

The Effects of Elevation upon Successional Trends in Jean-Lafitte National Park, Louisiana

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Abstract

The development of canals through the wetlands of southeast Louisiana has caused a disturbance resulting in an elevated mound of soil, known as a spoilbank, immediately along side the canal. Due to the elevational differences upon the spoilbank as compared to the undisturbed forest, the spoilbank soil is drier and exposed to less inundation than the undisturbed areas. It is thus hypothesized that the flora diversity and richness will increase with the elevational rise of the spoilbank.

Measurements of the flora within disturbed quadrats and associated control quadrats from three separate canals were made by counting stem number of present species and taking the diameter at breast height measurements of desired woody species. Elevations of these quadrats were measured using a string level method and were later used in the comparison of flora data among differing elevations. Statistical t-tests indicated any significance of differences among flora compositions or elevations.

Results illustrate that the species richness does increase with elevation. Further, more species are significantly diverse on the spoilbank than within the control sites. Allowing for analysis error and numerous assumptions, the hypothesis is supported with the plant communities upon the spoilbanks being the most diverse and species rich within the comparison. Thus, wetland succession and response to this human disturbance is now understood.

with a net gain in species number and diversity (Duever, 1983; Glasser, 1985) which continues for over 100 years (Duever, 1983).

Within the long time-line of succession, the species composition upon the disturbed site is greatly influenced by competition. The competition among species begins early with the primary factors being seed weight, germination speed, and rate of seedling growth (Stockey, 1994). In as little as one growing season, competitive effects among seedlings can be seen, with larger species usually outcompeting their smaller opponents (Keddy, 1994). Competition is also delicately influenced by the surrounding environment. Different species have been seen to have varying competitive affects depending greatly on the water content of the soil and the time inundated (Shaffer, 1992). The spoilbanks do not usually show this typical inundation and are therefore a unique case in wetland succession.

Spoilbanks are often greater than one meter above the water level in the canal and surrounding wetland. On peat mats, a rise in elevation of as little as one meter has had large effects on species composition upon this rise. Soil tests show a decrease in the water content of the elevated soils, allowing the colonization of many species that favor dry soils (Duever, 1983; Glasser, 1985; Johnson, 1985). Spoilbank soils are drier and more compact than the surrounding wetland making a habitable environment for these species that favor dry ground (Turner, 1994). By examining newly formed peat mats and comparing elevations with species composition, past tests have found that the average number of species per area increases with elevation (Shaffer, 1992).

Methods

To document successional trends upon a spoilbank found within a red maple - palmetto forest, three spoilbanks constructed at different times and found within this forest type were selected. At each site, the species composition and density was examined on the spoilbank and within a section of nearby undisturbed forest. This data was then paired with data on the elevational differences among the study sites so as to find any correlation that might exist between spoilbank elevation and its species composition.

Upon all three spoilbanks, the species composition and abundance was measured in the same manner. First, a starting point on the spoilbank was chosen where the surrounding ecosystem was that of a red maple - palmetto forest. Then, using a random number generating sheet, selected numbers provided how many paces forward and sideways would be taken. After pacing the desired distances, this new position now marked the corner of the first quadrat.

Quadrat size was a measured three meter by five meter rectangle with the long dimension running parallel to the associated canal. The quadrat was measured out from the initial corner chosen randomly, with each corner being marked with a stake so as to facilitate the perception of the boundaries. In some cases, a trodden path would cross through part of the quadrat. If this occurred, the quadrat was shifted so as to move it off the path but keep it entirely upon the top of the spoilbank. It should be noted that the quadrat size was selected so as to permit the quadrat to lie entirely upon this top and not

disturbed quadrats. The same techniques were used within the control quadrats to identify and record the flora present as were used within the disturbed quadrats.

The elevation of the disturbed quadrats was measured using the technique illustrated in figure 1. A staff marked with five centimeter increments was placed with the zero marking at the water level of the canal. A string was then stretched from the middle of the quadrat to the staff and pulled taught so as to remove error due to sagging. The string was leveled using a string level placed midway on the string so where the string met the staff was the height of the quadrat above canal water level.

The height above canal water level of the undisturbed control quadrats was collected in a similar manner. Once the height above canal water level of the spoilbank top was found (where the disturbed quadrats were located), the same method involving the staff was then used to measure the height of the spoilbank above the undisturbed forest floor. This value was subtracted off from the height of the spoilbank above canal water level to give the elevation of the undisturbed forest floor above canal water level.

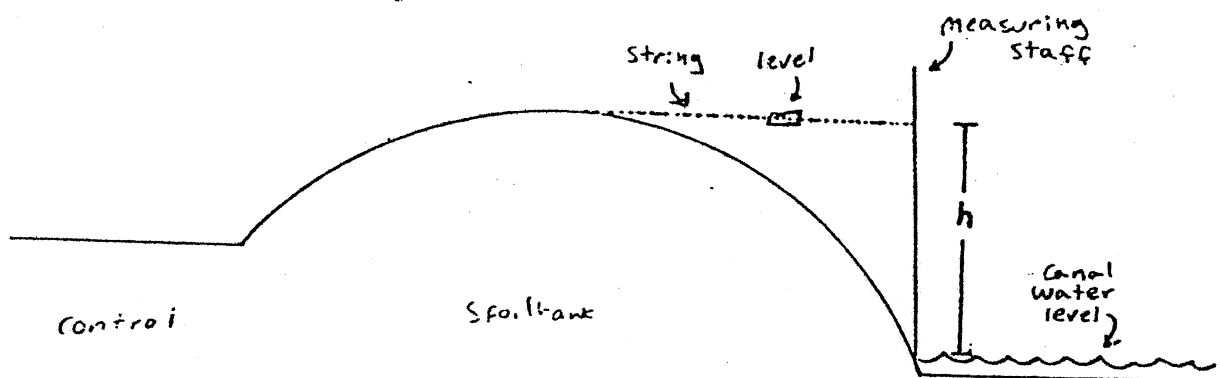


Figure 1: Illustration of the technique used to find elevations above canal water level.

between the three quadrats of each control site and between the three quadrats of each disturbed site.

Observations of the species distributions were made to allow for the selection of species found only in disturbed sites, only in control sites, or in an overwhelming majority in either the control or the disturbed sites. The densities (average species stem number per forty five square meter quadrat) of these species were calculated for all control sites and compared to the densities for these species found within the disturbed sites. Significant differences between the densities in the control sites versus the densities in the disturbed sites were calculated using statistical t-tests.

A final calculation carried out tested species richness upon the spoilbanks and compared that value to the species richness of the control quadrats. The species richness, measured as the number of species found per quadrat, was averaged over all control quadrats and averaged over all disturbed quadrats. These two averages were compared by again using a statistical t-test to test for a significant difference. A possible correlation between elevation and species number was investigated by plotting the number of species per quadrat on the y-axis with the quadrat elevations on the x-axis.

Results

Comparison of control site elevational means with disturbed site means showed the differences in elevation are extremely significant (Table 1). This

Eupatorium rugosum, and *Quercus virginiana* had respective density values (in stem number per quadrat) of 2.111, 3.333, 11.667, and 4.778 upon the spoilbank sites. These values are significantly greater than the density values in the control sites (0, 0.222, 0.333, 0.333 respectively). One species, *Sabal minor*, was found with a more significant density (3.667 stems/quadrat) in the control sites than in the spoilbank sites (0.333 stems/quadrat).

The final measurement related species richness upon spoilbanks and within the control sites by comparing the number of species found in each quadrat. Figure 2 is a scatter plot of the number of species found in each

control	Quadrat 1	Quadrat 2	Quadrat3	Average
Kenta	20.00	17.67	3.33	13.67
se	12.77	9.39	11.67	
Segnette	-52.67	-32.33	5.00	-26.67
se	15.24	4.26	5.00	
Twin	73.33	-4.67	3.67	24.11
se	21.06	4.09	8.82	

Table 2: The average elevation (in cm) and standard errors of each control quadrat from all three sites, with the average of all three quadrats for each control site.

disturbed	Quadrat 1	Quadrat 2	Quadrat3	Average
Kenta	159.67	144.00	128.00	143.89
se	11.80	12.86	5.00	
Segnette	146.33	157.33	219.67	174.44
se	17.64	7.84	3.33	
Twin	184.33	139.33	157.00	160.22
se	18.78	2.90	3.00	

Table 3: The average elevation (in cm) and standard errors of each disturbed quadrat from all three sites, with the average of all three quadrats for each disturbed site.

species per quadrat vs. elevation

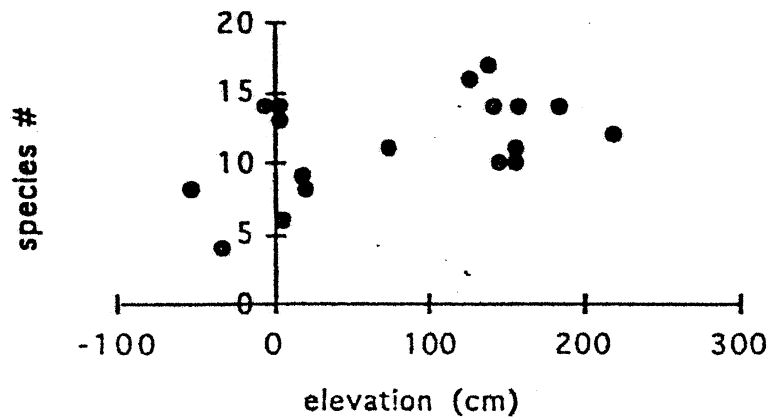


Figure 2: To illustrate the increase in species richness over elevation, this plot shows the number of species found in each quadrat versus the elevation of that quadrat (in cm).

Discussion

One problem that presents itself and challenges this report is the elevational fluctuations within each site. As previously mentioned, fluctuations within an individual site were oftentimes significant, and the elevational differences between the three disturbed or between the three control were often significant. The comparison of species present upon the spoilbank and within the control sites provided five species which had densities significantly affected by the growing location. Thus, of the thirty seven total species identified with the entire area sampled, only five were affected by elevation. However, this deduction may be an oversimplification. White *et al* mentions that within the Louisiana wetlands, elevational changes of

Flooding also has a large effect upon the wetlands, whether acting on seed dispersal, nutrient availability, or simply causing anoxic conditions (Gosselink, 1990). To more fully be able to explain why certain species were found where, further field research would have to be done on the hydroperiod of the study sites. Comparing a list of key species found within the present sites with species found in defined wetland types, the control sites seem to fall into a category of light flooding, meaning they are inundated for roughly twenty five per cent of the growing season (Gosselink, 1990). It is difficult to judge the inundation scale for the spoilbanks, however. It is speculated that the rate of flooding upon the spoilbank is much lower, if not entirely absent. Two species found to be significantly more diverse upon the spoilbanks are *Quercus alba* and *Quercus virginiana*. These two oak species are intermediate in their flood tolerance and grow better when inundation does not occur. This is illustrated nicely in nature by the preponderance of *Q. virginiana* growing on the natural levee, a ridge of high and dry soils free from lengthy inundation, found near the study sites. The other two species calculated to be more diverse upon the spoilbanks, *Campsis radicans* and *Eupatorium rugosum*, are both commonly found in thickets and densely populated areas. This may be due to their ability to outcompete other species for nutrients.

Though competition is not addressed in this study, it may play an important role in the species diversity and richness when comparing spoilbanks to controls (Fry, 1996; Keddy, 1994; Stockey, 1994). Certain aspects of competition are, however, tied into elevation. Shaffer has shown that the

richness to increase with elevation attributing it to the significant difference in soil water content. However, this is only a hypothesis using preliminary information on plant competition and environmental stress altered within an area of frequent inundation.

One final aspect to be addressed in relation to this increase in species richness upon the spoilbank is the factor of age. As communities age, the species richness increases (Barbour, 1987). Within the study sites, the spoilbanks are of a younger successional state than the control forest. It would then be expected for the richness to be less than the control sites. However, elevation and its affect upon moisture levels is such a strong factor that it compensates for the age difference and even provides the younger terrain with greater species richness.

Several experimental errors were encountered within the project which may have affected the results and conclusions. As mentioned previously, the elevational differences within control sites and disturbed sites are probably the largest source of uncertainty in the actual results. However, by focusing upon the differences in species density and richness from disturbed to undisturbed without focusing on the individual quadrats, this oversimplification will not affect the results presented here. Other errors may be found in the technique which provided the elevational readings. Though the technique itself is reliable and consistent, the leveling device was inexpensive and may have error inherent in its composition. However, this error would have been

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