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UCSB Talk 8 September 1994

Tree diversity in neotropical forests: large and small inventories

I. Introduction

Since most of you are unfamiliar with our research on forest ecology at STRI, I will take this opportunity to present an overview on my research. In general, it relates to the population dynamics of tree species and tree communities in the tropics, and is based on long-term censuses of large plots of forest. I will focus in this talk on research related to the abundance and distribution of tree species in tropical forests. In particular, since my interest in visiting Frank Davis and David Stoms at UCSB is based on geographical type questions on the distribution of species and communities, I will use this opportunity to describe recent research of mine and my colleagues on tree distributions. Remember at this point that knowledge on factors that control distributions and community composition in the tropics is for the most part rudimentary or non-existent.

I will be posing some rather basic questions which plant ecologists working in temperate forests may consider thoroughly answered for many decades. But even these basic questions take on new dimensions in tropical communities, owing to sheer diversity. For example, in California, we might assume that species distributions are simply determined by abiotic factors -- given a soil and climate type, the same plants will always appear. In the tropics, I would never make such an assumption, because there are 100's of tree species which can occur at any one site.

My research is part of a larger effort at STRI to develop a crash program in tropical forest dynamics (slide: aerial view of BCI). I manage a 50 ha plot of forest at Barro Colorado Island in Panama, installed in 1981 and fully censused in 82, 86, and 90. Thanks to collaborative efforts of scientific and forestry departments in other places, there are now similar programs in Malaysia, India, and Puerto Rico, and projects underway in Thailand, Malaysia, Sri Lanka, Zaire, Cameroon, and Ecuador (slides: world map, elephants in India). I will present data on the BCI plot today, but will mention other plots in passing to make a comparison. In several years, comparable data will be available from a dozen tropical forests on different continents and under different climates. There is a strong economic and forestry basis to this grand project, and among the primary goals of the research are demographic models that predict timber harvest cycles, and economic studies of the value of forest products. Today, I will focus on our ecological studies, and this is my background and remains my main interest (although I have delved quite a bit into the economics and sociology of forest management in recent years).

II BCI and plot (slides: map of Panama, trees and animals of BCI forest)

III. Limits of species distributions

Many species have restricted distribution in the BCI plot or are very rare (examples PRIC, ANAP, SHORM2, DIPTC1); it seems unlikely they are partitioning resources in any straightforward sense (eg ANAP is not growing on a particular soil that only occurs in the one hectare where it occurs). d

But there are specialists, and I would like to say how many (I was quoted as saying 10% in an article in Science News in June -- this was a science writer's simplification of my statement). Kyle Harms and I recently published a study of tree distributions in the plot relative to habitats (slide: habitats), but there are many weaknesses and we would like advice on improving the analysis (slides: species maps OCOTWH, BEILPE). A few species are gap specialists, but not many (map of gaps; slide: ZANB map)

Perhaps some species distributions are regulated by pathogens, as described by Janzen-Connell, on which we have published many studies. Current data do not support the view that many species abundacnes are regulated by pathogens, but it's difficult to eliminate density-dependent forces.

Many populations have changed rather abruptly over just eight years, and climate change seems to be responsible. But the drift hypothesis of Hubbell predicts changing abundances too.

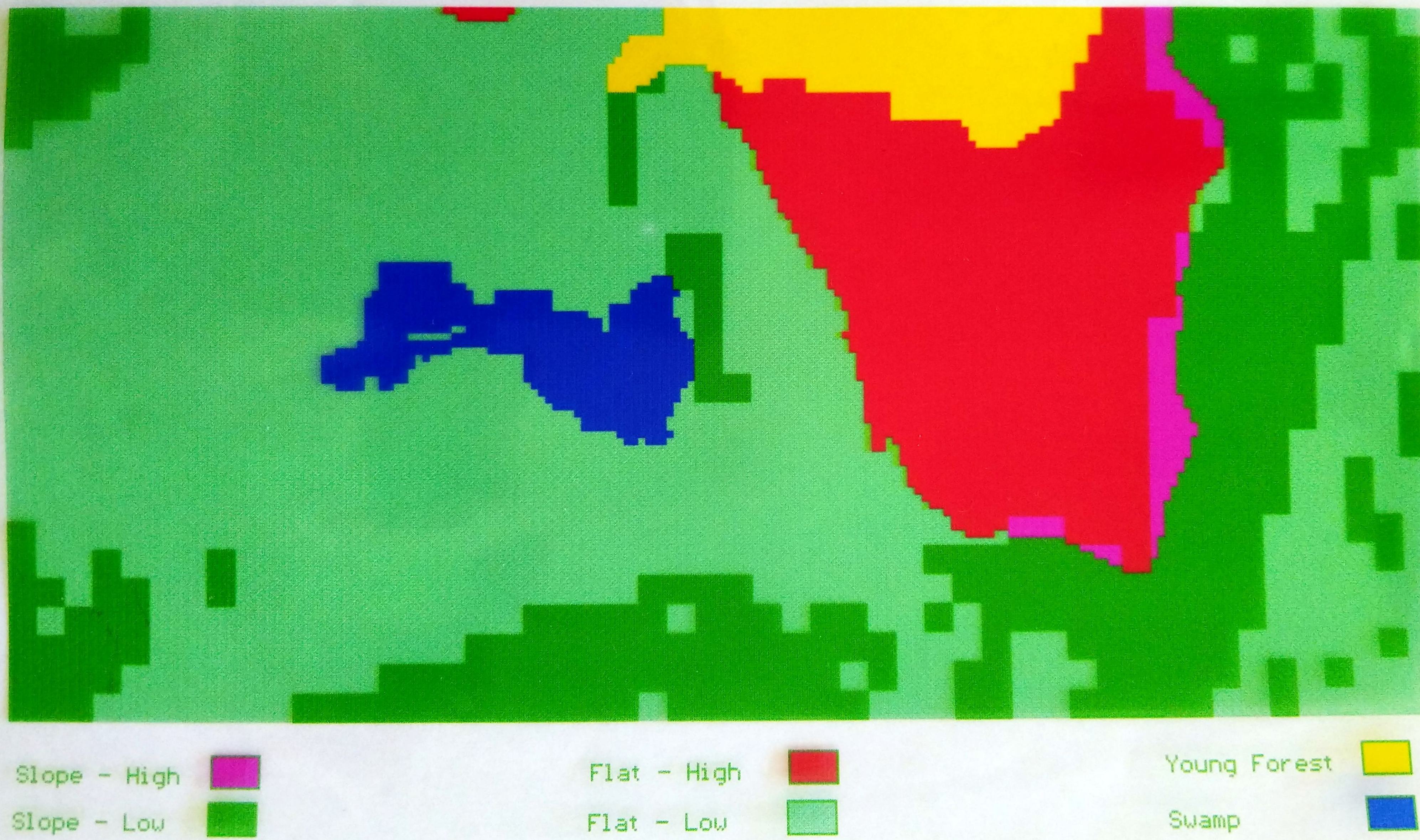
IV. How forests change with distance

Similarity indices decline exponentially with distance, consistent with dispersal limitation and the Hubbell drift hypothesis, but not consistent with species limited by abiotic features (graph of similarity vs. distance). But topographic habitats are revealed by the similarity analysis. A PCA type analysis would be useful here, and would like advice on which technique is the best. Species richness follows topographic habitats as well.

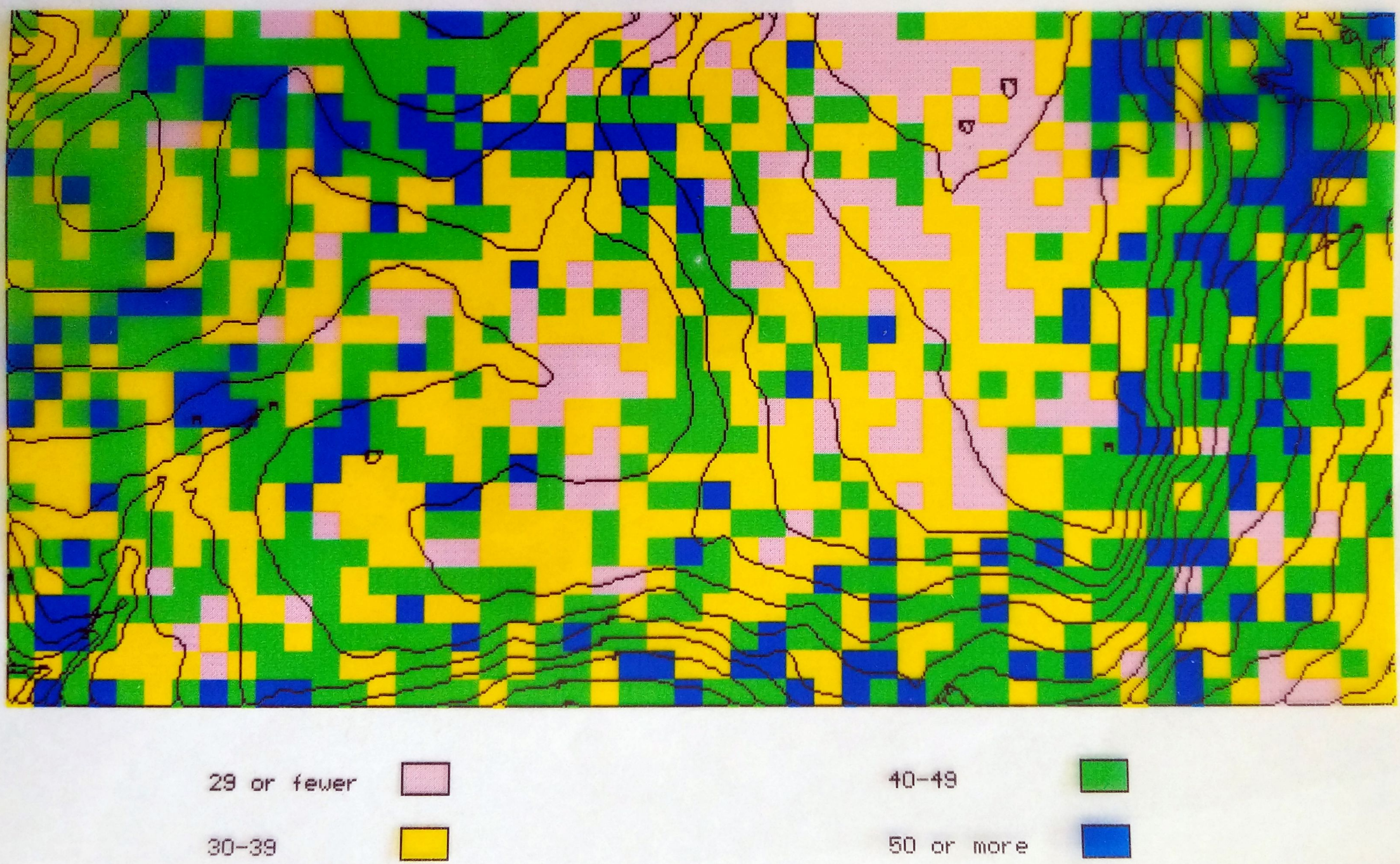
At larger scales, forests 10-50 km from BCI change abruptly with local climate, soil, and forest fragmentation (slide: map of isthmus). I am gathering more data from forests in the region of the Panama Canal to better understand forest turnover, and I hope to collaborate with remote-sensing experts.

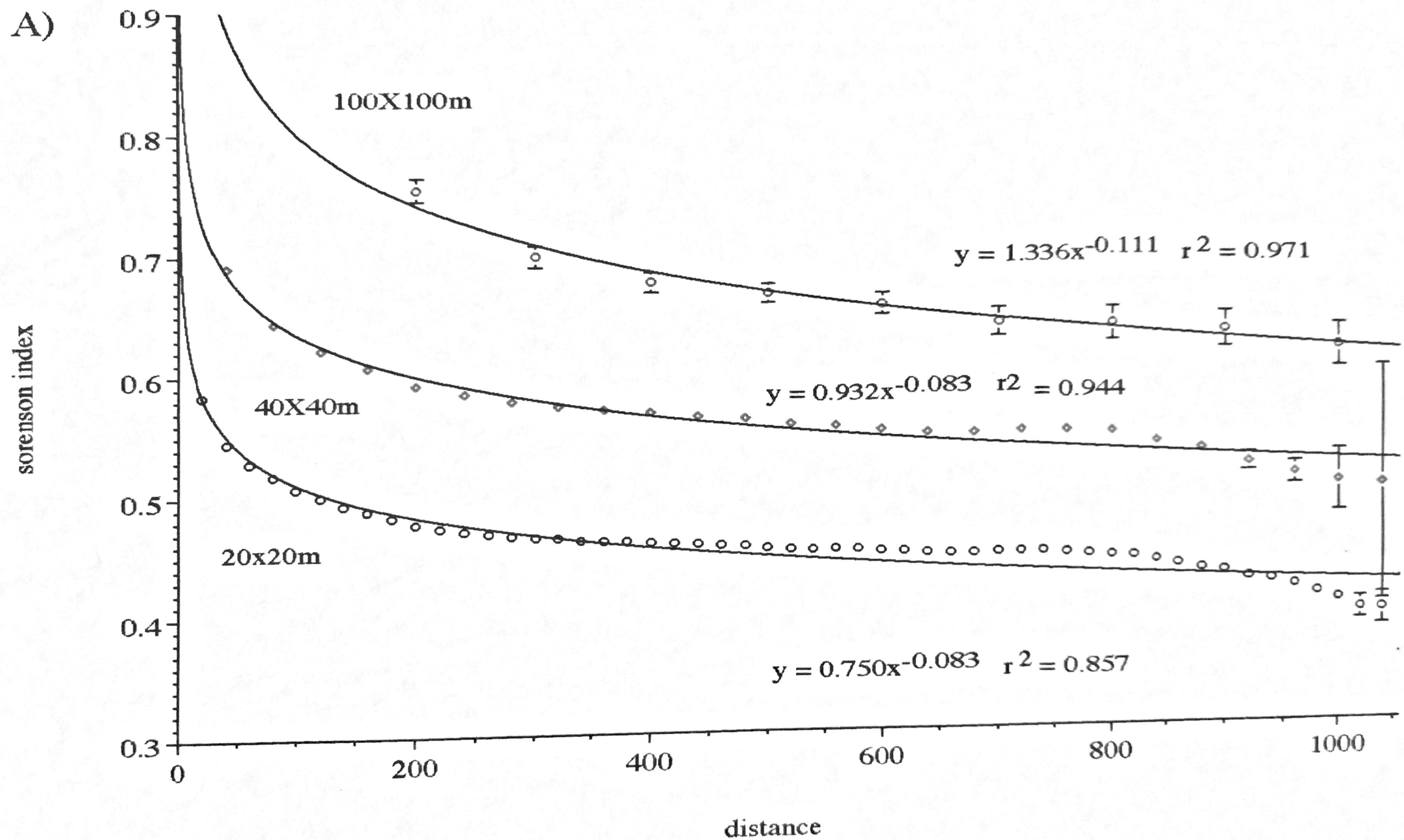
V. Conclusions

I'm taking one approach to understanding the workings of tropical tree communities -- large observational inventories. This is not the end of research on tropical trees -- we need studies of physiology of herbivores and pathogens, and of course we need experimental manipulation to pin down mechanisms responsible for dynamics that I have described. But the large plot studies are crucial at this stage in the tropics, because there are so many species about which nothing is known. I propose to describe patterns of distribution and population dynamics which include most of the species in the forest -- in a diverse community, this demands very large inventories. With this information, many hypotheses about mechanisms can be eliminated. We can thus focus our detailed attention on likely factors and important species. But there is no way to accumulate basic understanding of distributions without broad-scale inventories as well, combined with aerial surveys describing broad patterns of distribution.


Slope - High
Slope - Low
Flat - High
Flat - Low
Young Forest
Swamp

Number of Species - Saplings




A)
100X100m
40X40m
20x20m
y = 1.336x^-0.111 r^2 = 0.971
y = 0.932x^-0.083 r2 = 0.944
y = 0.750x^-0.083 r^2 = 0.857
sorenson index
distance
0.9
0.8
0.7
0.6
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0.4
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200
400
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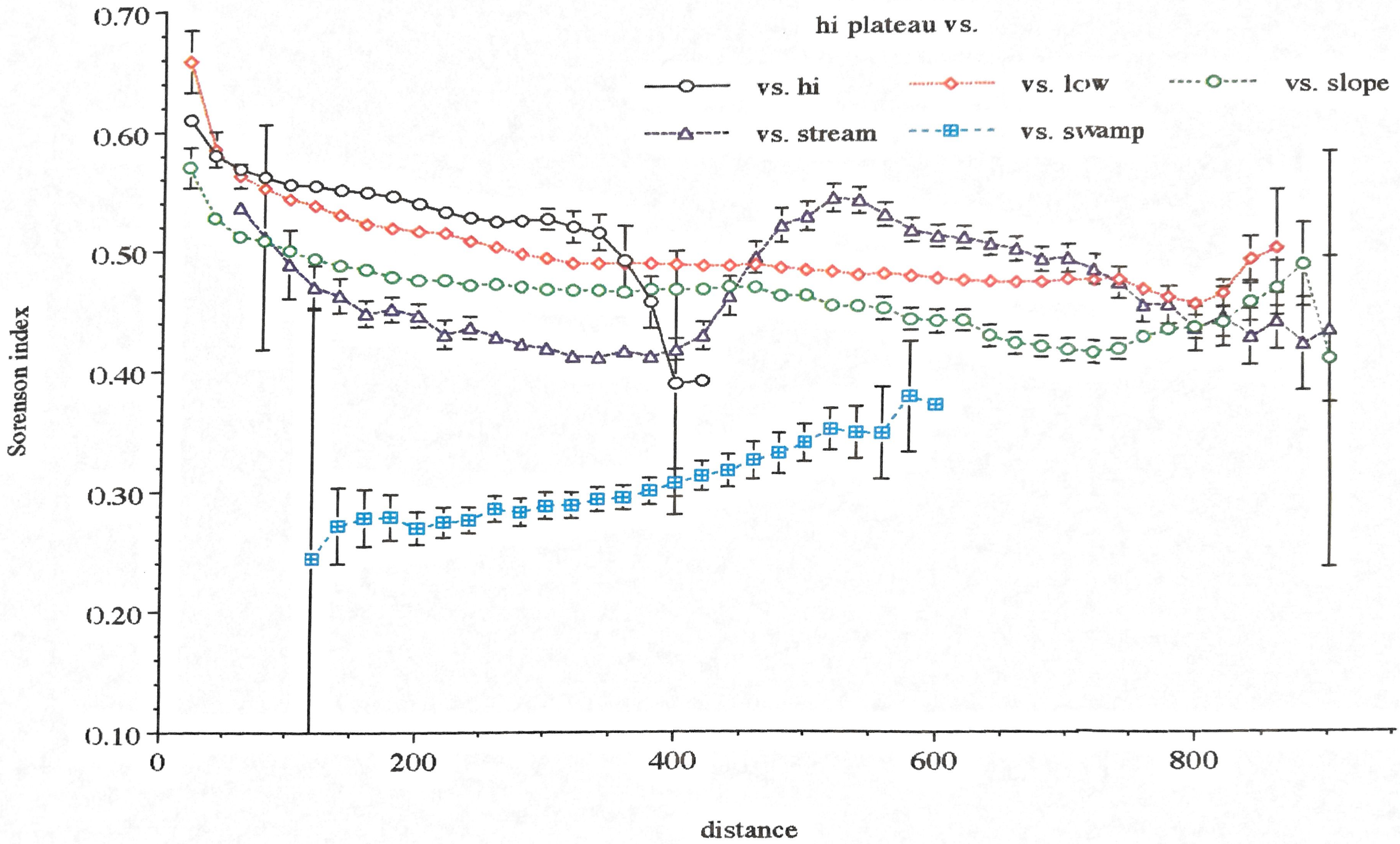
1000



hi plateau vs.
vs. hi
vs. low
vs. slope
vs. stream
vs. swamp
Sorenson index
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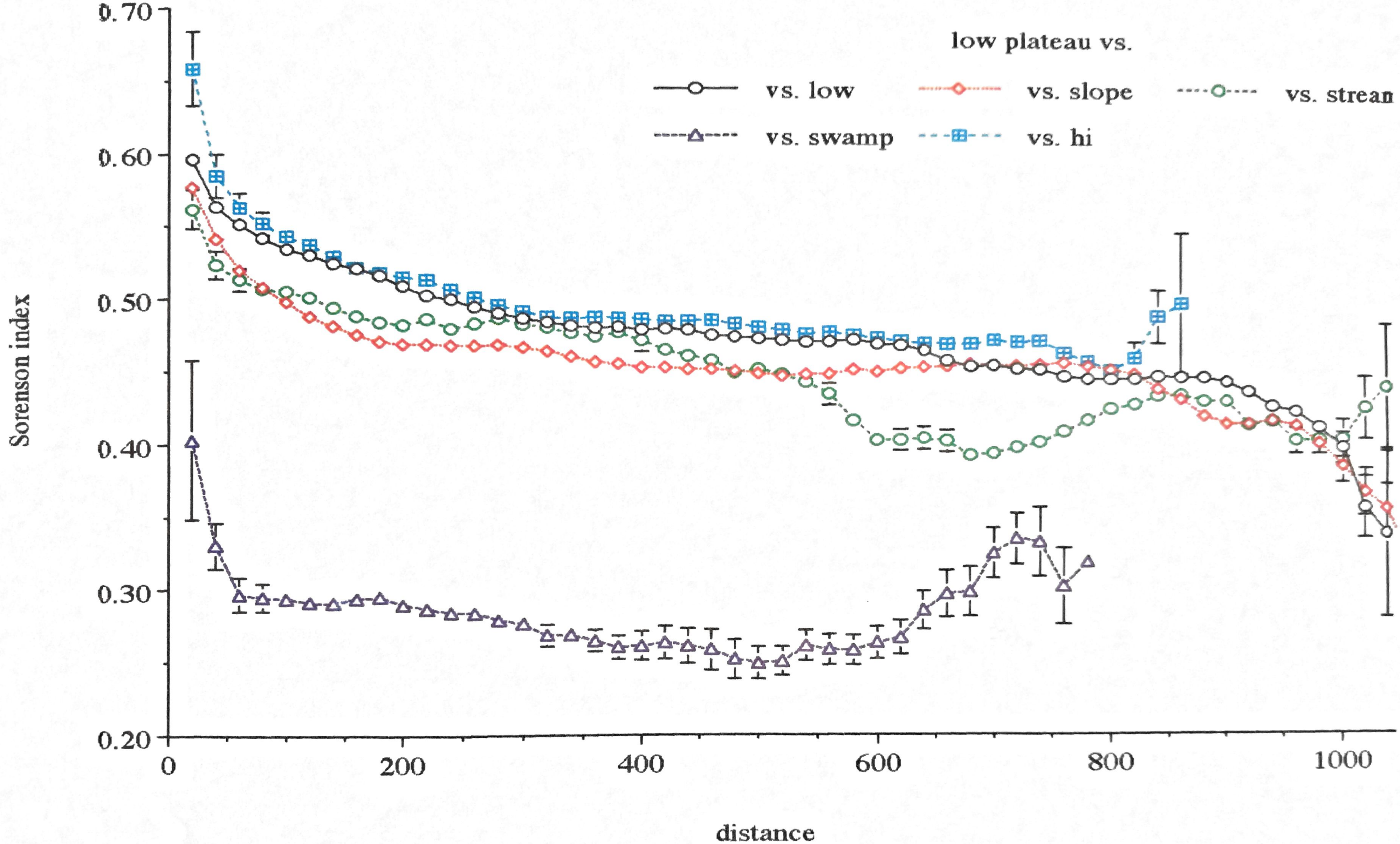
0.50
0.40
0.30
0.20
0.10
0
200
400
600
800
distance



low plateau vs.
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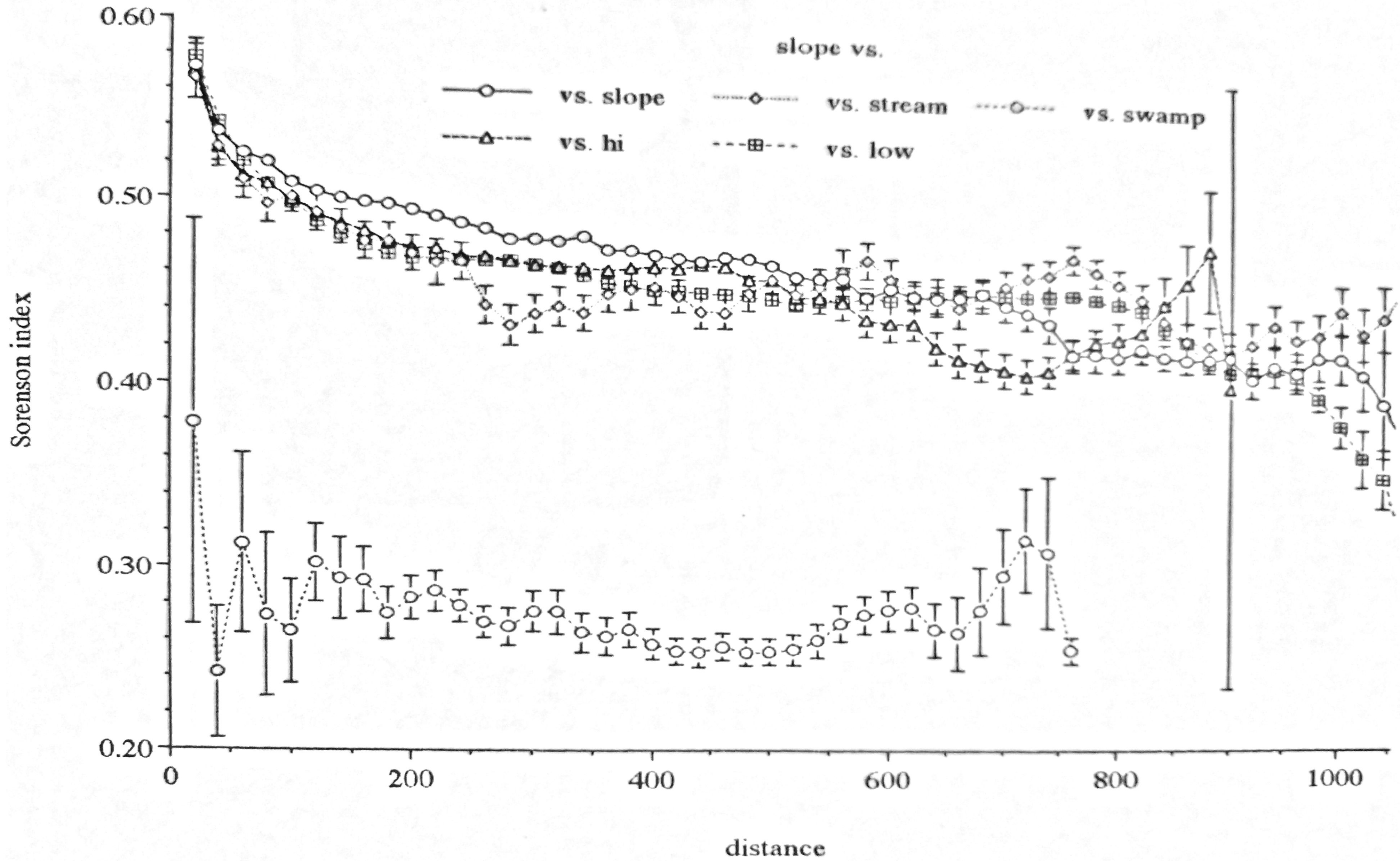
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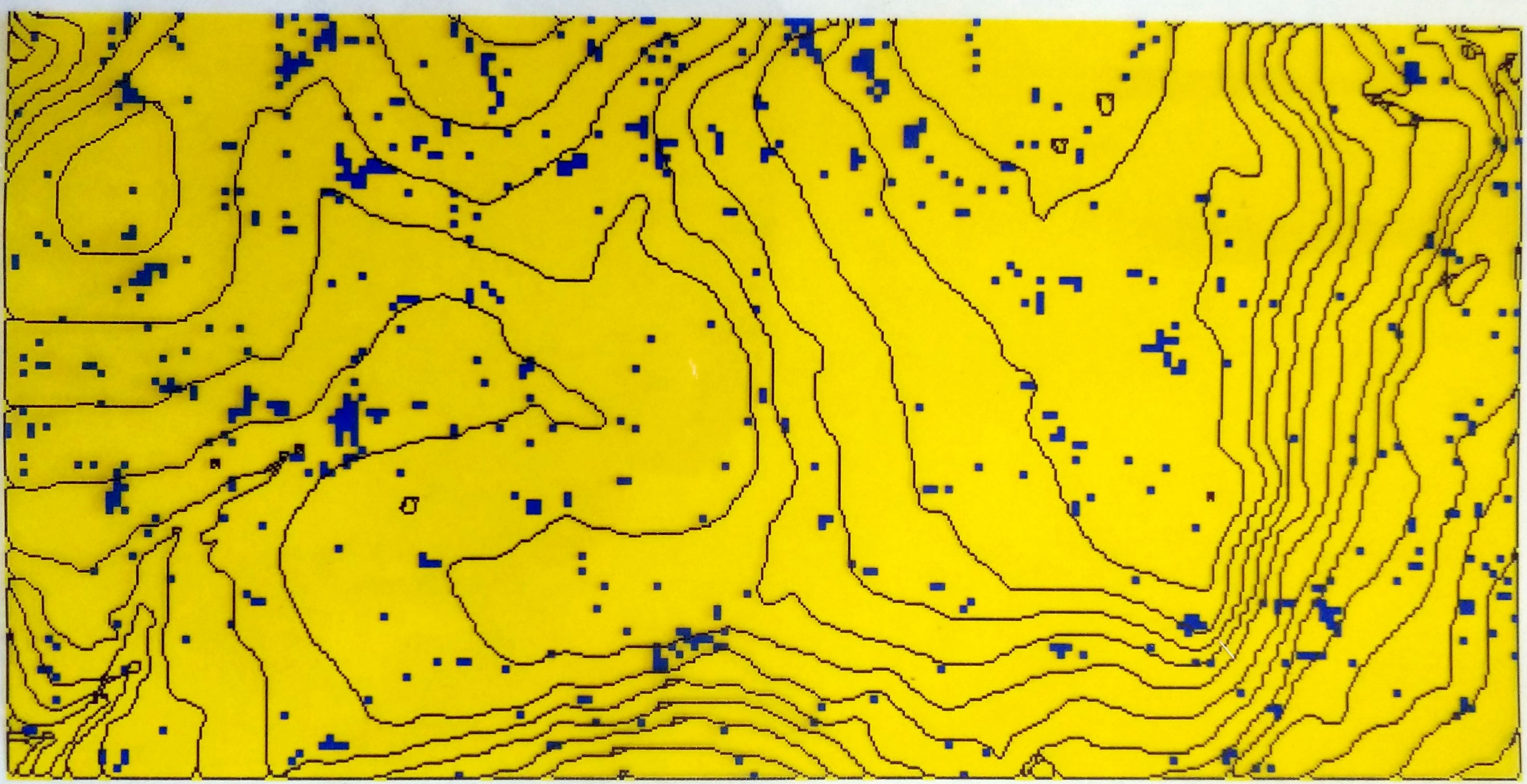
Canopy Gaps - 1984



Canopy Gaps - 1990