Classification and Ordination of 1997 Forest Understory Data

Boulder City Open Space
Forest Ecosystem Study
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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

TABLE PACKET

Classification and Ordination of 1997 Forest Understory Data

Summary

Boulder City Open Space Department collected 123 vegetation cover samples in the understory of the Ponderosa pine (Pinus ponderosa) foothill forests. Numerical analysis routines were used to classify the samples and construct a graphic ordination based on floristic similarity and environmental correlation.

Four subassociations of the Pinus ponderosa/Carex sp. association were defined. Pinus ponderosa, Carex sp. and a suite of about nine additional species were found to be widely distributed, and typify the association as a whole. Four subassociations (Groups A, B, D, E) appear to represent a complex gradient of grazing impacts superimposed on the well known ecotonal gradient from prairie grasslands to lower montane forests. A fifth group (Group C) appears to be composed of stands that are successional to three (Groups A, D, E) of the four primary groups.

The areas of more significant grazing impacts (Groups A, C, and D) typically have a significant cover of Poa compressa. The samples with the highest cover of Arnica fulgens (Group A) also had high cover of Poa compressa and lower cover of the tall and mid-grass prairie species. Group D had the higher cover of Andropogon gerardii, Hesperostipa comata, and Psoralidium tenuifolium and is probably representative of areas that have had longer to recover from grazing impacts. Grazing impacts include those that resulted from the last 150 years of European immigration, but may also include the less certain grazing impacts of Native American horses and Bison. Groups A, C, and D are part of the grassland/lower montane ecotone and represent a range of successional stages. The largest number of samples (63) were assigned to Group E and typically had higher cover of Danthonia spicata associated with some combination of Harbouria trachypleura, Ceanothus fendleri, Pseudotsuga menziesii and Mahonia repens. This group typifies the lower montane forest community of the study area.

Group B was composed of only three samples that occurred on a northwest exposure with high cover of Elymus lanceolatus and Leymus ambiguus, with an indicator of Oxytropis sericea. This could be an area that is both more mesic than the other samples from the lower montane forest subassociation (Group D), and has a history of more limited grazing. Alternatively, the uncertain identification of Elymus lanceolatus (possibly Pseudoroegneria spicata) may be a remnant of a relatively recent introduction that has propagated successfully at this mesic site. The wide distribution of Poa compressa is an example of how introduced species may naturalize and appear to be native. Poa agassizensis/Poa pratensis is an even better example of species with uncertain morphological distinctions that may confuse the native/introduced nature of some stands. Some efforts to investigate the true character of this subassociation should be made prior to management decisions.

Because virtually all of the sampled areas have received relatively recent (<150 years) disturbances, successional change is anticipated in all sampled stands. Areas that are more stable typically have a greater proportion of native perennial species, and are sometimes less "diverse" than successional stands. Management of some areas to achieve successional stability may result in a reduction of understory diversity. The diversity inherent in this ecotonal zone of the grassland and forest is expressed between and among plant associations rather than within plant associations.

Observations of site conditions during field review of the results of this study indicate that forestry management practices of the recent past (i.e. Project Greenslope) have introduced non-native species that may be difficult to remove. Management that seeks to modify forest overstory conditions should consider the negative impacts to the forest understory and adjacent grassland communities.

Introduction

The City of Boulder Open Space Department collected forest canopy and forest understory data from the Open Space Foothills in 1996 and 1997. The purpose of the forest understory study was defined as follows: "The main goals of the Understory Inventory are (1) to describe the composition and structure of the forest vegetation, (2) to form a picture of the current condition of forested open space lands, and (3) to provide baseline data for future management and monitoring projects."

The forest stands studied in this project form the lower treeline transition zone between mountain forests and prairie grassland vegetation communities. This transition zone includes the Grassland-Lower Montane Ecotone, and the Lower Montane Forest Climax regions described by Marr (1961). This component of the forest ecosystem study examines the associations of species that tend to occur together in the understory of these foothill forests, as well as the relationships that these associations have with selected environmental and disturbance characteristics associated with the sample sites. Once these plant associations are defined, the samples can be grouped (i.e. classified) based on their species composition and their resulting affiliation with the plant associations. The relationships of species, sample sites, environmental, and disturbance factors are presented in a single graphic or series of overlays. This is accomplished using a numerical analysis routine that takes into account the characteristic of species to be normally distributed in response to limiting or excessive environmental factors. This approach allows the large amount of data to be reduced to a more comprehensible level, without oversimplifying the complexity of the ecosystem. This information can be used to summarize the composition of the sampled stands, to understand the environmental position of the understory associations, and to evaluate the environmental, financial, and social costs and benefits of management options.

Methods

Data collection

Overstory data:

The overstory canopy cover data were not analyzed in this report, but some of the environmental data that were used for analysis of the understory data were collected by the overstory data collection team. This methodology is partially described here. The overstory method of canopy collection is also briefly described to allow an understanding of the incompatibility of the overstory data and the understory data. For a complete description of overstory and understory methods, refer to the City of Boulder (COB) Forest Inventory Handbook (COB 1988).

Cover

The forest overstory data were collected using a hand held densitometer. This optical device allows a sample point to be projected into the forest canopy, in approximately the same manner as the Cover-Point optical device. Four to ten sample points were collected at each $1/10^{th}$ acre plot. The overstory sample points were collected at the perimeter of the plot, but the 200 understory sample points were collected within the plot. The two sampling zones could easily be very different vegetation cover types. For example, if a clump of trees occur in the center of a plot surrounded by grassland, the understory will be associated with high overstory cover, but the overstory sample would indicate low overstory cover.

Slope

A clinometer is used to measure the plot slope. Greater detail on the use of a clinometer for slope measurements can be found in Appendix E of the Forest Inventory Handbook. Record percent slope.

Aspect

Direction which slope faces at plot center. (Example: N, NE, E, SE, S, SW, W, or NW). Enter 0 for plots with 0 slope.

Duff/Litter Depth

Enter the average depth of humus and fresh organic debris from four readings. Using a stiff ruler, push the end into the duff gently until it stops, and then observe depth. One measurement is typically taken at plot center and three more at the $1/100^{th}$ acre boundary in even thirds around the circle. Record depth to the nearest 0.1 inch.

Major Disturbances

The following disturbance categories were available only as a binary (True-False) data type for this study. Future studies may be able to use the subdivisions within each disturbance type when they become available. The underlined acronym is the acronym used in the ordination graphs.

BURN **burn scenarios (fire)**
- BB broadcast slash burn - planned ignition
- WS wildfire in slash
- DP dozer pile and burn
- UB understory burn
- WN wildfire - natural fuels
- PI prescribed burn - planned ignition
- UI prescribed burn - unplanned ignition natural fuels
- OB other burning

GRAZ **grazing systems**
- SL season long grazing system
- DR deferred rotation grazing system
- RR rest rotation grazing system
- DG deferred grazing system
- HN holistic management grazing system
- OC other cattle grazing system
- OS other domestic sheep grazing system

HARV **harvest methods**
- CC clearcut
- FW firewood harvest
- GS group selection cut
- HE heavy equipment disturbance not associated with one of the coded activities
- IS individual selection cut
- OR overstory removal
- PP post and pole harvest
- SK skid trail
- SN sanitation cut
- ST seed tree
- SV salvage cut
- SW shelterwood
- OH other timber harvest

INSECT **insect infestations**
- AP aphids
- MP mountain pine beetle (bark beetles)
- SP spruce budworm (defoliators)
- WE weevil
- OI other insect infestation

RECR **recreation activities**
- FI fishing
- HI hiking trails
- CA camping
- PI picnicking
- OR other recreation activity

REGE **regeneration activities**
- BR bareroot planting
- CS containerized stock planting
- FA fertilizer application
- FE fencing
- GS grass seeding
- HA herbicide application
- PA pesticide application
- PB poison baiting
- SC scarification
- SH shade cards
- SP scalping
- OG other regeneration activity

TIMB **timber stand improvements**
- CT commercial thinning
- PC precommercial thinning
- PR pruning
- WS weed species removal

WEAT **weather conditions**
- BD blow down
- DR drought damage
- FD frost damage
- FL flood damage
- IC ice
- SC soil creep
- SN snow
- SS sun scald
- WD winter desiccation

WILD **wildlife activities**
- AR antler rubs
- BR browsing
- BU burrows
- DN denning
- NE nesting
- RO rodents
- BB black bear
- BV beaver
- CA cattle
- CO coyote
- DE deer
- DO dog
- EL elk
- GS ground squirrel
- HO horse
- MG mountain goat
- NM mountain lion
- PD prairie dog
- PG pocket gopher
- PM pine marten
- PQ porcupine
- RA rabbit
- RT raptor
- TS tree squirrel
- UB upland birds

NA **not applicable**

OT **other event type**

Understory data

As detailed in the Overstory Methods, within each forest stand every first and fifth plot, and each multiple of five thereafter, was permanently monumented. The understory vegetation was sampled on all permanently monumented plots, with the exception of plots in areas that were either too steep or too densely forested. Alternative methods were used in these areas as discussed below.

Plot Orientation: A compass reading was taken from the permanent marker at the center point of the plot with the observer facing uphill

Plot Layout: Measure 10 meters at a 90 degree angle from the plot orientation on each side of the center point and then flag these points, establishing the central transect. From each end of the central transect, measure 10 meters upslope and 10 meters downslope to mark the 20-meter boundary lines. Flag each 20-meter line at 4.5, and 9.0, and 10 meters from the central transect for a total of five 20-meter transects and two boundary lines (Figure 1). The plot area was 20 meters by 20 meters (400 square meters) or approximately one-tenth of an acre. This plot corresponded almost exactly to the area of the Overstory plot except that it was square instead of round.

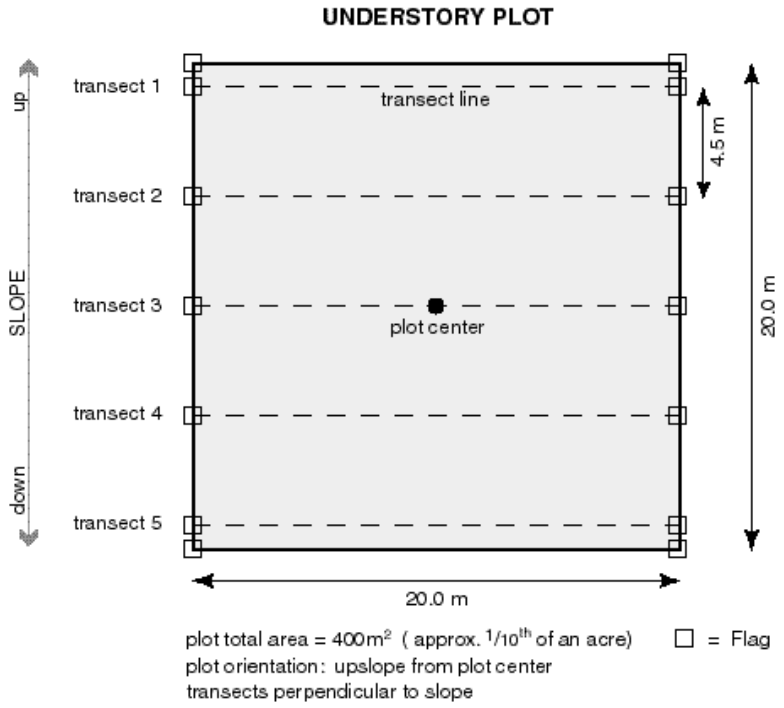

Figure 1. Plot Layout

The following cover categories were used for data collection:

Nonvegetation ground cover types

Litter: Plant litter on the ground.
Bare Ground: Indicates bare soil.
Gravel: Rock fragments less than one inch in diameter that form a ground cover.

Rock: Individual rocks (over one inch in diameter) or boulders.
Trail: Entered when plot includes a segment of trail (including designated trails, undesignated trails, wildlife trails, etc.)

Vegetation cover types

Plant species name (genus and species): Record when known.
Plant genus name: Record when genus is known but species is unknown (e.g., Carex sp.).
Unknown species: Record when species cannot be identified in the field. These species are collected and described during the vegetation inventory of the plot, as noted above.

Vegetation and Ground Cover Sampling

A Cover-point Optical Point Projection Device mounted on a sturdy tripod was used to project a point using cross hairs in an eyepiece. (See diagram of the optical device below and instructions for use in Field Inventory Manual) This vertical point was projected down on to the vegetation or ground cover on both sides of the transect line, at a distance of 0.5 m from the line. The points were taken on the sides of the transect line to avoid the vegetation that was lightly trampled during the transect installation. One sample point was taken on each side of the transect line at each meter, for a total of two points at each meter, and a total of 200 points for the five 20-meter transect lines. Percent cover for each species or ground cover component was calculated as number of hits divided by 2. Although the point-intercept method is an efficient way to collect accurate and precise data for the dominant species, the rarer species are likely to be missed by the method. This is compensated by listing all of the species present in the 20m X 20m plot. This allows the biodiversity qualities of species density / diversity / evenness to be evaluated on the basis of number of species per 400 sq.m. with abundance values for the dominant species.

The adjustable mirror on the cover-point device can be used alternately in upward and downward positions in order to sample both the canopy cover of overstory plants and the cover of the understory. When canopy cover data is collected with the cover-point device, the Plot Data form should include a column for collecting canopy cover data. Canopy cover was not measured by this method during the 1997 baseline inventory, since the overstory inventory methods include a measurement for canopy cover. A recommendation to include the simultaneous collection of canopy cover with understory cover is found in the discussion.

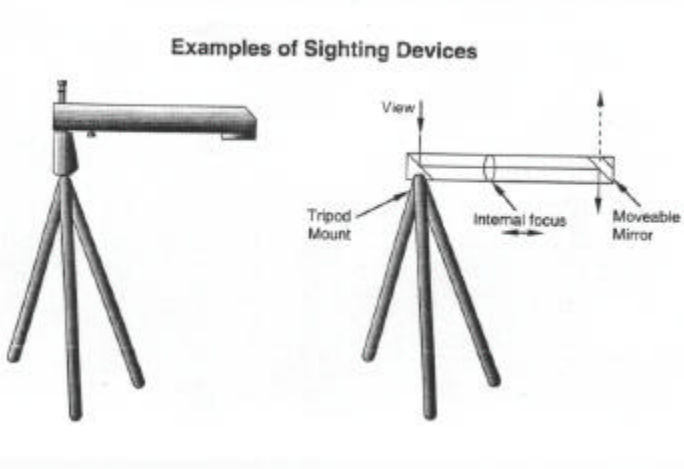

Figure 2. Cover-Point optical point projection device.

Classification

The vegetation cover data were classified using the TWINSPAN (Hill, 1979) divisive classification program with the strict convergence criteria of Oksanen & Minchin (1997). This program defines groups of samples based on the similarity of their species composition, and simultaneously groups the species that tend to occur together.

Certain settings must be entered for TWINSPAN to perform the classification. These settings are described in the following section.

Cover classes and pseudospecies

Because TWINSPAN was originally designed to be used for Presence-Absence (i.e. frequency) data rather than quantitative (i.e. abundance) data, the use of "Pseudospecies" was incorporated into the computer program. The concept of pseudospecies allows greater weight to be given to higher quantitative values. The first setting of TWINSPAN for pseudospecies requires that the cover classes (i.e. cut levels) be defined. TWINSPAN allows a maximum of nine cut levels. In this study the cut levels were defined as 0.0, 0.02, 1.0, 5.0, 10.0, 20.0, 30.0, 40.0, 60.0. The first cut level included all species cover values that were greater than zero, cut level two included all values that were greater than 0.02%, cut level three included all values greater than 1.0%, etc. The 0.02 cut level was used to distinguish those species that were present, but were not tallied as a hit by the cover sample. All of these "present" species were given a value of 0.01. Most species had cover values less than 30%. A species that was present (SPEX) in the plot but not "hit" would be assigned one pseudospecies (i.e. SPEX1). A species with a cover value of 12% would be assigned five pseudospecies (i.e. SPEX1, SPEX2, SPEX3, SPEX4, SPEX5) because it could be found to occur within five of the nine possible cover classes. If the cover classes are not equal in size to each other, there is a *de facto* weighting of the data. For example the species with 12% cover would occur in five out of nine possible classes, so its weighted cover would be 56% (i.e. 5/9). The net effect is to positively weight the lower cover values and negatively weight the higher cover values. This can be compensated by the weighting option of the TWINSPAN program. For this study the weights given to each class were respectively; 1, 10, 40, 50, 100, 100, 100, 200, 400. For example, the species with 12% cover would be given a weight of 100 that would be multiplied by 56 = 5,600. The maximum weighted value for a species with 100% cover would be 40,000. The net weighting for the 12% species is 5,600/40,000 = 14%. The final result is that the cover classes are "unweighted", and more representative of the true cover values.

Numerical Analysis Iterations

Numerous iterations of the understory classification were performed before a satisfactory grouping of the samples and species was achieved. The three main iterations were:

1. Understory with ground cover (i.e. litter, bare soil, …) and overstory :
The overstory species were combined with the understory data as separate species. For example, Pinus ponderosa in the overstory, and P. ponderosa in the understory were given separate codes. The ground cover categories were also included as species. This was found to be unsatisfactory because the overstory data tended to dominate the classification because of their higher cover values, and they were not always correlated with the understory. The fact that the overstory data were collected on the perimeter of the plot rather than internally could have influenced this discrepancy.

2. Understory with ground cover but without overstory:
The overstory species were excluded from the data. This classification was superior to the first classification with overstory, but was also found to be unsatisfactory. This was due to the fact that ground cover values were dominating the groupings due to the relatively low understory vegetation cover.

3. Understory without ground cover and without overstory:
The understory data were treated separately. As a further refinement of the classification, the data were "weighted/unweighted". The previous two classifications were conducted with the lower cover values "weighted" by the cut levels. Once the overwhelming influences of the canopy and ground cover were removed, the groupings of the understory vegetation were found to be satisfactory.

The TWINSPAN results were used to define the plant associations and the affiliation of the samples to the associations. This was presented in a dendrogram that includes those selected environmental factors that were most closely associated with each division. The determination of these environmental factors was accomplished using DISCRIM (ter Braak 1982).

Ordination

Since the understory data by itself provided the only satisfactory classification, the ordination was run using only the understory data. The samples were ordinated using CANOCO Version 3.15 (ter Braak 1997) which incorporates the strict convergence criteria of Oksanen & Minchin (1997). The ordinations of samples, species, and environmental vectors were produced separately for different combinations of two axes, as well as a simulated three-dimensional scatter plot. The associations as defined by the TWINSPAN classification were also represented with distinct symbols, to show the distribution of the groups in the ordination. The species that were found to distinguish the classification groups were also presented in separate attribute plots. The attribute plots show the actual cover values of the selected species for each sample. The cover values are represented by symbols with a diameter that is proportional to the cover value. The symbols have shapes that are associated with classification groups, and are centered on the location of the sample in the ordination. It is then possible to get a realistic idea of the distribution of cover values for each species with respect to the plant associations and the environmental factors.

Results & Discussion:

Data Tables

The understory data are presented in Appendix 13 as summary tables that include the original cover data, average and relative cover for each species and growth form, total cover for each sample, and number of species for each sample. The site data are presented in Appendix 12.

Classification

The TWINSPAN classification is presented in Figure 3 and defined five groups based on species composition. These five groups can be reduced to four associations that are relatively easy to distinguish in the field. The species listed at the top of Figure 3 commonly occurred in all groups, and were non-discriminatory. If the plant "association" were to be defined by the dominants or codomminants, 87 percent (107/123) of the samples could be included in the Pinus ponderosa / Carex sp. Association. The term "association" in this study is used to describe the understory groupings. There has been considerable complexity and confusion regarding definition of the terms "community", "association", and divisions above and below the level of association (Shimwell 1972). Although the term association is used for the understory groups, it is understood that all of the defined groups, including samples that are successional, are plant subassociations of the Pinus ponderosa/Carex sp. Association. Alternative vegetation-community taxonomic nomenclature is acknowledged, but no effort is made to select or create a definitive nomenclature. The 16 samples (13 percent of the 123 samples) that did not have Carex sp. present were also evenly distributed among the different groups, and no pattern was observed. The following list shows the percentage importance value, constancy, and average cover values for the top 21 species based on 123 samples. The importance value for P. ponderosa does not include the overstory.

	Percentage Importance	Constancy	Average Cover %
☛**Carex spp.**	100.00	86.99	2.85
Danthonia spicata pinetorum	84.53	52.03	3.07
☛**Pinus ponderosa scopulorum**	79.98	99.19	1.37
Poa compressa	75.95	70.73	2.02
Andropogon gerardii	68.53	60.98	1.91
Poa agassizensis	66.34	73.17	1.42
☛**Artemisia ludoviciana**	62.51	88.62	0.73
☛**Penstemon virens**	55.65	80.49	0.60
☛**Achillea lanulosa**	53.03	82.11	0.41
Rhus aromatica trilobata	50.06	54.47	1.09
☛**Ribes cereum**	45.58	74.80	0.22
Grindelia squarrosa/G. subalpina	45.47	73.98	0.24
☛**Opuntia macrorhiza**	44.56	74.80	0.16
Mahonia repens	44.54	48.78	0.96
Ambrosia psilostachya coronopifolia	41.42	57.72	0.52
☛**Drymocallis fissa**	41.28	67.48	0.21

Padus virginiana melanocarpa	39.90	47.15	0.76
Campanula rotundifolia	39.19	65.04	0.17
Tragopogon dubius major	38.58	67.48	0.06
☛Achnatherum nelsonii	37.88	52.03	0.49
☛Cerastium strictum	36.01	59.35	0.17

☛This symbol marks those species that are evenly distributed among all of the classification groups. The other species showed some degree of preference for specific groups.

Although Danthonia spicata ranks second in importance, it was found to be one of the species that was associated primarily with Group E, and so was not an appropriate species to be used for the highest classification level.

Although five groups were defined by the classification, only four are relatively distinct in the field.

1. Group A was defined by the presence of relatively higher cover of Arnica fulgens (>3%) and Poa compressa (>5%), and the low cover of most of the tall and mid-grass prairie species such as Andropogon gerardii, Schizachyrium scoparium, and Hesperostipa comata. Note: sample ELDE01 was moved from Group E to Group A because the 3% cover of Unknown Forb was probably Arnica fulgens.

   The combination of groups B-C-D from the TWINSPAN classification were centered on Group D. Group C was not easily defined, and was composed of samples that are possibly transitional to groups A, D, or E.

2. Group B was represented by only three samples on a stony, northwest-facing slope in Pinebrook Hills. This association was distinguished by the presence of Oxytropis sericea, and the relatively high cover of Elymus lanceolatus (formerly Agropyron albicans) and Elymus ambiguus. The E. lanceolatus was observed to be only occasionally rhizomatous, which makes it similar to Pseudoroegneria spicata. This taxonomic uncertainty merits resolution in the future.

3. Group D was defined by the presence of the tall and mid-grass prairie species such as Andropogon gerardii and Hesperostipa comata, the low cover or absence of A. fulgens, and the low cover or absence of the indicator species defining Group E.

4. Group E was defined by the low cover of A. fulgens (<1%), the lower cover (<1%) of the tall and mid-grass prairie species, and the presence or relatively higher cover of montane species such as the conifer Pseudotsuga menzesii, the shrub Ceanothus fendleri, the endemic forb Harbouria trachypleura, and especially the grass Danthonia spicata (5% average cover).

These four groups (i.e. A, B, D, E) partially describe the ecotonal transition from foothills grassland to foothill/montane forested communities in Boulder. Group C was possibly representative of successional locations. The distinction of successional and ecotonal associations is defined in this report as a function of stability over time. Successional sites are assumed to be changing from one association to another. Ecotonal sites are assumed to be static in the sense of species composition, however the term "dynamic equilibrium" best describes the processes that occur in an ecotone. The universally disturbed state of most, if not all, sites in the Boulder area is acknowledged, so these terms are made in reference to an arbitrary time scale that is relatively short.

Appendix 1 presents group affiliation of samples sorted by sample ID, and Appendix 2 presents group affiliation of samples sorted by group ID. Appendices 3 through 7 present the species and ground cover categories associated with Groups A, B, C, D, and E, respectively. These species lists are ranked by percentage importance and include the frequency (constancy) and cover value associated with each species. Appendix 9 presents all of the acronyms used for environmental vectors, sites, or species in the tables and figures of this report.

BCOS TWINSPAN RESULTS

☛ This symbol is used to mark the indicator species identified by TWINSPAN
The number of samples in each division is at the top of each column.
Single parenthesis = (xxxxx) = center in a moderately wide distribution
Double parenthesis = ((xxxxx)) = center in a broad distribution
Bracketed parenthesis = [(xxxxx)] = secondary center in moderate distribution

*Symphoricarpos occidentalis and Danthonia spicata in Group C seem to have two nodes of distribution in different groups, this might be an artifact of divisive classification. However Group C may be an ecotone or successionally transitional to A, D, or E based on the following characteristics; Danthonia spicata in group C vs. E is an isolated node of higher cover, and S. occidentalis is found in high frequency in groups A & C, and Andropogon gerardii cover is relatively high in groups D & E.

† This symbol identifies the environmental factors that the DISCRIM program identified as correlated with the TWINSPAN division.

Figure 3. TWINSPAN classification of understory data.

The following table presents the average cover of the indicator species identified by TWINSPAN and includes a matrix that can be used as a key to identify the grouping of a specific site in the field.

Table 1. Key to the Classification Groups

		Percent Average Cover of TWINSPAN Indicator Species.					
			Group ID				
			A	B	C	D	E
Arnica fulgens	>3%	A	**5.22**		P		0.02
Poa compressa	>5%	ACD	**7.35**	0.5	***1.53***	***1.38***	0.32
Hypericum perforatum	>0.5%	AD	**0.59**		P	**0.26**	P
Oxytropis sericea	P	B		**P**			
Elymus lanceolatus	>5%	B		**18.17**	P	0.09	0.03
Leymus ambiguus	>5%	B		**8.17**	0.53		0.13
Hesperostipa comata	>1%	CD	P	P	**0.82**	**1.47**	0.16
Andropogon gerardii	>5%	D	0.61		1.41	**9.29**	0.52
Psoralidium tenuiflorum	>1%	D	0.04		P	**1.26**	0.18
Danthonia spicata	>3%	EC	0.11		**2.56**	0.53	**5.07**
Ceanothus fendleri	>1%	E	0.04		P	P	**0.58**
Harbouria trachypleura	>0.5%	E	P	P	P	P	**0.06**
Pseudotsuga menzesii	>1%	E	0.11		P	P	**0.93**
			Group ID				
			A	B	C	D	E
Arnica fulgens	>=3%	A					
Poa compressa	>=3%	A					
Poa compressa	P	ACD					
Hypericum perforatum	P	AD					
Oxytropis sericea	P	B					
Elymus lanceolatus	>=3%	B					
Leymus ambiguus	>=3%	B					
Hesperostipa comata	P	CD					
Danthonia spicata	P	CE					
Danthonia spicata	>=2%	E					
Andropogon gerardii	>=5%	D					
Psoralidium tenuiflorum	P	DE					
Ceanothus fendleri	P	E					
Harbouria trachypleura	P	E					
Pseudotsuga menzesii	P	E					
	TOTAL						

To use the key, mark a one in each of the open cells for each species cover category that is present. Tally the totals at the bottom of each column. The classification goes to the group with the highest score. Ties are possibly successional or ecotonal samples that should be subjectively assigned based on observable trends of the indicator species. This simple key was tested against the TWINSPAN classification and 83/123 (67%) of the samples were correctly assigned, 24/123 (20%) were in a tie that included the classification group assigned by TWINSPAN, and 16/123 (13%) were assigned to a different group. This key is a coarse first-approximation guide, but should be useful for initial vegetation mapping efforts. Figure 4 shows the ten most important species or ground cover (not including litter) for each of the five groups.

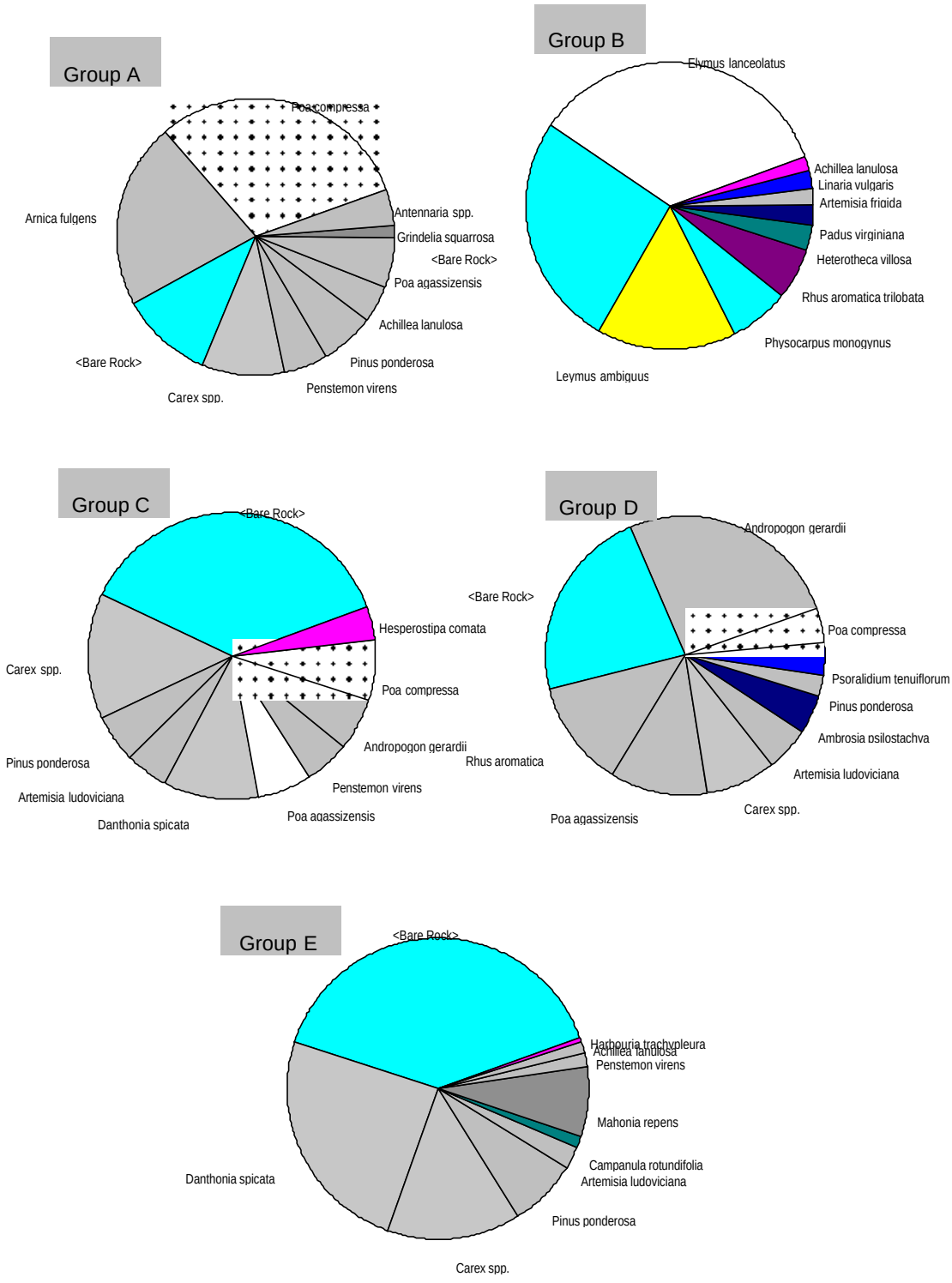

Figure 4. Dominant species of the five groups.

Ordination

The purpose of the ordination graphic is to reduce an extremely complex system to a fewer number of manageable factors. No presumption is made that all of the most important factors are represented. This is a first approximation that should be refined in an iterative process. The cross-tabulated correlation matrix of the ordination axes and environmental factors is presented in Table 2.

These graphics are presented in three sets of four figures. Each set of four figures consists of ordinations of the environmental vectors, the sample sites, indicator species, and many species. The four figures can be superimposed on each other to evaluate how the measured environmental factors were associated with certain sites, or with the centers of distribution for certain species. The position of a sample site in the ordination is determined both by its species composition, and its environmental site factors. The position of a species is determined by its cover distribution among the sites. The position and magnitude of the environmental vector is determined by its ability to maximize its contribution to an explanation of the species and site ordinations. CANOCO provides ordinations with four axes that are typically represented two axes at a time. The three sets of ordinations represent axes 1&2, 1&3, and 2&3, respectively. The fourth axis was found to be redundant and is not presented here.

Each sample site has been assigned a group symbol, that was assigned based on the TWINSPAN classification results, and the perimeter of the group has been defined in the sample site ordinations. The overlap of some of the groups was heavily influenced by the "Grazing" environmental factor. As can be seen from the ordinations, "Grazing" is the most influential factor correlated with species and sample distributions. However, since the "Grazing" factor was measured with a logical (binary) unit (i.e. true/false), some sites that may have had some grazing may have receive an incorrect "False" value. These samples would be grouped with the grazed sites because of species composition (via TWINSPAN), but would be "pushed" away (in the ordination) from the other samples in the group by the strong influence of the assigned "False" value. Although these outliers slightly complicate the interpretation of the ordination, the central areas of the groups are still distinctive.

Two species ordinations are presented with each set to facilitate the interpretation. The first species ordination includes only the thirteen species used in the association key. Eleven of these species were the indicator species defined by TWINSPAN. All of the acronyms used in these figures are defined in Appendix 9.

Table 2. CANOCO Correlation Matrix.

**** Weighted correlation matrix (weight = sample total) ****

SPEC AX1	1.0000												
SPEC AX2	.0433	1.0000											
SPEC AX3	.0531	-.0026	1.0000										
SPEC AX4	-.0012	.0263	-.0039	1.0000									
ENVI AX1	.9097	.0000	.0000	.0000	1.0000								
ENVI AX2	.0000	.8529	.0000	.0000	.0000	1.0000							
ENVI AX3	.0000	.0000	.8756	.0000	.0000	.0000	1.0000						
ENVI AX4	.0000	.0000	.0000	.8090	.0000	.0000	.0000	1.0000					
ELEV	.0899	-.1701	.3691	.2321	.0989	-.1995	.4215	.2868	1.0000				
ASP	-.0818	.2883	.4779	.0218	-.0899	.3380	.5458	.0270	-.0644	1.0000			
SLOPE	.6289	.2483	.0713	.2229	.6913	.2912	.0815	.2755	.2564	.1132	1.0000		
NORTH	-.1870	.2717	.4701	.0039	-.2055	.3186	.5369	.0048	-.0707	.9660	-.0031	1.0000	
EAST	-.3665	-.1870	-.1587	-.0537	-.4029	-.2192	-.1813	-.0663	-.0719	-.2122	-.4688	.0244	1.0000
ROCK	.0241	-.0525	.0035	-.0989	.0265	-.0615	.0040	-.1222	-.1664	.0315	-.1228	.0306	.0677
GRAVEL	.0070	-.0200	-.1750	.0296	.0077	-.0234	-.1998	.0366	-.2014	-.1585	-.0172	-.1642	-.0277
LITTER	.2209	.0854	.3055	-.2639	.2429	.1002	.3489	-.3262	-.0696	.1579	-.0287	.1705	.0772
SOIL	.0164	-.2380	.2542	.0637	.0180	-.2790	.2903	.0787	.1856	-.0525	.0085	-.0635	-.0291
LITDEP	.5336	.0436	.2307	.0116	.5866	.0511	.2635	.0143	.1461	.0388	.3480	-.0334	-.2703
CLAY	-.3316	.1863	-.1131	-.2486	-.3645	.2185	-.1291	-.3073	-.0783	.1755	-.0548	.2297	.1666
SAND	-.1532	-.2344	-.0965	.1635	-.1684	-.2748	-.1102	.2020	-.1490	-.0998	-.1305	-.1374	-.1010
REG	.0391	.0378	-.0269	-.0579	.0430	.0443	-.0308	-.0716	.0075	-.0720	.0232	-.0619	.0148
TIMB	.1862	-.5150	.2762	-.1632	.2047	-.6038	.3155	-.2018	-.1566	-.0080	-.1366	-.0118	.0303
WILD	.0879	.0178	-.2325	.5614	.0966	.0208	-.2655	.6939	.1524	-.1163	.2284	-.1107	.0916
INSEC	-.0243	-.0037	.1697	.1009	-.0267	-.0044	.1938	.1247	.0997	.1074	.0515	.0655	-.2193
REC	.0495	-.1148	.0076	.0130	.0544	-.1346	.0087	.0161	-.1581	-.0452	-.0143	-.0469	-.0150
BURN	.1213	-.3340	.1375	.3405	.1333	-.3916	.1571	.4209	.2722	-.1800	.0298	-.2106	-.1058
HARV	.3048	.4430	-.1395	.2069	.3350	.5194	-.1593	.2557	.0249	.0533	.2690	.0149	-.1991
GRAZ	-.7267	.3617	.3105	.0637	-.7988	.4241	.3547	.0788	.0634	.3092	-.3913	.3872	.1968
	SPEC AX1	SPEC AX2	SPEC AX3	SPEC AX4	ENVI AX1	ENVI AX2	ENVI AX3	ENVI AX4	ELEV	ASP	SLOPE	NORTH	EAST

ROCK	1.0000										
GRAVEL	.1356	1.0000									
LITTER	.1191	.1347	1.0000								
SOIL	-.0231	-.0593	-.0620	1.0000							
LITDEP	.0065	-.0511	.1715	.1340	1.0000						
CLAY	-.1111	-.0015	-.0517	-.0007	-.1568	1.0000					
SAND	.0945	.1183	-.0052	.0294	.0057	-.3155	1.0000				
REG	.0770	-.0028	.0588	-.0101	.0499	-.0022	.0041	1.0000			
TIMB	.1883	.0191	.2087	.2814	.1292	-.1952	.1195	-.0015	1.0000		
WILD	-.1716	-.0225	-.0764	-.1572	.0413	-.0943	-.0279	-.0066	-.2639	1.0000	
INSEC	-.0209	-.0386	-.1679	.2715	-.0637	.0241	.0163	.1060	-.0315	-.1252	1.0000
REC	.2106	-.0181	.0367	.0563	.0072	-.0807	.0913	-.0704	.1800	-.0391	-.0535
BURN	.0398	.0488	-.0292	.0447	.0779	-.2158	.0448	-.0305	.2381	.0579	-.0508
HARV	.1146	-.0141	.1316	-.1205	.1224	-.1489	.1056	.1528	-.2662	.0547	.0627
GRAZ	-.0134	-.1108	-.0155	-.0565	-.3083	.2486	.0061	-.0730	-.3533	-.0806	.0693
	ROCK	GRAVEL	LITTER	SOIL	LITDEP	CLAY	SAND	REG	TIMB	WILD	INSEC

REC	1.0000			
BURN	.0129	1.0000		
HARV	.0105	.0331	1.0000	
GRAZ	-.1041	-.1932	-.0982	1.0000
	REC	BURN	HARV	GRAZ

Degrees of freedom = 123-2 = 121
p .05 =.177
p .01 = .232

Environmental vectors, sample sites, and species figures.

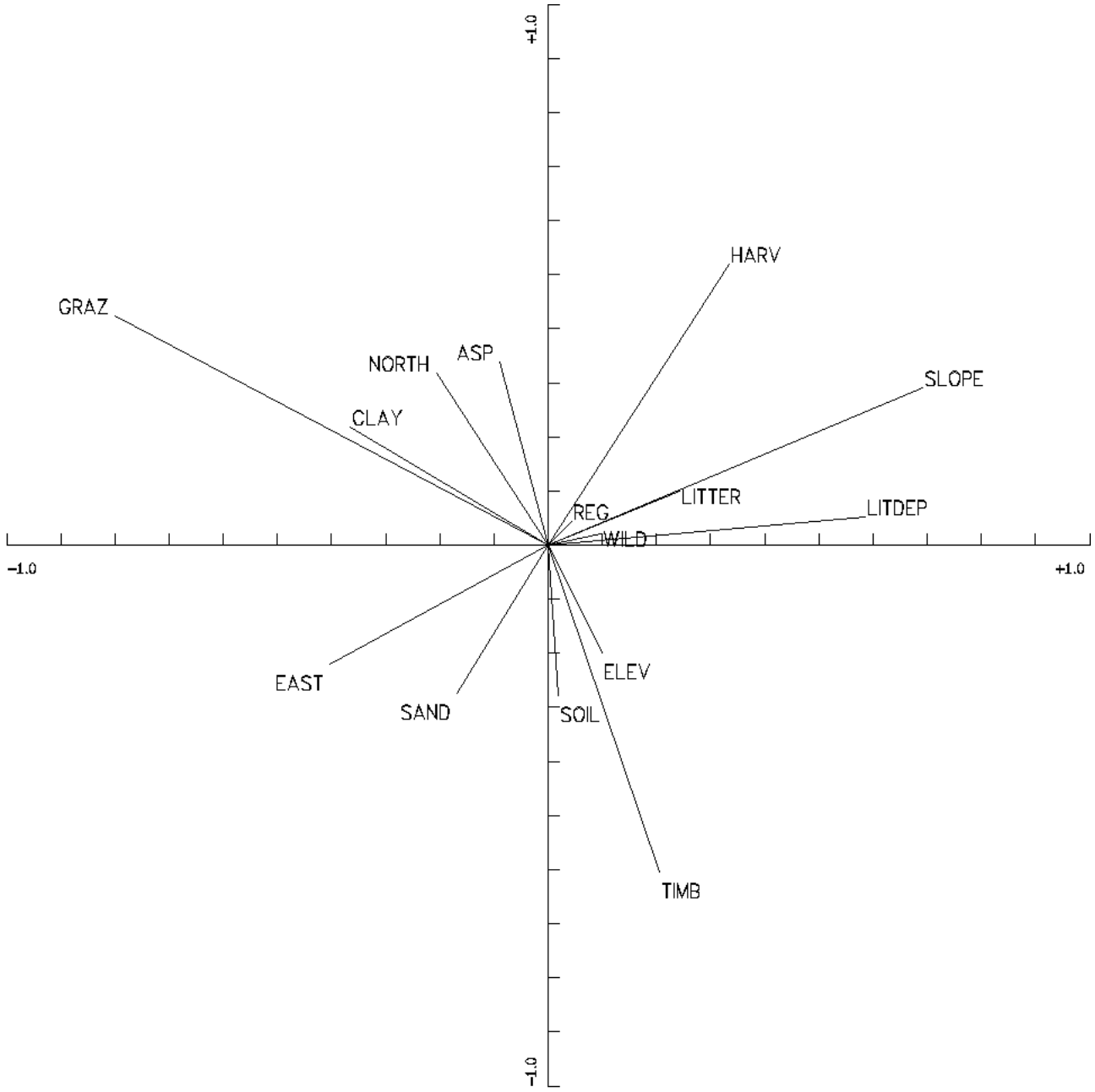

Figure 5. Axes 1-2 Environmental Vectors.

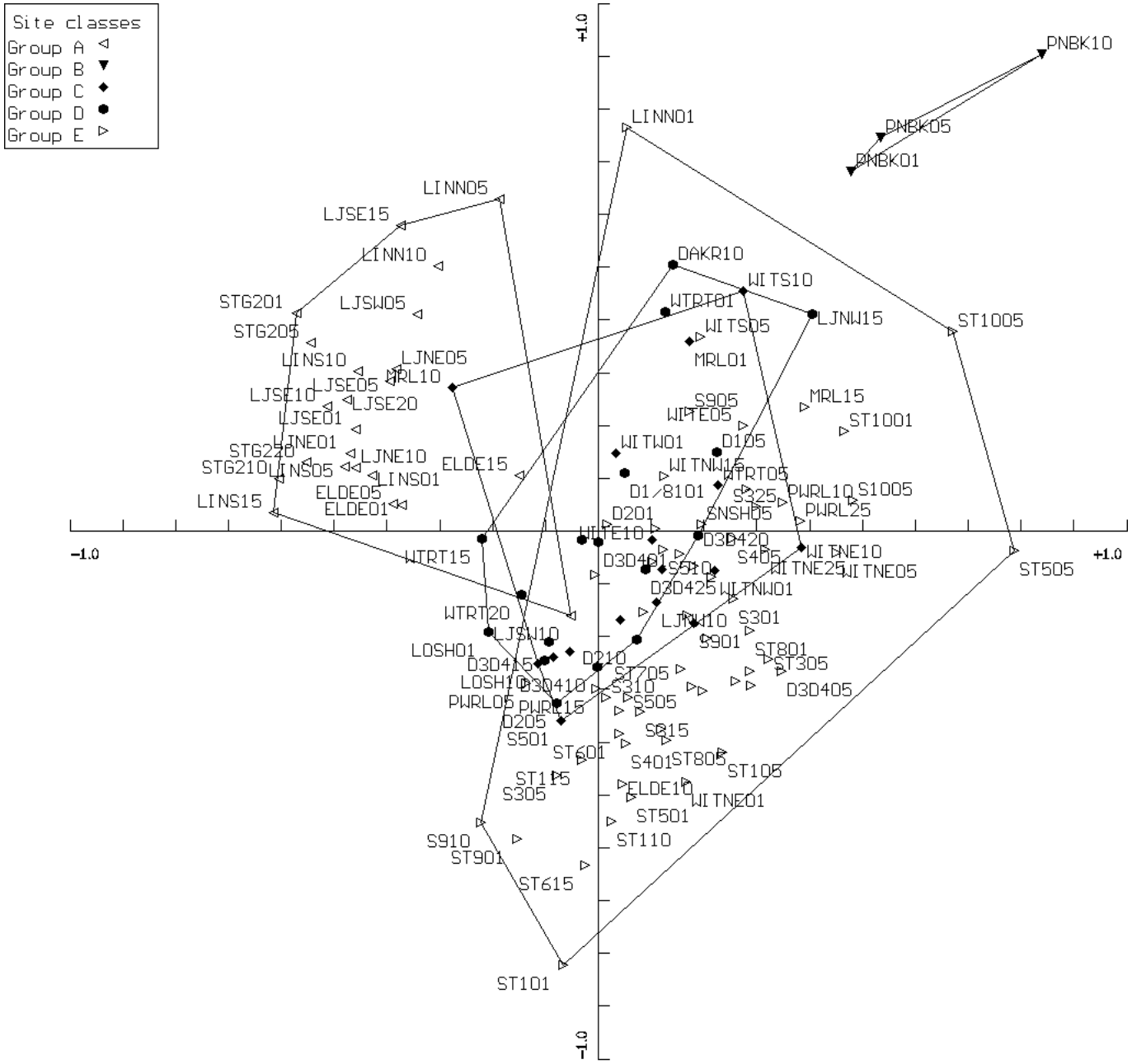

Figure 6. Axes 1-2 Sites.

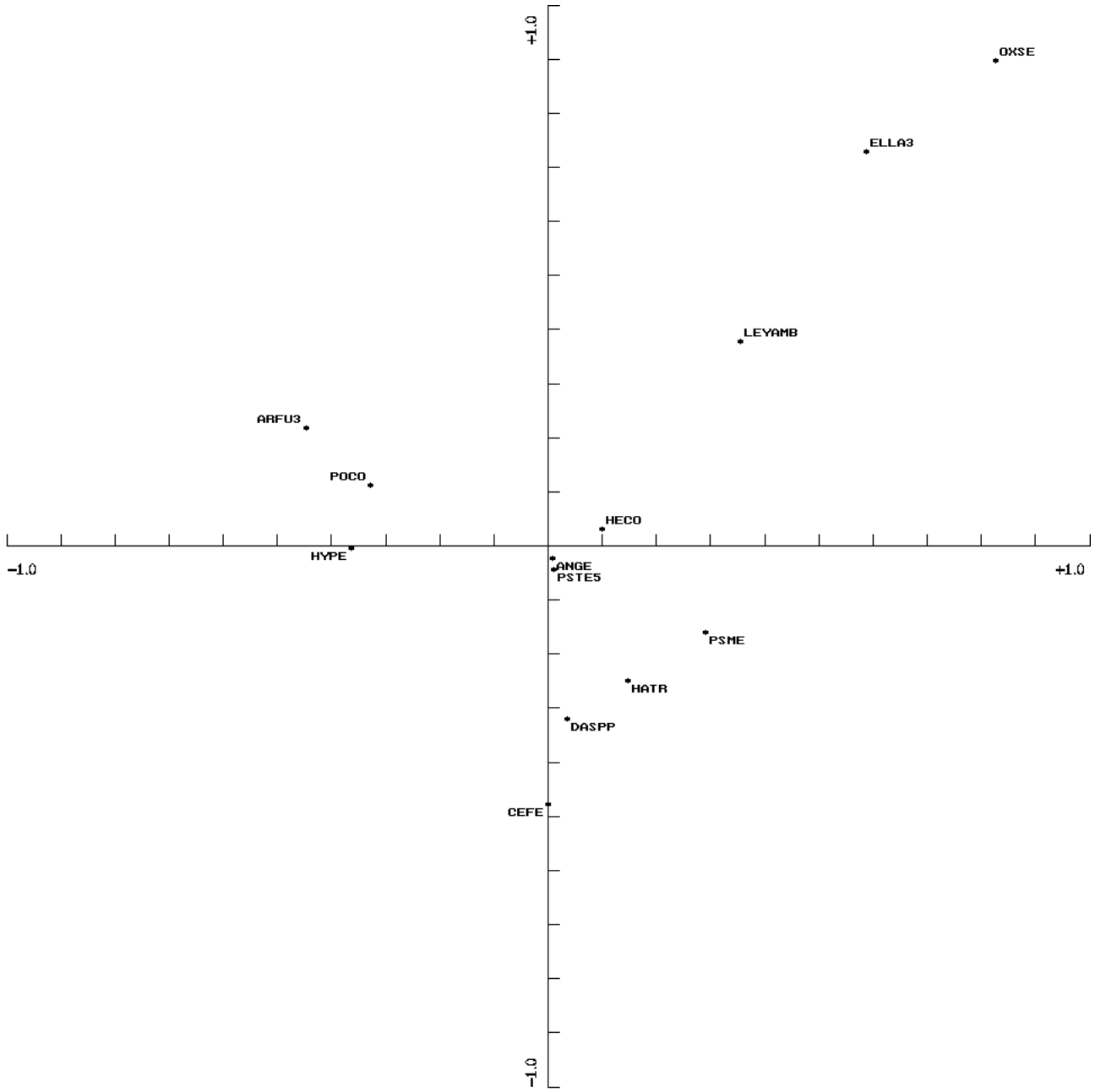

Figure 7. Axes 1-2 Selected Species.

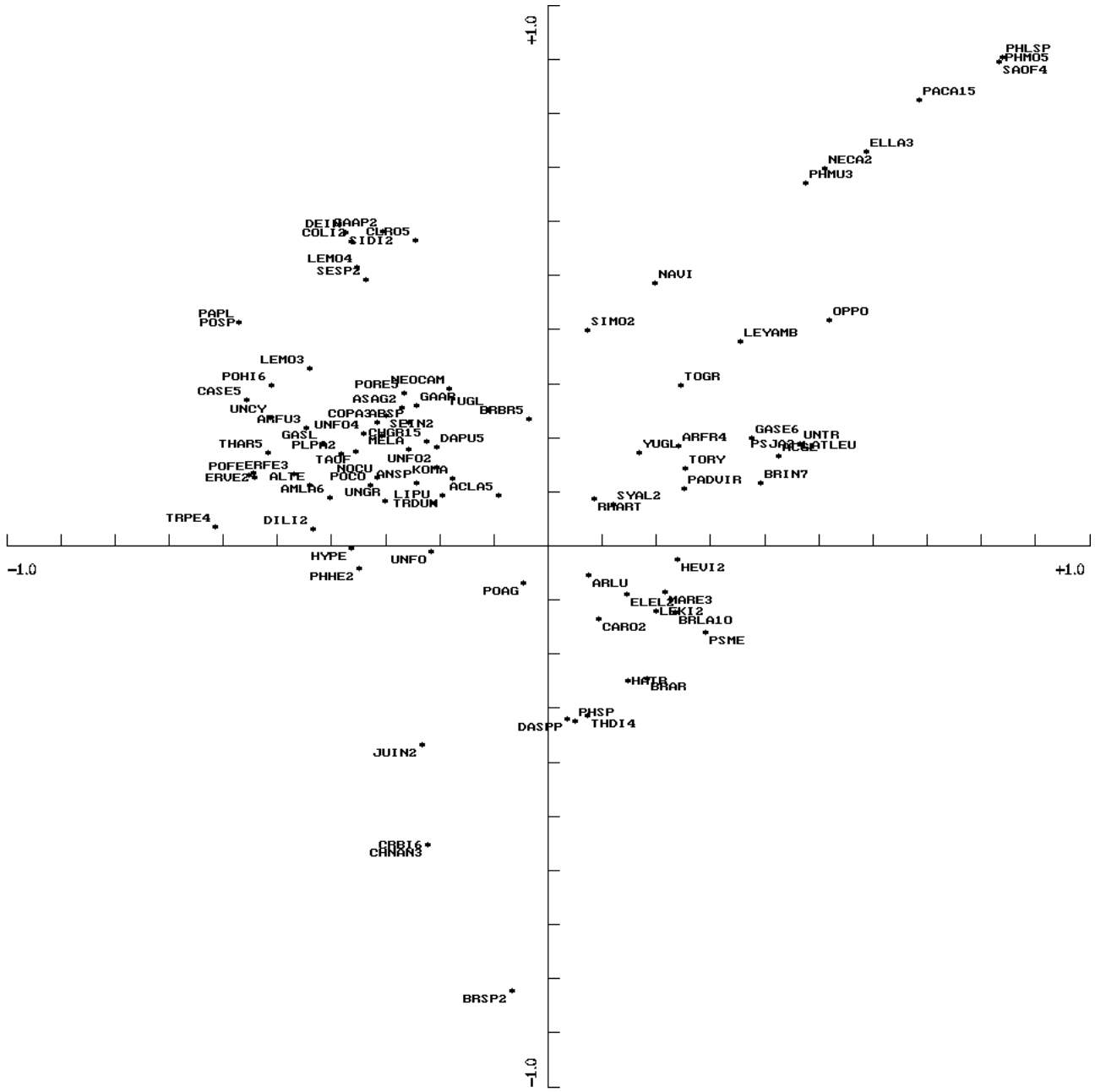

Figure 8. Axes 1-2 Species.

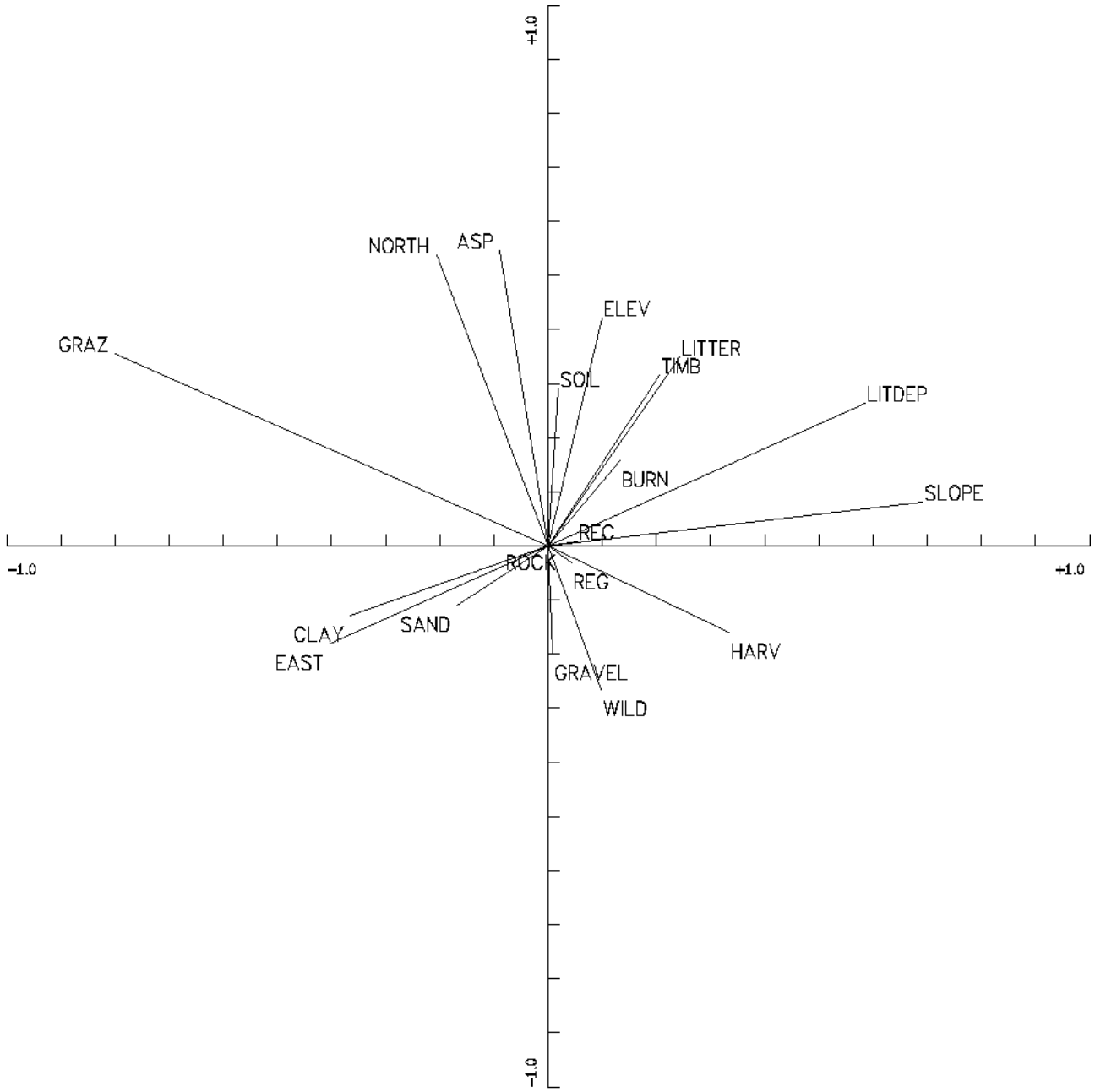

Figure 9. Axes 1-3 Environmental Vectors.

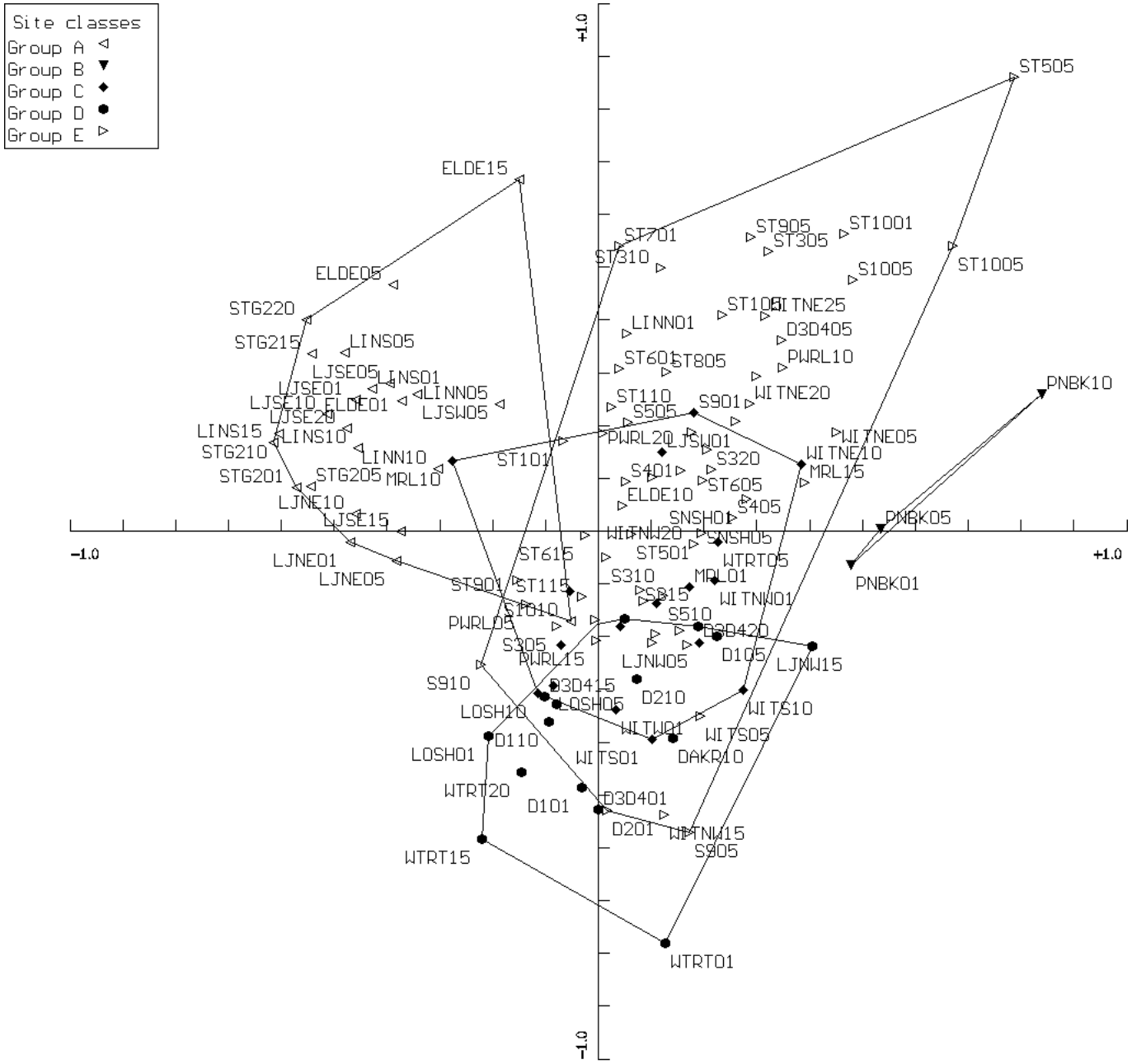

Figure 10. Axes 1-3 Sites.

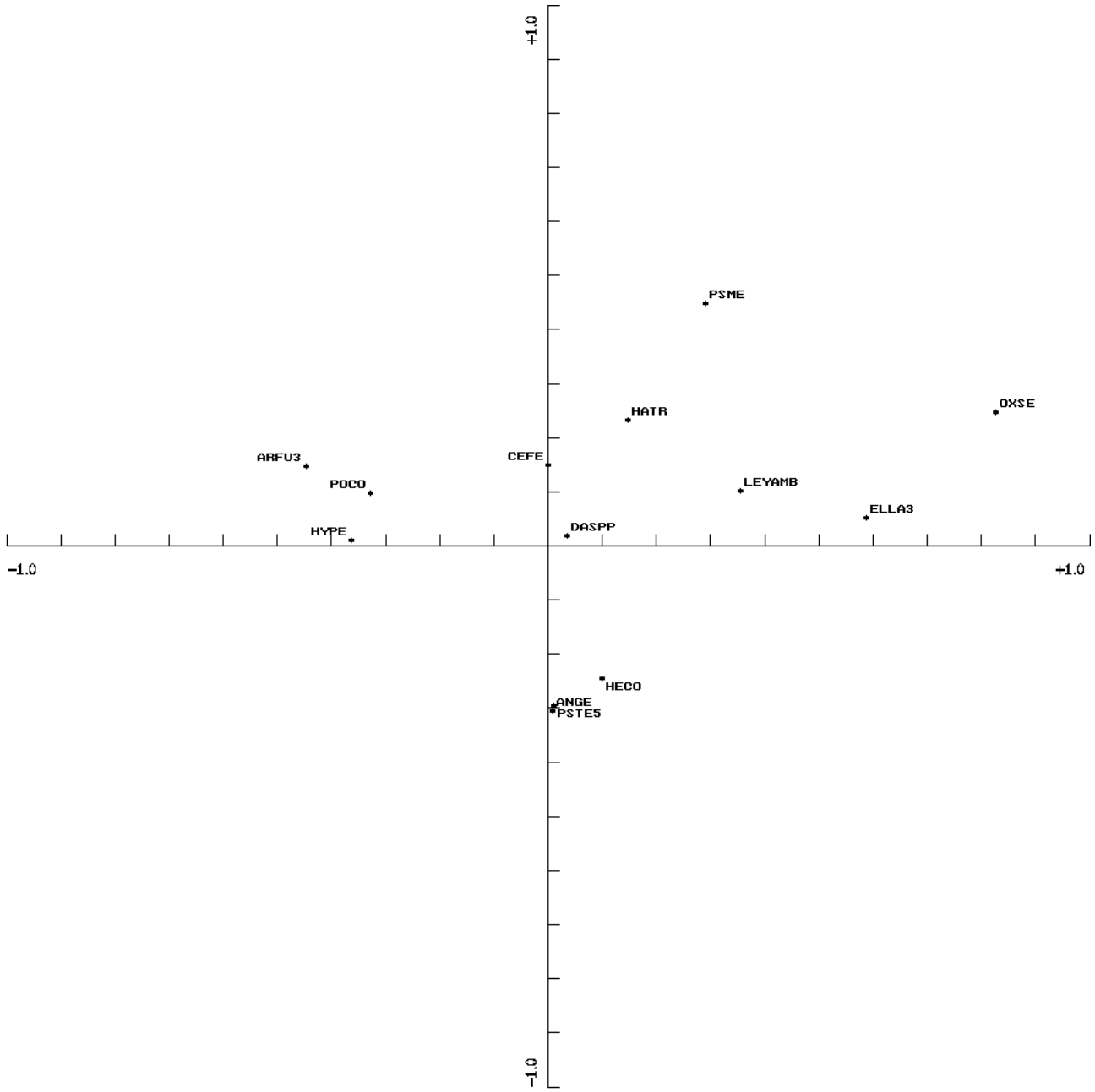

Figure 11. Axes 1-3 Selected Species.

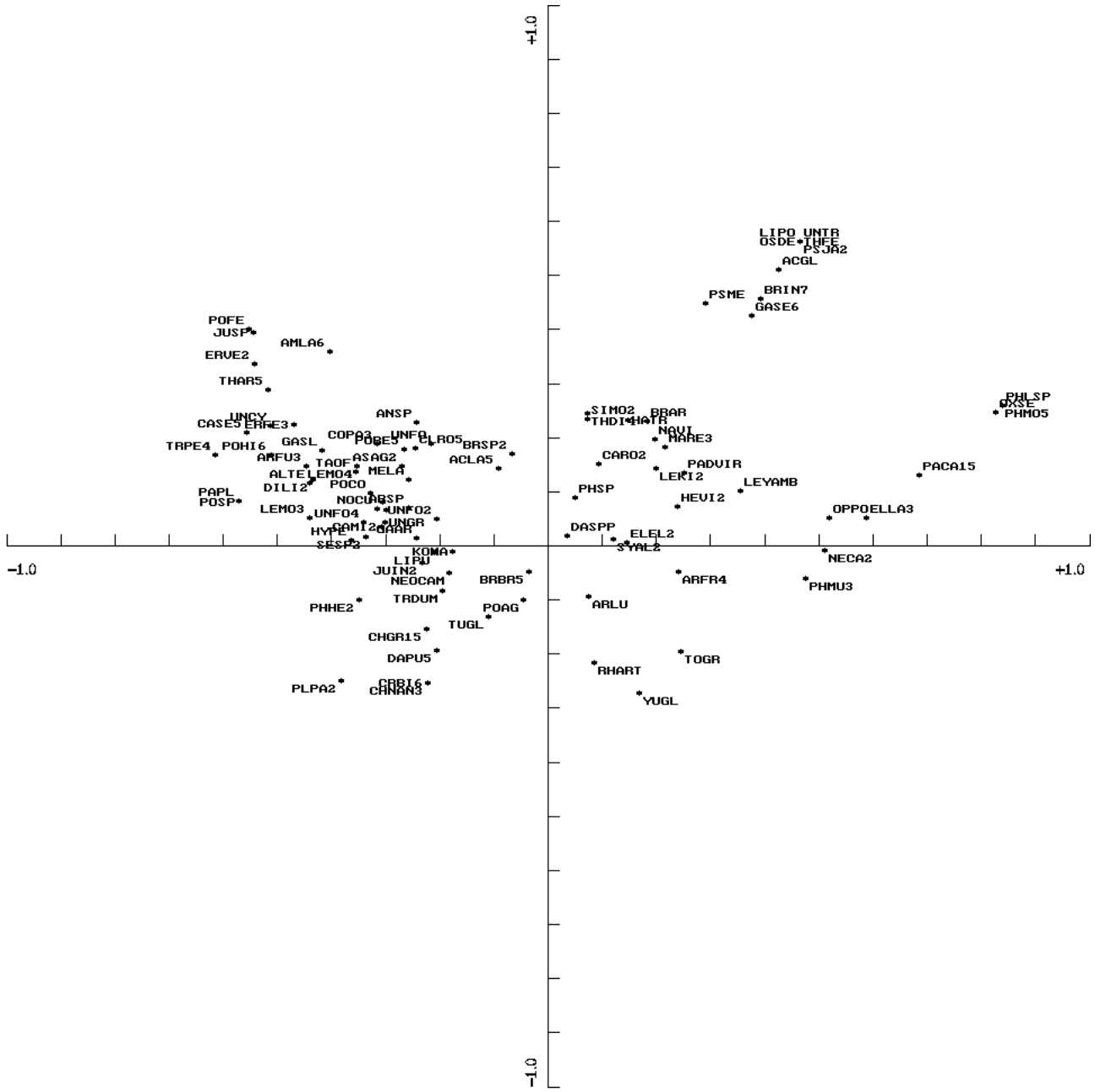

Figure 12. Axes 1-3 Species.

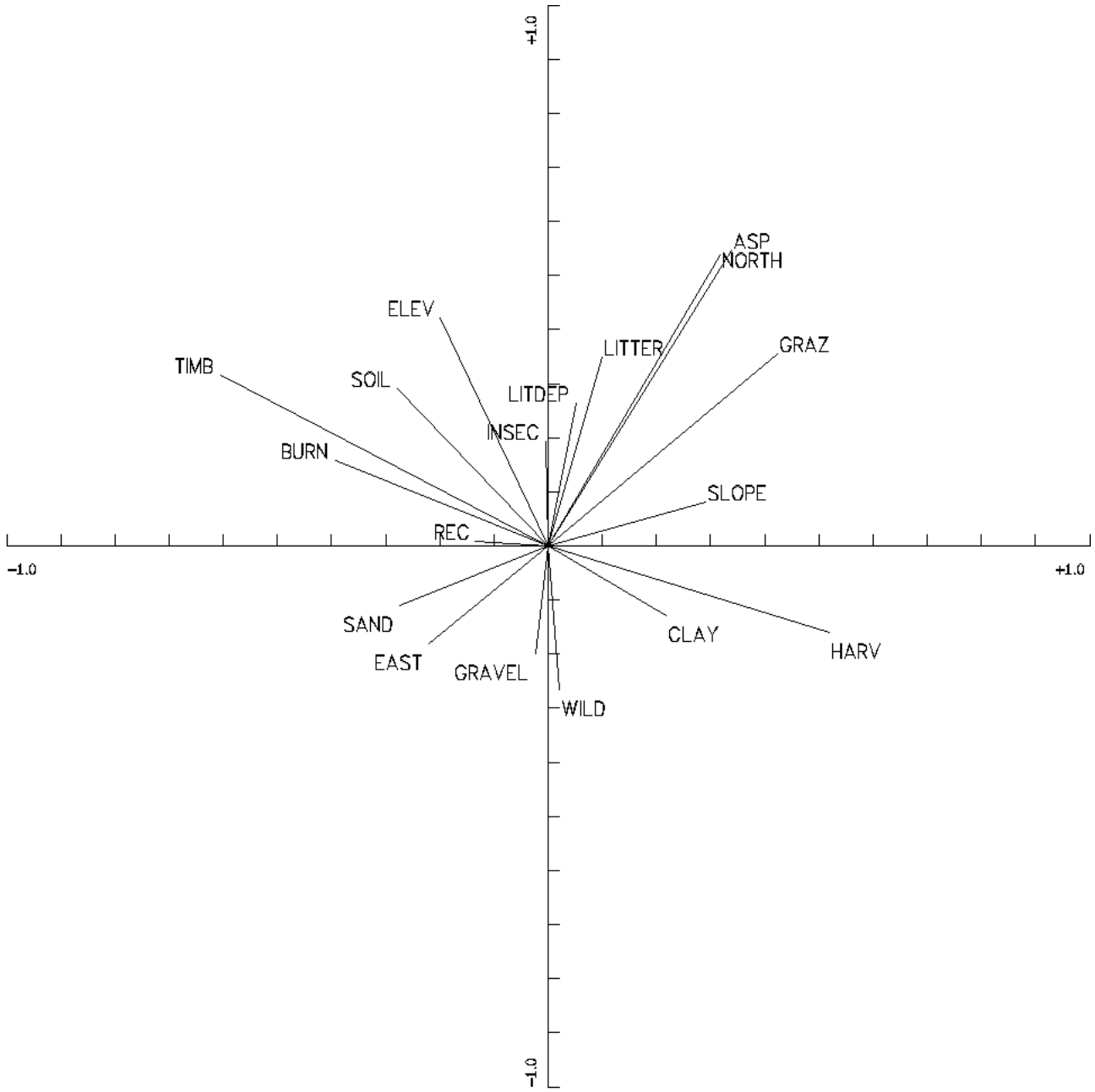

Figure 13. Axes 2-3 Environmental Vectors.

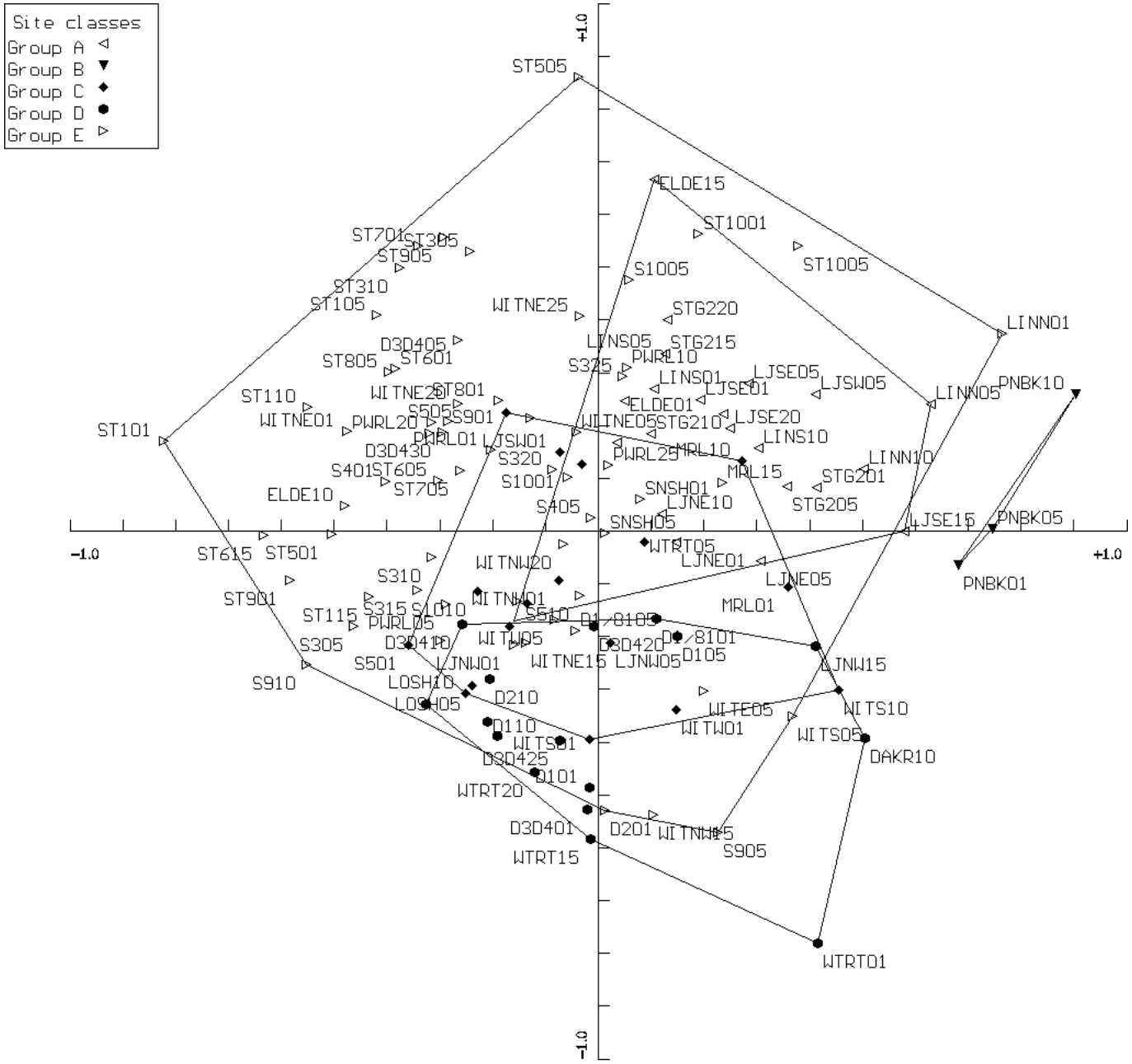

Figure 14. Axes 2-3 Sites.

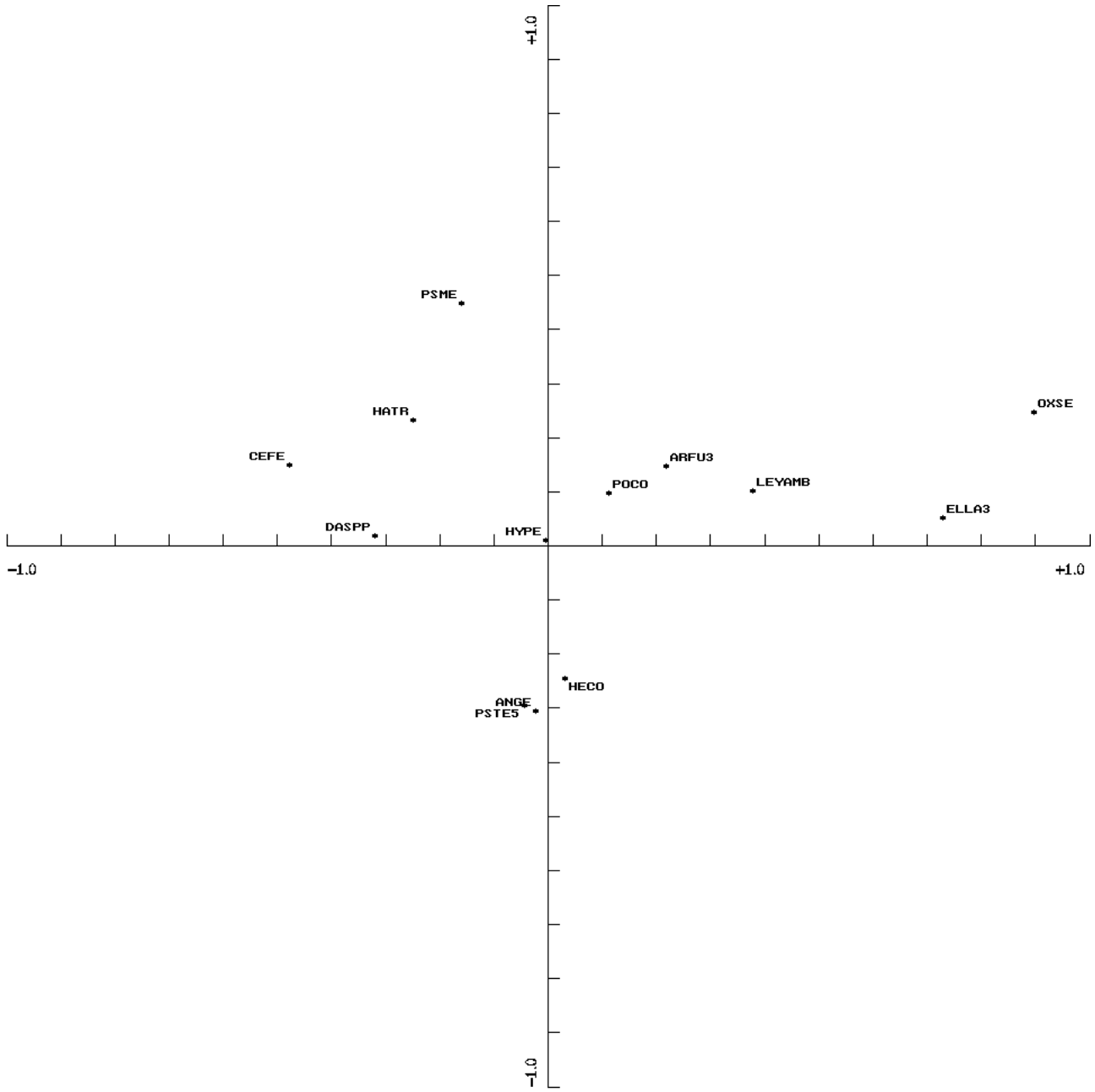

Figure 15. Axes 2-3 Selected Species.

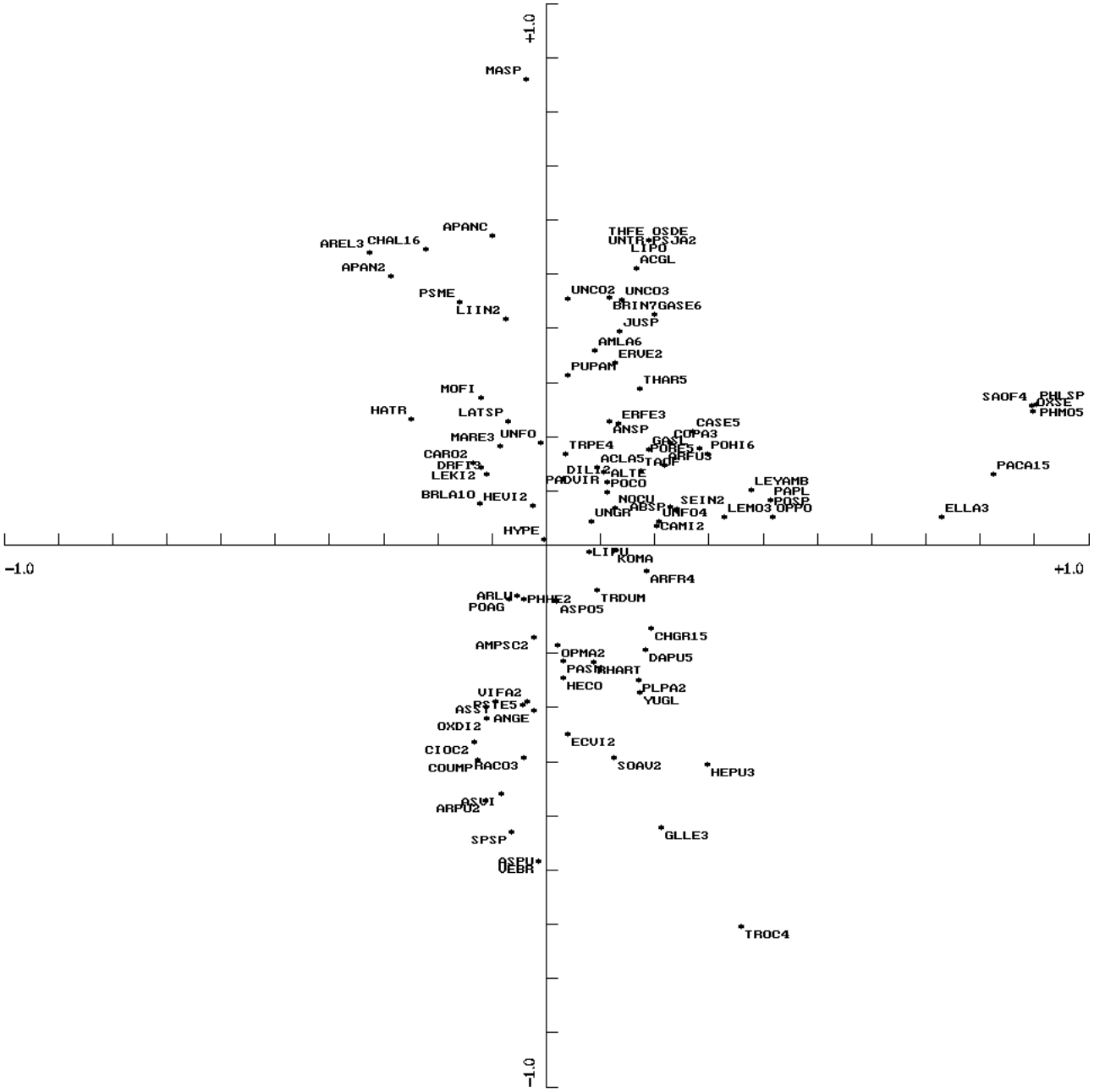

Figure 16. Axes 2-3 Species.

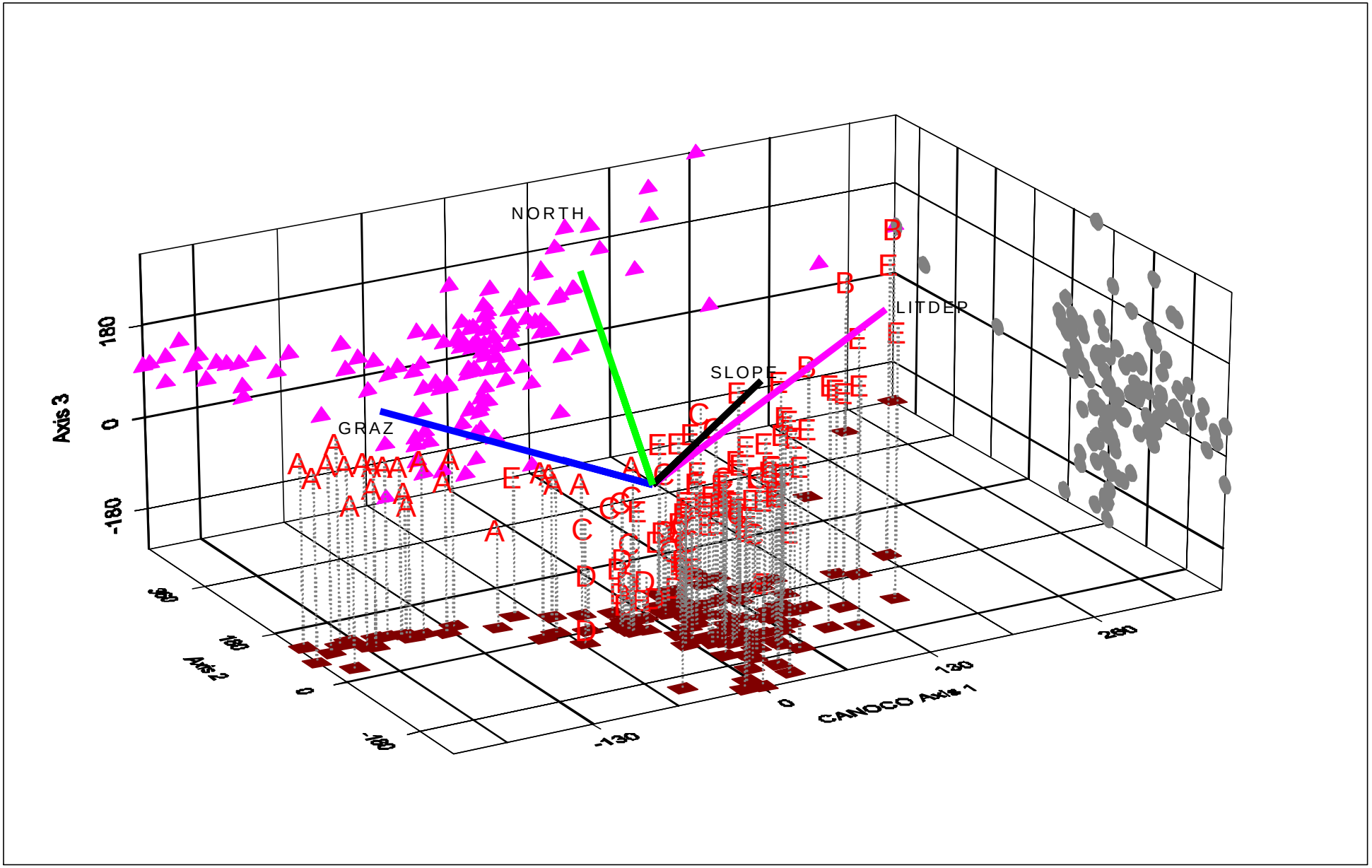

Figure 17. Axes 1-2-3 Sites.

Attribute figures

The attribute figures present the cover values for selected species at each sample site. This has been superimposed on the environmental vectors to represent the environmental centers of species distributions. The group symbols from the site ordinations are repeated in these ordinations. The position of the symbol indicates the sample site location in the ordination, and the size of the symbol is proportional to the actual cover value for the selected species. The species that were selected are those used for the group classification key. The species are presented in the same order as found in the key. This order progresses from Group A to Group E indicator species.

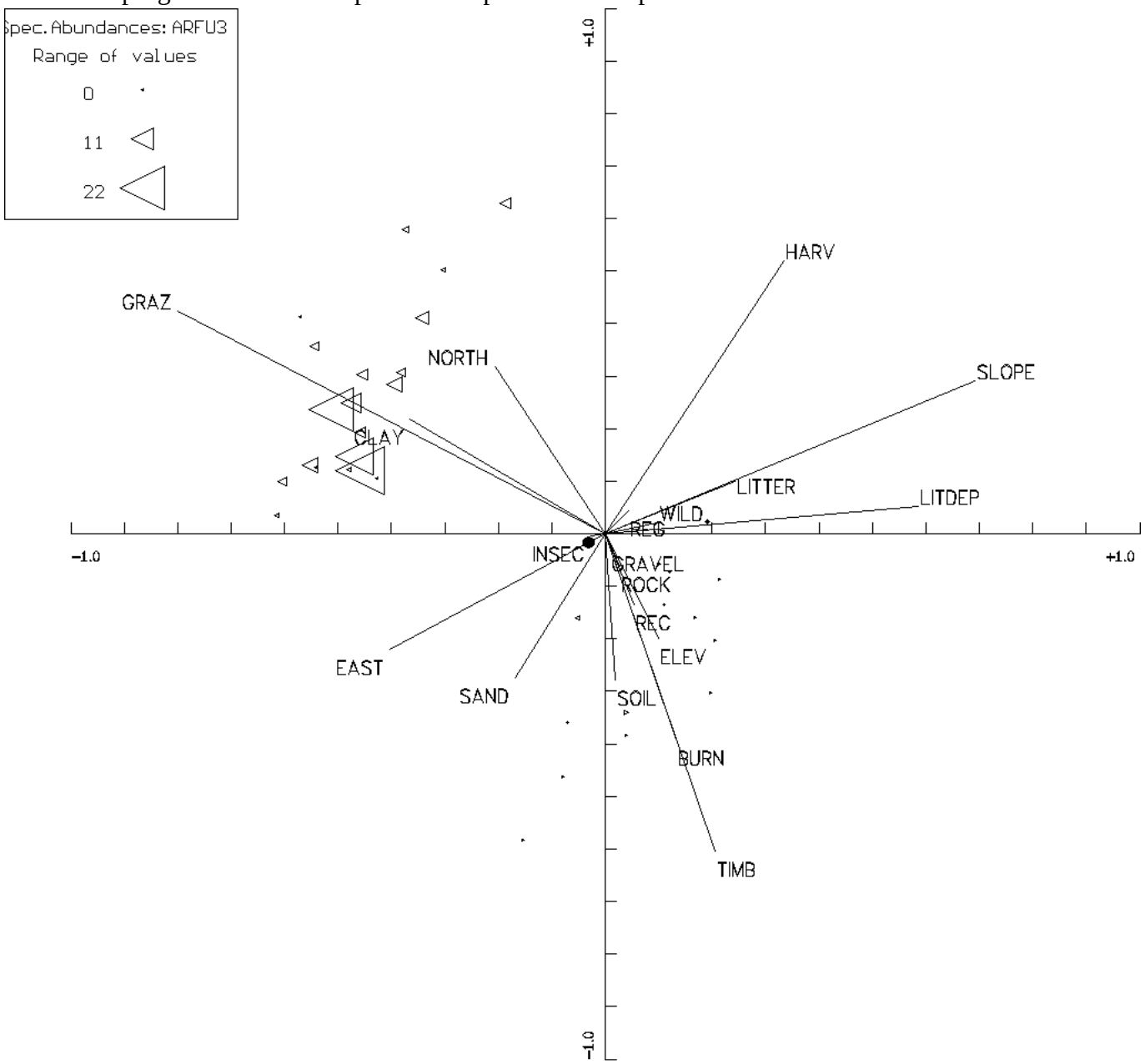

Figure 18. Arnica fulgens Cover Distribution.

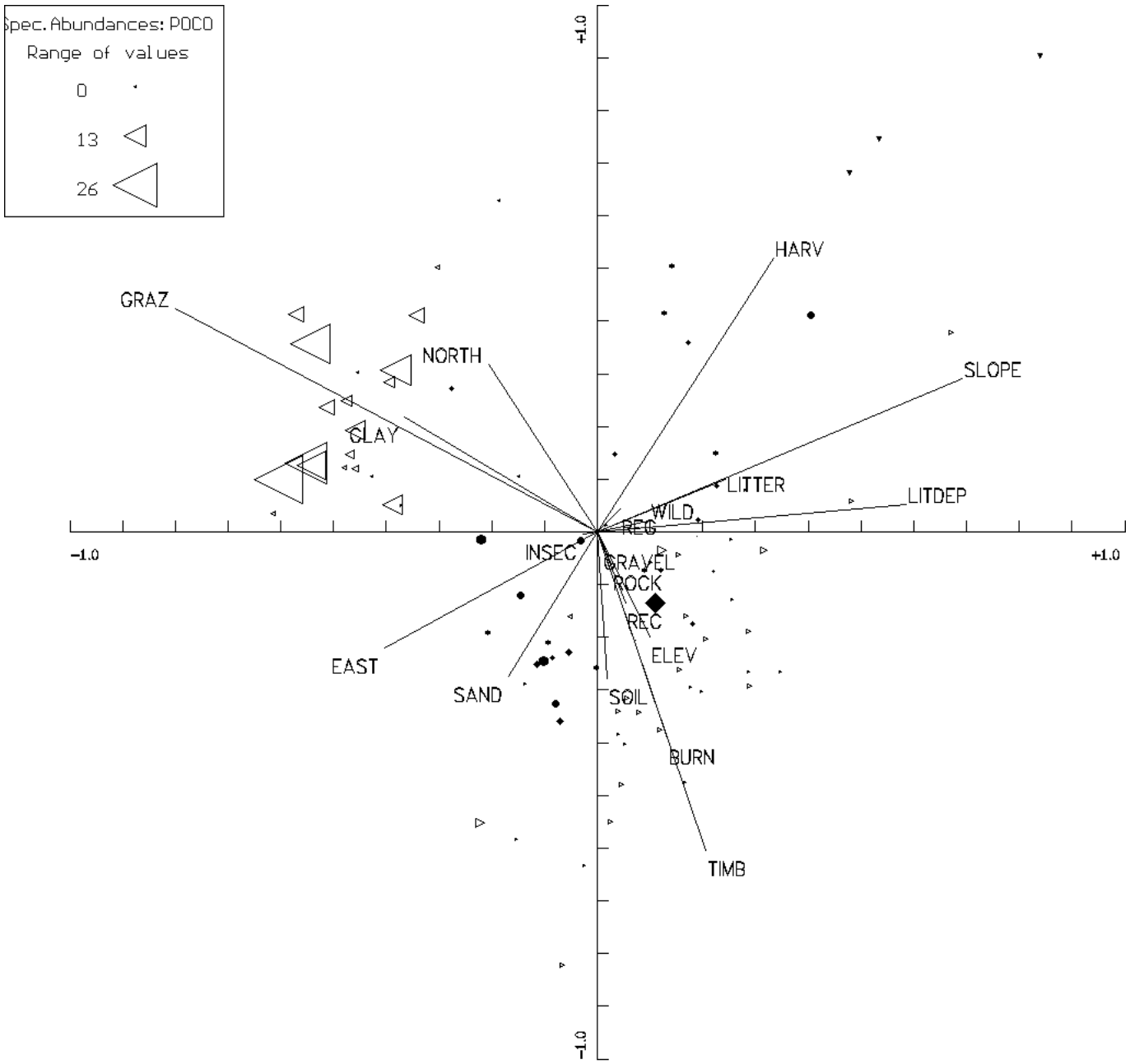

Figure 19. Poa compressa Cover Distribution.

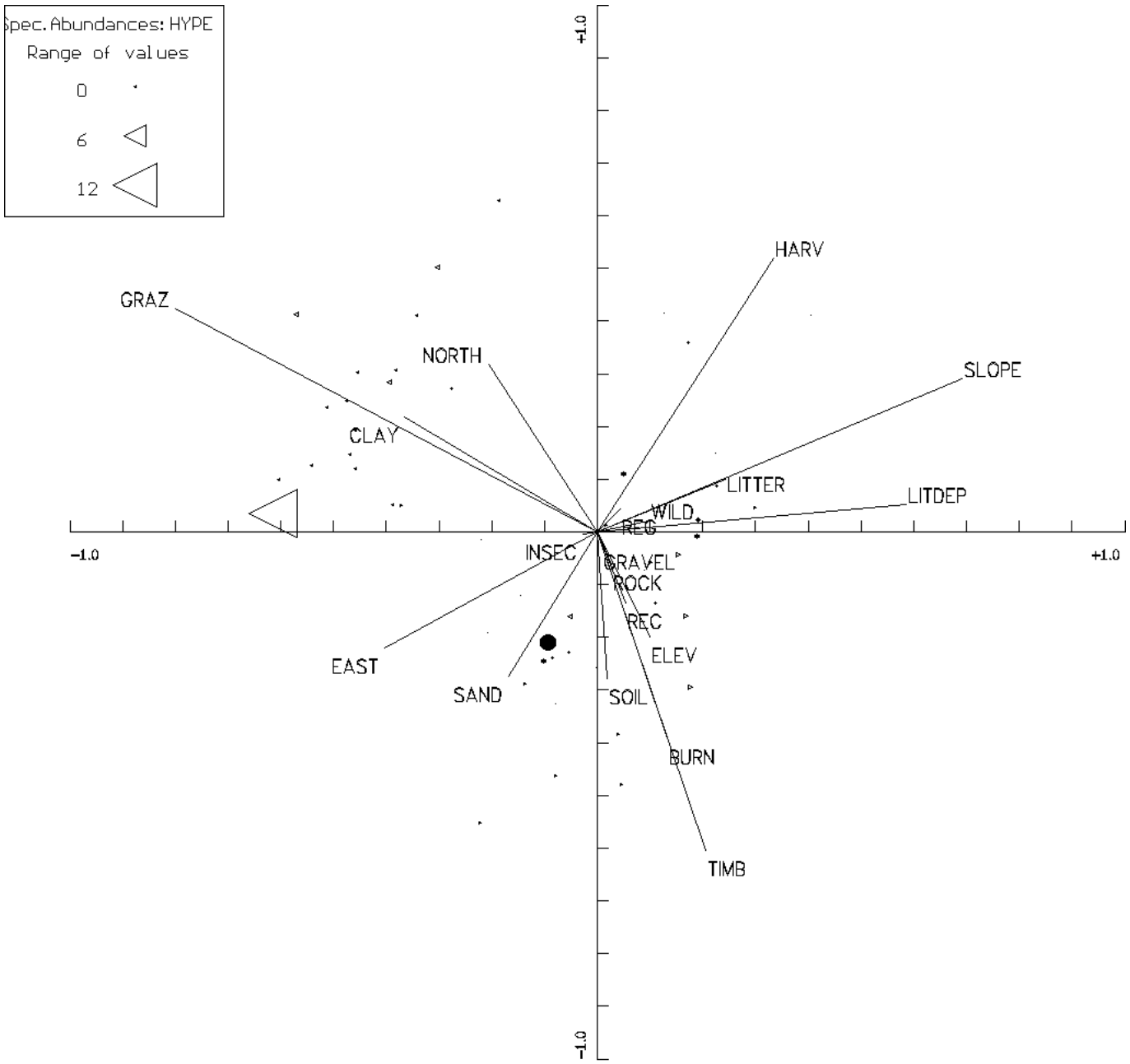

Figure 20. <u>Hypericum perforatum</u> Cover Distribution.

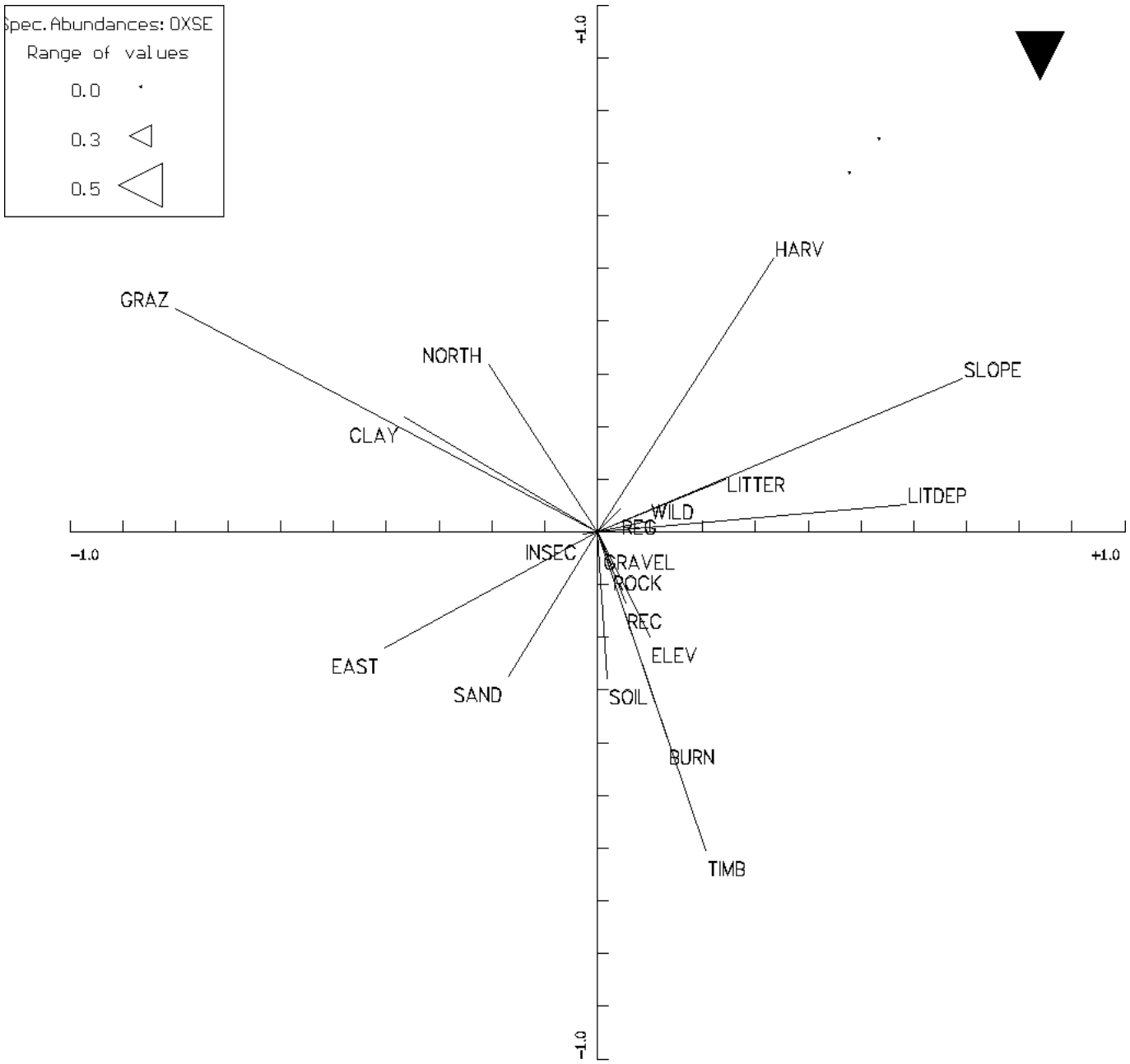

Figure 21. <u>Oxytropis sericea</u> Cover Distribution.

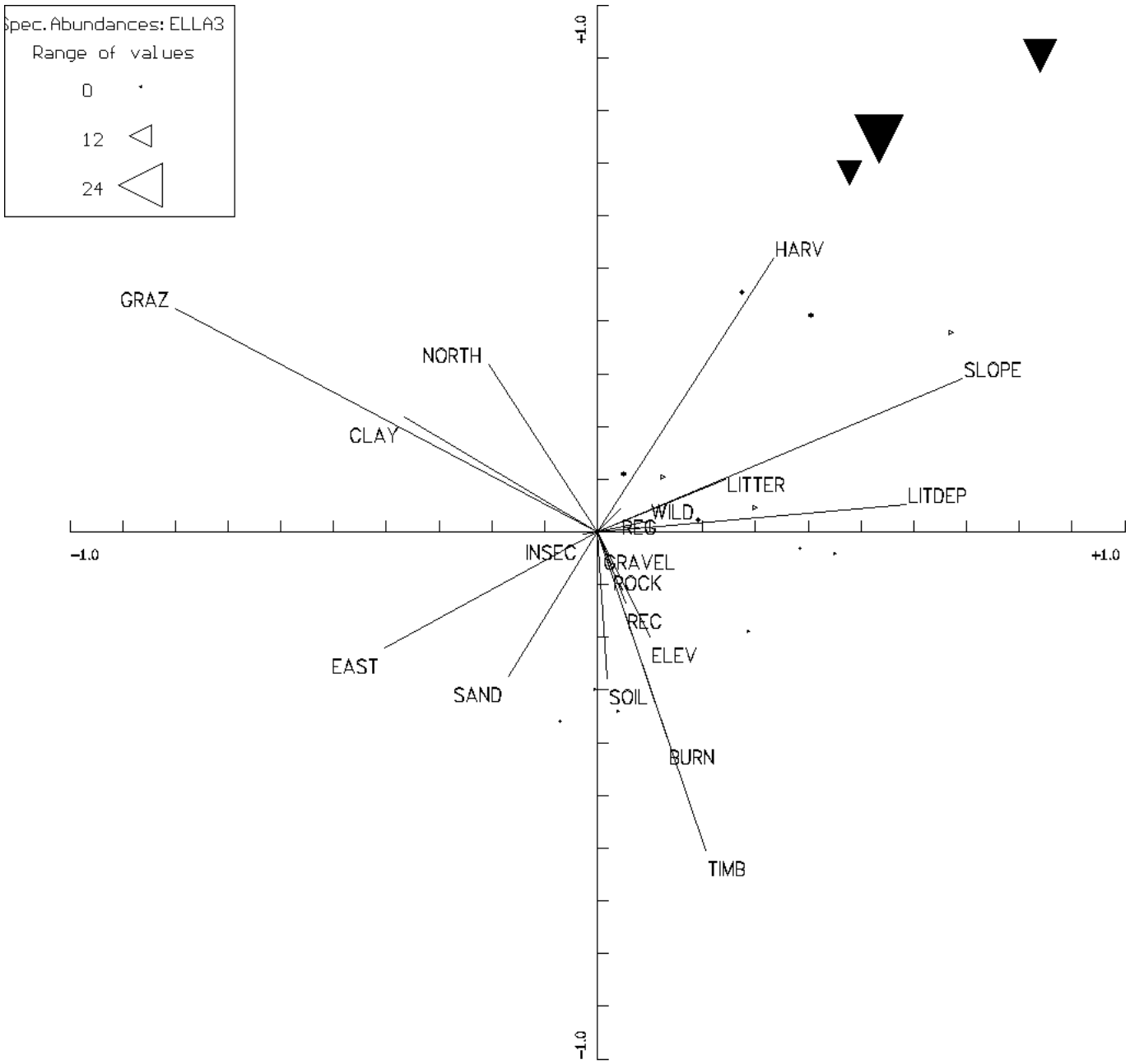

Figure 22. Elymus lanceolatus Cover Distribution.

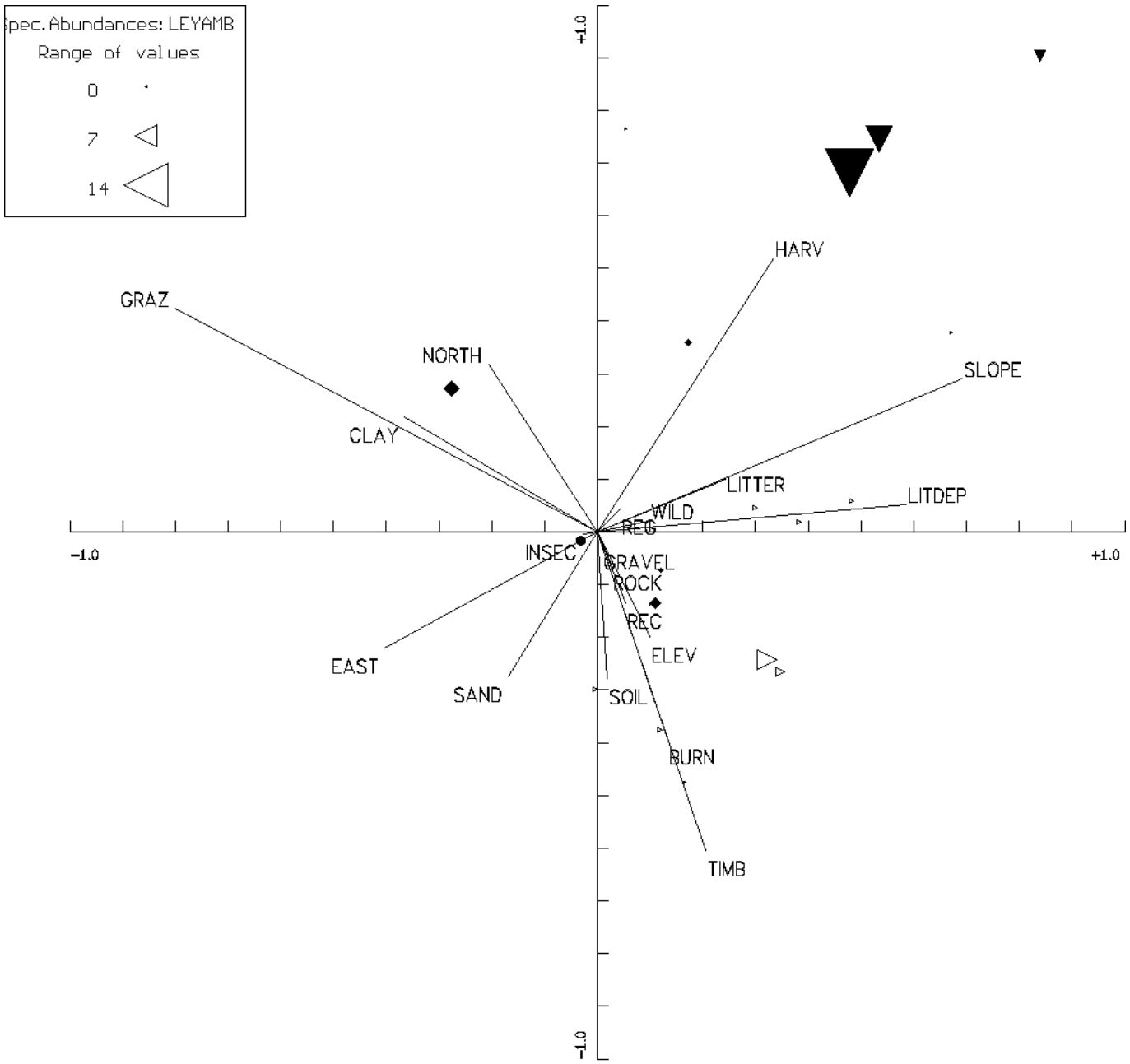

Figure 23. <u>Leymus ambiguus</u> Cover Distribution.

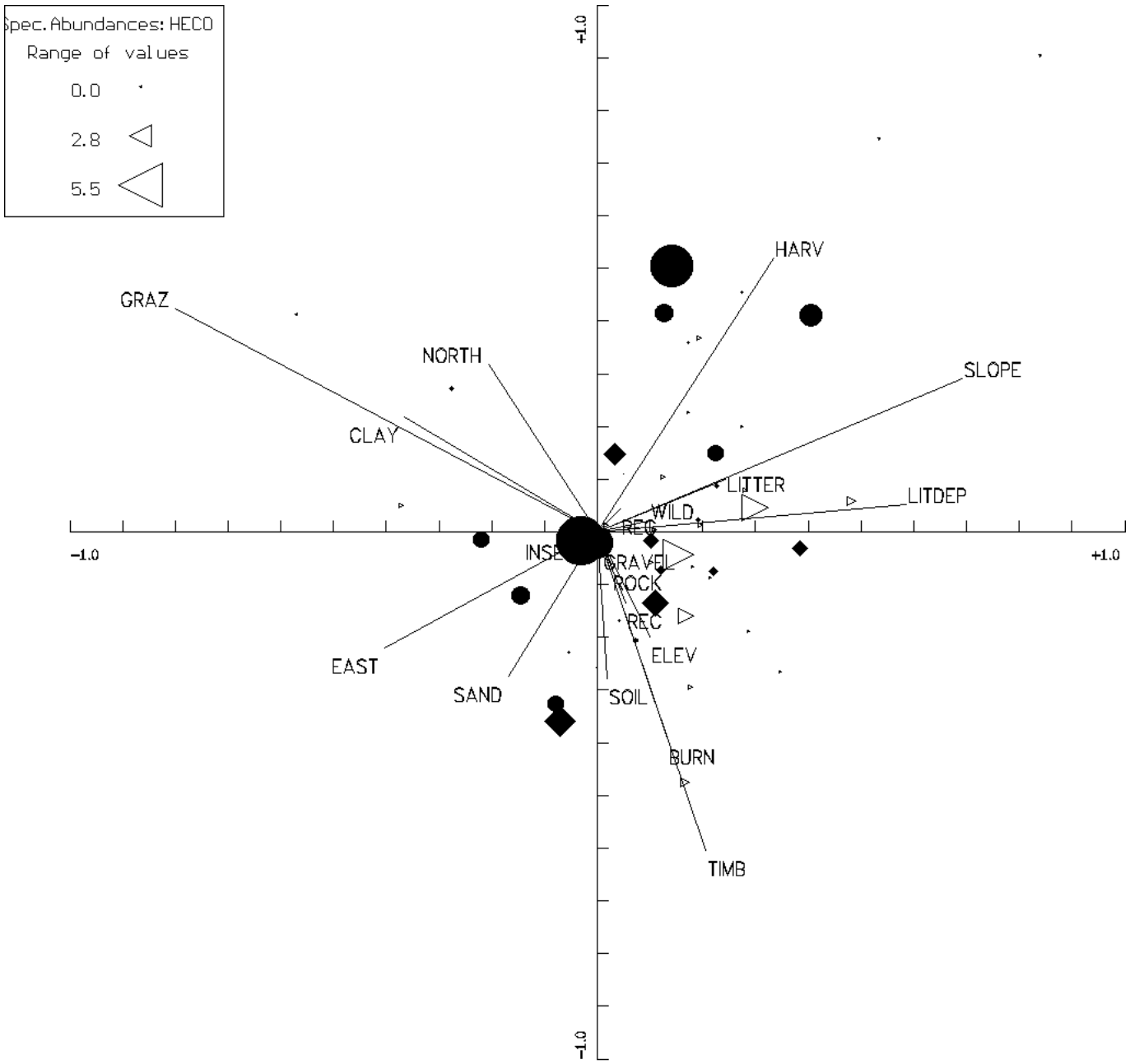

Figure 24. <u>Hesperostipa comata</u> Cover Distribution.

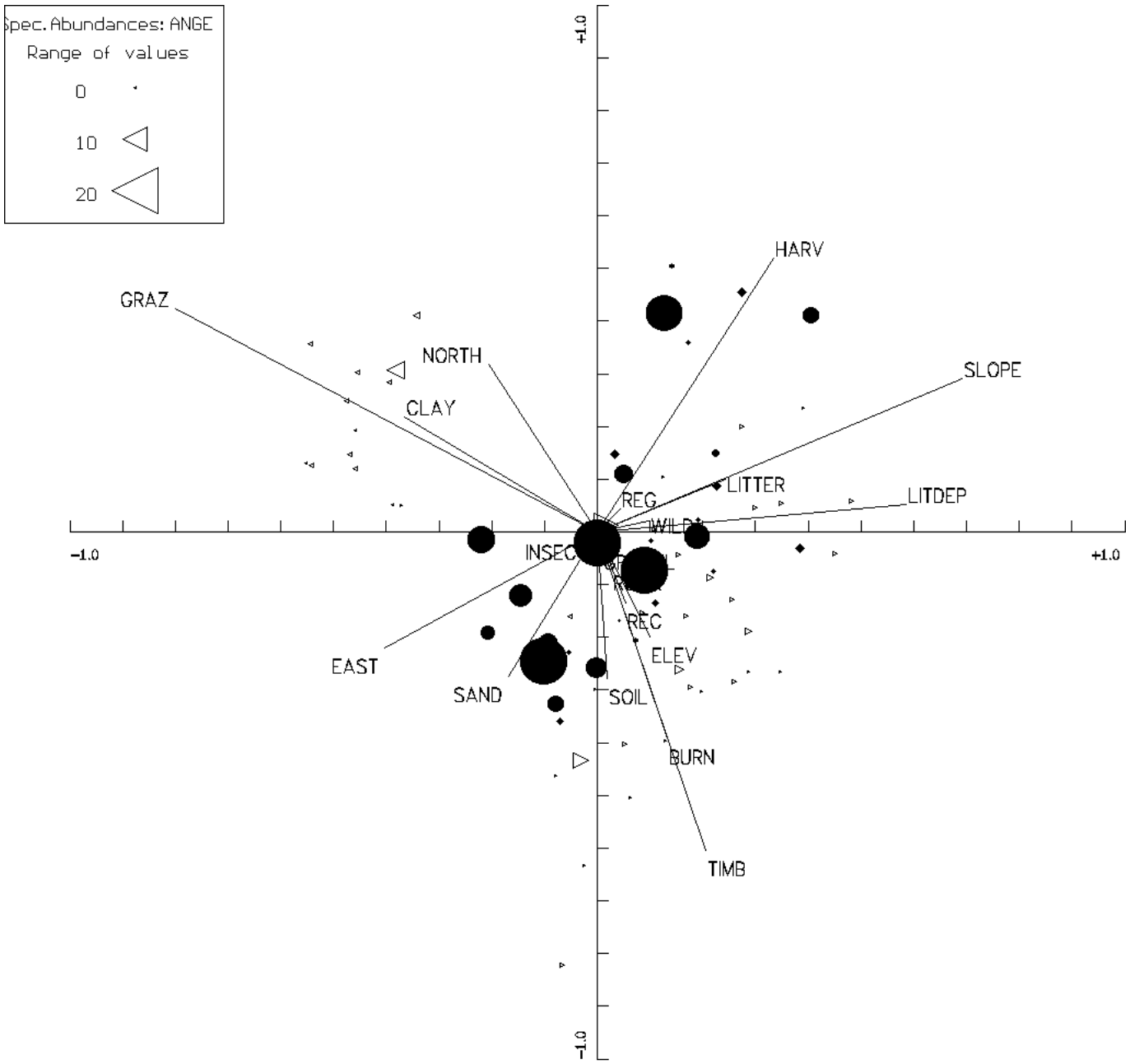

Figure 25. <u>Andropogon gerardii</u> Cover Distribution.

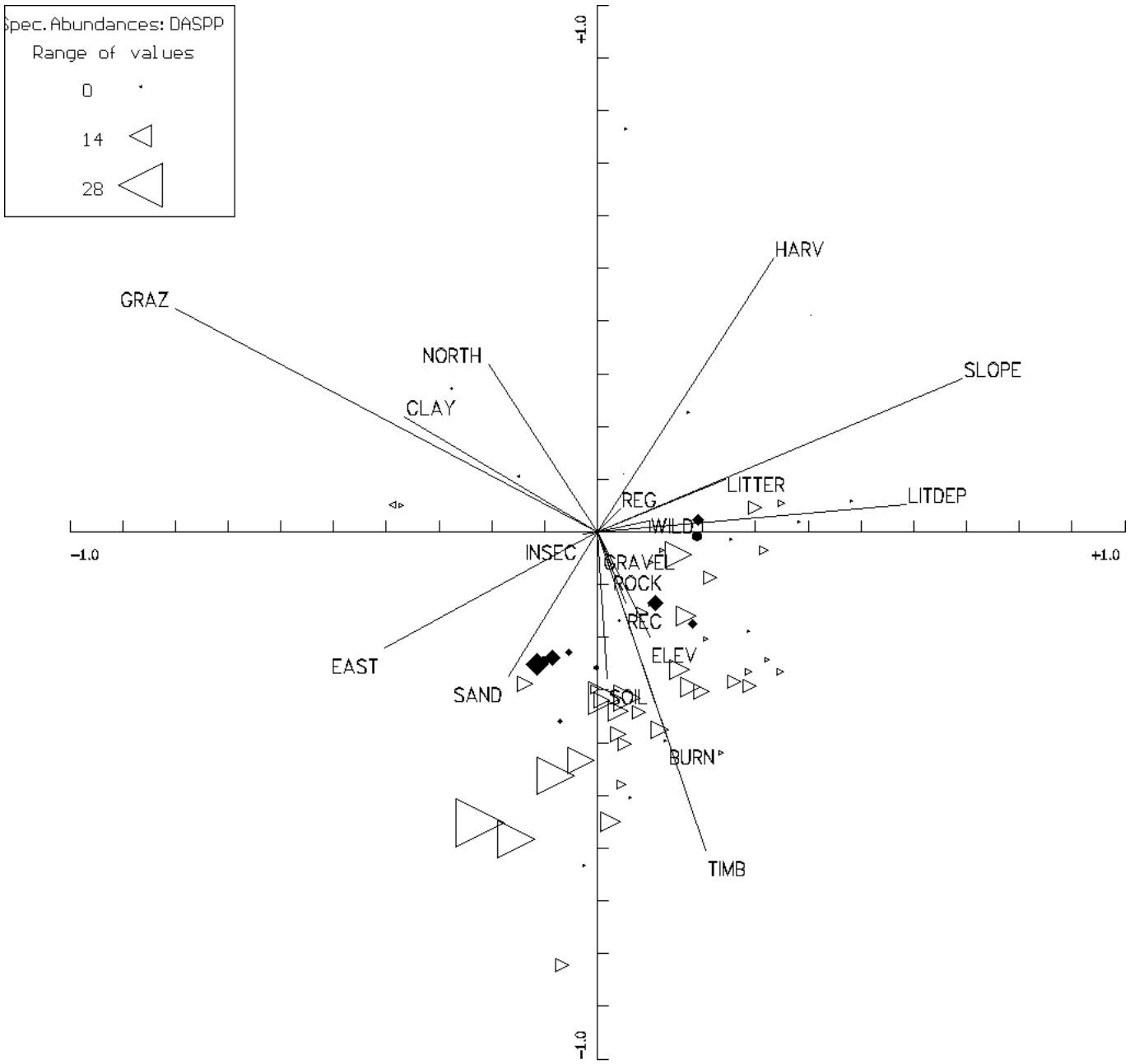

Figure 26. <u>Danthonia spicata var. pintorum</u> Cover Distribution.

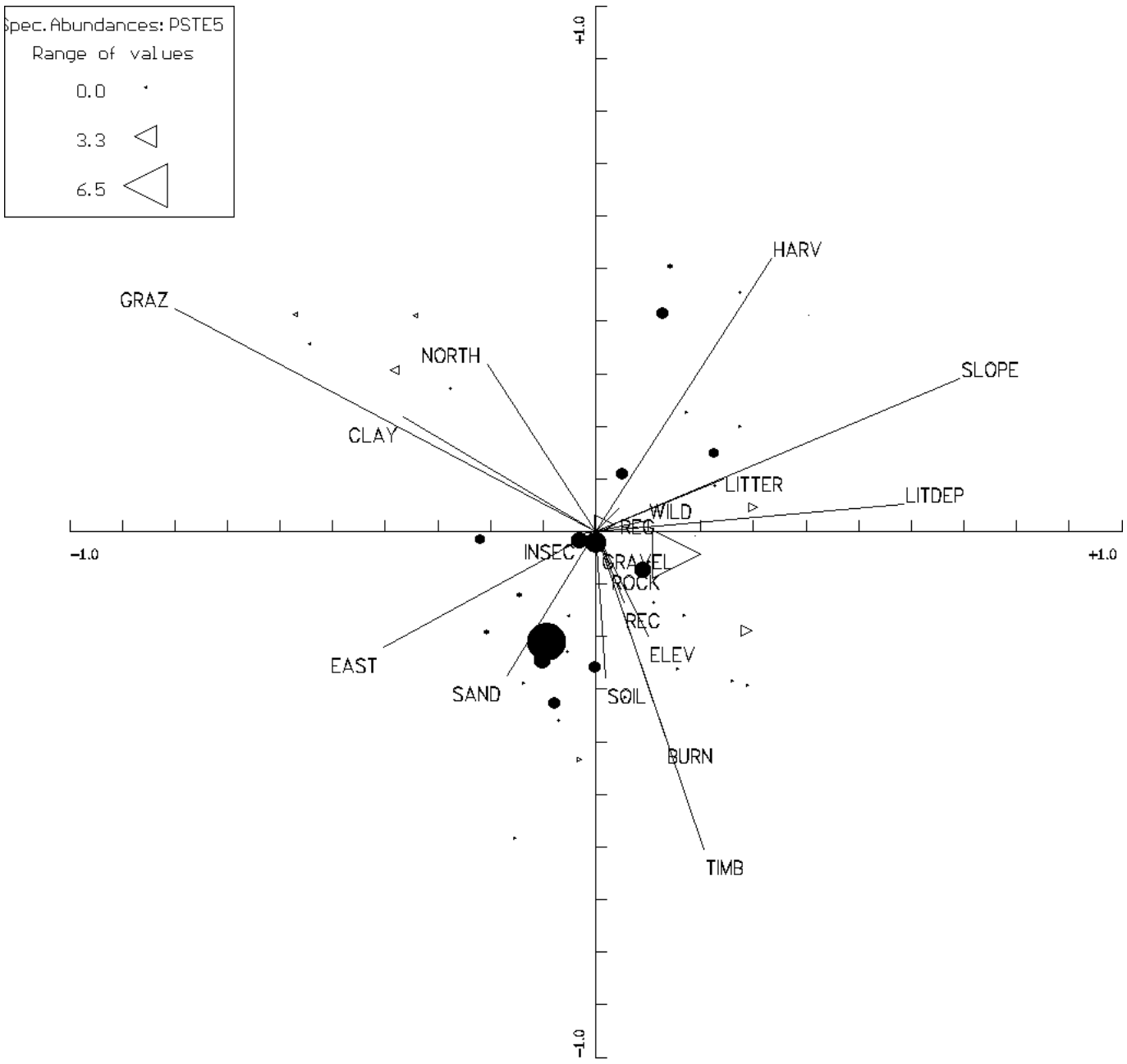

Figure 27. <u>Psoralidium tenuiflorum</u> Cover Distribution.

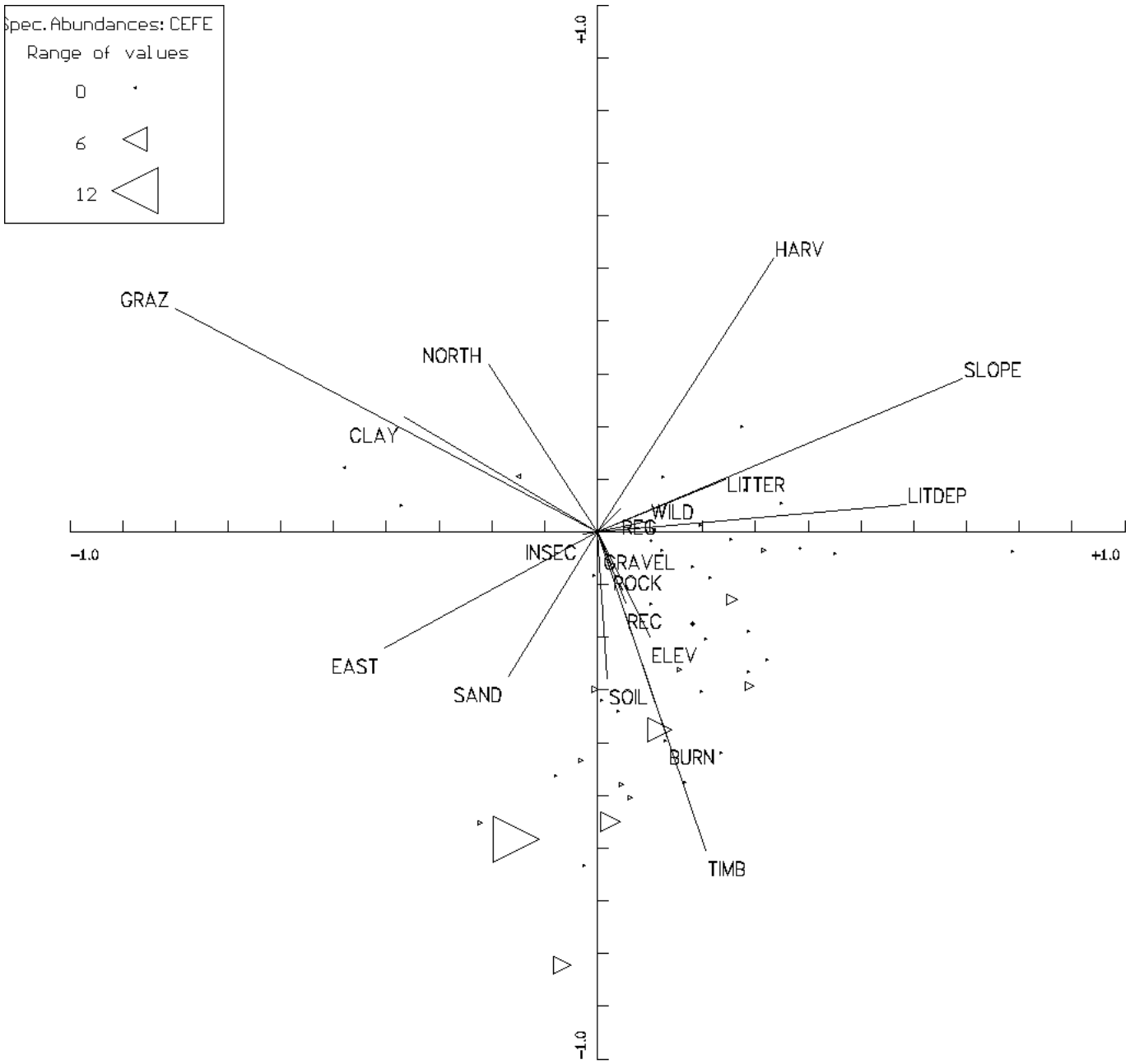

Figure 28. <u>Ceanothus fendleri</u> Cover Distribution.

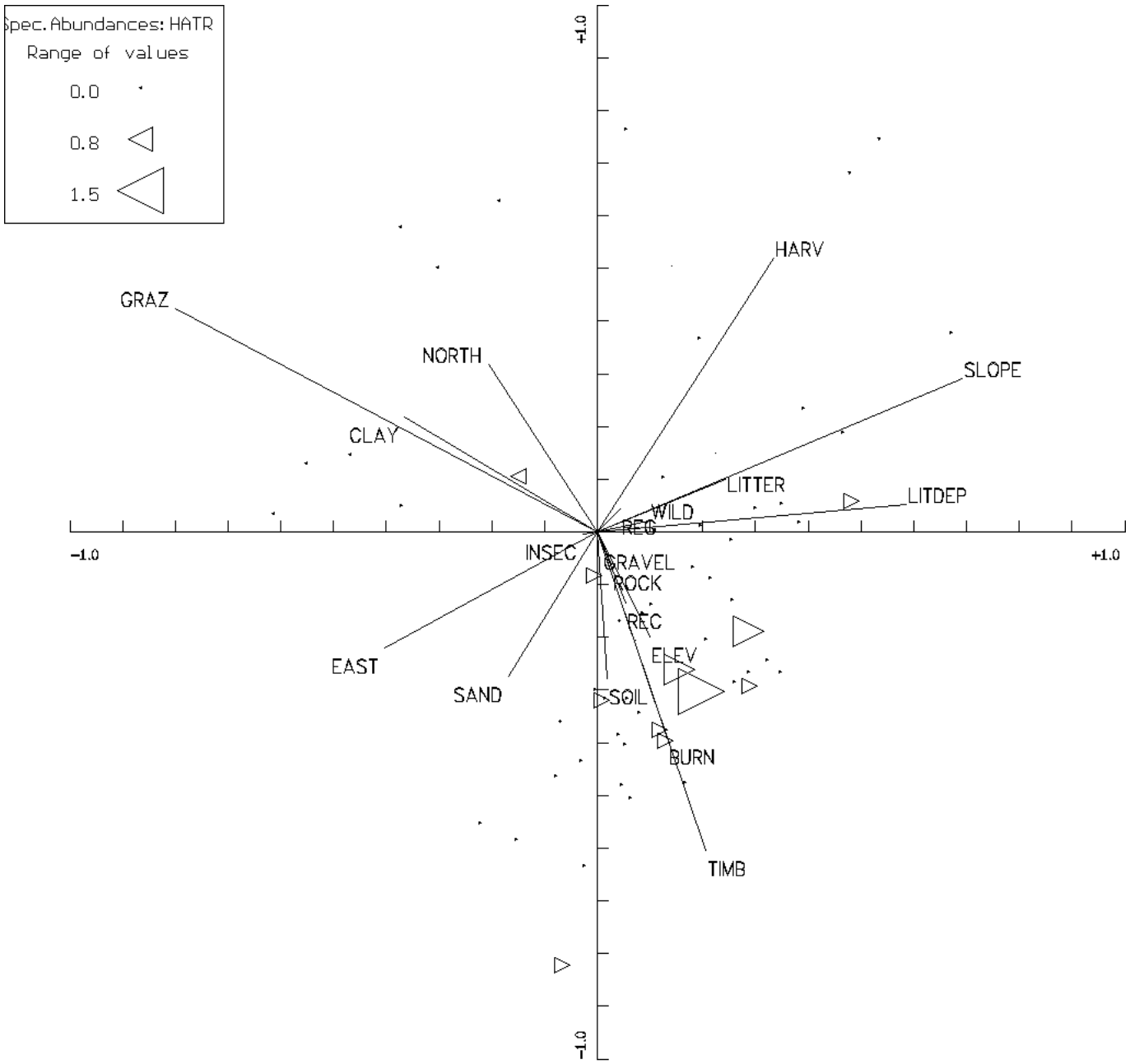

Figure 29. Harbouria trachypleura Cover Distribution.

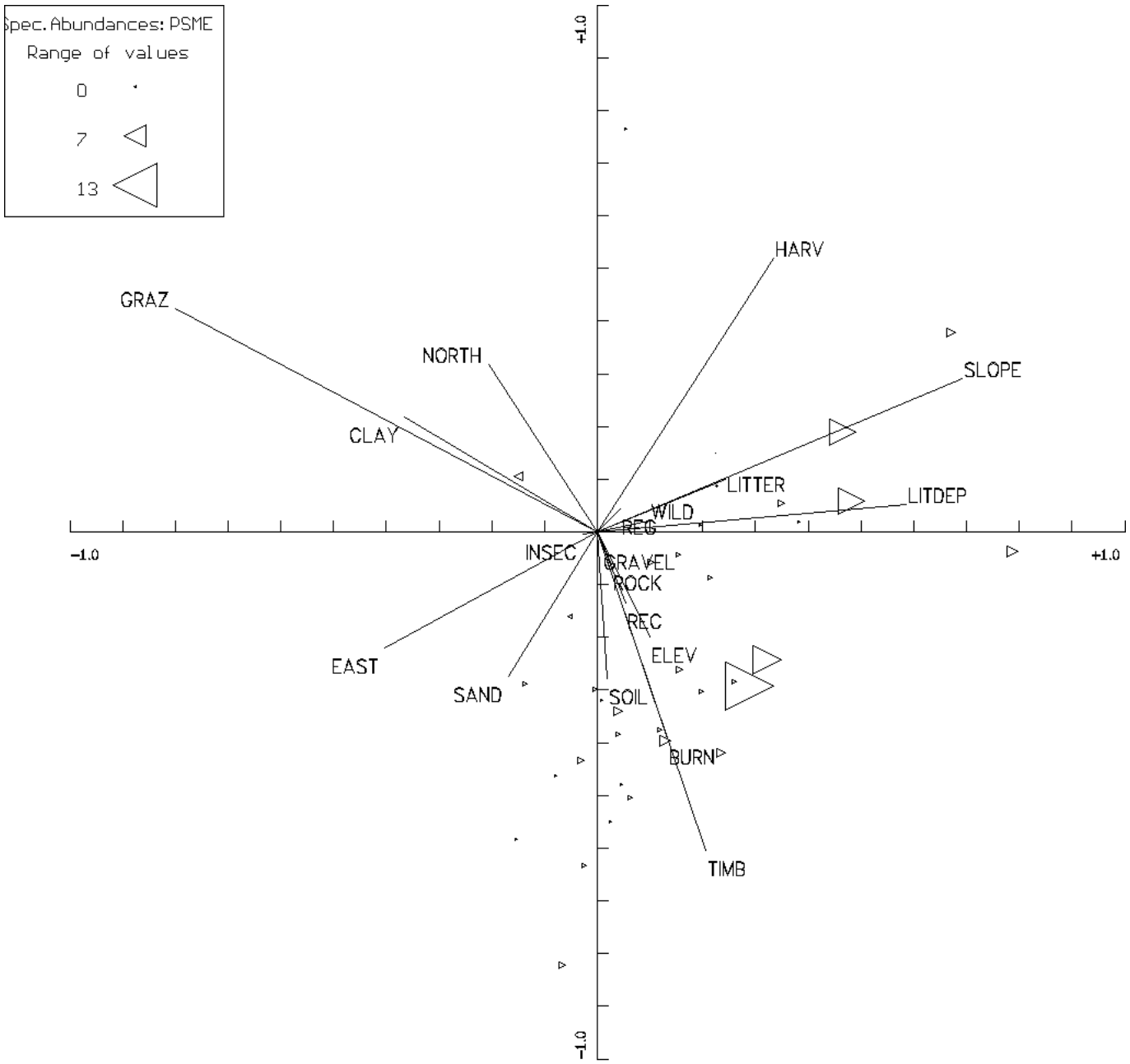

Figure 30. <u>Pseudotsuga menzesii</u> Cover Distribution.

Climatic Factors

Although this report does not discuss the historical disturbances or climatic factors that have resulted in the current plant associations, climatic data that may be used for that purpose are included in Appendix 10. The average annual precipitation as well as monthly temperature, precipitation and potential evapotranspiration, can provide great insight into the timing and severity of disturbance conditions that existed in the past. The first figure in Appendix 10 is the annual precipitation for Boulder from 1894 to 1997. The mean and +/- one standard deviation is also indicated on the graph. The Thornthwaite climate diagrams for 1894 to 1997 are also included in Appendix 10. The potential evapotranspiration was calculated according to a modified Thornthwaite formula (Dunne & Leopold 1978) that includes a latitude correction. The periods of potential soil drought occur when potential evapotranspiration (ET) exceeds precipitation. When using tree ring analysis to evaluate the timing and duration of disturbance or vegetation change, the climatic data should be assessed simultaneously. For example, the 1982 City of Boulder Forest Management Plan includes a picture of a cross section of a tree stump on Page 8. The earliest growth rings demonstrated slow growth followed by a release that came to a sudden end in 1954. The text attributed this reduced ring-growth to a closed tree canopy. This may be true, but 1954 also happened to be the severest drought year in Boulder in the last 100 years. This climatic fact was not mentioned, and may actually have been the primary cause of the reduced ring width.

Sampling methodology in steep areas

There will be times when the slope of a plot is too steep and/or the woody vegetation is too dense for safe and efficient use of the cover-point device. The following suggestions apply where the difficulty of laying out the transect lines and moving the ocular device from point to point suggests the use of an alternative method. In these cases, simply list all of the species possible, and make cover estimates for the understory species which have the estimated highest cover values as determined by visual inspection. The overstory cover can be estimated in a similar fashion, but a higher level of accuracy and precision can be achieved using a densiometer. (about $100 in catalogs). Care should be taken to be sure the measurement of tree canopy is in the same area as the understory cover estimates.

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ter Braak, C.J.F. (1987-1997). CANOCO Version 3.15 - A FORTRAN program for canonical community ordination. Microcomputer Power, Ithaca, New York, USA.

Appendices

Appendix 1. Samples with group affiliation, sorted by sample ID.

Samples with group affiliation, sorted by sample ID.

Sample #	ID	Group	Sample #	ID	Group	Sample #	ID	Group
1	D101	D	42	LJSW10	A	83	ST501	E
2	D105	D	43	LOSH01	D	84	ST505	E
3	D110	D	44	LOSH05	C	85	ST601	E
4	D1/8101	D	45	LOSH10	C	86	ST605	E
5	D1/8105	E	46	MRL01	C	87	ST610	E
6	D201	E	47	MRL10	C	88	ST615	E
7	D205	D	48	MRL15	E	89	ST701	E
8	D210	D	49	PNBK01	B	90	ST705	E
9	D3D401	D	50	PNBK05	B	91	ST801	E
10	D3D405	E	51	PNBK10	B	92	ST805	E
11	D3D410	D	52	PWRL01	E	93	ST901	E
12	D3D415	D	53	PWRL05	E	94	ST905	E
13	D3D420	D	54	PWRL10	E	95	STG201	A
14	D3D425	D	55	PWRL15	E	96	STG205	A
15	D3D430	E	56	PWRL20	E	97	STG210	A
16	DAKR10	D	57	PWRL25	E	98	STG215	A
17	ELDE01	A	58	S1001	E	99	STG220	A
18	ELDE05	A	59	S1005	E	100	SNSH01	E
19	ELDE10	E	60	S1010	C	101	SNSH05	E
20	ELDE15	A	61	S301	E	102	WTRT01	D
21	LINN01	E	62	S305	E	103	WTRT05	C
22	LINN05	A	63	S310	E	104	WTRT10	C
23	LINN10	A	64	S315	E	105	WTRT15	D
24	LINS01	A	65	S320	E	106	WTRT20	D
25	LINS05	A	66	S325	E	107	WITE05	E
26	LINS10	A	67	S401	E	108	WITE10	E
27	LINS15	A	68	S405	E	109	WITNE01	E
28	LJNE01	A	69	S501	C	110	WITNE05	E
29	LJNE05	A	70	S505	E	111	WITNE10	C
30	LJNE10	A	71	S510	E	112	WITNE15	E
31	LJNW01	E	72	S901	C	113	WITNE20	E
32	LJNW05	C	73	S905	E	114	WITNE25	E
33	LJNW10	C	74	S910	E	115	WITNE30	E
34	LJNW15	D	75	ST101	E	116	WITNW01	C
35	LJSE01	A	76	ST105	E	117	WITNW15	E
36	LJSE05	A	77	ST110	E	118	WITNW20	E
37	LJSE10	A	78	ST115	E	119	WITS01	C
38	LJSE15	A	79	ST1001	E	120	WITS05	E
39	LJSE20	A	80	ST1005	E	121	WITS10	C
40	LJSW01	C	81	ST305	E	122	WITW01	C
41	LJSW05	A	82	ST310	E	123	WITW05	E

Appendix 2. Samples with group affiliation, sorted by group ID

Samples with group affiliation, sorted by group ID.

Sample#	ID	Group	Sample#	ID	Group	Sample#	ID	Group
17	ELDE01	A	103	WTRT05	C	68	S405	E
18	ELDE05	A	104	WTRT10	C	70	S505	E
20	ELDE15	A	4	D1/8101	D	71	S510	E
22	LINN05	A	1	D101	D	73	S905	E
23	LINN10	A	2	D105	D	74	S910	E
24	LINS01	A	3	D110	D	100	SNSH01	E
25	LINS05	A	7	D205	D	101	SNSH05	E
26	LINS10	A	8	D210	D	79	ST1001	E
27	LINS15	A	9	D3D401	D	80	ST1005	E
28	LJNE01	A	11	D3D410	D	75	ST101	E
29	LJNE05	A	12	D3D415	D	76	ST105	E
30	LJNE10	A	13	D3D420	D	77	ST110	E
35	LJSE01	A	14	D3D425	D	78	ST115	E
36	LJSE05	A	16	DAKR10	D	81	ST305	E
37	LJSE10	A	34	LJNW15	D	82	ST310	E
38	LJSE15	A	43	LOSH01	D	83	ST501	E
39	LJSE20	A	102	WTRT01	D	84	ST505	E
41	LJSW05	A	105	WTRT15	D	85	ST601	E
42	LJSW10	A	106	WTRT20	D	86	ST605	E
95	STG201	A	5	D1/8105	E	87	ST610	E
96	STG205	A	6	D201	E	88	ST615	E
97	STG210	A	10	D3D405	E	89	ST701	E
98	STG215	A	15	D3D430	E	90	ST705	E
99	STG220	A	19	ELDE10	E	91	ST801	E
49	PNBK01	B	21	LINN01	E	92	ST805	E
50	PNBK05	B	31	LJNW01	E	93	ST901	E
51	PNBK10	B	48	MRL15	E	94	ST905	E
32	LJNW05	C	52	PWRL01	E	107	WITE05	E
33	LJNW10	C	53	PWRL05	E	108	WITE10	E
40	LJSW01	C	54	PWRL10	E	109	WITNE01	E
44	LOSH05	C	55	PWRL15	E	110	WITNE05	E
45	LOSH10	C	56	PWRL20	E	112	WITNE15	E
46	MRL01	C	57	PWRL25	E	113	WITNE20	E
47	MRL10	C	58	S1001	E	114	WITNE25	E
60	S1010	C	59	S1005	E	115	WITNE30	E
69	S501	C	61	S301	E	117	WITNW15	E
72	S901	C	62	S305	E	118	WITNW20	E
111	WITNE10	C	63	S310	E	120	WITS05	E
116	WITNW01	C	64	S315	E	123	WITW05	E
119	WITS01	C	65	S320	E			
121	WITS10	C	66	S325	E			
122	WITW01	C	67	S401	E			

Appendix 3. Group A Species Importance

RANKED Group A	Percentage Importance	Constancy	Average Cover
<Other - Litter>	415.25	100.00	52.83
Poa compressa	100.00	95.65	7.41
Arnica fulgens	82.94	91.30	5.26
<Other - Bare Rock>	64.50	91.30	2.59
Carex spp.	62.71	91.30	2.33
Penstemon virens	59.68	100.00	1.24
Pinus ponderosa scopulorum	59.38	95.65	1.52
Achillea lanulosa	58.17	100.00	1.02
Poa agassizensis	52.12	82.61	1.44
Grindelia squarrosa/G. subalpina	46.87	86.96	0.35
Antennaria spp.	44.69	73.91	1.00
Hypericum perforatum	42.31	73.91	0.66
Artemisia ludoviciana	41.98	78.26	0.29
Cerastium strictum	41.53	78.26	0.22
Eremogone fendleri	41.30	65.22	1.16
Taraxacum officinale	40.95	73.91	0.46
Tragopogon dubius major	38.72	73.91	0.14
Opuntia macrorhiza	38.42	73.91	0.09
Koeleria macrantha	38.12	69.57	0.37
Ribes cereum	37.09	69.57	0.22
Lomatium orientale	36.34	69.57	0.11
<Other - Soil>	35.98	47.83	1.67
Muhlenbergia montana	35.61	65.22	0.33
Rhus aromatica trilobata	35.47	60.87	0.63
Drymocallis fissa	34.86	65.22	0.22
Gaillardia aristata	34.12	65.22	0.11
Anisantha/Bromus spp.	33.86	52.17	1.04
Neolepia campestre	33.82	65.22	0.07
Andropogon gerardii	33.69	56.52	0.70
Symphoricarpos albus/S. occidentalis	33.55	56.52	0.68
Senecio integerrimus	33.37	60.87	0.33
Allium spp.	32.94	60.87	0.27
Galium spp.	32.80	56.52	0.57
Aster porteri	32.35	56.52	0.50
Achnatherum nelsonii	31.80	47.83	1.07
Mertensia lanceolata	29.67	56.52	0.11
Mahonia repens	27.77	47.83	0.48
Oreobatus deliciosus	27.74	52.17	0.16
Unknown grass	27.67	34.78	1.43
Pulsatilla patens multifida	27.44	52.17	0.11
Anisantha tectorum	26.14	43.48	0.57
Campanula rotundifolia	25.21	47.83	0.11
Potentilla hippiana	24.77	47.83	0.05
Collinsia parviflora	22.25	43.48	0.00
Potentilla recta	21.52	39.13	0.22
Padus virginiana melanocarpa	20.92	39.13	0.13
Camelina microcarpa	20.62	39.13	0.09
Erigeron spp.	20.62	39.13	0.09
Carduus nutans macrolepis	20.32	39.13	0.05
Rosa woodsii/R. sayi	19.29	34.78	0.22
Carex pensylvanica heliophila	19.00	34.78	0.18
Ambrosia psilostachya coronopifolia	18.11	30.43	0.37
Bromus japonicus	17.81	30.43	0.33
Chondrosum gracile	17.21	30.43	0.24
Unknown forb	16.93	26.09	0.52
Bromus briziformis	16.62	30.43	0.15
Pneumonanthe bigelovii	15.87	30.43	0.05
Artemisia frigida	15.72	30.43	0.02
Harbouria trachypleura	15.72	30.43	0.02
Liatris punctata	15.59	26.09	0.33
Pascopyrum smithii	14.84	26.09	0.22
Unknown grass 1	14.58	17.39	0.83
Phacelia heterophylla	14.25	26.09	0.13
Phleum pratense	13.94	26.09	0.09
Alyssum alyssoides	13.65	26.09	0.05
Amerosedum lanceolatum	13.65	26.09	0.05
Cynoglossum officinale	13.65	26.09	0.05
Psoralidium tenuiflorum	11.72	21.74	0.09
Geranium caespitosum	11.27	21.74	0.02
Gutierrezia sarothrae	11.27	21.74	0.02
Lesquerella montana	11.27	21.74	0.02
Allium textile	10.84	17.39	0.28

Heterotheca villosa/H. foliosa	9.34	17.39	0.07
Unknown forb 1	9.06	13.04	0.35
Alyssum spp.	9.05	17.39	0.02
Eriogonum spp.	9.05	17.39	0.02
Juncus spp.	9.05	17.39	0.02
Noccaea montana	9.05	17.39	0.02
Frasera speciosa	8.90	17.39	0.00
Unknown grass 2	8.32	13.04	0.24
Acetosella vulgaris	7.27	13.04	0.09
Juncus interior	7.12	13.04	0.07
Dalea purpurea	6.97	13.04	0.04
Elymus trachycaulus	6.82	13.04	0.02
Eriogonum umbellatum	6.82	13.04	0.02
Nassella viridula	6.82	13.04	0.02
Selaginella spp.	6.82	13.04	0.02
Senecio spp.	6.82	13.04	0.02
Sporobolus cryptandrus	6.82	13.04	0.02
Verbascum thapsus	6.82	13.04	0.02
Corallorhiza maculata	6.68	13.04	0.00
Heuchera spp.	6.68	13.04	0.00
Leucocrinum montanum	6.68	13.04	0.00
Lithospermum multiflorum	6.68	13.04	0.00
Oxalis dillenii	6.68	13.04	0.00
Rumex crispus	6.68	13.04	0.00
Scutellaria brittonii	6.68	13.04	0.00
Thermopsis divaricarpa	6.68	13.04	0.00
Thlaspi arvense	6.68	13.04	0.00
Turritis glabra	6.68	13.04	0.00
Lactuca serriola	6.40	8.70	0.28
Pseudotsuga menziesii	5.34	8.70	0.13
Danthonia spicata pinetorum	5.20	8.70	0.11
Erigeron vetensis	4.90	8.70	0.07
Galium aparine	4.89	8.70	0.07
Ceanothus fendleri	4.75	8.70	0.04
Monarda fistulosa methifolia/M. pectinata	4.75	8.70	0.04
Sabina scopulorum	4.75	8.70	0.04
Packera fendleri	4.74	8.70	0.04
Allium cernuum	4.60	8.70	0.02
Apocynum adrosaemifolium/A. cannabinum	4.60	8.70	0.02
Convolvulus arvensis	4.60	8.70	0.02
Elymus elymoides/E. longifolius	4.60	8.70	0.02
Astragalus agrestis	4.45	8.70	0.00
Breea arvensis	4.45	8.70	0.00
Calochortus gunnisonii	4.45	8.70	0.00
Castilleja sessiliflora	4.45	8.70	0.00
Cercocarpus montanus	4.45	8.70	0.00
Cirsium ochrocentrum	4.45	8.70	0.00
Claytonia rosea	4.45	8.70	0.00
Elytrigia repens	4.45	8.70	0.00
Erysimum capitatum	4.45	8.70	0.00
Lathyrus spp.	4.45	8.70	0.00
Nothocalais cuspidata	4.45	8.70	0.00
Oligosporus dracunculus glaucus	4.45	8.70	0.00
Opuntia fragilis	4.45	8.70	0.00
Oreocarya virgata	4.45	8.70	0.00
Ratibida columnifera	4.45	8.70	0.00
Silene antirrhina	4.45	8.70	0.00
Dichanthelium linearifolium	3.57	4.35	0.20
Poa spp.	3.42	4.35	0.17
Carex sp. 1	2.97	4.35	0.11
Danthonia spp.	2.67	4.35	0.07
Carex sp. 2	2.52	4.35	0.04
Collomia linearis	2.52	4.35	0.04
Crataegus spp.	2.52	4.35	0.04
Poa fendleriana longiligula	2.52	4.35	0.04
Poa nervosa	2.52	4.35	0.04
Silene dichotoma	2.52	4.35	0.04
Unknown forb 3	2.52	4.35	0.04
Alyssum parviflorum	2.37	4.35	0.02
Anaphalis margaritacea	2.37	4.35	0.02
Antennaria parvifolia	2.37	4.35	0.02
Delphinium nuttallianum	2.37	4.35	0.02
Galium septentrionale	2.37	4.35	0.02
Juniperus communis alpina	2.37	4.35	0.02
Poa secunda	2.37	4.35	0.02
Schizachyrium scoparium	2.37	4.35	0.02
Yucca glauca	2.37	4.35	0.02
Antennaria neglecta	2.23	4.35	0.00
Aristida spp.	2.23	4.35	0.00
Bromus commutatus	2.23	4.35	0.00
Carex brevior	2.23	4.35	0.00
Chenopodium spp.	2.23	4.35	0.00
Comandra umbellata pallida	2.23	4.35	0.00

Coriflora hirsutissima	2.23	4.35	0.00
Cystopteris fragilis	2.23	4.35	0.00
Descurainia incisa	2.23	4.35	0.00
Eleocharis elliptica compressa	2.23	4.35	0.00
Erigeron colo-mexicanus	2.23	4.35	0.00
Eriogonum flavum	2.23	4.35	0.00
Fallopia convolvulus	2.23	4.35	0.00
Helianthus spp.	2.23	4.35	0.00
Hesperostipa comata	2.23	4.35	0.00
Heuchera bracteata	2.23	4.35	0.00
Juncus arcticus ater	2.23	4.35	0.00
Muhlenbergia wrightii	2.23	4.35	0.00
Opuntia spp.	2.23	4.35	0.00
Oxytropis lambertii	2.23	4.35	0.00
Packera plattensis	2.23	4.35	0.00
Paronychia jamesii	2.23	4.35	0.00
Penstemon secundiflorus	2.23	4.35	0.00
Plantago patagonica	2.23	4.35	0.00
Poa pratensis	2.23	4.35	0.00
Polygonum douglasii	2.23	4.35	0.00
Ribes inerme	2.23	4.35	0.00
Rubus idaeus melanolasius	2.23	4.35	0.00
Sisyrinchium montanum	2.23	4.35	0.00
Solidago spp.	2.23	4.35	0.00
Toxicoscordion venenosum	2.23	4.35	0.00
Trifolium pratense	2.23	4.35	0.00
Triodanis perfoliata	2.23	4.35	0.00
Viola spp.	2.23	4.35	0.00

Appendix 4. Group B Species Importance.

RANKED Group B	Percentage Importance	Constancy	Average Cover
<Other - Litter>	109.00	100.00	36.33
Elymus lanceolatus	54.50	100.00	18.17
<Other - Bare Rock>	41.00	100.00	13.67
Leymus ambiguus	24.50	100.00	8.17
Physocarpus monogynus/P. opulifolius	10.50	33.33	3.50
Rhus aromatica trilobata	9.01	100.00	3.00
Heterotheca villosa/H. foliosa	4.51	100.00	1.50
Padus virginiana melanocarpa	3.51	100.00	1.17
Artemisia frigida	3.00	100.00	1.00
Linaria vulgaris	3.00	33.33	1.00
Achillea lanulosa	2.51	100.00	0.84
Anisantha tectorum	2.51	100.00	0.84
Yucca glauca	2.51	100.00	0.84
Poa compressa	2.50	100.00	0.83
Bromus japonicus	2.01	100.00	0.67
Carex spp.	2.01	100.00	0.67
Grindelia squarrosa/G. subalpina	2.01	100.00	0.67
Cerastium strictum	2.00	100.00	0.67
Achnatherum nelsonii	1.51	100.00	0.50
Leucopoa kingii	1.51	100.00	0.50
Carduus nutans macrolepis	1.50	100.00	0.50
Alyssum alyssoides	1.02	100.00	0.34
Artemisia ludoviciana	1.02	100.00	0.34
Opuntia polyacantha	1.02	100.00	0.34
Poa agassizensis	1.01	66.67	0.34
Saponaria officinalis	1.00	33.33	0.33
Campanula rotundifolia	0.52	100.00	0.17
Elymus elymoides/E. longifolius	0.52	100.00	0.17
Eriogonum flavum	0.52	100.00	0.17
Lathyrus spp.	0.52	100.00	0.17
Opuntia macrorhiza	0.52	100.00	0.17
Pinus ponderosa scopulorum	0.52	100.00	0.17
Verbascum thapsus	0.52	100.00	0.17
Astragalus flexuosus	0.52	100.00	0.17
Helianthus pumilus	0.52	100.00	0.17
Oxytropis sericea	0.52	100.00	0.17
Bromus briziformis	0.51	66.67	0.17
Galium septentrionale	0.51	66.67	0.17
Schizachyrium scoparium	0.51	66.67	0.17
Nepeta cataria	0.51	66.67	0.17
Phlox multiflora	0.51	66.67	0.17
<Other - Soil>	0.50	33.33	0.17
Nassella viridula	0.50	33.33	0.17
Iris missouriensis	0.50	33.33	0.17
Phlox spp.	0.50	33.33	0.17
Allium cernuum	0.03	100.00	0.01
Lithospermum multiflorum	0.03	100.00	0.01
Penstemon virens	0.03	100.00	0.01
Ribes cereum	0.03	100.00	0.01
Symphoricarpos albus/S. occidentalis	0.03	100.00	0.01
Tragopogon dubius major	0.03	100.00	0.01
Adenolinum lewisii	0.03	100.00	0.01
Cystopteris fragilis	0.02	66.67	0.01
Drymocallis fissa	0.02	66.67	0.01
Eriogonum umbellatum	0.02	66.67	0.01
Harbouria trachypleura	0.02	66.67	0.01
Hesperostipa comata	0.02	66.67	0.01
Koeleria macrantha	0.02	66.67	0.01
Taraxacum officinale	0.02	66.67	0.01
Elymus canadensis	0.02	66.67	0.01
Bouteloua curtipendula	0.02	66.67	0.01
Packera cana	0.02	66.67	0.01
Amerosedum lanceolatum	0.01	33.33	0.00
Aster porteri	0.01	33.33	0.00
Camelina microcarpa	0.01	33.33	0.00
Cirsium ochrocentrum	0.01	33.33	0.00
Convolvulus arvensis	0.01	33.33	0.00
Gaillardia aristata	0.01	33.33	0.00
Galium spp.	0.01	33.33	0.00
Lactuca serriola	0.01	33.33	0.00
Monarda fistulosa methifolia/M. pectinata	0.01	33.33	0.00
Oreobatus deliciosus	0.01	33.33	0.00
Paronychia jamesii	0.01	33.33	0.00
Phacelia heterophylla	0.01	33.33	0.00
Pulsatilla patens multifida	0.01	33.33	0.00
Rosa woodsii/R. sayi	0.01	33.33	0.00
Sabina scopulorum	0.01	33.33	0.00
Scutellaria brittonii	0.01	33.33	0.00
Silene antirrhina	0.01	33.33	0.00
Sisyrinchium montanum	0.01	33.33	0.00
Thermopsis divaricarpa	0.01	33.33	0.00
Poa cusickii epilis	0.01	33.33	0.00
Bromopsis lanatipes	0.01	33.33	0.00
Townsendia grandiflora	0.01	33.33	0.00
Linaria genistifolia dalmatica	0.01	33.33	0.00

Appendix 5. Group C Species Importance.

RANKED Group C	Percentage Importance	Constancy	Average Cover
<Other - Litter>	945.71	100.00	57.35
<Other - Bare Rock>	192.28	100.00	8.94
Carex spp.	100.00	88.24	3.41
Pinus ponderosa scopulorum	72.84	100.00	1.27
Artemisia ludoviciana	71.02	100.00	1.15
Danthonia spicata pinetorum	67.97	52.94	2.56
Poa agassizensis	66.21	82.35	1.44
Penstemon virens	66.17	88.24	1.24
Andropogon gerardii	65.74	82.35	1.41
Poa compressa	65.35	76.47	1.59
Hesperostipa comata	57.98	82.35	0.91
Ambrosia psilostachya coronopifolia	53.88	82.35	0.65
Opuntia macrorhiza	52.44	88.24	0.36
Achillea lanulosa	51.54	88.24	0.30
Rhus aromatica trilobata	49.97	64.71	1.00
Ribes cereum	49.32	82.35	0.36
Grindelia squarrosa/G. subalpina	48.38	82.35	0.30
Symphoricarpos albus/S. occidentalis	45.55	52.94	1.12
Padus virginiana melanocarpa	45.19	47.06	1.30
Schizachyrium scoparium	43.51	70.59	0.39
Heterotheca villosa/H. foliosa	42.23	64.71	0.50
Artemisia frigida	41.67	70.59	0.27
Bromus japonicus	40.35	64.71	0.38
Verbascum thapsus	39.86	70.59	0.15
Phacelia heterophylla	38.06	70.59	0.04
Muhlenbergia montana	35.42	58.82	0.27
Tragopogon dubius major	35.38	64.71	0.06
Oreobatus deliciosus	34.51	58.82	0.21
Drymocallis fissa	34.48	64.71	0.01
Mahonia repens	34.14	52.94	0.39
Cerastium strictum	34.05	58.82	0.18
Elymus elymoides/E. longifolius	33.15	58.82	0.12
Lathyrus spp.	32.82	47.06	0.50
Carduus nutans macrolepis	31.79	58.82	0.03
Anisantha tectorum	30.98	47.06	0.38
Koeleria macrantha	29.10	52.94	0.06
Erigeron spp.	28.70	47.06	0.24
Rosa woodsii/R. sayi	26.44	47.06	0.09
Bromus briziformis	26.02	41.18	0.27
Achnatherum nelsonii	25.56	41.18	0.24
Yucca glauca	23.75	41.18	0.12
Gaillardia aristata	22.39	41.18	0.03
Hypericum perforatum	22.39	41.18	0.03
Anisantha/Bromus spp.	22.05	29.41	0.41
Psoralidium tenuiflorum	21.94	41.18	0.00
Cercocarpus montanus	21.58	29.41	0.38
Leymus ambiguus	21.20	23.53	0.56
<Other - Soil>	21.12	29.41	0.35
Eriogonum flavum	20.69	29.41	0.33
<Other - Gravel>	20.36	17.65	0.71
Allium spp.	20.22	29.41	0.30
Chondrosum gracile	20.16	35.29	0.09
Bromopsis lanatipes	19.70	35.29	0.06
Geranium caespitosum	19.70	35.29	0.06
Campanula rotundifolia	19.25	35.29	0.03
Cirsium ochrocentrum	19.25	35.29	0.03
Eriogonum umbellatum	19.25	35.29	0.03
Allium cernuum	18.80	35.29	0.00
Bouteloua curtipendula	18.80	35.29	0.00
Liatris punctata	18.80	35.29	0.00
Monarda fistulosa methifolia/M. pectinata	18.40	29.41	0.18
Cynoglossum officinale	16.12	29.41	0.03
Mertensia lanceolata	16.12	29.41	0.03
Opuntia fragilis	16.12	29.41	0.03
Sporobolus cryptandrus	15.79	17.65	0.41
Breea arvensis	15.67	29.41	0.00
Cystopteris fragilis	15.67	29.41	0.00
Taraxacum officinale	15.67	29.41	0.00
Sabina scopulorum	14.82	23.53	0.15
Antennaria spp.	14.81	23.53	0.15
Galium spp.	14.35	23.53	0.12
Oreocarya virgata	14.34	23.53	0.12
Elymus trachycaulus	13.90	23.53	0.09
Eremogone fendleri	13.89	23.53	0.09
Toxicodendron rydbergii	13.44	23.53	0.06
Elymus lanceolatus	13.43	23.53	0.06
Opuntia polyacantha	13.43	23.53	0.06
Arnica fulgens	12.99	23.53	0.03
Aster porteri	12.99	23.53	0.03
Eriogonum spp.	12.99	23.53	0.03
Gutierrezia sarothrae	12.99	23.53	0.03
Pulsatilla patens multifida	12.99	23.53	0.03
Lactuca serriola	12.54	23.53	0.00

Tradescantia occidentalis scopulorum	12.54	23.53	0.00
Carex sp. 1	12.20	11.76	0.38
Alyssum alyssoides	12.13	17.65	0.18
Lupinus argenteus	11.29	11.76	0.32
<Other - Trail>	10.91	5.88	0.50
Neolepia campestre	10.30	17.65	0.06
Astragalus flexuosus	9.85	17.65	0.03
Ceanothus fendleri	9.85	17.65	0.03
Leucopoa kingii	9.85	17.65	0.03
Pneumonanthe bigelovii	9.85	17.65	0.03
Corallorhiza maculata	9.40	17.65	0.00
Helianthus pumilus	9.40	17.65	0.00
Hesperostipa spartea	9.40	17.65	0.00
Phleum pratense	9.40	17.65	0.00
Physalis virginiana	9.40	17.65	0.00
Linaria vulgaris	8.62	5.88	0.35
Bromopsis inermis	7.17	11.76	0.06
Lithospermum multiflorum	7.17	11.76	0.06
Oligosporus pacificus	7.17	11.76	0.06
Potentilla recta	7.17	11.76	0.06
Ribes inerme	7.17	11.76	0.06
Acosta diffusa	6.72	11.76	0.03
Colutea arborescens	6.72	11.76	0.03
Senecio integerrimus	6.72	11.76	0.03
Thermopsis divaricarpa	6.72	11.76	0.03
Amerosedum lanceolatum	6.27	11.76	0.00
Asclepias spp.	6.27	11.76	0.00
Calochortus gunnisonii	6.27	11.76	0.00
Carex pensylvanica heliophila	6.27	11.76	0.00
Coryphantha missouriensis	6.27	11.76	0.00
Dactylis glomerata	6.27	11.76	0.00
Echinocereus viridiflorus	6.27	11.76	0.00
Fallopia convolvulus	6.27	11.76	0.00
Frasera speciosa	6.27	11.76	0.00
Harbouria trachypleura	6.27	11.76	0.00
Lesquerella montana	6.27	11.76	0.00
Lomatium orientale	6.27	11.76	0.00
Nassella viridula	6.27	11.76	0.00
Onosmodium molle occidentale	6.27	11.76	0.00
Oxalis dillenii	6.27	11.76	0.00
Packera fendleri	6.27	11.76	0.00
Pseudognaphalium canescens	6.27	11.76	0.00
Senecio spp.	6.27	11.76	0.00
Silene antirrhina	6.27	11.76	0.00
Sorghastrum avenaceum	6.27	11.76	0.00
Townsendia grandiflora	6.27	11.76	0.00
Heterotheca villosa	5.87	5.88	0.18
Agrostis gigantea	4.96	5.88	0.12
Unknown grass	4.50	5.88	0.09
Arctostaphylos uva-ursi	4.04	5.88	0.06
Bromus spp.	4.04	5.88	0.06
Crataegus spp.	4.04	5.88	0.06
Grindelia squarrosa	4.04	5.88	0.06
Rhus glabra	4.04	5.88	0.06
Unknown forb	4.04	5.88	0.06
Alyssum parviflorum	3.58	5.88	0.03
Carex sp. 2	3.58	5.88	0.03
Convolvulus arvensis	3.58	5.88	0.03
Heuchera spp.	3.58	5.88	0.03
Rubus idaeus melanolasius	3.58	5.88	0.03
Tragia ramosa	3.58	5.88	0.03
Adenolinum lewisii	3.13	5.88	0.00
Agropyron cristatum desertorum	3.13	5.88	0.00
Aristida spp.	3.13	5.88	0.00
Aster laevis geyeri	3.13	5.88	0.00
Camelina microcarpa	3.13	5.88	0.00
Carex brevior	3.13	5.88	0.00
Castilleja miniata	3.13	5.88	0.00
Celtis reticulata	3.13	5.88	0.00
Chenopodium leptophyllum	3.13	5.88	0.00
Chlorocrepis albiflora	3.13	5.88	0.00
Clematis ligusticifolia	3.13	5.88	0.00
Collinsia parviflora	3.13	5.88	0.00
Comandra umbellata pallida	3.13	5.88	0.00
Coriflora hirsutissima	3.13	5.88	0.00
Dalea purpurea	3.13	5.88	0.00
Dichanthelium spp.	3.13	5.88	0.00
Elytrigia repens	3.13	5.88	0.00
Erigeron speciosus macranthus	3.13	5.88	0.00
Erysimum capitatum	3.13	5.88	0.00
Heuchera bracteata	3.13	5.88	0.00
Juncus arcticus ater	3.13	5.88	0.00
Lathyrus leucanthus	3.13	5.88	0.00
Linaria genistifolia dalmatica	3.13	5.88	0.00
Lithospermum incisum	3.13	5.88	0.00
Muhlenbergia wrightii	3.13	5.88	0.00
Nepeta cataria	3.13	5.88	0.00
Oenothera villosa strigosa	3.13	5.88	0.00
Oligosporus dracunculus glaucus	3.13	5.88	0.00
Penstemon secundiflorus	3.13	5.88	0.00
Penstemon spp.	3.13	5.88	0.00
Physalis hederifolia comata	3.13	5.88	0.00

Prunella vulgaris	3.13	5.88	0.00
Pseudotsuga menziesii	3.13	5.88	0.00
Quercus spp.	3.13	5.88	0.00
Scrophularia lanceolata	3.13	5.88	0.00
Scutellaria brittonii	3.13	5.88	0.00
Solidago spp.	3.13	5.88	0.00
Sporobolus heterolepis	3.13	5.88	0.00
Stenactis strigosa	3.13	5.88	0.00
Thinopyrum intermedium	3.13	5.88	0.00
Turritis glabra	3.13	5.88	0.00
Viola spp.	3.13	5.88	0.00

Appendix 6. Group D Species Importance.

RANKED Group D	Percentage Importance	Constancy	Average Cover
<Other - Litter>	286.91	100.00	44.18
Andropogon gerardii	100.00	100.00	9.32
<Other - Bare Rock>	93.69	100.00	8.15
Rhus aromatica trilobata	73.98	100.00	4.47
Poa agassizensis	71.93	100.00	4.09
Carex spp.	62.83	94.12	2.94
Artemisia ludoviciana	59.79	100.00	1.83
Ambrosia psilostachya coronopifolia	58.85	100.00	1.65
Pinus ponderosa scopulorum	54.74	100.00	0.88
Psoralidium tenuiflorum	54.32	94.12	1.35
Poa compressa	52.01	88.24	1.47
Grindelia squarrosa/G. subalpina	48.82	94.12	0.33
Tragopogon dubius major	47.88	94.12	0.15
Opuntia macrorhiza	45.88	88.24	0.33
Bromus japonicus	45.77	82.35	0.86
Hesperostipa comata	43.34	70.59	1.50
Hypericum perforatum	42.94	82.35	0.33
Ribes cereum	42.62	82.35	0.27
Liatris punctata	42.31	82.35	0.21
Achillea lanulosa	39.37	76.47	0.21
Rosa woodsii/R. sayi	37.52	70.59	0.42
Elymus elymoides/E. longifolius	37.05	70.59	0.33
Koeleria macrantha	36.42	70.59	0.21
Drymocallis fissa	34.41	64.71	0.38
Phacelia heterophylla	33.01	64.71	0.12
Cirsium ochrocentrum	32.70	64.71	0.06
Dalea purpurea	32.70	64.71	0.06
Verbascum thapsus	32.54	64.71	0.04
Yucca glauca	31.62	58.82	0.41
Penstemon virens	30.69	58.82	0.24
Achnatherum nelsonii	30.58	52.94	0.77
Muhlenbergia montana	28.85	52.94	0.44
Bouteloua curtipendula	27.75	52.94	0.24
Sorghastrum avenaceum	27.63	47.06	0.77
Aster porteri	27.48	47.06	0.74
Schizachyrium scoparium	27.28	52.94	0.15
Oxalis dillenii	27.12	52.94	0.12
Carduus nutans macrolepis	26.97	52.94	0.09
Onosmodium molle occidentale	26.97	52.94	0.09
Artemisia frigida	26.81	52.94	0.06
Ratibida columnifera	26.65	52.94	0.03
Heterotheca villosa/H. foliosa	23.71	47.06	0.03
Virgulus falcatus	22.49	41.18	0.35
Oreobatus deliciosus	22.02	41.18	0.27
Chondrosum gracile	22.01	41.18	0.27
Padus virginiana melanocarpa	21.92	35.29	0.80
Lactuca serriola	20.92	41.18	0.06
Oligosporus dracunculus glaucus	20.92	41.18	0.06
Cynoglossum officinale	20.92	41.18	0.06
Campanula rotundifolia	20.76	41.18	0.03
Gutierrezia sarothrae	20.76	41.18	0.03
Danthonia spicata pinetorum	20.65	35.29	0.56
Allium cernuum	20.61	41.18	0.00
Symphoricarpos albus/S. occidentalis	18.92	35.29	0.24
Comandra umbellata pallida	18.13	35.29	0.09
Adenolinum lewisii	17.98	35.29	0.06
Lathyrus spp.	17.82	35.29	0.03
Pneumonanthe bigelovii	17.82	35.29	0.03
Cerastium strictum	17.67	35.29	0.00
Opuntia fragilis	17.67	35.29	0.00
Pulsatilla patens multifida	17.67	35.29	0.00
Taraxacum officinale	17.67	35.29	0.00
Sabina scopulorum	17.24	29.41	0.47
Pascopyrum smithii	16.92	29.41	0.41
Anisantha tectorum	16.29	29.41	0.30
Helianthus pumilus	15.35	29.41	0.12
Eremogone fendleri	15.03	29.41	0.06
Monarda fistulosa methifolia/M. pectinata	14.72	29.41	0.00
<Other - Soil>	14.13	23.53	0.44
Erigeron colo-mexicanus/E. divergens	13.82	23.53	0.38
Mahonia repens	13.03	23.53	0.24
Tragia ramosa	12.71	23.53	0.18
Lithospermum multiflorum	12.25	23.53	0.09
Bromus briziformis	12.09	23.53	0.06
Antennaria spp.	12.09	23.53	0.06
Eriogonum umbellatum	12.09	23.53	0.06
Juncus interior	12.09	23.53	0.06
Camelina microcarpa	11.93	23.53	0.03
Hesperostipa spartea	11.93	23.53	0.03
Toxicodendron rydbergii	11.93	23.53	0.03
Tradescantia occidentalis scopulorum	11.93	23.53	0.03
Geranium caespitosum	11.78	23.53	0.00
Harbouria trachypleura	11.78	23.53	0.00
Unknown grass 2	10.40	17.65	0.29
Muhlenbergia wrightii	9.77	17.65	0.18
Agrostis spp.	9.61	17.65	0.15
Elymus lanceolatus	9.46	17.65	0.12

Erigeron spp.	9.30	17.65	0.09
Astragalus flexuosus	8.99	17.65	0.03
Celtis reticulata	8.99	17.65	0.03
Frasera speciosa	8.99	17.65	0.03
Gaillardia aristata	8.99	17.65	0.03
Solidago spp.	8.99	17.65	0.03
Acosta diffusa	8.83	17.65	0.00
Alyssum alyssoides	8.83	17.65	0.00
Apocynum adrosaemifolium/A. cannabinum	8.83	17.65	0.00
Asclepias stenophylla	8.83	17.65	0.00
Asclepias viridiflora	8.83	17.65	0.00
Bromopsis lanatipes	8.83	17.65	0.00
Calochortus gunnisonii	8.83	17.65	0.00
Chenopodium leptophyllum	8.83	17.65	0.00
Eriogonum spp.	8.83	17.65	0.00
Physalis virginiana	8.83	17.65	0.00
Thermopsis divaricarpa	8.83	17.65	0.00
Sporobolus spp.	7.62	11.76	0.32
Unknown grass	7.62	11.76	0.32
Anisantha/Bromus spp.	6.51	11.76	0.12
Dichanthelium oligosanthes scribnerianum	6.51	11.76	0.12
Panicum virgatum	6.51	11.76	0.12
Sporobolus heterolepis	6.20	11.76	0.06
Thinopyrum intermedium	6.04	11.76	0.03
Amorpha nana	5.89	11.76	0.00
Aristida purpurea	5.89	11.76	0.00
Aster laevis geyeri	5.89	11.76	0.00
Cystopteris fragilis	5.89	11.76	0.00
Echinocereus viridiflorus	5.89	11.76	0.00
Heuchera spp.	5.89	11.76	0.00
Lesquerella montana	5.89	11.76	0.00
Mertensia lanceolata	5.89	11.76	0.00
Neolepia campestre	5.89	11.76	0.00
Oligoneuron rigidum	5.89	11.76	0.00
Penstemon secundiflorus	5.89	11.76	0.00
Phleum pratense	5.89	11.76	0.00
Pseudotsuga menziesii	5.89	11.76	0.00
Scutellaria brittonii	5.89	11.76	0.00
Carex sp. 1	4.36	5.88	0.26
Lupinus argenteus	3.73	5.88	0.15
Dichanthelium linearifolium	3.57	5.88	0.12
Unknown grass 1	3.57	5.88	0.12
Asclepias pumila	3.41	5.88	0.09
Bromopsis inermis	3.41	5.88	0.09
Elymus canadensis	3.41	5.88	0.09
Tithymalus spathulatus	3.26	5.88	0.06
Unknown forb	3.26	5.88	0.06
Alyssum spp.	3.10	5.88	0.03
Calylophus serrulatus	3.10	5.88	0.03
Cercocarpus montanus	3.10	5.88	0.03
Heterotheca foliosa	3.10	5.88	0.03
Oligosporus pacificus	3.10	5.88	0.03
Potentilla recta	3.10	5.88	0.03
Prunus americana	3.10	5.88	0.03
Acer glabrum	2.94	5.88	0.00
Acetosella vulgaris	2.94	5.88	0.00
Alyssum parviflorum	2.94	5.88	0.00
Amelanchier alnifolia	2.94	5.88	0.00
Amerosedum lanceolatum	2.94	5.88	0.00
Asclepias spp.	2.94	5.88	0.00
Asparagus officinalis	2.94	5.88	0.00
Astragalus spp.	2.94	5.88	0.00
Bassia sieversiana	2.94	5.88	0.00
Breea arvensis	2.94	5.88	0.00
Brickellia rosmarinifolia chlorolepis	2.94	5.88	0.00
Bromopsis canadensis/B. porteri	2.94	5.88	0.00
Carex pensylvanica heliophila	2.94	5.88	0.00
Ceanothus fendleri	2.94	5.88	0.00
Ceanothus herbaceus	2.94	5.88	0.00
Corallorhiza maculata	2.94	5.88	0.00
Crataegus spp.	2.94	5.88	0.00
Dactylis glomerata	2.94	5.88	0.00
Dianthus armeria	2.94	5.88	0.00
Elymus trachycaulus	2.94	5.88	0.00
Fallopia convolvulus	2.94	5.88	0.00
Galium spp.	2.94	5.88	0.00
Heterotheca villosa	2.94	5.88	0.00
Iris missouriensis	2.94	5.88	0.00
Nassella viridula	2.94	5.88	0.00
Negundo aceroides interius	2.94	5.88	0.00
Opuntia polyacantha	2.94	5.88	0.00
Oreocarya virgata	2.94	5.88	0.00
Oxybaphus hirsutus	2.94	5.88	0.00
Oxybaphus spp.	2.94	5.88	0.00
Oxytropis lambertii	2.94	5.88	0.00
Packera fendleri	2.94	5.88	0.00
Penstemon spp.	2.94	5.88	0.00
Plantago patagonica	2.94	5.88	0.00
Silene antirrhina	2.94	5.88	0.00
Solidago missouriensis	2.94	5.88	0.00
Sporobolus cryptandrus	2.94	5.88	0.00
Verbena bracteata	2.94	5.88	0.00
Viola nuttallii	2.94	5.88	0.00
Viola spp.	2.94	5.88	0.00

Appendix 7. Group E Species Importance.

RANKED Group E	Percentage Importance	Constancy	Average Cover
<Other - Litter>	752.46	100.00	62.05
<Other - Bare Rock>	147.40	96.83	8.21
Danthonia spicata pinetorum	100.00	74.60	5.11
Carex spp.	80.54	82.54	2.97
Pinus ponderosa scopulorum	75.36	101.59	1.53
Artemisia ludoviciana	54.73	85.71	0.50
Campanula rotundifolia	52.00	85.71	0.26
Mahonia repens	50.82	58.73	1.53
Penstemon virens	47.24	76.19	0.32
Achillea lanulosa	45.44	74.60	0.24
Harbouria trachypleura	44.95	76.19	0.12
Ribes cereum	43.83	73.02	0.18
Ceanothus fendleri	43.17	63.49	0.61
Poa agassizensis	42.75	60.32	0.73
Drymocallis fissa	42.45	69.84	0.22
Pseudotsuga menziesii	40.22	50.79	0.99
Heterotheca villosa/H. foliosa	39.52	63.49	0.28
Elymus elymoides/E. longifolius	39.49	66.67	0.12
Opuntia macrorhiza	39.22	66.67	0.09
Padus virginiana melanocarpa	39.02	52.38	0.81
Grindelia squarrosa/G. subalpina	36.10	60.32	0.14
Verbascum thapsus	35.23	60.32	0.06
Poa compressa	35.12	53.97	0.38
Allium cernuum	34.87	60.32	0.03
Andropogon gerardii	34.69	49.21	0.58
Cerastium strictum	34.55	57.14	0.16
Achnatherum nelsonii	34.05	53.97	0.28
Ambrosia psilostachya coronopifolia	32.80	52.38	0.25
Tragopogon dubius major	32.79	57.14	0.01
Muhlenbergia montana	30.61	49.21	0.22
Anisantha tectorum	30.44	42.86	0.53
Carduus nutans macrolepis	28.59	49.21	0.04
Rosa woodsii/R. sayi	27.82	46.03	0.13
Antennaria spp.	27.56	46.03	0.11
Leucopoa kingii	26.63	38.10	0.43
Phleum pratense	26.31	39.68	0.32
Bromus japonicus	25.35	41.27	0.15
Liatris punctata	24.56	41.27	0.08
Symphoricarpos albus/S. occidentalis	24.43	31.75	0.56
Bromopsis lanatipes	23.56	39.68	0.07
Schizachyrium scoparium	23.53	38.10	0.15
<Other - Soil>	23.16	31.75	0.44
Rhus aromatica trilobata	23.14	34.92	0.28
Koeleria macrantha	22.83	38.10	0.09
Breea arvensis	22.66	33.33	0.32
Lathyrus spp.	21.91	30.16	0.41
Phacelia heterophylla	21.86	38.10	0.00
Geranium caespitosum	21.04	36.51	0.01
Oreobatus deliciosus	20.83	34.92	0.07
Hesperostipa comata	20.77	31.75	0.23
Artemisia frigida	20.66	34.92	0.06
Solidago spp.	19.48	33.33	0.03
Monarda fistulosa methifolia/M. pectinata	19.03	26.98	0.32
Sabina scopulorum	18.60	28.57	0.20
Gaillardia aristata	18.22	31.75	0.00
Pulsatilla patens multifida	16.66	28.57	0.03
Psoralidium tenuiflorum	15.79	23.81	0.19
Aster porteri	15.37	25.40	0.07
<Other - Gravel>	13.85	12.70	0.59
Cynoglossum officinale	13.75	23.81	0.01
Juniperus communis alpina	13.67	19.05	0.25
Rubus idaeus melanolasius	13.66	17.46	0.33
Eriogonum umbellatum	12.84	22.22	0.01
Bromopsis inermis	12.62	12.70	0.48
Mertensia lanceolata	12.02	20.63	0.02
Taraxacum officinale	12.02	20.63	0.02
Anaphalis margaritacea	11.93	20.63	0.01
Leymus ambiguus	11.87	17.46	0.17
Elytrigia repens	11.79	17.46	0.16
Elymus trachycaulus	11.63	19.05	0.06
Lactuca serriola	11.54	19.05	0.06
Erigeron spp.	11.37	19.05	0.04
Scutellaria brittonii	11.19	19.05	0.03
Hypericum perforatum	11.19	19.05	0.03
Cystopteris fragilis	11.10	19.05	0.02
Silene antirrhina	10.93	19.05	0.00
Eriogonum flavum	10.37	17.46	0.03
Chlorocrepis albiflora	10.19	17.46	0.02
Packera fendleri	10.19	17.46	0.02
Opuntia polyacantha	10.02	17.46	0.00
Yucca glauca	9.37	15.87	0.03
Cirsium ochrocentrum	9.11	15.87	0.00
Oreocarya virgata	9.11	15.87	0.00
Allium spp.	9.08	14.29	0.08
Sorghastrum avenaceum	8.88	12.70	0.14
Arnica fulgens	8.46	14.29	0.03
Lupinus argenteus	8.46	14.29	0.02

Thermopsis divaricarpa	8.44	12.70	0.10
Corallorhiza maculata	8.20	14.29	0.00
Frasera speciosa	8.20	14.29	0.00
Carex sp. 1	7.88	11.11	0.13
Helianthus pumilus	7.64	12.70	0.03
Arctostaphylos uva-ursi	7.61	11.11	0.11
Eremogone fendleri	7.55	12.70	0.02
Bromus briziformis	7.29	12.70	0.00
Lesquerella montana	7.29	12.70	0.00
Cercocarpus montanus	7.15	9.52	0.15
Galium septentrionale	6.99	11.11	0.06
Elymus lanceolatus	6.82	11.11	0.04
Acer glabrum	6.46	11.11	0.01
Gutierrezia sarothrae	6.46	11.11	0.01
Amerosedum lanceolatum	6.38	11.11	0.00
Achnatherum scribneri	6.35	9.52	0.08
Toxicodendron rydbergii	5.73	9.52	0.02
Elymus canadensis	5.64	9.52	0.02
Iris missouriensis	5.64	9.52	0.02
Unknown forb	5.59	6.35	0.17
Onosmodium molle occidentale	5.55	9.52	0.01
Calochortus gunnisonii	5.47	9.52	0.00
Physalis spp.	5.47	9.52	0.00
Glycyrrhiza lepidota	5.46	3.17	0.33
Carex pensylvanica heliophila	5.08	7.94	0.05
Carex occidentalis	4.99	7.94	0.04
Apocynum androsaemifolium	4.91	7.94	0.03
Muhlenbergia wrightii	4.73	7.94	0.02
Unknown grass	4.70	6.35	0.10
Rhus glabra	4.64	7.94	0.01
Dalea purpurea	4.55	7.94	0.00
Galium spp.	4.55	7.94	0.00
Oxalis dillenii	4.55	7.94	0.00
Solidago nana	4.09	6.35	0.04
Bouteloua curtipendula	3.91	6.35	0.02
Hesperostipa spartea	3.90	6.35	0.02
Sporobolus heterolepis	3.86	3.17	0.18
Sporobolus cryptandrus	3.82	6.35	0.02
Alyssum alyssoides	3.73	6.35	0.01
Apocynum adrosaemifolium/A. cannabinum	3.73	6.35	0.01
Fallopia convolvulus	3.73	6.35	0.01
Heterotheca foliosa	3.73	6.35	0.01
Heterotheca villosa	3.73	6.35	0.01
Nassella viridula	3.73	6.35	0.01
Physalis hederifolia comata	3.73	6.35	0.01
Dactylis glomerata	3.64	6.35	0.00
Heuchera spp.	3.64	6.35	0.00
Pterospora andromedea	3.64	6.35	0.00
<Other - Trail>	3.33	3.17	0.13
Selaginella spp.	3.17	4.76	0.04
Prunus americana	2.98	3.17	0.10
Elymus longifolius	2.91	4.76	0.02
Acosta diffusa	2.73	4.76	0.00
Astragalus adsurgens robustior	2.73	4.76	0.00
Chenopodium spp.	2.73	4.76	0.00
Erysimum capitatum	2.73	4.76	0.00
Galium aparine	2.73	4.76	0.00
Neolepia campestre	2.73	4.76	0.00
Oligosporus dracunculus glaucus	2.73	4.76	0.00
Senecio spp.	2.73	4.76	0.00
Viola spp.	2.73	4.76	0.00
Juncus interior	2.53	3.17	0.06
Pascopyrum smithii	2.26	3.17	0.04
Carex petasata	2.24	1.59	0.12
Thinopyrum intermedium	2.18	3.17	0.03
Carex brevior	2.09	3.17	0.02
Tragia ramosa	2.08	3.17	0.02
Agropyron cristatum desertorum	2.00	3.17	0.02
Osmorhiza depauperata	2.00	3.17	0.02
Carex sp. 2	2.00	3.17	0.02
Grindelia squarrosa	2.00	3.17	0.02
Crocanthemum bicknellii	1.98	1.59	0.10
Alyssum parviflorum	1.91	3.17	0.01
Arrhenatherum elatius	1.91	3.17	0.01
Astragalus flexuosus	1.91	3.17	0.01
Cirsium vulgare	1.91	3.17	0.01
Dicanthelium spp.	1.91	3.17	0.01
Pneumonanthe bigelovii	1.91	3.17	0.01
Senecio integerrimus	1.91	3.17	0.01
Alyssum spp.	1.82	3.17	0.00
Amorpha nana	1.82	3.17	0.00
Anisantha/Bromus spp.	1.82	3.17	0.00
Asclepias stenophylla	1.82	3.17	0.00
Bahia dissecta	1.82	3.17	0.00
Camelina microcarpa	1.82	3.17	0.00
Chenopodium leptophyllum	1.82	3.17	0.00
Chondrosum gracile	1.82	3.17	0.00
Collinsia parviflora	1.82	3.17	0.00
Collomia linearis	1.82	3.17	0.00
Colutea arborescens	1.82	3.17	0.00
Comandra umbellata pallida	1.82	3.17	0.00
Corallorhiza spp.	1.82	3.17	0.00
Dichanthelium oligosanthes	1.82	3.17	0.00

scribnerianum			
Eriogonum spp.	1.82	3.17	0.00
Lithospermum incisum	1.82	3.17	0.00
Lithospermum multiflorum	1.82	3.17	0.00
Maianthemum spp.	1.82	3.17	0.00
Nepeta cataria	1.82	3.17	0.00
Paronychia jamesii	1.82	3.17	0.00
Physalis virginiana	1.82	3.17	0.00
Poa cusickii epilis	1.82	3.17	0.00
Pseudognaphalium canescens	1.82	3.17	0.00
Rumex crispus	1.82	3.17	0.00
Acetosella vulgaris	1.35	1.59	0.04
Unknown grass 1	1.35	1.59	0.04
Unknown grass 3	1.26	1.59	0.03
Panicum virgatum	1.18	1.59	0.02
Allium textile	1.09	1.59	0.02
Lathyrus leucanthus	1.09	1.59	0.02
Unknown forb 1	1.09	1.59	0.02
Unknown grass 2	1.09	1.59	0.02
Agrostis gigantea	1.00	1.59	0.01
Astragalus tenellus	1.00	1.59	0.01
Bassia sieversiana	1.00	1.59	0.01
Dichanthelium linearifolium	1.00	1.59	0.01
Elymus glaucus	1.00	1.59	0.01
Holodiscus discolor	1.00	1.59	0.01
Jamesia americana	1.00	1.59	0.01
Ligusticum porteri	1.00	1.59	0.01
Oxytropis lambertii	1.00	1.59	0.01
Pseudognaphalium viscosum	1.00	1.59	0.01
Acosta maculosa	0.91	1.59	0.00
Adenolinum lewisii	0.91	1.59	0.00
Aletes acaulis	0.91	1.59	0.00
Aristida spp.	0.91	1.59	0.00
Aster laevis geyeri	0.91	1.59	0.00
Astragalus agrestis	0.91	1.59	0.00
Brickellia californica	0.91	1.59	0.00
Brickellia grandiflora	0.91	1.59	0.00
Bromopsis spp.	0.91	1.59	0.00
Carex foenea	0.91	1.59	0.00
Cerasus pensylvanica	0.91	1.59	0.00
Chrysothamnus nauseosus nauseosus	0.91	1.59	0.00
Clematis ligusticifolia	0.91	1.59	0.00
Convolvulus arvensis	0.91	1.59	0.00
Coriflora hirsutissima	0.91	1.59	0.00
Coryphantha missouriensis	0.91	1.59	0.00
Danthonia parryi	0.91	1.59	0.00
Drymocallis arguta	0.91	1.59	0.00
Elymus elymoides	0.91	1.59	0.00
Erigeron colo-mexicanus	0.91	1.59	0.00
Erigeron colo-mexicanus/E. divergens	0.91	1.59	0.00
Erigeron flagellaris	0.91	1.59	0.00
Erigeron speciosus macranthus	0.91	1.59	0.00
Helianthus spp.	0.91	1.59	0.00
Heliomeris multiflora	0.91	1.59	0.00
Hypericum formosum	0.91	1.59	0.00
Juncus acuminatus	0.91	1.59	0.00
Juncus arcticus ater	0.91	1.59	0.00
Linaria genistifolia dalmatica	0.91	1.59	0.00
Lomatium orientale	0.91	1.59	0.00
Maianthemum stellatum	0.91	1.59	0.00
Nothocalais cuspidata	0.91	1.59	0.00
Oligosporus pacificus	0.91	1.59	0.00
Opuntia fragilis	0.91	1.59	0.00
Penstemon spp.	0.91	1.59	0.00
Phlox multiflora	0.91	1.59	0.00
Physocarpus monogynus/P. opulifolius	0.91	1.59	0.00
Poa pratensis	0.91	1.59	0.00
Poa spp.	0.91	1.59	0.00
Polygonum douglasii	0.91	1.59	0.00
Pseudostellaria jamesiana	0.91	1.59	0.00
Pterogonum alatum	0.91	1.59	0.00
Ratibida columnifera	0.91	1.59	0.00
Saponaria officinalis	0.91	1.59	0.00
Scrophularia lanceolata	0.91	1.59	0.00
Senecio spartioides	0.91	1.59	0.00
Silene scouleri hallii	0.91	1.59	0.00
Thalictrum fendleri	0.91	1.59	0.00
Tithymalus myrsinites	0.91	1.59	0.00
Townsendia grandiflora	0.91	1.59	0.00
Toxicoscordion venenosum	0.91	1.59	0.00
Tradescantia occidentalis scopulorum	0.91	1.59	0.00
Turritis glabra	0.91	1.59	0.00
Virgulus falcatus	0.91	1.59	0.00

Appendix 8. All Samples Importance

	Percentage Importance	Constancy	Average Cover %
<Other - Litter>	1080.3201	100.0000	56.577
<Other - Bare Rock>	187.4962	96.7480	7.382
Carex spp.	100.0000	86.9919	2.851
Danthonia spicata pinetorum	84.5308	52.0325	3.070
Pinus ponderosa scopulorum	79.9809	99.1870	1.371
Poa compressa	75.9529	70.7317	2.022
Andropogon gerardii	68.5303	60.9756	1.912
Poa agassizensis	66.3374	73.1707	1.416
Artemisia ludoviciana	62.5143	88.6179	0.731
Penstemon virens	55.6511	80.4878	0.602
Achillea lanulosa	53.0256	82.1138	0.407
Rhus aromatica trilobata	50.0564	54.4715	1.092
Ribes cereum	45.5764	74.7967	0.220
Grindelia squarrosa/G. subalpina	45.4748	73.9837	0.240
Opuntia macrorhiza	44.5559	74.7967	0.164
Mahonia repens	44.5420	48.7805	0.962
Ambrosia psilostachya coronopifolia	41.4229	57.7236	0.515
Drymocallis fissa	41.2784	67.4797	0.208
Padus virginiana melanocarpa	39.8963	47.1545	0.755
Campanula rotundifolia	39.1889	65.0407	0.167
Tragopogon dubius major	38.5837	67.4797	0.059
Achnatherum nelsonii	37.8817	52.0325	0.494
Cerastium strictum	36.0144	59.3496	0.167
Heterotheca villosa/H. foliosa	34.6834	53.6585	0.268
Muhlenbergia montana	34.2947	52.8455	0.271
Symphoricarpos albus/S. occidentalis	33.9151	41.4634	0.600
Elymus elymoides/E. longifolius	33.5495	56.0976	0.130
Bromus japonicus	33.5055	49.5935	0.327
Arnica fulgens	33.5017	27.6423	1.001
Anisantha tectorum	32.8357	43.0894	0.490
Verbascum thapsus	31.4718	54.4715	0.065
Koeleria macrantha	31.2613	51.2195	0.154
<Other - Soil>	30.3872	33.3333	0.654
Hesperostipa comata	30.3443	39.8374	0.452
Rosa woodsii/R. sayi	29.4400	47.1545	0.178
Antennaria spp.	29.3164	43.9024	0.271
Harbouria trachypleura	29.2057	50.4065	0.065
Carduus nutans macrolepis	29.0570	50.4065	0.057
Ceanothus fendleri	26.6557	37.3984	0.324
Pseudotsuga menziesii	26.3865	30.0813	0.533
Hypericum perforatum	25.9695	40.6504	0.186
Liatris punctata	25.9164	42.2764	0.133
Artemisia frigida	25.8545	43.0894	0.105
Oreobatus deliciosus	25.4614	41.4634	0.133
Phacelia heterophylla	25.2935	43.9024	0.049
Allium cernuum	25.2316	44.7154	0.020
Psoralidium tenuiflorum	24.9168	34.9593	0.303
Schizachyrium scoparium	24.6089	39.0244	0.161
Aster porteri	23.2926	34.1463	0.238
Lathyrus spp.	22.4372	30.8943	0.290
Gaillardia aristata	21.3680	37.3984	0.032
Taraxacum officinale	21.1796	34.9593	0.096
Phleum pratense	19.5452	29.2683	0.181
Pulsatilla patens multifida	19.2477	33.3333	0.039
Eremogone fendleri	18.9828	26.0163	0.249
Geranium caespitosum	17.5220	30.8943	0.019
Leucopoa kingii	17.3926	23.5772	0.237
Monarda fistulosa methifolia/M. pectinata	17.1231	24.3902	0.197
Sabina scopulorum	17.1172	24.3902	0.196
Bromopsis lanatipes	16.6709	28.4553	0.047
Elymus lanceolatus	16.5300	13.8211	0.488
Breea arvensis	16.0791	23.5772	0.164
Yucca glauca	16.0231	25.2033	0.111
Mertensia lanceolata	15.5460	26.8293	0.035
Erigeron spp.	15.5151	25.2033	0.083
Allium spp.	15.0381	22.7642	0.131
Cynoglossum officinale	14.9452	26.0163	0.027
Leymus ambiguus	14.6952	14.6341	0.362
Anisantha/Bromus spp.	14.3594	17.0732	0.269
Bromus briziformis	14.0839	22.7642	0.079
Cirsium ochrocentrum	13.8217	24.3902	0.014
Unknown grass	13.5541	12.1951	0.374
Eriogonum umbellatum	13.5125	23.5772	0.022
Lactuca serriola	13.4007	21.1382	0.091
Galium spp.	13.0768	19.5122	0.123
<Other - Gravel>	12.1877	8.9431	0.398
Solidago spp.	12.1535	21.1382	0.022
Chondrosum gracile	11.6514	17.8862	0.094

Sorghastrum avenaceum	11.3865	14.6341	0.179
Neolepia campestre	10.7915	18.6992	0.022
Gutierrezia sarothrae	10.7193	18.6992	0.018
Bouteloua curtipendula	10.3262	17.0732	0.046
Eriogonum flavum	10.2408	16.2602	0.066
Cystopteris fragilis	10.1215	17.8862	0.010
Elymus trachycaulus	9.9449	16.2602	0.050
Bromopsis inermis	9.7654	8.9431	0.265
Alyssum alyssoides	9.4177	15.4472	0.046
Senecio integerrimus	9.3986	14.6341	0.070
Dalea purpurea	9.3588	16.2602	0.018
Helianthus pumilus	9.2749	15.4472	0.038
Unknown forb	9.1057	9.7561	0.203
Lomatium orientale	8.9804	15.4472	0.022
Opuntia polyacantha	8.9068	15.4472	0.018
Oxalis dillenii	8.9053	15.4472	0.017
Scutellaria brittonii	8.8346	15.4472	0.014
Cercocarpus montanus	8.7699	11.3821	0.135
Thermopsis divaricarpa	8.7330	13.8211	0.058
Rubus idaeus melanolasius	8.5255	9.7561	0.171
Pneumonanthe bigelovii	8.5254	14.6341	0.021
Carex pensylvanica heliophila	8.2810	13.0081	0.058
Juniperus communis alpina	8.2384	10.5691	0.130
Frasera speciosa	8.2353	14.6341	0.005
Carex sp. 1	8.2119	8.9431	0.179
Silene antirrhina	8.1632	14.6341	0.001
Camelina microcarpa	8.0719	13.8211	0.021
Pascopyrum smithii	8.0175	10.5691	0.118
Onosmodium molle occidentale	7.9997	13.8211	0.017
Oreocarya virgata	7.9997	13.8211	0.017
Amerosedum lanceolatum	7.8540	13.8211	0.009
Elytrigia repens	7.8143	11.3821	0.082
Lesquerella montana	7.7818	13.8211	0.005
Packera fendleri	7.5448	13.0081	0.017
Corallorhiza maculata	7.2561	13.0081	0.001
Lupinus argenteus	6.8322	9.7561	0.078
Toxicodendron rydbergii	6.7865	11.3821	0.025
Lithospermum multiflorum	6.7143	11.3821	0.021
Anaphalis margaritacea	6.4934	11.3821	0.009
Opuntia fragilis	6.4213	11.3821	0.005
Potentilla recta	6.3919	9.7561	0.053
Sporobolus cryptandrus	6.2329	8.9431	0.070
Unknown grass 1	6.1726	4.8780	0.191
Oligosporus dracunculus glaucus	6.0414	10.5691	0.009
Eriogonum spp.	6.0399	10.5691	0.009
Calochortus gunnisonii	5.8956	10.5691	0.001
Collinsia parviflora	5.8956	10.5691	0.001
Ratibida columnifera	5.5143	9.7561	0.005
Astragalus flexuosus	5.2772	8.9431	0.017
Hesperostipa spartea	5.2772	8.9431	0.017
Nassella viridula	5.2051	8.9431	0.013
Adenolinum lewisii	5.1344	8.9431	0.009
Chlorocrepis albiflora	5.1329	8.9431	0.009
Potentilla hippiana	5.1329	8.9431	0.009
Muhlenbergia wrightii	5.1197	8.1301	0.033
Juncus interior	5.0314	7.3171	0.053
Unknown grass 2	4.8576	5.6911	0.093
Arctostaphylos uva-ursi	4.7987	6.5041	0.065
Comandra umbellata pallida	4.7515	8.1301	0.013
Galium septentrionale	4.7368	7.3171	0.037
Heuchera spp.	4.6072	8.1301	0.005
Virgulus falcatus	4.5057	6.5041	0.049
Elymus canadensis	4.4453	7.3171	0.021
Apocynum adrosaemifolium/A. cannabinum	4.2259	7.3171	0.009
Tradescantia occidentalis scopulorum	4.1537	7.3171	0.005
Sporobolus heterolepis	4.1038	4.0650	0.102
Glycyrrhiza lepidota	3.9227	1.6260	0.167
Tragia ramosa	3.9005	5.6911	0.041
<Other - Trail>	3.8594	2.4390	0.138
Iris missouriensis	3.8445	6.5041	0.013
Acosta diffusa	3.7002	6.5041	0.005
Fallopia convolvulus	3.7002	6.5041	0.005
Senecio spp.	3.7002	6.5041	0.005
Physalis virginiana	3.6281	6.5041	0.001
Achnatherum scribneri	3.4544	4.8780	0.041
Allium textile	3.3660	4.0650	0.061
Alyssum spp.	3.3189	5.6911	0.009
Acer glabrum	3.2467	5.6911	0.005
Heterotheca villosa	3.2335	4.8780	0.029
Erigeron colo-mexicanus/E. divergens	3.2203	4.0650	0.053
Dactylis glomerata	3.1746	5.6911	0.001
Selaginella spp.	3.1569	4.8780	0.025
Unknown forb 1	3.1334	3.2520	0.073
Rhus glabra	2.9390	4.8780	0.013
Acetosella vulgaris	2.9258	4.0650	0.037
Chenopodium leptophyllum	2.7211	4.8780	0.000
Erysimum capitatum	2.7211	4.8780	0.000

Physalis spp.	2.7211	4.8780	0.000
Viola spp.	2.7211	4.8780	0.000
Thinopyrum intermedium	2.6327	4.0650	0.021
Carex occidentalis	2.6298	4.0650	0.020
Apocynum androsaemifolium	2.5591	4.0650	0.017
Galium aparine	2.4855	4.0650	0.012
Alyssum parviflorum	2.4840	4.0650	0.012
Physocarpus monogynus/P. opulifolius	2.4517	1.6260	0.085
Convolvulus arvensis	2.4119	4.0650	0.008
Heterotheca foliosa	2.4119	4.0650	0.008
Prunus americana	2.3883	2.4390	0.057
Dichanthelium linearifolium	2.3869	2.4390	0.057
Nepeta cataria	2.3397	4.0650	0.004
Physalis hederifolia comata	2.3397	4.0650	0.004
Asclepias stenophylla	2.2675	4.0650	0.000
Rumex crispus	2.2675	4.0650	0.000
Turritis glabra	2.2675	4.0650	0.000
Linaria vulgaris	2.2293	1.6260	0.073
Solidago nana	2.1807	3.2520	0.021
Carex sp. 2	2.1763	3.2520	0.020
Dichanthelium oligosanthes scribnerianum	2.1056	3.2520	0.016
Carex brevior	2.0334	3.2520	0.012
Oligosporus pacificus	2.0320	3.2520	0.012
Celtis reticulata	1.8862	3.2520	0.004
Colutea arborescens	1.8862	3.2520	0.004
Juncus spp.	1.8862	3.2520	0.004
Noccaea montana	1.8862	3.2520	0.004
Panicum virgatum	1.8715	2.4390	0.028
Amorpha nana	1.8140	3.2520	0.000
Aster laevis geyeri	1.8140	3.2520	0.000
Chenopodium spp.	1.8140	3.2520	0.000
Echinocereus viridiflorus	1.8140	3.2520	0.000
Paronychia jamesii	1.8140	3.2520	0.000
Penstemon secundiflorus	1.8140	3.2520	0.000
Pseudognaphaliu m canescens	1.8140	3.2520	0.000
Pterospora andromedea	1.8140	3.2520	0.000
Townsendia grandiflora	1.8140	3.2520	0.000
Agrostis spp.	1.7242	2.4390	0.020
Sporobolus spp.	1.7140	1.6260	0.045
Crataegus spp.	1.6521	2.4390	0.016
Grindelia squarrosa	1.6506	2.4390	0.016
Carex petasata	1.5564	0.8130	0.061
Agropyron cristatum desertorum	1.5063	2.4390	0.008
Collomia linearis	1.5063	2.4390	0.008
Ribes inerme	1.5063	2.4390	0.008
Elymus longifolius	1.5048	2.4390	0.008
Poa spp.	1.4945	1.6260	0.033
Oxytropis lambertii	1.4327	2.4390	0.004
Oxytropis sericea	1.4327	2.4390	0.004
Phlox multiflora	1.4327	2.4390	0.004
Aristida spp.	1.3605	2.4390	0.000
Asclepias spp.	1.3605	2.4390	0.000
Asclepias viridiflora	1.3605	2.4390	0.000
Astragalus adsurgens robustior	1.3605	2.4390	0.000
Astragalus agrestis	1.3605	2.4390	0.000
Coriflora hirsutissima	1.3605	2.4390	0.000
Coryphantha missouriensis	1.3605	2.4390	0.000
Juncus arcticus ater	1.3605	2.4390	0.000
Leucocrinum montanum	1.3605	2.4390	0.000
Linaria genistifolia dalmatica	1.3605	2.4390	0.000
Lithospermum incisum	1.3605	2.4390	0.000
Nothocalais cuspidata	1.3605	2.4390	0.000
Penstemon spp.	1.3605	2.4390	0.000
Poa cusickii epilis	1.3605	2.4390	0.000
Thlaspi arvense	1.3605	2.4390	0.000
Crocanthemum bicknellii	1.3355	0.8130	0.049
Agrostis gigantea	1.2722	1.6260	0.020
Erigeron vetensis	1.1264	1.6260	0.012
Lathyrus leucanthus	1.0528	1.6260	0.008
Saponaria officinalis	1.0528	1.6260	0.008
Arrhenatherum elatius	0.9792	1.6260	0.004
Bassia sieversiana	0.9792	1.6260	0.004
Cirsium vulgare	0.9792	1.6260	0.004
Dicanthelium spp.	0.9792	1.6260	0.004
Aristida purpurea	0.9070	1.6260	0.000
Bahia dissecta	0.9070	1.6260	0.000
Castilleja sessiliflora	0.9070	1.6260	0.000
Claytonia rosea	0.9070	1.6260	0.000
Clematis ligusticifolia	0.9070	1.6260	0.000
Corallorhiza spp.	0.9070	1.6260	0.000
Erigeron colo-mexicanus	0.9070	1.6260	0.000
Erigeron speciosus macranthus	0.9070	1.6260	0.000
Helianthus spp.	0.9070	1.6260	0.000
Heuchera bracteata	0.9070	1.6260	0.000
Oligoneuron rigidum	0.9070	1.6260	0.000
Packera cana	0.9070	1.6260	0.000
Plantago patagonica	0.9070	1.6260	0.000
Poa pratensis	0.9070	1.6260	0.000
Polygonum douglasii	0.9070	1.6260	0.000

Scrophularia lanceolata	0.9070	1.6260	0.000
Sisyrinchium montanum	0.9070	1.6260	0.000
Toxicoscordion venenosum	0.9070	1.6260	0.000
Unknown grass 3	0.7465	0.8130	0.016
Asclepias pumila	0.6729	0.8130	0.012
Danthonia spp.	0.6729	0.8130	0.012
Bromus spp.	0.5993	0.8130	0.008
Osmorhiza depauperata	0.5993	0.8130	0.008
Poa fendleriana longiligula	0.5993	0.8130	0.008
Poa nervosa	0.5993	0.8130	0.008
Silene dichotoma	0.5993	0.8130	0.008
Tithymalus spathulatus	0.5993	0.8130	0.008
Unknown forb 3	0.5993	0.8130	0.008
Antennaria parvifolia	0.5257	0.8130	0.004
Astragalus tenellus	0.5257	0.8130	0.004
Calylophus serrulatus	0.5257	0.8130	0.004
Delphinium nuttallianum	0.5257	0.8130	0.004
Elymus glaucus	0.5257	0.8130	0.004
Holodiscus discolor	0.5257	0.8130	0.004
Jamesia americana	0.5257	0.8130	0.004
Ligusticum porteri	0.5257	0.8130	0.004
Phlox spp.	0.5257	0.8130	0.004
Poa secunda	0.5257	0.8130	0.004
Pseudognaphaliu m viscosum	0.5257	0.8130	0.004
Acosta maculosa	0.4535	0.8130	0.000
Aletes acaulis	0.4535	0.8130	0.000
Amelanchier alnifolia	0.4535	0.8130	0.000
Antennaria neglecta	0.4535	0.8130	0.000
Asparagus officinalis	0.4535	0.8130	0.000
Astragalus spp.	0.4535	0.8130	0.000
Brickellia californica	0.4535	0.8130	0.000
Brickellia grandiflora	0.4535	0.8130	0.000
Brickellia rosmarinifolia chlorolepis	0.4535	0.8130	0.000
Bromopsis canadensis/B. porteri	0.4535	0.8130	0.000
Bromopsis spp.	0.4535	0.8130	0.000
Bromus commutatus	0.4535	0.8130	0.000
Carex foenea	0.4535	0.8130	0.000
Castilleja miniata	0.4535	0.8130	0.000
Ceanothus herbaceus	0.4535	0.8130	0.000
Cerasus pensylvanica	0.4535	0.8130	0.000
Chrysothamnus nauseosus nauseosus	0.4535	0.8130	0.000
Danthonia parryi	0.4535	0.8130	0.000
Descurainia incisa	0.4535	0.8130	0.000
Dianthus armeria	0.4535	0.8130	0.000
Dichanthelium spp.	0.4535	0.8130	0.000
Drymocallis arguta	0.4535	0.8130	0.000
Eleocharis elliptica compressa	0.4535	0.8130	0.000
Elymus elymoides	0.4535	0.8130	0.000
Erigeron flagellaris	0.4535	0.8130	0.000
Heliomeris multiflora	0.4535	0.8130	0.000
Hypericum formosum	0.4535	0.8130	0.000
Juncus acuminatus	0.4535	0.8130	0.000
Maianthemum spp.	0.4535	0.8130	0.000
Maianthemum stellatum	0.4535	0.8130	0.000
Negundo aceroides interius	0.4535	0.8130	0.000
Oenothera villosa strigosa	0.4535	0.8130	0.000
Opuntia spp.	0.4535	0.8130	0.000
Oxybaphus hirsutus	0.4535	0.8130	0.000
Oxybaphus spp.	0.4535	0.8130	0.000
Packera plattensis	0.4535	0.8130	0.000
Prunella vulgaris	0.4535	0.8130	0.000
Pseudostellaria jamesiana	0.4535	0.8130	0.000
Pterogonum alatum	0.4535	0.8130	0.000
Quercus spp.	0.4535	0.8130	0.000
Senecio spartioides	0.4535	0.8130	0.000
Silene scouleri hallii	0.4535	0.8130	0.000
Solidago missouriensis	0.4535	0.8130	0.000
Stenactis strigosa	0.4535	0.8130	0.000
Thalictrum fendleri	0.4535	0.8130	0.000
Tithymalus myrsinites	0.4535	0.8130	0.000
Trifolium pratense	0.4535	0.8130	0.000
Triodanis perfoliata	0.4535	0.8130	0.000
Verbena bracteata	0.4535	0.8130	0.000
Viola nuttallii	0.4535	0.8130	0.000

Appendix 9. Acronyms for environmental vectors, sites, and species.

ENVIRONMENTAL ACRONYMS

SLOPE	% Slope
ASPE	Aspect
LITDEP	Avg Duff/Litter Depth
CLAY	Soil Texture - Clay
SAND	Soil Texture - Sand
REGE	Major Dist - Regeneration activities
TIMB	Major Dist - Timber stand impro
WILD	Major Dist - Wildlife activities
INSECT	Major Dist - Insect infestations
RECR	Major Dist - Recreation activities
BURN	Major Dist - Burn scenarios
HARV	Major Dist - Harvest methods
GRAZ	Major Dist - Grazing systems
WEAT	Major Dist - Weather conditions
OTHER	Major Dist - Other event type

SITE ACRONYMS

D101	D-1 #01
D105	D-1 #05
D110	D-1 #10
D1/8101	D-1/81 #01
D1/8105	D-1/81 #05
D201	D-2 #01
D205	D-2 #05
D210	D-2 #10
D3D401	D-3 AND D-4 #01
D3D405	D-3 AND D-4 #05
D3D410	D-3 AND D-4 #10
D3D415	D-3 AND D-4 #15
D3D420	D-3 AND D-4 #20
D3D425	D-3 AND D-4 #25
D3D430	D-3 AND D-4 #30
DAKR01	DAKR #01
DAKR05	DAKR #05
DAKR10	DAKR #10
ELDE01	ELDO-E #01
ELDE05	ELDO-E #05
ELDE10	ELDO-E #10
ELDE15	ELDO-E #15
LINN01	LIND-N #01
LINN05	LIND-N #05
LINN10	LIND-N #10
LINS01	LIND-S #01
LINS05	LIND-S #05
LINS10	LIND-S #10
LINS15	LIND-S #15
LJNE01	LJC-NE #01
LJNE05	LJC-NE #05
LJNE10	LJC-NE #10
LJNW01	LJC-NW #01
LJNW05	LJC-NW #05
LJNW10	LJC-NW #10
LJNW15	LJC-NW #15
LJSE01	LJC-SE #01
LJSE05	LJC-SE #05
LJSE10	LJC-SE #10
LJSE15	LJC-SE #15
LJSE20	LJC-SE #20
LJSW01	LJC-SW #01
LJSW05	LJC-SW #05
LJSW10	LJC-SW #10
LOSH01	LOWER SHANAHAN #01
LOSH05	LOWER SHANAHAN #05
LOSH10	LOWER SHANAHAN #10
MRL01	MRL #01
MRL05	MRL #05
MRL10	MRL #10
MRL15	MRL #15
MRL20	MRL #20
PNBK01	PNBRK #01
PNBK05	PNBRK #05
PNBK10	PNBRK #10
PWRL01	POWERLINE #01
PWRL05	POWERLINE #05
PWRL10	POWERLINE #10
PWRL15	POWERLINE #15
PWRL20	POWERLINE #20
PWRL25	POWERLINE #25
S1001	S-10 #01
S1005	S-10 #05
S1010	S-10 #10
S301	S-3 #01
S305	S-3 #05
S310	S-3 #10
S315	S-3 #15
S320	S-3 #20
S325	S-3 #25
S401	S-4 #01
S405	S-4 #05
S410	S-4 #10
S501	S-5 #01
S505	S-5 #05
S510	S-5 #10
S901	S-9 #01
S905	S-9 #05
S910	S-9 #10
ST101	ST-1 #01
ST105	ST-1 #05
ST110	ST-1 #10
ST115	ST-1 #15
ST1001	ST-10 #01
ST1005	ST-10 #05
ST301	ST-3 #01
ST305	ST-3 #05
ST310	ST-3 #10
ST501	ST-5 #01
ST505	ST-5 #05
ST601	ST-6 #01
ST605	ST-6 #05
ST610	ST-6 #10
ST615	ST-6 #15
ST701	ST-7 #01
ST705	ST-7 #05
ST801	ST-8 #01
ST805	ST-8 #05
ST901	ST-9 #01
ST905	ST-9 #05
STG201	STGL-II #01
STG205	STGL-II #05
STG210	STGL-II #10
STG215	STGL-II #15
STG220	STGL-II #20
SNSH01	SUNSHINE #01
SNSH05	SUNSHINE #05
WTRT01	WATERTANK #01
WTRT05	WATERTANK #05
WTRT10	WATERTANK #10
WTRT15	WATERTANK #15
WTRT20	WATERTANK #20
WITE01	WITT-E #01
WITE05	WITT-E #05

WITE10	WITT-E #10
WITNE01	WITT-NE #01
WITNE05	WITT-NE #05
WITNE10	WITT-NE #10
WITNE15	WITT-NE #15
WITNE20	WITT-NE #20
WITNE25	WITT-NE #25
WITNE30	WITT-NE #30
WITNW01	WITT-NW #01
WITNW05	WITT-NW #05
WITNW10	WITT-NW #10
WITNW15	WITT-NW #15
WITNW20	WITT-NW #20
WITS01	WITT-S #01
WITS05	WITT-S #05
WITS10	WITT-S #10
WITW01	WITT-W #01
WITW05	WITT-W #05
WITW10	WITT-W #10

SPECIES ACRONYMS

ROCK	<Other - Bare Rock>
GRAVEL	<Other - Gravel>
LITTER	<Other - Litter>
SOIL	<Other - Soil>
TRAIL	<Other - Trail>
ACGL	Acer glabrum
ACVU	Acetosella vulgaris
ACLA5	Achillea lanulosa
ACHNEL	Achnatherum nelsonii
ACHSCR	Achnatherum scribneri
ACDI2	Acosta diffusa
ACMA9	Acosta maculosa
ADLE	Adenolinum lewisii
ACGRD	Agropyron cristatum desertorum
AGGI2	Agrostis gigantea
AGSP	Agrostis sp.
ALAC2	Aletes acaulis
ALCE2	Allium cernuum
ALSP	Allium sp.
ALTE	Allium textile
ALAL3	Alyssum alyssoides
ALPA7	Alyssum parviflorum
ALYSP	Alyssum sp.
AMPSC2	Ambrosia psilostachya coronopifolia
AMAL2	Amelanchier alnifolia
AMLA6	Amerosedum lanceolatum
AMNA	Amorpha nana
ANMA	Anaphalis margaritacea
ANGE	Andropogon gerardii
ANST4	Anisantha sterilis
ANTE6	Anisantha tectorum
ABSP	Anisantha/Bromus sp.
ANNE	Antennaria neglecta
ANPA4	Antennaria parvifolia
ANSP	Antennaria sp.
ANSP1	Antennaria sp. 1
ANSP2	Antennaria sp. 2
APANC	Apocynum adrosaemifolium/A. cannabinum
APAN2	Apocynum androsaemifolium
ARUV	Arctostaphylos uva-ursi
ARPU2	Aristida purpurea
ARISP	Aristida sp.
ARFU3	Arnica fulgens
AREL3	Arrhenatherum elatius
ARFR4	Artemisia frigida
ARLU	Artemisia ludoviciana
ASPU	Asclepias pumila
ASSP2	Asclepias sp.
ASST	Asclepias stenophylla
ASVI	Asclepias viridiflora
ASOF	Asparagus officinalis
ASLAG	Aster laevis geyeri
ASPO5	Aster porteri
ASADR	Astragalus adsurgens robustior
ASAG2	Astragalus agrestis
ASFL	Astragalus flexuosus
ASSP3	Astragalus sp.
ASTE5	Astragalus tenellus
BADI	Bahia dissecta
BASI	Bassia sieversiana
BOCU	Bouteloua curtipendula
BRAR	Breea arvensis
BRCA3	Brickellia californica

BRGR	Brickellia grandiflora
BRROC	Brickellia rosmarinifolia chlorolepis
BRSP	Brickellia sp.
BRPO	Bromopsis canadensis/B. porteri
BRIN7	Bromopsis inermis
BRLA10	Bromopsis lanatipes
BRSP2	Bromopsis sp.
BRBR5	Bromus briziformis
BRCO4	Bromus commutatus
BRJA	Bromus japonicus
BRSP3	Bromus sp.
CAGU	Calochortus gunnisonii
CASE12	Calylophus serrulatus
CAMI2	Camelina microcarpa
CARO2	Campanula rotundifolia
CANUM3	Carduus nutans macrolepis
CABR10	Carex brevior
CAFO3	Carex foenea
CAOC2	Carex occidentalis
CAPEH	Carex pensylvanica heliophila
CAPE7	Carex petasata
CASP	Carex sp.
CASP1	Carex sp. 1
CASP2	Carex sp. 2
CAMI12	Castilleja miniata
CASE5	Castilleja sessiliflora
CEFE	Ceanothus fendleri
CEHE	Ceanothus herbaceus
CERE2	Celtis reticulata
CEST3	Cerastium strictum
CEPE	Cerasus pensylvanica
CEMO2	Cercocarpus montanus
CHLE	Chenopodium leptophyllum
CHSP	Chenopodium sp.
CHAL16	Chlorocrepis albiflora
CHGR15	Chondrosum gracile
CHNAN3	Chrysothamnus nauseosus nauseosus
CIOC2	Cirsium ochrocentrum
CIVU	Cirsium vulgare
CLRO5	Claytonia rosea
CLLI2	Clematis ligusticifolia
COPA3	Collinsia parviflora
COLI2	Collomia linearis
COAR6	Colutea arborescens
COUMP	Comandra umbellata pallida
COAR4	Convolvulus arvensis
COMA	Corallorhiza maculata
COSP	Corallorhiza sp.
COHI5	Coriflora hirsutissima
COCO6	Corylus cornuta
COMI5	Coryphantha missouriensis
CRSP	Crataegus sp.
CRBI6	Crocanthemum bicknellii
CYOF	Cynoglossum officinale
CYFR2	Cystopteris fragilis
DAGL	Dactylis glomerata
DAPU5	Dalea purpurea
DAPA2	Danthonia parryi
DASP	Danthonia sp.
DASPP	Danthonia spicata pinetorum
DENU2	Delphinium nuttallianum
DEIN	Descurainia incisa
DIAR	Dianthus armeria
DICSP	Dicanthelium sp.
DILI2	Dichanthelium linearifolium
DIOLS	Dichanthelium oligosanthes scribnerianum
DISP	Dichanthelium sp.
DRYARG	Drymocallis arguta
DRFI3	Drymocallis fissa
ECVI2	Echinocereus viridiflorus
ELELC	Eleocharis elliptica compressa
ELCA4	Elymus canadensis
ELEL5	Elymus elymoides
ELEL2	Elymus elymoides/E. longifolius
ELGL	Elymus glaucus
ELLA3	Elymus lanceolatus
ELLO3	Elymus longifolius
ELTR	Elymus trachycaulus
ELRE3	Elytrigia repens
ERFE3	Eremogone fendleri
ERCO	Erigeron colo-mexicanus
ERCO2	Erigeron colo-mexicanus/E. divergens
ERFL	Erigeron flagellaris
ERSP	Erigeron sp.
ERSPM	Erigeron speciosus macranthus
ERVE2	Erigeron vetensis
ERFL2	Eriogonum flavum
ERSP2	Eriogonum sp.
ERUM	Eriogonum umbellatum
ERCA14	Erysimum capitatum
FACO	Fallopia convolvulus
FRSP	Frasera speciosa
GAAR	Gaillardia aristata
GAAP2	Galium aparine
GASE6	Galium septentrionale
GASL	Galium sp.
GECA	Geranium caespitosum
GLLE3	Glycyrrhiza lepidota
GRSQ	Grindelia squarrosa
GRSQ2	Grindelia squarrosa/G. subalpina
GASA2	Gutierrezia sarothrae
HATR	Harbouria trachypleura
HEPU3	Helianthus pumilus
HESP	Helianthus sp.
HEMU3	Heliomeris multiflora
HECO	Hesperostipa comata
HESP2	Hesperostipa spartea
HEFO	Heterotheca foliosa
HEVI	Heterotheca villosa
HEVI2	Heterotheca villosa/H. foliosa
HEBR2	Heuchera bracteata
HESP3	Heuchera sp.
HODID2	Holodiscus discolor
HYPFOR	Hypericum formosum
HYPE	Hypericum perforatum
IRMI	Iris missouriensis
JAAM	Jamesia americana
JUNACU	Juncus acuminatus
JUARA4	Juncus arcticus ater
JUIN2	Juncus interior
JUSP	Juncus sp.
JUCOA8	Juniperus communis alpina
KOMA	Koeleria macrantha
LASE	Lactuca serriola
LATLEU	Lathyrus leucanthus
LATSP	Lathyrus sp.
LEMO3	Lesquerella montana

LEMO4	Leucocrinum montanum
LEKI2	Leucopoa kingii
LEYAMB	Leymus ambiguus
LIPU	Liatris punctata
LIPO	Ligusticum porteri
LIGED	Linaria genistifolia dalmatica
LIVU2	Linaria vulgaris
LIIN2	Lithospermum incisum
LIMU3	Lithospermum multiflorum
LOOR	Lomatium orientale
LUAR3	Lupinus argenteus
MARE3	Mahonia repens
MAAM6	Maianthemum amplexicaule
MASP	Maianthemum sp.
MAST4	Maianthemum stellatum
MELA	Mertensia lanceolata
MOFI	Monarda fistulosa methifolia/M. pectinata
MUMO	Muhlenbergia montana
MUWR	Muhlenbergia wrightii
NAVI	Nassella viridula
NEAC1	Negundo aceroides interius
NEOCAM	Neolepia campestre
NECA2	Nepeta cataria
NOMO2	Noccaea montana
NOCU	Nothocalais cuspidata
OEVIS	Oenothera villosa strigosa
OLRI	Oligoneuron rigidum
OLDRG	Oligosporus dracunculus glaucus
OLPA	Oligosporus pacificus
ONMOO2	Onosmodium molle occidentale
OPFR	Opuntia fragilis
OPMA2	Opuntia macrorhiza
OPPH	Opuntia phaeacantha
OPPO	Opuntia polyacantha
OPSP	Opuntia sp.
ORDE2	Oreobatus deliciosus
ORVI	Oreocarya virgata
OSDE	Osmorhiza depauperata
OXDI2	Oxalis dillenii
OXYHIR	Oxybaphus hirsutus
OXSP	Oxybaphus sp.
OXLA3	Oxytropis lambertii
OXSE	Oxytropis sericea
PACA15	Packera cana
PAFE4	Packera fendleri
PAPL	Packera plattensis
PADVIR	Padus virginiana melanocarpa
PAVI2	Panicum virgatum
PAJA	Paronychia jamesii
PASM	Pascopyrum smithii
PESE11	Penstemon secundiflorus
PESE12	Penstemon sp.
PEVI3	Penstemon virens
PHHE2	Phacelia heterophylla
PHPR3	Phleum pratense
PHMU3	Phlox multiflora
PHLSP	Phlox sp.
PHHEC	Physalis hederifolia comata
PHSP	Physalis sp.
PHVI5	Physalis virginiana
PHMO5	Physocarpus monogynus/P. opulifolius
PIPOS	Pinus ponderosa scopulorum
PIPOOV OS	Pinus ponderosa scopulorum
PLPA2	Plantago patagonica
PNBI	Pneumonanthe bigelovii
POAG	Poa agassizensis
POCO	Poa compressa
POACUS	Poa cusickii epilis
POFE	Poa fendleriana longiligula
PONE2	Poa nervosa
POPR	Poa pratensis
POASEC	Poa secunda
POSP	Poa sp.
PODO4	Polygonum douglasii
POHI6	Potentilla hippiana
PORE5	Potentilla recta
PRVU	Prunella vulgaris
PRAM	Prunus americana
PSCA	Pseudognaphalium canescens
PSVI	Pseudognaphalium viscosum
PSJA2	Pseudostellaria jamesiana
PSME	Pseudotsuga menziesii
PSMEOV	Pseudotsuga menziesii OS
PSTE5	Psoralidium tenuiflorum
PTEALA	Pterogonum alatum
PTAN2	Pterospora andromedea
PUPAM	Pulsatilla patens multifida
QUSP	Quercus sp.
RACO3	Ratibida columnifera
RHART	Rhus aromatica trilobata
RHUGLA	Rhus glabra
RICE	Ribes cereum
RIIN2	Ribes inerme
ROWO2	Rosa woodsii/R. sayi
RUIDM8	Rubus idaeus melanolasius
RUCR	Rumex crispus
SASC5	Sabina scopulorum
SASCOV	Sabina scopulorum OS
SAOF4	Saponaria officinalis
SCSC	Schizachyrium scoparium
SCLA	Scrophularia lanceolata
SCBR3	Scutellaria brittonii
SESP	Selaginella sp.
SEIN2	Senecio integerrimus
SESP2	Senecio sp.
SESP3	Senecio spartioides
SIAN2	Silene antirrhina
SIDI2	Silene dichotoma
SILSCO	Silene scouleri hallii
SIMO2	Sisyrinchium montanum
SOGI	Solidago gigantea
SOMI2	Solidago missouriensis
SONA	Solidago nana
SOSIN	Solidago simplex nana
SOSP	Solidago sp.
SOSP1	Solidago sp. 1
SOSP2	Solidago sp. 2
SOAV2	Sorghastrum avenaceum
SPAS	Sporobolus asper
SPCR	Sporobolus cryptandrus
SPHE	Sporobolus heterolepis
SPSP	Sporobolus sp.
STST	Stenactis strigosa
SYAL2	Symphoricarpos albus/S. occidentalis
TAOF	Taraxacum officinale
THFE	Thalictrum fendleri
THDI4	Thermopsis divaricarpa
THIN6	Thinopyrum intermedium
THAR5	Thlaspi arvense

TIMY	Tithymalus myrsinites
TISP	Tithymalus spathulatus
TOGR	Townsendia grandiflora
TORY	Toxicodendron rydbergii
TOVE2	Toxicoscordion venenosum
TROC4	Tradescantia occidentalis scopulorum
TRRA5	Tragia ramosa
TRDUM	Tragopogon dubius major
TRPR2	Trifolium pratense
TRPE4	Triodanis perfoliata
TUGL	Turritis glabra
UNBR	Unknown brassicaceae
UNBR2	Unknown brassicaceae 2
UNCH	Unknown chenopod
UNCO	Unknown composite
UNCO2	Unknown composite 1
UNCO3	Unknown composite 2
UNCY	Unknown cyperaceae
UNFE	Unknown fern
UNFO	Unknown forb
UNFO2	Unknown forb 1
UNFO3	Unknown forb 2
UNFO4	Unknown forb 3
UNFO5	Unknown forb 4
UNFO6	Unknown forb 5
UNGRAM	Unknown graminoid
UNGR	Unknown grass
UNGR2	Unknown grass 1
UNGR3	Unknown grass 2
UNGR4	Unknown grass 3
UNLE	Unknown legume
UNSH	Unknown shrub
UNTR	Unknown tree
VETH	Verbascum thapsus
VEBR	Verbena bracteata
VINU2	Viola nuttallii
VISP	Viola sp.
VIFA2	Virgulus falcatus
YUGL	Yucca glauca

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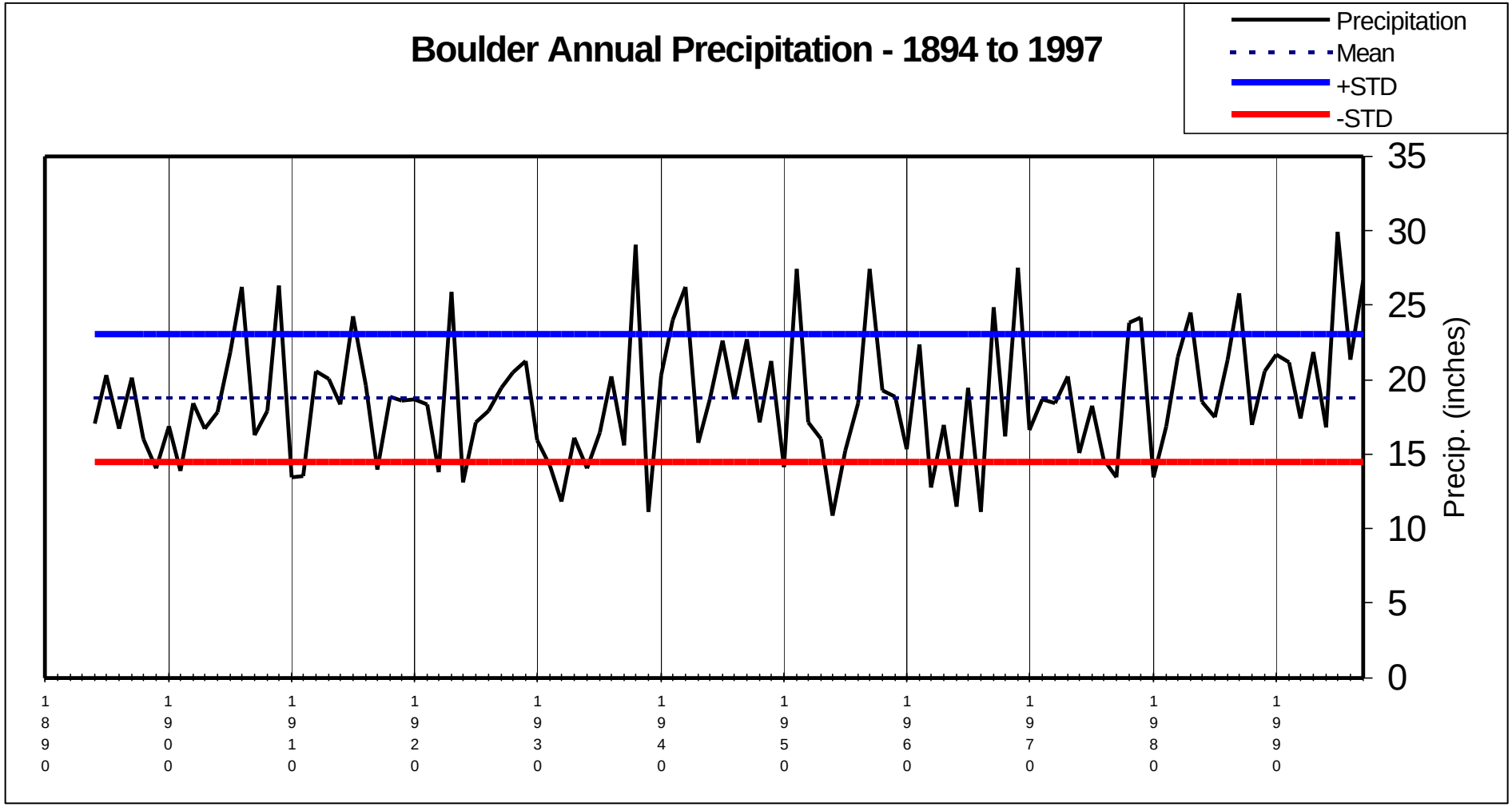
Appendix 10. Climate Diagrams

Boulder Annual Precipitation for 1894 to 1997.
104 Thornthwaite Diagrams for Boulder, Long term and 1894 to 1997


Boulder Annual Precipitation - 1894 to 1997
Precipitation
Mean
+STD
-STD
Precip. (inches)
35
30
25
20
15
10
5
0
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990

Page holder for 18 pages (page 73-90) of Thornthwaite Climate Diagrams – Diagrams can be found in File **climate.pdf.**

Appendix 11. Computer files

File inventory:

All of the data files have been compressed in a self-extracting file called FEWGDATA.EXE on the diskette. Approximately 5MB of disk space is required to expand this file. This report is found on a separate diskette with the file name of FEWGREPT.DOC, and is in WORD97 format.

All of these data sets have 123 sites (the 10 sites with zero cover were excluded), the missing soil texture at 15 sites were changed to the mean value in order to minimize their influence on the environmental vectors. There were 9 cut levels used in TWINSPAN(0-0.02-1-5-10-20-30-40-60) for all of the data runs. These cut levels result in a *de facto* positive weighting of the low values, and a negative weighting of the high values, but because the TWINSPAN program allows weighting to be directly applied, as it was in the D set, sets A-C are referred to as "NOT" weighted. The weighting that was applied to the D set neutralized the *de facto* weighting, so cover is approximately proportional to the weighting. So, to clarify the data manipulation, the weighted D set has actually been deweighted and is most representative of the actual vegetation cover conditions. The elevation data were received late in the analysis, and are only included in the D set of data.

A set

Combined Overstory & Understory Data - 350 species, 17 enviro

Species Data Input: COMCOND3.TXT
Environmental Data: ENVCOMB3.TXT
TWINSPAN Output: COM3TWN.OUT
CANOCO Output: COMB3.OUT, COMB3.SOL, COMB3.CON

B set

Understory Data - 347 species, 17 enviro

Species Data Input: UNDCND4.TXT
Environmental Data: ENVUND4.TXT
TWINSPAN Output: UND4TWN.OUT
CANOCO Output: UNDER4.OUT, UNDER4.SOL, UNDER4.CON

C set

Understory Data w/o weighting, w/o rock, litter ... -
342 species, 20 enviro

Species Data Input: UNDCND5.TXT
Environmental Data: ENVCON72.TXT
TWINSPAN Output: UND5TWN.OUT
CANOCO Output: ENVCON72.OUT, .SOL, .CON

D set

Understory Data w/weighting, w/o rock, litter ... -
342 species, 20 enviro with elevation

Species Data Input: UNDCND5.TXT (Same as C set)
Environmental Data: ENVCON72.TXT (Same as C set)
TWINSPAN Output: UND5TWNW.OUT
CANOCO Output: ENVCON72.OUT, .SOL, .CON (Same as C set)

DISCRIM

20 enviro modified to 40 classes

The DISCRIM program uses the sample classification output of TWINSPAN, and uses the environmental factors as "species" to find indicator environmental factors that best explain the TWINSPAN divisions. Because the pseudospecies concept may not work well with environmental factors that are always present to some degree (i.e. aspect, slope), many of the environmental factors were broken down into classes prior to data processing, and all continuous values were transformed to percentages based on the range of the respective value.

Environmental Data Input: ENVPCT72.CON
TWINSPAN Classification Data: UNDCND5.LST
DISCRIM Output: ENVDSCR.OUT

Appendix 12. Environmental data.

SITE	ELEV	ASPECT	SLOPE	NORTH	EAST	ROCK	GRAVEL	LITTER	SOIL	LITDEPTH	CLAY	SAND	REG	TIMB	WILD	INSECT	REC	BURN	HARV	GRAZ	WEATH	OTHER
D101	6015	4	0	0.000	1.000	9.0	0.0	45.0	0.000	1.100	15.0	20.0	0	0	1	0	0	0	0	0	0	0
D105	6015	8	42	1.000	0.000	27.5	0.0	42.5	0.000	2.000	25.0	60.0	0	0	1	0	0	0	0	0	0	0
D110	6015	4	9	0.000	1.000	4.5	0.0	49.5	0.000	1.500	40.0	55.0	0	1	1	0	0	0	0	0	0	0
D1/8101	6387	6	39	0.707	0.707	2.0	0.0	28.0	0.000	0.800	45.0	5.0	0	0	1	0	0	0	0	0	0	0
D1/8105	6387	4	20	0.000	1.000	2.5	0.0	38.0	0.000	0.800	0.0	0.0	0	0	1	0	0	0	0	0	0	0
D201	5919	3	7	-0.707	-0.707	6.5	0.0	50.0	0.000	1.500	5.0	85.0	0	0	1	0	0	0	0	0	0	0
D205	5919	2	12	-0.707	0.707	10.0	0.0	56.0	5.000	0.500	5.0	85.0	0	1	1	0	1	0	0	0	0	0
D210	5919	2	6	-0.707	0.707	12.5	0.0	73.5	0.000	1.600	5.0	90.0	0	1	1	0	0	0	0	0	0	0
D3D401	6406	2	26	-0.707	0.707	4.5	0.0	33.0	0.000	1.800	60.0	20.0	0	0	1	0	0	0	0	0	0	0
D3D405	6406	4	14	0.000	1.000	7.5	0.0	79.5	0.000	1.900	0.0	0.0	0	1	1	0	0	1	0	0	0	0
D3D410	6406	4	20	0.000	1.000	2.0	0.0	32.5	0.000	1.000	35.0	10.0	0	1	1	0	0	0	0	0	0	0
D3D415	6406	4	12	0.000	1.000	1.5	0.0	37.5	0.000	1.200	45.0	5.0	0	0	1	0	0	1	0	0	0	0
D3D420	6406	4	19	0.000	1.000	3.5	0.0	44.0	0.000	2.800	35.0	10.0	0	0	1	0	0	0	0	0	0	0
D3D425	6406	2	40	-0.707	0.707	3.0	0.0	32.5	0.000	1.200	25.0	60.0	0	0	1	0	0	0	0	0	0	0
D3D430	6406	1	16	-1.000	0.000	10.0	0.0	62.5	1.000	2.300	15.0	65.0	0	1	1	0	0	1	0	0	0	0
DAKR10	5882	5	51	0.000	-1.000	15.0	0.0	36.0	9.000	1.000	60.0	20.0	0	0	1	0	1	0	0	0	0	0
ELDE01	6604	4	20	0.000	1.000	3.5	0.0	72.5	0.000	0.800	25.0	60.0	0	0	1	0	0	0	0	1	0	0
ELDE05	6604	6	14	0.707	0.707	1.5	0.0	39.5	0.000	1.000	15.0	65.0	0	0	1	0	0	0	0	1	0	0
ELDE10	6604	4	14	0.000	1.000	1.5	0.0	73.0	0.000	1.600	25.0	60.0	0	0	1	0	0	1	0	0	0	0
ELDE15	6604	8	38	1.000	0.000	5.5	0.0	65.5	0.000	1.700	5.0	85.0	0	0	1	0	0	0	0	1	0	0
LINN01	6173	5	34	0.000	-1.000	16.0	0.0	77.5	0.000	1.500	5.0	85.0	0	0	1	1	0	0	1	1	0	0
LINN05	6173	6	16	0.707	0.707	2.0	0.0	73.0	2.000	1.400	15.0	65.0	0	0	1	0	1	0	1	1	0	0
LINN10	6173	8	16	1.000	0.000	9.5	0.0	69.5	1.000	0.800	25.0	60.0	0	0	1	0	0	1	1	1	0	0
LINS01	6331	8	12	1.000	0.000	6.0	0.0	80.0	0.000	0.500	15.0	65.0	0	0	1	0	0	0	0	1	0	0
LINS05	6331	6	10	0.707	0.707	1.5	0.0	75.0	0.000	0.500	35.0	30.0	0	0	1	1	0	0	0	1	0	0
LINS10	6331	6	12	0.707	0.707	2.0	0.0	71.5	0.000	1.300	35.0	30.0	0	0	1	0	0	0	0	1	0	0
LINS15	6331	6	10	0.707	0.707	3.0	0.0	45.0	2.000	0.800	25.0	60.0	0	0	1	0	0	1	0	1	0	0
LJNE01	6346	4	14	0.000	1.000	4.0	0.0	38.5	0.000	1.200	25.0	60.0	0	0	1	0	0	0	0	1	0	0
LJNE05	6346	4	18	0.000	1.000	3.5	0.0	28.5	0.000	1.000	35.0	10.0	0	0	1	0	0	0	0	1	0	0
LJNE10	6346	4	9	0.000	1.000	1.0	0.0	42.5	0.000	1.000	25.0	60.0	0	0	1	0	0	0	0	1	0	0
LJNW01	6574	2	36	-0.707	0.707	22.5	0.0	35.0	0.500	1.900	25.0	60.0	0	0	1	0	0	0	0	0	1	0
LJNW05	6574	4	35	0.000	1.000	6.0	0.0	61.0	0.000	0.900	20.0	45.0	0	0	1	0	0	1	1	0	0	0
LJNW10	6574	4	35	0.000	1.000	5.0	0.0	45.0	0.000	1.000	35.0	30.0	0	0	1	0	0	0	0	0	0	0
LJNW15	6574	4	51	0.000	1.000	12.0	0.0	47.5	0.500	1.200	35.0	10.0	0	0	1	0	0	0	1	0	0	0
LJSE01	6359	6	5	0.707	0.707	0.0	0.0	56.0	0.000	1.300	20.0	45.0	0	0	1	0	0	0	0	1	0	0
LJSE05	6359	6	5	0.707	0.707	1.0	0.0	55.5	0.000	1.800	35.0	30.0	0	0	1	0	0	0	0	1	0	0
LJSE10	6359	6	9	0.707	0.707	3.0	0.0	46.0	0.500	0.400	35.0	30.0	0	0	1	0	0	0	0	1	0	0
LJSE15	6359	6	7	0.707	0.707	3.0	0.0	58.0	0.000	1.000	35.0	30.0	0	0	1	0	0	0	1	1	0	0
LJSE20	6359	6	5	0.707	0.707	1.0	0.0	58.5	1.500	1.300	35.0	30.0	0	0	1	0	0	0	0	1	0	0
LJSW01	6412	7	26	0.707	-0.707	14.5	0.0	46.5	0.500	1.500	15.0	65.0	0	0	1	0	0	0	0	0	0	0
LJSW05	6412	6	22	0.707	0.707	1.5	0.0	48.5	0.000	1.000	45.0	5.0	0	0	1	0	0	0	0	1	0	0

SITE	ELEV	ASPECT	SLOPE	NORTH	EAST	ROCK	GRAVEL	LITTER	SOIL	LITDEPTH	CLAY	SAND	REG	TIMB	WILD	INSECT	REC	BURN	HARV	GRAZ	WEATH	OTHER
LJSW10	6412	4	17	0.000	1.000	4.0	0.0	55.0	1.500	1.300	35.0	30.0	1	0	1	0	0	0	0	0	0	0
LOSH01	5891	4	8	0.000	1.000	8.0	0.0	53.5	0.000	0.400	25.0	60.0	1	1	1	0	0	0	0	0	0	0
LOSH05	5891	4	10	0.000	1.000	1.0	0.0	62.0	2.000	1.500	25.0	60.0	0	1	0	0	1	0	0	0	0	0
LOSH10	5891	4	9	0.000	1.000	1.0	0.0	56.5	0.000	1.100	40.0	55.0	0	1	1	0	0	1	0	0	0	0
MRL01	6341	6	20	0.707	0.707	19.0	0.0	27.5	0.000	1.600	35.0	30.0	1	0	1	0	0	0	1	0	0	0
MRL10	6341	2	25	-0.707	0.707	8.5	0.0	62.0	0.000	1.800	35.0	30.0	1	0	1	1	0	0	0	1	0	0
MRL15	6341	7	41	0.707	-0.707	7.0	0.0	74.5	0.000	1.800	5.0	85.0	0	0	1	1	0	0	1	0	0	0
PNBK01	6243	6	57	0.707	0.707	12.0	0.0	30.0	0.000	1.300	35.0	30.0	0	0	1	0	0	0	1	0	0	0
PNBK05	6243	7	52	0.707	-0.707	12.5	0.0	42.5	0.500	2.100	35.0	30.0	0	0	1	0	0	0	1	0	0	0
PNBK10	6243	7	53	0.707	-0.707	16.5	0.0	36.5	0.000	2.800	0.0	0.0	0	0	1	0	0	0	1	0	0	0
PWRL01	6193	4	14	0.000	1.000	7.5	0.0	66.0	0.000	0.500	0.0	0.0	0	1	1	0	0	1	0	0	0	0
PWRL05	6193	6	15	0.707	0.707	4.5	0.0	73.5	0.000	1.100	25.0	60.0	0	1	1	0	0	0	0	0	0	0
PWRL10	6193	6	21	0.707	0.707	3.5	0.0	67.5	0.000	3.700	35.0	30.0	0	1	1	0	0	0	0	0	1	0
PWRL15	6193	2	8	-0.707	0.707	8.0	0.0	68.0	0.000	1.400	35.0	30.0	0	1	1	0	0	1	0	0	0	0
PWRL20	6193	6	13	0.707	0.707	5.0	0.0	78.0	0.500	1.100	25.0	60.0	0	1	1	0	1	0	0	0	0	0
PWRL25	6193	2	14	-0.707	0.707	11.0	0.0	20.0	0.000	1.500	0.0	0.0	0	1	0	0	0	0	0	0	0	0
S1001	6215	6	25	0.707	0.707	5.0	0.0	70.0	0.000	1.300	35.0	30.0	0	1	1	0	0	0	0	0	0	0
S1005	6215	6	53	0.707	0.707	4.0	0.0	60.0	0.000	2.700	5.0	85.0	0	1	1	0	0	0	0	0	0	0
S1010	6215	4	12	0.000	1.000	8.5	0.0	77.0	0.000	0.700	35.0	30.0	1	1	1	0	0	0	0	0	0	0
S301	6215	8	12	1.000	0.000	15.0	0.0	73.0	0.500	1.300	0.0	0.0	0	1	1	0	0	0	0	0	0	0
S305	6215	4	9	0.000	1.000	1.0	0.0	59.0	0.000	0.900	5.0	85.0	0	1	1	0	0	0	0	0	0	0
S310	6215	4	12	0.000	1.000	1.0	0.0	75.0	0.000	1.400	25.0	60.0	0	1	1	0	0	0	0	0	0	0
S315	6215	2	17	-0.707	0.707	8.0	0.0	76.5	0.000	0.600	5.0	85.0	0	1	1	0	0	0	0	0	0	0
S320	6215	4	30	0.000	1.000	12.5	0.0	62.0	0.000	2.500	20.0	45.0	1	1	1	0	0	0	0	0	0	0
S325	6215	6	28	0.707	0.707	11.5	0.0	48.5	0.000	0.300	0.0	0.0	0	1	1	0	0	0	0	0	0	0
S401	6247	4	7	0.000	1.000	3.0	0.0	70.0	2.000	1.600	5.0	85.0	0	1	0	0	0	0	0	0	0	0
S405	6247	1	30	-1.000	0.000	16.5	0.0	80.5	1.000	1.300	15.0	65.0	0	1	1	0	0	0	0	0	0	0
S501	6197	4	12	0.000	1.000	7.0	0.0	62.0	2.000	0.900	15.0	65.0	0	1	1	0	0	0	0	0	0	0
S505	6197	4	12	0.000	1.000	8.5	0.0	71.5	0.000	2.400	15.0	65.0	0	1	0	0	0	0	0	0	0	0
S510	6197	4	14	0.000	1.000	3.5	0.0	66.0	3.000	0.900	25.0	60.0	0	1	0	0	1	0	1	0	0	0
S901	6118	6	16	0.707	0.707	14.0	0.0	71.5	0.500	2.700	5.0	85.0	0	1	1	0	0	0	0	0	0	0
S905	6118	2	11	-0.707	0.707	8.5	0.0	26.5	0.000	2.000	5.0	85.0	0	0	1	0	0	0	1	0	0	0
S910	6118	4	9	0.000	1.000	2.0	0.0	45.5	0.000	0.400	5.0	85.0	0	1	1	0	0	1	0	0	0	0
ST101	6473	4	17	0.000	1.000	6.5	0.0	47.5	8.500	1.200	5.0	85.0	0	1	1	0	1	1	0	0	0	0
ST105	6473	8	35	1.000	0.000	20.5	0.0	69.0	1.000	2.600	15.0	65.0	0	1	1	0	0	1	0	0	0	0
ST110	6473	4	16	0.000	1.000	4.0	0.0	61.5	0.000	1.300	15.0	65.0	0	1	0	0	0	1	0	0	0	0
ST115	6473	4	12	0.000	1.000	3.0	0.0	54.5	0.500	0.800	35.0	30.0	0	1	1	0	0	0	0	0	0	0
ST1001	6254	7	34	0.707	-0.707	0.0	0.0	32.0	0.000	2.900	35.0	30.0	0	1	0	0	0	0	0	0	0	0
ST1005	6254	5	75	0.000	-1.000	43.5	0.0	41.5	4.000	0.500	0.0	0.0	0	1	1	0	0	1	0	0	0	0
ST305	6514	6	23	0.707	0.707	8.5	0.0	48.5	0.000	2.000	0.0	0.0	0	1	1	0	0	1	0	0	0	0
ST310	6514	6	19	0.707	0.707	1.0	0.0	57.0	0.000	1.300	35.0	30.0	0	1	1	0	0	1	0	0	0	0
ST501	6475	2	35	-0.707	0.707	28.0	0.0	53.0	0.000	1.100	5.0	85.0	0	1	1	0	0	1	0	0	0	0
ST505	6475	8	31	1.000	0.000	5.5	0.0	82.0	0.000	5.700	0.0	0.0	0	1	1	0	0	1	0	0	0	0
ST601	6446	5	6	0.000	-1.000	2.5	0.0	71.0	0.500	2.500	25.0	60.0	0	1	0	0	0	1	0	0	0	0

SITE	ELEV	ASPECT	SLOPE	NORTH	EAST	ROCK	GRAVEL	LITTER	SOIL	LITDEPTH	CLAY	SAND	REG	TIMB	WILD	INSECT	REC	BURN	HARV	GRAZ	WEATH	OTHER
ST605	6446	2	23	-0.707	0.707	3.5	0.0	70.0	0.000	2.000	35.0	30.0	0	1	1	0	0	1	0	0	0	0
ST610	6446	3	21	-0.707	-0.707	12.0	0.0	49.5	5.500	1.300	0.0	0.0	0	1	1	0	1	1	0	0	0	0
ST615	6446	2	14	-0.707	0.707	5.0	0.0	90.5	1.500	1.400	5.0	90.0	0	1	1	0	0	1	0	0	0	0
ST701	6455	7	24	0.707	-0.707	2.5	0.0	37.0	0.500	0.600	35.0	30.0	0	1	0	1	0	0	0	0	0	0
ST705	6455	3	18	-0.707	-0.707	4.5	0.0	66.5	0.000	2.400	20.0	45.0	0	1	1	0	0	0	0	0	0	0
ST801	6522	2	43	-0.707	0.707	4.5	0.0	38.5	0.000	2.400	35.0	10.0	0	1	1	0	0	1	0	0	0	0
ST805	6522	4	23	0.000	1.000	5.0	0.0	74.0	0.500	3.000	20.0	45.0	0	1	1	0	0	0	0	0	0	0
ST901	6510	4	8	0.000	1.000	0.0	0.0	48.0	0.000	0.900	25.0	60.0	0	1	1	0	0	0	0	0	0	0
ST905	6510	6	25	0.707	0.707	6.5	0.0	50.0	1.000	3.000	20.0	45.0	0	1	1	0	1	0	0	0	0	0
STG201	6131	6	4	0.707	0.707	2.0	0.0	38.5	6.000	0.500	60.0	20.0	0	0	0	0	0	0	0	1	0	0
STG205	6131	6	4	0.707	0.707	0.0	0.0	45.5	6.000	0.600	35.0	30.0	0	0	0	0	0	0	0	1	0	0
STG210	6131	6	3	0.707	0.707	0.5	0.0	45.5	6.500	0.500	40.0	55.0	0	1	1	0	0	0	0	1	0	0
STG215	6131	6	2	0.707	0.707	3.0	0.0	35.5	10.000	0.600	40.0	55.0	0	1	0	0	0	0	0	1	0	0
STG220	6131	6	4	0.707	0.707	1.0	0.0	44.0	1.500	1.100	40.0	55.0	0	1	0	0	0	0	0	1	0	0
SNSH01	5991	8	48	1.000	0.000	1.5	0.0	69.5	1.500	1.800	25.0	60.0	0	1	1	0	0	0	0	0	0	0
SNSH05	5991	8	38	1.000	0.000	4.0	0.0	59.0	0.000	1.800	40.0	55.0	0	1	1	0	0	0	0	0	0	0
WTRT01	5888	2	3	-0.707	0.707	12.0	0.0	36.5	0.000	1.300	20.0	45.0	0	0	1	0	0	0	1	0	0	0
WTRT05	5888	8	25	1.000	0.000	4.0	0.0	54.5	0.000	1.900	35.0	30.0	0	1	1	0	0	0	0	0	0	0
WTRT10	5888	4	7	0.000	1.000	13.5	0.0	60.5	8.500	1.500	20.0	45.0	0	1	1	0	1	0	0	0	0	0
WTRT15	5888	4	6	0.000	1.000	6.5	0.0	48.5	3.500	0.300	40.0	55.0	0	0	0	0	0	0	0	0	0	0
WTRT20	5888	4	14	0.000	1.000	5.0	0.0	55.0	0.000	0.900	40.0	55.0	0	1	1	0	0	0	0	0	0	0
WITE05	6224	3	44	-0.707	-0.707	18.5	0.0	62.5	0.500	2.100	25.0	60.0	0	0	1	0	0	0	0	0	0	0
WITE10	6224	1	35	-1.000	0.000	16.5	1.5	65.0	0.000	1.900	5.0	90.0	0	0	1	0	0	1	0	0	0	0
WITNE01	6593	3	36	-0.707	-0.707	20.5	0.5	71.0	0.000	1.500	5.0	85.0	0	1	1	0	0	1	0	0	0	0
WITNE05	6593	3	48	-0.707	-0.707	11.0	3.0	76.5	0.000	2.500	5.0	85.0	0	0	1	0	0	0	0	0	0	0
WITNE10	6593	3	34	-0.707	-0.707	5.0	3.5	60.5	0.000	1.500	15.0	65.0	0	1	1	0	0	1	1	0	0	0
WITNE15	6593	3	36	-0.707	-0.707	14.0	9.0	69.0	0.500	0.900	25.0	60.0	0	0	1	0	0	0	0	0	0	0
WITNE20	6593	3	25	-0.707	-0.707	10.0	3.5	71.5	0.000	0.800	0.0	0.0	0	1	1	0	0	1	0	0	0	0
WITNE25	6593	5	32	0.000	-1.000	6.5	2.5	48.5	0.000	2.200	5.0	85.0	1	1	0	0	0	1	1	0	0	0
WITNE30	6593	3	22	-0.707	-0.707	7.0	12.0	62.5	0.000	0.900	45.0	5.0	0	0	1	0	0	1	0	0	0	0
WITNW01	6542	3	34	-0.707	-0.707	4.0	0.0	45.0	1.000	1.300	25.0	60.0	0	0	1	0	0	0	0	0	0	0
WITNW15	6542	3	33	-0.707	-0.707	6.0	0.0	73.5	2.000	1.500	5.0	85.0	0	0	1	0	0	0	1	0	0	0
WITNW20	6542	5	30	0.000	-1.000	6.0	0.0	77.5	0.500	2.000	5.0	85.0	0	0	1	1	0	1	1	0	0	0
WITS01	6215	3	38	-0.707	-0.707	11.0	7.0	66.0	0.000	2.200	15.0	65.0	0	0	1	0	0	1	0	0	0	0
WITS05	6215	5	50	0.000	-1.000	10.5	5.0	69.0	0.000	1.200	5.0	85.0	0	0	1	0	0	1	1	0	0	0
WITS10	6215	1	48	-1.000	0.000	29.0	1.5	53.0	0.000	1.400	0.0	0.0	1	0	1	0	0	0	0	0	0	0
WITW01	6260	5	40	0.000	-1.000	1.0	0.0	64.5	0.000	0.800	20.0	45.0	0	0	1	0	0	0	0	0	0	0
WITW05	6260	5	28	0.000	-1.000	2.0	0.0	73.0	0.000	1.100	20.0	45.0	0	1	1	0	0	0	0	0	0	0

Appendix 13. Group summary data with sample data.