GRAZED AND UNGRAZED VEGETATION AROUND PONDS IN THE SOUTHWESTERN KILLPECKER SAND DUNES, SWEETWATER COUNTY, WYOMING.

Report for
Assistance Agreement KAA010012,
Task Order KAF031012

between the Bureau of Land Management's Rock Springs (Wyoming) Field Office and the University of Wyoming's Natural Diversity Database

By
George P. Jones
Wyoming Natural Diversity Database,
University of Wyoming
Laramie, Wyoming

November, 2006

ABSTRACT

In 2002, biologists of the Bureau of Land Management's Rock Springs Field Office erected an electric fence to exclude grazing animals from small ponds and mesic meadows along the southern edge of the Killpecker sand dune field north of Rock Springs. In 2003, biologists from the University of Wyoming's Natural Diversity Database established sampling points along transects across ponds and mesic meadows inside and outside of the exclosure. Data on plant species composition, canopy cover, and horizontal vegetation density were collected in 2003 and 2004 from those sampling points.

Horizontal vegetation density was estimated for three heights above the ground (0-10 cm, 20-30 cm, and 40-50 cm) early in the summer and again late in the summer in both years. In wet ponds with tall hardstem bulrush, the vegetation was denser inside the exclosure than outside at 40-50 cm (by several orders of magnitude) and at 20-30 cm (ca. 6-fold), but not close to the ground. In moist plots dominated by low arrowgrass, there was essentially no vegetation at 20-30 cm and none at 40-50 cm, and the vegetation near the ground (0-10 cm) was ca. 30% denser inside than outside the exclosure. Plots on moist-to-dry plots, where short bulrushes, inland saltgrass, baltic rush, and alkali cordgrass dominated, contained virtually no vegetation at 40-50 cm. At 20-30 cm, the vegetation in those plots was ca. 25 times denser inside the exclosure than outside early in the season, and there was no significant difference late in the season. At 0-10 cm, the vegetation inside the exclosure was some 20% greater than outside. Finally, in the driest plots dominated by alkali sacaton, the vegetation near the ground was ca. 16% denser inside the exclosure than outside; these plots had very little vegetation above 10 cm. Season of sampling had little effect on horizontal density estimates, and no clear difference was found in vegetation density between 2003 and 2004.

Canopy cover was estimated only in early summer in each year. Mean canopy cover was ca. 12% greater inside the exclosure than outside. In 2003, mean canopy cover in the tall bulrush plots was nearly 30% greater than in the other, lower types of vegetation. In 2004, though, there was no significant difference in mean cover among the types of vegetation. Canopy cover averaged across all types of vegetation did not differ significantly from 2003 to 2004, but cover increased significantly from 2003 to 2004 in the driest vegetation dominated by alkali sacaton and in the dry-to-moist vegetation dominated by low bulrush, inland saltgrass, baltic rush, and alkali cordgrass.

The exclosure was erected to determine if relief from continuous grazing will promote the growth of habitat suitable for amphibians around the ponds, and the 2003 and 2004 sampling program is intended to serve as the basis for a program to monitor changes in structure and composition of the vegetation. Because the transects and sampling points used in 2003 and 2004 can be re-located, vegetation data can be collected periodically from those points

TABLE OF CONTENTS

ACKNOWLEDGEMENTS IV
INTRODUCTION 1
METHODS 1
SAMPLING 1
Locating Samples 1
Horizontal Vegetation Density 2
Canopy Cover 2
Heights of Plots Above Local Low Points 2
DATA ANALYSIS 3
Organizing Sample Points Into Groups 3
Horizontal Vegetation Density 4
Canopy Cover 4
RESULTS 5
PLANT SPECIES ENCOUNTERED 5
ENVIRONMENTS SAMPLED INSIDE AND OUTSIDE OF EXCLOSURE 5
ORGANIZATION OF POINTS INTO GROUPS 5
HORIZONTAL VEGETATION DENSITY 7
Horizontal Density at 40-50 cm 7
Horizontal Density at 20-30 cm 7
Horizontal Density at 0-10 cm 8
Summary of Horizontal Density Results 8
PLANT CANOPY COVER 9
RELATIONSHIP OF HORIZONTAL VEGETATION DENSITY TO CANOPY COVER 10
DISCUSSION 10
SAMPLING AND ANALYSIS IN THE FUTURE 11
REFERENCES 11
FIGURES 13
TABLES 46
APPENDIX 1. PHOTOGRAPHS FROM THE 2003 - 2004 PONDS SAMPLING. 91
APPENDIX 2. COORDINATES OF POND SAMPLING TRANSECTS 92
APPENDIX 3. DETAILS ON SETTINGS USED IN THE NON-METRIC MULTIDIMENSIONAL SCALING ORDINATION AND DETAILS ON THE RESULTS OBTAINED. 95
APPENDIX 4. INFORMATION ON PONDS AND TRANSECTS FROM SAMPLING FORMS 98
APPENDIX 5. 2003-2004 HORIZONTAL VEGETATION DENSITY DATA 99
APPENDIX 6. 2003-2004 CANOPY COVER DATA. 100
APPENDIX 7. RESULTS OF BONFERRONI TESTS FOR SIGNIFICANT DIFFERENCES IN MEAN HORIZONTAL VEGETATION DENSITY AT 40-50 CM. 101
APPENDIX 8. BONFERRONI SIMULTANEOUS COMPARISONS OF MEANS FOR CANOPY COVER. 102

LIST OF FIGURES

Figure 1. Location of ponds study area in southwestern Wyoming. 14
Figure 2. Landscape of study area 15
Figure 3. Photos of pond types. 16
Figure 4. Ponds and depressions in which samples were taken. 18
Figure 5. Layout of sampling points along transects across a pond. 20
Figure 6. Density boards viewed from a distance of 2 meters. 21
Figure 7. Observer estimating horizontal vegetation density with density boards. 22
Figure 9. Numbers of plant species in various numbers of sample plots. 24

Figure 10. Numbers of plots in standing water, on bare soil, and in each of the four vegetated plot groups, inside and outside of the exclosure. 25
Figure 11. Graphs of sample plots from NMS ordination based on canopy cover. 26
Figure 12. Elevation of each plot above the low point of its pond or depression. 29
Figure 13. Horizontal vegetation density at 40-50 cm above ground in four plot groups, both seasons in both years. 30
Figure 14. Horizontal vegetation density at 40-50 cm above ground in the plots of group 62, by year, season, and location inside or outside of exclosure. 31
Figure 15. Horizontal vegetation density at 20-30 cm above ground in four plot groups, both seasons in both years. 32
Figure 16. Horizontal vegetation density at 20-30 cm above the ground in four plot groups, inside and outside the exclosure, early and late in the season in both years combined. 33
Figure 17. Summary of significant differences in mean horizontal vegetation density at 20-30 cm above the ground in combinations of inside or outside exclosure, early or late season, and plot group. 34
Figure 18. Horizontal vegetation density at 20-30 cm above the ground inside and outside the exclosure in 2003 and 2004, for all four plot groups and the two seasons combined. 35
Figure 19. Horizontal vegetation density at 0-10 cm above ground in four plot groups, both seasons in both years. 36
Figure 20. Horizontal density at 0-10 cm in plots inside or outside the exclosure in 2003 or 2004. 37
Figure 21. Horizontal density at 0-10 cm in plots in the four plot groups inside and outside the exclosure in both years. 38
Figure 22. Horizontal density at 0-10 cm early or late in the season in 2003 or 2004. 39
Figure 23. Canopy cover in plots inside exclosure vs. outside exclosure, all plot groups, both years. 40
Figure 24. Canopy cover in plots of the four plot groups in 2003 and 2004. 41
Figure 25. Relationship between horizontal vegetation density and canopy cover for the 300 vegetated plots in the four plot groups. 42
Figure 26. Cumulative precipitation received in the 12 months preceding each canopy cover sampling period. 45

LIST OF TABLES

Table 1. Ranges and mid-points used in estimating plant canopy cover. 47
Table 2. NMS ordination of plot data: settings and results. 48
Table 3. Vascular plant species documented from the study area, sorted by species name. 49
Table 4. Vascular plant species documented from the study area, sorted by number of plots. 51
Table 5. Chi-squared test on the number of plots in each of four vegetated plot groups, the open-water plots, and the bare-soil plots, inside and outside of the exclosure. 53
Table 6. Chi-squared test on the number of plots in each of four vegetated plot groups inside and outside of the exclosure. 54
Table 7. Analysis of variance in elevation of plots above low points of ponds or depressions. 55
Table 8. Stand table for plot group 1. 56
Table 9. Results of MRPP tests on species composition of group 2 plots inside the exclosure versus outside. 59
Table 10. Stand table for plot group 2, sub-group a. 60
Table 11. Stand table for plot group 2, sub-group b. 61
Table 12. Stand table for plot group 2, sub-group c. 63
Table 13. Stand table for plot group 2, sub-group d. 69
Table 14. Stand table for plot group 2, sub-group e. 70
Table 15. Results of MRPP tests on species composition of group 2 plots inside the exclosure versus outside. 71

Table 16. Statistically significant indicator species identified by analysis of group 2 plots inside the exclosure versus outside. 72
Table 17. Stand table for plot group 4. 73
Table 18. Results of MRPP tests on species composition of group 4 plots inside the exclosure versus outside. 75
Table 19. Stand table for plot group 62. 76
Table 20. Results of MRPP tests on species composition of group 62 plots inside the exclosure versus outside. 77
Table 21. Results of general linear model analysis of differences in horizontal vegetation density at 40-50 cm above the ground. 78
Table 22. Probability values for comparisons of mean horizontal vegetation density at 40-50 cm above the ground in combinations of inside or outside the exclosure, year of sampling, early or late season, and plot group. 79
Table 23. Results of general linear model analysis of differences in horizontal vegetation density at 20-30 cm above the ground. 81
Table 24. Probability values for comparisons of mean horizontal vegetation density at 20-30 cm above the ground in combinations of inside or outside exclosure, early or late season, and plot group. 82
Table 25. Probability values for comparisons of mean horizontal vegetation density at 20-30 cm above the ground in plots inside or outside the exclosure in 2003 and 2004. 83
Table 26. Results of general linear model analysis of differences in horizontal vegetation density at 0-10 cm above the ground. 84
Table 27. Probability values for comparisons of mean horizontal vegetation density at 0-10 cm above the ground in plots inside or outside the exclosure in 2003 and 2004. 85
Table 28. Probability values for comparisons of mean horizontal vegetation density at 0-10 cm above the ground in plots of each group inside or outside the exclosure, in both years. 86
Table 29. Probability values for comparisons of mean horizontal vegetation density at 0-10 cm above the ground in each season and each year. 87
Table 30. Results from analysis of variance for canopy cover in all four groups, inside and outside the exclosure, in 2003 and 2004. 88
Table 31. Probability values for comparisons of mean cover per plot among the four plot groups in 2003 and 2004. 89
Table 32. Correlation between horizontal vegetation density at each of three heights and canopy cover in plots of each group. 90

ACKNOWLEDGEMENTS

Jim Glennon and John Henderson of the BLM's Rock Springs Field Office helped with selection of the study sites and reviewed the methods for collecting data. Both also helped with numerous administrative tasks, and Glennon assisted with some field work. Gary Zakotnik of Farson spent the better part of a day at the study site, sharing his knowledge of and insights into the area and discussing the sampling methods and the project in general.

Hollis Marriott identified plant specimens. The facilities of the Rocky Mountain Herbarium at UW were made available for plant identification by Ron Hartman and Ernie Nelson, curator and manager, respectively.

Cathy Cooper provided invaluable assistance in collecting data in the field, entering those data in the office, and handling many other smaller tasks, all with characteristic thoroughness and cheer, sometimes in trying conditions.

The assistance of all these people is greatly appreciated.

INTRODUCTION

In the southwestern part of Wyoming's Killpecker sand dune field, north of Rock Springs, a number of depressions contain small ponds (generally smaller than 0.5 acre [0.2 ha]) surrounded by mesic meadows (Figures 1 - 3). In the winter of 2002-2003, biologists in the Bureau of Land Management's Rock Springs Field Office erected an electric fence to exclude grazing animals from several of those ponds and mesic meadows at the southern edge of the dune field, to learn if relief from continuous grazing would promote the growth of taller vegetation that might provide habitat for amphibians around the ponds.

In 2003, the BLM's Rock Springs Field Office and the University of Wyoming's Natural Diversity Database entered into a cooperative project to document the species composition and structure of the vegetation around ponds and in meadows inside and outside the exclosure. The purpose of the project was to provide the BLM with a data set, a series of sampling points, and a methodology upon which BLM biologists can base a program to monitor changes in the composition and structure of the vegetation.

This report presents vegetation data from the 2003 and 2004 sampling seasons, explains the methodology used to collect those data, and documents the locations of the sampling points.

METHODS

SAMPLING

Locating Samples

Reconnaissance revealed two features of the study area that had to be addressed if the data were to adequately represent the vegetation. First, the study area contains different types of ponds or depressions, with some that apparently are permanently wet and some that seem to contain standing water only rarely, if at all. Second, the vegetation around the ponds is organized into zones that differ from one another in species composition and height of the vegetation. The zones often form concentric rings around individual ponds and are related to height of the ground above the bottom of the pond or depression.

The sampling design addressed these two features by selecting representatives of the different types of ponds and by locating sample points in each of the vegetation zones. Before sampling started, the ponds and depressions were divided into three types based on the apparent presence or absence of water in the preceding several years (Figure 3). Wet ponds were substantially filled with water. Medium ponds contained no water at the time of sampling, but did have substantial areas of bare soil suggesting that they had recently been inundated. Dry ponds were completely vegetated depressions, without either water or substantial areas of bare soil that suggested recent inundation. Four ponds (two inside the exclosure and two outside) representing each of the three types were selected for study. Thus samples were collected around 12 ponds (Figure 4).

Selecting even the dry ponds for study seemed necessary because one of the objectives of this project is to establish a program for characterizing changes in the vegetation in the entire study area. The vegetation apparently is controlled in part by the height of the ground surface above the water table, as shown by the different vegetation zones at different heights above the ponds. It seems likely that the water table will be higher after wet years and lower after dry years and that this change in water table height will cause a vegetation change that must be accounted for in the sampling design.

To assure that sampling points were distributed throughout the vegetation zones, two transects were laid out at each pond. Each transect extended from the highest zone (or, in some ponds, the second-highest zone) on one side of the pond, across the pond and up to the highest (or second-highest) zone on the opposite side. (Coordinates for the end points of the transects are given in Appendix 2.) The two transects crossed but not necessarily at a right angle (Figure 5). Each transect was marked

during sampling by a fiberglass surveyor's rope stretched taut and affixed at each end to a piece of steel reinforcing bar driven into the ground. The starting point (at 0 on the surveyor's rope) and the ending point of each transect also were marked with pieces of reinforcing bar, which were left in the ground. (An aluminum survey cap [stamped with the pond number, the transect number, the label "Start" or "End", and an arrow indicating the alignment of the transect] was later added to each piece of reinforcing bar marking a transect starting or ending point). The compass bearing from the start of the transect to the end (from true north, magnetic declination 14.5^{o} E) was recorded and the coordinates (UTM Zone 12N, NAD83) of the starting and ending points were determined with a global positioning system receiver (GeoExplorer II, Trimble Navigation Ltd., Sunnyvale CA, USA). Multiple positions were recorded for each point (Appendix 2) in a digital file and the location is the average of the positions. The GPS data were treated with post-processing correction.

Along each transect, a sampling point was located on the surveyor's rope in each of the zones that the transect crossed (Figure 5). The location of the point within a zone was chosen subjectively to assure that the sample lay entirely with the zone. Each sampling point was marked temporarily with a pin flag (Figure 3) and the distance from the transect starting point (i.e., from 0 on the surveyor's rope) to each sampling point was recorded. No permanent markers were left at the sampling points but they can be re-located by measurement along a surveyor's rope or tape stretched between the transect ends.

Horizontal Vegetation Density

At each sampling point, the density of the vegetation was expressed as the percentage of a vertical, 10-cm high x 25-cm wide board that was obscured by the vegetation. Density was estimated at each point at three heights above the ground: 0-10 cm, 20-30 cm, and 40-50 cm (Figure 6). A wooden dowel with the three boards attached was driven into the ground at the sampling point with the boards facing 90° to the right of the transect (looking down the transect from the start to the end) and each board was adjusted to the correct height. An observer then lay on the ground with his or her eye at the same height as the center of the board being read (the observer used a pole to gauge height until he or she was well practiced) and 2 meters from the board (the distance was measured by boot-lengths) and recorded the percentage of the board that was obscured by the vegetation (Figure 7).

Horizontal density measurements were made in the periods July 3-7 and September 4-5, 2003, and June 22-29 and September 14-15, 2004. Data from different periods were treated as different samples in the data analysis.

Canopy Cover

Canopy cover was recorded at each sampling point in a 0.5 m x 2.0 m plot after the horizontal density estimates were made. One corner of the plot was placed on the ground at the sampling point with the 0.5 m side parallel to the transect and extending toward the transect's end, and with the 2 m side of the plot extending 90° from the right-hand side of the transect (viewing the transect from starting point to end point). The canopy cover of a plant was defined (following Daubenmire 1959) as the polygon described by a line drawn around the leaf tips of the undisturbed, above-ground portion of the plant. For each species, the percentage of the plot beneath the canopies of all the plants of the species was estimated and recorded as the mid-point of the appropriate cover range (Table 1).

Canopy cover was estimated in the periods July 3-7, 2003 and June 22-29, 2004, and the two readings were treated in the data analysis as samples from separate plots.

Heights of Plots Above Local Low Points

The height of each sampling point above the lowest point in its pond or depression was determined with an Abney level and a stadium rod.

DATA ANALYSIS

Data were analyzed in two steps. First, the sample points were organized into groups according to similarity in plant species composition, so that the points in each group were more similar to one another in plant species composition than to the points in the other groups. Organizing the sample points into groups was necessary because the sample points represent a variety of habitat conditions, and some of the difference in vegetation among the sample points results from differences in habitat, not from differences in grazing. After the sample points were organized into groups based on their vegetation, the statistical analyses could better separate the influence of habitat from the influence of grazing. The statistical techniques of classification and ordination were used to organize the points and to characterize the groups. Several other statistical techniques were used to examine the degree of difference in species composition among the groups.

Grouping the sampling points according to the vegetation zones in which they were found might seem more straightforward, but the zones around each pond were numbered without regard to whether or not those numbers represented the same zones around other ponds. Hence, for example, zones 1, 2, and 3 around a wet pond might differ substantially in vegetation from zones 1, 2, and 3 around a nearby dry pond.

Second, after the sample points had been grouped, then the standard statistical techniques of t-tests and analysis of variance were used to compare the vegetation at points inside the exclosure with the vegetation at points outside the exclosure (the comparison of most interest), and to look for differences between season of sampling and year of sampling.

Organizing Sample Points Into Groups

For their organization into groups, the sample points were represented by the canopy cover plots. Grouping was done with a combination of classification and ordination[1].

Classification was done with cluster analysis, a technique that combines individual plots (in this case, each representing a sampling point) into groups, and small groups into larger groups, until all of the plots are combined into one large group. In cluster analysis, the similarity in species composition between each pair of plots is calculated (using Sorensen's coefficient in this analysis) and then is converted to a measure of dissimilarity. That dissimilarity can be thought of as the distance between the plots in a space with the same number of dimensions as the number of species used in the analysis. The plot-to-plot distances are stored in a matrix, and the combining of plots starts with the closest (that is, most similar) plots and proceeds to the most distant plots. When plots are combined into a group, the distance from the center point of that group to each remaining plot or to the center point of every other group is calculated. The classification performed here used flexible-beta linkage (beta = -0.25) to combine plots and groups.

A classification resulting from cluster analysis typically is displayed in a dendrogram that shows how the plots are combined into groups, and how those groups are combined with one another (e.g., Figure 8). The final form of the classification depends on where the branches of the dendrogram are cut. Cutting the dendrogram close to its beginning gives a classification with many, usually small and relatively homogeneous, groups. If the dendrogram is cut too close to the beginning, the resulting classification does a poor job of summarizing the wealth of information present in the data. Cutting the dendrogram farther out toward its end produces a classification with few, but larger and more heterogeneous, groups. A classification with a few large groups can be difficult to interpret because a large group often contains disparate plots.

In ordination, the goal of the analysis is to examine patterns of similarity in species composition among plots or groups of plots. Ordination arranges plots along axes of similarity, and the results of an

[1] Classification and ordination were conducted with the PC-ORD software package, Version 4.27; MjM Software Design, Gleneden Beach, OR, USA.

ordination analysis are displayed on graphs that place similar plots close together and dissimilar plots far apart. Ordination (like classification) can be used to identify groups of plots, but its main use is revealing gradients of similarity among plots.

Ordination was performed with non-metric multidimensional scaling (NMS), a technique that is particularly well-suited for analyzing vegetation data, which usually are not normally distributed and contain a great range in values (McCune and Grace 2002). NMS works by first calculating a matrix of similarity between every pair of plots, then constructing axes and arranging the plots along the axes in a manner that preserves, as much as possible, the pattern of similarity among all of the plots contained in the original matrix. Table 2 shows the settings used in the NMS analysis. As with the cluster analysis, similarity between plots in the NMS ordination was calculated with Sorensen's coefficient.

Both cluster analysis and NMS used the canopy cover values from the 0.5 x 2.0 m plots. Each of the 163 sampling points was represented by two of those plots, one sampled in 2003 and one in 2004, and the entire data set consisted of 326 plots. Twenty-six of those plots were covered entirely by bare ground or water and contained no plants, so they were irrelevant to an analysis of vegetation density or canopy cover. Those 26 plots were removed from the classification and ordination analyses, leaving 300 vegetated plots.

Four groups of plots identified from the classification and ordination analyses were used in subsequent comparisons of canopy cover and vegetation density. For each, the species composition of the plots inside the exclosure was compared to that in the plots outside the exclosure with multi-response permutation procedures (MRPP), a statistical technique that tests the hypothesis of no difference in species composition between groups (McCune and Grace 2002).[2] MRPP is done as an alternative to repeated t-tests comparing the amount of every species in one group of plots versus the other group. The MRPP tests were done to check the assumption that the plots inside the exclosure represented the same types of vegetation as the plots outside the exclosure. All MRPP tests used the Sorenson measure of dissimilarity on absolute canopy cover values.

When MRPP tests indicated a statistically significant difference in overall species composition, then indicator species analysis (ISA)[3] was used to discover which plant species caused the difference. ISA examines, for each species, the abundance (i.e., the amount of canopy cover) and the frequency of occurrence (i.e., the percentage of plots with the species) in one group versus another group, and assesses whether the observed differences in abundance and frequency are likely to arise just by chance.

Horizontal Vegetation Density

The factors that affect horizontal vegetation density (such as location inside vs. outside the exclosure, year and season of sampling, and others) were examined with standard statistical analyses in the Minitab statistical package, release 14.20 (Minitab Inc., State College PA, USA). Separate analyses were performed for each of the three heights above the ground (0-10 cm, 20-30 cm, and 40-50 cm) because density obviously differed enormously between them. T-tests were used for simple comparisons, and general linear model analyses of variance followed by Bonferroni simultaneous comparisons of means were used for more complicated comparisons. Data from both seasons in both years were included in these analyses.

Canopy Cover

Analyses for differences in canopy cover (between plot groups, between groups inside vs. outside the exclosure, and in different years) also were performed with standard statistical techniques in the Minitab release 14.20, on the data collected in both years from the vegetated plots.

---

[2] MRPP was conducted with the PC-ORD software package, Version 4.27; MjM Software Design, Gleneden Beach, OR, USA.

[3] Indicator species analysis was conducted with the PC-ORD software package, Version 4.27; MjM Software Design, Gleneden Beach, OR, USA.

RESULTS

Copies of completed sampling forms, horizontal vegetation density data, and canopy cover data are being provided in Appendix 4, Appendix 5, and Appendix 6, respectively.

PLANT SPECIES ENCOUNTERED

Sixty-one taxa of vascular plants were encountered in the study area, 44 taxa in the 326 sample plots and 17 additional taxa in or near the exclosure but not in the plots (Table 3). Six of the plants (10% of all plants and 14% of the taxa in the plots) could not be identified even to genus and one additional plant, dandelion, could be identified only to genus, leaving 88% of all taxa (and 84% of the taxa in the plots) that could be identified to species. Thirty of the plant taxa were graminoids (grasses, bulrushes, spikerushes, and sedges), 29 were forbs, and two were shrubs.

Among the 44 taxa from the sample plots, only three -- Nevada bulrush (*Amphiscirpus nevadensis*), common threesquare bulrush (*Schoenoplectus pungens*), and inland saltgrass (*Distichlis spicata*) -- were found in at least half of the plots (Table 4, Figure 9).[4] Fourteen taxa (32% of the plants from the plots) were found in only one plot, and 23 taxa (52% of those in the plots and 38% of all taxa) were found in fewer than 1% of the plots.

Only one taxon is listed by the Wyoming Natural Diversity Database as a species of concern (Keinath *et al.* 2003). Deer sedge (*Carex hallii*; synonymous with Hall's sedge, *Carex parryana* var. *unica*) has a conservation rank of G4?QS1, indicating that it is thought to be common within its global range (G4?), but that the taxonomy of the variety is questionable (Q), and that it is very rare in Wyoming (S1). Heretofore, deer sedge was known only from southeastern Wyoming (Fertig 1999) and the collection in the ponds study area extends the geographic range of deer sedge substantially to the west.

ENVIRONMENTS SAMPLED INSIDE AND OUTSIDE OF EXCLOSURE

Differences between the habitats sampled inside and outside of the exclosure were minor. Chi-squared analysis of all 326 plots (that is, the 300 vegetated plots in the four plot groups, plus the 10 plots in standing water, plus the 16 plots on bare soil) showed that these habitats were sampled in different proportions inside the exclosure than outside (Table 5). Most of this difference came from the greater number of plots in standing water or on bare soil outside the exclosure than inside (Figure 10). When these two types of plots were removed from the analysis, then the numbers of plots in each of the four groups did not differ significantly inside the exclosure from outside (Table 6), indicating that the habitats represented by the vegetated plots occurred in essentially the same proportions inside and outside of the exclosure. Furthermore, analysis of variance in elevation above the local low points for the 300 vegetated plots showed no difference between plots inside and outside of the exclosure (Table 7).

ORGANIZATION OF POINTS INTO GROUPS

Three groups of sample points (represented by canopy-cover plots) remained separate from other plots until late in the classification (groups 1, 4, and 62 on Figure 8), indicating that they are reasonably distinct. The graphs from the NMS ordination (Figure 11), displaying the gradients of similarity between plots, also show that these groups (particularly group 62) are somewhat distinct. The

[4] Nevada bulrush and common threesquare bulrush, both of which are short bulrushes, each was documented from flowering specimens. Many plots, though, had short bulrushes without flowers, and those plants could not be assigned to either species. Consequently, the two short bulrushes are treated together in the data analyses.

majority of the plots, though, were not placed by cluster analysis into distinct groups, and so were treated as one large and variable group (number 2) in the analyses of canopy cover and horizontal vegetation density.

Plot group 1 is most dissimilar to the other plots. Plots in group 1 are in the outer vegetation zones around ponds and depressions and lie at the highest elevations above the nearby low points (Figure 12). The vegetation in these relatively dry plots usually was dominated by alkali sacaton (*Sporobolus airoides*), and inland saltgrass (*Distichlis spicata*) usually was present (Table 8). Short Nevada bulrush (*Amphiscirpus nevadensis*)/common threesquare bulrush (*Schoenoplectus pungens*) contributed substantial cover in some plots. The MRPP tests showed no significant difference in species composition inside the exclosure versus outside the exclosure in 2003 or 2004 (Table 9). Thus there is no reason to think that the two sets of plots were sampling different types of vegetation.

Plot group 2, the largest of the groups, includes plots over a wide range of elevation above the low point of the ponds, although most lie within 2 meters above the low point (Figure 12) and hence are generally more moist than the plots of group 1. The common species were Nevada bulrush/common threesquare bulrush, inland saltgrass, seaside arrowgrass (*Triglochin maritimum*), baltic rush (*Juncus balticus*), and alkali cordgrass (*Spartina gracilis*). The 177 plots of this group were divided by the cluster analysis based on species composition into five sub-groups. Sub-group A consists of 16 plots in which alkali cordgrass, baltic rush, or inland saltgrass usually contributed the most cover (Table 10). Nevada bulrush or common threesquare bulrush usually were present. The 42 plots of sub-group 2B also usually contained alkali cordgrass, Nevada bulrush/common threesquare bulrush, and inland saltgrass, but baltic rush generally dominated these plots (Table 11). The largest sub-group, 2C, contains 73 plots, most of which were dominated by Nevada bulrush/common threesquare bulrush (Table 12). Seaside arrowgrass often was present, and inland saltgrass, baltic rush, and alkali cordgrass were less common. In the 20 plots of sub-group 2D, Nevada bulrush/common threesquare bulrush was the most widespread species, but common spikerush (*Eleocharis palustris*) dominated most of the plots in which it occurred (Table 13). Seaside arrowgrass and alkali buttercup (*Ranunculus cymbalaria*) often were present. The final sub-group, 2E, was characterized by dominance by inland saltgrass (Table 14). Nevada bulrush/common threesquare bulrush and alkali cordgrass were present in most plots but contributed less cover.

The MRPP tests for differences in species composition in the plots of group 2 inside the exclosure versus outside produced statistically significant differences for both years, indicating that composition differed between the sets of plots of this group (Table 15). According to indicator species analysis, four plant species were statistically significant indicators of the plots inside the exclosure in 2003, and seven species were significant indicators in 2004 (Table 16). The plots outside the exclosure contained only one statistically significant indicator species in 2003 and two species in 2004. All of those species, though, were weak indicators, with a maximum value of 62 out of 100. The low indicator values result from either a high relative abundance in both sets of plots or a low frequency of occurrence in the set for which a species is an indicator. The low indicator values show that, while the results of the ISA are significant statistically, they probably are insignificant ecologically.

Plot group 4 includes 43 plots on low, wet sites (Figure 12). Short seaside arrowgrass dominated virtually all of the plots, and Nevada bulrush/common threesquare bulrush usually was present and often contributed a substantial amount of cover (Table 17). MRPP tests for differences between plots inside the exclosure and outside showed no difference in either year (Table 18).

The wettest plots are in group 62, which (like those of group 4) lie within a meter of the local low point (Figure 12). During the study periods they often lay in standing water, and tall hardstem bulrush (*Schoenoplectus acutus*) was virtually the only plant found in them (Table 19). According to the MRPP analysis, the species composition of the plots inside the exclosure differed from that outside the exclosure in both years (Table 20). ISA, though, showed that the difference must be very slight: in each year, only one statistically-significant indicator species could be identified (Nuttall's alkali grass [*Puccinellia nuttalliana*] for the outside plots in 2003, hardstem bulrush for the inside plots in 2004) and

both of those had low indicator values. As with the plots of group 4, the difference between the inside plots and the outside plots may have been significant statistically, but not ecologically.

HORIZONTAL VEGETATION DENSITY

Horizontal Density at 40-50 cm

Virtually all of the readings of horizontal vegetation density at 40-50 cm above the ground came from the tall bulrush-dominated plots of group 62 (Figure 13). Analysis of variance produced a statistically significant interaction between location inside or outside the exclosure, year, season, and plot group (Table 21), indicating that horizontal density was affected by all four factors interacting with one another. Comparisons of mean horizontal density among the combinations of location, year, season, and plot group showed that the differences detected by the analysis of variance were between the plots of group 62 inside the exclosure and other combinations of plots (Table 22). Within the group 62 plots, the horizontal density at 40-50 cm was consistently greater inside the exclosure than outside (Figure 14). The difference was always large, ranging from a mean of 45.8% inside vs. 0.4% outside late in 2004, to a mean of 83.5% inside vs. 0.5% outside in late 2003.

Seasonal change in density (again, in just the group 62 plots) depended on the year of sampling and the location inside or outside of the exclosure. Inside the exclosure, mean density increased very slightly and insignificantly through the summer in 2003 (mean 76.9% early to 83.5% late), but in 2004 it declined significantly, by nearly half (mean 72.9% early to 45.8% late). Outside the exclosure, mean density was very small in both years and changed only very slightly from early to late in the season in 2003 (mean 2.75% early and 0.5% late) and in 2004 (mean 6.2% early and 0.4% late).

Year-to-year difference in horizontal density at this height was restricted to group 62 plots inside the exclosure late in the season. Mean density for these plots in 2003 was 83.5%, but in 2004, it was only 45.8%. For the plots inside the exclosure early in the season, and for the plots outside the exclosure in both seasons, density did not differ significantly between years.

Horizontal Density at 20-30 cm

The tall bulrush-dominated plots of group 62 also had the largest estimates of horizontal vegetation density at 20-30 cm above the ground, but dense vegetation at that height was encountered in the plots of other groups as well (Figure 15). Analysis of variance showed that mean density differed significantly among plot groups, and that this difference was complicated by interactions with location inside or outside the exclosure and with season of sampling (Table 23). Comparisons of means (Table 24 and Figure 16 and Figure 17) showed that vegetation in group 62 was significantly denser than in the other groups inside the exclosure both early in the season (mean of 89.18% for group 62 vs. 13.64% for group 2) and late (mean of 84.12% for group 62 vs. 7.04% for group 2), and outside the exclosure early in the season (mean of 49.44% for group 62 vs. 2.704% for group 1) but not late.

Vegetation was denser in plots inside the exclosure than outside by approximately 15% in 2003 and 12% in 2004 (Table 25, Figure 18). This inside-to-outside difference was seen mainly in the plots of group 62 (Figure 16), in which vegetation was substantially denser inside the exclosure than outside (means of 89.18% inside vs. 49.44% outside early in the season and 84.12% inside vs.10.67% outside late in the season). An inside vs. outside difference was also seen in plots of group 2 (Figure 16) but only early in the season, when vegetation inside the exclosure was slightly denser than outside (mean 13.64% inside vs. 1.987% outside). By late in the season, though, density in the group 2 plots had declined and there was no difference between inside and outside. For groups 1 and 4, density of the vegetation at 20-30 cm never differed significantly outside the exclosure from inside.

Seasonal change was documented only in the plots of group 62 outside the exclosure, where the vegetation was denser early in the season (mean of 49.44%) than late (mean of 10.67%). Horizontal

density at this height did not change significantly from early to late in the season in the plots of any group inside the exclosure or in the plots of groups 1, 2, or 4 outside.

The analysis of variance showed that mean horizontal density probably differed between 2003 and 2004, but that this year-to-year effect was complicated by interaction with location of the plots (Table 23). According to pair-wise comparisons of means (Figure 18), vegetation was slightly denser inside the exclosure in 2003 (mean 18.75%) than in 2004 (mean 15.39%), but there was no significant difference between 2003 and 2004 in plots outside the exclosure.

Horizontal Density at 0-10 cm

Vegetation was dense near the ground in all of the vegetation types (Figure 19), so all four plot groups were included in the analysis of variance of horizontal density at 0-10 cm. That analysis showed that density at this height differed significantly between plots inside the exclosure and outside, between seasons, and between plot groups, and that those differences were complicated by interactions between factors (Table 26).

Vegetation inside the exclosure was denser than vegetation outside in both years (Figure 20). The small probability value for the inside/outside-by-year interaction (Table 26) suggests that the importance of location inside or outside differed from 2003 to 2004. Pair-wise comparisons of means for the location-by-year combinations (Figure 20, Table 27), though, showed no significant year-to-year difference. This inconsistency in test results arises because the Bonferroni method used for pair-wise comparisons is more conservative than the analysis of variance, and consequently is less likely to find significance in a small difference. Summary statistics (Figure 20) show that the inside-vs.-outside difference was slightly greater in 2003 (mean inside 86.25% vs. outside 62.12%) than in 2004 (mean inside 83.91% vs. outside 65.04%). This small year-to-year difference was significant in the analysis of variance but not in the more powerful pair-wise comparison.

The inside-to-outside difference was complicated, too, by an interaction with plot group (Table 26), as the pair-wise comparisons of location-by-group combinations clearly show (Figure 21, Table 28). Vegetation was denser inside the exclosure than outside for plots of group 1 (mean inside 67.06% vs. outside 51.67%), group 2 (mean inside 89.78% vs. outside 69.67%), and especially group 4 (mean inside 73.37% vs. outside 44.27%), but not group 62 (mean inside 99.441% vs. outside 98.056%).

Density differed among plot groups, and the degree of difference depended on location inside or outside of the exclosure (Figure 21, Table 28). Differences were modest inside the exclosure, where the vegetation was denser in the plots of groups 2 and 62 (means of 89.78% and 99.441%, respectively) than in groups 1 and 4 (means of 67.06% and 73.37%, respectively). Outside the exclosure, there was a greater spread in mean density among groups: the densest vegetation was in the plots of group 62 (mean 98.056%), vegetation was significantly less dense in group 2 (mean 69.67%), and significantly less than that in groups 1 and 4 (means of 51.67% and 44.27%, respectively).

The analysis of variance showed that density at 0-10 cm depended on season of sampling but that this effect was complicated by an interaction with year (Table 26). Pair-wise comparison of means for the year-by-season combinations (Figure 22, Table 29) showed that density declined very slightly (if at all) from early to late in 2003 (mean early 76.17% and late 74.13%) but more markedly (and significantly) in 2004 (mean early 80.99% and late 69.48%). This result, along with the inability of pair-wise comparisons of means to show a location-by-year interaction and with the insignificance of year of sampling in the analysis of variance (Table 26) all suggest that difference in density at 0-10 cm from 2003 to 2004 was very small.

Summary of Horizontal Density Results

The results, considered either by height of sampling or by type of vegetation (which is related to height), suggest that vegetation was denser inside the exclosure than outside. The tallest vegetation (the tall bulrushes in plots of group 62, at 40-50 cm) was consistently much denser inside than outside; in

fact, very little tall vegetation was encountered outside the exclosure. At intermediate heights (20-30 cm), vegetation was also consistently denser inside than outside in the wet, tall-bulrush dominated plots of group 62 (with 2- to 7-fold differences), and early in the season in mixed plots of group 2 (ca. 25-fold); but in the dry, alkali sacaton-dominated plots of group 1 and the short arrowgrass-dominated plots of group 4, there was very little vegetation at the intermediate heights and no difference between plots inside and outside the exclosure. Close to the ground (0-10 cm), vegetation was denser inside the exclosure than outside in all plots except the wet plots of group 62. The inside-to-outside differences were more modest at this height (16% to 22%) than at the intermediate and tallest heights.

In the wet, tall-bulrush dominated plots (group 62), the vegetation was denser inside the exclosure at the tallest height (by several orders of magnitude) and the intermediate height (ca. 6-fold), but not close to the ground. In the mesic plots dominated by low arrowgrass (group 4), there was essentially no vegetation at the intermediate heights and none at the tallest heights, and the vegetation near the ground (0-10 cm) was ca. 30% denser inside than outside the exclosure.
The mixed plots of group 2 contained virtually no vegetation at the tallest height. At the intermediate height, the vegetation was ca. 25 times denser inside the exclosure than outside early in the season, and there was no significant difference late in the season. Near the ground in the group 2 plots, the vegetation inside the exclosure was some 20% greater than outside. Finally, in the driest plots dominated by alkali sacaton (group 1), the vegetation near the ground was ca. 16% denser inside the exclosure than outside; these plots had very little vegetation at intermediate heights and only a trace at the greatest heights.

Season of sampling had little effect on horizontal density estimates. The vegetation at 40-50 cm in the tall bulrush stands (group 62) was only ca. 10% denser early in the season than late in 2004 and there was no difference in 2003. At 20-30 cm, the only seasonal difference was also restricted to the tall bulrush stands and outside the exclosure, where the vegetation was ca. 5 times denser early than late. Close to the ground, the vegetation was ca. 10% denser early in the year than late in 2004, and there was no difference in 2003.

The data show no clear difference in vegetation density between 2003 and 2004. At 40-50 cm, the vegetation was denser in 2003 than 2004 but only for the group 62 plots inside the exclosure early in the season. Similarly, at 20-30 cm, vegetation in plots of all groups inside the exclosure (but not outside) was denser in 2003 than in 2004; season of sampling did not affect this year-to-year difference. And at 0-10 cm, no difference in horizontal density was detected between 2003 and 2004.

PLANT CANOPY COVER

Mean canopy cover for the 300 vegetated plots was ca. 12% greater inside the exclosure than outside (Figure 23), a significant difference (Table 30). Mean cover also differed among the plot groups, but the significant interaction between plot group and year (Table 30) showed that the relationships among groups differed between years. In 2003, mean canopy cover in the tall bulrush plots of group 62 was nearly 30% greater than in the other groups, and cover did not differ among groups 1, 2, and 4 (Figure 24, Table 31). In 2004, though, mean cover in group 62 was ca. less (ca. 10% less than in 2003) and the differences among the four groups were minor and not statistically significant.

Mean per-plot canopy cover averaged across all 300 vegetated plots did not differ significantly from 2003 to 2004. When each group was considered separately, though, the pair-wise comparisons of means showed that cover increased significantly from 2003 to 2004 in group 1 (an increase of ca. 13%) and group 2 (an increase of ca. 11%) -- the groups representing the drier habitats. Mean cover apparently did not change significantly between years in group 4 or group 62, which represent the wetter habitats.

Relationship of Horizontal Vegetation Density to Canopy Cover

Both canopy cover and horizontal vegetation density (the latter at all three heights, but especially at 20-30 cm and 40-50 cm) were greater inside the exclosure than outside. A direct comparison of these two measures of the thickness of the vegetation shows, though, that they are not consistently related to each other: rather, most values of canopy cover were associated with a wide range of values of horizontal density (Figure 25). The correlation coefficient, r, was used to quantify the relationship between canopy cover and horizontal density in cases where the graphs suggested that the two were related (Table 32.) Statistically significant positive relationships were found for canopy cover with horizontal density at 40-50 cm and at 20-30 cm in the tall bulrush plots of group 62, and at 0-10 cm for the short vegetation of group 2. At 20-30 cm height, horizontal density was negatively and weakly correlated with canopy cover in group 2.

These coefficients indicate that, in group 62, plots with large canopy cover values also generally had dense vegetation at 40-50 cm and 20-30 cm. In group 2, there was a minor tendency for plots with large amounts of canopy cover to have denser vegetation at 0-10 cm but more open vegetation at 20-30 cm. In the vegetation in general, though, large canopy cover values did not necessarily mean dense vegetation.

Discussion

The data collected in this project suggest that the greatest effect of excluding grazing animals for two years is the protection of stands of tall bulrush from being eaten or knocked down. Grazing and trampling of shorter vegetation also was reduced, but less markedly. Only very minor differences in plant species composition were noted. Anecdotal observations suggest that cattle have the greatest effect on the vegetation in and around the ponds: cattle were grazing and resting in the mesic meadows near the exclosure at times during the sampling periods, a few cattle were in the exclosure one day in 2003, and cattle droppings and tracks were common in and around the ponds outside the exclosure and were present (but uncommon) inside the exclosure. Elk droppings and tracks also were observed inside and outside the exclosure but they seemed to be less common than cattle droppings and tracks. No elk were seen in the ponds or meadows.

Periodic sampling in future years may show more substantial changes in the vegetation inside the exclosure, but whether or not those changes matter to the amphibians (the animals of main interest), birds, and mammals that use the ponds is a question that this sampling program cannot answer. That can only be determined by looking specifically at the abundance of the animals. What this vegetation monitoring program can tell managers is whether or not changes in animal abundance likely are due to changes in habitat structure.

One would expect a stronger relationship between canopy cover and horizontal vegetation density, and sampling in future years would be simpler if the data indicated a strong relationship. The data do suggest that horizontal density and canopy cover are, in general, positively related. The apparent weakness of this relationship may be a consequence of the difference in how the measurements were taken. Each canopy cover estimate represented the vegetation over a 0.5 m x 2.0 m plot, or an area of 1 square meter. In contrast, each horizontal density measurement represented the vegetation in a very narrow zone (ideally, a line) 2 meters long, and the observer could obtain very different values by moving his or her head only a small distance to one side or the other. Had several horizontal density measurements been taken at each height at each sampling point, and the average at a height compared to the canopy cover estimate for that point, then a stronger relationship between the two variables might have been found. Even with this potential weakness, though, the horizontal density measurements still can indicate the relative density of the vegetation in different habitats and in grazed versus ungrazed areas. Such comparisons may prove valuable in explaining differences in animal abundance.

Both the 2003 and 2004 sampling times came at the ends of drier than average years (Figure 26). If sampling is repeated in future, wetter years, canopy cover and horizontal density estimates may

be greater (especially in the drier habitats represented by plot groups 1 and 2) and more sampling points may be covered with standing water or consist of bare ground. The potential effects of differences in precipitation highlight the necessity of collecting data outside as well as inside of the exclosure.

Even if both canopy cover and horizontal vegetation density must be collected at each point, sampling proceeds rather quickly. Two people were needed for initially laying out and marking the transects and surveying the heights of the sampling points, but the vegetation estimates can be made by one person. In spring of 2004, one person working alone re-located the transect end points, laid out the surveyor's ropes, marked the sampling points, and made both the horizontal density and the canopy cover estimates. For all 12 ponds, this work took just four days. In late summer 2004, when only the horizontal density measurements were made, one person completed the work on all 12 ponds in two days. Collecting and later identifying plant specimens, an important part of the work if changes in plant species composition and richness are to be documented, can add several days.

Sampling and Analysis in the Future

Canopy cover and horizontal density estimates can be taken in the future at the same sampling points as were used in 2003 and 2004. For each sampling transect, the coordinates of the endpoints and the compass bearing from start to end are being provided and the endpoints have been marked with reinforcing bar topped by survey caps. If the survey caps remain in place, then the transects can be easily re-located.

Although the sampling points have not been permanently marked in the field, workers in future years can re-locate them, too, by stringing a surveyor's rope (or similarly non-stretching tape) tightly between the starting and ending points of a transect and measuring the appropriate distances from the starting point. (Note that the 0 mark, not the handle, of the rope or tape must be placed at the starting point.) Horizontal density readings are taken to the right when the transect is viewed from the starting point. The canopy cover plot also is laid to the right of the transect, with the corner nearest the transect's start laid at the sampling point. If care is used in re-locating the transects and sampling points, then future measurements probably can be taken within several decimeters of the original measurements. Even if sampling points cannot be re-located with this degree of accuracy, the sampling design should allow for comparison of data from year to year because of the large number of sampling locations.

Analysis of data collected in the future almost certainly will require re-classification of the sampling locations into groups. The classification used in the present analysis was based on canopy cover data collected in 2003 and 2004. If species composition of the vegetation changes in the future as a result of protection from grazing or changes in the height of the water table, then the similarity among sampling points also will change, and the present classification will no longer usefully summarize the variation in the vegetation. The classification and ordination procedures used here are fairly standard among vegetation scientists and can be repeated.

References

Daubenmire, R. F. 1959. A canopy-coverage method of vegetational analysis. Northwest Science 33: 43-64.

Fertig, Walt. 1999. State species abstract for *Carex parryana* var. *unica*, Halls sedge. Wyoming Natural Diversity Database - University of Wyoming. On-line at http://uwadmnweb.uwyo.edu/WYNDD/Plants/state_spp_abstracts/C/Carex_parryana_unica.pdf. Accessed February 7, 2006.

Keinath, D., B. Heidel and G. P. Beauvais. 2003. Wyoming Plant and Animal Species of Concern. Prepared by the Wyoming Natural Diversity Database - University of Wyoming, Laramie, Wyoming. On-line at http://uwadmnweb.uwyo.edu/WYNDD/. Accessed February 7, 2006.

McCune, B. and J.B. Grace. 2002. Analysis of Ecological Communities. MjM Software Design, Gleneden Beach OR. 300 pp.

McCune, B. and M. J. Mefford. 1999. PC-ORD. Multivariate Analysis of Ecological Data, Version 4. MjM Software Design, Gleneden Beach OR, USA. 237 pp.

National Climatic Data Center. No date_a. Climatological Data Annual Summary, Wyoming. Volume 111, Number 13 (2002); Volume 112, Number 13 (2003); Volume 113, Number 13 (2004).

National Climatic Data Center. No date_b. Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, 1971-2000. Climatography of the United States No. 81, Wyoming.

USDA, NRCS. 2006. *The PLANTS Database*, Version 3.5 (http://plants.usda.gov). Data compiled from various sources by Mark W. Skinner. National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

FIGURES

Figure 1. Location of ponds study area in southwestern Wyoming.

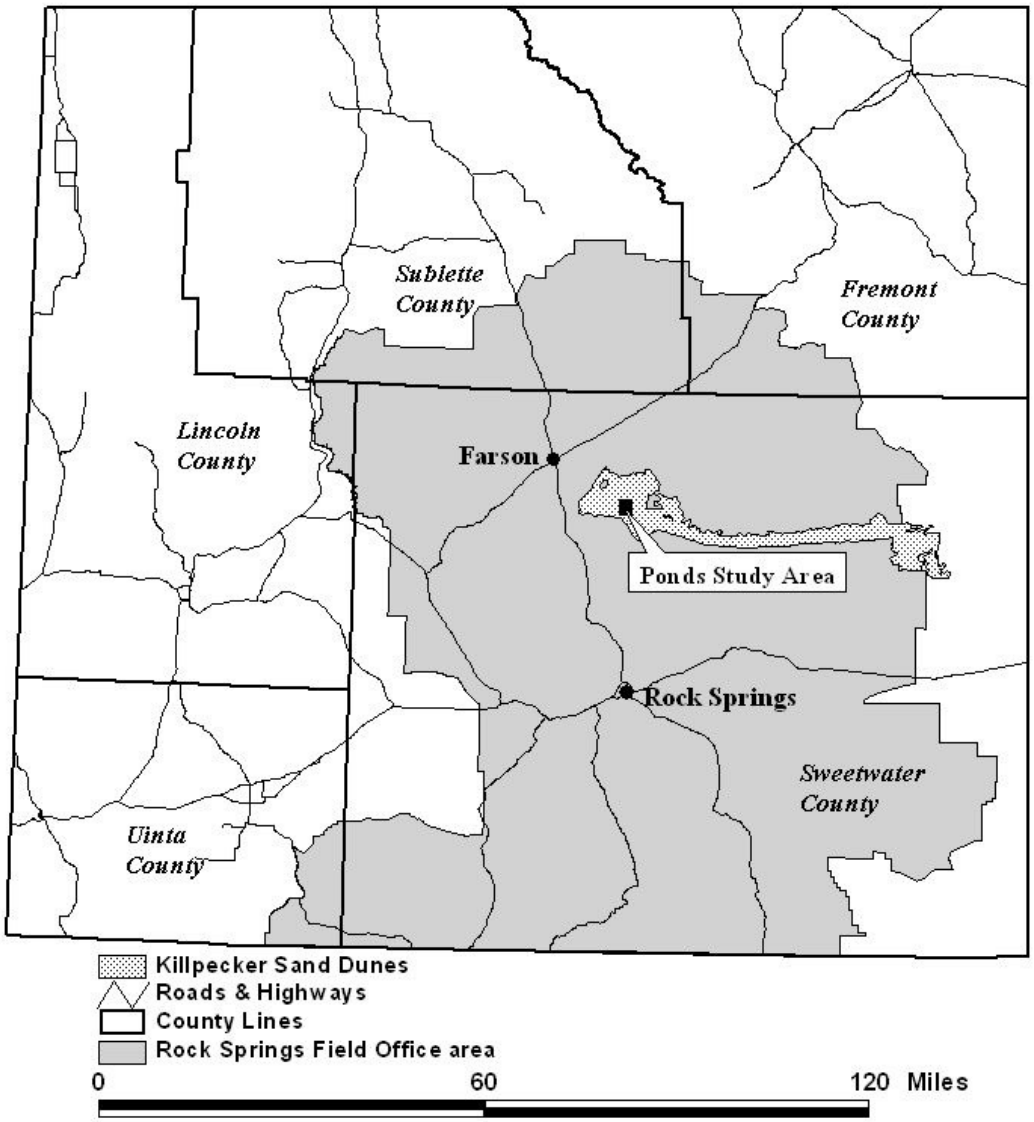


Figure 2. Landscape of study area

Landscape in which the ponds lie. Sagebrush dominates the gray shrub vegetation in the foreground and mid-ground; tan area in the background is active sand dunes. Green areas in the mid-ground are mesic meadows and the white patches are borders of wet ponds. G. Jones photo (7/8/2003) from White Mountain approximately 1 ½ mile south of the ponds.

Figure 3. Photos of pond types.

Additional photographs of ponds are in Appendix 1.

Wet pond. (G. Jones photo, 7/8/2003)

Medium pond. (G. Jones photo, 7/8/2003)

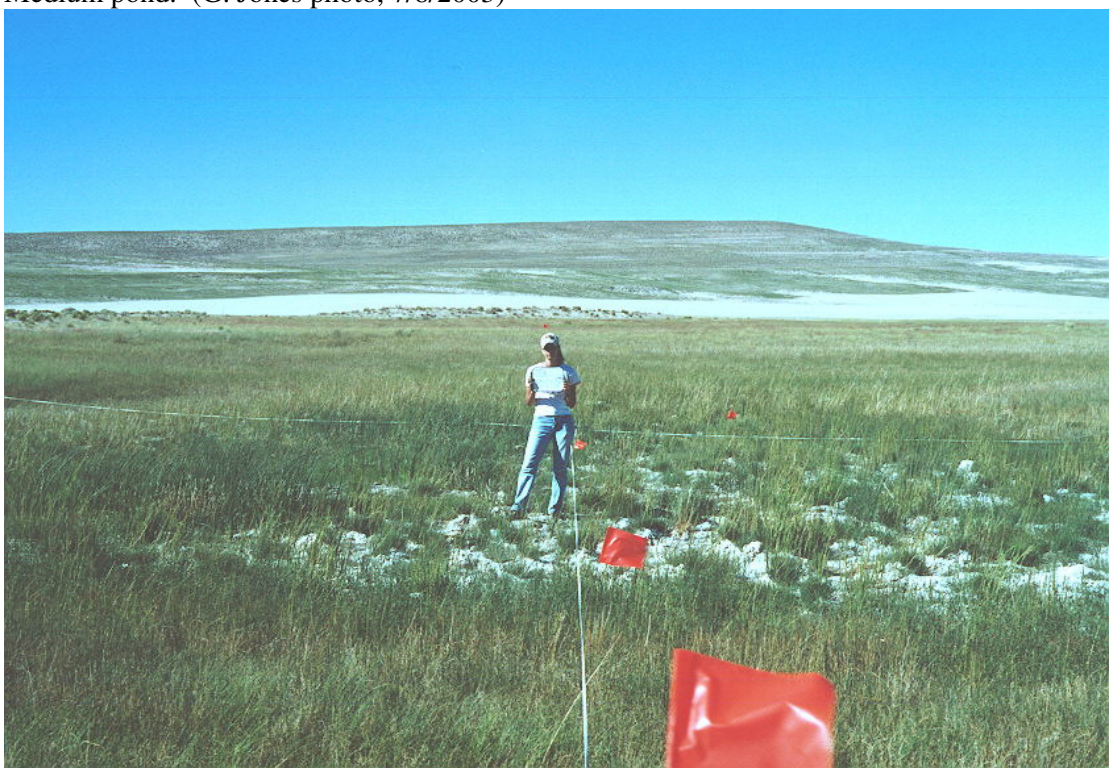


Figure 3 (continued).

Dry pond. (C. Cooper photo, 7/3/2003)

Figure 4. Ponds and depressions in which samples were taken.

The location is in the S ½ Section 6, T23N, R104W.

a. Ponds shown on the topographic map (portion of the Boars Tusk 7.5 minute topographic quadrangle). Red dots show ends of sampling transects. The red polygon is the electric-fence exclosure.

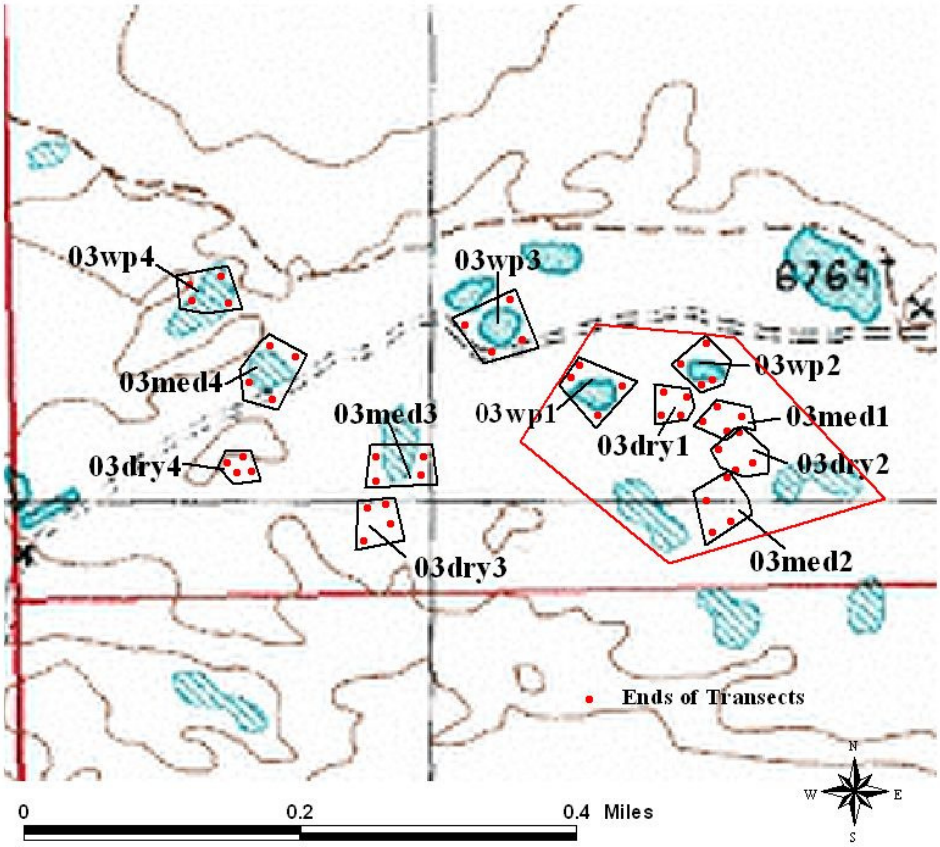


Figure 4 (continued).

b. Ponds shown on the black-and-white aerial photograph. White dots show ends of sampling transects. The large white polygon is the electric-fence exclosure.

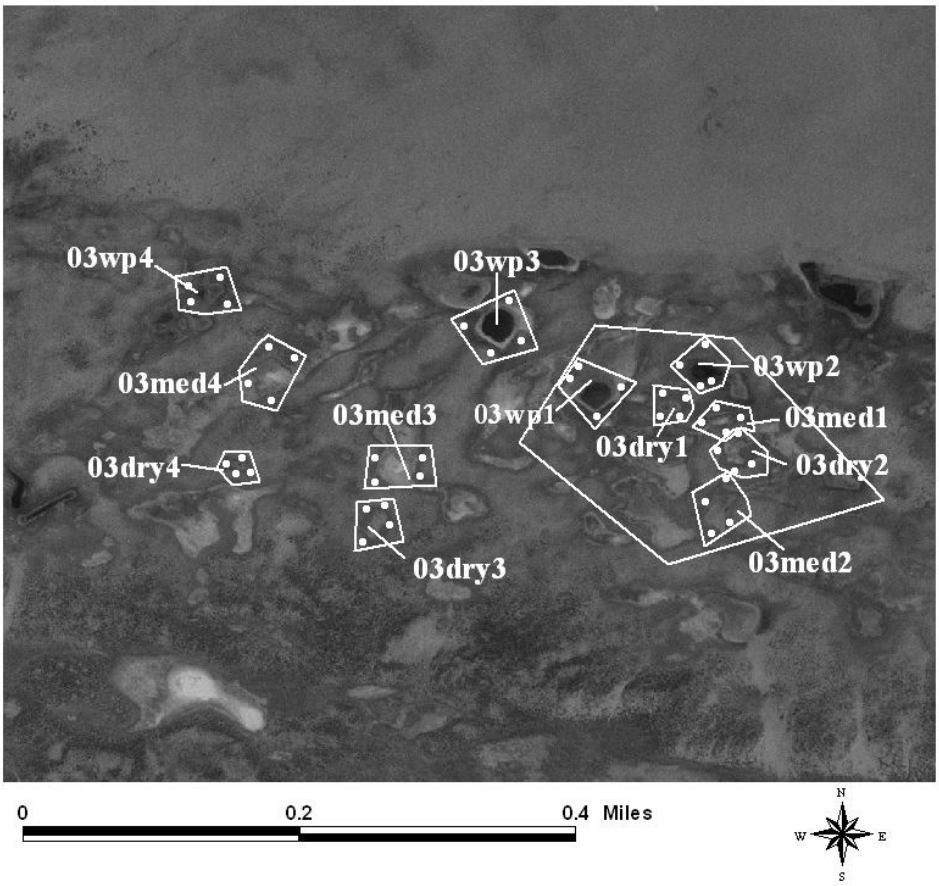


Figure 5. Layout of sampling points along transects across a pond.

Dashed lines are boundaries between the numbered vegetation zones. Zone 5 is water in a wet pond. Filled circles are sampling points. Nine points were located along transect 1, two points each in zones 1, 2, 4, and 5, and one in zone 3 (which is discontinuous). Ten points were located along transect 2, two points each in zones 1 - 5.

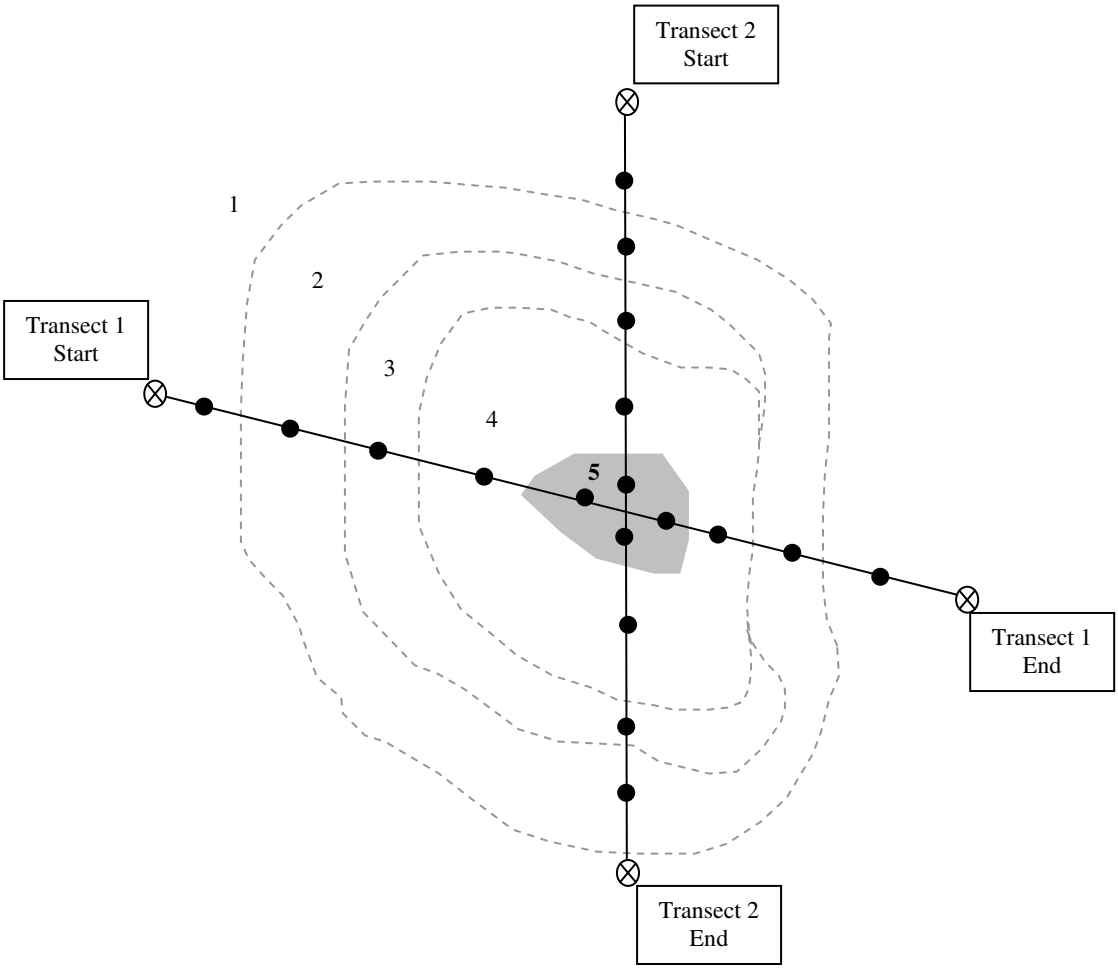


Figure 6. Density boards viewed from a distance of 2 meters.

The lowest board (nearly obscured) is 0 - 10 cm above the ground, the middle board is at 20 - 30 cm, and the highest board is at 40 - 50 cm.

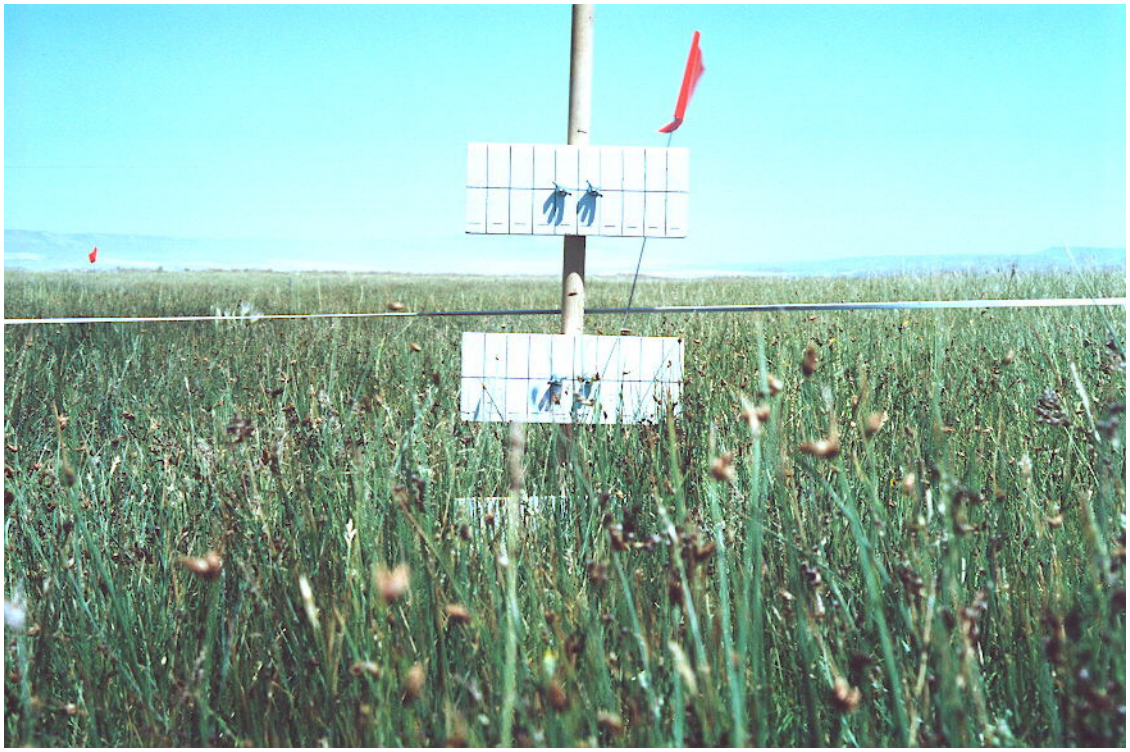


Figure 7. Observer estimating horizontal vegetation density with density boards. The lowest board, at 0 - 10 cm above the ground, is obscured by the vegetation.

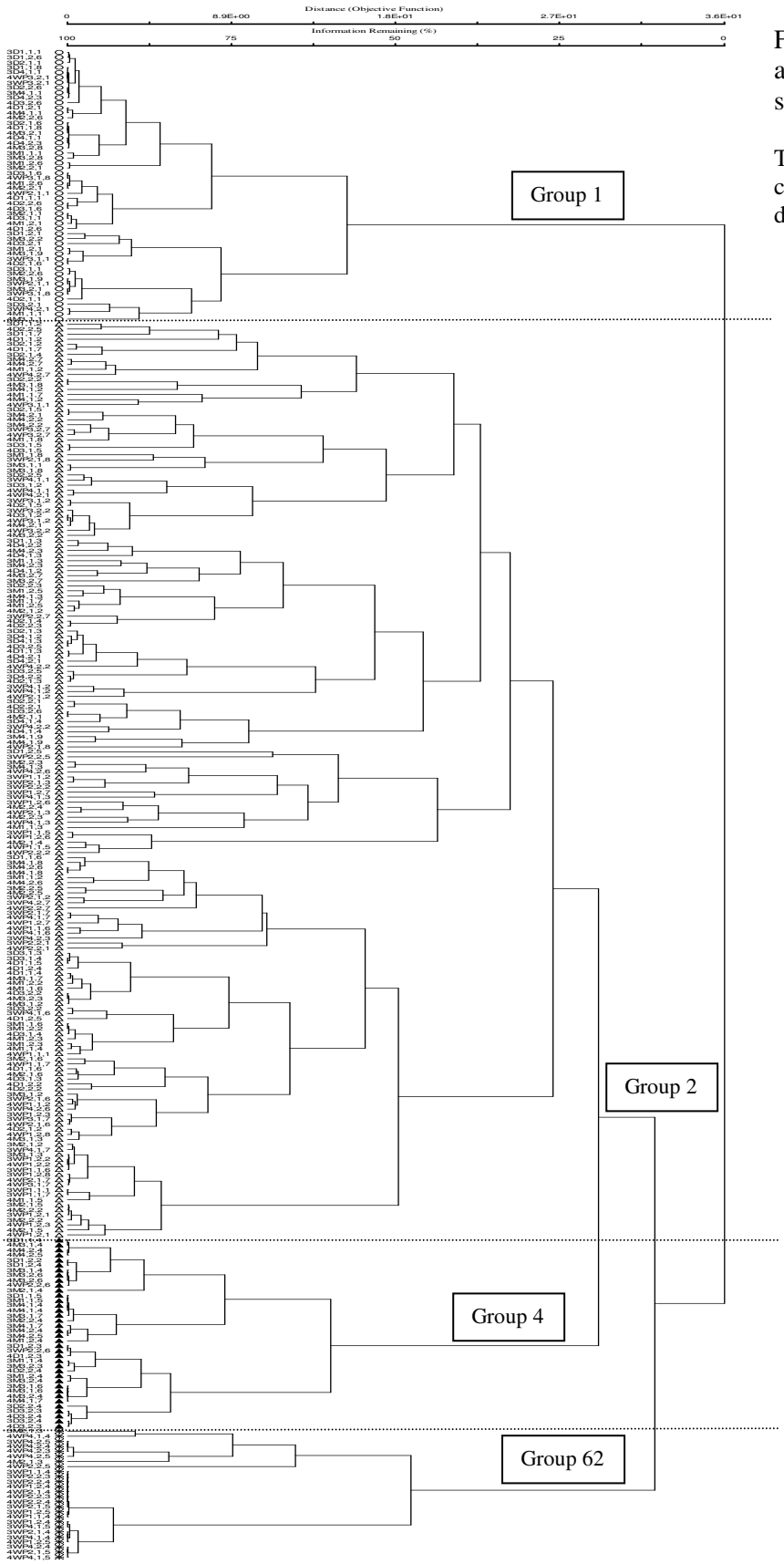


Figure 8. Dendrogram from cluster analysis classification of 300 vegetated sample plots.

The four plot groups used in the analyses of canopy cover and horizontal vegetation density are labeled.

Figure 9. Numbers of plant species in various numbers of sample plots.

Only 43 species are accounted for in this graph because two species (Nevada bulrush and common threesquare bulrush) are combined.

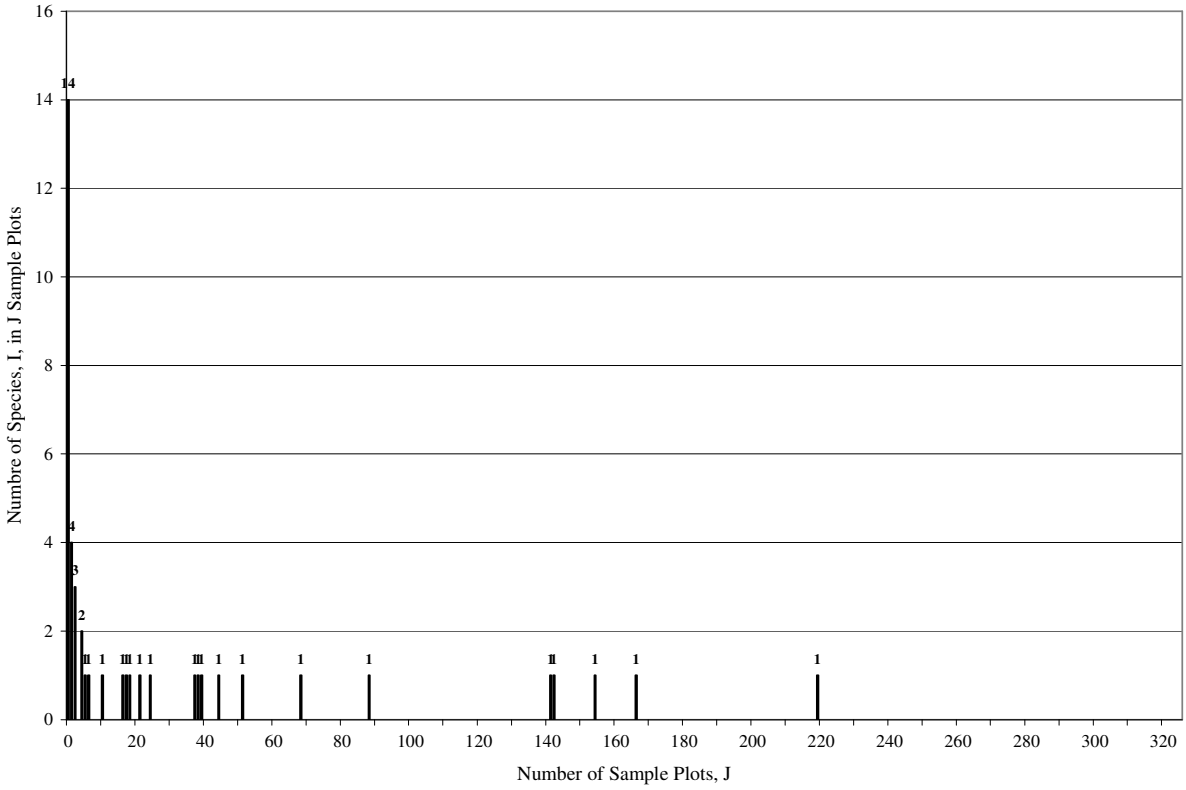


Figure 10. Numbers of plots in standing water, on bare soil, and in each of the four vegetated plot groups, inside and outside of the exclosure.

Standing water = group 100, bare soil = group 101

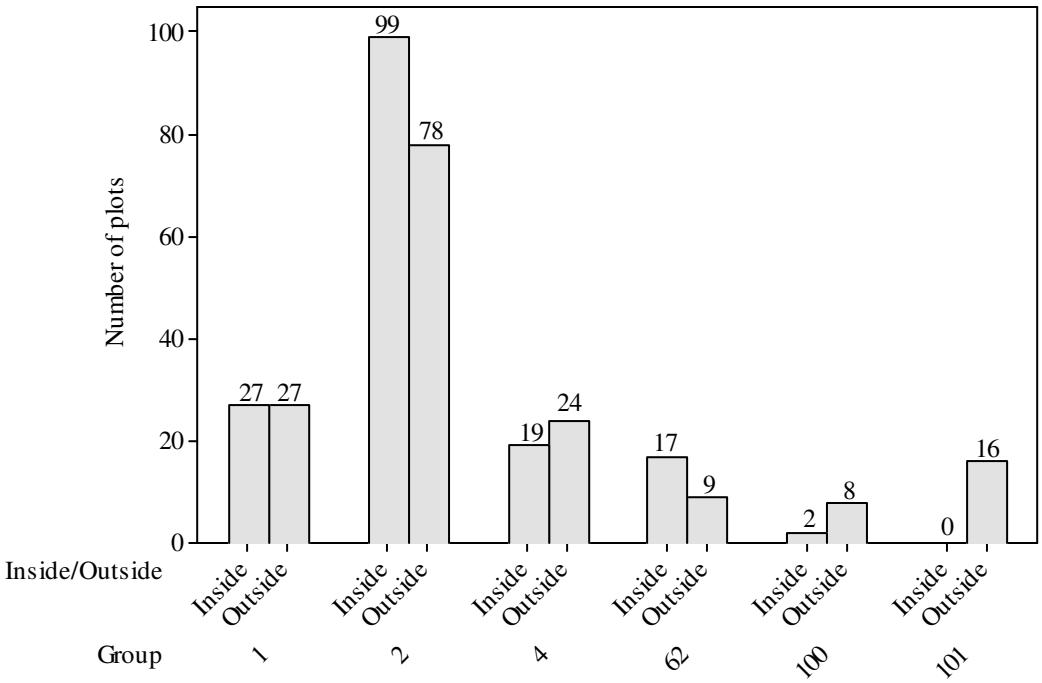


Figure 11. Graphs of sample plots from NMS ordination based on canopy cover.

a. Plots on axes 1 and 2

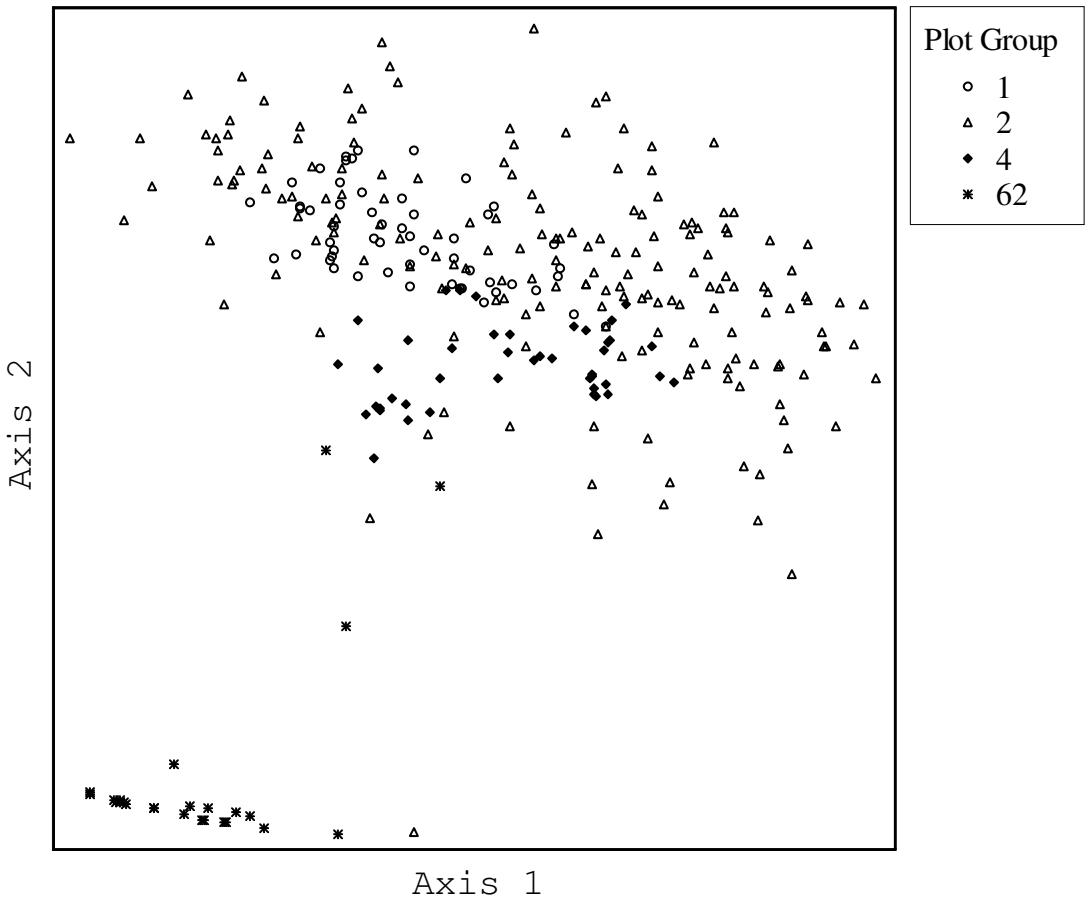


Figure 11 (continued).

b. Plots on axes 1 and 3

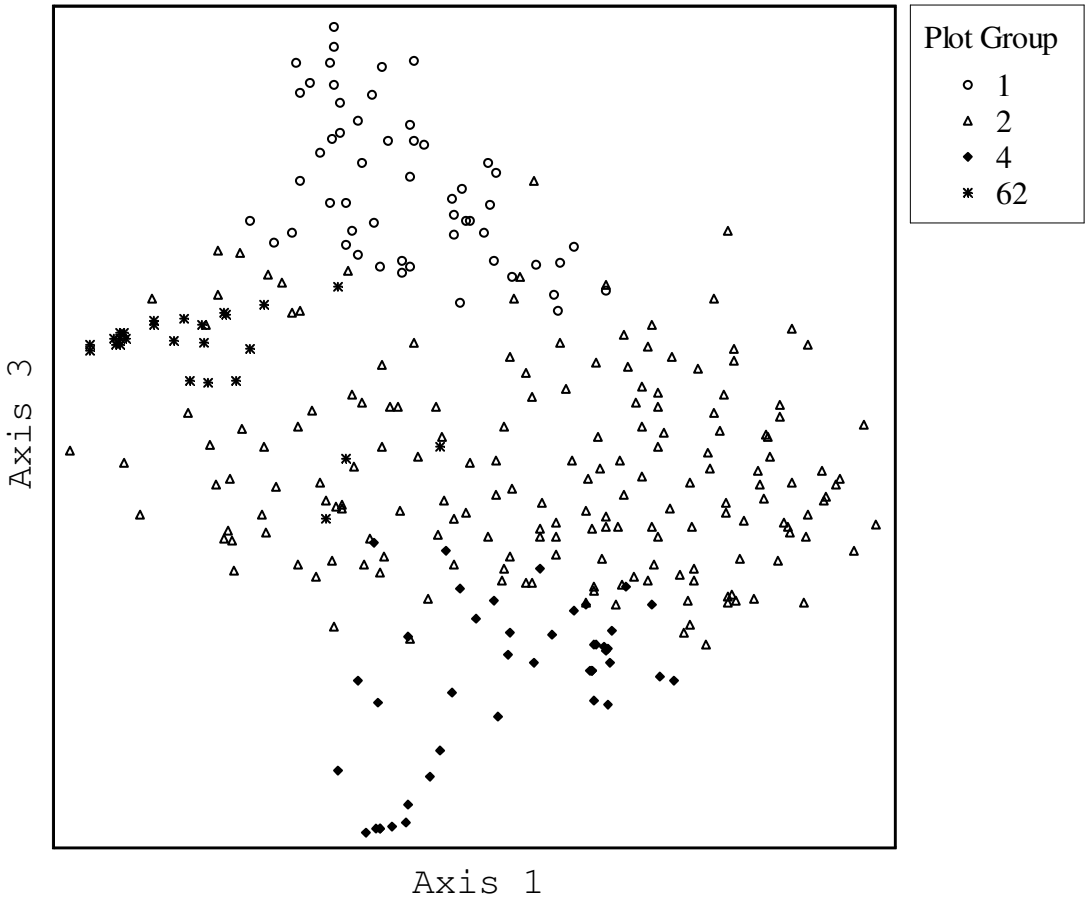


Figure 11 (continued).

c. Plots on axes 2 and 3

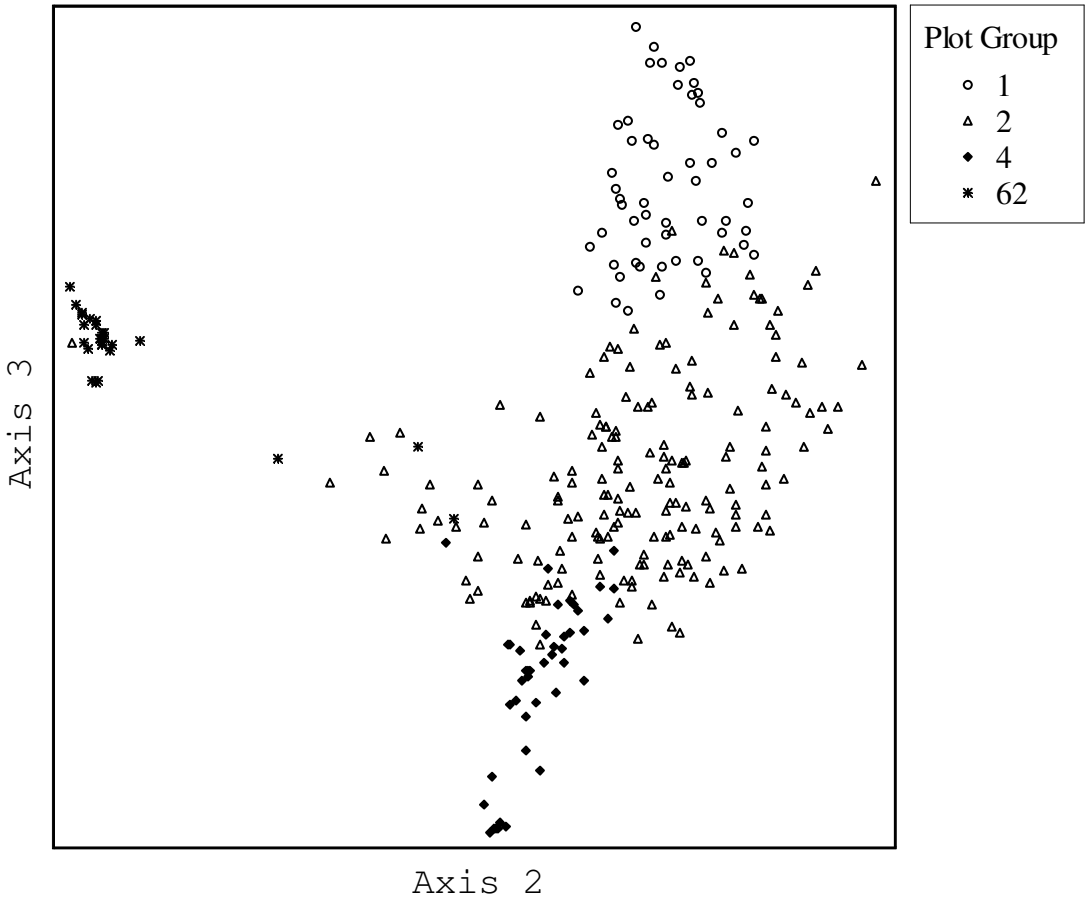
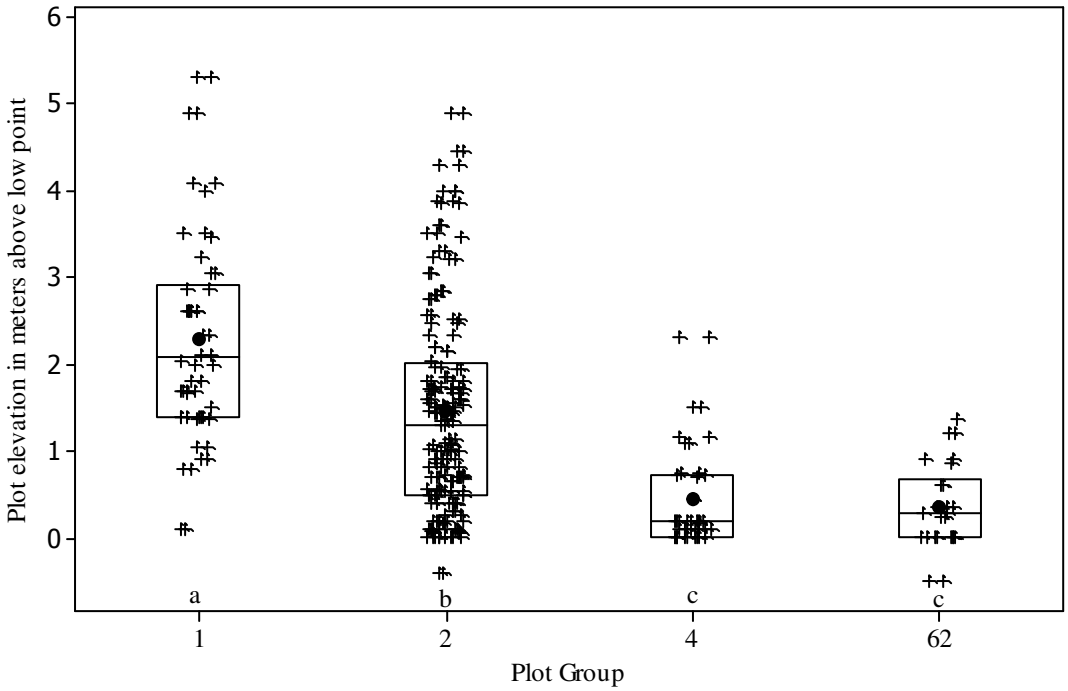


Figure 12. Elevation of each plot above the low point of its pond or depression.
Plots are shown by the four plot groups.

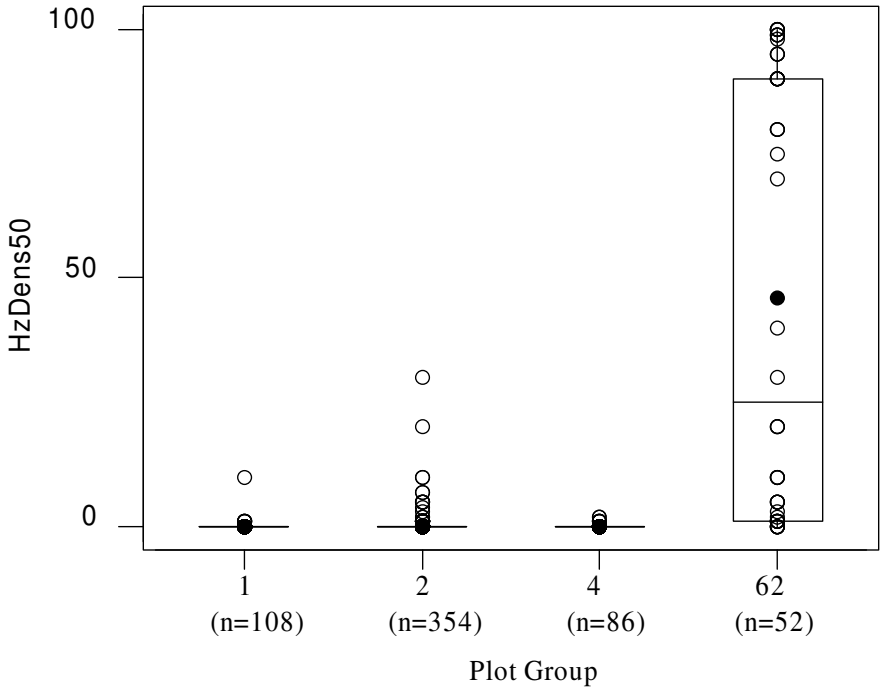
Upper and lower ends of boxes mark the 3rd and 1st quartiles, respectively. Horizontal lines across boxes are medians. Black circles are means. Crosses show elevations of individual plots. Letters above the X axis indicate significant differences: groups with different letters differ significantly in mean elevation, and groups with the same letter do not. Significance was determined through analysis of variance (Table 7).



Group	N	Mean	SE Mean	StDev	Minimum	Median	Maximum
1	54	2.298	0.167	1.228	0.100	2.070	5.3000
2	177	1.4573	0.0918	1.2207	-0.4000	1.3000	4.9000
4	43	0.4460	0.0914	0.5990	0.0000	0.2000	2.3000
62	26	0.3485	0.0954	0.4864	-0.5000	0.2800	1.3600

Figure 13. Horizontal vegetation density at 40-50 cm above ground in four plot groups, both seasons in both years.

Solid circles are means, open circles are individual density values, boxes indicate the 1st and 3rd quartiles, and horizontal lines across boxes are medians.

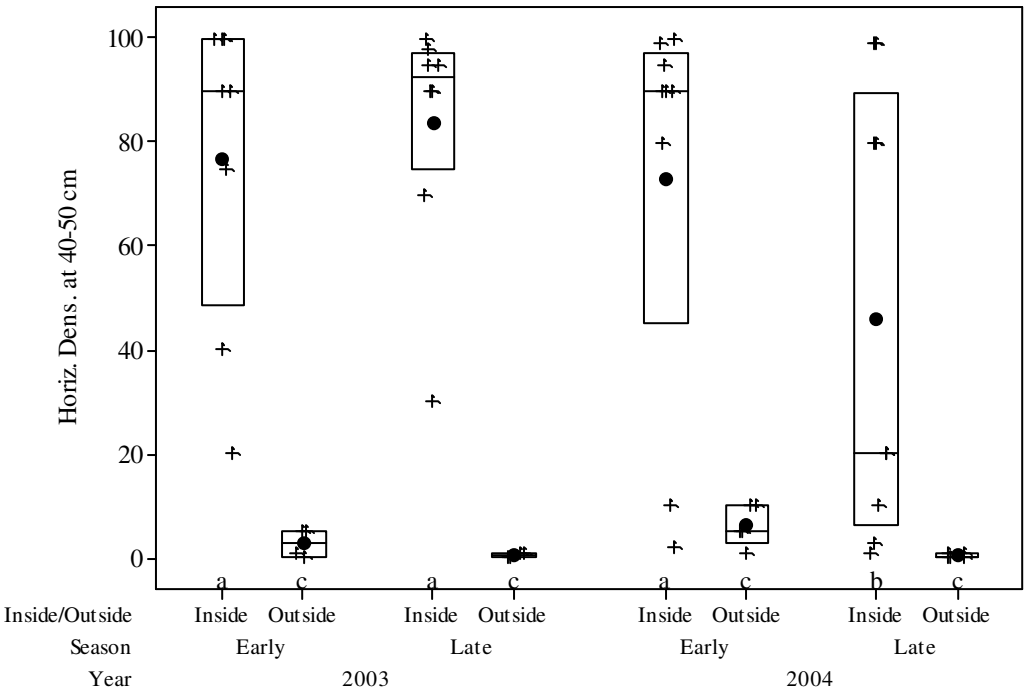


Variable	Plot Group	N	Mean	Median	TrMean	StDev
HzDens50	1	108	0.1389	0.0000	0.0102	0.9807
	2	354	0.410	0.000	0.082	2.196
	4	86	0.1047	0.0000	0.0385	0.3766
	62	52	46.10	25.00	45.59	43.44

Variable	Plot Group	SE Mean	Minimum	Maximum	Q1	Q3
HzDens50	1	0.0944	0.0000	10.0000	0.0000	0.0000
	2	0.117	0.000	30.000	0.000	0.000
	4	0.0406	0.0000	2.0000	0.0000	0.0000
	62	6.02	0.00	100.00	1.25	90.00

Figure 14. Horizontal vegetation density at 40-50 cm above ground in the plots of group 62, by year, season, and location inside or outside of exclosure.

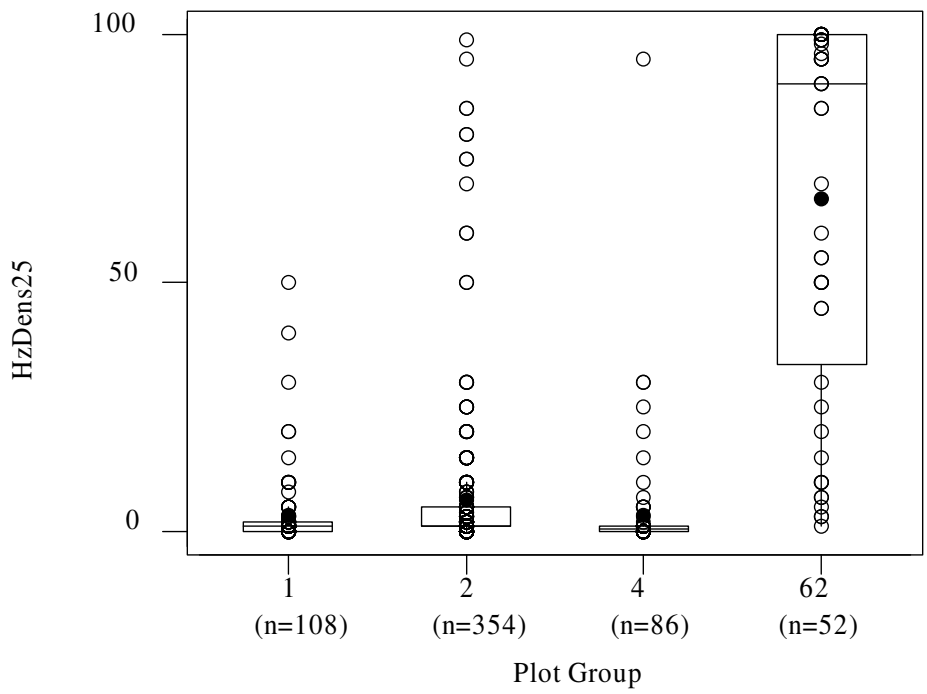
Solid circles are means, crosses are individual density values, boxes indicate the 1st and 3rd quartiles, and horizontal lines across boxes are medians. Letters immediately above the X axis indicate results of tests for differences in means: groups with the same letter have means that do not differ significantly, and groups with different letters have significantly different means. Summary statistics for each group are listed in the table below. Significance is based on the probability values in Table 22.



Year, Season, Location	N	Mean	Median	TrMean	StDev	SE Mean	Min.	Max.	Q1	Q3
03early, in	8	76.9	90.0	76.9	30.6	10.8	20.0	100.0	48.7	100.0
03early, out	4	2.75	3.00	2.75	2.63	1.3	0.0	5.0	0.25	5.0
03late, in	8	83.50	92.50	83.50	23.53	8.32	30.0	100.0	75.00	97.25
03late, out	4	0.500	0.500	0.500	0.577	0.289	0.0	1.0	0.00	1.00
04early, in	9	72.9	90.0	72.9	38.4	12.8	2.0	100.0	45.0	97.0
04early, out	5	6.20	5.00	6.20	3.83	1.71	1.0	10.0	3.00	10.00
04late, in	9	45.8	20.0	45.8	42.5	14.2	1.0	99.0	6.5	89.5
04late, out	5	0.400	0.000	0.400	0.548	0.245	0.0	1.0	0.0	1.00

Figure 15. Horizontal vegetation density at 20-30 cm above ground in four plot groups, both seasons in both years.

Solid circles are means, open circles are individual density values, boxes indicate the 1st and 3rd quartiles, and horizontal lines across boxes are medians.

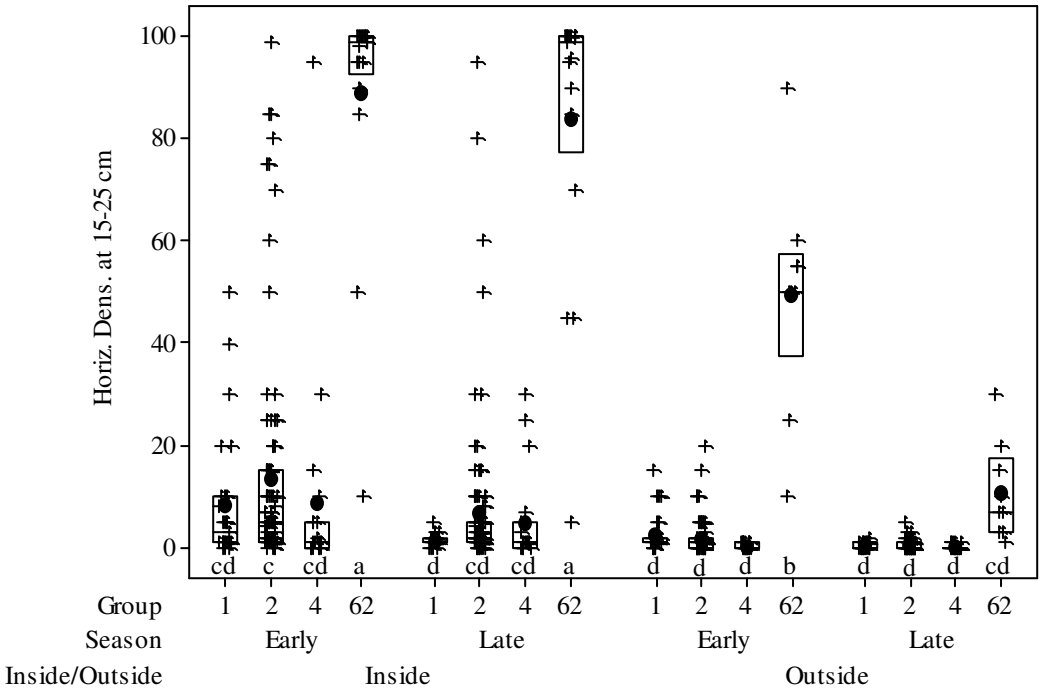


Variable	Plot Group	N	Mean	Median	TrMean	StDev
HzDens25	1	108	3.278	1.000	1.980	7.374
	2	354	6.342	1.000	3.572	14.778
	4	86	3.33	0.50	1.36	11.59
	62	52	67.06	90.00	69.13	37.16

Variable	Plot Group	SE Mean	Minimum	Maximum	Q1	Q3
HzDens25	1	0.710	0.000	50.000	0.000	2.000
	2	0.785	0.000	99.000	1.000	5.000
	4	1.25	0.00	95.00	0.00	1.00
	62	5.15	1.00	100.00	33.75	100.00

Figure 16. Horizontal vegetation density at 20-30 cm above the ground in four plot groups, inside and outside the exclosure, early and late in the season in both years combined.

Open circles are density estimates from individual plots and closed circles are means. Boxes show the 1st and 3rd quartiles and horizontal lines across boxes are medians. Letters along the X axis indicate results of Bonferroni pair-wise comparisons of means: groups with the same letters have means that do not differ significantly. Significant differences between groups are also shown in Figure 17 (with groups ranked by mean density). Probability values on which significance is based are shown in Table 24.



Combination	N	Mean	Median	TrMean	StDev	SE Mean	Min.	Max.	Q1	Q3
In,early,1	27	8.56	3.00	7.24	12.87	2.48	0.00	50.00	1.00	10.00
In,early,2	99	13.64	5.00	10.39	21.43	2.15	0.00	99.00	1.00	15.00
In,early,4	19	9.05	1.00	4.53	22.08	5.07	0.00	95.00	0.00	5.00
In,early,62	17	89.18	99.00	93.73	23.74	5.76	10.00	100.00	92.50	100.00
In,late,1	27	1.370	1.000	1.280	1.079	0.208	0.000	5.000	1.00	2.00
In,late,2	99	7.04	2.00	4.29	14.89	1.50	0.00	95.00	1.00	5.00
In,late,4	19	5.16	1.00	4.00	9.16	2.10	0.00	30.00	0.00	5.00
In,late,62	17	84.12	99.00	88.33	27.45	6.66	5.00	100.00	77.50	100.00
Out,early,1	27	2.704	1.000	2.320	3.930	0.756	0.00	15.00	1.00	2.00
Out,early,2	78	1.987	1.000	1.429	3.402	0.385	0.00	20.00	0.00	2.00
Out,early,4	24	0.458	0.000	0.455	0.509	0.104	0.00	1.00	0.00	1.00
Out,early,62	9	49.44	50.00	49.44	22.28	7.43	10.00	90.00	37.50	57.50
Out,late,1	27	0.481	0.000	0.440	0.580	0.112	0.00	2.000	0.00	1.00
Out,late,2	78	0.551	0.000	0.4286	0.8775	0.0994	0.000	5.000	0.00	1.00
Out,late,4	24	0.2083	0.000	0.1818	0.4149	0.0847	0.000	1.000	0.000	0.00
Out,late,62	9	10.67	7.00	10.67	9.47	3.16	1.00	30.00	3.00	17.50

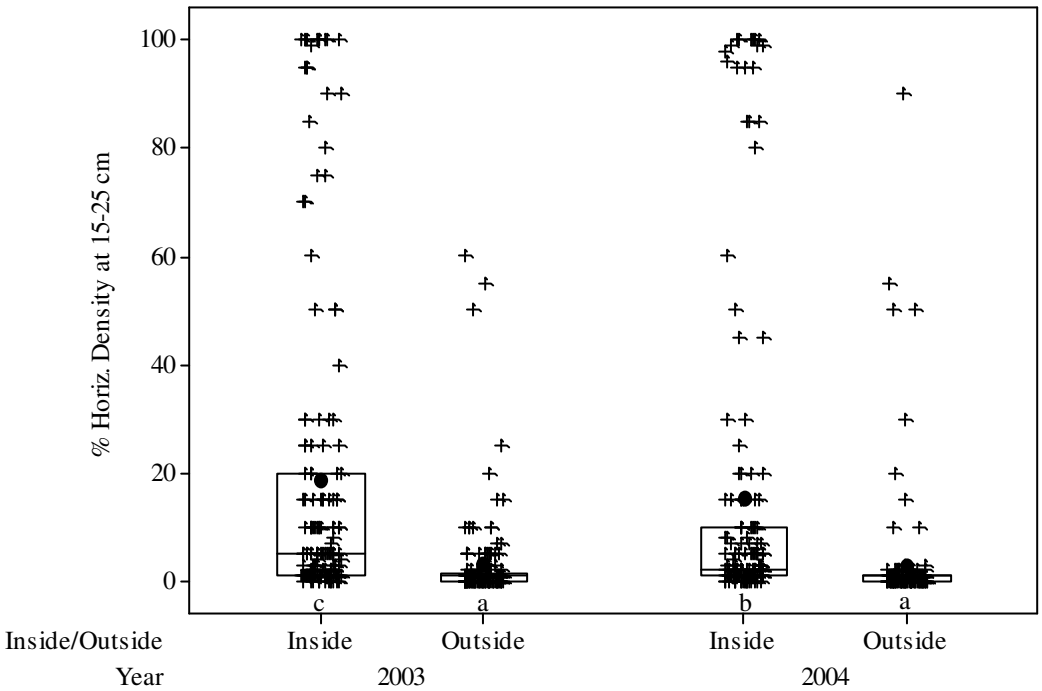
Figure 17. Summary of significant differences in mean horizontal vegetation density at 20-30 cm above the ground in combinations of inside or outside exclosure, early or late season, and plot group.

Combinations are in order from least dense to most dense vegetation. Lines indicate combinations that are not significantly different from one another. Significance is based on the probability values obtained from Bonferroni simultaneous tests of means, shown in Table 23.

Inside or Outside Exclosure	Out	Out	Out	Out	In	Out	Out	In	In	In	In	Out	In	Out	In	In
Early or Late Season	Late	Early	Late	Late	Late	Early	Early	Late	Late	Early	Early	Late	Early	Early	Late	Early
Plot Group	4	4	1	2	1	1	2	4	2	1	4	62	2	62	62	62
	d	d	d	d	d	d	d	cd	cd	cd	cd	cd	c	b	a	a

Figure 18. Horizontal vegetation density at 20-30 cm above the ground inside and outside the exclosure in 2003 and 2004, for all four plot groups and the two seasons combined.

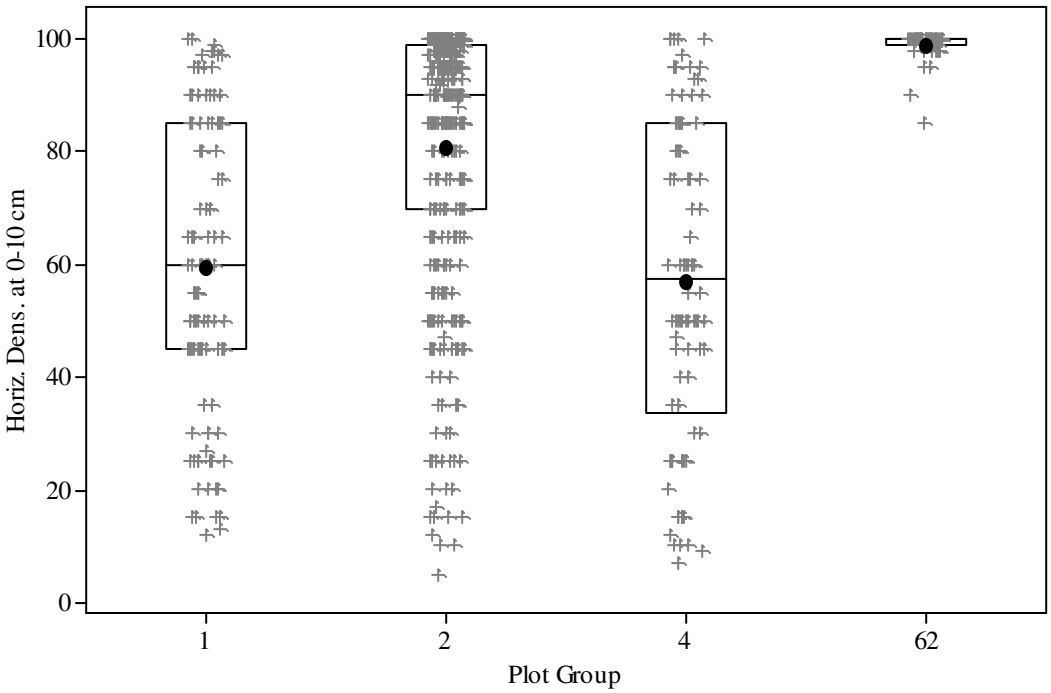
Crosses are density estimates from individual plots and closed circles are means. Boxes show the 1st and 3rd quartiles and horizontal lines across boxes are medians. Letters along the X axis indicate results of Bonferroni pair-wise comparisons of means; groups with the same letters have means that do not differ significantly. Probability values on which significance is based are shown in Table 25.



Inside/Outside*Year	N	Mean	SE Mean	StDev	Minimum	Median	Maximum
In2003	162	18.75	2.38	30.27	0.00	5.00	10.00
Out2003	138	3.130	0.739	8.676	0.000	1.000	60.00
In2004	162	15.39	2.34	29.74	0.00	2.00	100.00
Out2004	138	2.964	0.941	11.058	0.000	1.000	90.00

Figure 19. Horizontal vegetation density at 0-10 cm above ground in four plot groups, both seasons in both years.

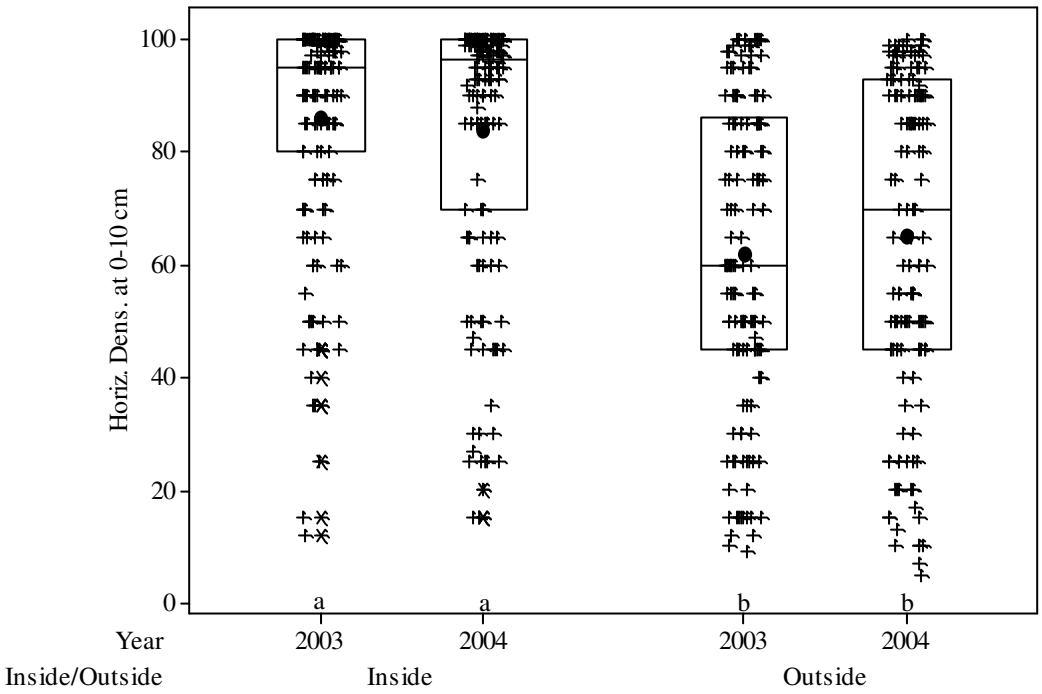
Upper and lower ends of boxes mark the 3rd quartile and the 1st quartile, respectively. Horizontal bars across boxes are medians. Black circles are means. Crosses are individual density estimates.



Plot Group	N	Mean	Median	StDev	SE Mean	Minimum	Maximum
1	108	59.36	60.00	26.71	2.57	12.00	100.00
2	354	80.92	90.00	23.79	1.26	5.00	100.00
4	86	57.13	57.50	28.38	3.06	7.00	100.00
62	52	98.962	100.000	2.619	0.363	85.000	100.000

Figure 20. Horizontal density at 0-10 cm in plots inside or outside the exclosure in 2003 or 2004.

Upper and lower ends of boxes mark the 3rd quartile and the 1st quartile, respectively. Horizontal bars across boxes are medians. Black circles are means. Crosses are individual density estimates. Lower-case letters above X axis indicate significant differences; location-by-year combinations with the same letter do not differ significantly and combinations with different letters do differ significantly. Significance is based on probability values shown in Table 27.

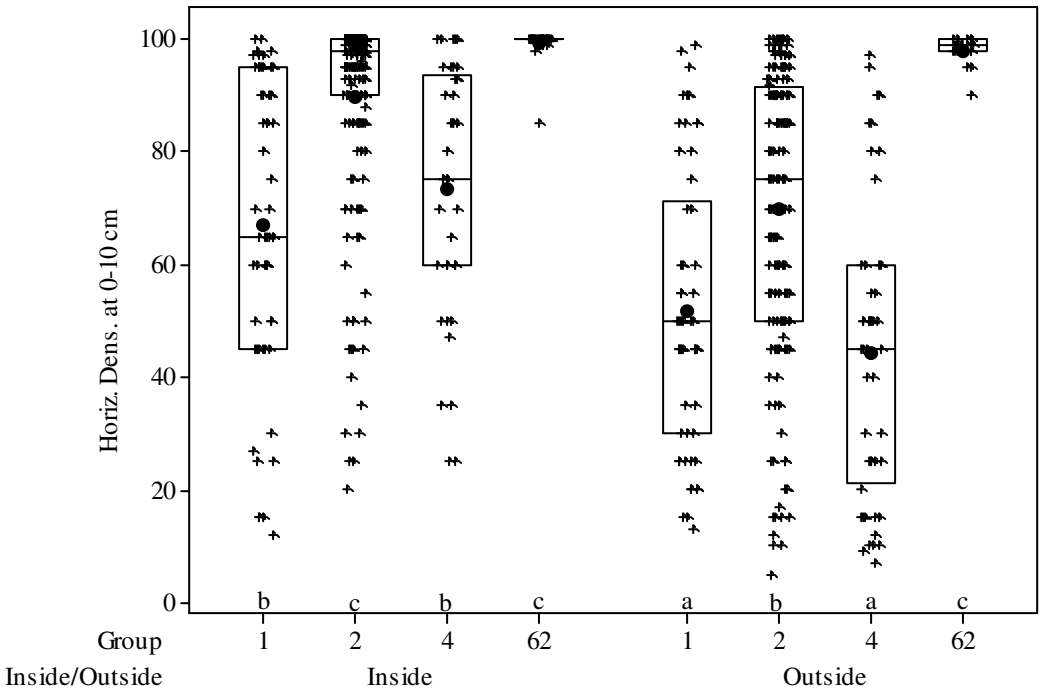


Inside/Outside

* Year	N	Mean	SE Mean	StDev	Minimum	Median	Maximum
Inside 2003	162	86.25	1.52	19.34	12.00	95.00	100.00
Inside 2004	162	83.91	1.86	23.64	15.00	96.50	100.00
Outside 2003	138	62.12	2.36	27.68	9.00	60.00	100.00
Outside 2004	138	65.04	2.48	29.10	5.00	70.00	100.00

Figure 21. Horizontal density at 0-10 cm in plots in the four plot groups inside and outside the exclosure in both years.

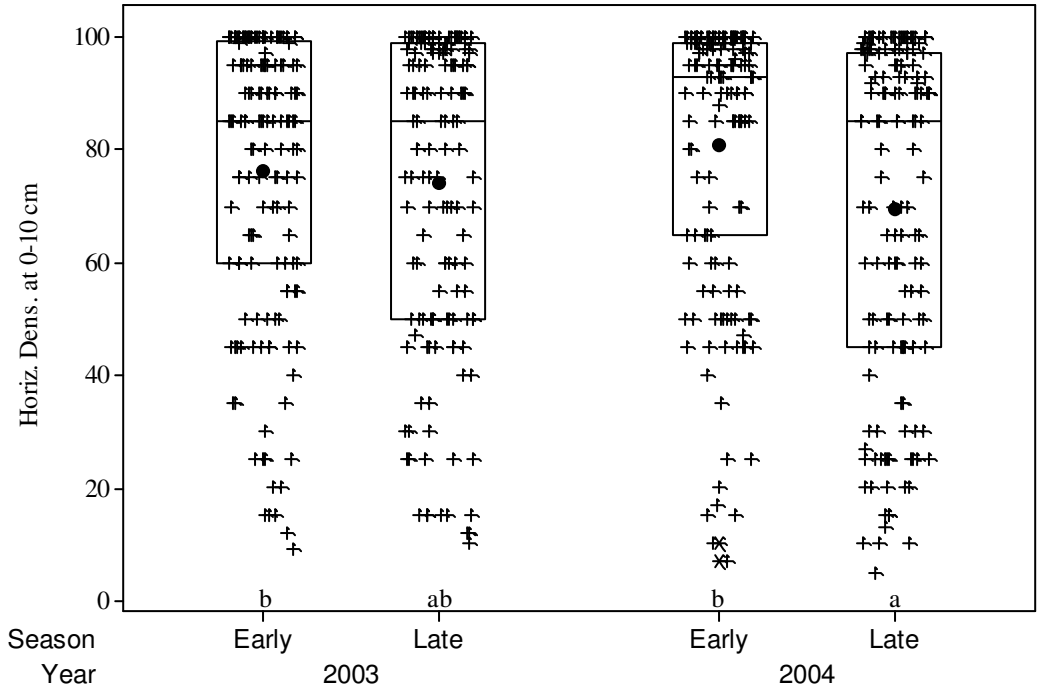
Upper and lower ends of boxes mark the 3rd quartile and the 1st quartile, respectively. Horizontal bars across boxes are medians. Black circles are means. Crosses are individual density estimates. Lower-case letters above X axis indicate significant differences; location-by-group combinations with the same letter do not differ significantly and combinations with different letters do differ significantly. Significance is based on probability values shown in Table 28.



Inside/Outside * Group	N	Mean	SE Mean	StDev	Minimum	Median	Maximum
Inside, Group 1	54	67.06	3.63	26.64	12.00	65.00	100.00
Inside, Group 2	198	89.78	1.24	17.50	20.00	98.00	100.00
Inside, Group 4	38	73.37	3.61	22.23	25.00	75.00	100.00
Inside, Group 62	34	99.441	0.443	2.584	85.000	100.000	100.00
Outside, Group 1	54	51.67	3.36	24.70	13.00	50.00	99.00
Outside, Group 2	156	69.67	2.08	25.92	5.00	75.00	100.00
Outside, Group 4	48	44.27	3.78	26.18	7.00	45.00	97.00
Outside, Group 62	18	98.056	0.591	2.508	90.000	99.000	100.00

Figure 22. Horizontal density at 0-10 cm early or late in the season in 2003 or 2004.

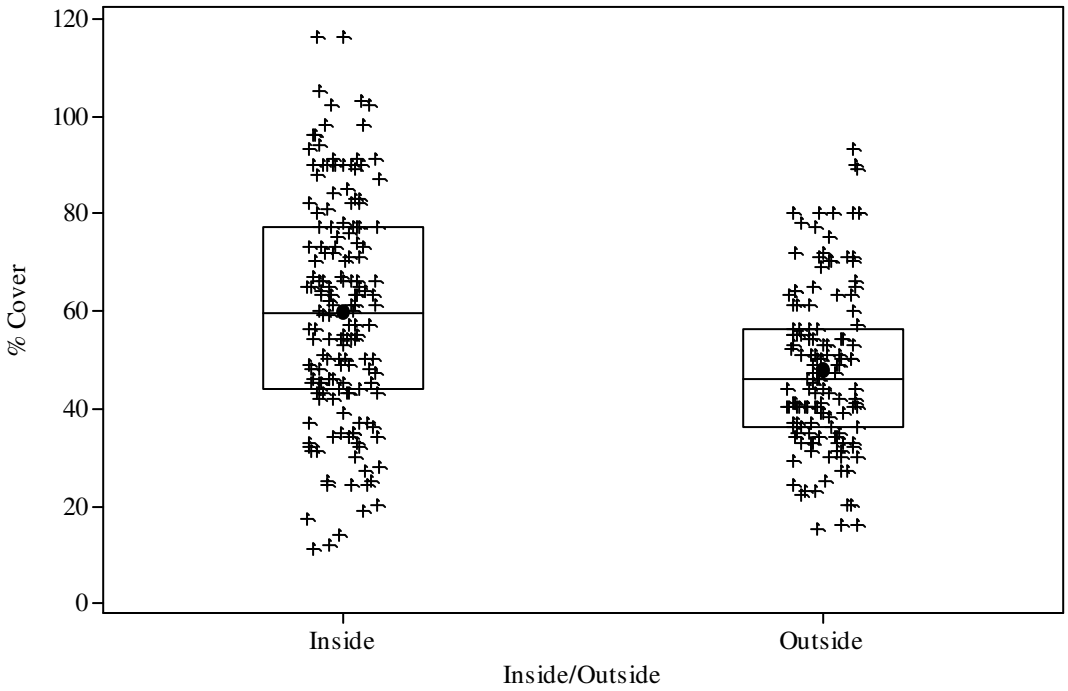
Upper and lower ends of boxes mark the 3rd quartile and the 1st quartile, respectively. Horizontal bars across boxes are medians. Black circles are means. Crosses are individual density estimates. Lower-case letters above X axis indicate significant differences; year-by-season combinations with the same letter do not differ significantly and combinations with different letters do differ significantly. Significance is based on probability values shown in Table 29.



Year * Season	N	Mean	SE Mean	StDev	Minimum	Median	Maximum
2003, Early	150	76.17	2.06	25.21	9.00	85.00	100.00
2003, Late	150	74.13	2.25	27.60	10.00	85.00	100.00
2004, Early	150	80.99	1.98	24.30	7.00	93.00	100.00
2004, Late	150	69.48	2.45	30.05	5.00	85.00	100.00

Figure 23. Canopy cover in plots inside exclosure vs. outside exclosure, all plot groups, both years.

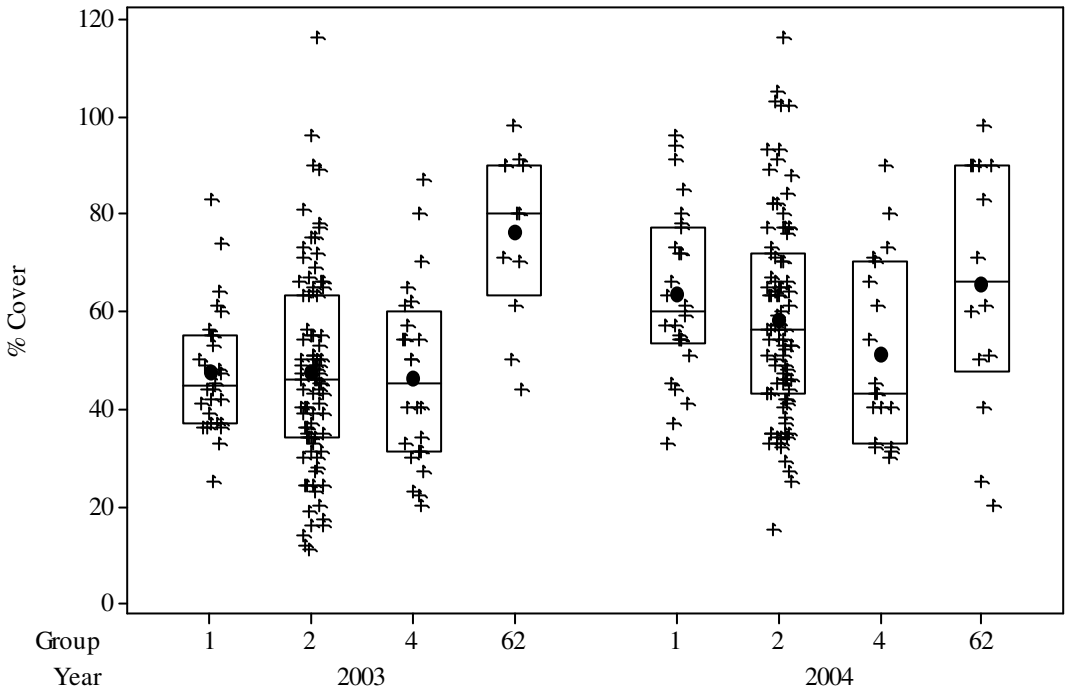
Upper and lower ends of boxes mark the 3rd quartile and the 1st quartile, respectively. Horizontal bars across boxes are medians. Black circles are means. Crosses are individual density estimates. Means are significantly different.



Inside/Outside	N	Mean	SE Mean	StDev	Minimum	Median	Maximum
Inside	162	59.82	1.79	22.72	11.00	59.50	116.00
Outside	138	47.87	1.41	16.53	15.00	46.00	93.00

Figure 24. Canopy cover in plots of the four plot groups in 2003 and 2004.

Upper and lower ends of boxes mark the 3rd quartile and the 1st quartile, respectively. Horizontal bars across boxes are medians. Black circles are means. Crosses are individual density estimates.



Year*Group	N	Mean	SE Mean	StDev	Minimum	Median	Maximum
2003, 1	28	47.46	2.43	12.83	25.00	44.50	83.00
2003, 2	86	47.42	2.21	20.51	11.00	46.00	116.00
2003, 4	24	46.46	3.77	18.49	20.00	45.00	87.00
2003, 62	12	76.25	5.01	17.36	44.00	80.00	98.00
2004, 1	26	63.42	3.42	17.42	33.00	60.00	96.00
2004, 2	91	58.44	2.18	20.79	15.00	56.00	116.00
2004, 4	19	51.26	4.31	18.79	30.00	43.00	90.00
2004, 62	14	65.64	6.90	25.80	20.00	66.00	98.00

Figure 25. Relationship between horizontal vegetation density and canopy cover for the 300 vegetated plots in the four plot groups.

See Table 32 for correlations coefficients between horizontal density and canopy cover.

a. Horizontal Density at 40-50 cm

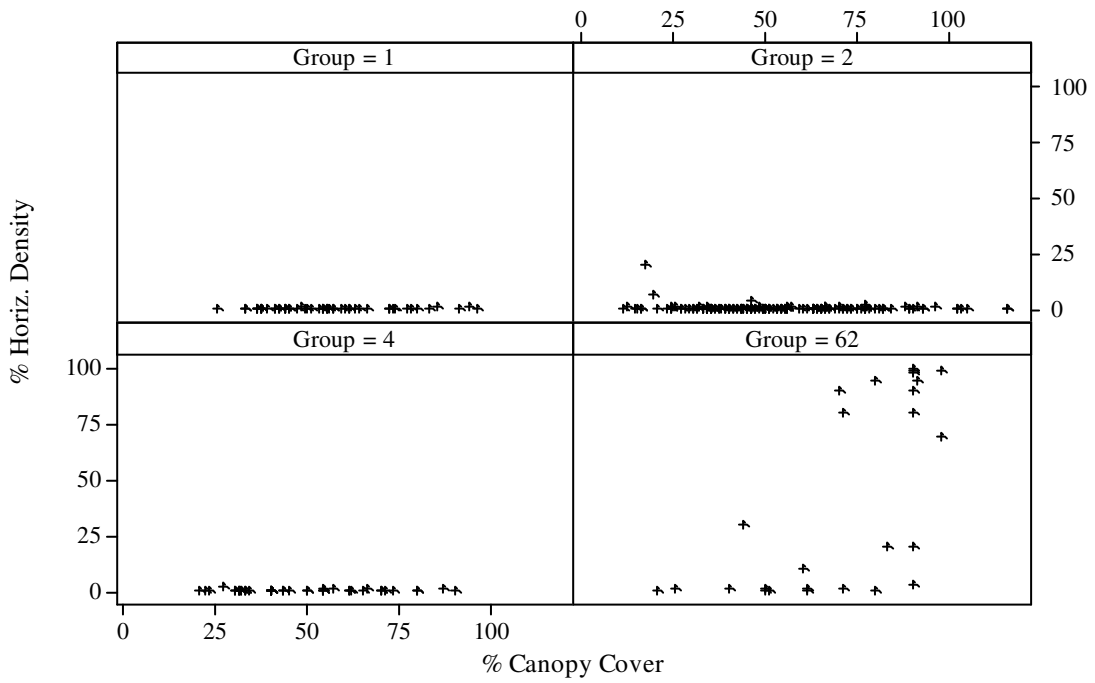


Figure 25 (continued).

b. Horizontal Density at 20-30 cm

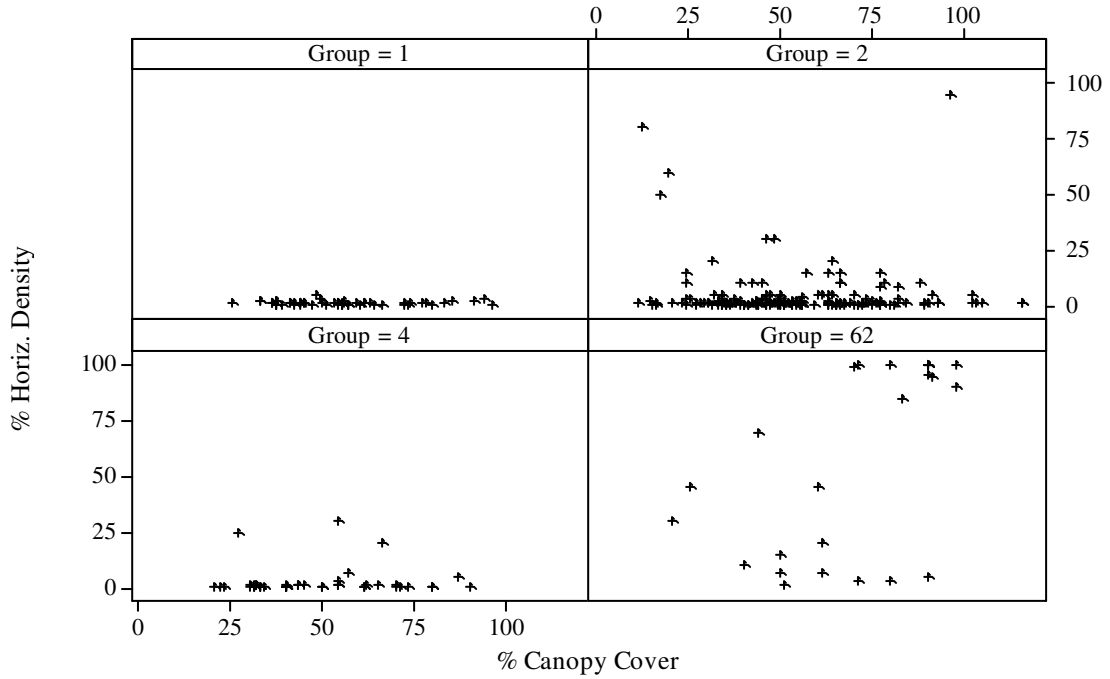


Figure 25 (continued).

c. Horizontal Density at 0-10 cm

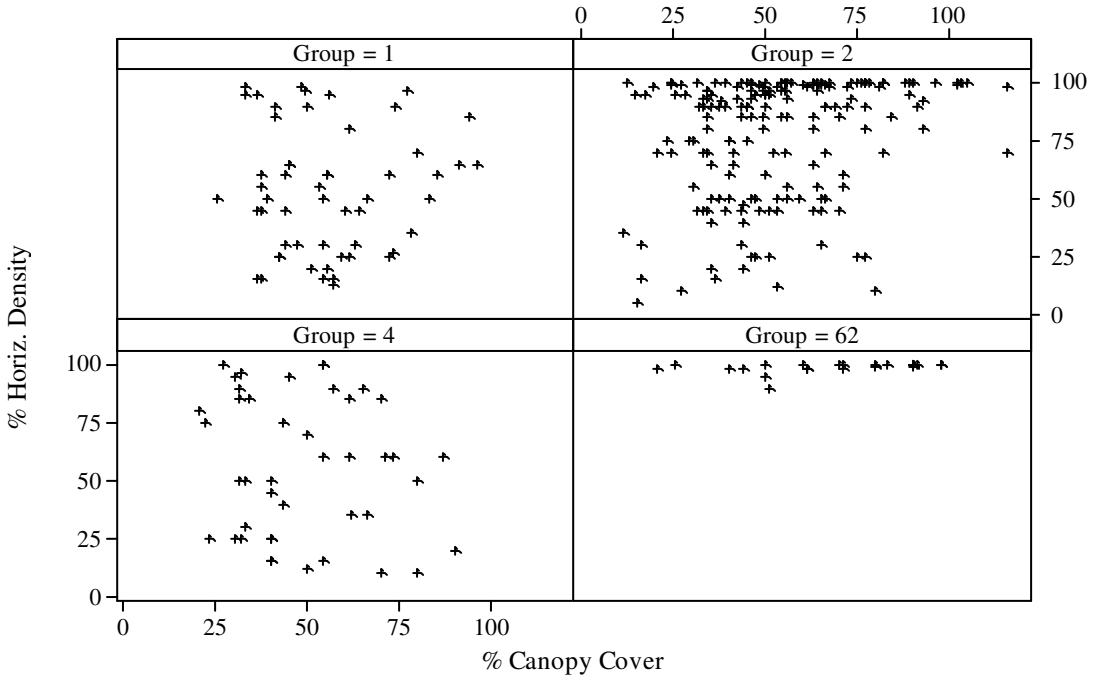
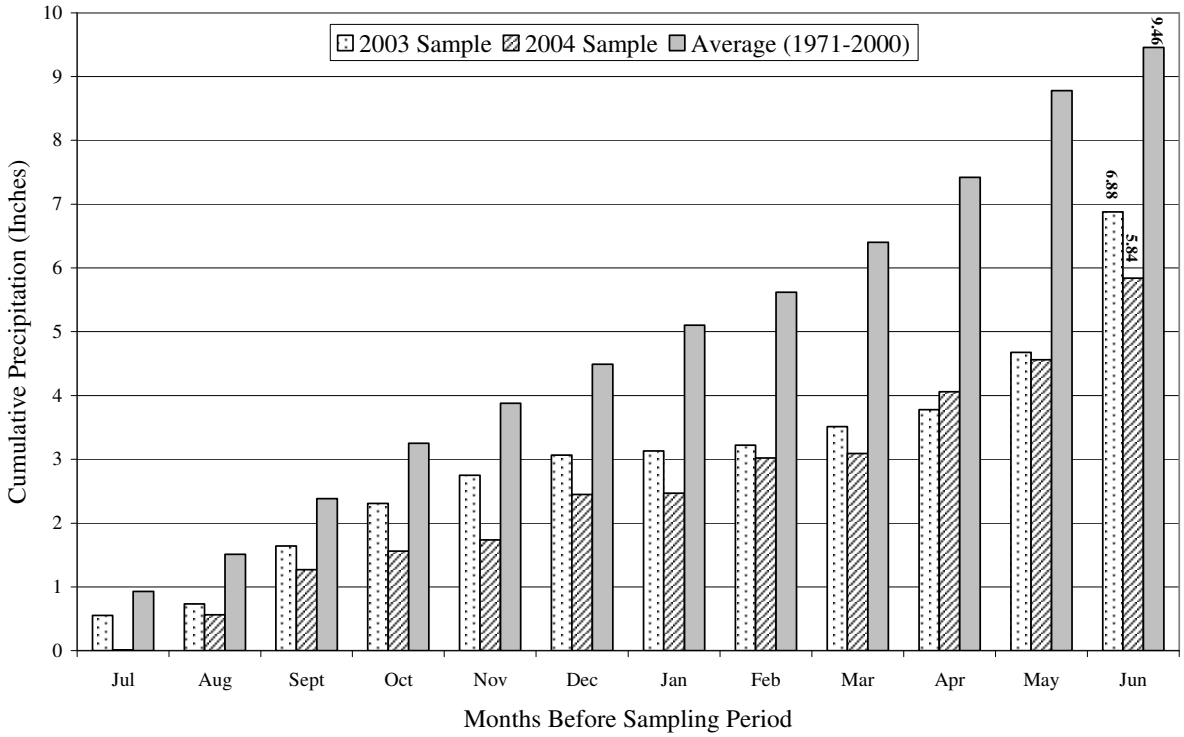


Figure 26. Cumulative precipitation received in the 12 months preceding each canopy cover sampling period.

The sampling periods were July 3 - 7, 2003 and June 22 - 29, 2004. Climate data are from the Rock Spring Airport. Data for the 2003 and 2004 sampling periods are from National Climatic Data Center (no date_a.) and averages are from National Climatic Data Center (no date_b).



TABLES

Table 1. Ranges and mid-points used in estimating plant canopy cover..

% cover	>1	1-5	5-15	15-25	25-35	35-45	45-55	55-65	65-75	75-85	85-95	95-99	>99
Mid-point (value recorded)	1	3	10	20	30	40	50	60	70	80	90	98	100

Table 2. NMS ordination of plot data: settings and results.

See Appendix 3 for details on NMS settings and results.

a. Settings for input parameters using PCORD's autopilot mode with "Quick and Dirty" thoroughness (McCune and Mefford 1999, p. 115)

Parameter	Value
Similarity measure	Sorensen on absolute cover data
Starting configuration	Random, using time-of-day
Starting number of dimensions (axes)	3
Reduction in dimensionality at each cycle of each run	1
Maximum number of iterations in each run	75
Step length between each iteration	0.2
Instability criterion (standard deviation in stress over preceding 10 iterations)	0.005
Number of runs with real data	5
Number of runs with randomized data for Monte Carlo test	20

b. Results

Parameter	Value
Number of final dimensions	3
Final stress for 3-dimensional result	17.365
Final instability	0.00094
Instability calculated over N iterations	200
Proportion of random runs with stress $\leq$ stress from runs with real data (i.e., probability from Monte Carlo test)	0.0476

Table 3. Vascular plant species documented from the study area, sorted by species name. Species known or strongly suspected to be exotic are shown in italic type-face. Species with "0" in the "# plots" column were collected in or near the exclosure but were not encountered in any sample plots.

Scientific and Common Names from NRCS (2006)	Synonyms from Dorn (2001)	Growth-form	# plots (n-326)
Almutaster pauciflorus, alkali marsh aster		Forb	69
Amphiscirpus nevadensis, Nevada bulrush*		Graminoid	222
Antennaria microphylla, littleleaf pussytoes		Forb	0
Calamagrostis stricta, slimstem reedgrass		Graminoid	0
Carex hallii, deer sedge	Carex parryana var. unica, Halls sedge	Graminoid	0
Carex lasiocarpa, American woollyfruit sedge	Carex lanuginosa, woolly sedge	Graminoid	1
Carex parryana var. parryana, Parry's sedge		Graminoid	7
Carex praegracilis, clustered field sedge		Graminoid	25
Chenopodium glaucum var. salinum, oakleaf goosefoot		Forb	5
Chenopodium pratericola, desert goosefoot		Forb	0
Chenopodium sp., goosefoot		Forb	1
Chrysothamnus viscidiflorus, yellow rabbitbrush		Shrub	1
Corispermum hyssopifolium, common bugseed		Forb	3
Crepis intermedia, limestone hawksbeard		Forb	1
Crepis runcinata var. glauca, fiddleleaf hawksbeard		Forb	52
Descurainia pinnata, western tanseymustard		Forb	0
Distichlis spicata, inland saltgrass	Distichlis stricta	Graminoid	167
Eleocharis palustris, common spikerush		Graminoid	19
Eleocharis quinqueflora, fewflower spikerush	Eleocharis pauciflora	Graminoid	0
Elymus albicans, Montana wheatgrass		Graminoid	0
Elymus lanceolatus, streambank wheatgrass	Elymus lanceolatus var. lanceolatus, thickspike wheatgrass	Graminoid	6
Elymus lanceolatus, streambank wheatgrass	Elymus lanceolatus var. riparius, streambank wheatgrass	Graminoid	1
Elymus trachycaulus var. trachycaulus, slender wheatgrass		Graminoid	2
Ericameria nauseosa, rubber rabbitbrush		Shrub	2
Erigeron lonchophyllus, shortray fleabane		Forb	0
Festuca octoflora, sixweek fescue		Graminoid	1
Forb Unknown, Ponds aquatic forb		Forb	1
Forb unknown, Ponds comp narrow lf		Forb	5
Forb unknown, ponds cotyledons		Forb	1
Forb unknown, Ponds long green linear leaf		Forb	1
Forb unknown, Ponds wide tooth		Forb	2
Glaux maritima, sea milkwort		Forb	39
Grass unknown, Ponds		Graminoid	1
Hordeum jubatum, foxtail barley		Graminoid	1
Juncus alpinoarticulatus, northern green rush		Graminoid	0
Juncus balticus, baltic rush		Graminoid	142
Lepidium montanum, mountain pepperweed		Forb	3
Lesquerella ludoviciana, foothill bladderpod		Forb	0
Lupinus pusillus, rusty lupine		Forb	1
Monolepis sp, monolepis		Forb	11
Muhlenbergia asperifolia, scratchgrass		Graminoid	0
Muhlenbergia richardsonis, mat muhly		Graminoid	1
Oenothera pallida ssp. pallida, pale evening-primrose		Forb	0
Penstemon arenicola, sand penstemon		Forb	0

Table 3 (continued).

Scientific and Common Names from NRCS (2006)	Synonyms from Dorn (2001)	Growth-form	# plots (n-326)
Plantago eriopoda, redwool plantain		Forb	18
Poa nemoralis ssp. interior, inland bluegrass	Poa interior	Graminoid	0
Poa secunda, Sandberg bluegrass	Poa secunda var. secunda, Sandberg bluegrass	Graminoid	3
Puccinellia distans, weeping alkaligrass		Graminoid	0
Puccinellia nuttalliana, nuttall's alkaligrass		Graminoid	46
Pyrrocoma lanceolata, lanceleaf goldenweed		Forb	22
Ranunculus cymbalaria, alkali buttercup		Forb	40
Schoenoplectus acutus, hardstem bulrush		Graminoid	38
Schoenoplectus pungens, common threesquare bulrush*		Graminoid	222
Spartina gracilis, alkali cordgrass		Graminoid	143
Sporobolus airoides, alkali sacaton		Graminoid	89
Symphyotrichum ciliatum, rayless alkali aster		Forb	0
Taraxacum sp., dandelion		Forb	1
Triglochin maritimum, seaside arrowgrass	Triglochin maritima	Forb	155
Zannichellia palustris, horned pondweed		Forb	2
	Poa juncifolia var. juncifolia, bluegrass	Graminoid	17
	Elymus x saundersii, hybrid wheatgrass	Graminoid	0

* Two short bulrushes, Nevada bulrush (*Amphiscirpus nevadensis*) and common threesquare bulrush (*Schoenoplectus pungens*), were documented from flowering specimens. Many plots contained short bulrushes without flowers, and those plants could not be assigned to either of the known species. Consequently, the two short bulrushes were treated together in the analysis of the data, so 222 plots were known to contain either Nevada bulrush or common threesquare bulrush or both.

Table 4. Vascular plant species documented from the study area, sorted by number of plots. Species known or strongly suspected to be exotic are shown in italic type-face. Species with "0" in the "# plots" column were collected in or near the exclosure but were not encountered in any sample plots.

Scientific and Common Names from NRCS (2006)	Synonyms from Dorn (2001)	Growth-form	# plots (n=326)
Amphiscirpus nevadensis, Nevada bulrush*		Graminoid	222
Schoenoplectus pungens, common threesquare bulrush*		Graminoid	222
Distichlis spicata, inland saltgrass	Distichlis stricta	Graminoid	167
Triglochin maritimum, seaside arrowgrass	Triglochin maritima	Forb	155
Spartina gracilis, alkali cordgrass		Graminoid	143
Juncus balticus, baltic rush		Graminoid	142
Sporobolus airoides, alkali sacaton		Graminoid	89
Almutaster pauciflorus, alkali marsh aster		Forb	69
Crepis runcinata var. glauca, fiddleleaf hawksbeard		Forb	52
Puccinellia nuttalliana, nuttall's alkaligrass		Graminoid	46
Ranunculus cymbalaria, alkali buttercup		Forb	40
Glaux maritima, sea milkwort		Forb	39
Schoenoplectus acutus, hardstem bulrush		Graminoid	38
Carex praegracilis, clustered field sedge		Graminoid	25
Pyrrocoma lanceolata, lanceleaf goldenweed		Forb	22
Eleocharis palustris, common spikerush		Graminoid	19
Plantago eriopoda, redwool plantain		Forb	18
	Poa juncifolia var. juncifolia, bluegrass	Graminoid	17
Monolepis sp., monolepis		Forb	11
Carex parryana var. parryana, Parry's sedge		Graminoid	7
Elymus lanceolatus, streambank wheatgrass	Elymus lanceolatus var. lanceolatus, thickspike wheatgrass	Graminoid	6
Chenopodium glaucum var. salinum, oakleaf goosefoot		Forb	5
Forb unknown, Ponds comp narrow lf		Forb	5
Corispermum hyssopifolium, common bugseed		Forb	3
Lepidium montanum, mountain pepperweed		Forb	3
Poa secunda, Sandberg bluegrass	Poa secunda var. secunda, Sandberg bluegrass	Graminoid	3
Elymus trachycaulus var. trachycaulus, slender wheatgrass		Graminoid	2
Ericameria nauseosa, rubber rabbitbrush		Shrub	2
Forb unknown, Ponds wide tooth		Forb	2
Zannichellia palustris, horned pondweed		Forb	2
Carex lasiocarpa, American woollyfruit sedge	Carex lanuginosa, woolly sedge	Graminoid	1
Chenopodium sp., goosefoot		Forb	1
Chrysothamnus viscidiflorus, yellow rabbitbrush		Shrub	1
Crepis intermedia, limestone hawksbeard		Forb	1
Elymus lanceolatus, streambank wheatgrass	Elymus lanceolatus var. riparius, streambank wheatgrass	Graminoid	1
Festuca octoflora, sixweek fescue		Graminoid	1
Forb Unknown, Ponds aquatic forb		Forb	1
Forb unknown, ponds cotyledons		Forb	1
Forb unknown, Ponds long green linear leaf		Forb	1
Grass unknown, Ponds		Graminoid	1
Hordeum jubatum, foxtail barley		Graminoid	1
Lupinus pusillus, rusty lupine		Forb	1
Muhlenbergia richardsonis, mat muhly		Graminoid	1
Taraxacum sp., dandelion		Forb	1

Table 4 (continued).

Scientific and Common Names from NRCS (2006)	Synonyms from Dorn (2001)	Growth-form	# plots (n=326)
Antennaria microphylla, littleleaf pussytoes		Forb	0
Calamagrostis stricta, slimstem reedgrass		Graminoid	0
Carex hallii, deer sedge	Carex parryana var. unica, Halls sedge	Graminoid	0
Chenopodium pratericola, desert goosefoot		Forb	0
Descurainia pinnata, western tanseymustard		Forb	0
Eleocharis quinqueflora, fewflower spikerush	Eleocharis pauciflora	Graminoid	0
Elymus albicans, Montana wheatgrass		Graminoid	0
Erigeron lonchophyllus, shortray fleabane		Forb	0
Juncus alpinoarticulatus, northern green rush		Graminoid	0
Lesquerella ludoviciana, foothill bladderpod		Forb	0
Muhlenbergia asperifolia, scratchgrass		Graminoid	0
Oenothera pallida ssp. pallida, pale evening-primrose		Forb	0
Penstemon arenicola, sand penstemon		Forb	0
Poa nemoralis ssp. interior, inland bluegrass	Poa interior	Graminoid	0
Puccinellia distans, weeping alkaligrass		Graminoid	0
Symphyotrichum ciliatum, rayless alkali aster		Forb	0
	Elymus x saundersii, hybrid wheatgrass	Graminoid	0

* Two short bulrushes, Nevada bulrush (*Amphiscirpus nevadensis*) and common threesquare bulrush (*Schoenoplectus pungens*), were documented from flowering specimens. Many plots contained short bulrushes without flowers, and those plants could not be assigned to either of the known species. Consequently, the two short bulrushes were treated together in the analysis of the data, so 222 plots were known to contain either Nevada bulrush or common threesquare bulrush or both.

Table 5. Chi-squared test on the number of plots in each of four vegetated plot groups, the open-water plots, and the bare-soil plots, inside and outside of the exclosure.

Observed numbers of plots are in regular type-face, expected numbers are in italic typeface, and the contribution of each group-by-location combination to the chi-squared value is in parentheses.

Group	Inside Exclosure	Outside Exclosure	All
1	27	27	54
	27.17	*26.83*	*54.00*
	(0.0010)	(0.0010)	--
2	99	78	177
	89.04	*87.96*	*177.00*
	(1.1134)	(1.1272)	--
4	19	24	43
	21.63	*21.37*	*43.00*
	(0.3202)	(0.3242)	--
62	17	9	26
	13.08	*12.92*	*26.00*
	(1.1750)	(1.1895)	--
Water	2	8	10
	5.03	*4.97*	*10.00*
	(1.8258)	(1.8483)	--
Bare Ground	0	16	16
	8.05	*7.95*	*16.00*
	(8.0491)	(8.1485)	--
All	164	162	326
	164.00	*162.00*	*326.00*
	--	--	--

Null Hypothesis: The plots occur in the group in the same proportions inside the exclosure as outside.
Alternative Hypothesis: The plots occur in the groups in different proportions inside the exclosure than outside.

Pearson Chi-Square = 25.123, Degrees of Freedom = 5, P-Value = 0.000
Conclusion: Reject the null hypothesis; the plots do not occur in the groups in the same proportions inside the exclosure as outside.

Table 6. Chi-squared test on the number of plots in each of four vegetated plot groups inside and outside of the exclosure.

Observed numbers of plots are in regular type-face and expected numbers are in italic typeface.

Group	Inside Exclosure	Outside Exclosure	All
1	27	27	54
	29.16	*24.84*	*54.00*
2	99	78	177
	95.58	*81.42*	*177.00*
4	19	24	43
	23.22	*19.78*	*43.00*
62	17	9	26
	14.04	*11.96*	*26.00*
All	162	138	300
	162.00	*138.00*	*300.00*

Null Hypothesis: The plots occur in the group in the same proportions inside the exclosure as outside.
Alternative Hypothesis: The plots occur in the groups in different proportions inside the exclosure than outside.

Pearson Chi-Square = 3.638, Degrees of Freedom = 3, P-Value = 0.303
Conclusion: Do not reject the null hypothesis; the plots occur in the groups in the same proportions inside the exclosure as outside.

Table 7. Analysis of variance in elevation of plots above low points of ponds or depressions.

A. Analysis of Variance Table

Factor	Type	Levels	Values
Inside/Outside	fixed	2	Inside, Outside
Group	fixed	4	1, 2, 4, 62

Source	Degrees of Freedom	Sequential Sums of Squares	Adjusted Sums of Squares	Adjusted Mean Square	F	P
Inside/Outside	1	4.068	0.501	0.501	0.41	0.523
Group	3	111.373	111.665	37.222	30.39	0.000
Inside/Outside*Group	3	1.708	1.708	0.569	0.46	0.707
Error	292	357.680	357.680	1.225		
Total	299	474.829				

S = 1.10677 R-Sq = 24.67% R-Sq(adj) = 22.87%

B. Probability values for comparisons among plot groups of mean elevation above low point.

The value in each cell is the probability of obtaining, by chance, a difference in mean elevation between plot groups as large as the observed difference. Small probability values, indicating significant differences between plot groups, are shown in bold type-face. These probability values were calculated by Bonferroni simultaneous tests of means.

Group	*1*	*2*	*4*	*62*
1	X	**0.0000**	**0.0000**	**0.0000**
2	**0.0000**	X	**0.0000**	**0.0000**
4	**0.0000**	**0.0000**	X	1.0000
62	**0.0000**	**0.0000**	1.0000	X

Table 8. Stand table for plot group 1.
Shown for each plant species are the percent cover in each plot, the number of plots in which it was found, and the average cover for those plots.

Growth-form	Graminoids											Forbs							
PlotName	Amphiscirpus nevadensis, Nevada bulrush / Schoenoplectus pungens, common threesquare bulrush	Carex praegracilis, clustered field sedge	Distichlis spicata, inland saltgrass	Elymus lanceolatus var. lanceolatus, thickspike wheatgrass	Festuca octoflora, sixweek fescue	Juncus balticus, baltic rush	Poa juncifolia var. juncifolia, bluegrass	Poa secunda, sandberg bluegrass	Puccinellia nuttalliana, nuttall's alkaligrass	Spartina gracilis, alkali cordgrass	Sporobolus airoides, alkali sacaton	Corispermum hyssopifolium, common bugseed	Crepis runcinata var. glauca, fiddleleaf hawksbeard	Forb unknown, Ponds wide tooth	Lepidium montanum, mountain pepperweed	Monolepis sp., monolepis	Plantago eriopoda, redwool plantain	Pyrrocoma lanceolata, lanceleaf goldenweed	Triglochin maritimum, seaside arrowgrass
# of plots (n=54)	29	9	51	1	1	17	9	1	1	37	54	1	5	1	2	3	5	1	3
Average	4.8	4.1	4.4	3.0	1.0	5.5	1.7	1.0	1.0	5.1	41.7	1.0	1.4	1.0	1.0	1.0	1.4	1.0	1.7
3D1,1,1	1	1	3	-	-	3	-	-	-	1	40	-	1	-	-	-	-	-	-
3D1,1,8	3	-	1	-	-	-	-	-	-	1	40	-	-	-	-	-	-	-	-
3D1,2,1	3	-	1	-	-	-	-	-	-	1	20	-	-	-	-	-	-	-	-
3D1,2,6	1	3	-	-	-	3	-	-	-	1	40	-	-	-	-	-	1	-	-
3D2,1,1	-	3	3	-	-	1	-	-	1	-	40	-	-	-	-	-	-	-	-
3D2,1,6	1	-	3	-	-	-	-	-	-	1	50	-	-	-	1	-	-	-	-
3D2,2,6	-	-	3	-	-	-	-	-	-	1	40	-	-	-	-	-	-	-	-
3D3,1,1	3	-	1	-	-	3	-	-	-	1	30	-	1	-	-	-	-	-	-
3D3,1,6	-	-	3	-	-	-	-	-	-	-	60	-	-	-	-	-	-	-	1
3D3,2,1	1	3	20	-	-	-	-	-	-	1	30	-	-	-	-	-	-	-	-
3D4,1,1	-	-	1	-	-	-	-	-	-	1	40	-	-	-	-	-	-	-	-
3D4,2,3	-	-	-	-	-	-	-	1	-	3	40	-	-	-	-	-	-	-	-
3M1,1,1	-	-	10	-	-	3	1	-	-	-	40	-	-	-	-	-	1	-	-
3M1,2,1	1	-	3	-	-	3	-	-	-	10	20	-	-	-	-	-	-	-	-
3M1,2,6	20	-	1	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-	-
3M2,1,1	3	-	10	-	-	10	-	-	-	-	60	-	-	-	-	-	-	-	-
3M2,2,1	20	-	3	-	-	-	-	-	-	10	40	1	-	-	-	-	-	-	-
3M2,2,6	-	-	1	-	-	3	-	-	-	-	30	-	1	1	-	-	-	-	1

Table 8 (continued).

PlotName	Amphiscirpus nevadensis, Nevada bulrush / Schoenoplectus pungens, common threesquare bulrush	Carex praegracilis, clustered field sedge	Distichlis spicata, inland saltgrass	Elymus lanceolatus var. lanceolatus, thickspike wheatgrass	Festuca octoflora, sixweek fescue	Juncus balticus, baltic rush	Poa juncifolia var. juncifolia, bluegrass	Poa secunda, sandberg bluegrass	Puccinellia nutalliana, nuttall's alkaligrass	Spartina gracilis, alkali cordgrass	Sporobolus airoides, alkali sacaton	Corispermum hyssopifolium, common bugseed	Crepis runcinata var. glauca, fiddleleaf hawksbeard	Forb unknown, Ponds wide tooth	Lepidium montanum, mountain pepperweed	Monolepis sp., monolepis	Plantago eriopoda, redwool plantain	Pyrrocoma lanceolata, lanceleaf goldenweed	Triglochin maritimum, seaside arrowgrass
3M3,1,9	-	-	3	-	-	3	-	-	-	-	30	-	-	-	-	-	-	-	-
3M3,2,1	3	-	3	-	-	-	-	-	-	-	30	-	-	-	-	-	-	-	-
3M3,2,2	3	-	10	-	-	-	-	-	-	-	20	-	-	-	-	-	-	-	3
3M3,2,8	-	-	10	-	-	-	-	-	-	-	50	-	-	-	-	-	-	-	-
3M4,1,1	1	-	3	-	-	-	-	-	-	3	40	-	-	-	-	-	-	-	-
3WP2,1,1	-	-	3	-	-	-	-	-	-	-	30	-	-	-	-	-	-	-	-
3WP3,1,1	1	-	10	-	-	-	-	-	-	10	20	-	-	-	-	-	-	-	-
3WP3,1,8	3	-	3	-	-	-	-	-	-	1	30	-	-	-	-	-	-	-	-
3WP3,2,1	1	-	1	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-	-
3WP4,2,1	-	-	10	-	-	10	-	-	-	3	30	-	-	-	-	-	-	-	-
4D1,1,1	10	-	1	-	-	1	3	-	-	10	70	-	1	-	-	-	-	-	-
4D1,1,8	3	-	3	-	-	-	-	-	-	3	50	-	-	-	-	-	-	-	-
4D1,2,1	3	-	3	-	-	-	-	-	-	10	40	-	-	-	-	1	-	-	-
4D1,2,6	-	10	1	-	-	10	-	-	-	3	60	-	-	-	-	-	1	-	-
4D2,1,1	-	3	1	3	-	-	-	-	-	-	30	-	-	-	-	-	-	-	-
4D2,1,6	3	-	10	-	1	-	-	-	-	10	20	-	-	-	1	-	-	-	-
4D2,2,6	-	-	1	-	-	-	-	-	-	1	70	-	-	-	-	-	-	-	-
4D3,1,1	3	-	3	-	-	10	-	-	-	1	60	-	-	-	-	-	1	-	-
4D3,1,6	-	-	1	-	-	-	-	-	-	-	70	-	-	-	-	1	-	-	-
4D3,2,1	-	10	10	-	-	-	1	-	-	3	20	-	-	-	-	-	-	-	-
4D3,2,6	-	-	1	-	-	10	-	-	-	3	40	-	-	-	-	-	-	-	-
4D4,1,1	-	-	1	-	-	-	-	-	-	3	50	-	-	-	-	-	-	-	-
4D4,2,3	-	-	-	-	-	-	1	-	-	3	50	-	-	-	-	-	-	-	-
4M1,1,1	-	-	10	-	-	10	3	-	-	10	30	-	-	-	-	-	-	-	-
4M1,2,1	-	-	10	-	-	10	1	-	-	10	60	-	-	-	-	-	-	-	-

Table 8 (continued).

PlotName	Amphiscirpus nevadensis, Nevada bulrush / Schoenoplectus pungens, common threesquare bulrush	Carex praegracilis, clustered field sedge	Distichlis spicata, inland saltgrass	Elymus lanceolatus var. lanceolatus, thickspike wheatgrass	Festuca octoflora, sixweek fescue	Juncus balticus, baltic rush	Poa juncifolia var. juncifolia, bluegrass	Poa secunda, sandberg bluegrass	Puccinellia nutalliana, nuttall's alkaligrass	Spartina gracilis, alkali cordgrass	Sporobolus airoides, alkali sacaton	Corispermum hyssopifolium, common bugseed	Crepis runcinata var. glauca, fiddleleaf hawksbeard	Forb unknown, Ponds wide tooth	Lepidium montanum, mountain pepperweed	Monolepis sp., monolepis	Plantago eriopoda, redwool plantain	Pyrrocoma lanceolata, lanceleaf goldenweed	Triglochin maritimum, seaside arrowgrass
4M1,2,6	10	-	3	-	-	-	-	-	-	-	60	-	-	-	-	-	-	-	-
4M2,2,1	10	-	3	-	-	-	-	-	-	3	60	-	-	-	-	1	-	-	-
4M2,2,6	-	-	1	-	-	-	3	-	-	10	40	-	3	-	-	-	3	1	-
4M3,1,1	10	-	10	-	-	-	-	-	-	30	30	-	-	-	-	-	-	-	-
4M3,1,9	-	-	1	-	-	1	1	-	-	10	20	-	-	-	-	-	-	-	-
4M3,2,1	3	-	1	-	-	-	-	-	-	1	50	-	-	-	-	-	-	-	-
4M3,2,8	1	3	1	-	-	-	1	-	-	1	50	-	-	-	-	-	-	-	-
4M4,1,1	-	-	1	-	-	-	-	-	-	10	40	-	-	-	-	-	-	-	-
4WP2,1,1	10	1	20	-	-	-	-	-	-	3	60	-	-	-	-	-	-	-	-
4WP3,1,8	3	-	3	-	-	-	-	-	-	-	60	-	-	-	-	-	-	-	-
4WP3,2,1	-	-	1	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-	-

Table 9. Results of MRPP tests on species composition of group 2 plots inside the exclosure versus outside.

Null hypothesis, H_0: Species composition of plots inside the exclosure does not differ from species composition of plots outside the exclosure.
Alternative hypothesis, H_1: Species composition of plots inside the exclosure differs from species composition of plots outside the exclosure.

Statistic	2003	2004
Weighted mean within-group distance between plots, δ	0.2761	0.3916
Probability of δ	0.4938	0.4828
Chance-corrected within-group agreement, A	-0.003131	-0.00395
Conclusion	Do not reject H_0	Do not reject H_0

Weighted mean within-group distance between plots, δ, is a measure of the dissimilarity among the plots of each group. Probability of δ is the probability of obtaining, by chance, a delta as large as that observed. A small probability indicates a statistically significant difference.

Chance-corrected within-group agreement, A, expresses the degree of homogeneity among plots within a group. It is a measure of the degree of difference between groups and is interpreted as follows: When all plots within a group share the identical species composition, A = 1. When the plots within a group show the amount of heterogeneity in species composition expected by chance, A = 0. When plots within a group show more heterogeneity in species composition than expected by chance, A = -1.

Table 10. Stand table for plot group 2, sub-group a.
Shown for each plant species are the percent cover in each plot, the number of plots in which it was found, and the average cover for those plots.

Growth-form	Graminoids									Forbs								
PlotName	Amphiscirpus nevadensis, Nevada bulrush / Schoenoplectus pungens, common threesquare bulrush	Carex praegracilis, clustered field sedge	Distichlis spicata, inland saltgrass	Eleocharis palustris, common spikerush	Juncus balticus, baltic rush	Poa juncifolia var. juncifolia, bluegrass	Puccinellia nuttalliana, nuttall's alkaligrass	Spartina gracilis, alkali cordgrass	Sporobolus airoides, alkali sacaton	Almutaster pauciflorus, alkali marsh aster	Corispermum hyssopifolium, common bugseed	Crepis runcinata var. glauca, fiddleleaf hawksbeard	Glaux maritima, sea milkwort	Monolepis sp., monolepis	Plantago eriopoda, redwool plantain	Pyrrocoma lanceolata, lanceleaf goldenweed	Taraxacum sp., dandelion	Triglochin maritimum, seaside arrowgrass
# of plots (n=16)	11	3	15	1	11	3	4	16	5	5	1	11	3	1	3	4	1	8
Average	6.4	3.0	5.3	1.0	12.1	1.7	2.0	16.8	1.8	1.4	1.0	5.3	4.0	1.0	2.3	4.3	1.0	3.0
3D1,1,2	1	-	10	-	10	-	-	3	1	-	-	10	-	-	-	-	-	4
3D1,1,7	1	3	3	-	10	-	1	3	-	-	-	3	-	-	-	-	-	-
3D2,1,2	-	-	1	-	20	-	-	20	-	1	-	3	1	-	-	3	1	-
3D2,1,4	1	-	10	-	20	-	-	10	-	-	1	3	-	-	-	3	-	-
3M4,1,2	-	-	3	-	-	-	-	10	-	-	-	-	-	-	-	-	-	3
3M4,2,7	3	-	1	-	10	-	-	10	-	1	-	1	-	-	-	-	-	1
4D1,1,2	3	-	10	-	3	1	-	10	3	-	-	20	-	-	3	-	-	-
4D1,1,7	1	3	3	-	20	1	3	20	-	-	-	3	-	-	-	-	-	-
4D2,2,5	-	-	10	-	10	3	-	3	1	-	-	1	-	-	3	1	-	1
4M1,1,2	10	-	-	-	10	-	3	10	-	1	-	10	1	-	1	-	-	-
4M1,1,7	10	-	1	-	-	-	1	30	-	-	-	3	-	-	-	10	-	10
4M3,1,8	20	-	3	-	-	-	-	10	1	-	-	-	-	-	-	-	-	-
4M4,1,2	-	-	3	-	-	-	-	40	-	-	-	-	-	1	-	-	-	3
4M4,2,7	10	-	1	-	10	-	-	10	-	1	-	1	-	-	-	-	-	1
4WP3,1,1	-	-	20	-	-	-	-	70	3	-	-	-	-	-	-	-	-	-
4WP4,2,7	10	3	1	1	10	-	-	10	-	3	-	-	10	-	-	-	-	1

Table 11. Stand table for plot group 2, sub-group b.
Shown for each plant species are the percent cover in each plot, the number of plots in which it was found, and the average cover for those plots.

Growth-form	Shrub	Graminoids												Forbs										
PlotName	Ericameria nauseosa, rubber rabbitbrush	Amphiscirpus nevadensis, Nevada bulrush / Schoenoplectus pungens, common threesquare bulrush	Carex praegracilis, clustered field sedge	Distichlis spicata, inland saltgrass	Elymus lanceolatus var. lanceolatus, thickspike wheatgrass	Elymus trachycaulus, slender wheatgrass	Juncus balticus, baltic rush	Muhlenbergia richardsonis, mat muhly	Poa juncifolia var. juncifolia, bluegrass	Poa secunda, sandberg bluegrass	Puccinellia nuttalliana, nuttall's alkaligrass	Spartina gracilis, alkali cordgrass	Sporobolus airoides, alkali sacaton	Almutaster pauciflorus, alkali marsh aster	Crepis runcinata var. glauca, fiddleleaf hawksbeard	Forb unknown, Ponds comp narrow lf	Glaux maritima, sea milkwort	Lepidium montanum, mountain pepperweed	Lupinus pusillus, rusty lupine	Monolepis sp., monolepis	Plantago eriopoda, redwool plantain	Pyrrocoma lanceolata, lanceleaf goldenweed	Ranunculus cymbalaria, alkali buttercup	Triglochin maritimum, seaside arrowgrass
# of plots (n=42)	2	28	4	31	4	2	42	1	2	1	5	32	12	25	16	3	12	1	1	2	6	10	5	28
Average	2.0	5.2	11.0	1.7	1.5	1.0	25.0	3.0	3.0	1.0	1.8	5.9	19.3	4.5	2.4	1.7	13.1	1.0	1.0	1.0	1.7	1.6	1.8	11.9
3D1,1,3	-	3	1	1	-	-	20	-	-	-	-	1	-	3	3	-	-	-	-	-	-	-	-	3
3D2,1,3	-	-	-	3	-	-	40	-	-	-	-	3	-	-	1	-	-	-	-	-	-	-	-	-
3D2,2,1	-	1	-	3	-	-	20	-	-	-	-	-	20	-	1	-	-	-	-	-	1	3	-	-
3D2,2,3	-	1	-	1	-	-	30	-	-	-	-	10	-	1	3	-	-	-	-	-	-	-	-	20
3D3,2,5	-	1	-	1	-	-	30	-	-	-	-	1	-	3	1	-	-	-	-	-	-	-	-	3
3D3,2,6	-	-	-	1	-	-	30	-	-	-	-	1	40	-	-	-	-	-	-	-	-	-	-	-
3D4,1,2	-	1	-	-	-	-	40	-	-	-	-	1	-	3	1	-	-	-	-	-	-	-	-	3
3D4,1,3	-	1	-	-	-	-	40	-	-	-	-	3	-	10	-	-	-	-	-	-	-	-	-	1
3D4,1,4	-	-	-	1	1	-	40	-	-	-	-	3	20	-	-	-	-	-	-	-	-	-	-	-
3D4,2,1	-	-	-	1	-	-	50	-	-	-	-	1	-	10	-	-	-	-	-	-	-	-	-	1
3D4,2,2	-	-	-	1	-	-	30	-	-	-	-	3	-	1	3	-	-	-	-	-	-	-	-	1
3M1,1,3	-	15	-	-	-	-	10	-	-	-	1	-	-	3	1	-	3	-	-	-	-	-	-	10
3M1,1,7	-	10	-	-	-	-	20	-	-	-	1	20	-	-	3	-	-	-	-	-	-	1	-	10
3M1,2,5	-	11	-	-	-	-	20	-	-	-	-	3	-	1	-	-	-	-	-	-	-	-	-	20
3M3,2,7	-	10	-	3	-	-	10	-	-	-	-	-	20	3	-	-	3	-	-	-	-	-	-	20
3M4,1,9	1	-	3	-	1	-	10	-	-	1	-	10	20	-	-	-	-	-	-	-	-	-	-	-
3M4,2,3	-	3	-	-	-	-	10	-	-	-	-	1	-	3	-	-	3	-	-	-	-	-	-	3

Table 11 (continued).

PlotName	Ericameria nauseosa, rubber rabbitbrush	Amphiscirpus nevadensis, Nevada bulrush / Schoenoplectus pungens, common threesquare bulrush	Carex praegracilis, clustered field sedge	Distichlis spicata, inland saltgrass	Elymus lanceolatus var. lanceolatus, thickspike wheatgrass	Elymus trachycaulus, slender wheatgrass	Juncus balticus, baltic rush	Muhlenbergia richardsonis, mat muhly	Poa juncifolia var. juncifolia, bluegrass	Poa secunda, sandberg bluegrass	Puccinellia nuttalliana, nuttall's alkaligrass	Spartina gracilis, alkali cordgrass	Sporobolus airoides, alkali sacaton	Almutaster pauciflorus, alkali marsh aster	Crepis runcinata var. glauca, fiddleleaf hawksbeard	Forb unknown, Ponds comp narrow lf	Glaux maritima, sea milkwort	Lepidium montanum, mountain pepperweed	Lupinus pusillus, rusty lupine	Monolepis sp., monolepis	Plantago eriopoda, redwool plantain	Pyrrocoma lanceolata, lanceleaf goldenweed	Ranunculus cymbalaria, alkali buttercup	Triglochin maritimum, seaside arrowgrass
3WP2,2,7	-	10	-	-	-	-	40	-	-	-	3	-	-	-	10	-	3	-	-	-	-	-	-	50
3WP4,1,2	-	-	-	1	-	-	30	-	-	-	-	-	1	3	1	-	40	-	-	-	-	-	1	-
3WP4,2,2	-	10	-	3	-	-	20	-	-	-	-	-	10	-	1	-	3	-	-	-	-	-	3	1
4D1,1,3	-	3	-	1	-	-	40	-	-	-	-	10	-	3	3	-	-	-	-	-	-	-	-	3
4D2,1,3	-	3	-	1	-	-	30	-	-	-	-	3	-	-	3	3	-	-	-	-	-	-	-	3
4D2,1,4	-	1	-	3	-	-	30	-	-	-	-	3	-	-	3	1	-	-	-	-	1	-	-	40
4D2,2,1	-	-	-	3	-	-	20	-	3	-	-	-	30	-	-	-	-	-	-	-	1	3	-	-
4D2,2,3	-	3	-	3	-	-	20	-	-	-	-	3	-	-	-	1	-	-	-	-	-	-	-	40
4D3,2,5	-	1	-	1	-	-	40	-	-	-	-	1	-	10	-	-	-	-	-	-	-	-	-	3
4D4,1,2	-	-	-	1	-	-	10	-	-	-	-	3	-	10	-	-	-	-	-	1	-	-	-	10
4D4,1,3	-	3	-	-	-	-	20	-	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-	10
4D4,1,4	-	-	-	-	1	-	20	-	-	-	-	3	10	-	-	-	-	-	1	-	-	-	-	-
4D4,2,1	-	-	-	1	-	-	40	-	-	-	-	10	-	3	-	-	-	-	-	-	-	1	-	1
4D4,2,2	-	-	-	1	-	-	20	-	-	-	-	3	-	3	-	-	-	-	-	-	-	3	-	3
4M1,2,5	-	3	-	-	-	-	20	-	-	-	-	20	-	1	-	-	-	-	-	-	-	-	-	20
4M2,1,1	-	1	-	1	-	-	30	-	-	-	-	3	40	-	-	-	-	-	-	1	-	1	-	-
4M2,1,2	-	20	-	1	-	-	20	-	-	-	-	20	-	-	-	-	-	-	-	-	-	1	-	20
4M3,2,7	-	3	-	1	-	-	10	-	-	-	-	10	-	3	-	-	1	-	-	-	-	-	-	10
4M4,1,3	-	10	-	3	-	-	10	-	-	-	-	10	-	1	-	-	-	-	-	-	-	-	-	20
4M4,1,9	-	-	-	1	-	-	10	-	3	-	-	10	10	-	-	-	-	-	-	-	-	1	-	-
4M4,2,3	-	3	-	1	-	-	20	-	-	-	-	3	-	10	-	-	10	-	-	-	-	-	-	3
4WP2,1,2	-	10	30	3	-	1	20	-	-	-	1	-	-	3	-	-	40	1	-	-	3	1	3	-
4WP2,1,8	3	-	10	1	3	1	10	3	-	-	-	-	10	-	1	-	1	-	-	-	1	-	-	-
4WP4,1,2	-	3	-	3	-	-	20	-	-	-	3	3	-	1	-	-	30	-	-	-	-	1	1	-
4WP4,2,2	-	1	-	3	-	-	50	-	-	-	-	10	-	1	-	-	20	-	-	-	3	-	1	-

Table 12. Stand table for plot group 2, sub-group c.
Shown for each plant species, the percent cover in each plot, the number of plots in which it was found, and the average cover for those plots.

Growth-form	Graminoids												
PlotName	Amphiscirpus nevadensis, Nevada bulrush / Schoenoplectus pungens, common threesquare bulrush	Carex parryana, parry's sedge	Carex praegracilis, clustered field sedge	Distichlis spicata, inland saltgrass	Eleocharis palustris, common spikerush	Elymus lanceolatus var. riparius, streambank wheatgrass	Hordeum jubatum, foxtail barley	Juncus balticus, baltic rush	Poa juncifolia var. juncifolia, bluegrass	Puccinellia nuttalliana, nuttall's alkaligrass	Schoenoplectus acutus, hardstem bulrush	Spartina gracilis, alkali cordgrass	Sporobolus airoides, alkali sacaton
# of plots (n=73)	73	5	4	35	3	1	1	33	3	18	4	32	6
Average	37.8	1.8	4.3	2.3	1.7	1.0	1.0	8.1	2.3	7.0	4.3	8.2	6.2
3D1,1,6	20	-	-	-	-	-	-	10	-	-	-	10	-
3D2,2,2	20	-	-	3	-	-	-	-	-	-	-	10	-
3D3,1,3	20	-	-	1	-	-	-	3	-	-	-	3	-
3D3,1,4	20	-	-	1	-	-	-	-	-	-	-	-	-
3D3,2,2	20	-	-	1	-	-	-	-	-	-	-	3	-
3M1,1,2	20	-	-	-	-	-	-	20	-	-	-	-	-
3M1,1,6	33	-	-	-	-	-	-	-	-	3	-	-	-
3M1,2,2	33	-	-	-	-	-	-	-	-	-	-	-	-
3M1,2,3	30	-	-	-	-	-	-	-	-	10	-	-	-
3M2,1,2	60	-	-	1	-	-	-	10	-	-	-	-	-
3M2,1,5	70	-	-	-	-	-	-	3	-	-	-	-	-
3M2,1,6	30	-	-	3	-	-	-	-	-	-	-	20	10
3M2,2,2	80	-	-	3	-	-	-	3	-	-	-	-	-
3M2,2,5	40	-	-	-	-	-	-	10	-	-	-	-	-
3M3,1,2	30	-	-	3	-	-	-	-	-	-	-	3	-
3M3,1,3	60	-	-	-	-	-	-	-	-	-	-	3	-
3M4,1,8	30	-	-	1	-	-	-	10	-	-	-	3	-
3M4,2,6	20	-	-	1	-	-	-	10	-	-	-	1	-
3WP1,1,1	60	-	-	1	-	-	-	-	-	-	-	-	-
3WP1,1,6	60	1	-	-	-	-	-	-	-	-	-	-	-
3WP1,1,7	60	-	-	1	-	-	-	1	-	-	-	1	-
3WP1,2,1	70	-	-	3	-	-	-	-	-	1	-	-	-
3WP1,2,2	60	-	-	1	-	-	-	-	-	1	-	-	-
3WP1,2,3	40	-	-	-	-	-	-	-	-	3	-	-	-
3WP1,2,8	50	-	-	-	-	-	-	3	-	-	-	-	-
3WP2,1,2	20	-	3	-	-	1	-	10	-	-	-	-	10
3WP2,1,6	30	-	-	-	-	-	-	-	-	-	-	-	3
3WP2,1,7	20	-	-	3	-	-	-	3	-	-	-	-	1
3WP2,2,1	40	-	-	-	-	-	-	10	-	30	-	-	-
3WP3,1,7	40	-	-	3	-	-	-	-	-	-	-	1	-

Table 12 (continued).

PlotName	Amphiscirpus nevadensis, Nevada bulrush / Schoenoplectus pungens, common threesquare bulrush	Carex parryana, parry's sedge	Carex praegracilis, clustered field sedge	Distichlis spicata, inland saltgrass	Eleocharis palustris, common spikerush	Elymus lanceolatus var. riparius, streambank wheatgrass	Hordeum jubatum, foxtail barley	Juncus balticus, baltic rush	Poa juncifolia var. juncifolia, bluegrass	Puccinellia nuttalliana, nuttall's alkaligrass	Schoenoplectus acutus, hardstem bulrush	Spartina gracilis, alkali cordgrass	Sporobolus airoides, alkali sacaton
3WP4,1,6	20	-	-	-	-	-	-	-	-	-	-	-	-
3WP4,1,7	60	-	-	3	-	-	-	3	-	-	-	-	3
3WP4,2,3	20	-	-	-	-	-	-	-	-	10	3	-	-
3WP4,2,6	30	-	-	-	-	-	-	-	-	-	-	-	-
3WP4,2,7	20	-	-	-	-	-	-	10	-	-	-	1	10
4D1,1,6	30	-	-	-	-	-	-	10	-	-	-	20	-
4D1,2,2	40	-	-	-	-	-	-	10	-	-	-	10	-
4D1,2,5	20	3	-	-	-	-	-	3	-	-	-	-	-
4D2,1,2	40	-	-	3	-	-	-	-	-	-	-	20	-
4D2,2,2	50	-	-	-	-	-	-	-	-	-	-	30	-
4D3,1,3	30	-	-	1	-	-	-	3	-	-	-	10	-
4D3,1,4	30	-	-	-	-	-	-	-	-	-	-	1	-
4D3,2,2	30	-	-	1	-	-	-	-	-	-	-	10	-
4M1,1,4	33	-	-	-	-	-	-	10	-	10	-	-	-
4M1,1,5	63	-	-	-	-	-	-	-	-	20	-	-	-
4M1,1,6	30	-	-	-	-	-	-	-	-	-	-	-	-
4M1,2,2	40	-	-	-	-	-	-	-	-	-	-	-	-
4M1,2,3	41	-	-	-	-	-	-	-	-	3	-	-	-
4M2,1,5	70	-	-	1	-	-	-	10	-	1	-	1	-
4M2,1,6	30	-	-	3	-	-	-	-	-	1	-	20	-
4M2,2,2	70	-	-	-	-	-	-	1	1	-	-	1	-
4M2,2,5	30	-	-	-	-	-	-	10	-	-	-	-	-
4M3,1,2	30	-	-	10	-	-	-	-	-	-	-	10	-
4M3,1,3	40	-	-	-	-	-	-	-	-	-	-	10	-
4M4,1,8	20	-	-	1	-	-	-	10	-	-	-	3	-
4M4,2,6	20	-	-	-	-	-	-	20	-	-	-	1	-
4WP1,1,1	30	-	-	3	-	-	-	10	-	3	-	-	-
4WP1,1,2	30	-	-	-	1	-	-	-	-	-	3	-	-
4WP1,1,6	20	3	-	-	-	-	1	3	-	-	-	-	-
4WP1,1,7	30	-	-	1	-	-	-	-	-	-	-	20	-
4WP1,2,1	90	-	-	10	-	-	-	-	3	-	-	-	-
4WP1,2,2	60	-	-	1	-	-	-	-	-	3	-	-	-
4WP1,2,3	70	-	3	1	-	-	-	-	-	3	10	-	-
4WP1,2,7	20	-	-	1	-	-	-	3	-	3	-	-	-
4WP1,2,8	40	-	-	1	-	-	-	-	-	-	-	30	-
4WP2,1,6	40	-	-	-	-	-	-	-	-	-	1	-	-
4WP2,1,7	50	-	-	3	-	-	-	3	-	-	-	1	-

Table 12 (continued).

PlotName	Amphiscirpus nevadensis, Nevada bulrush / Schoenoplectus pungens, common threesquare bulrush	Carex parryana, parry's sedge	Carex praegracilis, clustered field sedge	Distichlis spicata, inland saltgrass	Eleocharis palustris, common spikerush	Elymus lanceolatus var. riparius, streambank wheatgrass	Hordeum jubatum, foxtail barley	Juncus balticus, baltic rush	Poa juncifolia var. juncifolia, bluegrass	Puccinellia nuttalliana, nuttall's alkaligrass	Schoenoplectus acutus, hardstem bulrush	Spartina gracilis, alkali cordgrass	Sporobolus airoides, alkali sacaton
4WP2,2,1	33	-	10	1	-	-	-	30	3	20	-	-	-
4WP2,2,7	20	-	1	-	-	-	-	10	-	-	-	1	-
4WP3,1,7	50	-	-	3	-	-	-	-	-	-	-	3	-
4WP4,1,6	20	1	-	-	1	-	-	-	-	-	-	-	-
4WP4,1,7	20	-	-	1	-	-	-	3	-	-	-	1	-
4WP4,2,6	10	1	-	-	3	-	-	-	-	1	-	-	-

Table 12 (continued).

Growth-form	Forbs											
PlotName	Almutaster pauciflorus, alkali marsh aster	Crepis intermedia, limestone hawksbeard	Chenopodium glaucum var. salinum, oakleaf goosefoot	Crepis runcinata var. glauca, fiddleleaf hawksbeard	Forb unknown, Ponds comp narrow lf	Forb unknown, ponds cotyledons	Forb unknown, Ponds long green linear leaf	Glaux maritima, sea milkwort	Plantago eriopoda, redwool plantain	Pyrrocoma lanceolata, lanceleaf goldenweed	Ranunculus cymbalaria, alkali buttercup	Triglochin maritimum, seaside arrowgrass
# of plots (n=73)	31	1	3	14	2	1	1	20	2	4	18	52
Average	2.5	1.0	1.7	5.6	5.5	3.0	1.0	5.2	2.0	1.0	1.7	8.5
3D1,1,6	1	-	-	1	-	-	-	-	-	-	-	3
3D2,2,2	-	-	-	-	-	-	-	-	-	-	-	3
3D3,1,3	1	-	-	1	-	-	-	-	-	-	-	20
3D3,1,4	-	-	-	-	-	-	-	-	-	-	-	20
3D3,2,2	-	-	-	-	-	-	-	-	-	-	-	10
3M1,1,2	1	-	-	20	-	-	-	3	-	-	-	3
3M1,1,6	-	-	-	-	-	-	-	-	-	-	-	10
3M1,2,2	-	-	-	-	-	-	-	-	-	-	-	10
3M1,2,3	-	-	-	-	-	-	-	-	-	-	-	10
3M2,1,2	1	-	-	1	-	-	-	-	-	-	-	-
3M2,1,5	3	-	-	-	-	-	-	-	-	-	1	1
3M2,1,6	-	-	-	-	-	-	-	-	-	-	-	-
3M2,2,2	-	-	-	-	-	-	-	-	-	-	-	3
3M2,2,5	3	-	-	-	-	-	-	10	-	-	-	3
3M3,1,2	-	-	-	-	-	-	-	-	-	-	-	-
3M3,1,3	-	-	-	-	-	-	-	-	-	-	-	-
3M4,1,8	1	-	-	1	-	-	-	-	-	-	-	1
3M4,2,6	1	-	-	-	-	-	-	-	-	-	-	-
3WP1,1,1	-	-	-	-	-	-	-	-	-	-	-	20
3WP1,1,6	3	-	-	-	-	-	-	1	-	-	-	1
3WP1,1,7	3	-	-	-	-	-	-	3	-	-	-	21
3WP1,2,1	-	-	-	-	-	-	-	-	-	-	-	1
3WP1,2,2	-	-	1	-	-	-	-	-	-	-	-	1
3WP1,2,3	-	-	3	-	-	-	-	-	-	-	-	-
3WP1,2,8	1	-	-	-	-	-	-	-	-	-	-	-
3WP2,1,2	-	-	-	3	-	-	-	3	-	-	3	3
3WP2,1,6	-	-	-	-	-	-	-	-	-	-	1	-
3WP2,1,7	1	-	-	-	-	-	-	3	-	-	-	-
3WP2,2,1	-	-	-	1	-	-	-	1	-	-	3	11
3WP3,1,7	-	-	-	-	-	-	-	-	-	-	-	-

Table 12 (continued).

PlotName	Almutaster pauciflorus, alkali marsh aster	Crepis intermedia, limestone hawksbeard	Chenopodium glaucum var. salinum, oakleaf goosefoot	Crepis runcinata var. glauca, fiddleleaf hawksbeard	Forb unknown, Ponds comp narrow lf	Forb unknown, ponds cotyledons	Forb unknown, Ponds long green linear leaf	Glaux maritima, sea milkwort	Plantago eriopoda, redwool plantain	Pyrrocoma lanceolata, lanceleaf goldenweed	Ranunculus cymbalaria, alkali buttercup	Triglochin maritimum, seaside arrowgrass
3WP4,1,6	1	-	-	-	-	-	-	-	-	-	3	10
3WP4,1,7	3	-	-	-	-	-	1	1	-	-	1	-
3WP4,2,3	-	-	1	-	-	-	-	3	-	-	1	1
3WP4,2,6	-	-	-	-	-	-	-	1	-	-	3	3
3WP4,2,7	3	-	-	-	-	-	-	10	-	-	1	-
4D1,1,6	3	-	-	3	-	-	-	-	-	-	-	10
4D1,2,2	3	-	-	1	-	-	-	-	-	-	-	20
4D1,2,5	10	-	-	3	-	-	-	-	-	-	-	10
4D2,1,2	-	-	-	1	-	-	-	-	-	1	-	1
4D2,2,2	-	1	-	-	-	-	-	-	-	1	-	20
4D3,1,3	1	-	-	-	-	-	-	-	-	1	-	10
4D3,1,4	-	-	-	-	-	-	-	-	-	-	-	10
4D3,2,2	-	-	-	-	-	-	-	-	-	-	-	30
4M1,1,4	-	-	-	-	-	-	-	-	-	-	-	10
4M1,1,5	-	-	-	-	-	-	-	-	-	-	-	10
4M1,1,6	-	-	-	-	-	-	-	-	-	-	1	20
4M1,2,2	-	-	-	-	-	-	-	-	-	-	-	33
4M1,2,3	-	-	-	-	-	-	-	-	-	-	-	10
4M2,1,5	-	-	-	-	10	3	-	-	3	-	-	3
4M2,1,6	-	-	-	-	1	-	-	-	1	-	-	10
4M2,2,2	1	-	-	-	-	-	-	-	-	-	-	3
4M2,2,5	3	-	-	1	-	-	-	30	-	-	-	3
4M3,1,2	-	-	-	-	-	-	-	-	-	-	-	30
4M3,1,3	-	-	-	-	-	-	-	-	-	-	-	3
4M4,1,8	3	-	-	-	-	-	-	-	-	-	-	-
4M4,2,6	3	-	-	-	-	-	-	-	-	-	-	1
4WP1,1,1	3	-	-	-	-	-	-	-	-	-	-	10
4WP1,1,2	-	-	-	-	-	-	-	-	-	-	-	-
4WP1,1,6	3	-	-	-	-	-	-	1	-	-	1	3
4WP1,1,7	10	-	-	1	-	-	-	3	-	-	1	1
4WP1,2,1	-	-	-	-	-	-	-	-	-	-	-	-
4WP1,2,2	-	-	-	-	-	-	-	-	-	-	-	1
4WP1,2,3	-	-	-	-	-	-	-	-	-	-	1	-
4WP1,2,7	3	-	-	-	-	-	-	10	-	-	1	1
4WP1,2,8	1	-	-	-	-	-	-	-	-	-	-	-
4WP2,1,6	-	-	-	-	-	-	-	-	-	-	1	1
4WP2,1,7	-	-	-	-	-	-	-	3	-	-	-	1

Table 12 (continued).

PlotName	Almutaster pauciflorus, alkali marsh aster	Crepis intermedia, limestone hawksbeard	Chenopodium glaucum var. salinum, oakleaf goosefoot	Crepis runcinata var. glauca, fiddleleaf hawksbeard	Forb unknown, Ponds comp narrow lf	Forb unknown, ponds cotyledons	Forb unknown, Ponds long green linear leaf	Glaux maritima, sea milkwort	Plantago eriopoda, redwool plantain	Pyrrocoma lanceolata, lanceleaf goldenweed	Ranunculus cymbalaria, alkali buttercup	Triglochin maritimum, seaside arrowgrass
4WP2,2,1	1	-	-	-	-	-	-	3	-	1	3	-
4WP2,2,7	-	-	-	40	-	-	-	10	-	-	-	-
4WP3,1,7	-	-	-	-	-	-	-	-	-	-	-	-
4WP4,1,6	1	-	-	-	-	-	-	-	-	-	3	3
4WP4,1,7	1	-	-	-	-	-	-	1	-	-	-	-
4WP4,2,6	-	-	-	-	-	-	-	3	-	-	1	6

Table 13. Stand table for plot group 2, sub-group d.
Shown for each plant species are the percent cover in each plot, the number of plots in which it was found, and the average cover for those plot.

Growth-form	Graminoids											Forbs						
PlotName	Amphiscirpus nevadensis, Nevada bulrush / Schoenoplectus pungens, common threesquare bulrush	Carex lanuginosa, woolly sedge	Carex parryana, parry's sedge	Carex praegracilis, clustered field sedge	Distichlis spicata, inland saltgrass	Eleocharis palustris, common spikerush	Juncus balticus, baltic rush	Puccinellia nuttalliana, nuttall's alkaligrass	Schoenoplectus acutus, hardstem bulrush	Spartina gracilis, alkali cordgrass	Sporobolus airoides, alkali sacaton	Almutaster pauciflorus, alkali marsh aster	Chenopodium glaucum var. salinum, oakleaf goosefoot	Crepis runcinata var. glauca, fiddleleaf hawksbeard	Glaux maritima, sea milkwort	Ranunculus cymbalaria, alkali buttercup	Triglochin maritimum, seaside arrowgrass	Zannichellia palustris, horned pondweed
# of plots (n=20)	19	1	2	1	2	11	12	6	7	2	1	3	2	2	3	14	13	1
Average	8.4	10.0	2.0	1.0	2.0	30.0	4.7	3.2	7.3	3.0	1.0	4.7	1.0	1.0	7.7	2.6	5.2	1.0
3D1,2,5	3	-	3	1	-	-	3	-	-	-	-	3	-	1	-	-	-	-
3M2,2,3	10	-	-	-	-	-	3	-	-	-	-	-	-	-	-	1	10	-
3M4,1,3	10	-	-	-	3	-	3	-	-	3	-	1	-	-	-	-	10	-
3WP1,1,2	10	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
3WP1,1,5	3	-	-	-	-	40	-	-	-	-	-	-	-	-	-	1	1	-
3WP1,2,6	10	-	-	-	-	10	-	1	-	-	-	-	1	-	-	1	1	-
3WP1,2,7	10	-	1	-	-	-	-	3	-	-	-	-	-	-	10	10	1	-
3WP2,1,3	10	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-
3WP2,2,2	10	-	-	-	-	-	-	-	3	-	-	-	-	-	-	1	3	-
3WP2,2,5	4	-	-	-	-	-	1	10	-	-	-	-	-	-	-	-	3	1
3WP4,1,3	10	-	-	-	-	-	20	3	-	-	-	-	1	-	-	10	-	-
4M1,1,3	3	-	-	-	1	10	3	1	-	3	-	10	-	1	10	3	3	-
4M2,1,4	3	-	-	-	-	50	3	-	10	-	-	-	-	-	-	1	10	-
4M2,2,3	11	10	-	-	-	10	3	-	1	-	-	-	-	-	-	-	10	-
4M2,2,4	11	-	-	-	-	20	1	-	-	-	-	-	-	-	-	-	10	-
4WP1,1,5	10	-	-	-	-	60	3	-	3	-	-	-	-	-	-	1	-	-
4WP1,2,6	10	-	-	-	-	40	3	-	-	-	-	-	-	-	-	1	3	-
4WP2,1,3	10	-	-	-	-	20	-	-	1	-	-	-	-	-	-	1	-	-
4WP2,2,2	-	-	-	-	-	60	-	-	30	-	-	-	-	-	-	1	-	-
4WP4,1,3	11	-	-	-	-	10	10	-	3	-	-	-	-	-	3	3	3	-

Table 14. Stand table for plot group 2, sub-group e.
Shown for each plant species are the percent cover in each plot, the number of plots in which it was found, and the average cover for those plots.

Growth-form	Shrub	Graminoids								Forbs								
PlotName	Chrysothamnus viscidiflorus, yellow rabbitbrush	Nevada bulrush / Schoenoplectus pungens, common threesquare	Carex praegracilis, clustered field sedge	Distichlis spicata, inland saltgrass	Elymus lanceolatus var. lanceolatus, thickspike wheatgrass	Grass unknown, Ponds	Juncus balticus, baltic rush	Spartina gracilis, alkali cordgrass	Sporobolus airoides, alkali sacaton	Almutaster pauciflorus, alkali marsh aster	Chenopodium sp., goosefoot	Corispermum hyssopifolium, common bugseed	Crepis runcinata var. glauca, fiddleleaf hawksbeard	Forb unknown, Ponds wide tooth	Monolepis sp., monolepis	Plantago eriopoda, redwool plantain	Pyrrocoma lanceolata, lanceleaf goldenweed	Triglochin maritimum, seaside arrowgrass
# of plots (n=26)	1	22	1	26	1	1	7	19	11	2	1	1	2	1	5	2	3	6
Average	1.0	8.8	1.0	24.4	1.0	1.0	7.0	7.3	6.9	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.7	1.3
3D2,1,5	-	10	-	20	-	-	-	3	-	-	-	1	-	-	-	-	-	-
3D2,2,5	-	-	-	30	-	-	10	3	-	-	-	-	-	-	-	3	3	1
3D3,1,2	-	3	-	30	-	-	3	1	1	-	-	-	1	-	-	-	-	1
3D3,1,5	-	3	-	10	-	-	-	3	-	-	-	-	-	-	-	-	-	-
3M1,1,8	-	3	-	3	-	-	-	3	10	-	-	-	-	-	-	1	-	-
3M3,1,1	-	20	-	10	-	-	-	-	10	-	-	-	-	-	-	-	-	-
3M3,1,8	-	30	-	10	-	-	-	-	10	-	-	-	-	-	-	-	-	-
3M4,2,1	-	10	-	20	-	-	-	-	1	-	-	-	-	-	-	-	-	-
3M4,2,2	-	10	-	10	-	-	-	3	-	-	-	-	-	-	-	-	-	1
3WP2,1,8	1	10	-	1	-	1	3	-	10	-	-	-	-	1	-	-	-	1
3WP3,1,2	-	10	-	60	-	-	-	1	-	-	-	-	-	-	-	-	-	-
3WP3,2,2	-	10	-	40	-	-	-	3	-	-	-	-	-	-	-	-	-	-
3WP3,2,7	-	10	-	10	-	-	-	10	-	-	-	-	-	-	-	-	-	-
3WP4,1,1	-	-	-	30	1	-	10	-	10	-	-	-	-	-	-	-	-	-
4D2,1,5	-	10	-	50	-	-	-	-	1	-	-	-	-	-	1	-	1	-
4D3,1,2	-	3	-	40	-	-	3	3	-	-	-	-	-	-	1	-	1	-
4D3,1,5	-	1	-	10	-	-	-	3	-	-	-	-	-	-	1	-	-	-
4M1,1,8	-	10	-	10	-	-	-	10	10	1	-	-	1	-	1	-	-	-
4M3,2,2	-	1	-	40	-	-	-	10	10	-	-	-	-	-	-	-	-	3
4M4,2,1	-	3	-	40	-	-	-	-	3	-	-	-	-	-	-	-	-	-
4M4,2,2	-	3	-	20	-	-	-	10	-	-	-	-	-	-	-	-	-	-
4WP3,1,2	-	3	-	40	-	-	-	3	-	-	-	-	-	-	-	-	-	-
4WP3,2,2	-	20	-	40	-	-	-	10	-	-	-	-	-	-	-	-	-	-
4WP3,2,7	-	10	-	10	-	-	-	20	-	-	-	-	-	-	-	-	-	-
4WP4,1,1	-	-	1	30	-	-	10	20	-	1	1	-	-	-	-	-	-	-
4WP4,2,1	-	-	-	20	-	-	10	20	-	-	-	-	-	-	1	-	-	1

Table 15. Results of MRPP tests on species composition of group 2 plots inside the exclosure versus outside.

Null hypothesis, H_0: Species composition of plots inside the exclosure does not differ from species composition of plots outside the exclosure.
Alternative hypothesis, H_1: Species composition of plots inside the exclosure differs from species composition of plots outside the exclosure.

Statistic	2003	2004
Weighted mean within-group distance between plots, δ	0.6885	0.69
Probability of δ	0.0567	0.00003
Chance-corrected within-group agreement, A	0.0081	0.03
Conclusion	Reject H_0	Reject H_0

Weighted mean within-group distance between plots, δ, is a measure of the dissimilarity among the plots of each group. Probability of δ is the probability of obtaining, by chance, a delta as large as that observed. A small probability indicates a statistically significant difference.

Chance-corrected within-group agreement, A, expresses the degree of homogeneity among plots within a group. It is a measure of the degree of difference between groups and is interpreted as follows: When all plots within a group share the identical species composition, A = 1. When the plots within a group show the amount of heterogeneity in species composition expected by chance, A = 0. When plots within a group show more heterogeneity in species composition than expected by chance, A = -1.

Table 16. Statistically significant indicator species identified by analysis of group 2 plots inside the exclosure versus outside.

		Relative Abundance		Frequency		Indicator Value		Probability
2003								
		Inside	Outside	Inside (n=47)	Outside (n=39)	Inside	Outside	
Inside	Amphiscirpus nevadensis, Nevada bulrush/Schoenoplectus pungens, common threesquare bulrush*	62	38	94	79	**58**	30	0.018
	Crepis runcinata var. glauca, fiddleleaf hawksbeard	84	16	36	23	**30**	4	0.045
	Puccinellia nuttalliana, nuttall's alkaligrass	81	19	30	5	**24**	1	0.021
	Pyrrocoma lanceolata, lanceleaf goldenweed	100	0	11	0	**11**	0	0.052
Outside	Distichlis spicata, inland saltgrass	25	75	45	74	11	**56**	0.001
2004								
		Inside	Outside	Inside (n=49)	Outside (n=39)	Inside	Outside	
Inside	Amphiscirpus nevadensis, Nevada bulrush/Schoenoplectus pungens, common threesquare bulrush*	70	30	92	77	**64**	23	0.002
	Crepis runcinata var. glauca, fiddleleaf hawksbeard	98	2	31	3	**30**	0	0.002
	Puccinellia nuttalliana, nuttall's alkaligrass	94	6	31	5	**29**	0	0.005
	Eleocharis palustris, common spikerush	93	7	18	10	**17**	1	0.082
	Schoenoplectus acutus, hardstem bulrush	94	6	16	3	**15**	0	0.038
	Plantago eriopoda, redwool plantain	79	21	16	3	**13**	1	0.085
	Unknown forb	100	0	10	0	**10**	0	0.069
Outside	Distichlis spicata, inland saltgrass	21	79	53	79	11	**62**	0.002
	Spartina gracilis, alkali cordgrass	37	63	45	87	17	**55**	0.003

* Nevada bulrush (*Amphiscirpus nevadensis*) and common threesquare bulrush (*Schoenoplectus pungens*) could not be differentiated in many plots and so were grouped together in the data analyses.
Relative abundance = proportion of a species's total canopy cover that occurred in the plots of one group.
Frequency = the percentage of group's plots in which a species was found
Indicator Value = (Relative Abundance) x (Frequency). Maximum possible indicator value = 100
Probability = the probability of obtaining by chance an indicator value as large as the observed value

Table 17. Stand table for plot group 4.
Shown for each plant species are the percent cover in each plot, the number of plots in which it was found, and the average cover for those plots.

Growth-form	Graminoids									Forbs				
PlotName	Amphiscirpus nevadensis, Nevada bulrush / Schoenoplectus pungens, common threesquare bulrush	Carex praegracilis, clustered field sedge	Distichlis spicata, inland saltgrass	Eleocharis palustris, common spikerush	Juncus balticus, baltic rush	Poa secunda, sandberg bluegrass	Puccinellia nuttalliana, nuttall's alkaligrass	Schoenoplectus acutus, hardstem bulrush	Spartina gracilis, alkali cordgrass	Almutaster pauciflorus, alkali marsh aster	Crepis runcinata var. glauca, fiddleleaf hawksbeard	Glaux maritima, sea milkwort	Ranunculus cymbalaria, alkali buttercup	Triglochin maritimum, seaside arrowgrass
# of plots (n=43)	35	2	7	1	18	1	8	1	5	3	2	1	2	43
Average	11.8	2.0	1.6	10.0	3.2	1.0	1.8	10.0	3.6	1.0	1.0	1.0	2.0	35.8
3D1,1,4	3	-	-	-	1	-	-	-	-	-	-	-	-	30
3D1,1,5	10	-	-	-	1	-	-	-	-	-	-	-	-	20
3D1,2,2	10	1	-	-	10	-	-	-	1	1	1	-	-	30
3D1,2,3	20	-	-	-	1	-	-	-	-	-	-	-	-	40
3D1,2,4	10	-	-	-	10	-	-	-	-	-	-	-	-	30
3D2,2,4	3	-	1	-	3	-	-	-	-	-	-	-	-	80
3D3,2,3	10	-	-	-	-	-	-	-	-	-	-	-	-	70
3D3,2,4	10	-	-	-	-	-	-	-	-	-	-	-	-	60
3M1,1,4	10	-	-	-	1	-	3	-	-	-	-	-	-	40
3M1,1,5	10	-	-	-	-	-	-	-	-	-	-	-	-	20
3M1,2,4	1	-	-	-	-	-	1	-	-	-	-	-	-	60
3M2,1,4	3	-	1	10	3	-	-	10	-	-	-	-	-	30
3M2,2,4	6	-	-	-	1	-	-	-	-	-	-	-	-	20
3M3,1,4	10	-	-	-	-	-	-	-	-	-	-	-	-	30
3M3,1,6	-	-	-	-	-	-	-	-	-	-	-	-	-	40
3M3,1,7	10	-	3	-	-	-	-	-	-	-	-	-	-	20
3M3,2,3	10	-	1	-	-	-	-	-	3	-	-	-	-	40
3M3,2,4	-	-	-	-	-	-	-	-	-	-	-	-	-	50
3M3,2,6	10	-	-	-	-	-	-	-	-	-	-	-	-	30
3M4,1,4	10	-	-	-	-	-	1	-	-	-	-	-	-	20
3M4,1,7	-	-	-	-	-	-	3	-	-	-	-	-	-	20
3M4,2,4	1	-	-	-	-	1	-	-	-	-	-	-	-	20
3M4,2,5	-	-	-	-	-	-	-	-	-	-	-	-	-	20
3WP2,2,6	20	-	-	-	1	-	-	-	-	-	-	1	3	40
4D1,1,4	30	-	-	-	3	-	-	-	-	-	-	-	-	40
4D1,1,5	20	-	-	-	3	-	-	-	-	-	-	-	-	20
4D1,2,3	20	-	-	-	1	-	-	-	-	-	-	-	-	50
4D1,2,4	20	-	-	-	1	-	-	-	1	1	1	-	-	30
4D2,2,4	10	-	3	-	10	-	-	-	3	-	-	-	-	40
4D3,2,3	20	-	-	-	-	-	-	-	-	-	-	-	-	60

Table 17 (continued).

PlotName	Amphiscirpus nevadensis, Nevada bulrush / Schoenoplectus pungens, common threesquare bulrush	Carex praegracilis, clustered field sedge	Distichlis spicata, inland saltgrass	Eleocharis palustris, common spikerush	Juncus balticus, baltic rush	Poa secunda, sandberg bluegrass	Puccinellia nuttalliana, nuttall's alkaligrass	Schoenoplectus acutus, hardstem bulrush	Spartina gracilis, alkali cordgrass	Almutaster pauciflorus, alkali marsh aster	Crepis runcinata var. glauca, fiddleleaf hawksbeard	Glaux maritima, sea milkwort	Ranunculus cymbalaria, alkali buttercup	Triglochin maritimum, seaside arrowgrass
4D3,2,4	20	-	-	-	-	-	-	-	-	-	-	-	-	70
4M1,2,4	3	3	-	-	3	-	3	-	-	-	-	-	-	20
4M3,1,4	3	-	-	-	-	-	-	-	-	-	-	-	-	30
4M3,1,6	-	-	-	-	-	-	-	-	-	-	-	-	-	40
4M3,1,7	30	-	1	-	-	-	-	-	-	-	-	-	-	30
4M3,2,3	30	-	-	-	-	-	-	-	10	-	-	-	-	30
4M3,2,4	-	-	-	-	-	-	-	-	-	-	-	-	-	40
4M3,2,6	10	-	-	-	-	-	-	-	-	-	-	-	-	30
4M4,1,4	10	-	-	-	-	-	1	-	-	-	-	-	-	20
4M4,1,7	1	-	1	-	-	-	1	-	-	-	-	-	-	40
4M4,2,4	-	-	-	-	1	-	1	-	-	-	-	-	-	30
4M4,2,5	-	-	-	-	-	-	-	-	-	-	-	-	-	30
4WP2,2,6	10	-	-	-	3	-	-	-	-	1	-	-	1	30

Table 18. Results of MRPP tests on species composition of group 4 plots inside the exclosure versus outside.

Null hypothesis, H_0: Species composition of plots inside the exclosure does not differ from species composition of plots outside the exclosure.
Alternative hypothesis, H_1: Species composition of plots inside the exclosure differs from species composition of plots outside the exclosure.

Statistic	2003	2004
Weighted mean within-group distance between plots, δ	0.3208	0.274
Probability of δ	0.3489	0.068
Chance-corrected within-group agreement, A	0.0026	0.0519
Conclusion	Do not reject H_0	Do not reject H_0

Weighted mean within-group distance between plots, δ, is a measure of the dissimilarity among the plots of each group. Probability of δ is the probability of obtaining, by chance, a delta as large as that observed. A small probability indicates a statistically significant difference.

Chance-corrected within-group agreement, A, expresses the degree of homogeneity among plots within a group. It is a measure of the degree of difference between groups and is interpreted as follows: When all plots within a group share the identical species composition, A = 1. When the plots within a group show the amount of heterogeneity in species composition expected by chance, A = 0. When plots within a group show more heterogeneity in species composition than expected by chance, A = -1.

Table 19. Stand table for plot group 62.
Shown for each plant species are the percent cover in each plot, the number of plots in which it was found, and the average cover for those plots.

Growth-form	Graminoids						Forbs			
PlotName	Amphiscirpus nevadensis, Nevada bulrush / Schoenoplectus pungens, common threesquare bulrush	Carex praegracilis, clustered field sedge	Eleocharis palustris, common spikerush	Juncus balticus, baltic rush	Puccinellia nuttalliana, nuttall's alkaligrass	Schoenoplectus acutus, hardstem bulrush	Forb Unknown, Ponds aquatic forb	Ranunculus cymbalaria, alkali buttercup	Triglochin maritimum, seaside arrowgrass	Zannichellia palustris, horned pondweed
# of plots (n=26)	3	1	3	2	3	26	1	1	2	1
Average	8.0	10.0	2.3	15.0	1.0	67.2	1.0	1.0	5.5	1.0
3M2,1,3	3	-	-	10	-	20	-	-	10	1
3WP1,1,4	-	-	-	-	-	90	-	-	-	-
3WP1,2,4	-	-	-	-	-	80	-	-	-	-
3WP1,2,5	-	-	-	-	-	98	-	-	-	-
3WP2,1,4	-	-	-	-	-	70	-	-	-	-
3WP2,1,5	-	-	-	-	-	90	1	-	-	-
3WP2,2,3	-	-	-	-	-	90	-	-	-	-
3WP2,2,4	-	-	-	-	-	90	-	-	-	-
3WP4,1,4	-	-	-	-	1	70	-	-	-	-
3WP4,1,5	-	-	-	-	-	80	-	-	-	-
3WP4,2,4	-	-	-	-	1	60	-	-	-	-
3WP4,2,5	-	-	-	-	-	50	-	-	-	-
4M2,1,3	20	-	3	20	-	40	-	-	-	-
4WP1,1,4	-	-	-	-	-	98	-	-	-	-
4WP1,2,4	-	-	-	-	-	90	-	-	-	-
4WP1,2,5	-	-	1	-	-	70	-	-	-	-
4WP2,1,4	-	-	-	-	-	90	-	-	-	-
4WP2,1,5	-	-	-	-	-	60	-	-	-	-
4WP2,2,3	-	-	-	-	-	90	-	-	-	-
4WP2,2,4	-	-	-	-	-	90	-	-	-	-
4WP2,2,5	1	10	3	-	-	10	-	-	1	-
4WP4,1,4	-	-	-	-	-	20	-	-	-	-
4WP4,1,5	-	-	-	-	-	60	-	1	-	-
4WP4,2,3	-	-	-	-	1	50	-	-	-	-
4WP4,2,4	-	-	-	-	-	50	-	-	-	-
4WP4,2,5	-	-	-	-	-	40	-	-	-	-

Table 20. Results of MRPP tests on species composition of group 62 plots inside the exclosure versus outside.

Null hypothesis, H_0: Species composition of plots inside the exclosure does not differ from species composition of plots outside the exclosure.
Alternative hypothesis, H_1: Species composition of plots inside the exclosure differs from species composition of plots outside the exclosure.

Statistic	2003	2004
Weighted mean within-group distance between plots, δ	0.1903	0.299
Probability of δ	0.0482	0.0136
Chance-corrected within-group agreement, A	0.0905	0.1348
Conclusion	Reject H_0	Reject H_0

Weighted mean within-group distance between plots, δ, is a measure of the dissimilarity among the plots of each group. Probability of δ is the probability of obtaining, by chance, a delta as large as that observed. A small probability indicates a statistically significant difference.

Chance-corrected within-group agreement, A, expresses the degree of homogeneity among plots within a group. It is a measure of the degree of difference between groups and is interpreted as follows: When all plots within a group share the identical species composition, A = 1. When the plots within a group show the amount of heterogeneity in species composition expected by chance, A = 0. When plots within a group show more heterogeneity in species composition than expected by chance, A = -1.

Table 21. Results of general linear model analysis of differences in horizontal vegetation density at 40-50 cm above the ground.

Factor	Type	Levels	Values
Inside or Outside Exclosure	fixed	2	0 = Inside, 1 = Outside
Year	fixed	2	2003, 2004
Season	fixed	2	0 = early, 1 = late
Group	fixed	4	1, 2, 4, and 62

Model Term	DF	Sequential Sums of Squares	Adjusted Sums of Squares	Adjusted Mean Square	F	P
Inside or Outside Exclosure	1	8588.1	25531.7	25531.7	376.81	0.000
Year	1	54.0	515.3	515.3	7.61	0.006
Season	1	134.4	302.0	302.0	4.46	0.035
Group	3	96141.4	55112.9	18371.0	271.13	0.000
Inside/Outside * Year	1	63.6	716.6	716.6	10.58	0.001
Inside/Outside * Season	1	56.3	62.1	62.1	0.92	0.339
Inside/Outside * Group	3	47344.6	47831.8	15943.9	235.31	0.000
Year * Season	1	258.7	501.3	501.3	7.40	0.007
Year * Group	3	1961.4	994.4	331.5	4.89	0.002
Season * Group	3	831.1	522.3	174.1	2.57	0.053
Inside/Outside * Year * Season	1	173.8	329.3	329.3	4.86	0.028
Inside/Outside * Year * Group	3	1364.5	1364.5	454.8	6.71	0.000
Inside/Outside * Season * Group	3	114.8	95.2	31.7	0.47	0.704
Year * Season * Group	3	1475.7	893.9	298.0	4.40	0.005
Inside/Outside * Year * Season * Group	3	583.1	583.1	194.4	2.87	0.036
Error	568	38486.4	38486.4	67.8		
Total	599	197632.1				

Table 22. Probability values for comparisons of mean horizontal vegetation density at 40-50 cm above the ground in combinations of inside or outside the exclosure, year of sampling, early or late season, and plot group.

The value in each cell is the probability of obtaining, by chance, a difference in mean horizontal density between the two combinations as large as the observed difference. Small probability values, indicating significant differences between pairs of combinations, are shown in bold type-face. These probability values were calculated by Bonferroni simultaneous tests of means.

I = inside exclosure, O = outside exclosure, E = early season, L = Late season

I/O				I																							
	Yr			03	I																						
		Sea son		E	03	I																					
			Grp	1	L	04	I																				
I	03	E	1	X	1	E	04	O																			
I	03	L	1	1	X	1	L	03	O																		
I	04	E	1	1	1	X	1	E	03	O																	
I	04	L	1	1	1	1	X	1	L	04	O																
O	03	E	1	1	1	1	1	X	1	E	04	I															
O	03	L	1	1	1	1	1	1	X	1	L	03	I														
O	04	E	1	1	1	1	1	1	1	X	1	E	03	I													
O	04	L	1	1	1	1	1	1	1	1	X	2	L	04	I												
I	03	E	2	1	1	1	1	1	1	1	1	X	2	E	04	O											
I	03	L	2	1	1	1	1	1	1	1	1	1	X	2	L	03	O										
I	04	E	2	1	1	1	1	1	1	1	1	1	1	X	2	E	03	O									
I	04	L	2	1	1	1	1	1	1	1	1	1	1	1	X	2	L	04	O								
O	03	E	2	1	1	1	1	1	1	1	1	1	1	1	1	X	2	E	04	I							
O	03	L	2	1	1	1	1	1	1	1	1	1	1	1	1	1	X	2	L	03	I						
O	04	E	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	X	2	E	03	I					
O	04	L	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	X	4	L	04	I				
I	03	E	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	X	4	E	04				
I	03	L	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	X	4	L				
I	04	E	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	X	4				
I	04	L	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	X				

Table 22 (continued).

																									X				I																		
																										X			03	I																
																											X		E	03	I															
																												X	62	L	04	I														
I	03	E	62	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	X	62	E	04	O														
I	03	L	62	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	1	X	62	L	03	O													
I	04	E	62	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	1	1	X	62	E	03	O												
I	04	L	62	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	X	62	L	04	O											
O	03	E	62	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**0**	**0**	**0**	**0**	X	62	E	04											
O	03	L	62	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**0**	**0**	**0**	**0**	1	X	62	L											
O	04	E	62	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**0**	**0**	**0**	**0**	1	1	X	62											
O	04	L	62	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**0**	**0**	**0**	**0**	1	1	1	X											

Table 23. Results of general linear model analysis of differences in horizontal vegetation density at 20-30 cm above the ground.

Factor	Type	Levels	Values
Inside or Outside Exclosure	fixed	2	0 = Inside, 1 = Outside
Year	fixed	2	2003, 2004
Season	fixed	2	0 = early, 1 = late
Group	fixed	4	1, 2, 4, and 62

Analysis of Variance for Horizontal Density at 20-30 cm, using Adjusted Sums of Squares for Tests

Model Term	DF	Sequential Sums of Squares	Adjusted Sums of Squares	Adjusted Mean Square	F	P
Inside or Outside Exclosure	1	29311.6	31170.5	31170.5	170.65	0.000
Year	1	537.7	621.5	621.5	3.40	0.066
Season	1	3921.9	5533.6	5533.6	30.29	0.000
Group	3	173262.6	123196.2	41065.4	224.82	0.000
Inside/Outside * Year	1	377.4	1170.5	1170.5	6.4	0.012
Inside/Outside * Season	1	214.1	675.0	675.0	3.70	0.055
Inside/Outside * Group	3	26901.1	27384.6	9128.2	49.97	0.000
Year * Season	1	181.5	2.2	2.2	0.01	0.912
Year * Group	3	63.9	32.1	10.7	0.06	0.981
Season * Group	3	1911.1	3673.6	1224.5	6.70	0.000
Inside/Outside * Year * Season	1	500.7	177.9	177.9	0.97	0.324
Inside/Outside * Year * Group	3	713.3	713.3	237.8	1.30	0.273
Inside/Outside * Season * Group	3	4105.8	4130.1	1376.7	7.54	0.000
Year * Season * Group	3	712.3	662.9	221.0	1.21	0.305
Inside/Outside * Year * Season * Group	3	801.1	801.1	267.0	1.46	0.224
Error	568	103749.1	103749.1	182.7		
Total	599	347265.4				

Table 24. Probability values for comparisons of mean horizontal vegetation density at 20-30 cm above the ground in combinations of inside or outside exclosure, early or late season, and plot group.

The value in each cell is the probability of obtaining, by chance, a difference in mean horizontal density between the two combinations of inside vs. outside exclosure, early vs. late season, and plot group as large as the observed difference. Small probability values, indicating significant differences between pairs of combinations, are shown in bold type-face. These probability values were calculated by Bonferroni simultaneous tests of means.

Rank	In/Out	Season	Group	1 Outside Late 4	2 Outside Early 4	3 Outside Late 4	4 Outside Late 5	5 Inside Late 6	6 Outside Early 7	7 Outside Early 8	8 Inside Late 9	9 Inside Late 10	10 Inside Early 11	11 Inside Early 12	12 Outside Late 13	13 Inside Early 14	14 Outside Early 15	15 Inside Late 16	16 Inside Early 62
1	Outside	Late	4	X	4	Late	Outside	5											
2	Outside	Early	4	1	X	1	Late	Inside	6										
3	Outside	Late	1	1	1	X	2	Late	Outside	7									
4	Outside	Late	2	1	1	1	X	1	Early	Outside	8								
5	Inside	Late	1	1	1	1	1	X	1	Early	Inside	9							
6	Outside	Early	1	1	1	1	1	1	X	2	Late	Inside	10						
7	Outside	Early	2	1	1	1	1	1	1	X	4	Late	Inside	11					
8	Inside	Late	4	1	1	1	1	1	1	1	X	2	Early	Inside	12				
9	Inside	Late	2	1	1	1	0.1371	1	1	1	1	X	1	Early	Outside	13			
10	Inside	Early	1	1	1	1	1	1	1	1	1	1	X	4	Late	Inside	14		
11	Inside	Early	4	1	1	1	1	1	1	1	1	1	1	X	62	Early	Outside	15	
12	Outside	Late	62	1	1	1	1	1	1	1	1	1	1	1	X	2	Early	Inside	16
13	Inside	Early	2	**0.0019**	**0.0027**	**0.0012**	**0.0000**	**0.0043**	**0.0250**	**0.0000**	1	0.1226	1	1	1	X	62	Late	Inside
14	Outside	Early	62	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	X	62	Early
15	Inside	Late	62	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	X	62
16	Inside	Early	62	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	1	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	1	X

Table 25. Probability values for comparisons of mean horizontal vegetation density at 20-30 cm above the ground in plots inside or outside the exclosure in 2003 and 2004.

The value in each cell is the probability of obtaining, by chance, a difference in mean horizontal density between the two combinations of inside vs. outside exclosure and year as large as the observed difference. Small probability values, indicating significant differences between pairs of combinations, are shown in bold type-face. These probability values were calculated by Bonferroni simultaneous tests of means.

Year		*2003*		
	Location	*Inside*	*2003*	
2003	*Inside*	X	*Outside*	*2004*
2003	*Outside*	**0.0000**	X	*Inside*
2004	*Inside*	**0.0065**	**0.0000**	X
2004	*Outside*	**0.0000**	1.0000	**0.0000**

Table 26. Results of general linear model analysis of differences in horizontal vegetation density at 0-10 cm above the ground.

Factor	Type	Levels	Values
Inside or Outside Exclosure	fixed	2	0 = Inside, 1 = Outside
Year	fixed	2	2003, 2004
Season	fixed	2	0 = early, 1 = late
Group	fixed	4	1, 2, 4, and 62

Analysis of Variance for Horizontal Density at 0 - 15 cm, using Adjusted Sums of Squares for Tests

Model Term	DF	Sequential Sums of Squares	Adjusted Sums of Squares	Adjusted Mean Square	F	P
Inside or Outside Exclosure	1	68893.7	22032.9	22032.9	47.32	0.000
Year	1	1.0	512.0	512.0	1.10	0.295
Season	1	6881.7	2994.0	2994.0	6.43	0.011
Group	3	80810.3	84982.5	28327.5	60.84	0.000
Inside/Outside * Year	1	1585.6	1605.9	1605.9	3.45	0.064
Inside/Outside * Season	1	2322.0	555.6	555.6	1.19	0.275
Inside/Outside * Group	3	5998.0	5375.3	1791.8	3.85	0.010
Year * Season	1	3360.7	1380.8	1380.8	2.97	0.086
Year * Group	3	789.6	906.9	302.3	0.65	0.584
Season * Group	3	1568.9	1507.7	502.6	1.08	0.357
Inside/Outside * Year * Season	1	704.2	482.0	482.0	1.04	0.309
Inside/Outside * Year * Group	3	1778.5	1778.5	592.8	1.27	0.283
Inside/Outside * Season * Group	3	547.2	559.3	186.4	0.40	0.753
Year * Season * Group	3	1054.6	869.9	290.0	0.62	0.601
Inside/Outside * Year * Season * Group	3	220.5	220.5	73.5	0.16	0.925
Error	568	264481.2	264481.2	465.6		
Total	599	440997.6				

Table 27. Probability values for comparisons of mean horizontal vegetation density at 0-10 cm above the ground in plots inside or outside the exclosure in 2003 and 2004.

The value in each cell is the probability of obtaining, by chance, a difference in mean horizontal density between the two combinations of inside vs. outside exclosure and year as large as the observed difference. Small probability values, indicating significant differences between pairs of combinations, are shown in bold type-face. These probability values were calculated by Bonferroni simultaneous tests of means.

		In 2004	Out 2004	Out 2003	In 2003
In	2004	x			
Out	2004	**0.0025**	x		
Out	2003	**0.0004**	1.0000	x	
In	2003	0.1775	**0.0000**	**0.0000**	x

Table 28. Probability values for comparisons of mean horizontal vegetation density at 0-10 cm above the ground in plots of each group inside or outside the exclosure, in both years.

The value in each cell is the probability of obtaining, by chance, a difference in mean horizontal density between the two combinations of inside vs. outside exclosure and plot group as large as the observed difference. Small probability values, indicating significant differences between pairs of combinations, are shown in bold type-face. These probability values were calculated by Bonferroni simultaneous tests of means.

		Out 4	Out 1	In 1	Out 2	In 4	In 2	Out 62	In 62
Out	4	x							
Out	1	1.0000	x						
In	1	**0.0000**	**0.0077**	x					
Out	2	**0.0000**	**0.0000**	1.0000	x				
In	4	**0.0000**	**0.0010**	1.0000	1.0000	x			
In	2	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0001**	x		
Out	62	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0006**	1.0000	x	
In	62	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	0.4570	1.0000	x

Table 29. Probability values for comparisons of mean horizontal vegetation density at 0-10 cm above the ground in each season and each year.

The value in each cell is the probability of obtaining, by chance, a difference in mean horizontal density between the two combinations of season and year as large as the observed difference. Small probability values, indicating significant differences between pairs of combinations, are shown in bold type-face. These probability values were calculated by Bonferroni simultaneous tests of means.

		2004 Late	2003 Late	2003 Early	2004 Early
2004	Late	x			
2003	Late	0.3035	x		
2003	Early	**0.0692**	1.0000	x	
2004	Early	**0.0166**	1.0000	1.0000	x

Table 30. Results from analysis of variance for canopy cover in all four groups, inside and outside the exclosure, in 2003 and 2004.

Factor	Type	Levels	Values
Inside/Outside	fixed	2	Inside, Outside
Year	fixed	2	2003, 2004
Group	fixed	4	1, 2, 4, 62

Analysis of Variance for Total Cover, using Adjusted Sums of Squares for Tests

Source	Degrees of Freedom	Sequential Sums of Squares	Adjusted Sums of Squares	Adjusted Mean Square	F	P
Inside/Outside	1	10644.2	7234.5	7234.5	20.57	0.000
Year	1	6749.8	970.8	970.8	2.76	0.098
Group	3	6766.4	5630.7	1876.9	5.34	0.001
Inside/Outside*Year	1	1702.8	828.0	828.0	2.35	0.126
Inside/Outside*Group	3	1345.9	1273.7	424.6	1.21	0.307
Year*Group	3	3492.6	3539.7	1179.9	3.35	0.019
Inside/Outside*Year*Group	3	620.3	620.3	206.8	0.59	0.623
Error	284	99887.7	9887.7	351.7		
Total	299	131209.6				

S = 18.7541 R-Sq = 23.87% R-Sq(adj) = 19.85%

Table 31. Probability values for comparisons of mean cover per plot among the four plot groups in 2003 and 2004.

The value in each cell is the probability of obtaining, by chance, a difference in mean horizontal cover between the two groups as large as the observed difference. Small probability values, indicating significant differences between groups, are shown in bold type-face. The comparisons of interest (those among groups within the same year) are in the unshaded portions of the table. These probability values were calculated by Bonferroni simultaneous tests of means.

Year		*2003*	*2003*	*2003*	*2003*	*2004*	*2004*	*2004*	*2004*
	Group	*1*	*2*	*4*	*62*	*1*	*2*	*4*	*62*
2003	*1*	X	1.0000	1.0000	**0.0038**	**0.0550**	0.4752	1.0000	0.9527
2003	*2*	1.0000	X	1.0000	**0.0006**	**0.0040**	**0.0141**	1.0000	0.4262
2003	*4*	1.0000	1.0000	X	**0.0030**	**0.0435**	0.3680	1.0000	0.7399
2003	*62*	**0.0038**	**0.0006**	**0.0030**	X	1.0000	0.2123	0.0922	1.0000
2004	*1*	**0.0550**	**0.0040**	**0.0435**	1.0000	X	1.0000	1.0000	1.0000
2004	*2*	0.4752	**0.0141**	0.3680	0.2123	1.0000	X	1.0000	1.0000
2004	*4*	1.0000	1.0000	1.0000	0.0922	1.0000	1.0000	X	1.0000
2004	*62*	0.9527	0.4262	0.7399	1.0000	1.0000	1.0000	1.0000	X

Table 32. Correlation between horizontal vegetation density at each of three heights and canopy cover in plots of each group.

r = Pearson's product-moment coefficient of correlation between the horizontal vegetation density at the height shown and the canopy cover. r measures the intensity of the linear association between horizontal density and canopy cover.

P Value = the probability of obtaining, by chance, a correlation coefficient r as large as that observed. Italic typeface indicates statistically significant correlations.

r^2 = the coefficient of determination between horizontal density at the height shown and canopy cover. r^2 shows the percentage of the variability in one of the measures that is accounted for by variability in the other.

Height of Density Measurement	Plot Group	Correlation with % canopy cover	P Value	r^2
40-50 cm	*Group 62 (n=26)*	*0.701*	*0.000*	*0.4914*
20-30 cm	*Group 2 (n=177)*	*-0.192*	*0.011*	*0.0369*
	Group 62 (n=26)	*0.727*	*0.000*	*0.5285*
0-10 cm	Group 1 (n=54)	0.170	0.219	0.0289
	Group 2 (n=177)	*0.362*	*0.000*	*0.1310*
	Group 4 (n=43)	0.125	0.423	0.0156

APPENDIX 1. PHOTOGRAPHS FROM THE 2003 - 2004 PONDS SAMPLING.

Appendix 1 is in a separate Microsoft Word file, “Ponds_Appendix1_photo.doc”.

APPENDIX 2. COORDINATES OF POND SAMPLING TRANSECTS

The coordinates for the end points of the transects are shown in the following table and also are being provided in digital files in the folder “Ponds_Appendix2_gps”.

Coordinates are in UTM, NAD83, Zone 12N. Each is the average of a number of positions (shown in column "# OF POSITIONS RECORDED") collected with a GPS receiver (GeoExplorer II, Trimble Navigation Ltd., Sunnyvale CA, USA). The data were collected in a digital file and treated with post-processing correction.

POND	TRAN-SECT	POINT	GPS_DATE	GPS_TIME (MST)	# OF POSITIONS RECORDED	CORRECTED NORTHING	CORRECTED EASTING
03dry2	1	start	7/2/2003	02:06:53PM	66	4650262	646272
03dry2	1	end	7/2/2003	02:46:21PM	62	4650246	646312
03dry2	2	start	7/2/2003	04:26:13PM	70	4650282	646297
03dry2	2	end	7/2/2003	04:33:29PM	55	4650238	646293
03dry1	1	start	7/3/2003	12:16:45PM	51	4650302	646228
03dry1	1	end	7/3/2003	12:18:14PM	64	4650329	646209
03dry1	2	start	7/3/2003	12:19:53PM	65	4650323	646236
03dry1	2	end	7/3/2003	12:22:26PM	52	4650301	646206
03med1	2	start	7/3/2003	02:31:46PM	64	4650283	646283
03med1	2	end	7/3/2003	02:33:59PM	67	4650311	646271
03med1	1	start	7/3/2003	02:35:36PM	52	4650295	646254
03med1	1	end	7/3/2003	02:37:52PM	64	4650300	646300
03wp1	1	start	7/8/2003	11:19:02AM	58	4650301	646132
03wp1	1	end	7/8/2003	11:22:37AM	54	4650360	646111
03wp1	2	start	7/8/2003	11:24:37AM	54	4650335	646161
03wp1	2	end	7/8/2003	11:26:45AM	64	4650345	646101
03wp2	1	start	7/8/2003	02:37:28PM	58	4650337	646252
03wp2	1	end	7/8/2003	02:48:44PM	38	4650386	646258
03wp2	2	start	7/8/2003	02:50:19PM	53	4650343	646266
03wp2	2	end	7/8/2003	02:53:10PM	57	4650361	646228
03med2	1	start	7/8/2003	04:47:25PM	62	4650203	646259
03med2	1	end	7/8/2003	04:50:42PM	58	4650179	646286
03med2	2	start	7/8/2003	04:52:52PM	92	4650166	646265
03med2	2	end	7/8/2003	04:55:45PM	44	4650229	646283
03wp3	1	start	7/9/2003	10:47:39AM	58	4650389	646044
03wp3	1	end	7/9/2003	10:49:50AM	63	4650407	645978
03wp3	2	start	7/9/2003	10:52:06AM	53	4650376	646009
03wp3	2	end	7/9/2003	10:55:08AM	52	4650437	646030
03med3	1	start	7/9/2003	01:47:15PM	62	4650254	645930
03med3	2	start	7/9/2003	01:49:14PM	50	4650232	645927
03med3	1	end	7/9/2003	01:51:11PM	64	4650225	645874
03med3	2	end	7/9/2003	01:54:48PM	50	4650254	645874

POND	TRAN-SECT	POINT	GPS_DATE	GPS_TIME (MST)	# OF POSITIONS RECORDED	CORRECTED NORTHING	CORRECTED EASTING
03dry3	1	start	7/9/2003	03:39:45PM	46	4650194	645864
03dry3	1	end	7/9/2003	03:42:25PM	66	4650175	645891
03dry3	2	start	7/9/2003	03:44:21PM	72	4650156	645860
03dry3	2	end	7/9/2003	03:46:40PM	63	4650198	645885
03med4	1	start	7/10/2003	11:13:51AM	63	4650320	645753
03med4	2	end	7/10/2003	11:15:52AM	63	4650340	645726
03med4	1	end	7/10/2003	11:17:59AM	64	4650382	645751
03med4	2	start	7/10/2003	11:19:41AM	59	4650370	645781
03wp4	1	start	7/10/2003	01:37:37PM	52	4650432	645703
03wp4	2	start	7/10/2003	01:39:11PM	70	4650463	645694
03wp4	1	end	7/10/2003	01:41:20PM	61	4650454	645657
03wp4	2	end	7/10/2003	01:42:49PM	122	4650435	645660
03dry4	1	start	7/10/2003	02:59:15PM	23	4650235	645713
03dry4	1	end	7/10/2003	03:00:49PM	63	4650254	645719
03dry4	2	start	7/10/2003	03:04:13PM	60	4650247	645701
03dry4	2	end	7/10/2003	03:09:59PM	55	4650237	645729

APPENDIX 3. DETAILS ON SETTINGS USED IN THE NON-METRIC MULTIDIMENSIONAL SCALING ORDINATION AND DETAILS ON THE RESULTS OBTAINED.

Nonmetric Multidimensional Scaling, PC-ORD, Version 4.0

Ordination of plots in species space: 300 plots, 43 species

A. INITIAL ANALYSIS

The following options were selected.

ANALYSIS OPTIONS

1. SORENSEN = Distance measure
2. 3 = Number of axes (max. = 6)
3. 75 = Maximum number of iterations
4. RANDOM = Starting coordinates (random or from file)
5. 1 = Reduction in dimensionality at each cycle
6. 0.20 = Step length (rate of movement toward minimum stress)
7. USE TIME = Random number seeds (use time vs. user-supplied)
8. 5 = Number of runs with real data
9. 20 = Number of runs with randomized data
10. YES = Autopilot
11. 0.005000 = Stability criterion, standard deviations in stress over last 10 iterations.
12. QUICK = Speed vs. thoroughness

OUTPUT OPTIONS

13. NO = Write distance matrix?
14. NO = Write starting coordinates?
15. NO = List stress, etc. for each iteration?
18. NO = Plot stress vs. iteration?
17. NO = Plot distance vs. dissimilarity?
16. NO = Write final configuration?
19. UNROTATED = Write varimax-rotated or unrotated scores for graph?
20. YES = Write run log?
21. NO = Write weighted-average scores for species ?

3436 = Seed for random number generator.

RESULTING STRESS IN RELATION TO DIMENSIONALITY (Number of Axes)

	Stress in real data 5 run(s)			Stress in randomized data Monte Carlo test, 20 runs			
Axes	Minimum	Mean	Maximum	Minimum	Mean	Maximum	p
1	52.915	60.901	67.019	48.968	52.884	58.524	0.7619
2	23.387	31.338	39.418	31.847	36.655	46.296	0.0476
3	17.622	24.022	44.549	23.227	27.573	42.929	0.0476

p = proportion of randomized runs with stress < or = observed stress
i.e., p = (1 + no. permutations <= observed)/(1 + no. permutations)

Randomizing data resulted in undefined distances. Data were reshuffled for this reason a total of 4 times.

Conclusion: a 3-dimensional solution is recommended.

B. FINAL ANALYSIS

The best ordination from the initial analysis was re-run as the final analysis, with the following settings.

Selected file CONFIG3.GPH for the starting configuration for the final run. Increasing maximum number of iterations to 200. Decreasing stability criterion to 0.00100

Ordination of plots in species space. 300 plots 43 species

The following options were selected:

ANALYSIS OPTIONS

1. SORENSEN = Distance measure
2. 3 = Number of axes (max. = 6)
3. 200 = Maximum number of iterations
4. FROM FILE = Starting coordinates (random or from file)
5. 3 = Reduction in dimensionality at each cycle
6. 0.20 = Step length (rate of movement toward minimum stress)
7. USE TIME = Random number seeds (use time vs. user-supplied)
8. 1 = Number of runs with real data
9. 0 = Number of runs with randomized data
10. YES = Autopilot
11. 0.001000 = Stability criterion, standard deviations in stress over last 10 iterations.
12. QUICK = Speed vs. thoroughness

OUTPUT OPTIONS

13. NO = Write distance matrix?
14. NO = Write starting coordinates?
15. YES = List stress, etc. for each iteration?
18. YES = Plot stress vs. iteration?
17. NO = Plot distance vs. dissimilarity?
16. YES = Write final configuration?
19. UNROTATED = Write varimax-rotated or unrotated scores for graph?
20. NO = Write run log?
21. YES = Write weighted-average scores for species ?

RESULT:

17.36536 = final stress for 3-dimensional solution
0.00229 = final instability
200 = number of iterations

Randomizing data resulted in undefined distances. Data were reshuffled for this reason a total of 4 times.

APPENDIX 4. INFORMATION ON PONDS AND TRANSECTS FROM SAMPLING FORMS

The file "Ponds_Appendix4_DataSheet.pdf" contains copies of pages 1 and 2 of the field sampling form for each pond from early 2003 sampling. Page 1 shows a sketch of the pond with vegetation zones, orientation of the transects, and approximate locations of the sampling points on each transect. Page 2 has a description of the vegetation around the pond, and the coordinates for the end-points of the transects and the compass bearing of each transect.

The end-point coordinates are also given in Appendix 2. The distance of each sampling point from the transect starting point and the vegetation zone in which the point lies are listed in the fields "Dist Along Trans" and "Zone" (respectively) in Appendix 5 and Appendix 6. Taken together, all of this information can be used to re-locate each sampling point.

APPENDIX 5. 2003-2004 HORIZONTAL VEGETATION DENSITY DATA

The horizontal vegetation density data from the 2003 and 2004 sampling effort are being provided in a separate Microsoft Excel file, "Ponds_Appendix5_HDdata.xls".

APPENDIX 6. 2003-2004 CANOPY COVER DATA.

The canopy cover data from the 2003 and 2004 sampling effort are being provided in a separate Microsoft Excel file, “Ponds_Appendix6_Covdata.xls”.

APPENDIX 7. RESULTS OF BONFERRONI TESTS FOR SIGNIFICANT DIFFERENCES IN MEAN HORIZONTAL VEGETATION DENSITY AT 40-50 CM.

Appendix 7 is in a separate digital file, “Ponds_Appendix7_Bonferroni_Height.doc”.

APPENDIX 8. BONFERRONI SIMULTANEOUS COMPARISONS OF MEANS FOR CANOPY COVER.

Appendix 8 is in a separate digital file, “Ponds_Appendix8_Bonferroni_Cover.doc”.