RFP--5122

# Baseline Report



## Tall Upland Shrubland at the Rocky Flats Environmental Technology Site

**Prepared for**

**Kaiser-Hill Company, LLC**

**Golden, Colorado**

**by**

***PTI***

*Environmental Services*

*Boulder, Colorado*

# DISCLAIMER

**DISCLAIMER**

**Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.**

# Baseline Report

## Tall Upland Shrubland at the Rocky Flats Environmental Technology Site

**Prepared for**

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

**by**

***PTI***
Environmental Services
4940 Pearl East Circle, Suite 300
Boulder, Colorado 80301

PTI Contract CB3E-04-01

March 1997

# CONTENTS

Figures and Tables

APPENDIX A - Methods, and Figures A1 and A2

# LIST OF FIGURES

# LIST OF TABLES

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| CNHP | Colorado Natural Heritage Program |
| EcMP | Ecological Monitoring Program |
| Site | Rocky Flats Environmental Technology Site |
| T&E | threatened and endangered |

# INTRODUCTION

Rocky Flats Environmental Technology Site (Site) is located on the Colorado Piedmont east of the Front Range between Boulder and Golden. 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 close proximity to the mountain front. The Buffer Zone surrounding the Industrial Area is one of the largest remaining undeveloped areas of its kind along the Colorado Piedmont (approximately 5,600 acres; DOE 1996a). A number of plant communities at the Site have been identified as increasingly rare and unique by Site ecologists and the Colorado Natural Heritage Program (CNHP). These 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 Preble's meadow jumping mouse, grasshopper sparrow, loggerhead shrike, Merriam's shrew, black crowned night heron, and Hops blue and Argos skipper butterflies (CNHP 1994; 1995).

One of the more interesting and important plant communities at the Site is the tall upland shrubland community. It has been generally overlooked by previous Site ecological studies, probably due to its relatively small size; only 34 acres total (less than 1 percent of the total Site area; DOE 1996a). Although mentioned in a plant community ordination study conducted by Clark et al. (1980) and also in the Site baseline ecological study (DOE 1992), few data were available on this plant community before the present study.

## OBJECTIVES

The purpose of this study was to provide a baseline inventory of the species richness, the canopy composition, and the overall quality of the tall upland shrubland community.

## QUESTIONS

This study addressed questions concerning physical characteristics of the tall upland shrubland community, as well as questions about vegetation parameters. Physical characterization questions include the following:

- What is the slope position of the tall upland shrubland community?
- What are its slope and aspect?
- At what distance below the pediment does the tall upland shrubland community generally occur?

- Is erosion a problem in the tall upland shrubland community?
- Do seeps flow within the tall upland shrubland community?
- What types of soils are present in the tall upland shrubland community?

Questions about vegetation parameters included the following:

- What is the species richness of the tall upland shrubland community?
- What percentage of the species are native?
- What is the number of species in the tall upland shrubland community that are annuals vs. perennials, woody vs. graminoid or forb, and monocot vs. dicot?
- What species are restricted to the tall upland shrubland community at the Site?
- What threatened and endangered (T&E) species, Species of Special Concern, or Site rare (species uncommon on Site) species occur in the tall upland shrubland community?
- What are the predominant canopy species in the tall upland shrubland community?
- Do the predominant canopy species vary in different drainages?
- Are the canopy species reproducing?
- If the canopy species are reproducing, are they doing so beneath the canopy or outside the canopy?
- What is the abundance and distribution of noxious and introduced weed species in the tall upland shrubland community?
- Where is diffuse knapweed (*Centaurea diffusa*) potentially the greatest threat to the tall upland shrubland?

# METHODS

## STUDY AREA

The tall upland shrubland at the Site is shown in Figure 1. For ease of sampling, the tall upland shrubland was divided into ten different sites (management units) based on the drainages in which it occurred (Figure 2). Sampling for this study was done in the areas of tall upland shrubland found within the management unit boundaries shown in Figure 2. The patches of shrubland that were qualitatively sampled are also shown in Figure 2 (see methods below for sampling details).

| Drainage Name | Sample Site Code |
|---|---|
| Gentian Draw | TUS01 |
| Grape Draw | TUS02 |
| Lobelia Draw | TUS03 |
| Lindsay Draw | TUS04 |
| Snowberry Draw | TUS05 |
| Mahonia Draw | TUS06 |
| Plum Draw | TUS07 |
| Shortear Draw | TUS08 |
| South Walnut Creek | TUS09 |
| Apple Orchard Spring | TUS10 |

## METHODS

Initial attempts to locate 50-m transects for a quantitative sampling design in the thicket-like patches of tall upland shrubland proved too destructive; therefore, a qualitative sampling design was devised. Because no methodologies existed in the Environmental Management Department Operating Procedures Manual (DOE 1991) for this type of sampling, instructions and field data sheets were developed (Appendix A). The sampling plan was based on a variety of monitoring plans and data forms used by other land management agencies (CBOS 1996a,b; Lock 1996, pers. comm.; Wade 1996, pers. comm.; Robertson et al. 1990; and KEC 1996).

Two types of sampling were conducted in the tall upland shrubland community: a species richness inventory, and a qualitative assessment of the canopy composition and condition of the community. To allow collection of a complete species richness inventory for the tall upland shrubland, species richness sampling was conducted twice during 1996, once in the spring and once in the late summer. Each management unit of the tall upland shrubland community was traversed during both the spring and late summer, and all plant species were recorded that made up the canopy, and were observed beneath the canopy and within 2 m of the edge of the tall upland shrubland community. During the late summer sampling, a qualitative habitat assessment was conducted in addition to the species richness inventory. Two or three patches were selected subjectively from each management unit for qualitative assessments (Figure 1). They were chosen subjectively, rather than selected randomly, because of the interest in sampling the largest and oldest tall upland shrubland patches on the Site. Information gathered included physical parameters, presence and abundance of selected weeds, evidence of disease or disturbance, cover and distribution of predominant canopy species, and reproduction of canopy species.

Canopy cover for each major woody canopy species in each tall upland shrubland patch was estimated using a cover class system (Appendix A) adapted from the Braun-Blanquet scale (DOE 1991; Bonham 1989). This method was modified for this study such that each tall upland shrubland patch was considered to be equivalent to a quadrat. Although the actual size of the patches varied, the assumption was made that, because the estimates were in percentages, this approach would provide a quick, semi-quantitative means of estimating the woody species cover. Frequency and mean cover for each woody species were calculated from the data. Midpoints of the cover classes (Appendix A) were used to calculate a mean cover for each species. Canopy species reproduction was estimated for each major woody canopy species in each patch using a density distribution class (Appendix A). Both the canopy cover and canopy species reproduction estimates were made within the main canopy and outside the main canopy, separately. For purposes of this study, the main canopy was defined as the primary thicket of each patch. The area defined as outside the main canopy was the area surrounding the main canopy that had individuals or small clumps (i.e., sparse or scanty coverage) of the same woody species that made up the canopy. See Appendix A for the specific instructions, illustrations, and field data sheets used for the sampling.

# RESULTS

## PHYSICAL PARAMETERS

The tall upland shrubland community is located primarily in the Rock Creek drainage, with smaller portions found in the Walnut Creek, Woman Creek, and Smart Ditch drainages (Figure 1). Calculations based on the Site vegetation map (DOE 1996a) revealed that 94 percent of the tall upland shrubland community on the Site is located in Rock Creek. Slopes measured within the tall upland shrubland patches ranged from 3° to 34°, with 83 percent occurring on slopes of 16–30° (Table 1; Figure 3). Ninety-six percent of the sampled tall upland shrubland patches occurred on slopes with aspects ranging between 271° and 45° (west through northeast slopes; Table 1; Figure 4). In 74 percent of the measured tall upland shrubland patches, the upper edge of the patch was within 10 vertical meters of the top of the pediment (Table 1; Figure 5). The tall upland shrublands sampled occurred on slope positions ranging from streamsides to the top edge of the pediment (Table 1; Appendix A). Erosion was ranked in patches from none present, to as many as 10 locations of erosion per tall upland shrubland patch (Table 1), with 35 percent of the patches having no erosion and 57 percent having between one and five erosion locations per patch. Only six of the 23 tall upland shrubland patches sampled (26 percent) had seeps flowing from within the canopy of the patch (Table 1).

The soils beneath the tall upland shrublands were ranked as predominantly cobbly and gravelly (Table 1). The soil series most commonly associated with the tall upland shrubland locations on the shoulders and back slopes of the terrace escarpments was the Nederland very cobbly sandy loam, although in a few locations, some Flatirons very cobbly sandy loam was also present (SCS 1980). The soils units that supported portions of the tall upland shrubland community along the streambanks and lower hillsides included the Haverson loam and Denver-Kutch-Midway clay loam soil units (SCS 1980).

## VEGETATION PARAMETERS

### Species Richness

A total of 333 vascular plant species representing 65 plant families were found growing in the tall upland shrubland community at the Site in 1996 (Table 2). Of these, 81 percent were native species (Table 3). Eighty-five percent of the species were perennials, two percent were biennials, and 13 percent were annuals (Table 3). Seventy-five percent of the species were dicots (Table 3). Table 3 contains the other results for a list of measurements calculated from the species list.

Twenty species never before reported for the Site were recorded during the tall upland shrubland sampling during 1996. Voucher specimens for each species were collected, verified for identification at the University of Colorado herbarium in Boulder, cataloged, labeled, mounted, and filed in the Site herbarium. The new species reported for the Site were Canada goldenrod (*Solidago canadensis*), pitseed goosefoot (*Chenopodium berlandieri*), showy goldeneye (*Heliomeris multiflora*), Canada milk-vetch (*Astragalus canadensis*), white checker mallow (*Sidalcea candida*), Oregon fleabane (*Erigeron speciosa* var. *macranthus*), succulent hawthorn (*Crataegus succulenta* var. *occidentalis*), mountain rescue-grass (*Ceratochloa marginata*), highbush cranberry (*Viburnum opulus* var. *americanum*), sand cherry (*Prunus pumila* var. *besseyi*), thickspike wheatgrass (*Agropyron dasystachyum*), white-flowered silvery lupine (Lupinus *argenteus* ssp. *ingratus*), anise root (*Osmorhiza longistylis* var. *longistylis*), Porters lovage (*Ligusticum porteri*), manyflower gromwell (*Lithospermum multiflorum*), fragile fern (*Cystopteris fragilis*), Rydberg's violet (*Viola rydbergii*), bluestem willow (*Salix irrorata*), porcupine-grass (*Stipa spartea*), and Griffiths wheatgrass (*Agropyron griffithsii*).

## Noxious and Introduced Weed Distributions

Noxious and introduced weed abundance and distribution in the tall upland shrubland community were characterized using a density distribution class system (Robertson et al. 1990; Appendix A). Tabular results for the species characterized are found in Table 4. The two species with the greatest frequency (occurrence) at all tall upland shrubland patches sampled were Japanese brome (*Bromus japonicus*) and Canada thistle (*Cirsium arvense*), both of which occurred in all but one of the 23 patches sampled (96 percent frequency). Both of these species occurred with distributions ranging from a few clumps of plants to nearly continuous distribution throughout the tall upland shrubland patches sampled. The other two species with greater than 50 percent frequency in the tall upland shrubland were musk thistle (*Carduus nutans*) and common St. John's-wort (*Hypericum perforatum*). Both of these species, however, had only a few sporadic individuals scattered throughout the patches sampled. Diffuse knapweed occurred in 48 percent of the sampled locations; all but one of which were along the western edge of the Site.

## Canopy Cover

Within the main canopy of the tall upland shrubland, choke cherry (*Prunus virginiana*), occurred in 100 percent of the patches sampled (Table 5). The other canopy species with greater than 50 percent frequency were hawthorn (*Crataegus erythropoda*), skunkbush sumac (*Rhus aromatica*), and wild plum (*Prunus americana*), with percent frequencies of 78, 74, and 52 percent, respectively (Table 5). The woody canopy species with the greatest cover within the main canopy of the tall upland shrubland was choke cherry, with a mean canopy cover of 54 percent (Table 5). Hawthorn provided the second largest amount of mean canopy cover, at 40 percent, with wild plum and skunkbush sumac providing only 9 and 6 percent of the mean canopy cover, respectively (Table 5).

Outside the main canopy, choke cherry also had the greatest percent frequency, occurring in 96 percent of the patches sampled (Table 6). The other canopy species with greater than 50 percent frequency outside the main canopy were hawthorn, skunkbush sumac, and wild plum, with percent frequencies of 78, 74, and 57 percent, respectively (Table 6). The woody canopy species that had the greatest cover outside the main canopy was skunkbush sumac, with a mean canopy cover of 10 percent (Table 6). Choke cherry and hawthorn provided equal amounts of mean canopy cover outside the main canopy, at 9 percent each (Table 6). Wild plum provided only 5 percent of the cover outside the main canopy (Table 6).

## Canopy Reproduction

Young choke cherry (<1.5 m in height) occurred in 100 percent of the patches sampled (Table 7). Choke cherry had distribution class values ranging from 5 to 9, with a value of 7 for most patches sampled (Table 7). This distribution indicated a nearly continuous distribution of choke cherry beneath the canopy. Young hawthorn plants occurred in 78 percent of the patches sampled (Table 7). Hawthorn had distribution class values ranging from 1 to 6, with the largest number of patches recorded in classes 1 and 2, indicating that its distribution within the main canopy was restricted to single or a few sporadically occurring individuals (Table 7). Young skunkbush sumac and wild plum occurred within the main canopy in 70 and 48 percent of the patches sampled, respectively (Table 7). Both these species had occurrences recorded for distribution classes 2 through 6, with the most patches occurring in the 4 to 6 class range, indicating distributions ranging from a few scattered individuals to several well-spaced clumps (Table 7).

Young choke cherry were documented growing outside the main canopy in 96 percent of the patches sampled (Table 8). Choke cherry had distribution class values ranging from 1 to 8, with the largest number of patches occurring in classes 2, 4 and 5, indicating a distribution ranging from a few sporadically occurring individuals to a few scattered clumps (Table 8). Young hawthorn and skunkbush sumac occurred outside the main canopy in 78 percent of the patches sampled. Both these species had occurrences recorded for distribution classes 2 through 6, with hawthorn also having one record for class 7 (Table 8). Both species had the most patches occurring in class 6, indicating a distribution of several well-spaced clumps (Table 8). Wild plum occurred only outside the main canopy, in 57 percent of the patches sampled, with most of its distribution found in classes 4 to 6 (Table 8).

# DISCUSSION

## PHYSICAL PARAMETERS

The tall upland shrubland community on the Site is found primarily in the Rock Creek drainage. It is also found in limited areas in Walnut and Woman Creeks and in Smart Ditch, and is restricted to the intermittent streambanks and above seeps that commonly emerge from many of the hillsides (DOE 1996a). The position of the tall upland shrubland on the landscape is generally intermediate between the hydric wetland areas and drier grasslands. Although it is strongly associated with hydric areas, which probably accounts for its greater presence in the Rock Creek drainage, where hillside seeps are common, only six of the locations sampled had seeps exiting the shrubland from beneath the canopy. It was also found primarily on north-facing slopes, which have a higher moisture content.

Further evidence of this strong affinity for hydric areas was also revealed by comparing the tall upland shrubland locations (Figure 1) to Site wetland locations (USACE 1994) and to the depth to the water table (DOE 1995a). Eighteen of the 23 sampled tall upland shrubland patches (78 percent) occurred uphill and/or adjacent to delineated wetlands (USACE 1994). The depth to the water table of the tall upland shrubland locations at TUS01, TUS02, TUS03, TUS04, was 3–6 m, while at TUS09 and TUS10, it was less than 3 m (DOE 1995a; Plate 7, Average Depth to Water in Unconsolidated Surficial Deposits). No data on depth to water table were available for the other tall upland shrubland management units sampled. Roach (1948) sampled a hawthorn shrubland in two nearby canyons (Skunk or Pole Canyon and Cemetery Gulch) in what is now the Boulder Mountain Parks and found a similar set of physical parameters for those shrublands. He reported that the hawthorn shrublands were restricted to seep zones in small amphitheatres on the hillsides and to the streambanks. The seep zones were located at the juncture of the overlying alluvial rock cap and less permeable Pierre shale bedrock in situations similar to the geology found at the Site.

The moisture-holding capacity of the soils underlying the tall upland shrubland locations also tended to be fairly high. The Nederland very cobbly sandy loam and Haverson loam both had high available water capacity (SCS 1980). The Denver-Kutch-Midway clay loam soils varied from low to high available water capacity, depending on which specific unit was predominant. The Flatirons very cobbly sandy loam, occurred only in a couple of locations and had a low available water capacity (SCS 1980). In addition, all of these soils units were well drained, indicating that although water is available, the soils are not saturated.

Although evidence of erosion was observed in some patches of tall upland shrubland, it was not considered a serious problem at this time. This erosion was largely a result of deer trails and deer beds in particular tall upland shrubland patches where deer are frequently found. None of the erosion observed was serious enough to warrant action.

In summary, the tall upland shrubland community at the Site is typically found on moderately steep, north-aspect slopes near ridgetops, on Nederland very cobbly sandy loam soils, within 3–6 m of the water table, and in close proximity to seeps, or near valley bottoms on Haverson loam and Denver-Kutch-Midway clay loam soils along streams.

## VEGETATION PARAMETERS

### Species Richness

The high number of vascular plant species reported for the flora of the tall upland shrubland community (333 species; Tables 2 and 3) shows the ecological importance of this community at the Site. The tall upland shrubland alone constitutes 55 percent of the Site flora (602 species; DOE 1996b), while representing less than 1 percent of the total areal extent of the Site (DOE 1996a). The tall upland shrubland community also has the highest bird species richness of the plant communities at the Site (DOE 1996c). The findings of this study contrast with those presented in the Baseline Biological Characterization of the Site (DOE 1992), which reported the plant species diversity of the tall upland shrubland community as low, with only 57 species recorded. The low number of species recorded at that time was largely due to the different methodology used for that sampling (five 50-m × 2-m transects), so any comparisons between these data sets are misleading.

Direct comparisons of the tall upland shrubland species richness to other Site plant communities that have been sampled was not possible, because of similar methodological problems. No community-wide species richness sampling has been conducted in the other plant communities. Plant community species richness data gathered previously by the Ecological Monitoring Program (EcMP) were drawn from within 100-$m^2$ belt transects (DOE 1994, 1995b) and are therefore not directly comparable to community-wide species richness data. Beginning in 1997, however, community-wide species richness sampling will be conducted in the xeric tallgrass prairie, Great Plains riparian woodland, and selected wetlands at the Site. The tall upland shrubland data will be compared to these data when they are available.

A partial explanation for the high floristic richness in the tall upland shrubland community lies in the ecotonal (edge) effect that occurs wherever one community type adjoins another. The area along the edge often has a higher species richness, because the predominant species in the two communities mix. Because the average size of a tall upland shrubland patch is 0.3 acres (DOE 1996a), and the patches are often linear, there is a substantial edge effect. As a result, the surrounding plant community types contribute a large number of species to the overall tall upland shrubland community. Dominant species in the xeric tallgrass prairie, wetlands, mesic grasslands, and other communities that surround the tall upland shrubland were often found beneath the canopy or within the 2-m sampling boundary around the patches.

Soil moisture is another important factor in the species richness of the tall upland shrubland community. Previous ecological studies at the Site (Clark et al. 1980; DOE 1992) have stated that soil moisture is one of the most important factors affecting the diversity of plant species at Rocky Flats, with the highest diversity found in the more hydric areas. Results of the EcMP studies at the Site demonstrated this as well: the hydric (wet) riparian community was found to have a higher overall species richness than the other more xeric (dry) or mesic (moderate moisture) communities (DOE 1995b). The tall upland shrubland is a transition community between the hydric riparian and wetland communities and xeric/mesic grasslands, and so contains species representative of both.

Although no quantitative sampling was conducted in the understory of the tall upland shrubland community, the following observations were made on some of the species occurring there. The herbaceous understory of the tall upland shrubland community contains a number of species that, at the Site, are restricted to the cool, shaded microhabitat provided by the tall upland shrubland canopy. Many of these native species are predominant in the understory of the largest patches of tall upland shrubland on the Site. Their presence may indicate that these patches were affected less by past cattle grazing, or that they have returned to a more native state since the cessation of grazing. Other studies in hawthorn communities have shown that cattle grazing replaces the native understory species with non-native species (Hansen and Hoffman 1988; Franklin and Dyrness 1988; Hansen et al. 1988). (See the noxious and introduced weed species section for discussion concerning the non-native understory species.) These native species include Fendler waterleaf (*Hydrophyllum fendleri*), spreading sweetroot (*Osmorhiza chilensis*), anise root, carrionflower greenbriar (*Smilax herbacea* var. *lasioneuron*), fragile fern, Colorado violet, *(Viola scopulorum*), Rydberg's violet, and northern bedstraw *(Galium septentrionale*).

Some of the native species are ephemeral in nature, such as the Fendler waterleaf, spreading sweetroot, and anise root, which form a nearly solid ground cover beneath some of the larger patches of tall hawthorn dominated canopies. These species come up early in the spring and complete most of their life cycle before the overhead canopy species fully leaf out. Once the canopy is closed, and the sunlight and early spring warmth are blocked out, these species have finished their life cycle for another year. Late in the summer, it is often difficult to find any evidence that these species occurred at all. In this sense, the habitat provided by the tall upland shrubland is similar to that of the eastern deciduous forest, which has its own ephemeral plant community. Two other species known to occur only in the tall upland shrubland community at the Site, but which are found clambering across the top of the canopy instead of in the understory, are wild grape (*Vitis riparia*) and wild hops (*Humulus lupulus* var. *lupuloides*). Forty-one species were identified as being restricted primarily to the tall upland shrubland community at the Site. These species are highlighted in the species list (Table 2).

The percentage of native species (81 percent; Table 3) found in the tall upland shrubland was very similar to the percentages found on sampled transects of xeric mixed grassland and mesic mixed grassland at the Site (84 and 81 percent native species, respectively; DOE 1995b). Compared to the reclaimed grassland and riparian communities which had 62 and 74 percent native species, respectively (DOE 1995b), this further indicates the high-quality nature of the community.

A number of species reported from the tall upland shrubland community at the Site are remnants of the eastern woodland-prairie flora that was once much more widespread across the present-day Great Plains (Weber 1995). This element of the flora has survived since the Pleistocene, when the advancing glaciers spread the eastern woodland-prairie flora westward to the base of the Rocky Mountains (Weber 1976). As the glaciers receded and the climate became drier, this flora retreated, leaving relict populations of these species in isolated favorable mesic sites (Weber 1995). The eastern woodland-prairie relict populations reported for the tall upland shrubland community on the Site include striate agrimony (*Agrimonia striata*), big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), sun sedge (*Carex heliophila*), New Jersey tea (*Ceanothus herbaceus* var. *pubescens*), switchgrass panic (*Panicum virgatum*), porcupine-grass, yellow indian grass (*Sorghastrum nutans*), and prairie dropseed (*Sporobolus heterlepis*).

No listed threatened or endangered species were found in the tall upland shrubland. However, carrionflower greenbriar was found growing in the tall upland shrubland community. This species is listed by the Colorado Natural Heritage Program (CNHP 1996) as a rare and imperiled species and it has been given a Natural Heritage state rarity ranking of S3/S4. This ranking provides no legal designation or authority, but indicates that the species is rare in Colorado and further distributional information and monitoring of the species are necessary. The species was found in five of the drainages (TUS01, TUS02, TUS04, TUS05, and TUS06; Figure 2) in Rock Creek. This species will be monitored beginning in the 1997 field season (K-H 1997a).

## Canopy Cover and Reproduction

The tall upland shrubland community at the Site was tentatively classified as a hawthorn-choke cherry–wild plum (*Crataegus erythropoda–Prunus virginiana–Prunus americana*) plant association by the CNHP (CNHP 1995). Results of the current study indicate that the shrubland is more correctly classified as a choke cherry–hawthorn–wild plum (*Prunus virginiana–Crataegus erythropoda–Prunus americana*) plant association, because choke cherry occurs with greater frequency and provides more cover in the main canopy of the community than does hawthorn (Table 5).

The presence of the tall upland shrubland community at the Site is controlled and affected by a number of factors, including canopy species reproduction, hydrologic issues, disease and predation, and climatic change. Recent observations indicate a new threat as well; knapweed may be killing the canopy species in some locations. Canopy reproduction was measured during this study. Beneath the main canopy, young choke cherry plants (<1.5 m in height) were observed in every patch sampled, ranging in distribution from a few clumps to nearly continuous (Table 7). Young hawthorn plants (<1.5 m in height) were observed beneath the main canopy in every patch where it was also recorded as a canopy species (Tables 5 and 7), but the distribution was predominantly solitary plants or a few sporadically occurring individuals (Table 7). These few individuals of hawthorn were located either along the margins of the patch or near openings in the canopy where more light was available. The distinct contrast in the presence and abundance of young plants of these two species beneath the main canopy indicates a significant difference in their tolerance for low-light situations. Based on results from this study, young choke cherry are apparently shade tolerant, while young hawthorn are shade intolerant. Further evidence of this conclusion comes from the distribution of young plants of these species outside the main canopy. Young hawthorn were quite abundant outside the main canopy in open areas, where no shading was present (Table 8), indicating a high light need. Young choke cherry was also quite common outside the main canopy (Table 8), indicating that it grows well under low or high light. In summary, the dominant canopy species, choke cherry and hawthorn, are reproducing in the tall upland shrubland community.

It is also apparent from the young shrub growth occurring outside the main canopy that the tall upland shrubland community is expanding at the Site. However, other evidence indicates that this expansion may be only temporary. Observations outside the main canopy in the upper drainages of Rock Creek documented numerous small (<1.5 m) dead "stumps" of hawthorn, indicating that past expansions of the community have occurred, but ultimately these expansions died. The factors influencing these expansions and contractions of the tall upland shrubland are unknown and were beyond the scope of this study, but potential causes might include past grazing practices, hydrologic or precipitation changes, lack of natural wildfires, or climate change.

Examination of historical aerial photographs of the Site, dating back to 1937, revealed that all but two of the current major locations of tall upland shrubland were present at that time. Comparison of aerial photographs taken in 1937, 1951, 1972, 1981, and 1994, also revealed that although some slight increase or decrease in shrubland patch size and/or increased densities at some locations has occurred, the locations of the tall upland shrubland in general have been fairly static. The presence and longevity of hawthorn shrublands has been documented previously along the Colorado Piedmont in studies by Robbins (1908) and Roach (1948). Robbins mapped the locations of hawthorn shrublands in two canyons that are now in the Boulder Mountain Parks (Skunk or Pole Canyon and Cemetery Gulch). Roach re-mapped the shrubland locations 40 years later and found there to be no significant change in their position. Observation of these drainages by

Nelson in the fall of 1996 (Nelson 1996) revealed that the hawthorn shrublands mapped by Robbins and Roach are still present in essentially the same locations. Therefore, although there seems to be a current "expansion" of the tall upland shrubland, the long-term historical evidence indicates that the shrublands are unlikely to expand much beyond their current locations. Roach (1948) stated that the hawthorn shrublands in the Boulder Mountain Parks were restricted to the banks of intermittent streams and to seep areas where the alluvial rock cap met the underlying, less permeable Pierre shale. Soil moisture is the most likely factor restricting the locations of the tall upland shrubland at the Site, and unless this or other factors change substantially, it is likely that the tall upland shrubland community will continue to be present in essentially the same locations in the future.

The two locations where the tall upland shrubland has expanded throughout the years provide some insight into the factors that might facilitate expansion of the community. At TUS03, the 1951 photo reveals that the tall upland shrubland was restricted to a small area around a pine tree at a bend in the pediment. The original buffer-zone fence would have included this area and would have prevented grazing from then until the present. At some point between 1951 and 1972, a gravel road was also built parallel to the edge of the pediment. In the photos since 1972, when the road first shows up, there has been a continual increase in the development of tall upland shrubland west of the original patch, along the road, and between the road and the seeps below it. One theory is that the placement of the road altered the hydrology of the area enough to allow the shrubland to grow there. Another theory is that removal of grazing from the area after purchase of the land by DOE in the early 1950s helped the shrublands to become established.

At the other location where the tall upland shrubland has expanded, TUS10, no tall upland shrubland and few to no trees were present along Woman Creek in the 1951 photo, prior to the building of Rocky Flats. However, in the 1972 through 1994 photos, the tall upland shrubland and riparian woodlands originated along the stream and have continued to increase over the years. Release from grazing pressure and/or alteration of runoff and streamflow resulting from the building of Rocky Flats are both possible explanations for the growth of the tall upland shrubland and woodlands in Woman Creek. Since grazing is not currently used as a management tool at the Site, alteration of the hydrogeology at the Site is the primary factor that could potentially affect the tall upland shrubland community. An increase in soil moisture at particular locations could expand the community; conversely, a decrease in available soil moisture could kill off parts of the community.

Some evidence of predation was apparent on choke cherry in many of the patches sampled. Bagworms and leaf galls were present on some of the shrubs. At present, however, there did not appear to be any substantial problems resulting from predation, although continued observations should be made to monitor any changes that might indicate a need for action to control these pests.

## Noxious and Introduced Weeds

The most immediate weed threat to the existence of the tall upland shrubland community in many locations on the Site is diffuse knapweed. In the upper drainages of Rock Creek, large populations of diffuse knapweed are present on the mesic hillsides upwind of the tall upland shrubland community. Observations in these drainages indicate that portions of the community possibly are being damaged or killed by diffuse knapweed piling on top of the branches of the shrubs. In one patch of wild plum in Plum Draw, approximately 50 percent of the patch was dead where diffuse knapweed was piled 7 to 8 ft deep. Communication with Dr. George Beck, a weed control expert at Colorado State University in Fort Collins (Beck 1996, pers. comm.), indicated that diffuse knapweed does not have any allelopathic characteristics, and the death of these shrubs is most likely due to the shading that results when the weeds pile up. Because diffuse knapweed is a shade-intolerant species (Beck 1994), there is little likelihood that it will grow beneath the tall upland shrubland canopy. However, the high densities of diffuse knapweed present on the hillsides in areas upwind of the community, and the presence of large piles of dead diffuse knapweed in the tall upland shrubland community, could contribute to the reduction of the dominant canopy species and other understory species, and could also hinder travel routes and wildlife habitat usage in the community. Preservation and management of the tall upland shrubland community will require control of the diffuse knapweed on the hillsides upwind of the community and physical removal of the diffuse knapweed from the community itself. The FY97 weed control plan (K-H 1997b) addresses these issues and includes plans for spraying and controlling these diffuse knapweed-infested areas. Further study of this issue may be warranted if actions do not solve the problem.

Many of the tall upland shrubland patches that were characterized on the Site showed evidence of past overgrazing. A number of studies have indicated that in hawthorn and choke cherry shrublands where heavy grazing takes place, the native understory is replaced by noxious and introduced species (Hansen and Hoffman 1988; Franklin and Dyrness 1988; Hansen et al. 1988). Grazed stands are often composed only of large, old shrubs, with an open understory containing a low shrub and herbaceous layer (Hansen and Hoffman 1988; Franklin and Dyrness 1988; Hansen et al. 1988). A number of tall upland shrubland patches sampled on the Site had these characteristics, which helps explain many of the non-native species found growing in the understory. Distributions of 16 noxious and introduced weed species were characterized in the tall upland shrubland community (Table 4). Given the nature of the distributions and population sizes of these species within the tall upland shrubland community, most of the weedy forb and graminoid species listed would best be controlled by spot herbicide applications directly on the small infestations. Spot spraying or wick application of herbicides in the tall upland shrubland would be required to prevent defoliating the shrubland itself.

Japanese brome and Canada thistle had the highest frequency and greatest distributions (Table 4). The largest noxious weed infestation problem in the tall upland shrubland community and surrounding wetlands comes from Canada thistle. Canada thistle formed nearly solid stands on the lower (wetland) sides of many of the tall upland shrubland patches sampled. Herbicides, controlled burns, and biological controls would help to control this problem. The musk thistle and common St. John's-wort infestations could be controlled by augmenting existing biological control agents (insects). See the Weed Control Strategy and Integrated Treatment Plan for FY97 (K-H 1997b) for more details on the weed control issues and treatment strategies that could be applied in the tall upland shrubland.

## Uniqueness of the Tall Upland Shrubland Community

One of the important questions that remains to be answered is whether the choke cherry–hawthorn–wild plum shrubland at the Site is rare—locally, regionally, or globally. The CNHP identified it as a unique shrubland and ranked it with their Natural Heritage Global and State rarity rankings as GU/SU, indicating its poorly known status at both the global and state levels (CNHP 1994, 1995). This ranking carries no legal designation or authority, but rather indicates that further study of the community is warranted in making future decisions concerning its status.

Although the current study focused solely on the shrubland found at the Site, a search of the literature, communication with other ecologists, and personal observations provided some additional information concerning distribution of this community in the local area. As previously mentioned, Robbins (1908) and Roach (1948) studied a hawthorn shrubland in two canyons of the Boulder Mountain Parks. Roach concluded that hawthorn was an endemic foothills ecotonal species, restricted to the base of the foothills and forming a separate vegetational unit. Because the hawthorn did not occur in the plant communities in the mountains or farther out on the plains, it did not belong to either the Plains Grassland Formation or Montane Coniferous Formation. McHenry (1929) mentioned a hawthorn shrubland at the mouth of Gregory Canyon, also in the Boulder Mountain Parks. Small amounts of a hawthorn shrubland are known to occur north of the Site on Boulder Open Space land, across the south Site boundary on the McKay property, and in Layden Gulch west of the small town of Layden, approximately two miles south of the Site, based on personal observations by Nelson (1996). Personal communication with other researchers (Berry 1996; Prather 1996; Murdock 1996) revealed that small locations of a shrubland similar to those described at the Site are known to occur from Morrison to Lyons along the streams and on hillsides and gulches cut in the alluvial outwash fans along the eastern edge of the foothills. However, because no data exist for the off-Site locations, it is unclear whether they contain the same plant association. The locations and similar physical conditions in which these shrublands occur would indicate that they are probably quite similar, if not the same, but further study by other researchers would be required to confirm this.

Similar choke cherry–hawthorn shrublands are reported in Washington, Oregon, and Montana (Hansen et al. 1988; Franklin and Dyrness 1988; Kovalchik 1987). The species of hawthorn in these shrublands (succulent hawthorn or Douglas hawthorn = *C. douglassii*) differs from the dominant species found at the Site, which would indicate a different plant association. However, descriptions of the communities reveal a similar set of understory species, similar growth patterns, and a similar substrate preference for alluvial deposits (Hansen et al. 1988; Franklin and Dyrness 1988).

The fact that the hawthorn shrublands tend to occur only in a narrow band along the base of the foothills would indicate that the tall upland shrubland has never been a very common community type in the region. This characteristic is similar to the relict xeric tallgrass prairie at the Site, which occurs with a similar distribution pattern in a narrow band along the edge of the mountain front (Livingston 1952). Increasing urbanization and development along the Front Range continues to destroy what little remains of many of the plant communities that were once more common. To determine how much of this community remains along the Front Range will require inventorying and mapping of the community type by other researchers. However, given the quality and amount of the habitat known to exist at the Site along with other increasingly rare plant communities such as xeric tallgrass prairie, seep wetlands, and Great Plains riparian woodland, the tall upland shrubland should continue to be protected and monitored as a unique natural resource.

# CONCLUSIONS

Although the tall upland shrubland represents less than 1 percent of the total area of the Site, it serves an important ecological role. Three hundred thirty-three species of vascular plants (55 percent of the Site flora) were recorded in the community in 1996. Other studies revealed that the community contains the highest species richness of birds on the Site and is very important as bird and wildlife habitat, providing food, thermal and hiding cover, nesting locations, and fawning areas.

The tall upland shrubland community at the Site is classified as a choke cherry–hawthorn–wild plum plant association. Most of the community is located in the Rock Creek drainage, with small amounts also in the Walnut Creek, Woman Creek, and Smart Ditch drainages. It typically occurs on north-facing, moderately steep slopes, often associated with seeps that emerge on the hillsides below it. The canopy species in the tall upland shrubland are reproducing, and evidence indicates that the shrubland is expanding at the Site.

Historical evidence reveals that the tall upland shrubland has been present at most locations on the Site for more than 60 years. The most significant threat to the tall upland shrubland at present is apparently from diffuse knapweed. Plans are under development to begin controlling the diffuse knapweed on the hillsides upwind of the tall upland shrubland areas. Monitoring of the tall upland shrubland community will continue as part of the Ecology Program's objective to maintain the high-quality plant and animal communities found on the site.

# REFERENCES


Beck, K.G. 1994. Diffuse and spotted knapweed: Biology and management. Service in Action No. 3.110. Colorado State University Cooperative Extension, Colorado State University, Fort Collins.

Beck, K.G. 1996. Personal communication (electronic mail to J. Nelson, PTI Environmental Services, Boulder, CO). Colorado State University, Fort Collins.

Berry, M.E. 1996. Personal communication (electronic mail to J. Nelson, PTI Environmental Services, Boulder, CO). University of Colorado, Boulder.

Bonham C.D. 1989. Measurements for terrestrial vegetation. John Wiley and Sons, New York.

CBOS. 1996a. Training session for Native Plant Conservation Program. Bureau of Land Management outline, Section 5A: Overview of monitoring. From Land Management and Monitoring Training Workshop. City of Boulder Open Space Department, Boulder, CO.

CBOS. 1996b. Training session for Native Plant Conservation Program. Vegetation monitoring training. Prairie dog town evaluation forms and IPM weed inventory sheets used by Open Space Department. City of Boulder Open Space Department, Boulder, CO.

Clark, S.V., P.J. Webber, V. Komarkova, and W.A. Weber. 1980. Map of mixed prairie grassland vegetation, Rocky Flats, Colorado. Occasional Paper No. 35. Institute of Arctic and Alpine Research, University of Colorado, Boulder, CO.

CNHP. 1994. Natural heritage resources of the Rocky Flats Environmental Technology Site and their conservation. Phase 1: Rock Creek. Final Report. Colorado Natural Heritage Program, Colorado State University, Fort Collins.

CNHP. 1995. Natural heritage resources of the Rocky Flats Environmental Technology Site and their conservation. Phase 2: The Buffer Zone. Final Report. Colorado Natural Heritage Program, Colorado State University, Fort Collins.

CNHP. 1996. Colorado's natural heritage: Rare and imperiled animals, plants, and natural communities. (Internet—World Wide Web, http://www.ColoState.EDU/Orgs/CNHP/docs). Colorado Natural Heritage Program, Colorado State University, Fort Collins.

DOE. 1991. Environmental Management Department Operating Procedures Manual. Vol. V: Ecology. U.S. Department of Energy, 5-21200-OPS-EE. EG&G, Rocky Flats, Golden, CO.

DOE. 1992. Baseline biological characterization of the terrestrial and aquatic habitats at Rocky Flats Plant. Final Report. U.S. Department of Energy, Rocky Flats Plant, Golden, CO.

DOE. 1994. Rocky Flats Plant ecological monitoring program annual report. Rocky Flats Field Office, U.S. Department of Energy, Golden, CO.

DOE. 1995a. Hydrogeologic characterization report for the Rocky Flats Environmental Technology Site. Sitewide geoscience characterization study. Final Report. EG&G Rocky Flats, Golden, CO.

DOE. 1995b. Rocky Flats Environmental Technology Site ecological monitoring program 1995 annual report. Rocky Flats Field Office, U.S. Department of Energy, Golden, CO.

DOE. 1996a. Rocky Flats Environmental Technology Site vegetation types map. Rocky Flats Environmental Technology Site, Golden, CO.

DOE. 1996b. Current approved species code list. Environmental Management Department Operating Procedures Manual. Vol. V: Ecology. U.S. Department of Energy, 5-21200-OPS-EE. EG&G, Rocky Flats, Golden, CO.

DOE. 1996c. 1995 annual wildlife survey report. Natural Resource Protection and Compliance Program, Rocky Mountain Remediation Services, Rocky Flats Environmental Technology Site, Golden, CO.

Franklin, J.F., and C.T. Dyrness. 1988. Natural vegetation of Oregon and Washington. Oregon State University Press.

Hansen, P.L., and G.R. Hoffman. 1988. The vegetation of the Grand River/Cedar River, Sioux, and Ashland districts of the Custer National Forest: A habitat type classification. U.S. Department of Agriculture, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Hansen, P.L., S.W. Chaddle, and R.D. Pfister. 1988. Riparian dominance types of Montana. Misc. Pub. #49. Montana Riparian Association. Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula.

KEC. 1996. Training session for Native Plant Conservation Program, City of Boulder Open Space Department. Sand Creek riparian corridor vegetation/restoration/habitat assessment form. Keammerer Ecological Consultants, Inc., Boulder, CO.

K-H. 1997A. High value vegetation survey plan for the Rocky Flats Environmental Technology Site. Prepared for Kaiser-Hill Company, LLC, by PTI Environmental Services, Boulder, CO.

K-H. 1997b. Integrated weed control strategy for the Rocky Flats Environmental Technology Site. Prepared for Kaiser-Hill Company, LLC, by PTI Environmental Services, Boulder, CO.

Kovalchik, B.L. 1987. Riparian zone associations: Deschutes, Ochoco, Fremont, and Winema National Forests. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. R6 ECOL TP-279-87.

Livingston, R.B. 1952. Relict true prairie communities in central Colorado. Ecology 33:72–86.

Lock, M. 1996. Personal communication (electronic mail to J. Nelson, PTI Environmental Services, Boulder, CO). Royal Botanic Gardens, Kew, England.

McHenry, D.E. 1929. The vegetation of Gregory Canyon, Colorado. M.A. thesis. Archives, University of Colorado libraries, Boulder, CO.

Murdock, M.B. 1996. Personal communication (with J. Nelson, PTI Environmental Services, Boulder, CO). PTI Environmental Services, Rocky Flats Environmental Technology Site, Golden, CO.

Nelson, J.K. 1996. Personal observations of tall upland shrubland areas near Rocky Flats Environmental Technology Site. PTI Environmental Services, Rocky Flats Environmental Technology Site, Golden, CO.

Neptune. 1996. Rocky Flats Environmental Technology Site integrated environmental monitoring plan. Formal review draft. Prepared for Kaiser-Hill Company by Neptune and Company, Inc., Los Alamos, NM.

Prather, J.W. 1996. Personal communication (electronic mail to J. Nelson, PTI Environmental Services, Boulder, CO). Department of Biological Sciences, University of Arkansas, Fayetteville, AR.

Roach, A.W. 1948. The ecology of vegetation change in the foothills ecotone near Boulder, CO. M.A. thesis. Archives, University of Colorado libraries, Boulder, CO.

Robbins, W.W. 1908. Studies in mesa and foothill vegetation, I. 4. Distribution of deciduous trees and shrubs on the mesas. The University of Colorado Studies, University of Colorado, Boulder.

Robertson, A., S. Park, and B.W. Adams. 1990. Two worksheets for range vegetation monitoring. Range Notes. Issue No. 8. Range Management—Public Lands Division, Alberta Forestry, Lands, and Wildlife, Edmonton, Alberta.

SCS. 1980. Soil survey of Golden area, Colorado. Parts of Denver, Douglas, Jefferson, and Park counties. U.S. Department of Agriculture, Soil Conservation Service.

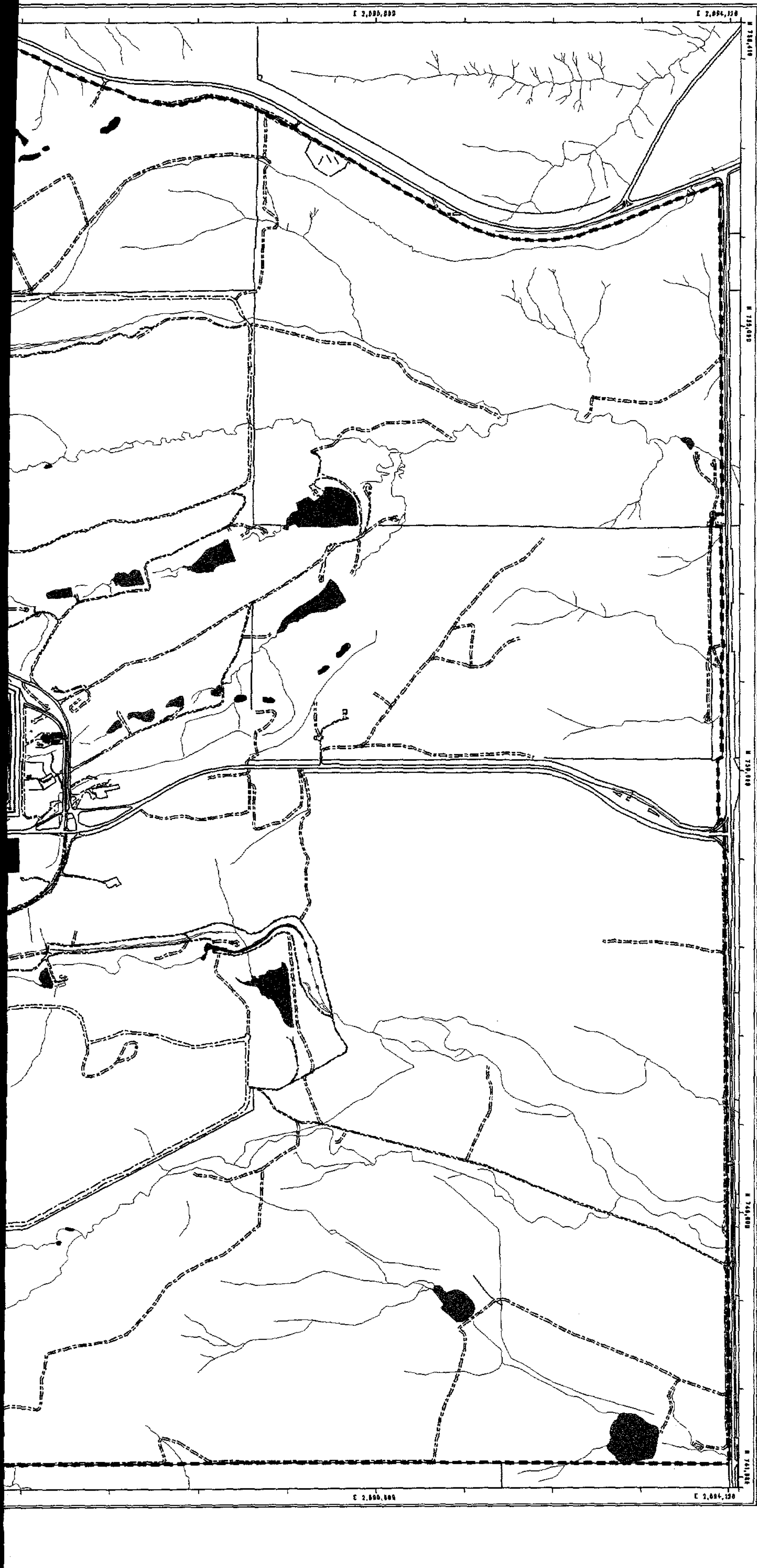
USACE. 1994. Rocky Flats Plant wetlands mapping and resource study. U.S. Army Corps of Engineers, prepared for U.S. Department of Energy, Rocky Flats Field Office, Golden, CO.

Wade, G.L. 1996. Personal communication (electronic mail to J. Nelson, PTI Environmental Services, Boulder, CO). USDA Forest Service, Burlington, VT.

Weber, W.A. 1976. Rocky Mountain flora. Colorado Associated University Press, Boulder, CO.

Weber, W.A. 1995. Checklist of vascular plants of Boulder County, Colorado. Natural history inventory of Colorado. University of Colorado Museum, Boulder, CO.

# Figures and Tables



# Tall upland shrubland community

## Figure 1

**LEGEND**

- Tall Upland Shrubland

**Standard Map Features**

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

*DATA SOURCE:*
*Buildings, roads, and fences provided by Facilities Engr., EG&G Rocky Flats, Inc. - 1991.*
*Hydrology provided by USGS - (date unknown)*
*Tall Upland Shrubland Community data provided by PTI Environmental Services - 1996.*

NOTE:
This map shows the tall upland shrubland community based on the 1996 vegetation map. There may be small patches which do not show up on the map.

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 0 1000 2000 ft

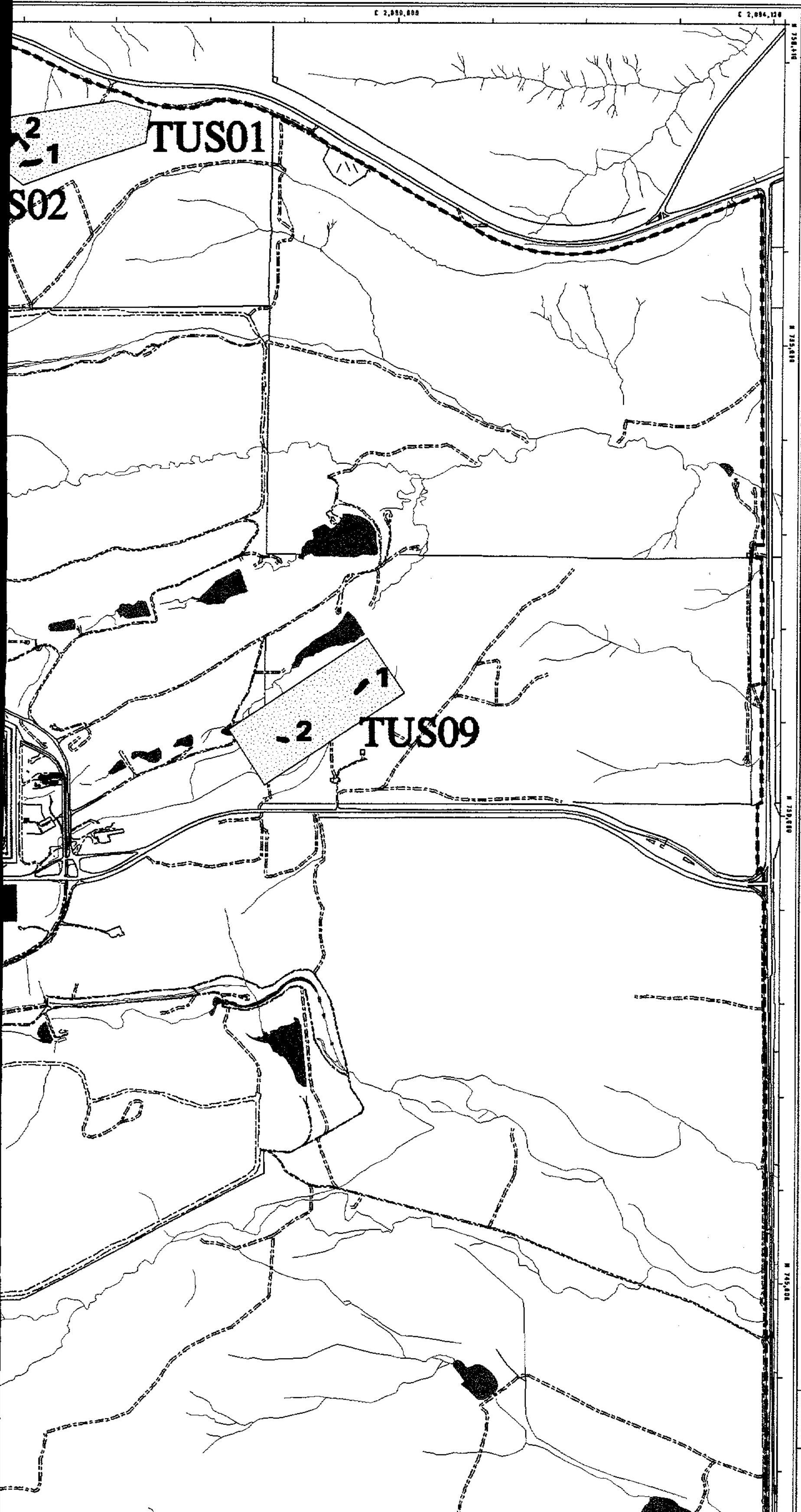
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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

Prepared by:
RMRS Rocky Mountain Remediation Services, L.L.C.
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

MAP ID: 97-0026 March 31, 1997

/gis/data/rfp-map-ami/97-0026/tus962.aml




# Tall upland shrubland community locations qualitatively assessed during 1996

## Figure 2

### LEGEND

- Management Unit
- Tall Upland Shrubland Patches Qualitatively Sampled
- Tall Upland Shrubland Patch Number

### Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

*DATA SOURCE:*
*Buildings, roads, and fences provided by Facilities Engr., EG&G Rocky Flats, Inc. - 1991.*
*Hydrology provided by USGS - (date unknown)*
*Tall Upland Shrubland Community data provided by PTI Environmental Services - 1996.*

NOTE:
Only those patches of Tall Upland Shrubland Qualitatively Assessed during 1996 are shown on the map. This map is not intended to show the extent of the Tall Upland Shrubland Community at the Site.

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 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:
RMRS Rocky Mountain Remediation Services, L.L.C.
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

MAP ID: 97-0028 March 31, 1997

/gis/data/rfp-map-amls/97-0028/tus96el.aml

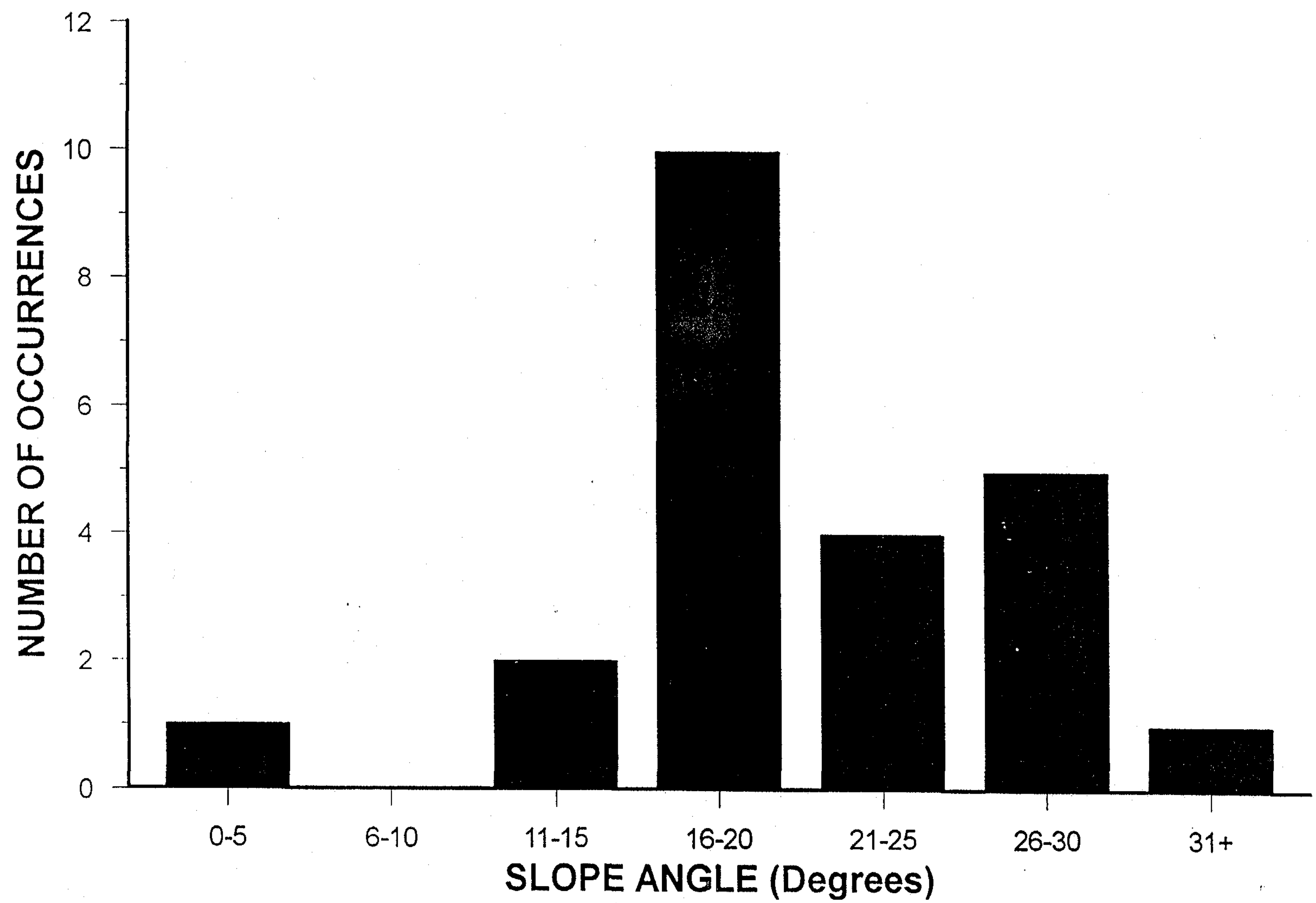



Figure 3. Summary of slope angle measurements associated with the tall upland shrubland.

i:datamgmt\cb3e\usrep\fig_3.pre

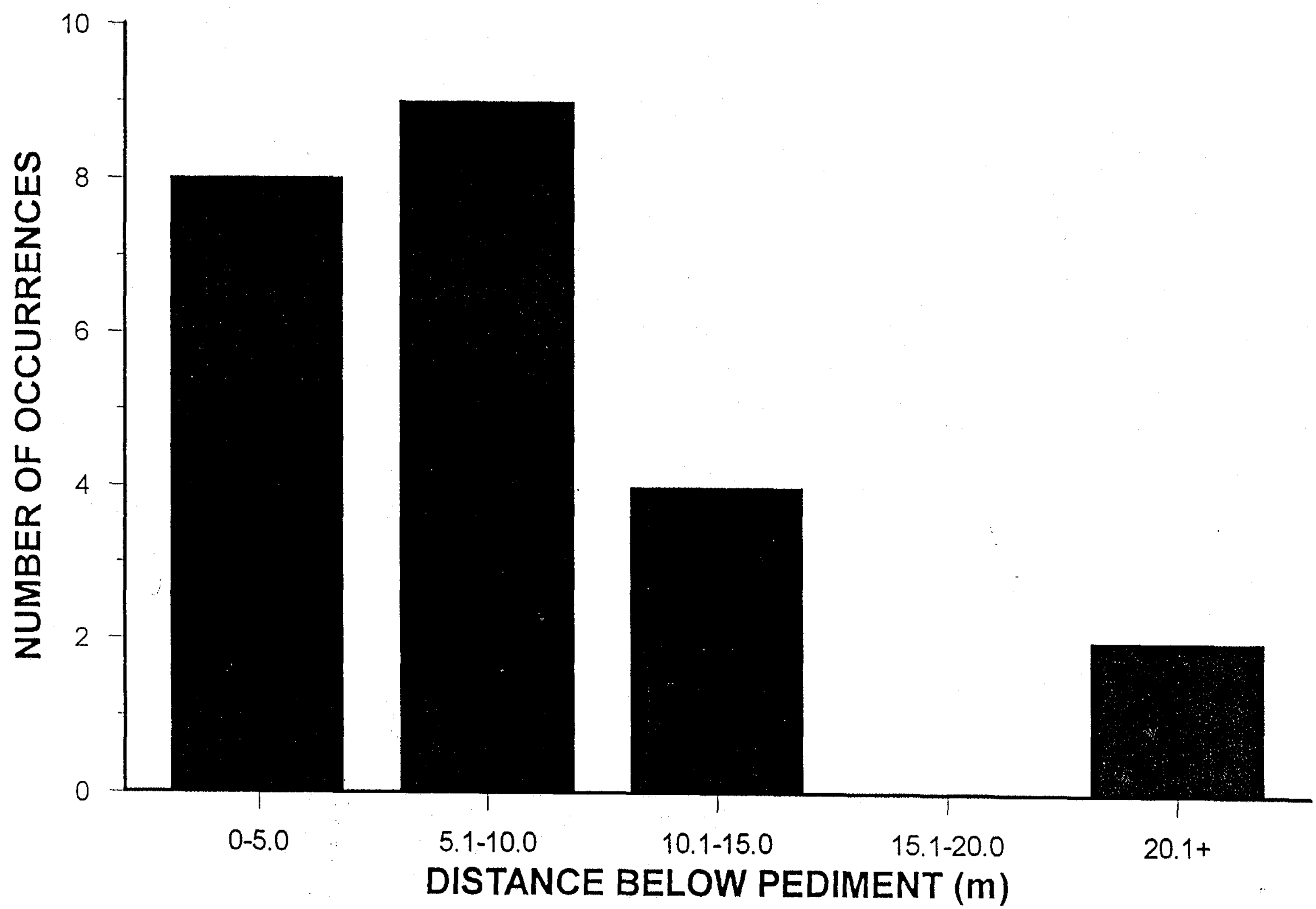



Figure 5. Summary of distance below pediment measurements for the tall upland shrubland.

i:datamgmt\cb3e\usrep\fig_5.pre 020697

## TABLE 1. 1996 TALL UPLAND SHRUBLAND QUALITATIVE HABITAT ASSESSMENT DATA (SUMMER)

| Site | Unit # | Slopepos1 | Slopepos2 | Slopepos3 | Slopepos4 | Slope | Aspect | Distance | Angle | Dbelowped | Erosion | Trash | Soils1 | Soils2 | Seeps | CEDI1in |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TUS01 | 1 | U | | | | 20 | 352 | 24 | 19 | 6.09 | 1 | 1 | COBBLY | | Y | 1 |
| TUS01 | 2 | T | U | | | 20 | 328 | 24 | 33 | 11.35 | 4 | 1 | COBBLY | GRAVELLY | N | 1 |
| TUS02 | 1 | U | M | B | | 22 | 277 | 26 | 12 | 3.69 | 2 | 1 | COBBLY | GRAVELLY | N | 1 |
| TUS02 | 2 | U | M | B | R | 26 | 23 | 27 | 20 | 7.51 | 2 | 1 | COBBLY | GRAVELLY | N | 2 |
| TUS03 | 1 | U | | | | 24 | 343 | 17 | 19 | 3.81 | 1 | 1 | COBBLY | GRAVELLY | Y | 1 |
| TUS03 | 2 | M | B | R | | 20 | 316 | 200 | 10 | 33.01 | 1 | 2 | LOAMY | | Y | 1 |
| TUS03 | 3 | U | | | | 21 | 316 | 14 | 24 | 3.97 | 1 | 1 | COBBLY | | N | 1 |
| TUS04 | 1 | U | | | | 16 | 321 | 24 | 27 | 9.18 | 2 | 1 | COBBLY | GRAVELLY | N | 1 |
| TUS04 | 2 | U | | | | 24 | 315 | 15 | 24 | 4.38 | 3 | 2 | COBBLY | GRAVELLY | N | 1 |
| TUS04 | 3 | U | | | | 30 | 315 | 19 | 24 | 6.01 | 3 | 1 | COBBLY | GRAVELLY | N | 1 |
| TUS05 | 1 | U | | | | 20 | 333 | 34 | 24 | 12.11 | 3 | 1 | GRAVELLY | LOAMY | N | 1 |
| TUS05 | 2 | M | B | R | | 26 | 307 | 36 | 19 | 10.00 | 2 | 2 | COBBLY | GRAVELLY | Y | 2 |
| TUS06 | 1 | M | B | R | | 27 | 327 | 20 | 29 | 7.98 | 2 | 5 | COBBLY | GRAVELLY | N | 4 |
| TUS06 | 2 | M | B | R | | 34 | 328 | 16 | 31 | 6.52 | 3 | 4 | COBBLY | GRAVELLY | N | 5 |
| TUS07 | 1 | M | B | R | | 17 | 326 | 24 | 31 | 10.64 | 3 | 4 | COBBLY | GRAVELLY | N | 4 |
| TUS07 | 2 | M | B | | | 12 | 144 | 37 | 23 | 12.74 | 1 | 5 | LOAMY | SILTY | Y | 5 |
| TUS07 | 3 | M | B | R | | 12 | 14 | 37 | 9 | 4.07 | 2 | 3 | LOAMY | | N | 4 |
| TUS08 | 1 | T | U | | | 20 | 10 | 9 | 19 | 1.21 | 2 | 2 | COBBLY | | Y | 2 |
| TUS08 | 2 | M | B | R | | 20 | 306 | 23 | 17 | 5.00 | 4 | 5 | COBBLY | LOAMY | N | 5 |
| TUS09 | 1 | U | | | | 30 | 324 | 17 | 25 | 5.46 | 2 | 1 | COBBLY | GRAVELLY | N | 1 |
| TUS09 | 2 | U | | | | 20 | 13 | 22 | 20 | 5.80 | 1 | 1 | COBBLY | GRAVELLY | N | 1 |
| TUS10 | 1 | U | | | | 19 | 2 | 8 | 21 | 1.15 | 1 | 1 | COBBLY | | N | 2 |
| TUS10 | 2 | B | R | | | 3 | 356 | 171 | 7.5 | 20.60 | 1 | 1 | LOAMY | | N | 1 |
| | | | | | Mean | 21 | | | | | | | | | | |

Note: dbelowped values are + or - 1 m.
Site = Management unit ID code.
Unit # = Tall upland shrubland patch number.
Slopepos 1-4 = Position of tall upland shrubland on hillside (see Appendix A for details).
Slope = Slope angle in degrees.
Aspect = Slope aspect in degrees.
Distance = Distance in meters from the top of the pediment to the upper edge of the tall upland shrubland patch.
Angle = Angle in degrees from the top of the pediment to the upper edge of the tall upland shrubland patch.
Dbelowped = Calculated vertical distance in meters from the top of the pediment to the upper edge of the tall upland shrubland patch.
Erosion = Erosion estimate code for tall upland shrubland patch (see Appendix A for details).
Trash = Trash estimate code for tall upland shrubland patch (see Appendix A for details).
Soils 1-2 = Soil decription estimate for top two soil categories if applicable (see Appendix A for details).
Seeps = Were seeps present within the canopy of the tall upland shrubland patch? Y or N.
CEDI1in = Code estimating amount of knapweed blown into tall upland shrubland patch (see Appendix A for details).

# TABLE 2. 1996 TALL UPLAND SHRUBLAND VASCULAR PLANT SPECIES LIST

| Family | Scientific Name | Species Code |
|---|---|---|
| ACERACEAE | Acer glabrum Torr. | ACGL1 |
| | Acer negundo L. var. interius (Britt.) Sarg. | ACNE1 |
| AGAVACEAE | Yucca glauca Nutt. | YUGL1 |
| ALISMATACEAE | Sagittaria latifolia Willd. | SALA1 |
| ANACARDIACEAE | Rhus aromatica Ait. var. trilobata (Nutt.) A. Gray | RHAR1 |
| | Toxicodendron rydbergii (Small) Greene | TORY1 |
| APIACEAE | Cicuta maculata L. var. angustifolia Hook. | CIMA1 |
| | Harbouria trachypleura (Gray) C. & R. | HATR1 |
| | Heracleum sphondylium L. ssp. montanum (Schleich.) Briq. | HESP1 |
| | **Ligusticum porteri C. & R.** | LIPO1 |
| | Lomatium orientale Coult. & Rose | LOOR1 |
| | Musineon divaricatum (Pursh.) Nutt. var. hookeri T. & G. | MUDI1 |
| | **Osmorhiza chiliensis H. & A.** | **OSCH1** |
| | **Osmorhiza longistylis (Torr.) DC var. longistylis** | **OSLO1** |
| APOCYNACEAE | Apocynum cannabinum L. | APCA1 |
| ASCLEPIADACEAE | Asclepias incarnata L. | ASIN1 |
| | Asclepias speciosa Torr. | ASSP1 |
| | Asclepias viridiflora Raf. | ASVI1 |
| ASTERACEAE | Achillea millefolium L. ssp. lanulosa (Nutt.) Piper | ACMI1 |
| | Ambrosia artemisiifolia L. | AMAR1 |
| | Ambrosia psilostachya DC. | AMPS1 |
| | Ambrosia trifida L. | AMTR1 |
| | Antennaria microphylla Rydb. | ANMI1 |
| | Antennaria parvifolia Nutt. | ANPA1 |
| | Arctium minus Bernh. | ARMI1 |
| | Arnica fulgens Pursh. | ARFU1 |
| | Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem. | ARCA1 |
| | Artemisia dracunculus L. | ARDR1 |
| | Artemisia frigida Willd. | ARFR1 |
| | Artemisia ludoviciana Nutt. var. ludoviciana | ARLU1 |
| | Aster ericoides L. | ASER1 |
| | Aster laevis L. var. geyeri A. Gray | ASLA1 |
| | Aster porteri Gray | ASPO1 |
| | Bidens frondosa L. | BIFR1 |
| | Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi | CANU1 |
| | Centaurea diffusa Lam. | CEDI1 |
| | Chrysopsis fulcrata Greene | CHFU1 |
| | Chrysopsis villosa Pursh. | CHVI1 |
| | Cirsium arvense (L.) Scop. | CIAR1 |
| | Cirsium undulatum (Nutt.) Spreng. | CIUN1 |
| | Cirsium vulgare (Savi) Ten. | CIVU1 |
| | Conyza canadensis (L.) Cronq. | COCA1 |
| | Crepis occidentalis Nutt. | CROC1 |
| | Erigeron canus A. Gray | ERCA1 |
| | Erigeron divergens T. & G. | ERDI1 |
| | Erigeron flagellaris A. Gray | ERFL1 |
| | **Erigeron speciosa (Lindl.) DC. var. macranthus (Nutt.) Cronq.** | ERSP1 |
| | Gaillardia aristata Pursh. | GAAR1 |
| | Grindelia squarrosa (Pursh.) Dun. | GRSQ1 |
| | Gutierrezia sarothrae (Pursh.) Britt. & Rusby | GUSA1 |
| | Helianthus nuttallii T. & G. | HENU1 |
| | Helianthus pumilus Nutt. | HEPU1 |
| | Helianthus rigidus (Cass.) Desf. ssp. subrhomboideus (Rydb.) Heiser | HERI1 |

TABLE 2. (cont.)

| Family | Scientific Name | Species Code |
|---|---|---|
| | **Heliomeris multiflora Nuttall** | **HEMU1** |
| | Hymenopappus filifolius Hook. var. cinereus (Rydb.) I. M. Johnst. | HYFI1 |
| | Kuhnia chlorolepis Woot. & Standl. | KUCH1 |
| | Kuhnia eupatorioides L. | KUEU1 |
| | Lactuca oblongifolia Nutt. | LAOB1 |
| | Lactuca serriola L. | LASE1 |
| | Liatris punctata Hook. | LIPU1 |
| | Microseris cuspidata (Pursh.) Sch. Bip. | MICU1 |
| | Ratibida columnifera (Nutt.) Woot. & Standl. | RACO1 |
| | Scorzonera laciniata L. | SCLA1 |
| | Senecio fendleri Gray | SEFE1 |
| | Senecio integerrimus Nutt. | SEIN1 |
| | Senecio plattensis Nutt. | SEPL1 |
| | Senecio spartioides T. & G. | SESP1 |
| | **Solidago canadensis L.** | **SOCA1** |
| | Solidago gigantea Ait. | SOGI1 |
| | Solidago missouriensis Nutt. | SOMI1 |
| | Solidago mollis Bart. | SOMO1 |
| | Solidago rigida L. | SORI1 |
| | Sonchus sp. | SON1 |
| | Taraxacum officinale Weber | TAOF1 |
| | Thelesperma megapotanicum (Spreng.) O. Ktze. | THME1 |
| | Townsendia grandiflora (Nutt.) | TOGR1 |
| | Townsendia hookeri Beaman | TOHO1 |
| | Tragopogon dubius Scop. | TRDU1 |
| | Xanthium strumarium L. | XAST1 |
| BERBERIDACEAE | **Berberis repens Lindl.** | **BERE1** |
| BETULACEAE | **Betula occidentalis Hook.** | BEOC1 |
| BORAGINACEAE | Asperugo procumbens L. | ASPR1 |
| | Cynoglossum officinale L. | CYOF1 |
| | **Lithospermum multiflorum Torr.** | **LIMU1** |
| | Mertensia lanceolata (Pursh.) A. DC. | MELA1 |
| | Onosmodium molle Michx. var. occidentale (Mack.) Johnst. | ONMO1 |
| BRASSICACEAE | Alyssum alyssoides (L.) L. | ALAL1 |
| | Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley | ALMI1 |
| | Arabis fendleri (S. Wats.) Greene var. fendleri | ARFE3 |
| | Arabis glabra (L.) Bernh. | ARGL1 |
| | Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins | ARHI1 |
| | Barbarea vulgaris R. Br. | BAVU1 |
| | Camelina microcarpa Andrz. ex DC. | CAMI1 |
| | Descurainia pinnata (Walt.) Britt. | DEPI1 |
| | Descurainia richardsonii (Sweet) Schultz | DERI1 |
| | Descurainia sophia (L.) Webb ex Prantl. | DESO1 |
| | Erysimum capitatum (Nutt.) DC. | ERCA2 |
| | Lepidium campestre (L.) R. Br. | LECA1 |
| | Lesquerella montana (A. Gray) Wats. | LEMO1 |
| | Nasturtium officinale R. Br. | NAOF1 |
| | Physaria vitulifera Rydb. | PHVI1 |
| | Sisymbrium altissimum L. | SIAL1 |
| | Thlaspi arvense L. | THAR1 |
| CACTACEAE | *Coryphantha missouriensis (Sweet) Britt. & Rose* | COMI1 |
| | Echinocereus viridiflorus Engelm. | ECVI1 |
| | Opuntia fragilis (Nutt.) Haw. | OPFR1 |

TABLE 2. (cont.)

| Family | Scientific Name | Species Code |
|---|---|---|
| | Opuntia macrorhiza Engelm. | OPMA1 |
| | Pediocactus simpsonii (Engelm.) Britt. & Rose | PESI1 |
| CAMPANULACEAE | Campanula rotundifolia L. | CARO1 |
| CANNABACEAE | **Humulus lupulus L. var. lupuloides E. Small** | **HULU1** |
| CAPRIFOLIACEAE | Symphoricarpos occidentalis Hook. | SYOC1 |
| | **Symphoricarpos oreophilus Gray** | **SYOR1** |
| | **Viburnum opulus L. var. americanum Ait** | **VIOP1** |
| CARYOPHYLLACEAE | Arenaria fendleri A. Gray | ARFE2 |
| | Cerastium arvense L. | CEAR1 |
| | Cerastium vulgatum L. | CEVU1 |
| | Paronychia jamesii T. & G. | PAJA1 |
| | Saponaria officinalis L. | SAOF1 |
| | Silene antirrhina L. | SIAN1 |
| | Silene drummondii Hook. | SIDR1 |
| | Silene pratensis (Raf.)Godr. & Gren | SIPR1 |
| CHENOPODIACEAE | Chenopodium album L. | CHAL1 |
| | Chenopodium berlandieri Moq. | CHBE1 |
| | Chenopodium fremontii S. Wats. | CHFR1 |
| | Salsola iberica Senn. & Pau. | SAIB1 |
| CLUSIACEAE | Hypericum perforatum L. | HYPE1 |
| COMMELINACEAE | Tradescantia occidentalis (Britt.) Smyth | TROC1 |
| CONVOLVULACEAE | Convolvulus arvensis L. | COAR1 |
| CRASSULACEAE | Sedum lanceolatum Torr. | SELA1 |
| CUPRESSACEAE | **Juniperus communis L.** | **JUCO1** |
| CYPERACEAE | Carex brevior (Dew.) Mack. ex Lunell. | CABR1 |
| | Carex heliophila Mack. | CAHE1 |
| | Carex hystericina Muhl. ex Willd. | CAHY1 |
| | Carex interior Bailey | CAIN1 |
| | Carex lanuginosa Michx. | CALA1 |
| | Carex nebraskensis Dew. | CANE1 |
| | Carex praegracilis W. Boott. | CAPR1 |
| | Eleocharis macrostachya Britt. | ELMA1 |
| | Scirpus pungens Vahl | SCPU1 |
| | Scirpus validus Vahl. | SCVA1 |
| EQUISETACEAE | Equisetum laevigatum A. Br. | EQLA1 |
| EUPHORBIACEAE | Euphorbia robusta (Engelm.) Small | EURO1 |
| FABACEAE | Amorpha fruticosa L. | AMFR1 |
| | **Astragalus adsurgens Pall. var. robustior Hook.** | **ASAD1** |
| | Astragalus agrestis Dougl. ex G. Don | ASAG1 |
| | Astragalus canadensis L. | ASCA1 |
| | Astragalus drummondii Dougl. ex Hook. | ASDR1 |
| | Astragalus flexuosus (Hook.) G. Don | ASFL1 |
| | Astragalus shortianus Nutt. ex T.&G. | ASSH1 |
| | Astragalus tridactylicus Gray | ASTR1 |
| | Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinners. | DACA1 |
| | Dalea purpurea Vent | DAPU1 |
| | Glycyrrhiza lepidota Pursh. | GLLE1 |
| | Lathyrus eucosmus Butters and St. John | LAEU1 |
| | Lathyrus polymorphus Nutt. ssp. incanus (Sm. & Rydb.) C. L. Hitchc. | LAPO1 |
| | **Lupinus argenteus Pursh ssp. ingratus (Greene) Harmon** | **LUAR2** |
| | Lupinus argenteus Pursh var. argenteus | LUAR1 |
| | Melilotus officinalis (L.) Pall. | MEOF1 |
| | Oxytropis lambertii Pursh. | OXLA1 |

TABLE 2. (cont.)

| Family | Scientific Name | Species Code |
|---|---|---|
| | Psoralea tenuiflora Pursh. | PSTE1 |
| | Thermopsis rhombifolia var. divaricarpa (Nels.) Isely | THRH1 |
| | Vicia americana Muhl. ex Willd. | VIAM1 |
| GENTIANACEAE | Gentiana affinis Griseb. | GEAF1 |
| | Swertia radiata (Kell.) O. Ktze. | SWRA1 |
| GERANIACEAE | Erodium cicutarium (L.) L'Her. | ERCI1 |
| | Geranium caespitosum James ssp. caespitosum | GECA1 |
| GROSSULARIACEAE | Ribes aureum Pursh | RIAU1 |
| | Ribes cereum Dougl. | RICE1 |
| HYDROPHYLLACEAE | **Hydrophyllum fendleri (Gray) Heller** | **HYFE1** |
| | Phacelia heterophylla Pursh. | PHHE1 |
| IRIDACEAE | Iris missouriensis Nutt. | IRMI1 |
| JUNCACEAE | Juncus balticus Willd. | JUBA1 |
| | Juncus dudleyi Wieg. | JUDU1 |
| | Juncus ensifolius Wikst. var. montanus (Engl.) C. L. Hitchc. | JUEN1 |
| | Juncus nodosus L. | JUNO1 |
| | Juncus torreyi Cov. | JUTO1 |
| LAMIACEAE | Lycopus americanus Muhl. ex Barton | LYAM1 |
| | Mentha arvensis L. | MEAR1 |
| | Monarda fistulosa L. var. menthifolia (Grah.) Fern. | MOFI1 |
| | Nepeta cataria L. | NECA1 |
| | Prunella vulgaris L. | PRVU1 |
| | Scutellaria brittonii Porter | SCBR1 |
| LEMNACEAE | Lemna minor L. | LEMI1 |
| LILIACEAE | **Allium cernuum Roth** | **ALCE1** |
| | Allium geyeri S. Wats. | ALGE1 |
| | Allium textile A. Nels. & Macbr. | ALTE1 |
| | Asparagus officinalis L. | ASOF1 |
| | Calochortus gunnisonii S. Wats. | CAGU1 |
| | Leucocrinum montanum Nutt. | LEMO2 |
| | **Smilacina stellata (L.) Desf.** | **SMST1** |
| | Zigadenus venenosus Wats. var. gramineus (Rydb.) Walsh ex Peck | ZIVE1 |
| | Linum perenne L. var. lewisii (Pursh.) Eat. & Wright | LIPE1 |
| MALVACEAE | Malva neglecta Wallr. | MANE1 |
| | **Sidalcea candida Gray** | SICA1 |
| NYCTAGINACEAE | Mirabilis hirsuta (Pursh.) MacM. | MIHI1 |
| | Mirabilis linearis (Pursh.) Heimerl | MILI1 |
| | Mirabilis nyctaginea (Michx.) MacM. | MINY1 |
| ONAGRACEAE | Calylophus serrulatus (Nutt.) Raven | CASE2 |
| | Epilobium ciliatum Raf. ssp. glandulosum (Lehm.) Hock & Raven | EPCI1 |
| | Epilobium paniculatum Nutt. | EPPA1 |
| | Gaura coccinea Pursh. | GACO1 |
| | Gaura parviflora Dougl. | GAPA1 |
| | Oenothera howardii (A. Nels.) W. L. Wagner | OEHO1 |
| | Oenothera villosa Thunb. ssp. strigosa (Rydb.) Dietrich & Raven | OEVI1 |
| OXALIDACEAE | Oxalis dillenii Jacq. | OXDI1 |
| PINACEAE | Pinus ponderosa Laws | PIPO1 |
| PINACEAE | Pseudotsuga menziesii (Mirb.) Franco | PSME1 |
| PLANTAGINACE | Plantago lanceolata L. | PLLA1 |
| POACEAE | Agropyron caninum (L.) Beauv. ssp. majus (Vasey) C. L. Hitchc. | AGCA1 |
| | Agropyron cristatum (L.) Gaertn. | AGCR1 |
| | Agropyron dasystachyum (Hook.) Scribn. | AGDA1 |
| | Agropyron desertorum (Fisch.) Schult. | AGDE1 |

TABLE 2. (cont.)

| Family | Scientific Name | Species Code |
|---|---|---|
| | Veronica anagallis-aquatica L. | VEAN1 |
| SMILACACEAE | **Smilax herbacea L. var. lasioneura (Small) Rydb..** | **SMHE1** |
| SOLANACEAE | Physalis heterophylla Nees | PHHE2 |
| | Physalis virginiana P. Mill. | PHVI2 |
| TYPHACEAE | Typha latifolia L. | TYLA1 |
| ULMACEAE | Ulmus pumila L. | ULPU1 |
| URTICACEAE | Parietaria pensylvanica Muhl. ex Willd. | PAPE1 |
| | **Urtica dioica L. ssp. gracilis (Ait.) Seland.** | **URDI1** |
| VERBENACEAE | Verbena bracteata Lag. & Rodr. | VEBR1 |
| | Verbena hastata L. | VEHA1 |
| VIOLACEAE | Viola nuttallii Pursh. | VINU1 |
| | **Viola rydbergii Greene** | **VIRY1** |
| | Viola scopulorum (Gray) Greene | VISC1 |
| | Viola sororia Willd. | VISO1 |
| VITACEAE | **Vitis riparia Michx.** | **VIRI1** |

Note: Bolded species are primarily restricted on Site to the tall upland shrubland.

## TABLE 3. 1996 SUMMARY OF TALL UPLAND SHRUBLAND SPECIES RICHNESS VARIABLES

| Number of | Value[1] |
|---|---|
| Families | 65 |
| Species | 333 |
| Native Species (Percent) | 81 % |
| Annuals | 43 (12.9 %) |
| Biennials | 8 (2.4 %) |
| Perennials | 282 (84.7 %) |
| Monocots | 78 (23.4 %) |
| Dicots | 250 (75.1 %) |
| Gymnosperms | 3 (0.9 %) |
| Pteridophytes | 2 (0.6 %) |
| Forbs | 227 (68.2 %) |
| Graminoids | 64 (19.2 %) |
| Shrubs | 20 (6.0 %) |
| Trees | 15 (4.5 %) |
| Cacti | 5 (1.5 %) |
| Vines | 2 (0.6 %) |

[1] The sum of the annuals, biennials, and perennials totals one less than 333, because the one species was only identified to the genus level and could not be assigned to a category.

## TABLE 4. 1996 NOXIOUS AND INTRODUCED WEED DENSITY DISTRIBUTIONS IN THE TALL UPLAND SHRUBLAND COMMUNITY

| Scientific Name | Density Distribution Class | | | | | | | | | Frequency | Percent Frequency |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |
| Bromus japonicus | 1 | | | 2 | 3 | 4 | 8 | 4 | | 22 | 96 |
| Cirsium arvense | | | | 1 | 4 | 11 | | 6 | | 22 | 96 |
| Carduus nutans | | 6 | | 14 | | | | | | 20 | 87 |
| Hypericum perforatum | 1 | 11 | | 6 | | | | | | 18 | 78 |
| Centaurea diffusa | 1 | 4 | | 2 | 2 | | 2 | | | 11 | 48 |
| Alyssum minus | | 3 | | 3 | 2 | | | | | 8 | 35 |
| Bromus tectorum | | | 1 | 1 | 2 | 1 | 1 | | | 6 | 26 |
| Bromus inermis | | | 3 | | 1 | | | | | 4 | 17 |
| Elymus canadensis | | | 1 | | 1 | 2 | | | | 4 | 17 |
| Arctium minus | | | | 1 | 1 | 1 | | | | 3 | 13 |
| Cynoglossum officinale | | | | 1 | | | 1 | | | 2 | 9 |
| Dactylis glomerata | | | 1 | | | 1 | | | | 2 | 9 |
| Ambrosia trifida | | | 1 | | | | | | | 1 | 4 |
| Phleum pratensis | | | | | 1 | | | | | 1 | 4 |
| Sisymbrium altissimum | | | | | 1 | | | | | 1 | 4 |
| Urtica dioica | | | | | | 1 | | | | 1 | 4 |

Note: See Appendix A for description and illustration of density distribution values.

## TABLE 5. 1996 CANOPY SPECIES COVER CLASS VALUES WITHIN THE MAIN TALL UPLAND SHRUBLAND CANOPY

| Scientific Name | Cover Class r | + | 1 | 2 | 3 | 4 | 5 | Frequency | Percent Frequency | Mean Percent Cover |
|---|---|---|---|---|---|---|---|---|---|---|
| Prunus virginiana | | | 1 | 2 | 10 | 4 | 6 | 23 | 100 | 54.4 |
| Crataegus erythropoda | | 1 | | 3 | 4 | 6 | 4 | 18 | 78 | 40.0 |
| Rhus aromatica | | 3 | 6 | 8 | | | | 17 | 74 | 6.00 |
| Prunus americana | | 3 | 2 | 5 | 1 | | 1 | 12 | 52 | 9.04 |
| Physocarpus monogynus | | | 2 | | | | | 2 | 9 | 0.22 |
| Acer glabrum | | 1 | | | | | | 1 | 4 | 0.04 |
| Amalanchier alnifolia | | 1 | | | | | | 1 | 4 | 0.04 |
| Amorpha fruticosa | | 1 | | | | | | 1 | 4 | 0.04 |

Note: See Appendix A for description and illustration of density distribution values.

## TABLE 6. 1996 CANOPY SPECIES COVER CLASS VALUES OUTSIDE THE MAIN TALL UPLAND SHRUBLAND CANOPY

| Scientific Name | Cover Class r | + | 1 | 2 | 3 | 4 | 5 | Frequency | Percent Frequency | Mean Percent Cover |
|---|---|---|---|---|---|---|---|---|---|---|
| Prunus virginiana | | 8 | 8 | 4 | | 2 | | 22 | 96 | 9.26 |
| Crataegus erythropoda | | 4 | 4 | 9 | | 1 | | 18 | 78 | 9.20 |
| Rhus aromatica | | 2 | 5 | 7 | 3 | | | 17 | 74 | 10.1 |
| Prunus americana | 1 | 3 | 5 | 3 | | 1 | | 13 | 57 | 5.37 |
| Amalanchier alnifolia | | 1 | 1 | | | | | 2 | 9 | 0.15 |
| Amorpha fruticosa | | 1 | | | | | | 1 | 4 | 0.04 |
| Physocarpus monogynus | | | | 1 | | | | 1 | 4 | 0.65 |
| Prunus pumila | | 1 | | | | | | 1 | 4 | 0.04 |

Note: See Appendix A for description and illustration of density distribution values.

## TABLE 7. 1996 CANOPY SPECIES REPRODUCTION DENSITY DISTRIBUTION VALUES WITHIN THE MAIN TALL UPLAND SHRUBLAND CANOPY

| Scientific Name | Density Distribution Class | | | | | | | | | Frequency | Percent Frequency |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |
| Prunus virginiana | | | | | 1 | 5 | 10 | 6 | 1 | 23 | 100 |
| Crataegus erythropoda | 6 | 8 | | 3 | | 1 | | | | 18 | 78 |
| Rhus aromatica | | 1 | | 7 | 5 | 3 | | | | 16 | 70 |
| Prunus americana | | 3 | | 3 | 4 | 1 | | | | 11 | 48 |
| Physocarpus monogynus | | 1 | | 1 | | | | | | 2 | 9 |
| Amalanchier alnifolia | | 1 | | | | | | | | 1 | 4 |
| Amorpha fruticosa | | 1 | | | | | | | | 1 | 4 |

Note: See Appendix A for description and illustration of density distribution values.

## TABLE 8. 1996 CANOPY SPECIES REPRODUCTION DENSITY DISTRIBUTION VALUES OUTSIDE THE MAIN TALL UPLAND SHRUBLAND CANOPY

| Scientific Name | Density Distribution Class | | | | | | | | | Frequency | Percent Frequency |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |
| Prunus virginiana | 1 | 4 | | 4 | 9 | 2 | | 2 | | 22 | 96 |
| Crataegus erythropoda | | 3 | | 1 | 2 | 11 | 1 | | | 18 | 78 |
| Rhus aromatica | | 1 | | 2 | 4 | 11 | | | | 18 | 78 |
| Prunus americana | 1 | 2 | | 2 | 4 | 3 | | 1 | | 13 | 57 |
| Amalanchier alnifolia | | 1 | | | | 1 | | | | 2 | 9 |
| Amorpha fruticosa | | 1 | | | | | | | | 1 | 4 |
| Physocarpus monogynus | | | 1 | | | | | | | 1 | 4 |
| Prunus pumila | | | 1 | | | | | | | 1 | 4 |

Note: See Appendix A for description and illustration of density distribution values.

## Appendix A

# Methods, and Figures A1 and A2

# 1996 TALL UPLAND SHRUBLAND SPECIES RICHNESS FIELD SAMPLING PLAN

A baseline characterization of the species richness of the Tall Upland Shrubland (TUS) will be conducted at Rocky Flats Environmental Technology Site (Site) by the RMRS Natural Resource Protection and Compliance Program (Ecology) staff during the 1996 field season.

## 1) Objective

The goal is to provide an inventory of the plant species for the TUS plant community.

## 2) Site Selection and Description

The TUS community was mapped as part of the 1996 updating of the current Site vegetation map. The TUS community is found primarily in the Rock Creek drainage on the Site, although smaller, isolated units are found in the Walnut Creek and Woman Creek drainages also. The predominant canopy species are Chokecherry (*Prunus virginiana*), *Hawthorne (Crataegus erythropoda)*, and American Plum (*Prunus americana*). The TUS community as a whole on Site will serve as the location for determining the species richness for this habitat.

## 3) Sampling Procedures

Sampling will be done as part of the Ecology program. Currently no procedure exists for this type of species richness determination, so the following methodology will be used. Species richness for the TUS will be sampled throughout the growing season by hiking through the TUS community and recording the speccodes and scientific names of the species found there. Plants found growing within the TUS areas and up to approximately 2m from the edge of these areas will be recorded. The scientific names and speccodes of the species reported for a given date will be reported on the Belt Transect Species Richness form (Form RF-48054). Speccodes will follow those found in the Current Approved Species Code List (CASCL). See the sample form and instructions for filling out the form attached at the end of the field sampling plan. If observations of plant species occurring in the TUS are made during other activities or surveys and recorded on other data sheets or forms, these observations will be transferred to the Belt Transect Species Richness forms and signed and dated by the observer(s) in order to be considered an official record of the species occurance in the TUS for 1996. Unknown plants or plants not in identifiable condition should be collected or flagged so that their identity can be confirmed at a later time. Any collections of unknown specimens should be recorded on the data sheets with an observer specific unknown number (ex. Jody Nelson unknown collection # 2 = JKN2) that corresponds to the specimen which is also tagged with this number. Reports of new species for the Site will require a specimen (of herbarium mounting quality if possible) to allow for final verification of the specimen's identification at the University of Colorado (CU) herbarium in Boulder. New species for the Site will be assigned speccodes according to the Species Code procedure (4-F22-ENV-Ecol.14).

## 4) Sampling Schedule

At a minimum, sampling will be done in the spring and again in the fall, to record the spring ephermals species and the late summer species. Sampling may also be done at other times as opportunity is available.

## 5) Staff

The Ecology staff will conduct the sampling for this project.

## 6) Data Entry and QA/QC

Data entry and QA/QC will be done following the steps outlined in the "QA Procedure for Ecology Data Entry."

## Appendum to 1996 Tall Upland Shrubland Species Richness Field Sampling Plan

The following activity is being added at this time because the previous attempts to quantitatively assess the TUS using transects was not possible due to the destructive nature of the sampling methods. This qualitative assessment will gather information in addition to the species richness data during the second TUS sampling session in 1996. Because a qualitative habitat assessment form was not yet developed at the time of the first TUS sampling this past spring it is being added now for the late summer TUS sampling.

### 1) Objective

The goal is to provide a qualitative assessment of the current condition of the the TUS plant community at the Site.

### 2) Site Selection and Description

The TUS community was mapped as part of the 1996 updating of the current Site vegetation map. The TUS community is found primarily in the Rock Creek drainage on the Site, although smaller, isolated units are found in the Walnut Creek and Woman Creek drainages also. The predominant canopy species are Chokecherry (*Prunus virginiana*), *Hawthorne (Crataegus erythropoda*), and American Plum (*Prunus americana*). The TUS community as a whole on Site will serve as the location for determining the species richness for this habitat. The attached map shows the locations of the TUS patches which were subjectively chosen in the various draws to be sampled using the qualitative assessment form. The total number of patches to be qualitatively assessed is twenty-three.

### 3) Sampling Procedures

The qualitative habitat assessment will be done as part of the previous TUS field sampling plan being conducted by the Ecology program. Currently no procedure exists for this type of qualitative habitat characterization, so the attached methodology will be used.

### 4) Sampling Schedule

The qualitative habitat assessment will be done concurrently with the TUS species richness sampling to be conducted in August-September, 1996.

### 5) Staff

The Ecology staff will conduct the sampling for this project.

### 6) Data Entry and QA/QC

Data entry and QA/QC will be done following the steps outlined in the "QA Procedure for Ecology Data Entry."

### 7) Analyses

A basic summary of the condition of the TUS habitat will be generated from the qualitative data collected. Other analyses may be explored.

Program Manager E.W. Hogue (Print) [signature] (Signature) Date 5 Aug 96

7/31/96

7) **Analyses**

A checklist of the unique scientific names and speccodes found in the TUS during 1996 will be produced from the data. Other analyses may be explored.

Program Manager JEFFREY D. KRAUSE [signature] Date 5-24-96

Print Signature

EXAMPLE **BELT TRANSECT SPECIES RICHNESS FORM** EXAMPLE



Site I.D.: TUS 96
Time Started: NA
Field Notebook(s): TV#1 & other
Transect No.: NA
Belt Length: NA

Project I.D.: NRPCP
Time Finished: NA
Observers: JKN
Habitat Type: 230
Belt Width: NA

Page 1 of whatever it is
Date: 5/24/96
Location[1]: NA
Sample Site: NA
*Populus* Seedling Tally: NA

**HERBACEOUS SPECIES**

| OBS. NUM | SCIENTIFIC NAME | SPECIES CODE | PHEN. STATE |
|---|---|---|---|
| | Poa pratensis | POPRI | |
| | Hydrophyllum fendleri | HYFEI | |
| | Harbouria trachypleura | HATRI | |

JKN 5/24/96

**CACTUS, YUCCA, AND WOODY SPECIES**

| OBS. NUM | SCIENTIFIC NAME | SPECIES CODE | PHEN. STATE | TALLY |
|---|---|---|---|---|
| | Prunus virginiana | PRVII | | |
| | Crataegus erythropoda | CRERI | | |
| | Ribes aureum | RIODI | | |
| | Rhus aromatica | RHARI | | |

**HERBACEOUS SPECIES, cont'd**

| | | | |
|---|---|---|---|
| | | | |

JKN 5/24/96

[1] Designate location as A = North, B = South, O = Outside of transect, I = Inside of transect (e.g., north inside of transect = AI). This applies to riparian sites only.

Comments:

Completed by Jody K Nelson / [signature] / 5/24/96
Print / Sign / Date

RF-48054 (Rev 7/94) Supersedes Previous Issues

Instructions for filling out Belt Transect Species Richness Form (Form 48054) for the Tall Upland Shrub species richness sampling.

1. Fill in the following fields at the top of the data sheet:
   - Site I.D. = TUS 96
   - Project I.D. = NRPCP
   - Page = 1 of however many there are for that set of data.
   - Date = use following format mm/dd/yy
   - Field Notebook = Use field notebook of observer or the TV #1 field notebook if using that.
   - Observers = initials of observer(s)
   - Habitat type = 230

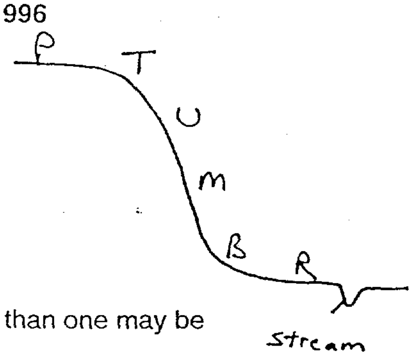
All the other fields at the top of the page should be either lined out with a dash or have the letters NA place in them.

2. In the main part of the data sheet the only information recorded will be the scientific name and species code.

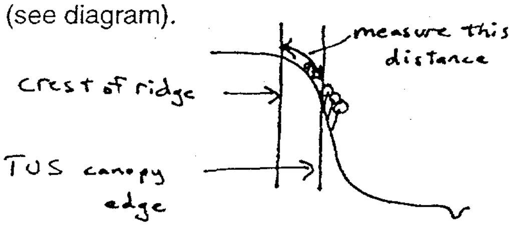
3. The tally and phenological state columns and any unused lines in the scientific name and species code columns will be lined out and initialled and dated by the observer prior to the turning in of the data sheet.

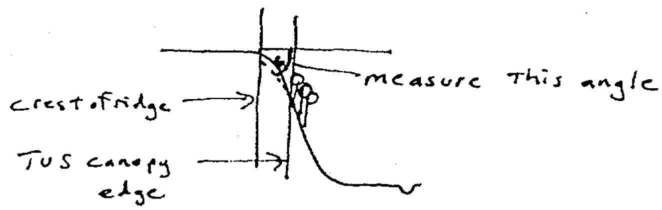
4. The observer will print their name, sign their signature, and date the completed form prior to turning in the data sheet.

Qualitative Habitat Assessment Form - Instructions on Filling Out Sheet for 1996

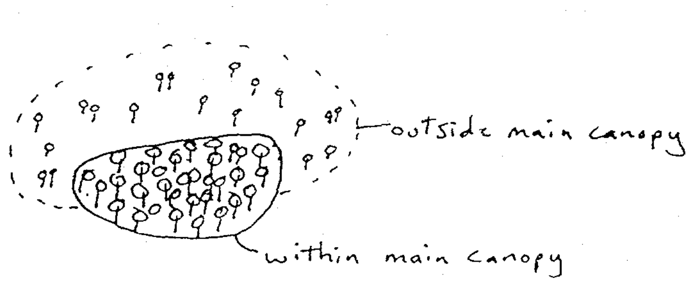



1. Site I.D.: Use draw or drainage code.
2. Project I.D.: TUS96
3. Page__of__
4. Date: MM/DD/YY
5. Unit or Transect #: Use patch number from draw or drainage code list or map.
6. Habitat Type: 230
7. Observer(s): List initials of observer(s).
8. Field Notebook(s): List initials of field notebook being used.
9. Slope Position: Circle the letters which apply for the unit being described (more than one may be circled). See diagram at right for slope position and codes.
10. Slope: Measure in degrees with compass or clinometer.
11. Aspect: Measure in degrees with compass.
12. Distance of TUS patch from top of ridge (m): Measure distance with tape from crest of ridge to edge of canopy (see diagram).




13. Angle: Measure the angle from the crest of the ridge to the base of the main TUS canopy (see diagram above).
14. Erosion status: Estimate erosion problem for TUS patch. No erosion=1. One or two spots of erosion=2. Three to five spots of erosion=3. SIx to ten spots of erosion=4. Greater than 10 spots of erosion=5.
15. Abundance of Trash: Provides an estimate of the amount trash which has blown into the TUS patch. No trash = 1. One or two pieces of trash=2. Three to five pieces of trash=3. Six to ten pieces of trash=4. Greater than 10 pieces of trash=5.
16. Soil Condition: Circle the name(s) which best describes the visual condition of the soil.
17. Flowing seeps present within the TUS unit: If any seeps are present originating from within the canopy of the TUS patch, circle yes. If not, circle no.
18. Abundance of noxious weeds: Noxious weeds are defined as CEDI1, CIAR1, CANU1, and HYPE1. Using the density distribution class diagram on the form, estimate which category best describes the distribution of the species present. Add other noxious species if they are present.
19. Abundance of introduced species: Introduced species are defined as non-native species which tend to take over areas. Examples include but are not limited to BRJA1, BRTE1, COAR1, DAGL1, ALMI1, and BRIN1. Using the density distribution class diagram on the form, estimate which category best describes the distribution of the species present. Add other introduced species if they are present.
20. CEDI1 (blown in) abundance: In order to get an estimate of the problem created in the TUS by CEDI1 that gets blown into the TUS patches estimate the problem on a scale of 1-5, where 1 is low and 5 is high.
21. Predominate Canopy Species: Using the cover class system listed on the form, estimate the amount of cover provided by the woody canopy species for the TUS patch being sampled, both within the main canopy and outside the main canopy. The following diagram shows the difference between within the main canopy and outside the main canopy. Additional canopy species may be entered if present.



22. Canopy Species Reproduction Assessment: Use the density distribution class diagram on the form to describe the distribution of young plants of each canopy species present both within the main canopy and outside the main canopy. The previous diagram shows the difference between within the the main canopy and outside the main canopy.

23. Comments: Place any additional information concerning the TUS patch in this section.

24. Location Drawing: Hand sketch a quick diagram showing the general shape of the TUS patch as seen from the air with any important aspects relating to the TUS patch shown (i.e. large weed patches, large areas of dead canopy, etc.)

25. Print and sign your name and date the form when completed.

**Qualitative Habitat Assessment Form**

Form #____________

Site I.D. ____________________ Project I.D.______________ Page___of___

Date____________________ Unit or Transect #__________ Habitat Type__________

Observer(s)____________________ Field Notebook(s)__________________

Slope Position P T U M B R

Slope______________ Aspect______________

Distance of TUS patch from top of ridge (m)______________Angle__________

Erosion Status (low) 1 2 3 4 5 (high)

Abundance of Trash (low) 1 2 3 4 5 (high)

Soil Condition Cobbly Gravelly Sandy Loamy Silty Clayey

Flowing seeps present within the TUS unit Y N

Abundance of Noxious Weeds

| | Density Distribution Class | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CEDI1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| CIAR1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| CANU1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| HYPE1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| ______ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| ______ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Abundance of Introduced Species

| | Density Distribution Class | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| BRJA1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| BRTE1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| ALMI1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| DAGL1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| ______ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| ______ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| ______ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| ______ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| ______ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

| CLASS | DENSITY DISTRIBUTION |
|---|---|
| 1 | Rare individual, a single occurrence |
| 2 | A few sporadically occurring individuals |
| 3 | A single patch or clump of a species |
| 4 | Several sporadically occurring individuals |
| 5 | A few patches or clumps of a species |
| 6 | Several well spaced patches or clumps |
| 7 | Continuous uniform occurrence of well spaced individuals |
| 8 | Continuous occurrence of a species with a few gaps in the distribution |
| 9 | Continuous dense occurrence of a species |

CEDI1 (blown in) abundance (low) 1 2 3 4 5 (high)

Predominate Canopy Species

| | Percent Cover Class: Within Main Canopy | | | | | | | Outside Main Canopy | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRER1 | r | + | 1 | 2 | 3 | 4 | 5 | r | + | 1 | 2 | 3 | 4 | 5 |
| PRVI1 | r | + | 1 | 2 | 3 | 4 | 5 | r | + | 1 | 2 | 3 | 4 | 5 |
| PRAM1 | r | + | 1 | 2 | 3 | 4 | 5 | r | + | 1 | 2 | 3 | 4 | 5 |
| ______ | r | + | 1 | 2 | 3 | 4 | 5 | r | + | 1 | 2 | 3 | 4 | 5 |
| ______ | r | + | 1 | 2 | 3 | 4 | 5 | r | + | 1 | 2 | 3 | 4 | 5 |
| ______ | r | + | 1 | 2 | 3 | 4 | 5 | r | + | 1 | 2 | 3 | 4 | 5 |

(r= solitary, with small cover, +=few, with small cover, 1=numerous, <5% cover, 2=5-25% cover, 3=25-50% cover, 4=50-75% cover, 5=>75% cover)

Canopy Species Reproduction Assessment

| | Density Distribution Class: Within Main Canopy | | | | | | | | | Outside Main Canopy | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRER1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| PRVI1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| PRAM1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| ______ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| ______ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| ______ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Comments:

Location Drawing:

Completed by: ______________________ ______________________ Date ____________

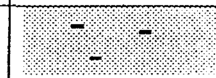
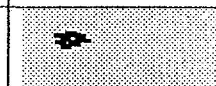
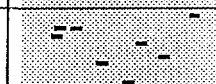
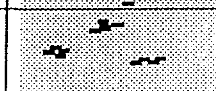
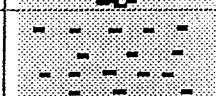
Print Signature

TUS Materials List

location maps and TUS units to be used
field notebook - with signature for sampling
field sampling plan - signed
health and saftey plan
clipboard
black pens
permanent markers
training session for personnel (sign roster)
plant keys
plastic bags
speccode list
herbarium collection list
herbarium field sampling plan
hand lens

5/24/96

## Density Distribution Classes

| Class | Description | Distribution |
|---|---|---|
| 1 | Rare individual, a single occurrence |  |
| 2 | A few sporadically occurring individuals |  |
| 3 | A single patch or clump of a species |  |
| 4 | Several sporadically occurring individuals |  |
| 5 | A few patches or clumps of a species |  |
| 6 | Several well-spaced patches or clumps |  |
| 7 | Continuous uniform occurrence of well-spaced individuals |  |
| 8 | Continuous occurrence of a species with a few gaps in the distribution |  |
| 9 | Continuous dense occurrence of a species |  |

Source: Robinson et al. 1990

## Cover Classes

| | |
|---|---|
| r | solitary, with small cover |
| + | few, with small cover |
| 1 | numerous, <5% cover |
| 2 | 5–25% |
| 3 | 26–50% |
| 4 | 51–75% |
| 5 | >75% |

Figure A1. Density distribution classes and cover classes.

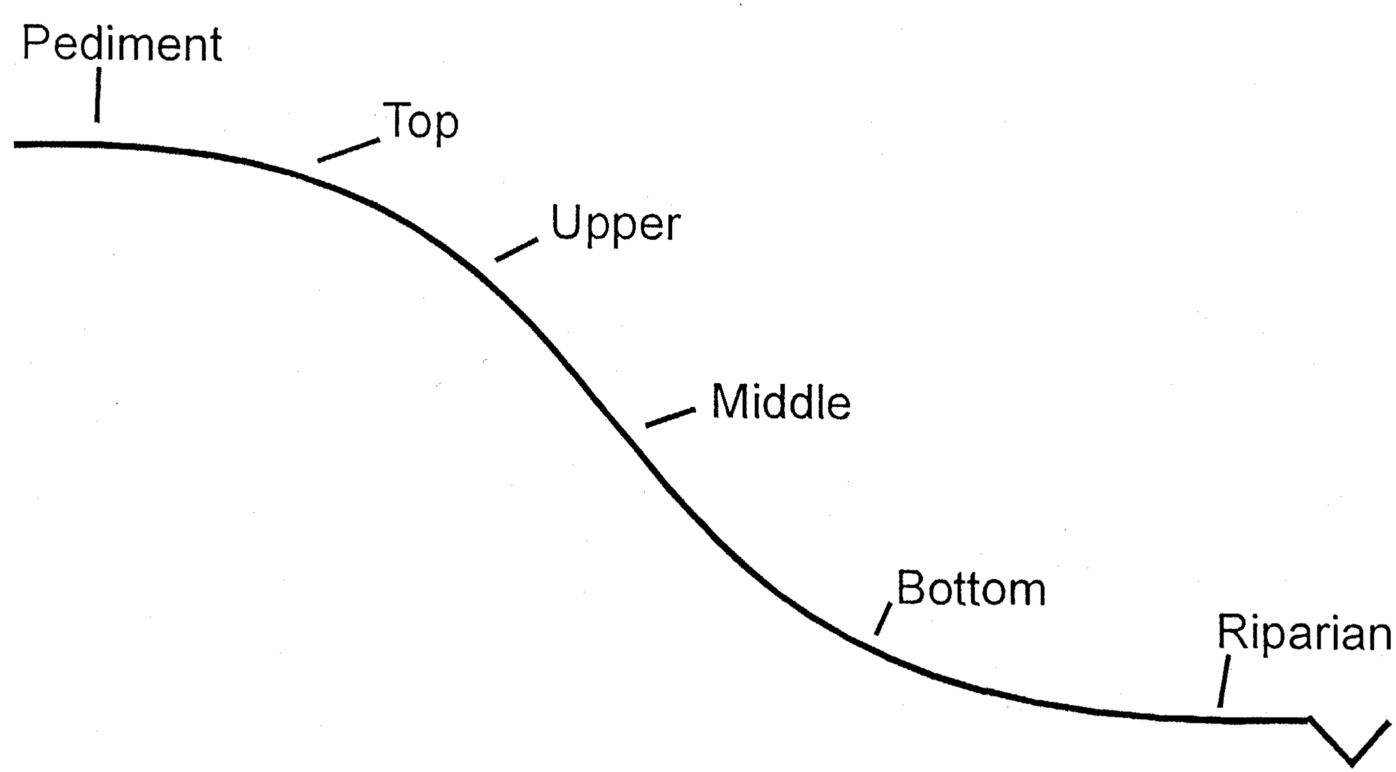



Figure A2. Slope positions.

i:dataмgmt\cb3e\appx_aVig_a2.cdr 020697