STATISTICAL ANALYSIS OF WETLAND VEGETATION NEAR ROADS

Prepared for

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STATISTICAL ANALYSIS OF WETLAND VEGETATION NEAR ROADS

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II. EXECUTIVE SUMMARY

This is a report of the results of statistical analysis of wetland vegetation community data collected near roads in the Tongass National Forest. Data that were analyzed were percent cover estimates of species in UPSLOPE and DOWNSLOPE plots along transects in seven wetlands.

The report includes a summary of the project and discussion of the structure of the data, the explanatory and response variables, and the statistical procedures employed in the analysis.

After reducing the number of species for analysis to those occurring in more than ten percent of the plots sampled, the data were analyzed using multivariate techniques to discover patterns in the distributions of species. Specifically, the data were first analyzed using Principal Component Analysis (PCA) to find general ordination patterns of the sites in species space. The resulting PCA configurations were rescaled using Nonmetric Multidimensional Scaling (NMS) and the axis scores were examined using Multi-Response Permutation Procedures (MRPP) and Multivariate Analysis of Variance (MANOVA).

A similar analysis was applied to three transects selected by the client. A follow-up analysis of the percent cover of species that had axis scores greater than 0.5 on the first three PCA axes using Welch’s t-test.

III. INTRODUCTION

There are over 4 million acres of mapped wetlands on the Tongass National Forest covering about 24 percent of the entire forest area. As of 2008 over 1,000 miles of Forest Road have been constructed across wetlands (Tongass Land and Resource Management Plan FEIS 2008). Since 1972 and the passage of the Clean Water Act, most of the forest roads have been constructed under the silvicultural exemption to the 404 permitting process. The 1997 and 2008 Tongass forest plan revisions included a wetland monitoring question that asks: “Were the wetland conservation practices implemented and effective to avoid and or minimize impacts to wetlands to the extent practicable?”

To address the wetlands monitoring question Landwehr (2006) wrote a new monitoring protocol. The protocol required measurements of the physical impacts of the road on the wetland including abiotic factors and the composition of the vegetation both upslope and downslope of the road. Studies indicate that construction of a typical forest road through wetlands disturbs a soil corridor about 37 feet wide. Research from the Tongass and similar hypermaritime environments suggest that soil hydrologic response adjacent to the disturbed soil corridor is typically limited to 3 to 5 meters beyond the disturbed soil corridor and that it may take 30 years or more for changes in soil drainage and vegetation to become apparent beyond the road corridor.

There is a need to understand the magnitude and extent of the chemical effect of limestone roads through wetlands. The information is needed because regulations require the Forest Service to avoid and minimize to the extent practicable the long and short term impacts associated with the destruction and modifications of wetlands. Currently there is an information gap in our understanding of the effect of limestone roads on the soil and water chemistry of the wetlands the roads cross. The objective of this study is to provide information about vegetation changes in TNF wetlands near roads constructed of limestone through those wetlands.

Questions of Interest

The primary objective of this study is to obtain an understanding of the differences in vegetation UPSLOPE and DOWNSLOPE of roads in TNF wetlands. More specifically, this work aims to:

1. What plant species characterize the community composition UPSLOPE and DOWNSLOPE of TNF wetland roads?
2. Is there a difference in vegetation UPSLOPE and DOWNSLOPE of the roads?

Populations of Interest

The populations of interest are the percent cover of plant species UPSLOPE and DOWNSLOPE of roads in TNF wetlands.

IV. STATISTICAL PROCEDURES

Dataset Reduction

The original trap data sets contained percent cover information for 86 species of plants. Some of the species were present at very low abundance, an expected condition in biologically diverse communities. Low abundance may indicate truly rare species (i.e., those whose abundance is typically low in the sampled habitats) or species that occur temporarily or accidentally.

In the context of community differentiation, uncommon species are usually removed from multivariate analyses because their occurrence are often limited to one habitat type, and may be due to chance rather than an underlying ecological condition (Gauch 1982, Pilanka 1986). Eliminating uncommon species results in less distortion in multivariate analyses, and a decrease in noise that can mask underlying patterns (Gaston 1994). Truly "rare" species, those restricted to specific habitats and occurring in very low abundance are dealt with separately.

Pilanka (1986) recommends eliminating non-abundant species from multivariate analyses, only after careful consideration and with standards applied to all species. Species that did not appear in at least ten percent of the total plots sampled were identified as non-abundant, and candidates for removal from the multivariate analysis. The resulting dataset consisted of 37 plant species.

Multivariate Analysis

Ordination

Ordination is one of the many multivariate techniques used to analyze community data. Ordination is the collective term for multivariate analytical methods that arrange sampling units along axes such that similar sites are close together and dissimilar sites are far apart. The result is an objective summary of the relationships between sampling units in a low-dimensional species space. The goal is to reveal underlying structure in the data that represent patterns of species occurrence as determined by environmental variables.

Principal component analysis (PCA) is perhaps the most popular and widely used ordination technique. The method was developed by Pearson (1901) and refined by Hotelling (1933). It was first used to analyze ecological data by Goodall (1954) and has been used extensively since. Entomologists have successfully used PCA for a wide range of studies including analysis of forest canopy-arthropod community structure (e.g., Schowalter et al. 1988, Schowalter 1995).

In PCA, distance measures on component axes are Euclidean and the reduced space is no more than the original variable space with new component axes. The maximum amount of variation is accounted for after minimizing distance distortions. The positions of the sampling units on the axes are determined from the data alone and hence PCA is an objective rendition of the intrinsic ecological relationships in the data.

The method is most efficient when the data have a normal distribution, although the method is robust to departures from the ideal structure (Hotelling 1933, Greig-Smith 1980, Gauch 1982). However, the results of PCA are strongly influenced by non-linear relationships between sampling units (Gauch 1982). When habitat diversity is large and environmental gradients complex, the true ecological proximity between sampling units often lies along a curved response. In this situation, PCA ordination distorts ecological distances between sampling units, with some appearing much more closely related than they really are (Digby and Kempton 1987).

The TNF vegetation community data were analyzed using PCA with a Variance/Covariance Cross-Products matrix. Final configurations of three axes combinations showing sampling sites were plotted. The sampling site PCA eigenvector scores for these three axes were output for further analysis using Nonmetric Multidimensional Scaling (NMS).

NMS is ordination technique that uses rank order information from a similarity matrix, rather than the metric information, to evaluate ordinal relationships between sampling units. The intention is to eliminate the strong and problematic assumption of linearity of species responses to underlying environmental gradients made by other ordination methods. NMS relies on a weaker assumption of monotonicity. The goal of NMS is to locate sampling units in a low-dimensional ordination space in such a manner that the interpoint distances in the ordination have the same rank order as do the interpoint similarities in the similarity matrix. NMS is more robust when the input trial vectors are derived from another robust ordination method, such as PCA. Use of randomly generated coordinates is not recommended because of the possibility of arriving at an invalid solution. Input trial vectors from PCA provide greater assurance of obtaining a global minimum solution. Random trial vectors are more likely to result in local minimum solutions (Pimentel 1993). Random trial vector results are also more susceptible to non-linear relationships between sampling units and final configurations can suffer from “arch” distortion (Gauch 1982).

Trial vectors from PCA were analyzed using NMS with a Euclidean Distance Measure, run on Autopilot with Medium Speed and Thoroughness. Final NMS configurations of three axes combinations showing sampling sites were plotted.

Manova and MRPP

Differences in species composition between habitat types were assessed using Multi-Response Permutation Procedures (MRPP) and Multivariate Analysis of Variance (MANOVA). MRPP is a non-parametric method based on the same similarity indices used in NMS (Zimmerman et al. 1985). The means and standard deviations of weighted mean within group similarities, delta, are calculated. The probability of differences between groups is determined by comparing the resulting delta to those calculated from all permutations of the data. A chance-corrected within-group agreement statistic is calculated to describe the within-group homogeneity (Mielke 1984). Values above 0.3 are considered high in community ecology research (McCune and Grace 2002). MRPP comparisons of habitat type species composition were conducted on the two datasets and were based on the Euclidean Distance similarity index.

MANOVA is a parametric approach to group comparisons that requires multivariate normality of the data and homogeneity of group variances (Tabachnick and Fidell 1989). NMS vectors are scaled to the standard normal distribution, and meet the underlying assumptions of MANOVA. The site axes scores from the final NMS solution was examined with MANOVA. Significant differences between habitat types were determined by calculating the p-values for Wilks' Lambda. Wilks' lambda is the multivariate equivalent of an F test in univariate analysis of variance. Agreement of significant test results between MRPP and MANOVA is considered as supporting evidence for true habitat type differences in community composition (Pimentel 1979).

Table IV-1 is a list of all species, the count of the number of plots in which they occurred, and the average percent cover. This is the starting dataset. Much information can be extracted from this table, even before analysis begins. For example, one may evaluate the average percent cover for various species in UPSLOPE and DOWNSLOPE areas, determine which types of species (i.e., Tree, Tall Shrub, Forb, etc) occur in the two areas being compared, and hypothesize potential indicators of changes in chemistry.

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Statistical Report
WETLAND VEGETATION NEAR ROADS

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SPECIES	ACRONYM	VEG TYPE	UPSLOPE COUNT	UPSLOPE AVERAGE	DOWNSLOPE COUNT	DOWNSLOPE AVERAGE	TOTAL COUNT	TOTAL AVERAGE
Chamacyparis nootkatensis	CHNO	TREE	21	10	23	8	44	9
Picea sitchensis	PISI	TREE	7	2	19	2	26	2
Pinus contorta	PICO	TREE	31	15	46	14	77	14
Thuja plicata	THPL	TREE	5	0	12	1	17	1
Tsuga heterophylla	TSHE	TREE	7	2	26	7	33	5
Malus fusca	MAFU	TREE	0	0	1	0	1	0
Tsuga mertensiana	TSME	TREE	6	1	16	2	22	2
Andromeda polifolia	ANPO	TALL SHRUB	23	3	28	4	51	4
Cladothamnus pyrolaeflorus	CLPY	TALL SHRUB	3	1	0	0	3	0
Empetrum nigrum	EMNI	TALL SHRUB	32	19	39	12	71	15
Juniperis communis	JUCO	TALL SHRUB	19	5	15	3	34	4
Loisleura procumbens	LOPR	TALL SHRUB	7	3	8	2	15	2
Menziesi ferruginea	MEFE	TALL SHRUB	11	2	20	2	31	2
Oplopanax horridus	OPHO	TALL SHRUB	1	0	0	0	1	0
Phyllodoce glanduliflora	PHGL	TALL SHRUB	4	0	0	0	4	0
Rubus spectabilis	RUSP	TALL SHRUB	3	0	2	0	5	0
Vaccinium alaskense	VAAL	TALL SHRUB	1	0	0	0	1	0
Vaccinium caespitosum	VACA	TALL SHRUB	7	1	10	2	17	2
Vaccinium uliginosum	VAUL	TALL SHRUB	32	16	38	12	70	13
Vaccinium ovalifolium	VAOV	TALL SHRUB	12	2	16	4	28	3
Vaccinium oxycoccus	VAOX	TALL SHRUB	22	2	23	2	45	2
Vaccinium parvifolia	VAPA	TALL SHRUB	2	0	0	0	2	0
Kalmia polifolia	KAPO	TALL SHRUB	35	7	38	5	73	6
Ledum groenlandicum	LEGR	TALL SHRUB	35	11	46	10	81	11

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SPECIES	ACRONYM	VEG TYPE	UPSLOPE COUNT	UPSLOPE AVERAGE	DOWNSLOPE COUNT	DOWNSLOPE AVERAGE	TOTAL COUNT	TOTAL AVERAGE
Viburnum edule	VIED	TALL SHRUB	0	0	1	0	1	0
Vaccinium vitis-idea	VAVI	TALL SHRUB	12	3	24	5	36	4
Angelica genuflexa	ANGE2	FORB	1	0	3	0	4	0
Caltha biflora	CABI2	FORB	12	4	10	1	22	2
Coptis asplenifolia	COAS	FORB	13	2	21	1	34	2
Coptis trifoliata	COTR2	FORB	22	2	16	1	38	1
Cornus canadensis	COCA13	FORB	42	14	55	10	97	12
Drosera rotundifolia	DRRO	FORB	6	1	2	0	8	0
Dodecatheon pulchellum	DOPU	FORB	3	0	6	1	9	0
Erigeron perigrinis	ERPE3	FORB	2	0	8	0	10	0
Epilobium ciliatum	EPCI	FORB	1	0	0	0	1	0
Galium trifidim	GATR2	FORB	0	0	1	0	1	0
Gentiana dougiasiana	GEDO	FORB	13	1	1	0	14	0
Geum calthifolium	GECA6	FORB	6	1	2	0	8	0
Heracleum lanatum	HELA4	FORB	1	0	0	0	1	0
Leptarrhena pyrofolia	LEPY	FORB	2	0	0	0	2	0
Linnea borealis	LIBO3	FORB	6	0	17	1	23	1
Listera cordata	LICO	FORB	0	0	4	0	4	0
Listera convallarioides	LICO5	FORB	2	0	0	0	2	0
Lysichiton americanum	LYAM	FORB	15	5	27	6	42	5
Maianthemum dilatatum	MADI	FORB	6	0	11	0	17	0
Mitella pedandra	MIPE	FORB	2	0	0	0	2	0
Microseris borealis	MIBO	FORB	12	0	10	0	22	0
Faurai-cristagalli	NECK2	FORB	18	6	35	4	53	5

SPECIES	ACRONYM	VEG TYPE	UPSLOPE COUNT	UPSLOPE AVERAGE	DOWNSLOPE COUNT	DOWNSLOPE AVERAGE	TOTAL COUNT	TOTAL AVERAGE
Parnassia fimbriata	PAFI3	FORB	2	0	3	0	5	0
Platanthera chorisiana	PLCH3	FORB	2	0	0	0	2	0
Platanthera dilitata	PLDI4	FORB	3	0	3	0	6	0
Plantago macrocarpa	PLMA	FORB	0	0	1	0	1	0
Platanthera saccata	PLSA6	FORB	4	0	5	0	9	0
Pyrola secunda	PYSE	FORB	0	0	1	0	1	0
Rubus pedatis	RUPE	FORB	2	0	7	0	9	0
Rubus chamaemorus	RUCH	FORB	5	0	4	0	9	0
Sanguisorba menziesii	SAME6	FORB	34	4	43	3	77	3
Streptopus roseus	STRO4	FORB	3	0	5	0	8	0
Taraxacum officinale	TAOF	FORB	0	0	3	0	3	0
Tiarella trifoliata	TITR	FORB	1	0	0	0	1	0
Tofieldia glutinosa	TOGL2	FORB	17	1	20	1	37	1
Triantalis europa	TREU	FORB	22	1	15	0	37	1
Viola sp	VI	FORB	1	0	0	0	1	0
Carex anthoxanthea	CAAN10	GRAMINOIDES	1	0	1	0	2	0
Carex livida	CALI	GRAMINOIDES	4	1	8	2	12	2
Carex sitchensis	CASI3	GRAMINOIDES	8	1	12	4	20	3
Calamagrostis canadensis	CACA4	GRAMINOIDES	1	0	10	1	11	1
Carex lenticularis	CALE8	GRAMINOIDES	2	0	9	1	11	1
Carex pauciflora	CAPA19	GRAMINOIDES	11	4	7	1	18	2
Carex pluriflora	CAPL6	GRAMINOIDES	6	1	14	4	20	3
Carex stylosa	CAST10	GRAMINOIDES	0	0	3	1	3	0
Carex laeviculmis	CALAE	GRAMINOIDES	1	0	4	1	5	1

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SPECIES	ACRONYM	VEG TYPE	UPSLOPE COUNT	UPSLOPE AVERAGE	DOWNSLOPE COUNT	DOWNSLOPE AVERAGE	TOTAL COUNT	TOTAL AVERAGE
Carex vividula	CAVI5	GRAMINOIDES	0	0	3	0	3	0
Rhynchospora alba	RHAL	GRAMINOIDES	2	0	4	1	6	1
Eriophorum angustifolium	ERAN	GRAMINOIDES	30	7	30	5	60	5
Phalaris arundinaceae	PHAR3	GRAMINOIDES	0	0	4	0	4	0
Trichophorum cespitosum	TRCE3	GRAMINOIDES	22	9	32	12	54	11
Adiantum pedatum	ADPE	FORB 2	0	0	4	0	4	0
Athyrium felixm femina	ATFI	FORB 3	4	1	7	0	11	1
Blecnum spicant	BLSP	FORB 4	7	0	3	0	10	0
Pteridium aquilinium	PTAQ	FORB 5	0	0	6	1	6	1
Dryopteris expansa	DREX	FORB 6	2	0	1	0	3	0
Lycopodium annotinum	LYAN2	MISC	4	0	8	0	12	0
Lycopodium clavatum	LYCL	MISC	1	0	0	0	1	0
Lycopodiella inundata	LYIN2	MISC	0	0	1	0	1	0
Equisetum	EQ	MISC	2	0	8	0	10	0

Two Sample t-tests

Differences in percent cover of selected species between habitat types were assessed using t-tests. T-tests are probably the most widely used statistical test found in scientific literature. The two-sample t-test is a test concerning the differences between the means of two populations. The two samples are independent of each other in the obvious sense that they are separate samples containing different sets of sampling units (e.g. plots). The individual measures in group A are in no way linked with or related to any of the individual measures in group B, and vice versa.

The mathematical assumptions of the standard t-test are:

(i) that the two samples are randomly drawn from normally distributed populations; and
(ii) that the measures of variation of the two samples are equal.

These conditions are seldom met when sampling biological populations, but t-tests are robust and in certain circumstances, the tests are valid even when the actual conditions do not match ideal models the tests are based upon. If the population sample sizes are equal, and standard errors are similar, then t-tests are valid even if the population distribution differs from the normal distribution. If the two populations have different variances, t-tests are fairly valid as long as the sample sizes are roughly the same.

When the characteristics of the populations do not meet the standard t-test assumptions other methods may be applied. Welch's t-test is used when the variances of the two populations are very different. The exact distribution of the Welch test statistic is unknown, but can be approximated using the t-distribution.

In the analysis of selected species, both t-tests were conducted and the results compared. Welch's t-tests returned higher p-values than those of the standard t-tests. In all cases in this report, the results of both tests were similar and the same inferences were drawn. The results reported are those of the Welch's t-test.

Another method to account for deviation from the assumptions is data transformation. The standard accepted transformation for proportion (percent cover) is the ARC-SIN Square Root transformation. Also known as the *angular transformation*, this transformation finds

$$\theta = arcsin\sqrt{p}$$

Where p is the proportion (percent cover).

The species t-tests were conducted using untransformed data and transformed data. Inferences were similar in both analyses, and the results of the untransformed data analyses are reported because the transformed measure is not particularly appealing for interpretation, nor can it be back-transformed to a convenient metric.

ANALYSIS FLOW CHART

The following is a flow chart of the analysis beginning with receiving the data.

COMPLETE DATASET

1) DATA REDUCTION – Remove all species from the analysis that occur in less than ten percent of the plots (<12). Fill all blank values with "0".
2) PRINCIPAL COMPONENT ANALYSIS (PCA) – Apply PCA to the data. Save axis scores for plots for the first six axes. Report axes scores for the first six Eigenvectors and Percentage Variance and Cumulative Variance.
3) NON-METRIC MULTIDIMENSIONAL SCALING (NMS) – Apply NMS to first six eigenvectors from PCA. Report NMS axes scores for first three axes and NMS ordinations.
4) MULTI-RESPONSE PERMUTATION PROCEDURES (MRPP) – Apply MRPP to the same dataset as used in PCA, accounting for UPSLOPE and DOWNSLOPE groups. Report MRPP Table and inference.
5) Multivariate Analysis of Variance (MANOVA) – Apply MANOVA to axes scores from first three NMS axes. Report MANOVA Table and inference.

SELECTED TRANSECT DATASET

Three transects were selected by the client for further analysis. These include Logjam Transect #3, Red Bay Transect #3, and Mike's Road Transect #1. The following procedure was applied to each of these three transects separately. Analyses were limited to the three UPSLOPE plots and the first three DOWNSLOPE plots.

6) DATA REDUCTION – Remove all species from the analysis that occur in less than ten percent of the plots (<3). Fill all blank values with "0". Create a second dataset, removing those species that occurred in less than 2 plots. The following procedure was applied to both of these datasets.
7) PRINCIPAL COMPONENT ANALYSIS (PCA) – Apply PCA to the data. Save axis scores for plots for the first six axes. Report axes scores for the first six Eigenvectors and Percentage Variance and Cumulative Variance. Highlight species on first three axes with scores greater than 0.5.
8) NON-METRIC MULTIDIMENSIONAL SCALING (NMS) – Apply NMS to first six eigenvectors from PCA. Report NMS axes scores for first three axes and NMS ordinations.
9) MULTI-RESPONSE PERMUTATION PROCEDURES (MRPP) – Apply MRPP to the same dataset as used in PCA, accounting for UPSLOPE and DOWNSLOPE groups. Report MRPP Table and inference.
10) Multivariate Analysis of Variance (MANOVA) – Apply MANOVA to axes scores from first three NMS axes. Report MANOVA Table and inference.

SELECTED SPECIES DATASET

Species that had axes scores greater than 0.5 on the first three PCA axes were selected for further analysis.

11) TRANSFORMATION – Two datasets were created for each species. The first is the untransformed percent cover data. The second is an ARC-SIN Square Root transformed dataset.
12) T-TESTS – Apply Standard t-test and Welch's t-test to both datasets for each species. Report t-statistic, degrees of freedom and p-value for Welch's t-test and inference.

SOFTWARE

PC-ORD Version 4 (MjM Software Design, 1999) was used for PCA, NMS, and MRPP analyses. R version 2.8.0 (The R Foundation for Statistical Computing 2008) was used for MANOVA analyses. S-PLUS 2000 Professional Release 1 (Mathsoft 1999) was used for t-tests.

V. RESULTS

DATA REDUCTION

Exclusive Species

Some species occurred in both UPSLOPE and DOWNSLOPE plots, while others occurred in only one or the other. Table V-1 is a list of species that occurred *only* in UPSLOPE plots. Table V-2 is a list of species that occurred *only* in DOWNSLOPE plots. Careful consideration of these species list along with life history, biogeography, distribution, or important physiological characteristics may provide additional insight about how soil chemistry is affecting the distribution of these plant species.

Table V-1. Species that occurred only in UPSLOPE plots.

SPECIES	ACRONYM	TYPE
Cladothamnus pyrolaeflorus	CLPY	tall shrub
Oplopanax horridus	OPHO	tall shrub
Phyllodoce glanduliflora	PHGL	tall shrub
Vaccinium alaskense	VAAL	tall shrub
Vaccinium parvifolia	VAPA	tall shrub
Epilobium ciliatum	EPCI	forb
Heracleum lanatum	HELA4	forb
Leptarrhena pyrofolia	LEPY	forb
Listera convallarioides	LICO5	forb
Mitella pedandra	MIPE	forb
Platanthera chorisiana	PLCH3	forb
Tiarella trifoliata	TITR	forb
Viola sp	VI	forb
Lycopodium clavatum	LYCL	misc

Table V-2. Species that occurred only in DOWNSLOPE plots.

SPECIES	ACRONYM	TYPE
Malus fusca	MAFU	tree
Viburnum edule	VIED	tall shrub
Galium trifidim	GATR2	forb
Listera cordata	LICO	forb
Plantago macrocarpa	PLMA	forb
Pyrola secunda	PYSE	forb
Taraxacum officinale	TAOF	forb
Carex stylosa	CAST10	graminoides
Carex vividula	CAVI5	graminoides
Phalaris arundinaceae	PHAR3	graminoides
Adiantum pedatum	ADPE	forb 2
Pteridium aquilinium	PTAQ	forb2
Lycopodiella inundata	LYIN2	misc

Review of species in Tables V-1 and V-2 may provide additional insight into how conditions in UPSLOPE and DOWNSLOPE areas differ. For example, if there are more non-indigenous species in the DOWNSLOPE plots, that might indicate the DOWNSLOPE areas may be more disturbed, or excluding indigenous species (with the hypothesis that the difference in conditions is the result of soil chemistry changes due to road building) is an indication of changes from “natural” conditions.

Non-Abundant Species

Some species were not abundant in both UPSLOPE and DOWNSLOPE plots in, occurring in less than ten percent of the total plots (<12 plots). Table V-3 is a list of species that occurred in less than ten percent of the total plots. These species were removed from the analysis datasets for reasons described in the Methods (Chapter IV above). This list is important because it may provide insight into how soil chemistry influences plant species distribution between habitat types. Table V-4 is a list of the species used in the analysis.

Table V-3 is on the following two pages. UPSLOPE COUNTS, DOWNSLOPE COUNTS, and TOTAL COUNTS are the number of plots in which the species occurred. UPSLOPE AVERAGE, DOWNSLOPE AVERAGE, AND TOTAL AVERAGE are the average percent cover for the species. Note that average values that appear as “0” are actually less than 0.5%. Average percent cover values are rounded to reflect precision of the estimates.

Table V-4 is on the next two pages following Table V-3. Table V-4 is a list of the species that were used in the analysis, and their counts and averages as in Table V-3.

Table V-3. Species that occurred in less than ten percent of the total plots.

SPECIES	ACRONYM	VEG TYPE	UPSLOPE COUNT	UPSLOPE AVERAGE	DOWNSLOPE COUNT	DOWNSLOPE AVERAGE	TOTAL COUNT	TOTAL AVERAGE
Malus fusca	MAFU	TREE	0	0	1	0	1	0
Cladothamnus pyrolaeflorus	CLPY	TALL SHRUB	3	1	0	0	3	0
Oplopanax horridus	OPHO	TALL SHRUB	1	0	0	0	1	0
Phyllodoce glanduliflora	PHGL	TALL SHRUB	4	0	0	0	4	0
Rubus spectabilis	RUSP	TALL SHRUB	3	0	2	0	5	0
Vaccinium alaskense	VAAL	TALL SHRUB	1	0	0	0	1	0
Vaccinium parvifolia	VAPA	TALL SHRUB	2	0	0	0	2	0
Viburnum edule	VIED	TALL SHRUB	0	0	1	0	1	0
Angelica genuflexa	ANGE2	FORB	1	0	3	0	4	0
Drosera rotundifolia	DRRO	FORB	6	1	2	0	8	0
Dodecatheon pulchellum	DOPU	FORB	3	0	6	1	9	0
Erigeron perigrinis	ERPE3	FORB	2	0	8	0	10	0
Epilobium ciliatum	EPCI	FORB	1	0	0	0	1	0
Galium trifidim	GATR2	FORB	0	0	1	0	1	0
Geum calthifolium	GECA6	FORB	6	1	2	0	8	0
Heracleum lanatum	HELA4	FORB	1	0	0	0	1	0
Leptarrhena pyrofolia	LEPY	FORB	2	0	0	0	2	0
Listera cordata	LICO	FORB	0	0	4	0	4	0
Listera convallarioides	LICO5	FORB	2	0	0	0	2	0
Mitella pedandra	MIPE	FORB	2	0	0	0	2	0
Parnassia fimbriata	PAFI3	FORB	2	0	3	0	5	0
Platanthera chorisiana	PLCH3	FORB	2	0	0	0	2	0

Table V-3 continued								
SPECIES	ACRONYM	VEG TYPE	UPSLOPE COUNT	UPSLOPE AVERAGE	DOWNSLOPE COUNT	DOWNSLOPE AVERAGE	TOTAL COUNT	TOTAL AVERAGE
Platanthera dilitata	PLDI4	FORB	3	0	3	0	6	0
Plantago macrocarpa	PLMA	FORB	0	0	1	0	1	0
Platanthera saccata	PLSA6	FORB	4	0	5	0	9	0
Pyrola secunda	PYSE	FORB	0	0	1	0	1	0
Rubus pedatis	RUPE	FORB	2	0	7	0	9	0
Rubus chamaemorus	RUCH	FORB	5	0	4	0	9	0
Streptopus roseus	STRO4	FORB	3	0	5	0	8	0
Taraxacum officinale	TAOF	FORB	0	0	3	0	3	0
Tiarella trifoliata	TITR	FORB	1	0	0	0	1	0
Viola sp	VI	FORB	1	0	0	0	1	0
Carex anthoxanthea	CAAN10	GRAMINOIDES	1	0	1	0	2	0
Calamagrostis canadensis	CACA4	GRAMINOIDES	1	0	10	1	11	1
Carex lenticularis	CALE8	GRAMINOIDES	2	0	9	1	11	1
Carex stylosa	CAST10	GRAMINOIDES	0	0	3	1	3	0
Carex laeviculmis	CALAE	GRAMINOIDES	1	0	4	1	5	1
Carex vividula	CAVI5	GRAMINOIDES	0	0	3	0	3	0
Rhynchospora alba	RHAL	GRAMINOIDES	2	0	4	1	6	1
Phalaris arundinaceae	PHAR3	GRAMINOIDES	0	0	4	0	4	0
Adiantum pedatum	ADPE	FORB 2	0	0	4	0	4	0
Athyrium felixm femina	ATFI	FORB 3	4	1	7	0	11	1
Blecnum spicant	BLSP	FORB 4	7	0	3	0	10	0
Pteridium aquilinium	PTAQ	FORB 5	0	0	6	1	6	1
Dryopteris expansa	DREX	FORB 6	2	0	1	0	3	0

Table V-3 continued								
SPECIES	ACRONYM	VEG TYPE	UPSLOPE COUNT	UPSLOPE AVERAGE	DOWNSLOPE COUNT	DOWNSLOPE AVERAGE	TOTAL COUNT	TOTAL AVERAGE
Lycopodium clavatum	LYCL	MISC	1	0	0	0	1	0
Lycopodiella inundata	LYIN2	MISC	0	0	1	0	1	0
Equisetum	EQ	MISC	2	0	8	0	10	0

Table V-4. Species that occurred in more than ten percent of the total plots and were used in the analysis.

SPECIES	ACRONYM	VEG TYPE	UPSLOPE COUNT	UPSLOPE AVERAGE	DOWNSLOPE COUNT	DOWNSLOPE AVERAGE	TOTAL COUNT	TOTAL AVERAGE
Chamacyparis nootkatensis	CHNO	TREE	21	10	23	8	44	9
Picea sitchensis	PISI	TREE	7	2	19	2	26	2
Pinus contorta	PICO	TREE	31	15	46	14	77	14
Thuja plicata	THPL	TREE	5	0	12	1	17	1
Tsuga heterophylla	TSHE	TREE	7	2	26	7	33	5
Tsuga mertensiana	TSME	TREE	6	1	16	2	22	2
Andromeda polifolia	ANPO	TALL SHRUB	23	3	28	4	51	4
Empetrum nigrum	EMNI	TALL SHRUB	32	19	39	12	71	15
Juniperis communis	JUCO	TALL SHRUB	19	5	15	3	34	4
Loisleura procumbens	LOPR	TALL SHRUB	7	3	8	2	15	2
Menziesi ferruginea	MEFE	TALL SHRUB	11	2	20	2	31	2
Vaccinium caespitosum	VACA	TALL SHRUB	7	1	10	2	17	2
Vaccinium uliginosum	VAUL	TALL SHRUB	32	16	38	12	70	13
Vaccinium ovalifolium	VAOV	TALL SHRUB	12	2	16	4	28	3
Vaccinium oxycoccus	VAOX	TALL SHRUB	22	2	23	2	45	2
Kalmia polifolia	KAPO	TALL SHRUB	35	7	38	5	73	6
Ledum groenlandicum	LEGR	TALL SHRUB	35	11	46	10	81	11
Vaccinium vitis-idea	VAVI	TALL SHRUB	12	3	24	5	36	4
Caltha biflora	CABI2	FORB	12	4	10	1	22	2
Coptis asplenifolia	COAS	FORB	13	2	21	1	34	2
Coptis trifoliate	COTR2	FORB	22	2	16	1	38	1

Table V-4 continued								
SPECIES	ACRONYM	VEG TYPE	UPSLOPE COUNT	UPSLOPE AVERAGE	DOWNSLOPE COUNT	DOWNSLOPE AVERAGE	TOTAL COUNT	TOTAL AVERAGE
Cornus canadensis	COCA13	FORB	42	14	55	10	97	12
Gentiana dougiasiana	GEDO	FORB	13	1	1	0	14	0
Linnea borealis	LIBO3	FORB	6	0	17	1	23	1
Lysichiton americanum	LYAM	FORB	15	5	27	6	42	5
Maianthemum dilatatum	MADI	FORB	6	0	11	0	17	0
Microseris borealis	MIBO	FORB	12	0	10	0	22	0
Sanguisorba menziesii	SAME6	FORB	34	4	43	3	77	3
Tofieldia glutinosa	TOGL2	FORB	17	1	20	1	37	1
Triantalis europa	TREU	FORB	22	1	15	0	37	1
Carex livida	CALI	GRAMINOIDES	4	1	8	2	12	2
Carex sitchensis	CASI3	GRAMINOIDES	8	1	12	4	20	3
Carex pauciflora	CAPA19	GRAMINOIDES	11	4	7	1	18	2
Carex pluriflora	CAPL6	GRAMINOIDES	6	1	14	4	20	3
Eriophorum angustifolium	ERAN	GRAMINOIDES	30	7	30	5	60	5
Trichophorum cespitosum	TRCE3	GRAMINOIDES	22	9	32	12	54	11
Lycopodium annotinum	LYAN2	MISC	4	0	8	0	12	0

Ordination

Principal Component Analysis (PCA)

Principal Component Correlations

Correlations of the thirty-seven plant species with the Principal Component Axes were obtained using Principal Component Analysis (Table V-5). The strength of the association of a species with a Principal Component is represented by the magnitude of the correlation (absolute value). In Tables V-6 through V-11 the species are sorted by the strength of their correlation with Principal Components 1 through 6. The species with the highest associations appear at the top of the tables, along with their Principal Component axis correlation.

Table V-5. Principal Component Correlations. The correlations of the 37 plant species with the 6 Principal Component axes obtained from PCA analysis of plant community data.

SPECIES	ACRONYM	EIGENVECTOR 1	EIGENVECTOR 2	EIGENVECTOR 3	EIGENVECTOR 4	EIGENVECTOR 5	EIGENVECTOR 6
Chamacyparis nootkatensis	CHNO	0.0753	0.7897	-0.1978	0.4675	-0.1224	-0.1202
Picea sitchensis	PISI	0.0859	-0.0143	0.0329	-0.0354	0.1033	0.0922
Pinus contorta	PICO	-0.3915	-0.2183	0.5199	0.5335	0.0759	-0.2979
Thuja plicata	THPL	0.026	-0.0186	0.0363	0.0114	-0.0133	-0.0336
Tsuga heterophylla	TSHE	0.2956	-0.0052	0.1927	-0.2151	-0.3921	-0.3972
Tsuga mertensiana	TSME	0.0552	0.0476	0.0042	-0.0385	0.0214	-0.0772
Andromeda polifolia	ANPO	-0.0456	-0.1631	-0.2216	0.1234	-0.0361	-0.1208
Empetrum nigrum	EMNI	-0.4984	0.2605	0.0372	-0.4003	-0.2094	0.3184
Juniperis communis	JUCO	-0.0519	-0.1537	-0.1707	0.0399	0.0725	-0.1184
Loisleura procumbens	LOPR	-0.0571	-0.0083	-0.0394	-0.1028	0.0541	0.0099
Menziesi ferruginea	MEFE	0.1302	-0.0101	0.0795	-0.0678	-0.0395	-0.062
Vaccinium caespitosum	VACA	-0.0277	0.0819	-0.0212	-0.0287	0.0732	-0.0684
Vaccinium uliginosum	VAUL	-0.4551	0.2146	0.0282	-0.35	0.3387	-0.4468
Vaccinium ovalifolium	VAOV	0.1904	-0.0035	0.0944	-0.181	-0.2102	-0.234
Vaccinium oxycoccus	VAOX	-0.0411	-0.0394	-0.0217	0.0105	-0.0945	0.1141
Kalmia polifolia	KAPO	-0.1005	0.0607	0.0196	0.0075	-0.0442	0.1345
Ledum groenlandicum	LEGR	-0.2287	-0.1067	0.2065	0.1686	-0.3805	0.3183
Vaccinium vitis-idea	VAVI	0.1747	-0.0084	0.1802	-0.0144	-0.0573	0.0198
Caltha biflora	CABI2	0.0741	-0.0058	0.015	-0.002	0.1794	0.1695
Coptis asplenifolia	COAS	0.0641	-0.0053	0.057	0.0168	0.0121	0.0234
Coptis trifoliata	COTR2	-0.0239	-0.0018	-0.001	0.016	-0.0455	0.022
Cornus canadensis	COCA13	-0.106	0.0418	0.199	-0.1883	-0.3695	-0.1474

Table V-5 continued							
SPECIES	ACRONYM	EIGENVECTOR 1	EIGENVECTOR 2	EIGENVECTOR 3	EIGENVECTOR 4	EIGENVECTOR 5	EIGENVECTOR 6
Gentiana dougiasiana	GEDO	0.0072	-0.001	0.0034	-0.0002	0.0163	0.0132
Linnea borealis	LIBO3	0.0182	-0.0034	0.0116	-0.0016	-0.016	0.0007
Lysichiton americanum	LYAM	0.2369	-0.0438	0.178	-0.1004	0.1567	0.0593
Maianthemum dilatatum	MADI	0.0157	-0.0032	0.014	-0.0048	-0.0096	-0.0065
Microseris borealis	MIBO	0.0028	0.0021	0.0017	-0.0031	0.0136	0.0049
Sanguisorba menziesii	SAME6	-0.0369	-0.0193	-0.0162	0.0074	0.1273	0.0184
Tofieldia glutinosa	TOGL2	-0.0139	-0.0152	-0.0333	0.0035	0.0114	-0.0338
Triantalis europa	TREU	0.0047	-0.0047	-0.0095	0.0092	0.0072	0.0108
Carex livida	CALI	-0.0057	-0.0565	-0.0715	-0.0184	0.0608	0.0482
Carex sitchensis	CASI3	-0.0461	-0.0818	-0.0568	0.0898	-0.2409	0.2144
Carex pauciflora	CAPA19	0.0322	0.0468	0.0099	-0.0192	0.1226	0.1619
Carex pluriflora	CAPL6	0.0911	0.0258	0.0393	-0.1063	0.0062	0.0309
Eriophorum angustifolium	ERAN	0.0471	-0.0931	0.0304	-0.035	0.2966	0.1231
Trichophorum cespitosum	TRCE3	-0.1919	-0.3352	-0.6245	0.0541	-0.2418	-0.2238
Lycopodium annotinum	LYAN2	0.0085	0.0005	0.0047	-0.0073	-0.0079	-0.0087

Table V-6. Principal Component Correlations. The correlations of the 37 plant species with the Principal Component Axis 1 obtained from PCA analysis of plant community data.

SPECIES	ACRONYM	EIGENVECTOR 1
Empetrum nigrum	EMNI	-0.4984
Vaccinium uliginosum	VAUL	-0.4551
Pinus contorta	PICO	-0.3915
Tsuga heterophylla	TSHE	0.2956
Lysichiton americanum	LYAM	0.2369
Ledum groenlandicum	LEGR	-0.2287
Trichophorum cespitosum	TRCE3	-0.1919
Vaccinium ovalifolium	VAOV	0.1904
Vaccinium vitis-idea	VAVI	0.1747
Menziesi ferruginea	MEFE	0.1302
Cornus canadensis	COCA13	-0.106
Kalmia polifolia	KAPO	-0.1005
Carex pluriflora	CAPL6	0.0911
Picea sitchensis	PISI	0.0859
Chamacyparis nootkatensis	CHNO	0.0753
Caltha biflora	CABI2	0.0741
Coptis asplenifolia	COAS	0.0641
Loisleura procumbens	LOPR	-0.0571
Tsuga mertensiana	TSME	0.0552
Juniperis communis	JUCO	-0.0519
Eriophorum angustifolium	ERAN	0.0471
Carex sitchensis	CASI3	-0.0461
Andromeda polifolia	ANPO	-0.0456
Vaccinium oxycoccus	VAOX	-0.0411
Sanguisorba menziesii	SAME6	-0.0369
Carex pauciflora	CAPA19	0.0322
Vaccinium caespitosum	VACA	-0.0277
Thuja plicata	THPL	0.026
Coptis trifoliata	COTR2	-0.0239
Linnea borealis	LIBO3	0.0182
Maianthemum dilatatum	MADI	0.0157
Tofieldia glutinosa	TOGL2	-0.0139

Table V-6 continued		
SPECIES	ACRONYM	EIGENVECTOR 1
Lycopodium annotinum	LYAN2	0.0085
Gentiana dougiasiana	GEDO	0.0072
Carex livida	CALI	-0.0057
Triantalis europa	TREU	0.0047
Microseris borealis	MIBO	0.0028

Table V-7. Principal Component Correlations. The correlations of the 37 plant species with the Principal Component Axis 2 obtained from PCA analysis of plant community data.

SPECIES	ACRONYM	EIGENVECTOR 2
Chamacyparis nootkatensis	CHNO	0.7897
Trichophorum cespitosum	TRCE3	-0.3352
Empetrum nigrum	EMNI	0.2605
Pinus contorta	PICO	-0.2183
Vaccinium uliginosum	VAUL	0.2146
Andromeda polifolia	ANPO	-0.1631
Juniperis communis	JUCO	-0.1537
Ledum groenlandicum	LEGR	-0.1067
Eriophorum angustifolium	ERAN	-0.0931
Vaccinium caespitosum	VACA	0.0819
Carex sitchensis	CASI3	-0.0818
Kalmia polifolia	KAPO	0.0607
Carex livida	CALI	-0.0565
Tsuga mertensiana	TSME	0.0476
Carex pauciflora	CAPA19	0.0468
Lysichiton americanum	LYAM	-0.0438
Cornus canadensis	COCA13	0.0418
Vaccinium oxycoccus	VAOX	-0.0394
Carex pluriflora	CAPL6	0.0258
Sanguisorba menziesii	SAME6	-0.0193
Thuja plicata	THPL	-0.0186
Tofieldia glutinosa	TOGL2	-0.0152
Picea sitchensis	PISI	-0.0143
Menziesi ferruginea	MEFE	-0.0101
Vaccinium vitis-idea	VAVI	-0.0084
Loisleura procumbens	LOPR	-0.0083
Caltha biflora	CABI2	-0.0058
Coptis asplenifolia	COAS	-0.0053
Tsuga heterophylla	TSHE	-0.0052
Triantalis europa	TREU	-0.0047
Vaccinium ovalifolium	VAOV	-0.0035
Linnea borealis	LIBO3	-0.0034
Table V-7 continued		

SPECIES	ACRONYM	EIGENVECTOR 2
Maianthemum dilatatum	MADI	-0.0032
Microseris borealis	MIBO	0.0021
Coptis trifoliata	COTR2	-0.0018
Gentiana dougiasiana	GEDO	-0.001
Lycopodium annotinum	LYAN2	0.0005

Table V-8. Principal Component Correlations. The correlations of the 37 plant species with the Principal Component Axis 3 obtained from PCA analysis of plant community data.

SPECIES	ACRONYM	EIGENVECTOR 3
Trichophorum cespitosum	TRCE3	-0.6245
Pinus contorta	PICO	0.5199
Andromeda polifolia	ANPO	-0.2216
Ledum groenlandicum	LEGR	0.2065
Cornus canadensis	COCA13	0.199
Chamacyparis nootkatensis	CHNO	-0.1978
Tsuga heterophylla	TSHE	0.1927
Vaccinium vitis-idea	VAVI	0.1802
Lysichiton americanum	LYAM	0.178
Juniperis communis	JUCO	-0.1707
Vaccinium ovalifolium	VAOV	0.0944
Menziesi ferruginea	MEFE	0.0795
Carex livida	CALI	-0.0715
Coptis asplenifolia	COAS	0.057
Carex sitchensis	CASI3	-0.0568
Loisleura procumbens	LOPR	-0.0394
Carex pluriflora	CAPL6	0.0393
Empetrum nigrum	EMNI	0.0372
Thuja plicata	THPL	0.0363
Tofieldia glutinosa	TOGL2	-0.0333
Picea sitchensis	PISI	0.0329
Eriophorum angustifolium	ERAN	0.0304
Vaccinium uliginosum	VAUL	0.0282
Vaccinium oxycoccus	VAOX	-0.0217
Vaccinium caespitosum	VACA	-0.0212
Kalmia polifolia	KAPO	0.0196
Sanguisorba menziesii	SAME6	-0.0162
Caltha biflora	CABI2	0.015
Maianthemum dilatatum	MADI	0.014
Linnea borealis	LIBO3	0.0116
Carex pauciflora	CAPA19	0.0099
Triantalis europa	TREU	-0.0095
Table V-8 continued		

SPECIES	ACRONYM	EIGENVECTOR 3
Lycopodium annotinum	LYAN2	0.0047
Tsuga mertensiana	TSME	0.0042
Gentiana dougiasiana	GEDO	0.0034
Microseris borealis	MIBO	0.0017
Coptis trifoliata	COTR2	-0.001

Table V-9. Principal Component Correlations. The correlations of the 37 plant species with the Principal Component Axis 4 obtained from PCA analysis of plant community data.

SPECIES	ACRONYM	EIGENVECTOR 4
Pinus contorta	PICO	0.5335
Chamacyparis nootkatensis	CHNO	0.4675
Empetrum nigrum	EMNI	-0.4003
Vaccinium uliginosum	VAUL	-0.35
Tsuga heterophylla	TSHE	-0.2151
Cornus canadensis	COCA13	-0.1883
Vaccinium ovalifolium	VAOV	-0.181
Ledum groenlandicum	LEGR	0.1686
Andromeda polifolia	ANPO	0.1234
Carex pluriflora	CAPL6	-0.1063
Loisleura procumbens	LOPR	-0.1028
Lysichiton americanum	LYAM	-0.1004
Carex sitchensis	CASI3	0.0898
Menziesi ferruginea	MEFE	-0.0678
Trichophorum cespitosum	TRCE3	0.0541
Juniperis communis	JUCO	0.0399
Tsuga mertensiana	TSME	-0.0385
Picea sitchensis	PISI	-0.0354
Eriophorum angustifolium	ERAN	-0.035
Vaccinium caespitosum	VACA	-0.0287
Carex pauciflora	CAPA19	-0.0192
Carex livida	CALI	-0.0184
Coptis asplenifolia	COAS	0.0168
Coptis trifoliata	COTR2	0.016
Vaccinium vitis-idea	VAVI	-0.0144
Thuja plicata	THPL	0.0114
Vaccinium oxycoccus	VAOX	0.0105
Triantalis europa	TREU	0.0092
Kalmia polifolia	KAPO	0.0075
Sanguisorba menziesii	SAME6	0.0074
Lycopodium annotinum	LYAN2	-0.0073
Maianthemum dilatatum	MADI	-0.0048
Table V-9 continued		

SPECIES	ACRONYM	EIGENVECTOR 4
Tofieldia glutinosa	TOGL2	0.0035
Microseris borealis	MIBO	-0.0031
Caltha biflora	CABI2	-0.002
Linnea borealis	LIBO3	-0.0016
Gentiana dougiasiana	GEDO	-0.0002

Table V-10. Principal Component Correlations. The correlations of the 37 plant species with the Principal Component Axis 5 obtained from PCA analysis of plant community data.

SPECIES	ACRONYM	EIGENVECTOR 5
Tsuga heterophylla	TSHE	-0.3921
Ledum groenlandicum	LEGR	-0.3805
Cornus canadensis	COCA13	-0.3695
Vaccinium uliginosum	VAUL	0.3387
Eriophorum angustifolium	ERAN	0.2966
Trichophorum cespitosum	TRCE3	-0.2418
Carex sitchensis	CASI3	-0.2409
Vaccinium ovalifolium	VAOV	-0.2102
Empetrum nigrum	EMNI	-0.2094
Caltha biflora	CABI2	0.1794
Lysichiton americanum	LYAM	0.1567
Sanguisorba menziesii	SAME6	0.1273
Carex pauciflora	CAPA19	0.1226
Chamacyparis nootkatensis	CHNO	-0.1224
Picea sitchensis	PISI	0.1033
Vaccinium oxycoccus	VAOX	-0.0945
Pinus contorta	PICO	0.0759
Vaccinium caespitosum	VACA	0.0732
Juniperis communis	JUCO	0.0725
Carex livida	CALI	0.0608
Vaccinium vitis-idea	VAVI	-0.0573
Loisleura procumbens	LOPR	0.0541
Coptis trifoliata	COTR2	-0.0455
Kalmia polifolia	KAPO	-0.0442
Menziesi ferruginea	MEFE	-0.0395
Andromeda polifolia	ANPO	-0.0361
Tsuga mertensiana	TSME	0.0214
Gentiana dougiasiana	GEDO	0.0163
Linnea borealis	LIBO3	-0.016
Microseris borealis	MIBO	0.0136
Thuja plicata	THPL	-0.0133
Coptis asplenifolia	COAS	0.0121
Table V-10 continued		

SPECIES	ACRONYM	EIGENVECTOR 5
Tofieldia glutinosa	TOGL2	0.0114
Maianthemum dilatatum	MADI	-0.0096
Lycopodium annotinum	LYAN2	-0.0079
Triantalis europa	TREU	0.0072
Carex pluriflora	CAPL6	0.0062

Table V-11. Principal Component Correlations. The correlations of the 37 plant species with the Principal Component Axis 6 obtained from PCA analysis of plant community data.

SPECIES	ACRONYM	EIGENVECTOR 6
Vaccinium uliginosum	VAUL	-0.4468
Tsuga heterophylla	TSHE	-0.3972
Empetrum nigrum	EMNI	0.3184
Ledum groenlandicum	LEGR	0.3183
Pinus contorta	PICO	-0.2979
Vaccinium ovalifolium	VAOV	-0.234
Trichophorum cespitosum	TRCE3	-0.2238
Carex sitchensis	CASI3	0.2144
Caltha biflora	CABI2	0.1695
Carex pauciflora	CAPA19	0.1619
Cornus canadensis	COCA13	-0.1474
Kalmia polifolia	KAPO	0.1345
Eriophorum angustifolium	ERAN	0.1231
Andromeda polifolia	ANPO	-0.1208
Chamacyparis nootkatensis	CHNO	-0.1202
Juniperis communis	JUCO	-0.1184
Vaccinium oxycoccus	VAOX	0.1141
Picea sitchensis	PISI	0.0922
Tsuga mertensiana	TSME	-0.0772
Vaccinium caespitosum	VACA	-0.0684
Menziesi ferruginea	MEFE	-0.062
Lysichiton americanum	LYAM	0.0593
Carex livida	CALI	0.0482
Tofieldia glutinosa	TOGL2	-0.0338
Thuja plicata	THPL	-0.0336
Carex pluriflora	CAPL6	0.0309
Coptis asplenifolia	COAS	0.0234
Coptis trifoliata	COTR2	0.022
Vaccinium vitis-idea	VAVI	0.0198
Sanguisorba menziesii	SAME6	0.0184
Gentiana dougiasiana	GEDO	0.0132
Triantalis europa	TREU	0.0108
Table V-11 continued		

SPECIES	ACRONYM	EIGENVECTOR 6
Loisleura procumbens	LOPR	0.0099
Lycopodium annotinum	LYAN2	-0.0087
Maianthemum dilatatum	MADI	-0.0065
Microseris borealis	MIBO	0.0049
Linnea borealis	LIBO3	0.0007

Percentage Variance

The importance of the Principal Component axes is measured by the amount of total variance accounted for by those axes. By definition, the first axis accounts for the most variation, and the proportion of the total variance decreases with succeeding axes. It is important to report the amount of total variance accounted for in the axes that are discussed in a scientific paper.

The amount of total variance accounted for, in a way, alludes to the strength of the analysis, somewhat similar to an R^2 value in a regression analysis. For example, reporting that the first three axes account for 51.06 percent of the total variance is equivalent to saying the R^2 value of the analysis is 0.5106. It is up to the reader to determine whether enough of the variance was accounted for, and therefore estimate the strength of the conclusions. All six PCA axes (vectors) accounting for 69.12 percent of the total variation was examined with NMS.

Table V-12. Percentage Variance and Cumulative Variance for Principal Component Axes. The percentage of the total variance and the cumulative variance for the Principal Component Axes resulting from PCA analysis of the plant community data.

	Vector 1	Vector 2	Vector 3	Vector 4	Vector 5	Vector 6
Eigenvalue	71456.469	43161.641	37620.52	22707.52	16690.334	14452.135
Percent Variance	23.965	14.475	12.617	7.615	5.597	4.847
Cumulative Variance	23.965	38.44	51.057	58.672	64.27	69.116

Nonmetric Multidimensional Scaling (NMS)

Site NMS Axes Scores

Included in the results of NMS are the scores (position) of the sampling sites on the Component Axes. These scores are used to produce graphs (Figures V-1, V-2, and V-3), to explore the structure of the data, and to form hypotheses about group associations for the sampling sites.

Table V-13. Nonmetric Multidimensional Scaling Axes Scores. The scores (positions) of the sampling sites on the NMS Axes obtained from NMS analysis of the plant community data.

PLOTNUM	WETLAND	Transect	REP	TYPE	VEC1	VEC2	VEC3
L1AD	L	A	A	D	0.8998	-0.1485	-0.1787
L1BD	L	A	B	D	0.8002	0.1684	0.4286
L1CD	L	A	C	D	0.2385	0.03	0.7599
L1DD	L	A	D	D	0.4828	0.4022	0.3658
L1ED	L	A	E	D	1.0335	0.2614	0.5954
L1FD	L	A	F	D	0.6899	0.051	0.7895
L1GD	L	A	G	D	0.6483	0.242	0.6673
L2AD	L	B	A	D	0.6695	-0.1545	-0.0431
L2BD	L	B	B	D	0.6499	0.1141	0.1791
L2CD	L	B	C	D	1.0238	-0.4553	-0.2728
L2DD	L	B	D	D	0.973	-0.0351	0.7416
L3AD	L	C	A	D	1.2048	-0.14	1.2508
L3BD	L	C	B	D	0.182	-0.0052	1.2452
L3CD	L	C	C	D	0.6029	0.2534	0.6223
L3DD	L	C	D	D	0.9852	-0.1075	0.7364
L3ED	L	C	E	D	1.1325	0.0578	0.9309
L3FD	L	C	F	D	0.8918	-0.0112	0.8441
L3GD	L	C	G	D	0.781	-0.0462	0.7991
L3HD	L	C	H	D	0.1659	0.1316	0.6737
L3ID	L	C	I	D	0.4313	0.2662	0.4379
L3JD	L	C	J	D	0.9186	-0.1299	1.0118
LC1AD	LC	A	A	D	0.6755	-0.065	-0.0976
LC1BD	LC	A	B	D	-0.6291	-0.1564	-0.2311
LC1CD	LC	A	C	D	-1.1897	-0.1571	-0.3685
LC2AD	LC	B	A	D	-0.3931	-0.1087	0.1126

Table V-13 continued							
PLOTNUM	WETLAND	Transect	REP	TYPE	VEC1	VEC2	VEC3
LC2BD	LC	B	B	D	-1.145	-0.4152	1.4032
LC2CD	LC	B	C	D	-0.5876	-0.0714	0.8536
LC3AD	LC	C	A	D	0.0971	0.0694	-0.0884
LC3BD	LC	C	B	D	-0.2818	0.4428	-0.3027
LC3CD	LC	C	C	D	-0.5705	-0.4113	0.0643
EH1AD	EH	A	A	D	-0.4659	-0.2203	-0.5764
EH1BD	EH	A	B	D	-0.5266	0.4496	-0.2945
EH1CD	EH	A	C	D	-0.4548	0.6406	-0.2649
EH2AD	EH	B	A	D	0.0427	0.5064	0.1074
EH2BD	EH	B	B	D	0.1702	0.3337	0.1878
EH2CD	EH	B	C	D	0.2191	0.4154	0.2383
EH3AD	EH	C	A	D	-0.6984	-0.3023	-0.5214
EH3BD	EH	C	B	D	-1.1263	-0.6576	0.1017
EH3CD	EH	C	C	D	0.1401	-0.9235	-0.4249
RB1AD	RB	A	A	D	-0.4153	-1.1452	-0.0878
RB1BD	RB	A	B	D	0.4318	-0.9504	-0.9089
RB1CD	RB	A	C	D	0.2279	-0.478	-0.5761
RB1DD	RB	A	D	D	-0.6313	-0.6002	-0.6415
RB2AD	RB	B	A	D	0.1385	0.1561	-0.3839
RB2BD	RB	B	B	D	-0.1531	0.5958	-0.2062
RB2CD	RB	B	C	D	0.1948	0.1284	-0.8498
RB2DD	RB	B	D	D	-0.277	0.1628	-0.6102
RB2ED	RB	B	E	D	-0.1941	0.6223	-0.3233
RB2FD	RB	B	F	D	-0.0313	0.801	-0.1118
RB2GD	RB	B	G	D	-0.1175	-1.0935	-1.2211
RB3AD	RB	C	A	D	0.6539	-0.0995	-0.4276
RB3BD	RB	C	B	D	0.2861	-0.0497	-0.1089
RB3CD	RB	C	C	D	-0.0009	0.3599	-0.1254
RB3DD	RB	C	D	D	-0.2942	-0.0894	-0.7342
RB3ED	RB	C	E	D	0.1864	-0.3371	-0.8286
MR1AD	MR	A	A	D	-0.0587	0.8016	-0.473
MR1BD	MR	A	B	D	-0.3749	0.9732	-0.4868
MR1CD	MR	A	C	D	-0.3075	1.4848	-0.4315
MR1DD	MR	A	D	D	0.1028	0.8785	-0.319

Table V-13 continued							
PLOTNUM	WETLAND	Transect	REP	TYPE	VEC1	VEC2	VEC3
MR1ED	MR	A	E	D	0.1183	-0.3233	-1.1424
MR2AD	MR	B	A	D	-0.1353	-0.7466	0.8897
MR2BD	MR	B	B	D	-0.8005	-0.5825	1.4926
MR2CD	MR	B	C	D	0.0657	-0.8892	-0.6649
BC1AD	BC	A	A	D	0.0139	1.0486	-0.0973
BC1BD	BC	A	B	D	-0.1242	1.3035	-0.6071
BC1CD	BC	A	C	D	-0.2972	0.5783	-0.7945
TC1AD	TC	A	A	D	-1.0271	-0.0577	1.3366
TC1BD	TC	A	B	D	-0.8071	0.3873	-0.2358
TC1CD	TC	A	C	D	-0.7586	0.0698	0.3706
L1AU	L	A	A	U	0.6713	0.0053	0.8509
L1BU	L	A	B	U	1.1113	0.2215	0.9034
L1CU	L	A	C	U	0.9734	0.1939	0.0115
L2AU	L	B	A	U	0.7226	0.309	0.0595
L2BU	L	B	B	U	0.3264	0.492	0.3524
L2CU	L	B	C	U	0.4639	0.3248	0.1954
L3AU	L	C	A	U	0.4447	-0.1488	0.9778
L3BU	L	C	B	U	0.6034	0.1979	0.5302
L3CU	L	C	C	U	0.7742	-0.4596	0.1023
LC1AU	LC	A	A	U	-0.6045	-0.1611	0.2944
LC1BU	LC	A	B	U	-0.8161	-0.335	0.6033
LC1CU	LC	A	C	U	-0.4409	-0.2661	0.4607
LC2AU	LC	B	A	U	-0.4997	-0.1202	1.2998
LC2BU	LC	B	B	U	-0.4994	-0.1462	0.8835
LC2CU	LC	B	C	U	-0.7584	0.1198	0.1754
LC3AU	LC	C	A	U	0.6907	0.5289	0.5244
LC3BU	LC	C	B	U	0.6085	0.6494	0.5006
LC3CU	LC	C	C	U	0.4898	0.6829	0.3935
EH1AU	EH	A	A	U	-0.649	-0.1806	-0.7951
EH1BU	EH	A	B	U	-0.6028	0.1195	-0.6231
EH1CU	EH	A	C	U	-0.8959	-0.4232	-0.5754
EH2AU	EH	B	A	U	-0.0056	-0.1032	-0.3899
EH2BU	EH	B	B	U	0.0358	0.0364	-0.2092
EH2CU	EH	B	C	U	-0.0628	0.017	-0.0373

Table V-13 continued							
PLOTNUM	WETLAND	Transect	REP	TYPE	VEC1	VEC2	VEC3
EH3AU	EH	C	A	U	-0.2923	0.0013	-0.2918
EH3BU	EH	C	B	U	-0.4064	-0.435	-0.2051
EH3CU	EH	C	C	U	-0.2779	-0.5476	-0.0934
RB1AU	RB	A	A	U	-0.3634	-0.6545	-0.7569
RB1BU	RB	A	B	U	0.1599	-0.936	-1.0065
RB1CU	RB	A	C	U	-0.364	-0.9231	-0.6652
RB2AU	RB	B	A	U	0.0012	0.635	-0.3856
RB2BU	RB	B	B	U	0.0581	0.1513	-0.6658
RB2CU	RB	B	C	U	0.0093	0.3399	-0.513
RB3AU	RB	C	A	U	0.0979	-0.7111	-0.9669
RB3BU	RB	C	B	U	0.0405	-0.6734	-0.7195
RB3CU	RB	C	C	U	0.1185	-0.2399	-0.7044
MR1AU	MR	A	A	U	-0.1907	-0.4897	-0.4829
MR1BU	MR	A	B	U	-0.7857	-0.6014	-0.4069
MR1CU	MR	A	C	U	-0.4918	-0.807	-0.1821
MR2AU	MR	B	A	U	-0.6057	-0.3556	0.2411
MR2BU	MR	B	B	U	-0.0993	-0.6069	-0.913
MR2CU	MR	B	C	U	-1.0556	-0.6032	-0.6867
BC1AU	BC	A	A	U	-0.0708	0.2483	-0.7283
BC1BU	BC	A	B	U	0.221	0.8698	-0.7391
BC1CU	BC	A	C	U	-0.0757	1.4169	-0.3239
TC1AU	TC	A	A	U	-0.7866	-0.0041	0.6158
TC1BU	TC	A	B	U	-0.775	0.0929	0.7673
TC1CU	TC	A	C	U	-0.4418	0.2549	0.1487

Nonmetric Multidimensional Scaling Axes Ordinations

Figures V-1 through V-3 are ordinations (graphs) of the NMS axis scores of the plant community data showing UPSLOPE and DOWNSLOPE plots. Figure V-1 is a graph of Axis 1 vs. Axis 2, Figure V-2 is a graph of Axis 1 vs. Axis 3, and Figure V-3 is a graph of Axis 2 vs. Axis 3.

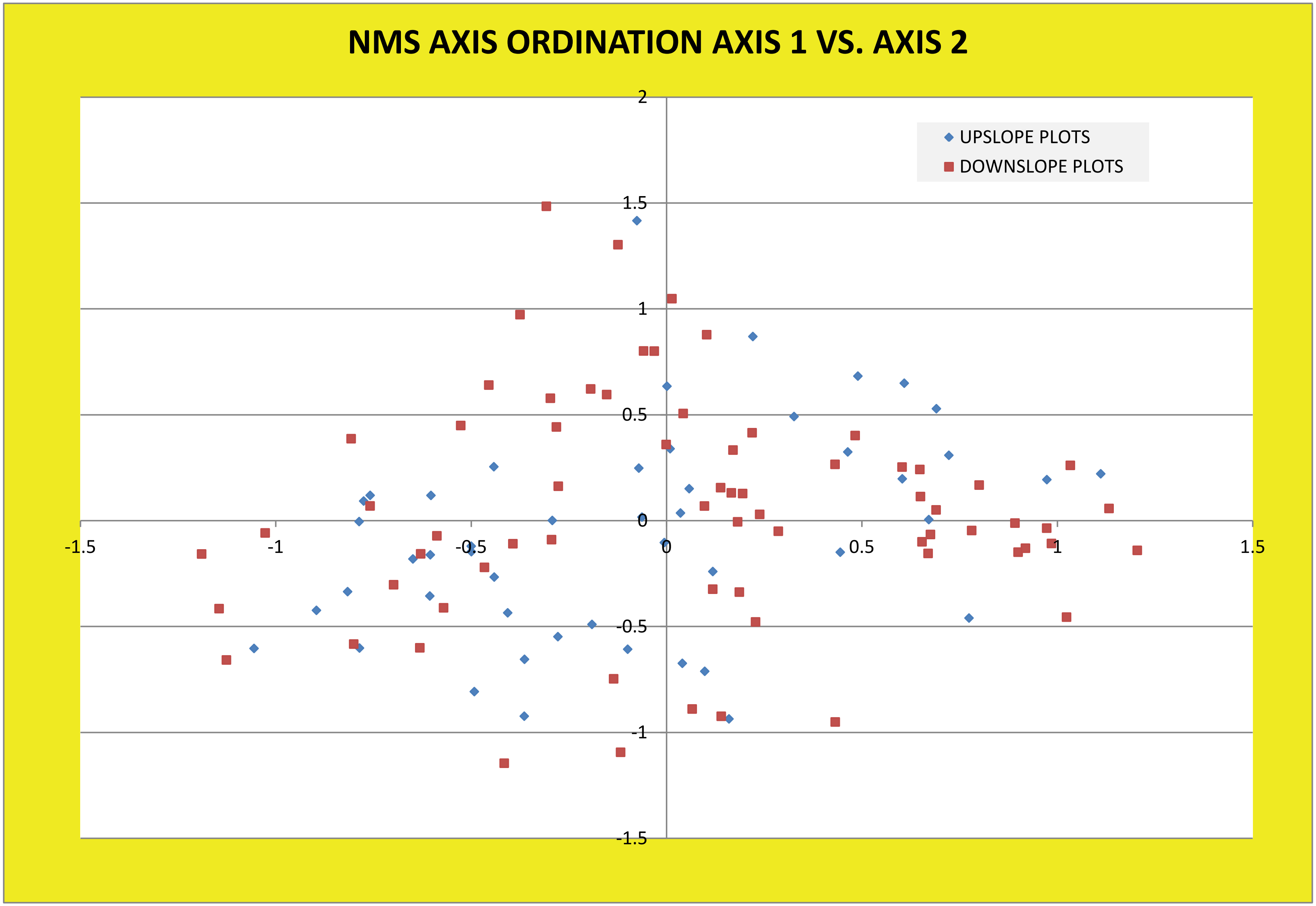


Figure V-1. NMS Ordination of plant community data, Axis 1 vs. Axis 2.

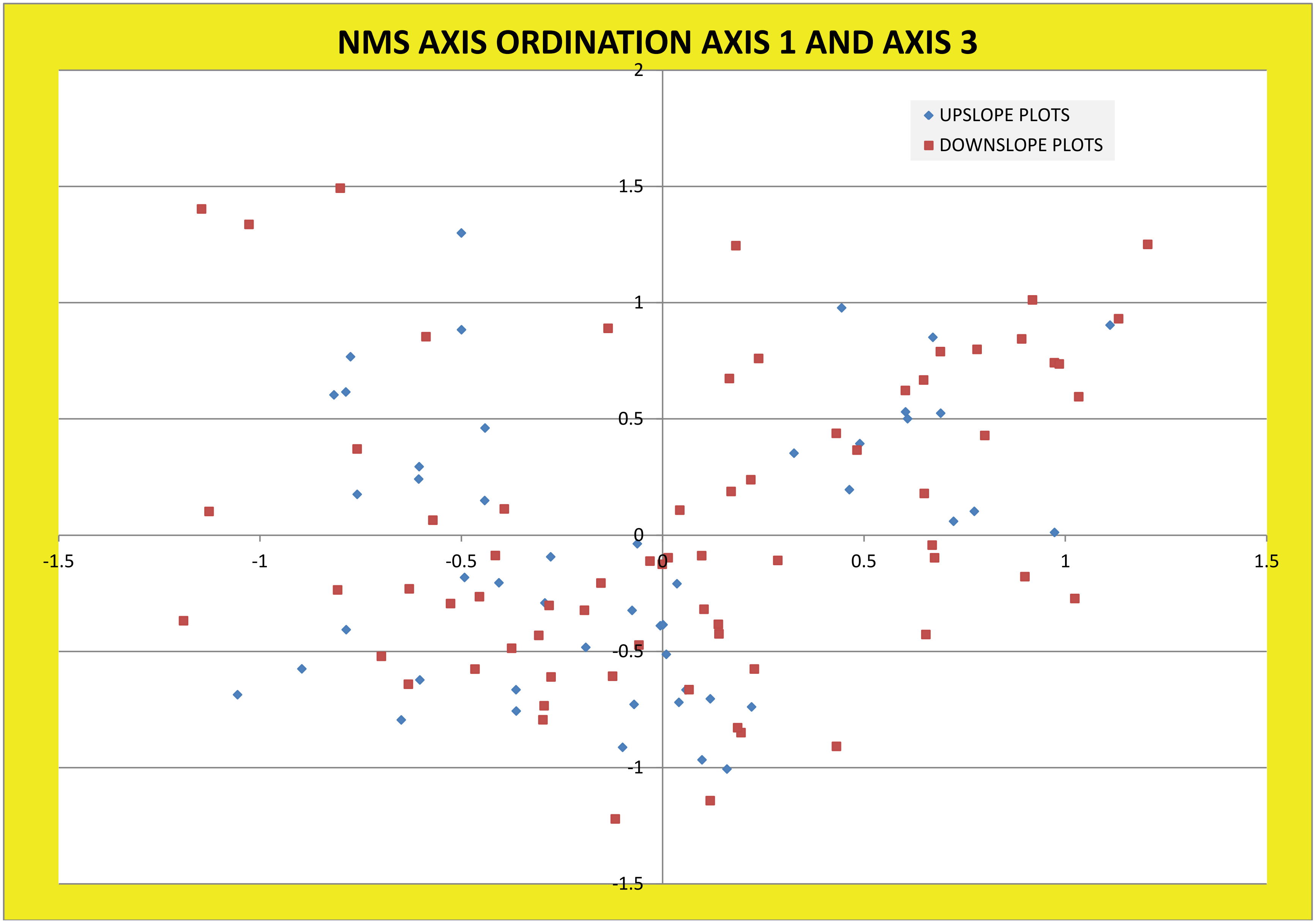


Figure V- 2. NMS Ordination of plant community data, Axis 1 vs. Axis 3.

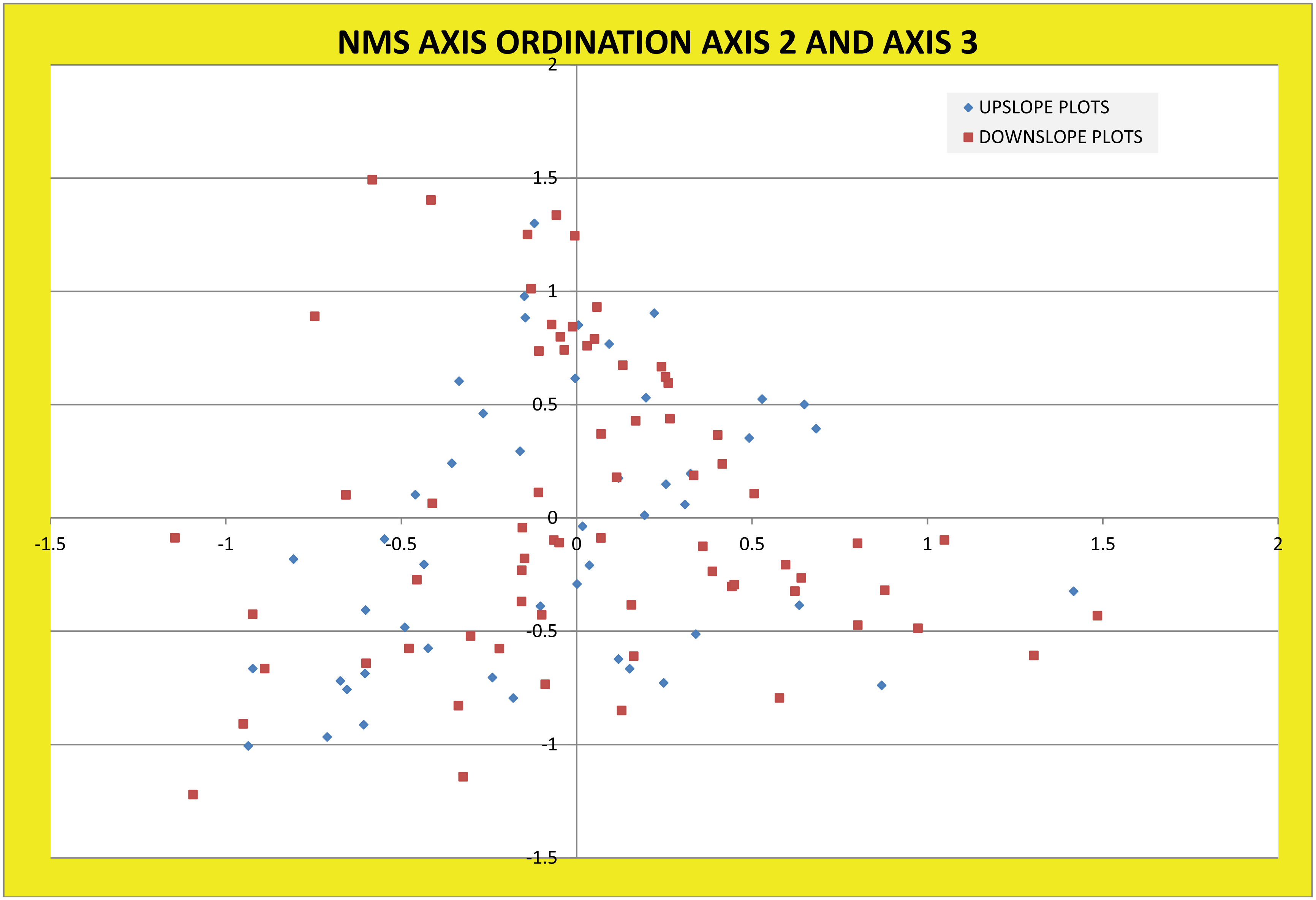


Figure V-3. NMS Ordination of plant community data, Axis 2 vs. Axis 3.

Multi-Response Permutation Procedures (MRPP)

MRPP Table

Test statistic: T = -1.7848138
Observed delta = 56.232745
Expected delta = 56.571745
Variance of delta = 0.036075634
Skewness of delta = -1.4259161

Chance-corrected within-group agreement, A = 0.00599239
A = 1 - (observed delta/expected delta)
Amax = 1 when all items are identical within groups (delta=0)
A = 0 when heterogeneity within groups equals expectation by chance
A < 0 with more heterogeneity within groups than expected by chance

Probability of a smaller or equal delta, p = 0.05997257

Statistical Inference

There is suggestive evidence of a difference between UPSLOPE and DOWNSLOPE plots (p-value = 0.05997). The “A” statistic is close to zero (0.00599) and suggests that the group heterogeneity of the species (UPSLOPE and DOWNSLOPE) is close to that expected by chance, and does not indicate strong group affinities of the species.

Multivariate Analysis of Variance (MANOVA)

MANOVA Table

	Df	Wilks	approx F	num Df	den Df	Pr(>F)
Wetland	6.00	0.1270	17.7538	18.00	297.47	<0.0001
Transect	2.00	0.8696	2.5326	6.00	210.00	0.02179
Type	1.00	0.9733	0.9616	3.00	105.00	0.41380
Residuals	107.00					

Statistical Inference

There is no evidence of a difference between UPSLOPE and DOWNSLOPE plots (p-value = 0.4138).

VI. DISCUSSION

1. What plant species characterize the community composition of UPSLOPE and DOWNSLOPE areas?

The plant species that characterize the UPSLOPE and DOWNSLOPE areas can be extracted from Tables V-6 through V-11. Those species with positive PCA scores are most associated with UPSLOPE areas, and those with negative PCA scores are most associated with DOWNSLOPE areas. The greater the magnitude of the PCA scores, the most the species is associated with its area.

There were only three species that had a PCA axis score with a magnitude of greater than 0.5 (MAX = 1, MIN = 0). Chamacyparis nootkatensis (CHNO) had a positive PCA score on Axis 2 and is more associated with UPSLOPE areas. Pinus contorta (PICO) had a positive PCA scores on Axis 2 and Axis 3 and is more associated with UPSLOPE areas. Trichophorum cespitosum (TRCE3) had a negative PCA score on Axis 3 and is more associated with DOWNSLOPE areas. Other species have PCA axis scores less than 0.5 and their associated areas can be determined from Tables V-6 through V-11.

2. Is there a difference in plant communities in UPSLOPE and DOWNSLOPE areas?

MRPP and MANOVA agree somewhat that there is no difference in the plant communities in UPSLOPE and DOWNSLOPE areas. MRPP provided suggestive evidence of a difference (p-value = 0.05997) and MANOVA provided no evidence of a difference (p-value = 0.4138). MRPP is notorious for returning smaller p-values in large multivariate community datasets and while the p-value is suggestive of a difference, the strong evidence for no difference provided by MANOVA suggests there is no real difference between the two areas.

3. What is the strength of the plant species affinities to UPSLOPE and DOWNSLOPE areas?

There are weak affinities of species with the areas. Figures V-1 through V-3 show no definite groupings of the plots in species space. Both groups overlap considerably and no definite pattern is visible.

VII. ADDITIONAL MULTIVARIATE ANALYSES

Additional analyses were performed on selected transects of the Plant Community dataset. The transects selected for further study were Logjam Transect #3, Red Bay Transect #3, and Mike's Road Transect #1. Each transect was limited to the three UPSLOPE plots and the first three DOWNSLOPE plots (those closest to the road).

The client wished to include as many species as possible in these analyses, therefore two datasets for each transect were constructed. Data reduction was limited to those species that occurred in more than one plot. A second dataset was limited to those species that occurred in more than two plots.

The same procedures were followed as described in the Methods Chapter. First PCA was performed and the eigenvectors extracted for analysis with NMS. The NMS axis scores were then analyzed with MRPP and MANOVA to locate differences between UPSLOPE and DOWNSLOPE plots. The results for each dataset include the Cumulative Variance table for the PCA, the species PCA axis scores, the NMS ordination graph, the MRPP table with inference, and the MANOVA table with inference.

LOGJAM TRANSECT #3 WITH SPECIES OCCURRING IN MORE THAN ONE PLOT

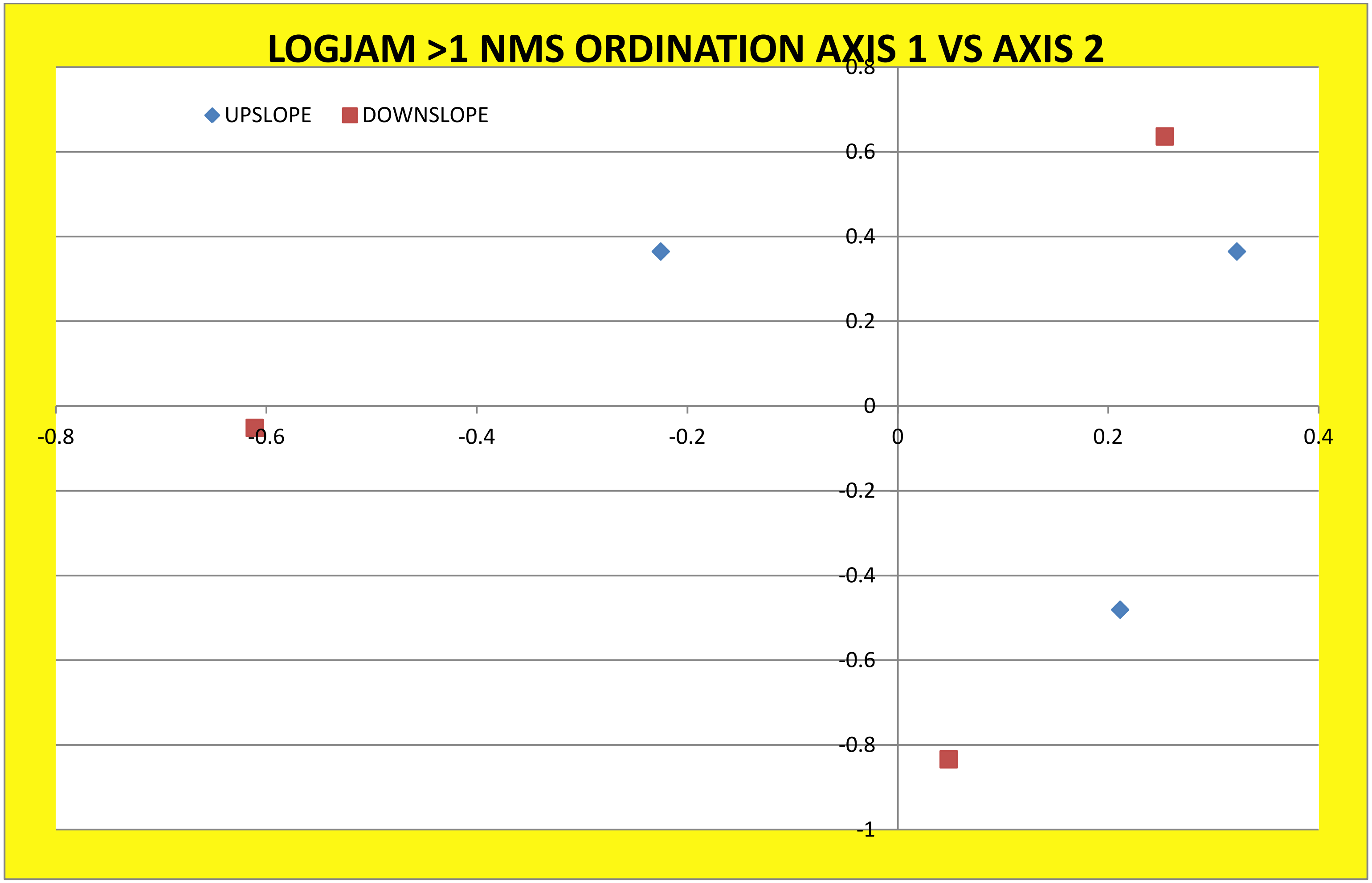
PCA Cumulative Variance Table

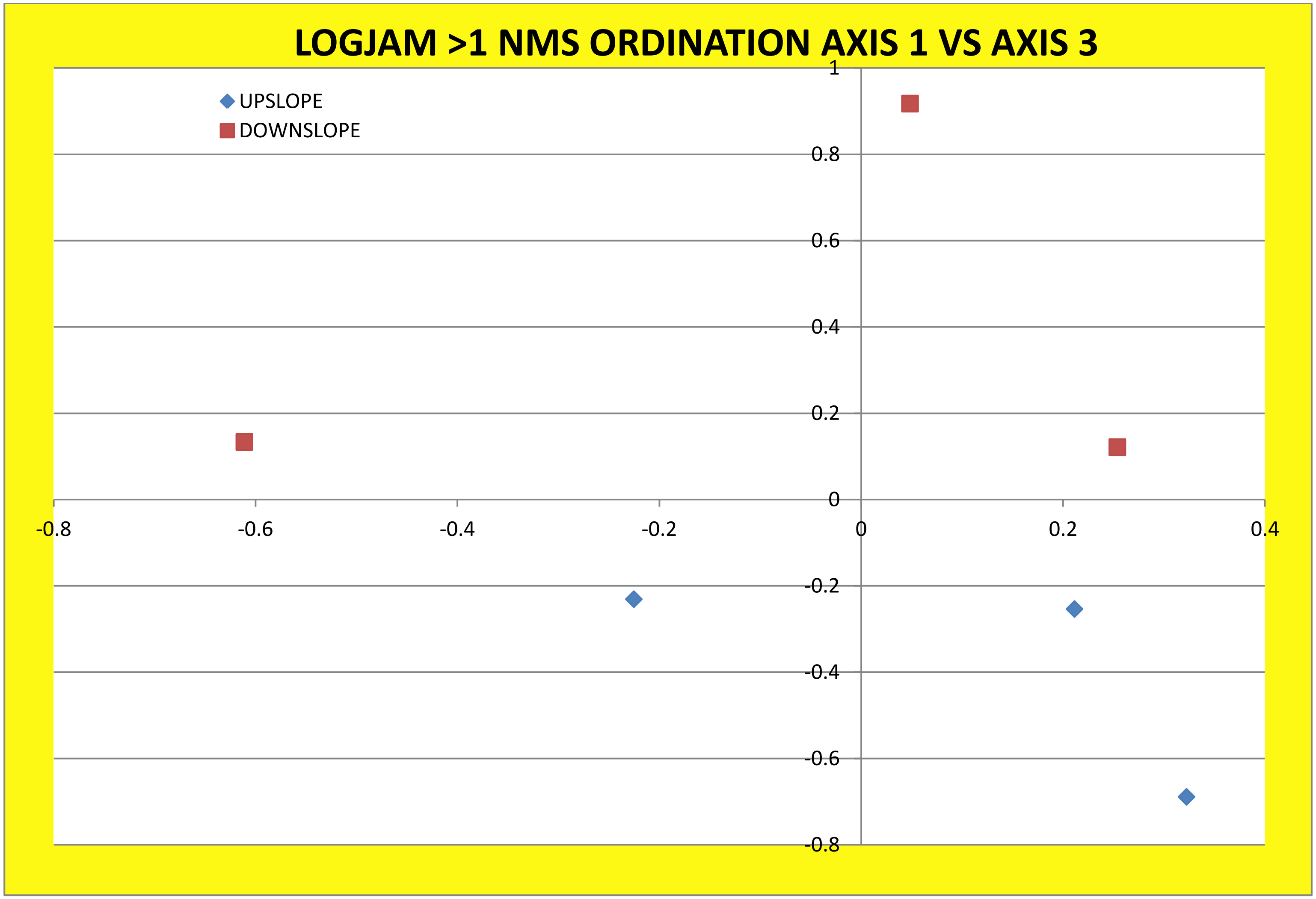
AXIS	1	2	3	4	5
Eigenvalue	4127.637	3303.201	1595.266	722.341	298.888
% of Variancce	41.082	32.876	15.878	7.189	2.975
Cum.% of Variance	41.082	73.958	89.836	97.025	100

PCA Species Axis Scores

SPECIES	1	2	3	4	5	6
CHNO	-0.07	-0.0147	-0.8468	0.3897	0.1726	-0.0162
PISI	0.0346	-0.1301	-0.1051	0.0536	0.0969	0.0938
THPL	-0.0416	-0.0394	0.0687	0.0311	0.034	0.0701
TSHE	-0.4137	-0.5892	-0.028	-0.1491	-0.0421	0.5042
MEFE	-0.1376	0.1532	0.0477	0.3797	-0.1577	-0.1976
VAOV	-0.3645	-0.2284	0.3525	0.3956	-0.1919	-0.3007
VAPA	-0.0348	0.0915	-0.0413	0.1566	-0.3	0.079
VAVI	-0.0233	0.5408	0.0654	0.1298	-0.2318	0.6578
CABI2	-0.0176	0.0386	-0.0207	-0.1336	0.0272	-0.1032
COAS	-0.0857	0.0731	-0.1238	-0.4906	0.1234	-0.2067
COCA13	-0.122	0.3124	-0.125	-0.257	-0.3218	-0.2682
GEDO	-0.0091	0.0438	0.0127	-0.1163	0.1176	-0.0351
LIBO3	0.0418	-0.024	-0.0129	-0.0661	-0.0879	-0.0286
LYAM	0.1442	-0.0609	-0.1003	-0.0775	-0.1925	0.0945
MADI	-0.0154	0.085	-0.0028	-0.0458	-0.0566	0.0402
NECK2	0.0651	0.1262	0.2285	0.328	0.4776	-0.0075
STRO4	-0.0065	0.0476	0.0208	0.0118	0.0365	0.0349
CAPL6	0.786	-0.3061	0.0559	0.1089	-0.1865	0.0304
ERAN	0.007	0.1593	0.1719	-0.0676	0.5373	0.1444
BLSP	0.0018	0.0192	0.0239	0.0007	0.0675	0.0012
LYAN2	-0.0033	0.0287	0.0131	0.0553	-0.0161	0.0063
EQ	0.0035	-0.038	-0.078	0.0458	0.1153	-0.049

NMS Ordination Graph




LOGJAM >1 NMS ORDINATION AXIS 1 VS AXIS 3
UPSLOPE
DOWNSLOPE
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4

MRPP Table

Test statistic: T	=	-1.7861627
Observed delta	=	1.3285211
Expected delta	=	1.5070507
Variance of delta	=	0.0099903062
Skewness of delta	=	-0.43863285

Chance-corrected within-group agreement, A = 0.11846295
A = 1 - (observed delta/expected delta)
Amax = 1 when all items are identical within groups (delta=0)
A = 0 when heterogeneity within groups equals expectation by chance
A < 0 with more heterogeneity within groups than expected by chance

Probability of a smaller or equal delta, p = 0.04785030

There is evidence of a difference in plant communities from UPSLOPE and DOWNSLOPE (p-value = 0.0479).

MANOVA Table

	Df	Wilks	approx F	num Df	den Df	Pr(>F)
TYPE	1	6.405e-07	390325	4	1	0.0012
Residuals	4					

There is evidence of a difference in plant communities from UPSLOPE and DOWNSLOPE (p-value = 0.0012).

LOGJAM TRANSECT #3 WITH SPECIES OCCURRING IN MORE THAN TWO PLOTS

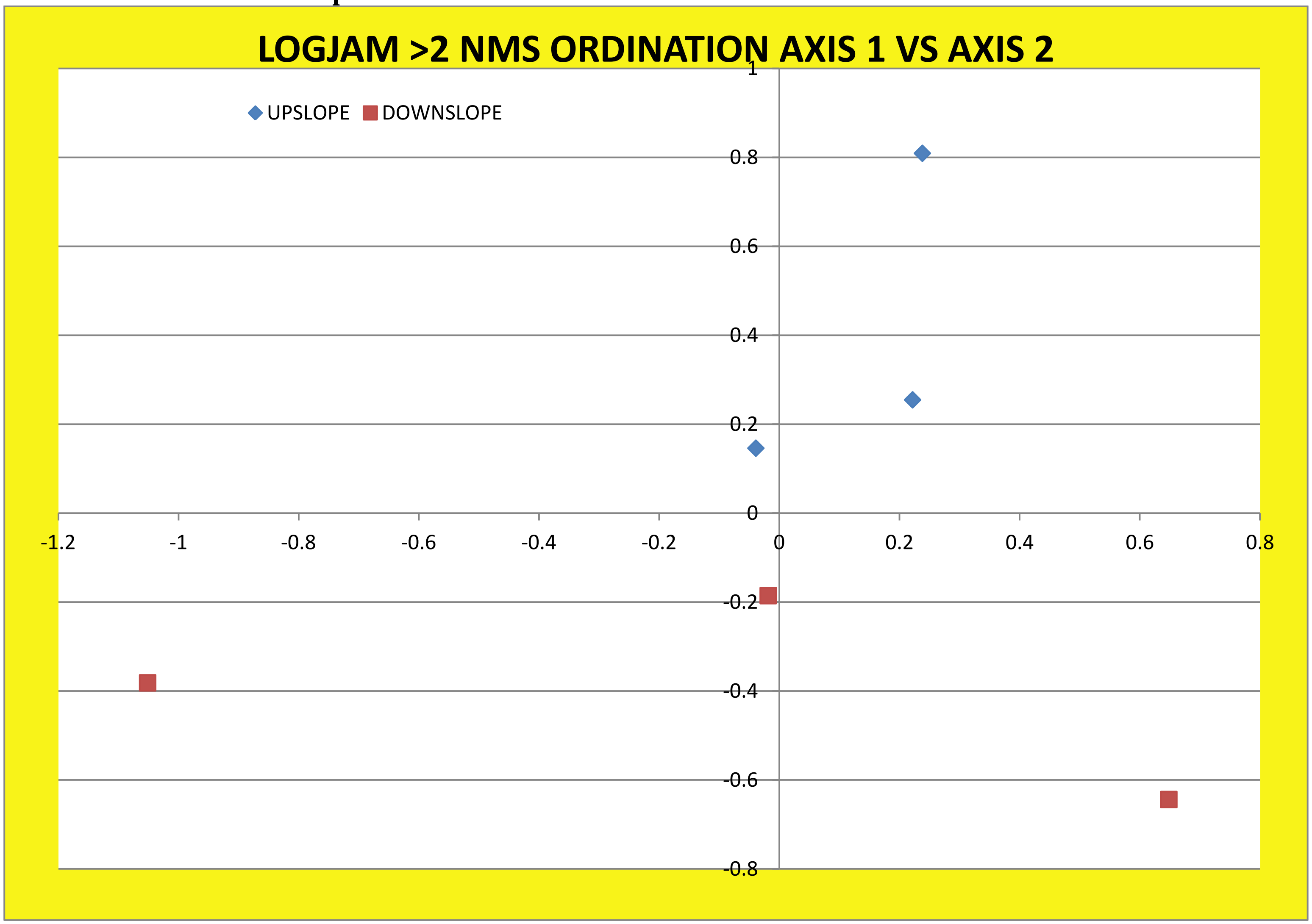
PCA Cumulative Variance Table

AXIS	1	2	3	4	5	6
Eigenvalue	4113.681	3169.584	1528.204	677.899	166.632	0
% of Variance	42.602	32.825	15.826	7.02	1.726	0
Cum.% of Variance	42.602	75.427	91.254	98.274	100	100

PCA Species Axis Scores

SPECIES	1	2	3	4	5	6
CHNO	-0.0701	-0.0054	0.8626	-0.4307	0.0166	-0.0358
PISI	0.0338	0.1309	0.1148	-0.0641	0.0904	0.0992
TSHE	-0.4181	0.5971	0.057	0.1495	-0.0949	0.4873
MEFE	-0.1364	-0.1579	-0.0648	-0.3792	-0.2608	-0.2059
VAOV	-0.3659	0.2364	-0.3587	-0.3901	-0.2989	-0.3113
VAVI	-0.0197	-0.5519	-0.0994	-0.1144	-0.2721	0.6782
COAS	-0.0859	-0.0764	0.1322	0.4943	0.2405	-0.2132
COCA13	-0.1202	-0.324	0.1087	0.2823	-0.3743	-0.3091
LIBO3	0.0417	0.0241	0.0132	0.0729	-0.1084	-0.0409
LYAM	0.1442	0.0599	0.1019	0.089	-0.2615	0.0739
MADI	-0.0149	-0.0871	-0.0018	0.0509	-0.0597	0.0329
NECK2	0.0659	-0.1207	-0.2324	-0.3594	0.6255	0.0437
STRO4	-0.0062	-0.0479	-0.0228	-0.0135	0.0541	0.0315
CAPL6	0.7857	0.3184	-0.0475	-0.0986	-0.2746	0.0033

NMS Ordination Graph



MRPP Table

Test statistic: T	=	1.7120035
Observed delta	=	1.3223055
Expected delta	=	1.5093289
Variance of delta	=	0.011933912
Skewness of delta	=	-0.49796647

Chance-corrected within-group agreement, A = 0.12391166
A = 1 - (observed delta/expected delta)
Amax = 1 when all items are identical within groups (delta=0)
A = 0 when heterogeneity within groups equals expectation by chance
A < 0 with more heterogeneity within groups than expected by chance

Probability of a smaller or equal delta, p = 0.05522662

There issuggestive evidence of a difference in plant communities from UPSLOPE and DOWNSLOPE (p-value = 0.0523).

MANOVA Table

	Df	Wilks	approx F	num Df	den Df	Pr(>F)
TYPE	1	0.004	65.152	4	1	0.09262 .
Residuals	4					

There is no evidence of a difference in plant communities from UPSLOPE and DOWNSLOPE (p-value = 0.0926).

RED BAY TRANSECT #3 WITH SPECIES OCCURRING IN MORE THAN ONE PLOT

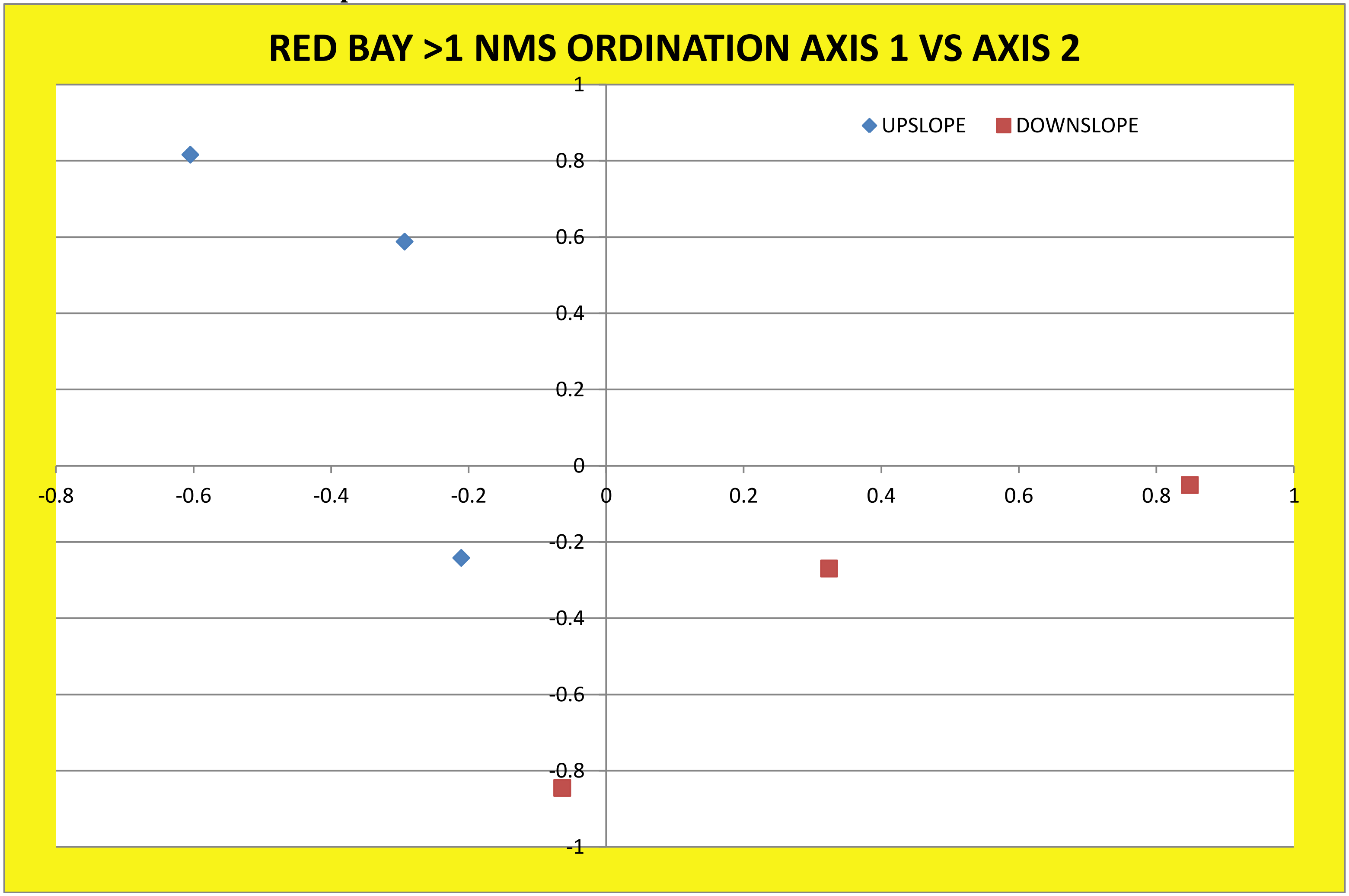
PCA Cumulative Variance Table

AXIS	1	2	3	4	5
Eigenvalue	4653.882	1850.087	561.182	247.172	130.511
% of Variance	62.528	24.857	7.54	3.321	1.754
Cum. % of Variance	62.528	87.386	94.926	98.246	100

PCA Species Axis Scores

SPECIES	1	2	3	4	5	6
PICO	0.4196	0.5968	0.0563	-0.1079	-0.0398	-0.4057
THPL	-0.2347	0.3969	0.119	0.1291	0.0292	-0.0175
ANPO	-0.013	-0.092	0.0933	-0.0882	-0.023	0.059
EMNI	0.3157	-0.1289	-0.3813	-0.4732	0.2687	-0.2544
JUCO	-0.0199	0.1568	0.0596	-0.3481	0.0758	0.2021
VAUL	0.2211	-0.1286	-0.3013	0.4973	0.0663	0.1567
VAOX	-0.0396	-0.1709	0.0392	-0.2117	-0.1647	0.1266
KAPO	0.2629	-0.0171	0.3069	0.1009	0.2764	0.1906
LEGR	0.1005	-0.0732	-0.0081	0.0113	-0.3252	-0.474
ANGE2	-0.0856	-0.1639	-0.0544	0.028	-0.1189	-0.1656
COTR2	0.1042	0.0246	-0.1626	0.0965	-0.3782	0.1694
COCA13	0.5832	0.0193	0.1448	0.2835	-0.2056	0.1178
ERPE3	-0.0423	0.0323	-0.0065	0.0478	0.0042	-0.0842
LIBO3	-0.0167	-0.0802	-0.0482	-0.1515	-0.0704	-0.0526
NECK2	-0.0183	-0.0451	0.4496	0.0401	0.486	-0.114
SAME6	-0.0472	-0.1574	-0.1515	-0.0933	0.0314	-0.033
TOGL2	0.0014	-0.0076	0.0691	0.0897	0.1761	-0.1208
CACA4	-0.3596	0.3177	0.0491	0.0514	-0.2683	-0.0689
CALE8	-0.0142	-0.0012	-0.0036	0.1294	0.1311	-0.0815
ERAN	-0.1611	-0.2459	-0.1307	0.3353	0.1639	-0.4881
PHAR3	-0.1282	0.1466	-0.0223	0.2025	0.078	-0.1511
TRCE3	0.0636	-0.3744	0.5795	-0.0972	-0.3327	-0.2084

NMS Ordination Graph



MRPP Table

Test statistic: T	=	-2.5650067
Observed delta	=	1.2107570
Expected delta	=	1.5053064
Variance of delta	=	0.013186798
Skewness of delta	=	-1.3533343

Chance-corrected within-group agreement, A = 0.19567407
A = 1 - (observed delta/expected delta)
Amax = 1 when all items are identical within groups (delta=0)
A = 0 when heterogeneity within groups equals expectation by chance
A < 0 with more heterogeneity within groups than expected by chance

Probability of a smaller or equal delta, p = 0.02325553

There is evidence of a difference in plant communities from UPSLOPE and DOWNSLOPE (p-value = 0.0233).

MANOVA Table

	Df	Wilks	approx F	num Df	den Df	Pr(>F)
TYPE	1	0.14428	1.48278	4	1	0.5424
Residuals	4					

There is no evidence of a difference in plant communities from UPSLOPE and DOWNSLOPE (p-value = 0.5424).

RED BAY TRANSECT #3 WITH SPECIES OCCURRING IN MORE THAN TWO PLOTS

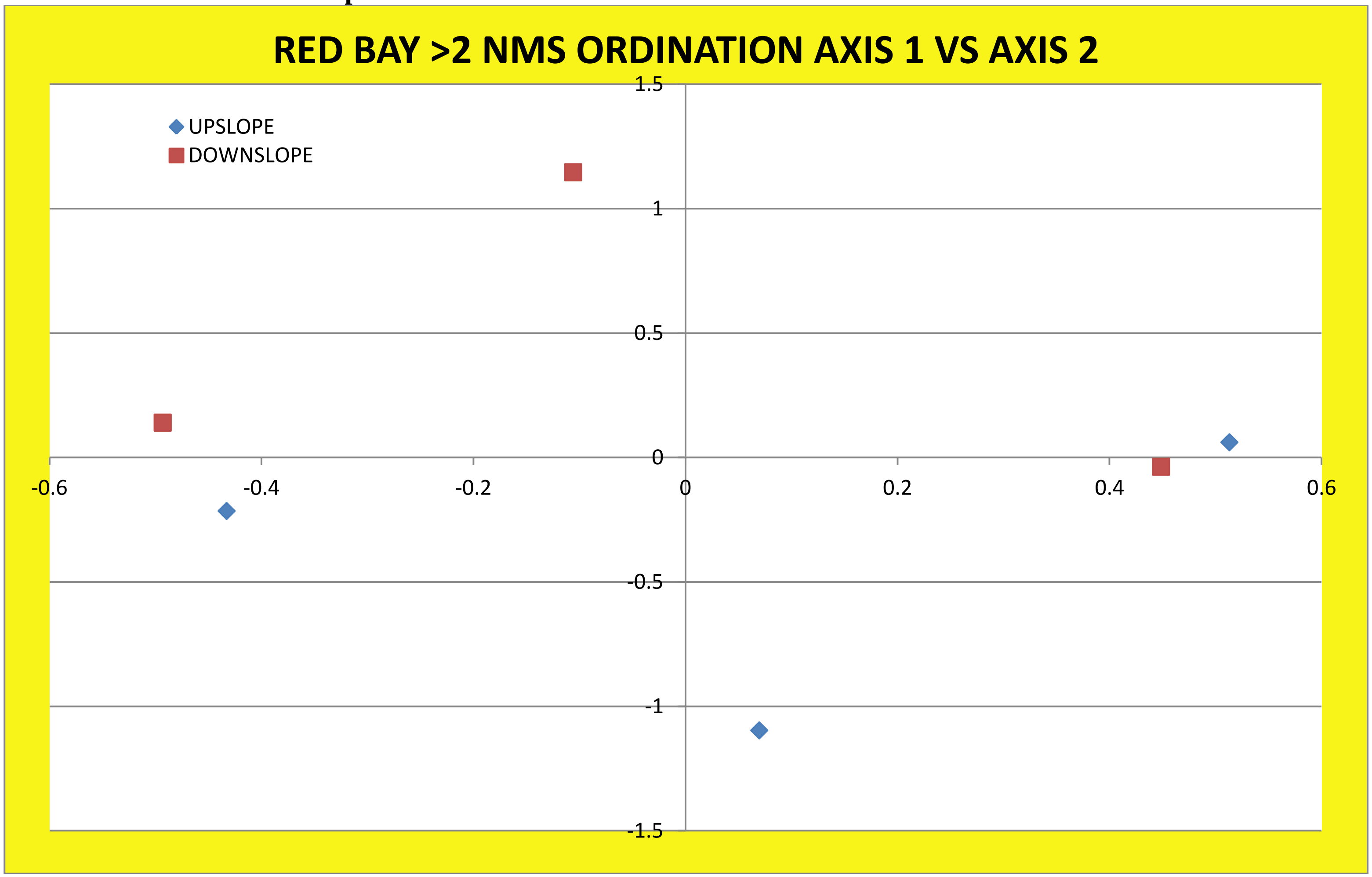
PCA Cumulative Variance Table

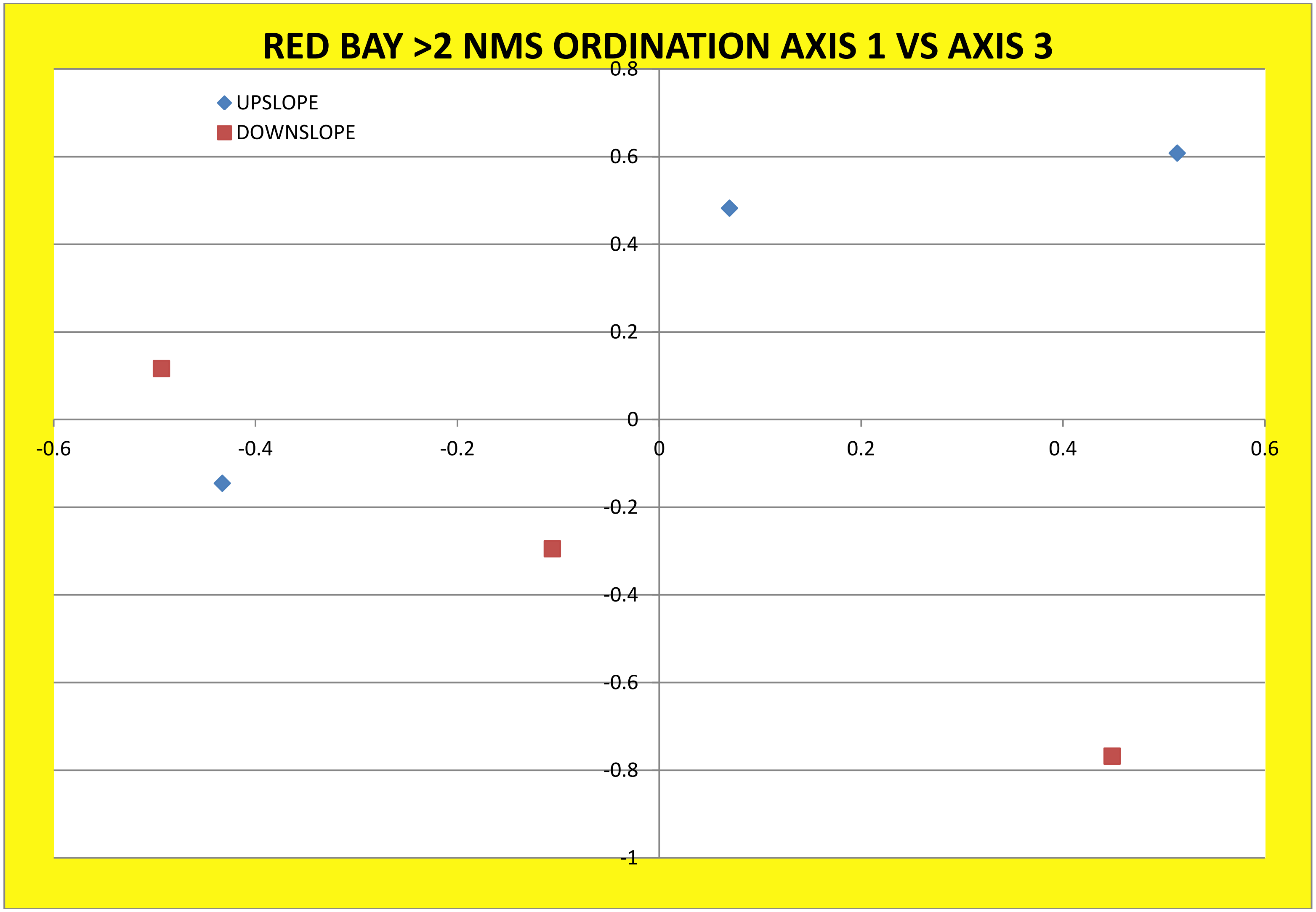
AXIS	1	2	3	4	5
Eigenvalue	4567.539	1770.581	536.9	230.767	101.713
% of Variance	63.372	24.566	7.449	3.202	1.411
Cum.% of Variance	63.372	87.938	95.387	98.589	100

PCA Species Axis Scores

SPECIES	1	2	3	4	5	6
PICO	0.416	0.624	-0.0508	-0.0951	0.0424	-0.3963
THPL	-0.2418	0.3976	-0.1248	0.1364	-0.0646	-0.02
EMNI	0.32	-0.1205	0.4052	-0.4805	-0.2404	-0.2605
JUCO	-0.0217	0.1605	-0.0554	-0.3588	-0.0934	0.2029
VAUL	0.2241	-0.1259	0.307	0.5215	-0.0334	0.1766
VAOX	-0.0377	-0.1751	-0.0427	-0.2236	0.1856	0.1333
KAPO	0.2662	-0.0095	-0.3039	0.0985	-0.3403	0.1689
LEGR	0.1021	-0.0712	0.0013	0.0128	0.3738	-0.4519
COCA13	0.5882	0.0382	-0.1479	0.2978	0.2332	0.157
ERPE3	-0.0431	0.0315	0.0057	0.0498	-0.0066	-0.0856
NECK2	-0.0167	-0.0473	-0.4476	0.0274	-0.6033	-0.1788
SAME6	-0.0458	-0.1622	0.1556	-0.0969	-0.0152	-0.0488
CACA4	-0.3672	0.3131	-0.062	0.0557	0.278	-0.0479
ERAN	-0.1597	-0.2578	0.1315	0.3423	-0.1738	-0.5639
PHAR3	-0.1314	0.145	0.021	0.2115	-0.095	-0.1511
TRCE3	0.0697	-0.3796	-0.5985	-0.1209	0.3183	-0.2058

NMS Ordination Graph




RED BAY >2 NMS ORDINATION AXIS 1 VS AXIS 3
UPSLOPE
DOWNSLOPE
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-0.6
-0.4
-0.2
0
0.2
0.4
0.6

MRPP Table

Test statistic: T	=	-2.0042486
Observed delta	=	1.3565097
Expected delta	=	1.5255671
Variance of delta	=	0.71148387E-02
Skewness of delta	=	-0.37236135

Chance-corrected within-group agreement, A = 0.11081609
A = 1 - (observed delta/expected delta)
Amax = 1 when all items are identical within groups (delta=0)
A = 0 when heterogeneity within groups equals expectation by chance
A < 0 with more heterogeneity within groups than expected by chance

Probability of a smaller or equal delta, p = 0.03154217

There is evidence of a difference in plant communities from UPSLOPE and DOWNSLOPE (p-value = 0.0315).

MANOVA Table

	Df	Wilks	approx F	num Df	den Df	Pr(>F)
TYPE	1	0.0446	5.3612	4	1	0.3119
Residuals	4					

There is no evidence of a difference in plant communities from UPSLOPE and DOWNSLOPE (p-value = 0.3119).

MIKE'S ROAD TRANSECT #1 WITH SPECIES OCCURRING IN MORE THAN ONE PLOT

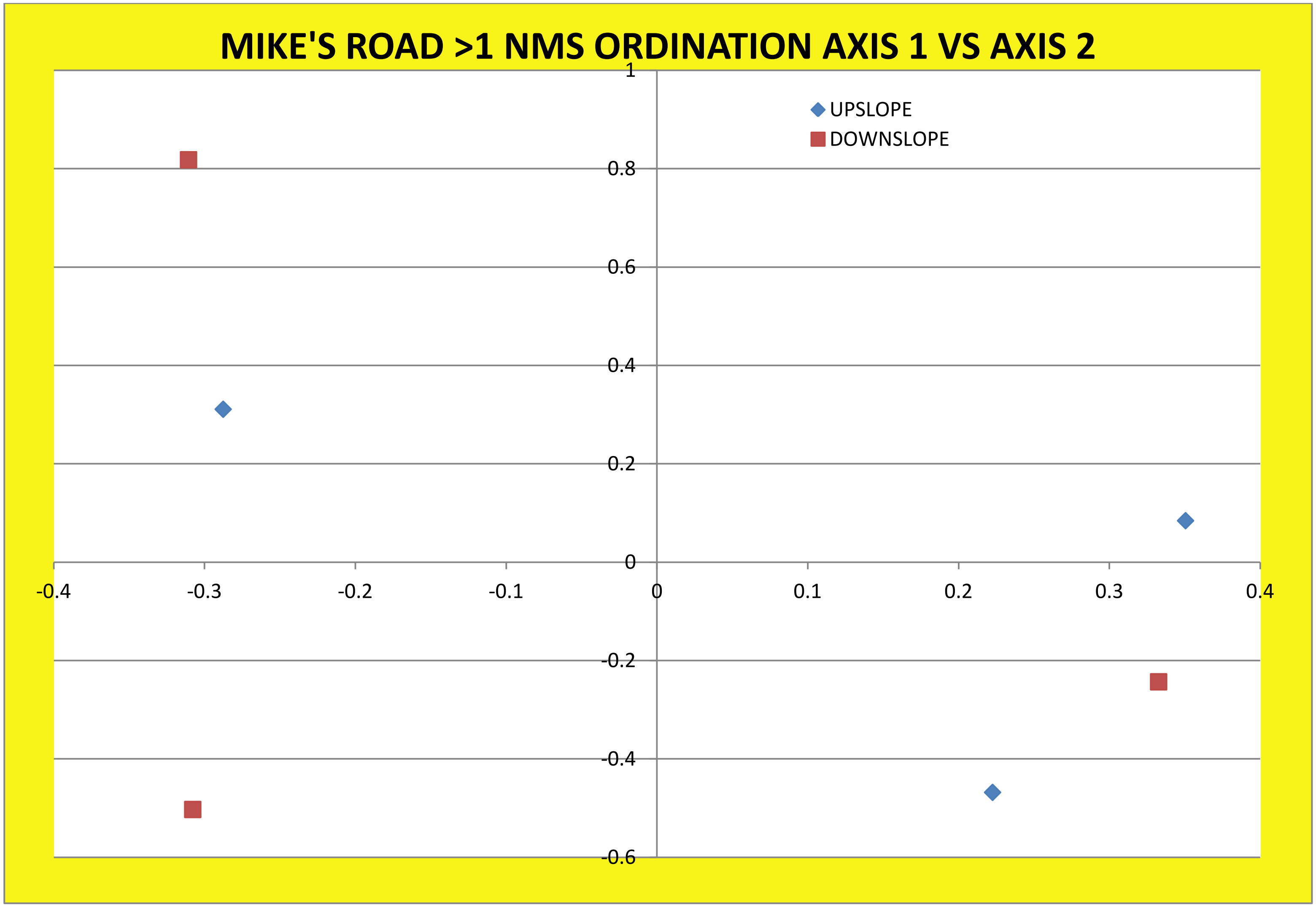
PCA Cumulative Variance Table

AXIS	1	2	3	4	5
Eigenvalue	8828.79	1623.617	870.388	489.977	151.895
% of Variance	73.791	13.57	7.275	4.095	1.27
Cum.% of Variance	73.791	87.361	94.635	98.73	100

PCA Species Axis Scores

SPECIES	1	2	3	4	5	6
PICO	-0.1591	0.0177	0.3757	-0.5627	0.2725	0.5075
ANPO	0.1446	0.0655	0.0753	0.1072	0.3511	-0.3465
EMNI	-0.4263	0.0176	-0.0088	0.3812	-0.2752	0.3646
VAUL	-0.309	0.0412	-0.5922	-0.1494	0.3754	-0.0194
VAOX	-0.0444	-0.0194	0.4695	0.3565	0.4082	-0.1328
KAPO	-0.1439	-0.0015	-0.0344	-0.2306	-0.0343	0.1896
LEGR	-0.175	0.2196	0.0092	-0.3193	-0.4785	-0.4476
VAVI	-0.0608	-0.0183	-0.1972	0.1348	0.1794	0.0208
COTR2	-0.0219	0.0026	0.0581	0.0824	-0.2435	-0.064
COCA13	-0.1075	0.1662	-0.0972	0.1568	-0.1385	0.2427
TREU	0.0152	-0.0201	-0.0191	-0.012	-0.053	-0.0334
CASI3	0.3961	0.8455	-0.0101	0.0897	0.0061	0.2339
CAPA19	-0.0938	-0.0661	-0.1652	0.3908	0.0067	0.2016
ERAN	-0.0245	-0.153	0.3933	0.0965	-0.2341	0.0613
TRCE3	0.6641	-0.4168	-0.2155	-0.0473	-0.1435	0.2673

NMS Ordination Graph



MRPP Table

Test statistic: T	=	-2.4629669
Observed delta	=	1.2049322
Expected delta	=	1.5093600
Variance of delta	=	0.015277472
Skewness of delta	=	-1.1728815

Chance-corrected within-group agreement, A = 0.20169331
A = 1 - (observed delta/expected delta)
Amax = 1 when all items are identical within groups (delta=0)
A = 0 when heterogeneity within groups equals expectation by chance
A < 0 with more heterogeneity within groups than expected by chance

Probability of a smaller or equal delta, p = 0.02443347

There is evidence of a difference in plant communities from UPSLOPE and DOWNSLOPE (p-value = 0.0244).

MANOVA Table

	Df	Wilks	approx F	num Df	den Df	Pr(>F)
TYPE	1	0.007	35.901	4	1	0.1245
Residuals	4					

There is no evidence of a difference in plant communities from UPSLOPE and DOWNSLOPE (p-value = 0.1245).

MIKE'S ROAD TRANSECT #1 WITH SPECIES OCCURRING IN MORE THAN TWO PLOTS

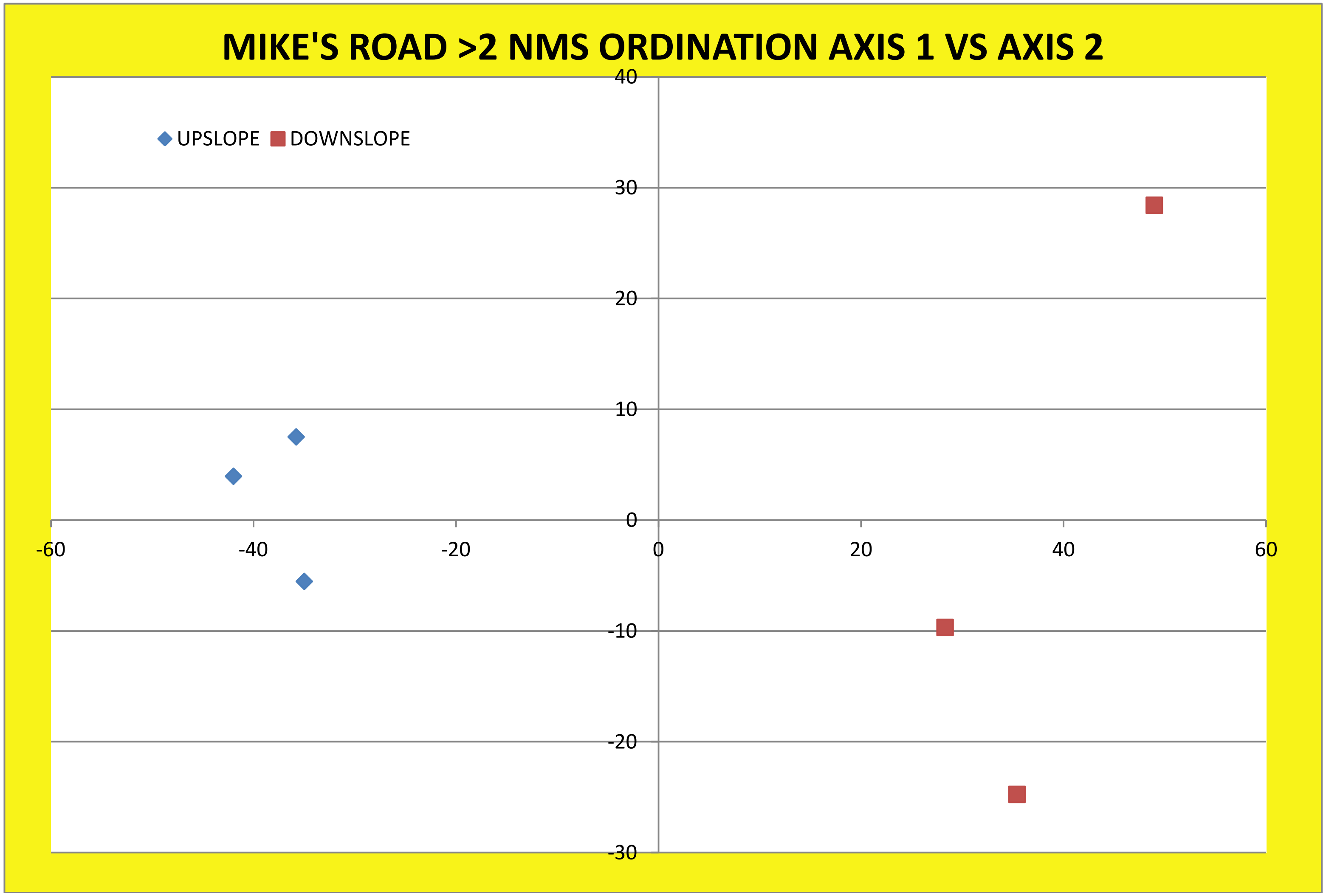
PCA Cumulative Variance Table

AXIS	1	2	3	4	5
Eigenvalue	8718.368	1616.11	820.44	396.102	145.98
% of Variance	74.535	13.816	7.014	3.386	1.248
Cum.% of Variance	74.535	88.352	95.366	98.752	100

PCA Species Axis Scores

SPECIES	1	2	3	4	5	6
PICO	-0.1627	-0.0046	0.3185	-0.6962	-0.2235	-0.4439
ANPO	0.1455	-0.0669	0.0966	0.0822	-0.3576	0.3555
EMNI	-0.428	-0.0186	0.021	0.4517	0.2483	-0.4178
VAUL	-0.3095	-0.0465	-0.6241	-0.0312	-0.4111	-0.0023
VAOX	-0.045	0.023	0.5196	0.2863	-0.4137	0.1285
KAPO	-0.1453	0.0046	-0.0647	-0.237	0.0453	-0.1723
LEGR	-0.1774	-0.2149	-0.0288	-0.3416	0.5069	0.5158
COTR2	-0.022	-0.0024	0.066	0.0851	0.2458	0.0567
COCA13	-0.1077	-0.1689	-0.0811	0.195	0.1248	-0.2613
CASI3	0.3975	-0.8513	0.031	0.0387	-0.0005	-0.2249
ERAN	-0.0253	0.1585	0.4053	0.0366	0.2529	-0.0554
TRCE3	0.6694	0.4098	-0.2194	-0.0229	0.1464	-0.2542

NMS Ordination Graph



MRPP Table

Test statistic: T	=	-2.7966282
Observed delta	=	1.1570144
Expected delta	=	1.4992746
Variance of delta	=	0.14977639E-01
Skewness of delta	=	-2.0413549

Chance-corrected within-group agreement, A = 0.22828388
A = 1 - (observed delta/expected delta)
Amax = 1 when all items are identical within groups (delta=0)
A = 0 when heterogeneity within groups equals expectation by chance
A < 0 with more heterogeneity within groups than expected by chance

Probability of a smaller or equal delta, p = 0.02269096

There is evidence of a difference in plant communities from UPSLOPE and DOWNSLOPE (p-value = 0.0227).

MANOVA Table

	Df	Wilks	approx F	num Df	den Df	Pr(>F)
TYPE	1	0.003	90.439	4	1	0.07868 .
Residuals	4					

There is no evidence of a difference in plant communities from UPSLOPE and DOWNSLOPE (p-value = 0.0787).

VIII. SPECIES ANALYSIS

Analyses of selected species were performed on selected transects of the Plant Community dataset. The transects selected for further study were Logjam Transect #3, Red Bay Transect #3, and Mike's Road Transect #1. Each transect was limited to the three UPSLOPE plots and the first three DOWNSLOPE plots (those closest to the road). The Species data analyzed were:

WETLAND	SPECIES	ACRONYM
LOGJAM	Chamacyparis nootkatensis	CHNO
LOGJAM	Tsuga heterophylla	TSHE
LOGJAM	Vaccinium vitis-idea	VAVI
LOGJAM	Carex pluriflora	CAPL6
RED BAY	Cornus canadensis	COCA13
RED BAY	Pinus contorta	PICO
RED BAY	Trichophorum cespitosum	TRCE3
MIKE'S ROAD	Trichophorum cespitosum	TRCE3
MIKE'S ROAD	Carex sitchensis	CASI3
MIKE'S ROAD	Vaccinium uliginosum	VAUL

LOGJAM TRANSECT #3

Percent Cover

	CHNO		TSHE		VAVI		CAPL6	
	MEAN	S.E.	MEAN	S.E.	MEAN	S.E.	MEAN	S.E.
UPSLOPE	12	7	13	4	30	3	7	7
DOWNSLOPE	15	13	35	13	5	3	30	17

***Chamacyparis nootkatensis* CHNO**

Welch's Two-Sided Two-Sample t-Test

t = 0.2294, df = 3.2, p-value = 0.8324

There is no evidence of a difference in percent cover of CHNO between Logjam Transect #3 UPSLOPE and DOWNSLOPE plots (p-value = 0. 8324).

***Tsuga heterophylla* TSHE**

Welch's Two-Sided Two-Sample t-Test

t = 1.5538, df = 2.439, p-value = 0.2381

There is no evidence of a difference in percent cover of TSHE between Logjam Transect #3 UPSLOPE and DOWNSLOPE plots (p-value = 0. 2381).

***Vaccinium vitis-idea* VAVI**

Welch's Two-Sided Two-Sample t-Test

t = -6.3454, df = 3.958, p-value = 0.0033

There is evidence of a difference in percent cover of VAVI between Logjam Transect #3 UPSLOPE and DOWNSLOPE plots (p-value = 0.0033). The mean percent cover in UPSLOPE plots is higher than in DOWNSLOPE plots.

Carex pluriflora **CAPL6**

Welch’s Two-Sided Two-Sample t-Test

t = 1.2572, df = 2.58, p-value = 0.3105

There is no evidence of a difference in percent cover of CAPL6 between Logjam Transect #3 UPSLOPE and DOWNSLOPE plots (p-value = 0. 3105).

RED BAY TRANSECT #3

Percent Cover

	PICO		COCA13		TRCE3	
	MEAN	S.E.	MEAN	S.E.	MEAN	S.E.
UPSLOPE	45	3	32	4	10	6
DOWNSLOPE	22	10	0	0	7	7

Pinus contorta PICO

Welch's Two-Sided Two-Sample t-Test

t = -2.2136, df = 2.322, p-value = 0.1395

There is suggestive evidence of a difference in percent cover of PICO between Red Bay Transect #3 UPSLOPE and DOWNSLOPE plots (p-value = 0. 1395). The mean percent cover in UPSLOPE plots is higher than in DOWNSLOPE plots.

Cornus Canadensis COCA13

Welch's Two-Sided Two-Sample t-Test

t = -7.1813, df = 2, p-value = 0.0188

There is evidence of a difference in percent cover of COCA13 between Red Bay Transect #3 UPSLOPE and DOWNSLOPE plots (p-value = 0. 0188). The mean percent cover in UPSLOPE plots is higher than in DOWNSLOPE plots.

Trichophorum cespitosum TRCE3

Welch's Two-Sided Two-Sample t-Test

t = -0.378, df = 3.92, p-value = 0.725

There is no evidence of a difference in percent cover of TRCE3 between Red Bay Transect #3 UPSLOPE and DOWNSLOPE plots (p-value = 0.725).

MIKE'S ROAD TRANSECT #1

Percent Cover

	VAUL		CASI3		TRCE3	
	MEAN	S.E.	MEAN	S.E.	MEAN	S.E.
UPSLOPE	30	8	8	3	0	0
DOWNSLOPE	7	2	42	12	48	11

***Vaccinium uliginosum* VAUL**

Welch's Two-Sided Two-Sample t-Test

t = -2.9848, df = 2.19, p-value = 0.0863

There is suggestive evidence of a difference in percent cover of VAUL between Mike's Road Transect #1 UPSLOPE and DOWNSLOPE plots (p-value = 0. 0863). The mean percent cover in UPSLOPE plots is higher than in DOWNSLOPE plots.

***Carex sitchensis* CASI3**

Welch's Two-Sided Two-Sample t-Test

t = 2.7472, df = 2.324, p-value = 0.0941

There is suggestive evidence of a difference in percent cover of CASI3 between Mike's Road Transect #1 UPSLOPE and DOWNSLOPE plots (p-value = 0. 0941). The mean percent cover in UPSLOPE plots is lower than in DOWNSLOPE plots.

***Trichophorum cespitosum* TRCE3**

Welch's Two-Sided Two-Sample t-Test

t = 4.4225, df = 2, p-value = 0.0475

There is evidence of a difference in percent cover of TRCE3 between Mike's Road Transect #1 UPSLOPE and DOWNSLOPE plots (p-value = 0. 0475). The mean percent cover in UPSLOPE plots is lower than in DOWNSLOPE plots.

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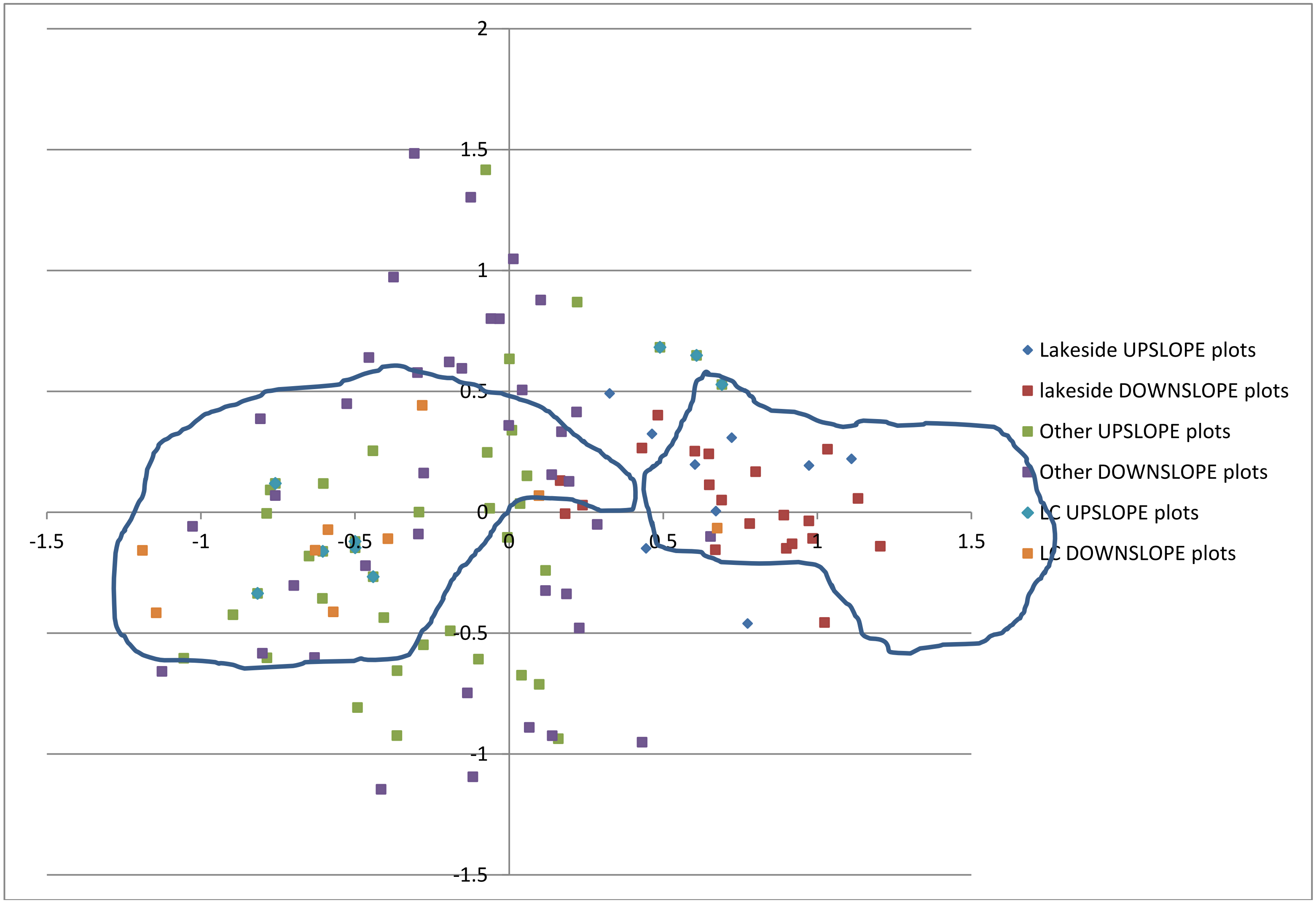
Bonus Graph

There are further possibilities for exploring the plant community dataset that was analyzed in this report. These other lines of investigation are beyond the scope of the analysis in this report, but could prove interesting to those who manage the TNF wetlands. For example, there is a possibility that the wetland plant communities studied are different from each other, requiring different management techniques and procedures.

As an example, the following “preliminary” graph indicates that wetland plant communities are more similar within a wetland (i.e., UPSLOPE and DOWNSLOPE plant communities within a wetland) than to those plant communities in other wetlands.

In the following graph the Lakeside and Lava Creek (LC) UPSLOPE and DOWNSLOPE plots separately from the other wetlands. Notice how the wetland plots grouped together, but again showed little difference between UPSLOPE and DOWNSLOPE areas within a wetland. This indicates that UPSLOPE and DOWNSLOPE areas within a wetland are more similar to each other than they are to UPSLOPE OR DOWNSLOPE in other wetlands.


2
1.5
1
0.5
0
-0.5
-1
-1.5
-1.5
-1
-0.5
0
0.5
1
1.5
Lakeside UPSLOPE plots
lakeside DOWNSLOPE plots
Other UPSLOPE plots
Other DOWNSLOPE plots
LC UPSLOPE plots
LC DOWNSLOPE plots