Nested Quadrats for Spatially Explicit Measurements of Pasture Plant Communities

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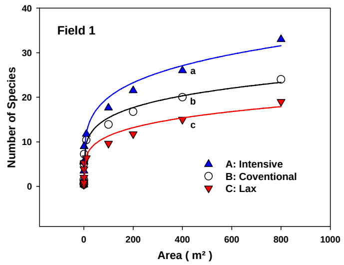

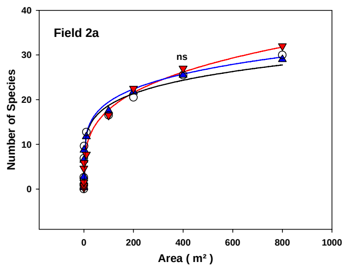

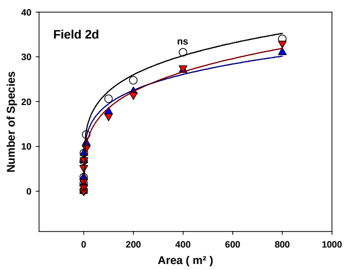

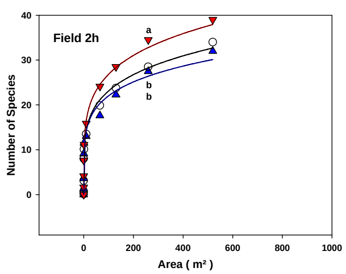

Highest

Field Productivity

Lowest

INTRODUCTION

Pastures are modified grassland ecosystems were biodiversity is essential and potentially beneficial.

Biodiversity increases the resilience and stability of agricultural production in the face of pests, diseases, variable weather and climate, and economic fluctuations.

Biodiversity is enhanced by complexity in habitats at scales ranging from landscapes, within fields, among plants, down to the soil fabric.

At NSAC we used grazing intensity by dairy cattle to create three different types of pasture sward habitat and studied the impact on biodiversity.

This poster focuses on our experience with nested quadrats to measure the impact on botanical diversity.

Nests of quadrats are a spatially explicit method of observation accounting for the need to observe ubiquitous species at < 0.1 m² and occasional species at larger scales. Ecological processes also function at different scales.

METHODS

Starting in 2004, rotational grazing was used on a naturalized pasture to create four levels of management intensity replicated in eight paddocks:

A) **Intensive management:** grazed every rotation, then mowed and chain harrowed.

B) **Conventional management:** grazed every rotation, mowed only once in June.

C) **Lax management:** grazed every second rotation.

In 2006, a botanical survey was conducted using nested quadrats.

- Quadrat sizes were 1, 10, 100, 1000 cm², 1, 10, 100 m²
- Nests were arranged in a row of eight, and were summed to get areas of 200, 400, and 800 m².

Starting with the smallest quadrat and moving sequentially to larger quadrats, the number of species present were counted.

SPECIES ACCUMULATION CURVES (LEFT PANNEL)

Three common models were fitted to the species/area data.

1. Arrhenius (1921): $S = aA^b$ $R^2 > 0.97$
2. Gleason (1922): $S = a + b \log10(A)$ R^2 0.80-0.90
3. Monod (1950): $S = a *(A /(b + A))$ R^2 0.70-0.90

The Arrhenius model best described the accumulation of species with increasing area searched (LEFT PANNEL).

1. Intensive management increased diversity in the productive field.
2. Extensive management reduced diversity in the productive field and increased it in the lower yield field.
3. Overall, botanical diversity increased as productivity decreased.

Conclusion: in the productive field, plant competition limited botanical diversity. In the low yielding field, grazing disturbance reduced botanical diversity.

SPECIES ACCUMULATION RATES (RIGHT PANNEL)

Analyzing the rate of species accumulation as one steps from one quadrat size to the next size up can detect patterns of species dynamics occurring at different scales (RIGHT PANNEL).

1 to 100 cm²: At this scale, physical space limits species numbers. Higher rates at this scale may reflect less plant competition for light and rooting space.

100 to 1000 cm²: At this scale the sward is occupied by ubiquitous plants that form the basic sward "matrix". Low rates occur in pastures dominated by a few plants such as *Poa* spp., *Taraxacum officinale*, and *Trifolium repens*. Higher rates indicate that other common pasture plants are being included.

1 to 10 m²: The rate slowed down.

10 to 100 m²: The rate accelerated with the accumulation of common pasture forbs. This may reflect opportunities for establishment caused by cattle disturbance (grazing, manure, urine, hooves), localized death of a matrix specie, and the rate of propagule introduction (soil seed bank and seed rain). Higher rate could also have resulted from heterogeneous patches of plants at the 1-10 m² scale.

100 to 200 m²: The rate slowed down.

200 to 800 m²: At this scale we accumulated infrequent pasture species. However, the rates were more idiosyncratic. As surveys extended over a greater area, they can encounter patchy colonization, and changes in soil and topography.

DISCUSSION

Nested quadrats have been used for decades to measure the relationship between botanical diversity and area. In our study, we used replicated nests and measured an interaction between pasture productivity and grazing intensity on botanical diversity.

In pastures, processes that affect botanical diversity operate at different spatial scales. Nested quadrats were able to detect two major peaks in species accumulation rates.

Replicated nests can also measure the frequency of individual species and the change in their frequency with management and environment (not shown). We can also rank species according to abundance and analyze their co-occurrence.

Nests account for the fact that ubiquitous species, such as *Poa* spp., need to be measured at scales < 100 cm². But we would rarely observe common plants with 100 cm² quadrats: those plants can need to be observed with 1 – 100 m² quadrats.

Disadvantages of nested quadrats include:

1. Like other quadrat techniques, nests are affected by non-random, patchy distributions of plants.
2. Observation on individual species may need more than eight nests for sufficient sensitivity. A partial solution may be to increase the number of observations in nests < 1 m² size.

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