CUSHION-PLANT VEGETATION ON PUBLIC LANDS IN THE BLM RAWLINS FIELD OFFICE, WYOMING

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ABSTRACT

Cushion-form forbs contribute substantial cover to short, often sparse vegetation along windblown rims and on rock outcrops in south-central Wyoming. Botanical survey had shown that rare plant species grow in the cushion-plant vegetation in some areas, and had led to the suggestion that the vegetation in those areas represents unusual plant communities. This conclusion, though, was formed with little information about cushion-plant vegetation throughout the state.

The present study was undertaken to document the variability in species composition of the cushion-plant vegetation in south-central Wyoming, to look for relationships between that variation and geographic or geologic factors, and to find out if the rims and outcrops provide habitat for cushion-plants that are absent from the surrounding shrub-steppe vegetation. Forty-two sample plots were used in five geographic areas to collect data on plant canopy cover, ground cover, and other habitat variables. Twenty-four of the plots were placed immediately along rims and on resistant bedrock outcrops to sample the cushion-plant vegetation and the remaining 18 were placed at some distance from the rims and outcrops in an attempt to sample the surrounding shrub-steppe.

Rims and outcrops do not provide habitat for plant species that are absent from the nearby vegetation. Of the 249 plant taxa documented in the 42 plots, only a handful of incidental taxa were found exclusively on rims and outcrops or exclusively in the nearby vegetation. And there appears to be no difference in the number of cushion-plant species found in small areas (the size of sample plots) within each vegetation type. Cushion-plant vegetation on rims and outcrops differs from nearby vegetation mainly in the relative amounts of different kinds of plants: cushion-plants contributed over twice the proportion of cover to plots on rims and outcrops as they did to plots in the vegetation nearby, while shrubs and graminoids contributed more cover to the plots away from rims and outcrops. The data suggest that rims and outcrops support greater amounts of cushion-plants, and with increasing distance from rims, the importance of cushion-plants is diluted by shrubs and grasses. The extent to which cushion-plants continue to decline in importance with increasing distance from rims and outcrops is unknown.

Arenaria hookeri and *Pseudoroegneria spicata* are almost always present in the cushion-plant vegetation and often contribute a substantial amount of the canopy cover. At many sites, those species are joined by *Phlox muscoides* (a cushion-plant) as a dominant or co-dominant. Elsewhere, *P. muscoides* is absent, and a number of other cushion-plants (*Astragalus spatulatus*, *Astragalus simplicifolius*, *Tetraneuris acaulis*, *Stenotus armerioides*) or non-cushion forbs (especially *Phlox hoodii*) are regularly present and sometimes contribute much of the canopy cover.

Most of the cushion-plant vegetation types identified in cluster analysis classification of the plot data occur at several locations, and neither geographic location nor geologic substrate are good predictors of which type of cushion-plant vegetation is found at a particular place. The cushion-plant vegetation sampled in south-central Wyoming shows no strong similartiy any vegetation types in the National Vegetation Classification.

Vehicle tire tracks and mammal burrows are common along rims, but the magnitude of impacts from these disturbances is unclear. The data suggest that they have not allowed weeds to become a major component of the vegetation, because only a handful of exotic plant taxa were documented in the sample plots, in trace amounts

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INTRODUCTION

In April 2002, the Bureau of Land Management entered into a cooperative agreement with the University of Wyoming's Natural Diversity Database (WYNDD) to survey vegetation dominated by cushion-form forbs on public lands managed by the Bureau's Rawlins Field Office. This project was undertaken because botanical studies in the past had suggested that cushion-plant vegetation in specific areas (including the Ferris Mountains) is unusual and worthy of special management, but little information was available that could provide a frame of reference for the vegetation in specific areas. Potential sampling locations for the project were selected in the spring of 2002. Field work was conducted during June 2002 and June 2003.

Three questions whose answers are important to BLM biologists and managers were posed at the beginning of the project. First, do the cushion-plants that seem so obvious in the short, often sparse vegetation along rims and on rock outcrops occur only there, or are they also present in the nearby, taller, grass and shrub vegetation? If cushion-form forbs are largely restricted to the windblown rims and rock outcrops, then land managers might need to pay special attention to those habitats to assure that healthy populations of the plants persist in the region.

Second, how variable in species composition is the cushion-plant dominated vegetation in south-central Wyoming? If the vegetation varies little from place to place, then protection of this resource on BLM lands might be accomplished through special management of only a few sites. If, on the other hand, many types of cushion-plant vegetation occur in the area, management of more areas might be necessary to maintain the variety of vegetation types on public lands.

Third, is the variability in cushion-plant vegetation related to differences in geographic location or geologic substrate? Plant species in the vegetation at a particular location are drawn from the regional flora, and heterogeneity in that flora might well be reflected in heterogeneity in the cushion-plant vegetation among locations. Regarding geologic substrate, even casual observation shows that cushion-plants are most obvious on rims and outcrops of resistant bedrock. Beyond that, though, do different cushion-plant species occur or dominate on different types of resistant rock?

For this project, "cushion-plant" was defined as a prostrate, acaulescent, tap-rooted forb that typically grows in a dense mat. Examples can be found in a number of plant families and include *Arenaria hookeri* (Caryophyllaceae), *Astragalus spatulatus* (Fabaceae), *Erigeron compositus* (Asteraceae), *Eriogonum acaule* (Polygonaceae), *Draba oligosperma* (Brassicaceae), and *Phlox muscoides* (Polemoniaceae). By "cushion-plant vegetation" is meant the short, often sparse vegetation on rims and outcrops formed in resistant bedrock, where cushion-plants contribute a major proportion of the plant canopy cover. The concept of cushion-plant vegetation used in this project excludes sparse vegetation dominated by non-cushion forbs or sub-shrubs (such as *Atriplex nuttallii* or *Artemisia pedatifida*) that occurs on soft bedrock. In the field, cushion-plant vegetation was defined as vegetation in which cushion-plants were estimated to contribute at least 50% of the canopy cover and the grasses and shrubs common in the surrounding shrub-steppe vegetation contributed < 50% of the canopy cover.

The concepts and methods used in this study are basically the same as those used in a study conducted two years earlier in southwestern Wyoming (Jones 2004).

METHODS

SAMPLE AREA AND SAMPLING POINT SELECTION

Through botanical work and observations in the past two decades by BLM and WYNDD botanists, cushion-plant vegetation was known to grow at the western end of the Ferris Mountains, on Chalk Mountain, and along parts of Shirley Rim. Consequently, these were considered at the outset of the project to be sampling sites. For each, black-and-white digital orthophotoquad quarters (i.e., digital black-and-white photographs) were obtained from the web site of the University of Wyoming's

Geographic Information Science Center (<http://www.wygisc.uwyo.edu/ doqq/search.html>) and incorporated into an ArcView 3.0 geographic information system project (ESRI, Redlands CA, USA) and then examined for features that corresponded to the reported locations of the cushion-plant vegetation. In almost every case, the orthophotoquads showed pale strips or patches along rims and on bedrock outcrops that differed markedly in appearance from the surrounding landscape

Narrow polygon features were then digitized in ArcView atop those bands and patches on the orthophotoquads. A grid of random points was laid over the polygons, and the points that intersected the polygons were selected and numbered. From this subset of points, a second and smaller subset of points was randomly selected to serve as potential sampling points, with the requirement that the potential sampling points at a location be several hundred meters apart. For each potential sampling point, the UTM coordinates (NAD27, Zone 12 North) were determined from ArcView.

A two- or three-person field crew used maps and a geographic positioning system receiver (Trimble GeoExplorer 2, Trimble Navigation Ltd., Sunnyvale CA, USA) to navigate to each of the potential sampling points. If the vegetation at or close to that point met the definition of cushion-plant vegetation, then a sampling plot was laid out and data collected. If not, then the crew moved to the next point.

Other areas (Lost Soldier Divide, Cyclone Rim, the Shirley Mountains, Pine Hill) were suggested by BLM biologists as possible sampling locations, and potential sampling points were selected at these locations in the same manner. Reconnaissance trips were made to Cyclone Rim and parts of the Shirley Mountains before the sampling points were selected.

Land ownership and bedrock geology maps were examined to identify accessible tracts of public land on limestone and sandstone substrates that might serve as additional sampling locations in the eastern part of the project area. After reconnaissance, only two of these areas (one along the Fetterman Road and the other along the Marshall Road) were chosen. Sampling points were chosen subjectively in the field at those locations.

The potential sampling points selected before field work were intended to represent cushion-plant vegetation along rims and on rock outcrops. At some of the sampling areas, additional sampling points were selected subjectively by the crews in the field, in the nearby grass-and-shrub-dominated vegetation. These sampling points, intended to provide data to show in what respects the vegetation along rims and on outcrops differs from the surrounding vegetation, were generally within 100 meters of the plots on rims and outcrops.

DATA COLLECTION

The nested vegetation-sampling plots developed by Stohlgren *et al.* (1995) were used to estimate canopy cover of plants at each sampling point. This plot design features a macroplot (in this case, measuring 10 m x 25 m) with 13 sub-plots inside it (Figure 1). The field crew placed the starting corner for the macroplot close to the sampling point, then used a GPS receiver (Trimble GeoExplorer 2, Trimble Navigation Ltd., Sunnyvale CA, USA) to determine the UTM coordinates (NAD27, Zone 12 North) of the corner's actual location. UTM coordinates were recorded by hand. The azimuth of the macroplot's long axis was determined with a sighting compass.

Sampling began with the microplots: in each, the percentage of the microplot beneath the canopy of each plant species was estimated, and was recorded as the mid-point of the appropriate cover range (Table 1). 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. After canopy cover had been estimated in the 10 microplots, the two corner sub-plots were searched for species that had not been recorded in the microplots, and their presence was noted. The center sub-plot was next searched for species that had not been recorded in the microplots or in the corner sub-plots, and finally, the area of the macroplot outside of the microplots and the corner and center sub-plots was searched for new species. With this procedure, canopy cover was recorded only for the plants in the microplots, and presence alone was recorded for species in the larger sub-plots and

in the macroplot. Specimens of plants that could not be identified to species, or for which identification was uncertain, were collected, pressed, and identified later.

The values for a species from the 10 microplots were then averaged to give an estimate of the species's cover for the entire macroplot, and that estimate was converted to the mid-point of the appropriate cover range. For example, suppose that the 10 values for species A (each a mid-point value from a microplot) averaged 7.6, which average falls within the 5% - 15% cover range (Table 1). The value for species A for the macroplot then was given as 10, the mid-point of that range. Any species that was not found in a microplot but was found in one of the corner plots, or in the center plot, or in the macroplot was assumed to have a canopy cover of less than 1%, and was assigned a value of 1 for the macroplot. This method of estimating canopy cover allows one to say that the canopy cover for a given species in a macroplot falls within a range. It does not yield a precise, point estimate of canopy cover for the species.

The vegetation at the sampling point was briefly described and, at most plots, a photograph was taken of the macroplot. The percentage of the ground surface in the macroplot covered by each of 9 categories of material (Table 2) was estimated. Selected environmental variables were recorded, including type of surface material (residual, colluvial, alluvial, or aeolian), soil texture (based on one hand texture of the top 10 cm of soil, made near the starting corner), slope steepness, and aspect.

DATA ANALYSIS

-- Classification of Plots

The sample plots were classified into groups using cluster analysis, a procedure that combines individual plots 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 (in this case, using Sorensen's coefficient) and then is converted to a measure of dissimilarity, or distance in a space whose dimensions are determined by the species. 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 centroid of the group to each remaining plot or to the centroid of every other group is calculated. The classification performed here used flexible-beta linkage (beta = -0.25) to combine plots and groups[1].

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 9). 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.

Generally, the goal in cutting the classification dendrogram is to produce a classification with enough groups that the variability in the original plot data can be summarized and explained, without having groups so large that the ecological differences between them is obscured. PC-ORD provides two scales by which to judge the effect of combining plots and groups (McCune and Mefford 1999, McCune and Grace 2002). Combining plots into a group results in the loss of some of the original information about how dissimilar the plots are from one another, and when all the plots have been combined into one group, all of that information has been lost. PC-ORD includes on the dendrogram a scale showing the amount of that information remaining in the data at each step in the classification,

[1] Analysis was conducted with PC-ORD, Version 4.27; MjM Software Design, Gleneden Beach, OR, USA.

as a percentage of the information on plot-to-plot distances that was present in the original data matrix. A second scale on the dendrogram, the objective function, shows the amount of variability among the plots within the groups, calculated as the sum of squares of the distance between each plot and the group centroid. This variability increases as plots are added to groups, because the closest (that is, most similar) plots are combined first, and the most distant (that is, most dissimilar) plots and groups are combined later. In terms of these scales, the goal of cutting the classification dendrogram is to have a classification with low variability within groups and that retains a large amount of the information present in the original data set.

Indicator species analysis (ISA) is a second non-parametric statistical procedure that helps in indicating where the classification dendrogram might best be cut (McCune and Grace 2002). ISA identifies the species that can be used to distinguish between groups. It starts by calculating, for each species in each group, the proportional abundance (that is, the degree of concentration of the species in the group) and the frequency (the proportion of plots in the group that contain the species). The abundance and frequency values are then combined into an indicator value for each species in each group. For each species, the indicator values for each group are compared, and the largest is saved as the final, observed indicator value for the species. Indicator values range from 0 to 100. A value of 100 for species *i* in group *j* indicates that species *i* is found only in the plots of group *j* and is found in all of those plots, and so is a perfect indicator of group *j*.

The statistical significance of each observed indicator value can be judged through a Monte Carlo test, in which the plots are randomly assigned to groups and species indicator values are calculated for those groups. This random reassignment of plots is repeated 1000 times, and the distribution of possible indicator values for a species from the Monte Carlo test allows one to calculate the probability of obtaining an indicator value as large as the one observed in the real data.

-- Comparison of Plot Groups

Plots along rims and on rock outcrops were compared to plots back from rims and outcrops for the number of species of each growth-form, the amount of canopy cover of each growth-form, and the proportion of the total canopy cover contributed by each growth-form. Each of these comparisons was made in a two-way analysis of variance (using the general linear model in Minitab for Windows Release 12.21; Minitab, Inc., 1998), with plant growth-form, plot position, and the growth-form-by-position interaction as the model factors. Pairwise comparisons for each growth-form were made with the Bonferroni method of multiple comparisons of means.

After plot groups had been identified with cluster analysis, Kruskal-Wallis non-parametric tests (also performed in Minitab Release 12.21), followed by non-parametric multiple comparisons (Zar 1984), were used to examine differences between plot groups in numbers of species and canopy cover of plants of different plant growth-forms.

-- Relationship to geologic substrate

The geologic map unit upon which each sample plot was located was determined by comparing the geographic coordinates of the plots to a digital geologic map in ArcView 3.2. Plot coordinates had been determined in the field as described above. The digital geologic map (U.S. Geological Survey 1994), obtained from the University of Wyoming's Geographic Information Science Center, was based on the latest 1:500,000-scale geologic map of Wyoming (Love and Christiansen 1985).

RESULTS

FLORA AND VEGETATION

Data were collected from 42 sample plots, located mainly in large blocks of public lands (Figure 2, Table 3). Twenty-four of the plots were positioned along rims or on rocky hilltops, and 18 away from rims and outcrops. Two-hundred forty-nine taxa of vascular plants were recorded in the sample plots (Table 4). (Names and codes of plants are from USDA Natural Resources Conservation Service 2002.) Forty plants (16% of the total), 39 of them forbs and 1 grass, could not be identified to genus. An additional 25 (10%) were identified only to genus. Seventy-four percent of the plants were identified to species. Note that some of the unknowns recorded in different plots likely were the same species, and some of those species likely had been identified in other plots and hence are duplicates. If the unknown plants could have been identified, then the number of taxa encountered would certainly have been smaller.

Of the 249 taxa, only four are known or strongly suspected to be exotics. None of those were widespread. *Taraxacum laevigatum*, the most widespread exotic, was found in only 7 of the 42 plots, *Alyssum desertorum* was found in only 3, *Taraxacum* sp. (which may have included native plants) was found in 2, and *Sisymbrium altissimum* was found in 1 plot (Table 4, Table 5). Some of the unknown plants may be exotics, and had they been identified, the proportion of exotics in the flora may have been slightly higher. The four exotic taxa occurred in 12 of the 42 plots (Table 6). Eleven of those plots had just one exotic taxon, and the twelfth had two taxa. In these plots, the known exotics contributed only a trace of canopy cover.

Half of the plants were found in only one or two sample plots, and 41% of them were found in only one plot (Figure 3, Table 5). This preponderance of infrequent species is no doubt due in part to the large proportion of unknown plants. Of the 40 unknowns, 37 were recorded from only one plot, and if their identities were known, the number of species from a single plot would decrease substantially. Even so, most of the species documented in the project are far from widespread: note than only 6 of the 249 plant taxa occurred in more than half of the plots (Figure 3).

The plots along rims and on outcrops had significantly fewer forb species per plot, but not of other growth-forms, and they had fewer species in total (Figure 4). Per-plot canopy cover of shrubs, graminoids, and forbs, and total canopy cover of all plants, was significantly less in the rim plots than the plots away from rims (Figure 5). The relative cover of cushion-plants (that is, the proportion of the canopy cover contributed by cushion-plants) in rim and outcrop plots was twice that in nearby plots, and the relative cover of shrubs and gramnoids was less (Figure 6).

Most of the individual cushion-plant species were encountered more often in plots along rims and on outcrops than in the plots back from rims, but the differences between the plot types in this regard were modest. Of the 37 species considered to be cushion-form forbs, only seven were found exclusively in plots along rims (Figure 7). An additional 15 species were found in both types of plots but in a higher proportion in rim plots than in the back-from-rim plots. For only 9 of those was the frequency in the rim plots $\geq$ 1.5 times that in the back-from-rim plots.

Two species were found only in plots back from rims, and 11 more were found in a higher proportion of the back-from-rim plots than in the rim plots, or in the same proportion in the two types of plots. The most common of the cushion-plants (also the most common of all species in the plots), *Arenaria hookeri*, was found in nearly equal proportions in both types of plots.

Ground-cover in the plots along rims and on rock outcrops consisted mostly of gravel (Figure 8). Percent cover of litter and of soil was significantly ($p=0.05$) less in those plots than in the plots back from the rims.

CLASSIFICATION OF PLOTS BASED ON CANOPY COVER

The cluster analysis classification of plots based on plant canopy cover also recognized a distinction between the vegetation along rims and on outcrops and the adjacent vegetation. This distinction appeared in the relative amounts of the most common plant species.

In a classification such as this one, groups of plots differ from one another in the amounts of each species that they contain, not just in the species present; the point is to find vegetation types that are repeated combinations of certain amounts of some species. Abundant species typically are given greater weight than are rare species. This approach is widely used in the U.S. and is the basis for the national vegetation classification being developed by the Ecological Society of America's Vegetation Panel (Jennings *et al.* 2003).

Often, species that occur in only a few plots obscure the relationships between plots in terms of relative amounts of species. Those rare species can be excluded as long as species richness is not being used as a feature for classifying the vegetation (McCune and Grace 2002). Hence, 124 taxa that occurred in only one or two sample plots and contributed < 10% canopy cover to a plot were excluded from the classification based on canopy cover data. The number of species was also reduced slightly by combining sub-specific taxa as follows:

-- *Erigeron ochroleucus* Nutt. and *Erigeron ochroleucus* Nutt. var. *scribneri* (Canby ex. Rydb.) Cronq. were combined into *Erigeron ochroleucus*,
-- *Eriogonum ovalifolium* Nutt. and *Eriogonum ovalifolium* Nutt. var. *purpureum* (Nutt.) Durand were combined into *Eriogonum ovalifolium*, and
-- *Tetraneuris acaulis* (Pursh) Greene, *Tetraneuris acaulis* (Pursh) Greene var. *acaulis*, and *Tetraneuris acaulis* (Pursh) Greene var. *caespitosa* A. Nels. were combined into *Tetraneuris acaulis*.

These combinations made the analysis conform more closely to a similar analysis of data from southwestern Wyoming (Jones 2004).

The data set used in the cluster analysis contained the remaining 121 taxa. The canopy cover data for these taxa were then changed from absolute cover (the mean cover-class for each taxon in each plot) to relative cover (the cover-class for each taxon in a plot divided by the total cover in the plot). This "relativization by plot total" (McCune and Grace 2002) focuses the analysis on the proportions of taxa in each plot (rather than absolute amounts of each taxon) and decreases the influence of differences between plots in the amounts of vegetation present.

Several statistics reveal the effect of reducing the number of species and relativizing the cover-class values (Table 11). In the full, unrelativized data set, the heterogeneity among plots in number of taxa (the beta diversity)[2] was 7.83, an indication that the data set might be difficult to analyze successfully (McCune and Grace 2002). The average number of taxa per sample plot (average species richness, or alpha diversity) also was high, at 28 species. In contrast, the coefficient of variation among plots in total cover was not particularly high, at 41%. Excluding the rarest species reduced the heterogeneity between plots (beta diversity) to 3.34, the average number of species per plot (alpha diversity) to 24.5, and the number of empty cells in the species-by-plot matrix from 88.7% to 79.8%. Relativizing the data by plot total reduced the coefficient of variation in cover to 0.

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[2] The measure of beta diversity used here is $B_w = (S_c / S) - 1$, where S_c = the number of species found in all plots of a group and S = the average number of species per plot. B_w expresses the degree to which individual plots contain all of the species found in the group of plots. If $B_w = 0$, the minimum value possible, then every plot contains all of the species found in the group of plots. The maximum possible value of B_w is Sc-1, and is obtained when each plot contains only one species and, hence, no species are shared among plots. See discussion in McCune and Grace 2002, pp. 30 - 31.

Cluster analysis of this reduced data set produced two large plot-groups that remained separate until the final step of the analysis (Figure 9) and that mostly divided the plots on rims and outcrops from the plots away from rims and outcrops. Twenty-five plots from along rims and 3 plots back from rims composed plot-group 2-1, and 13 plots back from rims and one plot from a bedrock outcrop composed plot-group 2-14. Indicator species analysis was not particularly helpful in identifying plant species that distinguish these groups from each other. For group 2-1 of the plots along rims, indicator species analysis identified 7 species as statistically-significant (p=0.05) indicators (Table 12), but all had low indicator values, in most cases because the plants had low frequency among the plots of the group. For group 2-14 of the plots away from rims, indicator species analysis identified 35 plant species as statistically-significant indicators (p=0.05) of the plots in this group (Table 12), but this is a weak collection of indicators, also because most of the species occurred in few plots. Only one species, *Elymus lanceolatus* ssp. *lanceolatus*, had an indicator value higher than 75 of a possible 100. Two others, *Phlox hoodii* and *Poa secunda*, were present in all plots of group 2-14 but had low indicator values because they were fairly common in plots of group 2-1 as well. Only two cushion-plants were among the indicators. *Elymus lanceolatus* ssp. *lanceolatus*, *Phlox hoodii*, and *Poa secunda* were widespread but did not consistently contribute much canopy cover.

The weak indicator values suggest that each of these two groups is heterogeneous in species composition and might best be understood by examining the smaller groups that compose them. At the four-group level of the classification dendrogram (Figure 9), group 2-1 of the plots along rims was divided into 3 smaller groups. Each of these plot-groups is discussed below, as is the group of plots back from rims.

Plot-group 4-4 (n=6)

These six plots, all from Chalk Mountain (Figure 10), had, among the plot-groups, the greatest number per plot of cushion-plant species (Figure 11) and the greatest cover of cushion-plants (Figure 12). Cushion-plants and non-cushion forbs contributed the greatest number of species (Figure 14) and, along with graminoids, the most canopy cover (Figure 15). Cushion-plants accounted for the greatest proportion of the canopy cover among the plant growth-forms (Figure 16).

Phlox muscoides, *Tetraneuris acaulis*, and *Castilleja* sp. occurred in all of these plots, and the first two species (both cushion-plants) contributed substantial cover in three plots (Table 19). Other species present in most plots and that contributed substantial cover were *Pseudoroegneria spicata*, *Paronychia depressa*, *Stenotus armerioides*, *Ericameria nauseosa*, *Erigeron engelmannii*, *Arenaria hookeri*, and *Eriognonum acaule*. Four of these species are cushion-plants. *Pseudoroegneria spicata* strongly dominated several plots and grew in most. Eighteen species were identified as statistically-significant indicators (p=0.05; Table 20), but only 3 had high indicator values (>75 out of 100). Those three were found only in plots of this group.

The plots in group 4-4 had, on average, the least amount of litter and bare soil as ground cover (Figure 17). No exotic plant taxa were noted in these plots (Table 6).

Plot-group 4-12 (n=10)

A second group of plots within plot-group 2-1, group 4-12, consisted of ten plots in which the cushion-plant *Phlox muscoides* contributed a substantial amount of cover and often dominated, and *Arenaria hookeri* (another cushion-plant) usually was present in substantial amounts (Table 22), compared to other plot-groups. A large proportion of the canopy cover in these plots was contributed by cushion-plants (Figure 13), which contributed more cover than did other forms of plants (Figure 15, Figure 16). Cushion-plants were the most common form of plants in plots of this group (Figure 14). These plots had a large amount of gravel on the soil surface (Figure 17). Two cushion-plant species, *Phlox muscoides* and *Lesquerella condensata*, were identified as statistically significant indicators of this group (Table 20), but neither had a particularly high indicator value, because *Phlox muscoides* was present in group 4-4 as well, and *Lesquerella condensata* had low frequency in the plots of group 4-12.

Plot-group 4-12 was split into two sub-groups at the 7-group level of the classification (Figure 9). Group 7-12 consisted of three plots from Cyclone Rim in the northwestern part of the study area (Figure 10), in which the sub-shrub *Artemisia pedatifida* contributed substantial cover (along with the cushion-plants *Phlox muscoides* and *Arenaria hookeri*), and the grasses *Achnatherum hymenoides* and *Hesperostipa comata* were present (Table 22). The other sub-group, 7-17, contained seven plots from throughout the study area, that lacked *Artemisia pedatifida*, *Achnatherum hymenoides*, and *Hesperostipa comata*, and often were co-dominated by *Pseudoroegneria spicata*.

Two of the plots in this group included the exotic species *Taraxacum laevigatum* in trace amounts (Table 6).

Plot-group 4-1 (n-12)

The third major group of plots along rims, group 4-1, contained 12 plots in which *Pseudoroegneria spicata*, *Arenaria hookeri*, and *Phlox hoodii* were widespread and usually dominated or co-dominated (Table 23). *Phlox muscoides*, a major species in the two other groups of rim plots, was not recorded in the plots of this group. Non-cushion forbs were the most common single growth-form in these plots (Figure 14) and they, along with cushion-plants and graminoids, contributed most of the cover (Figure 15, Figure 16). Four species (two of them cushion-plants) were identified as statistically significant indicators (Table 20), but all had low indicator values.

At the 7-group level of the classification, this plot-group was divided into two sub-groups (Figure 9). Group 7-1 consisted of 5 plots from the Muddy Gap area (Figure 10), in which *Tetraneuris acaulis* and *Astragalus simplicifolius* were present. *Artemisia nova* was present in most of those plots and contributed substantial canopy cover to two of them. The other 5 plots, from the Shirley Rim and the Miller Hill areas, were in group 7-25. *Stenotus acaulis* usually was present and often contributed a substantial amount of canopy cover. *Astragalus spatulatus* also was present but in small amounts.

Two of the plots in this group had trace amounts of the exotic forb *Alyssum desertorum* and one had a trace of *Taraxacum laevigatum* (Table 6).

Plot-group 4-14 (n=14)

These are nearly all plots intended to represent the vegetation back from rims and around rock outcrops. These 14 plots had more species and more cover of shrubs, graminoids, and forbs than did the plots along rims, and fewer species and cover of cushion-plants (Figure 11 and Figure 12). More species of plants in these plots were non-cushion forbs than other growth-forms (Figure 14), and forbs and graminoids contributed more cover than did plants of other growth-forms (Figure 15). Shrubs, graminoids, and forbs accounted for the largest proportions of the canopy cover per plot (Figure 16). The ground-cover in these plots was primarily litter and bare soil (Figure 17).

Eighteen plant species were identified as statistically significant indicators for this group (Table 20), but only *Elymus lanceolatus* ssp. *lanceolatus* had a high indicator value. The others were weak indicators either because they occurred in few plots of this group, or because they were present in plots of other groups as well.

At the 7-group level, the plots of this group were split into two groups (Figure 9). Group 7-14 contained 10 plots from throughout the study area (Figure 10), in which *Phlox hoodii*, *Poa secunda*, and *Elymus lanceolatus* ssp. *lanceolatus* were present and accounted for substantial cover in most plots (Table 24). *Arenaria hookeri* was the only widespread cushion-plant in the plots of this group. *Artemisia tridentata* ssp. *wyomingensis* strongly dominated three of the plots. Four of these plots contained trace amounts of one exotic taxon (Table 6). Four plots on Chalk Mountain were in the other sub-group, 7-32 (Figure 10). *Phlox hoodii*, *Poa secunda*, and *Elymus lanceolatus* ssp. *lanceolatus* also were present in these plots, as were a number of additional species (Table 24), of which only *Poa fendleriana* contributed a substantial amount of cover. *Artemisia nova* and *Artemisia tripartita* ssp. *rupicola* each were present in most plots and each dominated or co-dominated in two. Three of these 4 plots contained trace amounts of one exotic taxon or two taxa (Table 6).

The characteristics of the plot-groups are summarized in Table 25.

GEOLOGIC AND GEOGRAPHIC FACTORS

Of the 4 major plot-groups, only group 4-4 was restricted to a single geologic map unit. The six plots of that group, all of which occurred at Chalk Mountain (Figure 10), were located on Miocene-age tuffaceous sandstone, siltstone, and marl (Table 26). Plots from each of the other two groups of plots along rims (4-1 and 4-12) occurred on a number of geologic map units. Most of these map units include several rock types (Table 26), and it is impossible to tell on which rock type within a map unit a plot lay. This imprecision in the geologic map units may be obscuring relationships between vegetation composition (as expressed by the cluster analysis classification) and rock type.

Plots back from rims, composing plot-group 4-14, also were found on a variety of geologic map units that include a variety of rock types (Table 26), and relationships between them and rock types may be similarly obscured.

Of the three major groups representing cushion-plant vegetation, only group 4-4, in which cushion-plants dominated the vegetation, is restricted geographically; all six plots were located at Chalk Mountain (Figure 10). The plots of group 4-1 were found throughout the study area, including the north-central part near plots of groups 4-4 and 4-12. Plots of group 4-12 were scattered throughout the study area and occurred near plots of groups 4-1 and 4-4. At the 7-group level of the classification, the plot groups were more restricted geographically -- group 7-1 to the Muddy Gap area, group 7-12 to Cyclone Rim, and group 7-17 to the northeastern part of the study area.

SIGNS OF DISTURBANCE IN CUSHION-PLANT STANDS

All but three of the plots along rims and on outcrops contained a sign of at least one form of disturbance (Table 27). Eleven of those plots had signs of disturbance by humans, primarily the presence of two-track roads. Seventeen of the plots along rims contained signs of disturbance by animals, mostly cattle droppings (in many plots, from previous years), which were assumed to indicate that cattle grazed or rested in the plot. Mammal burrows (primarily from pocket gophers) were noted in six plots.

Signs of disturbances were recorded in a lower proportion of plots back from rims (Table 27). Mammal burrows were the most common sign of disturbance in those plots. Signs of anthropogenic disturbance were not noted from the plots back from rims.

DISCUSSION

COMPOSITION OF CUSHION-PLANT VEGETATION

This study focused on the vegetation of windblown rims and rock outcrops where cushion-form forbs appear to dominate. One of the questions posed is whether those rims and outcrops provide habitat for cushion-plant species that are absent from the environments occupied by the nearby grasslands and shrub steppe. To the extent that the data compare different vegetation types, they suggest that this is not the case. Of the 37 plant species considered in this report to be cushion-plants, only seven were found in plots on rims and outcrops but not in plots in the nearby vegetation (Figure 7). For only 15 additional species was the per-plot canopy cover in plots along rims $\geq$ 1.5 times that in plots back from rims. Two cushion-plant species were recorded only in the plots back from rims, and 11 more had greater per-plot canopy cover in those plots than in rim plots. These numbers suggest, at most, a modest difference between rims and other parts of the landscape in the plant species present.

The vegetation along rims and on outcrops differs from the surrounding vegetation mainly in the amounts of different species present. Vegetation on rims and outcrops has roughly twice as much of the canopy-cover contributed by cushion-plants (Figure 6) and less canopy cover of shrubs,

graminoids, and non-cushion forbs (and of total plant canopy cover) (Figure 5). This cushion-plant vegetation also contains fewer plant species and fewer non-cushion forbs, at least in limited areas (Figure 4).

This study does not, however, provide the last word on whether rims and rock outcrops provide unusual habitats. It is possible that, had the back-from-the-rim plots been placed farther from the rims and rock outcrops, the data would show that the cushion-plant vegetation along rims and on outcrops differs from the surrounding grassland and shrub-steppe in species composition as well as amounts of species -- that is, that the rims and outcrops do provide habitat for cushion-plants that are virtually absent from the surrounding vegetation. In this study, we minimized the time spent at each location so that we could collect data from as many stands of cushion-plant vegetation as possible, and hence the back-from-the-rim plot was, in nearly all cases, placed within several hundred meters of the rim plot. This was a great enough distance to produce a difference in the soil environment (Figure 8). But the back-from-the-rim plot at many locations may have been so close to the rim that it was sampling an ecotone between the rims and the matrix vegetation farther away.

The data suggest that rims and outcrops support greater amounts of cushion-plants, and with increasing distance from rims, the importance of cushion-plants is diluted by shrubs and grasses. The extent to which the importance of cushion-plants continues to decline with increasing distance from rims and outcrops is unknown. A comparison of the plot data from this project to those from other projects where plots were located throughout the shrub-steppe and grass vegetation of the region will be useful.

A second point of this project was to characterize the variability in cushion-plant vegetation throughout south-central Wyoming. The classification of plots into groups, based on the relative cover of the most commonly encountered plant species, is an expression of that variability. In cushion-plant vegetation throughout the study area, the two most common species are *Arenaria hookeri* (a cushion-plant) and the grass *Pseudoroegneria spicata*. Both contribute a substantial proportion of the canopy cover at most sites and often dominate or co-dominate the vegetation. *Phlox muscoides*, another cushion-plant, often occurs with them as a dominant or co-dominant. At many sites in the northeastern part of the study area, no additional species consistently accompany these three common species, at least in stands of the size measured by 10 m x 25 m sample plots. This vegetation is represented by plot group 4-12, sub-group 7-17. At Cyclone Rim in the northwestern part of the study area, where the cushion-plant vegetation occupies a long, narrow, low outcrop of resistant rock, three additional species occur with *A. hookeri*, *P. spicata*, and *P .muscoides*: the sub-shrub *Artemisia pedatifida* and the grasses *Hesperostipa comata* and *Achnatherum hymenoides*. This vegetation is represented by group 4-12, sub-group 7-12.

On Chalk Mountain, *P. spicata*, *A. hookeri*, and *P. muscoides* occur in the cushion-plant vegetation with *Castilleja* sp. (a non-cushion forb) and the cushion-plants *Paronychia depressa* and *Tetraneuris acaulis*. Plot-group 4-4 represents this vegetation.

In much of the cushion-plant vegetation in the study area, *Phlox muscoides* appears to be absent, and *Arenaria hookeri* and *Pseudoroegneria spicata* are joined by the non-cushion forb *Phlox hoodii* (plot group 4-1). A handful of additional species are consistently present in this vegetation at different sites, sometimes in substantial amounts. In the Muddy Gap area, *A. hookeri*, *P. spicata*, and *P. hoodii* grow with the cushion-plants *Tetraneuris acaulis* (also present at Chalk Mountain) and *Astragalus simplicifolius*, and the shrub *Artemisia nova*. This vegetation is represented by sub-group 7-1. In the southern part of the study area and in the north-central part, the vegetation on some sites includes the cushion-plants *Astragalus spatulatus* and *Stenotus acaulis* growing with *A. hookeri*, *P. spicata*, and *P. hoodii*. This vegetation is represented by plot group 7-25. This cushion-plant vegetation without *Phlox muscoides* occurs in the north-central part of the study area (the Shirley Mountains) near sites where *Phlox muscoides* is an important part of the vegetation (Figure 10).

Cushion-plant vegetation varies enough that no one site can be said to represent the composition of this type of vegetation throughout south-central Wyoming.

COMPARISON WITH SOUTHWESTERN WYOMING

The cushion-plant vegetation in this study area is generally similar in species composition to that described from southwestern Wyoming (Jones 2004). In southwestern Wyoming, as in this study area, *Arenaria hookeri* is the most widespread cushion-plant and it contributes substantial cover at most sites. (That species also is common in the vegetation back from rims in both areas.) At many sites in southwestern Wyoming, *Phlox muscoides* dominates or co-dominates with *A. hookeri* and the vegetation has a strong resemblance to that of plot-groups 4-4 and 4-12 from this study. In other southwest Wyoming sites, *Phlox muscoides* is absent and *A. hookeri* is joined by *Astragalus spatulatus*, *Tetraneuris torreyana*, and the non-cushion forbs *Artemisia frigida* and *Arenaria nuttallii*. The vegetation in southwestern Wyoming, though, rarely contains *Pseudoroegneria spicata* as a dominant or co-dominant plant, as does the cushion-plant vegetation from this study area (that grass dominates in vegetation back from some rims in southwestern Wyoming), and it appears to contain more *Poa secunda* than the cushion-plant vegetation from this area. Future analysis on a combination of the south-central Wyoming and southwestern Wyoming data sets will give a better picture of cushion-plant vegetation across southern Wyoming.

Although the extent of cushion-plant vegetation at each sampling site was not quantified in either southwestern Wyoming or in this project, observations and notes suggest that this vegetation occurs in larger stands in the southwest than in this study area. This possibility might be examined by analysis of aerial photographs or satellite images.

GEOLOGIC AND GEOGRAPHIC FACTORS

The distributions of the three major plot-groups representing cushion-plant vegetation, groups 4-1, 4-4, and 4-12, suggest that geographic location has little to do with differences in the amounts of the most common species. The proximity of plots with substantial amounts of *Phlox muscoides* (plot group 4-4) to those with no *Phlox muscoides* (group 4-1) in the Shirley Mountains - Chalk Mountain area (Figure 10) suggest that these major differences are not due to geographic factors. Finer distinctions in species composition, though, as reflected at the 7-group level of the classification, may be due to geographic differences. A relationship of the composition of cushion-plant vegetation to geographic location may appear in an examination of the combined data from this study and the southwestern Wyoming study (Jones 2004).

Unfortunately, the geologic substrate of each plot was not characterized in the field, and the resolution of the state-wide digital geologic layer is too coarse for determining which rock type in a map unit underlies the plot. Reference to more detailed geologic maps of smaller areas, or to information gathered in the field, might yield useful information. Until such an analysis can be performed, though, there is no clear picture of how the composition of cushion-plant vegetation responds to geologic substrate.

RELATIONSHIP OF THE PLOT-GROUPS TO THE NATIONAL VEGETATION CLASSIFICATION

The U.S. National Vegetation Classification provides a framework for interpreting vegetation types around the country. The Ecological Society of America's Vegetation Panel recently adopted guidelines for using plot data to identify the plant associations that will constitute the most detailed level of the national classification (Jennings *et al.* 2003). In the meantime, the national classification already includes a list of plant associations and plant alliances (slightly broader vegetation units that subsume related plant associations; NatureServe 2004) taken primarily from the literature. Many of these have not been described at all or are only poorly described, and the existing list of plant associations is incomplete. Still, a comparison of local classifications, such as this one of south-central Wyoming cushion-plant vegetation, to the existing national classification can help resource managers understand the context for vegetation in their areas.

The list of plant associations and alliances in the national classification at present contains one type that resembles the cushion-plant vegetation from south-central Wyoming (Table 28). The *Arenaria hookeri* Barrens Herbaceous Alliance has been described from slopes and ravines developed in siltstones in the shortgrass steppe of northeastern Colorado and western Nebraska (NatureServe 2004). *Arenaria hookeri* is considered a diagnostic species in that alliance, and a number of other forbs (including *Astragalus spatulatus*) may be present. This vegetation association is poorly enough known that the single association within it, the *Arenaria hookeri* Barrens Herbaceous Vegetation Association, has been assigned no conservation status rank. The three groups of plots with substantial amounts of cushion-plants, groups 4-1, 4-4, and 4-12, probably can be assigned to the *Arenaria hookeri* Alliance, but the description of that alliance must be substantially changed.

The remaining plot group, 4-14, in which shrubs, graminoids, and non-cushion forbs are the main species, has no obvious place in the national classification. An *Elymus lanceolatus* Herbaceous Alliance has been described from western Montana, Washington, and Oregon, but the description of that type suggests that it is substantially different in species composition and the sites on which it grows from the plots in group 4-14.

DISTURBANCE IN CUSHION-PLANT VEGETATION

Anthropogenic disturbance of some form is common on rims and rock outcrops, with evidence of at least one form of disturbance being noted in 11 of 24 plots (Table 27). Unvegetated vehicle trails (two-track roads) or tire tracks in the vegetation were noted at seven of the 24 plots along rims or on rock outcrops. This is a lower percentage (29%) than was observed in southwestern Wyoming (14 of 17 plots, or 52%; Jones 2004). Signs of vehicle traffic may have been more common in southwestern Wyoming because more of the sample plots there lay along extensive rims that afford easy travel. In this study, more of the plots lay on rounded outcrops of resistant rock that are less appealing as travel routes. As was the case in the southwestern Wyoming study, the plot data say little about the impact of vehicles on the cushion-plant vegetation. The presence of unvegetated vehicle tracks demonstrates beyond a doubt that some level of vehicle traffic kills the plants. In many cases, the tracks lay in ruts noticeably lower than the undisturbed ground surface, due to compaction of the soil, or to wind deflation of the bare surface, or both. No estimates were made of the proportion of the ground surface at the sampling sites disturbed by vehicle tracks. The presence of tire tracks without ruts is more worrisome; if vehicles begin to travel these new tracks often enough, then unvegetated ruts probably will form and a substantial part of the vegetation be killed.

Burrowing mammals are common in cushion-plant vegetation and in the adjoining vegetation types. Mammal burrows (in most cases, probably made by pocket-gophers, *Thomomys* sp.) were noted at a third of the plots along rims and on outcrops, and in 44% of plots away from rims and outcrops (Table 27).

The paucity of exotic weed species at the sample sites, despite the frequent signs of disturbance, is encouraging. The weed species now in the region may be unable to survive in environments along rims and on outcrops. It is possible, though, that vehicles and burrowing mammals may have created suitable habitat in the vegetation for weeds but their propagules have not yet reached the sites visited in this project.

CONCLUSION

The visually-distinct vegetation growing on rims and rock outcrops in south-central Wyoming differs from the nearby shrub-steppe and grass vegetation in having more cushion-form forb species and a greater proportion of the canopy cover contributed by cushion-form forbs. Different species also generally dominate in the cushion-plant vegetation along rims and on outcrops than in the nearby vegetation. Vegetation on rims and outcrops shares many plant species with the nearby shrub-steppe

and grassland, but it is unclear whether or not the vegetation at greater distances also shares a substantial number of species.

Species widespread in the cushion-plant vegetation and that often contribute a substantial amount of canopy cover are *Arenaria hookeri* (a cushion-plant also common in the shrub-steppe and grassland), *Phlox muscoides* (another cushion-plant, common in some areas but missing from others), and *Pseudoroegneria spicata* (a bunchgrass). The amounts of these species, and of other species (especially cushion-plants, non-cushion forbs, and sub-shrubs), vary from site to site, but no group of species seems to provide a basis for clear delineation of cushion-plant community-types. The cushion-plant-rich vegetation in this part of the state generally resembles, in structure and in species composition, that in southwestern Wyoming.

The data from this study, and from a similar study in southwestern Wyoming (Jones 2004) suggest that the rocky, windblown rims and rock outcrops do not provide clearly delimited habitat for plant species that are absent from nearby shrub-steppe and grass vegetation. Comparison of these data to plot data from shrub-steppe and grassland farther away may show that the plants common on the rims and outcrops are very rare throughout the matrix vegetation, and that rims and outcrops are important to maintaining the floristic diversity of the region.

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TABLES

Table 1. Canopy cover ranges and mid-points used in vegetation sampling.

% 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. Categories of ground cover recorded in the sampling plots

Category	Description
Bare Soil	Particles < 2 mm across
Gravel	Particles 2 mm - 75 mm across
Cobble	Rocks 75 mm - 250 mm across
Boulder	Rocks > 250 mm across
Bedrock	Consolidated rock
Litter	Loose organic matter < 6 mm across
Wood	Loose organic matter > 6 mm across
Lichen	Fruticose lichens on soil surface
Moss	--

Table 3. Sampling plots used in the BLM Rawlins Field Office cushion-plant project.

Plot Name	Position	Date	UTM Northing	UTM Easting	UTM Datum	UTM Zone	Township	Range	Sec.	1/4-sec.	7.5' Map Name	Elev. (ft.)
02BAI01.01	Rim	5/31/2002	4675039	281657	NAD 83	13N	26N	91W	25	NW	Hadsell Spring	8040
02BAI01.02	Back	5/31/2002	4674956	281499	NAD 83	13N	26N	91W	25	SW	Hadsell Spring	8020
02BAI02.01	Rim	6/6/2002	4668643	288752	NAD 83	13N	25N	90W	14	NW	Bairoil	7840
2CHLK01.01	Rim	5/29/2002	4690003	377676	NAD 83	13N	28N	81W	36	NE	Wild Irish Reservoir	7900
2CHLK0610.01	Back	6/10/2002	4690287	377251	NAD 83	13N	28N	81W	36	SW	Wild Irish Reservoir	7850
2CHLK0612.01	Rim	6/12/2002	4690268	377275	NAD 83	13N	28N	81W	36	NW	Wild Irish Reservoir	7800
2CHLK0604.01	Back	6/4/2002	4690070	377736	NAD 83	13N	28N	81W	36	NE	Wild Irish Reservoir	7900
2CHLK0606.01	Rim	6/6/2002	4690492	377254	NAD 83	13N	28N	81W	36	SW	Wild Irish Reservoir	7750
2CHLK0606.02	Back	6/6/2002	4690525	377278	NAD 83	13N	28N	81W	36	NW	Wild Irish Reservoir	7900
2FER01.01	Rim	5/30/2002	4690746	299461	NAD 83	13N	27N	89W	2	NW	Muddy Gap	6800
2FER01.02	Back	5/30/2002	4690771	299577	NAD 83	13N	27N	89W	2	NW	Muddy Gap	6800
3CYR01.01	Rim	6/16/2003	4678267	716584	NAD 83	12N	26N	97W	14	SE	Five Fingers Butte	7180
3CYR02.01	Rim	6/16/2003	4677942	715136	NAD 83	12N	26N	97W	15	SE	Five Fingers Butte	7100
3CYR02.02	Back	6/16/2003	4677773	715103	NAD 83	12N	26N	97W	15	NE	Five Fingers Butte	7120
3CYR03.01	Rim	6/17/2003	4678772	731433	NAD 83	12N	26N	95W	17	NW	Cyclone Draw	7020
3CYR03.02	Back	6/17/2003	4678839	731422	NAD 83	12N	26N	95W	17	SE	Cyclone Draw	7030
3DRY01.01	Rim	6/5/2003	4678939	371577	NAD 83	13N	28N	82W	36	NE	Fourmile Point	7200
3DRY01.02	Back	6/5/2003	4690503	368694	NAD 83	13N	28N	82W	36	NE	Fourmile Point	7120
3FETT01.01	Rim	6/3/2003	4650064	435206	NAD 83	13N	23N	75W	2	NE	Laramie Peak	7185
3FETT01.02	Back	6/3/2003	4649961	435170	NAD 83	13N	23N	75W	2	NE	Laramie Peak	7185
3FM01.01	Rim	6/11/2003	4683473	368823	NAD 83	13N	27N	81W	19	SW	Fourmile Point	7200
3FM01.02	Back	6/11/2003	4683508	368779	NAD 83	13N	27N	81W	19	SW	Fourmile Point	7200
3MB01.01	Rim	6/10/2003	4642985	405176	NAD 83	13N	23N	78W	26	SW	Medicine Bow	6560
3MB01.02	Back	6/10/2003	4643137	405126	NAD 83	13N	23N	78W	26	SW	Medicine Bow	6560

Table 3 (continued).

Plot Name	Position	Date	UTM Northing	UTM Easting	UTM Datum	UTM Zone	Township	Range	Sec.	1/4-sec.	7.5' Map Name	Elev. (ft.)
3MILL01.01	Rim	6/19/2003	4600827	306882	NAD 83	13N	19N	88W	21	NE	Rawlins	7152
3MILL02.01	Rim	6/20/2003	4584735	307791	NAD 83	13N	16N	88W	33	NE	Baggs	7874
3MILL03.01	Rim	6/20/2003	4583230	310083	NAD 83	13N	16N	87W	2	NW	Baggs	8040
3MILL04.01	Rim	6/20/2003	4590201	317988	NAD 83	13N	17N	87W	15	NE	Baggs	7680
3PH01.01	Rim	6/10/2003	4672524	384263	NAD 83	13N	26N	80W	27	NW	Pine Hill	7420
3PH01.02	Back	6/10/2003	4671982	384597	NAD 83	13N	26N	80W	27	NW	Pine Hill	7480
3PH02.01	Rim	6/11/2003	4668662	385659	NAD 83	13N	25N	80W	2	SW	Pine Hill	7840
3PH02.02	Back	6/11/2003	4668602	385612	NAD 83	13N	25N	80W	2	SW	Pine Hill	7840
3SHR01.01	Rim	6/12/2003	4675005	369648	NAD 83	13N	26N	81W	18	SW	The Q Ranch	8520
3SHR01.02	Back	6/12/2003	4674990	369521	NAD 83	13N	26N	81W	18	NE	The Q Ranch	8580
3SHR02.01	Rim	6/12/2003	4676390	365883	NAD 83	13N	26N	82W	14	NW	The Q Ranch	8000
3SHR02.02	Back	6/12/2003	4676420	366061	NAD 83	13N	26N	82W	11	SW	The Q Ranch	7900
3SHR04.01	Rim	6/19/2003	4666168	377257	NAD 83	13N	25N	81W	13	NE	Pine Hill	8320
3SHR04.02	Back	6/19/2003	4666148	377204	NAD 83	13N	25N	81W	13	SE	Pine Hill	8200
3SHRM01.01	Rim	6/4/2003	4693725	392227	NAD 83	13N	28N	79W	21	NE	Mud Springs	7280
3SHRM01.02	Back	6/4/2003	4693762	392234	NAD 83	13N	28N	79W	21	NW	Mud Springs	7285
3SHRM02.01	Rim	6/4/2003	4693260	392538	NAD 83	13N	28N	79W	21	NE	Mud Springs	7723
3SHRM02.02	Back	6/4/2003	4693224	392589	NAD 83	13N	28N	79W	21	NE	Mud Springs	7220

Table 4. The 249 vascular plant taxa documented in the 42 sample plots, sorted by name. Cushion-plants are shown in italic typeface. Taxa known or strongly suspected to be exotic are indicated by **, and taxa of unknown origin are indicated by *. For each taxon, the number of plot of occurrence and the maximum canopy-cover class is shown for all sample plots, for plots along rims, and for plots back from rims.

		All Plots		Rim Plots		Plots Back	
Name	**NRCS Code**	# plots (n=42)	Max	# plots (n=24)	Max	# plots (n=18)	Max
achillea millefolium, common yarrow	acmi2	3	1	0	0	3	1
achnatherum hymenoides, indian ricegrass	achy	7	3	4	3	3	3
agoseris glauca, pale agoseris	aggl	4	3	0	0	4	3
allium cernuum, nodding onion	alce2	1	1	0	0	1	1
allium textile, textile onion	alte	12	1	4	1	8	1
allium, wild onion	alliu	2	1	1	1	1	1
alyssum desertorum, desert madwort**	alde	3	1	2	1	1	1
antennaria anaphaloides, pearly pussytoes	anan2	1	1	0	0	1	1
antennaria dimorpha, low pussytoes	andi2	6	1	1	1	5	1
antennaria microphylla, littleleaf pussytoes	anmi3	7	3	1	1	6	3
antennaria parvifolia, smallleaf pussytoes	anpa4	1	1	0	0	1	1
antennaria umbrinella, umber pussytoes	anum	1	3	0	0	1	3
arabis glabra, tower rockcress	argl	1	1	0	0	1	1
arabis holboellii, holboell's rockcress	arho2	3	1	0	0	3	1
arabis pendulina var. russeola, russeola rockcress	arper	7	1	3	1	4	1
arabis, rockcress	arabi2	1	1	0	0	1	1
arenaria congesta, ballhead sandwort	arco5	6	3	1	1	5	3
arenaria hookeri, hooker's sandwort	arho4	35	10	21	10	14	3
arnica fulgens, foothill arnica	arfu3	2	1	0	0	2	1
artemisia arbuscula, low sagebrush	arar8	1	1	1	1	0	0
artemisia frigida, fringed sagewort	arfr4	21	3	13	3	8	3
artemisia ludoviciana, louisiana sagewort	arlu	1	1	1	1	0	0
artemisia nova, black sagebrush	arno4	16	30	8	3	8	30
artemisia pedatifida, birdfoot sagebrush	arpe6	8	10	4	10	4	3
artemisia tridentata ssp. vaseyana, mountain big sagebrush	artrv	3	10	1	1	2	10
artemisia tridentata ssp. wyomingensis, wyoming big sagebrush	artrw	12	40	1	1	11	40
artemisia tripartita ssp. rupicola, wyoming threetip sagebrush	artrr2	9	10	4	3	5	10
astragalus agrestis, purple milkvetch	asag2	1	1	1	1	0	0
astragalus australis, indian milkvetch	asau4	2	1	2	1	0	0
astragalus convallarius, timber milkvetch	asco12	2	1	0	0	2	1
astragalus drummondii, drummond's milkvetch	asdr3	1	1	0	0	1	1
astragalus kentrophyta, spiny milkvetch	aske	1	1	1	1	0	0
astragalus miser, weedy milkvetch	asmi9	9	3	2	3	7	3
astragalus purshii, woollypod milkvetch	aspu9	6	1	0	0	6	1
astragalus sericoleucus, silky milkvetch	asse5	1	1	1	1	0	0
astragalus simplicifolius, little bun milkvetch	assi4	13	10	8	10	5	3
astragalus sp., milkvetch	astra	1	1	0	0	1	1
astragalus spatulatus, tufted milkvetch	assp6	15	3	10	3	5	1
atriplex confertifolia, shadscale saltbush	atco	1	1	0	0	1	1
atriplex gardneri, gardner's saltbush	atga	3	1	0	0	3	1

Table 4 (continued).

Name	NRCS Code	All Plots # plots (n=42)	All Plots Max	Rim Plots # plots (n=24)	Rim Plots Max	Plots Back # plots (n=18)	Plots Back Max
balsamorhiza sagittata, arrowleaf balsamroot	basa3	2	1	0	0	2	1
besseya wyomingensis, wyoming besseya	bewy	7	1	0	0	7	1
bouteloua gracilis, blue grama	bogr2	1	1	0	0	1	1
calochortus, mariposa lily	caloc	1	1	0	0	1	1
campanula rotundifolia, bluebell bellflower	caro2	1	1	1	1	0	0
carex duriuscula, needleleaf sedge	cadu6	12	3	4	3	8	3
carex filifolia, threadleaf sedge	cafi	13	20	7	3	6	20
carex rossii, ross' sedge	caro5	1	1	1	1	0	0
carex rupestris, rock sedge	caru3	1	10	1	10	0	0
castilleja angustifolia, northwestern indian paintbrush	caan7	8	3	4	1	4	3
castilleja applegatei ssp. martinii, wavyleaf indian paintbrush	caapm	1	1	0	0	1	1
castilleja pallescens, pale indian paintbrush	capa25	4	1	1	1	3	1
castilleja, indian paintbrush	casti2	6	3	3	1	3	3
cerastium arvense, field chickweed	cear4	3	1	1	1	2	1
cercocarpus montanus, true mountain mahogany	cemo2	1	1	1	1	0	0
chaenactis douglasii, douglas' dustymaiden	chdo	8	1	8	1	0	0
chenopodium sp., goosefoot	cheno	1	1	1	1	0	0
chrysothamnus viscidiflorus, yellow rabbitbrush	chvi8	17	10	5	3	12	10
cirsium aridum,	ciar9	5	1	2	1	3	1
collinsia parviflora, smallflower blue eyed mary	copa3	3	1	0	0	3	1
comandra umbellata, bastard toadflax	coum	7	1	4	1	3	1
cordylanthus ramosus, bushy bird's beak	cora5	4	1	0	0	4	1
crepis modocensis, siskiyou hawksbeard	crmo4	9	3	1	1	8	3
crepis, hawksbeard	crepi	3	1	1	1	2	1
cryptantha caespitosa, tufted catseye	crca7	6	3	6	3	0	0
cryptantha celosioides, buttecandle	crce	5	1	3	1	2	1
cryptantha sericea, silky catseye	crse3	1	1	1	1	0	0
cryptantha sp., cryptantha	crypt	7	1	4	1	3	1
cymopterus acaulis, plains springparsley	cyac	1	1	0	0	1	1
cymopterus sp., cymopterus	cymop2	1	1	0	0	1	1
delphinium geyeri, geyer's larkspur	dege2	1	1	0	0	1	1
delphinium sp., larkspur	delph	1	1	0	0	1	1
descurainia pinnata, western tansymustard	depi	2	1	0	0	2	1
draba nemorosa, woodland whitlowgrass	drne	2	1	1	1	1	1
draba oligosperma, fewseed whitlowgrass	drol	7	1	4	1	3	1
draba sp., whitlowgrass	draba	1	1	0	0	1	1
elymus elymoides, bottlebrush squirreltail	elel5	3	1	3	1	0	0
elymus lanceolatus ssp. lanceolatus, thickspike wheatgrass	ellal	14	20	2	1	12	20
elymus trachycaulus ssp. trachycaulus, slender wheatgrass	eltrt	1	1	0	0	1	1
ericameria nauseosa, rubber rabbitbrush	erna10	14	10	6	3	8	10
erigeron compositus, cutleaf daisy	erco4	5	1	3	1	2	1
erigeron concinnus var. concinnus, navajo fleabane	ercoc3	3	1	2	1	1	1
erigeron eatonii, eaton's fleabane	erea	4	1	0	0	4	1
erigeron engelmannii var. engelmannii, engelmann`s fleabane	erene	5	3	2	1	3	3

Table 4 (continued).

Name	NRCS Code	All Plots # plots (n=42)	All Plots Max	Rim Plots # plots (n=24)	Rim Plots Max	Plots Back # plots (n=18)	Plots Back Max
erigeron nematophyllus, needleleaf fleabane	erne2	15	3	9	3	6	3
erigeron ochroleucus var. scribneri, buff fleabane	erocs2	4	3	4	3	0	0
erigeron ochroleucus, buff fleabane	eroc	6	10	5	10	1	1
erigeron pumilus, shaggy fleabane	erpu2	2	1	1	1	1	1
erigeron, fleabane	erige2	3	1	1	1	2	1
eriogonum acaule, singlestem buckwheat	erac3	7	3	4	3	3	1
eriogonum brevicaule, shortstem buckwheat	erbr5	5	3	4	3	1	1
eriogonum caespitosum, matted buckwheat	erca8	2	1	1	1	1	1
eriogonum flavum, yellow eriogonum	erfl4	13	1	12	1	1	1
eriogonum microthecum var. laxiflorum, slender buckwheat	ermil2	2	3	1	3	1	1
eriogonum ovalifolium var. purpureum, cushion buckwheat	erovp2	1	1	0	0	1	1
eriogonum ovalifolium, cushion buckwheat	erov	11	1	4	1	7	1
eriogonum sp., eriogonum	eriog	3	1	2	1	1	1
eriogonum umbellatum, sulphur wildbuckwheat	erum	1	1	0	0	1	1
erysimum asperum,	eras2	1	1	0	0	1	1
erysimum capitatum var. capitatum, western wallflower	ercac	1	1	0	0	1	1
erysimum inconspicuum, shy wallflower	erin7	2	1	1	1	1	1
escobaria vivipara, spinystar	esvi2	4	1	1	1	3	1
euphorbia robusta, rocky mountain spurge	euro5	1	1	1	1	0	0
festuca idahoensis, idaho fescue	feid	1	10	0	0	1	10
festuca octoflora	feoc3	1	1	0	0	1	1
forb unknown (3 bundle yellow flower)*	forbck12	1	1	1	1	0	0
forb unknown (apiaceae bright grn)*	forbfm1	1	1	0	0	1	1
forb unknown (apiaceae fine)*	forbdry3	1	1	0	0	1	1
forb unknown (artichoke plant)	forbck1	4	3	2	3	2	3
forb unknown (bud fab)*	forbmil1	1	1	1	1	0	0
forb unknown (chenopodium small)*	forbph1	1	1	0	0	1	1
forb unknown (fab fuzzy pinn)*	forbmb1	1	1	0	0	1	1
forb unknown (fab green tall)*	forbph7	1	1	0	0	1	1
forb unknown (fab small fleshy)*	forbdry1	1	1	0	0	1	1
forb unknown (feather leaf mat)*	forbck14	1	1	0	0	1	1
forb unknown (forb ciliate leaf)*	forbshr3	1	1	0	0	1	1
forb unknown (forb cotyledon)*	forbph5	1	1	0	0	1	1
forb unknown (forb obov lvs)*	forbph6	1	1	0	0	1	1
forb unknown (forb tooth green)*	forbshm1	1	1	1	1	0	0
forb unknown (forb upright tooth)*	forbshm2	1	1	0	0	1	1
forb unknown (green little tooth lf)*	forbfer1	1	1	0	0	1	1
forb unknown (green once comp.)*	forbshm4	1	1	1	1	0	0
forb unknown (het vel?)*	forbsh1	1	1	0	0	1	1
forb unknown (less hairy pinnate)*	forbfer2	1	1	0	0	1	1
forb unknown (linear leaf forb)*	forbfet1	1	1	0	0	1	1
forb unknown (linear leaf forb)*	forbsh2	1	1	0	0	1	1
forb unknown (little artichoke plant)*	forbck11	1	1	0	0	1	1
forb unknown (must gray)*	forbmil2	1	1	1	1	0	0

Table 4 (continued).

Name	NRCS Code	All Plots # plots (n=42)	All Plots Max	Rim Plots # plots (n=24)	Rim Plots Max	Plots Back # plots (n=18)	Plots Back Max
forb unknown (oblanc grey lf)*	forbdry2	1	1	0	0	1	1
forb unknown (palmate leaf)*	forbshr2	1	1	1	1	0	0
forb unknown (powder long leaf)*	forbck6	1	1	1	1	0	0
forb unknown (purple underside paddle)*	forbck10	1	1	0	0	1	1
forb unknown (rubber leaf)*	forbph2	1	1	1	1	0	0
forb unknown (silver fab)*	forbshr1	1	1	1	1	0	0
forb unknown (small green)*	forbph4	1	1	1	1	0	0
forb unknown (snakeweed?)*	forbph3	1	1	1	1	0	0
forb unknown (stinky fab, fab pointed lflt)*	forbcyr1	2	1	1	1	1	1
forb unknown (tall tooth leaf)*	forbfet2	1	1	0	0	1	1
forb unknown (woody stem)	forbshm3	1	1	0	0	1	1
forb unknown (yellow flwr grn bunch)*	forbck13	1	3	1	3	0	0
forb unknown chalk 2 (thick leaf onion)*	forbck2	1	1	0	0	1	1
forb unknown chalk 3 (spur leaf)*	forbck3	1	1	0	0	1	1
forb unknown chalk 4 (taco plant)*	forbck4	1	1	0	0	1	1
forb unknown chalk 5 (purple base paintbrush)*	forbck5	3	3	1	1	2	3
fritillaria atropurpurea, spotted missionbells	frat	1	1	0	0	1	1
gayophytum diffusum, spreading groundsmoke	gadi2	1	1	0	0	1	1
grass unknown (bunchgrass)*	grasph1	1	3	1	3	0	0
gutierrezia sarothrae, broom snakeweed	gusa2	13	3	6	3	7	3
halimolobos virgata, rod halimolobos	havi3	2	1	0	0	2	1
hesperostipa comata, needle and thread	heco26	13	10	6	3	7	10
hymenopappus filifolius, fineleaf hymenopappus	hyfi	1	1	1	1	0	0
ipomopsis aggregata, skyrocket gilia	ipag	2	1	1	1	1	1
ipomopsis spicata ssp. spicata, spiked ipomopsis	ipsps	1	1	0	0	1	1
koeleria macrantha, prairie junegrass	koma	23	10	13	3	10	10
krascheninnikovia lanata, winterfat	krla2	9	1	4	1	5	1
lappula occidentalis var. occidentalis, flatspine stickseed	laoco	4	1	2	1	2	1
leptodactylon pungens, granite pricklygilia	lepu	4	3	1	1	3	3
lesquerella alpina, alpine bladderpod	leal	5	3	2	3	3	3
lesquerella condensata, dense bladderpod	leco2	11	3	9	3	2	1
lesquerella ludoviciana, foothill bladderpod	lelu	12	1	4	1	8	1
lesquerella sp., bladderpod	lesqu	1	1	1	1	0	0
leucopoa kingii, spike fescue	leki2	3	10	1	1	2	10
lewisia rediviva, oregon bitterroot	lere7	2	1	0	0	2	1
linum lewisii, prairie flax	lile3	15	3	7	3	8	3
linum, flax	linum	1	1	1	1	0	0
lithospermum incisum, narrowleaf gromwell	liin2	4	1	1	1	3	1
lomatium foeniculaceum, desert biscuitroot	lofo	5	3	1	1	4	3
lomatium nuttallii, nuttall's biscuitroot	lonu3	1	1	1	1	0	0
lomatium orientale, northern idaho biscuitroot	loor	10	1	4	1	6	1

Table 4 (continued).

Name	NRCS Code	All Plots # plots (n=42)	All Plots Max	Rim Plots # plots (n=24)	Rim Plots Max	Plots Back # plots (n=18)	Plots Back Max
lupinus argenteus, silvery lupine	luar3	3	1	1	1	2	1
lupinus sp., lupine	lupin	4	3	1	1	3	3
lygodesmia grandiflora, largeflower skeletonplant	lygr	2	1	0	0	2	1
machaeranthera grindelioides, rayless aster	magr2	19	10	13	10	6	1
mentzelia humilis, gypsum blazingstar	mehu	1	1	1	1	0	0
mertensia humilis, rocky mountain bluebells	mehu2	15	3	6	1	9	3
mertensia lanceolata, lanceleaf bluebells	mela3	3	1	1	1	2	1
mertensia, bluebells	merte	2	1	1	1	1	1
monolepis nuttalliana, nuttall's povertyweed	monu	1	1	1	1	0	0
musineon divaricatum, leafy wildparsley	mudi	4	1	1	1	3	1
musineon tenuifolium, slender wildparsley	mute3	7	10	7	10	0	0
oenothera caespitosa ssp. caespitosa, tufted evening primrose	oecac2	1	1	1	1	0	0
opuntia polyacantha, plains pricklypear	oppo	8	3	4	3	4	1
oxytropis besseyi, bessey's locoweed	oxbe2	3	1	2	1	1	1
oxytropis campestris, cold mountain crazyweed	oxca4	1	1	1	1	0	0
oxytropis lagopus, haresfoot pointloco	oxla2	8	1	6	1	2	1
oxytropis multiceps, southwestern locoweed	oxmu	3	3	2	3	1	1
oxytropis nana, wyoming locoweed	oxna	2	1	2	1	0	0
oxytropis sericea, silvery oxytrope	oxse	8	1	5	1	3	1
oxytropis sp., crazyweed	oxytr	4	1	1	1	3	1
packera cana, woolly groundsel	paca15	11	3	7	3	4	1
paronychia depressa, spreading nailwort	pade4	8	10	5	10	3	3
paronychia sessiliflora, creeping nailwort	pase	9	3	9	3	0	0
parthenium alpinum, alpine feverfew	paal6	2	3	2	3	0	0
penstemon eriantherus, fuzzytongue penstemon	peer	12	1	5	1	7	1
penstemon fremontii, fremont's beardtongue	pefr	1	1	0	0	1	1
penstemon laricifolius, larchleaf beardtongue	pela9	11	1	5	1	6	1
penstemon radicosus, matroot penstemon	pera2	4	1	0	0	4	1
penstemon sp., penstemon	penst	1	1	0	0	1	1
phlox hoodii, hoods phlox	phho	27	10	10	3	17	10
phlox multiflora, flowery phlox	phmu3	4	3	0	0	4	3
phlox muscoides, musk phlox	phmu4	18	10	13	10	5	3
physaria condensata, tufted twinpod	phco16	1	1	1	1	0	0
physaria eburniflora, devils gate twinpod	pheb	1	1	1	1	0	0
pinus flexilis, limber pine	pifl2	3	1	1	1	2	1
poa cusickii, cusick`s bluegrass	pocu3	1	1	1	1	0	0
poa fendleriana, muttongrass	pofe	9	20	0	0	9	20
poa secunda, sandberg bluegrass	pose	30	10	14	3	16	10
poa sp., bluegrass*	poa	1	3	0	0	1	3
polygonum sp., knotweed*	polyg4	1	1	1	1	0	0
potentilla concinna, elegant cinquefoil	poco13	2	1	2	1	0	0
potentilla hippiana, woolly cinquefoil	pohi6	2	1	2	1	0	0

Table 4 (continued).

Name	NRCS Code	All Plots # plots (n=42)	All Plots Max	Rim Plots # plots (n=24)	Rim Plots Max	Plots Back # plots (n=18)	Plots Back Max
potentilla ovina, sheep cinquefoil	poov2	6	3	6	3	0	0
potentilla sp., cinquefoil	poten	1	1	1	1	0	0
pseudoroegneria spicata, bluebunch wheatgrass	pssp6	30	40	19	10	11	40
ranunculus glaberrimus, sagebrush buttercup	ragl	1	1	0	0	1	1
schoenocrambe linifolia, flaxleaf plainsmustard	scli	1	1	0	0	1	1
sedum lanceolatum, spearleaf stonecrop	sela	18	1	9	1	9	1
sedum stenopetalum, wormleaf stonecrop	sest2	3	1	2	1	1	1
selaginella densa, lesser spikemoss	sede2	2	3	2	3	0	0
senecio integerrimus, lambstongue groundsel	sein2	6	3	0	0	6	3
sisymbrium altissimum, tall tumblemustard**	sial2	1	1	0	0	1	1
sphaeralcea coccinea, scarlet globemallow	spco	2	1	1	1	1	1
sphaeromeria capitata, rock tansy	spca8	1	3	1	3	0	0
sphaeromeria simplex, laramie chickensage	spsi3	7	3	5	3	2	3
stanleya viridiflora, green princesplume	stvi	3	1	2	1	1	1
stenotus acaulis, stemless mock goldenweed	stac	17	10	11	10	6	3
stenotus armerioides, thrift mock goldenweed	star10	14	10	8	3	6	10
stephanomeria runcinata, desert wirelettuce	stru3	2	1	2	1	0	0
symphoricarpos oreophilus, whortleleaf snowberry	syor2	3	3	1	1	2	3
taraxacum laevigatum, rock dandelion**	tala2	7	1	3	1	4	1
taraxacum, dandelion**	tarax	2	1	0	0	2	1
tetradymia canescens, spineless horsebrush	teca2	11	3	5	1	6	3
tetradymia nuttallii, nuttall's horsebrush	tenu2	1	1	0	0	1	1
tetradymia, horsebrush	tetra3	1	1	0	0	1	1
tetraneuris acaulis var. acaulis, stemless four-nerve daisy	teaca2	5	1	3	1	2	1
tetraneuris acaulis var. caespitosa, caespitose four-nerve daisy	teacc	6	10	3	10	3	3
tetraneuris acaulis, stemless hymenoxys	teac	8	3	7	3	1	1
tetraneuris torreyana, torrey's hymenoxys	teto	12	3	9	3	3	1
thermopsis rhombifolia, prairie thermopsis	thrh	1	1	1	1	0	0
townsendia nuttallii, nuttall's townsend daisy	tonu	3	1	1	1	2	1
townsendia spathulata, sword townsendia	tosp	1	1	1	1	0	0
townsendia, townsendia	towns	1	1	0	0	1	1
tradescantia occidentalis, prairie spiderwort	troc	3	1	2	1	1	1
trifolium andinum, andes clover	tran2	3	3	2	1	1	3
trifolium gymnocarpon, hollyleaf clover	trgy	9	3	0	0	9	3
vicia americana, american vetch	viam	3	1	0	0	3	1
viola nuttallii, nuttall's violet	vinu2	3	1	0	0	3	1
xylorhiza glabriuscula, smooth woodyaster	xygl	1	1	0	0	1	1
zigadenus venenosus, meadow deathcamas	zive	10	1	1	1	9	1

Table 5. The 249 vascular plant taxa documented in the 42 sample plots, arranged from the most common to the rarest.
Cushion-plants are shown in italic typeface. Taxa known or strongly suspected to be exotic are indicated by **, and taxa of unknown origin are indicated by *. For each taxon, the number of plot of occurrence and the maximum canopy-cover class is shown for all sample plots, for plots along rims, and for plots back from rims. Taxa found in only one or two plots were deleted from the cluster analysis classification of plots.

		All Plots		Rim Plots		Plots Back	
Name	**NRCS Code**	# plots (n=42)	Max	# plots (n=24)	Max	# plots (n=18)	Max
arenaria hookeri, hooker's sandwort	arho4	35	10	21	10	14	3
poa secunda, sandberg bluegrass	pose	30	10	14	3	16	10
pseudoroegneria spicata, bluebunch wheatgrass	pssp6	30	40	19	10	11	40
phlox hoodii, hoods phlox	phho	27	10	10	3	17	10
koeleria macrantha, prairie junegrass	koma	23	10	13	3	10	10
artemisia frigida, fringed sagewort	arfr4	21	3	13	3	8	3
machaeranthera grindelioides, rayless aster	magr2	19	10	13	10	6	1
phlox muscoides, musk phlox	phmu4	18	10	13	10	5	3
sedum lanceolatum, spearleaf stonecrop	sela	18	1	9	1	9	1
chrysothamnus viscidiflorus, yellow rabbitbrush	chvi8	17	10	5	3	12	10
stenotus acaulis, stemless mock goldenweed	stac	17	10	11	10	6	3
artemisia nova, black sagebrush	arno4	16	30	8	3	8	30
astragalus spatulatus, tufted milkvetch	assp6	15	3	10	3	5	1
erigeron nematophyllus, needleleaf fleabane	erne2	15	3	9	3	6	3
linum lewisii, prairie flax	lile3	15	3	7	3	8	3
mertensia humilis, rocky mountain bluebells	mehu2	15	3	6	1	9	3
elymus lanceolatus ssp. lanceolatus, thickspike wheatgrass	ellal	14	20	2	1	12	20
ericameria nauseosa, rubber rabbitbrush	erna10	14	10	6	3	8	10
stenotus armerioides, thrift mock goldenweed	star10	14	10	8	3	6	10
astragalus simplicifolius, little bun milkvetch	assi4	13	10	8	10	5	3
carex filifolia, threadleaf sedge	cafi	13	20	7	3	6	20
eriogonum flavum, yellow eriogonum	erfl4	13	1	12	1	1	1
gutierrezia sarothrae, broom snakeweed	gusa2	13	3	6	3	7	3
hesperostipa comata, needle and thread	heco26	13	10	6	3	7	10
allium textile, textile onion	alte	12	1	4	1	8	1
artemisia tridentata ssp. wyomingensis, wyoming big sagebrush	artrw	12	40	1	1	11	40
carex duriuscula, needleleaf sedge	cadu6	12	3	4	3	8	3
lesquerella ludoviciana, foothill bladderpod	lelu	12	1	4	1	8	1
penstemon eriantherus, fuzzytongue penstemon	peer	12	1	5	1	7	1
tetraneuris torreyana, torrey's hymenoxys	teto	12	3	9	3	3	1
eriogonum ovalifolium, cushion buckwheat	erov	11	1	4	1	7	1
lesquerella condensata, dense bladderpod	leco2	11	3	9	3	2	1
packera cana, woolly groundsel	paca15	11	3	7	3	4	1
penstemon laricifolius, larchleaf beardtongue	pela9	11	1	5	1	6	1
tetradymia canescens, spineless horsebrush	teca2	11	3	5	1	6	3
lomatium orientale, northern idaho biscuitroot	loor	10	1	4	1	6	1
zigadenus venenosus, meadow deathcamas	zive	10	1	1	1	9	1
artemisia tripartita ssp. rupicola, wyoming threetip sagebrush	artrr2	9	10	4	3	5	10

Table 5 (continued).

Name	NRCS Code	All Plots # plots (n=42)	All Plots Max	Rim Plots # plots (n=24)	Rim Plots Max	Plots Back # plots (n=18)	Plots Back Max
astragalus miser, weedy milkvetch	asmi9	9	3	2	3	7	3
crepis modocensis, siskiyou hawksbeard	crmo4	9	3	1	1	8	3
krascheninnikovia lanata, winterfat	krla2	9	1	4	1	5	1
paronychia sessiliflora, creeping nailwort	pase	9	3	9	3	0	0
poa fendleriana, muttongrass	pofe	9	20	0	0	9	20
trifolium gymnocarpon, hollyleaf clover	trgy	9	3	0	0	9	3
artemisia pedatifida, birdfoot sagebrush	arpe6	8	10	4	10	4	3
castilleja angustifolia, northwestern indian paintbrush	caan7	8	3	4	1	4	3
chaenactis douglasii, douglas' dustymaiden	chdo	8	1	8	1	0	0
opuntia polyacantha, plains pricklypear	oppo	8	3	4	3	4	1
oxytropis lagopus, haresfoot pointloco	oxla2	8	1	6	1	2	1
oxytropis sericea, silvery oxytrope	oxse	8	1	5	1	3	1
paronychia depressa, spreading nailwort	pade4	8	10	5	10	3	3
tetraneuris acaulis, stemless hymenoxys	teac	8	3	7	3	1	1
achnatherum hymenoides, indian ricegrass	achy	7	3	4	3	3	3
antennaria microphylla, littleleaf pussytoes	anmi3	7	3	1	1	6	3
arabis pendulina var. russeola, russeola rockcress	arper	7	1	3	1	4	1
besseya wyomingensis, wyoming besseya	bewy	7	1	0	0	7	1
comandra umbellata, bastard toadflax	coum	7	1	4	1	3	1
cryptantha sp., cryptantha	crypt	7	1	4	1	3	1
draba oligosperma, fewseed whitlowgrass	drol	7	1	4	1	3	1
eriogonum acaule, singlestem buckwheat	erac3	7	3	4	3	3	1
musineon tenuifolium, slender wildparsley	mute3	7	10	7	10	0	0
sphaeromeria simplex, laramie chickensage	spsi3	7	3	5	3	2	3
taraxacum laevigatum, rock dandelion**	tala2	7	1	3	1	4	1
antennaria dimorpha, low pussytoes	andi2	6	1	1	1	5	1
arenaria congesta, ballhead sandwort	arco5	6	3	1	1	5	3
astragalus purshii, woollypod milkvetch	aspu9	6	1	0	0	6	1
castilleja, indian paintbrush	casti2	6	3	3	1	3	3
cryptantha caespitosa, tufted catseye	crca7	6	3	6	3	0	0
erigeron ochroleucus, buff fleabane	eroc	6	10	5	10	1	1
potentilla ovina, sheep cinquefoil	poov2	6	3	6	3	0	0
senecio integerrimus, lambstongue groundsel	sein2	6	3	0	0	6	3
tetraneuris acaulis var. caespitosa, caespitose four-nerve daisy	teacc	6	10	3	10	3	3
cirsium aridum,	ciar9	5	1	2	1	3	1
cryptantha celosioides, buttecandle	crce	5	1	3	1	2	1
erigeron compositus, cutleaf daisy	erco4	5	1	3	1	2	1
erigeron engelmannii var. engelmannii, engelmann`s fleabane	erene	5	3	2	1	3	3
eriogonum brevicaule, shortstem buckwheat	erbr5	5	3	4	3	1	1
lesquerella alpina, alpine bladderpod	leal	5	3	2	3	3	3
lomatium foeniculaceum, desert biscuitroot	lofo	5	3	1	1	4	3
tetraneuris acaulis var. acaulis, stemless four-nerve daisy	teaca2	5	1	3	1	2	1
agoseris glauca, pale agoseris	aggl	4	3	0	0	4	3
castilleja pallescens, pale indian paintbrush	capa25	4	1	1	1	3	1

Table 5 (continued).

Name	NRCS Code	All Plots # plots (n=42)	All Plots Max	Rim Plots # plots (n=24)	Rim Plots Max	Plots Back # plots (n=18)	Plots Back Max
cordylanthus ramosus, bushy bird's beak	cora5	4	1	0	0	4	1
erigeron eatonii, eaton's fleabane	erea	4	1	0	0	4	1
erigeron ochroleucus var. scribneri, buff fleabane	erocs2	4	3	4	3	0	0
escobaria vivipara, spinystar	esvi2	4	1	1	1	3	1
forb unknown (artichoke plant)	forbck1	4	3	2	3	2	3
lappula occidentalis var. occidentalis, flatspine stickseed	laoco	4	1	2	1	2	1
leptodactylon pungens, granite pricklygilia	lepu	4	3	1	1	3	3
lithospermum incisum, narrowleaf gromwell	liin2	4	1	1	1	3	1
lupinus sp., lupine	lupin	4	3	1	1	3	3
musineon divaricatum, leafy wildparsley	mudi	4	1	1	1	3	1
oxytropis sp., crazyweed	oxytr	4	1	1	1	3	1
penstemon radicosus, matroot penstemon	pera2	4	1	0	0	4	1
phlox multiflora, flowery phlox	phmu3	4	3	0	0	4	3
achillea millefolium, common yarrow	acmi2	3	1	0	0	3	1
alyssum desertorum, desert madwort**	alde	3	1	2	1	1	1
arabis holboellii, holboell's rockcress	arho2	3	1	0	0	3	1
artemisia tridentata ssp. vaseyana, mountain big sagebrush	artrv	3	10	1	1	2	10
atriplex gardneri, gardner's saltbush	atga	3	1	0	0	3	1
cerastium arvense, field chickweed	cear4	3	1	1	1	2	1
collinsia parviflora, smallflower blue eyed mary	copa3	3	1	0	0	3	1
crepis, hawksbeard	crepi	3	1	1	1	2	1
elymus elymoides, bottlebrush squirreltail	elel5	3	1	3	1	0	0
erigeron concinnus var. concinnus, navajo fleabane	ercoc3	3	1	2	1	1	1
erigeron, fleabane	erige2	3	1	1	1	2	1
eriogonum sp., eriogonum	eriog	3	1	2	1	1	1
forb unknown chalk 5 (purple base paintbrush)*	forbck5	3	3	1	1	2	3
leucopoa kingii, spike fescue	leki2	3	10	1	1	2	10
lupinus argenteus, silvery lupine	luar3	3	1	1	1	2	1
mertensia lanceolata, lanceleaf bluebells	mela3	3	1	1	1	2	1
oxytropis besseyi, bessey's locoweed	oxbe2	3	1	2	1	1	1
oxytropis multiceps, southwestern locoweed	oxmu	3	3	2	3	1	1
pinus flexilis, limber pine	pifl2	3	1	1	1	2	1
sedum stenopetalum, wormleaf stonecrop	sest2	3	1	2	1	1	1
stanleya viridiflora, green princesplume	stvi	3	1	2	1	1	1
symphoricarpos oreophilus, whortleleaf snowberry	syor2	3	3	1	1	2	3
townsendia nuttallii, nuttall's townsend daisy	tonu	3	1	1	1	2	1
tradescantia occidentalis, prairie spiderwort	troc	3	1	2	1	1	1
trifolium andinum, andes clover	tran2	3	3	2	1	1	3
vicia americana, american vetch	viam	3	1	0	0	3	1
viola nuttallii, nuttall's violet	vinu2	3	1	0	0	3	1
allium, wild onion	alliu	2	1	1	1	1	1
arnica fulgens, foothill arnica	arfu3	2	1	0	0	2	1
astragalus australis, indian milkvetch	asau4	2	1	2	1	0	0
astragalus convallarius, timber milkvetch	asco12	2	1	0	0	2	1
balsamorhiza sagittata, arrowleaf balsamroot	basa3	2	1	0	0	2	1

Table 5 (continued).

Name	NRCS Code	All Plots # plots (n=42)	All Plots Max	Rim Plots # plots (n=24)	Rim Plots Max	Plots Back # plots (n=18)	Plots Back Max
descurainia pinnata, western tansymustard	depi	2	1	0	0	2	1
draba nemorosa, woodland whitlowgrass	drne	2	1	1	1	1	1
erigeron pumilus, shaggy fleabane	erpu2	2	1	1	1	1	1
eriogonum caespitosum, matted buckwheat	erca8	2	1	1	1	1	1
eriogonum microthecum var. laxiflorum, slender buckwheat	ermil2	2	3	1	3	1	1
erysimum inconspicuum, shy wallflower	erin7	2	1	1	1	1	1
forb unknown (stinky fab, fab pointed lflt)*	forbcyr1	2	1	1	1	1	1
halimolobos virgata, rod halimolobos	havi3	2	1	0	0	2	1
ipomopsis aggregata, skyrocket gilia	ipag	2	1	1	1	1	1
lewisia rediviva, oregon bitterroot	lere7	2	1	0	0	2	1
lygodesmia grandiflora, largeflower skeletonplant	lygr	2	1	0	0	2	1
mertensia, bluebells	merte	2	1	1	1	1	1
oxytropis nana, wyoming locoweed	oxna	2	1	2	1	0	0
parthenium alpinum, alpine feverfew	paal6	2	3	2	3	0	0
potentilla concinna, elegant cinquefoil	poco13	2	1	2	1	0	0
potentilla hippiana, woolly cinquefoil	pohi6	2	1	2	1	0	0
selaginella densa, lesser spikemoss	sede2	2	3	2	3	0	0
sphaeralcea coccinea, scarlet globemallow	spco	2	1	1	1	1	1
stephanomeria runcinata, desert wirelettuce	stru3	2	1	2	1	0	0
taraxacum, dandelion**	tarax	2	1	0	0	2	1
allium cernuum, nodding onion	alce2	1	1	0	0	1	1
antennaria anaphaloides, pearly pussytoes	anan2	1	1	0	0	1	1
antennaria parvifolia, smallleaf pussytoes	anpa4	1	1	0	0	1	1
antennaria umbrinella, umber pussytoes	anum	1	3	0	0	1	3
arabis glabra, tower rockcress	argl	1	1	0	0	1	1
arabis, rockcress	arabi2	1	1	0	0	1	1
artemisia arbuscula, low sagebrush	arar8	1	1	1	1	0	0
artemisia ludoviciana, louisiana sagewort	arlu	1	1	1	1	0	0
astragalus agrestis, purple milkvetch	asag2	1	1	1	1	0	0
astragalus drummondii, drummond's milkvetch	asdr3	1	1	0	0	1	1
astragalus kentrophyta, spiny milkvetch	aske	1	1	1	1	0	0
astragalus sericoleucus, silky milkvetch	asse5	1	1	1	1	0	0
astragalus sp., milkvetch	astra	1	1	0	0	1	1
atriplex confertifolia, shadscale saltbush	atco	1	1	0	0	1	1
bouteloua gracilis, blue grama	bogr2	1	1	0	0	1	1
calochortus, mariposa lily	caloc	1	1	0	0	1	1
campanula rotundifolia, bluebell bellflower	caro2	1	1	1	1	0	0
carex rossii, ross' sedge	caro5	1	1	1	1	0	0
carex rupestris, rock sedge	caru3	1	10	1	10	0	0
castilleja applegatei ssp. martinii, wavyleaf indian paintbrush	caapm	1	1	0	0	1	1
cercocarpus montanus, true mountain mahogany	cemo2	1	1	1	1	0	0
chenopodium sp., goosefoot	cheno	1	1	1	1	0	0
cryptantha sericea, silky catseye	crse3	1	1	1	1	0	0
cymopterus acaulis, plains springparsley	cyac	1	1	0	0	1	1
cymopterus sp., cymopterus	cymop2	1	1	0	0	1	1

Table 5 (continued).

Name	NRCS Code	All Plots # plots (n=42)	All Plots Max	Rim Plots # plots (n=24)	Rim Plots Max	Plots Back # plots (n=18)	Plots Back Max
delphinium geyeri, geyer's larkspur	dege2	1	1	0	0	1	1
delphinium sp., larkspur	delph	1	1	0	0	1	1
draba sp., whitlowgrass	draba	1	1	0	0	1	1
elymus trachycaulus ssp. trachycaulus, slender wheatgrass	eltrt	1	1	0	0	1	1
eriogonum ovalifolium var. purpureum, cushion buckwheat	erovp2	1	1	0	0	1	1
eriogonum umbellatum, sulphur wildbuckwheat	erum	1	1	0	0	1	1
erysimum asperum,	eras2	1	1	0	0	1	1
erysimum capitatum var. capitatum, western wallflower	ercac	1	1	0	0	1	1
euphorbia robusta, rocky mountain spurge	euro5	1	1	1	1	0	0
festuca idahoensis, idaho fescue	feid	1	10	0	0	1	10
festuca octoflora	feoc3	1	1	0	0	1	1
forb unknown (3 bundle yellow flower)*	forbck12	1	1	1	1	0	0
forb unknown (apiaceae bright grn)*	forbfm1	1	1	0	0	1	1
forb unknown (apiaceae fine)*	forbdry3	1	1	0	0	1	1
forb unknown (bud fab)*	forbmil1	1	1	1	1	0	0
forb unknown (chenopodium small)*	forbph1	1	1	0	0	1	1
forb unknown (fab fuzzy pinn)*	forbmb1	1	1	0	0	1	1
forb unknown (fab green tall)*	forbph7	1	1	0	0	1	1
forb unknown (fab small fleshy)*	forbdry1	1	1	0	0	1	1
forb unknown (feather leaf mat)*	forbck14	1	1	0	0	1	1
forb unknown (forb ciliate leaf)*	forbshr3	1	1	0	0	1	1
forb unknown (forb cotyledon)*	forbph5	1	1	0	0	1	1
forb unknown (forb obov lvs)*	forbph6	1	1	0	0	1	1
forb unknown (forb tooth green)*	forbshm1	1	1	1	1	0	0
forb unknown (forb upright tooth)*	forbshm2	1	1	0	0	1	1
forb unknown (green little tooth lf)*	forbfer1	1	1	0	0	1	1
forb unknown (green once comp.)*	forbshm4	1	1	1	1	0	0
forb unknown (het vel?)*	forbsh1	1	1	0	0	1	1
forb unknown (less hairy pinnate)*	forbfer2	1	1	0	0	1	1
forb unknown (linear leaf forb)*	forbfet1	1	1	0	0	1	1
forb unknown (linear leaf forb)*	forbsh2	1	1	0	0	1	1
forb unknown (little artichoke plant)*	forbck11	1	1	0	0	1	1
forb unknown (must gray)*	forbmil2	1	1	1	1	0	0
forb unknown (oblanc grey lf)*	forbdry2	1	1	0	0	1	1
forb unknown (palmate leaf)*	forbshr2	1	1	1	1	0	0
forb unknown (powder long leaf)*	forbck6	1	1	1	1	0	0
forb unknown (purple underside paddle)*	forbck10	1	1	0	0	1	1
forb unknown (rubber leaf)*	forbph2	1	1	1	1	0	0
forb unknown (silver fab)*	forbshr1	1	1	1	1	0	0
forb unknown (small green)*	forbph4	1	1	1	1	0	0
forb unknown (snakeweed?)*	forbph3	1	1	1	1	0	0
forb unknown (tall tooth leaf)*	forbfet2	1	1	0	0	1	1
forb unknown (woody stem)	forbshm3	1	1	0	0	1	1
forb unknown (yellow flwr grn bunch)*	forbck13	1	3	1	3	0	0
forb unknown chalk 2 (thick leaf onion)*	forbck2	1	1	0	0	1	1

Table 5 (continued).

Name	NRCS Code	All Plots # plots (n=42)	All Plots Max	Rim Plots # plots (n=24)	Rim Plots Max	Plots Back # plots (n=18)	Plots Back Max
forb unknown chalk 3 (spur leaf)*	forbck3	1	1	0	0	1	1
forb unknown chalk 4 (taco plant)*	forbck4	1	1	0	0	1	1
fritillaria atropurpurea, spotted missionbells	frat	1	1	0	0	1	1
gayophytum diffusum, spreading groundsmoke	gadi2	1	1	0	0	1	1
grass unknown (bunchgrass)*	grasph1	1	3	1	3	0	0
hymenopappus filifolius, fineleaf hymenopappus	hyfi	1	1	1	1	0	0
ipomopsis spicata ssp. spicata, spiked ipomopsis	ipsps	1	1	0	0	1	1
lesquerella sp., bladderpod	lesqu	1	1	1	1	0	0
linum, flax	linum	1	1	1	1	0	0
lomatium nuttallii, nuttall's biscuitroot	lonu3	1	1	1	1	0	0
mentzelia humilis, gypsum blazingstar	mehu	1	1	1	1	0	0
monolepis nuttalliana, nuttall's povertyweed	monu	1	1	1	1	0	0
oenothera caespitosa ssp. caespitosa, tufted evening primrose	oecac2	1	1	1	1	0	0
oxytropis campestris, cold mountain crazyweed	oxca4	1	1	1	1	0	0
penstemon fremontii, fremont's beardtongue	pefr	1	1	0	0	1	1
penstemon sp., penstemon	penst	1	1	0	0	1	1
physaria condensata, tufted twinpod	phco16	1	1	1	1	0	0
physaria eburniflora, devils gate twinpod	pheb	1	1	1	1	0	0
poa cusickii, cusick`s bluegrass	pocu3	1	1	1	1	0	0
poa sp., bluegrass*	poa	1	3	0	0	1	3
polygonum sp., knotweed*	polyg4	1	1	1	1	0	0
potentilla sp., cinquefoil	poten	1	1	1	1	0	0
ranunculus glaberrimus, sagebrush buttercup	ragl	1	1	0	0	1	1
schoenocrambe linifolia, flaxleaf plainsmustard	scli	1	1	0	0	1	1
sisymbrium altissimum, tall tumblemustard**	sial2	1	1	0	0	1	1
sphaeromeria capitata, rock tansy	spca8	1	3	1	3	0	0
tetradymia nuttallii, nuttall's horsebrush	tenu2	1	1	0	0	1	1
tetradymia, horsebrush	tetra3	1	1	0	0	1	1
thermopsis rhombifolia, prairie thermopsis	thrh	1	1	1	1	0	0
townsendia spathulata, sword townsendia	tosp	1	1	1	1	0	0
townsendia, townsendia	towns	1	1	0	0	1	1
xylorhiza glabriuscula, smooth woodyaster	xygl	1	1	0	0	1	1

Table 6. Canopy cover-class of the 4 known exotic taxa in the sample plots.

Plot Name	Plot-group	alyssum desertorum, desert madwort	sisymbrium altisissimum, tall tumblemustard	taraxacum laevigatum, rock dandelion	taraxacum sp., dandelion
3MILL02.01	4-1, sub-group 7-25	1	-	-	-
3MILL03.01	4-1, sub-group 7-25	1	-	-	-
3SHR04.01	4-1, sub-group 7-25	-	-	1	-
3SHRM01.01	4-12 ,sub-group 7-17	-	-	1	-
3SHRM02.01	4-12, sub-group 7-17	-	-	1	-
3DRY01.02	4-14, sub-group 7-14	-	-	-	1
3FM01.02	4-14, sub-group 7-14	-	-	-	1
3PH01.02	4-14, sub-group 7-14	-	1	-	-
3SHRM01.02	4-14, sub-group 7-14	-	-	1	-
3PH02.02	4-14, sub-group 7-32	-	-	1	-
3SHR01.02	4-14, sub-group 7-32	-	-	1	-
3SHR04.02	4-14, sub-group 7-32	1	-	1	-

Table 7. Results of two-way analysis of variance of number per plot of species of different growth-forms, plots along rims vs. plots back from rims.

a. Analysis of variance (general linear model) for number of species per plot, using adjusted sums of squares (SS) for tests

Model Term	Type of Factor	DF	Seq SS	Adj SS	Adj MS	F	P
Position (rim vs. back)	Fixed	1	796.5	796.5	796.5	39.48	0.000
Growth-form	Fixed	5	21012.9	21835.0	21835.0	216.47	0.000
Position x Growth-form	Fixed	5	1245.4	1245.4	249.1	12.35	0.000
Error		240	4841.7	4841.7	20.2		
Total		251	27896.6				

b. Bonferroni simultaneous tests for differences within each growth-form, rim vs. back from rim

Growth-form & Location	N	Mean	StDev	Difference of Means	SE of Difference	T-value	P-value
Shrubs							
Along Rims	24	1.38	1.1	1.74	1.4	-1.24	1.00
Back From Rims	18	3.11	1.45				
Sub-shrubs							
Along Rims	24	1.63	1.47	-0.99	1.4	-0.7	1.00
Back From Rims	18	2.61	1.91				
Graminoids							
Along Rims	24	3.21	1.39	-1.43	1.4	-1.00	1.00
Back From Rims	18	5.00	1.71				
Forbs							
Along Rims	24	9.29	3.84	-8.65	1.4	-6.18	0.00
Back From Rims	18	17.94	8.96				
Cushion-plants							
Along Rims	24	7.63	2.87	1.9	1.4	1.36	1.00
Back From Rims	18	5.72	2.89				
All Forms							
Along Rims	24	23.38	5.37	-10.68	1.4	-7.63	0.00
Back From Rims	18	34.06	10.3				

Table 8. Results of two-way analysis of variance of canopy-cover of species of different growth-forms, plots along rims vs. plots back from rims.

a. Analysis of variance (general linear model) for average canopy-cover per plot, using adjusted sums of squares (SS) for tests

Model Term	Type of Factor	DF	Seq SS	Adj SS	Adj MS	F	P
Position (rim vs. back)	Fixed	1	6185.7	6185.7	6185.7	62.27	0.000
Growth-form	Fixed	5	74014.3	77970.4	15594.1	156.99	0.000
Position x Growth-form	Fixed	5	8762.8	8762.8	1752.6	17.64	0.000
Error		240	23839.2	23839.2	99.3		
Total		251	112802				

b. Bonferroni simultaneous tests for differences within each growth-form, rim vs. back from rim

Growth-form & Location	N	Mean	StDev	Difference of Means	SE of Difference	T-value	P-value
Shrubs							
Along Rims	24	1.71	1.55	-13.29	3.11	-4.28	0.01
Back From Rims	15	15	12.18				
Sub-shrubs							
Along Rims	24	2.75	3.05	-0.53	3.11	-0.17	1.00
Back From Rims	18	3.28	2.7				
Graminoids							
Along Rims	24	7.96	4.55	-14.65	3.11	-4.72	0.00
Back From Rims	18	22.61	12.69				
Forbs							
Along Rims	24	12.42	6.52	-10.58	3.11	-3.41	0.05
Back From Rims	18	23	10.47				
Cushion-plants							
Along Rims	24	17.42	9.5	8.58	3.11	2.76	0.41
Back From Rims	18	9.83	6.79				
All Forms							
Along Rims	24	42.63	11.82	-29.6	3.11	-9.52	0.00
Back From Rims	18	72.22	22.74				

Table 9. Results of two-way analysis of variance of relative canopy-cover of species of different growth-forms, plots along rims vs. plots back from rims.

a. Analysis of variance (general linear model) for average relative canopy-cover per plot, using adjusted sums of squares (SS) for tests

Model Term	Type of Factor	DF	Seq SS	Adj SS	Adj MS	F	P
Position (rim vs. back)	Fixed	1	0.0001	0.0001	0.0001	0.04	0.843
Growth-form	Fixed	4	2.0016	1.8065	0.4516	40.04	0.000
Position x Growth-form	Fixed	4	1.1547	1.1547	0.2887	25.59	0.000
Error		200	2.2557	2.2557	0.0113		
Total		209	5.4124				

b. Bonferroni simultaneous tests for differences within each growth-form, rim vs. back from rim

Growth-form & Location	N	Mean	StDev	Difference of Means	SE of Difference	T-value	P-value
Shrubs							
Along Rims	24	0.04	0.04	-0.16	0.03	-4.85	0.00
Back From Rims	15	0.20	0.13				
Sub-shrubs							
Along Rims	24	0.07	0.08	0.01	0.03	0.42	1.00
Back From Rims	18	0.05	0.05				
Graminoids							
Along Rims	24	0.19	0.1	0.12	0.03	-3.64	0.02
Back From Rims	18	0.31	0.12				
Forbs							
Along Rims	24	0.3	0.14	0.02	0.03	-0.45	1.00
Back From Rims	18	0.31	0.1				
Cushion-plants							
Along Rims	24	0.4	0.14	0.27	0.03	8.1	0.00
Back From Rims	18	0.14	0.11				

Table 10. Results of two-way analysis of variance of ground-cover in plots along rims vs. plots back from rims.

a. Analysis of variance (general linear model) for average relative canopy-cover per plot, using adjusted sums of squares (SS) for tests

Model Term	Type of Factor	DF	Seq SS	Adj SS	Adj MS	F	P
Position	Fixed	1	100.7	100.7	100.7	1.01	0.316
Cover type	Fixed	8	74832.3	72689.6	9086.2	91.06	0.000
Position*Cover type	Fixed	8	29283.5	29283.5	3660.4	36.68	0.000
Error		360	35923.3	35923.3	99.8		
Total		377	140139.9				

b. Bonferroni simultaneous tests for differences within each growth-form, rim vs. back from rim

Growth-form & Location	N	Mean	StDev	Difference of Means	SE of Difference	T-value	P-value
Bedrock							
Along Rims	24	3.17	4.83	2.61	3.12	0.84	1.00
Back From Rims	18	0.56	2.36				
Boulder							
Along Rims	24	2.60	6.32	1.25	3.12	0.40	1.00
Back From Rims	18	1.36	3.19				
Cobble							
Along Rims	24	4.8	5.17	3.84	3.12	1.23	1.00
Back From Rims	18	0.96	1.85				
Gravel							
Along Rims	24	51.71	18.46	43.9	3.12	14.11	0.00
Back From Rims	18	7.76	8.36				
Lichen							
Along Rims	24	0.76	0.79	0.76	3.12	0.28	1.00
Back From Rims	18	1.51	1.29				
Litter							
Along Rims	24	3.73	3.34	15.52	3.12	4.98	0.00
Back From Rims	18	19.25	18.1				
Moss							
Along Rims	24	0.68	2.1	0.23	3.12	0.08	1.00
Back From Rims	18	0.44	0.62				
Soil							
Along Rims	24	27.91	18.01	25.70	3.12	8.25	0.00
Back From Rims	18	53.6	25.5				
Wood							
Along Rims	24	0.76	0.53	0.52	3.12	0.17	1.00
Back From Rims	18	1.29	0.55				

Table 11. Statistical effects of reducing the number of plant species in the data set and relativizing the canopy-cover measurements.

Statistic	Full data set, unrelativized cover class	Reduced data set, relativized cover class
Number of species	249	121
Average number of species / plot (alpha diversity)	28.0	24.5
Heterogeneity among plots (beta diversity)	7.83	3.34
Percent of empty cells in species-by-plot matrix	88.7%	79.8%
Coefficient of variation among plots in canopy cover	41.0%	0.0%

Table 12. Statistically significant (p=0.05) indicator species for plot groups from the two-group level of the cluster analysis classification based on relative canopy cover.
The maximum possible indicator value is 100. Cushion-plant species are shown in italic typeface.

		Abudance		Frequency		Indicator Value	
Species	Prob-ability	Group 1 (n=28)	Group 14 (n=14)	Group 1 (n=28)	Group 14 (n=14)	Group 1 (n=28)	Group 14 (n=14)
pseudoroegneria spicata, bluebunch wheatgrass	0.003	**78**	22	**86**	50	**67**	11
tetraneuris acaulis, stemless hymenoxys	0.002	**97**	3	**64**	7	**62**	0
phlox muscoides, musk phlox	0.006	**91**	9	**57**	14	**52**	1
eriogonum flavum, yellow eriogonum	0.01	**90**	10	**43**	7	**39**	1
lesquerella condensata, dense bladderpod	0.043	**93**	7	**36**	7	**33**	0
paronychia sessiliflora, creeping nailwort	0.038	**100**	0	**32**	0	**32**	0
chaenactis douglasii, douglas' dustymaiden	0.046	**100**	0	**29**	0	**29**	0
elymus lanceolatus ssp. lanceolatus, thickspike wheatgrass	0.001	1	**99**	4	**93**	0	**92**
chrysothamnus viscidiflorus, yellow rabbitbrush	0.001	19	**81**	18	**86**	3	**70**
phlox hoodii, hoods phlox	0.002	33	**67**	46	**100**	15	**67**
trifolium gymnocarpon, hollyleaf clover	0.001	0	**100**	0	**64**	0	**64**
poa secunda, sandberg bluegrass	0.009	39	**61**	57	**100**	22	**61**
allium textile, textile onion	0.002	20	**80**	11	**64**	2	**52**
zigadenus venenosus, meadow deathcamas	0.001	13	**87**	7	**57**	1	**50**
hesperostipa comata, needle and thread	0.008	18	**82**	18	**57**	3	**47**
crepis modocensis, siskiyou hawksbeard	0.001	11	**89**	7	**50**	1	**45**
astragalus purshii, woollypod milkvetch	0.002	0	**100**	0	**43**	0	**43**
senecio integerrimus, lambstongue groundsel	0.002	0	**100**	0	**43**	0	**43**
carex duriuscula, needleleaf sedge	0.009	25	**75**	14	**57**	4	**43**
astragalus miser, weedy milkvetch	0.004	17	**83**	7	**50**	1	**42**
artemisia tridentata ssp. wyomingensis, wyoming big sagebrush	0.01	16	**84**	18	**50**	3	**42**
besseya wyomingensis, wyoming besseya	0.001	5	**95**	4	**43**	0	**41**
poa fendleriana, muttongrass	0.005	18	**82**	7	**50**	1	**41**
lesquerella ludoviciana, foothill bladderpod	0.011	31	**69**	14	**57**	4	**40**
antennaria microphylla, littleleaf pussytoes	0.003	10	**90**	4	**43**	0	**39**
mertensia humilis, rocky mountain bluebells	0.047	35	**65**	25	**57**	9	**37**
eriogonum ovalifolium, cushion buckwheat	0.03	31	**69**	18	**50**	6	**34**
antennaria dimorpha, low pussytoes	0.01	13	**87**	4	**36**	0	**31**
arenaria congesta, ballhead sandwort	0.012	14	**86**	4	**36**	0	**31**
phlox multiflora, flowery phlox	0.007	0	**100**	0	**29**	0	**29**
cordylanthus ramosus, bushy bird's beak	0.009	0	**100**	0	**29**	0	**29**
penstemon radicosus, matroot penstemon	0.009	0	**100**	0	**29**	0	**29**
agoseris glauca, pale agoseris	0.013	0	**100**	0	**29**	0	**29**
erigeron eatonii, eaton's fleabane	0.013	0	**100**	0	**29**	0	**29**
lomatium foeniculaceum, desert biscuitroot	0.031	12	**88**	4	**29**	0	**25**
atriplex gardneri, gardner's saltbush	0.025	0	**100**	0	**21**	0	**21**
collinsia parviflora, smallflower blue eyed mary	0.027	0	**100**	0	**21**	0	**21**
viola nuttallii, nuttall's violet	0.029	0	**100**	0	**21**	0	**21**
arabis holboellii, holboell's rockcress	0.03	0	**100**	0	**21**	0	**21**
achillea millefolium, common yarrow	0.036	0	**100**	0	**21**	0	**21**
vicia americana, american vetch	0.04	0	**100**	0	**21**	0	**21**
escobaria vivipara, spinystar	0.04	8	**92**	4	**21**	0	**20**

Table 13. Results of statistical analysis for differences among the 4 plot groups in number of species of different growth-forms.

a. Shrubs

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	1.50	16.8	-1.56
4-4	6	2.00	23.8	0.50
4-12	10	1.00	13.3	-2.44
4-14	14	3.00	30.4	3.32
Overall	42		21.5	

H = 14.63, DF = 3, p = 0.002 (adjusted for ties)
Conclusion: Reject H_o. Average number per plot of shrubs differs between plot groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-12 vs 4-14	17.1	4.938	3.643	2.639	Reject H_o: groups differ
4-12 vs 4-4	10.5	6.273	1.674	2.639	Do not reject H_o: groups do not differ
4-1 vs 4-14	13.6	4.701	2.893	2.639	Rject H_o: groups differ
4-4 vs 4-14	6.6	5.826	1.133	2.639	Do not reject H_o: groups do not differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-12	4-1	4-4	4-14
N	10	12	6	14
Mean Rank	13.3	16.8	23.8	30.4

Table 13 (continued).

b. Sub-shrubs

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	1.00	18.1	-1.13
4-4	6	2.50	13.0	-1.83
4-12	10	2.00	22.0	0.13
4-14	14	1.00	27.7	2.32
Overall	42		21.5	

H = 7.74, DF = 3, p = 0.052 (adjusted for ties)
Conclusion: Do not reject H_o. Average number per plot of sub-shrubs does not differ between plot groups.

c Graminoids

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	4.00	19.1	-0.81
4-4	6	2.50	10.7	-2.34
4-12	10	3.00	14.2	-2.17
4-14	14	6.00	33.5	4.47
Overall	42		21.5	

H = 22.74, DF = 3, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Average number per plot of graminoids differs between plot groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-4 vs 4-14	22.5	5.885	3.823	2.639	Reject H_o: groups differ
4-12 vs 4-14	19.1	4.993	3.825	2.639	Reject H_o: groups differ
4-1 vs 4-14	14.2	4.744	2.993	2.639	Rject H_o: groups differ
4-4 vs 4-1	8.3	6.030	1.337	2.639	Do not reject H_o: groups do not differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-4	4-12	4-1	4-14
N	6	10	12	14
Mean Rank	11.0	14.4	19.3	33.5

Table 13 (continued).

d. Forbs

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	9.50	19.3	-0.72
4-4	6	12.00	24.2	0.59
4-12	10	7.50	13.5	-2.38
4-14	14	18.50	27.9	2.40
Overall	42		21.5	

H = 8.87, DF = 3, p = 0.031 (adjusted for ties)
Conclusion: Reject H_o. Average number per plot of forbs differs between plot groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-12 vs 4-14	14.4	4.950	3.909	2.639	Reject H_o: groups differ
4-1 vs 4-14	8.6	4.700	1.830	2.639	Do not reject H_o: groups do not differ
4-12 vs 4-4	10.8	6.170	1.750	2.639	Do not reject H_o: groups do not differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-12	4-1	4-4	4-14
N	10	12	6	14
Mean Rank	13.5	19.3	24.3	27.9

Table 13 (continued).

e. Cushion-plants

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	8.50	22.6	0.38
4-4	6	11.00	33.2	2.53
4-12	10	8.00	23.8	0.66
4-14	14	5.50	13.9	-2.84
Overall	42		21.5	

H = 11.51, DF = 3, p = 0.009 (adjusted for ties)
Conclusion: Reject H_o. Average number per plot of cushion-plants differs between plot groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-14 vs 4-4	19.4	5.947	3.262	2.639	Reject H_o: groups differ
4-14 vs 4-12	9.9	5.046	1.962	2.639	Do not reject H_o: groups do not differ
4-1 vs 4-4	10.7	6.093	1.756	2.639	Do not reject H_o: groups do not differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-14	4-1	4-12	4-4
N	14	12	10	6
Mean Rank	13.9	22.6	23.8	33.3
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Table 13 (continued).

f. All Forms

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	24.50	17.8	-1.24
4-4	6	27.50	22.8	0.27
4-12	10	23.00	12.8	-2.55
4-14	14	32.50	30.3	3.30
Overall	42		21.5	

H = 13.44, DF = 3, p = 0.004 (adjusted for ties)
Conclusion: Reject H_o. Average number per plot of species of all growth-forms differs between plot groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-12 vs 4-14	17.4	5.065	3.435	2.639	Reject H_o: groups differ
4-1 vs 4-14	12.5	4.812	2.597	2.639	Do not reject H_o: groups do not differ
4-12 vs 4-4	9.9	6.317	1.567	2.639	Do not reject H_o: groups do not differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-12	4-1	4-4	4-14
N	10	12	4	14
Mean Rank	12.9	17.8	22.8	30.3

Table 14. Results of statistical analysis for differences among the 4 plot groups in per-plot canopy cover of different growth-forms.

a. Shrubs.

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	1.50	17.0	-1.52
4-4	6	4.50	24.3	0.61
4-12	10	1.00	10.9	-3.13
4-14	14	12.50	31.8	3.83
Overall	42		21.5	

H = 19.48, DF = 3, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Average per-plot cover of shrubs differs between plot groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-12 vs 4-14	20.9	5.043	4.144	2.639	Reject H_o: groups differ
4-1 vs 4-14	14.8	4.792	3.089	2.639	Reject H_o: groups differ
4-4 vs 4-14	7.5	5.943	1.262	2.639	Do not reject H_o: groups do not differ
4-12 vs 4-4	13.4	6.290	2.130	2.639	Do not reject H_o: groups do not differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-12	4-1	4-4	4-14
N	10	12	6	14
Mean Rank	10.9	17.0	24.3	31.8

Table 14 (continued).

b. Sub-shrubs

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	2.00	19.9	-0.53
4-4	6	1.00	11.7	-2.12
4-12	10	3.00	23.6	0.62
4-14	14	3.00	25.6	1.52
Overall	42		21.5	

H = 6.05, DF = 3, p = 0.109 (adjusted for ties)
Conclusion: Do not reject H_o. Average per-plot cover of sub-shrubs does not differ between plot groups.

c. Graminoids

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	9.50	19.5	-0.67
4-4	6	11.00	18.9	-0.56
4-12	10	7.00	13.3	-2.42
4-14	14	19.50	30.2	3.24
Overall	42		21.5	

H = 12.10, DF = 3, p = 0.007 (adjusted for ties)
Conclusion: Reject H_o. Average per-plot cover of graminoids differs between plot groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-12 vs 4-14	16.9	5.07	3.334	2.639	Reject H_o: groups differ
4-12 vs 4-1	6.2	5.242	1.183	2.639	Do not reject H_o: groups do not differ
4-4 vs 4-14	10.9	5.974	1.824	2.639	Do not reject H_o: groups do not differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-12	4-4	4-1	4-14
N	10	6	12	14
Mean Rank	13.3	19.3	19.5	30.2

Table 14 (continued).

d. Forbs

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	12.00	20.5	-0.33
4-4	6	15.50	26.3	1.04
4-12	10	9.00	12.8	-2.55
4-14	14	21.50	26.5	1.85
Overall	42		21.5	

H = 8.30, DF = 3, p = 0.040 (adjusted for ties)
Conclusion: Reject H_o. Average per-plot cover of forbs differs between plot groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-12 vs 4-14	13.6	5.075	2.680	2.639	Reject H_o: groups differ
4-12 vs 4-4	13.4	6.330	2.117	2.639	Do not reject H_o: groups do not differ
4-1 vs 4-14	6.0	4.822	1.244	2.639	Do not reject H_o: groups do not differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-12	4-1	4-4	4-14
N	10	12	6	14
Mean Rank	12.9	20.5	26.3	26.5
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Table 14 (continued).

e. Cushion-plants

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	13.50	21.3	-0.06
4-4	6	23.00	33.3	2.55
4-12	10	17.50	29.9	2.48
4-14	14	8.50	10.6	-4.08
Overall	42		21.5	

H = 21.51, DF = 3, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Average per-plot cover of cushion-plants differs between plot groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-14 vs 4- 4	21.8	5.968	3.653	2.639	Reject H_o: groups differ
4-14 vs 4-12	18.4	5.064	3.634	2.639	Reject H_o: groups differ
4-14 vs 4-1	9.8	4.811	2.037	2.639	Do not reject H_o: groups do not differ
4-1 vs 4-4	12.0	6.115	1.962	2.639	Do not reject H_o: groups do not differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-14	4-1	4-12	4-4
N	14	12	10	6
Mean Rank	11.5	21.3	29.9	33.3

Table 14 (continued).

f. All growth-forms

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	45.50	17.4	-1.36
4-4	6	59.50	26.8	1.13
4-12	10	39.50	13.3	-2.44
4-14	14	65.50	28.6	2.67
Overall	42		21.5	

H = 11.71, DF = 3, p = 0.008 (adjusted for ties)
Conclusion: Reject H_o. Average per-plot cover of all growth-forms differs between plot groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-12 vs 4- 14	15.3	5.074	3.015	2.639	Reject H_o: groups differ
4-12 vs 4-4	13.5	6.329	2.133	2.639	Do not reject H_o: groups do not differ
4-1 vs 4-14	11.2	4.821	2.322	2.639	Do not reject H_o: groups do not differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-12	4-1	4-4	4-14
N	10	12	6	14
Mean Rank	13.3	17.4	26.8	28.6

Table 15. Results of statistical analysis for differences among the 4 plot groups in per-plot relative cover of each growth-form.

a. Shrubs.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	0.044	17.5	-1.32
4-4	6	0.068	22.3	0.18
4-12	10	0.025	11.8	-2.86
4-14	14	0.182	31.5	3.72
Overall	42		21.5	

H = 16.79, DF = 3, p = 0.001 (adjusted for ties)
Conclusion: Reject H_o. Average per-plot cover of shrubs differs between plot groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-12 vs 4-14	19.7	5.075	3.818	2.639	Reject H_o: groups differ
4-12 vs 4-4	10.6	6.329	1.675	2.639	Do not reject H_o: groups do not differ
4-1 vs 4-14	14.0	4.822	2.904	2.639	Reject H_o: groups differ
4-4 vs 4-14	9.1	5.981	1.522	2.639	Do not reject H_o: groups do not differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-12	4-1	4-4	4-14
N	10	12	6	14
Mean Rank	11.8	17.5	22.4	31.5
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Table 15 (continued).

b. Sub-shrubs

Plot Group	N	Median	Ave. Rank	Z
4-1	12	0.04	20.7	-0.26
4-4	6	0.015	10.3	-2.41
4-12	10	0.055	25.6	1.21
4-14	14	0.062	24.0	0.95
Overall	42		21.5	

H = 6.78, DF = 3, p = 0.079 (adjusted for ties)
Conclusion: Do no reject H_o. Average per-plot cover of sub-shrubs does not diffes between plot groups.

c. Graminoids

Plot Group	N	Median	Ave. Rank	Z
4-1	12	0.217	21.1	-0.14
4-4	6	0.169	17.9	-0.77
4-12	10	0.172	15.3	-1.85
4-14	14	0.268	27.9	2.37
Overall	42		21.5	

H = 6.88, DF = 3, p = 0.076 (adjusted for ties)
Conclusion: Do no reject H_o. Average per-plot cover of graminoids does not differ between plot groups.

d. Forbs

Plot Group	N	Median	Ave. Rank	Z
4-1	12	0.280	23.8	0.78
4-4	6	0.260	22.5	0.22
4-12	10	0.214	17.3	-1.24
4-14	14	0.279	22.1	0.21
Overall	42		21.5	

H = 1.68, DF = 3, p = 0.642 (adjusted for ties)

Conclusion: Do no reject H_o. Average per-plot cover of forbs does not differ between plot groups.

Table 15 (continued).

e. Cushion-plants

Plot Group	N	Median	Ave. Rank	Z
4-1	12	0.33	22.2	0.24
4-4	6	0.385	28.2	1.44
4-12	10	0.44	33.5	3.54
4-14	14	0.118	9.5	-4.50
Overall	42		21.5	

H = 24.86, DF = 3, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Average per-plot cover of cushion-plants differs between plot groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-14 vs 4-12	24.0	5.079	4.725	2.639	Reject H_o: groups differ
4-14 vs 4-4	18.7	5.986	3.124	2.639	Reject H_o: groups differ
4-14 vs 4-1	12.7	4.827	2.632	2.639	Do not reject H_o: groups do not differ
4-1 vs 4-12	21.3	5.253	4.055	2.639	Reject H_o: groups differ
4-1 vs 4-4	6.0	6.134	0.978	2.639	Do not reject H_o: groups do not differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-14	4-1	4-4	4-12
N	14	12	6	10
Mean Rank	9.5	22.2	28.2	33.5

Table 16. Results of statistical analysis for differences in number of species of each growth-form in each plot-group.

a. Group 4-1

Kruskal-Wallis test for differences between growth-forms.

Plot Group	N	Median	Ave. Rank	Z
Cushion-plants	12	8.500	46.6	3.58
Forbs	12	9.500	50.1	4.35
Graminoids	12	4.000	28.1	-0.54
Shrubs	12	1.500	13.9	-3.68
Sub-shrubs	12	1.000	13.8	-3.71
Overall	60		30.5	

H = 47.93, DF = 4, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Number of species per plot differs among growth-forms.

Non-parametric pairwise comparisons for differences between growth-forms.

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
Sub-shrub vs. Forb	36.68	5.041	7.217	2.807	Reject H_o
Sub-shrub vs. Cush-pl	32.38		6.523		Reject H_o
Sub-shrub vs. Gram.	14.33		2.843		Reject H_o
Sub-shrub vs. Shrub	0.17		0.034		Do not reject H_o
Shrub vs. Forb	36.21		7.183		Reject H_o
Shrub vs. Cush-pl.	32.71		6.489		Reject H_o
Shrub vs. Gram.	14.16		2.809		Reject H_o
Gram. vs. Forb	22.05		4.374		Reject H_o
Gram. vs. Cush-pl.	18.55		3.68		Reject H_o
Cush-pl. vs. Forb	3.5		0.694		Do not reject H_o

Lines beneath mean ranks link growth-forms that do not differ significantly (p = 0.05)

Groups (by mean rank)	Sub-shrubs	Shrubs	Graminoids	Cushion-plants	Forbs
N	12	12	12	12	12
Mean Rank	13.75	13.92	28.08	46.63	50.13
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Table 16 (continued).

b. Group 4-4

Kruskal-Wallis test for differences between growth-forms.

Plot Group	N	Median	Ave. Rank	Z
Cushion-plants	6	11.000	23.2	2.38
Forbs	6	12.000	25.8	3.21
Graminoids	6	2.500	12.6	-0.91
Shrubs	6	2.000	11.4	-1.27
Sub-shrubs	6	1.000	4.5	-3.42
Overall	30		15.5	

H = 24.74, DF = 4, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Number of species per plot differs among growth-forms.

Non-parametric pairwise comparisons for differences between growth-forms.

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
Sub-shrub vs. Forb	21.33	3.594	5.934	2.807	Reject H_o
Sub-shrub vs. Cush-pl	18.67		5.195		Reject H_o
Sub-shrub vs. Gram.	8.08		2.248		Do not reject H_o
Shrub vs. Forb	14.41		4.01		Reject H_o
Shrub vs. Cush-pl.	11.75		3.269		Reject H_o
Shrub vs. Gram.	1.16		0.323		Do not reject H_o
Gram. vs. Forb	13.25		3.686		Reject H_o
Gram. vs. Cush-pl.	10.59		2.947		Reject H_o
Cush-pl. vs. Forb	2.66		0.74		Do not reject H_o

Lines beneath mean ranks link growth-forms that do not differ significantly (p = 0.05)

Groups (by mean rank)	Sub-shrubs	Shrubs	Graminoids	Cushion-plants	Forbs
N	6	6	6	6	6
Mean Rank	4.5	11.42	12.58	23.17	25.83
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Table 16 (continued).

c. Group 4-12

Kruskal-Wallis test for differences between growth-forms.

Plot Group	N	Median	Ave. Rank	Z
Cushion-plants	10	8.000	40.1	3.55
Forbs	10	7.500	36.7	2.72
Graminoids	10	3.000	22.2	-0.81
Shrubs	10	1.000	11.6	-3.38
Sub-shrubs	10	2.000	17.0	-2.07
Overall	50		25.5	

H = 29.67, DF = 4, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Number of species per plot differs among growth-forms.

Non-parametric pairwise comparisons for differences between growth-forms.

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
Shrub vs. Cush-pl	38.4	3.594	4.61	2.807	Reject H_o
Shrub vs. Forb	28.4		6.16		Reject H_o
Shrub vs. Gram.	10.6		2.299		Reject H_o
Shrub vs. Sub-sh.	5.4		1.171		Do not reject H_o
Sub-shrub vs. Cush-pl.	23.2		5.033		Reject H_o
Sub-sh. vs. Forb	19.75		4.284		Reject H_o
Sub-shrub vs. Gram.	5.2		1.128		Do not reject H_o
Gram. vs. Cush-pl.	18.0		3.905		Reject H_o
Gram. vs. Forb	14.55		3.156		Reject H_o
Forb vs. Cush-pl.	3.45		0.749		Do not reject H_o

Lines beneath mean ranks link growth-forms that do not differ significantly (p = 0.05)

Groups (by mean rank)	Shrubs	Sub-shrubs	Graminoids	Forbs	Cushion-plants
N	10	10	10	10	10
Mean Rank	7.0	11.42	12.58	23.17	25.83
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Table 16 (continued).

d. Group 4-14

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
Cushion-plants	14	5.500	37.6	0.44
Forbs	14	18.500	59.0	4.84
Graminoids	14	6.000	41.1	1.15
Shrubs	14	3.000	20.4	-3.11
Sub-shrubs	14	3.000	19.3	-3.33
Overall	70		35.5	

H = 36.94, DF = 4, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Number of species per plot differs among growth-forms.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
Sub-shrub vs. Forb	39.71	5.439	7.301		Reject H_o
Sub-shrub vs. Gram.	21.71		3.992		Reject H_o
Sub-shrub vs. Cush-pl.	18.28		3.361		Reject H_o
Sub-shrub vs. Shrub	1.0		0.184		Do not reject H_o
Shrub. vs. Forb	38.71		7.117		Reject H_o
Shrub vs. Gram.	20.71		3.808		Reject H_o
Shrub vs. Cush-pl	17.28		3.177		Reject H_o
Cush-pl. vs. Forb	21.43		3.94		Reject H_o
Cush-p. vs. Gram.	3.43		0.631		Do not reject H_o
Gram. vs. Forb	18.0		3.309		Reject H_o

Lines beneath mean ranks link growth-forms that do not differ significantly (p = 0.05)

Groups (by mean rank)	Sub-shrubs	Shrubs	Cush-pl.	Graminoids	Forbs
N	14	14	14	14	14
Mean Rank	19.29	20.29	37.57	41.0	59.0
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Table 17. Results of statistical analysis for differences in per-plot cover of species of each growth-form in each plot-group.

a. Group 4-1

Kruskal-Wallis test for differences between growth-forms.

Plot Group	N	Median	Ave. Rank	Z
Cushion-plants	12	13.500	43.6	2.90
Forbs	12	12.000	41.1	2.35
Graminoids	12	9.500	35.9	1.20
Shrubs	12	1.500	18.4	-2.69
Sub-shrubs	12	2.000	13.5	-3.76
Overall	60		30.5	

H = 29.51, DF = 4, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Number of species per plot differs among growth-forms.

Non-parametric pairwise comparisons for differences between growth-forms.

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
Cush-pl. vs. Sub-shrub	31.02	5.041	6.15	2.807	Reject H_o
Cush-pl. vs. Shrub	32.38		5.16		Reject H_o
Cush-pl. vs. Gram.	8.74		1.73		Do not reject H_o
Forb vs. Sub-shrub	27.49		5.45		Reject H_o
Forb vs. Shrub	22.46		4.46		Reject H_o
Forb vs. Gram.	5.21		1.03		Do not reject H_o
Gram. vs. Sub-shrub	22.28		4.42		Reject H_o
Gram. vs. Shrub	17.25		3.42		Reject H_o
Shrub vs. Sub-shrub	5.03		0.998		Do not reject H_o

Lines beneath mean ranks link growth-forms that do not differ significantly (p = 0.05)

Groups (by mean rank)	Sub-shrubs	Shrubs	Graminoids	Forbs	Cushion-plants
N	12	12	12	12	12
Mean Rank	13.43	18.46	35.71	40.92	44.45
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Table 17 (continued).

b. Group 4-4

Kruskal-Wallis test for differences between growth-forms.

Plot Group	N	Median	Ave. Rank	Z
Cushion-plants	6	23.000	24.9	2.93
Forbs	6	15.500	20.4	1.53
Graminoids	6	11.000	17.2	0.52
Shrubs	6	4.500	11.3	-1.32
Sub-shrubs	6	1.000	3.7	-3.66
Overall	30		15.5	

H = 21.14, DF = 4, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Number of species per plot differs among growth-forms.

Non-parametric pairwise comparisons for differences between growth-forms.

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
Cush-pl. vs. Sub-shrub	21.17	3.594	5.89	2.807	Reject H_o
Cush-pl. vs. Shrub	13.67		3.803		Reject H_o
Cush-pl. vs. Gram.	7.75		2.16		Do not reject H_o
Forb vs. Sub-shrub	16.67		4.683		Reject H_o
Forb vs. Shrub	9.17		2.551		Do not reject H_o
Shrub vs. Gram.	1.16		0.323		Do not reject H_o
Gram. vs. Sub-shrub	13.42		3.73		Reject H_o
Shrub vs. Sub-shrub	7.5		2.087		Do not reject H_o

Lines beneath mean ranks link growth-forms that do not differ significantly (p = 0.05)

Groups (by mean rank)	Sub-shrubs	Shrubs	Graminoids	Forbs	Cushion-plants
N	6	6	6	6	6
Mean Rank	3.75	11.25	17.17	20.42	24.92
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Table 17 (continued).

c. Group 4-12

Kruskal-Wallis test for differences between growth-forms.

Plot Group	N	Median	Ave. Rank	Z
Cushion-plants	10	17.500	44.1	4.51
Forbs	10	9.000	29.5	0.97
Graminoids	10	7.000	26.6	0.27
Shrubs	10	1.000	10.2	-3.72
Sub-shrubs	10	3.000	17.1	-2.03
Overall	50		25.5	

H = 31.76, DF = 4, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Number of species per plot differs among growth-forms.

Non-parametric pairwise comparisons for differences between growth-forms.

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
Cush-pl. vs. Shrub	33.95	4.61	7.36	2.807	Reject H_o
Cush-pl. vs. Sub-shrub	26.95		5.846		Reject H_o
Cush-pl. vs. Gram.	17.5		3.796		Reject H_o
Cush-pl. vs. Forb	14.6		3.167		Reject H_o
Forb vs. Shrub	19.35		4.197		Reject H_o
Forb vs. Sub-shrub	12.35		2.679		Do not reject H_o
Gram. vs. Shrub	16.45		3.568		Reject H_o
Sub-shrub vs. Shrub	7.0		1.152		Do not reject H_o

Lines beneath mean ranks link growth-forms that do not differ significantly (p = 0.05)

Groups (by mean rank)	Shrubs	Sub-shrubs	Graminoids	Forbs	Cushion-plants
N	10	10	10	10	10
Mean Rank	10.45	17.15	26.6	29.5	44.1
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Table 17 (continued).

d. Group 4-14

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
Cushion-plants	14	8.500	29.9	-1.15
Forbs	14	21.500	47.5	2.46
Graminoids	14	19.500	50.3	3.03
Shrubs	14	12.500	36.6	0.23
Sub-shrubs	14	3.000	13.3	-4.57
Overall	70		35.5	

H = 30.10, DF = 4, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Number of species per plot differs among growth-forms.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
Gram. vs. Sub-shrub	37.0	5.439	6.803		Reject H_o
Gram. vs. Cush-pl.	20.36		3.743		Reject H_o
Gram. vs. Shrub	13.61		2.502		Do not reject H_o
Forb vs. Sub-shrub	34.21		6.29		Reject H_o
Forb vs. Cush-pl.	17.57		3.23		Reject H_o
Shrub vs. Sub-shrub	23.39		4.3		Reject H_o
Shrub vs. Cush-pl	17.28		3.177		Reject H_o
Cush-p. vs. Sub-shrub	16.64		3.06		Reject H_o

Lines beneath mean ranks link growth-forms that do not differ significantly (p = 0.05)

Groups (by mean rank)	Sub-shrubs	Cushion-plants	Shrubs	Forbs	Graminoids
N	14	14	14	14	14
Mean Rank	13.25	29.89	36.64	47.46	50.25

Table 18. Results of statistical analysis for differences in per-plot relative cover of species of each growth-form in each plot-group.

a. Group 4-1

Kruskal-Wallis test for differences between growth-forms.

Plot Group	N	Median	Ave. Rank	Z
Cushion-plants	12	0.33	45.3	3.28
Forbs	12	0.28	41.8	2.51
Graminoids	12	0.217	36.0	1.21
Shrubs	12	0.044	16.2	-3.18
Sub-shrubs	12	0.04	13.3	-3.83
Overall	60		30.5	

H = 34.65, DF = 4, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Number of species per plot differs among growth-forms.

Non-parametric pairwise comparisons for differences between growth-forms.

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
Cush-pl. vs. Sub-shrub	32.27	5.041	6.40	2.807	Reject H_o
Cush-pl. vs. Shrub	29.31		5.81		Reject H_o
Cush-pl. vs. Gram.	9.77		1.94		Do not reject H_o
Forb vs. Sub-shrub	28.42		5.64		Reject H_o
Forb vs. Shrub	25.46		5.05		Reject H_o
Gram. vs. Sub-shrub	22.5		4.46		Reject H_o
Gram. vs. Shrub	19.54		3.88		Reject H_o
Shrub vs. Sub-shrub	2.96		0.59		Do not reject H_o

Lines beneath mean ranks link growth-forms that do not differ significantly (p = 0.05)

Groups (by mean rank)	Sub-shrubs	Shrubs	Graminoids	Forbs	Cushion-plants
N	12	12	12	12	12
Mean Rank	13.29	16.25	35.79	41.71	45.56
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Table 18 (continued).

b. Group 4-4

Kruskal-Wallis test for differences between growth-forms.

Plot Group	N	Median	Ave. Rank	Z
Cushion-plants	6	0.385	25.0	2.96
Forbs	6	0.26	20.7	1.61
Graminoids	6	0.169	17.2	0.54
Shrubs	6	0.068	11.1	-1.37
Sub-shrubs	6	0.015	3.5	-3.73
Overall	30		15.5	

H = 21.96, DF = 4, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Number of species per plot differs among growth-forms.

Non-parametric pairwise comparisons for differences between growth-forms.

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
Cush-pl. vs. Sub-shrub	21.5	3.594	5.982	2.807	Reject H_o
Cush-pl. vs. Shrub	13.92		3.873		Reject H_o
Cush-pl. vs. Gram.	7.75		2.156		Do not reject H_o
Forb vs. Sub-shrub	17.17		4.777		Reject H_o
Forb vs. Shrub	9.59		2.668		Do not reject H_o
Gram. vs. Sub-shrub	13.75		3.826		Reject H_o

Lines beneath mean ranks link growth-forms that do not differ significantly (p = 0.05)

Groups (by mean rank)	Sub-shrubs	Shrubs	Graminoids	Forbs	Cushion-plants
N	6	6	6	6	6
Mean Rank	3.5	11.08	17.25	20.67	25.0
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Table 18 (continued).

c. Group 4-12

Kruskal-Wallis test for differences between growth-forms.

Plot Group	N	Median	Ave. Rank	Z
Cushion-plants	10	0.44	44.9	4.71
Forbs	10	0.214	29.3	0.91
Graminoids	10	0.172	26.8	0.32
Shrubs	10	0.025	9.5	-3.89
Sub-shrubs	10	0.055	17.1	-2.04
Overall	50		25.5	

H = 33.94, DF = 4, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Number of species per plot differs among growth-forms.

Non-parametric pairwise comparisons for differences between growth-forms.

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
Cush-pl. vs. Shrub	35.45	4.61	7.69	2.807	Reject H_o
Cush-pl. vs. Sub-shrub	27.8		6.03		Reject H_o
Cush-pl. vs. Gram.	18.1		3.926		Reject H_o
Cush-pl. vs. Forb	51.65		3.395		Reject H_o
Forb vs. Shrub	19.8		4.295		Reject H_o
Forb vs. Sub-shrub	12.15		2.636		Do not reject H_o
Gram. vs. Shrub	17.35		3.764		Reject H_o
Sub-shrub vs. Shrub	7.65		1.659		Do not reject H_o

Lines beneath mean ranks link growth-forms that do not differ significantly (p = 0.05)

Groups (by mean rank)	Shrubs	Sub-shrubs	Graminoids	Forbs	Cushion-plants
N	10	10	10	10	10
Mean Rank	9.45	17.1	26.8	29.25	44.9
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Table 18 (continued).

d. Group 4-14

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
Cushion-plants	14	0.118	29.1	-1.32
Forbs	14	0.279	48.4	2.64
Graminoids	14	0.268	51.0	3.19
Shrubs	14	0.182	35.6	0.02
Sub-shrubs	14	0.062	13.4	-4.54
Overall	70		35.5	

H = 31.61, DF = 4, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Number of species per plot differs among growth-forms.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
Gram. vs. Sub-shrub	37.64	5.439	6.92	2.807	Reject H_o
Gram. vs. Cush-pl.	22		4.045		Reject H_o
Gram. vs. Shrub	15.5		2.85		Reject H_o
Gram. vs. Forb	2.71		0.498		Do not reject H_o
Forb vs. Sub-shrub	34.93		6.422		Reject H_o
Forb vs. Cush-pl.	19.29		3.547		Reject H_o
Forb vs. Shrub	12.79		2.352		Do not reject H_o
Shrub vs. Sub-shrub	22.14		4.071		Reject H_o
Shrub vs. Cush-pl	6.5		1.195		Do not reject H_o
Cush-p. vs. Sub-shrub	15.64		2.876		Reject H_o

Lines beneath mean ranks link growth-forms that do not differ significantly (p = 0.05)

Groups (by mean rank)	Sub-shrubs	Cushion-plants	Shrubs	Forbs	Graminoids
N	14	14	14	14	14
Mean Rank	13.43	29.07	35.57	48.36	51.07
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Table 19. Relative canopy cover in plots of group 4-4.
Average cover for a species in a group is calculated just for the plots in which that species occurred.
Cushion-plants are shown in italic typeface.

Species	Group 4-4 = Group 7-4							
	# plots (n=6)	4-4 and 7-4 Ave.	2CHLK0101	2CHLK0610.01	2CHLK0612.01	2CHLK0604.01	2CHLK0606.01	2CHLK0606.02
phlox muscoides, musk phlox	6	3.50	10	3	1	1	3	3
tetraneuris acaulis, stemless hymenoxys	6	3.50	3	1	3	1	10	3
castilleja, indian paintbrush	6	1.67	1	1	1	3	1	3
pseudoroegneria spicata, bluebunch wheatgrass	5	11.80	3	10	0	3	3	40
paronychia depressa, spreading nailwort	5	5.40	10	1	3	0	10	3
stenotus armerioides, thrift mock goldenweed	5	4.00	0	3	3	3	1	10
ericameria nauseosa, rubber rabbitbrush	5	2.80	1	10	1	0	1	1
erigeron engelmannii var. engelmannii, engelmann`s fleabane	5	2.20	0	3	1	3	1	3
arenaria hookeri, hooker's sandwort	5	1.80	0	1	1	3	1	3
eriogonum acaule, singlestem buckwheat	5	1.80	0	1	3	1	3	1
lesquerella alpina, alpine bladderpod	5	1.80	0	1	1	1	3	3
linum lewisii, prairie flax	5	1.40	0	1	1	1	1	3
sedum lanceolatum, spearleaf stonecrop	5	1.00	1	1	1	1	0	1
artemisia tripartita ssp. rupicola, wyoming threetip sagebrush	4	2.50	0	0	1	3	3	3
forb unknown (artichoke plant)	4	2.50	0	1	3	0	3	3
lupinus sp., lupine	4	2.50	0	3	1	3	0	3
erigeron compositus, cutleaf daisy	4	1.00	1	1	0	0	1	1
poa secunda, sandberg bluegrass	3	4.67	0	3	1	10	0	0
forb unknown chalk 5 (purple base paintbrush)	3	2.33	0	3	0	0	1	3
phlox hoodii, hoods phlox	3	2.33	3	0	0	3	0	1
artemisia tridentata ssp. wyomingensis, wyoming big sagebrush	3	1.67	0	1	0	3	0	1
koeleria macrantha, prairie junegrass	3	1.67	1	3	1	0	0	0
artemisia frigida, fringed sagewort	3	1.00	1	1	0	0	0	1
chaenactis douglasii, douglas' dustymaiden	3	1.00	1	0	1	0	1	0
cryptantha sp., cryptantha	3	1.00	0	0	1	0	1	1
draba oligosperma, fewseed whitlowgrass	3	1.00	1	1	0	1	0	0
mertensia lanceolata, lanceleaf bluebells	3	1.00	0	1	1	1	0	0
penstemon laricifolius, larchleaf beardtongue	3	1.00	0	1	0	0	1	1
sphaeromeria simplex, laramie chickensage	2	3.00	3	3	0	0	0	0
erigeron ochroleucus, buff fleabane	2	2.00	3	0	0	0	1	0
eriogonum sp., eriogonum	2	1.00	0	0	1	0	0	1
machaeranthera grindelioides, rayless aster	2	1.00	1	0	1	0	0	0
oxytropis multiceps, southwestern locoweed	2	1.00	0	0	0	1	1	0
oxytropis sp., crazyweed	2	1.00	1	1	0	0	0	0
penstemon eriantherus, fuzzytongue penstemon	2	1.00	0	0	0	0	1	1
poa fendleriana, muttongrass	1	20.00	0	0	0	0	0	20
astragalus spatulatus, tufted milkvetch	1	3.00	3	0	0	0	0	0
cryptantha caespitosa, tufted catseye	1	3.00	3	0	0	0	0	0
forb unknown (yellow flwr grn bunch)	1	3.00	3	0	0	0	0	0
mertensia humilis, rocky mountain bluebells	1	3.00	0	0	0	0	0	3
poa sp., bluegrass	1	3.00	0	0	0	3	0	0
stenotus acaulis, stemless mock goldenweed	1	3.00	3	0	0	0	0	0
besseya wyomingensis, wyoming besseya	1	1.00	0	0	0	0	0	1

Table 19 (continued).

Species	Group 4-4 = Group 7-4							
	# plots (n=6)	4-4 and 7-4 Ave.	2CHLK011.01	2CHLK0610.01	2CHLK0612.01	2CHLK0604.01	2CHLK0606.01	2CHLK0606.02
carex filifolia, threadleaf sedge	1	1.00	1	0	0	0	0	0
castilleja pallescens, pale indian paintbrush	1	1.00	0	0	0	1	0	0
chrysothamnus viscidiflorus, yellow rabbitbrush	1	1.00	1	0	0	0	0	0
comandra umbellata, bastard toadflax	1	1.00	1	0	0	0	0	0
crepis, hawksbeard	1	1.00	0	0	0	0	0	1
erigeron nematophyllus, needleleaf fleabane	1	1.00	0	0	0	0	1	0
erigeron, fleabane	1	1.00	0	1	0	0	0	0
forb unknown (3 bundle yellow flower)	1	1.00	0	0	1	0	0	0
forb unknown (feather leaf mat)	1	1.00	0	1	0	0	0	0
forb unknown (little artichoke plant)	1	1.00	0	0	0	1	0	0
forb unknown (powder long leaf)	1	1.00	1	0	0	0	0	0
forb unknown (purple underside paddle)	1	1.00	0	0	0	0	0	1
forb unknown chalk 2 (thick leaf onion)	1	1.00	0	1	0	0	0	0
forb unknown chalk 3 (spur leaf)	1	1.00	0	1	0	0	0	0
forb unknown chalk 4 (taco plant)	1	1.00	0	1	0	0	0	0
lesquerella condensata, dense bladderpod	1	1.00	0	0	0	1	0	0
lesquerella sp., bladderpod	1	1.00	1	0	0	0	0	0
mentzelia humilis, gypsum blazingstar	1	1.00	1	0	0	0	0	0
penstemon sp., penstemon	1	1.00	0	0	0	1	0	0
poa cusickii, cusick`s bluegrass	1	1.00	1	0	0	0	0	0
potentilla ovina, sheep cinquefoil	1	1.00	1	0	0	0	0	0
tetraneuris torreyana, torrey's hymenoxys	1	1.00	0	0	0	1	0	0
townsendia spathulata, sword townsendia	1	1.00	1	0	0	0	0	0

Table 20. Statistically significant (p=0.05) indicator species for plot groups from the 4-group level of the classification based on relative canopy cover.
The maximum possible indicator value is 100. Cushion-plant species are shown in italic typeface.

Species	Prob-ability	Abundance				Frequency				Indicator Value			
		Group 4-1 (n=12)	Group 4-4 (n=6)	Group 4-12 (n=10)	Group 4-14 (n=14)	Group 4-1 (n=12)	Group 4-4 (n=6)	Group 4-12 (n=10)	Group 4-14 (n=14)	Group 4-1 (n=12)	Group 4-4 (n=6)	Group 4-12 (n=10)	Group 4-14 (n=14)
stenotus acaulis, stemless mock goldenweed	0.001	**77**	11	5	7	**75**	17	20	36	**58**	2	1	2
pseudoroegneria spicata, bluebunch wheatgrass	0.04	**40**	33	19	9	**100**	83	70	50	**40**	27	13	4
eriogonum flavum, yellow eriogonum	0.048	**55**	0	41	4	**58**	0	50	7	**32**	0	21	0
oxytropis sericea, silvery oxytrope	0.026	**76**	0	11	14	**42**	0	10	14	**32**	0	1	2
castilleja, indian paintbrush	0.001	0	**100**	0	0	0	**100**	0	0	0	**100**	0	0
erigeron engelmannii var. engelmannii, engelmann`s fleabane	0.001	0	**100**	0	0	0	**83**	0	0	0	**83**	0	0
lesquerella alpina, alpine bladderpod	0.001	0	**100**	0	0	0	**83**	0	0	0	**83**	0	0
paronychia depressa, spreading nailwort	0.001	4	**89**	8	0	17	**83**	10	0	1	**74**	1	0
eriogonum acaule, singlestem buckwheat	0.001	0	**87**	13	0	0	**83**	20	0	0	**72**	3	0
forb unknown (artichoke plant)	0.001	0	**100**	0	0	0	**67**	0	0	0	**67**	0	0
lupinus sp., lupine	0.001	0	**100**	0	0	0	**67**	0	0	0	**67**	0	0
tetraneuris acaulis, stemless hymenoxys	0.002	10	**62**	27	1	50	**100**	60	7	5	**62**	16	0
erigeron compositus, cutleaf daisy	0.001	0	**81**	19	0	0	**67**	10	0	0	**54**	2	0
ericameria nauseosa, rubber rabbitbrush	0.005	5	**63**	4	27	17	**83**	10	43	1	**53**	0	12
forb unknown chalk 5 (purple base paintbrush)	0.003	0	**100**	0	0	0	**50**	0	0	0	**50**	0	0
mertensia lanceolata, lanceleaf bluebells	0.002	0	**100**	0	0	0	**50**	0	0	0	**50**	0	0
stenotus armerioides, thrift mock goldenweed	0.003	18	**61**	14	7	17	**83**	40	21	3	**50**	5	2
artemisia tripartita ssp. rupicola, wyoming threetip sagebrush	0.013	4	**60**	5	31	8	**67**	10	21	0	**40**	1	7
linum lewisii, prairie flax	0.031	10	**45**	32	13	17	**83**	30	36	2	**38**	10	4
sedum lanceolatum, spearleaf stonecrop	0.039	30	**43**	9	17	42	**83**	20	43	13	**36**	2	7
cryptantha sp., cryptantha	0.038	33	**62**	0	5	25	**50**	0	7	8	**31**	0	0
eriogonum sp., eriogonum	0.036	23	**77**	0	0	8	**33**	0	0	2	**26**	0	0
phlox muscoides, musk phlox	0.001	0	24	**73**	3	0	100	**100**	14	0	24	**73**	0
lesquerella condensata, dense bladderpod	0.04	30	10	**57**	3	25	17	**60**	7	8	2	**34**	0

(table continues on next page)

Table 20 (continued).

Species	Prob-ability	Abundance				Frequency				Indicator Value			
		Group 4-1 (n=12)	Group 4-4 (n=6)	Group 4-12 (n=10)	Group 4-14 (n=14)	Group 4-1 (n=12)	Group 4-4 (n=6)	Group 4-12 (n=10)	Group 4-14 (n=14)	Group 4-1 (n=12)	Group 4-4 (n=6)	Group 4-12 (n=10)	Group 4-14 (n=14)
elymus lanceolatus ssp. lanceolatus, thickspike wheatgrass	0.001	0	0	4	**96**	0	0	10	**93**	0	0	0	**90**
trifolium gymnocarpon, hollyleaf clover	0.001	0	0	0	**100**	0	0	0	**64**	0	0	0	**64**
chrysothamnus viscidiflorus, yellow rabbitbrush	0.007	4	7	30	**60**	8	17	30	**86**	0	1	9	**51**
astragalus purshii, woollypod milkvetch	0.005	0	0	0	**100**	0	0	0	**43**	0	0	0	**43**
senecio integerrimus, lambstongue groundsel	0.004	0	0	0	**100**	0	0	0	**43**	0	0	0	**43**
zigadenus venenosus, meadow deathcamas	0.003	10	0	18	**72**	8	0	10	**57**	1	0	2	**41**
allium textile, textile onion	0.013	27	0	11	**63**	17	0	10	**64**	4	0	1	**40**
crepis modocensis, siskiyou hawksbeard	0.016	9	0	16	**76**	8	0	10	**50**	1	0	2	**38**
hesperostipa comata, needle and thread	0.048	7	0	29	**63**	17	0	30	**57**	1	0	9	**36**
antennaria microphylla, littleleaf pussytoes	0.015	20	0	0	**80**	8	0	0	**43**	2	0	0	**34**
besseya wyomingensis, wyoming besseya	0.015	0	20	0	**80**	0	17	0	**43**	0	3	0	**34**
astragalus miser, weedy milkvetch	0.038	25	0	9	**67**	8	0	10	**50**	2	0	1	**33**
agoseris glauca, pale agoseris	0.029	0	0	0	**100**	0	0	0	**29**	0	0	0	**29**
cordylanthus ramosus, bushy bird's beak	0.021	0	0	0	**100**	0	0	0	**29**	0	0	0	**29**
erigeron eatonii, eaton's fleabane	0.026	0	0	0	**100**	0	0	0	**29**	0	0	0	**29**
penstemon radicosus, matroot penstemon	0.02	0	0	0	**100**	0	0	0	**29**	0	0	0	**29**
phlox multiflora, flowery phlox	0.04	0	0	0	**100**	0	0	0	**29**	0	0	0	**29**
phlox hoodii, hoods phlox	0.016	39	18	0	**43**	83	50	0	**100**	33	9	0	**43**

Table 21. Results of statistical analysis for differences in ground-cover among the 4 plot groups.

a. Cobble

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	0.005	29.3	2.59
4-4	6	0.002	23.8	0.49
4-12	10	0.002	23.9	0.69
4-14	14	0.000	12.2	-3.47
Overall	42		21.5	

H = 14.18, DF = 3, p = 0.003 (adjusted for ties)
Conclusion: Reject H_o. Average percent cobble cover per plot differs between plot groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-14 vs 4-1	17.1	4.692	3.645	2.639	Reject H_o: groups differ
4-14 vs 4-12	11.7	4.928	2.374	2.639	Do not reject H_o: groups do not differ
4-1 vs 4-4	5.1	5.959	0.923	2.639	Do not reject H_o: groups do not differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-14	4-4	4-12	4-1
N	14	6	10	12
Mean Rank	12.2	23.8	23.9	29.3

Table 21 (continued).

b. Gravel

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	45.00	29.0	2.52
4-4	6	35.15	25.0	0.75
4-12	10	48.00	27.5	1.73
4-14	14	2.63	9.4	-4.54
Overall	42		21.5	

H = 21.03, DF = 3, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Average percent gravel cover per plot differs between plot groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-14 vs 4-1	19.68	4.83	4.076	2.639	Reject H_o: groups differ
4-14 vs 4-12	17.99	17.99	5.078	2.639	Reject H_o: groups differ
4-14 vs 4-4	15.64	5.984	2.614	2.639	Do not reject H_o: groups do not differ
4-1 vs 4-4	4.04	6.132	0.659	2.639	Do not reject H_o: groups do not differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-14	4-4	4-12	4-1
N	14	6	10	12
Mean Rank	9.36	25.0	27.35	29.04

Table 21 (continued).

c. Litter

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	5.650	19.7	-0.60
4-4	6	2.318	13.0	-1.83
4-12	10	2.243	15.1	-1.89
4-14	14	18.879	31.2	3.64
Overall	42		21.5	

H = 14.78, DF = 3, p = 0.002 (adjusted for ties)
Conclusion: Reject H_o. Average percent litter cover per plot differs between groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-4 vs. 4-14	18.18	5.97	3.045	2.639	Reject H_o: groups differ
4-4 vs. 4-1	6.63	6.12	1.084	2.639	Do not reject H_o: groups do not differ
4-12 vs. 4-14	16.18	5.067	3.193	2.639	Reject H_o: groups differ
4-1 vs. 4-14	11.55	4.814	2.399	2.639	Do not reject H_o: groups do not differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-4	4-12	4-1	4-14
N	6	10	12	14
Mean Rank	13	15	19.63	31.18

Table 21 (continued).

d. Soil

Kruskal-Wallis test for differences between groups.

Plot Group	N	Median	Ave. Rank	Z
4-1	12	21.3	16	-1.85
4-4	6	11.7	7.4	-3.04
4-12	10	39	22.8	0.37
4-14	14	68.5	31.4	3.7
Overall	42		21.5	

H = 19.58, DF = 3, p = 0.000 (adjusted for ties)
Conclusion: Reject H_o. Average percent soil cover per plot differs between groups.

Non-parametric pairwise comparisons for differences between groups

Comparison	Difference in Mean Ranks	Std Error	Q	$Q_{0.05, 4}$	Conclusion
4-4 vs. 4-14	23.97	6.947	3.45	2.639	Reject H_o: groups differ
4-4 vs. 4-1	8.54	6.131	1.393	2.639	Do not reject H_o: groups do not differ
4-12 vs. 4-14	17.39	5.077	3.425	2.639	Reject H_o: groups differ
4-1 vs. 4-14	15.43	4.824	3.199	2.639	Reject H_o: groups differ

Lines beneath mean ranks link groups that do not differ significantly (p = 0.05)

Groups (by mean rank)	4-4	4-12	4-1	4-14
N	6	10	12	14
Mean Rank	7.42	14	15.96	31.39

Table 22. Relative canopy cover in plots of group 4-12.
Average cover for a species in a group is calculated just for the plots in which that species occurred. Cushion-plants are shown in italic typeface.

Species	Group 4-12															
			Group 7-12					Group 7-17								
	4-12 # plots (n=10)	4-12 Ave.	7-12 # plots (n=3)	7-12 Ave.	3CYR01.01	3CYR02.01	3CYR03.01	7-17 # plots (n=7)	7-17 Ave.	3DRY01.01	3FETT01.01	3FM01.01	3PH01.01	3PH02.01	3SHRM01.01	3SHRM02.01
phlox muscoides, musk phlox	10	6.50	3	10.00	10	10	10	7	5.00	10	3	10	3	3	3	3
arenaria hookeri, hooker's sandwort	9	3.89	3	3.00	3	3	3	6	4.33	10	1	1	3	1	0	10
pseudoroegneria spicata, bluebunch wheatgrass	7	4.14	1	1.00	0	1	0	6	4.67	10	1	10	3	0	1	3
machaeranthera grindelioides, rayless aster	7	1.57	2	1.00	0	1	1	5	1.80	3	1	3	0	1	0	1
tetraneuris acaulis, stemless hymenoxys	6	1.67	2	1.00	1	0	1	4	2.00	1	3	0	1	3	0	0
lesquerella condensata, dense bladderpod	6	1.33	1	1.00	0	1	0	5	1.40	1	3	1	1	1	0	0
astragalus simplicifolius, little bun milkvetch	5	3.20	2	2.00	1	3	0	3	4.00	10	1	1	0	0	0	0
eriogonum flavum, yellow eriogonum	5	1.00	0	-	0	0	0	5	1.00	1	1	1	1	0	0	1
paronychia sessiliflora, creeping nailwort	4	2.50	0	-	0	0	0	4	2.50	3	0	3	1	3	0	0
packera cana, woolly groundsel	4	2.00	0	-	0	0	0	4	2.00	0	3	0	1	3	1	0
tetraneuris torreyana, torrey's hymenoxys	4	2.00	0	-	0	0	0	4	2.00	0	0	3	1	0	3	1
artemisia frigida, fringed sagewort	4	1.50	1	1.00	0	1	0	3	1.67	1	0	1	0	0	0	3
erigeron nematophyllus, needleleaf fleabane	4	1.50	0	-	0	0	0	4	1.50	1	1	3	1	0	0	0
gutierrezia sarothrae, broom snakeweed	4	1.50	0	-	0	0	0	4	1.50	1	1	1	0	0	0	3
musineon tenuifolium, slender wildparsley	4	1.50	0	-	0	0	0	4	1.50	0	3	0	1	1	1	0
cryptantha caespitosa, tufted catseye	4	1.00	1	1.00	0	0	1	3	1.00	0	1	0	1	1	0	0
poa secunda, sandberg bluegrass	4	1.00	2	1.00	1	1	0	2	1.00	1	1	0	0	0	0	0
stenotus armerioides, thrift mock goldenweed	4	1.00	1	1.00	0	0	1	3	1.00	0	1	1	1	0	0	0
tetradymia canescens, spineless horsebrush	4	1.00	1	1.00	0	1	0	3	1.00	1	1	0	0	0	1	0
artemisia pedatifida, birdfoot sagebrush	3	4.67	3	4.67	10	1	3	0	-	0	0	0	0	0	0	0
carex filifolia, threadleaf sedge	3	3.00	1	3.00	0	0	3	2	3.00	0	0	0	3	3	0	0
achnatherum hymenoides, indian ricegrass	3	1.67	3	1.67	3	1	1	0	-	0	0	0	0	0	0	0
chrysothamnus viscidiflorus, yellow rabbitbrush	3	1.67	2	2.00	0	3	1	1	1.00	1	0	0	0	0	0	0
hesperostipa comata, needle and thread	3	1.67	3	1.67	3	1	1	0	-	0	0	0	0	0	0	0

Table 22 (continued).

Species	Group 4-12															
			Group 7-12					Group 7-17								
	4-12 # plots (n=10)	4-12 Ave.	7-12 # plots (n=3)	7-12 Ave.	3CYR01.01	3CYR02.01	3CYR03.01	7-17 # plots (n=7)	7-17 Ave.	3DRY01.01	3FETT01.01	3FM01.01	3PH01.01	3PH02.01	3SHRM01.01	3SHRM02.01
linum lewisii, prairie flax	3	1.67	0	-	0	0	0	3	1.67	0	1	0	0	1	0	3
cryptantha celosioides, buttecandle	3	1.00	1	1.00	0	1	0	2	1.00	1	0	0	0	0	1	0
koeleria macrantha, prairie junegrass	3	1.00	0	-	0	0	0	3	1.00	1	0	1	1	0	0	0
krascheninnikovia lanata, winterfat	3	1.00	2	1.00	1	1	0	1	1.00	1	0	0	0	0	0	0
mertensia humilis, rocky mountain bluebells	3	1.00	0	-	0	0	0	3	1.00	0	0	1	1	0	0	1
penstemon eriantherus, fuzzytongue penstemon	3	1.00	0	-	0	0	0	3	1.00	1	0	1	0	0	0	1
opuntia polyacantha, plains pricklypear	2	2.00	2	2.00	1	3	0	0	-	0	0	0	0	0	0	0
parthenium alpinum, alpine feverfew	2	2.00	0	-	0	0	0	2	2.00	3	0	0	1	0	0	0
astragalus spatulatus, tufted milkvetch	2	1.00	0	-	0	0	0	2	1.00	0	0	0	1	0	0	1
castilleja angustifolia, northwestern indian paintbrush	2	1.00	0	-	0	0	0	2	1.00	1	0	0	0	1	0	0
chaenactis douglasii, douglas' dustymaiden	2	1.00	0	-	0	0	0	2	1.00	0	1	0	0	1	0	0
cirsium aridum,	2	1.00	0	-	0	0	0	2	1.00	0	0	0	0	0	1	1
comandra umbellata, bastard toadflax	2	1.00	0	-	0	0	0	2	1.00	0	1	0	0	1	0	0
elymus elymoides, bottlebrush squirreltail	2	1.00	2	1.00	1	1	0	0	-	0	0	0	0	0	0	0
erigeron ochroleucus, buff fleabane	2	1.00	0	-	0	0	0	2	1.00	0	0	0	0	1	0	1
eriogonum acaule, singlestem buckwheat	2	1.00	1	1.00	1	0	0	1	1.00	0	1	0	0	0	0	0
eriogonum brevicaule, shortstem buckwheat	2	1.00	2	1.00	0	1	1	0	-	0	0	0	0	0	0	0
eriogonum ovalifolium, cushion buckwheat	2	1.00	0	-	0	0	0	2	1.00	0	0	1	0	0	1	0
lesquerella ludoviciana, foothill bladderpod	2	1.00	0	-	0	0	0	2	1.00	1	0	0	0	0	0	1
oxytropis besseyi, bessey's locoweed	2	1.00	0	-	0	0	0	2	1.00	0	0	0	0	0	1	1
oxytropis lagopus, haresfoot pointloco	2	1.00	0	-	0	0	0	2	1.00	0	0	1	1	0	0	0
sedum lanceolatum, spearleaf stonecrop	2	1.00	0	-	0	0	0	2	1.00	1	0	1	0	0	0	0
sphaeromeria simplex, laramie chickensage	2	1.00	0	-	0	0	0	2	1.00	1	0	0	1	0	0	0
stenotus acaulis, stemless mock goldenweed	2	1.00	0	-	0	0	0	2	1.00	1	0	0	0	0	0	1
taraxacum laevigatum, rock dandelion	2	1.00	0	-	0	0	0	2	1.00	0	0	0	0	0	1	1
carex rupestris, rock sedge	1	10.00	0	-	0	0	0	1	10.00	0	10	0	0	0	0	0
grass unknown (bunchgrass)	1	3.00	0	-	0	0	0	1	3.00	0	0	0	0	3	0	0

Table 22 (continued).

Species	Group 4-12															
			Group 7-12					Group 7-17								
	4-12 # plots (n=10)	4-12 Ave.	7-12 # plots (n=3)	7-12 Ave.	3CYR01.01	3CYR02.01	3CYR03.01	7-17 # plots (n=7)	7-17 Ave.	3DRY01.01	3FETT01.01	3FM01.01	3PH01.01	3PH02.01	3SHRM01.01	3SHRM02.01
oxytropis multiceps, southwestern locoweed	1	3.00	0	-	0	0	0	1	3.00	0	0	0	0	3	0	0
paronychia depressa, spreading nailwort	1	3.00	0	-	0	0	0	1	3.00	0	3	0	0	0	0	0
sphaeromeria capitata, rock tansy	1	3.00	0	-	0	0	0	1	3.00	0	0	3	0	0	0	0
allium textile, textile onion	1	1.00	0	-	0	0	0	1	1.00	0	0	1	0	0	0	0
artemisia nova, black sagebrush	1	1.00	0	-	0	0	0	1	1.00	1	0	0	0	0	0	0
artemisia tridentata ssp. wyomingensis, wyoming big sagebrush	1	1.00	1	1.00	0	1	0	0	-	0	0	0	0	0	0	0
artemisia tripartita ssp. rupicola, wyoming threetip sagebrush	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	0	0	1
astragalus australis, indian milkvetch	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	0	1	0
astragalus kentrophyta, spiny milkvetch	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	0	1	0
astragalus miser, weedy milkvetch	1	1.00	0	-	0	0	0	1	1.00	0	0	1	0	0	0	0
astragalus sericoleucus, silky milkvetch	1	1.00	1	1.00	0	0	1	0	-	0	0	0	0	0	0	0
carex rossii, ross' sedge	1	1.00	0	-	0	0	0	1	1.00	0	0	0	1	0	0	0
castilleja pallescens, pale indian paintbrush	1	1.00	0	-	0	0	0	1	1.00	0	0	1	0	0	0	0
cercocarpus montanus, true mountain mahogany	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	1	0	0
crepis modocensis, siskiyou hawksbeard	1	1.00	0	-	0	0	0	1	1.00	0	0	1	0	0	0	0
draba oligosperma, fewseed whitlowgrass	1	1.00	0	-	0	0	0	1	1.00	0	0	0	1	0	0	0
elymus lanceolatus ssp. lanceolatus, thickspike wheatgrass	1	1.00	1	1.00	1	0	0	0	-	0	0	0	0	0	0	0
ericameria nauseosa, rubber rabbitbrush	1	1.00	1	1.00	0	1	0	0	-	0	0	0	0	0	0	0
erigeron compositus, cutleaf daisy	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	0	0	1
erigeron pumilus, shaggy fleabane	1	1.00	1	1.00	1	0	0	0	-	0	0	0	0	0	0	0
erigeron, fleabane	1	1.00	1	1.00	0	1	0	0	-	0	0	0	0	0	0	0
eriogonum caespitosum, matted buckwheat	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	1	0	0
euphorbia robusta, rocky mountain spurge	1	1.00	0	-	0	0	0	1	1.00	0	1	0	0	0	0	0
forb unknown (forb tooth green)	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	0	1	0
forb unknown (green once comp.)	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	0	0	1

Table 22 (continued).

Species	Group 4-12															
			Group 7-12					Group 7-17								
	4-12 # plots (n=10)	4-12 Ave.	7-12 # plots (n=3)	7-12 Ave.	3CYR01.01	3CYR02.01	3CYR03.01	7-17 # plots (n=7)	7-17 Ave.	3DRY01.01	3FETT01.01	3FM01.01	3PH01.01	3PH02.01	3SHRM01.01	3SHRM02.01
forb unknown (rubber leaf)	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	1	0	0
forb unknown (small green)	1	1.00	0	-	0	0	0	1	1.00	0	0	0	1	0	0	0
forb unknown (snakeweed?)	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	1	0	0
forb unknown (stinky fab, fab pointed lflt)	1	1.00	1	1.00	0	0	1	0	-	0	0	0	0	0	0	0
hymenopappus filifolius, fineleaf hymenopappus	1	1.00	0	-	0	0	0	1	1.00	0	0	1	0	0	0	0
leptodactylon pungens, granite pricklygilia	1	1.00	1	1.00	0	1	0	0	-	0	0	0	0	0	0	0
lithospermum incisum, narrowleaf gromwell	1	1.00	0	-	0	0	0	1	1.00	1	0	0	0	0	0	0
lomatium foeniculaceum, desert biscuitroot	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	0	0	1
lomatium nuttallii, nuttall's biscuitroot	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	0	0	1
lupinus argenteus, silvery lupine	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	0	1	0
musineon divaricatum, leafy wildparsley	1	1.00	0	-	0	0	0	1	1.00	0	0	1	0	0	0	0
oxytropis campestris, cold mountain crazyweed	1	1.00	0	-	0	0	0	1	1.00	0	1	0	0	0	0	0
oxytropis sericea, silvery oxytrope	1	1.00	0	-	0	0	0	1	1.00	1	0	0	0	0	0	0
physaria condensata, tufted twinpod	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	0	1	0
potentilla concinna, elegant cinquefoil	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	0	0	1
potentilla ovina, sheep cinquefoil	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	1	0	0
potentilla sp., cinquefoil	1	1.00	0	-	0	0	0	1	1.00	0	0	1	0	0	0	0
sphaeralcea coccinea, scarlet globemallow	1	1.00	1	1.00	1	0	0	0	-	0	0	0	0	0	0	0
stephanomeria runcinata, desert wirelettuce	1	1.00	1	1.00	0	1	0	0	-	0	0	0	0	0	0	0
townsendia nuttallii, nuttall's townsend daisy	1	1.00	0	-	0	0	0	1	1.00	0	0	0	0	0	0	1
trifolium andinum, andes clover	1	1.00	0	-	0	0	0	1	1.00	0	0	1	0	0	0	0
zigadenus venenosus, meadow deathcamas	1	1.00	0	-	0	0	0	1	1.00	0	0	1	0	0	0	0

Table 23. Relative canopy cover in plots of group 4-1 and sub-groups 7-1 and 7-25.
Average cover for a species in a group is calculated just for the plots in which that species occurred. Cushion-plants are shown in italic typeface.

	Group 4-1																	
			Group 7-1							Group 7-25								
Species	4-1 # plots (n=12)	4-1 Ave.	7-1 # plots (n=5)	7-1 Ave.	02BAI01.01	02BAI01.02	02BAI02.01	2FER01.01	2FER01.02	7-25 # plots (n=7)	7-25 Ave.	3MILL01.01	3MILL02.01	3MILL03.01	3MILL04.01	3SHR01.01	3SHR02.01	3SHR04.01
pseudoroegneria spicata, bluebunch wheatgrass	12	5.92	5	8.60	10	10	10	3	10	7	4.00	3	3	3	3	3	3	10
arenaria hookeri, hooker's sandwort	11	2.09	5	2.20	3	1	3	3	1	6	2.00	3	3	3	0	1	1	1
phlox hoodii, hoods phlox	10	2.40	5	3.00	3	3	3	3	3	5	1.80	1	3	0	1	3	0	1
artemisia nova, black sagebrush	9	3.33	4	6.25	0	1	1	3	20	5	1.00	1	1	0	1	0	1	1
stenotus acaulis, stemless mock goldenweed	9	3.33	3	2.33	3	3	1	0	0	6	3.83	10	3	1	3	0	3	3
poa secunda, sandberg bluegrass	9	1.89	4	2.00	3	0	3	1	1	5	1.80	3	3	0	1	0	1	1
koeleria macrantha, prairie junegrass	9	1.67	3	3.00	3	3	3	0	0	6	1.00	1	1	1	1	0	1	1
artemisia frigida, fringed sagewort	8	1.75	4	2.00	3	1	3	1	0	4	1.50	3	1	0	1	0	0	1
astragalus spatulatus, tufted milkvetch	7	1.29	0	-	0	0	0	0	0	7	1.29	1	3	1	1	1	1	1
eriogonum flavum, yellow eriogonum	7	1.00	1	1.00	0	0	0	1	0	6	1.00	1	0	1	1	1	1	1
tetraneuris acaulis, stemless hymenoxys	6	1.00	5	1.00	1	1	1	1	1	1	1.00	0	0	0	0	0	0	1
erigeron ochroleucus, buff fleabane	5	3.20	2	1.00	1	0	1	0	0	3	4.67	0	0	0	0	10	1	3
machaeranthera grindelioides, rayless aster	5	3.20	2	1.00	0	0	0	1	1	3	4.67	0	10	3	1	0	0	0
astragalus simplicifolius, little bun milkvetch	5	2.60	5	2.60	3	3	3	3	1	0	-	0	0	0	0	0	0	0
tetraneuris torreyana, torrey's hymenoxys	5	2.20	0	-	0	0	0	0	0	5	2.20	1	1	3	3	3	0	0
paronychia sessiliflora, creeping nailwort	5	1.80	0	-	0	0	0	0	0	5	1.80	0	0	3	1	1	1	3
lomatium orientale, northern idaho biscuitroot	5	1.00	2	1.00	1	1	0	0	0	3	1.00	1	1	0	0	0	1	0
oxytropis lagopus, haresfoot pointloco	5	1.00	1	1.00	0	1	0	0	0	4	1.00	1	1	1	0	0	0	1
oxytropis sericea, silvery oxytrope	5	1.00	1	1.00	0	0	0	0	1	4	1.00	0	0	1	1	0	1	1
penstemon laricifolius, larchleaf beardtongue	5	1.00	2	1.00	0	0	0	1	1	3	1.00	1	1	1	0	0	0	0
sedum lanceolatum, spearleaf stonecrop	5	1.00	0	-	0	0	0	0	0	5	1.00	0	1	1	0	1	1	1
carex filifolia, threadleaf sedge	4	5.75	2	10.50	0	0	0	1	20	2	1.00	0	0	1	1	0	0	0
carex duriuscula, needleleaf sedge	4	2.00	3	1.67	3	1	1	0	0	1	3.00	3	0	0	0	0	0	0
potentilla ovina, sheep cinquefoil	4	1.50	0	-	0	0	0	0	0	4	1.50	0	1	3	1	1	0	0
arabis pendulina var. russeola, russeola rockcress	4	1.00	3	1.00	1	0	1	0	1	1	1.00	0	1	0	0	0	0	0
erigeron nematophyllus, needleleaf fleabane	4	1.00	0	-	0	0	0	0	0	4	1.00	1	1	1	1	0	0	0
musineon tenuifolium, slender wildparsley	3	5.33	0	-	0	0	0	0	0	3	5.33	0	0	0	0	10	3	3
gutierrezia sarothrae, broom snakeweed	3	1.67	2	2.00	0	0	0	3	1	1	1.00	0	0	0	0	0	0	1
lesquerella condensata, dense bladderpod	3	1.67	0	-	0	0	0	0	0	3	1.67	0	0	0	0	3	1	1
chaenactis douglasii, douglas' dustymaiden	3	1.00	1	1.00	0	0	0	1	0	2	1.00	0	0	1	1	0	0	0

Table 23 (continued).

Species	4-1 # plots (n=12)	4-1 Ave.	7-1 # plots (n=5)	7-1 Ave.	02BA101.01	02BA101.02	02BA102.01	2FER01.01	2FER01.02	7-25 # plots (n=7)	7-25 Ave.	3MILL01.01	3MILL02.01	3MILL03.01	3MILL04.01	3SHR01.01	3SHR02.01	3SHR04.01
cryptantha sp., cryptantha	3	1.00	3	1.00	1	0	0	1	1	0	-	0	0	0	0	0	0	0
erigeron concinnus var. concinnus, navajo fleabane	3	1.00	3	1.00	1	1	0	1	0	0	-	0	0	0	0	0	0	0
eriogonum ovalifolium, cushion buckwheat	3	1.00	2	1.00	0	1	0	0	1	1	1.00	1	0	0	0	0	0	0
mertensia humilis, rocky mountain bluebells	3	1.00	1	1.00	1	0	0	0	0	2	1.00	1	0	0	0	0	0	1
packera cana, woolly groundsel	3	1.00	0	-	0	0	0	0	0	3	1.00	0	0	1	1	0	0	1
sedum stenopetalum, wormleaf stonecrop	3	1.00	3	1.00	1	1	1	0	0	0	-	0	0	0	0	0	0	0
stanleya viridiflora, green princesplume	3	1.00	2	1.00	0	0	0	1	1	1	1.00	0	0	0	1	0	0	0
stenotus armerioides, thrift mock goldenweed	2	3.00	1	3.00	0	0	0	3	0	1	3.00	0	0	0	0	0	3	0
eriogonum brevicaule, shortstem buckwheat	2	2.00	0	-	0	0	0	0	0	2	2.00	0	1	0	3	0	0	0
eriogonum microthecum var. laxiflorum, slender buckwheat	2	2.00	2	2.00	0	0	0	3	1	0	-	0	0	0	0	0	0	0
selaginella densa, lesser spikemoss	2	2.00	0	-	0	0	0	0	0	2	2.00	0	0	0	0	3	0	1
sphaeromeria simplex, laramie chickensage	2	2.00	0	-	0	0	0	0	0	2	2.00	0	0	0	0	3	1	0
trifolium andinum, andes clover	2	2.00	1	3.00	0	0	0	0	3	1	1.00	0	0	0	0	0	1	0
allium textile, textile onion	2	1.00	0	-	0	0	0	0	0	2	1.00	0	0	0	0	0	1	1
alyssum desertorum, desert madwort	2	1.00	0	-	0	0	0	0	0	2	1.00	0	1	1	0	0	0	0
castilleja angustifolia, northwestern indian paintbrush	2	1.00	0	-	0	0	0	0	0	2	1.00	0	0	0	1	0	0	1
crepis, hawksbeard	2	1.00	2	1.00	0	0	0	1	1	0	-	0	0	0	0	0	0	0
draba oligosperma, fewseed whitlowgrass	2	1.00	0	-	0	0	0	0	0	2	1.00	0	0	0	0	1	1	0
ericameria nauseosa, rubber rabbitbrush	2	1.00	2	1.00	0	0	0	1	1	0	-	0	0	0	0	0	0	0
hesperostipa comata, needle and thread	2	1.00	0	-	0	0	0	0	0	2	1.00	1	1	0	0	0	0	0
lappula occidentalis var. occidentalis, flatspine stickseed	2	1.00	0	-	0	0	0	0	0	2	1.00	1	1	0	0	0	0	0
lesquerella ludoviciana, foothill bladderpod	2	1.00	0	-	0	0	0	0	0	2	1.00	0	0	1	0	0	1	0
linum lewisii, prairie flax	2	1.00	0	-	0	0	0	0	0	2	1.00	0	0	1	0	0	0	1
mertensia, bluebells	2	1.00	2	1.00	0	1	1	0	0	0	-	0	0	0	0	0	0	0
oxytropis nana, wyoming locoweed	2	1.00	2	1.00	1	0	1	0	0	0	-	0	0	0	0	0	0	0
paronychia depressa, spreading nailwort	2	1.00	2	1.00	0	0	0	1	1	0	-	0	0	0	0	0	0	0
penstemon eriantherus, fuzzytongue penstemon	2	1.00	2	1.00	0	0	0	1	1	0	-	0	0	0	0	0	0	0
potentilla hippiana, woolly cinquefoil	2	1.00	0	-	0	0	0	0	0	2	1.00	0	0	0	0	0	1	1
tradescantia occidentalis, prairie spiderwort	2	1.00	0	-	0	0	0	0	0	2	1.00	0	0	1	1	0	0	0

Table 23 (continued).

Species	4-1 # plots (n=12)	4-1 Ave.	7-1 # plots (n=5)	7-1 Ave.	02BA101.01	02BA101.02	02BA102.01	2FER01.01	2FER01.02	7-25 # plots (n=7)	7-25 Ave.	3MILL01.01	3MILL02.01	3MILL03.01	3MILL04.01	3SHR01.01	3SHR02.01	3SHR04.01
artemisia tridentata ssp. wyomingensis, wyoming big sagebrush	1	20.00	1	20.00	0	20	0	0	0	0	-	0	0	0	0	0	0	0
astragalus miser, weedy milkvetch	1	3.00	0	-	0	0	0	0	0	1	3.00	3	0	0	0	0	0	0
leptodactylon pungens, granite pricklygilia	1	3.00	1	3.00	0	0	0	0	3	0	-	0	0	0	0	0	0	0
poa fendleriana, muttongrass	1	3.00	1	3.00	0	3	0	0	0	0	-	0	0	0	0	0	0	0
achnatherum hymenoides, indian ricegrass	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	1	0	0	0
allium, wild onion	1	1.00	0	-	0	0	0	0	0	1	1.00	0	1	0	0	0	0	0
antennaria dimorpha, low pussytoes	1	1.00	0	-	0	0	0	0	0	1	1.00	0	1	0	0	0	0	0
antennaria microphylla, littleleaf pussytoes	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	0	0	0	1
arenaria congesta, ballhead sandwort	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	1	0	0	0
artemisia arbuscula, low sagebrush	1	1.00	1	1.00	1	0	0	0	0	0	-	0	0	0	0	0	0	0
artemisia tridentata ssp. vaseyana, mountain big sagebrush	1	1.00	0	-	0	0	0	0	0	1	1.00	0	1	0	0	0	0	0
artemisia tripartita ssp. rupicola, wyoming threetip sagebrush	1	1.00	0	-	0	0	0	0	0	1	1.00	0	1	0	0	0	0	0
astragalus agrestis, purple milkvetch	1	1.00	0	-	0	0	0	0	0	1	1.00	1	0	0	0	0	0	0
astragalus australis, indian milkvetch	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	1	0	0	0	0
campanula rotundifolia, bluebell bellflower	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	0	0	0	1
castilleja applegatei ssp. martinii, wavyleaf indian paintbrush	1	1.00	1	1.00	0	0	0	0	1	0	-	0	0	0	0	0	0	0
cerastium arvense, field chickweed	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	0	0	0	1
chrysothamnus viscidiflorus, yellow rabbitbrush	1	1.00	0	-	0	0	0	0	0	1	1.00	1	0	0	0	0	0	0
comandra umbellata, bastard toadflax	1	1.00	1	1.00	0	0	0	1	0	0	-	0	0	0	0	0	0	0
crepis modocensis, siskiyou hawksbeard	1	1.00	1	1.00	0	0	0	0	1	0	-	0	0	0	0	0	0	0
cryptantha caespitosa, tufted catseye	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	1	0	0	0
cryptantha sericea, silky catseye	1	1.00	1	1.00	0	0	0	1	0	0	-	0	0	0	0	0	0	0
cymopterus sp., cymopterus	1	1.00	1	1.00	0	0	0	0	1	0	-	0	0	0	0	0	0	0
draba nemorosa, woodland whitlowgrass	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	0	0	0	1
draba, whitlowgrass	1	1.00	1	1.00	0	1	0	0	0	0	-	0	0	0	0	0	0	0
erigeron, fleabane	1	1.00	1	1.00	0	0	0	0	1	0	-	0	0	0	0	0	0	0
eriogonum sp., eriogonum	1	1.00	1	1.00	1	0	0	0	0	0	-	0	0	0	0	0	0	0
escobaria vivipara, spinystar	1	1.00	1	1.00	0	0	0	0	1	0	-	0	0	0	0	0	0	0
for unknown (less hairy pinnate)	1	1.00	1	1.00	0	0	0	0	1	0	-	0	0	0	0	0	0	0

Table 23 (continued).

Species	4-1 # plots (n=12)	4-1 Ave.	7-1 # plots (n=5)	7-1 Ave.	02BA101.01	02BA101.02	02BA102.01	2FER01.01	2FER01.02	7-25 # plots (n=7)	7-25 Ave.	3MILL01.01	3MILL02.01	3MILL03.01	3MILL04.01	3SHR01.01	3SHR02.01	3SHR04.01
forb unknown (bud fab)	1	1.00	0	-	0	0	0	0	0	1	1.00	0	1	0	0	0	0	0
forb unknown (green little tooth lf)	1	1.00	1	1.00	0	0	0	0	1	0	-	0	0	0	0	0	0	0
forb unknown (must gray)	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	1	0	0	0
forb unknown (palmate leaf)	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	0	0	0	1
forb unknown (silver fab)	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	0	1	0	0
ipomopsis aggregata, skyrocket gilia	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	1	0	0	0	0
ipomopsis spicata ssp. spicata, spiked ipomopsis	1	1.00	1	1.00	0	0	0	0	1	0	-	0	0	0	0	0	0	0
krascheninnikovia lanata, winterfat	1	1.00	0	-	0	0	0	0	0	1	1.00	0	1	0	0	0	0	0
leucopoa kingii, spike fescue	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	0	0	0	1
lewisia rediviva, oregon bitterroot	1	1.00	1	1.00	0	1	0	0	0	0	-	0	0	0	0	0	0	0
linum, flax	1	1.00	1	1.00	0	0	0	1	0	0	-	0	0	0	0	0	0	0
lithospermum incisum, narrowleaf gromwell	1	1.00	1	1.00	0	0	0	0	1	0	-	0	0	0	0	0	0	0
lygodesmia grandiflora, largeflower skeletonplant	1	1.00	1	1.00	0	0	0	0	1	0	-	0	0	0	0	0	0	0
oenothera caespitosa ssp. caespitosa, tufted evening primrose	1	1.00	1	1.00	0	0	0	1	0	0	-	0	0	0	0	0	0	0
opuntia polyacantha, plains pricklypear	1	1.00	0	-	0	0	0	0	0	1	1.00	1	0	0	0	0	0	0
physaria eburniflora, devils gate twinpod	1	1.00	1	1.00	0	0	0	1	0	0	-	0	0	0	0	0	0	0
pinus flexilis, limber pine	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	0	0	0	1
polygonum sp., knotweed	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	0	0	0	1
potentilla concinna, elegant cinquefoil	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	0	1	0	0
stephanomeria runcinata, desert wirelettuce	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	1	0	0	0
symphoricarpos oreophilus, whortleleaf snowberry	1	1.00	0	-	0	0	0	0	0	1	1.00	1	0	0	0	0	0	0
taraxacum laevigatum, rock dandelion	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	0	0	0	1
tetradymia canescens, spineless horsebrush	1	1.00	0	-	0	0	0	0	0	1	1.00	0	0	0	1	0	0	0
townsendia, townsendia	1	1.00	1	1.00	0	0	0	0	1	0	-	0	0	0	0	0	0	0
zigadenus venenosus, meadow deathcamas	1	1.00	1	1.00	0	0	0	0	1	0	-	0	0	0	0	0	0	0

Table 24. Relative canopy cover in plots of group 4-14 and sub-groups 7-14 and 7-32.
Average cover for a species in a group is calculated just for the plots in which that species occurred. Cushion-plants are shown in italic typeface.

	Group 4-14																			
			Group 7-14												Group 7-32					
Species	4-14 # plots (n=14)	4-14 Ave.	7-14 # plots (n=10)	7-14 Ave.	3CYR02.02	3CYR03.02	3DRY01.02	3FETT01.02	3FM01.02	3MB01.01	3MB01.02	3PH01.02	3SHRM01.02	3SHRM02.02	7-32 # plots (n=4)	7-32 Ave.	3PH02.02	3SHR01.02	3SHR02.02	3SHR04.02
phlox hoodii, hoods phlox	14	2.93	10	3.30	3	3	3	3	1	1	3	10	3	3	4	2.00	3	1	3	1
poa secunda, sandberg bluegrass	14	2.57	10	2.40	3	3	3	3	3	1	3	3	1	1	4	3.00	3	3	3	3
elymus lanceolatus ssp. lanceolatus, thickspike wheatgrass	13	4.54	9	5.44	3	0	3	3	3	1	10	3	20	3	4	2.50	3	1	3	3
chrysothamnus viscidiflorus, yellow rabbitbrush	12	2.08	8	2.38	1	1	10	0	1	0	3	1	1	1	4	1.50	3	1	1	1
arenaria hookeri, hooker's sandwort	10	2.10	8	2.38	1	3	0	1	1	10	1	1	0	1	2	1.00	1	0	1	0
trifolium gymnocarpon, hollyleaf clover	9	1.67	5	1.80	1	0	3	1	3	0	0	1	0	0	4	1.50	1	1	3	1
allium textile, textile onion	9	1.00	7	1.00	0	0	1	1	1	1	0	1	1	1	2	1.00	1	0	1	0
koeleria macrantha, prairie junegrass	8	3.38	5	3.60	0	0	1	10	1	0	0	3	0	3	3	3.00	3	0	3	3
hesperostipa comata, needle and thread	8	2.88	7	2.86	3	1	0	10	0	1	1	3	0	1	1	3.00	3	0	0	0
carex duriuscula, needleleaf sedge	8	1.50	6	1.67	0	1	0	1	0	3	3	1	1	0	2	1.00	1	0	1	0
mertensia humilis, rocky mountain bluebells	8	1.25	4	1.50	0	1	0	0	0	0	0	1	3	1	4	1.00	1	1	1	1
lesquerella ludoviciana, foothill bladderpod	8	1.00	6	1.00	0	0	1	1	1	0	0	1	1	1	2	1.00	1	0	1	0
zigadenus venenosus, meadow deathcamas	8	1.00	4	1.00	0	0	1	1	0	0	0	1	1	0	4	1.00	1	1	1	1
artemisia tridentata ssp. wyomingensis, wyoming big sagebrush	7	11.86	6	13.67	10	1	40	0	20	0	1	0	0	10	1	1.00	1	0	0	0
poa fendleriana, muttongrass	7	6.00	3	5.33	0	0	10	0	3	0	0	3	0	0	4	6.50	3	10	10	3
pseudoroegneria spicata, bluebunch wheatgrass	7	3.71	4	2.50	3	3	0	0	0	0	1	3	0	0	3	5.33	3	0	3	10
astragalus miser, weedy milkvetch	7	1.86	5	2.20	0	1	3	0	1	0	0	0	3	3	2	1.00	0	1	0	1
crepis modocensis, siskiyou hawksbeard	7	1.29	3	1.67	0	0	0	0	3	0	0	1	0	1	4	1.00	1	1	1	1
eriogonum ovalifolium, cushion buckwheat	7	1.00	6	1.00	1	1	0	0	1	1	1	1	0	0	1	1.00	1	0	0	0
artemisia nova, black sagebrush	6	8.00	3	1.67	0	3	0	1	0	0	0	1	0	0	3	14.33	10	0	30	3
artemisia frigida, fringed sagewort	6	1.67	5	1.80	0	0	0	3	0	1	1	3	0	1	1	1.00	0	0	0	1
ericameria nauseosa, rubber rabbitbrush	6	1.67	5	1.80	1	0	0	0	0	3	3	1	1	0	1	1.00	1	0	0	0
antennaria microphylla, littleleaf pussytoes	6	1.33	3	1.00	0	0	1	0	1	0	0	1	0	0	3	1.67	1	0	1	3
erigeron nematophyllus, needleleaf fleabane	6	1.33	3	1.00	0	0	0	1	0	0	0	1	0	1	3	1.67	1	3	1	0
gutierrezia sarothrae, broom snakeweed	6	1.33	4	1.50	0	0	0	3	0	0	0	1	1	1	2	1.00	1	0	0	1
senecio integerrimus, lambstongue groundsel	6	1.33	2	1.00	0	0	1	0	1	0	0	0	0	0	4	1.50	1	3	1	1
tetradymia canescens, spineless horsebrush	6	1.33	3	1.67	1	0	0	0	0	0	0	1	3	0	3	1.00	1	0	1	1
astragalus purshii, woollypod milkvetch	6	1.00	4	1.00	1	1	0	1	0	0	0	1	0	0	2	1.00	1	0	0	1
besseya wyomingensis, wyoming besseya	6	1.00	3	1.00	0	0	1	0	1	0	0	1	0	0	3	1.00	1	1	1	0
sedum lanceolatum, spearleaf stonecrop	6	1.00	2	1.00	0	0	0	0	1	0	0	0	0	1	4	1.00	1	1	1	1

Table 24 (continued).

Species	4-14 # plots (n=14)	4-14 Ave.	7-14 # plots (n=10)	7-14 Ave.	3CYR02.02	3CYR03.02	3DRY01.02	3FETT01.02	3FM01.02	3MB01.01	3MB01.02	3PH01.02	3SHRM01.02	3SHRM02.02	7-32 # plots (n=4)	7-32 Ave.	3PH02.02	3SHR01.02	3SHR02.02	3SHR04.02
carex filifolia, threadleaf sedge	5	3.60	5	3.60	1	1	0	3	0	0	0	10	0	3	0	-	0	0	0	0
artemisia pedatifida, birdfoot sagebrush	5	1.80	5	1.80	1	1	0	0	0	1	3	0	0	3	0	-	0	0	0	0
arenaria congesta, ballhead sandwort	5	1.40	1	1.00	0	0	0	0	1	0	0	0	0	0	4	1.50	1	3	1	1
antennaria dimorpha, low pussytoes	5	1.00	2	1.00	0	0	0	0	1	0	0	0	0	1	3	1.00	1	1	1	0
astragalus spatulatus, tufted milkvetch	5	1.00	3	1.00	0	1	0	1	0	0	0	0	0	1	2	1.00	1	1	0	0
krascheninnikovia lanata, winterfat	5	1.00	5	1.00	1	1	0	1	0	0	1	1	0	0	0	-	0	0	0	0
linum lewisii, prairie flax	5	1.00	2	1.00	0	0	0	1	0	0	0	0	1	0	3	1.00	1	0	1	1
lomatium orientale, northern idaho biscuitroot	5	1.00	2	1.00	0	0	0	0	0	0	1	1	0	0	3	1.00	1	0	1	1
machaeranthera grindelioides, rayless aster	5	1.00	4	1.00	0	0	0	0	0	0	1	1	1	1	1	1.00	1	0	0	0
opuntia polyacantha, plains pricklypear	5	1.00	5	1.00	1	1	0	0	0	1	1	1	0	0	0	-	0	0	0	0
penstemon eriantherus, fuzzytongue penstemon	5	1.00	3	1.00	0	0	0	0	1	0	1	1	0	0	2	1.00	0	0	1	1
stenotus acaulis, stemless mock goldenweed	5	1.00	2	1.00	1	0	0	0	1	0	0	0	0	0	3	1.00	1	0	1	1
phlox multiflora, flowery phlox	4	2.00	2	2.00	0	0	1	0	3	0	0	0	0	0	2	2.00	1	3	0	0
agoseris glauca, pale agoseris	4	1.50	1	1.00	0	0	1	0	0	0	0	0	0	0	3	1.67	1	3	0	1
castilleja angustifolia, northwestern indian paintbrush	4	1.50	0	-	0	0	0	0	0	0	0	0	0	0	4	1.50	1	1	3	1
lomatium foeniculaceum, desert biscuitroot	4	1.50	3	1.67	0	0	1	0	3	0	0	0	0	1	1	1.00	0	1	0	0
cordylanthus ramosus, bushy bird's beak	4	1.00	3	1.00	1	1	0	0	1	0	0	0	0	0	1	1.00	1	0	0	0
erigeron eatonii, eaton's fleabane	4	1.00	3	1.00	0	0	1	0	1	0	0	0	0	1	1	1.00	0	0	0	1
packera cana, woolly groundsel	4	1.00	2	1.00	0	0	0	0	0	0	0	1	1	0	2	1.00	1	0	0	1
penstemon radicosus, matroot penstemon	4	1.00	0	-	0	0	0	0	0	0	0	0	0	0	4	1.00	1	1	1	1
taraxacum laevigatum, rock dandelion	4	1.00	1	1.00	0	0	0	0	0	0	0	0	1	0	3	1.00	1	1	0	1
artemisia tripartita ssp. rupicola, wyoming threetip sagebrush	3	5.33	0	-	0	0	0	0	0	0	0	0	0	0	3	5.33	3	3	0	10
achnatherum hymenoides, indian ricegrass	3	1.67	3	1.67	3	1	0	0	0	0	1	0	0	0	0	-	0	0	0	0
astragalus simplicifolius, little bun milkvetch	3	1.67	3	1.67	3	0	0	0	0	0	0	1	1	0	0	-	0	0	0	0
stenotus armerioides, thrift mock goldenweed	3	1.67	2	1.00	0	1	0	0	0	0	0	0	0	1	1	3.00	0	3	0	0
achillea millefolium, common yarrow	3	1.00	1	1.00	0	0	1	0	0	0	0	0	0	0	2	1.00	0	1	0	1
arabis holboellii, holboell's rockcress	3	1.00	1	1.00	0	0	0	0	1	0	0	0	0	0	2	1.00	1	0	1	0
arabis pendulina var. russeola, russeola rockcress	3	1.00	1	1.00	1	0	0	0	0	0	0	0	0	0	2	1.00	0	0	1	1
atriplex gardneri, gardner's saltbush	3	1.00	3	1.00	1	0	0	0	0	0	1	0	0	1	0	-	0	0	0	0
cirsium aridum, desert thistle	3	1.00	2	1.00	0	0	1	0	0	0	0	0	1	0	1	1.00	0	1	0	0
collinsia parviflora, smallflower blue eyed mary	3	1.00	0	-	0	0	0	0	0	0	0	0	0	0	3	1.00	1	0	1	1
comandra umbellata, bastard toadflax	3	1.00	1	1.00	0	0	1	0	0	0	0	0	0	0	2	1.00	1	0	0	1
escobaria vivipara, spinystar	3	1.00	2	1.00	0	0	0	1	0	1	0	0	0	0	1	1.00	0	0	1	0

Table 24 (continued).

Species	4-14 # plots (n=14)	4-14 Ave.	7-14 # plots (n=10)	7-14 Ave.	3CYR02.02	3CYR03.02	3DRY01.02	3FETT01.02	3FM01.02	3MB01.01	3MB01.02	3PH01.02	3SHRM01.02	3SHRM02.02	7-32 # plots (n=4)	7-32 Ave.	3PH02.02	3SHR01.02	3SHR02.02	3SHR04.02
musineon divaricatum, leafy wildparsley	3	1.00	3	1.00	0	0	0	0	0	0	0	1	1	1	0	-	0	0	0	0
penstemon laricifolius, larchleaf beardtongue	3	1.00	2	1.00	0	1	0	0	0	0	0	1	0	0	1	1.00	1	0	0	0
vicia americana, american vetch	3	1.00	3	1.00	0	0	1	0	1	0	0	0	1	0	0	-	0	0	0	0
viola nuttallii, nuttall's violet	3	1.00	3	1.00	0	0	1	0	0	0	1	0	1	0	0	-	0	0	0	0
leucopoa kingii, spike fescue	2	10.00	1	10.00	0	0	0	0	0	0	0	0	10	0	1	10.00	0	10	0	0
artemisia tridentata ssp. vaseyana, mountain big sagebrush	2	6.50	1	10.00	0	0	0	0	0	0	0	10	0	0	1	3.00	0	0	0	3
phlox muscoides, musk phlox	2	2.00	2	2.00	1	3	0	0	0	0	0	0	0	0	0	-	0	0	0	0
symphoricarpos oreophilus, whortleleaf snowberry	2	2.00	1	1.00	0	0	1	0	0	0	0	0	0	0	1	3.00	3	0	0	0
arnica fulgens, foothill arnica	2	1.00	1	1.00	0	0	0	0	1	0	0	0	0	0	1	1.00	0	0	0	1
astragalus convallarius, timber milkvetch	2	1.00	1	1.00	0	0	1	0	0	0	0	0	0	0	1	1.00	0	0	1	0
balsamorhiza sagittata, arrowleaf balsamroot	2	1.00	1	1.00	0	0	1	0	0	0	0	0	0	0	1	1.00	0	0	0	1
castilleja pallescens, pale indian paintbrush	2	1.00	2	1.00	0	0	1	0	1	0	0	0	0	0	0	-	0	0	0	0
cerastium arvense, field chickweed	2	1.00	0	-	0	0	0	0	0	0	0	0	0	0	2	1.00	0	1	0	1
cryptantha celosioides, buttecandle	2	1.00	2	1.00	0	0	0	1	0	0	0	1	0	0	0	-	0	0	0	0
descurainia pinnata, western tansymustard	2	1.00	2	1.00	0	0	0	0	1	0	1	0	0	0	0	-	0	0	0	0
erysimum inconspicuum, shy wallflower	2	1.00	1	1.00	0	0	0	0	0	1	0	0	0	0	1	1.00	0	0	0	1
halimolobos virgata, rod halimolobos	2	1.00	1	1.00	0	0	0	0	0	0	0	1	0	0	1	1.00	0	0	0	1
lappula occidentalis var. occidentalis, flatspine stickseed	2	1.00	2	1.00	0	0	0	0	0	0	1	1	0	0	0	-	0	0	0	0
leptodactylon pungens, granite pricklygilia	2	1.00	1	1.00	1	0	0	0	0	0	0	0	0	0	1	1.00	1	0	0	0
lithospermum incisum, narrowleaf gromwell	2	1.00	1	1.00	0	0	0	0	0	0	0	1	0	0	1	1.00	1	0	0	0
lupinus argenteus, silvery lupine	2	1.00	0	-	0	0	0	0	0	0	0	0	0	0	2	1.00	0	0	1	1
oxytropis sericea, silvery oxytrope	2	1.00	0	-	0	0	0	0	0	0	0	0	0	0	2	1.00	0	1	0	1
oxytropis sp., crazyweed	2	1.00	1	1.00	0	0	0	0	0	0	0	0	0	1	1	1.00	0	0	1	0
pinus flexilis, limber pine	2	1.00	0	-	0	0	0	0	0	0	0	0	0	0	2	1.00	0	0	1	1
taraxacum, dandelion	2	1.00	2	1.00	0	0	1	0	1	0	0	0	0	0	0	-	0	0	0	0
tetraneuris torreyana, torrey's hymenoxys	2	1.00	0	-	0	0	0	0	0	0	0	0	0	0	2	1.00	1	1	0	0
townsendia nuttallii, nuttall's townsend daisy	2	1.00	2	1.00	0	0	0	0	0	0	0	0	1	1	0	-	0	0	0	0
festuca idahoensis, idaho fescue	1	10.00	0	-	0	0	0	0	0	0	0	0	0	0	1	10.00	0	10	0	0
antennaria umbrinella, umber pussytoes	1	3.00	0	-	0	0	0	0	0	0	0	0	0	0	1	3.00	0	3	0	0
allium cernuum, nodding onion	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	0	0	1
allium, wild onion	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	1	0	0
alyssum desertorum, desert madwort	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	0	0	1
antennaria anaphaloides, pearly pussytoes	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	1	0	0

Table 24 (continued).

Species	4-14 # plots (n=14)	4-14 Ave.	7-14 # plots (n=10)	7-14 Ave.	3CYR02.02	3CYR03.02	3DRY01.02	3FETT01.02	3FM01.02	3MB01.01	3MB01.02	3PH01.02	3SHRM01.02	3SHRM02.02	7-32 # plots (n=4)	7-32 Ave.	3PH02.02	3SHR01.02	3SHR02.02	3SHR04.02
antennaria parvifolia, smallleaf pussytoes	1	1.00	1	1.00	0	0	0	1	0	0	0	0	0	0	0	-	0	0	0	0
arabis glabra, tower rockcress	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	0	0	1
arabis, rockcress	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	1	0	0
artemisia ludoviciana, louisiana sagewort	1	1.00	1	1.00	0	0	0	0	0	1	0	0	0	0	0	-	0	0	0	0
astragalus drummondii, drummond's milkvetch	1	1.00	1	1.00	0	0	1	0	0	0	0	0	0	0	0	-	0	0	0	0
astragalus sp., milkvetch	1	1.00	1	1.00	0	0	0	0	0	0	0	1	0	0	0	-	0	0	0	0
atriplex confertifolia, shadscale saltbush	1	1.00	1	1.00	1	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0
bouteloua gracilis, blue grama	1	1.00	1	1.00	0	0	0	1	0	0	0	0	0	0	0	-	0	0	0	0
calochortus, mariposa lily	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	0	0	1
chenopodium sp., goosefoot	1	1.00	1	1.00	0	0	0	0	0	1	0	0	0	0	0	-	0	0	0	0
cryptantha sp., cryptantha	1	1.00	1	1.00	0	0	0	0	0	0	0	1	0	0	0	-	0	0	0	0
cymopterus acaulis, plains springparsley	1	1.00	1	1.00	0	0	0	1	0	0	0	0	0	0	0	-	0	0	0	0
delphinium geyeri, geyer's larkspur	1	1.00	1	1.00	0	0	0	0	0	0	0	1	0	0	0	-	0	0	0	0
delphinium sp., larkspur	1	1.00	1	1.00	0	0	0	0	1	0	0	0	0	0	0	-	0	0	0	0
draba nemorosa, woodland whitlowgrass	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	0	0	1
draba oligosperma, fewseed whitlowgrass	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	0	1	0
elymus elymoides, bottlebrush squirreltail	1	1.00	1	1.00	0	0	0	0	0	1	0	0	0	0	0	-	0	0	0	0
elymus trachycaulus ssp. trachycaulus, slender wheatgrass	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	1	0	0
erigeron ochroleucus, buff fleabane	1	1.00	1	1.00	0	0	0	0	0	0	0	0	0	1	0	-	0	0	0	0
erigeron pumilus, shaggy fleabane	1	1.00	1	1.00	1	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0
eriogonum brevicaule, shortstem buckwheat	1	1.00	1	1.00	0	1	0	0	0	0	0	0	0	0	0	-	0	0	0	0
eriogonum caespitosum, matted buckwheat	1	1.00	1	1.00	1	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0
eriogonum flavum, yellow eriogonum	1	1.00	1	1.00	0	0	0	0	0	0	0	0	1	0	0	-	0	0	0	0
eriogonum umbellatum, sulphur wildbuckwheat	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	1	0	0	0
erysimum asperum,	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	0	1	0
erysimum capitatum var. capitatum, western wallflower	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	1	0	0
festuca octoflora	1	1.00	1	1.00	0	0	0	0	0	0	1	0	0	0	0	-	0	0	0	0
forb unknown (apiaceae bright grn)	1	1.00	1	1.00	0	0	0	0	1	0	0	0	0	0	0	-	0	0	0	0
forb unknown (apiaceae fine)	1	1.00	1	1.00	0	0	1	0	0	0	0	0	0	0	0	-	0	0	0	0
forb unknown (chenopodium small)	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	1	0	0	0
forb unknown (fab fuzzy pinn)	1	1.00	1	1.00	0	0	0	0	0	0	1	0	0	0	0	-	0	0	0	0
forb unknown (fab green tall)	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	1	0	0	0
forb unknown (fab small fleshy)	1	1.00	1	1.00	0	0	1	0	0	0	0	0	0	0	0	-	0	0	0	0

Table 24 (continued).

Species	4-14 # plots (n=14)	4-14 Ave.	7-14 # plots (n=10)	7-14 Ave.	3CYR02.02	3CYR03.02	3DRY01.02	3FETT01.02	3FM01.02	3MB01.01	3MB01.02	3PH01.02	3SHRM01.02	3SHRM02.02	7-32 # plots (n=4)	7-32 Ave.	3PH02.02	3SHR01.02	3SHR02.02	3SHR04.02
forb unknown (forb ciliate leaf)	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	0	0	1
forb unknown (forb cotyledon)	1	1.00	1	1.00	0	0	0	0	0	0	0	1	0	0	0	-	0	0	0	0
forb unknown (forb obov lvs)	1	1.00	1	1.00	0	0	0	0	0	0	0	1	0	0	0	-	0	0	0	0
forb unknown (forb upright tooth)	1	1.00	1	1.00	0	0	0	0	0	0	1	0	0	0	0	-	0	0	0	0
forb unknown (het vel?)	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	0	0	1
forb unknown (linear leaf forb)	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	1	0	0
forb unknown (linear leaf forb)	1	1.00	1	1.00	0	0	0	1	0	0	0	0	0	0	0	-	0	0	0	0
forb unknown (oblanc grey lf)	1	1.00	1	1.00	0	0	1	0	0	0	0	0	0	0	0	-	0	0	0	0
forb unknown (stinky fab, fab pointed lflt)	1	1.00	1	1.00	1	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0
forb unknown (tall tooth leaf)	1	1.00	1	1.00	0	0	0	1	0	0	0	0	0	0	0	-	0	0	0	0
forb unknown (woody stem)	1	1.00	1	1.00	0	0	0	0	0	0	0	0	1	0	0	-	0	0	0	0
fritillaria atropurpurea, spotted missionbells	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	1	0	0
gayophytum diffusum, spreading groundsmoke	1	1.00	1	1.00	1	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0
ipomopsis aggregata, skyrocket gilia	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	1	0	0	0
lesquerella condensata, dense bladderpod	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	1	0	0	0
lewisia rediviva, oregon bitterroot	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	1	0	0
lygodesmia grandiflora, largeflower skeletonplant	1	1.00	1	1.00	0	0	0	0	0	0	0	1	0	0	0	-	0	0	0	0
monolepis nuttalliana, nuttall's povertyweed	1	1.00	1	1.00	0	0	0	0	0	1	0	0	0	0	0	-	0	0	0	0
oxytropis besseyi, bessey's locoweed	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	0	0	1
oxytropis lagopus, haresfoot pointloco	1	1.00	1	1.00	0	0	0	0	0	0	0	1	0	0	0	-	0	0	0	0
penstemon fremontii, fremont's beardtongue	1	1.00	1	1.00	0	0	0	0	0	0	0	0	1	0	0	-	0	0	0	0
ranunculus glaberrimus, sagebrush buttercup	1	1.00	0	-	0	0	0	0	0	0	0	0	0	0	1	1.00	0	1	0	0
schoenocrambe linifolia, flaxleaf plainsmustard	1	1.00	1	1.00	0	0	0	0	1	0	0	0	0	0	0	-	0	0	0	0
sisymbrium altissimum, tall tumblemustard	1	1.00	1	1.00	0	0	0	0	0	0	0	1	0	0	0	-	0	0	0	0
sphaeralcea coccinea, scarlet globemallow	1	1.00	1	1.00	0	0	0	0	0	0	1	0	0	0	0	-	0	0	0	0
sphaeromeria simplex, laramie chickensage	1	1.00	1	1.00	0	0	0	0	0	0	0	1	0	0	0	-	0	0	0	0
tetradymia nuttallii, nuttall's horsebrush	1	1.00	1	1.00	1	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0
tetradymia, horsebrush	1	1.00	1	1.00	0	0	0	1	0	0	0	0	0	0	0	-	0	0	0	0
tetraneuris acaulis, stemless hymenoxys	1	1.00	1	1.00	0	0	0	0	0	0	0	1	0	0	0	-	0	0	0	0
thermopsis rhombifolia, prairie thermopsis	1	1.00	1	1.00	0	0	0	0	0	1	0	0	0	0	0	-	0	0	0	0
tradescantia occidentalis, prairie spiderwort	1	1.00	1	1.00	0	0	1	0	0	0	0	0	0	0	0	-	0	0	0	0
xylorhiza glabriuscula, smooth woodyaster	1	1.00	1	1.00	0	0	0	0	0	0	1	0	0	0	0	-	0	0	0	0

Table 25. Summary of features of plot groups from different levels in the cluster analysis based on relative canopy cover of common species. The dendrogram from the cluster analysis is shown in Figure 9.

Main Group	Topo. Position	Ground-cover	4-level Sub-groups	Vegetation	Species	7-level Sub-groups	Distribution
2-1 (n=28)	Virtually all along rims and outcrops	Mostly gravel, generally with little bare soil or litter. More cobble than plots back from rims.	4-1 (n=12)	CUSHION-PLANT, NON-CUSHION FORB, AND GRASS. Cushion-plants and non-cushion forbs are the most numerous plants; with graminoids, they account for most of the canopy cover. Woody plants minor.	*Pseudoroegneria spicata*, *Phlox hoodii*, and *Arenaria hookeri* are widespread.	7-1 (n=5), with *Astragalus simplicifolius*, *Tetraneuris acaulis*, and (usually) *Artemisia nova* present.	Muddy Gap area: Lost Soldier Divide, Ferris Mtns.
						7-25 (n=7), with *Astragalus spatulatus* and *Stenotus acaulis* present.	Central: Miller Hill and Shirley Rim
			4-4 (n=6)	CUSHION-PLANT WITH GRASSES. Cushion-plants and graminoids are most numerous species; cushion-plants contribute largest proportion of cover but graminoids and non-cushion forbs contribute substantially.	*Phlox muscoides*, *Pseudotoegneria spicata*, *Tetraneuris acaulis*, *Castilleja* sp., and (usually) *Paronychia depressa* and *Arenaria hookeri* are present.	None (7-4 is equivalent to 4-4)	North-central: Chalk Mountain
			4-12 (n=10)	CUSHION-PLANT. Cushion-plants and non-cushion forbs are most numerous species; cushion-plants account for most cover, non-cushion forbs and graminoids are secondary. Woody plants minor.	*Phlox muscoides* is common, and *Pseudoroegneria spicata* usually contributes substantial cover. *Arenaria hookeri* usually is present.	7-12, (n=3). *Artemisia pedatifida* contributes substantial cover, and *Achnatherum hymenoides* and *Hesperostipa comata* are present.	Northwest: Cyclone Rim
						7-17, (n=7). Without *Artemisia pedatifida*, *Achnatherum hymenoides*, or *Hesperostipa comata*.	Widespread: Foot of Laramie Range west through Shirley Mtns and Pine Hill, to Ferris Mtns.
2-14 (n=14)	Virtually all back from rims and outcrops	Mostly bare soil and litter	None (4-14 is equivalent to 2-14)	GRASS AND FORB. Non-cushion forbs are the most numerous species; grasses and non-cushion forbs contribute most of the cover, and shrubs are secondary.	*Phlox hoodii*, *Poa secunda*, and *Elymus lanceolatus* ssp. *lanceolatus* are widespread	7-14, (n=10). *Elymus lanceolatus* ssp. *lanceolatus* usually contributes substantial cover. *Arenaria hookeri* is slightly less widespread	Widespread, across entire study area
						7-32, (n=4). *Poa fendleriana* is widespread and contributes substantial cover. *Artemisia nova* and *Artemisia tripartita* ssp. *rupicola* each are present in 3 of 4 plots and contribute substantial cover to some.	North-Central: Shirley Rim and Pine Hill

Table 26. Geologic units and rock types on which plots of the plot-groups were located. Numbers in cells show the number of plots in each plot-group found on each map unit.

Geologic map unit	Description of map unit	Plot-groups			
		4-1	4-4	4-12	4-14
Madison limestone, Darby formation	Massive limestone and dolomite, cherty limestone and dolomites	2			2
Mesozoic and Paleozoic Rocks	Nugget sandstone, Chugwater formation (shale and siltstone, lenses of lime-pebble conglomerate, thick-bedded sandstone, limestone), and Goose Egg formations(sandstone, gypsum, dolomite and limestone)	1			
Wells and Amsden formations	Former limestone and limey sandstone, latter shale and dolomite with basal sandstone			1	1
Chugwater formation or group	Shale and siltstone, lenses of lime-pebble conglomerate, thick-bedded sandstone, limestone			2	2
Frontier formation	Sandstone and sandy shale	1			
Battle Spring formation	Basin-margin conglomerate	3			
Lower Miocene rocks	Tuffaceous sandstone, siltstone, and marl		6		
Miocene Rocks	Soft tuffaceous sandstone	3			
Tensleep sandstone	Sandstone containing thin limestone and dolomite beds	2			1
White River formation	Blocky tuffaceous claystone and lenticular arkosic conglomerate			3	4
Wind River formation - at base	Claystone and sandstone with lenticular conglomerate			1	1
Wastach Formation: Cathedral Bluffs Tongue	Claystone and lenticular sandstone			2	1
Mowry shale	Hard siliceous shale				2
Steele shale	Soft marine shale containing lenticular sandtsones			1	

Table 27. Numbers of plots in or near which disturbances were noted. More than one sign of disturbance was recorded for many of the plots.

Type of Disturbance	Plots Along Rims (n = 24)	Plots Back From Rims (n = 18)
Unvegetated vehicle trail	5	
Tire tracks	2	
Rock monument	1	
Excavation by humans	1	
Fence	1	
Trash	1	1
Ant mound	1	2
Mammal burrow	6	8
Cattle droppings	9	3
Pronghorn or deer droppings*	1	1
Grazed vegetation		2
Plots with ≥ one disturbance	21	13
No disturbance reported	3	5

*For many plots, the presence of pronghorn or deer droppings may not have been recorded.

Table 28. Relationships of south-central Wyoming plot-groups to vegetation types from the national vegetation classification.

Plot-group	National Vegetation Classification Unit	Relationship
4-1	*Arenaria hookeri* Barren Herbaceous Alliance	Plot-group probably can be included in this alliance.
4-4	*Arenaria hookeri* Barren Herbaceous Alliance	Plot-group probably can be included in this alliance.
4-12	*Arenaria hookeri* Barren Herbaceous Alliance	Plot-group probably can be included in this alliance, but the relationship is uncertain..
4-14	Unknown	

FIGURES

Figure 1. Layout of the nested, modified-Whittaker sampling plots.

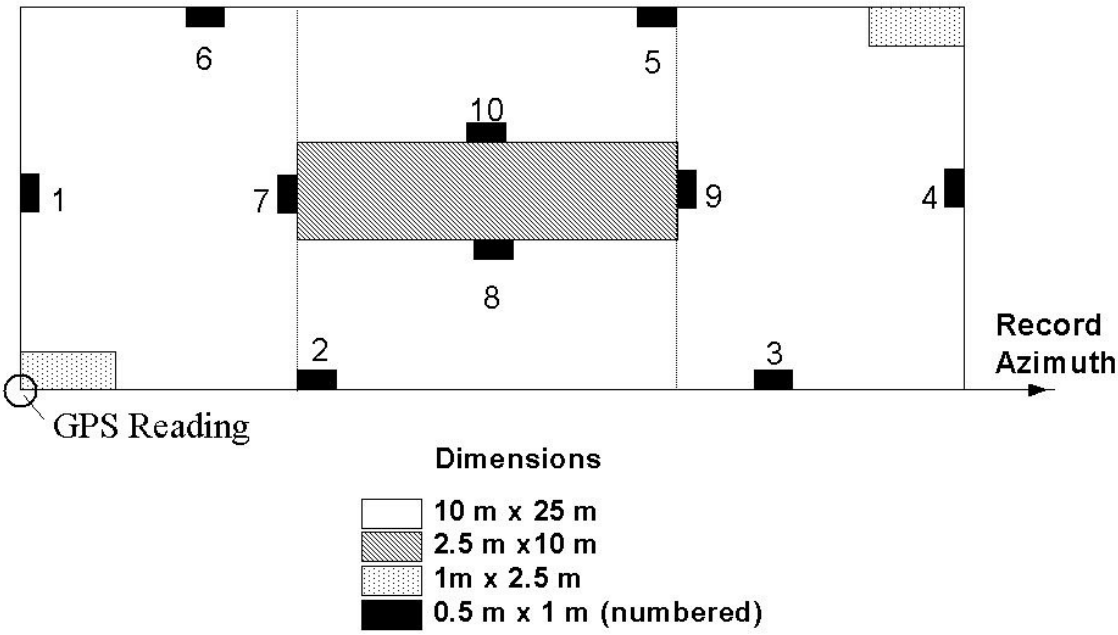


Figure 2. Locations of sampling plots used in the BLM Rawlins Field Office cushion-plant project.

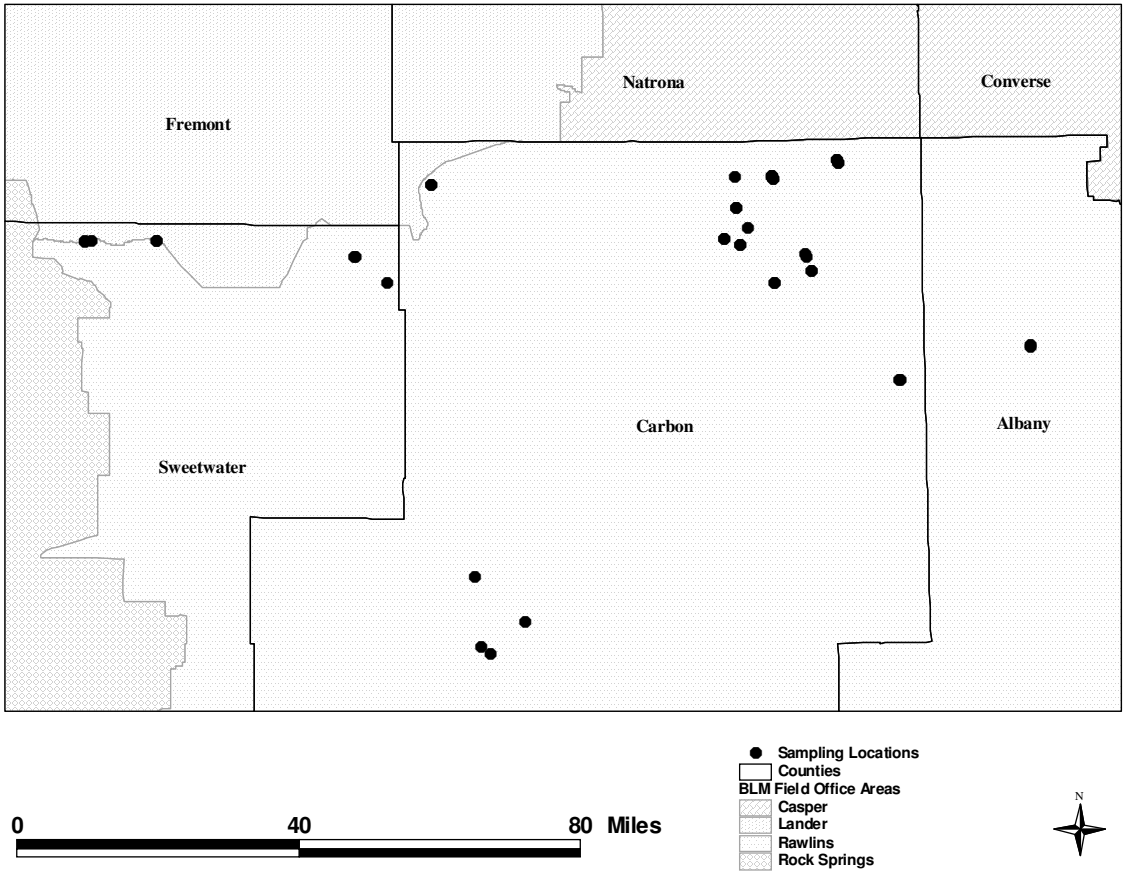


Figure 3. Frequency of occurrence of 249 vascular plant taxa in 42 plots.
The number above each bar shows how many taxa were found in exactly that number of plots.

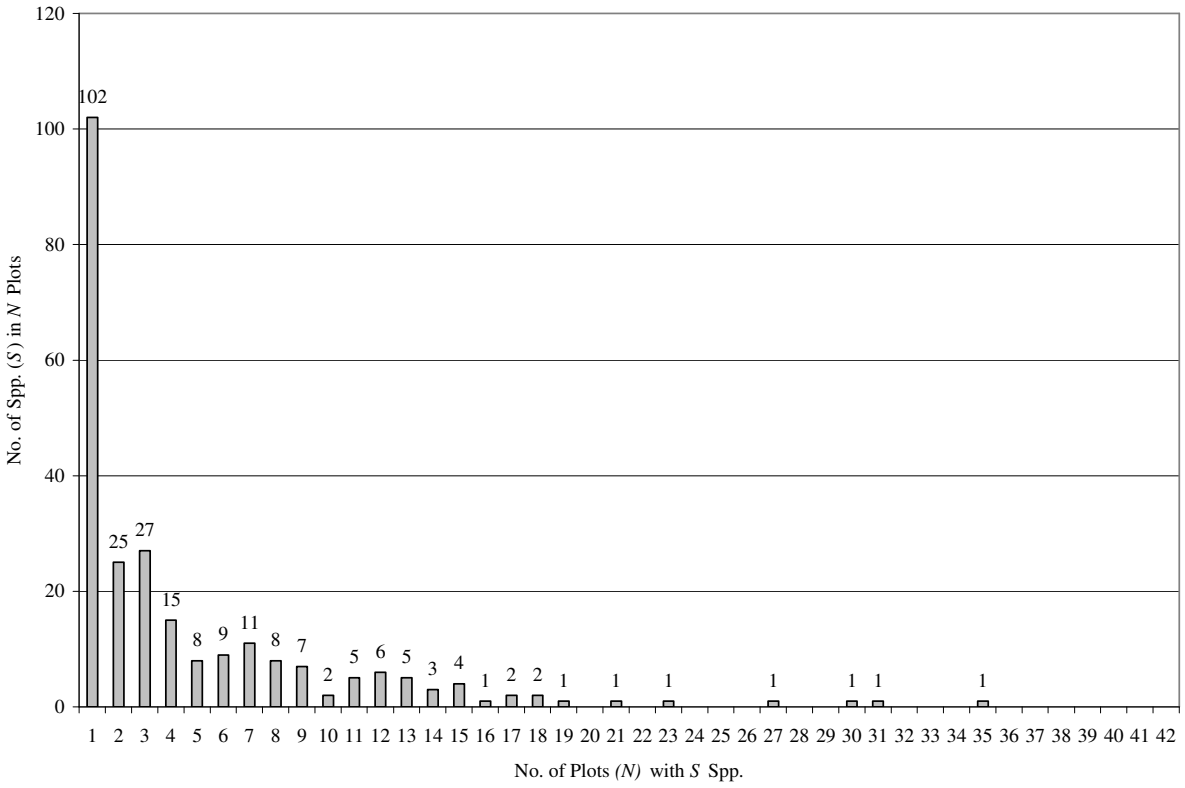


Figure 4. Average number per plot of species of different growth-forms, plots along rims vs. plots back from rims.
Columns are average number of species per plot. Lines are 95% confidence intervals. Asterisks indicate statistically significant differences ($p \leq 0.05$) between rim plots and plots back from rims. See Table 7 for results of statistical tests.

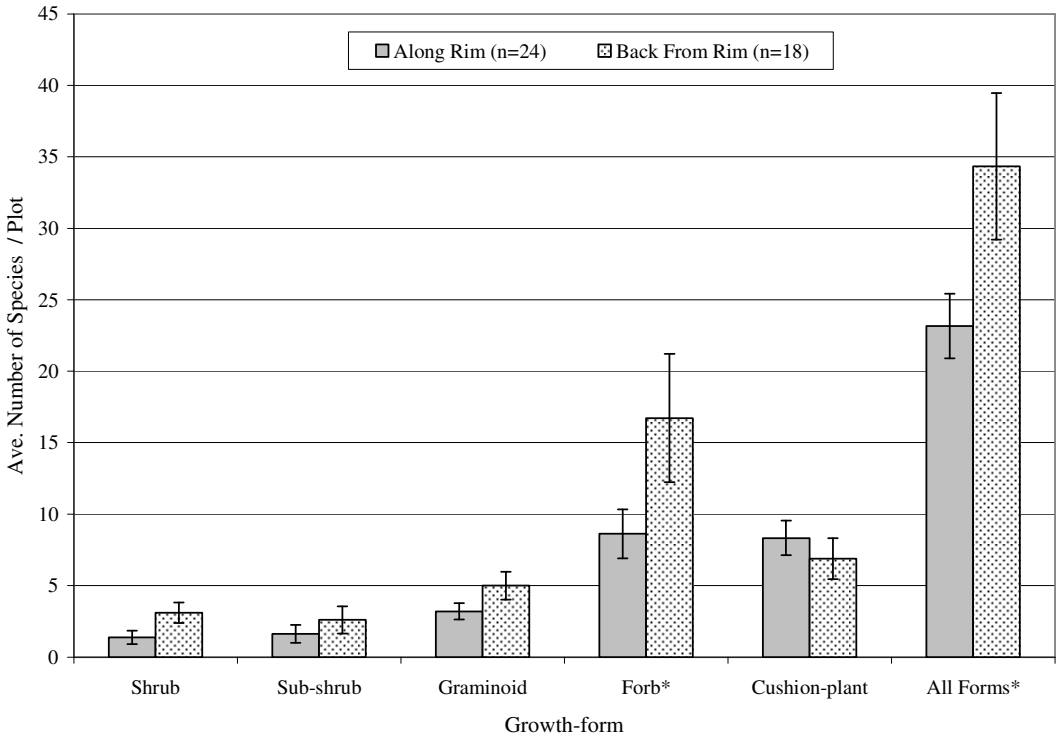


Figure 5. Average canopy cover per plot of different growth-forms, plots along rims versus plots back from rims.
Columns are average total canopy-cover (i.e., sum of cover-class values for all species of that growth-form) per plot. Lines are 95% confidence intervals. Asterisks indicate statistically significant differences ($p \leq 0.05$) between rim plots and plots back from rims. See Table 8 for results of statistical tests.

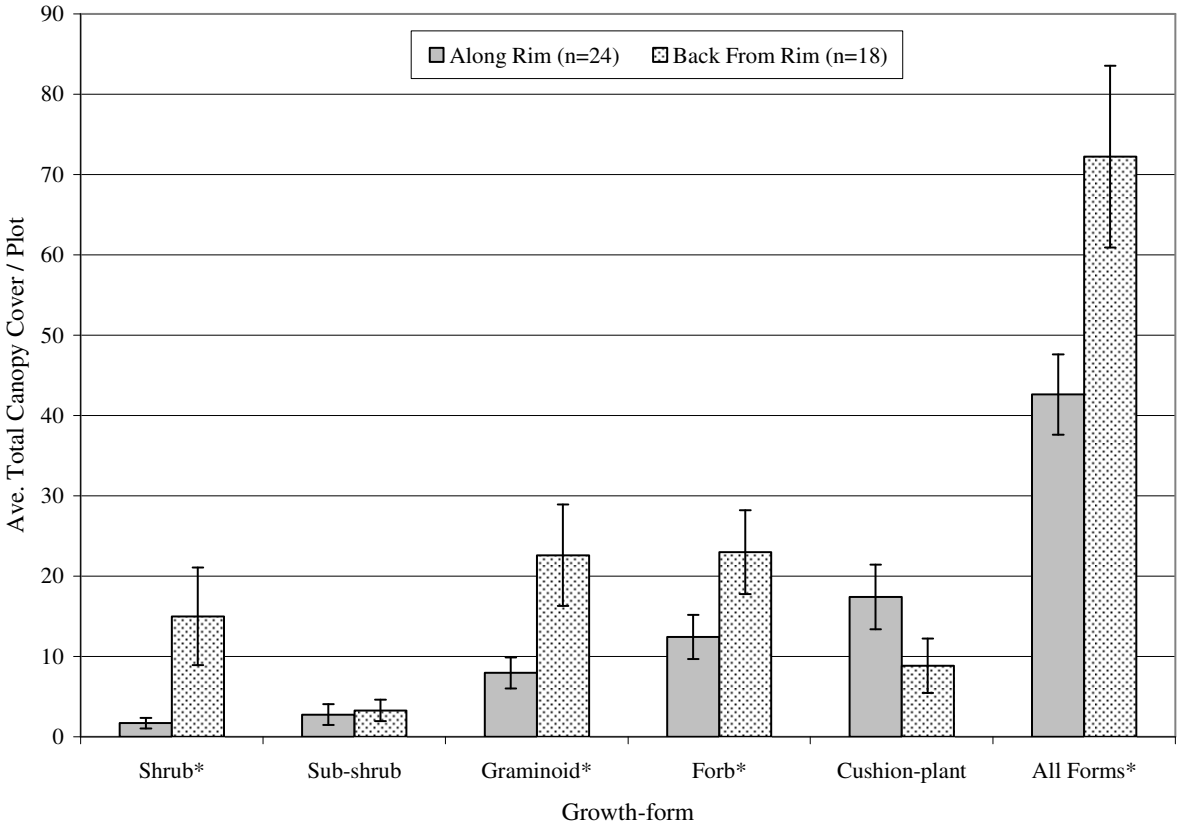


Figure 6. Average relative canopy cover per plot of different growth-forms, plots along rims versus plots back from rims.
Columns are average relative cover (total cover-class for species of that growth-form / total of cover-class for all species). Lines are 95% confidence intervals. Asterisks indicate statistically significant differences ($p \leq 0.05$) between rim plots and plots back from rims. See Table 9 for results of statistical tests.

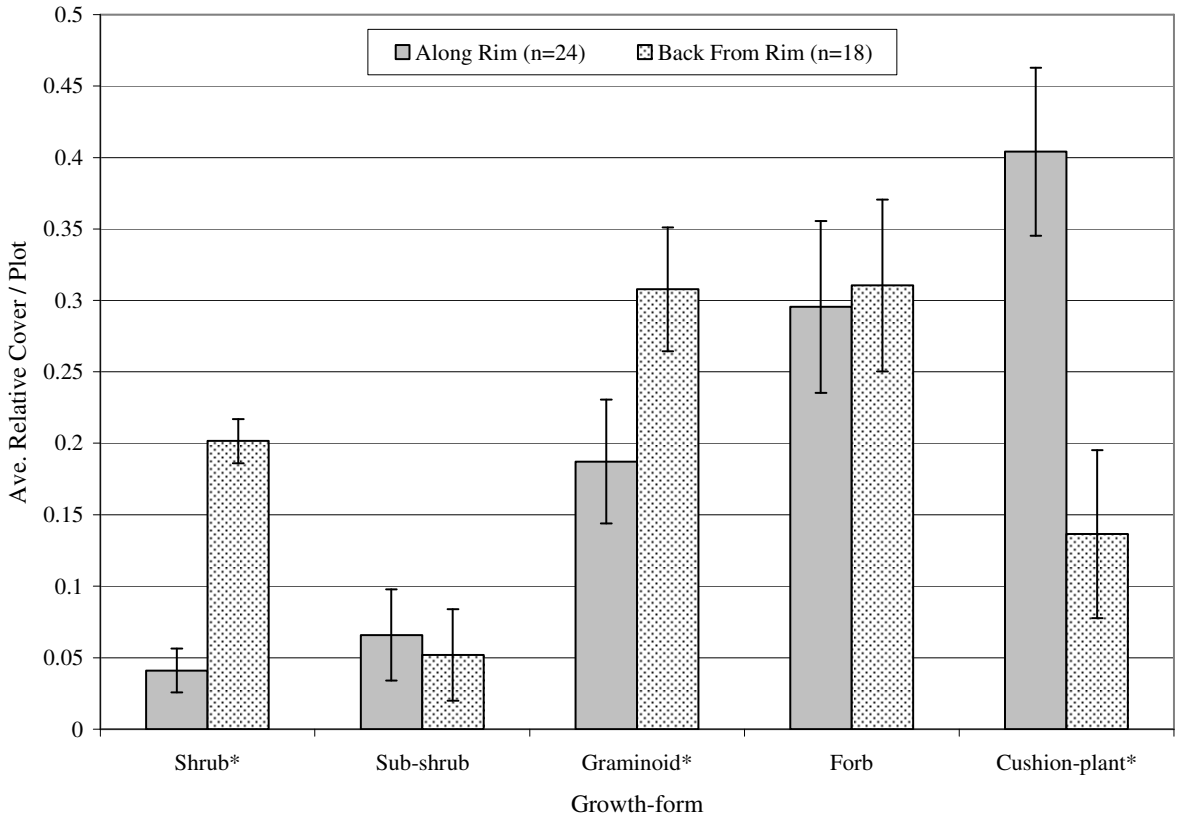


Figure 7. Frequency of occurrence of each cushion-plant species in plots along rims and plots back from rims.

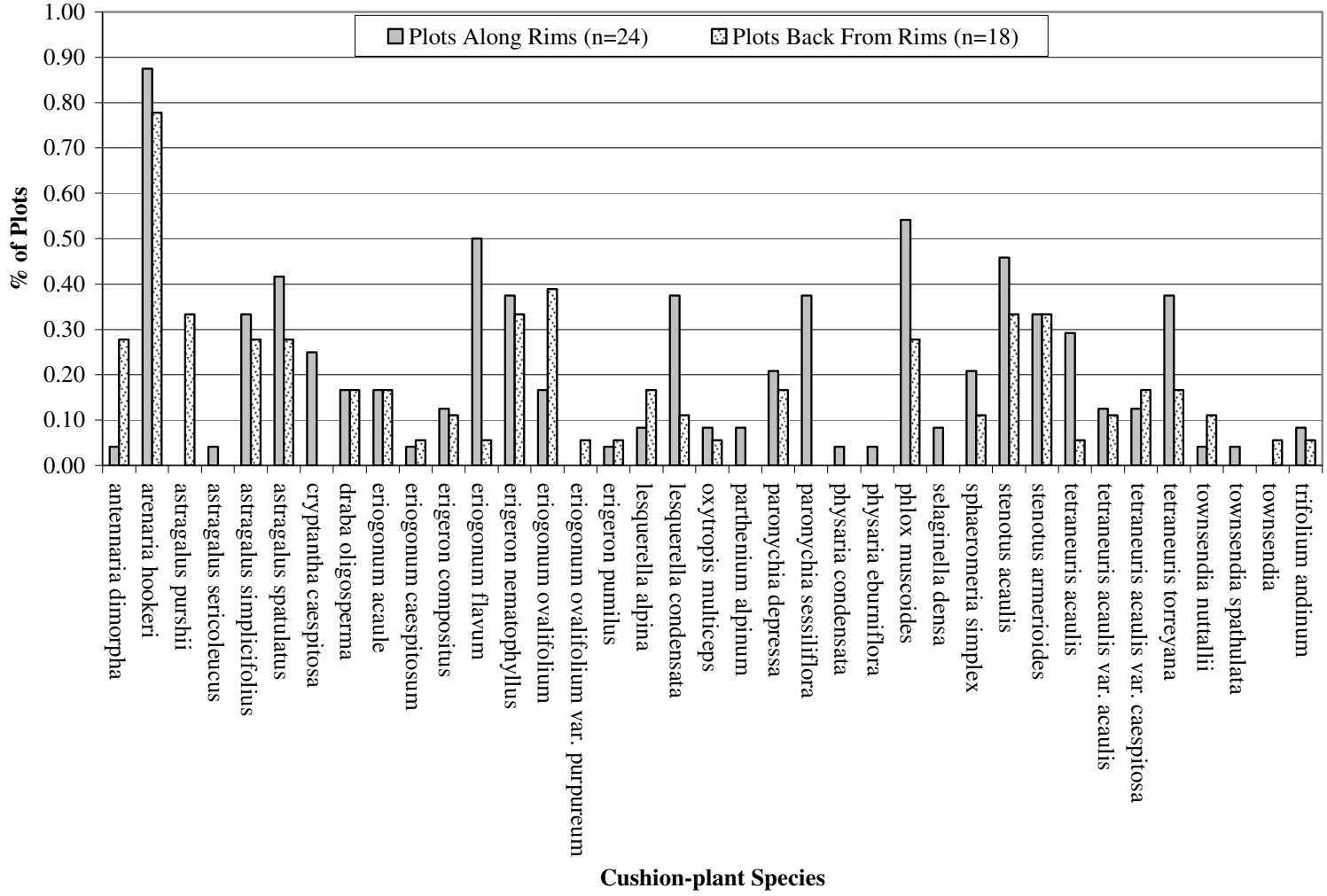


Figure 8. Average cover per plot of different categories of ground cover, rim plots vs. plots back from rims.
Columns are average percent cover. Lines are 95% confidence intervals. Asterisks indicate statistically significant differences ($p \leq 0.05$) between rim plots and plots back from rims. See Table 10 for results of statistical tests.

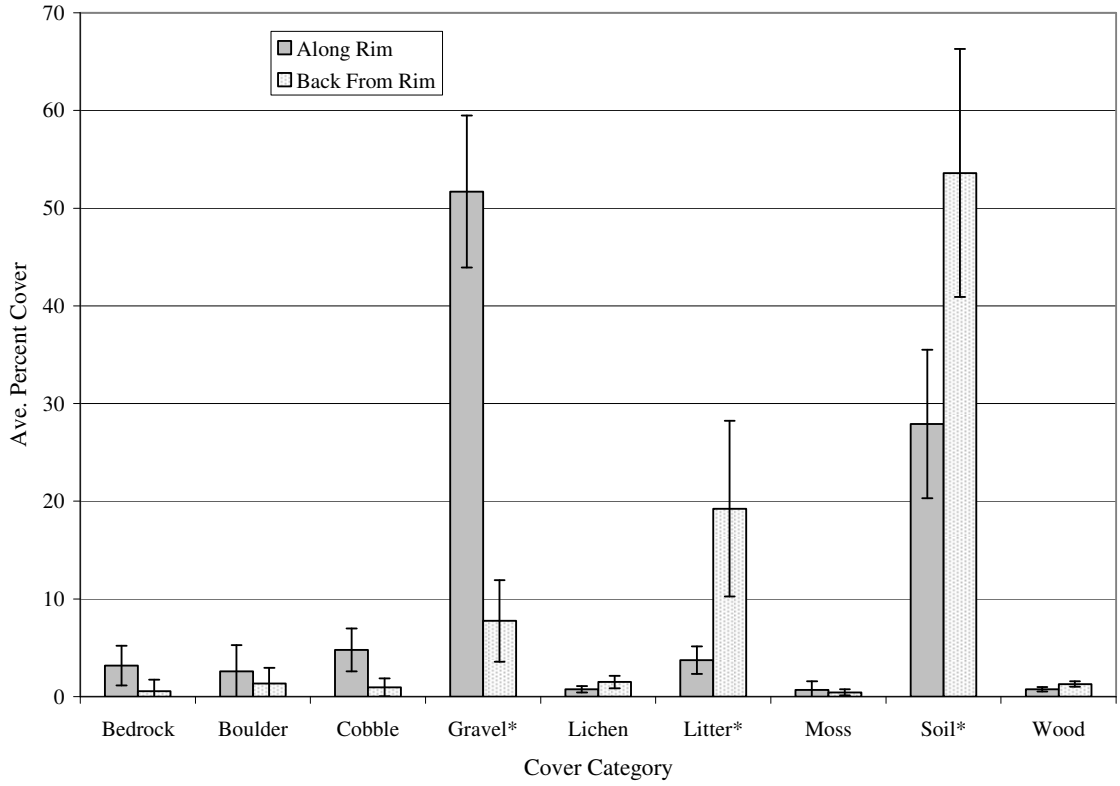


Figure 9. Classification of plots from cluster-analysis of relativized cover data.
Plot-group numbers at different levels are shown on dendrogram branches. Symbols for plots represent 7-level groups. Plot names have been abbreviated.

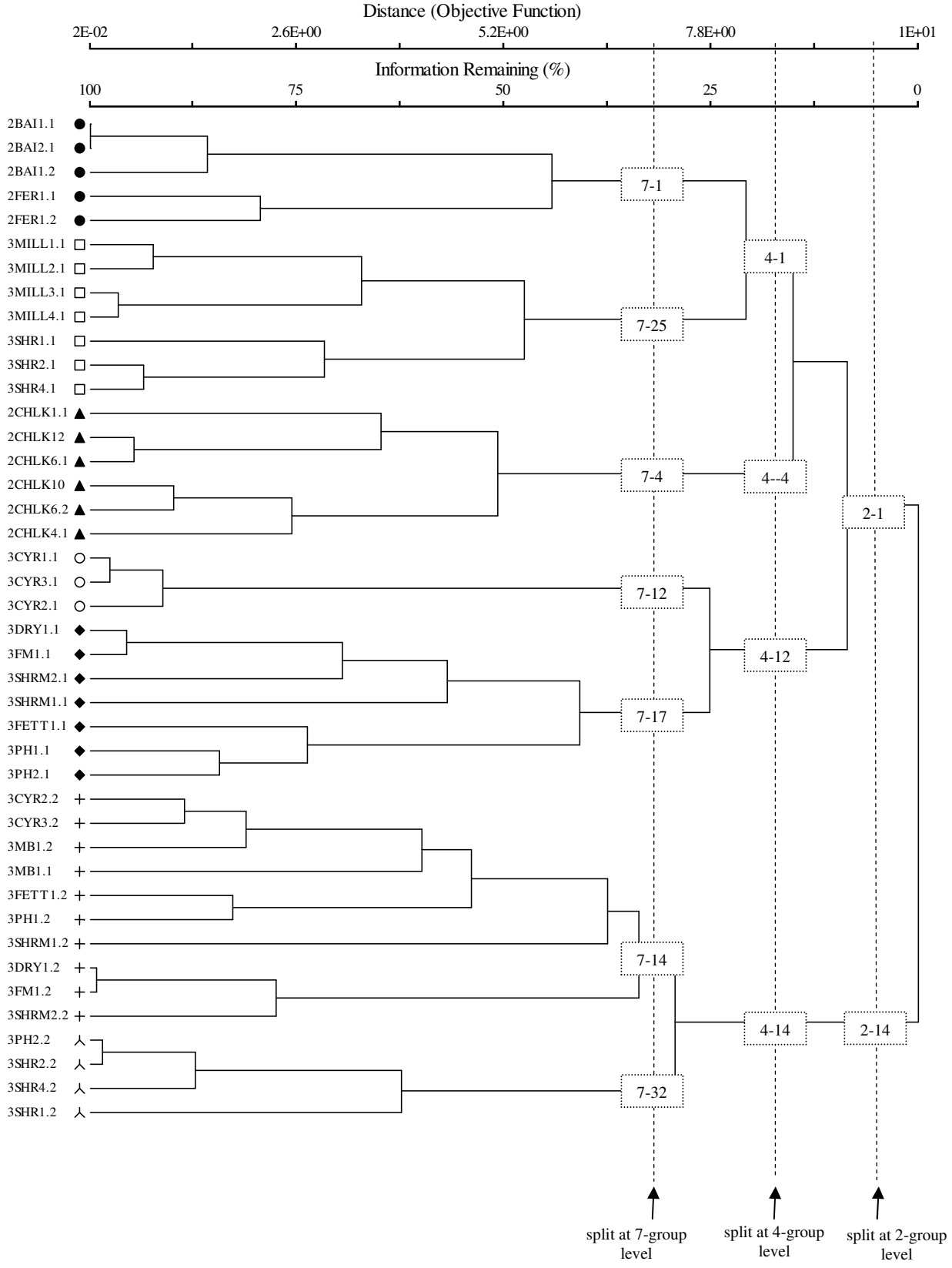


Figure 10. Locations of sample plots in the different plot-groups
a. Groups of plots mainly on rims and outcrops

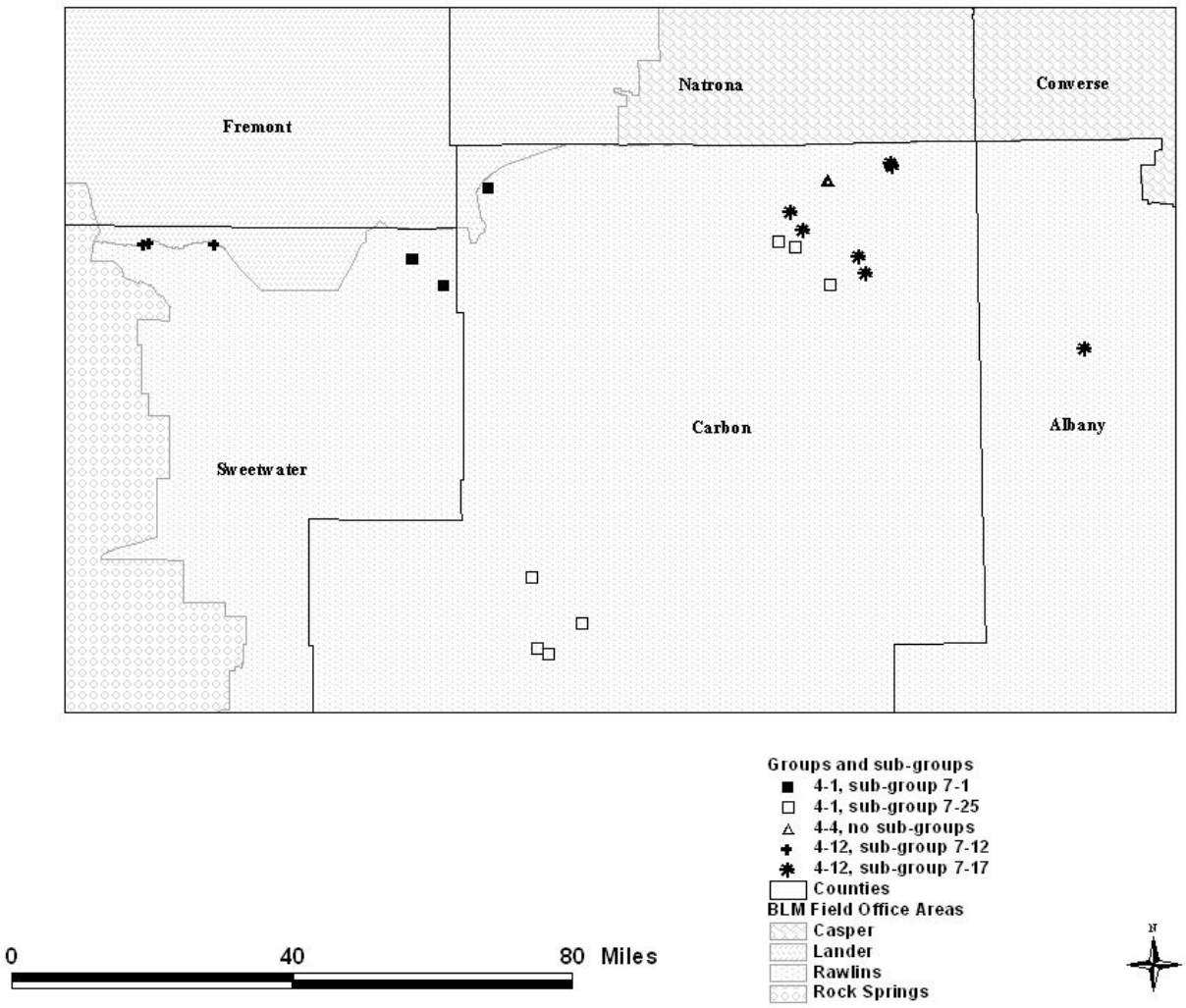


Figure 10 (continued).
b. Groups of plots mainly back from rims and outcrops

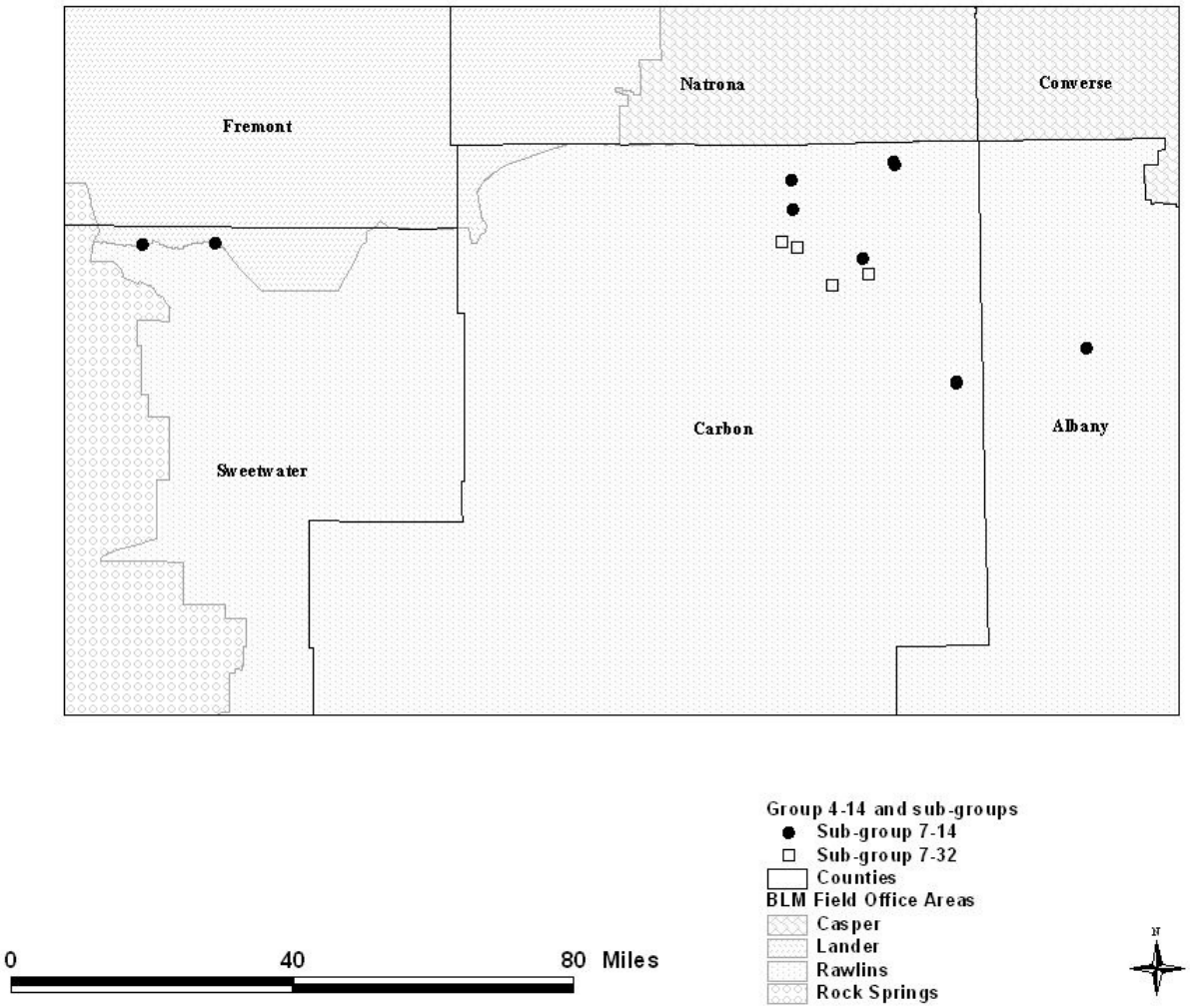


Figure 11. Comparison among plot-groups of the average number per plot of species of each growth-form.
Bars are average number of species per plot. Asterisks indicate significant (p=0.05) differences among groups based on Kruskal-Wallis test. Different letters above bars indicate which groups differ significantly from each other based on non-parametric multiple comparisons. See Table 13.

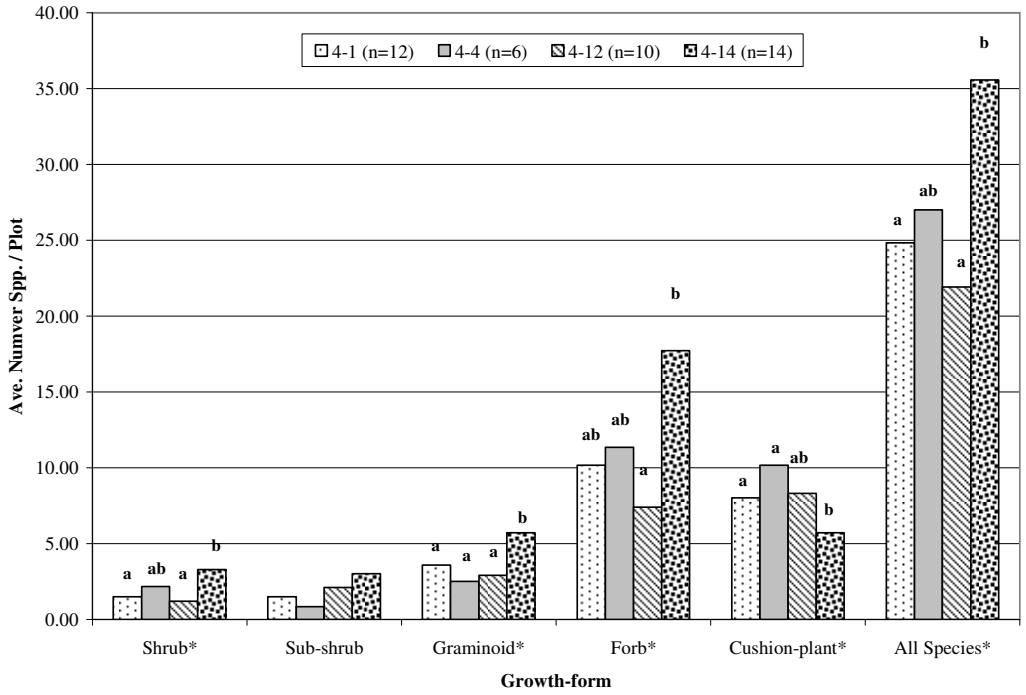


Figure 12. Comparison among plot-groups of the average per-plot canopy cover of each growth-form. Bars are average percent cover per plot. Asterisks indicate significant (p=0.05) differences among groups based on Kruskal-Wallis test. Different letters above bars indicate which groups differ significantly from each other based on non-parametric multiple comparisons. See Table 14.

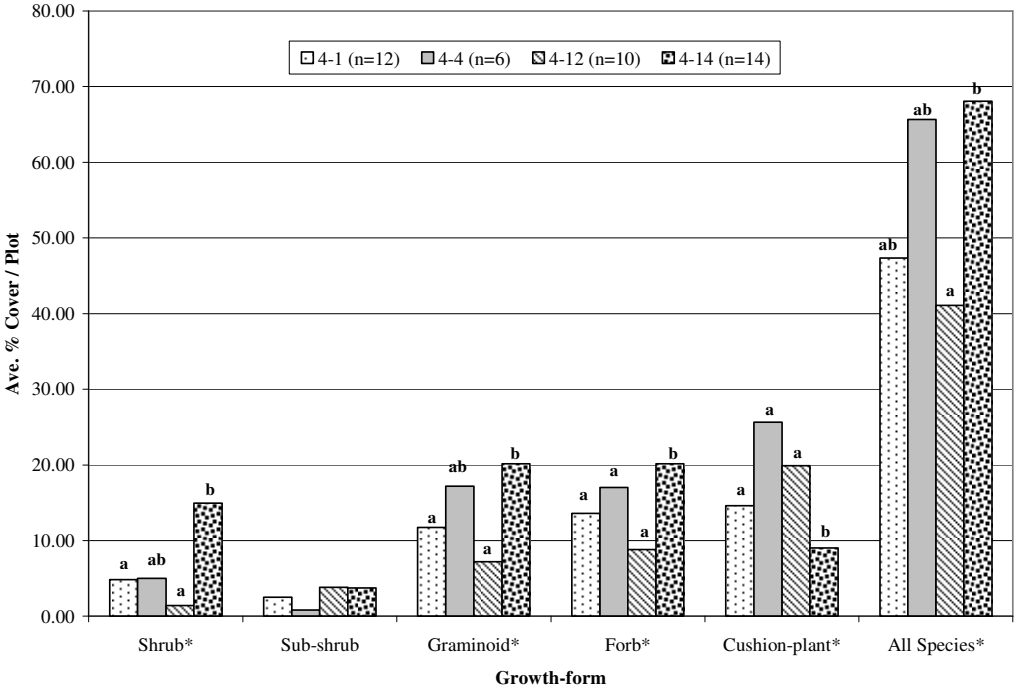


Figure 13. Comparison among plot-groups of the average per-plot relative canopy cover of each growth-form.
Bars are average per-plot relative cover. Asterisks indicate significant (p=0.05) differences among groups based on Kruskal-Wallis test. Different letters above bars indicate which groups differ significantly from each other based on non-parametric multiple comparisons. See Table 15.

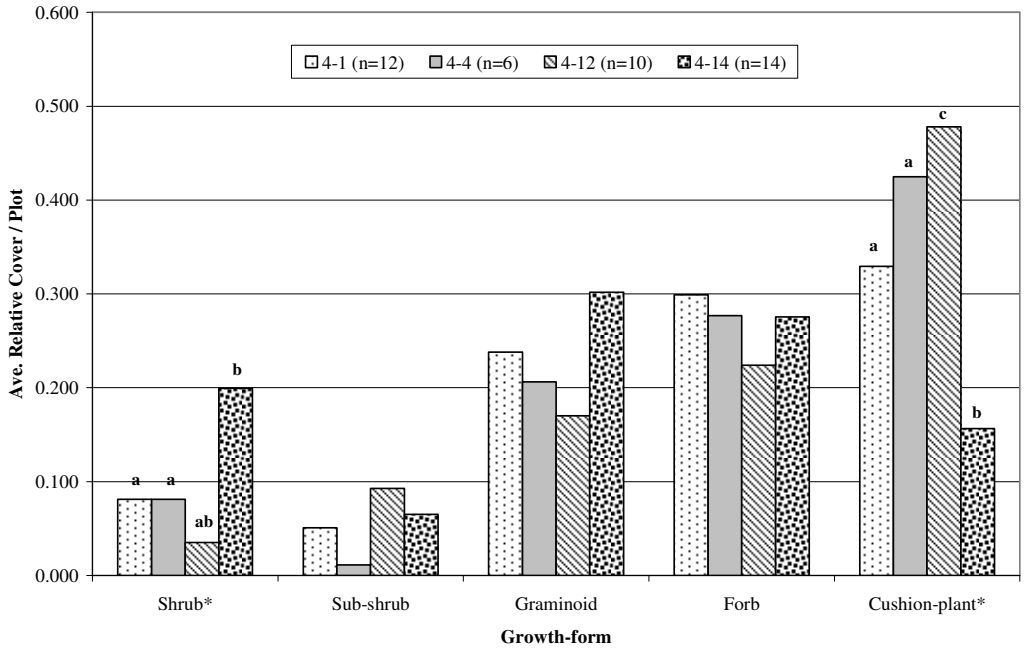


Figure 14. Comparison within plot-groups of the number of species of each growth-form. Bars are average number of species per plot. Asterisks indicate significant (p=0.05) differences among the growth-forms within each plot-group based on Kruskal-Wallis test. Different letters above bars indicate which growth-forms differ significantly from one another based on non-parametric multiple comparisons. See Table 16.

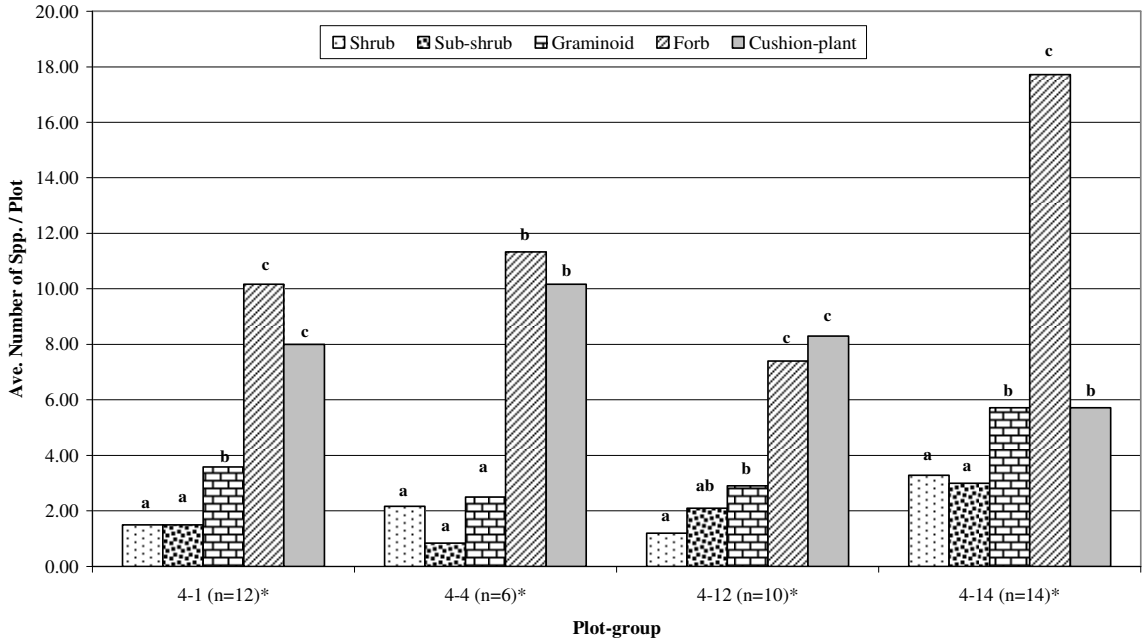


Figure 15. Comparison within plot-groups of the canopy cover of species of each growth-form. Bars are average per-plot cover. Asterisks indicate significant (p=0.05) differences among the growth-forms within each plot-group based on Kruskal-Wallis test; different letters above bars indicate which growth-forms differ significantly from one another based on non-parametric multiple comparisons. See Table 17.

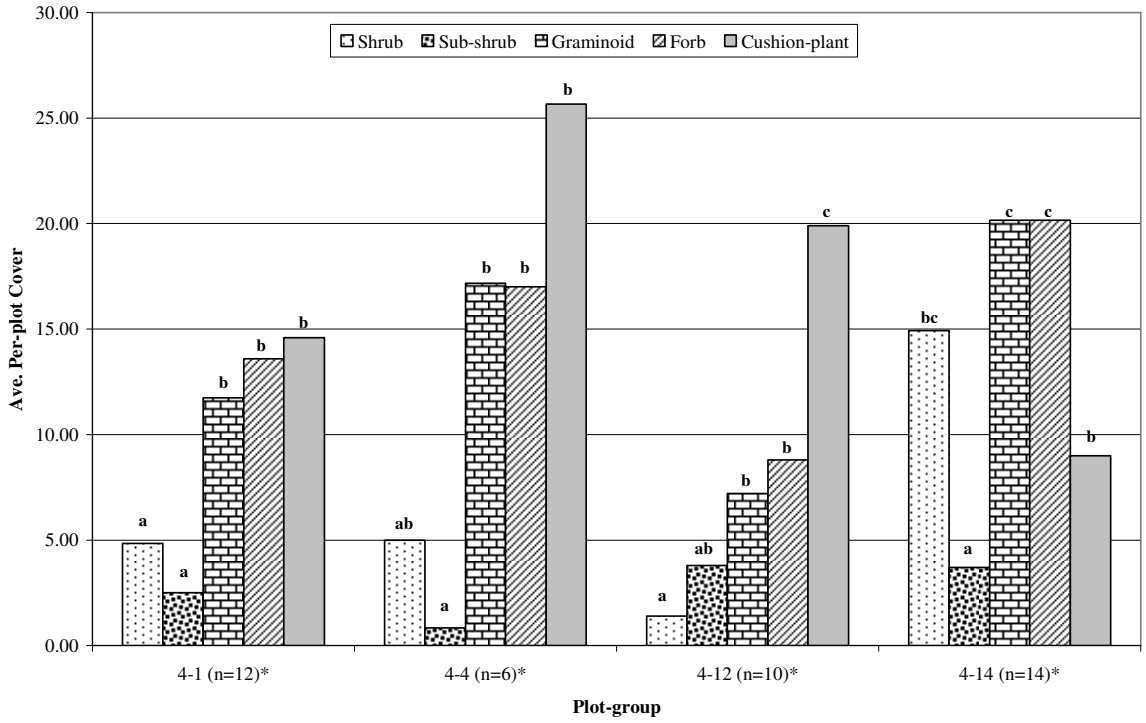


Figure 16. Comparison within plot-groups of relative canopy cover of species of each growth-form. Bars are average per-plot relative cover. Asterisks indicate significant (p=0.05) differences among the growth-forms within each plot-group based on Kruskal-Wallis test. Different letters above bars indicate which growth-forms differ significantly from one another based on non-parametric multiple comparisons. See Table 18.

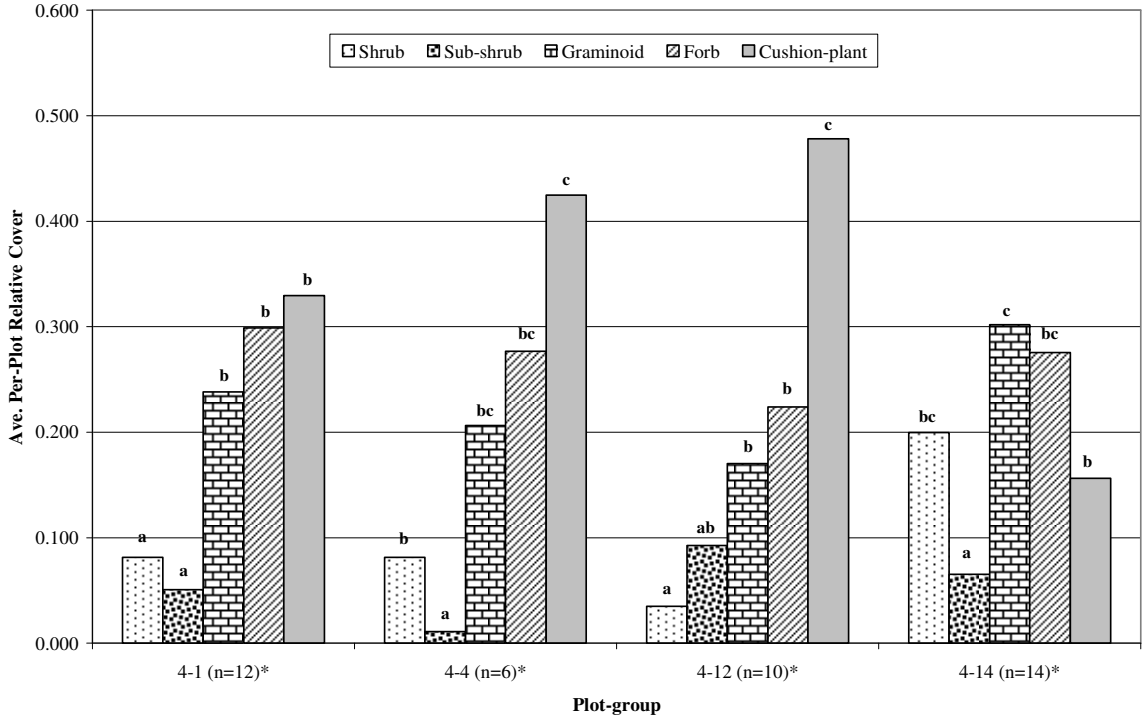
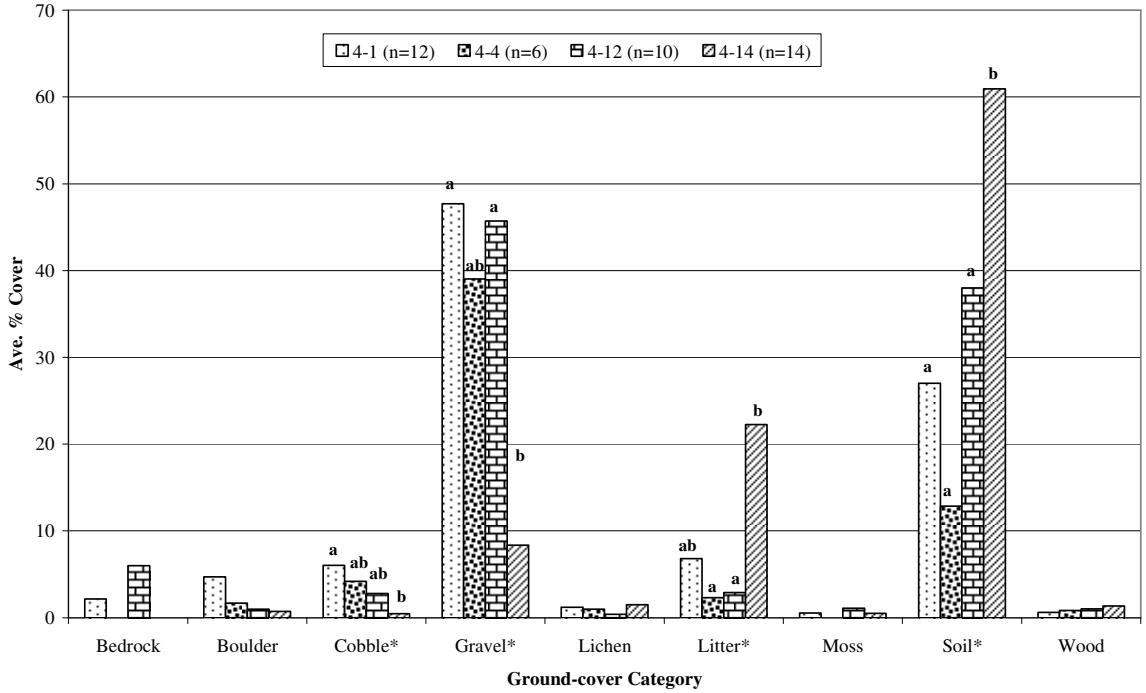


Figure 17. Comparison among plot-groups of average per-plot cover of ground-cover categories. Bars are average percent cover per plot. Asterisks indicate significant (p=0.05) differences among groups based on Kruskal-Wallis tests (performed only for the 4 most common ground-cover types: cobble, gravel, litter, and soil). Different letters above bars indicate which groups differ significantly from each other based on non-parametric multiple comparisons. See Table 21.



APPENDIX 1. INFORMATION FROM INDIVIDUAL SAMPLE PLOTS.

Appendix 1 is in a separate digital file, “Rawlins Cushion-plant Report Appendix 1 Plots.doc.”

APPENDIX 2. PHOTOGRAPHS OF SELECTED SAMPLE PLOTS.

Appendix 2 is in a separate digital file, "Rawlins Cushion-plant Report Appendix 2 Photos.doc."