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Field Botany

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Species Richness Along Elevation Gradient and Possible Correlation Factors

Introduction: The diverse landscape, topography and rainfall are responsible for the rich diversity of the Gunnison County area. Many areas receive different rain exposure as well have different drainage, where rock type and formation has created different stream types. In the areas that have Talus deposits and have a steep slope, most vegetation cant grow here even at lower elevation., where as in areas of Shale, it forms open valleys (Langenheim, 1962). At the base of these drainage systems the water flows slower and accumulates, which allows for a richer diversity. The altitude of the general region also has an effect, where the higher altitudes are subject to frosts that many plants cannot withstand. Permafrost has been recorded in the Colorado Rockies that could also affect soil content and development (Langneheim, 1962). The harsh weather that comes with altitude as well as rocky soil conditions will affect the species richness of the vegetation patterns. I believe that are areas at optimal elevations and soil composition that can support a richer diversity. In areas that are at too high of elevation and are too steep, richness will drop off dramatically, as well in areas that are at too low of elevation, for example the arid alkaline sagebrush community that receive little rain fall, the richness will also drop. Though many different factors effect vegetation species richness, many of these have a correlation with altitude.

Along the altitude gradient a large diversity in different communities is possible. These communites include Alpine Meadow, Lodge Pole Pine, Aspen Forest, Spruce Fur, Upland Herb, High Altitude Willow, Streamside Willow, Fescue, Sagebrush, as well bare and undifferentiated areas. These communities where mapped and categorized by Jean Langenheim in 1962. The areas are relatively similar now to what they were when the study was conducted. Our group tired to sample different meadow areas along a elevation gradient, excluding the forest areas. In the case of Adobe hills, this area is an arid sagebrush community. Through this study we are able to see the species richness along the western slope of the Colorado Rockies.

Methods and Materials: Areas were chosen to be meadow, or open areas along an elevation gradient, because these areas have the greatest richness of vegetation. As well these areas have the most similarity, for example an Aspen forest is going to have little similarity to lower Sagebrush communities, though there might be some similarity between a meadow and sagebrush communities. The communities richness will be cross examined to find similarities within the communities. For example, the % plot species will be found by taking the total amount of species in an area / total amount of species collected in all plots. The richness is determined by the different amount of species within a 20x20 m² area.

Areas were plotted and all species were collected, pressed and/or identified at the location. Nested plots were taken to determine how the amount of species changes within a 20x20 m area. The nested plots were 10cm, 30cm, 1m, 3m, 10m, and 20m. Each new species was categorized within the area sector that it was found in. A diversity curve will be created to determine how the diversity changes over a large area at different elevations to examine how this curve changes over different communities. The equation $S=cA^z$ will be used, where S= #of species, A=area, and c and z are constants.

Results: All species and similarities were recorded and compiled into Appendix 1, which contained a total of 130 different species within the 20x20m plots at the 4 different sites.

A best fit was created for the log of the species diversity curve that describes the expected amount of species diversity over an area, which was equated from $S=cA^Z$, within 20x20m plots. The R² value was obtained to see if the correlation is valid, as seen in Figure 1. If the R² value is close to 1, then there is a positive correlation between diversity and area. The values are close to 1 therefore we can see that there is a relationship between diversity and species.

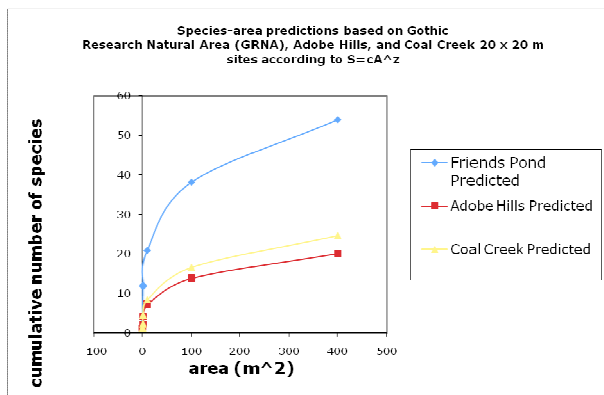


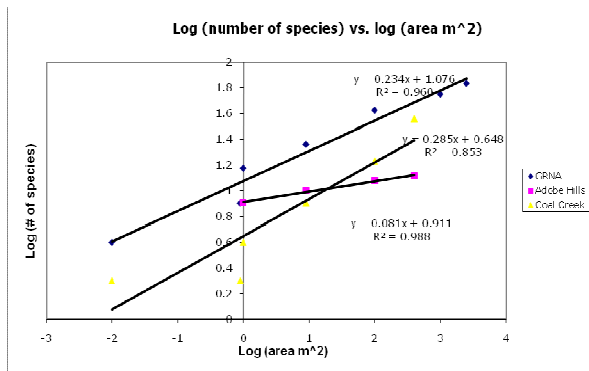
Figure 1. Predicted Species Diversity to Area with in a

20x20m plot.

Plot	c (intercept ¹⁰)	z (slope)	R ²
Friends Pond	2.08415434	0.2344	0.9608
Coal Creek	0.01315527	0.2856	0.853
Adobe Hills	0.39588289	0.081	0.9887

Table 1. Summary of Species-Area observations

Figure 2. Plot of observed log values of Species-Area.



The Similarities of the sites was gathered from the species lists and similarity was calculated. Figure 4 shows that there was a 12.38% species similarity between GNRA and Virginia Basin, as well there was a 7.04% similarity between Virginia Basin/ Coal Creek and a 2.94% similarity between GRNA and Coal Creek. There was only a 2.1%

similarity between Coal Creek and Adobe Hills, there were no other relations between the different sites

Figure 4. Similarities between sites including similar species names.

FP/CC	FP/VB	CC/VB	CC/AH
Castilleja miniata	Androsace septentrionalis	Eriogonum umbellatum	Tragopogon dubius
Oligosporous dracunculus	Arnica cordifolia	Taraxacum officinale	
Achilea millefolium	Boechera divaricarpa	Achilea millefolium	
Fragaria virginiana	Erigeron coulteri	Fragaria virginiana	
Potentilla gracilis	Erigeron elatior	Potentilla gracilis	
	Festuca thurberi		
	Geranium richardsonii		
	Lathyrus leucanthus		
	Mertensia ciliata		
	Poa aretica		
	Pseudocymopterus montanus		
	Ribes montigenum		
	Thalictrum fendleri		
	Vaccinium myrtillus		
	Achilea millefolium		
	Fragaria virginiana		
	Potentilla gracilis		
	Valeriana edulis		

Table 2. Community Similarities

Community similarity of 20x20 meter vegetation plots at four sites.				
	FP	VB	CC	AH
FP	--	26.10%	6.30%	0%
VB		--	7.00%	0%
CC			--	2%
AH				--

A matrix was created from the community's similarities and its relation between elevation, annual rainfall, and geographical distances. This table shows that there is a positive relation between both rainfall and Geographical distances, but no correlation between altitude and species similarities as shown in Table 2. We found justified that the relation was true and found that it was significant because $p < .05$.

Table 2

Mantell Test			
	r value	Critical Value	Accept or Reject Null Hyp
Community Structure X Difference in Annual Average Rainfall	-0.7997	$p < .05$	Reject
Community Structure X Geographical Distance	-0.8767	$p < .05$	Reject
Community Structure X Difference in Altitude	-0.556	$p > .05$	Accept

Table 2 shows the results calculated using Mantel Nonparametric Test Calculator Version 2.00 for Windows 1997-2000. Written by Adam Liedloff.

Discussion: The species richness curves show the relation between the amount of new species and area, and from this we are able to tell that we found most of the species representatives for Adobe Hills, but to get a accurate representation of Friends Pond and Coal Creek, a larger plot size would be need. The Coal Creek species-area could also be better predicted if we took more plots along that area. Through an understanding of the richness of an area we can determine how the occurrence of different species changes over an area. With the help of this we can determine how this richness relates to elevation, rain fall and geographical distances.

Through the species similarties the percent similarities was obtained. The best relation between plots was Virginia Basin and GNRA, which had a 12.38% similarity. This is due to the their closeness to each other, also because they have similar annual rainfall. Though they are at different altitudes, the both sit at the base of a mountain, and are near a creek and are alpine meadows. The community structures of these areas

are very similar, whereas the Adobe Hills has a much different soil type, and annual precipitation. The communities are very different between Adobe Hills and all the other sites, it can be assumed that there is more to the community structure than elevation alone, the distribution of species and the zones that different species live in can be explained better through geographical location rather than elevation alone.

By examining the community structure, or similarity of species between sites, and relating it to the elevation, annual rainfall, and geographical distances from each other. Matrices were created using the similarities and the relative distances, rainfall and elevation. We performed a Mantel test on these variables to determine whether the Null hypothesis is correct or if there are other factors in relation to the community structure of an area. The Mantel test allowed us to reject the null hypothesis for both the annual rainfall and the geographical distance, where there is significance between community structures and rainfall and geographical distances, though we also found that the null hypothesis is accepted when considering elevation. Through further studies it can be determined if rainfall and geographical distance has a significant effect on community structures.

The results of this study show us that there are many different factors that effect the community structure and species richness. Through the data collected we can see that elevation itself has little affect, but other factors that correlate to elevation might have a stronger influence on richness, for example rain fall and geological location. The soils of Adobe Hills are a harsh saline environment that few plants have been able to adapt to. Even though the elevation can support a vast richness, where other areas of the world at this elevation can support richness, because of the soil content and the rainfall, the area has a very low richness. This study is a good preliminary experiment for a better understanding of community structure and what factors effect this.

References:

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