact, although diffuse knapweed densities continue to be controlled to low levels, frequency data for diffuse knapweed in the treatment plot showed that after bottoming out at 20 percent in 1998, diffuse knapweed frequency increased to 44 percent in 1999 (Table 4-3). Additionally, in the larger area surrounding the treatment plot, which received the same herbicide application, weed mapping results have begun to show an increase and return of diffuse knapweed to the larger area. Thus, although the herbicide application in the treatment plot is and continues to control the diffuse knapweed, long-term integrated weed control using multiple methods is necessary for sustainable control of this species. This is especially important because of the potential long-term impacts that the native plants in the community could experience in response to repeated long-term herbicide applications. Cooperative weed control in conjunction with surrounding land owners would help address the issue of seed being transported onto the Site.

The response of the non-target species on the xeric tallgrass prairie was varied, but fell within generally expected parameters. One of the most affected non-target species groups was cacti, particularly the twistspine cactus. Twistspine cactus density was reduced by 87 percent, from approximately 79 stems/100 $m^2$ in 1997 to 10 stems/100 $m^2$ in 1999. This decrease was statistically significant. Most of these cacti turned yellow after the herbicide application and later died. The hedgehog cactus, the other common species on the xeric tallgrass prairie, was less severely affected, and while showing a numerical loss of just over 50 percent, the loss was not statistically significant. Continued monitoring will document whether the cacti begin to return to the treatment plot, but any return will be gradual because the cacti grow slowly.

Total absolute (actual) cover on the xeric tallgrass prairie was not substantially affected by the herbicide treatment—changes in the treatment plot generally paralleled changes in the control plot (Figure 4-9). This is important because it illustrates that no large, barren, unvegetated areas were created on the prairie as a result of the herbicide application. Instead, other species (graminoids) expanded, moving in and filling in the canopy to replace the species that were reduced by the spraying.

The forb, or non-grass, component of the prairie, both non-native and native, was affected by the herbicide treatment. This was not unexpected, however, because the herbicide, Tordon 22K, although most injurious to certain plant families, is still a broadleaf herbicide. Based on three field seasons of post-treatment data, total relative forb cover declined for the first two field seasons after treatment, reaching its lowest point in summer 1998. By the third season, it was no longer significantly different from the control plot and was returning to pre-treatment levels (Figure 4-10). Non-native relative forb cover was eliminated from the treatment plot during 1998, the second growing season after treatment, but began to return again in 1999 (Figure 4-12). Diffuse

knapweed relative cover accounted for less than half of the returning non-native forb cover in 1999 and was itself less than one percent of the total relative cover at the treatment plot (Table 4-6).

Native relative forb cover dropped initially after the herbicide application and reached its lowest point during the summer of the second season after treatment. In the third season, native relative forb cover was no longer significantly different from the control plot and was returning to pre-treatment levels (Figure 4-11). Native relative forb cover is still below initial pre-treatment levels, and continued monitoring will determine how long it takes for native forb cover to fully return to pre-treatment levels. This is important because it is not desirable to re-treat the area with a broadleaf herbicide if the native forb component of the community cannot return to its former level of abundance. Repeated broadcast applications of a broad-spectrum herbicide without appropriate time for the native forbs to rebound could potentially stress them to the point of elimination from the grassland, an undesirable result. A broadcast application of a more species-specific herbicide such as Transline, which controls diffuse knapweed very effectively, with little impact to other species, might be useful as a follow-up a few years after a Tordon 22K application. One drawback to Transline, however, is its lack of a multi-year residual effect. Therefore, it would require annual retreatment to remain effective. The feasibility of using selective wick applications and/or hand control to maintain low diffuse knapweed densities after a broadcast, broad-spectrum application will be evaluated for FY2000 at some locations where aerial herbicide applications were used in 1999. This approach may provide another alternative to extend the effectiveness of the Tordon 22K application.

The loss of absolute and relative forb cover in the treatment plot did not cause a loss of overall foliar cover—as mentioned above, the total foliar cover in the treatment plot paralleled the response in the control plot. The loss of relative forb cover was offset by an increase in relative graminoid cover in response to reduced competition from forb species (Figure 4-17). The increase in relative graminoid cover in the treatment plot began after the herbicide application and continued throughout 1999, three growing seasons after the herbicide treatment (Figure 4-17). The response of the warm-season grasses to the herbicide application was an increase in relative cover, which was most pronounced immediately after the treatment (Figure 4-15), although the changes were not statistically significant. This effect was most likely due to the timing of the herbicide application, which having been conducted in mid-June, would have reduced the competition of forbs for much of the rest of the growing season, thus giving the warm-season species the greatest benefit. The cool-season graminoid response was delayed until the following season, when it was able to take advantage of the reduced forb competition and showed increases as well (Figure 4-16), some of which were significant. By 1999, however, it was apparent that much of the graminoid response in the treatment plot was returning to normal. The cool-season graminoids had returned to the level of the control plot in summer 1999, and the warm-season species had returned to the control plot level in spring 1999. The warm-season increase to a level above that of the control plot in summer 1999 is most likely due to the higher precipitation during summer 1999 and the continued reduced forb competition. Monitoring during 2000 will confirm

whether the overall graminoid cover returns to pre-treatment levels and remains essentially equal to that of the control plot.

Data from the Site are consistent with data from other studies that have shown an initial decline of species diversity, loss of forb and weed cover, and increase in graminoid vigor and cover after spraying with Tordon 22K. Rice and Toney (1996) reported decreases in forb cover due to herbicide treatments on native prairie in Montana. They reported that these responses were transitory, however, and that forb values returned to pre-treatment levels after about three years. Rice et al. (1997) found that species diversity also declined after spraying with Tordon 22K, but recovered after 2–3 years. Both of these studies also indicated that, as a result of lost weed and forb cover (i.e., reduced competition), the graminoid component of the community responded vigorously. In the Lolo National Forest in Montana, Henry (1998) reported that two years after spraying with Tordon 22K, a mountain grassland community had a 95 percent reduction in weed biomass and an 86 percent decrease in forb biomass. Associated with this was a 714 percent increase in grass biomass.

The only substantial difference between data from the Site and data from the Montana studies is that in Montana, the native plant communities had recovery times of 2–3 years (Rice and Toney,1996; Rice et al., 1997), while some measures at the Site have not returned to pre-treatment levels on a numerical basis (although most measures in the treatment plot are no longer statistically different from those in the control plot). Continued monitoring will document the time needed for complete recovery under the conditions present in the xeric tallgrass prairie at the Site. This information will be useful for developing improved weed control strategies and provide for better long-term management of the Site's grassland communities.

## 4.6 Conclusions

Application of Tordon 22K on the xeric tallgrass prairie at the Site continues to provide good control of diffuse knapweed, the primary target species, three years after herbicide treatment. In the treatment plot, initial declines in species richness were transitory, and no changes in overall foliar cover were observed. Although species diversity, overall forb cover, native forb cover, and non-native forb cover declined initially in the treatment plot as a result of the herbicide application, these measures were reversed in 1999. No longer statistically different from the control plot, they are returning to near pre-treatment levels. Reduced competition from forbs has improved the vigor and cover of the graminoid species. The results at the Site are consistent with previous studies that examined the effect of Tordon 22K on grassland communities. Continued monitoring in 2000 will provide additional information for management of the grassland communities at the Site.

## 4.7 References


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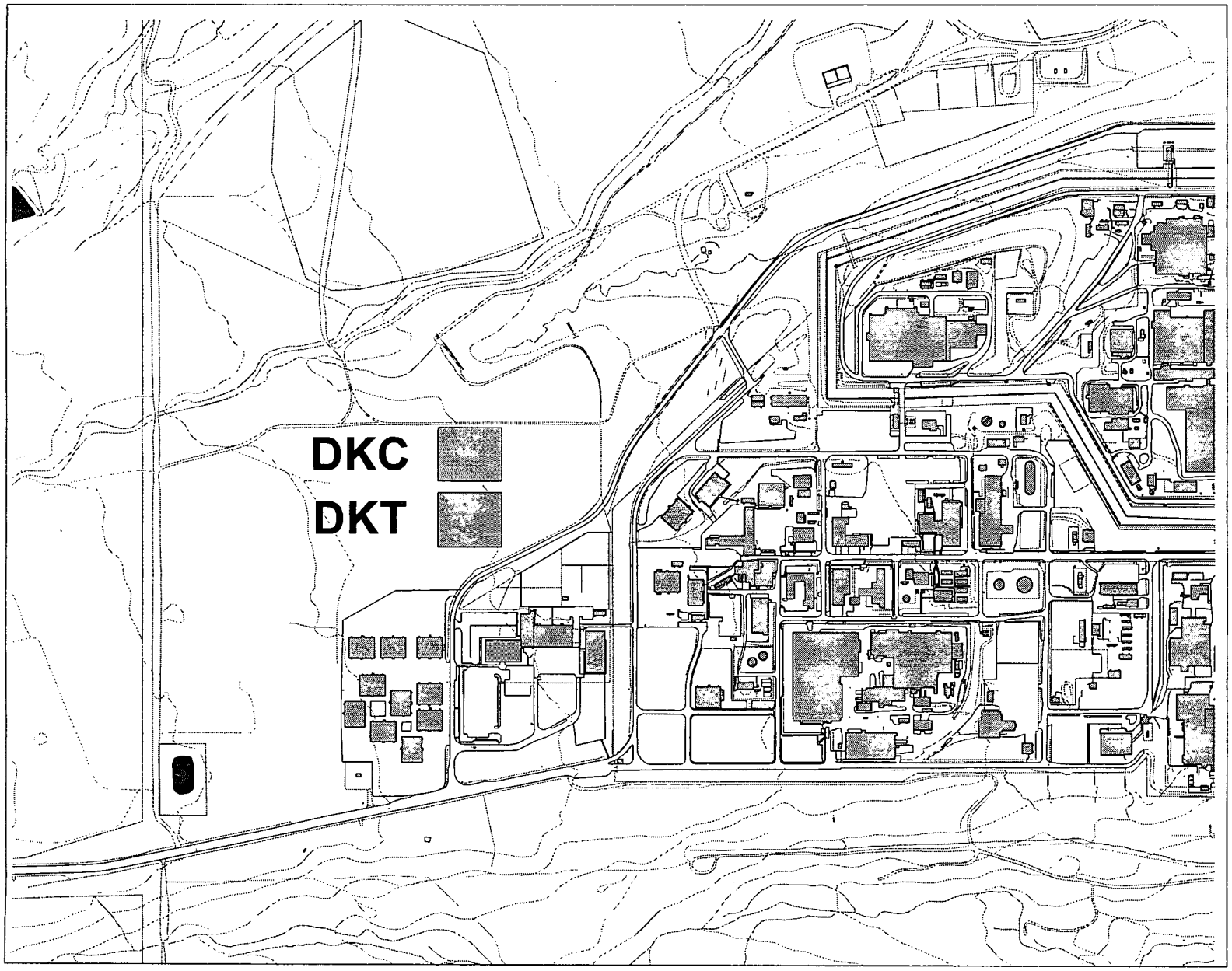
# Figures




# Diffuse Knapweed Herbicide Monitoring Plot Locations

Figure 4-1

MAP LEGEND

- Control Plot
- Treatment Plot

Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
Permanent vegetation monitoring locations provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial flyover data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Note:

Monitoring locations are approximate. Permanent transects endpoints are marked with rebar

N

1:6961

500 0 500 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology S

Prepared by: Exponent™

For: Kaiser-Hill Company, LL

MAP ID: K2-0038

March 14, 2000

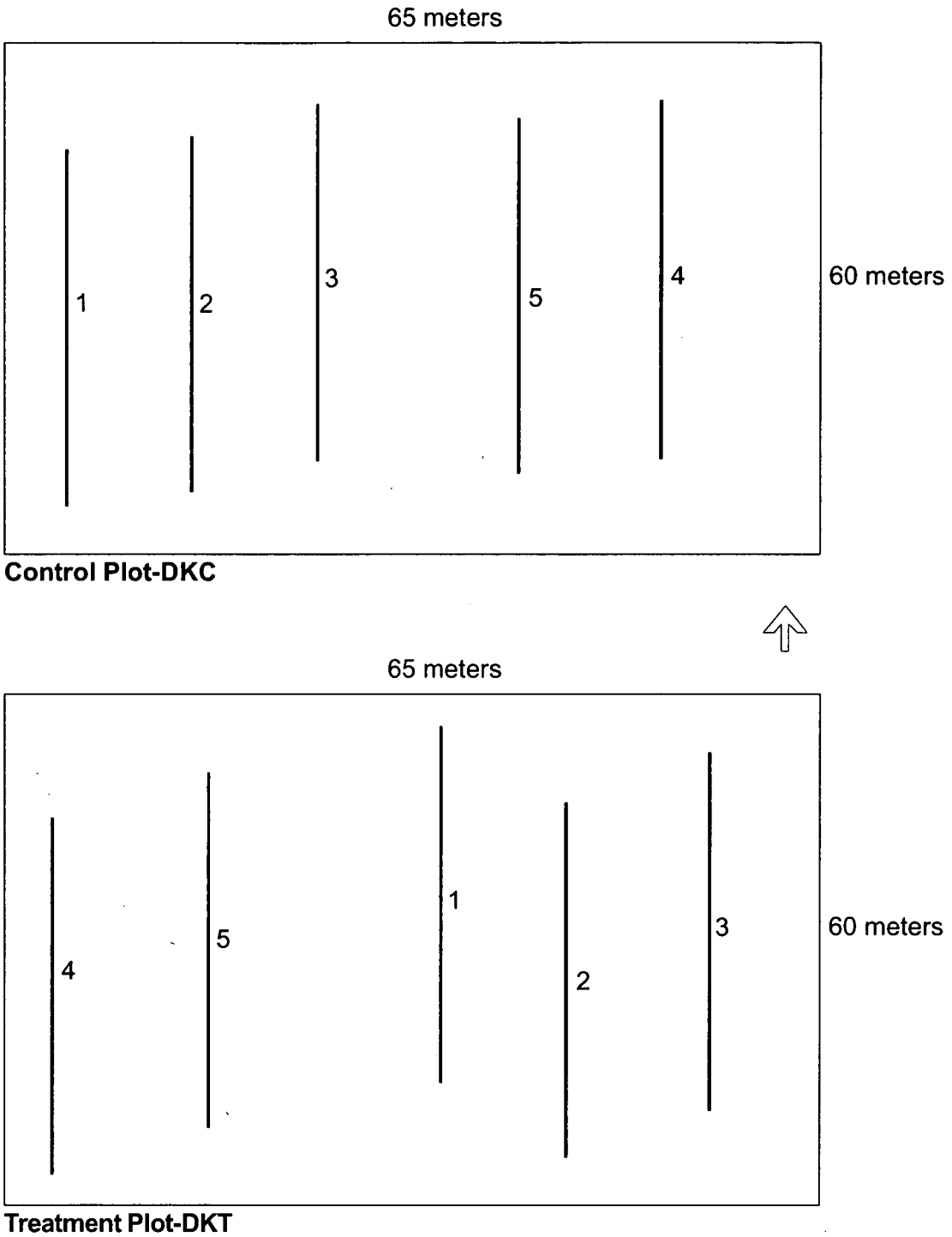



Figure 4-2. Diffuse knapweed monitoring plot and transect locations.

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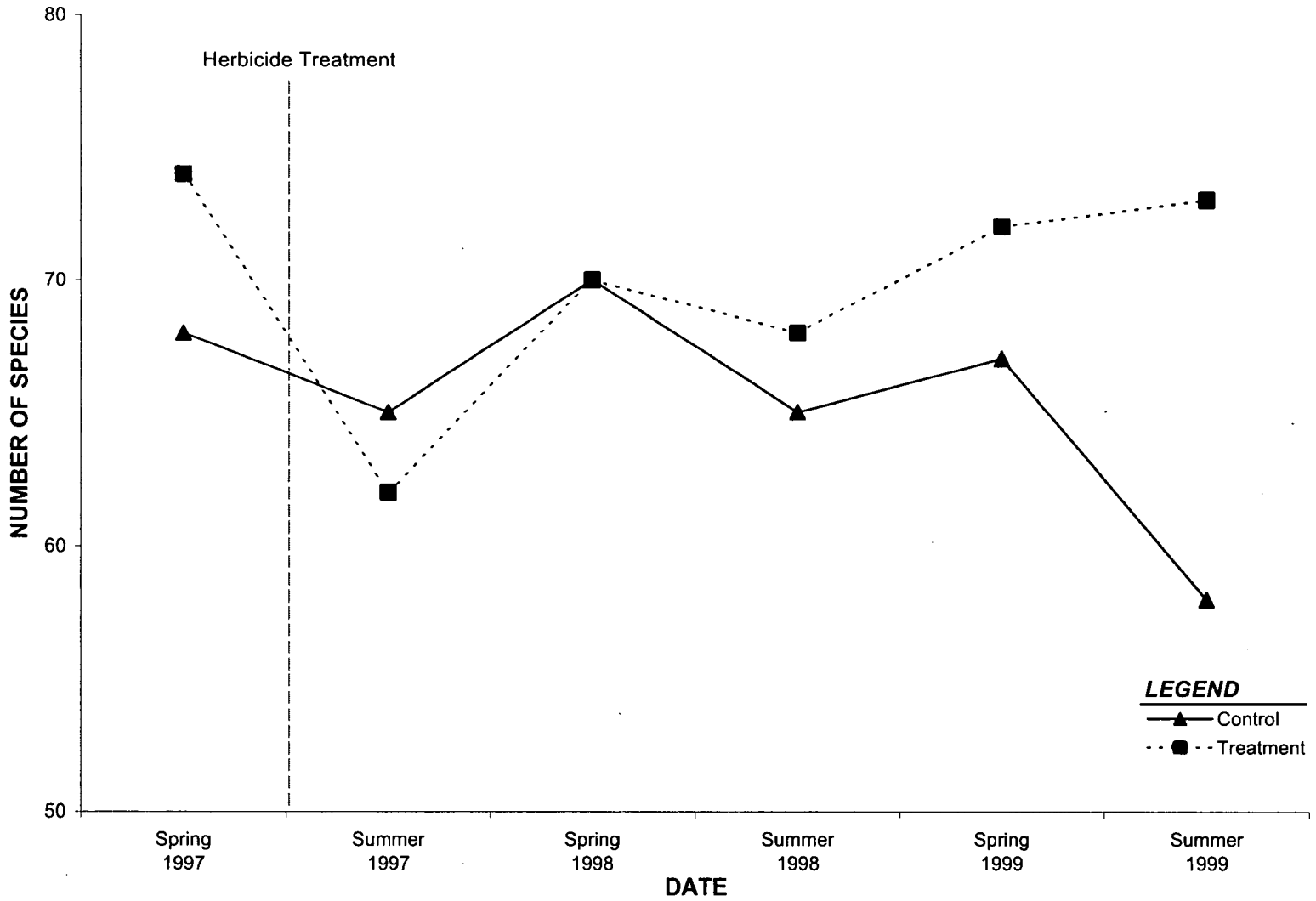


Figure 4-3. 1997-1999 species richness totals at the control and treatment plots by sampling event.

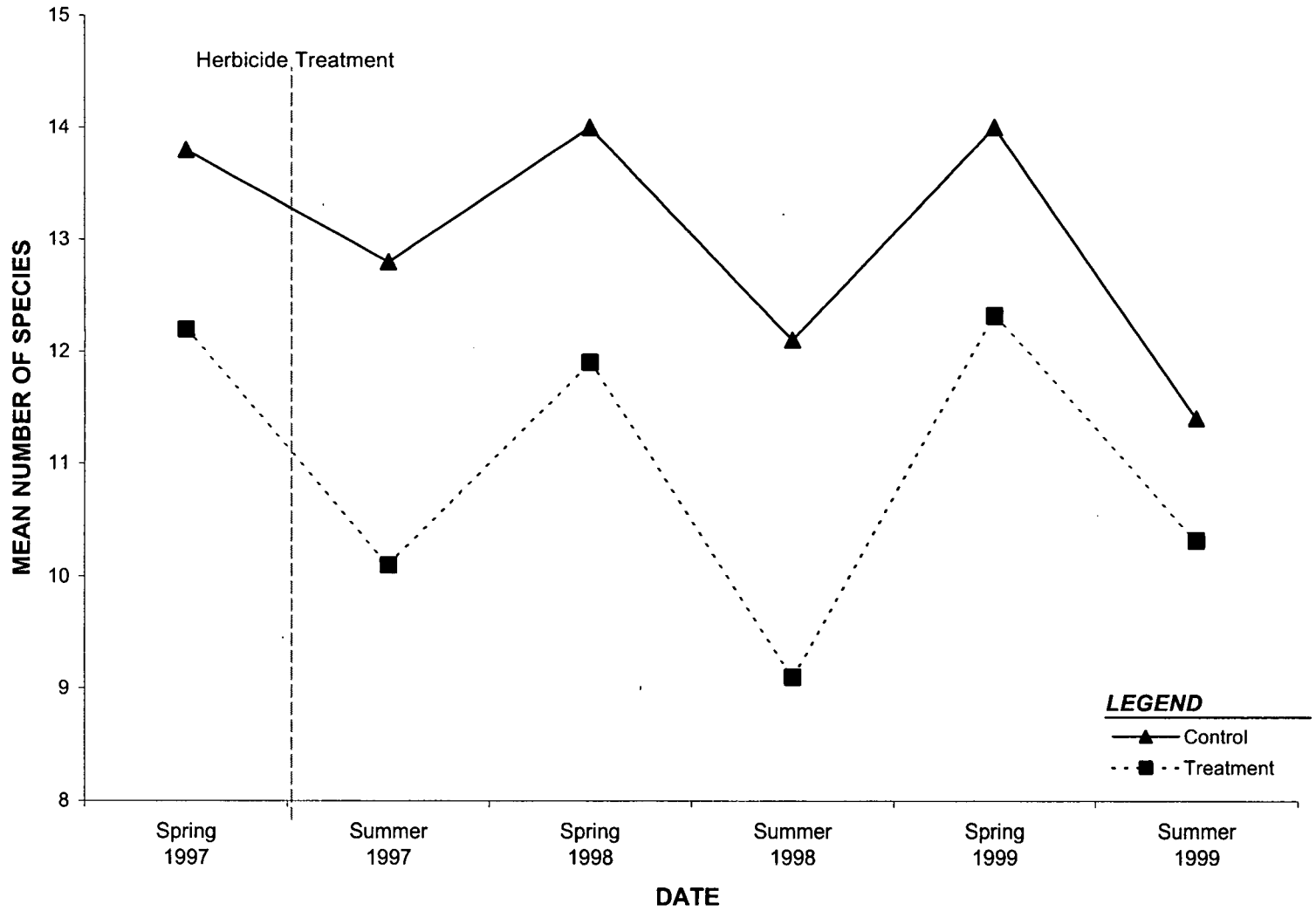


Figure 4-4. 1997-1999 mean number of species/quadrat at control and treatment plots by sampling event.

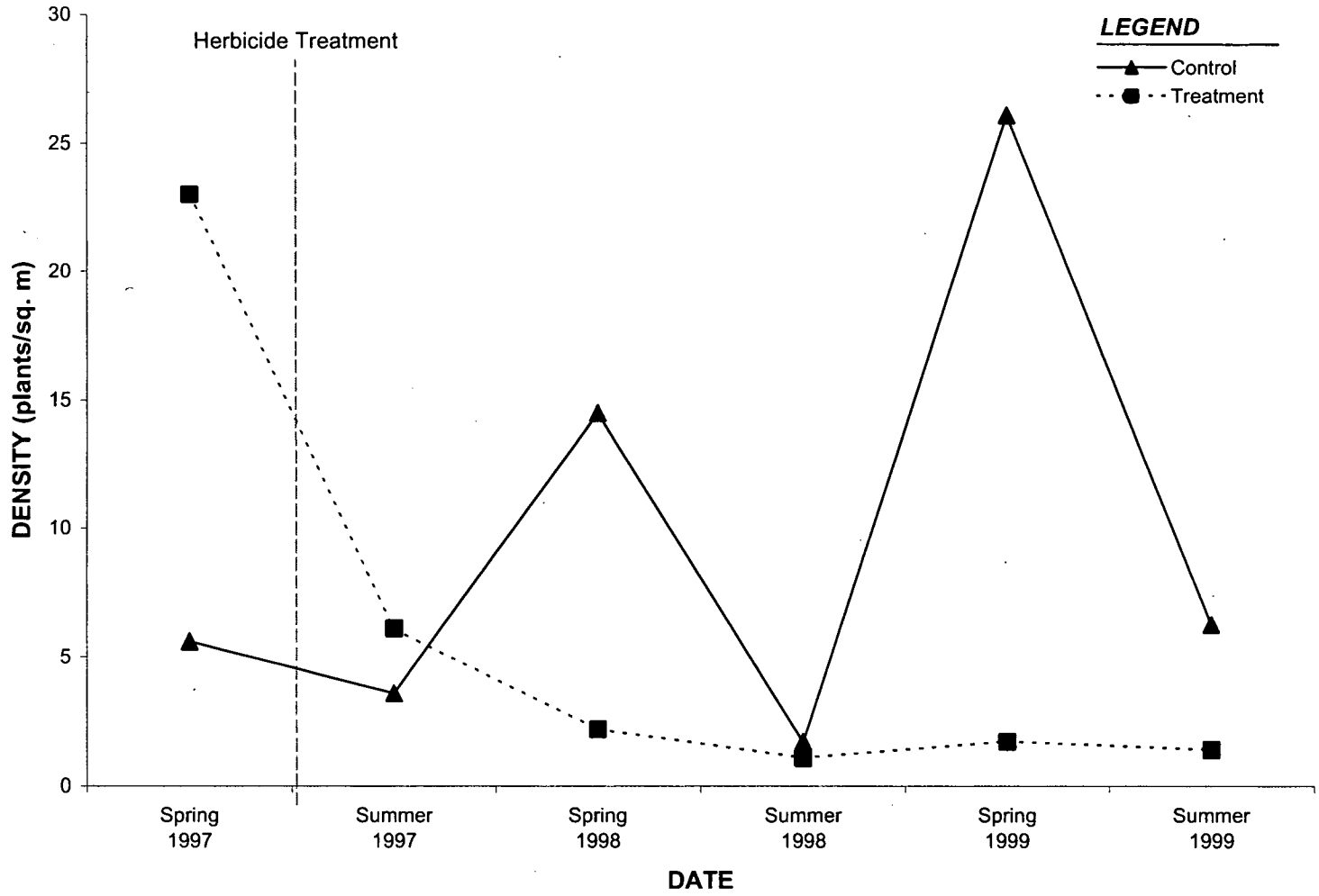


Figure 4-5. Diffuse knapweed densities at control and treatment plots by sampling event.

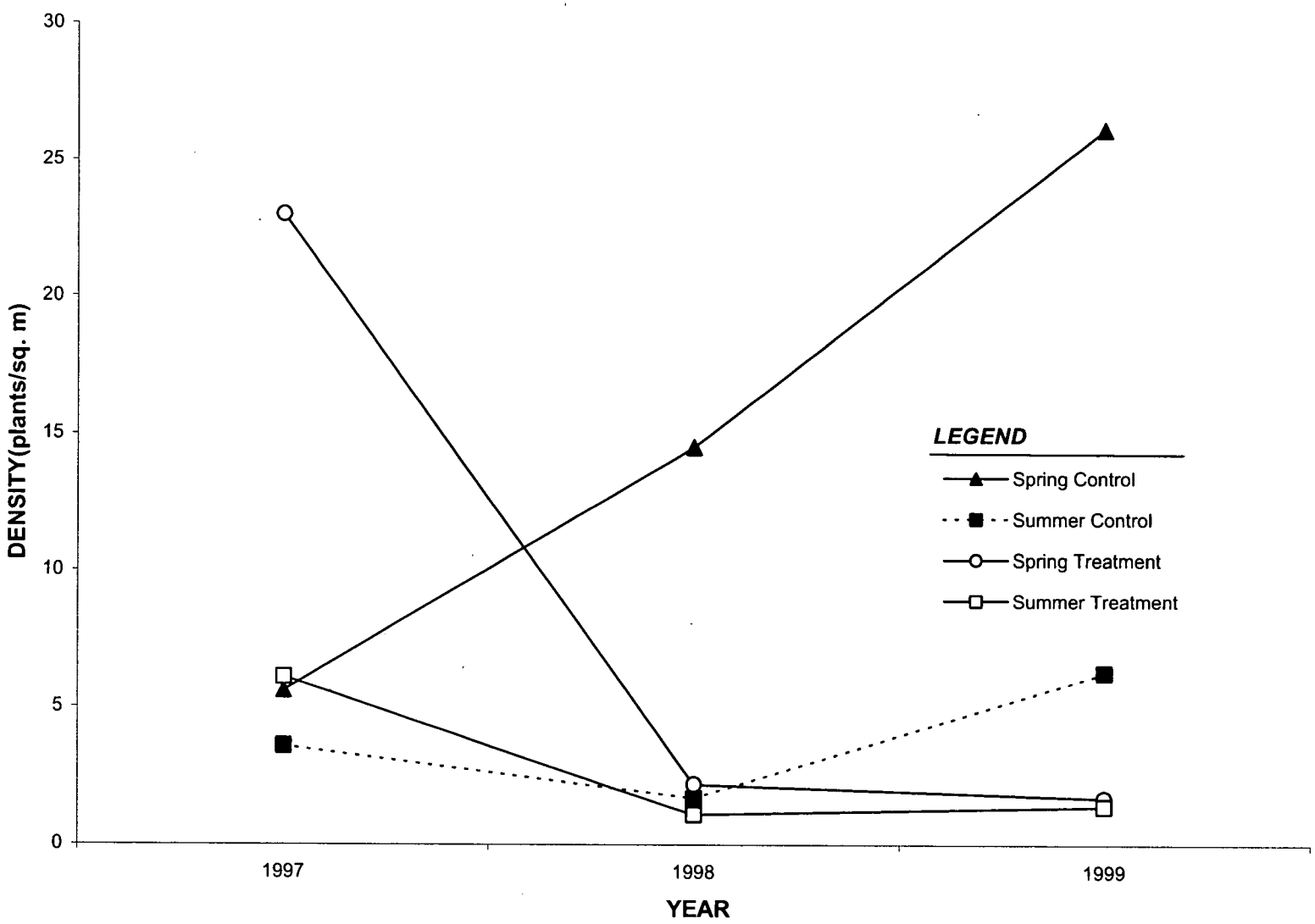


Figure 4-6. Diffuse knapweed densities at control and treatment plots by sampling event examined by season.

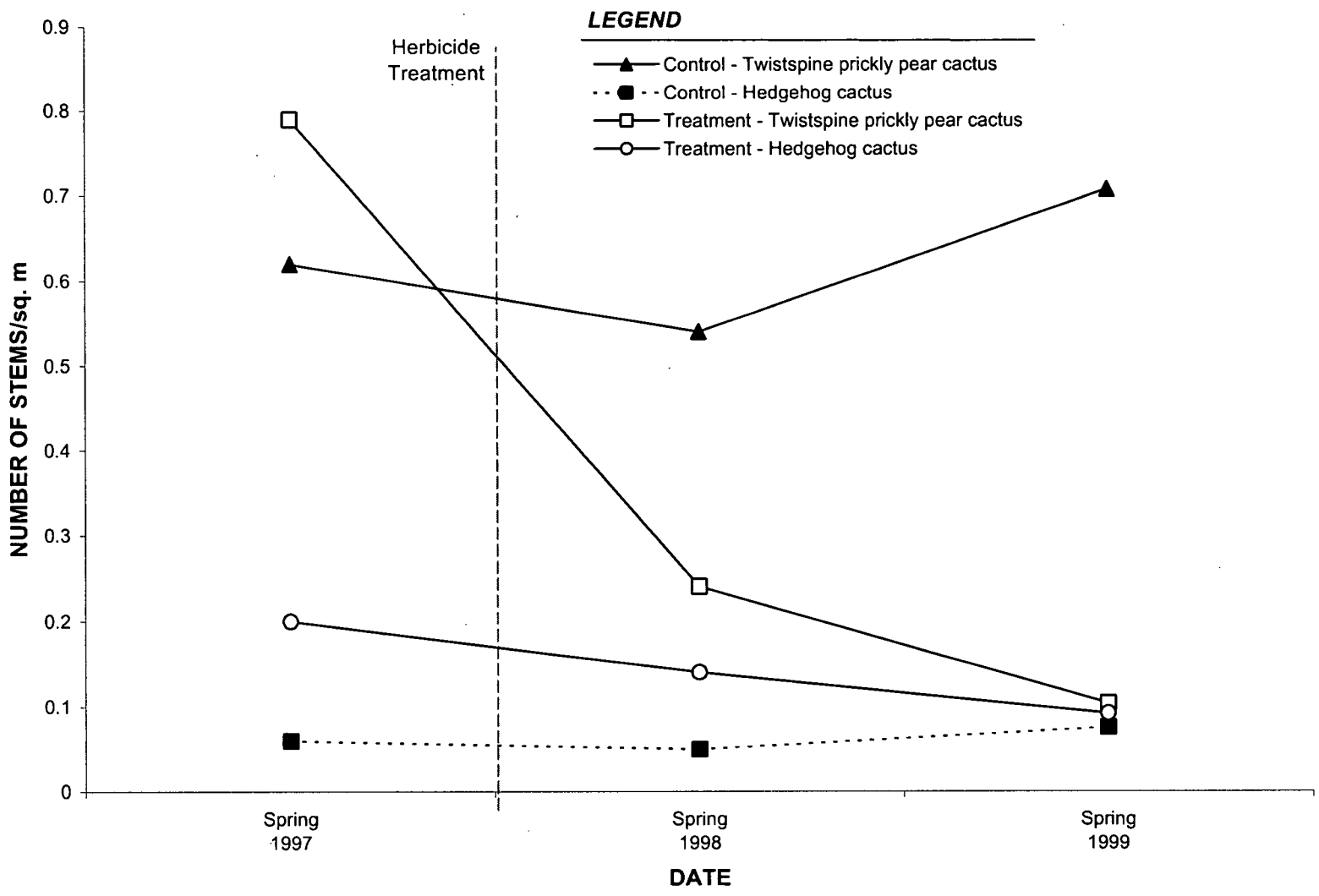


Figure 4-7. 1997-1999 cactus density response to herbicide treatment by sampling event.

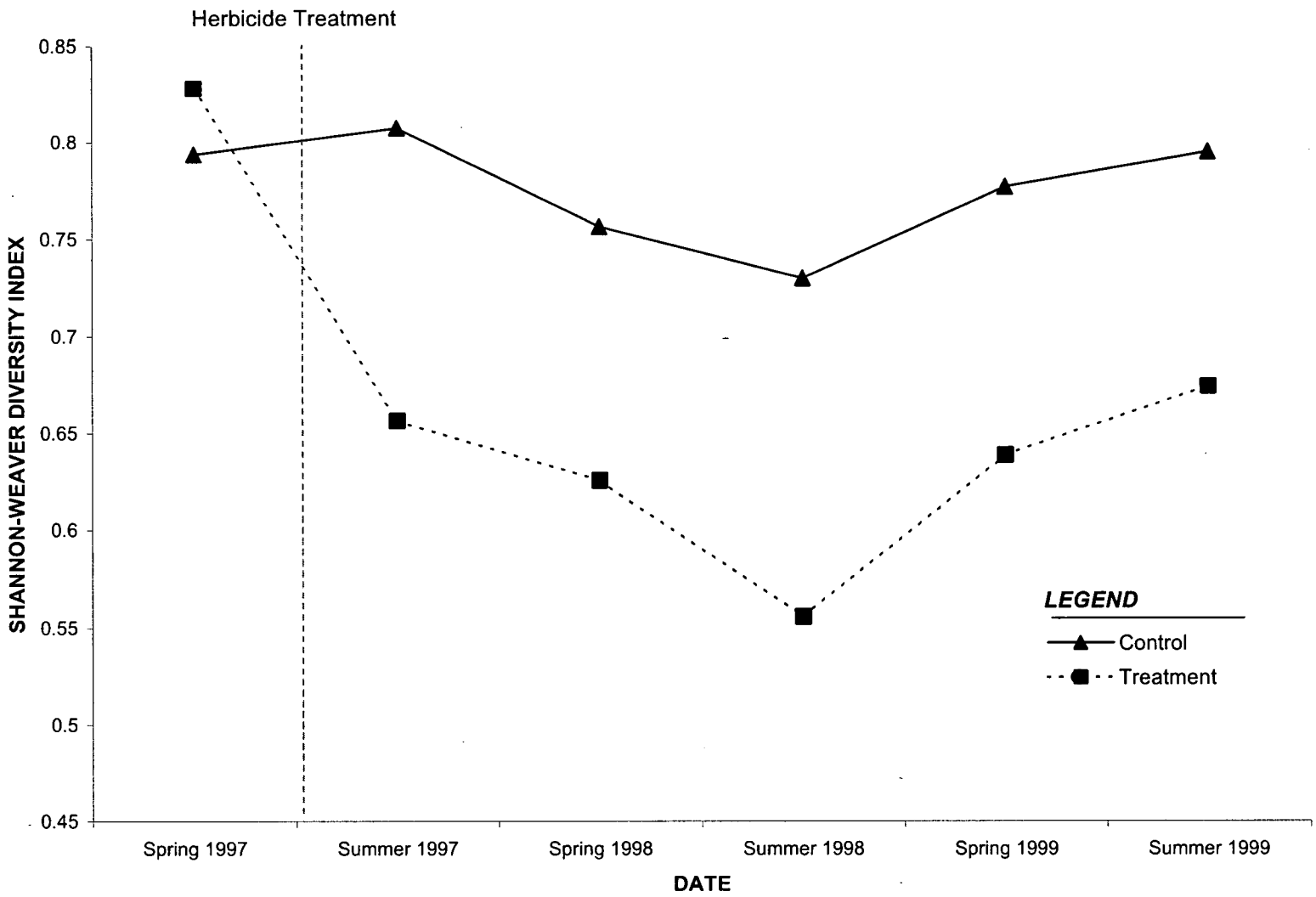


Figure 4-8. 1997-1999 Shannon-Weaver diversity indices at the control and treatment plots by sampling event.

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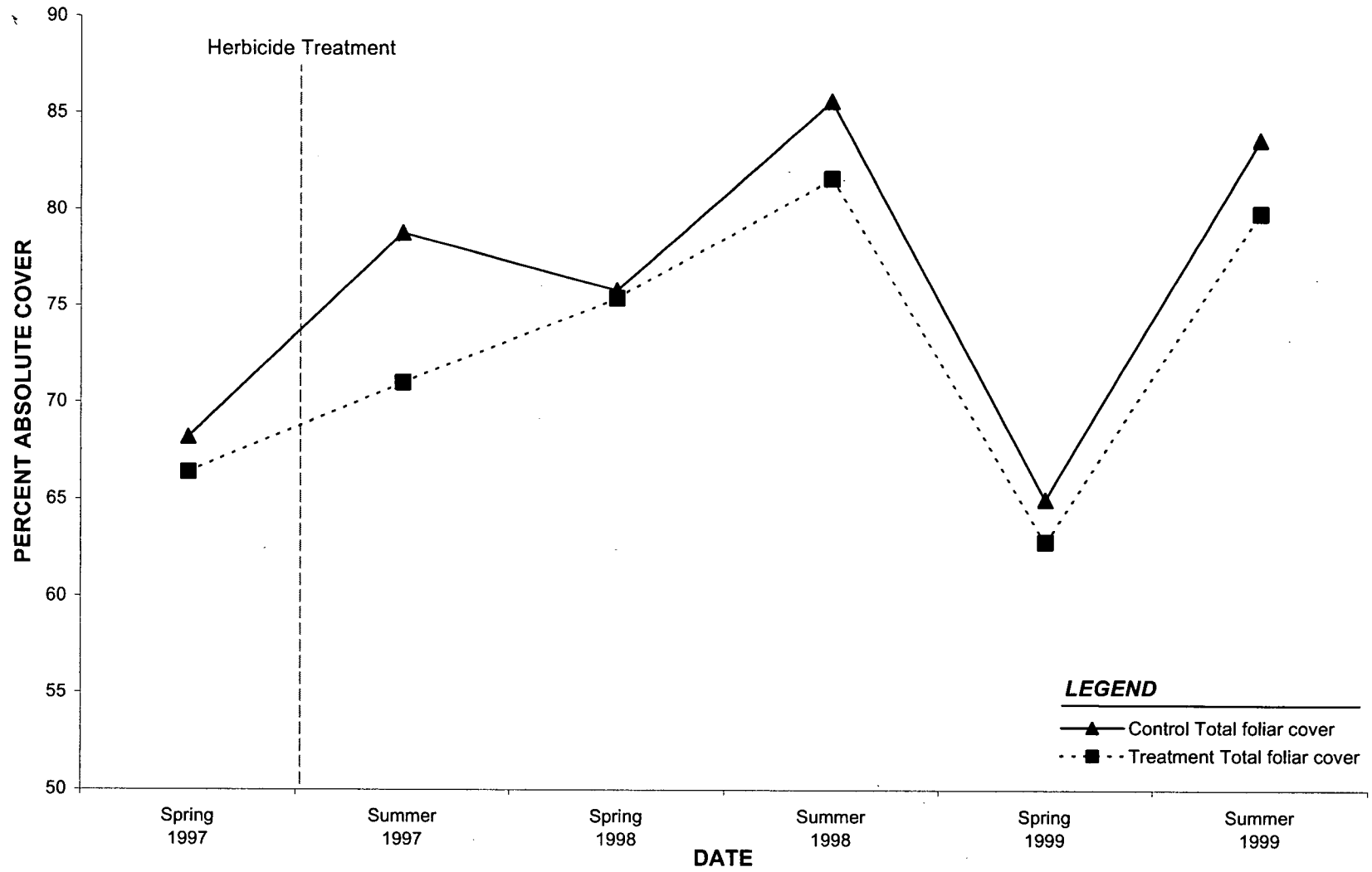


Figure 4-9. Total foliar vegetation cover at the control and treatment plots by sampling event.

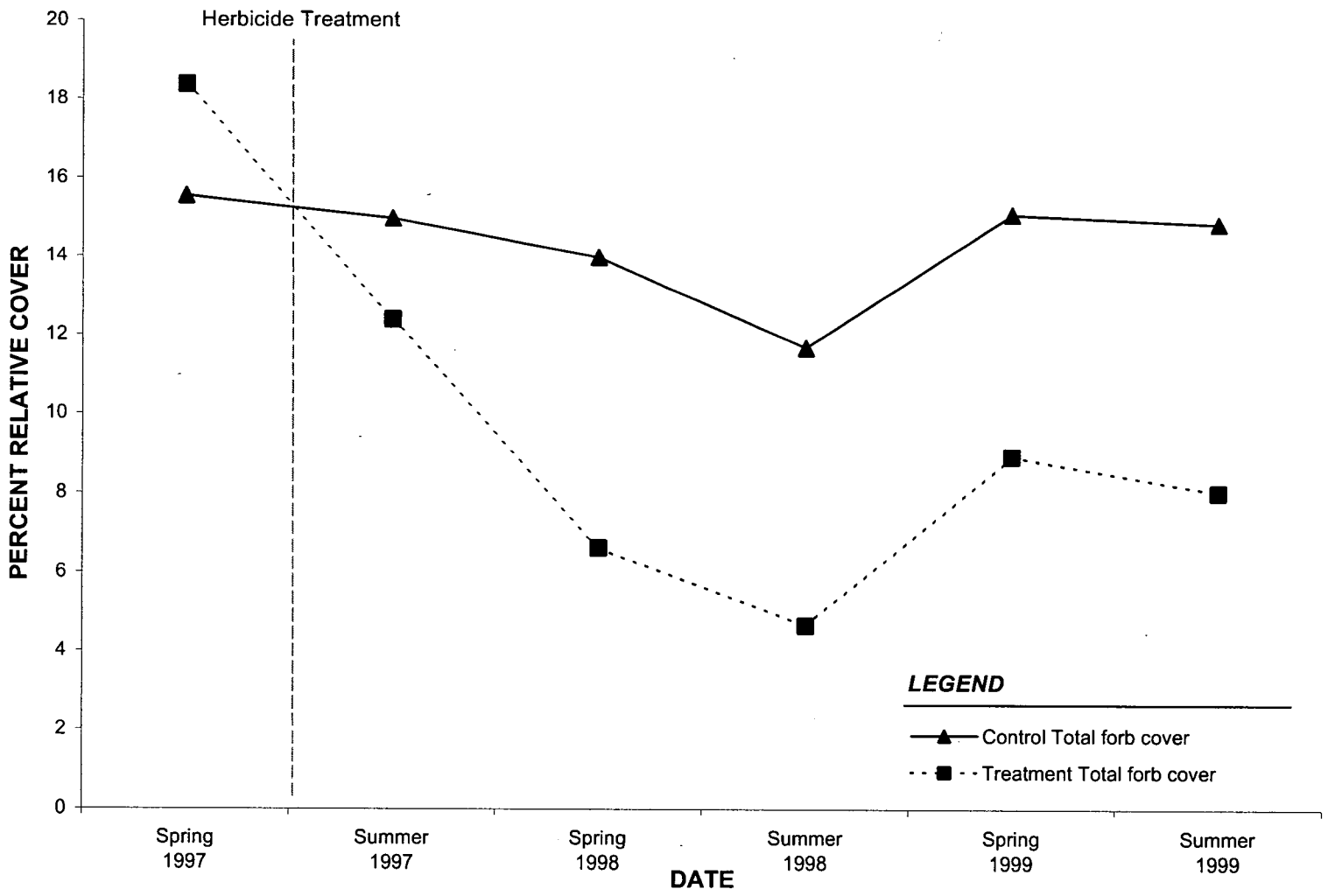


Figure 4-10. Total forb relative foliar cover at the control and treatment plots by sampling event.

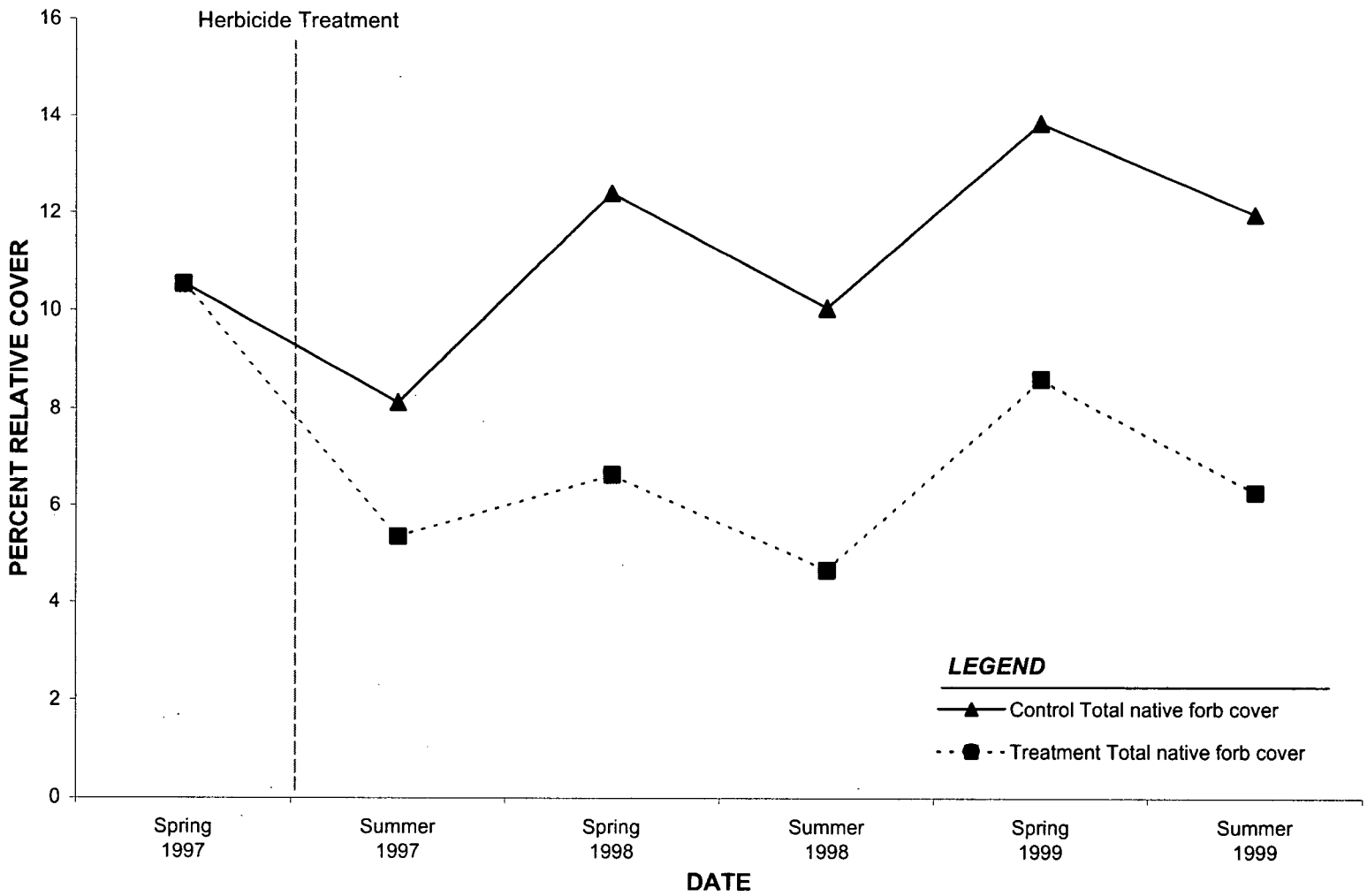


Figure 4-11. Total native forb relative foliar cover at the control and treatment plots by sampling event.

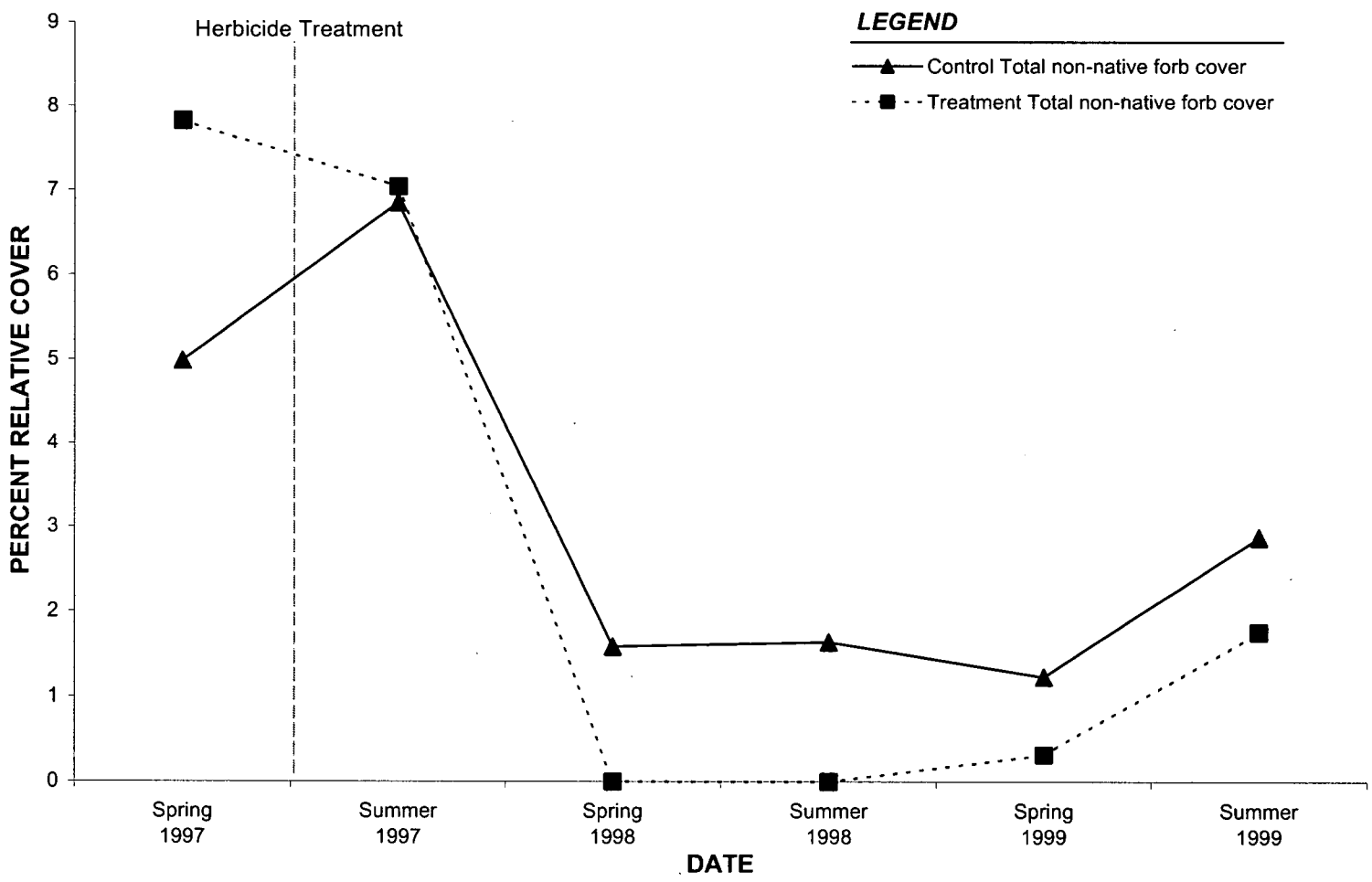


Figure 4-12. Total non-native forb relative foliar cover at the control and treatment plots by sampling event.

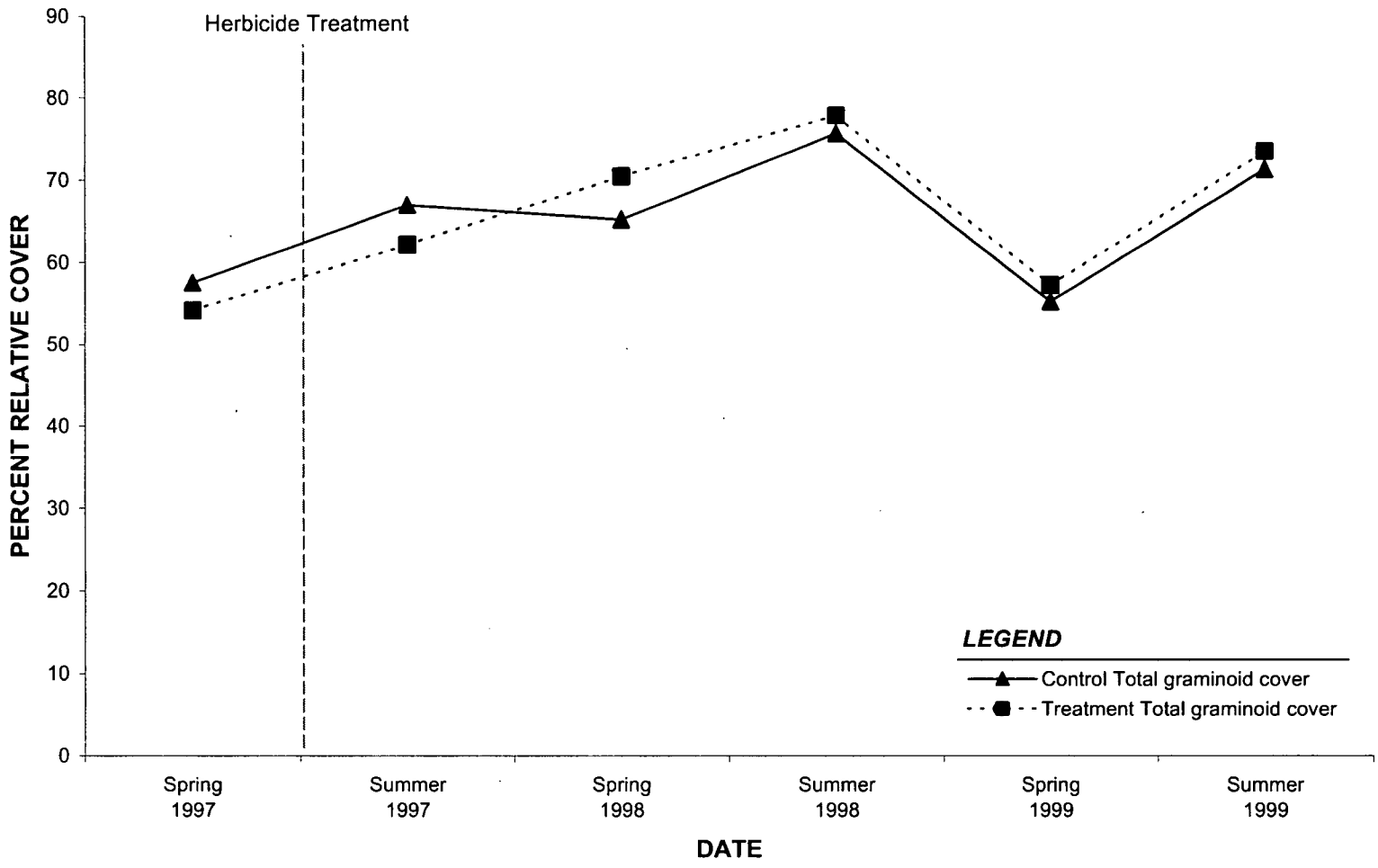


Figure 4-13. Total graminoid absolute foliar cover at the control and treatment plots by sampling event.

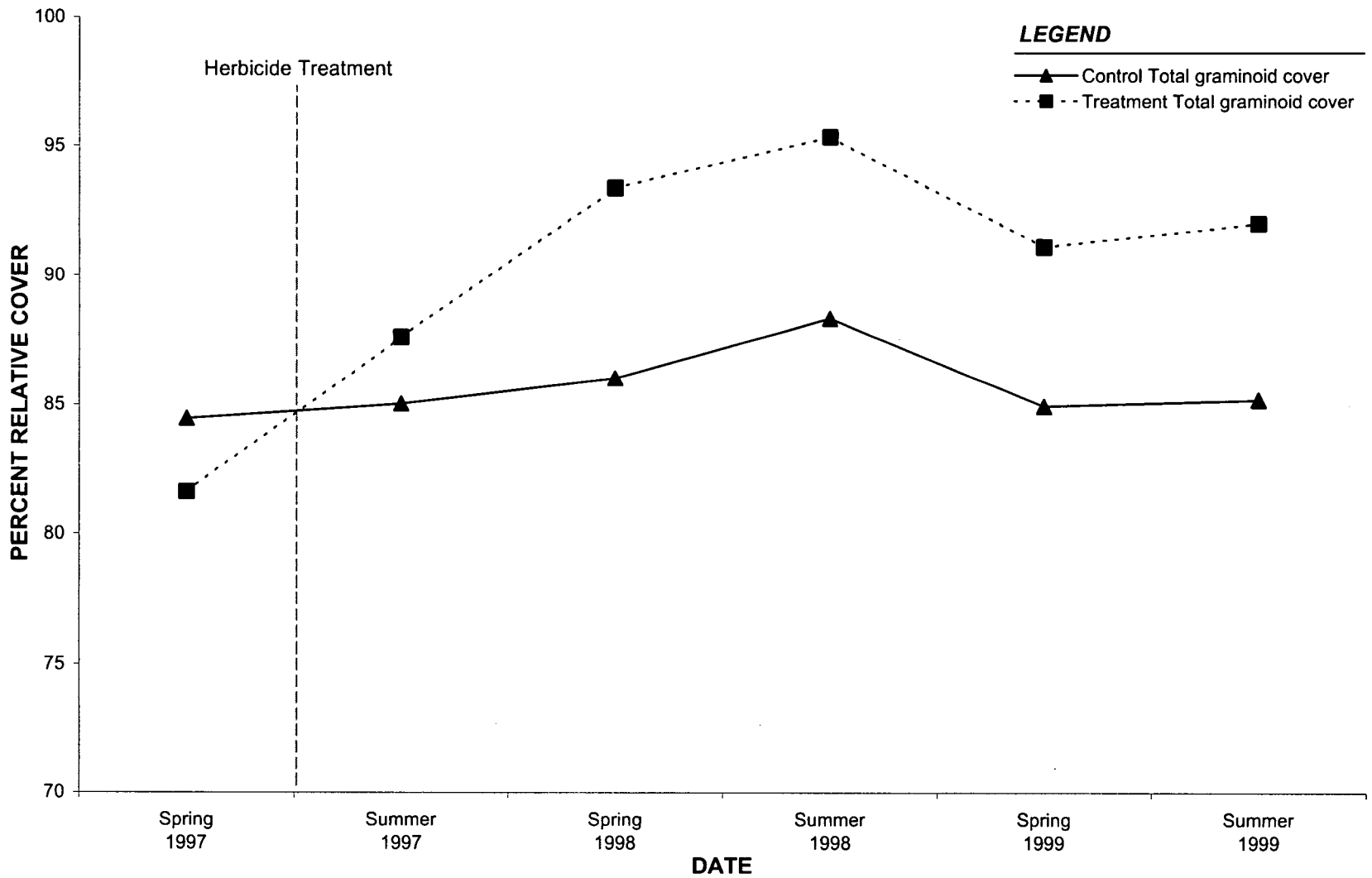


Figure 4-14. Total graminoid relative foliar cover at the control and treatment plots by sampling event.

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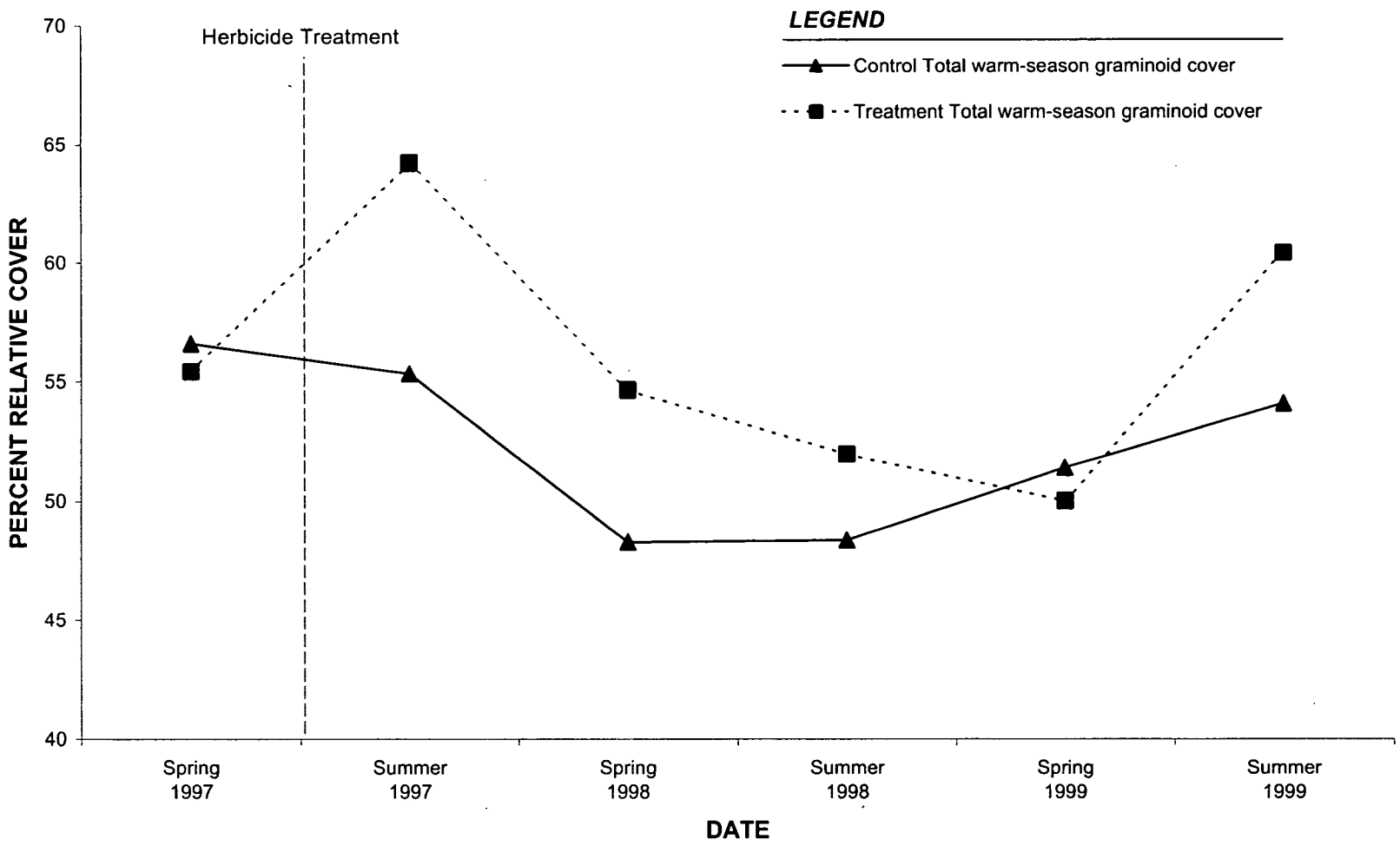


Figure 4-15. Total warm-season graminoid relative foliar cover at the control and treatment plots by sampling event.

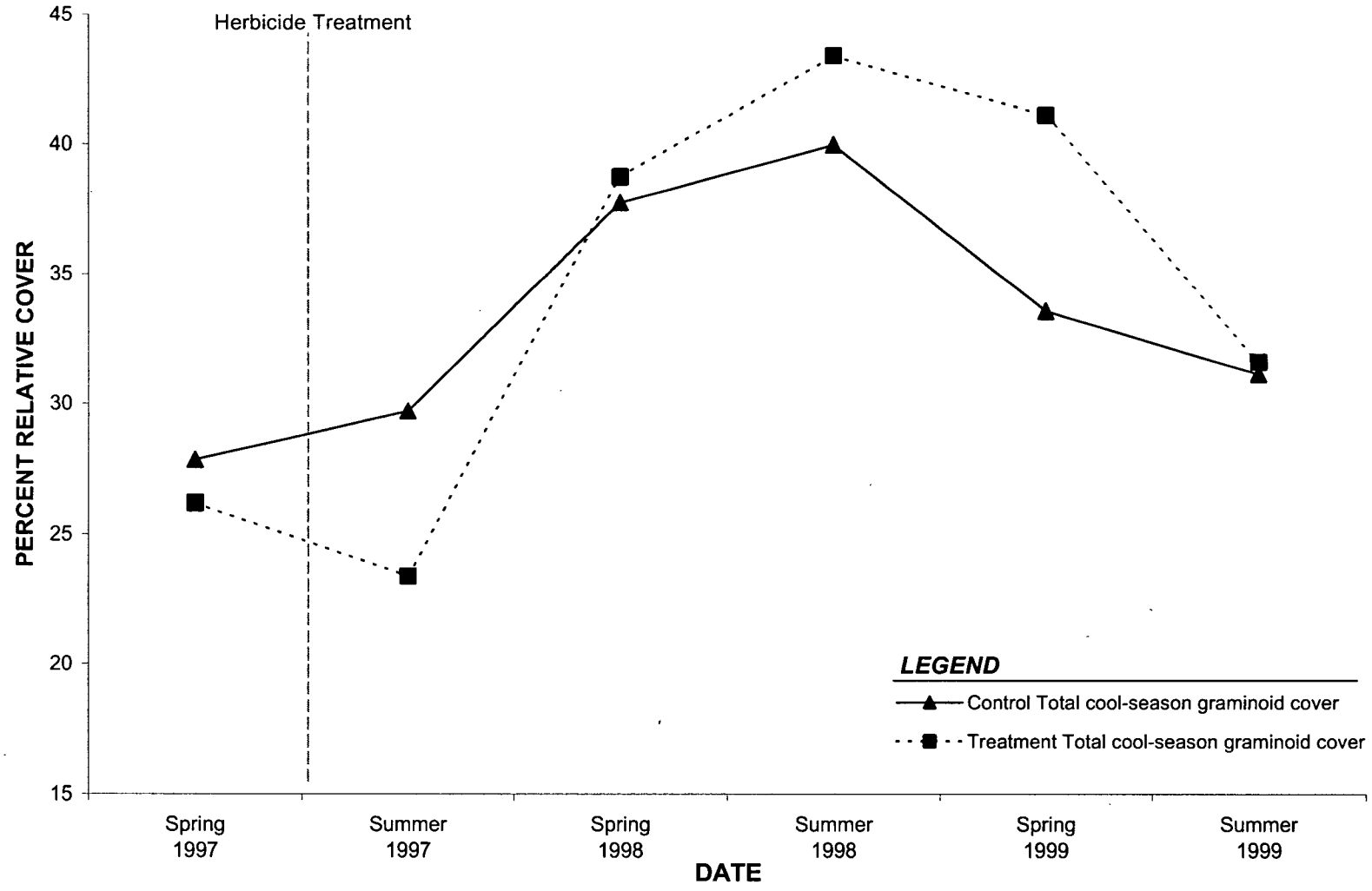


Figure 4-16. Total cool-season graminoid relative foliar cover at the control and treatment plots by sampling event.

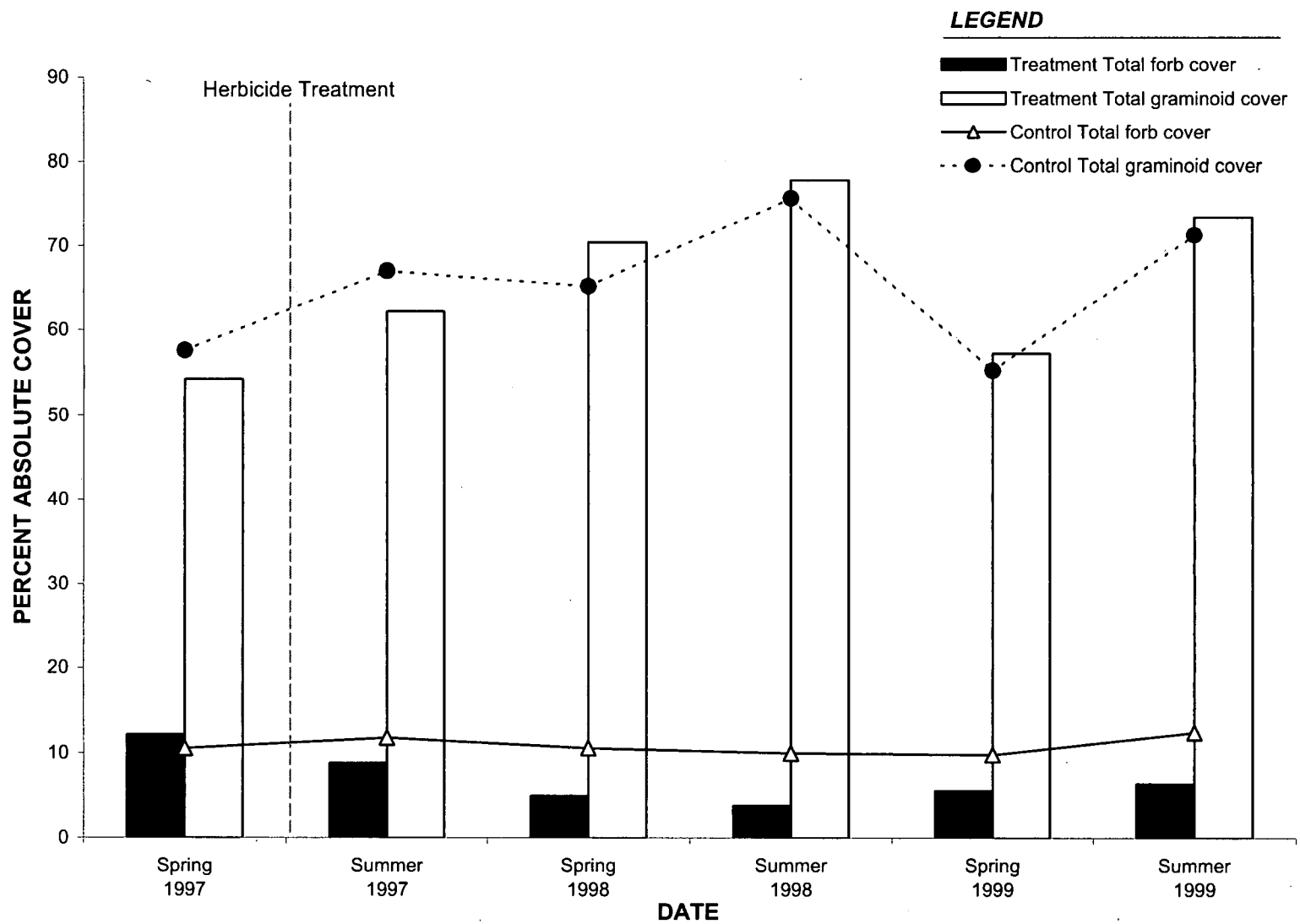


Figure 4-17. 1997-1999 Control and treatment plot graminoid and forb absolute foliar cover hanges.

# Tables

**Table 4-1. 1997-1999 Diffuse Knapweed Herbicide Monitoring Data Summary**

| | DKC - Control | | | | | | DKT - Treatment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variables** | **Spring97** | **Summer97** | **Spring98** | **Summer98** | **Spring99** | **Summer99** | **Spring97** | **Summer97** | **Spring98** | **Summer98** | **Spring99** | **Summer99** |
| **Species Richness** | | | | | | | | | | | | |
| # plant families | 18.0 | 18.0 | 19.0 | 18.0 | 20.0 | 16.0 | 20.0 | 17.0 | 21.0 | 20.0 | 22.0 | 22.0 |
| # species | 68.0 | 65.0 | 70.0 | 65.0 | 67.0 | 58.0 | 74.0 | 62.0 | 70.0 | 68.0 | 72.0 | 73.0 |
| % natives | 75.0 | 74.0 | 74.0 | 77.0 | 76.0 | 76.0 | 73.0 | 77.0 | 77.0 | 79.0 | 75.0 | 76.0 |
| mean # species/quadrat | 13.8 | 12.8 | 14.0 | 12.1 | 14.0 | 11.4 | 12.2 | 10.1 | 11.9 | 9.1 | 12.3 | 10.3 |
| | | | | | | | | | | | | |
| **Mean Percent Cover** | | | | | | | | | | | | |
| total basal vegetation cover | 10.8 | 8.0 | 11.2 | 9.2 | 10.4 | 9.6 | 10.8 | 10.2 | 10.2 | 8.8 | 8.8 | 9.4 |
| rock cover | 12.8 | 12.0 | 10.2 | 10.8 | 13.4 | 9.0 | 19.8 | 17.4 | 18.2 | 17.2 | 17.6 | 19.2 |
| bare ground cover | 11.6 | 4.0 | 3.0 | 2.2 | 5.8 | 2.6 | 9.0 | 5.4 | 2.6 | 3.0 | 4.0 | 3.2 |
| litter cover | 64.8 | 76.0 | 75.6 | 77.8 | 70.4 | 78.8 | 60.4 | 67.0 | 69.0 | 71.0 | 69.6 | 68.2 |
| | | | | | | | | | | | | |
| **Weed Densities (mean # stems/m2)** | | | | | | | | | | | | |
| Diffuse knapweed | 5.6 | 3.6 | 14.5 | 1.7 | 26.1 | 6.2 | 23.0 | 6.1 | 2.2 | 1.1 | 1.7 | 1.4 |
| Curly-top gumweed | 1.7 | 1.3 | 7.4 | 1.3 | 0.8 | 0.8 | 1.4 | 1.2 | 0.7 | 0.0 | 0.2 | 0.1 |
| St. John's-wort | 0.8 | 1.3 | 1.0 | 0.3 | 0.5 | 0.2 | 0.6 | 0.3 | 2.7 | 0.2 | 2.5 | 0.4 |
| | | | | | | | | | | | | |
| **Weed Frequencies (%)** | | | | | | | | | | | | |
| Diffuse knapweed | 76.0 | 76.0 | 76.0 | 60.0 | 96.0 | 64.0 | 80.0 | 60.0 | 52.0 | 20.0 | 44.0 | 44.0 |
| Curly-top gumweed | 56.0 | 48.0 | 68.0 | 40.0 | 40.0 | 32.0 | 20.0 | 16.0 | 12.0 | 0.0 | 12.0 | 4.0 |
| St. John's-wort | 52.0 | 64.0 | 44.0 | 16.0 | 24.0 | 16.0 | 16.0 | 8.0 | 72.0 | 12.0 | 36.0 | 24.0 |
| | | | | | | | | | | | | |
| **Cactus Densities (mean # stems/m2)** | | | | | | | | | | | | |
| Twistspine prickly pear cactus | 0.62 | | 0.54 | | 0.71 | | 0.79 | | 0.24 | | 0.10 | |
| Hedgehog cactus | 0.06 | | 0.05 | | 0.08 | | 0.20 | | 0.14 | | 0.09 | |

**Table 4-2. 1997-1999 Diffuse Knapweed Herbicide Monitoring Species Richness Summary**

| | | | | DKC - Control | | | | | | DKT - Treatment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Native | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| APIACEAE | Lomatium orientale Coult. & Rose | LOOR1 | Y | X | X | X | X | X | | X | X | X | X | X | X |
| ASCLEPIADACEAE | Asclepias stenophylla A. Gray | ASST1 | Y | X | X | X | X | X | X | X | | | X | X | X |
| ASCLEPIADACEAE | Asclepias viridiflora Raf. | ASVI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | ACMI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Ambrosia psilostachya DC. | AMPS1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Antennaria parvifolia Nutt. | ANPA1 | Y | X | X | X | | X | X | X | X | X | X | X | X |
| ASTERACEAE | Amica fulgens Pursh. | ARFU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem. | ARCA1 | Y | X | X | | X | | | X | X | X | | | |
| ASTERACEAE | Artemisia frigida Willd. | ARFR1 | Y | | | | | | | X | | | | | |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Aster porteri Gray | ASPO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | CANU1 | N | X | X | X | X | | | X | | | | | X |
| ASTERACEAE | Centaurea diffusa Lam. | CEDI1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Chrysopsis fulcrata Greene | CHFU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Chrysopsis villosa Pursh. | CHVI1 | Y | | | X | X | | | | | X | X | | |
| ASTERACEAE | Cirsium arvense (L.) Scop. | CIAR1 | N | | | | | | | X | | X | | X | |
| ASTERACEAE | Conyza canadensis (L.) Cronq. | COCA1 | Y | | | | | | | | | | | | X |
| ASTERACEAE | Erigeron divergens T. & G. | ERDI1 | Y | | | | X | X | | X | X | | X | X | |
| ASTERACEAE | Erigeron flagellaris A. Gray | ERFL1 | Y | X | X | X | X | | X | X | X | X | | | |
| ASTERACEAE | Gaillardia aristata Pursh. | GAAR1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Lactuca serriola L. | LASE1 | N | X | X | X | X | X | X | X | X | | X | X | X |
| ASTERACEAE | Liatris punctata Hook. | LIPU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Microseris cuspidata (Pursh.) Sch. Bip. | MICU1 | Y | X | | X | | X | | X | | X | | X | |
| ASTERACEAE | Scorzonera laciniata L. | SCLA1 | N | X | X | X | | X | | X | X | | | | |
| ASTERACEAE | Senecio plattensis Nutt. | SEPL1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Senecio spartioides T. & G. | SESP1 | Y | | | | | | | | X | | X | X | X |
| ASTERACEAE | Solidago mollis Bart. | SOMO1 | Y | X | X | X | X | X | X | X | X | X | X | | X |
| ASTERACEAE | Solidago rigida L. | SORI1 | Y | | X | X | X | X | X | | | | | | |
| ASTERACEAE | Taraxacum officinale Weber | TAOF1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Tragopogon dubius Scop. | TRDU1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| BORAGINACEAE | Lithospermum incisum Lehm. | LIIN1 | Y | X | X | X | | X | | | | | | | |
| BORAGINACEAE | Mertensia lanceolata (Pursh.) A. DC. | MELA1 | Y | | | X | | X | | X | | | | | |
| BRASSICACEAE | Alyssum alyssoides (L.) L. | ALAL1 | N | | | X | | | | X | | | | | |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | N | X | X | X | X | X. | X | X | X | X | X | X | X |
| BRASSICACEAE | Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins | ARHI1 | Y | | | X | X | | | X | X | | | X | X |
| BRASSICACEAE | Barbarea vulgaris R. Br. | BAVU1 | N | | | | | | | X | X | X | | X | X |
| BRASSICACEAE | Camelina microcarpa Andrz. ex DC. | CAMI1 | N | X | X | X | X | X | X | X | | X | X | X | X |
| BRASSICACEAE | Draba reptans (Lam.) Fern. | DRRE1 | Y | X | X | X | | X | | | | | X | | |
| BRASSICACEAE | Erysimum capitatum (Nutt.) DC. | ERCA2 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | LECA1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| BRASSICACEAE | Lepidium densiflorum Schrad. | LEDE1 | Y | X | X | | | | | X | X | X | X | | X |
| BRASSICACEAE | Lesquerella montana (A. Gray) Wats. | LEMO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| BRASSICACEAE | Sisymbrium altissimum L. | SIAL1 | N | X | X | | | | | | | X | | X | X |
| CACTACEAE | Coryphantha missouriensis (Sweet) Britt. & Rose | COMI1 | Y | X | | | | X | | X | | | | | |
| CACTACEAE | Echinocereus viridiflorus Engelm. | ECVI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| CACTACEAE | Opuntia macrorhiza Engelm. | OPMA1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| CARYOPHYLLACEAE | Arenaria fendleri A. Gray | ARFE2 | Y | X | X | X | X | X | X | X | X | X | X | X | X |

Table 4-2. (cont.)

| | | | | DKC - Control | | | | | | DKT - Treatment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Native | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| CARYOPHYLLACEAE | Paronychia jamesii T. & G. | PAJA1 | Y | X | | | X | | | X | X | X | X | X | X |
| CARYOPHYLLACEAE | Silene antirrhina L. | SIAN1 | Y | X | X | X | | X | | X | X | X | X | X | X |
| CLUSIACEAE | Hypericum perforatum L. | HYPE1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| COMMELINACEAE | Tradescantia occidentalis (Britt.) Smyth | TROC1 | Y | X | | | | | | X | | X | X | X | X |
| CRASSULACEAE | Sedum lanceolatum Torr. | SELA1 | Y | | | | | | | X | X | X | X | X | X |
| CYPERACEAE | Carex heliophila Mack. | CAHE1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| CYPERACEAE | Eleocharis compressa Sulliv. | ELCO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| FABACEAE | Dalea purpurea Vent | DAPU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| FABACEAE | Medicago lupulina L. | MELU1 | N | | | | | | | X | | | | | |
| FABACEAE | Oxytropis lambertii Pursh. | OXLA1 | Y | X | | | | | X | | | | | | |
| FABACEAE | Psoralea tenuiflora Pursh. | PSTE1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| HYDROPHYLLACEAE | Phacelia heterophylla Pursh. | PHHE1 | Y | | | | | | | | X | X | X | X | X |
| JUNCACEAE | Juncus interior Wieg. | JUIN1 | Y | | X | X | X | X | X | | | X | X | X | X |
| LAMIACEAE | Hedeoma hispidum Pursh. | HEHI1 | Y | | | | | | | | | X | | | |
| LILIACEAE | Allium textile A. Nels. & Macbr. | ALTE1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| LILIACEAE | Leucocrinum montanum Nutt. | LEMO2 | Y | X | | X | | X | | | | | | | |
| ONAGRACEAE | Oenothera villosa Thunb. ssp. strigosa (Rydb.) Dietrich & Raven | OEVI1 | Y | X | X | X | X | X | X | | | | | X | X |
| OROBANCHACEAE | Orobanche fasciculata Nutt. | ORFA1 | Y | X | | | | X | | | X | X | X | X | |
| PLANTAGINACE | Plantago lanceolata L. | PLLA1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| PLANTAGINACE | Plantago patagonica Jacq. | PLPA1 | Y | | | | | | | X | | | | | |
| POACEAE | Agropyron smithii Rydb. | AGSM1 | Y | X | | | | | | | | X | | X | |
| POACEAE | Andropogon gerardii Vitman | ANGE1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Andropogon scoparius Michx. | ANSC1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | Y | | X | | | | X | | | | | | X |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | BOCU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bouteloua hirsuta Lag | BOHI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bromus inermis Leyss. ssp. inermis | BRIN1 | N | X | X | X | X | X | X | | | | | | |
| POACEAE | Bromus japonicus Thunb. ex Murr. | BRJA1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bromus tectorum L. | BRTE1 | N | | | | | | | X | X | X | X | X | X |
| POACEAE | Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | Y | | | | | | | X | X | | X | X | X |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | KOPY1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Muhlenbergia wrightii Vasey | MUWR1 | Y | | | | | | | | | X | X | X | |
| POACEAE | Panicum capillare L. | PACA1 | Y | | | | | | | | | | | | X |
| POACEAE | Poa compressa L. | POCO1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Poa pratensis L. | POPR1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | Y | X | X | | X | X | X | X | X | | X | X | X |
| POACEAE | Sorghastrum nutans (L.) Nash | SONU1 | Y | | X | X | X | | X | | X | X | X | | X |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Stipa comata Trin. & Rupr. | STCO1 | Y | | | | X | | X | | | X | | | |
| POLEMONIACEAE | Collomia linearis Nutt. | COLI1 | Y | | | | | | | X | | X | X | X | X |
| POLYGONACEAE | Eriogonum alatum Torr. | ERAL1 | Y | | | X | X | | | X | X | X | X | X | X |
| POLYGONACEAE | Polygonum arenastrum Jord. ex Bor. | POAR1 | N | | | | | | | | | | | X | |
| POLYGONACEAE | Polygonum convolvulus L. | POCO2 | N | | | X | | | | | | | | | |
| POLYGONACEAE | Polygonum ramosissimum Michx. | PORA1 | Y | | | X | X | | | | | X | X | X | X |
| POLYGONACEAE | Rumex crispus L. | RUCR1 | N | | | | | | | X | | X | X | X | X |
| PORTULACACEAE | Talinum parviflorum Nutt. | TAPA1 | Y | | X | X | X | X | X | X | | | | X | X |

Table 4-2. (cont.)

| | | | | DKC - Control | | | | | | DKT - Treatment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Native | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| ROSACEAE | Potentilla gracilis Dougl. ex Hook. var. glabrata (Lehm.) C. L. Hitchc. | POGR1 | Y | | | | | | | X | | | | | |
| ROSACEAE | Prunus virginiana L. var. melanocarpa (A. Nels.) Sarg. | PRVI1 | Y | X | X | X | X | X | X | | | | | | |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | LIDA1 | N | | | | | X | | | | | | | |
| SCROPHULARIACEAE | Penstemon virens Penn. | PEVI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| SCROPHULARIACEAE | Verbascum blattaria L. | VEBL1 | N | X | X | X | X | X | X | | | | | | |
| SCROPHULARIACEAE | Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren | VEPE1 | Y | | | X | X | X | | | | X | X | X | X |
| VIOLACEAE | Viola nuttallii Pursh. | VINU1 | Y | | | | | X | | | | | | | |
| | | UNKN | | | | | | | | | | | | | X |
| | # Plant Families | | | 18.0 | 18.0 | 19.0 | 18.0 | 20.0 | 16.0 | 20.0 | 17.0 | 21.0 | 20.0 | 22.0 | 22.0 |
| | # Species | | | 68.0 | 65.0 | 70.0 | 65.0 | 67.0 | 58.0 | 74.0 | 62.0 | 70.0 | 68.0 | 72.0 | 73.0 |
| | % Natives | | | 75.0 | 74.0 | 74.0 | 77.0 | 76.0 | 76.0 | 73.0 | 77.0 | 77.0 | 79.0 | 75.0 | 76.0 |

Table 4-3. 1997-1999 Diffuse Knapweed Monitoring Species Frequency Data Summary

| | | | Frequency (%) at DKC - Control | | | | | | Frequency (%) at DKT - Treatment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| APIACEAE | Lomatium orientale Coult. & Rose | LOOR1 | 92 | | 92 | 48 | 100 | | 80 | 8 | 92 | 72 | 92 | 24 |
| ASCLEPIADACEAE | Asclepias stenophylla A. Gray | ASST1 | 8 | 4 | | | 4 | 4 | | | | | | |
| ASCLEPIADACEAE | Asclepias viridiflora Raf. | ASVI1 | 8 | 12 | 8 | 8 | 12 | 12 | | | | | | |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | ACMI1 | 8 | 8 | 8 | 4 | 8 | 4 | | | | | | |
| ASTERACEAE | Ambrosia psilostachya DC. | AMPS1 | 72 | 68 | 64 | 68 | 64 | 60 | 32 | 32 | 12 | 16 | 16 | 12 |
| ASTERACEAE | Arnica fulgens Pursh. | ARFU1 | 36 | 16 | 40 | 28 | 40 | 12 | 16 | 12 | 16 | 12 | 20 | 8 |
| ASTERACEAE | Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem. | ARCA1 | | | | | | | 4 | 4 | 4 | | | |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | 68 | 68 | 68 | 64 | 68 | 64 | 36 | 36 | 32 | 16 | 24 | 16 |
| ASTERACEAE | Aster porteri Gray | ASPO1 | 76 | 76 | 84 | 76 | 76 | 76 | 80 | 84 | 80 | 72 | 80 | 72 |
| ASTERACEAE | Centaurea diffusa Lam. | CEDI1 | 76 | 76 | 76 | 60 | 96 | 64 | 80 | 60 | 52 | 20 | 44 | 44 |
| ASTERACEAE | Chrysopsis fulcrata Greene | CHFU1 | 8 | 8 | 8 | 4 | 4 | 4 | | | | | 4 | 4 |
| ASTERACEAE | Erigeron divergens T. & G. | ERDI1 | | | | | 4 | | 4 | | | | | |
| ASTERACEAE | Erigeron flagellaris A. Gray | ERFL1 | 4 | 4 | 4 | 4 | | 4 | | 4 | | | | |
| ASTERACEAE | Gaillardia aristata Pursh. | GAAR1 | 12 | 4 | 8 | 4 | 12 | 8 | 8 | 4 | | 4 | 4 | 4 |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | 56 | 48 | 68 | 40 | 40 | 32 | 20 | 16 | 12 | | 12 | 4 |
| ASTERACEAE | Lactuca serriola L. | LASE1 | 12 | 12 | 28 | 8 | 20 | 4 | 20 | 8 | | | 28 | 16 |
| ASTERACEAE | Liatris punctata Hook. | LIPU1 | 16 | 20 | 20 | 28 | 24 | 24 | 20 | 20 | 28 | 20 | 28 | 24 |
| ASTERACEAE | Microseris cuspidata (Pursh.) Sch. Bip. | MICU1 | 4 | | 8 | | 4 | | 4 | | 4 | | 8 | |
| ASTERACEAE | Scorzonera laciniata L. | SCLA1 | | | | | | | 4 | 4 | | | | |
| ASTERACEAE | Senecio plattensis Nutt. | SEPL1 | 8 | 4 | 4 | | 16 | 4 | 24 | 12 | 20 | 4 | 12 | 4 |
| ASTERACEAE | Solidago mollis Bart. | SOMO1 | 24 | 24 | 28 | 28 | 28 | 24 | | | | | | |
| ASTERACEAE | Taraxacum officinale Weber | TAOF1 | | | | | | | 4 | | | | | |
| ASTERACEAE | Tragopogon dubius Scop. | TRDU1 | 8 | 16 | 44 | 32 | 32 | 20 | 12 | 8 | | 4 | 8 | 4 |
| BORAGINACEAE | Lithospermum incisum Lehm. | LIIN1 | 4 | 4 | | | | | | | | | | |
| BORAGINACEAE | Mertensia lanceolata (Pursh.) A. DC. | MELA1 | | | 4 | | | | 4 | | | | | |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | 28 | 20 | 12 | 16 | 20 | 8 | 4 | 4 | 16 | 4 | 8 | 4 |
| BRASSICACEAE | Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins | ARHI1 | | | | | | | 4 | | | | 4 | 4 |
| BRASSICACEAE | Barbarea vulgaris R. Br. | BAVU1 | | | | | | | 4 | | | | | |
| BRASSICACEAE | Camelina microcarpa Andrz. ex DC. | CAMI1 | 8 | | | | 8 | 4 | | | | | 4 | |
| BRASSICACEAE | Draba reptans (Lam.) Fern. | DRRE1 | 16 | 4 | 4 | | 12 | | | | | 4 | | |
| BRASSICACEAE | Erysimum capitatum (Nutt.) DC. | ERCA2 | 8 | 4 | 8 | | 4 | | 4 | | | | 8 | 8 |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | LECA1 | | 4 | 4 | 4 | 12 | 8 | 16 | 8 | 16 | 12 | 20 | 12 |
| BRASSICACEAE | Lepidium densiflorum Schrad. | LEDE1 | 4 | 4 | | | | | 12 | 8 | | | | |
| BRASSICACEAE | Lesquerella montana (A. Gray) Wats. | LEMO1 | 8 | 8 | 12 | 16 | 28 | 16 | 12 | 16 | 12 | 12 | 20 | 20 |
| CACTACEAE | Echinocereus viridiflorus Engelm. | ECVI1 | 16 | 16 | 20 | 8 | 8 | 4 | 40 | 36 | 28 | 32 | 28 | 24 |
| CACTACEAE | Opuntia macrorhiza Engelm. | OPMA1 | 40 | 40 | 40 | 40 | 36 | 32 | 64 | 76 | 20 | 32 | 24 | 28 |
| CARYOPHYLLACEAE | Arenaria fendleri A. Gray | ARFE2 | 32 | 44 | 20 | 44 | 32 | 36 | 52 | 40 | 28 | 28 | 28 | 24 |
| CARYOPHYLLACEAE | Paronychia jamesii T. & G. | PAJA1 | | | | | | | 12 | 12 | 4 | 4 | 4 | 4 |
| CARYOPHYLLACEAE | Silene antirrhina L. | SIAN1 | 8 | 8 | 4 | | 12 | | 4 | | 28 | | 24 | 8 |
| CLUSIACEAE | Hypericum perforatum L. | HYPE1 | 52 | 64 | 44 | 16 | 24 | 16 | 16 | 8 | 72 | 12 | 36 | 24 |
| COMMELINACEAE | Tradescantia occidentalis (Britt.) Smyth | TROC1 | | | | | | | 4 | | 4 | | 4 | 4 |
| CYPERACEAE | Carex heliophila Mack. | CAHE1 | 64 | 72 | 72 | 68 | 56 | 60 | 32 | 40 | 52 | 40 | 36 | 28 |
| FABACEAE | Dalea purpurea Vent | DAPU1 | 8 | 4 | 8 | 8 | 8 | 8 | 12 | 12 | 8 | 12 | 12 | 12 |
| FABACEAE | Psoralea tenuiflora Pursh. | PSTE1 | 32 | 40 | 44 | 36 | 36 | 44 | 20 | 8 | 16 | 16 | 12 | 16 |
| JUNCACEAE | Juncus interior Wieg. | JUIN1 | | 4 | | 4 | | 4 | | | | 4 | | |

**Table 4-3. 1997-1999 Diffuse Knapweed Monitoring Species Frequency Data Summary**

| | | | Frequency (%) at DKC - Control | | | | | | Frequency (%) at DKT - Treatment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| LILIACEAE | Allium textile A. Nels. & Macbr. | ALTE1 | 20 | 4 | 8 | | 8 | | 36 | 12 | 24 | 12 | 28 | 16 |
| ONAGRACEAE | Oenothera villosa Thunb. ssp. strigosa (Rydb.) Dietrich & Raven | OEVI1 | | | 4 | | | | | | | | 4 | 4 |
| OROBANCHACEAE | Orobanche fasciculata Nutt. | ORFA1 | | | | | 4 | | | 4 | 4 | 4 | 20 | |
| POACEAE | Andropogon gerardii Vitman | ANGE1 | 88 | 88 | 88 | 84 | 88 | 92 | 68 | 64 | 64 | 64 | 64 | 68 |
| POACEAE | Andropogon scoparius Michx. | ANSC1 | 28 | 28 | 20 | 24 | 16 | 36 | 20 | 40 | 20 | 20 | 20 | 28 |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | BOCU1 | 36 | 40 | 28 | 28 | 40 | 40 | 8 | 32 | 28 | 12 | 24 | 32 |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | | 16 | 8 | 8 | 8 | 20 | 16 | 28 | 16 | 24 | 36 | 48 |
| POACEAE | Bouteloua hirsuta Lag | BOHI1 | 16 | 16 | 16 | 28 | 16 | 20 | 16 | | | 4 | 8 | 20 |
| POACEAE | Bromus japonicus Thunb. ex Murr. | BRJA1 | | | 4 | 4 | 4 | | 36 | 32 | 32 | 36 | 40 | 24 |
| POACEAE | Bromus tectorum L. | BRTE1 | | | | | | | 8 | 4 | 12 | 8 | | 12 |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | KOPY1 | 40 | 32 | 28 | 20 | 28 | 24 | 36 | 20 | 28 | 20 | 20 | 32 |
| POACEAE | Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | 100 | 100 | 96 | 100 | 96 | 100 | 96 | 96 | 92 | 92 | 96 | 100 |
| POACEAE | Poa compressa L. | POCO1 | 92 | 100 | 100 | 100 | 100 | 96 | 96 | 96 | 100 | 100 | 100 | 100 |
| POACEAE | Poa pratensis L. | POPR1 | 8 | 8 | 8 | 8 | 4 | 4 | | | 4 | 4 | 8 | 4 |
| POACEAE | Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | 8 | 12 | | | 8 | 12 | | | | | | 4 |
| POACEAE | Sorghastrum nutans (L.) Nash | SONU1 | | 4 | 4 | 4 | | 4 | | | | 4 | | 4 |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | 20 | 20 | 20 | 24 | 20 | 20 | | | | | | |
| POACEAE | Stipa comata Trin. & Rupr. | STCO1 | | | | 4 | | 4 | | | | | | |
| POLEMONIACEAE | Collomia linearis Nutt. | COLI1 | | | | | | | 4 | | 4 | 4 | 4 | 4 |
| POLYGONACEAE | Polygonum ramosissimum Michx. | PORA1 | | | | 8 | | | | | 4 | 8 | 8 | 4 |
| POLYGONACEAE | Rumex crispus L. | RUCR1 | | | | | | | 4 | | | | | |
| PORTULACACEAE | Talinum parviflorum Nutt. | TAPA1 | | 4 | 4 | | 8 | 4 | | | | | 12 | 28 |
| SCROPHULARIACEAE | Penstemon virens Penn. | PEVI1 | 4 | | 4 | 4 | 4 | 4 | 16 | | 28 | 12 | 28 | 24 |
| SCROPHULARIACEAE | Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren | VEPE1 | | | 4 | | | | | | 72 | 32 | 60 | 16 |
| | Unknown | UNKN | | | | | | | | | | | | 4 |

Note: Frequency values are percentages (n = 25).

**Table 4-4. 1997-1999 Diffuse Knapweed Monitoring Species Frequency Data Summary**

| | | Percent | | |
|---|---|---|---|---|
| **Scientific Name** | **Native** | **Control Change** | **Treatment Change** | **Control vs. Treatment Difference** |
| Centaurea diffusa Lam. | N | 20 | -36 | -56 |
| Opuntia macrorhiza Engelm. | Y | -4 | -40 | -36 |
| Tragopogon dubius Scop. | N | 24 | -4 | -28 |
| Arenaria fendleri A. Gray | Y | 0 | -24 | -24 |
| Senecio plattensis Nutt. | Y | 8 | -12 | -20 |
| Artemisia ludoviciana Nutt. var. ludoviciana | Y | 0 | -12 | -12 |
| Psoralea tenuiflora Pursh. | Y | 4 | -8 | -12 |
| Lesquerella montana (A. Gray) Wats. | Y | 20 | 8 | -12 |
| Andropogon scoparius Michx. | Y | -12 | 0 | 12 |
| Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | N | -8 | 4 | 12 |
| Carex heliophila Mack. | Y | -8 | 4 | 12 |
| Poa pratensis L. | N | -4 | 8 | 12 |
| Penstemon virens Penn. | Y | 0 | 12 | 12 |
| Bouteloua curtipendula (Michx.) Torr. | Y | 4 | 16 | 12 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | Y | 8 | 20 | 12 |
| Silene antirrhina L. | Y | 4 | 20 | 16 |
| Orobanche fasciculata Nutt. | Y | 4 | 20 | 16 |
| Hypericum perforatum L. | N | -28 | 20 | 48 |
| Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren | Y | 0 | 60 | 60 |

Control and Treatment Change column values based on Spring 1997 and Spring 1999 differences. See Table 3.

**Table 4-5. 1997-1999 Diffuse Knapweed Herbicide Monitoring Foliar Cover Summary - Control Data**

| | | | | | Frequency | | | | | | Absolute Foliar Cover (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| Camelina microcarpa Andrz. ex DC. | CAMI1 | F | N | | | | | 20 | | | | | | 0.2 | | |
| Centaurea diffusa Lam. | CEDI1 | F | N | | 100 | 100 | 40 | 80 | 20 | 60 | 2.6 | 4.8 | 0.4 | 1 | 0.6 | 2 |
| Hypericum perforatum L. | HYPE1 | F | N | | | 20 | | | | | | 0.2 | | | | |
| Lepidium campestre (L.) R. Br. | LECA1 | F | N | | 20 | 20 | 20 | 20 | | 20 | 0.4 | 0.2 | 0.2 | 0.2 | | 0.2 |
| Tragopogon dubius Scop. | TRDU1 | F | N | | 40 | 20 | 60 | | 20 | 20 | 0.4 | 0.2 | 0.6 | | 0.2 | 0.2 |
| Allium textile A. Nels. & Macbr. | ALTE1 | F | Y | | | | | | | | | | | | | |
| Ambrosia psilostachya DC. | AMPS1 | F | Y | | 60 | 60 | 100 | 80 | 80 | 60 | 1.2 | 0.6 | 1.2 | 1.4 | 1.8 | 1.4 |
| Arenaria fendleri A. Gray | ARFE2 | F | Y | | 40 | 20 | | 40 | 20 | 40 | 0.4 | 0.2 | | 0.4 | 0.6 | 0.4 |
| Arnica fulgens Pursh. | ARFU1 | F | Y | | 20 | | 20 | | | 20 | 0.2 | | 0.2 | | | 0.2 |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 100 | 20 | 40 | 40 | 40 | 40 | 1 | 0.2 | 0.6 | 0.4 | 0.6 | 0.4 |
| Asclepias stenophylla A. Gray | ASST1 | F | Y | | 20 | 20 | | | | 40 | 0.2 | 0.2 | | | | 0.4 |
| Aster porteri Gray | ASPO1 | F | Y | | 100 | 100 | 100 | 100 | 100 | 100 | 2.6 | 2 | 5.4 | 4.6 | 4.6 | 5.6 |
| Dalea purpurea Vent | DAPU1 | F | Y | | | 20 | 20 | | 20 | 20 | | 0.2 | 0.2 | | 0.2 | 0.2 |
| Erigeron divergens T. & G. | ERDI1 | F | Y | | | | | | 40 | | | | | | 0.4 | |
| Erigeron flagellaris A. Gray | ERFL1 | F | Y | | | 20 | 20 | | | | | 0.2 | 0.2 | | | |
| Gaillardia aristata Pursh. | GAAR1 | F | Y | | | 20 | | | 20 | | | 0.2 | | | 0.2 | |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | F | Y | | 40 | 80 | | 20 | | | 0.4 | 1.2 | | 0.2 | | |
| Liatris punctata Hook. | LIPU1 | F | Y | | 20 | | | | | | 0.2 | | | | | |
| Lomatium orientale Coult. & Rose | LOOR1 | F | Y | | | | 60 | | 40 | | | | 0.8 | | 0.4 | |
| Psoralea tenuiflora Pursh. | PSTE1 | F | Y | | 40 | 80 | 40 | 80 | 20 | 100 | 0.8 | 1.4 | 0.8 | 1.6 | 0.2 | 1.4 |
| Silene antirrhina L. | SIAN1 | F | Y | | 20 | | | | | | 0.2 | | | | | |
| Poa compressa L. | POCO1 | G | N | C | 100 | 100 | 100 | 100 | 100 | 100 | 17.2 | 20.8 | 25.4 | 31.8 | 19.2 | 24.2 |
| Poa pratensis L. | POPR1 | G | N | C | 20 | 40 | 40 | 20 | | | 0.4 | 0.6 | 0.8 | 0.2 | | |
| Carex heliophila Mack. | CAHE1 | G | Y | C | 60 | 100 | 80 | 80 | 60 | 60 | 0.6 | 1.6 | 2 | 2 | 2 | 1.2 |
| Eleocharis compressa Sulliv. | ELCO1 | G | Y | C | 20 | | 20 | | | 20 | 0.4 | | 0.2 | | | 0.2 |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | 40 | 20 | 20 | 20 | 40 | 40 | 0.4 | 0.2 | 0.2 | 0.2 | 0.4 | 0.4 |
| Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | G | Y | C | | 20 | | | 20 | | | 0.2 | | | 0.2 | |
| Andropogon gerardii Vitman | ANGE1 | G | Y | W | 100 | 100 | 100 | 100 | 100 | 100 | 8.6 | 11 | 7.2 | 12.2 | 6.6 | 12 |
| Andropogon scoparius Michx. | ANSC1 | G | Y | W | 20 | 20 | 20 | | | 60 | 0.4 | 0.2 | 0.2 | | | 0.6 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 40 | 80 | 40 | 80 | 40 | 60 | 0.4 | 1.8 | 1 | 0.8 | 1.2 | 2 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 20 | | | 20 | 20 | 20 | 0.4 | | | 0.2 | 0.2 | 0.4 |
| Bouteloua hirsuta Lag | BOHI1 | G | Y | W | | | 20 | | 20 | 40 | | | 0.2 | | 0.2 | 0.4 |
| Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | G | Y | W | 100 | 100 | 100 | 100 | 100 | 100 | 23.2 | 24.4 | 23.2 | 22.2 | 19.6 | 23.4 |
| Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | G | Y | W | 100 | 100 | 100 | 100 | 100 | 100 | 5.6 | 6.2 | 4.8 | 6 | 5.6 | 6.4 |
| Total foliar cover | | | | | | | | | | | 68.2 | 78.8 | 75.8 | 85.6 | 65.0 | 83.6 |
| Total forb cover | | | | | | | | | | | 10.6 | 11.8 | 10.6 | 10.0 | 9.8 | 12.4 |
| Total native forb cover | | | | | | | | | | | 7.2 | 6.4 | 9.4 | 8.6 | 9.0 | 10.0 |
| Total non-native forb cover | | | | | | | | | | | 3.4 | 5.4 | 1.2 | 1.4 | 0.8 | 2.4 |
| Total graminoid cover | | | | | | | | | | | 57.6 | 67.0 | 65.2 | 75.6 | 55.2 | 71.2 |
| Total native cover | | | | | | | | | | | 47.2 | 52.0 | 48.4 | 52.2 | 45.0 | 57.0 |
| Total non-native cover | | | | | | | | | | | 21.0 | 26.8 | 27.4 | 33.4 | 20.0 | 26.6 |
| Total warm-season graminoid cover | | | | | | | | | | | 38.6 | 43.6 | 36.6 | 41.4 | 33.4 | 45.2 |
| Total cool-season graminoid cover | | | | | | | | | | | 19.0 | 23.4 | 28.6 | 34.2 | 21.8 | 26.0 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (500).
Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).
All cover values presented are means (n = 5).
Native categories: Y = Native, N = Non-Native
Form categories: C = Cactus, F = Forb, G = Graminoid
Cool/Warm Season categories: C = Cool season species, W = Warm season species

Table 4-5. (cont.)

| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | Relative Foliar Cover (%) Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| Camelina microcarpa Andrz. ex DC. | CAMI1 | F | N | | | | | 0.2 | | |
| Centaurea diffusa Lam. | CEDI1 | F | N | | 3.8 | 6.1 | 0.5 | 1.2 | 0.9 | 2.4 |
| Hypericum perforatum L. | HYPE1 | F | N | | | 0.3 | | | | |
| Lepidium campestre (L.) R. Br. | LECA1 | F | N | | 0.6 | 0.3 | 0.3 | 0.2 | | 0.2 |
| Tragopogon dubius Scop. | TRDU1 | F | N | | 0.6 | 0.3 | 0.8 | | 0.3 | 0.2 |
| Allium textile A. Nels. & Macbr. | ALTE1 | F | Y | | | | | | | |
| Ambrosia psilostachya DC. | AMPS1 | F | Y | | 1.8 | 0.8 | 1.6 | 1.6 | 2.8 | 1.7 |
| Arenaria fendleri A. Gray | ARFE2 | F | Y | | 0.6 | 0.3 | | 0.5 | 0.9 | 0.5 |
| Arnica fulgens Pursh. | ARFU1 | F | Y | | 0.3 | | 0.3 | | | 0.2 |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 1.5 | 0.3 | 0.8 | 0.5 | 0.9 | 0.5 |
| Asclepias stenophylla A. Gray | ASST1 | F | Y | | 0.3 | 0.3 | | | | 0.5 |
| Aster porteri Gray | ASPO1 | F | Y | | 3.8 | 2.5 | 7.1 | 5.4 | 7.1 | 6.7 |
| Dalea purpurea Vent | DAPU1 | F | Y | | | 0.3 | 0.3 | | 0.3 | 0.2 |
| Erigeron divergens T. & G. | ERDI1 | F | Y | | | | | | 0.6 | |
| Erigeron flagellaris A. Gray | ERFL1 | F | Y | | | 0.3 | 0.3 | | | |
| Gaillardia aristata Pursh. | GAAR1 | F | Y | | | 0.3 | | | 0.3 | |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | F | Y | | 0.6 | 1.5 | | 0.2 | | |
| Liatris punctata Hook. | LIPU1 | F | Y | | 0.3 | | | | | |
| Lomatium orientale Coult. & Rose | LOOR1 | F | Y | | | | 1.1 | | 0.6 | |
| Psoralea tenuiflora Pursh. | PSTE1 | F | Y | | 1.2 | 1.8 | 1.1 | 1.9 | 0.3 | 1.7 |
| Silene antirrhina L. | SIAN1 | F | Y | | 0.3 | | | | | |
| Poa compressa L. | POCO1 | G | N | C | 25.2 | 26.4 | 33.5 | 37.1 | 29.5 | 28.9 |
| Poa pratensis L. | POPR1 | G | N | C | 0.6 | 0.8 | 1.1 | 0.2 | | |
| Carex heliophila Mack. | CAHE1 | G | Y | C | 0.9 | 2.0 | 2.6 | 2.3 | 3.1 | 1.4 |
| Eleocharis compressa Sulliv. | ELCO1 | G | Y | C | 0.6 | | 0.3 | | | 0.2 |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | 0.6 | 0.3 | 0.3 | 0.2 | 0.6 | 0.5 |
| Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | G | Y | C | | 0.3 | | | 0.3 | |
| Andropogon gerardii Vitman | ANGE1 | G | Y | W | 12.6 | 14.0 | 9.5 | 14.3 | 10.2 | 14.4 |
| Andropogon scoparius Michx. | ANSC1 | G | Y | W | 0.6 | 0.3 | 0.3 | | | 0.7 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 0.6 | 2.3 | 1.3 | 0.9 | 1.8 | 2.4 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 0.6 | | | 0.2 | 0.3 | 0.5 |
| Bouteloua hirsuta Lag | BOHI1 | G | Y | W | | | 0.3 | | 0.3 | 0.5 |
| Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | G | Y | W | 34.0 | 31.0 | 30.6 | 25.9 | 30.2 | 28.0 |
| Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | G | Y | W | 8.2 | 7.9 | 6.3 | 7.0 | 8.6 | 7.7 |
| Total foliar cover | | | | | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Total forb cover | | | | | 15.5 | 15.0 | 14.0 | 11.7 | 15.1 | 14.8 |
| Total native forb cover | | | | | 10.6 | 8.1 | 12.4 | 10.0 | 13.8 | 12.0 |
| Total non-native forb cover | | | | | 5.0 | 6.9 | 1.6 | 1.6 | 1.2 | 2.9 |
| Total graminoid cover | | | | | 84.5 | 85.0 | 86.0 | 88.3 | 84.9 | 85.2 |
| Total native cover | | | | | 69.2 | 66.0 | 63.9 | 61.0 | 69.2 | 68.2 |
| Total non-native cover | | | | | 30.8 | 34.0 | 36.1 | 39.0 | 30.8 | 31.8 |
| Total warm-season graminoid cover | | | | | 56.6 | 55.3 | 48.3 | 48.4 | 51.4 | 54.1 |
| Total cool-season graminoid cover | | | | | 27.9 | 29.7 | 37.7 | 40.0 | 33.5 | 31.1 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (500).
Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).
All cover values presented are means (n = 5).
Native categories: Y = Native, N = Non-Native
Form categories: C = Cactus, F = Forb, G = Graminoid
Cool/Warm Season categories: C = Cool season species, W = Warm season species

Table 4-6. 1997-1999 Diffuse Knapweed Herbicide Monitoring Foliar Cover Summary - Treatment Data

| | | | | | Frequency | | | | | | Absolute Foliar Cover (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | F | N | | | | | | 20 | 20 | | | | | 0.2 | 0.2 |
| Centaurea diffusa Lam. | CEDI1 | F | N | | 100 | 100 | | | | 20 | 4.4 | 4.8 | | | | 0.6 |
| Hypericum perforatum L. | HYPE1 | F | N | | 20 | 20 | | | | | 0.2 | 0.2 | | | | |
| Lactuca serriola L. | LASE1 | F | N | | | | | | | 20 | | | | | | 0.2 |
| Lepidium campestre (L.) R. Br. | LECA1 | F | N | | 20 | | | | | | 0.2 | | | | | |
| Plantago lanceolata L. | PLLA1 | F | N | | 20 | | | | | | 0.2 | | | | | |
| Tragopogon dubius Scop. | TRDU1 | F | N | | 20 | | | | | 40 | 0.2 | | | | | 0.4 |
| Allium textile A. Nels. & Macbr. | ALTE1 | F | Y | | 20 | 20 | 20 | | | | 0.2 | 0.2 | 0.2 | | | |
| Ambrosia psilostachya DC. | AMPS1 | F | Y | | 80 | | | | | 20 | 1.6 | | | | | 0.2 |
| Arenaria fendleri A. Gray | ARFE2 | F | Y | | 20 | | | | | | 0.4 | | | | | |
| Arnica fulgens Pursh. | ARFU1 | F | Y | | 60 | 20 | 20 | 40 | 40 | | 0.6 | 0.2 | 0.4 | 0.4 | 0.8 | |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 20 | 60 | | 60 | | 60 | 0.4 | 1 | | 0.6 | | 0.6 |
| Asclepias stenophylla A. Gray | ASST1 | F | Y | | 20 | | | 20 | | | 0.2 | | | 0.2 | | |
| Aster porteri Gray | ASPO1 | F | Y | | 80 | 100 | 60 | 60 | 60 | 80 | 2 | 2 | 1.8 | 2.6 | 2.6 | 3.2 |
| Dalea purpurea Vent | DAPU1 | F | Y | | | 20 | 20 | | | | | 0.2 | 0.2 | | | |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | F | Y | | 60 | 20 | 20 | | 20 | | 0.6 | 0.2 | 0.2 | | 0.2 | |
| Lesquerella montana (A. Gray) Wats. | LEMO1 | F | Y | | | | | | | 20 | | | | | | 0.2 |
| Liatris punctata Hook. | LIPU1 | F | Y | | 20 | | 20 | | | 40 | 0.2 | | 0.2 | | | 0.6 |
| Lomatium orientale Coult. & Rose | LOOR1 | F | Y | | 60 | | 80 | | 80 | | 0.8 | | 1.6 | | 1.2 | |
| Penstemon virens Penn. | PEVI1 | F | Y | | | | 20 | | | | | | 0.2 | | | |
| Senecio plattensis Nutt. | SEPL1 | F | Y | | | | 20 | | | | | | 0.2 | | | |
| Senecio spartioides T. & G. | SESP1 | F | Y | | | | | | | 20 | | | | | | 0.2 |
| Tradescantia occidentalis (Britt.) Smyth | TROC1 | F | Y | | | | | | 20 | | | | | | 0.4 | |
| Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren | VEPE1 | F | Y | | | | | | 20 | | | | | | 0.2 | |
| Bromus japonicus Thunb. ex Murr. | BRJA1 | G | N | C | 60 | 80 | 40 | 60 | 40 | 40 | 2.2 | 2.4 | 2 | 2.2 | 1.2 | 0.8 |
| Bromus tectorum L. | BRTE1 | G | N | C | 20 | | 40 | 40 | | 20 | 1.8 | | 1.2 | 0.6 | | 0.6 |
| Poa compressa L. | POCO1 | G | N | C | 100 | 100 | 100 | 100 | 100 | 100 | 12.2 | 12.4 | 25 | 31.6 | 23.8 | 22.8 |
| Poa pratensis L. | POPR1 | G | N | C | 20 | 20 | 20 | | | | 0.2 | 0.4 | 0.2 | | | |
| Carex heliophila Mack. | CAHE1 | G | Y | C | 60 | 40 | 60 | 40 | 40 | 40 | 0.8 | 1.2 | 0.8 | 0.8 | 0.6 | 0.8 |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | 40 | 20 | | | 20 | | 0.2 | 0.2 | | | 0.2 | |
| Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | G | Y | C | | | | 20 | | 20 | | | | 0.2 | | 0.2 |
| Andropogon gerardii Vitman | ANGE1 | G | Y | W | 80 | 100 | 80 | 100 | 100 | 100 | 5 | 8.2 | 5.4 | 7.8 | 4.6 | 10.2 |
| Andropogon scoparius Michx. | ANSC1 | G | Y | W | 80 | 60 | 80 | 60 | 40 | 40 | 1.6 | 1 | 1 | 1 | 0.8 | 1.4 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 60 | 40 | 60 | 20 | 60 | 80 | 0.8 | 0.4 | 1.4 | 0.2 | 1.6 | 2 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 40 | 20 | 80 | | | 80 | 0.6 | 0.2 | 1.2 | | | 0.8 |
| Bouteloua hirsuta Lag | BOHI1 | G | Y | W | 80 | | | 20 | 40 | | 0.8 | | | 0.2 | 0.6 | |
| Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | G | Y | W | 100 | 100 | 100 | 100 | 100 | 100 | 26.4 | 35.2 | 31.6 | 32.6 | 23 | 32.6 |
| Sorghastrum nutans (L.) Nash | SONU1 | G | Y | W | | | | | | 20 | | | | | | 0.2 |
| Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | G | Y | W | 60 | 20 | 40 | 40 | 40 | 40 | 1.6 | 0.6 | 0.6 | 0.6 | 0.8 | 1 |
| Total foliar cover | | | | | | | | | | | 66.4 | 71.0 | 75.4 | 81.6 | 62.8 | 79.8 |
| Total forb cover | | | | | | | | | | | 12.2 | 8.8 | 5.0 | 3.8 | 5.6 | 6.4 |
| Total native forb cover | | | | | | | | | | | 7.0 | 3.8 | 5.0 | 3.8 | 5.4 | 5.0 |
| Total non-native forb cover | | | | | | | | | | | 5.2 | 5.0 | 0.0 | 0.0 | 0.2 | 1.4 |
| Total graminoid cover | | | | | | | | | | | 54.2 | 62.2 | 70.4 | 77.8 | 57.2 | 73.4 |

Table 4-6. (cont.)

| | | | | | Frequency | | | | | | Absolute Foliar Cover (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| Total native cover | | | | | | | | | | | 44.8 | 50.8 | 47.0 | 47.2 | 37.6 | 54.2 |
| Total non-native cover | | | | | | | | | | | 21.6 | 20.2 | 28.4 | 34.4 | 25.2 | 25.6 |
| Total warm-season graminoid cover | | | | | | | | | | | 36.8 | 45.6 | 41.2 | 42.4 | 31.4 | 48.2 |
| Total cool-season graminoid cover | | | | | | | | | | | 17.4 | 16.6 | 29.2 | 35.4 | 25.8 | 25.2 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (500).
Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).
All cover values presented are means (n = 5).
Native categories: Y = Native, N = Non-Native
Form categories: C = Cactus, F = Forb, G = Graminoid
Cool/Warm Season categories: C = Cool season species, W = Warm season species

Table 4-6. (cont.)

| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | Relative Foliar Cover (%) Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | F | N | | | | | | 0.3 | 0.3 |
| Centaurea diffusa Lam. | CEDI1 | F | N | | 6.6 | 6.8 | | | | 0.8 |
| Hypericum perforatum L. | HYPE1 | F | N | | 0.3 | 0.3 | | | | |
| Lactuca serriola L. | LASE1 | F | N | | | | | | | 0.3 |
| Lepidium campestre (L.) R. Br. | LECA1 | F | N | | 0.3 | | | | | |
| Plantago lanceolata L. | PLLA1 | F | N | | 0.3 | | | | | |
| Tragopogon dubius Scop. | TRDU1 | F | N | | 0.3 | | | | | 0.5 |
| Allium textile A. Nels. & Macbr. | ALTE1 | F | Y | | 0.3 | 0.3 | 0.3 | | | |
| Ambrosia psilostachya DC. | AMPS1 | F | Y | | 2.4 | | | | | 0.3 |
| Arenaria fendleri A. Gray | ARFE2 | F | Y | | 0.6 | | | | | |
| Arnica fulgens Pursh. | ARFU1 | F | Y | | 0.9 | 0.3 | 0.5 | 0.5 | 1.3 | |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 0.6 | 1.4 | | 0.7 | | 0.8 |
| Asclepias stenophylla A. Gray | ASST1 | F | Y | | 0.3 | | | 0.2 | | |
| Aster porteri Gray | ASPO1 | F | Y | | 3.0 | 2.8 | 2.4 | 3.2 | 4.1 | 4.0 |
| Dalea purpurea Vent | DAPU1 | F | Y | | | 0.3 | 0.3 | | | |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | F | Y | | 0.9 | 0.3 | 0.3 | | 0.3 | |
| Lesquerella montana (A. Gray) Wats. | LEMO1 | F | Y | | | | | | | 0.3 |
| Liatris punctata Hook. | LIPU1 | F | Y | | 0.3 | | 0.3 | | | 0.8 |
| Lomatium orientale Coult. & Rose | LOOR1 | F | Y | | 1.2 | | 2.1 | | 1.9 | |
| Penstemon virens Penn. | PEVI1 | F | Y | | | | 0.3 | | | |
| Senecio plattensis Nutt. | SEPL1 | F | Y | | | | 0.3 | | | |
| Senecio spartioides T. & G. | SESP1 | F | Y | | | | | | | 0.3 |
| Tradescantia occidentalis (Britt.) Smyth | TROC1 | F | Y | | | | | | 0.6 | |
| Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren | VEPE1 | F | Y | | | | | | 0.3 | |
| Bromus japonicus Thunb. ex Murr. | BRJA1 | G | N | C | 3.3 | 3.4 | 2.7 | 2.7 | 1.9 | 1.0 |
| Bromus tectorum L. | BRTE1 | G | N | C | 2.7 | | 1.6 | 0.7 | | 0.8 |
| Poa compressa L. | POCO1 | G | N | C | 18.4 | 17.5 | 33.2 | 38.7 | 37.9 | 28.6 |
| Poa pratensis L. | POPR1 | G | N | C | 0.3 | 0.6 | 0.3 | | | |
| Carex heliophila Mack. | CAHE1 | G | Y | C | 1.2 | 1.7 | 1.1 | 1.0 | 1.0 | 1.0 |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | 0.3 | 0.3 | | | 0.3 | |
| Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | G | Y | C | | | | 0.2 | | 0.3 |
| Andropogon gerardii Vitman | ANGE1 | G | Y | W | 7.5 | 11.5 | 7.2 | 9.6 | 7.3 | 12.8 |
| Andropogon scoparius Michx. | ANSC1 | G | Y | W | 2.4 | 1.4 | 1.3 | 1.2 | 1.3 | 1.8 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 1.2 | 0.6 | 1.9 | 0.2 | 2.5 | 2.5 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 0.9 | 0.3 | 1.6 | | | 1.0 |
| Bouteloua hirsuta Lag | BOHI1 | G | Y | W | 1.2 | | | 0.2 | 1.0 | |
| Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | G | Y | W | 39.8 | 49.6 | 41.9 | 40.0 | 36.6 | 40.9 |
| Sorghastrum nutans (L.) Nash | SONU1 | G | Y | W | | | | | | 0.3 |
| Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | G | Y | W | 2.4 | 0.8 | 0.8 | 0.7 | 1.3 | 1.3 |
| Total foliar cover | | | | | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Total forb cover | | | | | 18.4 | 12.4 | 6.6 | 4.7 | 8.9 | 8.0 |
| Total native forb cover | | | | | 10.5 | 5.4 | 6.6 | 4.7 | 8.6 | 6.3 |
| Total non-native forb cover | | | | | 7.8 | 7.0 | 0.0 | 0.0 | 0.3 | 1.8 |
| Total graminoid cover | | | | | 81.6 | 87.6 | 93.4 | 95.3 | 91.1 | 92.0 |

Table 4-6. (cont.)

| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | Relative Foliar Cover (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Spring 1997 | Summer 1997 | Spring 1998 | Summer 1998 | Spring 1999 | Summer 1999 |
| Total native cover | | | | | 67.5 | 71.5 | 62.3 | 57.8 | 59.9 | 67.9 |
| Total non-native cover | | | | | 32.5 | 28.5 | 37.7 | 42.2 | 40.1 | 32.1 |
| Total warm-season graminoid cover | | | | | 55.4 | 64.2 | 54.6 | 52.0 | 50.0 | 60.4 |
| Total cool-season graminoid cover | | | | | 26.2 | 23.4 | 38.7 | 43.4 | 41.1 | 31.6 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (500).
Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).
All cover values presented are means (n = 5).
Native categories: Y = Native, N = Non-Native
Form categories: C = Cactus, F = Forb, G = Graminoid
Cool/Warm Season categories: C = Cool season species, W = Warm season species

# Appendix A

## Report 5

## 1999 Mesic Mixed Grassland Monitoring Summary

# 5. 1999 Mesic Mixed Grassland Monitoring Summary

## 5.1 Purpose

Monitoring is an integral part of determining whether the management objectives and goals for the plant communities at Rocky Flats Environmental Technology Site (the Site) are being achieved (K-H 1997a,b). Consistent with this goal, long-term quantitative monitoring is necessary to determine whether changes are taking place in the plant communities that would otherwise go undetected through the use of broader-scale qualitative monitoring techniques.

During 1999, three permanent monitoring sites (TR02, TR04, and TR11) in the mesic mixed grassland community that were last monitored in 1995 were monitored again to reassess conditions and document any change (DOE 1995a; K-H 1997c).

## 5.2 Background Information

The plant communities monitored at the Site from 1993 through 1995 were organized along a soil moisture (hydrologic) gradient that ranged from xeric (dry) to mesic (moderate moisture) to hydric (wet). This followed the plant community classification that was outlined in the baseline study (DOE 1992), which identified xeric (xeric mixed grassland), mesic (mesic mixed grassland), and hydric (riparian community) communities at the Site. Since these mesic mixed grassland sites were monitored in 1995, weed control efforts had been conducted at some locations. In May 1999, site TR02 was sprayed with Tordon 22K by helicopter to control the noxious weed diffuse knapweed (*Centaurea diffusa*).

## 5.3 Methods

During 1999, the mesic mixed grassland sites, TR02, TR04, and TR11 (Figure 5-1), were monitored for species richness, cover, and frequency. The sampling methods and procedures used at these sites during 1999 were the same as those used in 1993–1995, with the addition of a measure for species frequency. A total of fifteen 50-m transects (five at each site) were monitored in 1999. Transects were sampled in the spring and again in late summer. Species richness and frequency were monitored during both sampling sessions. Cover was sampled only during the late-summer session. Species richness was determined in a 2-m-wide belt centered along the length of each 50-m transect. Every plant species rooted within the 100-$m^2$ area was recorded. In addition, the numbers of woody plant stems and cactus stems were counted and recorded for the 100-$m^2$ area.

Basal cover and foliar cover were estimated using a point-intercept method along each 50-m transect. A 2-m-long, 6-mm-diameter rod was dropped vertically at 50-cm intervals along the transect to record a total of 100 intercept points. Two categories of hits were recorded, basal and foliar. Basal cover hits were recorded based on what material was hit by the rod at the ground surface. Hits could be vegetation (live plants), litter (fallen dead material), rock (pebbles and cobbles that were greater than the rod diameter), bare ground, or water, in that order of priority based on the protection from erosion provided by each type of cover. Basal vegetation hits were recorded by species only if the rod was touching the stem or crown of the plant where the plant entered the ground. Foliar vegetation hits (defined as a portion of a plant touching the rod) were recorded by species in three categories as defined by height and growth form. The topmost hit of each growth form was recorded. The growth forms measured were herbaceous, woody <2 m in height, and woody >2 m in height.

Frequency information by species was gathered by randomly locating 25 1-$m^2$ quadrats (five per transect) at each site. Additionally, a single photograph was taken of each transect during the late summer sampling session to visually document the condition of the transect. Photographs were taken from the 0-m end of the transect near the permanent marker, looking toward the 50-m endpoint. A placard placed in the photograph against the 0-m endpoint provided the site and transect numbers and date.

For more detailed information on these methods see, the *Ecological Monitoring Program, Final Program Plan* (DOE 1993), the *Environmental Management Operating Procedures Manual, Volume V, Ecology, 5-51200-OPS-EE* (DOE 1995b), and the *1999 Ecological Field Monitoring Plans for the Rocky Flats Environmental Technology Site* (K-H 1999a).

Species richness data were summarized by generating a species list for each site. To make the 1999 data compatible with past data analyses, belt-transect data, point-intercept data, and quadrat data were combined to provide overall species richness for analysis. Other species richness variables were calculated from the species lists and used for comparison. Basal cover data are reported as total percent cover of vegetation, litter, rock, and bare ground. Foliar cover data are reported as frequency, absolute cover, and relative cover for each species encountered. Frequency from the cover data was defined as the percent of point-intercept transects on which a species occurred, out of the total possible five sampled at each site. Absolute foliar cover was the percentage of the number of hits on a species out of the total number of hits possible at a site (500). This value is the actual cover of a species. Relative foliar cover was the number of hits a species had relative to the total number of vegetative hits recorded per site (i.e., the percent of total vegetative cover [100 percent] represented by the species). Both absolute and relative foliar cover values are presented as means. A Shannon-Weaver diversity index was used to calculate diversity and was conducted using the relative foliar cover data (Brower and Zar 1977). Frequency based on quadrats (n=25) was defined as the number of quadrats in which a species was recorded, divided by 25 (the total number of quadrats possible), and multiplied by 100. Descriptive comparisons were made between the 1993–1995 and 1999 data sets to examine potential changes over time.

## 5.4 Results

A total of 141 species were recorded at all three mesic mixed grassland sites monitored in 1999. The number of species found at each site varied from 93 (TR02) to 111(TR11) (Table 5-1). The percentage of native species found across all sites combined was 80 percent, with individual sites ranging from 76 to 82 percent (Table 5-1).

Overall cactus and woody plant densities across all three sites were 0.27 and 1.15 plants/$m^2$, respectively (Table 5-2). Cactus density was highest at site TR11 (0.31 plants/$m^2$), and lowest at TR04 (0.21 plants/$m^2$; Table 5-2). Woody plant density, composed of Spanish bayonet (*Yucca glauca*) and/or prairie wild rose (*Rosa arkansana*) was highest at TR02 (2.01 plants/$m^2$) and lowest at TR11 (0.53 plants/$m^2$; Table 5-2).

Basal vegetation cover in 1999 was 8.3 percent for the mesic mixed grassland community. Other ground cover classifications, in descending order of importance, came from litter (71 percent), rock (15 percent), and bare ground (5.7 percent). Total foliar cover for the mesic mixed grassland community in 1999 was 84.7 percent, with individual sites ranging from 77 percent at TR02 to 91 percent at TR11 (Tables 5-3 through 5-6). Total native relative foliar cover averaged approximately 65 percent across all sites (Table 5-3). Graminoid cover provided approximately 82 percent of the relative vegetation cover, with cool-season and warm-season grasses providing approximately 50 and 32 percent, respectively (Table 5-3). Forbs provided about 18 percent relative cover (Table 5-3). Shannon-Weaver diversity indices were calculated for the mesic mixed grassland cover data for 1993, 1994, 1995, and 1999. From 1993 to 1995, diversity values declined slightly, from 1.160 to 1.057. In 1999, however, the value increased to 1.256.

The mesic mixed grassland in 1999 was dominated by blue grama (*Bouteloua gracilis*; 17.6 percent), western wheatgrass (*Agropyron smithii*; 14.8 percent), Japanese brome (*Bromus japonicus*; 12 percent), and sideoats grama (*Bouteloua curtipendula*; 8.8 percent; Table 5-3). However, considerable differences existed among individual sites in terms of dominant species. Site TR02 was dominated by blue grama, western wheatgrass, and sideoats grama, all of which are native species (Table 5-4). At TR04, the dominant species were blue grama, western wheatgrass, and Japanese brome; the latter is an exotic species (Table 5-5). Site TR11 was dominated by three exotic species, Japanese brome, downy brome (*Bromus tectorum*), and Kentucky bluegrass (*Poa pratensis*; Table 5-6).

Species frequency results from the quadrat data are presented for the first time, having never been collected before, for both spring and summer sampling sessions in Table 5-7. Different sites had differing frequencies for the various species, and this information will be most useful for comparing to future monitoring results, to assess any changes that may occur.

## 5.5 Discussion

The permanent transects at the mesic mixed grassland sites TR02, TR04, and TR11 were monitored during 1999, and the data were compared to those from 1993–1995. Total community species richness in 1999 (141 species) was the same as measured in 1994 and 1995 (143 and 141 species, respectively). Total species richness at sites TR04 and TR11 in 1999 was slightly higher than past values, indicating that little change had occurred at these sites (Table 5-1). At TR02, however, a decrease of 15 species was noted from the 1995 species richness values (Table 5-1). Most of the species that were observed in 1995 but not in 1999 were forbs, which likely were affected by the aerial herbicide application in May 1999. Of those not present in 1999, 12 (80 percent) were native species and 3 (20 percent) were non-native species. Based on studies elsewhere on the Site that are examining the impact of herbicide treatments on non-target species, it is expected that these species richness values should return to pre-treatment levels in the next year or two. Also, many of these species were observed outside the transect boundaries, so they were not eliminated from the grassland. Future monitoring will document the return of these species to the transects. The percentage of native species at each site remained consistent with past measurements (Table 5-1).

Litter cover in mesic mixed grassland in 1999 (71 percent) was substantially higher than that documented in 1995 (59 percent; K-H 1997c). The high litter amounts continue to underscore the need for prescribed burning and/or grazing to help remove the built-up dead plant matter on the grasslands at the Site. Planning is underway for a spring 2000 prescribed burn on some of the grasslands at the Site, which will help alleviate this problem. Fire will reduce litter loads and recycle tied up nutrients, thus increasing the vigor and health of many of the native species.

Total foliar cover for the mesic mixed grassland community in 1999 was not substantially different from past measurements (Table 5-3). Additionally, total graminoid cover and total forb cover across all sites combined were within previously measured ranges, suggesting that no changes in the community structure have occurred (Table 5-3). Species diversity (Shannon-Weaver) changed little and actually increased slightly from past measures. The percent of cover from native plant species increased in 1999 compared to past measurements, which had shown continuing declines for 1993–1995 at all three sites and in the community as a whole (Tables 5-3 through 5-6). This reversal suggests improvement of the mesic mixed grassland community, some of which is likely explained by the changes in cool- versus warm-season graminoid cover discussed below. While total non-native foliar cover decreased in the community, non-native forb cover changed little across all sites combined, indicating that the weeds are still a problem in general (Table 5-3). However, at TR02, where the aerial herbicide application was conducted, declines in forb cover of both native and non-native species were observed (Table 5-4). The declines in native forb cover were expected, and these species should return to pre-treatment levels over the next few years, based on other studies where Tordon 22K has been sprayed (Rice and Toney 1996; Rice et al. 1997; K-H 1998).

One measure that changed substantially from past measurements is the cool- versus warm-season graminoid composition of the mesic mixed grassland. In the past, cool-

season graminoids accounted for approximately 70 percent of the total foliar cover on the mesic mixed grassland at the Site, while warm-season graminoids accounted for 5–14 percent (Table 5-3, Figure 5-2). In 1999, cool-season graminoid cover dropped to about 50 percent of the total cover, while warm-season graminoid cover increased to approximately 32 percent (Table 5-3; Figure 5-2). The loss of cool-season graminoid cover is due largely to the 26-percent reduction in the cover of Japanese brome and 6-percent loss of western wheatgrass observed from 1995 to 1999 (Table 5-3). Although relative cover values are mentioned here because they are the best measure of actual species composition of the vegetation present, the absolute or actual cover of these species also declined by similar amounts. This decline indicates that the reduction is real, not just an artifact of increasing warm-season cover (Table 5-3).

In previous monitoring, Japanese brome had the highest cover of all species on the mesic mixed grassland. As an annual grass, large fluctuations in Japanese brome cover are possible due to annual fluctuations in the timing of precipitation events (Rosentreter 1994). This fact, combined with a lack of cover data for the years 1996–1998, make interpretation of the 1999 results difficult. Was the low cover of Japanese brome and/or other cool-season graminoids in 1999 part of a normal cyclical fluctuation in response to environmental conditions, or perhaps part of a steady decline that has been occurring over the past several years? The lack of a continuous data set (i.e., three years of missing data) and other biotic and abiotic measurements make it difficult to say for sure. The fact remains that, in 1999, Japanese brome and cool-season graminoids in general accounted for substantially less cover than in the past on the mesic mixed grassland.

The lack of data for 1996–1998 confounds any attempt to discern a pattern that would elucidate the cause of the large increase in warm-season graminoid cover observed in 1999. Without intermediate data between 1995 and 1999, the increase cannot be explained as simply a mathematical reversal of relative foliar cover (i.e., loss of relative cover of cool-season graminoids automatically means an increase in warm-season graminoids). Precipitation rates also may have been a factor. Summer precipitation was above average in 1999, and the Site has received above-average precipitation for the July–September timeframe in three of the past four years (Figure 5-3). The moisture appeared in 1999 to have benefited many of the warm-season graminoid species at the Site. Substantial increases were noted in the absolute or actual cover of blue grama and sideoats grama on the mesic mixed grassland, both native grasses to the region. Additionally, species such as big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), indiangrass (*Sorghastrum nutans*), and mountain muhly (*Muhlenbergia montana*) common xeric tallgrass prairie species, all flowered profusely in 1999. While the heavier summer precipitation could account, at least partially, for the increase in warm-season cover, no similar decreases in spring precipitation were apparent that might account for the decreases in cool-season species over the same time period (Figure 5-3). Without data on the warm-season graminoid cover for 1996—1998, it is difficult to support the hypothesis that a steady increase in cover has occurred since 1995, or alternatively, that this change was observed only in 1999. This issue illustrates that when monitoring is not done on an annual basis, it becomes difficult to determine

whether changes from one data set to another represent ongoing trends or isolated anomalies.

Taken separately, individual sites also demonstrated these differences, although with some variation. The change in cool-season versus warm-season graminoid composition was most pronounced at TR02, where the warm-season graminoids actually became the dominant species in 1999. Relative foliar cover of warm-season graminoids at TR02 increased from 8 percent in 1995 to just over 50 percent in 1999, with most of this increase coming from blue grama and sideoats grama (Table 5-3). Relative foliar cover of cool-season graminoids decreased from 66 percent to 40 percent during the same time period (Table 5-3). In addition to the higher summer precipitation mentioned above as a possible reason for this change in composition, this site also received the aerial herbicide treatment of Tordon 22K that was applied in mid-May 1999. By the time the herbicide was applied, most of the cool-season graminoid species would have been growing and getting ready to flower. Thus, by the time the herbicide actually took effect on the target species and some of the non-target species, the opportunity for the cool-season graminoid species to take advantage of the reduced competition would have passed. Instead, the warm-season graminoid species, which would have just started their growth period, would have been able to take advantage of the reduced competition and higher summer precipitation, thus accounting for much of the increase in cover.

Large changes in cool- versus warm-season graminoid cover were also observed at TR04, which received no herbicide treatment (Table 5-5). At TR11 increased warm-season and decreased cool-season graminoid cover was also observed, but at much lower amounts (Table 5-6). Thus, although a shift in cover composition was noted across all sites, the shift was not of equal magnitude at every site. The intra-site differences may be due to microsite differences and, at TR02, the herbicide treatment.

From a management standpoint, the shift in graminoid composition observed in 1999 is a beneficial one. Japanese brome and downy brome, commonly referred to as cheatgrasses, are both non-native species that have taken over millions of acres across the western United States (Pellant and Hall 1994). Areas infested by these cool-season annual grasses often have lower species richness and diversity, less ecosystem stability, increased potential for soil erosion, more frequent wildfires, and lower wildlife and livestock utilization (Rosentreter 1994). Infestation by these grasses has been mentioned previously as a potential management concern for the Site (DOE 1995a). The concern is lessened by the reduction of these species in the mesic mixed grassland, as seen in the 1999 data, and a shift to a more perennial, warm-season graminoid composition.

In general, the 1999 monitoring data showed that the mesic mixed grassland sites have remained much the same since they were last monitored in 1995. Species richness, diversity, and most foliar cover measures remained essentially unchanged. Native foliar cover increased, which is a positive change. The most unexpected change was the overall increase in warm-season graminoid cover observed at all sites and in the community overall. The reduced cover of Japanese brome and increased cover of native, perennial graminoids should reduce the potential for soil erosion and accidental fire, in addition to

providing higher quality habitat. An important question is whether this observed shift is only a short-term change or an indication of a longer-term trend. The lack of continuous data sets for these sites makes this difficult to interpret, but future monitoring will show whether the current status continues. Either way, the 1999 results indicate a beneficial shift, and suggest that the overall quality of the mesic mixed grassland at these locations has improved somewhat since they were last monitored.

Based on these results and the criteria mentioned in the Integrated Monitoring Plan (K-H 1999b), when a substantial change is noted in any of the measured variables, an evaluation is recommended to determine whether the management goals are being achieved. As mentioned above, the large decrease in cover of Japanese brome and increase in warm-season perennial, native grasses is a beneficial change. However, from a management standpoint, it is important to know whether this was simply an annual fluctuation observed in 1999, or part of a longer-term trend. Therefore, it is suggested that consideration be given to monitoring the mesic grassland sites again during 2000. A second year of continuous data would help answer this question.

The information based on quantitative monitoring, combined with qualitative assessments of Site ecological resources from other monitoring efforts, continues to suggest that active management of the grassland communities on the Site is necessary to maintain the quality and health of these communities, and to preserve these resources for future generations. The integrated weed management program at the Site continues to address the noxious weed issues. As in the other grassland communities at the Site, the buildup of dead plant litter that results from a lack of fire and grazing is also a problem, and progress is being made in instituting the use of prescribed burns for resource management. In conclusion, the mesic mixed grassland remains a dominant plant community at the Site. As such, its preservation is important for providing habitat for many of the wildlife species at the Site and because it is an increasingly rare community in the region as development continues to transform the landscape around the boundaries of the Site. As good stewards of the ecological resources at the Site, the DOE and K-H will continue to use best management practices to preserve this disappearing landscape for the American public.

## 5.6 References

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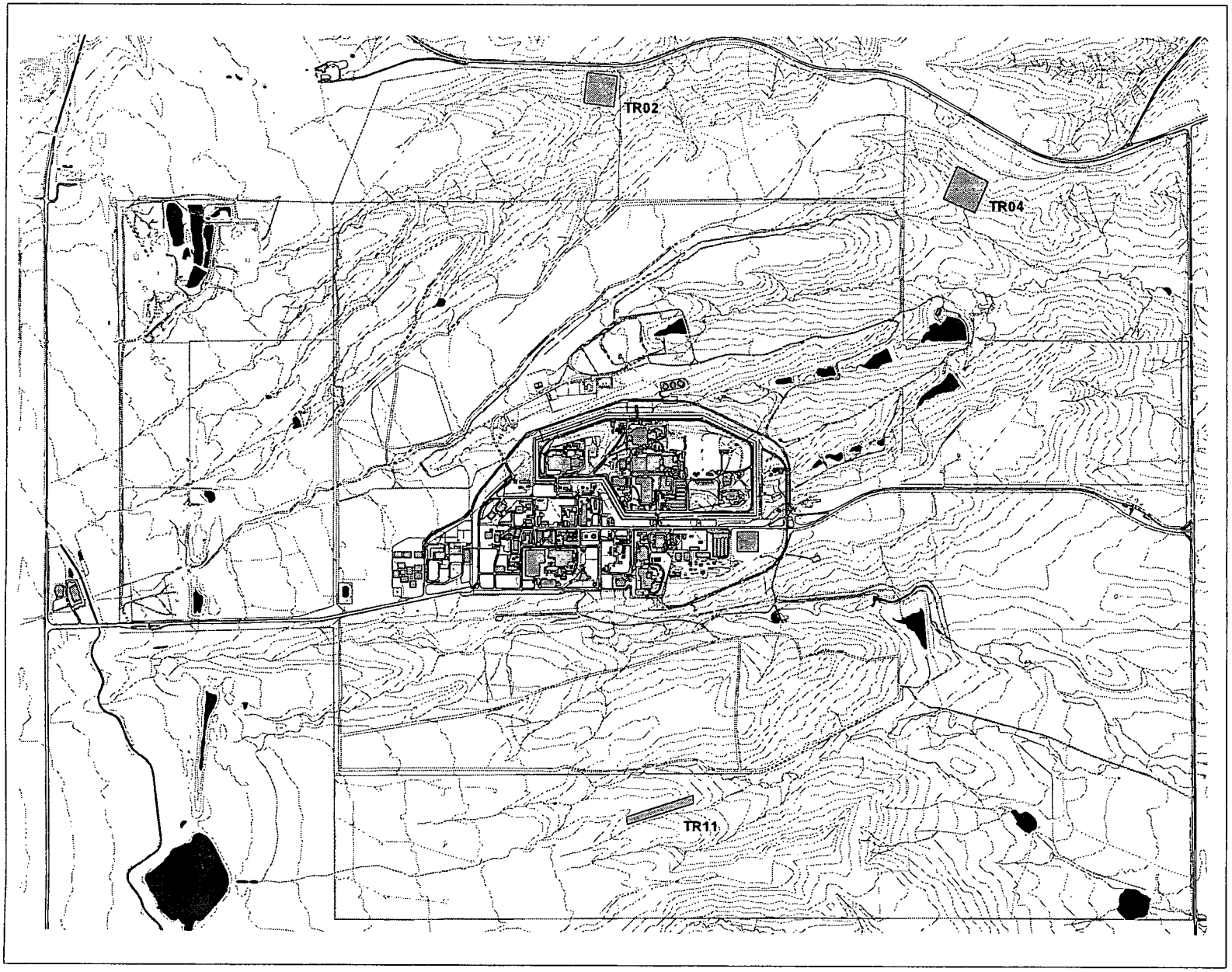
# Figures




# Mesic Mixed Grassland Monitoring Plot Locations

Figure 5-1

MAP LEGEND

Mesic Mixed Grassland

Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
Permanent vegetation monitoring locations provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G R&L, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

Note:

Monitoring locations are approximate. Permanent transects endpoints are marked with rebar.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0035

March 14, 2000

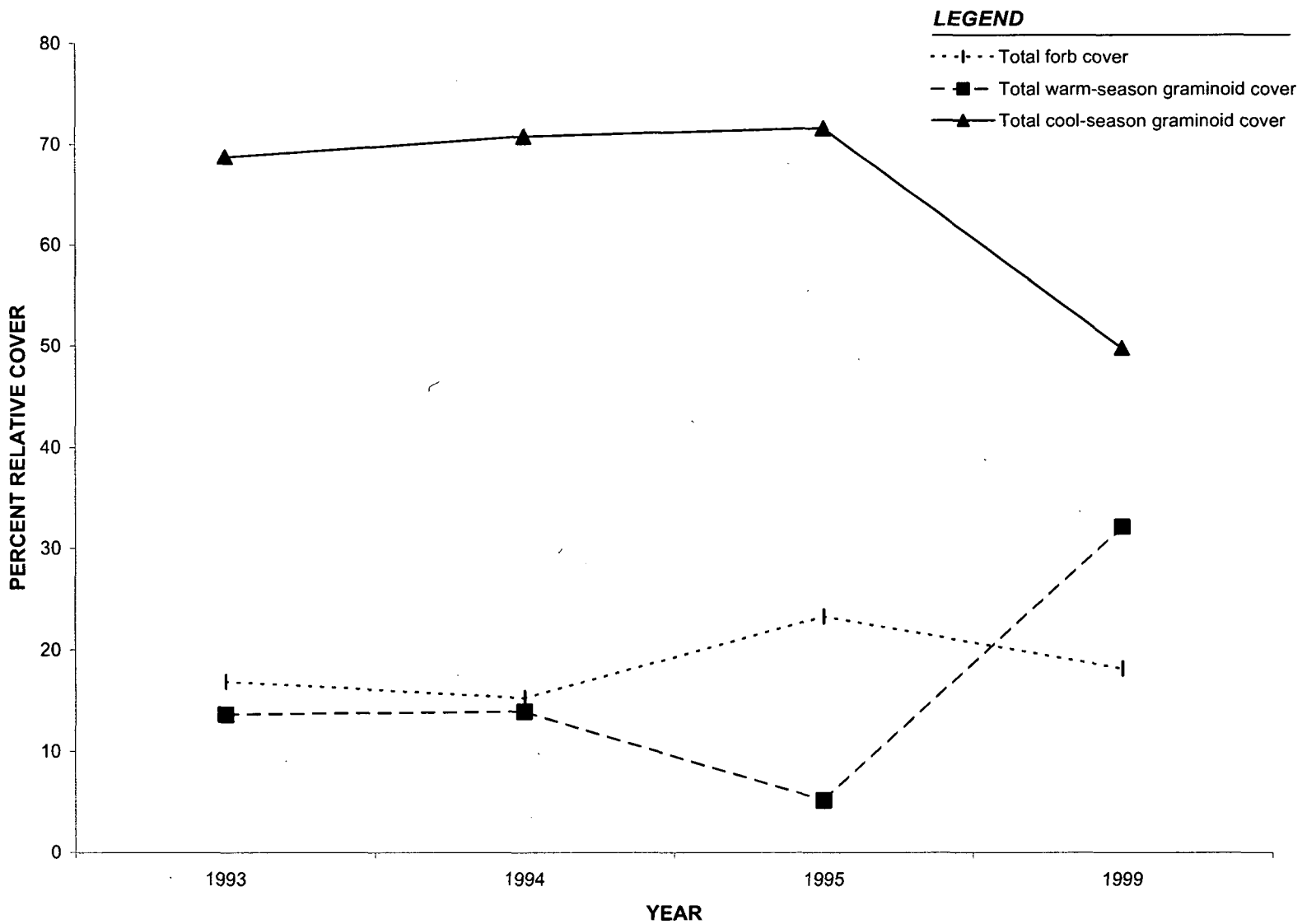



Figure 5-2. Cool-season versus warm-season graminoid cover: 1993-1995, 1999.

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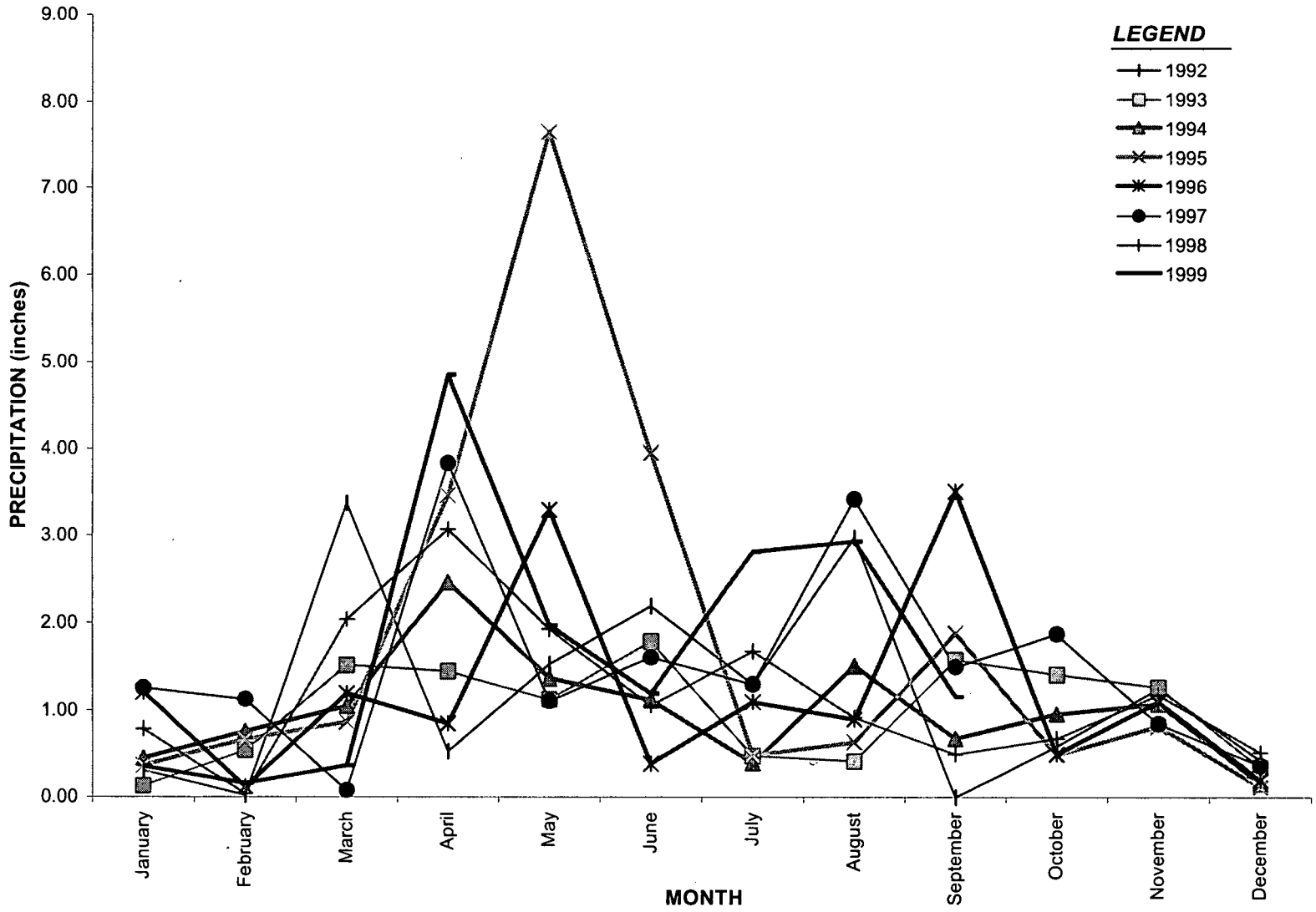


Figure 5-3. 1992-1999 monthly precipitation means for Rocky Flats Environmental Technology Site.

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# Tables

Table 5-1. 1993-1995, And 1999 Mesic Mixed Grassland Species Richness

| Family | Scientific Name | Speccode | Native | TR02 | | | | TR04 | | | | TR11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| AGAVACEAE | Yucca glauca Nutt. | YUGL1 | Y | X | X | X | X | | | | | X | X | X | X |
| APIACEAE | Astragalus lotiflorus Hook. | ASLO1 | Y | | | | | | | | X | | | | |
| APIACEAE | Harbouria trachypleura (Gray) C. & R. | HATR1 | Y | X | | | | | | | | | | | |
| APIACEAE | *Lomatium orientale Coult. & Rose* | *LOOR1* | Y | | X | X | X | | X | X | X | | X | X | X |
| APIACEAE | Musineon divaricatum (Pursh.) Nutt. var. hookeri T. & G. | MUDI1 | Y | | X | X | X | | X | X | X | | X | X | X |
| ASCLEPIADACEAE | Asclepias pumila (Gray) Vail | ASPU1 | Y | X | X | X | X | | | | | | | | |
| ASCLEPIADACEAE | Asclepias speciosa Torr. | ASSP1 | Y | | | | | | | | | X | | X | X |
| ASCLEPIADACEAE | Asclepias viridiflora Raf. | ASVI1 | Y | | | | | | | X | | | | X | |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | ACMI1 | Y | | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Ambrosia psilostachya DC. | AMPS1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Arnica fulgens Pursh. | ARFU1 | Y | | | | | | X | | | | X | X | X |
| ASTERACEAE | Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem. | ARCA1 | Y | | | | X | X | | | X | | | | X |
| ASTERACEAE | Artemisia dracunculus L. | ARDR1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Artemisia frigida Willd. | ARFR1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Aster falcatus Lindl. | ASFA1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Aster porteri Gray | ASPO1 | Y | X | X | X | X | | | | X | X | X | X | X |
| ASTERACEAE | Aster sp. | AST1 | | | | | | X | X | | | | | | |
| ASTERACEAE | Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | CANU1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Centaurea diffusa Lam. | CEDI1 | N | X | X | X | X | X | | X | X | | | X | X |
| ASTERACEAE | *Chrysopsis fulcrata Greene* | *CHFU1* | Y | X | | | X | | | | | X | X | X | X |
| ASTERACEAE | Chrysopsis villosa Pursh. | CHVI1 | Y | X | X | X | X | X | X | X | X | | | X | X |
| ASTERACEAE | Cirsium arvense (L.) Scop. | CIAR1 | N | | X | | | X | X | X | X | X | X | X | X |
| ASTERACEAE | Cirsium undulatum (Nutt.) Spreng. | CIUN1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Crepis occidentalis Nutt. | CROC1 | Y | | | | | | | | | | X | | |
| ASTERACEAE | Erigeron divergens T. & G. | ERDI1 | Y | X | X | X | X | X | X | X | X | | X | | X |
| ASTERACEAE | *Erigeron flagellaris A. Gray* | ERFL1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Gutierrezia sarothrae (Pursh.) Britt. & Rusby | GUSA1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Helianthus annuus L. | HEAN1 | Y | | | X | | | | | X | | X | X | |
| ASTERACEAE | Helianthus petiolaris Nutt. | HEPE1 | Y | | | | X | | | X | X | | | X | X |
| ASTERACEAE | Helianthus pumilus Nutt. | HEPU1 | Y | X | X | X | X | X | X | | | X | X | | |
| ASTERACEAE | Helianthus sp. | HEL1 | | | | X | | | | X | | | X | | |
| ASTERACEAE | Hymenopappus filifolius Hook. var. cinereus (Rydb.) I. M. Johnst. | HYFI1 | Y | X | | X | X | | | | | X | | | |
| ASTERACEAE | Kuhnia chlorolepis Woot. & Standl. | KUCH1 | Y | | | X | X | X | | | | X | | X | X |
| ASTERACEAE | Kuhnia eupatorioides L. | KUEU1 | Y | X | X | X | X | X | X | X | X | | X | X | X |
| ASTERACEAE | Kuhnia sp. | KUH1 | | | | | | | X | | | | X | | |
| ASTERACEAE | *Lactuca serriola L.* | LASE1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Liatris punctata Hook. | LIPU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Microseris cuspidata (Pursh.) Sch. Bip. | MICU1 | Y | | X | X | X | | X | X | | | X | X | X |
| ASTERACEAE | Picradeniopsis oppositifolia (Nutt.) Rydb. | PIOP1 | Y | | | | | | | | | | X | X | X |
| ASTERACEAE | Ratibida columnifera (Nutt.) Woot. & Standl. | RACO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ASTERACEAE | Scorzonera laciniata L. | SCLA1 | N | X | X | X | X | X | X | X | X | | X | X | X |

Table 5-1. (cont.)

| | | | | TR02 | | | | TR04 | | | | TR11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Native | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| ASTERACEAE | Senecio integerrimus Nutt. | SEIN1 | Y | | X | | | | X | X | X | | X | | |
| ASTERACEAE | Senecio plattensis Nutt. | SEPL1 | Y | | X | X | X | | X | | | | X | X | X |
| ASTERACEAE | Senecio spartioides T. & G. | SESP1 | Y | X | X | X | X | | | | | X | X | X | X |
| ASTERACEAE | Solidago missouriensis Nutt. | SOMI1 | Y | | | | | X | X | X | X | X | X | X | X |
| ASTERACEAE | Solidago mollis Bart. | SOMO1 | Y | | | | | X | | | | | | | |
| ASTERACEAE | Solidago rigida L. | SORI1 | Y | | X | X | X | | | | | | | | |
| ASTERACEAE | Solidago sp. | SOL2 | | | | | | | X | | | | X | | |
| ASTERACEAE | Sonchus asper (L.) Hill | SOAS1 | N | | | | | | | | X | | | | |
| ASTERACEAE | Taraxacum laevigatum (Willd.) DC. | TALA1 | N | | | X | | | | | | | | | |
| ASTERACEAE | Taraxacum officinale Weber | TAOF1 | N | X | X | X | X | X | X | X | X | | X | X | X |
| ASTERACEAE | Thelesperma megapotanicum (Spreng.) O. Ktze. | THME1 | Y | | | X | | | | | | | | | |
| ASTERACEAE | Tragopogon dubius Scop. | TRDU1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| BORAGINACEAE | Lappula redowskii (Hornem.) Greene | LARE1 | Y | | X | X | X | | X | X | | | X | X | X |
| BORAGINACEAE | Lithospermum incisum Lehm. | LIIN1 | Y | | X | | X | | | | X | X | X | X | X |
| BORAGINACEAE | Onosmodium molle Michx. var. occidentale (Mack.) Johnst. | ONMO1 | Y | X | X | X | X | | | | X | | | | |
| BRASSICACEAE | | BR1 | | | | X | | | | | | | X | | |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| BRASSICACEAE | Arabis fendleri (S. Wats.) Greene var. fendleri | ARFE3 | Y | | | | | | | | | | X | | |
| BRASSICACEAE | Arabis glabra (L.) Bernh. | ARGL1 | N | | | | | | X | X | X | | | | |
| BRASSICACEAE | Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins | ARHI1 | Y | | | | | | | | X | | | | |
| BRASSICACEAE | Arabis sp. | ARA1 | | | X | | | | | | | | | | |
| BRASSICACEAE | Camelina microcarpa Andrz. ex DC. | CAMI1 | N | | X | X | | X | X | X | X | X | X | X | X |
| BRASSICACEAE | Descurainia pinnata (Walt.) Britt. | DEPI1 | Y | | X | X | X | | X | X | X | | X | X | X |
| BRASSICACEAE | Descurainia richardsonii (Sweet) Schultz | DERI1 | Y | | | | | | X | X | X | | X | X | X |
| BRASSICACEAE | Descurainia sophia (L.) Webb ex Prantl. | DESO1 | N | | | | | | | | | X | | | |
| BRASSICACEAE | Descurainia sp. | DES1 | | | | | | | X | | | | | | |
| BRASSICACEAE | Draba reptans (Lam.) Fern. | DRRE1 | Y | | X | X | | | X | X | X | | X | X | X |
| BRASSICACEAE | Erysimum capitatum (Nutt.) DC. | ERCA2 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| BRASSICACEAE | Erysimum repandum L. | ERRE1 | N | | | | | | X | X | X | | | | |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | LECA1 | N | | | | X | | | | X | | | | |
| BRASSICACEAE | Lepidium densiflorum Schrad. | LEDE1 | Y | | | X | | | X | X | | | | | |
| BRASSICACEAE | Lepidium sp. | LEP1 | | | | | | | X | | | | X | X | |
| BRASSICACEAE | Lesquerella montana (A. Gray) Wats. | LEMO1 | Y | X | X | X | X | | | | | X | X | X | X |
| BRASSICACEAE | Sisymbrium altissimum L. | SIAL1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| BRASSICACEAE | Thlaspi arvense L. | THAR1 | N | | | X | | | X | X | | | | | |
| CACTACEAE | Coryphantha missouriensis (Sweet) Britt. & Rose | COMI1 | Y | | X | X | X | | X | X | X | | X | X | |
| CACTACEAE | Echinocereus viridiflorus Engelm. | ECVI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| CACTACEAE | Opuntia fragilis (Nutt.) Haw. | OPFR1 | Y | X | X | X | | X | X | X | X | X | X | X | X |
| CACTACEAE | Opuntia macrorhiza Engelm. | OPMA1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| CACTACEAE | Opuntia polyacantha Haw. | OPPO1 | Y | | | | | X | | | | | | | |
| CACTACEAE | Pediocactus simpsonii (Engelm.) Britt. & Rose | PESI1 | Y | | X | | | | | | | | | | |
| CAMPANULACEAE | Triodanis leptocarpa (Nutt.) Nieuw. | TRLE1 | Y | | | X | | | | | | | | | |
| CAMPANULACEAE | Triodanis sp. | TRI2 | | | X | | | | X | | | | | | |

Table 5-1. (cont.)

| | | | | TR02 | | | | TR04 | | | | TR11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Native | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| CARYOPHYLLACEAE | Paronychia jamesii T. & G. | PAJA1 | Y | | X | | | | | | | | | | |
| CARYOPHYLLACEAE | Silene antirrhina L. | SIAN1 | Y | | X | X | | | X | X | X | | X | X | X |
| CARYOPHYLLACEAE | Silene drummondii Hook. | SIDR1 | Y | | | X | | | | | | | X | | X |
| CHENOPODIACEAE | | CH1 | | | | X | | | | | | | | | |
| CHENOPODIACEAE | Chenopodium album L. | CHAL1 | N | | | | X | | | | | | | | |
| CHENOPODIACEAE | Chenopodium leptophyllum Nutt. ex Moq. | CHLE2 | Y | X | X | X | | X | X | X | X | X | X | X | |
| CLUSIACEAE | Hypericum perforatum L. | HYPE1 | N | X | X | X | X | X | X | | X | X | X | X | X |
| COMMELINACEAE | Tradescantia occidentalis (Britt.) Smyth | TROC1 | Y | | X | X | X | | X | X | X | | X | X | X |
| CONVOLVULACEAE | Convolvulus arvensis L. | COAR1 | N | X | X | X | X | | | | | | | X | X |
| CONVOLVULACEAE | Evolvulus nuttallianus R. & S. | EVNU1 | Y | X | X | X | X | X | | X | X | X | X | X | X |
| CYPERACEAE | Carex sp. | CAR1 | | | | | | | X | | | | | | |
| CYPERACEAE | Carex eleocharis Bailey | CAEL1 | Y | X | X | X | | X | X | X | X | X | | | X |
| CYPERACEAE | Carex heliophila Mack. | CAHE1 | Y | | X | X | X | | X | | X | | X | X | X |
| CYPERACEAE | Carex interior Bailey | CAIN1 | Y | | | | | | | | | | X | | |
| CYPERACEAE | Carex oreocharis Holm. | CAOR1 | Y | | X | | | | | | | X | | | |
| EUPHORBIACEAE | Euphorbia dentata Michx. | EUDE1 | Y | | | | | | | | | | X | | X |
| EUPHORBIACEAE | Euphorbia marginata Pursh. | EUMA1 | Y | | | X | | | | | | | | X | |
| EUPHORBIACEAE | Euphorbia robusta (Engelm.) Small | EURO1 | Y | | X | X | | | | | | | | X | |
| EUPHORBIACEAE | Euphorbia spathulata Lam. | EUSP1 | Y | | X | X | X | | X | X | X | | X | X | X |
| FABACEAE | Astragalus agrestis Dougl. ex G. Don | ASAG1 | Y | | X | | | X | X | X | X | | X | | X |
| FABACEAE | Astragalus crassicarpus Nutt. | ASCR1 | Y | | X | X | | | X | X | X | | | | |
| FABACEAE | Astragalus drummondii Dougl. ex Hook. | ASDR1 | Y | | | | | X | X | X | | | | | |
| FABACEAE | Astragalus flexuosus (Hook.) G. Don | ASFL1 | Y | X | X | X | X | | | | X | | | | |
| FABACEAE | Astragalus shortianus Nutt. ex T.&G. | ASSH1 | Y | | X | X | | | X | | | | X | X | X |
| FABACEAE | Astragalus sp. | AST2 | | | X | | | | | | | | | | |
| FABACEAE | Astragalus tridactylicus Gray | ASTR1 | Y | | X | | | | | | | | | | |
| FABACEAE | Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinners. | DACA1 | Y | X | | X | X | | | X | | X | X | X | X |
| FABACEAE | Dalea purpurea Vent | DAPU1 | Y | X | X | X | X | | | X | X | X | X | X | X |
| FABACEAE | Lathyrus eucosmus Butters and St. John | LAEU1 | Y | | | | | | | | | | | | X |
| FABACEAE | Melilotus officinalis (L.) Pall. | MEOF1 | N | | | | | X | | | | | | | |
| FABACEAE | Oxytropis lambertii Pursh. | OXLA1 | Y | | X | X | X | | | | | | | X | X |
| FABACEAE | Psoralea tenuiflora Pursh. | PSTE1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| FABACEAE | Trifolium sp. | TRI1 | | | | | | | | | | | X | | |
| FABACEAE | Vicia americana Muhl. ex Willd. | VIAM1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| GERANIACEAE | Erodium cicutarium (L.) L'Her. | ERCI1 | N | | X | X | X | | X | X | X | | | X | X |
| HYDROPHYLLACEAE | Phacelia heterophylla Pursh. | PHHE1 | Y | | X | | | | | | | X | X | X | X |
| JUNCACEAE | Juncus dudleyi Wieg. | JUDU1 | Y | | | | | | | | | | | X | |
| JUNCACEAE | Juncus interior Wieg. | JUIN1 | Y | | | | | | | | | | | | X |
| LAMIACEAE | Hedeoma hispidum Pursh. | HEHI1 | Y | | | | | X | | | | X | | | |
| LAMIACEAE | Nepeta cataria L. | NECA1 | N | | | X | | | | | | | | | |
| LAMIACEAE | Scutellaria brittonii Porter | SCBR1 | Y | | | | | | | | | | X | | X |
| LILIACEAE | Allium textile A. Nels. & Macbr. | ALTE1 | Y | X | X | X | X | | X | X | | X | X | X | X |
| LILIACEAE | Calochortus gunnisonii S. Wats. | CAGU1 | Y | | | | | | | X | | X | | X | |

Table 5-1. (cont.)

| | | | | TR02 | | | | TR04 | | | | TR11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Native | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| LILIACEAE | Leucocrinum montanum Nutt. | LEMO2 | Y | | X | X | X | | | X | X | | X | X | X |
| LINACEAE | Linum perenne L. var. lewisii (Pursh.) Eat. & Wright | LIPE1 | Y | X | X | X | X | X | X | X | X | | | | X |
| LINACEAE | Linum pratense (Nort.) Small | LIPR1 | Y | | | | | | | | X | | | | |
| MALVACEAE | Sphaeralcea coccinea (Pursh.) Rydb. | SPCO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| NYCTAGINACEAE | Mirabilis linearis (Pursh.) Heimerl | MILI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ONAGRACEAE | Epilobium paniculatum Nutt. | EPPA1 | Y | X | | | | | | X | | | | | |
| ONAGRACEAE | Gaura coccinea Pursh. | GACO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| ONAGRACEAE | Oenothera howardii (A. Nels.) W. L. Wagner | OEHO1 | Y | | | | | | X | X | X | | | | |
| OROBANCHACEAE | Orobanche fasciculata Nutt. | ORFA1 | Y | | | | | | | X | X | | X | X | X |
| PLANTAGINACE | Plantago lanceolata L. | PLLA1 | N | | | | | X | X | | X | | | | |
| PLANTAGINACE | Plantago patagonica Jacq. | PLPA1 | Y | | | | | X | | X | X | | | X | |
| POACEAE | | PO1 | | | | X | | | | | | | | | |
| POACEAE | Agropyron intermedium (Host) Beauv. | AGIN1 | N | | | | | X | X | | | | | | |
| POACEAE | Agropyron smithii Rydb. | AGSM1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Andropogon gerardii Vitman | ANGE1 | Y | X | X | X | X | | | X | X | X | X | X | X |
| POACEAE | Andropogon scoparius Michx. | ANSC1 | Y | X | X | X | X | | | | | X | X | X | X |
| POACEAE | Aristida purpurea Nutt. var. longiseta (Steud.) Vasey | ARFE1 | Y | X | X | X | | X | X | X | | X | X | X | |
| POACEAE | Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Aristida sp. | ARI1 | | | | | | | X | | | | | | |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | BOCU1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bouteloua hirsuta Lag | BOHI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bouteloua sp. | BOU1 | | | | | | | X | | | | | | |
| POACEAE | Bromus inermis Leyss. ssp. inermis | BRIN1 | N | X | X | X | X | | | | | | | | |
| POACEAE | Bromus japonicus Thunb. ex Murr. | BRJA1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Bromus tectorum L. | BRTE1 | N | X | | X | | X | X | X | X | X | X | X | X |
| POACEAE | Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | Y | X | X | X | X | X | X | X | X | | X | X | X |
| POACEAE | Festuca octoflora Walt. | FEOC1 | Y | | | | | | | | | | | X | |
| POACEAE | Festuca pratensis Huds. | FEPR1 | Y | | | | X | | | | X | | | | |
| POACEAE | Hordeum jubatum L. | HOJU1 | Y | | | | | X | | X | X | | X | | |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | KOPY1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | Y | | | | | X | X | | | | | X | |
| POACEAE | Muhlenbergia wrightii Vasey | MUWR1 | Y | | X | | | X | | X | X | X | X | X | X |
| POACEAE | Poa compressa L. | POCO1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Poa pratensis L. | POPR1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Schedonnardus paniculatus (Nutt.) Trel. | SCPA2 | N | | | | | | | | X | | | | |
| POACEAE | Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | Y | X | X | X | X | X | | | | X | | X | X |
| POACEAE | Sporobolus asper (Michx.) Kunth | SPAS1 | Y | | | | X | | | | | | | | X |
| POACEAE | Sporobolus cryptandrus (Torr.) A. Gray | SPCR1 | Y | X | X | | | | | | X | | | | |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | Y | | | | | | | | | | X | X | X |
| POACEAE | Stipa comata Trin. & Rupr. | STCO1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |
| POACEAE | Stipa sp. | STI1 | | | | | | | | | | | X | | |
| POACEAE | Stipa viridula Trin. | STVI1 | Y | X | X | X | X | X | X | X | X | X | X | X | X |

Table 5-1. (cont.)

| | | | | TR02 | | | | TR04 | | | | TR11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Native | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| POACEAE | Triticum aestivum L. | TRAE1 | N | | | | | | X | | | | | | |
| POLEMONIACEAE | Collomia linearis Nutt. | COLI1 | Y | | X | | | | | X | | | X | X | |
| POLEMONIACEAE | Microsteris gracilis (Hook.) Greene | MIGR1 | Y | | | | | | X | X | X | | | | |
| POLYGONACEAE | Eriogonum alatum Torr. | ERAL1 | Y | X | X | X | X | | | | | X | | | X |
| POLYGONACEAE | Polygonum aviculare L. | POAV1 | N | | | | | X | | | | | | | |
| POLYGONACEAE | Polygonum ramosissimum Michx. | PORA1 | Y | | | | | | | | X | | | | |
| POLYGONACEAE | Polygonum sawatchense Small | POSA1 | Y | | | X | | | X | X | | | | | |
| POLYGONACEAE | Polygonum sp. | POL1 | | | | X | | | | | | | | | |
| RANUNCULACEAE | Delphinium nuttalianum Pritz. ex Walpers | DENU1 | Y | | | | | | | | | | | | X |
| RANUNCULACEAE | Delphinium sp. | DEL1 | | | | | | | X | | | | X | | |
| RANUNCULACEAE | Delphinium virescens Nutt. ssp. penardii (Huth) Ewan | DEVI1 | Y | | | | | | | X | | | | X | X |
| ROSACEAE | Rosa acicularis Lindl. | ROAC1 | Y | X | | | | X | | | | X | | X | |
| ROSACEAE | Rosa arkansana Porter | ROAR1 | Y | | X | X | X | | X | X | X | | X | X | X |
| SANTALACEAE | Comandra umbellata (L.) Nutt. | COUM1 | Y | | X | X | | | X | | X | | X | | X |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | LIDA1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| SCROPHULARIACEAE | Penstemon angustifolius Nutt. ex Pursh | PEAN1 | Y | | X | | | | | | | | | | |
| SCROPHULARIACEAE | Penstemon secundiflorus Benth. | PESE1 | Y | | | X | X | | | | | | X | X | X |
| SCROPHULARIACEAE | Penstemon virens Penn. | PEVI1 | Y | | X | X | | | | | | | X | X | X |
| SCROPHULARIACEAE | Penstemon virgatus Gray ssp. asa-grayi Crosswhite | PEVI2 | Y | | | | | | | | | | | | X |
| SCROPHULARIACEAE | Verbascum blattaria L. | VEBL1 | N | X | X | X | X | X | X | X | X | X | X | X | X |
| SCROPHULARIACEAE | Verbascum thapsus L. | VETH1 | N | | X | | | | | | | X | X | | X |
| SCROPHULARIACEAE | Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren | VEPE1 | Y | | | | | | | X | | | | | |
| SOLANACEAE | Physalis heterophylla Nees | PHHE2 | Y | | | | | | | | | X | | | |
| SOLANACEAE | Physalis sp. | PHY1 | | | | | | | X | | | | | | |
| SOLANACEAE | Physalis virginiana P. Mill. | PHVI2 | Y | | | | | | | X | | | | | |
| TYPHACEAE | Typha latifolia L. | TYLA1 | Y | | | | | X | X | | | | | | |
| VERBENACEAE | Verbena bracteata Lag. & Rodr. | VEBR1 | Y | | | | | | X | | X | | | | |
| VIOLACEAE | Hybanthus verticillatus (Ort.) Baill. | HYVE1 | Y | | X | X | X | | | | | | X | X | X |
| VIOLACEAE | Viola nuttallii Pursh. | VINU1 | Y | | | X | X | | | X | | | X | X | X |
| | Total Number of Species | | | 75 | 107 | 108 | 93 | 75 | 95 | 97 | 100 | 76 | 106 | 110 | 111 |
| | Percent Native Species | | | 77 | 81 | 80 | 80 | 72 | 76 | 79 | 76 | 79 | 83 | 83 | 82 |

**Table 5-2. Woody Stem and Cactus Densities at EcMP Sites (1993-1995 and 1999)**

| | Cactus Density (cacti/sq. meter) | | | | Woody Stem Density (stems/sq. meter) | | | |
|---|---|---|---|---|---|---|---|---|
| **Site** | **1993** | **1994** | **1995** | **1999** | **1993** | **1994** | **1995** | **1999** |
| Mesic Mixed Grassland Community | 0.34 | 0.32 | 0.36 | 0.27 | 0.70 | 0.86 | 1.15 | 1.15 |
| TR02 | 0.43 | 0.25 | 0.47 | 0.29 | 1.24 | 1.32 | 2.17 | 2.01 |
| TR04 | 0.27 | 0.24 | 0.25 | 0.21 | 0.46 | 0.67 | 0.79 | 0.91 |
| TR11 | 0.32 | 0.47 | 0.37 | 0.31 | 0.41 | 0.60 | 0.55 | 0.53 |

Site values are based on n=5.
Community values are based on n=15.

**Table 5-3. 1993-1995, And 1999 Mesic Mixed Grassland Foliar Cover by Community**

| | | | | | Absolute Cover (%) | | | | Relative Cover (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Native | Form | Cool/ Warm Season | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| Opuntia macrorhiza Engelm. | OPMA1 | Y | C | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | N | F | | 0.9 | 2.1 | 2.1 | 2.5 | 1.2 | 2.2 | 2.2 | 2.9 |
| Camelina microcarpa Andrz. ex DC. | CAMI1 | N | F | | 0.3 | 1.3 | 1.0 | 0.1 | 0.3 | 1.4 | 1.0 | 0.1 |
| Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | CANU1 | N | F | | 1.0 | 0.1 | 1.4 | 0.1 | 1.3 | 0.1 | 1.4 | 0.1 |
| Centaurea diffusa Lam. | CEDI1 | N | F | | 0.1 | 0.2 | 0.5 | 0.5 | 0.2 | 0.2 | 0.5 | 0.7 |
| Cirsium arvense (L.) Scop. | CIAR1 | N | F | | 0.1 | 0.0 | 0.0 | 0.3 | 0.1 | 0.0 | 0.0 | 0.3 |
| Convolvulus arvensis L. | COAR1 | N | F | | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 |
| Hypericum perforatum L. | HYPE1 | N | F | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Lactuca serriola L. | LASE1 | N | F | | 0.1 | 0.0 | 0.5 | 0.3 | 0.1 | 0.0 | 0.6 | 0.3 |
| Linaria dalmatica (L.) Mill. | LIDA1 | N | F | | 0.5 | 1.0 | 0.9 | 0.4 | 0.6 | 1.1 | 0.9 | 0.5 |
| Scorzonera laciniata L. | SCLA1 | N | F | | 0.5 | 1.5 | 1.8 | 2.3 | 0.7 | 1.7 | 1.8 | 2.8 |
| Sisymbrium altissimum L. | SIAL1 | N | F | | 0.2 | 0.3 | 0.6 | 0.0 | 0.2 | 0.3 | 0.6 | 0.0 |
| Tragopogon dubius Scop. | TRDU1 | N | F | | 0.9 | 0.1 | 1.3 | 0.5 | 1.3 | 0.2 | 1.4 | 0.6 |
| Verbascum thapsus L. | VETH1 | N | F | | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.6 |
| Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | ACMI1 | Y | F | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Ambrosia psilostachya DC. | AMPS1 | Y | F | | 0.3 | 0.1 | 0.1 | 0.3 | 0.3 | 0.1 | 0.1 | 0.3 |
| Artemisia dracunculus L. | ARDR1 | Y | F | | 0.1 | 0.3 | 0.7 | 0.7 | 0.1 | 0.3 | 0.7 | 0.8 |
| Artemisia frigida Willd. | ARFR1 | Y | F | | 0.2 | 0.3 | 0.3 | 0.1 | 0.3 | 0.3 | 0.3 | 0.1 |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | Y | F | | 1.5 | 0.6 | 1.4 | 0.3 | 1.8 | 0.6 | 1.5 | 0.3 |
| Aster falcatus Lindl. | ASFA1 | Y | F | | 0.8 | 0.3 | 0.7 | 0.8 | 1.1 | 0.3 | 0.7 | 0.9 |
| Astragalus flexuosus (Hook.) G. Don | ASFL1 | Y | F | | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.2 | 0.1 | 0.1 |
| Aster porteri Gray | ASPO1 | Y | F | | 0.1 | 0.0 | 0.3 | 0.0 | 0.1 | 0.0 | 0.3 | 0.0 |
| Chrysopsis villosa Pursh. | CHVI1 | Y | F | | 0.5 | 0.2 | 0.1 | 0.0 | 0.8 | 0.2 | 0.1 | 0.0 |
| Cirsium undulatum (Nutt.) Spreng. | CIUN1 | Y | F | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Comandra umbellata (L.) Nutt. | COUM1 | Y | F | | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 |
| Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinners. | DACA1 | Y | F | | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 |
| Dalea purpurea Vent | DAPU1 | Y | F | | 0.1 | 0.2 | 0.0 | 0.0 | 0.1 | 0.2 | 0.0 | 0.0 |
| Descurainia pinnata (Walt.) Britt. | DEPI1 | Y | F | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Descurainia richardsonii (Sweet) Schultz | DERI1 | Y | F | | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 |
| Eriogonum alatum Torr. | ERAL1 | Y | F | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Erysimum capitatum (Nutt.) DC. | ERAS1 | Y | F | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Erigeron divergens T. & G. | ERDI1 | Y | F | | 0.1 | 0.1 | 0.0 | 0.1 | 0.2 | 0.1 | 0.0 | 0.1 |
| Erigeron flagellaris A. Gray | ERFL1 | Y | F | | 0.3 | 0.5 | 0.2 | 0.5 | 0.4 | 0.5 | 0.2 | 0.5 |

Table 5-3. (cont.)

| Scientific Name | Speccode | Native | Form | Cool/ Warm Season | Absolute Cover (%) 1993 | 1994 | 1995 | 1999 | Relative Cover (%) 1993 | 1994 | 1995 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Evolvulus nuttallianus R. & S. | EVNU1 | Y | F | | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 |
| Gaura coccinea Pursh. | GACO1 | Y | F | | 0.0 | 0.2 | 0.1 | 0.0 | 0.0 | 0.2 | 0.1 | 0.0 |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | Y | F | | 0.1 | 0.2 | 1.0 | 0.2 | 0.2 | 0.2 | 1.0 | 0.2 |
| Gutierrezia sarothrae (Pursh.) Britt. & Rusby | GUSA1 | Y | F | | 0.1 | 0.3 | 0.5 | 0.8 | 0.1 | 0.3 | 0.5 | 0.9 |
| Helianthus petiolaris Nutt. | HEPE1 | Y | F | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Helianthus pumilus Nutt. | HEPU1 | Y | F | | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 |
| Kuhnia chlorolepis Woot. & Standl. | KUCH1 | Y | F | | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Kuhnia eupatorioides L. | KUEU1 | Y | F | | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 |
| Lesquerella montana (A. Gray) Wats. | LEMO1 | Y | F | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Lepidium sp. | LEP1 | Y | F | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Linum perenne L. var. lewisii (Pursh.) Eat. & Wright | LIPE1 | Y | F | | 0.2 | 0.5 | 0.0 | 0.0 | 0.3 | 0.5 | 0.0 | 0.0 |
| Liatris punctata Hook. | LIPU1 | Y | F | | 0.1 | 0.1 | 0.6 | 0.0 | 0.2 | 0.1 | 0.6 | 0.0 |
| Lomatium orientale Coult. & Rose | LOOR1 | Y | F | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Mirabilis linearis (Pursh.) Heimerl | MILI1 | Y | F | | 0.2 | 0.2 | 0.1 | 0.1 | 0.3 | 0.2 | 0.1 | 0.2 |
| Phacelia heterophylla Pursh. | PHHE1 | Y | F | | 0.1 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 |
| Polygonum sawatchense Small | POSA1 | Y | F | | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Psoralea tenuiflora Pursh. | PSTE1 | Y | F | | 2.5 | 2.2 | 4.8 | 2.9 | 3.3 | 2.4 | 4.9 | 3.3 |
| Ratibida columnifera (Nutt.) Woot. & Standl. | RACO1 | Y | F | | 0.4 | 0.1 | 0.5 | 0.4 | 0.6 | 0.1 | 0.5 | 0.5 |
| Solidago missouriensis Nutt. | SOMI1 | Y | F | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Sphaeralcea coccinea (Pursh.) Rydb. | SPCO1 | Y | F | | 0.3 | 0.2 | 0.1 | 0.5 | 0.4 | 0.2 | 0.1 | 0.6 |
| Vicia americana Muhl. ex Willd. | VIAM1 | Y | F | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Agropyron intermedium (Host) Beauv. | AGIN1 | N | G | C | 0.8 | 0.0 | 0.0 | 0.0 | 1.1 | 0.0 | 0.0 | 0.0 |
| Bromus inermis Leyss. ssp. inermis | BRIN1 | N | G | C | 0.1 | 0.1 | 0.2 | 1.1 | 0.2 | 0.2 | 0.2 | 1.4 |
| Bromus japonicus Thunb. ex Murr. | BRJA1 | N | G | C | 14.5 | 29.1 | 37.1 | 10.5 | 19.6 | 31.8 | 38.2 | 12.0 |
| Bromus tectorum L. | BRTE1 | N | G | C | 0.3 | 3.9 | 3.7 | 4.7 | 0.3 | 4.2 | 3.8 | 5.2 |
| Poaceae sp. | PO1 | N | G | C | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Poa compressa L. | POCO1 | N | G | C | 1.4 | 0.9 | 1.2 | 1.8 | 1.8 | 1.0 | 1.2 | 2.0 |
| Poa pratensis L. | POPR1 | N | G | C | 2.9 | 2.6 | 1.0 | 4.6 | 3.6 | 2.8 | 1.0 | 5.2 |
| Schedonnardus paniculatus (Nutt.) Trel. | SCPA2 | N | G | C | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.2 |
| Agropyron smithii Rydb. | AGSM1 | Y | G | C | 21.7 | 18.1 | 20.2 | 12.1 | 29.7 | 20.1 | 20.8 | 14.8 |
| Aristida purpurea Nutt. var. longiseta (Steud.) Vasey | ARFE1 | Y | G | C | 0.1 | 0.2 | 0.0 | 0.0 | 0.1 | 0.2 | 0.0 | 0.0 |
| Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | Y | G | C | 1.1 | 0.5 | 0.8 | 0.6 | 1.4 | 0.6 | 0.8 | 0.7 |
| Carex eleocharis Bailey | CAEL1 | Y | G | C | 2.9 | 0.1 | 0.2 | 0.1 | 3.9 | 0.1 | 0.2 | 0.2 |

Table 5-3. (cont.)

| Scientific Name | Speccode | Native | Form | Cool/ Warm Season | Absolute Cover (%) 1993 | 1994 | 1995 | 1999 | Relative Cover (%) 1993 | 1994 | 1995 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Carex heliophila Mack. | CAHE1 | Y | G | C | 0.0 | 4.1 | 2.2 | 2.5 | 0.0 | 4.5 | 2.3 | 3.0 |
| Carex oreocharis Holm. | CAOR1 | Y | G | C | 1.1 | 0.0 | 0.0 | 0.0 | 1.3 | 0.0 | 0.0 | 0.0 |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | Y | G | C | 0.1 | 0.1 | 0.0 | 0.4 | 0.2 | 0.1 | 0.0 | 0.5 |
| Stipa comata Trin. & Rupr. | STCO1 | Y | G | C | 3.9 | 3.1 | 1.2 | 2.1 | 4.7 | 3.3 | 1.3 | 2.4 |
| Stipa viridula Trin. | STVI1 | Y | G | C | 0.7 | 1.7 | 1.5 | 1.9 | 0.8 | 1.9 | 1.6 | 2.2 |
| Andropogon gerardii Vitman | ANGE1 | Y | G | W | 3.2 | 1.7 | 1.8 | 2.7 | 4.0 | 1.9 | 1.9 | 3.1 |
| Andropogon scoparius Michx. | ANSC1 | Y | G | W | 0.1 | 0.2 | 0.0 | 0.2 | 0.2 | 0.2 | 0.0 | 0.2 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | Y | G | W | 1.6 | 2.4 | 0.9 | 7.1 | 2.2 | 2.7 | 1.0 | 8.8 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | Y | G | W | 4.4 | 6.5 | 2.1 | 14.4 | 6.2 | 7.3 | 2.1 | 17.6 |
| Bouteloua hirsuta Lag | BOHI1 | Y | G | W | 0.4 | 0.9 | 0.1 | 0.1 | 0.6 | 1.0 | 0.1 | 0.1 |
| Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | Y | G | W | 0.1 | 0.5 | 0.1 | 1.8 | 0.2 | 0.6 | 0.1 | 2.1 |
| Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | Y | G | W | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Muhlenbergia wrightii Vasey | MUWR1 | Y | G | W | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 |
| Sporobolus cryptandrus (Torr.) A. Gray | SPCR1 | Y | G | W | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | Y | G | W | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 |
| Rosa arkansana Porter | ROAR1 | Y | S | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Yucca glauca Nutt. | YUGL1 | Y | S | | 0.4 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 |
| Total foliar cover | | | | | 74.7 | 91.3 | 97.0 | 84.7 | 99.9 | 100.0 | 100.0 | 100.0 |
| Total forb cover | | | | | 12.7 | 13.9 | 22.6 | 15.6 | 16.9 | 15.2 | 23.3 | 18.1 |
| Total native forb cover | | | | | 8.1 | 7.3 | 12.3 | 8.1 | 10.9 | 8.0 | 12.6 | 9.3 |
| Total non-native forb cover | | | | | 4.6 | 6.7 | 10.3 | 7.5 | 6.0 | 7.3 | 10.7 | 8.8 |
| Total graminoid cover | | | | | 61.5 | 77.3 | 74.4 | 69.1 | 82.4 | 84.7 | 76.7 | 81.9 |
| Total native cover | | | | | 50.1 | 47.9 | 43.4 | 54.3 | 67.2 | 52.8 | 44.7 | 65.1 |
| Total non-native cover | | | | | 24.6 | 43.4 | 53.6 | 30.3 | 32.7 | 47.2 | 55.3 | 34.9 |
| Total warm-season graminoid cover | | | | | 10.0 | 12.5 | 5.0 | 26.4 | 13.6 | 13.9 | 5.2 | 32.1 |
| Total cool-season graminoid cover | | | | | 51.5 | 64.8 | 69.4 | 42.7 | 68.8 | 70.8 | 71.6 | 49.7 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (1500).

Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).

All cover values presented are means (n = 15).

Native categories: Y = Native, N = Non-Native

Form categories: C = Cactus, F = Forb, G = Graminoid

Cool/Warm Season categories: C = Cool season species, W = Warm season species

**Table 5-4. 1993-1995, And 1999 Mesic Mixed Grassland Foliar Cover at TR02**

| | | | | | TR02 - Frequency (%) | | | | TR02 - Absolute Cover (%) | | | | TR02 - Relative Cover (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | F | N | | 20 | 40 | 60 | 80 | 0.8 | 1.6 | 2.0 | 2.0 | 1.2 | 1.8 | 2.1 | 2.6 |
| Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | CANU1 | F | N | | | | | | | | | | | | | |
| Centaurea diffusa Lam. | CEDI1 | F | N | | 20 | 60 | 60 | 60 | 0.4 | 0.6 | 1.6 | 1.4 | 0.6 | 0.7 | 1.6 | 1.8 |
| Convolvulus arvensis L. | COAR1 | F | N | | | | 20 | 20 | | | 0.2 | 0.2 | | | 0.2 | 0.3 |
| Hypericum perforatum L. | HYPE1 | F | N | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Lactuca serriola L. | LASE1 | F | N | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Scorzonera laciniata L. | SCLA1 | F | N | | | 100 | 80 | 40 | | 1.8 | 1.6 | 1.2 | | 2.0 | 1.6 | 1.6 |
| Sisymbrium altissimum L. | SIAL1 | F | N | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Tragopogon dubius Scop. | TRDU1 | F | N | | 60 | 20 | 80 | | 1.2 | 0.4 | 3.0 | | 1.8 | 0.5 | 3.1 | |
| Ambrosia psilostachya DC. | AMPS1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Artemisia dracunculus L. | ARDR1 | F | Y | | | | | | | | | | | | | |
| Artemisia frigida Willd. | ARFR1 | F | Y | | 40 | 60 | 40 | | 0.4 | 0.8 | 0.6 | | 0.6 | 0.9 | 0.6 | |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 20 | 20 | 40 | | 0.4 | 0.4 | 0.4 | | 0.6 | 0.5 | 0.4 | |
| Aster falcatus Lindl. | ASFA1 | F | Y | | 60 | 20 | 40 | 20 | 0.6 | 0.2 | 0.4 | 0.2 | 0.9 | 0.2 | 0.4 | 0.3 |
| Aster porteri Gray | ASPO1 | F | Y | | 20 | | 40 | | 0.2 | | 0.6 | | 0.3 | | 0.6 | |
| Astragalus flexuosus (Hook.) G. Don | ASFL1 | F | Y | | | 20 | 20 | | | 0.4 | 0.2 | | | 0.5 | 0.2 | |
| Chrysopsis villosa Pursh. | CHVI1 | F | Y | | 80 | 20 | 20 | | 1.4 | 0.4 | 0.4 | | 2.1 | 0.5 | 0.4 | |
| Cirsium undulatum (Nutt.) Spreng. | CIUN1 | F | Y | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinners. | DACA1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Erigeron divergens T. & G. | ERDI1 | F | Y | | 20 | | | | 0.4 | | | | 0.6 | | | |
| Erigeron flagellaris A. Gray | ERFL1 | F | Y | | 20 | 40 | 20 | | 0.4 | 0.4 | 0.4 | | 0.6 | 0.5 | 0.4 | |
| Eriogonum alatum Torr. | ERAL1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Erysimum capitatum (Nutt.) DC. | ERAS1 | F | Y | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Evolvulus nuttallianus R. & S. | EVNU1 | F | Y | | 20 | | | | 0.2 | | | | 0.3 | | | |
| Gaura coccinea Pursh. | GACO1 | F | Y | | | 20 | 20 | | | 0.2 | 0.2 | | | 0.2 | 0.2 | |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | F | Y | | 20 | 20 | 60 | | 0.2 | 0.2 | 1.2 | | 0.3 | 0.2 | 1.2 | |
| Gutierrezia sarothrae (Pursh.) Britt. & Rusby | GUSA1 | F | Y | | | | 60 | 20 | | | 0.6 | 0.2 | | | 0.6 | 0.3 |
| Helianthus pumilus Nutt. | HEPU1 | F | Y | | | | | 20 | | | | 0.2 | | | | 0.3 |
| Lesquerella montana (A. Gray) Wats. | LEMO1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Liatris punctata Hook. | LIPU1 | F | Y | | 20 | 20 | 40 | | 0.2 | 0.2 | 1.8 | | 0.3 | 0.2 | 1.9 | |
| Linum perenne L. var. lewisii (Pursh.) Eat. & Wright | LIPE1 | F | Y | | | 40 | | | | 1.2 | | | | 1.4 | | |
| Mirabilis linearis (Pursh.) Heimerl | MILI1 | F | Y | | 20 | 40 | | | 0.2 | 0.4 | | | 0.3 | 0.5 | | |
| Psoralea tenuiflora Pursh. | PSTE1 | F | Y | | 80 | 60 | 100 | 80 | 2.4 | 2.2 | 7.6 | 1.4 | 3.5 | 2.5 | 7.8 | 1.8 |
| Ratibida columnifera (Nutt.) Woot. & Standl. | RACO1 | F | Y | | 80 | | 80 | 20 | 1.2 | | 1.2 | 0.2 | 1.8 | | 1.2 | 0.3 |
| Sphaeralcea coccinea (Pursh.) Rydb. | SPCO1 | F | Y | | 20 | 20 | 20 | 40 | 0.6 | 0.6 | 0.4 | 0.4 | 0.9 | 0.7 | 0.4 | 0.5 |
| Bromus inermis Leyss. ssp. inermis | BRIN1 | G | N | C | 20 | 20 | 20 | 40 | 0.4 | 0.4 | 0.6 | 3.2 | 0.6 | 0.5 | 0.6 | 4.1 |
| Bromus japonicus Thunb. ex Murr. | BRJA1 | G | N | C | 100 | 100 | 100 | 100 | 5.6 | 18.4 | 27.6 | 3.8 | 8.2 | 20.9 | 28.4 | 4.9 |
| Poa compressa L. | POCO1 | G | N | C | 40 | 40 | 20 | 20 | 1.0 | 0.4 | 0.2 | 0.4 | 1.5 | 0.5 | 0.2 | 0.5 |
| Poa pratensis L. | POPR1 | G | N | C | 20 | 20 | | 20 | 0.2 | 0.2 | | 0.2 | 0.3 | 0.2 | | 0.3 |
| Agropyron smithii Rydb. | AGSM1 | G | Y | C | 100 | 100 | 100 | 100 | 27.6 | 29.0 | 30.6 | 18.2 | 40.5 | 33.0 | 31.5 | 23.5 |
| Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | G | Y | C | 60 | 20 | 40 | 40 | 1.2 | 0.6 | 0.4 | 0.6 | 1.8 | 0.7 | 0.4 | 0.8 |

Table 5-4. (cont.)

| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | TR02 - Frequency (%) | | | | TR02 - Absolute Cover (%) | | | | TR02 - Relative Cover (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| Carex eleocharis Bailey | CAEL1 | G | Y | C | 40 | | 20 | | 3.4 | | 0.2 | | 5.0 | | 0.2 | |
| Carex heliophila Mack. | CAHE1 | G | Y | C | | 40 | 20 | 40 | | 3.6 | 2.8 | 3.2 | | 4.1 | 2.9 | 4.1 |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | | | | 40 | | | | 0.4 | | | | 0.5 |
| Stipa comata Trin. & Rupr. | STCO1 | G | Y | C | 40 | 40 | 20 | 20 | 1.8 | 1.0 | 0.6 | 0.2 | 2.6 | 1.1 | 0.6 | 0.3 |
| Stipa viridula Trin. | STVI1 | G | Y | C | 20 | 40 | 40 | 80 | 0.2 | 0.6 | 1.0 | 1.0 | | 0.7 | 1.0 | 1.3 |
| Andropogon gerardii Vitman | ANGE1 | G | Y | W | 40 | 40 | 40 | 40 | 2.2 | 1.4 | 1.8 | 1.6 | 3.2 | 1.6 | 1.9 | 2.1 |
| Andropogon scoparius Michx. | ANSC1 | G | Y | W | 40 | 20 | | 20 | 0.4 | 0.2 | | 0.4 | 0.6 | 0.2 | | 0.5 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 80 | 80 | 40 | 80 | 3.2 | 4.8 | 2.6 | 14.8 | 4.7 | 5.5 | 2.7 | 19.1 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 80 | 100 | 60 | 100 | 6.8 | 11.8 | 2.8 | 20.6 | 10.0 | 13.4 | 2.9 | 26.6 |
| Bouteloua hirsuta Lag | BOHI1 | G | Y | W | 60 | 60 | | | 1.2 | 2.0 | | | 1.8 | 2.3 | | |
| Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | G | Y | W | 40 | 60 | 20 | 80 | 0.4 | 1.0 | 0.2 | 1.4 | 0.6 | 1.1 | 0.2 | 1.8 |
| Sporobolus cryptandrus (Torr.) A. Gray | SPCR1 | G | Y | W | 20 | | | | 0.2 | | | | 0.3 | | | |
| Poaceae sp. | PO1 | G | | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Yucca glauca Nutt. | YUGL1 | S | Y | | 20 | | | | 1.2 | | | | 1.8 | | | |
| Total foliar cover | | | | | | | | | 68.2 | 88.0 | 97.2 | 77.4 | 99.7 | 100.0 | 100.0 | 100.0 |
| Total forb cover | | | | | | | | | 11.2 | 12.6 | 25.6 | 7.4 | 16.4 | 14.3 | 26.3 | 9.6 |
| Total native forb cover | | | | | | | | | 8.8 | 8.0 | 16.8 | 2.6 | 12.9 | 9.1 | 17.3 | 3.4 |
| Total non-native forb cover | | | | | | | | | 2.4 | 4.6 | 8.8 | 4.8 | 3.5 | 5.2 | 9.1 | 6.2 |
| Total graminoid cover | | | | | | | | | 55.8 | 75.4 | 71.6 | 70.0 | 81.5 | 85.7 | 73.7 | 90.4 |
| Total native cover | | | | | | | | | 58.6 | 64.0 | 59.8 | 65.0 | 85.6 | 72.7 | 61.5 | 84.0 |
| Total non-native cover | | | | | | | | | 9.6 | 24.0 | 37.2 | 12.4 | 14.1 | 27.3 | 38.3 | 16.0 |
| Total warm-season graminoid cover | | | | | | | | | 14.4 | 21.2 | 7.4 | 38.8 | 21.1 | 24.1 | 7.6 | 50.1 |
| Total cool-season graminoid cover | | | | | | | | | 41.4 | 54.2 | 64.0 | 31.2 | 60.4 | 61.6 | 65.8 | 40.3 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (500).

Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).

All cover values presented are means (n = 5).

Native categories: Y = Native, N = Non-Native

Form categories: C = Cactus, F = Forb, G = Graminoid

Cool/Warm Season categories: C = Cool season species, W = Warm season species

**Table 5-5. 1993-1995, And 1999 Mesic Mixed Grassland Foliar Cover at TR04**

| | | | | | TR04 - Frequency (%) | | | | TR04 - Absolute Cover (%) | | | | TR04 - Relative Cover (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| Opuntia macrorhiza Engelm. | OPMA1 | C | Y | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | F | N | | 40 | 40 | 40 | 60 | 0.8 | 1.8 | 1.4 | 2.6 | 1.1 | 2.0 | 1.4 | 3.0 |
| Camelina microcarpa Andrz. ex DC. | CAMI1 | F | N | | 20 | 60 | 60 | | 0.2 | 1.2 | 1.2 | | 0.3 | 1.3 | 1.2 | |
| Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | CANU1 | F | N | | 60 | 40 | 40 | | 1.4 | 0.4 | 2.0 | | 2.0 | 0.4 | 2.0 | |
| Lactuca serriola L. | LASE1 | F | N | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Linaria dalmatica (L.) Mill. | LIDA1 | F | N | | 20 | 80 | 60 | 40 | 0.6 | 0.8 | 1.4 | 0.6 | 0.8 | 0.9 | 1.4 | 0.7 |
| Scorzonera laciniata L. | SCLA1 | F | N | | 60 | 60 | 100 | 100 | 1.4 | 2.8 | 3.8 | 5.6 | 2.0 | 3.1 | 3.9 | 6.5 |
| Sisymbrium altissimum L. | SIAL1 | F | N | | | 40 | 20 | | | 0.4 | 0.6 | | | 0.4 | 0.6 | |
| Tragopogon dubius Scop. | TRDU1 | F | N | | 40 | | 60 | 60 | 0.6 | | 0.8 | 1.4 | 0.8 | | 0.8 | 1.6 |
| Ambrosia psilostachya DC. | AMPS1 | F | Y | | 20 | 20 | | | 0.4 | 0.2 | | | 0.6 | 0.2 | | |
| Artemisia dracunculus L. | ARDR1 | F | Y | | 20 | 40 | 80 | 40 | 0.2 | 0.8 | 1.8 | 2.0 | 0.3 | 0.9 | 1.8 | 2.3 |
| Artemisia frigida Willd. | ARFR1 | F | Y | | 20 | | | 20 | 0.2 | | | 0.2 | 0.3 | | | 0.2 |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 20 | | 20 | | 0.2 | | 0.6 | | 0.3 | | 0.6 | |
| Aster falcatus Lindl. | ASFA1 | F | Y | | 60 | 40 | 80 | 80 | 1.4 | 0.6 | 1.8 | 1.8 | 2.0 | 0.7 | 1.8 | 2.1 |
| Astragalus flexuosus (Hook.) G. Don | ASFL1 | F | Y | | | | | 20 | | | | 0.2 | | | | 0.2 |
| Chrysopsis villosa Pursh. | CHVI1 | F | Y | | 20 | 20 | | | 0.2 | 0.2 | | | 0.3 | 0.2 | | |
| Descurainia pinnata (Walt.) Britt. | DEPI1 | F | Y | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Erigeron divergens T. & G. | ERDI1 | F | Y | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Erigeron flagellaris A. Gray | ERFL1 | F | Y | | 20 | 20 | 20 | 20 | 0.2 | 0.6 | 0.2 | 1.0 | 0.3 | 0.7 | 0.2 | 1.2 |
| Evolvulus nuttallianus R. & S. | EVNU1 | F | Y | | | | | 20 | | | | 0.2 | | | | 0.2 |
| Gaura coccinea Pursh. | GACO1 | F | Y | | | 40 | 20 | | | 0.4 | 0.2 | | | 0.4 | 0.2 | |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | F | Y | | 20 | 20 | 60 | 60 | 0.2 | 0.4 | 1.4 | 0.6 | 0.3 | 0.4 | 1.4 | 0.7 |
| Gutierrezia sarothrae (Pursh.) Britt. & Rusby | GUSA1 | F | Y | | 20 | 40 | 40 | 60 | 0.2 | 0.6 | 0.6 | 1.2 | 0.3 | 0.7 | 0.6 | 1.4 |
| Lepidium sp. | LEP1 | F | | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Linum perenne L. var. lewisii (Pursh.) Eat. & Wright | LIPE1 | F | Y | | 20 | 20 | | | 0.6 | 0.2 | | | 0.8 | 0.2 | | |
| Mirabilis linearis (Pursh.) Heimerl | MILI1 | F | Y | | 20 | 20 | 20 | 40 | 0.2 | 0.2 | 0.2 | 0.4 | 0.3 | 0.2 | 0.2 | 0.5 |
| Polygonum sawatchense Small | POSA1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Psoralea tenuiflora Pursh. | PSTE1 | F | Y | | 80 | 80 | 100 | 100 | 1.4 | 2.4 | 3.6 | 4.2 | 2.0 | 2.6 | 3.7 | 4.9 |
| Ratibida columnifera (Nutt.) Woot. & Standl. | RACO1 | F | Y | | | 20 | 40 | 20 | | 0.4 | 0.4 | 0.2 | | 0.4 | 0.4 | 0.2 |
| Sphaeralcea coccinea (Pursh.) Rydb. | SPCO1 | F | Y | | 20 | | | 60 | 0.2 | | | 1.2 | 0.3 | | | 1.4 |
| Vicia americana Muhl. ex Willd. | VIAM1 | F | Y | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Agropyron intermedium (Host) Beauv. | AGIN1 | G | N | C | 20 | | | | 2.4 | | | | 3.4 | | | |
| Bromus japonicus Thunb. ex Murr. | BRJA1 | G | N | C | 100 | 100 | 100 | 100 | 26.8 | 44.6 | 46.6 | 10.2 | 37.6 | 48.7 | 47.3 | 11.9 |
| Bromus tectorum L. | BRTE1 | G | N | C | | 40 | 40 | 40 | | 4.2 | 3.0 | 2.4 | | 4.6 | 3.0 | 2.8 |
| Poa compressa L. | POCO1 | G | N | C | 60 | 60 | 80 | 80 | 0.8 | 0.8 | 1.6 | 1.2 | 1.1 | 0.9 | 1.6 | 1.4 |
| Poa pratensis L. | POPR1 | G | N | C | 60 | 80 | 40 | 80 | 2.0 | 1.6 | 1.2 | 6.8 | 2.8 | 1.7 | 1.2 | 7.9 |
| Schedonnardus paniculatus (Nutt.) Trel. | SCPA2 | G | N | C | | | | 20 | | | | 0.6 | | | | 0.7 |
| Agropyron smithii Rydb. | AGSM1 | G | Y | C | 100 | 100 | 100 | 100 | 20.4 | 14.4 | 19.0 | 11.8 | 28.6 | 15.7 | 19.3 | 13.7 |
| Aristida purpurea Nutt. var. longiseta (Steud.) Vasey | ARFE1 | G | Y | C | 20 | 20 | | | 0.2 | 0.2 | | | 0.3 | 0.2 | | |
| Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | G | Y | C | | 20 | 20 | 20 | | 0.2 | 0.4 | 0.2 | | 0.2 | 0.4 | 0.2 |
| Carex eleocharis Bailey | CAEL1 | G | Y | C | 40 | 20 | 20 | 20 | 1.8 | 0.4 | 0.4 | 0.4 | 2.5 | 0.4 | 0.4 | 0.5 |

Table 5-5. (cont.)

| | | | | | TR04 - Frequency (%) | | | | TR04 - Absolute Cover (%) | | | | TR04 - Relative Cover (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| Carex heliophila Mack. | CAHE1 | G | Y | C | | | | 20 | | | | 0.2 | | | | 0.2 |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | 20 | 20 | | | 0.2 | 0.2 | | | 0.3 | 0.2 | | |
| Stipa comata Trin. & Rupr. | STCO1 | G | Y | C | | 20 | | 20 | | 0.2 | | 0.2 | | 0.2 | | 0.2 |
| Stipa viridula Trin. | STVI1 | G | Y | C | | 40 | 40 | 40 | | 0.6 | 0.8 | 0.4 | | 0.7 | 0.8 | 0.5 |
| Andropogon gerardii Vitman | ANGE1 | G | Y | W | | | | 20 | | | | 0.2 | | | | 0.2 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 40 | 40 | 20 | 40 | 0.4 | 1.6 | 0.2 | 4.0 | 0.6 | 1.7 | 0.2 | 4.7 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 80 | 80 | 80 | 100 | 5.4 | 6.2 | 2.6 | 20.4 | 7.6 | 6.8 | 2.6 | 23.7 |
| Bouteloua hirsuta Lag | BOHI1 | G | Y | W | | 20 | 20 | 20 | | 0.4 | 0.2 | 0.2 | | 0.4 | 0.2 | 0.2 |
| Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | G | Y | W | | 20 | | 100 | | 0.6 | | 3.4 | | 0.7 | | 4.0 |
| Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | G | Y | W | 20 | | | | 0.2 | | | | 0.3 | | | |
| Muhlenbergia wrightii Vasey | MUWR1 | G | Y | W | | | 20 | | | | 0.2 | | | | 0.2 | |
| Total foliar cover | | | | | | | | | 71.2 | 91.6 | 98.6 | 86.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Total forb cover | | | | | | | | | 10.6 | 15.2 | 22.4 | 23.4 | 14.9 | 16.6 | 22.7 | 27.2 |
| Total native forb cover | | | | | | | | | 5.6 | 7.6 | 11.0 | 13.2 | 7.9 | 8.3 | 11.2 | 15.3 |
| Total non-native forb cover | | | | | | | | | 5.0 | 7.4 | 11.4 | 10.2 | 7.0 | 8.1 | 11.6 | 11.9 |
| Total graminoid cover | | | | | | | | | 60.6 | 76.2 | 76.2 | 62.6 | 85.1 | 83.2 | 77.3 | 72.8 |
| Total native cover | | | | | | | | | 34.2 | 32.6 | 34.8 | 54.6 | 48.0 | 35.6 | 35.3 | 63.5 |
| Total non-native cover | | | | | | | | | 37.0 | 58.6 | 63.8 | 31.4 | 52.0 | 64.0 | 64.7 | 36.5 |
| Total warm-season graminoid cover | | | | | | | | | 6.0 | 8.8 | 3.2 | 28.2 | 8.4 | 9.6 | 3.2 | 32.8 |
| Total cool-season graminoid cover | | | | | | | | | 54.6 | 67.4 | 73.0 | 34.4 | 76.7 | 73.6 | 74.0 | 40.0 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (500).

Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).

All cover values presented are means (n = 5).

Native categories: Y = Native, N = Non-Native

Form categories: C = Cactus, F = Forb, G = Graminoid

Cool/Warm Season categories: C = Cool season species, W = Warm season species

Table 5-6. 1993-1995, And 1999 Mesic Mixed Grassland Foliar Cover at TR11

| | | | | | TR11 - Frequency (%) | | | | TR11 - Absolute Cover (%) | | | | TR11 - Relative Cover (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | F | N | | 60 | 60 | 60 | 80 | 1.2 | 2.8 | 3.0 | 2.8 | 1.4 | 3.0 | 3.2 | 3.1 |
| Camelina microcarpa Andrz. ex DC. | CAMI1 | F | N | | 20 | 60 | 40 | 20 | 0.6 | 2.8 | 1.8 | 0.2 | 0.7 | 3.0 | 1.9 | 0.2 |
| Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | CANU1 | F | N | | 60 | | 60 | 20 | 1.6 | | 2.2 | 0.2 | 1.9 | | 2.3 | 0.2 |
| Centaurea diffusa Lam. | CEDI1 | F | N | | | | | 20 | | | | 0.2 | | | | 0.2 |
| Cirsium arvense (L.) Scop. | CIAR1 | F | N | | 20 | | | 20 | 0.2 | | | 0.8 | 0.2 | | | 0.9 |
| Convolvulus arvensis L. | COAR1 | F | N | | 20 | | | | 0.2 | | | | 0.2 | | | |
| Lactuca serriola L. | LASE1 | F | N | | 20 | | 80 | 60 | 0.2 | | 1.2 | 0.8 | 0.2 | | 1.3 | 0.9 |
| Linaria dalmatica (L.) Mill. | LIDA1 | F | N | | 40 | 40 | 60 | 60 | 0.8 | 2.2 | 1.2 | 0.6 | 0.9 | 2.3 | 1.3 | 0.7 |
| Scorzonera laciniata L. | SCLA1 | F | N | | | | | 20 | | | | 0.2 | | | | 0.2 |
| Sisymbrium altissimum L. | SIAL1 | F | N | | 20 | 20 | 20 | | 0.6 | 0.2 | 1.2 | | 0.7 | 0.2 | 1.3 | |
| Tragopogon dubius Scop. | TRDU1 | F | N | | 60 | | 20 | 20 | 1.0 | | 0.2 | 0.2 | 1.2 | | 0.2 | 0.2 |
| Verbascum thapsus L. | VETH1 | F | N | | | | | 40 | | | | 1.6 | | | | 1.8 |
| Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | ACMI1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Ambrosia psilostachya DC. | AMPS1 | F | Y | | 20 | 20 | 20 | 40 | 0.4 | 0.2 | 0.2 | 0.8 | 0.5 | 0.2 | 0.2 | 0.9 |
| Artemisia dracunculus L. | ARDR1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Artemisia frigida Willd. | ARFR1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 100 | 60 | 100 | 60 | 3.8 | 1.4 | 3.2 | 0.8 | 4.5 | 1.5 | 3.4 | 0.9 |
| Aster falcatus Lindl. | ASFA1 | F | Y | | 40 | | | 40 | 0.4 | | | 0.4 | 0.5 | | | 0.4 |
| Aster porteri Gray | ASPO1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Comandra umbellata (L.) Nutt. | COUM1 | F | Y | | | | | 20 | | | | 0.2 | | | | 0.2 |
| Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinners. | DACA1 | F | Y | | | 20 | | 20 | | 0.2 | | 0.4 | | 0.2 | | 0.4 |
| Dalea purpurea Vent | DAPU1 | F | Y | | 20 | 40 | | | 0.2 | 0.6 | | | 0.2 | 0.6 | | |
| Descurainia pinnata (Walt.) Britt. | DEPI1 | F | Y | | | | | | | | | | | | | |
| Descurainia richardsonii (Sweet) Schultz | DERI1 | F | Y | | | 40 | 20 | | | 0.4 | 0.2 | | | 0.4 | 0.2 | |
| Erigeron divergens T. & G. | ERDI1 | F | Y | | | | | 20 | | | | 0.2 | | | | 0.2 |
| Erigeron flagellaris A. Gray | ERFL1 | F | Y | | 40 | 20 | | 40 | 0.4 | 0.4 | | 0.4 | 0.5 | 0.4 | | 0.4 |
| Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | F | Y | | | | 40 | | | | 0.4 | | | | 0.4 | |
| Gutierrezia sarothrae (Pursh.) Britt. & Rusby | GUSA1 | F | Y | | | 20 | 20 | 20 | | 0.2 | 0.2 | 1.0 | | 0.2 | 0.2 | 1.1 |
| Helianthus petiolaris Nutt. | HEPE1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Kuhnia chlorolepis Woot. & Standl. | KUCH1 | F | Y | | 20 | | | | 0.2 | | | | 0.2 | | | |
| Kuhnia eupatorioides L. | KUEU1 | F | Y | | | 20 | 20 | 20 | | 0.4 | 0.4 | 0.4 | | 0.4 | 0.4 | 0.4 |
| Liatris punctata Hook. | LIPU1 | F | Y | | 20 | | | | 0.2 | | | | 0.2 | | | |
| Lomatium orientale Coult. & Rose | LOOR1 | F | Y | | | | 20 | | | | 0.2 | | | | 0.2 | |
| Mirabilis linearis (Pursh.) Heimerl | MILI1 | F | Y | | 20 | | | | 0.2 | | | | 0.2 | | | |
| Phacelia heterophylla Pursh. | PHHE1 | F | Y | | 20 | | | | 0.4 | | | | 0.5 | | | |
| Psoralea tenuiflora Pursh. | PSTE1 | F | Y | | 100 | 100 | 100 | 80 | 3.8 | 2.0 | 3.2 | 3.0 | 4.5 | 2.1 | 3.4 | 3.3 |
| Ratibida columnifera (Nutt.) Woot. & Standl. | RACO1 | F | Y | | | | | 60 | | | | 0.8 | | | | 0.9 |
| Solidago missouriensis Nutt. | SOMI1 | F | Y | | | 20 | | | | 0.2 | | | | 0.2 | | |
| Bromus japonicus Thunb. ex Murr. | BRJA1 | G | N | C | 100 | 100 | 100 | 100 | 11.0 | 24.4 | 37.2 | 17.4 | 13.0 | 25.8 | 39.1 | 19.2 |
| Bromus tectorum L. | BRTE1 | G | N | C | 40 | 60 | 80 | 80 | 0.8 | 7.6 | 8.0 | 11.6 | 0.9 | 8.1 | 8.4 | 12.8 |
| Poa compressa L. | POCO1 | G | N | C | 40 | 40 | 40 | 40 | 2.4 | 1.6 | 1.8 | 3.8 | 2.8 | 1.7 | 1.9 | 4.2 |

Table 5-6. (cont.)

| | | | | | TR11 - Frequency (%) | | | | TR11 - Absolute Cover (%) | | | | TR11 - Relative Cover (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Speccode | Form | Native | Cool/ Warm Season | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 | 1993 | 1994 | 1995 | 1999 |
| Poa pratensis L. | POPR1 | G | N | C | 60 | 80 | 80 | 60 | 6.6 | 6.0 | 1.8 | 6.8 | 7.8 | 6.4 | 1.9 | 7.5 |
| Agropyron smithii Rydb. | AGSM1 | G | Y | C | 100 | 80 | 100 | 80 | 17.0 | 11.0 | 11.0 | 6.4 | 20.1 | 11.7 | 11.6 | 7.1 |
| Aristida purpurea Nutt. var. longiseta (Steud.) Vasey | ARFE1 | G | Y | C | | 40 | | | | 0.4 | | | | 0.4 | | |
| Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | G | Y | C | 40 | 40 | 60 | 40 | 2.0 | 0.8 | 1.6 | 1.0 | 2.4 | 0.8 | 1.7 | 1.1 |
| Carex eleocharis Bailey | CAEL1 | G | Y | C | 40 | | | | 3.6 | | | | 4.3 | | | |
| Carex heliophila Mack. | CAHE1 | G | Y | C | | 100 | 100 | 100 | | 8.8 | 3.8 | 4.2 | | 9.3 | 4.0 | 4.6 |
| Carex oreocharis Holm. | CAOR1 | G | Y | C | 60 | | | | 3.2 | | | | 3.8 | | | |
| Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | 20 | | | 40 | 0.2 | | | 0.8 | 0.2 | | | 0.9 |
| Stipa comata Trin. & Rupr. | STCO1 | G | Y | C | 100 | 60 | 80 | 60 | 9.8 | 8.2 | 3.0 | 6.0 | 11.6 | 8.7 | 3.2 | 6.6 |
| Stipa viridula Trin. | STVI1 | G | Y | C | 20 | 60 | 60 | 40 | 2.0 | 4.0 | 2.8 | 4.4 | 2.4 | 4.2 | 2.9 | 4.9 |
| Andropogon gerardii Vitman | ANGE1 | G | Y | W | 80 | 60 | 60 | 80 | 7.4 | 3.8 | 3.6 | 6.4 | 8.7 | 4.0 | 3.8 | 7.1 |
| Andropogon scoparius Michx. | ANSC1 | G | Y | W | | 40 | | 20 | | 0.4 | | 0.2 | | 0.4 | | 0.2 |
| Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 40 | 40 | | 60 | 1.2 | 0.8 | | 2.4 | 1.4 | 0.8 | | 2.6 |
| Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 40 | 100 | 60 | 80 | 1.0 | 1.6 | 0.8 | 2.2 | 1.2 | 1.7 | 0.8 | 2.4 |
| Bouteloua hirsuta Lag | BOHI1 | G | Y | W | | 20 | | | | 0.2 | | | | 0.2 | | |
| Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | G | Y | W | | | | 40 | | | | 0.6 | | | | 0.7 |
| Muhlenbergia wrightii Vasey | MUWR1 | G | Y | W | | 20 | | | | 0.4 | | | | 0.4 | | |
| Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | G | Y | W | | 20 | | 20 | | 0.4 | | 0.4 | | 0.4 | | 0.4 |
| Total foliar cover | | | | | | | | | 84.6 | 94.4 | 95.2 | 90.6 | 100.0 | 100.0 | 100.0 | 100.0 |
| Total forb cover | | | | | | | | | 16.4 | 14.0 | 19.8 | 16.0 | 19.4 | 14.8 | 20.8 | 17.7 |
| Total native forb cover | | | | | | | | | 10.0 | 6.0 | 9.0 | 8.4 | 11.8 | 6.4 | 9.5 | 9.3 |
| Total non-native forb cover | | | | | | | | | 6.4 | 8.0 | 10.8 | 7.6 | 7.6 | 8.5 | 11.3 | 8.4 |
| Total graminoid cover | | | | | | | | | 68.2 | 80.4 | 75.4 | 74.6 | 80.6 | 85.2 | 79.2 | 82.3 |
| Total native cover | | | | | | | | | 57.4 | 46.8 | 35.6 | 43.4 | 67.8 | 49.6 | 37.4 | 47.9 |
| Total non-native cover | | | | | | | | | 27.2 | 47.6 | 59.6 | 47.2 | 32.2 | 50.4 | 62.6 | 52.1 |
| Total warm-season graminoid cover | | | | | | | | | 9.6 | 7.6 | 4.4 | 12.2 | 11.3 | 8.1 | 4.6 | 13.5 |
| Total cool-season graminoid cover | | | | | | | | | 58.6 | 72.8 | 71.0 | 62.4 | 69.3 | 77.1 | 74.6 | 68.9 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (500).

Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).

All cover values presented are means (n = 5).

Native categories: Y = Native, N = Non-Native

Form categories: C = Cactus, F = Forb, G = Graminoid

Cool/Warm Season categories: C = Cool season species, W = Warm season species

**Table 5-7. 1999 Mesic Mixed Grassland Species Frequencies**

| | | | | Frequency (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | TR02 | | TR04 | | TR11 | |
| Family | Scientific Name | Native | Speccode | Spring | Summer | Spring | Summer | Spring | Summer |
| APIACEAE | Lomatium orientale Coult. & Rose | Y | LOOR1 | 56 | | 44 | | 72 | 4 |
| APIACEAE | Musineon divaricatum (Pursh.) Nutt. var. hookeri T. & G. | Y | MUDI1 | 12 | | 12 | | 4 | |
| ASCLEPIADACEAE | Asclepias pumila (Gray) Vail | Y | ASPU1 | | 4 | | | | |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | Y | ACMI1 | | | | | 8 | 8 |
| ASTERACEAE | Ambrosia psilostachya DC. | Y | AMPS1 | 12 | 12 | 20 | 24 | 16 | 20 |
| ASTERACEAE | Arnica fulgens Pursh. | Y | ARFU1 | | | | | 4 | |
| ASTERACEAE | Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem. | Y | ARCA1 | 8 | | 32 | | | |
| ASTERACEAE | Artemisia dracunculus L. | Y | ARDR1 | | 4 | | 40 | | |
| ASTERACEAE | Artemisia frigida Willd. | Y | ARFR1 | 8 | 8 | 16 | 16 | 8 | 4 |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | Y | ARLU1 | 24 | 24 | 12 | 16 | 64 | 60 |
| ASTERACEAE | Aster falcatus Lindl. | Y | ASFA1 | 16 | 20 | 68 | 56 | 8 | 12 |
| ASTERACEAE | Aster porteri Gray | Y | ASPO1 | 16 | 12 | | 4 | 12 | 20 |
| ASTERACEAE | Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | N | CANU1 | | | 12 | 8 | 20 | 24 |
| ASTERACEAE | Centaurea diffusa Lam. | N | CEDI1 | 96 | 44 | | | | |
| ASTERACEAE | Chrysopsis fulcrata Greene | Y | CHFU1 | 4 | | | | | |
| ASTERACEAE | Chrysopsis villosa Pursh. | Y | CHVI1 | 16 | 12 | 4 | 8 | | |
| ASTERACEAE | Cirsium arvense (L.) Scop. | N | CIAR1 | | | 12 | 8 | 12 | 12 |
| ASTERACEAE | Cirsium undulatum (Nutt.) Spreng. | Y | CIUN1 | 12 | 8 | | 4 | 8 | |
| ASTERACEAE | Erigeron divergens T. & G. | Y | ERDI1 | 16 | | 8 | 4 | 24 | |
| ASTERACEAE | Erigeron flagellaris A. Gray | Y | ERFL1 | | | | 8 | | 20 |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | Y | GRSQ1 | 12 | 4 | 32 | 40 | 16 | 8 |
| ASTERACEAE | Gutierrezia sarothrae (Pursh.) Britt. & Rusby | Y | GUSA1 | 24 | 20 | 20 | 24 | 8 | 8 |
| ASTERACEAE | Helianthus petiolaris Nutt. | Y | HEPE1 | | 4 | | 4 | | 4 |
| ASTERACEAE | Helianthus pumilus Nutt. | Y | HEPU1 | 12 | 12 | | | | |
| ASTERACEAE | Kuhnia chlorolepis Woot. & Standl. | Y | KUCH1 | | | | | | 4 |
| ASTERACEAE | Kuhnia eupatorioides L. | Y | KUEU1 | | 4 | | 4 | | |
| ASTERACEAE | Lactuca serriola L. | N | LASE1 | 24 | 4 | 28 | 32 | 84 | 84 |
| ASTERACEAE | Liatris punctata Hook. | Y | LIPU1 | 4 | | | | | 4 |
| ASTERACEAE | Microseris cuspidata (Pursh.) Sch. Bip. | Y | MICU1 | | | | | 12 | |
| ASTERACEAE | Picradeniopsis oppositifolia (Nutt.) Rydb. | Y | PIOP1 | | | | | | 4 |
| ASTERACEAE | Ratibida columnifera (Nutt.) Woot. & Standl. | Y | RACO1 | 60 | 44 | 28 | 16 | 28 | 16 |
| ASTERACEAE | Scorzonera laciniata L. | N | SCLA1 | 84 | 56 | 92 | 92 | 32 | 12 |
| ASTERACEAE | Senecio integerrimus Nutt. | Y | SEIN1 | | | 4 | | | |
| ASTERACEAE | Senecio plattensis Nutt. | Y | SEPL1 | 12 | | | | 32 | |
| ASTERACEAE | Solidago missouriensis Nutt. | Y | SOMI1 | | | 4 | 4 | | |
| ASTERACEAE | Solidago rigida L. | Y | SORI1 | 4 | | | | | |
| ASTERACEAE | Taraxacum officinale Weber | N | TAOF1 | 4 | | 28 | 20 | 12 | 8 |
| ASTERACEAE | Tragopogon dubius Scop. | N | TRDU1 | 20 | 4 | 76 | 76 | 44 | 64 |
| BORAGINACEAE | Lappula redowskii (Hornem.) Greene | Y | LARE1 | 4 | | | | 16 | |
| BORAGINACEAE | Lithospermum incisum Lehm. | Y | LIIN1 | | 8 | | 8 | 4 | 8 |
| BORAGINACEAE | Onosmodium molle Michx. var. occidentale (Mack.) Johnst. | Y | ONMO1 | 8 | | | | | |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | N | ALMI1 | 92 | 76 | 64 | 64 | 76 | 72 |
| BRASSICACEAE | Camelina microcarpa Andrz. ex DC. | N | CAMI1 | | | 20 | 4 | 52 | 28 |
| BRASSICACEAE | Descurainia pinnata (Walt.) Britt. | Y | DEPI1 | 4 | | 12 | | 16 | |
| BRASSICACEAE | Descurainia richardsonii (Sweet) Schultz | Y | DERI1 | | | | 4 | | |
| BRASSICACEAE | Draba reptans (Lam.) Fern. | Y | DRRE1 | | | 4 | | 4 | |
| BRASSICACEAE | Erysimum capitatum (Nutt.) DC. | Y | ERCA2 | 8 | | 4 | 4 | | |
| BRASSICACEAE | Erysimum repandum L. | N | ERRE1 | | | 16 | | | |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | N | LECA1 | 24 | 8 | | | | |
| BRASSICACEAE | Lesquerella montana (A. Gray) Wats. | Y | LEMO1 | 20 | 12 | | | 8 | 4 |
| BRASSICACEAE | Sisymbrium altissimum L. | N | SIAL1 | 4 | | 4 | 4 | 8 | |
| CACTACEAE | Coryphantha missouriensis (Sweet) Britt. & Rose | Y | COMI1 | 16 | 8 | 4 | | | |
| CACTACEAE | Echinocereus viridiflorus Engelm. | Y | ECVI1 | 4 | 4 | | | 12 | 16 |
| CACTACEAE | Opuntia macrorhiza Engelm. | Y | OPMA1 | 36 | 40 | 24 | 24 | 24 | 16 |
| CARYOPHYLLACEAE | Silene antirrhina L. | Y | SIAN1 | | | 8 | | | |
| CARYOPHYLLACEAE | Silene drummondii Hook. | Y | SIDR1 | | | | | | 4 |
| CHENOPODIACEAE | Chenopodium leptophyllum Nutt. ex Moq. | Y | CHLE2 | | | | 4 | | |
| CLUSIACEAE | Hypericum perforatum L. | N | HYPE1 | 4 | | | | | 4 |
| COMMELINACEAE | Tradescantia occidentalis (Britt.) Smyth | Y | TROC1 | 8 | | 24 | | 16 | |
| CONVOLVULACEAE | Convolvulus arvensis L. | N | COAR1 | 4 | 8 | | | | |
| CONVOLVULACEAE | Evolvulus nuttallianus R. & S. | Y | EVNU1 | | 8 | | | | |
| CYPERACEAE | Carex eleocharis Bailey | Y | CAEL1 | | | | | 4 | |
| CYPERACEAE | Carex heliophila Mack. | Y | CAHE1 | 24 | 24 | | | 60 | 72 |
| EUPHORBIACEAE | Euphorbia dentata Michx. | Y | EUDE1 | | | | | | 4 |
| EUPHORBIACEAE | Euphorbia spathulata Lam. | Y | EUSP1 | 16 | | 16 | | 24 | |
| FABACEAE | Astragalus agrestis Dougl. ex G. Don | Y | ASAG1 | | | 8 | 8 | | |
| FABACEAE | Astragalus shortianus Nutt. ex T.&G. | Y | ASSH1 | | | | | 4 | 4 |
| FABACEAE | Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinners. | Y | DACA1 | 8 | 4 | | | 4 | 8 |
| FABACEAE | Dalea purpurea Vent | Y | DAPU1 | 4 | 4 | | | 4 | 4 |
| FABACEAE | Psoralea tenuiflora Pursh. | Y | PSTE1 | 64 | 56 | 20 | 48 | 32 | 52 |
| FABACEAE | Vicia americana Muhl. ex Willd. | Y | VIAM1 | 20 | | 28 | | 8 | |

Table 5-7. (cont.)

| | | | | Frequency (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | TR02 | | TR04 | | TR11 | |
| Family | Scientific Name | Native | Speccode | Spring | Summer | Spring | Summer | Spring | Summer |
| GERANIACEAE | Erodium cicutarium (L.) L'Her. | N | ERCI1 | 28 | 12 | 8 | | | |
| LILIACEAE | Allium textile A. Nels. & Macbr. | Y | ALTE1 | 4 | | | | 4 | 4 |
| LILIACEAE | Leucocrinum montanum Nutt. | Y | LEMO2 | 16 | | 8 | | | |
| LINACEAE | Linum perenne L. var. lewisii (Pursh.) Eat. & Wright | Y | LIPE1 | 40 | 4 | 16 | | | |
| LINACEAE | Linum pratense (Nort.) Small | Y | LIPR1 | | | | 12 | | |
| MALVACEAE | Sphaeralcea coccinea (Pursh.) Rydb. | Y | SPCO1 | 40 | 32 | 40 | 40 | 8 | 4 |
| NYCTAGINACEAE | Mirabilis linearis (Pursh.) Heimerl | Y | MILI1 | | | | 4 | | 4 |
| ONAGRACEAE | Gaura coccinea Pursh. | Y | GACO1 | 12 | | 32 | 16 | 20 | 8 |
| ONAGRACEAE | Oenothera howardii (A. Nels.) W. L. Wagner | Y | OEHO1 | | | 4 | 4 | | |
| OROBANCHACEAE | Orobanche fasciculata Nutt. | Y | ORFA1 | | | | 4 | 20 | |
| PLANTAGINACE | Plantago patagonica Jacq. | Y | PLPA1 | | | | 4 | | |
| POACEAE | Agropyron smithii Rydb. | Y | AGSM1 | 68 | 64 | 88 | 56 | 80 | 56 |
| POACEAE | Andropogon gerardii Vitman | Y | ANGE1 | 12 | 12 | | | 32 | 32 |
| POACEAE | Andropogon scoparius Michx. | Y | ANSC1 | | 4 | | | | |
| POACEAE | Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | Y | ARLO1 | 20 | 24 | 4 | 8 | 8 | 20 |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | Y | BOCU1 | 52 | 48 | 4 | 4 | 24 | 32 |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | Y | BOGR1 | 92 | 80 | 72 | 76 | 36 | 52 |
| POACEAE | Bouteloua hirsuta Lag | Y | BOHI1 | | 4 | | | 4 | |
| POACEAE | Bromus inermis Leyss. ssp. inermis | N | BRIN1 | 8 | 8 | | | | |
| POACEAE | Bromus japonicus Thunb. ex Murr. | N | BRJA1 | 68 | 72 | 68 | 84 | 96 | 92 |
| POACEAE | Bromus tectorum L. | N | BRTE1 | | | 8 | 12 | 44 | 48 |
| POACEAE | Buchloe dactyloides (Nutt.) Engelm. | Y | BUDA1 | 32 | 36 | 40 | 40 | 16 | 16 |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | Y | KOPY1 | | 4 | 4 | 4 | 24 | 12 |
| POACEAE | Muhlenbergia wrightii Vasey | Y | MUWR1 | | | 4 | | 4 | 4 |
| POACEAE | Poa compressa L. | N | POCO1 | 8 | 8 | 12 | 20 | 12 | 12 |
| POACEAE | Poa pratensis L. | N | POPR1 | | | 24 | 20 | 28 | 24 |
| POACEAE | Schedonnardus paniculatus (Nutt.) Trel. | N | SCPA2 | | | | 4 | | |
| POACEAE | Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | Y | SIHY1 | | 4 | | | | 4 |
| POACEAE | Sporobolus cryptandrus (Torr.) A. Gray | Y | SPCR1 | | | | 4 | | |
| POACEAE | Stipa comata Trin. & Rupr. | Y | STCO1 | 8 | 12 | | 4 | 36 | 40 |
| POACEAE | Stipa viridula Trin. | Y | STVI1 | 8 | | 4 | 8 | 32 | 28 |
| POLEMONIACEAE | Microsteris gracilis (Hook.) Greene | Y | MIGR1 | | | 8 | | | |
| POLYGONACEAE | Eriogonum alatum Torr. | Y | ERAL1 | 8 | 4 | | | | |
| POLYGONACEAE | Polygonum ramosissimum Michx. | Y | PORA1 | | | | 4 | | |
| RANUNCULACEAE | Delphinium virescens Nutt. ssp. penardii (Huth) Ewan | Y | DEVI1 | | | | | 4 | 4 |
| ROSACEAE | Rosa arkansana Porter | Y | ROAR1 | 12 | 12 | 8 | 8 | 4 | 4 |
| SANTALACEAE | Comandra umbellata (L.) Nutt. | Y | COUM1 | | | | | 16 | 12 |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | N | LIDA1 | | | 28 | 24 | 52 | 48 |
| SCROPHULARIACEAE | Penstemon virens Penn. | Y | PEVI1 | | | | | 16 | 12 |
| SCROPHULARIACEAE | Verbascum blattaria L. | N | VEBL1 | 4 | | | | | |
| SCROPHULARIACEAE | Verbascum thapsus L. | N | VETH1 | | | | | 20 | 20 |
| VIOLACEAE | Hybanthus verticillatus (Ort.) Baill. | Y | HYVE1 | 12 | 16 | | | 4 | |
| VIOLACEAE | Viola nuttallii Pursh. | Y | VINU1 | 16 | | | | 20 | |

Frequency calculations based on n = 25.

# Appendix A

## Report 6

## 1999 Prescribed Burn Pre-Burn Monitoring Summary

# 6. 1999 Prescribed Burn Pre-Burn Monitoring Summary

## 6.1 Purpose

Prescribed burning is an important tool for native grassland management. To maintain the health and vigor of the native plant species, reduce plant litter and the potential for wildfire, and help with weed control, the use of prescribed burns is being planned to help manage the grassland communities at the Rocky Flats Environmental Technology Site (the Site). As with all land management actions, monitoring is an integral part of determining whether the management objectives and goals for a particular management technique are being achieved. During 1999, a prescribed burn was proposed for the xeric tallgrass prairie plant community, to be conducted in the spring of 2000. To evaluate the effect of the prescribed burn on the plant community, a monitoring program was instituted to provide quantitative monitoring data for a number of questions of interest.

The following general questions were proposed for investigation:

1. How will a prescribed burn affect the species richness and species diversity of the xeric tallgrass prairie?
2. What impact will a prescribed burn have on the foliar cover of the xeric tallgrass prairie? Specifically, what impact is there to the following categories of foliar cover: overall cover, native cover, non-native cover, forb cover, overall graminoid cover, warm-season graminoid cover, and cool-season graminoid cover?
3. What impact will a prescribed burn have on the frequency of individual plant species on the xeric tallgrass prairie?
4. What impact will a prescribed burn have on specific weed species?
5. How does the fire response of the xeric tallgrass prairie at the Site compare to the response of the tallgrass prairie of the eastern great plains, or to that of the more mesic tallgrass prairie found on City of Boulder Open space?
6. What recommendations can be made with regard to the use of prescribed burns for management of the xeric tallgrass prairie at the Site?

This report summarizes the pre-burn conditions at the locations where monitoring was conducted during 1999.

## 6.2 Methods

The xeric tallgrass prairie at the Site is located primarily on the pediment, which is underlain by Rocky Flats Alluvium (SCS 1980). The soils are classified as Flatirons very cobbly sandy loams (SCS 1980). During 1999, a monitoring program was developed and initiated to provide quantitative pre-burn and post-burn information to help answer the questions listed above. A stratified, random sampling design was used. Six plots—three control (no burn), and three treatment (burn)—were chosen for monitoring the response of the Site's xeric tallgrass prairie to the prescribed burn (Figure 6-1).

The control plots selected were BC1, BC2, and TR01. Plots BC1 and TR01 were pre-existing sites that had been used previously for other quantitative monitoring. BC2 was set out specifically for this study as a third replicate. The treatment plots were BT1, BT2, and BT3. Sites BT1 and BT2 were also pre-existing plots used for other monitoring, and BT3 was set out specifically for this study to provide a third replicate treatment site. At each site, a total of five randomly located 50-m transects were sampled. Sampling was conducted from September 9 through 24, 1999. The decision to conduct a controlled burn was made at a time that precluded collecting any spring pre-burn data. Thus, the study will evaluate only the late-summer effects on the prairie. Additionally, in May 1999, all six sites were sprayed by helicopter with Tordon 22K to help control the noxious weed diffuse knapweed (*Centaurea diffusa*).

Species richness, cover, and frequency were measured at each of the 50-m transects. Species richness was determined in a 2-m-wide belt centered along the length of each 50-m transect. Every plant species rooted within the 100-$m^2$ area was recorded. In addition, the number of woody plant stems and cactus stems were counted for the 100-$m^2$ area and recorded. Basal cover and foliar cover estimates were made using a point-intercept method along each of the 50-m transects. A 2-m-long rod, with a 6-mm diameter, was dropped vertically at 50-cm increments along the transect to record a total of 100 intercept points. Two categories of hits were recorded, basal and foliar. Basal cover hits indicated what material the rod contacted at the ground surface. Hits could be vegetation (live plants), litter (fallen dead material), rock (pebbles and cobbles that were greater than the rod diameter), bare ground, or water, in that order of priority based on the protection from erosion provided by each type of cover. Basal vegetation hits were recorded by species only if the rod was touching the stem or crown of the plant where the plant entered the ground. Foliar vegetation hits (defined as a portion of a plant touching the rod) were recorded by species in three categories as defined by height and growth form. The topmost hit of each growth form was recorded. The growth forms measured were herbaceous, woody <2 m in height, and woody >2 m in height. Frequency information by species was gathered by randomly locating five 1-$m^2$ quadrats along each of the 50-m transects (total of 25 quadrats/site) and recording all species present in each plot. Density stem counts for diffuse knapweed were also made using these same quadrats. No distinctions were made during counts to differentiate seedlings, rosettes, or adult plants. More detailed summaries of these specific methods are found in the *Environmental Monitoring Department Operating Procedures Manual* (DOE 1995), the *High-Value Vegetation Survey Plan for the Rocky Flats Environmental Technology Site*

(K-H 1997), and the *1999 Ecological Field Monitoring Plans for the Rocky Flats Environmental Technology Site* (K-H 1999a).

Data were summarized by combining the data from the three control sites and three treatment sites, respectively. Species richness data were summarized by generating a species list for the control and treatment locations. In addition, other species richness variables were calculated from the species lists. A Sorensen coefficient of similarity was used to assess the species richness similarity between the control and treatment data (Brower and Zar 1977). Basal cover data were reported as total percent cover of vegetation, litter, rock, and bare ground. Foliar cover data were reported as frequency, absolute cover, and relative cover for each species encountered. Frequency from the cover data was defined as the percent of point-intercept transects in which a species occurred, out of the total 15 possible. Absolute foliar cover was the percentage of the number of hits on a species out of the total number of hits possible (1500). This value is the actual cover of a species. Relative foliar cover was the number of hits on a species relative to the total number of vegetative hits recorded (i.e., the percent of total vegetative cover [100 percent] represented by the species). A Shannon-Weaver diversity index was used to calculate diversity based on the relative foliar cover data (Brower and Zar 1977).

Frequency based on quadrats (n=75; 3 transects × 25 quadrats each) was defined as the number of quadrats in which a species was recorded, divided by 75 (the total number of quadrats possible), multiplied by 100. Density count data were summarized as the mean number of stems per square meter.

Additionally, a single photograph of each transect was taken during the late summer sampling session to visually document the condition of the transect. Photographs were taken from the 0-m end of the transect near the permanent marker, looking toward the 50-m endpoint. A placard was placed in the photograph against the 0-m endpoint, providing the site and transect numbers and date.

For the 1999 data, results are presented as descriptive comparisons to show current pre-burn control and treatment conditions. Future data and analyses will examine potential changes over time—pre-treatment to post-treatment—resulting from the controlled burn. No statistical analyses were conducted on the 1999 data.

## 6.3 Results

In all, 103 species were recorded at the control and treatment locations monitored in 1999 (Table 6-1). The control areas had a total of 89 species, and the treatment areas had 86 species (Table 6-1). The control and treatment areas had 72 species in common. A Sorensen coefficient of similarity index showed a high similarity in species richness between the control and treatment areas (0.82). The percentage of native species was slightly higher in the control areas than in the treatment areas—84 percent and 79 percent, respectively. The mean number of species per quadrat differed by one between the control and treatment areas—12.4 and 11.6, respectively.

Cactus densities were higher in the treatment areas than in the control areas (Table 6-2). Twistspine prickly pear (*Opuntia macorhiza*) density was 1.2 stems/$m^2$ in the treatment areas and 0.36 stems/$m^2$ in the control areas. Hedgehog cacti (*Echinocereous viridiflorus*) density was 1.1 stems/$m^2$ in the treatment areas and 0.93 stems/$m^2$ in the control areas. Three woody plants were recorded at the control and treatment locations—Spanish bayonet (*Yucca glauca*), prairie wild rose (*Rosa arkansana*), and skunkbush sumac (*Rhus aromatica*)—but amounts were very small (Table 6-2).

Total foliar vegetation cover was 80.2 percent in the control areas and 76.1 percent in the treatment areas. Table 6-3 shows the foliar cover for individual species and various groupings of species for both the control and treatment locations. Of the total vegetation cover, more than 93 percent was provided by graminoids at both the control and treatment locations (Table 6-3). The total graminoid cover was evenly split between the cool-season grasses and warm-season grasses, averaging 45–48 percent in both the control and treatment areas (Table 6-3). Three graminoid species—big bluestem (*Andropogon gerardii*), Canada bluegrass (*Poa compressa*), and mountain muhly (*Muhlenbergia montana*)—dominated the vegetative cover, providing 51 percent and 66 percent of the total relative foliar cover at the control and treatment areas, respectively (Table 6-3). Only the order of dominance of these three species differed between the control and treatment areas. Approximately two-thirds of the total vegetation cover at both the control and treatment locations was from native species (Table 6-3). Total relative forb cover accounted for less than 7 percent at both the control and treatment locations during 1999.

Basal cover was dominated by litter, which accounted for 75 and 77 percent of the ground cover at the control and treatment locations, respectively. Rock cover provided 13 and 11 percent of the ground cover at the control and treatment locations, respectively, while bare ground was approximately 4 percent at both.

Individual species frequency results from the 1-$m^2$ quadrats are presented in Table 6-4. The most frequently encountered species in the control plots were sun sedge (*Carex heliophila*), blue grama (*Bouteloua gracilis*), dotted gayfeather (*Liatris punctata*), sideoats grama (*Bouteloua curtipendula*), and big bluestem (Table 6-4). In the treatment plots, the most frequently encountered species were mountain muhly, big bluestem, sun sedge, Canada bluegrass, blue grama, and twistspine prickly pear (Table 6-4). Post-fire monitoring will document whether any of these measurements change.

## 6.4 Discussion

Monitoring was conducted during the summer of 1999 to collect pre-burn vegetation data from three locations scheduled for prescribed burning in spring 2000. Data were also collected from three control areas for comparison. All control and treatment monitoring areas were treated with the herbicide Tordon 22K, applied from a helicopter, in May 1999. Pre-burn results indicate a high measure of similarity between the control and treatment areas for most of the variables measured. Little difference was noted in terms of species richness or overall foliar vegetation cover between the control and treatment

areas. Overall forb and graminoid cover amounts were also essentially equal at both the control and treatment locations. Forb cover was somewhat low (5–7 percent, Table 6-3) in the control and treatment areas compared to past monitoring at other locations on the xeric tallgrass prairie, where relative forb cover amounts have ranged from 10 to 39 percent (K-H 1999b). Additionally, graminoid cover was higher in the control and treatment areas (93–95 percent; Table 6-3) compared to past measurements at other locations that have ranged from 61 to 90 percent (K-H 1999b). The lower forb and higher graminoid cover is to be expected, however, as a result of the herbicide treatment these areas received in the spring of 1999.

The control and treatment locations were dominated by big bluestem, mountain muhly, and Canada bluegrass. Although the order of dominance differed between the control and treatment locations, all three species are the dominant graminoid species on the xeric tallgrass prairie at the Site. Warm-season and cool-season grasses accounted for nearly equal amounts of relative foliar cover at the control and treatment locations, and this ratio is one of the measures that it is hoped a prescribed burn would change. The two predominant cool-season grasses at the control and treatment locations are Kentucky bluegrass (*Poa pratensis*) and Canada bluegrass, both non-native species. One of the objectives of a spring prescribed burn is to reduce the amount of exotic graminoid cover and increase the native warm-season graminoids. Thus, a prescribed burn conducted in the spring would have the greatest impact on the cool-season grasses, particularly Kentucky bluegrass and Canada bluegrass, and should reduce the foliar cover of both species.

A prescribed burn will also reduce the high litter amounts found on the xeric tallgrass prairie. Seventy-seven percent of the ground surface was covered with dead plant litter in the treatment areas. Pre-burn monitoring in the prescribed burn area, conducted in spring 2000, showed total biomass amounts of 465 $g/m^2$ (4152 lbs/acre). The high litter amounts on the prairie at the Site contribute substantially to the potential for wildfires. In addition, the litter ties up nutrients, making them unavailable for plant growth. Part of the goal of a prescribed burn is to remove much of this litter, thereby reducing the potential for catastrophic wildfire and recycling nutrients. Monitoring after the prescribed fire will determine how much of this has been accomplished.

Of the measurements that differed between the control and treatment locations, cactus densities were higher at the treatment locations. Individual species frequencies differed considerably between the control and treatment areas for many species (Table 6-4). This is understandable for many of the less frequently encountered species on the xeric tallgrass prairie, because they would be expected to be encountered infrequently. However, even for the dominant graminoid species—big bluestem, mountain muhly, and Canada bluegrass—frequency values differed by 20–30 percent between the control and treatment areas. These values are expected for the xeric tallgrass prairie at the Site. Monitoring in 1998 showed the same pattern of frequency variability on the xeric tallgrass prairie at other locations (K-H 1999b). Because frequency is somewhat a measure of both the evenness and commonality of a species across the landscape, these data reveal the heterogeneous nature of the species distribution in the xeric tallgrass

prairie at the Site. The combination of both bunchgrasses like big bluestem and mountain muhly, and rhizome or turf grasses like Canada bluegrass, creates a mosaic pattern of species distribution that varies from location to location. This mosaic pattern is common in natural communities because of variations in microclimate and microtopography that influence such factors as light, temperature, soil moisture, and soil type.

## 6.5 Conclusions

The 1999 xeric tallgrass prairie monitoring data provide a good baseline of information from both control and treatment locations prior to the prescribed burn slated for spring 2000. The data also reveal the heterogeneous nature of the species distribution and species composition variability found in the xeric tallgrass prairie community at the Site. These results will provide useful information to evaluate how the use of prescribed burning as a management tool will affect the species composition and structure of the xeric tallgrass prairie at the Site.

## 6.6 References

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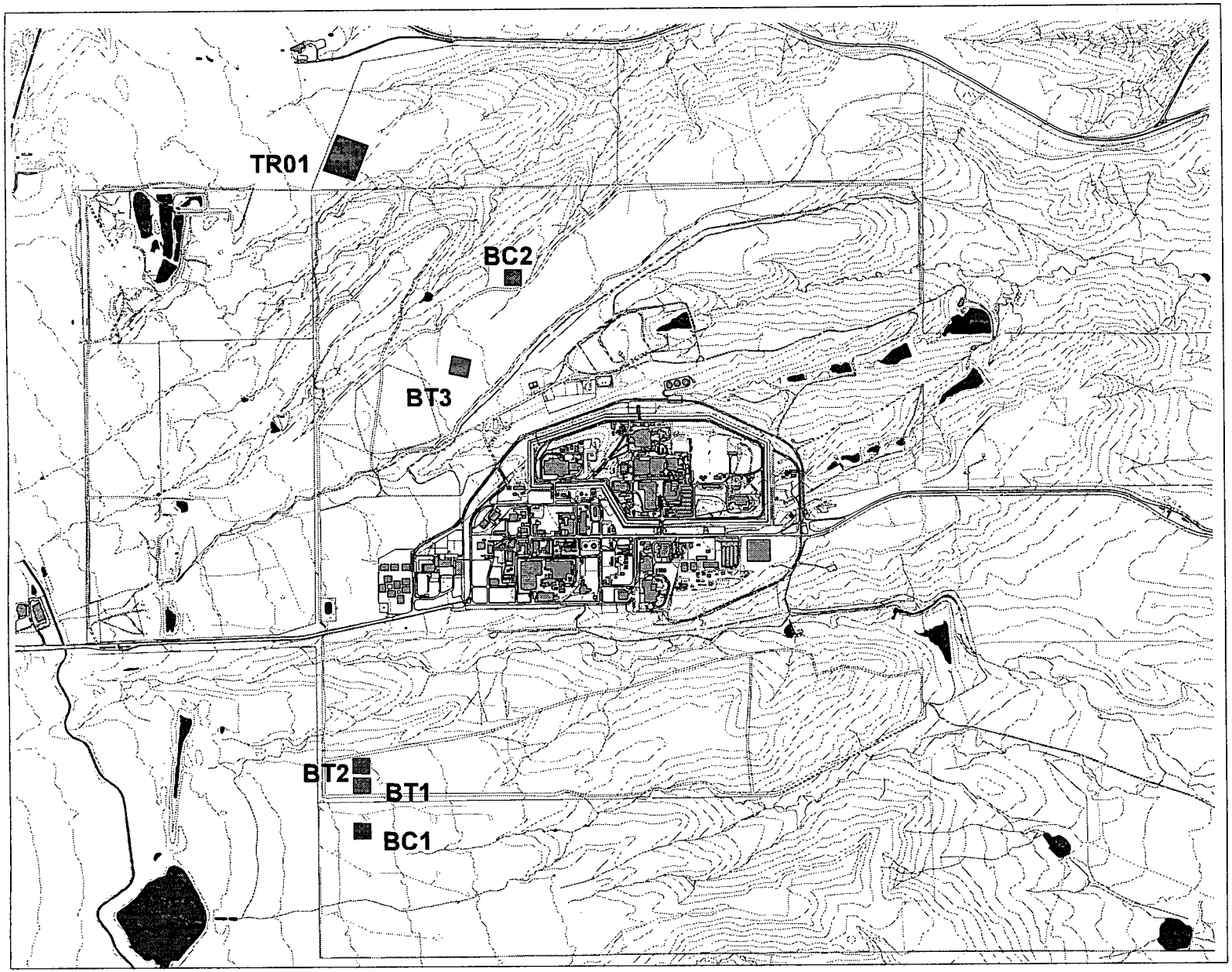
# Figures




# Prescribed Burn Monitoring Plot Locations

Figure 6-1

MAP LEGEND

- Control Plots
- Treatment Plots

Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
Permanent vegetation monitoring locations provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial flyover data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

Note:

Monitoring locations are approximate. Permanent transects endpoints are marked with rebar.

N

1:21920

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0038

March 14, 2000

# Tables

**Table 6-1. 1999 Prescribed Burn Pre-Burn Species Richness**

| Family | Scientific Name | Speccode | Native | Control | Treatment |
|---|---|---|---|---|---|
| AGAVACEAE | Yucca glauca Nutt. | YUGL1 | Y | X | X |
| ANACARDIACEAE | Rhus aromatica Ait. var. trilobata (Nutt.) A. Gray | RHAR1 | Y | X | |
| APIACEAE | Lomatium orientale Coult. & Rose | LOOR1 | Y | X | X |
| ASCLEPIADACEAE | Asclepias speciosa Torr. | ASSP1 | Y | X | X |
| ASCLEPIADACEAE | Asclepias stenophylla A. Gray | ASST1 | Y | X | X |
| ASCLEPIADACEAE | Asclepias viridiflora Raf. | ASVI1 | Y | X | X |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | ACMI1 | Y | X | |
| ASTERACEAE | Ambrosia psilostachya DC. | AMPS1 | Y | X | X |
| ASTERACEAE | Antennaria parvifolia Nutt. | ANPA1 | Y | X | X |
| ASTERACEAE | Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem. | ARCA1 | Y | | X |
| ASTERACEAE | Artemisia dracunculus L. | ARDR1 | Y | X | |
| ASTERACEAE | Artemisia frigida Willd. | ARFR1 | Y | X | X |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | Y | X | X |
| ASTERACEAE | Aster porteri Gray | ASPO1 | Y | X | X |
| ASTERACEAE | Centaurea diffusa Lam. | CEDI1 | N | X | X |
| ASTERACEAE | Chrysopsis fulcrata Greene | CHFU1 | Y | X | X |
| ASTERACEAE | Chrysopsis villosa Pursh. | CHVI1 | Y | X | X |
| ASTERACEAE | Cirsium arvense (L.) Scop. | CIAR1 | N | X | |
| ASTERACEAE | Cirsium undulatum (Nutt.) Spreng. | CIUN1 | Y | X | X |
| ASTERACEAE | Erigeron divergens T. & G. | ERDI1 | Y | X | X |
| ASTERACEAE | Gaillardia aristata Pursh. | GAAR1 | Y | X | X |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | Y | X | X |
| ASTERACEAE | Helianthus pumilus Nutt. | HEPU1 | Y | X | X |
| ASTERACEAE | Helianthus rigidus (Cass.) Desf. ssp. subrhomboideus (Rydb.) Heiser | HERI1 | Y | X | |
| ASTERACEAE | Kuhnia chlorolepis Woot. & Standl. | KUCH1 | Y | X | |
| ASTERACEAE | Kuhnia eupatorioides L. | KUEU1 | Y | X | |
| ASTERACEAE | Lactuca serriola L. | LASE1 | N | X | X |
| ASTERACEAE | Liatris punctata Hook. | LIPU1 | Y | X | X |
| ASTERACEAE | Ratibida columnifera (Nutt.) Woot. & Standl. | RACO1 | Y | X | X |
| ASTERACEAE | Senecio plattensis Nutt. | SEPL1 | Y | X | X |
| ASTERACEAE | Senecio spartioides T. & G. | SESP1 | Y | X | X |
| ASTERACEAE | Solidago mollis Bart. | SOMO1 | Y | X | X |
| ASTERACEAE | Taraxacum officinale Weber | TAOF1 | N | X | X |
| ASTERACEAE | Tragopogon dubius Scop. | TRDU1 | N | X | X |
| BORAGINACEAE | Cryptantha virgata (Porter) Payson | CRVI1 | Y | | X |
| BORAGINACEAE | Lithospermum incisum Lehm. | LIIN1 | Y | X | X |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | N | X | X |
| BRASSICACEAE | Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins | ARHI1 | Y | X | X |
| BRASSICACEAE | Camelina microcarpa Andrz. ex DC. | CAMI1 | N | | X |
| BRASSICACEAE | Erysimum capitatum (Nutt.) DC. | ERCA2 | Y | X | X |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | LECA1 | N | X | X |
| BRASSICACEAE | Lepidium densiflorum Schrad. | LEDE1 | Y | | X |
| BRASSICACEAE | Lesquerella montana (A. Gray) Wats. | LEMO1 | Y | X | X |
| CACTACEAE | Echinocereus viridiflorus Engelm. | ECVI1 | Y | X | X |
| CACTACEAE | Opuntia macrorhiza Engelm. | OPMA1 | Y | X | X |
| CARYOPHYLLACEAE | Arenaria fendleri A. Gray | ARFE2 | Y | X | X |
| CARYOPHYLLACEAE | Paronychia jamesii T. & G. | PAJA1 | Y | X | X |
| CARYOPHYLLACEAE | Silene drummondii Hook. | SIDR1 | Y | X | |
| CLUSIACEAE | Hypericum perforatum L. | HYPE1 | N | X | X |
| CRASSULACEAE | Sedum lanceolatum Torr. | SELA1 | Y | | X |
| CYPERACEAE | Carex heliophila Mack. | CAHE1 | Y | X | X |
| EUPHORBIACEAE | Euphorbia robusta (Engelm.) Small | EURO1 | Y | X | X |
| FABACEAE | Astragalus agrestis Dougl. ex G. Don | ASAG1 | Y | | X |
| FABACEAE | Astragalus shortianus Nutt. ex T.&G. | ASSH1 | Y | X | |
| FABACEAE | Dalea purpurea Vent | DAPU1 | Y | X | X |
| FABACEAE | Oxytropis lambertii Pursh. | OXLA1 | Y | | X |
| FABACEAE | Psoralea tenuiflora Pursh. | PSTE1 | Y | X | X |
| GERANIACEAE | Erodium cicutarium (L.) L'Her. | ERCI1 | N | X | X |
| HYDROPHYLLACEAE | Phacelia heterophylla Pursh. | PHHE1 | Y | X | |
| JUNCACEAE | Juncus interior Wieg. | JUIN1 | Y | X | X |
| LILIACEAE | Allium textile A. Nels. & Macbr. | ALTE1 | Y | X | X |
| NYCTAGINACEAE | Mirabilis linearis (Pursh.) Heimerl | MILI1 | Y | X | X |

**Table 6-1. (cont.)**

| Family | Scientific Name | Speccode | Native | Control | Treatment |
|---|---|---|---|---|---|
| ONAGRACEAE | Calylophus serrulatus (Nutt.) Raven | CASE2 | Y | X | |
| ONAGRACEAE | Gaura coccinea Pursh. | GACO1 | Y | X | |
| OROBANCHACEAE | Orobanche fasciculata Nutt. | ORFA1 | Y | X | |
| PLANTAGINACE | Plantago lanceolata L. | PLLA1 | N | | X |
| POACEAE | Aegilops cylindrica Host | AECY1 | N | | X |
| POACEAE | Agropyron smithii Rydb. | AGSM1 | Y | X | X |
| POACEAE | Andropogon gerardii Vitman | ANGE1 | Y | X | X |
| POACEAE | Andropogon scoparius Michx. | ANSC1 | Y | X | X |
| POACEAE | Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | Y | X | X |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | BOCU1 | Y | X | X |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | Y | X | X |
| POACEAE | Bouteloua hirsuta Lag | BOHI1 | Y | X | X |
| POACEAE | Bromus japonicus Thunb. ex Murr. | BRJA1 | N | X | X |
| POACEAE | Bromus tectorum L. | BRTE1 | N | X | X |
| POACEAE | Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | Y | X | |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | KOPY1 | Y | X | X |
| POACEAE | Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | Y | X | X |
| POACEAE | Muhlenbergia wrightii Vasey | MUWR1 | Y | X | X |
| POACEAE | Panicum capillare L. | PACA1 | Y | | X |
| POACEAE | Poa compressa L. | POCO1 | N | X | X |
| POACEAE | Poa pratensis L. | POPR1 | N | X | X |
| POACEAE | Setaria viridis (L.) Beauv. | SEVI1 | N | | X |
| POACEAE | Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | Y | X | X |
| POACEAE | Sorghastrum nutans (L.) Nash | SONU1 | Y | X | X |
| POACEAE | Sporobolus asper (Michx.) Kunth | SPAS1 | Y | | X |
| POACEAE | Sporobolus cryptandrus (Torr.) A. Gray | SPCR1 | Y | X | X |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | Y | X | X |
| POACEAE | Stipa comata Trin. & Rupr. | STCO1 | Y | X | X |
| POLEMONIACEAE | Ipomopsis spicata (Nutt.) V. Grant ssp. spicata | IPSP1 | Y | X | |
| POLYGONACEAE | Eriogonum alatum Torr. | ERAL1 | Y | X | X |
| POLYGONACEAE | Eriogonum umbellatum Torr. | ERUM1 | Y | X | X |
| PORTULACACEAE | Talinum parviflorum Nutt. | TAPA1 | Y | X | X |
| ROSACEAE | Potentilla fissa Nutt. | POFI1 | Y | X | X |
| ROSACEAE | Potentilla hippiana Lehm. | POHI1 | Y | X | |
| ROSACEAE | Rosa arkansana Porter | ROAR1 | Y | | X |
| SANTALACEAE | Comandra umbellata (L.) Nutt. | COUM1 | Y | X | X |
| SCROPHULARIACEAE | Castilleja sessiliflora Pursh. | CASE3 | Y | X | X |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | LIDA1 | N | X | X |
| SCROPHULARIACEAE | Penstemon secundiflorus Benth. | PESE1 | Y | X | |
| SCROPHULARIACEAE | Penstemon virens Penn. | PEVI1 | Y | X | X |
| SCROPHULARIACEAE | Verbascum thapsus L. | VETH1 | N | | X |
| | Total Number of Species/Treatment | | | 89 | 86 |
| | Total Number of Species/Combined | | | 103 | |
| | Sorenson Similarity Index | | | 0.82 | |

**Table 6-2. 1999 Prescribed Burn Pre-Burn Cactus and Woody Plant Densities**

| | | Density (stems/m$^2$) | |
|---|---|---|---|
| **Scientific Name** | **Speccode** | **Control** | **Treatment** |
| Echinocereus viridiflorus Engelm. | ECVI1 | 0.93 | 1.12 |
| Opuntia macrorhiza Engelm. | OPMA1 | 0.36 | 1.24 |
| Rhus aromatica Ait. var. trilobata (Nutt.) A. Gray | RHAR1 | 0.003 | 0.00 |
| Yucca glauca Nutt. | YUGL1 | 0.009 | 0.002 |
| Rosa arkansana Porter | ROAR1 | 0.00 | 0.001 |

Based on n = 5.

**Table 6-3. 1999 Prescribed Burn Pre-Burn Foliar Cover Summary**

| | | | | | | Control | | | Treatment | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Form | Native | Cool/Warm Season | Frequency | Absolute Cover | Relative Cover | Frequency | Absolute Cover | Relative Cover |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | F | N | | 33 | 1.60 | 2.00 | 33 | 1.00 | 1.31 |
| ASTERACEAE | Centaurea diffusa Lam. | CEDI1 | F | N | | | | | 7 | 0.07 | 0.09 |
| GERANIACEAE | Erodium cicutarium (L.) L'Her. | ERCI1 | F | N | | 13 | 0.20 | 0.25 | | | |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | LIDA1 | F | N | | 20 | 0.27 | 0.33 | 7 | 0.07 | 0.09 |
| ASTERACEAE | Ambrosia psilostachya DC. | AMPS1 | F | Y | | | | | 7 | 0.27 | 0.35 |
| CARYOPHYLLACEAE | Arenaria fendleri A. Gray | ARFE2 | F | Y | | 13 | 0.13 | 0.17 | 7 | 0.07 | 0.09 |
| ASTERACEAE | Artemisia frigida Willd. | ARFR1 | F | Y | | 7 | 0.07 | 0.08 | 7 | 0.07 | 0.09 |
| BRASSICACEAE | Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins | ARHI1 | F | Y | | 7 | 0.07 | 0.08 | | | |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | F | Y | | 7 | 0.07 | 0.08 | 27 | 0.27 | 0.35 |
| ASTERACEAE | Aster porteri Gray | ASPO1 | F | Y | | 7 | 0.20 | 0.25 | | | |
| ASTERACEAE | Chrysopsis villosa Pursh. | CHVI1 | F | Y | | 13 | 0.13 | 0.17 | 7 | 0.07 | 0.09 |
| SANTALACEAE | Comandra umbellata (L.) Nutt. | COUM1 | F | Y | | | | | 7 | 0.07 | 0.09 |
| POLYGONACEAE | Eriogonum alatum Torr. | ERAL1 | F | Y | | 7 | 0.13 | 0.17 | | | |
| ASTERACEAE | Kuhnia eupatorioides L. | KUEU1 | F | Y | | 7 | 0.07 | 0.08 | | | |
| ASTERACEAE | Liatris punctata Hook. | LIPU1 | F | Y | | 80 | 1.87 | 2.33 | 67 | 1.20 | 1.58 |
| APIACEAE | Lomatium orientale Coult. & Rose | LOOR1 | F | Y | | | | | 7 | 0.07 | 0.09 |
| SCROPHULARIACEAE | Penstemon virens Penn. | PEVI1 | F | Y | | 7 | 0.07 | 0.08 | 7 | 0.07 | 0.09 |
| FABACEAE | Psoralea tenuiflora Pursh. | PSTE1 | F | Y | | 40 | 0.53 | 0.67 | 13 | 0.20 | 0.26 |
| ASTERACEAE | Solidago mollis Bart. | SOMO1 | F | Y | | 7 | 0.07 | 0.08 | | | |
| POACEAE | Aegilops cylindrica Host | AECY1 | G | N | C | | | | 7 | 0.07 | 0.09 |
| POACEAE | Bromus japonicus Thunb. ex Murr. | BRJA1 | G | N | C | 53 | 1.07 | 1.33 | 60 | 1.20 | 1.58 |
| POACEAE | Bromus tectorum L. | BRTE1 | G | N | C | 47 | 1.73 | 2.16 | 20 | 0.40 | 0.53 |
| POACEAE | Poa compressa L. | POCO1 | G | N | C | 93 | 13.47 | 16.79 | 100 | 20.47 | 26.91 |
| POACEAE | Poa pratensis L. | POPR1 | G | N | C | 80 | 6.53 | 8.15 | 73 | 5.20 | 6.84 |
| POACEAE | Agropyron smithii Rydb. | AGSM1 | G | Y | C | 7 | 0.07 | 0.08 | 7 | 0.27 | 0.35 |
| POACEAE | Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | G | Y | C | 67 | 0.93 | 1.16 | 13 | 0.13 | 0.18 |
| CYPERACEAE | Carex heliophila Mack. | CAHE1 | G | Y | C | 93 | 4.80 | 5.99 | 87 | 2.93 | 3.86 |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | KOPY1 | G | Y | C | 87 | 2.93 | 3.66 | 60 | 0.93 | 1.23 |
| JUNCACEAE | Juncus interior Wieg. | JUIN1 | G | Y | C | 7 | 0.07 | 0.08 | | | |
| POACEAE | Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | G | Y | C | 13 | 0.13 | 0.17 | 7 | 0.07 | 0.09 |
| POACEAE | Stipa comata Trin. & Rupr. | STCO1 | G | Y | C | 87 | 4.73 | 5.90 | 87 | 4.93 | 6.49 |
| POACEAE | Andropogon gerardii Vitman | ANGE1 | G | Y | W | 100 | 15.07 | 18.79 | 100 | 12.67 | 16.65 |

Table 6-3. (cont.)

| | | | | | | Control | | | Treatment | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Scientific Name | Speccode | Form | Native | Cool/Warm Season | Frequency | Absolute Cover | Relative Cover | Frequency | Absolute Cover | Relative Cover |
| POACEAE | Andropogon scoparius Michx. | ANSC1 | G | Y | W | 47 | 1.33 | 1.66 | 67 | 1.40 | 1.84 |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | BOCU1 | G | Y | W | 87 | 3.47 | 4.32 | 47 | 1.40 | 1.84 |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | G | Y | W | 93 | 3.13 | 3.91 | 80 | 1.80 | 2.37 |
| POACEAE | Bouteloua hirsuta Lag | BOHI1 | G | Y | W | 40 | 0.73 | 0.91 | 40 | 0.40 | 0.53 |
| POACEAE | Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | G | Y | W | 7 | 0.07 | 0.08 | | | |
| POACEAE | Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | G | Y | W | 73 | 12.47 | 15.54 | 100 | 17.13 | 22.52 |
| POACEAE | Muhlenbergia wrightii Vasey | MUWR1 | G | Y | W | 7 | 0.07 | 0.08 | | | |
| POACEAE | Sorghastrum nutans (L.) Nash | SONU1 | G | Y | W | 53 | 1.53 | 1.91 | 33 | 1.07 | 1.40 |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | G | Y | W | 20 | 0.40 | 0.50 | 7 | 0.13 | 0.18 |
| Total foliar cover | | | | | | | 80.20 | 100.00 | | 76.07 | 100.00 |
| Total forb cover | | | | | | | 5.47 | 6.82 | | 3.47 | 4.56 |
| Total native forb cover | | | | | | | 3.40 | 4.24 | | 2.33 | 3.07 |
| Total non-native forb cover | | | | | | | 2.07 | 2.58 | | 1.13 | 1.49 |
| Total graminoid cover | | | | | | | 74.73 | 93.18 | | 72.60 | 95.44 |
| Total native cover | | | | | | | 55.33 | 68.99 | | 47.60 | 62.58 |
| Total non-native cover | | | | | | | 24.87 | 31.01 | | 28.47 | 37.42 |
| Total warm-season graminoid cover | | | | | | | 38.27 | 47.71 | | 36.00 | 47.33 |
| Total cool-season graminoid cover | | | | | | | 36.47 | 45.47 | | 36.60 | 48.12 |

Absolute cover = Absolute foliar cover is the percentage of the number of hits on a species out of the total number of hits possible (1500).

Relative cover = Relative foliar cover was the number of hits a species had relative to the total number of all vegetative hits recorded per site (i.e., the percent of vegetative cover the species represented).

All cover values presented are means (n = 15).

Native categories: Y = Native, N = Non-Native

Form categories: C = Cactus, F = Forb, G = Graminoid

Cool/Warm Season categories: C = Cool season species, W = Warm season species

Frequency values are in percent (n = 15).

**Table 6-4. 1999 Prescribed Burn Pre-Burn Frequency Summary**

| | | | Frequency (%) | |
|---|---|---|---|---|
| Family | Scientific Name | Speccode | Control | Treatment |
| APIACEAE | Lomatium orientale Coult. & Rose | LOOR1 | 12.0 | 24.0 |
| ASCLEPIADACEAE | Asclepias viridiflora Raf. | ASVI1 | 1.3 | |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | ACMI1 | 4.0 | |
| ASTERACEAE | Ambrosia psilostachya DC. | AMPS1 | 9.3 | 5.3 |
| ASTERACEAE | Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem. | ARCA1 | | 1.3 |
| ASTERACEAE | Artemisia dracunculus L. | ARDR1 | 1.3 | |
| ASTERACEAE | Artemisia frigida Willd. | ARFR1 | 8.0 | 8.0 |
| ASTERACEAE | Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 | 6.7 | 34.7 |
| ASTERACEAE | Aster porteri Gray | ASPO1 | 20.0 | 8.0 |
| ASTERACEAE | Centaurea diffusa Lam. | CEDI1 | 2.7 | 5.3 |
| ASTERACEAE | Chrysopsis fulcrata Greene | CHFU1 | 5.3 | 1.3 |
| ASTERACEAE | Chrysopsis villosa Pursh. | CHVI1 | 20.0 | 1.3 |
| ASTERACEAE | Cirsium arvense (L.) Scop. | CIAR1 | 1.3 | |
| ASTERACEAE | Cirsium undulatum (Nutt.) Spreng. | CIUN1 | 1.3 | 1.3 |
| ASTERACEAE | Erigeron divergens T. & G. | ERDI1 | 1.3 | 2.7 |
| ASTERACEAE | Gaillardia aristata Pursh. | GAAR1 | 5.3 | 12.0 |
| ASTERACEAE | Grindelia squarrosa (Pursh.) Dun. | GRSQ1 | | 5.3 |
| ASTERACEAE | Helianthus pumilus Nutt. | HEPU1 | 1.3 | 1.3 |
| ASTERACEAE | Kuhnia chlorolepis Woot. & Standl. | KUCH1 | 1.3 | |
| ASTERACEAE | Kuhnia eupatorioides L. | KUEU1 | 1.3 | |
| ASTERACEAE | Liatris punctata Hook. | LIPU1 | 69.3 | 45.3 |
| ASTERACEAE | Ratibida columnifera (Nutt.) Woot. & Standl. | RACO1 | 1.3 | |
| ASTERACEAE | Senecio plattensis Nutt. | SEPL1 | 4.0 | 4.0 |
| ASTERACEAE | Senecio spartioides T. & G. | SESP1 | 1.3 | |
| ASTERACEAE | Solidago mollis Bart. | SOMO1 | 4.0 | |
| ASTERACEAE | Taraxacum officinale Weber | TAOF1 | | 1.3 |
| ASTERACEAE | Tragopogon dubius Scop. | TRDU1 | 2.7 | 2.7 |
| BORAGINACEAE | Lithospermum incisum Lehm. | LIIN1 | 2.7 | |
| BRASSICACEAE | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 | 38.7 | 37.3 |
| BRASSICACEAE | Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins | ARHI1 | 5.3 | 5.3 |
| BRASSICACEAE | Erysimum capitatum (Nutt.) DC. | ERCA2 | 4.0 | 4.0 |
| BRASSICACEAE | Lepidium campestre (L.) R. Br. | LECA1 | 12.0 | 1.3 |
| BRASSICACEAE | Lesquerella montana (A. Gray) Wats. | LEMO1 | 29.3 | 46.7 |
| CACTACEAE | Echinocereus viridiflorus Engelm. | ECVI1 | 53.3 | 58.7 |
| CACTACEAE | Opuntia macrorhiza Engelm. | OPMA1 | 34.7 | 60.0 |
| CARYOPHYLLACEAE | Arenaria fendleri A. Gray | ARFE2 | 21.3 | 13.3 |
| CARYOPHYLLACEAE | Paronychia jamesii T. & G. | PAJA1 | 14.7 | 2.7 |
| CLUSIACEAE | Hypericum perforatum L. | HYPE1 | 2.7 | 1.3 |
| CRASSULACEAE | Sedum lanceolatum Torr. | SELA1 | | 4.0 |
| CYPERACEAE | Carex heliophila Mack. | CAHE1 | 90.7 | 77.3 |
| FABACEAE | Astragalus agrestis Dougl. ex G. Don | ASAG1 | | 2.7 |
| FABACEAE | Dalea purpurea Vent | DAPU1 | 9.3 | 4.0 |
| FABACEAE | Psoralea tenuiflora Pursh. | PSTE1 | 22.7 | 18.7 |
| GERANIACEAE | Erodium cicutarium (L.) L'Her. | ERCI1 | 8.0 | |
| HYDROPHYLLACEAE | Phacelia heterophylla Pursh. | PHHE1 | 2.7 | |
| JUNCACEAE | Juncus interior Wieg. | JUIN1 | 2.7 | 5.3 |
| LILIACEAE | Allium textile A. Nels. & Macbr. | ALTE1 | 2.7 | 4.0 |
| NYCTAGINACEAE | Mirabilis linearis (Pursh.) Heimerl | MILI1 | 1.3 | 1.3 |
| ONAGRACEAE | Gaura coccinea Pursh. | GACO1 | 1.3 | |
| OROBANCHACEAE | Orobanche fasciculata Nutt. | ORFA1 | 1.3 | |
| POACEAE | Agropyron smithii Rydb. | AGSM1 | 5.3 | 2.7 |
| POACEAE | Andropogon gerardii Vitman | ANGE1 | 58.7 | 80.0 |
| POACEAE | Andropogon scoparius Michx. | ANSC1 | 41.3 | 34.7 |
| POACEAE | Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr | ARLO1 | 17.3 | 6.7 |
| POACEAE | Bouteloua curtipendula (Michx.) Torr. | BOCU1 | 66.7 | 49.3 |
| POACEAE | Bouteloua gracilis (H. B. K.) Lag ex Griffiths | BOGR1 | 74.7 | 60.0 |
| POACEAE | Bouteloua hirsuta Lag | BOHI1 | 45.3 | 18.7 |

**Table 6-4. (cont.)**

| | | | Frequency (%) | |
|---|---|---|---|---|
| **Family** | **Scientific Name** | **Speccode** | **Control** | **Treatment** |
| POACEAE | Bromus japonicus Thunb. ex Murr. | BRJA1 | 20.0 | 38.7 |
| POACEAE | Bromus tectorum L. | BRTE1 | 21.3 | 8.0 |
| POACEAE | Buchloe dactyloides (Nutt.) Engelm. | BUDA1 | 1.3 | |
| POACEAE | Koeleria pyramidata (Lam.) Beauv. | KOPY1 | 45.3 | 34.7 |
| POACEAE | Muhlenbergia montana (Nutt.) Hitchc. | MUMO1 | 50.7 | 82.7 |
| POACEAE | Muhlenbergia wrightii Vasey | MUWR1 | 1.3 | |
| POACEAE | Poa compressa L. | POCO1 | 54.7 | 73.3 |
| POACEAE | Poa pratensis L. | POPR1 | 40.0 | 33.3 |
| POACEAE | Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc. | SIHY1 | 21.3 | 6.7 |
| POACEAE | Sorghastrum nutans (L.) Nash | SONU1 | 16.0 | |
| POACEAE | Sporobolus heterolepis (A. Gray) A. Gray | SPHE1 | 5.3 | |
| POACEAE | Stipa comata Trin. & Rupr. | STCO1 | 49.3 | 56.0 |
| POLYGONACEAE | Eriogonum alatum Torr. | ERAL1 | 25.3 | 16.0 |
| PORTULACACEAE | Talinum parviflorum Nutt. | TAPA1 | 2.7 | 2.7 |
| ROSACEAE | Potentilla fissa Nutt. | POFI1 | 1.3 | 1.3 |
| ROSACEAE | Potentilla hippiana Lehm. | POHI1 | 1.3 | |
| SANTALACEAE | Comandra umbellata (L.) Nutt. | COUM1 | 4.0 | 9.3 |
| SCROPHULARIACEAE | Castilleja sessiliflora Pursh. | CASE3 | 2.7 | |
| SCROPHULARIACEAE | Linaria dalmatica (L.) Mill. | LIDA1 | 12.0 | 2.7 |
| SCROPHULARIACEAE | Penstemon virens Penn. | PEVI1 | 5.3 | 4.0 |
| SCROPHULARIACEAE | Verbascum thapsus L. | VETH1 | | 1.3 |

Frequency values based on n = 75.