

WESTERN ENERGY COMPANY

VEGETATION REPORT FOR MINING AREA B-EAST
1980

December 31, 1980

Clifton Youmans, M.S., Area Manager - Principal Investigator
Darwin L. Sell, M.S., Associate Investigator

Project 247-83-A

Prepared By

ECON INC.
1300 Cedar Street
Helena, Montana 59601

T A B L E O F C O N T E N T S

	<u>Page</u>
LIST OF FIGURES.....	ii
LIST OF TABLES.....	iii
ABSTRACT.....	iv
1. INTRODUCTION.....	1
2. STUDY AREA DESCRIPTION.....	2
3. METHODS.....	4
3.1 Study Plot Design and Location.....	4
3.2 Sampling Design.....	4
3.21 Canopy Coverage of Low-Growing Taxa.....	4
3.22 Shrub Density.....	6
3.23 Annual Plant Biomass Production.....	6
3.24 Overstory.....	7
4. RESULTS.....	9
4.1 Vegetation Community Descriptions.....	9
4.11 Upland Grassland (111).....	9
4.12 Big Sagebrush Grassland (211).....	12
4.13 Silver Sagebrush Grassland (212).....	14
4.14 Skunkbush Sumac Grassland (213).....	15
4.15 Gumbo Knob (214).....	17
4.16 Ponderosa Pine Grassland (351).....	19
4.2 Overstory Description.....	21
TABLES.....	23
LITERATURE CITED.....	39
APPENDIX: Partial Plant List for Western Energy Company's Mining Area B-East - Colstrip, Montana.....	40
EXHIBIT A: Western Energy Company Mining Area B-East, Sections 4, 9, 10, and 11, Vegetation Survey Map.....	Inside Back Cover

L I S T O F F I G U R E S

<u>Number</u>		<u>Page</u>
1.	Location of Western Energy Company's Mining Area B-East Study Area (Map).....	3
2.	Sample Plot Design (Diagram).....	5
3.	Upland Grassland Vegetation Community (111) - <i>Bouteloua</i> <i>gracilis</i> - <i>Stipa comata</i> - Macroplot No. 8 (Photo).....	10
4.	Big Sagebrush Grassland Vegetation Community (211) - <i>Artemisia tridentata</i> - <i>Agropyron spicatum</i> - <i>Carex</i> <i>filifolia</i> - Macroplot No. 10 (Photo).....	12
5.	Silver Sagebrush Grassland Vegetation Community (212) - <i>Artemisia cana</i> - <i>Bouteloua gracilis</i> - <i>Agropyron smithii</i> - Macroplot No. 22 (Photo).....	14
6.	Skunkbush Sumac Grassland Vegetation Community (213) - <i>Rhus trilobata</i> - <i>Carex filifolia</i> - <i>Stipa comata</i> - Macroplot No. 19 (Photo).....	16
7.	Gumbo Knob Vegetation Community (214) - <i>Agropyron</i> <i>spicatum</i> - <i>Bouteloua curtipendula</i> - Macroplot No. 23 (Photo).....	18
8.	Ponderosa Pine Grassland Vegetation Community (352) - <i>Pinus ponderosa</i> - <i>Rhus trilobata</i> - <i>Agropyron spicatum</i> - Macroplot No. 28 (Photo).....	20
9.	Regression of Height on Age for Ponderosa Pine on Western Energy Company's Mining Area B-East (Diagram).....	22

L I S T O F T A B L E S

<u>Number</u>		<u>Page</u>
I.	Acreage and Percent of Area of Vegetation Communities on Western Energy Company's Mining Area B-East.....	24
II.	Canopy Coverage, Frequency, and Constancy for Seven Upland Grassland Sites on Western Energy Company's Mining Area B-East.....	25
III.	Ground Characteristics for Six Native Vegetation Communities on Western Energy Company's Mining Area B-East.....	27
IV.	Annual Plant Biomass Production (g/m ²) by Forage Class for Six Native Vegetation Communities on Western Energy Company's Mining Area B-East.....	28
V.	Canopy Coverage, Frequency, and Constancy for Four Big Sagebrush Grassland (211) Sites on Western Energy Company's Mining Area B-East.....	29
VI.	Average Percent Shrub Canopy Coverage for Four Shrub Grassland and One Timber Grassland Vegetation Communities on Western Energy Company's Mining Area B-East...	31
VII.	Canopy Coverage, Frequency, and Constancy for Eight Silver Sagebrush Grassland (212) Sites on Western Energy Company's Mining Area B-East.....	33
VIII.	Canopy Coverage, Frequency, and Constancy for Three Skunkbush Grassland (213) Sites on Western Energy Company's Mining Area B-East.....	35
IX.	Canopy Coverage, Frequency, and Constancy for Three Gumbo Knob (214) Sites on Western Energy Company's Mining Area B-East.....	36
X.	Canopy Coverage, Frequency, and Constancy for Two Ponderosa Pine Grassland (351) Sites on Western Energy Company's Mining Area B-East.....	38

ABSTRACT

ECON INC. of Helena, Montana conducted a baseline vegetation survey of Western Energy Company's Mining Area B-East in July and August of 1980. Six vegetation communities were quantitatively measured on 27 macroplots within the 1,193-acre study area. Upland Grassland community type (111) composed 310 acres (26%) of the entire study area and was sampled on seven macroplots. The highest average total plant biomass production was estimated on the 111 community type (28.7 g/m^2). Big Sagebrush Grassland community type (211) composed 152 acres (13%) of the area and was sampled on four macroplots. Total grass coverage was highest of all communities sampled within the Big Sagebrush Grassland type (34.7%). Total annual plant production for the 211 community was estimated at 53.2 g/m^2 . Silver Sagebrush Grassland community type (212) composed 456 acres (38%) of the area and was sampled on eight macroplots. Total forb coverage within the 212 community type exceeded all other communities sampled (8.1%). Annual plant biomass production was estimated at 31.9 g/m^2 . Skunkbush Sumac Grassland community type (213) composed 95 acres (8%) of the area and was sampled on three macroplots. The average annual plant biomass production estimate (61.8 g/m^2) was highest of all communities sampled. Gumbo Knob community type (214) composed 27 acres (2%) of the study area and was sampled on three macroplots. Total grass canopy coverage on the 214 community type was lowest of all communities sampled (18.7%), while total forb canopy coverage was the highest (9.4%). Average total plant biomass production was estimated at 45.7 g/m^2 . Ponderosa Pine Grassland community type (351) composed 29 acres (2%) of the study area and two macroplots were sampled. Average total plant biomass production for the 351 community type was estimated at 53.2 g/m^2 . Average age and height of 11 ponderosa pine trees sampled on two macroplots was 40.7 years and 26.8 feet respectively.

1. INTRODUCTION

ECON INC. of Helena, Montana was contracted by Western Energy Company (WECO) to conduct a baseline survey of the vegetative resource on their Mining Area B (secs. 4, 9, and 10, T. 1 N., R. 41 E.), hereafter referred to as Mining Area B-East. The study was designed to comply with Montana Department of State Lands (MDSL) Draft Vegetation Guidelines 1980 and, with some modifications, follows the design presented.

The purpose of this survey was to quantitatively describe the various vegetation communities in terms of canopy coverage and annual plant biomass production. Descriptions of the timber resource are also provided.

Vegetation communities described within this report are based on two or more dominant species which by their structure, number, or canopy coverage have the greatest functional influence on the plant community. Vegetation communities described within this report are naturally occurring communities, variously affected by historical and present management practices. The findings presented within this report are based on field work conducted during July 1980.

2. STUDY AREA DESCRIPTION

Mining Area B-East lies in the Armells Creek drainage (Figure 1). The East Fork of Armells Creek drains the area into Armells Creek, which eventually flows into the Yellowstone River approximately 30 miles to the north.

The area is typified by rolling uplands dominated by grassland and shrub grassland vegetation communities, with a grading into pine-covered ridges along the southernmost boundary.

Zonal soils of the study area belong to the major soil group of brown soils, formed by the calcification of parent material (Lyon and Buckman 1948, Daubenmire 1959).

The climate of the Colstrip area is continental in character, with a range in temperatures of as much as 140 degrees. January and July are the coldest and warmest months, respectively. Mean annual precipitation is 15.79 inches, with nearly 9 inches falling between April and July. May and June are generally the wettest months. Winter precipitation averages just over one-half inch per month and is mostly in the form of snow. Summer thunderstorms are a common occurrence, but are, for the most part, short-lived.

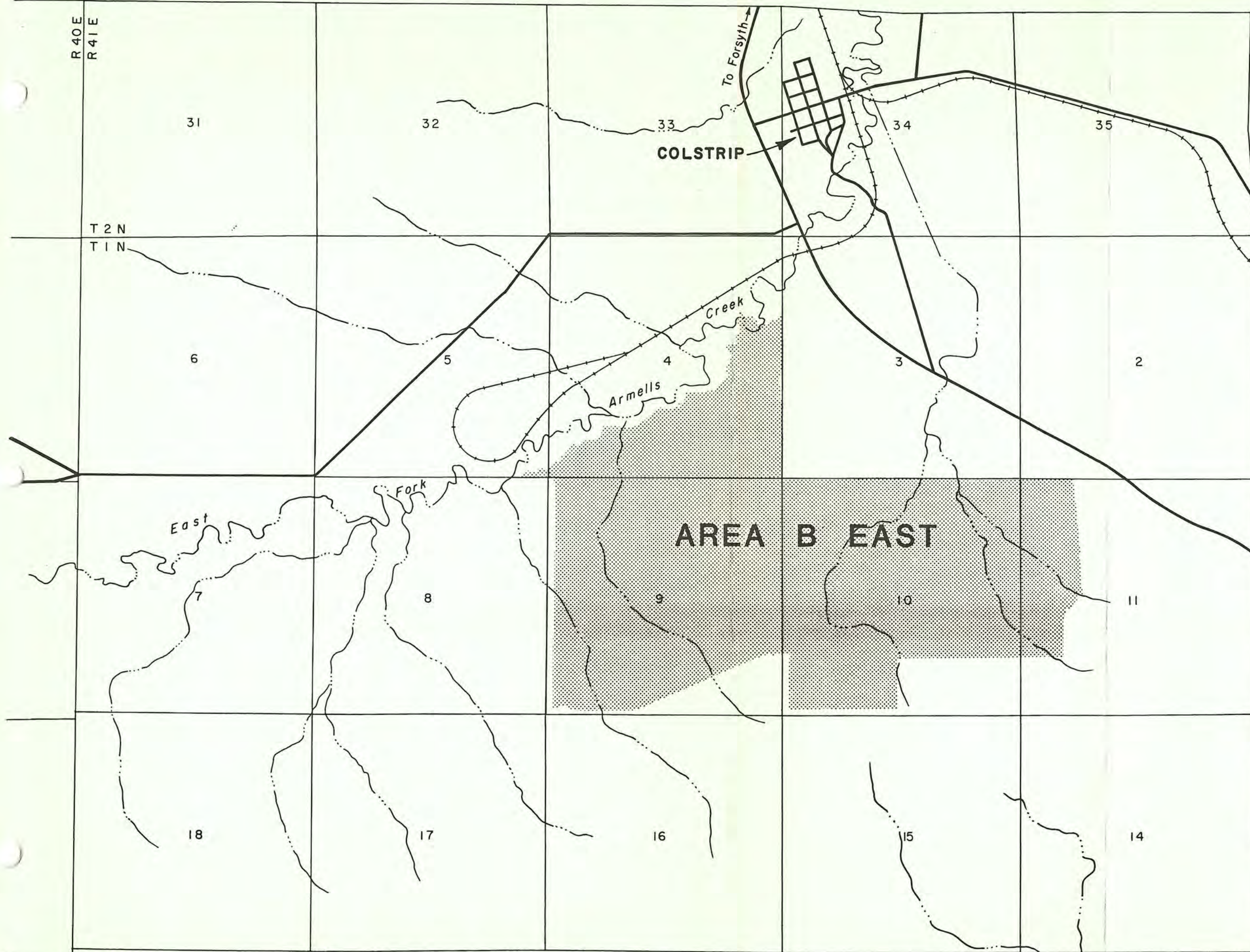


Figure 1. Location of Western Energy Company's Mining Area B-East Study Area.

3. METHODS

3.1 Study Plot Design and Location

The macroplot utilized during this study (Figure 2) was a slight modification of that presented in MDSL's Draft Vegetation Guidelines 1980. The entire study area has previously been surveyed into a 1,000-foot grid, making the selection of and the exact location of 100x100-foot plots possible. This modification in design was approved by MDSL personnel (W. F. Schwarzkoph, personal communication, 1980).

Random plot location was conducted by selecting a 5-number set of random digits from "A table of randomly assorted digits" (Snedecor and Cochran 1967) identifying a unique 100x100-foot area within the study area. This plot was then located on both a vegetation type map (ECON 1975) and an aerial photograph of the study area. The 1975 vegetation map was updated and locations are shown on the attached map (Exhibit A). Enough points were generated to fulfill the desired sample size for each vegetation community. A 5-foot steel fence post was then driven into the ground, locating the southeast corner of the plot for permanency. Prior to data collection, the plot was marked using a hand-held compass, a 100-foot tape, and marking flags.

3.2 Sampling Design

3.21 Canopy Coverage of Low-Growing Taxa:

A total of 20 2x5-decimeter frames were read for canopy coverage of low-growing taxa along parallel lines within each macroplot (Figure 2). Each plant taxa observed within a frame was recorded as to species and coverage class. Cover classes used were:

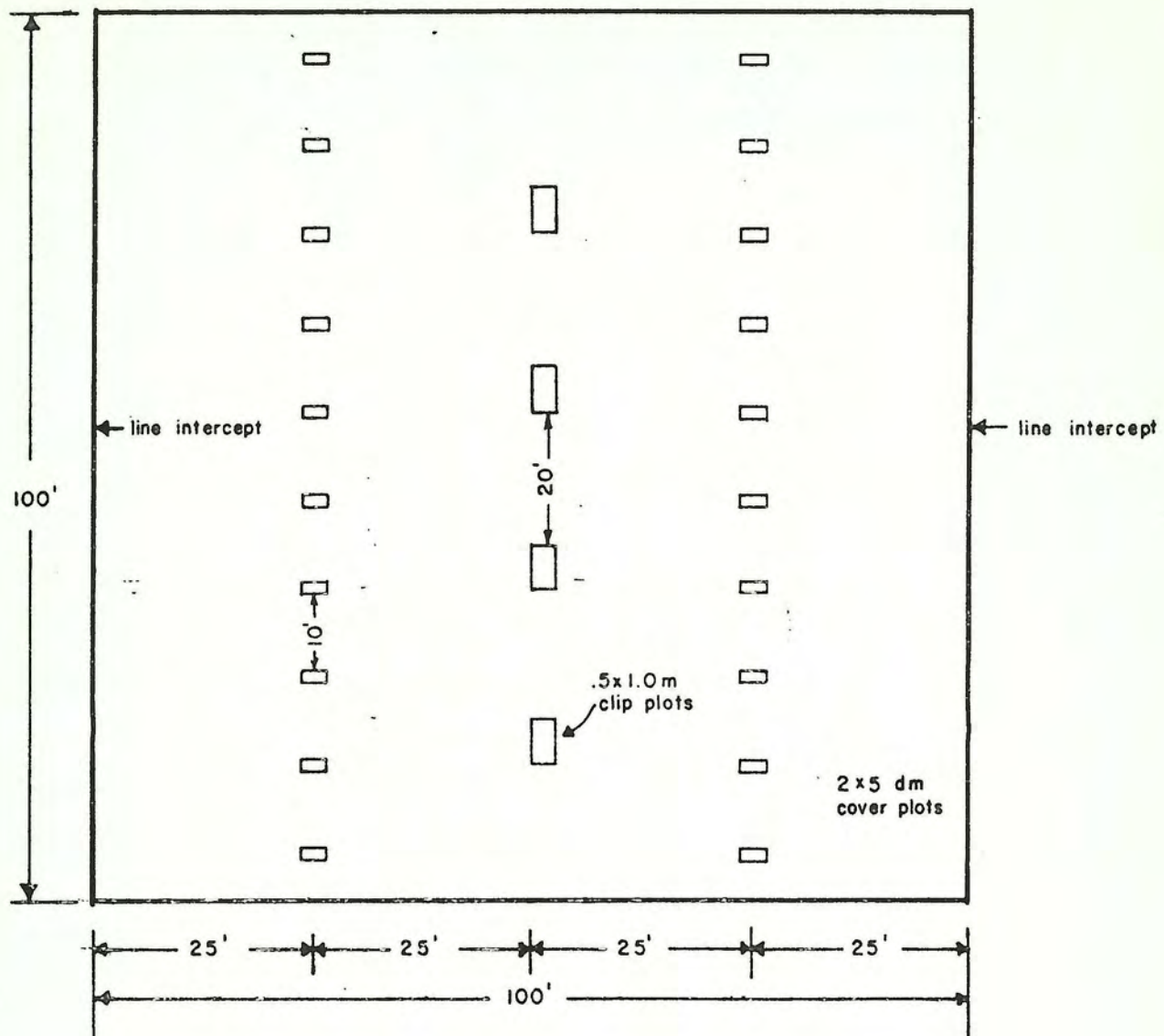


Figure 2. Sample Plot Design.

- 1 - 0-1%
- 2 - 2-5%
- 3 - 6-25%
- 4 - 26-50%
- 5 - 51-75%
- 6 - 76-96%
- 7 - 96-100%.

In addition to canopy coverage of individual species, coverage by forage class and ground characteristics was recorded. This data set was then used in the calculation of canopy coverage, frequency, and constancy of low-growing taxa, forage classes, and ground characteristics for each vegetation community.

3.22 Shrub Canopy Coverage:

Shrub canopy coverage was calculated from data obtained by running two 100-foot shrub intercept lines. These lines were the east and west boundary lines of the macroplot (Figure 2). An average shrub canopy coverage was reported by species and height class for each vegetation community. Height classes used were:

- 1 - 0-6"
- 2 - 7-12"
- 3 - 13-18"
- 4 - 19-24"
- 5 - 25-30"
- 6 - Over 30".

3.23 Annual Plant Biomass Production:

Annual biomass production was determined by hand-clipping four 0.5x1.0-meter plots, systematically located within each macroplot (Figure 2). Each forage class was individually placed in sacks and marked. Forage classes were:

- Annual grasses
- Perennial grasses
- Annual and biennial forbs
- Perennial forbs
- Shrubs

Shrub production was sampled using the microunit method (USDA, Soil Conservation Service {SCS} 1976). This involves clipping a leader of a shrub species and considering it as a microunit. The number of microunits within the clip plot is then achieved by counting. The oven-dry weight of the clipped microunit is determined and used as a multiplier with the number of microunits present to procure the total current year's biomass production.

All production samples were shipped to ECON's Helena, Montana laboratory for oven-drying and weighing. All weights were recorded to the nearest 0.1 gram.

3.24 Overstory:

All trees were sampled for age and height within each timber community macroplot. Heights were determined using ocular estimation. Age was determined using an increment borer, placing the core into a drinking straw, and counting the annual rings under a dissecting microscope in the laboratory.

A linear regression (Snedecor and Cochran 1967) was applied to the age and height data with both a regression line and confidence intervals being presented. Height at 100 years age was predicted.

A template representing one hectare was placed as an overlay on

a color infrared photo series of the study area at each timber community sampling site. All trees within the template were then counted using an Old Delft scanning stereoscope to determine timber density.

4. RESULTS

4.1 Vegetation Community Descriptions

Six vegetation communities were sampled and described within WECO Mining Area B-East. These consisted of the following communities, named by dominant plant species:

Upland Grassland (111) *Bouteloua gracilis* - *Stipa comata*

Big Sagebrush Grassland (211) *Artemisia tridentata* - *Agropyron spicatum* - *Carex filifolia*

Silver Sagebrush Grassland (212) *Artemisia cana* - *Bouteloua gracilis* - *Agropyron smithii*

Skunkbush Sumac Grassland (213) *Rhus trilobata* - *Carex filifolia* - *Stipa comata*

Gumbo Knob (214) *Agropyron spicatum* - *Bouteloua curtipendula*

Ponderosa Pine Grassland (351) *Pinus ponderosa* - *Rhus trilobata* - *Agropyron spicatum*

Following is a description of each vegetation community sampled.

4.11 Upland Grassland (111):

The Upland Grassland vegetation community (Figure 3) comprised 26 percent, or 310 acres, within the study area (Table I). Seven macroplots were sampled within this community to determine canopy coverage and frequency of low-growing taxa, as well as annual plant biomass production.

Dominant grasses included blue grama (*Bouteloua gracilis*) and needle-and-thread (*Stipa comata*) (Table II). Other important grasses



Figure 3. Upland Grassland Vegetation Community (111) -
Bouteloua gracilis - *Stipa comata* - Macroplot
 No. 8.

and grasslike plants recorded during sampling included western wheatgrass (*Agropyron smithii*), and threadleaf sedge (*Carex filifolia*).

Increaser grass species (in terms of response to grazing) predominated within this community, although decreaser species such as bluebunch wheatgrass (*Agropyron spicatum*), sand bluestem (*Andropogon hallii*), sideoats grama (*Bouteloua curtipendula*), prairie sandreed (*Calamovilfa longifolia*), little bluestem (*Schizachyrium scoparium*), and green needlegrass (*Stipa viridula*) were all represented in lesser amounts. Three grass species were recorded only within this community: sand bluestem, Sandberg bluegrass (*Poa sandbergii*) and six weeks grass (*Vulpia octoflora*).

Forb diversity was relatively high, with 20 species being identified within the Upland Grassland vegetation community sampling sites.

The most important in terms of canopy coverage, frequency, and constancy were common yarrow (*Achillea millefolium*), false tarragon sagewort (*Artemisia dracunculoides*), fringed sagewort (*Artemisia frigida*), Hood's phlox (*Phlox hoodii*), and scarlet globemallow (*Sphaeralcea coccinea*) (Table II). Forb species recorded only within this community included field pussytoes (*Antennaria neglecta*), rock cress (*Arabis* species), plains milkweed (*Asclepias pumilla*), field bindweed (*Convolvulus arvensis*), blue lettuce (*Lactuca pulchella*), and Russian thistle (*Salsola kali*).

Shrub species were uncommon and contributed little to the total canopy coverage (Table II). The most common shrub species present was silver sagebrush (*Artemisia cana*). Also represented in lesser amounts were shrubby evening primrose (*Oenothera serrulata*), prairie rose (*Rosa arkansana*), and skunkbush sumac (*Rhus trilobata*).

In terms of ground characteristics (Table III), those calculated values that showed obvious differences from the other vegetation communities described included low values for rock and standing litter coverage, and a higher than average coverage of lichens.

Precipitation in the past two years has been far below the 30-year average. This was reflected in the extremely low plant biomass production measured during this study for all vegetation communities. Average total plant biomass production for the Upland Grassland vegetation community was 28.7 g/m² (256.1 lbs/acre) (Table IV). More than 99 percent of this was made up of perennial grasses and forbs, with 65 and 34 percent, respectively. The Upland Grassland vegetation community had the lowest total production of all communities sampled, and

may partially be attributed to heavy grazing pressure on the areas sampled, together with the droughty conditions.

4.12 Big Sagebrush Grassland (211):

A total of four macroplots was sampled within the Big Sagebrush Grassland vegetation community (Figure 4). This community comprised 13 percent of the study area, including 152 acres (Table I).

Codominant grasses, in terms of canopy coverage, frequency and constancy, for which this community was named included bluebunch wheatgrass (a decreaser) and threadleaf sedge (an increaser) (Table V). Other subdominant grasses included blue grama, prairie junegrass (*Koeleria cristata*), and western wheatgrass. Total grass canopy



Figure 4. Big Sagebrush Grassland Vegetation Community (211) - *Artemisia tridentata* - *Agropyron spicatum* - *Carex filifolia* - Macroplot No. 10.

coverage was highest of all communities sampled within the Big Sagebrush Grassland community, and can be partially attributed to the protection afforded from grazing by the sagebrush cover.

Important forbs in terms of canopy coverage, frequency, and constancy included fringed sagewort, scarlet gaura (*Gaura coccinea*), broom snakeweed (*Gutierrezia sarothrae*), Hood's phlox, and scarlet globemallow (Table V). Total forb coverage was the lowest of all communities described.

The dominant shrub, as implied by the community naming, was big sagebrush (*Artemisia tridentata*). Other shrub species represented within this community included silver sagebrush, shrubby evening primrose, and skunkbush sumac.

Line intercepts run within the macroplots resulted in a calculated average shrub canopy coverage of 13.9 percent (Table VI). Big sagebrush represented 88 percent of this total shrub canopy coverage with an average of 12.2 percent.

In terms of ground characteristics (Table III); rock coverage was quite low and down litter was superseded only by the Ponderosa Pine Grassland (351) community. Other parameters were in an intermediate range.

Total annual plant biomass production for the Big Sagebrush Grassland vegetation community averaged 53.2 g/m² (474.7 lbs/acre) (Table IV). Forty-seven percent of this total was made up of shrubs, while 36 percent was in the form of perennial grasses. Total production was superseded

only by the Skunkbush Sumac Grassland vegetation community (213) and equaled by the Ponderosa Pine Grassland (351). Again, the low average total production was affected by drought and grazing pressure.

4.13 Silver Sagebrush Grassland (212):

The Silver Sagebrush Grassland vegetation community (Figure 5) comprised 38 percent of the study area, or 456 acres (Table I). Eight macroplots were sampled within this community for descriptive purposes.

Grass dominance was shared by blue grama and western wheatgrass (Table VII). Other important grasses included bluebunch wheatgrass, red three-awn (*Aristida longiseta*) and needle-and-thread. This was the only vegetation community in which Canada bluegrass (*Poa compressa*) was recorded.



Figure 5. Silver Sagebrush Grassland Vegetation Community (212) - *Artemisia cana* - *Bouteloua gracilis* - *Agropyron smithii* - Macroplot No. 22.

Important forbs within this community included fringed sagewort, broom snakeweed, Hood's phlox, and scarlet globemallow. Total forb coverage was highest of all communities sampled (Table VII), but consisted mainly of invader or increaser species.

As the community name implies, silver sagebrush was the dominant shrub species. Other shrubs recorded during sampling included big sagebrush and skunkbush sumac (Table VII). Average percent shrub canopy coverage was calculated to be 5.6 percent (Table VI). Silver sagebrush average canopy coverage was 4.9 percent and comprised 88 percent of the total shrub cover.

Ground characteristics included the highest percentage of bare ground as well as lichens of all communities sampled (Table III). Both standing litter and down litter values were relatively high. Again, the presence of shrub coverage allowed for the accumulation of litter in the absence of availability to grazing.

Annual plant biomass production averaged 31.9 g/m² (284.6 lbs/acre) for the Silver Sagebrush Grassland vegetation community and superseded only the Upland Grassland vegetation community (111) (Table IV). Fifty-three percent of the total was contributed by perennial grasses. Perennial forbs (34 percent) were the other major contributing forage class.

4.14 Skunkbush Sumac Grassland (213):

The Skunkbush Sumac Grassland vegetation community (Figure 6) was a relatively minor community consisting of 95 acres, or 8 percent, of the study area (Table I). Three macroplots were sampled within this vegetation community.



Figure 6. Skunkbush Sumac Grassland Vegetation Community (213) - *Rhus trilobata* - *Carex filifolia* - *Stipa comata* - Macroplot No. 19.

The understory was dominated by threadleaf sedge and needle-and-thread (Table VIII). Other important grasses included bluebunch wheatgrass, blue grama, and prairie sandreed. Dominance was shared by increaser species; however, decreaser species such as bluebunch wheatgrass, side-oats grama, prairie sandreed, little bluestem, and green needlegrass were well represented. Total grass canopy coverage was superseded only by the Big Sagebrush Grassland vegetation community (211).

Canopy coverage by forbs was relatively low (Table VIII). Important species represented included false tarragon sagewort, fringed sagewort, and soap-weed (*Yucca glauca*). Miner's candle (*Cryptantha bradburiana*) and stiffstem flax (*Linum rigidum*) were observed only within this vegetation community.

Shrub dominance was held by skunkbush sumac (Table VIII). Silver sagebrush was the only other shrub species recorded during sampling. Shrub canopy coverage, as determined by line intercepts, averaged 5.9 percent and was made up totally by skunkbush sumac (Table VI).

In terms of ground characteristics (Table III), lichen coverage was very low. Rocky coverage was high, second only to the Gumbo Knob community (214). Litter values, both standing and down, were quite low.

Average annual plant biomass production for the Skunkbush Sumac Grassland vegetation community was 61.8 g/m^2 (551.4 lbs/acre) (Table IV). This was the most productive of the vegetation communities sampled during this droughty year. A majority of the total biomass was contributed by shrubs and perennial grasses, contributing 61 and 36 percent, respectively.

4.15 Gumbo Knob (214):

The Gumbo Knob vegetation community (Figure 7) is situated on highly eroded hilltops and, while being very visible, represented a small percentage of the total area (2 percent) (Table I). This 27-acre community was sampled within three macroplots.

Grass dominance was shared by two decreasing species: bluebunch wheatgrass and sideoats grama (Table IX). Total grass canopy coverage was lowest of all vegetation communities described and can be attributed to the extremely harsh edaphic conditions. The predominance of decreaser grasses is a result of low grazing pressure due to topographic characteristics.



Figure 7. Gumbo Knob Vegetation Community (214) - *Agropyron spicatum* - *Bouteloua curtipendula* - Macroplot No. 23.

Total forb canopy coverage within the Gumbo Knob vegetation community was highest of all vegetation communities described (Table IX). Important species included cudweed sagewort (*Artemisia ludoviciana*), Eriogonum (*Eriogonum multiceps*), broom snakeweed, and Hood's phlox.

Shrub species were well represented within this community, although total coverage was relatively low (Table IX). Silver sagebrush, big sagebrush, shrubby evening primrose, prairie rose, skunkbush sumac, and common snowberry (*Symphoricarpos alba*) were all represented.

Total shrub canopy coverage was 9.0 percent (Table VI), a majority of which was contributed by skunkbush sumac (6.9 percent). Other important shrubs, in terms of their contribution to total shrub canopy coverage were big sagebrush and silver sagebrush with 1.2 and 0.9 percent, respectively.

Typical of the Gumbo Knob vegetation community was the high percentage of bare ground and rock recorded (26.4 and 22.8 percent, respectively) (Table III). Ground coverage by down litter was lowest of all communities described within the Gumbo Knob vegetation community.

Average total plant biomass production was 45.7 g/m² (407.7 lbs/acre) within the Gumbo Knob vegetation community (Table IV). This was made up of nearly equal percentages of perennial grass (32 percent), perennial forb (38 percent), and shrub (31 percent) forage classes.

4.16 Ponderosa Pine Grassland (351):

The Ponderosa Pine Grassland vegetation community (Figure 8) was a minor component of the entire study area, consisting of 29 acres, or 2 percent of the total area (Table I). Two macroplots were sampled for canopy coverage, frequency, and production.

The dominant grass in the Ponderosa Pine Grassland was bluebunch wheatgrass, a decreaser (Table X). Other important components of the graminoid segment included western wheatgrass, red three-awn, blue grama, and green needlegrass. Total grass canopy coverage was quite low compared to the other vegetation communities described, and was attributable to the dense layer of shed pine needles covering large portions of the ground area.

Forbs had a moderate coverage when compared to the other vegetation communities described (Table X). Important species included common yarrow, false tarragon sagewort, and cudweed sagewort. American vetch (*Vicia americana*) was recorded only within the Ponderosa Pine Grassland vegetation type.



Figure 8. Ponderosa Pine Grassland Vegetation Community (352) - *Pinus ponderosa* - *Rhus trilobata* - *Agropyron spicatum* - Macroplot No. 28.

Skunkbush sumac was a common component of the vegetation community within the Ponderosa Pine Grassland. Silver sagebrush, creeping juniper (*Juniperus horizontalis*), and common snowberry were also represented (Table X). Line intercepts resulted in a total calculated shrub canopy coverage of 14.6 percent (Table VI). This was the highest shrub canopy coverage of any of the vegetation communities described. Skunkbush sumac contributed 64 percent to this total.

Due to the high amount of pine needle litter and bunchgrass residuals, both standing and down litter categories were greatest within the Ponderosa Pine Grassland (Table III). Bare ground had a correspondingly low ground coverage value.

Average total plant biomass production for the Ponderosa Pine Grassland vegetation community was 53.2 g/m² (474.7 lbs/acre), a

relatively high value (Table IV). Sixty-one percent of the total was contributed by the shrub forage class. Perennial grasses and forbs contributed 18 and 21 percent, respectively, to the total.

4.2 Overstory Description

A total of 11 ponderosa pine trees was sampled within the two macroplots for age and height. Average age was 40.7 years and average height was 26.8 feet. The resulting regression equation was:

$$\hat{Y} = 7.86 + 0.4653 x$$

where:

\hat{Y} = the predicted height
x = the measured age.

This translates to a predicted height of 54.4 ± 18.6 feet at 100 years. A graph of the regression line, data points and confidence intervals is given as Figure 9.

Density estimates for trees were accomplished by overlaying a hectare template on 1:12,000 scale, 1977 color infrared aerial photography of the Colstrip area, and directly counting the occurrences of trees by species within the template. Only two species were evident in the two templates examined: ponderosa pine (*Pinus ponderosa*) and Rocky Mountain juniper (*Juniperus scopulorum*). The ponderosa pine count ranged from 20-25 per template, which resulted in an average density of 22.5 per hectare (9.1 per acre). The Rocky Mountain juniper count ranged from 6-33 per template, which resulted in an average density of 19.5 per hectare (7.9 per acre).

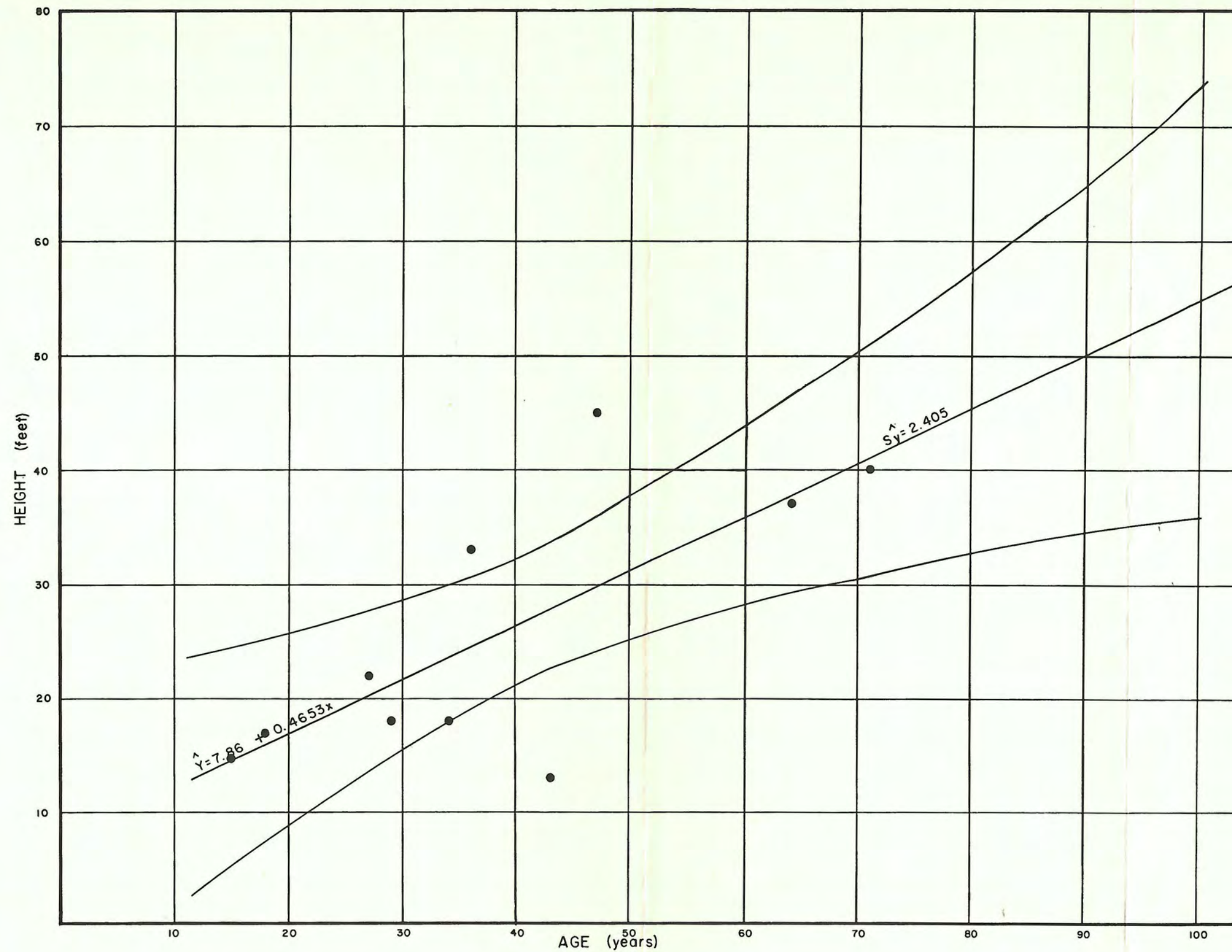


Figure 9. Regression of height on age for ponderosa pine on Western Energy Company's Mining Area B-East.

T A B L E S

TABLE I

ACREAGE AND PERCENT OF AREA OF VEGETATION COMMUNITIES
ON WESTERN ENERGY COMPANY'S MINING AREA B-EAST

Vegetation Community	Acres	Percent of Area
Upland Grassland (111).....	310	26
Big Sagebrush Grassland (211).....	152	13
Silver Sagebrush Grassland (212).....	456	38
Skunkbush Grassland (213).....	95	8
Gumbo Knob (214).....	27	2
Creek Bottom (220).....	6	<1.
Ponderosa Pine Grassland (351).....	29	2
Agricultural (500).....	<u>118</u>	<u>10</u>
Total.....	1193	100

TABLE II

CANOPY COVERAGE, FREQUENCY, AND CONSTANCY FOR SEVEN UPLAND GRASSLAND
SITES ON WESTERN ENERGY COMPANY'S MINING AREA B-EAST

Species	Macroplot Number							Average
	1	5	8	13	15	16	21	
Grasses:								
<i>Agropyron smithii</i>	¹ 10.8/295	1.4/95	2.1/85	6.5/100	4.9/100	5.8/70	2.1/30	4.8/82/ ³ 100
<i>Agropyron spicatum</i>.....	.....	.....	.....	.....	1.0/10	.....	1.9/20	0.4/4/29
<i>Andropogon hallii</i>.....	.....	.....	.....	.....	.....	.....	2.1/10	0.3/1/14
<i>Aristida longiseta</i>.....	.....	.....	.....	1.3/20	0.2/5	0.2/5	0.8/5	0.4/6/57
<i>Bouteloua curtipendula</i>.....	.....	.....	.....	.....	.....	.....	0.8/5	0.1/1/14
<i>Bouteloua gracilis</i>	3.7/30	1.7/70	11.6/85	20.7/90	7.4/70	5.3/65	1.6/10	7.4/60/100
<i>Bromus japonicus</i>.....	.....	⁴ tr/5	0.3/25	0.4/25	0.4/15	.....	.....	0.2/10/57
<i>Bromus tectorum</i>.....	.....	0.1/10	.....	0.4/20	.....	0.2/5	.....	0.1/5/43
<i>Calamagrostis montanensis</i>...	.....	.....	.....	.....	0.2/5	.....	.....	tr/1/14
<i>Calamovilfa longifolia</i>.....	.....	0.6/30	.....	.....	.....	.....	3.5/15	0.6/6/29
<i>Carex eleocharis</i>.....	.....	.....	.....	.....	1.0/10	.....	2.9/40	0.6/7/29
<i>Carex filifolia</i>	2.3/35	8.2/70	0.8/10	0.2/5	8.5/70	.....	11.3/55	4.5/49/86
<i>Koeleria cristata</i>	0.8/5	.....	.....	.....	0.2/5	.....	0.4/10	0.2/3/43
<i>Poa sandbergii</i>.....	.....	.....	.....	.....	.....	4.0/45	.....	0.6/6/14
<i>Schizachyrium scoparium</i>.....	.....	.....	.....	.....	.....	.....	3.8/10	0.5/1/14
<i>Stipa comata</i>	1.2/30	4.1/75	5.9/60	1.7/15	9.0/85	6.0/55	9.7/60	5.4/54/100
<i>Stipa viridula</i>	1.0/10	.....	.....	.....	.....	.....	.....	0.1/1/14
<i>Vulpia octoflora</i>.....	.....	.....	tr/5	.....	.....	.....	.....	tr/1/14
Total Grasses.....	21.1/100	24.5/100	32.6/100	32.6/100	20.0/100	16.6/100	51.9/100	28.5/100/100
Forbs:								
<i>Achillea millefolium</i>	0.2/15	.....	0.2/15	0.4/15	.....	1.0/15	tr/5	0.3/9/71
<i>Antennaria neglecta</i>.....	.....	.....	1.0/10	.....	.....	.....	.....	0.1/1/14
<i>Antennaria species</i>.....	.....	.....	.....	.....	.....	0.8/5	.....	0.1/1/14
<i>Arabis species</i>.....	.....	.....	.....	.....	0.2/5	.....	.....	tr/1/14
<i>Artemisia dracunculus</i>	0.9/25	5.0/35	.....	.....	.....	0.8/5	1.0/10	1.1/11/57
<i>Artemisia frigida</i>	1.6/45	0.4/10	0.9/30	6.0/60	1.0/10	4.6/45	tr/5	2.1/29/100

(Continued)

^{1,2,3,4}See footnotes at end of table.

Table II (Continued)

Species	Macroplot Number							Average
	1	5	8	13	15	16	21	
Forbs (Continued):								
<i>Artemisia ludoviciana</i>.....	.....	0.2/5	.....	.....	.....	.....	2.3/35	0.4/6/29
<i>Asclepias pumila</i>.....	.....	.....	.....	.....	.....	.....	0.2/10	tr/1/14
<i>Astragalus</i> species.....	.....	.....	.....	.....	.....	.....	0.2/5	tr/1/14
<i>Cirsium undulatum</i>.....	.....	.....	.....	.....	.....	0.2/5	.....	tr/1/14
<i>Convolvulus arvensis</i>.....	.....	tr/5	.....	.....	.....	.....	.....	tr/1/14
<i>Eriogonum multiceps</i>.....	.....	.....	.....	.....	.....	0.2/5	.....	tr/1/14
<i>Gaura coccinea</i>.....	.....	.....	.....	.....	.....	.....	0.2/15	tr/2/14
<i>Gutierrezia sarothrae</i>	1.3/20	.....	.....	.....	.....	5.0/25	.....	0.9/6/29
<i>Heterotheca villosa</i>.....	.....	.....	.....	.....	0.2/10	.....	0.2/5	0.1/2/29
<i>Lactuca pulchella</i>.....	.....	0.1/10	.....	.....	.....	.....	.....	tr/1/14
<i>Lithospermum incisum</i>.....	.....	0.2/5	.....	.....	.....	.....	.....	tr/1/14
<i>Lygodesmia juncea</i>.....	.....	.....	.....	.....	tr/5	0.8/5	0.2/5	0.1/2/43
<i>Opuntia polyacantha</i>.....	.....	.....	0.2/5	.....	tr/5	.....	tr/5	tr/2/43
<i>Phlox hoodii</i>	7.1/90	0.2/5	.....	0.2/10	0.1/10	.....	1.1/30	1.2/21/71
<i>Plantago patagonica</i>.....	.....	tr/5	.....	.....	.....	.....	.....	tr/1/14
<i>Salsola kali</i>	1.9/20	.....	.....	.....	.....	.....	.....	0.3/3/14
<i>Sphaeralcea coccinea</i>	0.2/10	0.1/10	1.9/55	0.6/20	0.4/20	0.4/10	tr/5	0.5/19/100
<i>Taraxacum officinale</i>.....	.....	.....	0.1/10	0.1/10	tr/5	0.4/10	.....	0.1/6/57
<i>Tragopogon dubius</i>	tr/5	.....	.....	0.2/5	.....	.....	.....	tr/1/29
<i>Yucca glauca</i>.....	.....	.....	.....	.....	.....	.....	3.2/5	0.5/1/14
Unknown forbs.....	0.1/10	0.8/40	.....	0.2/5	0.5/15	2.6/45	0.1/15	0.6/19/86
Total Forbs.....	10.7/100	8.2/85	5.9/85	7.4/95	2.0/60	12.7/95	9.1/85	8.0/86/100
Shrubs:								
<i>Artemisia cana</i>	0.4/15	.....	.....	1.9/5	5.2/30	.....	.....	1.1/7/43
<i>Oenothera serrulata</i>.....	.....	.....	.....	.....	.....	.....	0.8/10	0.1/1/14
<i>Rhus trilobata</i>.....	.....	0.8/5	.....	.....	.....	.....	5.1/10	0.8/2/29
<i>Rosa arkansana</i>.....	.....	0.6/25	.....	.....	.....	.....	tr/5	0.1/4/29
Total Shrubs.....	1.1/15	1.4/30	.....	1.9/5	4.4/25	.....	5.9/25	2.1/14/71

¹Canopy coverage (percent of area covered).²Frequency (percent of occurrence among plots).³Constancy (percent occurrence among sites).⁴Trace = a value less than 0.05 percent.

TABLE III

GROUND CHARACTERISTICS FOR SIX NATIVE VEGETATION COMMUNITIES
ON WESTERN ENERGY COMPANY'S MINING AREA B-EAST

Ground Characteristics	Vegetation Community					
	111	211	212	213	214	351
Bare ground.....	¹ 25.8/ ² 99/ ³ 100	25.8/96/100	34.4/98/100	27.6/87/100	26.4/97/100	2.3/50/100
Lichen.....	0.6/56/100	0.4/20/75	0.9/43/88	0.1/8/67	0.2/28/100	0.4/20/50
Rock.....	⁴ tr/3/14	1.1/21/50	0.1/3/25	16.5/37/100	22.8/87/100	7.4/50/100
Standing litter...	1.6/48/100	4.3/53/75	4.4/66/100	2.9/42/100	2.6/62/100	9.9/75/100
Down litter.....	38.9/100/100	50.2/100/100	47.3/100/100	35.2/98/100	24.5/92/100	84.2/100/100

¹Canopy coverage (percent of area covered).²Frequency (percent occurrence among plots).³Constancy (percent occurrence among sites).⁴Trace = a value less than 0.05 percent.

TABLE IV

ANNUAL PLANT BIOMASS PRODUCTION (g/m²) BY FORAGE CLASS FOR SIX
NATIVE VEGETATION COMMUNITIES ON WESTERN ENERGY
COMPANY'S MINING AREA B-EAST

Forage Class	Vegetation Community					
	111	211	212	213	214	351
Annual grasses.....	0.1	0.3	0.1	0.2	...	0.1
Perennial grasses....	18.7	18.9	16.8	22.1	14.5	9.6
Annual & biennial forbs.....	...	...	...	...	...	...
Perennial forbs.....	9.8	9.0	10.7	2.0	17.2	11.2
Shrubs.....	<u>0.1</u>	<u>25.0</u>	<u>4.3</u>	<u>37.5</u>	<u>14.0</u>	<u>32.3</u>
Total annual biomass production.....	28.7	53.2	31.9	61.8	45.7	53.2
Pounds/acre equivalent.....	256.1	474.7	284.6	551.4	407.7	474.7

TABLE V

CANOPY COVERAGE, FREQUENCY, AND CONSTANCY FOR FOUR BIG SAGEBRUSH GRASSLAND
(211) SITES ON WESTERN ENERGY COMPANY'S MINING AREA B-EAST

Species	Macroplot Number				Average
	10	24	26	27	
Grasses:					
<i>Agropyron smithii</i>	¹ 1.2/235	0.2/10	3.4/50	0.7/45	1.4/35/ ³ 100
<i>Agropyron spicatum</i>	8.3/50	15.2/80	3.6/20	19.0/80	11.5/58/100
<i>Bouteloua gracilis</i>	1.3/10	1.6/10	9.3/45	1.0/10	3.3/19/100
<i>Carex filifolia</i>	9.2/45	4.6/30	17.3/60	7.1/35	9.6/43/100
<i>Koeleria cristata</i>	1.8/35	2.2/45	1.2/25	1.0/40	1.6/36/100
<i>Stipa comata</i>	2.2/45	5.0/40	.....	.....	1.8/21/50
<i>Stipa viridula</i>.....	.....	0.8/5	0.4/10	.....	0.3/4/50
Total Grasses.....	35.1/100	36.4/100	33.8/100	33.5/100	34.7/100/100
Forbs:					
<i>Achillea millefolium</i>	0.1/10	.....	0.2/5	.....	0.1/4/50
<i>Artemisia frigida</i>	0.5/45	0.2/5	0.2/5	.....	0.2/14/75
<i>Astragalus species</i>	⁴ tr/5	0.6/20	0.2/5	.....	0.2/8/75
<i>Cirsium undulatum</i>.....	.....	tr/5	.....	.....	tr/1/25
<i>Echinacea pallida</i>.....	.....	0.2/15	.....	.....	0.1/4/25
<i>Gaura coccinea</i>	0.2/5	tr/5	0.1/10	tr/5	0.1/6/100
<i>Gutierrezia sarothrae</i>	0.5/15	0.8/10	0.2/5	1.9/5	0.9/9/100
<i>Grindelia squarrosa</i>.....	.....	.....	.....	0.2/5	0.1/1/25
<i>Lygodesmia juncea</i>	0.2/10	.....	.....	.....	0.1/3/25
<i>Phlox hoodii</i>	0.8/30	1.5/55	1.5/30	2.1/55	1.5/43/100
<i>Plantago patagonica</i>.....	.....	tr/5	.....	.....	tr/1/25
<i>Psoralea argophylla</i>.....	.....	tr/5	.....	.....	tr/1/25
<i>Sphaeralcea coccinea</i>	tr/5	.....	0.4/25	0.2/10	0.2/10/75
<i>Tragopogon dubius</i>.....	.....	tr/5	.....	.....	tr/1/25
<i>Yucca glauca</i>.....	.....	0.2/5	.....	.....	0.1/1/25
Unknown forbs.....	0.1/10	.....	tr/5	.....	tr/4/40
Total Forbs.....	3.0/85	4.3/85	3.2/65	4.8/70	3.8/76/100

(Continued)

^{1,2,3,4}See footnotes at end of table.

Table V (Continued)

Species	Macroplot Number				Average
	10	24	26	27	
Shrubs:					
<i>Artemisia cana</i>.....	.....	.....	4.2/20	.....	1.1/5/25
<i>Artemisia tridentata</i>	1.1/15	4.2/25	22.8/45	11.8/65	10.0/38/100
<i>Oenothera serrulata</i>.....	.....	0.2/5	.....	.....	0.1/1/25
<i>Rhus trilobata</i>	<u>.....</u>	<u>4.3/5</u>	<u>.....</u>	<u>.....</u>	<u>1.1/1/25</u>
Total Shrubs.....	1.1/15	8.6/35	27.9/70	11.8/65	12.4/46/100

¹Canopy coverage (percent of area covered).

²Frequency (percent occurrence among plots).

³Constancy (percent occurrence among sites).

⁴Trace = a value less than 0.05 percent.

TABLE VI

AVERAGE PERCENT SHRUB CANOPY COVERAGE FOR FOUR SHRUB GRASSLAND
AND ONE TIMBER GRASSLAND VEGETATION COMMUNITIES ON
WESTERN ENERGY COMPANY'S MINING AREA B-EAST

Species	Height Class ¹	Vegetation Community				
		211	212	213	214	351
<i>Artemisia cana</i>	1	0.1	0.1	...	² tr	0.6
	2	0.1	0.9	...	0.6	0.2
	3	0.2	1.7	...	0.3	1.0
	4	0.2	1.0	...	...	0.9
	5	...	...	...	...	...
	6	...	<u>1.2</u>	...	...	...
Total.....		0.6	4.9	...	0.9	2.7
<i>Artemisia tridentata</i>	1	0.9	0.1	...	0.1	...
	2	3.4	0.2	...	0.8	...
	3	4.3	0.3	...	0.3	...
	4	3.6	0.1	...	...	...
	5	...	...	...	...	...
	6	...	...	...	...	...
Total.....		12.2	0.7	...	1.2	...
<i>Juniperus horizontalis</i>	1	...	...	...	...	...
	2	...	...	...	...	...
	3	...	...	...	...	...
	4	...	...	...	...	...
	5	...	...	...	...	...
	6	...	...	...	...	<u>2.1</u>
Total.....		...	...	...	...	2.1
<i>Rhus trilobata</i>	1	tr	...	...	0.2	0.8
	2	0.6	...	1.5	3.7	2.7
	3	0.5	tr	3.0	2.4	4.3
	4	...	...	1.4	0.6	...
	5	...	...	...	...	1.6
	6	...	...	...	...	...
Total.....		1.1	tr	5.9	6.9	9.4

(Continued)

^{1,2}See footnotes at end of table.

Table VI (Continued)

Species	Height ¹ Class	Vegetation Community				
		211	212	213	214	351
<i>Symphoricarpos alba</i>	1	...	...	...	...	...
	2	...	...	...	...	0.4
	3	...	...	...	...	...
	4	...	...	...	...	...
	5	...	...	...	...	...
	6	...	...	...	...	...
Total.....		...	...	...	...	0.4
GRAND TOTAL.....		13.9	5.6	5.9	9.0	14.6

¹Height classes: 1 - 0-6"
 2 - 7-12"
 3 - 13-18"
 4 - 19-24"
 5 - 25-30"
 6 - Over 30"

²Trace = a value less than 0.05 percent.

TABLE VII

CANOPY COVERAGE, FREQUENCY, AND CONSTANCY FOR EIGHT SILVER SAGEBRUSH GRASSLAND
(212) SITES ON WESTERN ENERGY COMPANY'S MINING AREA B-EAST

Species	Macroplot Number								Average
	2	7	9	14	17	18	20	22	
Grasses:									
<i>Agropyron smithii</i>	¹ 5.4/ ² 80	5.7/85	3.1/85	9.2/100	10.4/85	7.9/80	4.8/85	3.2/60	6.2/83/ ³ 100
<i>Agropyron spicatum</i>	1.0/10	1.0/10	1.0/10	3.3/25	.....	.....	.....	15.0/60	5.3/14/63
<i>Agropyron</i> species.....	.....	.....	.....	.....	.....	1.3/20	.....	.....	0.2/3/12
<i>Aristida longiseta</i>.....	.....	2.5/20	.....	1.8/35	.....	2.3/30	2.4/35	0.2/5	1.2/16/75
<i>Bouteloua gracilis</i>	21.8/70	13.2/90	13.3/65	13.3/90	7.8/40	16.3/50	11.3/95	3.5/15	12.6/64/100
<i>Bromus japonicus</i>	0.9/25	.....	.....	.....	⁴ tr/5	.....	.....	.....	0.1/4/25
<i>Bromus tectorum</i>	0.2/10	0.5/15	.....	.....	.....	0.7/20	.....	tr/5	0.2/6/50
<i>Calamagrostis montanensis</i> ..	0.4/10	.....	tr/5	.....	.....	.....	.....	0.1/10	0.1/3/38
<i>Carex filifolia</i>.....	.....	5.4/35	0.8/5	.....	.....	.....	0.4/15	0.2/5	0.9/8/50
<i>Koeleria cristata</i>	0.2/5	.....	1.2/60	.....	.....	.....	2.7/80	3.6/55	1.0/25/50
<i>Poa compressa</i>	10.8/5	.....	.....	.....	tr/5	.....	.....	.....	0.1/1/25
<i>Poa</i> species.....	.....	.....	.....	.....	.....	3.2/40	.....	.....	0.4/5/12
<i>Stipa comata</i>	2.1/25	2.3/30	0.4/15	0.8/5	1.9/5	0.2/15	.....	.....	1.0/12/75
<i>Stipa viridula</i>.....	.....	.....	.....	.....	3.5/15	.....	.....	.....	0.4/2/12
Total Grasses.....	27.9/100	25.0/100	26.3/100	20.0/100	24.0/100	26.3/100	26.4/100	29.7/100	25.7/100/100
Forbs:									
<i>Achillea millefolium</i>	0.2/5	.....	.....	1.6/15	1.0/25	1.4/45	.....	.....	0.5/11/50
<i>Artemisia dracunculus</i>.....	.....	0.8/5	tr/5	.....	.....	.....	1.0/10	.....	0.2/3/38
<i>Artemisia frigida</i>.....	.....	5.0/25	0.1/20	2.7/25	.....	0.1/10	0.6/35	.....	1.1/14/63
<i>Artemisia ludoviciana</i>	0.2/5	.....	.....	.....	.....	.....	.....	.....	tr/1/12
<i>Erigeron</i> species.....	.....	.....	.....	.....	.....	.....	tr/5	.....	tr/1/12
<i>Gaura coccinea</i>.....	.....	.....	.....	.....	tr/5	.....	.....	tr/5	tr/1/25
<i>Gutierrezia sarothrae</i>	1.2/20	5.2/45	3.7/70	5.8/30	.....	1.6/10	0.7/20	12.7/75	3.9/34/88
<i>Opuntia polyacantha</i>	tr/5	.....	.....	.....	.....	.....	.....	.....	tr/1/12
<i>Phlox hoodii</i>	1.5/25	4.9/40	1.5/65	9.4/70	0.8/5	0.8/5	0.4/10	0.9/60	2.5/35/100
<i>Sphaeralcea coccinea</i>	0.9/30	0.2/5	0.1/10	2.2/80	1.4/35	1.3/20	0.4/40	.....	0.8/28/88

(Continued)

^{1,2,3,4}See footnotes at end of table.

Table VII (Continued)

Species	Macroplot Number								Average
	2	7	9	14	17	18	20	22	
Forbs (Continued):									
<i>Taraxacum officinale</i>.....	.....	0.2/5	.....	.....	.....	0.2/10	.....	.....	0.1/2/25
<i>Tragopogon dubius</i>.....	.....	.....	.....	.....	.....	.....	tr/5	.....	tr/1/12
Unknown forbs.....	<u>tr/5</u>	<u>0.5/15</u>	<u>0.1/10</u>	<u>0.5/15</u>	<u>.....</u>	<u>0.2/5</u>	<u>.....</u>	<u>tr/5</u>	<u>0.2/7/75</u>
Total Forbs.....	3.6/60	12.7/75	7.1/95	16.3/100	3.6/50	4.9/60	3.9/80	12.3/85	8.1/76/100
Shrubs:									
<i>Artemisia cana</i>	7.2/25	0.8/10	2.9/20	1.9/5	12.3/45	22.4/55	.....	2.7/10	6.3/21/88
<i>Artemisia tridentata</i>.....	.....	.....	.....	.....	2.7/10	.....	.....	.....	0.3/1/12
<i>Rhus trilobata</i>	<u>.....</u>	<u>0.8/5</u>	<u>.....</u>	<u>.....</u>	<u>.....</u>	<u>.....</u>	<u>.....</u>	<u>.....</u>	<u>0.1/1/12</u>
Total Shrubs.....	7.2/25	1.6/15	2.9/20	1.9/10	13.1/50	22.4/55	.....	2.7/10	6.5/23/88

¹Canopy coverage (percent of area covered).²Frequency (percent occurrence among plots).³Constancy (percent occurrence among sites).⁴Trace = a value less than 0.05 percent.

TABLE VIII

CANOPY COVERAGE, FREQUENCY, AND CONSTANCY FOR THREE SKUNKBUSH
GRASSLAND (213) SITES ON WESTERN ENERGY
COMPANY'S MINING AREA B-EAST

Species	Macroplot Number			Average
	6	11	19	
Grasses:				
<i>Agropyron smithii</i>	¹ tr/25	tr/5	.....	tr/3/ ³ 67
<i>Agropyron spicatum</i>	⁴ 2.5/25	10.0/80	.....	4.2/35/67
<i>Bouteloua curtipendula</i>.....	.....	0.2/5	.....	0.1/2/33
<i>Bouteloua gracilis</i>	2.7/60	.....	4.2/35	2.3/32/67
<i>Bromus japonicus</i>	0.1/10	.....	.....	tr/3/33
<i>Bromus tectorum</i>	0.1/10	.....	0.6/85	0.2/32/67
<i>Calamovilfa longifolia</i>	0.2/5	.....	7.4/30	2.5/12/67
<i>Carex filifolia</i>	22.0/95	.....	4.9/40	9.0/45/67
<i>Koeleria cristata</i>.....	.....	.....	0.3/20	0.1/7/33
<i>Schizachyrium scoparium</i>	0.1/10	.....	tr/5	tr/5/67
<i>Stipa comata</i>	2.0/75	.....	18.1/65	6.7/47/67
<i>Stipa viridula</i>.....	.....	0.8/5	.....	0.3/2/33
Total Grasses.....	39.8/100	10.8/80	43.9/100	31.5/93/100
Forbs:				
<i>Artemisia dracunculus</i>	1.3/20	0.8/5	3.2/25	1.8/17/100
<i>Artemisia frigida</i>	0.8/10	tr/5	.....	0.3/5/67
<i>Cirsium undulatum</i>.....	.....	tr/5	.....	tr/2/33
<i>Cryptantha bradburiana</i>.....	.....	tr/5	.....	tr/2/33
<i>Echinaceae pallida</i>	tr/5	.....	.....	tr/2/33
<i>Eriogonum multiceps</i>.....	.....	1.6/10	.....	0.5/3/33
<i>Gutierrezia sarothrae</i>.....	.....	0.4/10	.....	0.1/3/33
<i>Heterotheca villosa</i>.....	.....	.....	0.2/5	0.1/2/33
<i>Linum rigidum</i>.....	.....	.....	tr/5	tr/2/33
<i>Lithospermum incisum</i>.....	.....	.....	0.2/5	0.1/2/33
<i>Lygodesmia juncea</i>.....	.....	.....	0.2/5	0.1/2/33
<i>Opuntia polyacantha</i>.....	.....	.....	0.8/5	0.3/2/33
<i>Ratibida columnifera</i>.....	.....	0.2/5	.....	0.1/2/33
<i>Solidago missouriensis</i>.....	.....	tr/5	.....	tr/2/33
<i>Sphaeralcea coccinea</i>.....	.....	0.1/10	.....	tr/3/33
<i>Taraxacum officinale</i>	tr/5	.....	.....	tr/2/33
<i>Yucca glauca</i>.....	.....	.....	5.1/10	1.7/3/33
Unknown forbs.....	tr/5	tr/5	0.1/15	tr/8/100
Total Forbs.....	2.2/45	4.5/45	9.1/50	5.3/47/100
Shrubs:				
<i>Artemisia cana</i>	3.8/25	3.2/5	.....	2.3/10/67
<i>Rhus trilobata</i>	6.4/20	11.7/35	17.7/20	11.9/25/100
Total Shrubs.....	10.7/40	14.9/35	17.7/20	14.4/32/100

¹Trace = a value less than 0.05 percent.

²Frequency (percent occurrence among plots).

³Constancy (percent occurrence among sites).

⁴Canopy coverage (percent of area covered).

TABLE IX
CANOPY COVERAGE, FREQUENCY, AND CONSTANCY FOR THREE GUMBO
KNOB (214) SITES ON WESTERN ENERGY
COMPANY'S MINING AREA B-EAST

Species	Macroplot Number			Average
	3	12	23	
Grasses:				
<i>Agropyron smithii</i>	¹ 2.1/25	0.8/5	2.1/25	1.7/18/ ³ 100
<i>Agropyron spicatum</i>	8.5/60	8.0/60	7.1/50	7.9/57/100
<i>Aristida longiseta</i>	0.2/5	1.0/10	.....	0.4/5/67
<i>Bouteloua curtipendula</i>.....	.....	.....	6.6/35	2.2/12/33
<i>Bouteloua gracilis</i>	1.6/10	0.8/5	0.2/5	0.9/7/100
<i>Bromus japonicus</i>	0.2/10	.....	.....	0.1/3/33
<i>Calamovilfa longifolia</i>	2.6/25	.....	.....	0.9/8/33
<i>Carex eleocharis</i>	1.5/25	.....	.....	0.5/8/33
<i>Carex filifolia</i>.....	.....	2.3/15	.....	0.8/5/33
<i>Koeleria cristata</i>	0.2/5	.....	1.0/15	0.4/7/67
<i>Schizachyrium scoparium</i>	1.8/20	.....	.....	0.6/7/33
<i>Stipa comata</i>	1.1/15	1.7/15	0.2/5	1.0/12/100
Total Grasses.....	22.4/90	13.2/70	20.6/100	18.7/87/100
Forbs:				
<i>Achillea millefolium</i>	0.3/20	.....	.....	0.1/7/33
<i>Artemisia dracuncululus</i>	0.8/5	.....	.....	0.3/2/33
<i>Artemisia frigida</i>	⁴ tr/5	.....	0.2/5	0.1/3/67
<i>Artemisia ludoviciana</i>	1.1/15	0.2/5	.....	0.4/7/67
<i>Astragalus species</i>	0.2/5	.....	.....	0.1/2/33
<i>Echinaceae pallida</i>	0.2/5	.....	0.1/10	0.1/5/67
<i>Eriogonum multiceps</i>	tr/5	6.0/40	.....	2.0/15/67
<i>Gaura coccinea</i>.....	.....	.....	0.4/20	0.1/7/33
<i>Gutierrezia sarothrae</i>	0.4/20	4.2/50	1.0/10	1.9/27/100
<i>Grindelia squarrosa</i>.....	.....	.....	tr/5	tr/2/33
<i>Heterotheca villosa</i>	1.1/15	.....	.....	0.4/5/33
Legume species.....	.....	0.8/5	.....	0.3/2/33
<i>Lithospermum incisum</i>.....	.....	.....	0.2/5	0.1/2/33
<i>Petalostemon purpureum</i>.....	.....	0.2/5	.....	0.1/2/33
<i>Phlox hoodii</i>	0.7/25	4.8/50	2.6/45	2.7/40/100
<i>Psoralea argophylla</i>.....	.....	.....	0.2/5	0.1/2/33
<i>Solidago missouriensis</i>.....	.....	.....	tr/5	tr/2/33
<i>Yucca glauca</i>.....	.....	.....	3.2/5	1.1/2/33
Unknown forbs.....	0.6/20	1.1/30	0.2/5	0.6/18/100
Total Forbs.....	8.2/65	12.7/90	7.3/80	9.4/78/100

(Continued)

^{1,2,3,4}See footnotes at end of table.

Table IX (Continued)

Species	Macroplot Number			Average
	3	12	23	
Shrubs:				
<i>Artemisia cana</i>.....	.....	.....	tr/5	tr/2/33
<i>Artemisia tridentata</i>.....	.....	.....	8.2/45	2.7/15/33
<i>Oenothera serrulata</i>	2.2/50	0.2/5	.....	0.8/18/67
<i>Rhus trilobata</i>	7.0/15	5.1/10	.....	4.0/8/67
<i>Rosa arkansana</i>	0.2/5	.....	.....	0.1/2/33
<i>Symphoricarpos alba</i>.....	.....	0.2/5	.....	0.1/2/33
Total Shrubs.....	10.7/65	5.4/20	8.2/50	8.1/45/100

¹Canopy coverage (percent of area covered).

²Frequency (percent occurrence among plots).

³Constancy (percent occurrence among sites).

⁴Trace = a value less than 0.05 percent.

TABLE X

CANOPY COVERAGE, FREQUENCY, AND CONSTANCY FOR TWO PONDEROSA
PINE GRASSLAND (351) SITES ON WESTERN ENERGY
COMPANY'S MINING AREA B-EAST

Species	Macroplot Number		Average
	25	28	
Grasses:			
<i>Agropyron smithii</i>	¹ tr/25	³ 3.8/45	1.9/25/ ⁴ 100
<i>Agropyron spicatum</i>	5.5/80	9.2/60	7.4/70/100
<i>Aristida longiseta</i>	2.1/10	1.9/5	2.0/8/100
<i>Bouteloua curtipendula</i>	1.7/15	2.7/25	2.2/20/100
<i>Calamagrostis montanensis</i>.....	.....	0.2/5	0.1/3/50
<i>Carex eleocharis</i>.....	.....	0.2/10	0.1/5/50
<i>Carex filifolia</i>.....	.....	0.4/10	0.2/5/50
<i>Koeleria cristata</i>.....	.....	1.0/10	0.5/5/50
<i>Stipa comata</i>.....	.....	0.8/5	0.4/3/50
<i>Stipa viridula</i>	<u>0.8/5</u>	<u>1.7/15</u>	<u>1.3/10/100</u>
Total Grasses.....	12.3/90	26.7/100	19.5/95/100
Forbs:			
<i>Achillea millefolium</i>	1.1/30	0.8/35	1.0/33/100
<i>Artemisia dracuncululus</i>	1.6/10	0.2/5	0.9/8/100
<i>Artemisia frigida</i>.....	.....	2.0/35	1.0/18/50
<i>Artemisia ludoviciana</i>	3.3/25	0.4/10	1.9/18/100
<i>Balsamorhiza sagittata</i>	tr/5	1.0/10	0.5/8/100
<i>Echinaceae pallida</i>.....	.....	0.1/10	0.1/5/50
<i>Gaura coccinea</i>.....	.....	0.4/20	0.2/10/50
<i>Gutierrezia sarothrae</i>.....	.....	0.2/5	0.1/3/50
<i>Phlox hoodii</i>.....	.....	0.1/15	0.1/8/50
<i>Ratibida columnifera</i>.....	.....	0.1/5	0.1/3/50
<i>Sphaeralcea coccinea</i>	tr/5	0.3/20	0.2/13/100
<i>Vicia americana</i>	tr/5	.....	tr/3/50
Unknown forbs.....	<u>tr/5</u>	<u>0.2/15</u>	<u>0.1/10/100</u>
Total Forbs.....	5.9/65	5.7/95	5.8/80/100
Shrubs:			
<i>Artemisia cana</i>.....	.....	3.2/55	1.6/28/50
<i>Juniperus horizontalis</i>	1.9/5	.....	1.0/3/50
<i>Rhus trilobata</i>	6.9/45	10.6/15	8.8/30/100
<i>Symphoricarpos alba</i>	<u>tr/5</u>	<u>2.9/30</u>	<u>1.5/18/100</u>
Total Shrubs.....	7.1/45	18.0/70	12.6/58/100

¹Trace = a value less than 0.05 percent.

²Frequency (percent occurrence among plots).

³Canopy coverage (percent of area covered).

⁴Constancy (percent occurrence among sites).

LITERATURE CITED

- Daubenmire, R. F. 1959. *A Canopy Coverage Method of Vegetational Analysis*. Northwest Science 3(1):43-64.
- ECON INC. 1975. *Vegetation Communities, Mining Area B* (Vegetation Map). Progress report Western Energy Company.
- Lyon, T. L. and H. D. Buckman. 1948. *The Nature and Properties of Soils - A College Text of Edaphology*. The McMillan Co., NYC. 499 pp.
- Snedecor, G. W. and W. G. Cochran. 1967. *Statistical Methods*. 6th ed. Iowa State Univ. Press, Ames. 593 pp.
- USDA, Soil Conservation Service (SCS). 1976. *Methods of Determining Production and Composition*. Range Handbook, Section 604.

A P P E N D I X

APPENDIX

PARTIAL PLANT LIST FOR WESTERN ENERGY COMPANY'S MINING AREA B-EAST - COLSTRIP, MONTANA

Scientific Name	Common Name	111	211	212	213	214	351
Grasses:							
<i>Agropyron smithii</i>	Western wheatgrass	X	X	X	X	X	X
<i>Agropyron spicatum</i>	Bluebunch wheatgrass	X	X	X	X	X	X
<i>Agropyron species</i>	Wheatgrass			X			
<i>Andropogon hallii</i>	Sand bluestem	X					
<i>Aristida longiseta</i>	Red three-awn	X		X		X	X
<i>Bouteloua curtipendula</i>	Sideoats grama	X			X	X	
<i>Bouteloua gracilis</i>	Blue grama	X	X	X	X	X	X
<i>Bromus japonicus</i>	Japanese chess	X		X	X	X	
<i>Bromus tectorum</i>	Cheatgrass	X		X	X		
<i>Calamagrostis montanensis</i>	Plains reedgrass	X		X			X
<i>Calamovilfa longifolia</i>	Prairie sandreed	X			X	X	
<i>Carex eleocharis</i>	Needleleaf sedge	X				X	X
<i>Carex filifolia</i>	Threadleaf sedge	X	X	X	X	X	X
<i>Koeleria cristata</i>	Prairie junegrass	X	X	X	X	X	X
<i>Poa compressa</i>	Canada bluegrass			X			
<i>Poa sandbergii</i>	Sandberg bluegrass	X					
<i>Poa species</i>	Bluegrass			X			
<i>Schizachyrium scoparium</i>	Little bluestem	X			X	X	
<i>Stipa comata</i>	Needle-and-thread	X	X	X	X	X	X
<i>Stipa viridula</i>	Green needlegrass	X	X	X	X		X
<i>Vulpia octoflora</i>	Six weeks fescue	X					
Forbs:							
<i>Achillea millefolium</i>	Common yarrow	X	X	X		X	X
<i>Antennaria neglecta</i>	Field pussytoes	X					
<i>Antennaria species</i>	Pussytoes	X					
<i>Arabis species</i>	Rock cress	X					
<i>Artemisia dracuncululus</i>	False tarragon sagewort	X		X	X	X	X
<i>Artemisia frigida</i>	Fringed sagewort	X	X	X	X	X	X
<i>Artemisia ludoviciana</i>	Cudweed sagewort	X		X		X	X
<i>Asclepias pumila</i>	Plains milkweed	X					
<i>Astragalus species</i>	Milkvetch	X	X			X	
<i>Balsamorhiza sagittata</i>	Arrowleaf balsamroot						X
<i>Cirsium undulatum</i>	Wavyleaf thistle	X	X		X		
<i>Convolvulus arvensis</i>	Field bindweed	X					
<i>Cryptantha bradburiana</i>	Miners candle				X		
<i>Echinaceae pallida</i>	Black sampson		X		X	X	X
<i>Erigeron species</i>	Fleabane			X			
<i>Eriogonum multiceps</i>	Eriogonum	X			X	X	
<i>Gaura coccinea</i>	Scarlet gaura	X	X	X		X	X
<i>Grindelia squarrosa</i>	Curlycup gumweed		X			X	
<i>Gutierrezia sarothrae</i>	Broom snakeweed	X	X	X	X	X	X

Appendix (Continued)

Scientific Name	Common Name	111	211	212	213	214	351
Forbs (Continued):							
<i>Heterotheca villosa</i>	Hairy golden aster	X			X	X	
<i>Lactuca pulchella</i>	Blue lettuce	X					
Legume species	Unidentified legume					X	
<i>Linum rigidum</i>	Stiffstem flax				X		
<i>Lithospermum incisum</i>	Narrowleaf gromwell	X			X	X	
<i>Lygodesmia juncea</i>	Rush skeleton weed	X	X		X		
<i>Opuntia polyacantha</i>	Plains pricklypear	X		X	X		
<i>Petalostemon purpureum</i>	Purple prairie-clover					X	
<i>Phlox hoodii</i>	Hood's phlox	X	X	X		X	X
<i>Plantago patagonica</i>	Wooly plantain	X	X				
<i>Psoralea argophylla</i>	Silverleaf scurfpea		X			X	
<i>Ratibida columnifera</i>	Prairie coneflower				X		X
<i>Salsola kali</i>	Russian thistle	X					
<i>Solidago missouriensis</i>	Missouri goldenrod				X	X	
<i>Sphaeralcea coccinea</i>	Scarlet globemallow	X	X	X	X		X
<i>Taraxacum officinale</i>	Dandelion	X		X	X		
<i>Tragopogon dubius</i>	Common salsify	X	X	X			
<i>Vicia americana</i>	American vetch						X
<i>Yucca glauca</i>	Soap-weed	X	X		X	X	
Shrubs:							
<i>Artemisia cana</i>	Silver sagebrush	X	X	X	X	X	X
<i>Artemisia tridentata</i>	Big sagebrush		X	X		X	
<i>Juniperus horizontalis</i>	Creeping juniper						X
<i>Oenothera serrulata</i>	Shrubby evening primrose	X	X			X	
<i>Rhus trilobata</i>	Prairie rose	X				X	
<i>Rosa arkansana</i>	Skunkbush sumac	X	X	X	X	X	X
<i>Symphoricarpos alba</i>	Common snowberry					X	X