The effect of aspect on the forest edge along a power line corridor at Greenwoods Conservancy, summer 1999

Henry Adams[1]

INTRODUCTION

The fragmentation of forest ecosystems is common in the northeastern United States (Cadenasso, 1997). Many studies have focused on the biotic factors of forest edges. These have shown that edge vegetation is different compositionally and structurally from forest interior vegetation (Brothers, 1992; Luken, 1991; Matlack, 1993; 1994). Steeper climactic gradients are created when trees are removed, the understory expands, and species distributions become edge oriented (Matlack, 1994). Trends among abiotic factors influencing forest edges, including light, temperature, and soil moisture, are much more difficult to generalize (Cadenasso, 1997; Saunders, 1999). The zone of temperature change from a clearing to the interior at a forest edge can vary by as much as 45m during a single day and by 40m for any one time of day during a week (Saunders, 1999). Abiotic factors influencing a forest edge may not correspond with forest boundaries defined by canopy cover (Cadenasso, 1999).

Definition of forest edges is important for management purposes. A severely fragmented forest can become compositionally all edge. To conserve interior forest habitat, Matlack (1994) suggests a circular forest of at least 2.7 ha or a square forest of at least 3.4 ha. These size recommendations also protect against 98% of possible central disturbance due to canopy openings.

Environmental conditions along forest edges are strongly influenced by aspect (defined here as the compass direction that the forest edge is facing) in the eastern deciduous forest (Matlack, 1993). Cadenasso (1997) found that his NW facing edge had higher maximum and noon air temperatures and had lower soil moisture than his NE facing edge. Invasion and establishment of non-native species in a forest edge is enhanced by light availability. The south and east facing edges studied by Brothers and Springarn (1992), which receive more light, were more susceptible to invasion. They also found that newer forest edges were more susceptible to non-native species.

The Marcy South Line was constructed in the mid 1980s across central New York State. The power corridor, or right of way (ROW), is periodically maintained to stop trees from interfering with the power lines. New York Power Authority (NYPA) crews manage the right of way by cutting trees and poisoning their stumps with herbicides. The crews try not to disturb woody plants that will not grow high enough to interfere with the power lines. Examples of such plants are crabapple (*Malus coronaria*), arrowood (*Viburnum recognitum*), nannyberry (*Viburnum lentago*), and crack willow (*Salix fragilis*).

In August 1998 this treatment was applied to the section of the Marcy South corridor which passes through the study site. In this area the power corridor is heading northeast – southwest, creating east-southeast and west northwest edges in the forest (Figure 1). The intent of this project was to compare the overstory and understory vegetation, temperature, and soil moisture gradients of

[1] Cooperstown Lake and Valley Garden Club intern, summer 1999. Present affiliation: Alfred State University, Alfred, NY

the two edges. Because of the angle of sunlight reaching it, the east southeast facing edge was hypothesized to have a warmer, drier environment that is reflected by its vegetation.

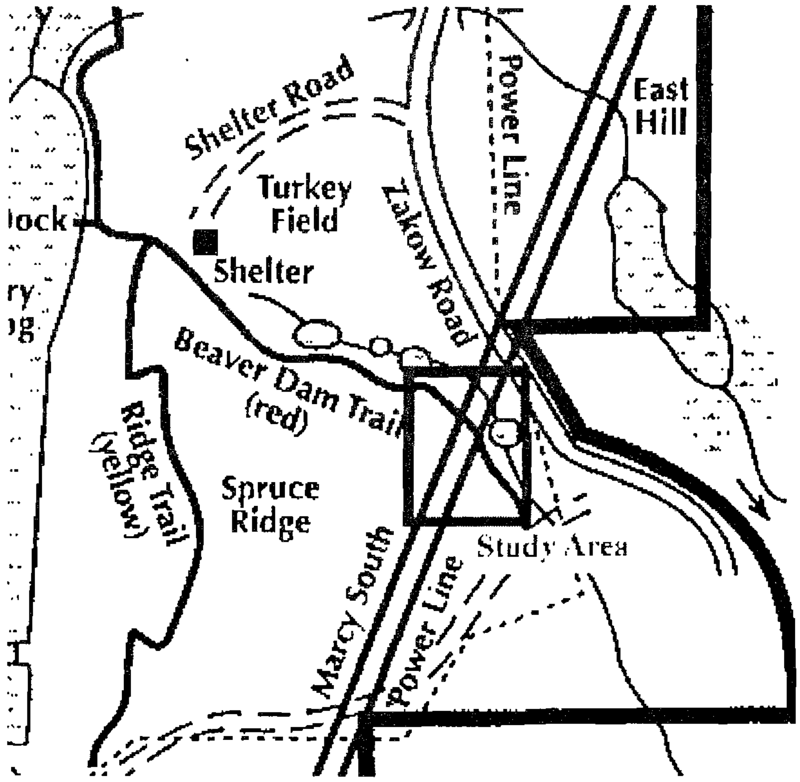

Figure 1. Marcy South Power Line at the Greenwoods Conservancy.

METHODS

The study site is located in the town of Burlington in Otsego County, NY at the Greenwoods Conservancy. The forest edge in this study is defined as a line connecting the center of tree stems along the power corridor, measured to be on a 126° SE azimuth. Rectangular belt plots were laid out parallel to the forest edge on adjacent sides of the power corridor using methods modified from Brothers and Springarn (1991). Five belt plots of 30m x 3m were established to study the understory. They were placed at 0 to 3m into the clear-cut corridor, 0 to 3 m into the forest, between 6 and 9m, centered at 20m and the last at 50m (Figure 2). Three overstory belt plots of 50m x 9m were placed between 0 and 9m and centered at 20m and 50m. Each understory belt plot was divided into three subplots of 3 x 10m to facilitate sampling.

Plants less than two meters in height were considered part of the understory and those greater than two meters the overstory. Species were identified in understory subplots and percent cover was sampled using methods of Mueller-Dombois (1974). Overstory species were identified and individuals were sampled for diameter at breast height (DBH), defined as 1.4m in this study.

To establish if either edge was more associated with species preferring moist soils, species were placed in one of five categories based on frequency of occurrence in wetlands versus non-wetlands in New York State (Porter, 1986). The five categories are: upland (0% frequency), facultative upland (1%-33%), facultative (34%-66%), facultative wetland (67%-99%), and obligate wetland (>99%).

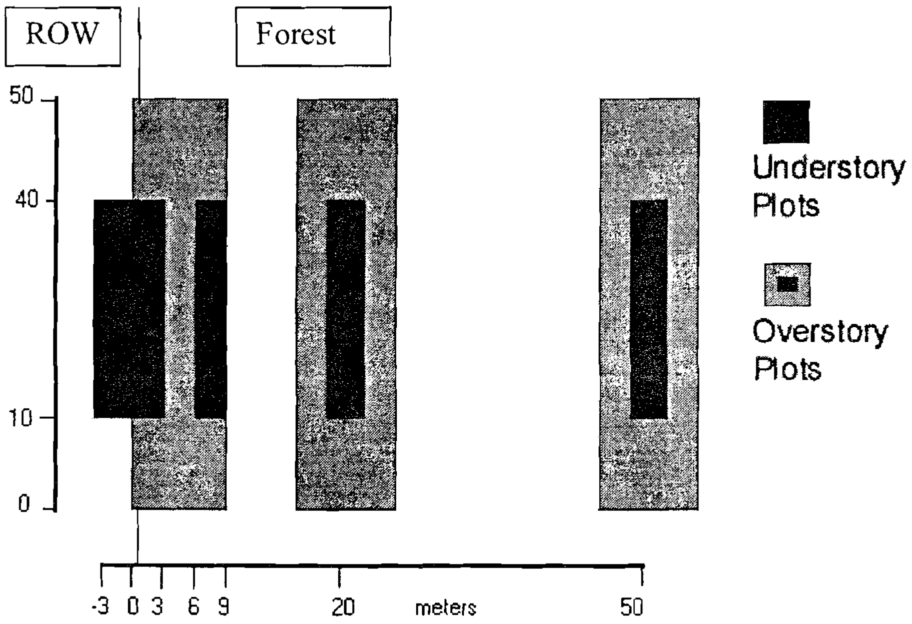

Figure 2. Schematic representation of belt plot layout.

Temperature data were obtained with Green Mechanical Recorders. Temperature recorders were placed in the centers of each belt while in use. Since there were not enough recorders to collect data on all belts concurrently, they were moved from site to site during sampling periods. Soil moisture was sampled using a Kelway HB-2 tester which measures relative percent saturation. This was done on two occasions: after rain, and after a week without precipitation. Relative percent saturation was measured in the center of each understory subplot, yielding three readings per belt and 15 readings per edge.

RESULTS

In the understory, 41 species of vascular plants were found at edge A and 52 were found at edge B. In the overstory, eleven tree species were found in edge A and ten species in edge B. In the understory of edge A, the average total percent cover was 60.9%. Edge B had an average total percent cover of 57.2%. In the overstory of edge A, total DBH was 775 cm; in edge B it was 773 cm. Edge A had an average soil moisture (percent relative saturation) of 32% while edge B had an average of 13.5%. On average edge B was 0.82° C warmer than edge A.

DISCUSION

Species preferring forest interior habitats (Gleason 1991) tended to have higher % cover values in edge A than in edge B (Figures 3 & 4) (Refer to Table 1 for species names and codes). These species also decreased between the 20m and 50m plot in edge A. In edge B, arrowood

(*Viburnum recognitum*) and White Ash (*Fraxinus americanus*) showed the apparent real trends. In both edges arrowood decreased from the 0 to 3 m plot to the 50m plot. White ash increased from 0 to 6-20 m then decreased towards to 50 m plot. Dayton (1999) considers white ash a "forest gap" species.

Open and edge-preferring species (Gleason 1991) tended to have lower % cover values than forest interior preferring species (Figures 5 & 6). With the exception of blackberry (*Rubus allegheniensis*), the dominant species have higher values than anticipated at 20m into the forest at edge A. At edge B these same species tend to decline further into the forest interior as expected. In both edges the 0 to 3m plot is a relative high point for all edge and open habitat species except Blackberry. High % cover of Blackberry was found in the -3 to 0m corridor plot.

In both edges, the dominant shrubs, one an open field species (blackberry) and the other an edge species (arrowood) decrease from the edge into the forest. Choke cherry (an edge species) is present in the forest, primarily as seedlings.

Common name	**Latin name**	**Code**
Red maple	*Acer rubrum*	AR
Sugar maple	*Acer sacchrum*	AS
Sweet Vernal Grass	*Anthoxanthum odoratum*	ANO
Sedge	*Carex crinita*	CAC
Crested fern	*Dryopteris cristata*	DRC
Wood fern	*Dryopteris spinulose*	DRS
Strawberry	*Fragaria viriginiana*	FRGV
White ash	*Fraxinus americanus*	FRA
Kentucky bluegrass	*Poa pretensis*	POAP
Black Cherry	*Prunus serotina*	PRS
Choke cherry	*Prunus virginiana*	PRV
Blackberry	*Rubus allegheniensis*	RA
Lance leafed goldenrod	*Solidago graminifolia*	SOLG
Arrowwood	*Viburnum recognitum*	VIR

Table 1. Summary of species, including codes used in Figures 3– 8.

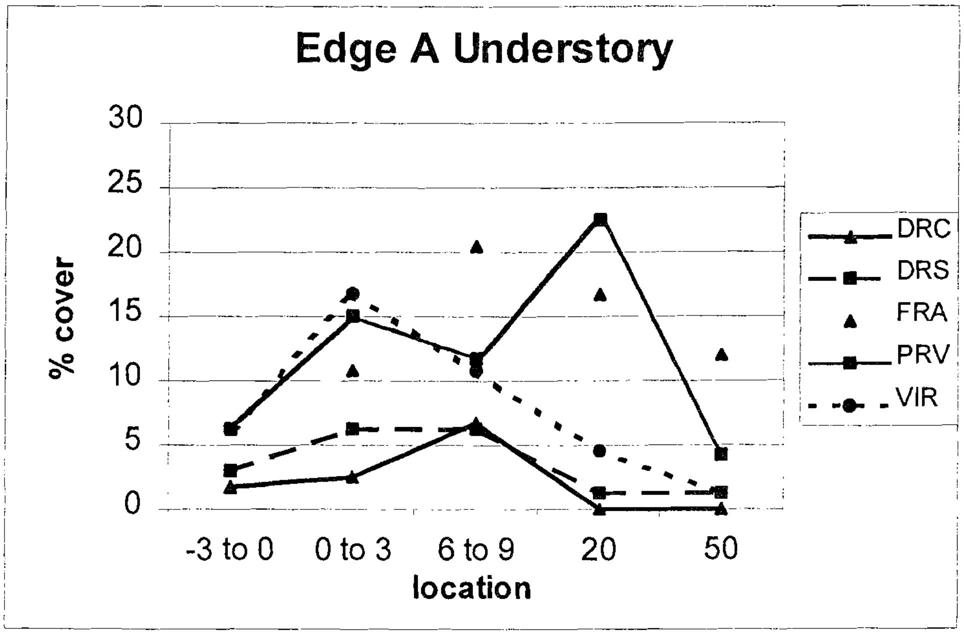

Figure 3. Percent covers of forest interior-preferring species vs. distance (meters) from edge (refer to Table 1 for species code definitions).

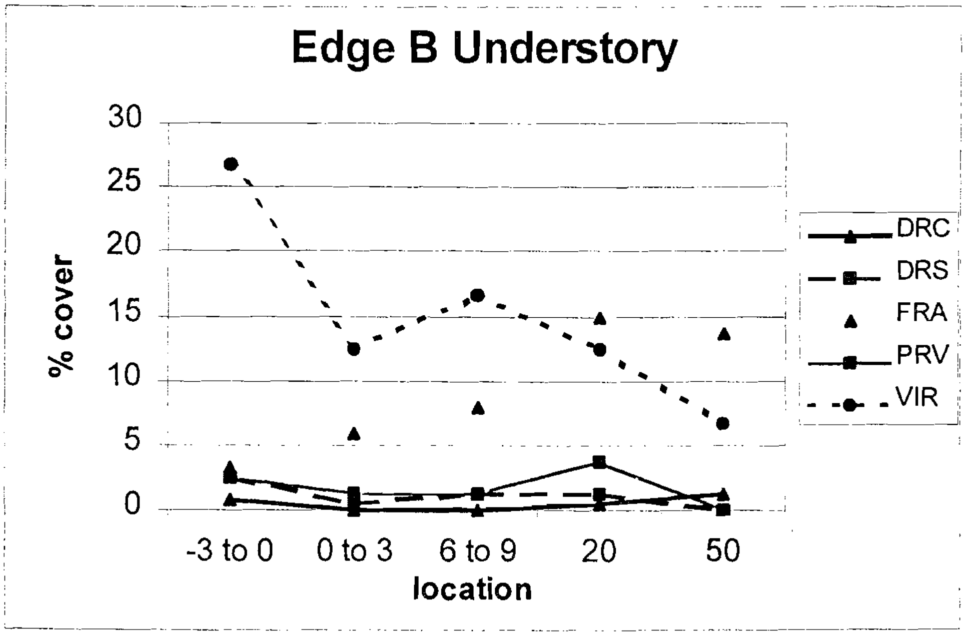

Figure 4. Percent covers of forest interior-preferring species vs. distance (meters) from edge.

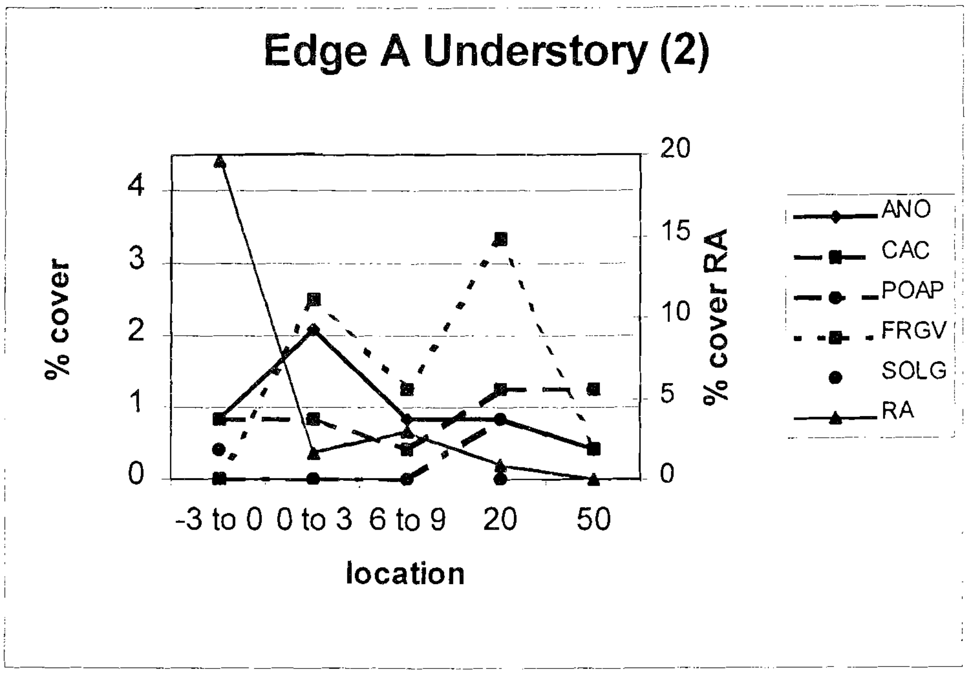

Figure 5. Percent covers of open and edge-preferring species vs. distance (meters) from edge (refer to Table 1 for species code definitions).

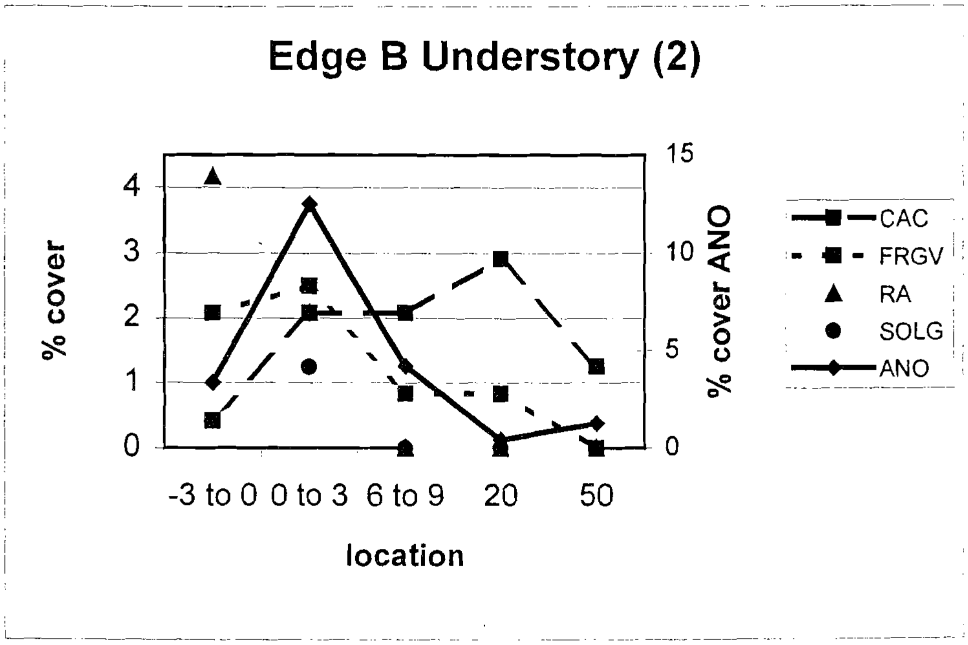

Figure 6. Percent covers of open and edge-preferring species vs. distance (meters) from edge.

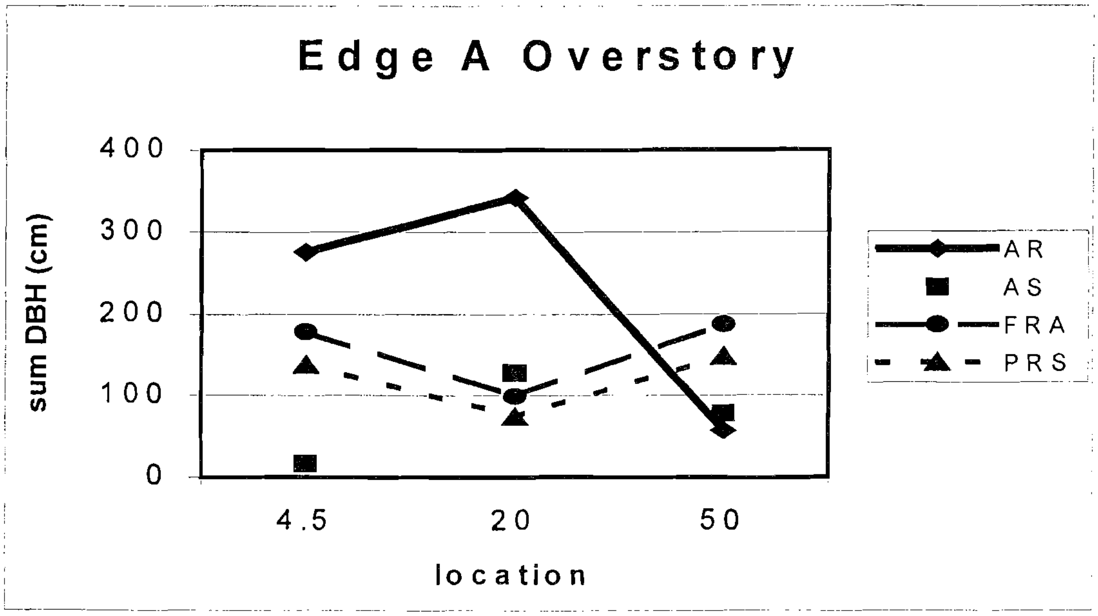

Figure 7. Percent covers of overstory species vs. distance (meters) from edge (refer to Table 1 for species code definitions).

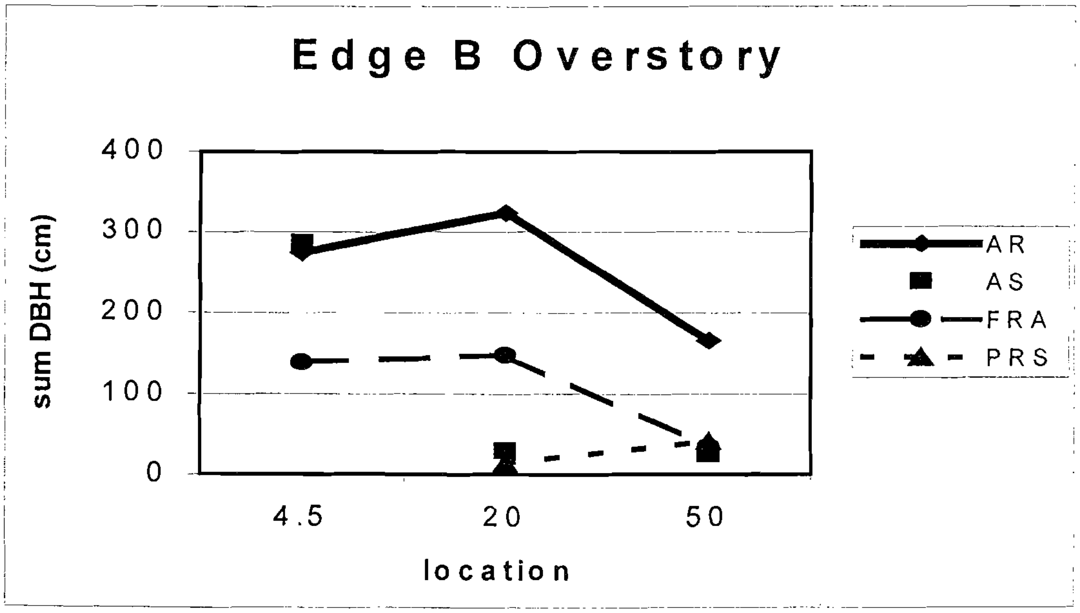

Figure 8. Percent covers of overstory species vs. distance (meters) from edge.

A chi- square analysis of understory species and wetland frequency revealed an association between edge A and species preferring moist soils. The understory of edge A has more moist soil preferring species than edge B ($p < .1$).

Paired sample t-tests reveal that there is a difference in temperature between the edges at all belts ($p < .01$) except at -3 to 0m. Edge A is warmer than edge B at 0 to 3m, while B is warmer at 6 to 9m, 20m, and 50m. An analysis of variance (ANOVA) shows significant trends in temperature gradients at both edges. At edge A temperature decreases from the power corridor into the forest interior ($p < .01$) (Figure 9). At edge B temperature increases from the power corridor until 6 to 9m, then temperature decrease in to the forest interior ($p < .01$) (Figure 10).

A paired sample t-test shows that overall edge A has a higher soil moisture (percent relative saturation) than edge B at all belts ($p < .05$). ANOVA testing reveals that there is no significant gradient in soil moisture along either edge. The data appear to show a negative correlation but there are too few values to test this (Figure 11).

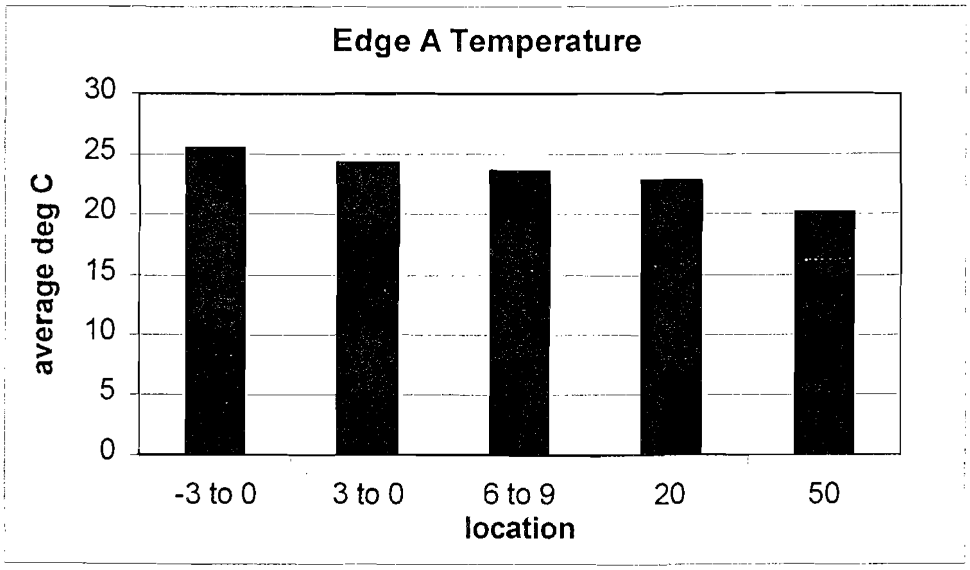

Figure 9. Temperature gradients at edge A vs. distance (meters) from edge.

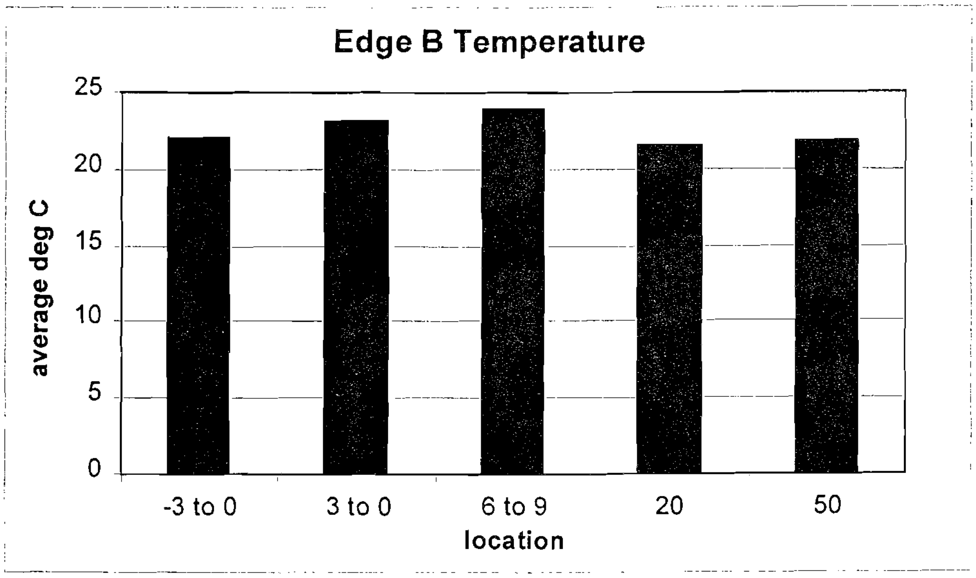

Figure 10. Temperature gradients at edge B vs. distance (meters) from edge.

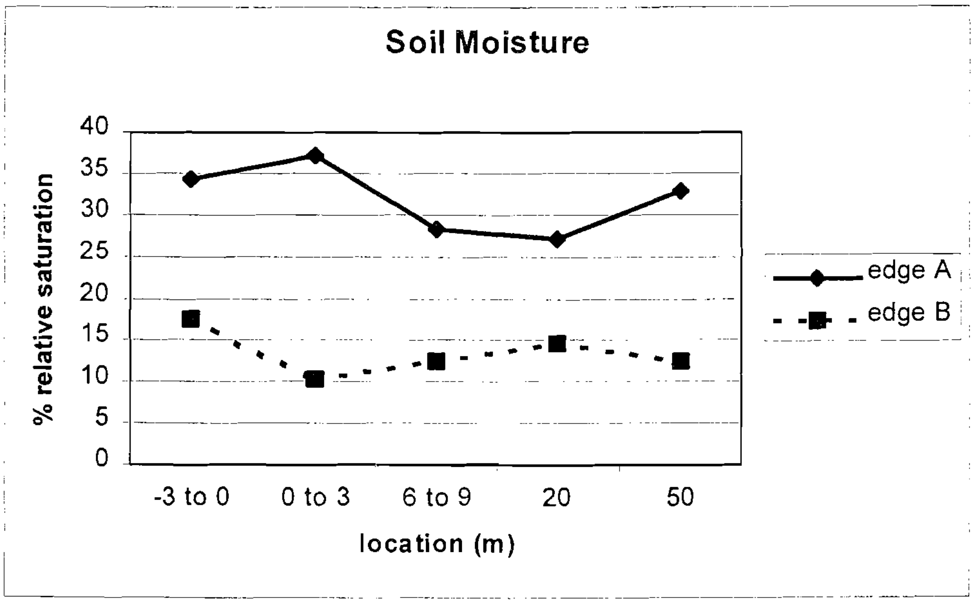

Figure 11. Soil moisture gradients vs. distance (meters) from edge.

SUMMARY

Clearer trends can be seen in the understory vegetation than in the overstory, probably because the edges were created only 11 months prior to the sampling. It is hypothesized that overstory tree composition is not yet influenced by the power corridor gap. It's current state is in response to conditions that were present when cultivation of the fields that previously covered the area ceased. However, the understory species composition is at least partly in response to the creation of the power corridor.

Edge B (the ESE edge) tends to be warmer than edge A at 3 of 5 belts. Overall, edge B has a lower soil moisture than edge A. Edge B also has fewer species with high frequencies of occurrence in wetlands. This supports the hypothesis that the ESE facing edge (B) has a warmer, drier environment that is reflected in its vegetation.

There are some points that complicate this conclusion. The ESE edge is slightly uphill from the WNW edge (A). This may cause the WNW edge to receive more runoff or more water to be transferred from subsurface sources to the surface soils. It was observed that the forest on the ESE edge has more leaf litter and that this leaf litter tended to be moist while soils below it were not. It may be that under some conditions leaf litter absorbs precipitation, which later evaporates, never reaching the soil below.

RECOMMENDATIONS FOR FUTURE WORK

Funding from the New York Power Authority for further study of the Marcy South Power Corridor at the Greenwoods Conservancy is expected to continue. Improvements to the methods of future work on the forest edge can be made.

This study only looked at two sites. More should be studied to get a more robust idea of what is actually taking place. Many other edge researchers have emphasized that more repetition in edge studies is needed (Matlack, 1994; Saunders, 1999). Forest-field edges at Greenwoods should also be examined to make better comparisons with power corridor edges. In order to facilitate this a change in sampling methods is recommended. A larger number of smaller plots would make increased sites logistically possible (Matlack, 1994). He placed 50, $1m^2$ plots at each of his 14 field sites, with 5 plots each at 0, 5, 10, 20, and 40m into the forest.

If funding is available, improved sampling of environmental conditions could be made using digital equipment. A small station, including data logger, temperature sensor, and a light (PAR) sensor, would greatly improve the accuracy of this data. If possible, stations could be placed at multiple plots at a study site. This type of equipment is standard for current forest edge research (Brothers, 1991; Cadenasso, 1997; Matlack, 1994; Saunders, 1999).

Vegetation sampling methods should be modified to better fit them with the aims of the project. A more advanced analysis of vegetation data, such as a multivariate analysis, incorporating temperature, moisture, and light data, would strengthen any conclusions of the project.

Another possibility for future work is to focus only on the edge vegetation and examine changes in species composition over time. A five to ten-year study of several sites may exhibit increasing influence of the edge on the plant community. This data could be compared to field-forest edges, whose ages are known, to study the differences in community development between the two types of edges.

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