Landscape Heterogeneity and Plant Species Richness in the Southeastern US

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Overview

- Several studies suggest that habitat heterogeneity plays an important role in determining patterns of species richness at regional to continental extents (Kerr and Packer 2001, Rahbek and Graves 2001).
- We examined the heterogeneity-plant species richness relationship for vegetation plots across three geographic extents in Virginia, North and South Carolina using the variation of MODIS NDVI values.
- We found an overall decrease in total, native, and exotic plant species richness with increasing heterogeneity at all three extents.
- This relationship becomes more negative as the grain size at which heterogeneity is measured increases.

Questions

How does heterogeneity of NDVI affect plant species richness in the Southeast US?

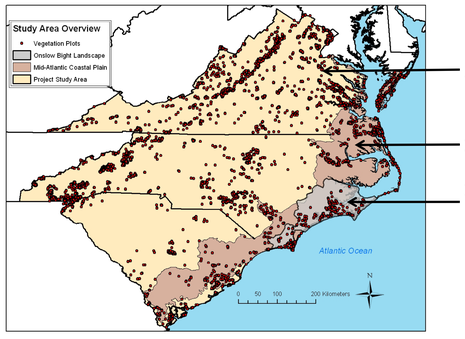
In particular, how does the richness-heterogeneity relationship vary with:

- Native, exotic, and total plant species richness?
- Geographic extent of sampling?
- Grain size at which heterogeneity is measured?

Methods

Study Area: Geographic Extent

We analyzed the richness-heterogeneity relationship at three spatial extents



1. Across NC, SC, and VA
2. In the Coastal Plain
3. In the Onslow Bight Conservation Landscape

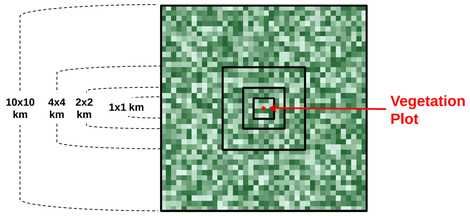
Plant Species Richness Data

We used data from 7000 vegetation plots in the Carolina Vegetation Survey (CVS) and Virginia Natural Heritage (VNH) databases. CVS and VNH plots are detailed, georeferenced records of species richness collected over the past 20 years.

Heterogeneity Grain Size

We measured heterogeneity as the standard deviation of MODIS NDVI values from a day in the growing season, 2006. This analysis was conducted at four window sizes surrounding each plot location.

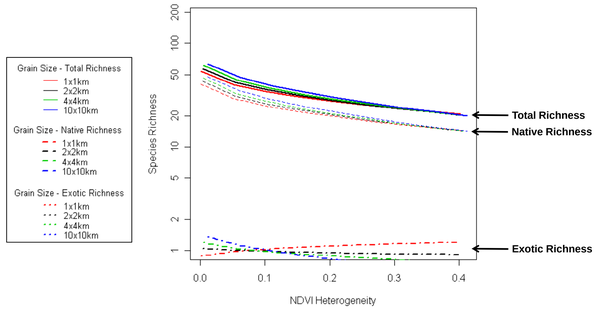
We modeled the relationship between heterogeneity and plant species richness using a Poisson regression with log-transformed richness.



Results

Across the Three-State Area

For Total, Native, and Exotic Richness:
Heterogeneity has an increasingly negative effect as grain size increases



Model Summaries

Total Richness

Grain Size	n	Deviance	AIC	p
1x1km	6927	104109	140840	< 0.001
2x2km	7065	103978	141351	< 0.001
4x4km	7087	102598	140087	< 0.001
10x10km	7097	101056	138591	< 0.001

Native Richness

Grain Size	n	Deviance	AIC	p
1x1km	6927	72694	107420	< 0.001
2x2km	7065	72418	107740	< 0.001
4x4km	7087	71381	106812	< 0.001
10x10km	7097	70291	105764	< 0.001

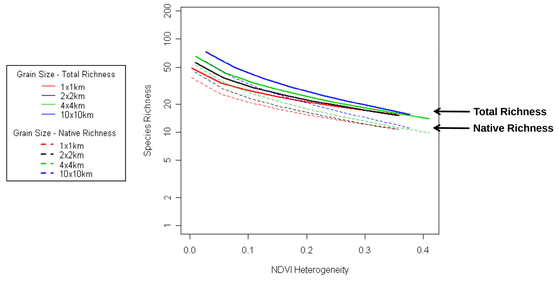
Exotic Richness

Grain Size	n	Deviance	AIC	p
1x1km	6927	19710	26003	< 0.001
2x2km	7065	20547	27002	0.05
4x4km	7087	20601	27096	< 0.001
10x10km	7097	20485	26984	< 0.001

Across the three-state area, the slope of the heterogeneity-richness relationship becomes more negative with increasing grain size, for total, native, and exotic species richness. The slope of each line is significantly different from every other slope.

In the Middle Atlantic Coastal Plain

For Total and Native Richness:
Heterogeneity has an increasingly negative effect as grain size increases



Model Summaries

Total Richness

Grain Size	n	Deviance	AIC	p
1x1km	1598	25172	33117	< 0.001
2x2km	1667	24553	32798	< 0.001
4x4km	1675	23869	32153	< 0.001
10x10km	1685	22316	30645	< 0.001

Native Richness

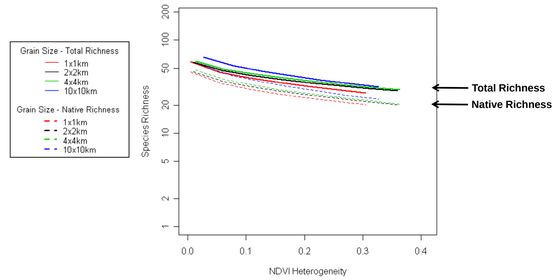
Grain Size	n	Deviance	AIC	p
1x1km	1598	18373	25885	< 0.001
2x2km	1667	17743	25529	< 0.001
4x4km	1675	17143	24966	< 0.001
10x10km	1685	15903	23768	< 0.001

Exotic Richness

For exotic richness in the Middle Atlantic Coastal Plain, the parameters of the model were not significant at most heterogeneity grain sizes, and are thus not presented here.

In the Onslow Bight Landscape

Heterogeneity of growing season NDVI and elevation are related to species richness at most grain sizes.



Model Summaries

Total Richness

Grain Size	n	Deviance	AIC	p
1x1km	283	5038.4	6569	< 0.001
2x2km	286	5081.1	6628	< 0.001
4x4km	286	5078.5	6625	< 0.001
10x10km	286	4761.9	6308	< 0.001

Native Richness

Grain Size	n	Deviance	AIC	p
1x1km	283	3888.3	5346	< 0.001
2x2km	286	3881.7	5354	< 0.001
4x4km	286	3856.0	5328	< 0.001
10x10km	286	3589.6	5061	< 0.001

Exotic Richness

For exotic richness in the Onslow Bight, the parameters of the model were not significant at most heterogeneity grain sizes, and are thus not presented here.

For grain sizes across most groups of species and geographic extents, heterogeneity has a negative effect on plant species richness.

Heterogeneity at large window sizes may capture between-habitat variation, thus leading to more of a decrease in richness.

Conclusions & Further Work

Linear regressions indicate that heterogeneity has a negative effect on total, native, and exotic species richness.

The relationship becomes more negative at larger grain sizes of heterogeneity. This pattern is similar for all spatial extents we examined.

Further work is planned to refine the measure of heterogeneity:

1. Calculate heterogeneity at grain sizes smaller than 1x1km, using measures derived from Landsat TM data.
2. Calculate heterogeneity across habitat patches where vegetation plots occur, rather than across square windows.
3. Use landcover, soils, and elevation data to derive multivariate measures of heterogeneity.

References

Kerr, J.T., and Packer, L. 1997. Nature 385:252-254.
Rahbek, C., and Graves, G.R. 2001. PNAS 98:4534-4539.

Acknowledgments

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