

US EPA ARCHIVE DOCUMENT

A satellite image of a hurricane, likely Hurricane Frances, as it approaches the Mid-Atlantic region of the United States. The hurricane's eye is clearly visible, surrounded by dense, swirling cloud bands. The coastline of the United States is visible on the left, with the Atlantic Ocean to the right. The text is overlaid in orange at the top and bottom of the image.

Integrating Field-based Sampling and Landscape Data for Regional Scale Assessments: Examples from the United States Mid-Atlantic Region

K. Bruce Jones, James D. Wickham, and Anne C. Neale
EMAP Science Symposium, 3-7 May, 2004

Presentation Highlights

- Present results of landscape modeling efforts where ecological field data are integrated with measures of landscape conditions at multiple scales.
 - Nitrogen export to streams
 - Breeding birds
 - Integrated bird/nutrient export assessment
- Describe different statistical approaches used to integrate data
- Examples primarily from the mid-Atlantic

Primary Objectives Related to EMAP

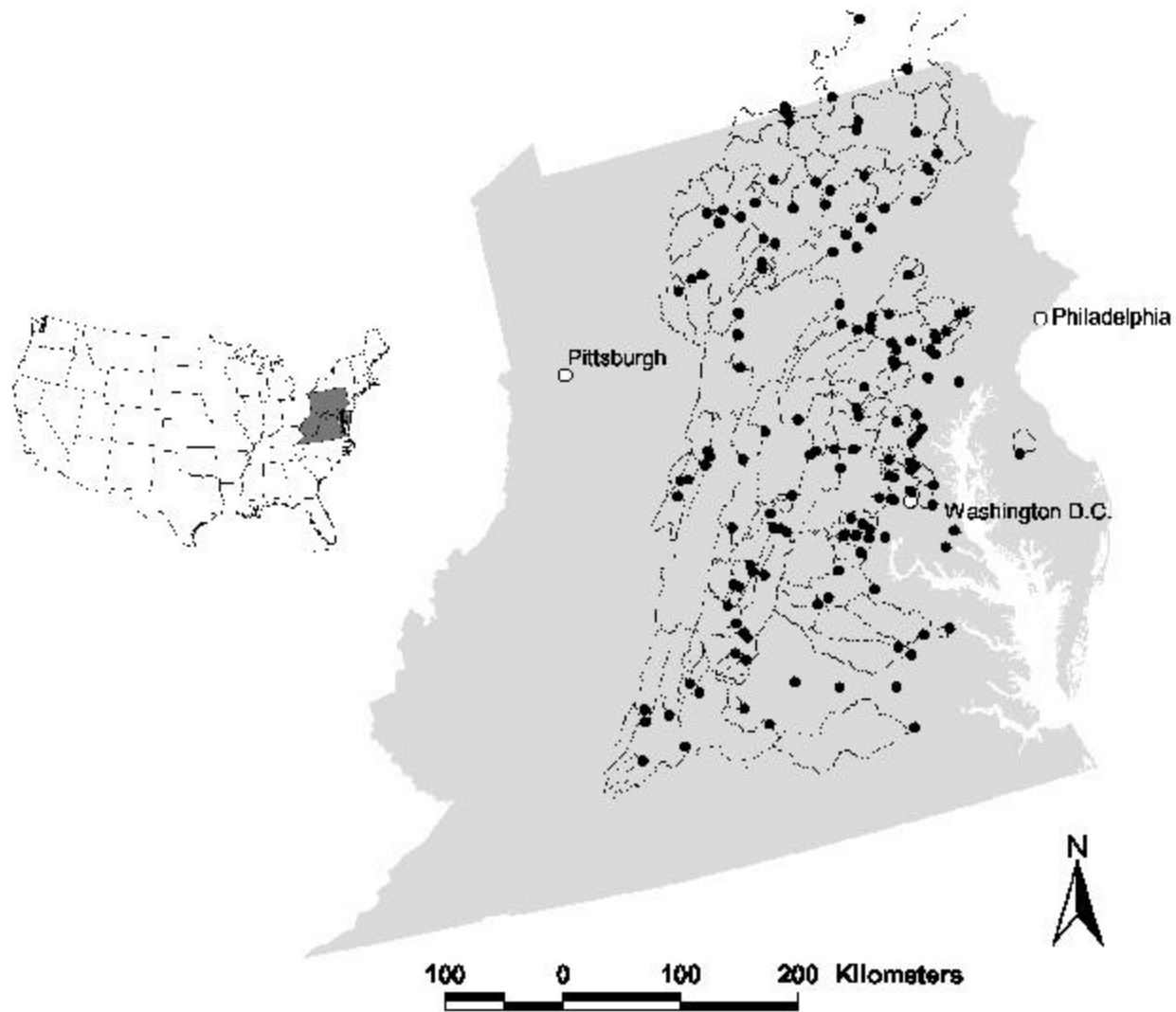
- Evaluate potential causes/factors influencing the condition of ecological resources at a range of scales
- Extend EMAP probability estimates to spatial continuous surfaces and areas not sampled

Models

- Empirical
 - Multiple regression
 - Logistics regression
 - Classification and Regression Tree (CART)
- Bayesian
- Combination ... rule-based/empirical
(integrated assessment of breeding bird habitat suitability and nutrient export)

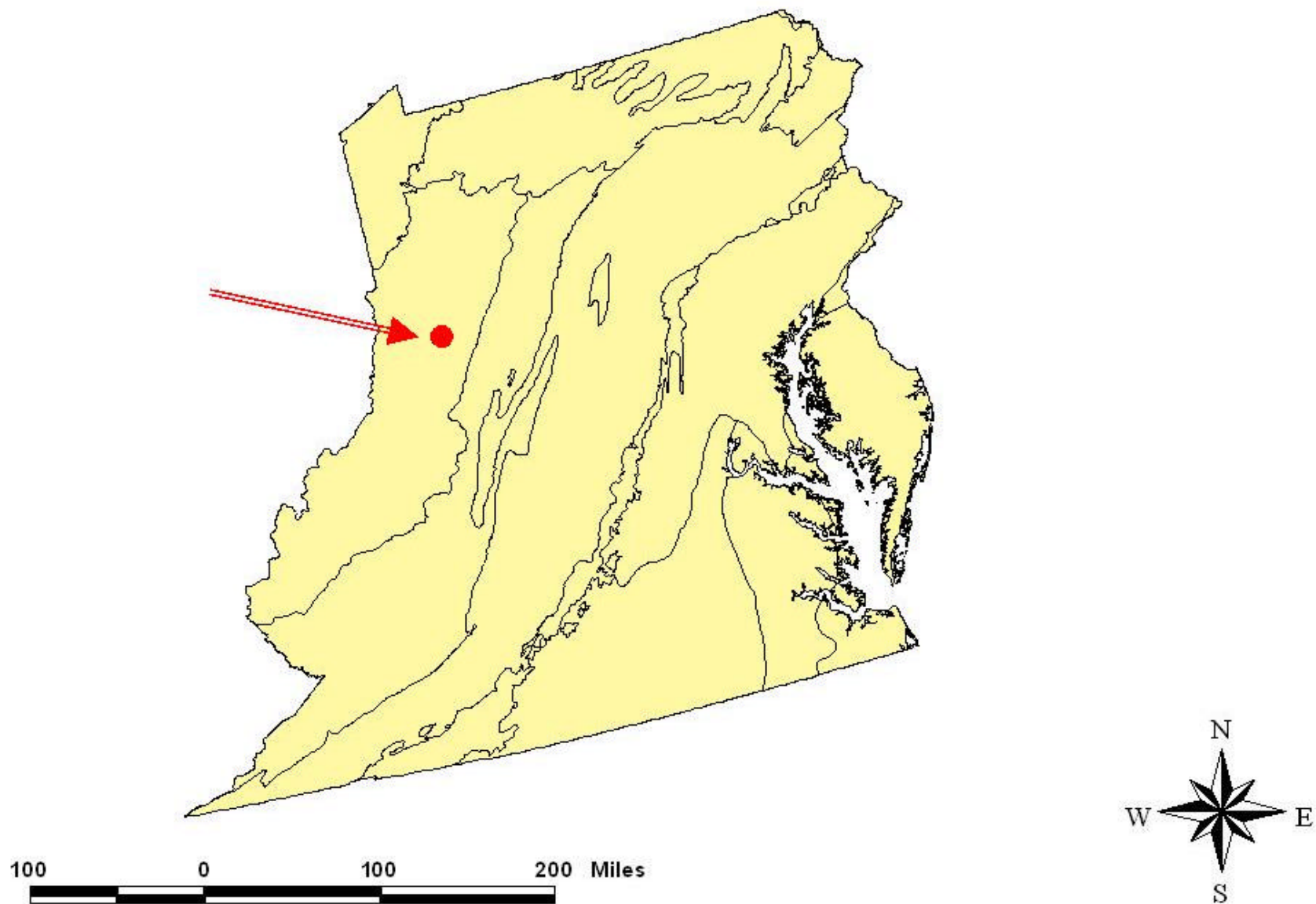
General Approach

- Select specific endpoint of interest
 - Two examples in our studies
 - Nutrients/Sediment in streams as they affect water quality
 - Breeding bird habitats
- Collect/acquire field samples
- Filter data based on selection criteria
- Assemble spatial data at various scales on various units (functional and arbitrary)
- Generate metrics and or measures ... pair metrics with individual samples sites in a SAS database
- Conduct statistical analyses

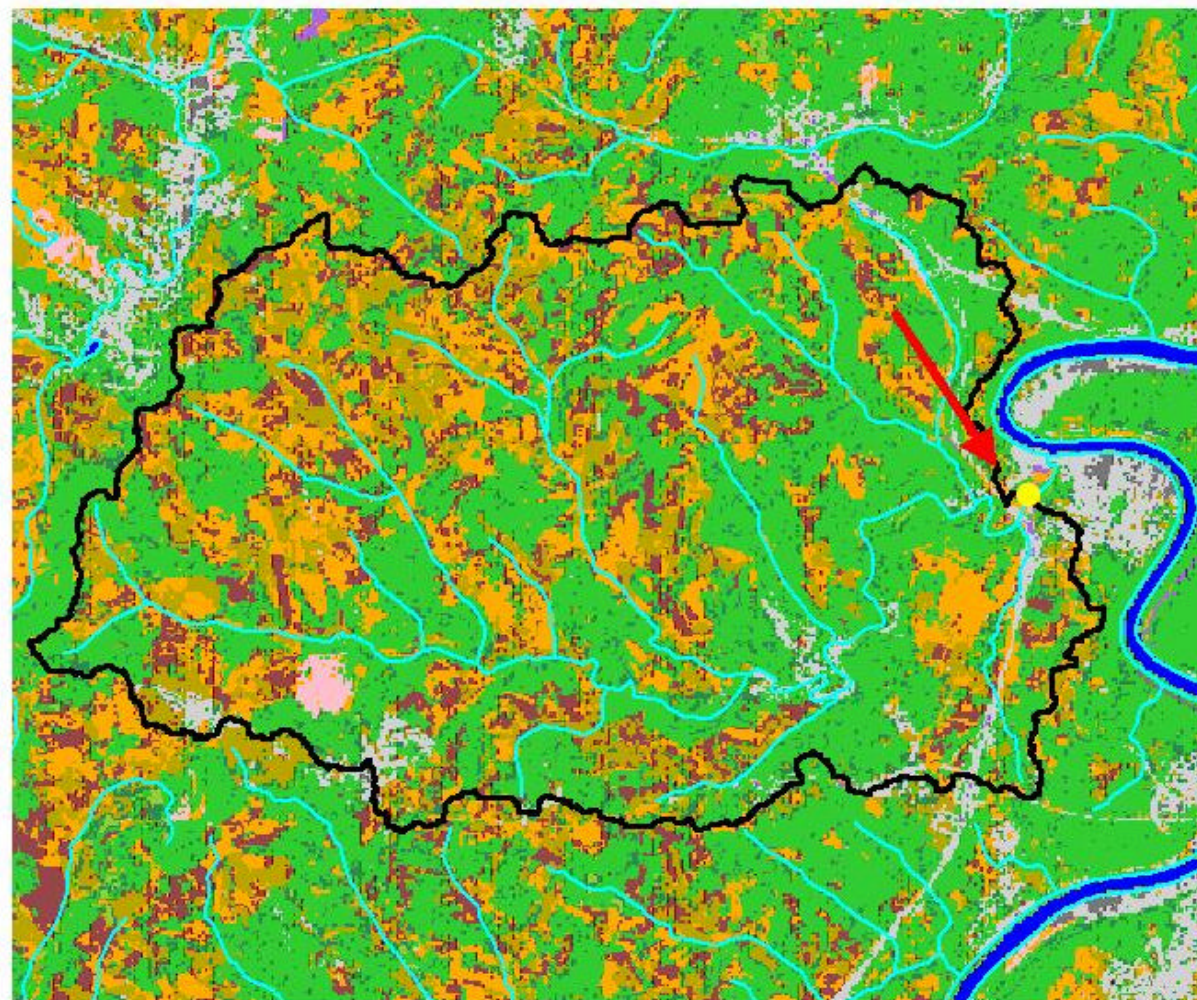


USGS Loading Sample Sites and Associated Watersheds

Location of Example Watershed



Example Watershed



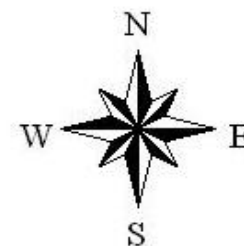
● EMAP 93 Sampling Point

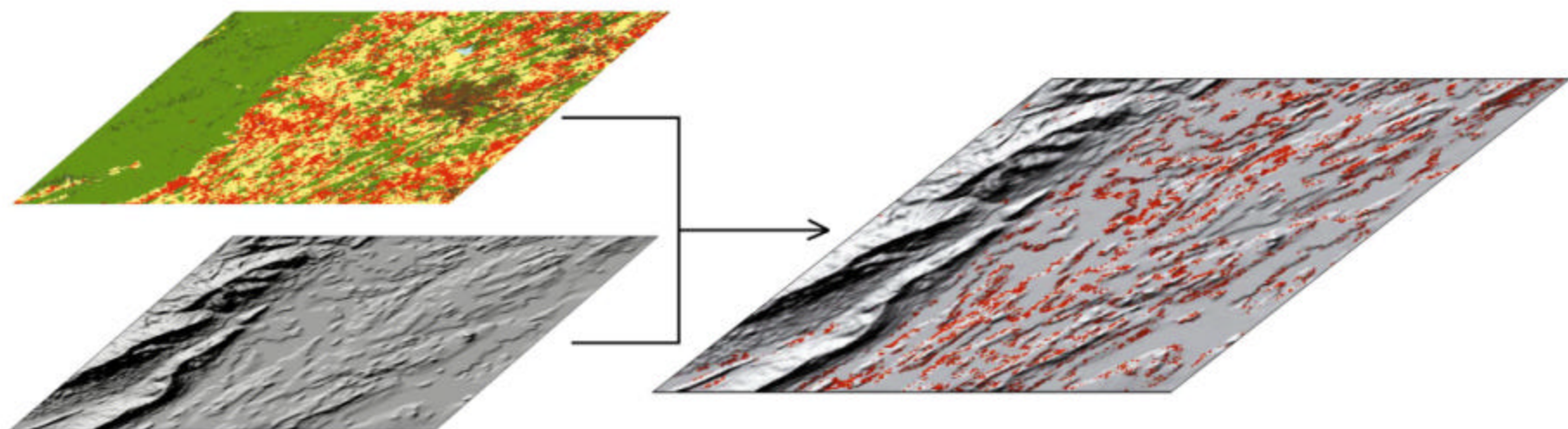
~ Streams

Land Cover

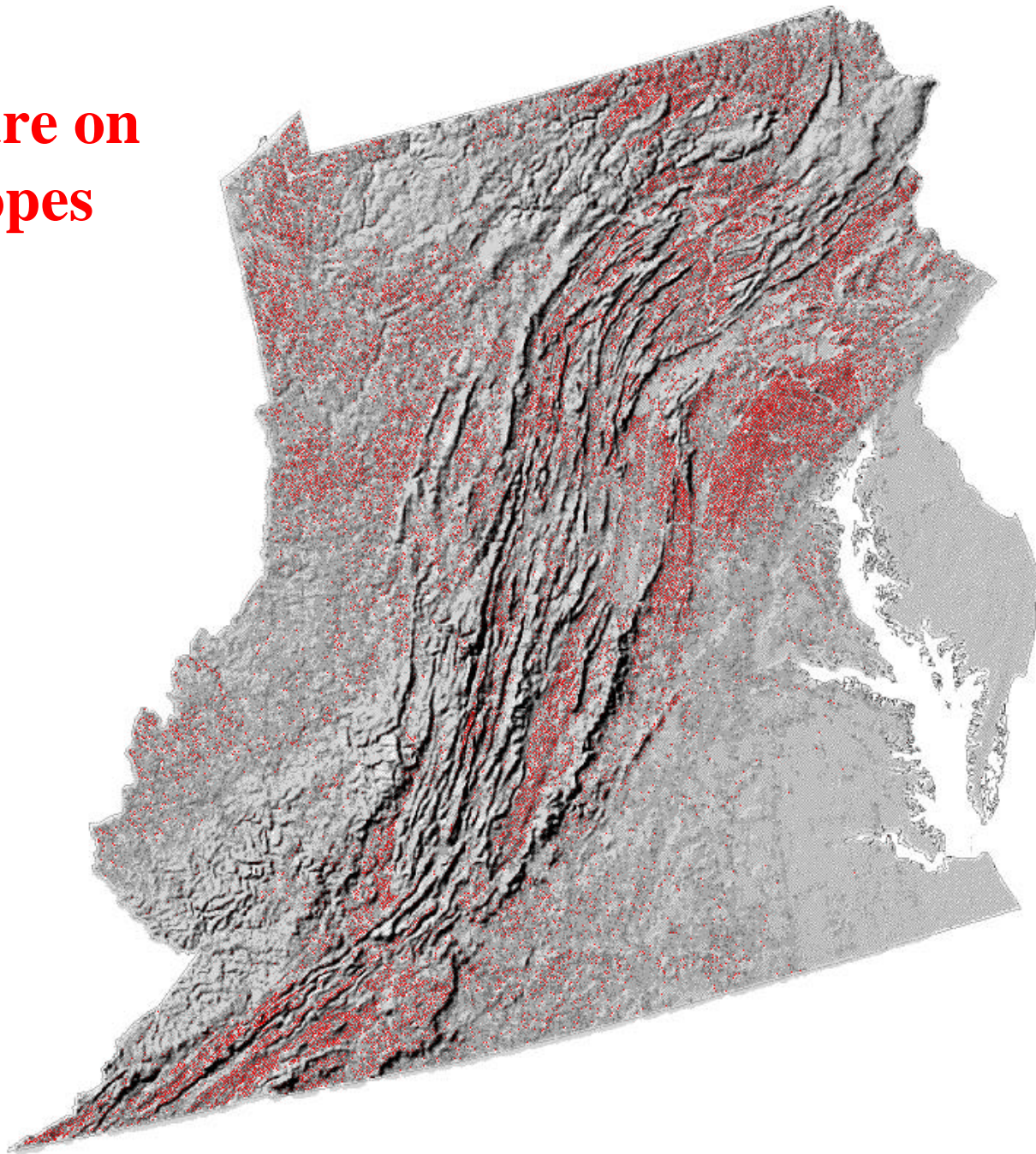
- Water
- Low Intensity - Developed
- High Intensity - Developed
- Hay/Pasture/Grass
- Row Crops
- Probable Row Crops
- Conifer Forest
- Mixed Forest
- Deciduous Forest
- Woody Wetlands
- Emergent Wetlands
- Barren; Quarry
- Barren; Coal Mines
- Barren; Beach Areas
- Barren; Transitional

3 0 3 6 Miles





**Agriculture on
> 3 % Slopes**



Landscape Metrics

Mean Riparian agriculture

Riparian forest

Forest fragmentation

Road density

Forest land cover

Agricultural land cover

**Agricultural land cover
on steep slopes**

Nitrate deposition

Potential soil loss

Roads near streams

Slope gradient

Slope gradient range

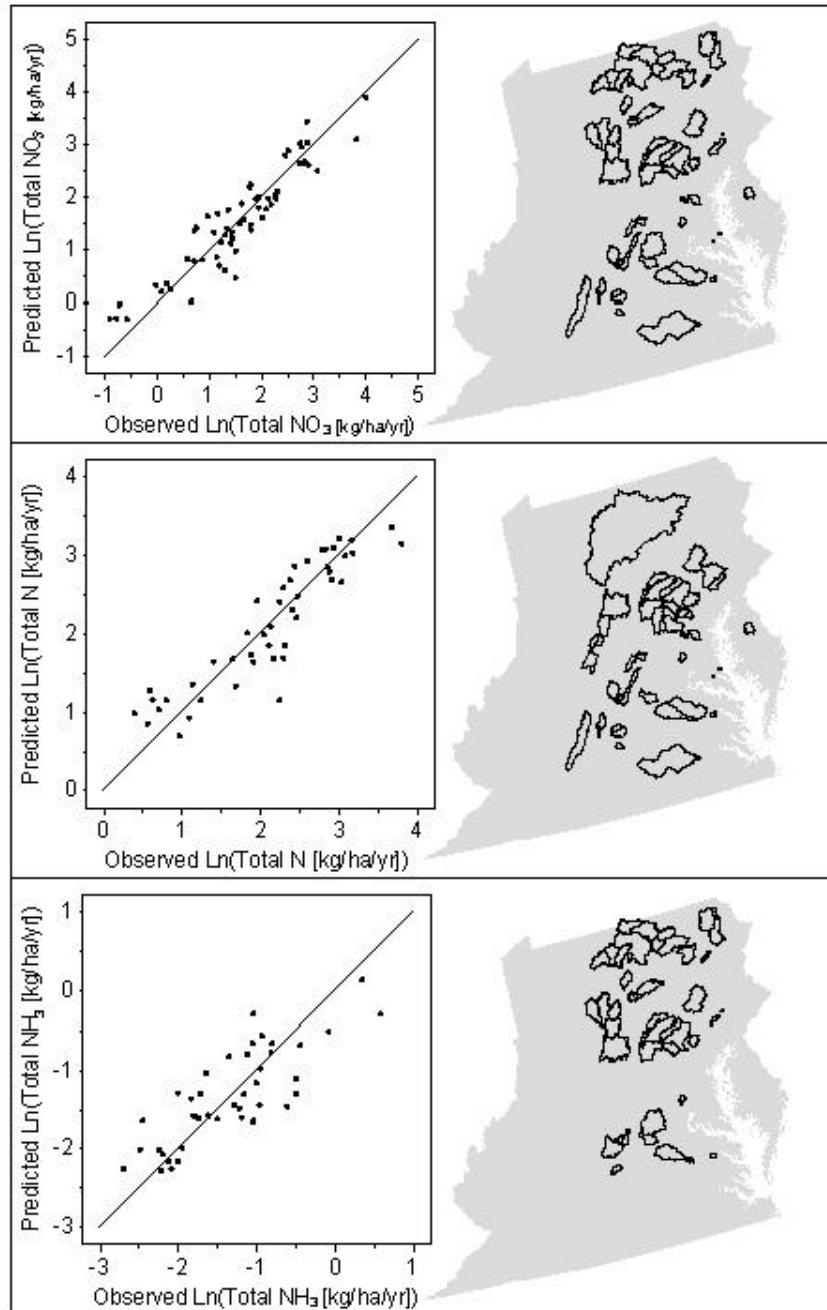
Slope gradient variance

Urban land cover

Wetland land cover

Barren land cover

Multiple Regression



$$R^2 = .86$$

% Ag

Nitrate Dep

Roads x Streams

% Urban

Riparian Ag

$$R^2 = .83$$

Riparian Forest

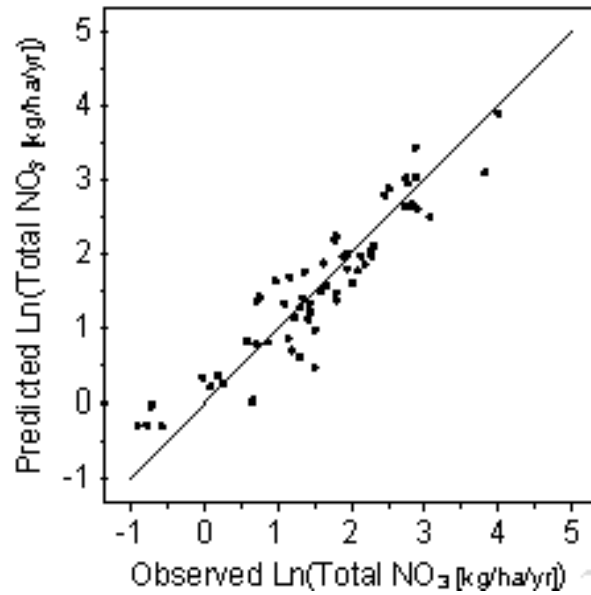
Nitrate Dep

$$R^2 = .65$$

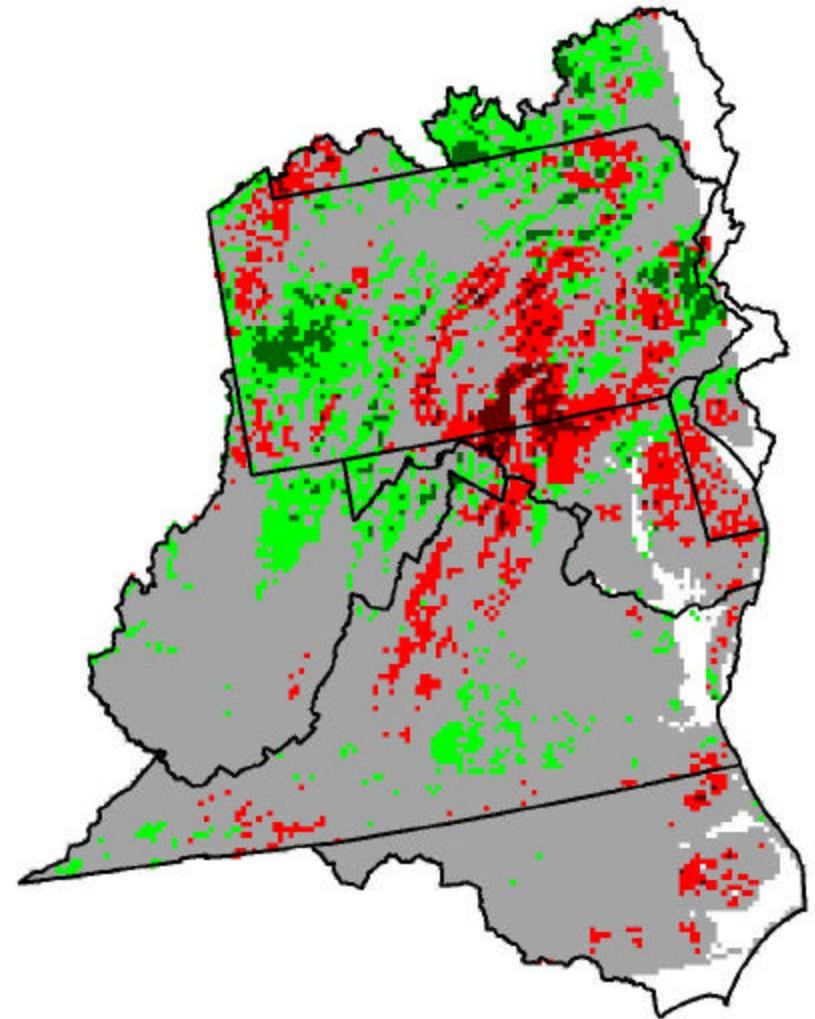
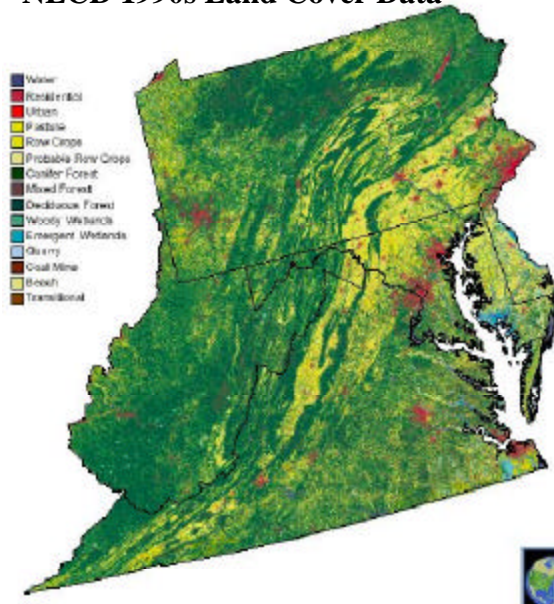
Road Density

Riparian Forest

Integration to Create a Surface Map of Conditions



NLCD 1990s Land Cover Data



Nitrogen Yield Changes (kg/ha/yr)



Logistics Regression

- Uses threshold values and provides cross-validation and probabilities of exceeding a threshold (yes/no relative to a dependent variable) based on a set of independent variables (landscape and biophysical variables)
- Useful for evaluating probability of exceeding a TMDL threshold/condition threshold

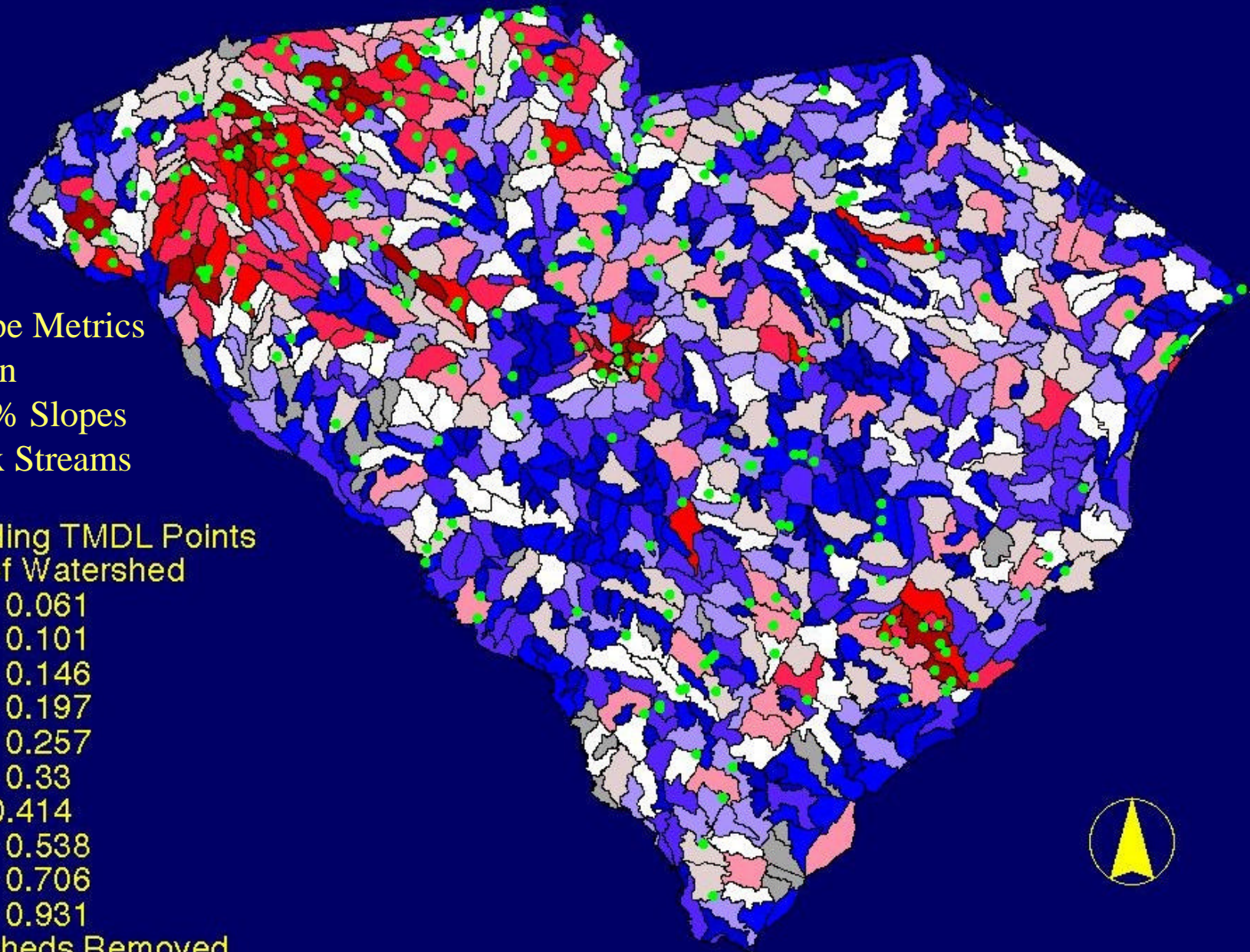
Logistic Regression Results with Test Points

Landscape Metrics

- % Urban
- Ag > 9% Slopes
- Roads x Streams

• Exceeding TMDL Points

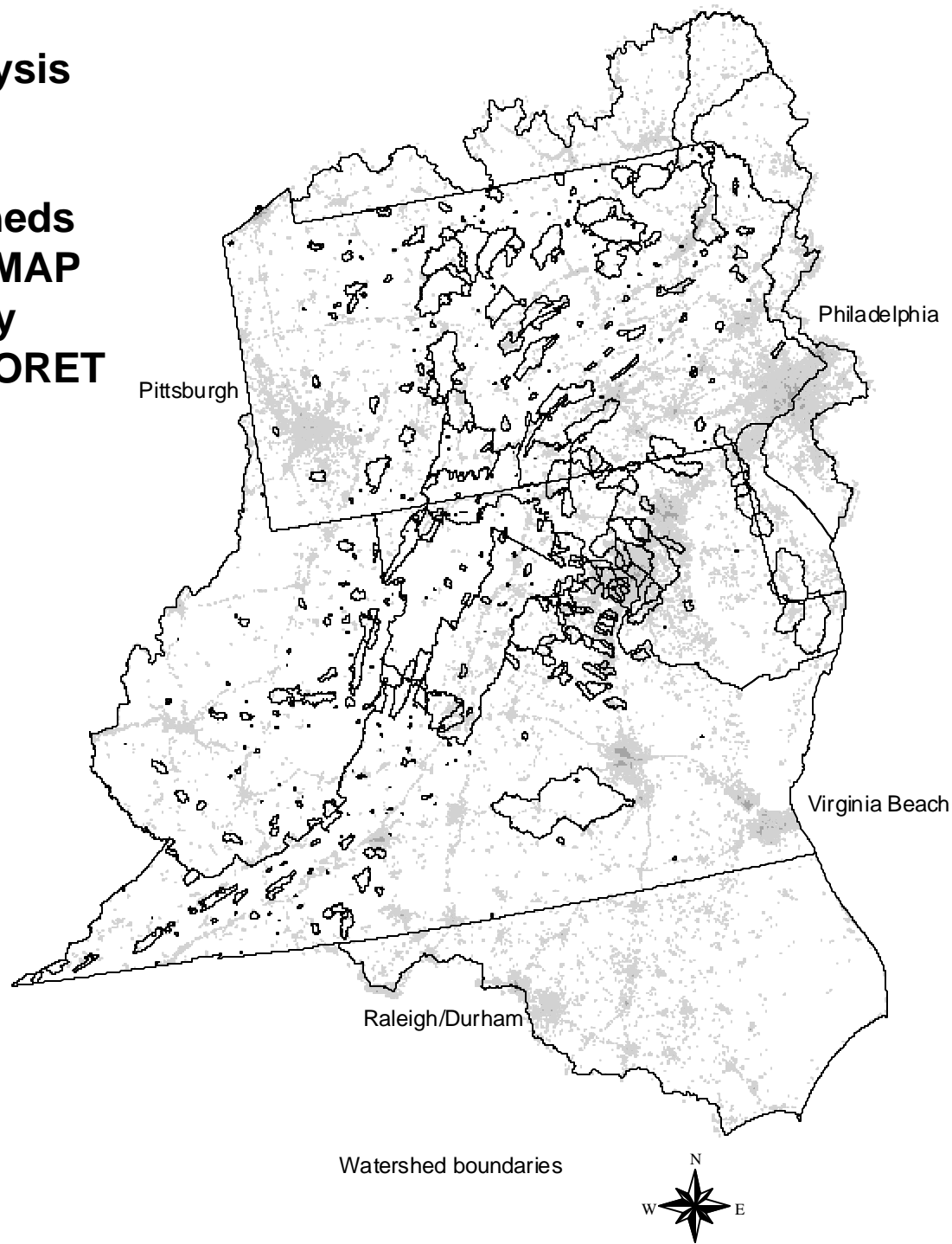
Probability of Watershed



Classification and Regression Tree Study

CART Analysis

**477 Watersheds
Based on EMAP
and carefully
selected STORET
sites**



CART Analysis – N concentration in MAIA Streams

% Forest

FLC ≤ 68.3
STD = 1.090
Avg = 6.301
N = 477
(% ALC, FFLS)
(0.45)

N Deposition

ND ≤ 18.2
STD = 1.0
Avg = 7.2
N = 177

(No surrogates)
(0.07)

N Deposition

ND ≤ 15.6
STD = 0.8
Avg = 5.8
N = 300

(No surrogates)
(0.05)

Riparian Forest

RIPF ≤ 69.3
STD = 0.9
Avg = 6.9
N = 111

(No surrogates)
(0.04)

Potential Soil Loss

POSO ≤ 35.5
STD = 0.9
Avg = 7.7
N = 66

(Slope; % ALC)
(0.04)

Riparian Forest

RIPF ≤ 90.4
STD = 0.8
Avg = 5.5
N = 136

(% ALC; % Forest)
(0.03)

% Forest

FLC ≤ 87.8
STD = 0.7
Avg = 6.0
N = 164

(% ALC)
(0.04)

Terminal
Node 1
Avg = 7.0
(4.9-10.0)
N = 94

Good - 3
Fair - 21
Poor - 70

Terminal
Node 2
Avg = 5.9
(4.6-7.2)
N = 17

Good - 9
Fair - 3
Poor - 5

Terminal
Node 3
Avg = 7.2
(5.7-8.5)
N = 25

Good - 1
Fair - 5
Poor - 19

Terminal
Node 4
Avg = 8.1
(5.8-9.7)
N = 41

Good - 1
Fair - 2
Poor - 38

Terminal
Node 5
Avg = 5.8
(4.3-8.5)
N = 69

Good - 40
Fair - 20
Poor - 9

Terminal
Node 6
Avg = 5.1
(3.8-6.5)
N = 67

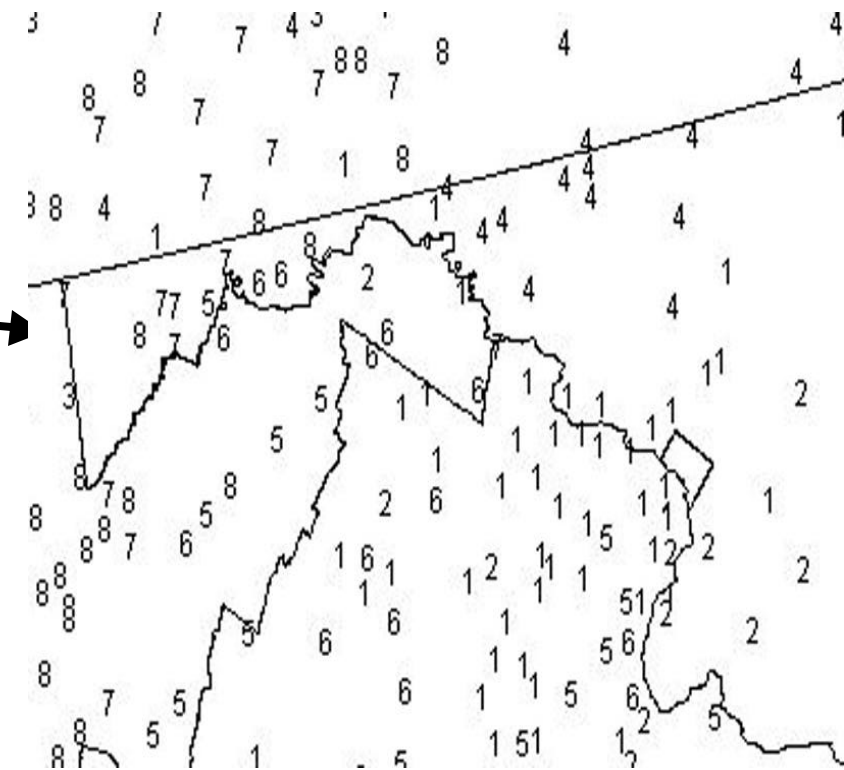
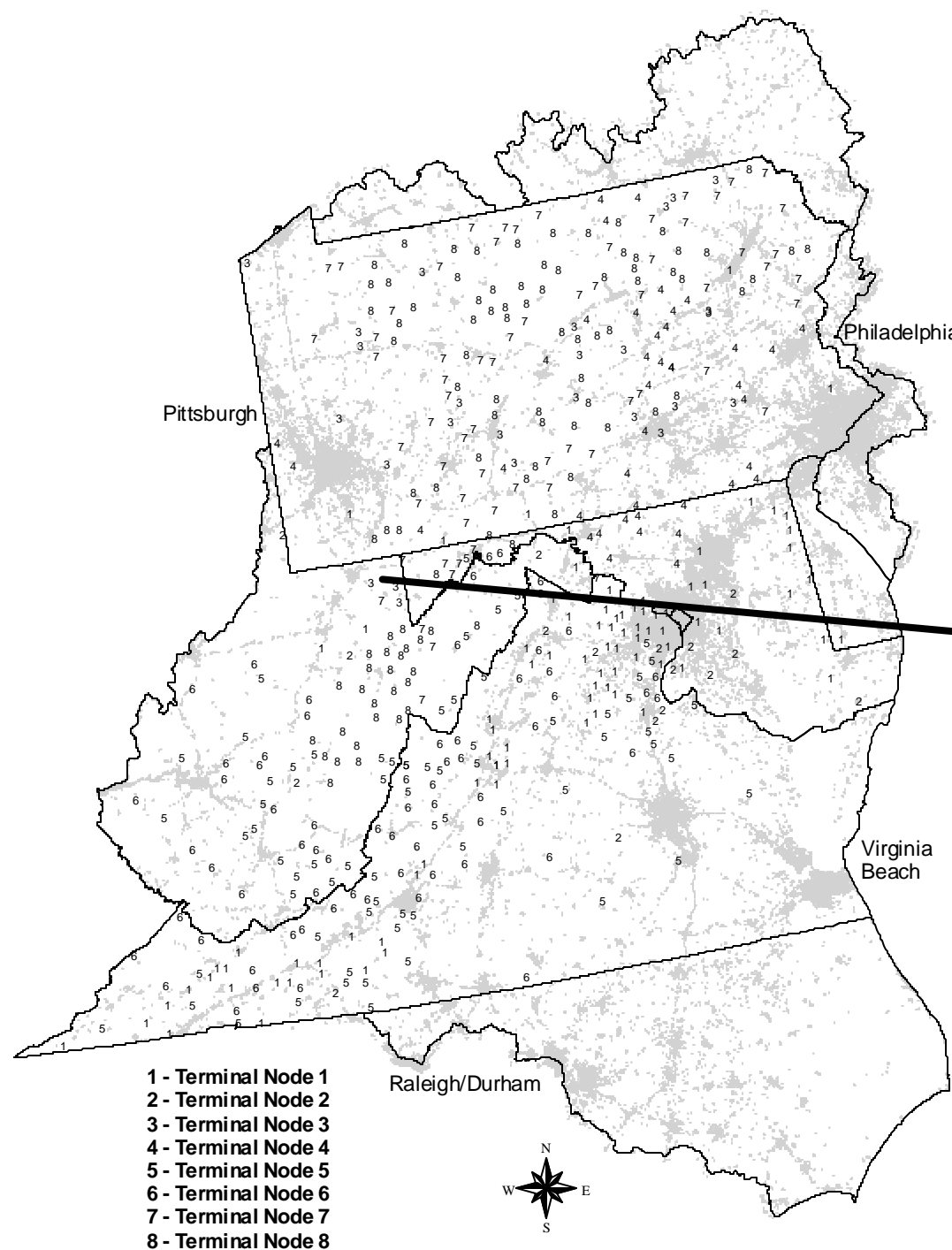
Good - 56
Fair - 11
Poor - 0

Terminal
Node 7
Avg = 6.4
(4.7-7.7)
N = 66

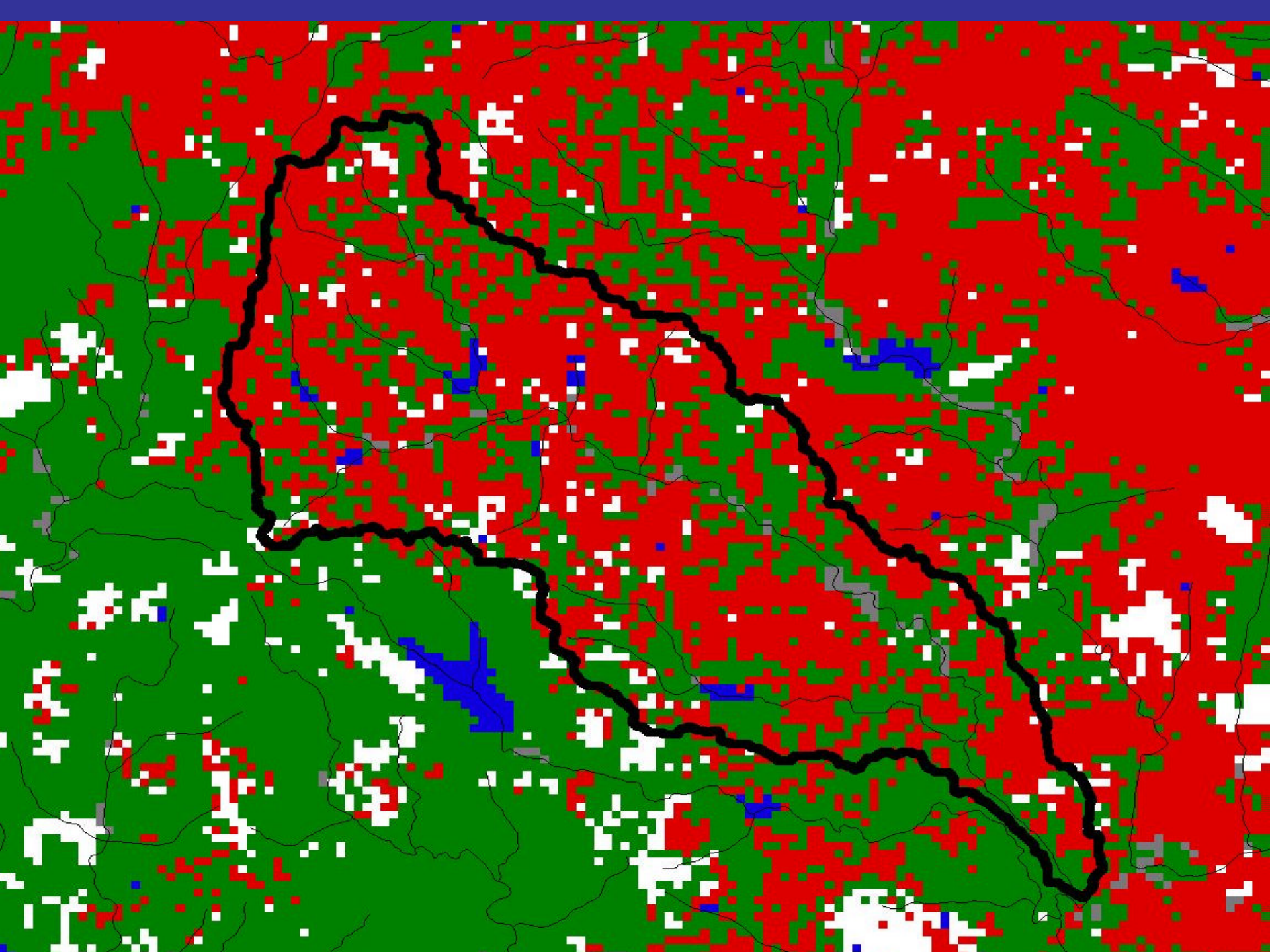
Good - 7
Fair - 33
Poor - 26

Terminal
Node 8
Avg = 5.8
(3.9-7.6)
N = 98

Good - 56
Fair - 36
Poor - 6



1 – poor 5 – good
 2 – fair 6 – good
 3 – poor 7 – fair
 4 – poor 8 – good



Bayesian Landscape Models

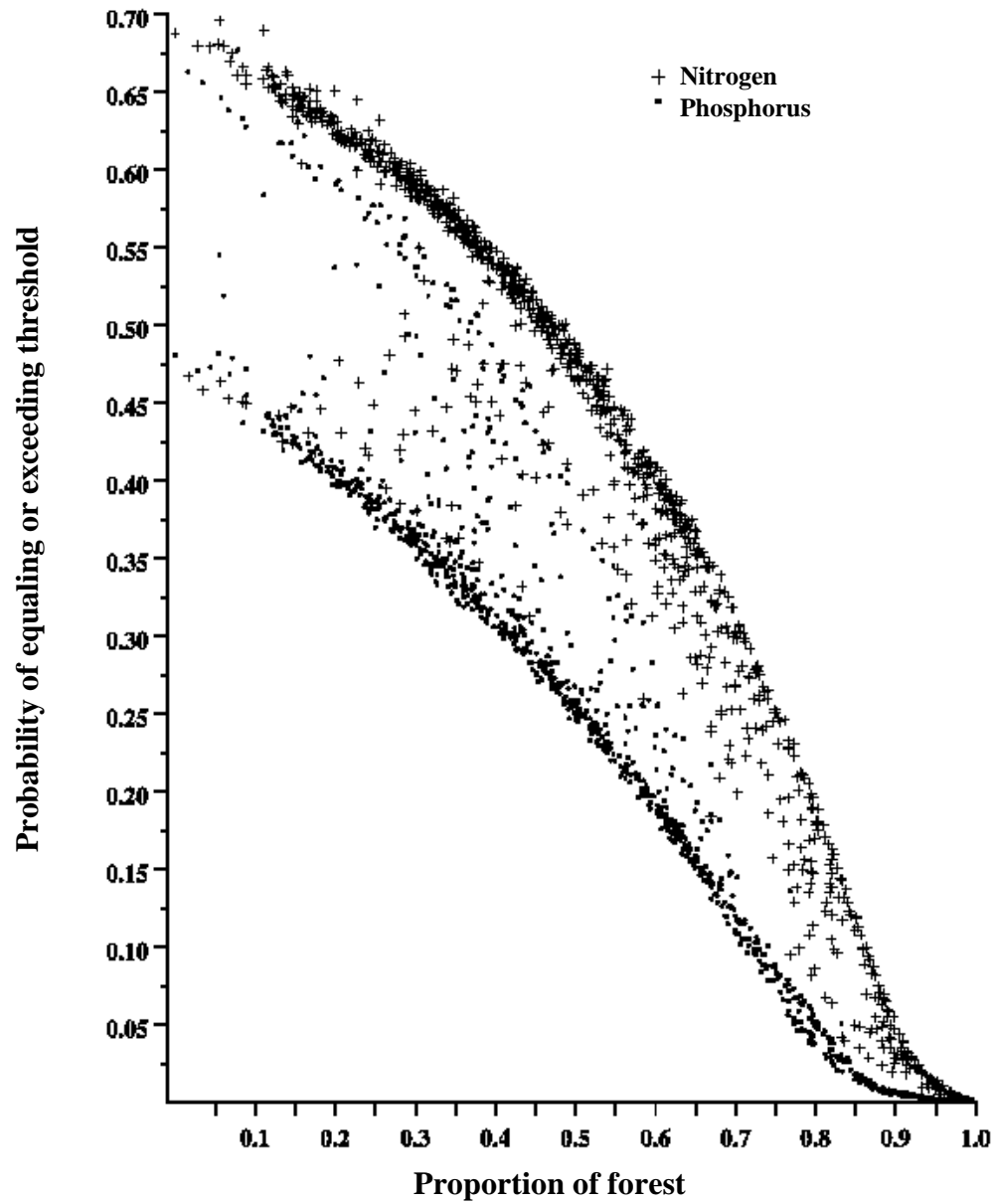
Nitrogen Export kg/ha/yr

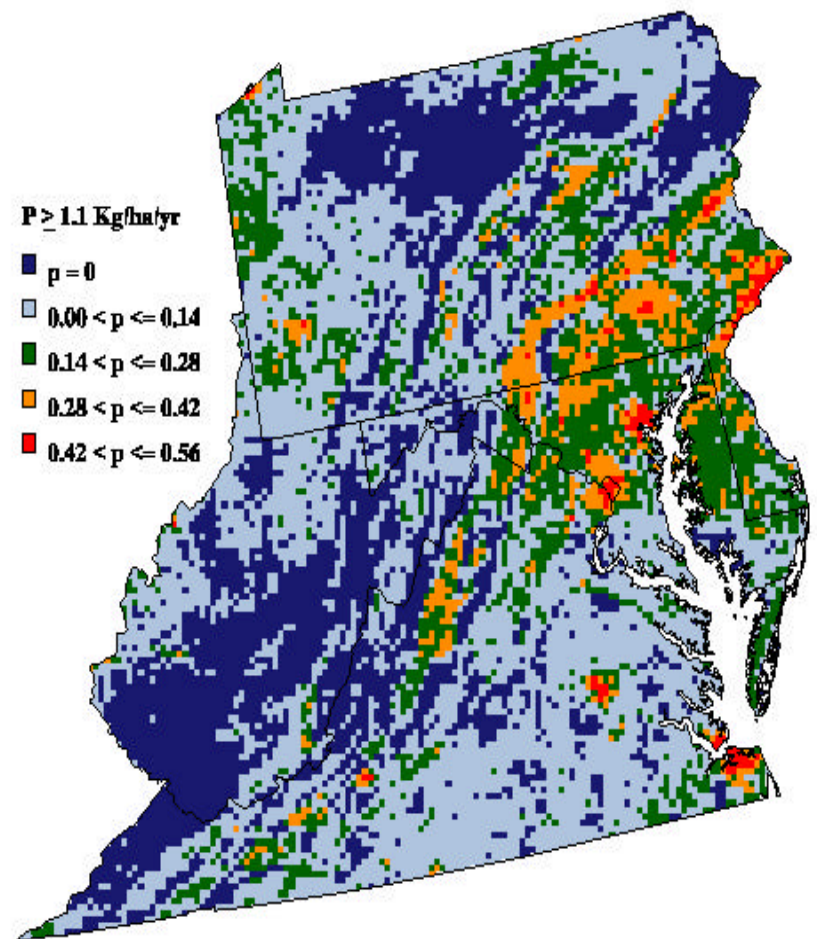
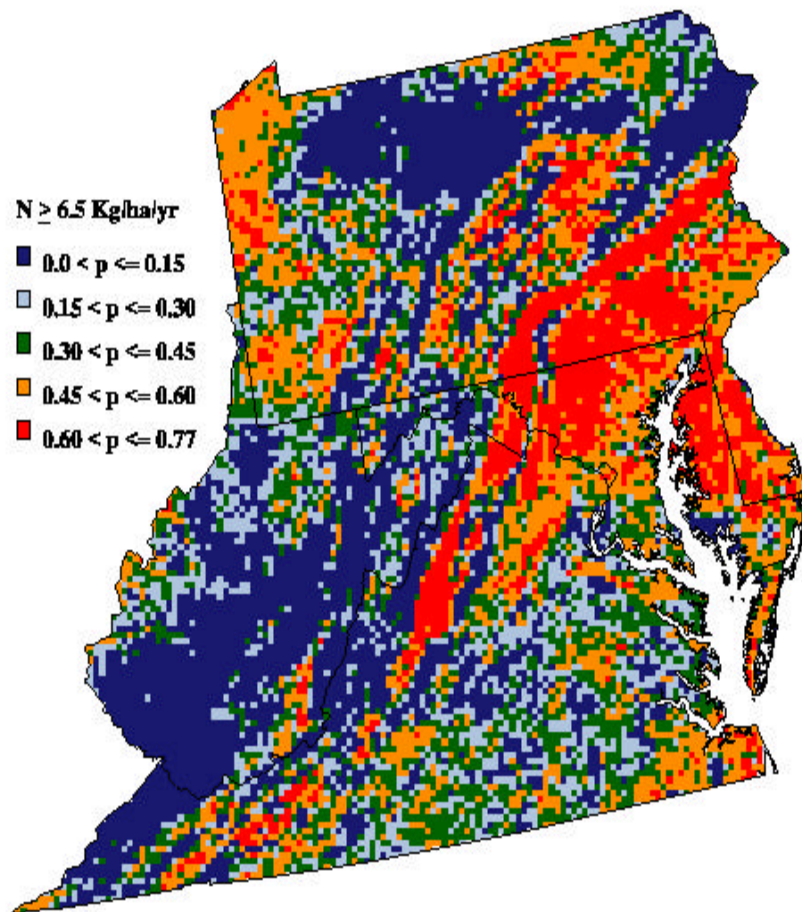
Forest	Urban	Agriculture
0.1	5.0	3.2
0.1	5.0	4.8
0.2	5.0	5.0
0.7	5.1	5.0
2.2	5.4	5.8
2.5	6.7	9.1
2.5	7.9	9.6
2.6	9.6	9.8
3.0	9.6	11.9
3.7	12.0	14.0
4.4	16.3	20.0
7.6	18.0	20.6
12.2	28.0	22.3
		23.5
Source: Frink (<i>JEQ</i> , 1991, 20:717)		33.3

Land-Cover	WS (ha)	N/P	# of Obs.	Min	Q ₂₅	Q ₅₀	Q ₇₅	Max
Agriculture	40-8000	N	30	2.1	6.6	11.1	20.3	53.2
Urban	4-4800	N	19	1.5	4.0	6.5	12.8	38.5
Forest	7-47000	N	21	1.4	1.9	2.5	3.3	7.3
Agriculture	40-8000	P	27	0.08	0.49	0.91	1.34	5.40
Urban	4-4800	P	24	0.19	0.69	1.10	3.39	6.23
Forest	7-47000	P	62	0.01	0.04	0.08	0.22	0.83

$$N, P = \sum_i^n (C_i * A_i) \quad \begin{matrix} \text{N} & \text{P} \\ \text{Threshold} & 7.0 & 0.8 \end{matrix}$$

Risk: # of iterations / 10000 >= 7.0 or 0.8



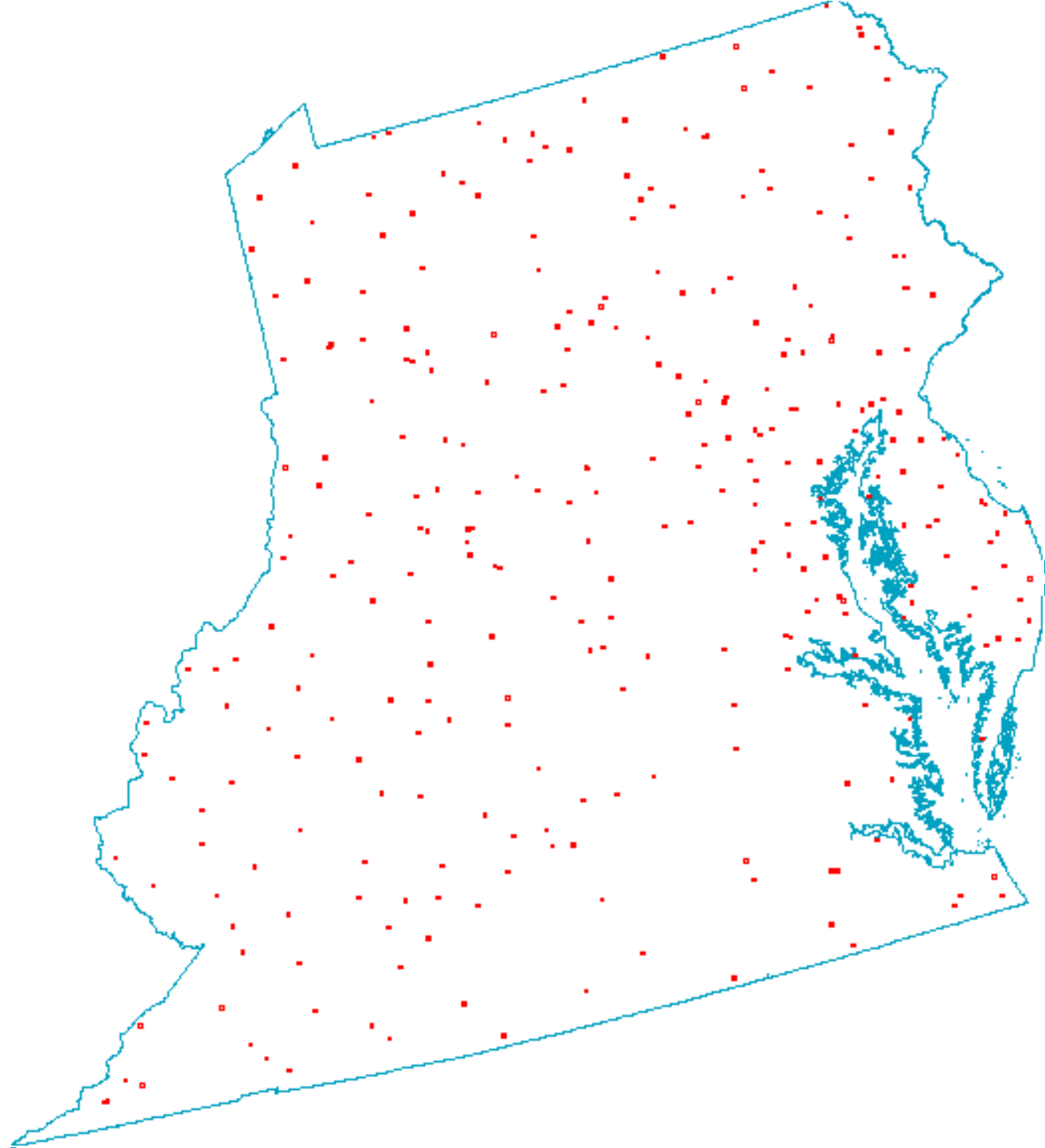


A large, dark, rocky formation shaped like a bird with spread wings, perched on a rocky outcrop against a blue sky with clouds. The formation is the central focus of the image, with its wings spread wide to the left and right. The background shows a steep, rocky hillside and a clear blue sky with some light clouds. The overall scene is a natural landscape featuring a unique rock formation.

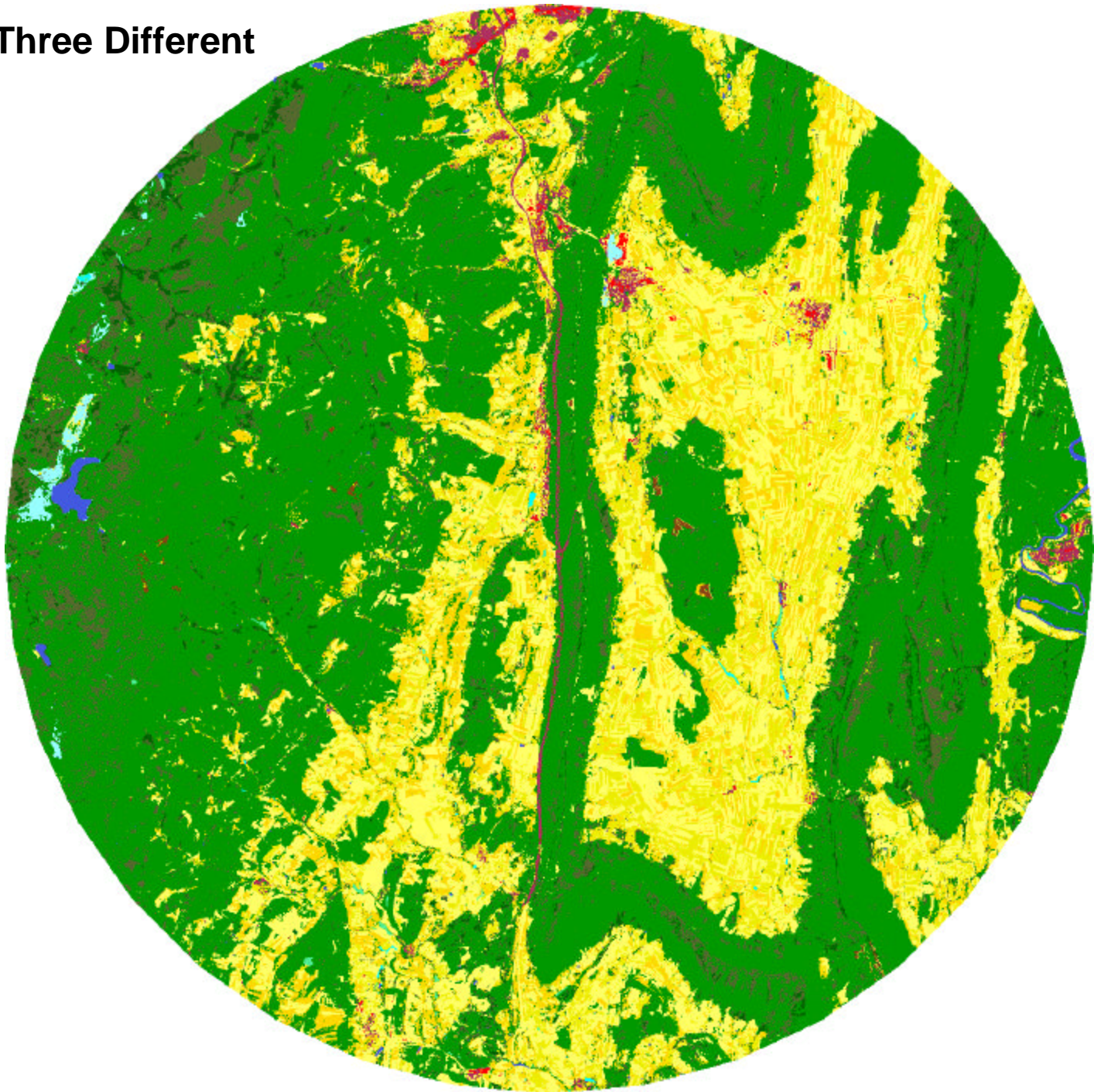
Birds and Landscape Condition

MAIA BBS Study

- Compare landscape metrics to breeding bird guild structure based on O'Connell et al
- 182 BBS transects
- Center point of route
- Circular support area at three different scales
- Bird data from BBS routes of highest quality

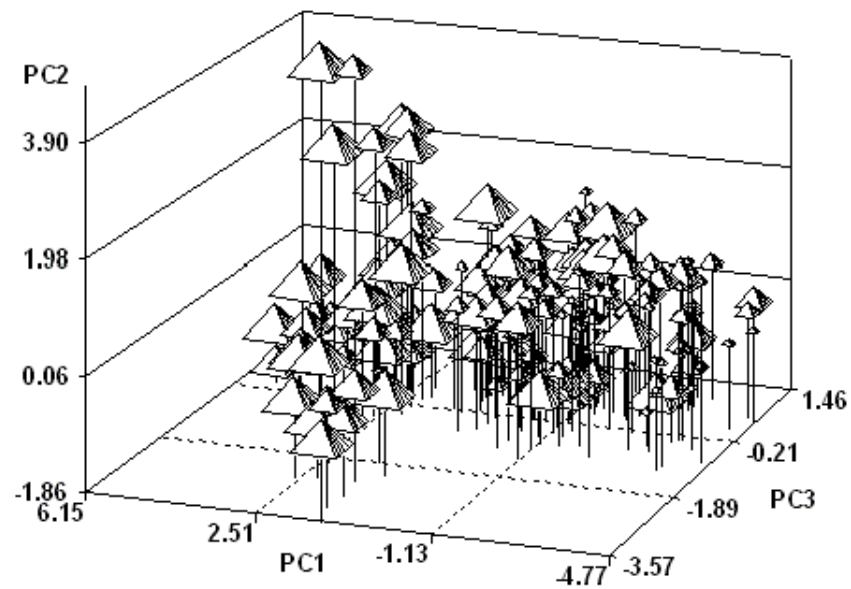


**Looked at Three Different
Scales**

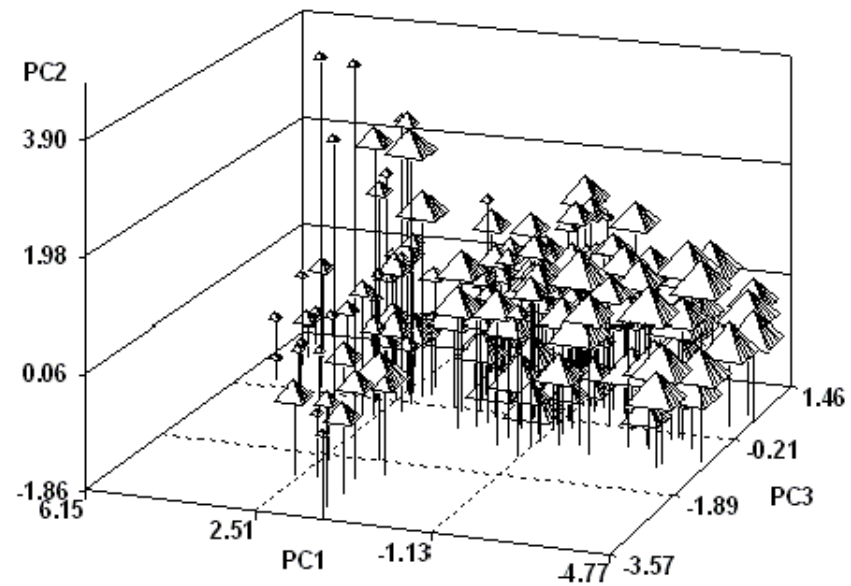


Results of MAIA BBS Study

- **Generalists**
 - Forest edge (30% of variation) +
 - Forest fragmentation (2% of variation) -
 - Only one guild > 40% of variation
 - Exotic (46%)
- **Specialists**
 - Forest edge (44% of variation) -
 - Forest @ 3 scales (2% of variation) +
 - Two guilds > 40% of variation
 - Interior forest obligate (53%)

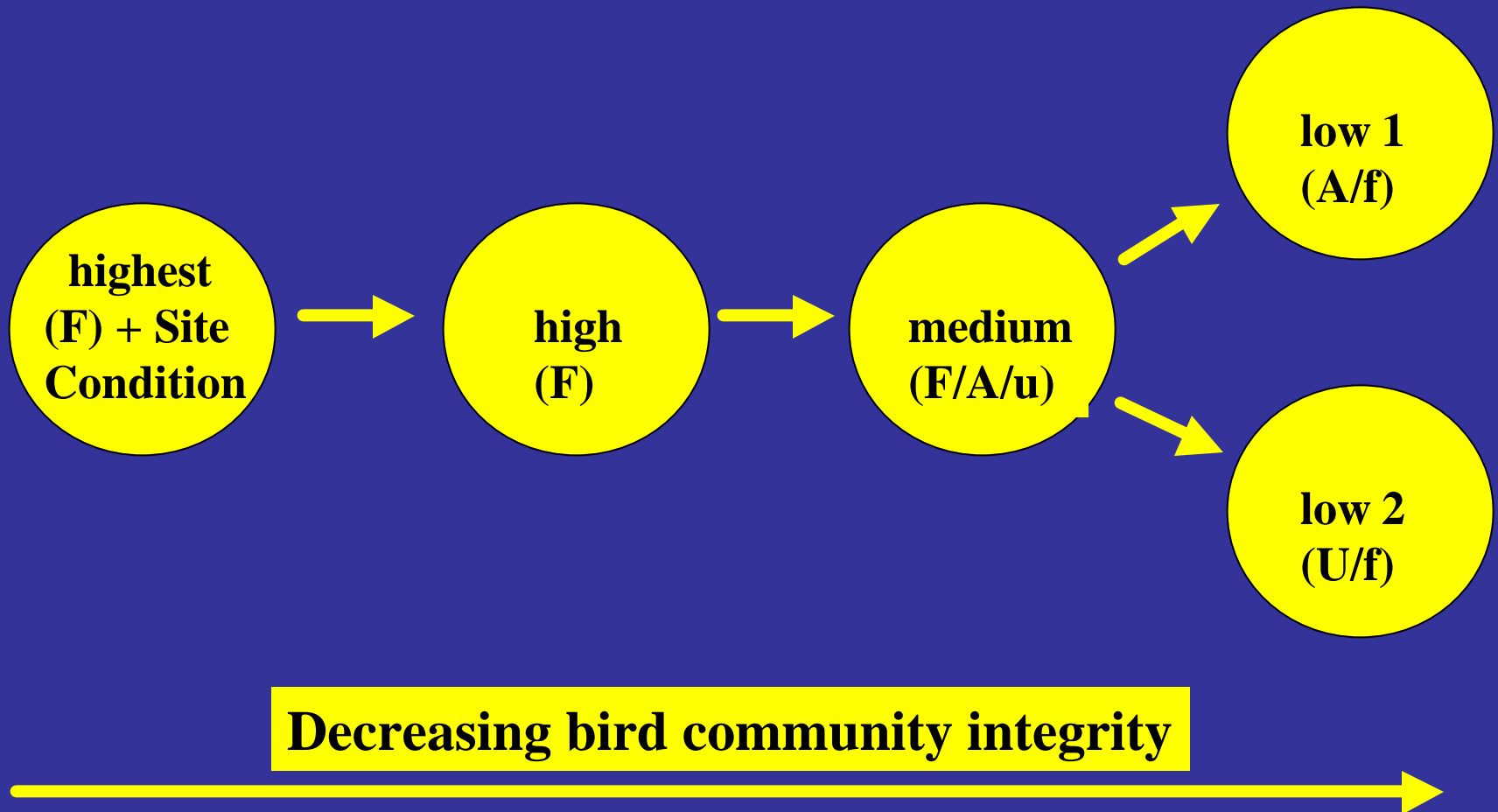


Generalists (A)

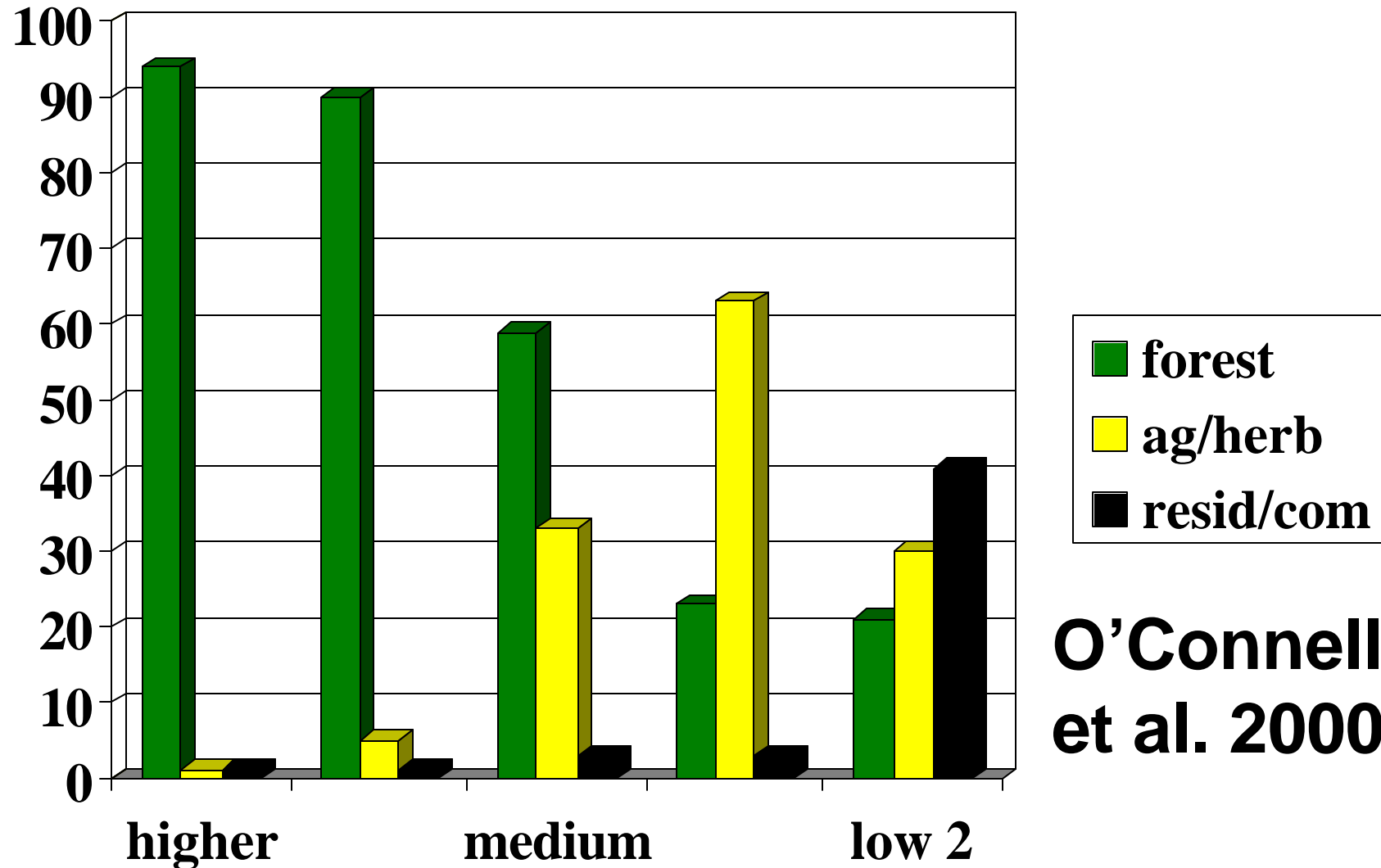


Specialists (B)

Bird Community Integrity



Percent Land Cover Type by BCI Grouping



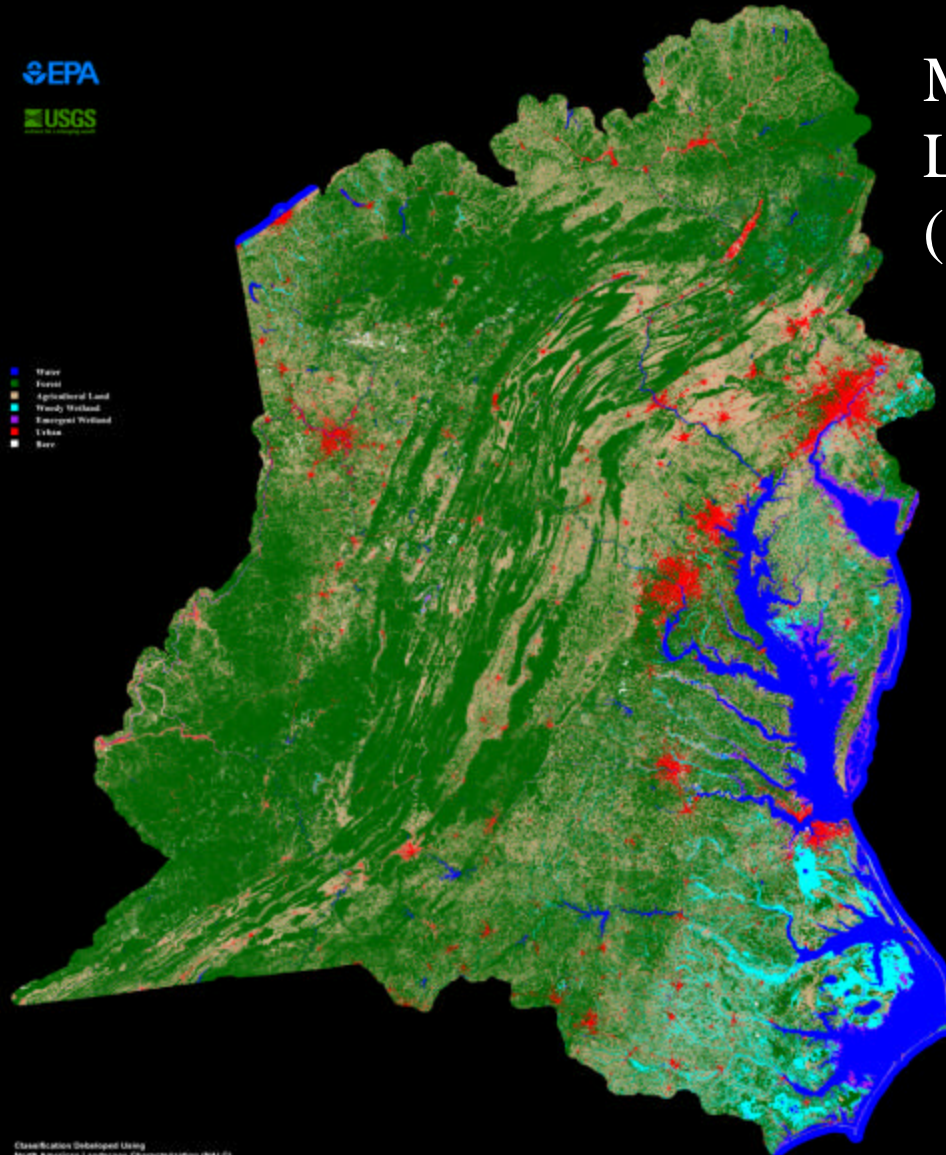
CROSS-VALUE INTEGRATION

An example related to
landscape change

Mid-Atlantic Integrated Assessment (MAIA) Study Area Land Cover (1970's)



- Water
- Forest
- Agricultural Land
- Wetland
- Emergent Wetland
- Urban
- Bar

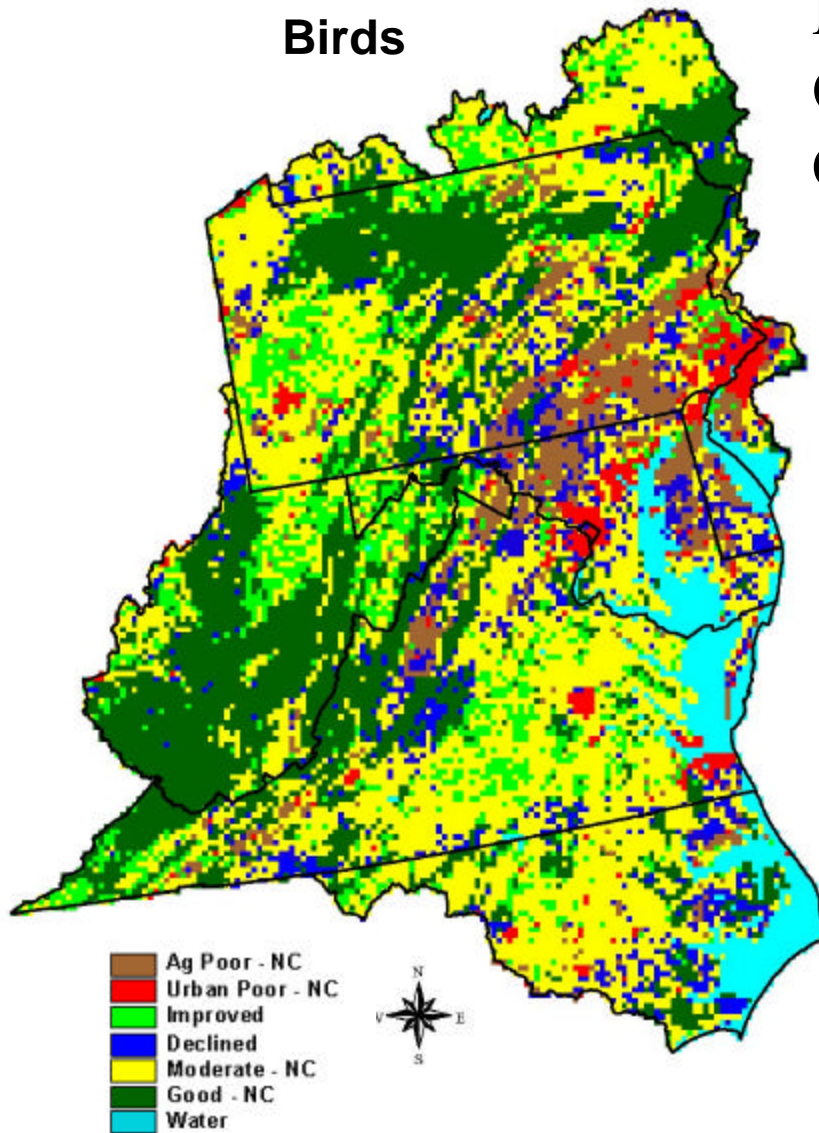


Classification Developed Using
North American Landscape Characterization (NALC)
Acquired from 1973 through 1978
Projection: Albers Conical Equal Area
Datum: NAD83
Spheroid: GRS1980

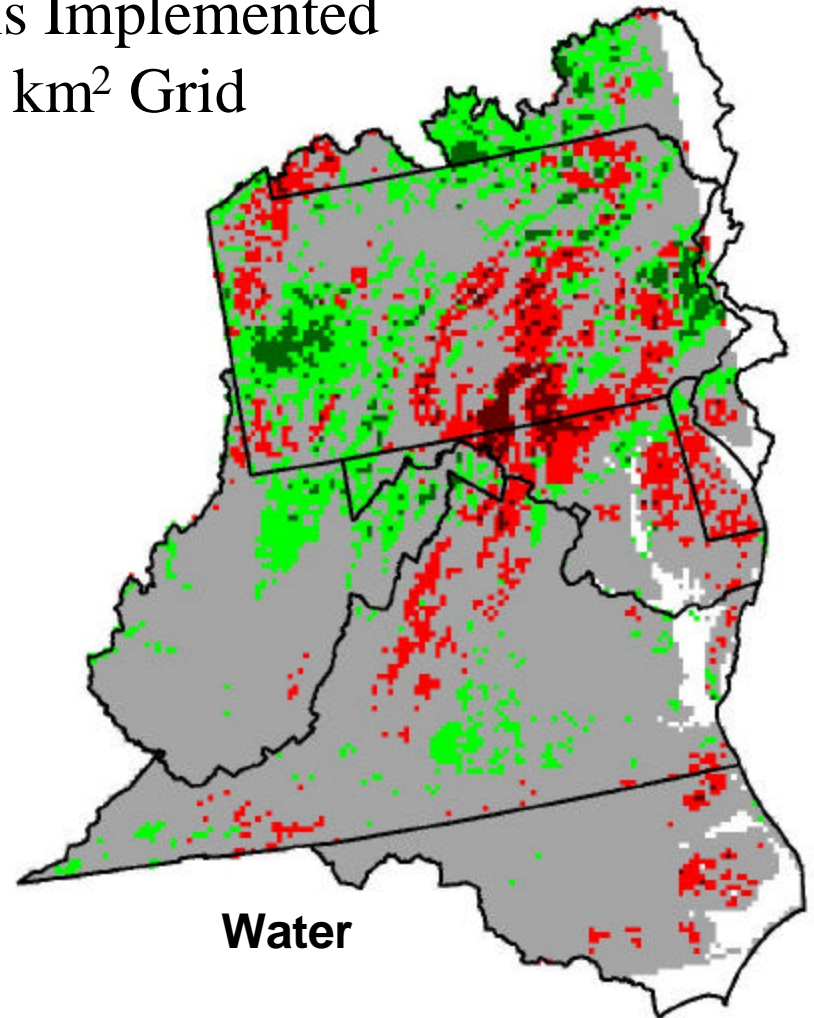
U.S. Geological Survey
EROS Data Center
Fergus Falls, MN

Mid-Atlantic Landscape Change (1970s-1990s)

Birds



Models Implemented
On 25 km² Grid
Cells



Water

Nitrogen Yield Changes (kg/ha/yr)

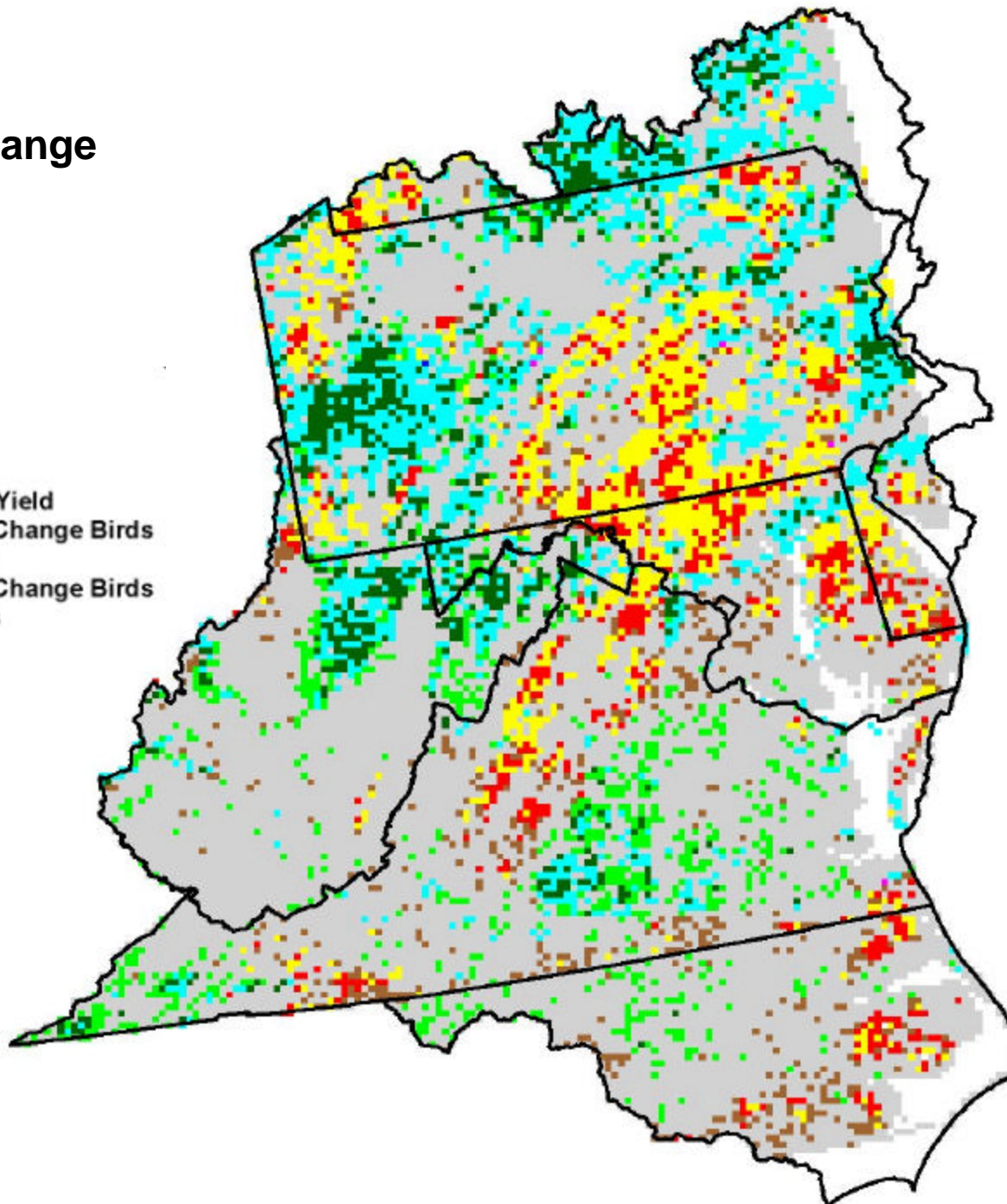
- 31.893 - -6.55
- 6.55 - -1.74
- 1.74 - 1.418
- 1.418 - 6.926
- 6.926 - 26.01



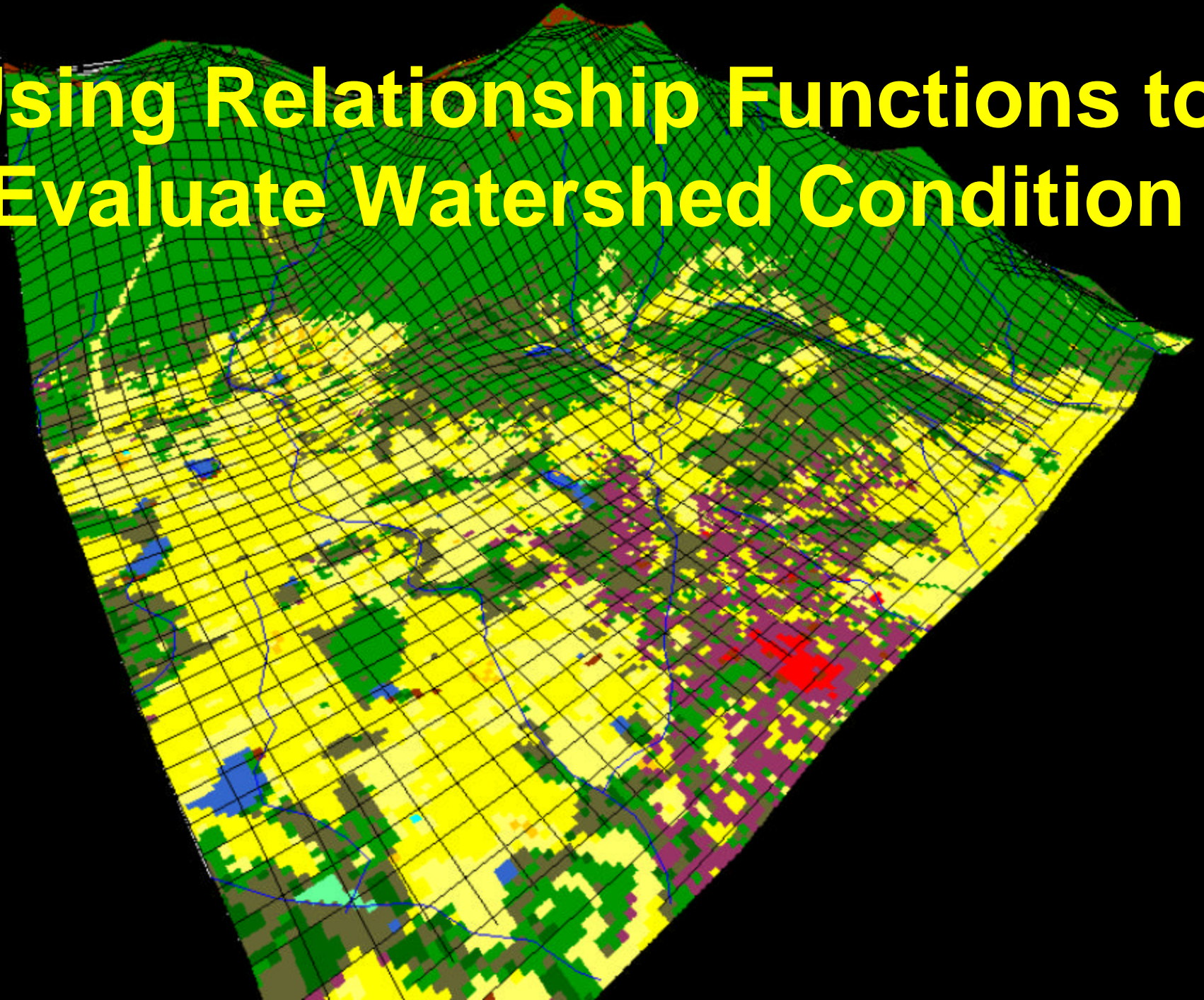
1970s to 1990s Change

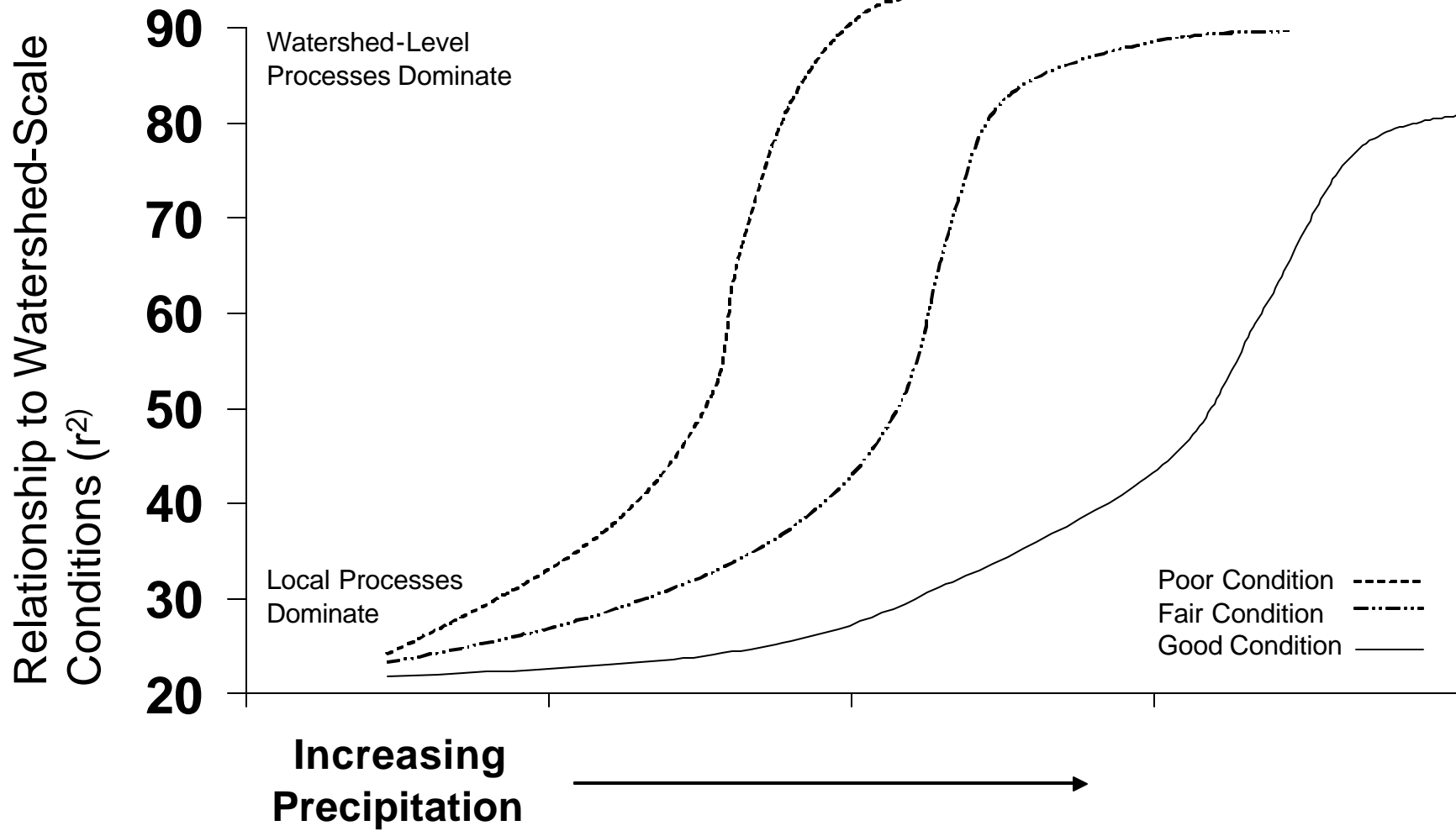


25 km² grid cells



Using Relationship Functions to Evaluate Watershed Condition







The End

THE
LITTLE
RASCALS
.NET