SPATIAL ANALYSIS

Understanding process from pattern

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Why a Geographic Perspective?

- Location matters
  - The spatial aspects of an ecosystem (eg. proximity, heterogeneity, configuration of resources) impact the functional role of that system
- Interdisciplinary framework
  - Considers “all” factors within a space

Landscapes

- Organization of elements in the environment
- Is the aquatic environment ‘structured’?
- If so, how does structure affect function?

Some spatial tools

- Geographic Information Systems (GIS)
- Spatial statistics / geostatistics
- Landscape ecology (landscape metrics)
- Underwater acoustics in fisheries research

Geographic Information Systems (GIS)

- Computerized mapping

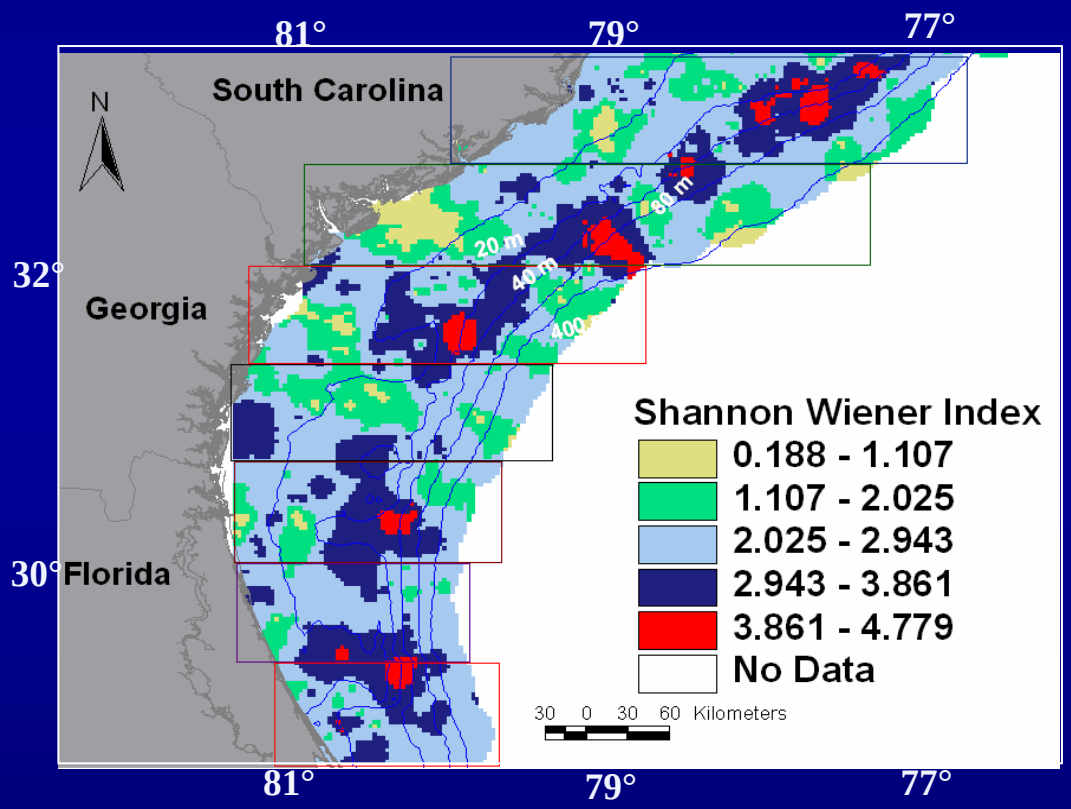
  visualization and data management

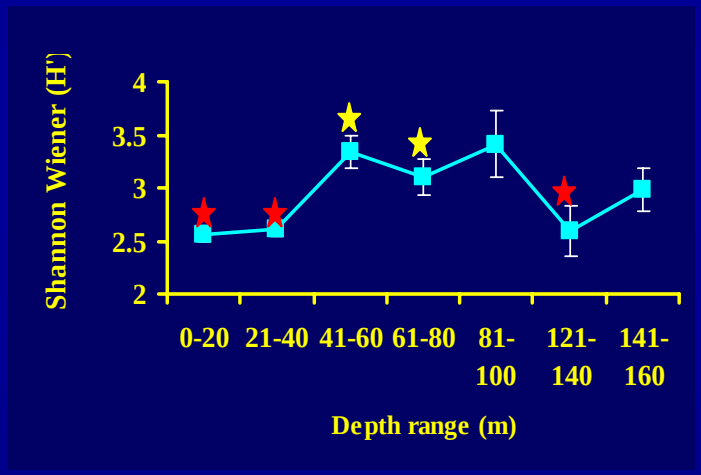
- Spatial functions

  overlay, proximity, neighbors, buffers

GIS and inferential statistics

Species diversity (H') from MARMAP Yankee trawls (1973-1980)





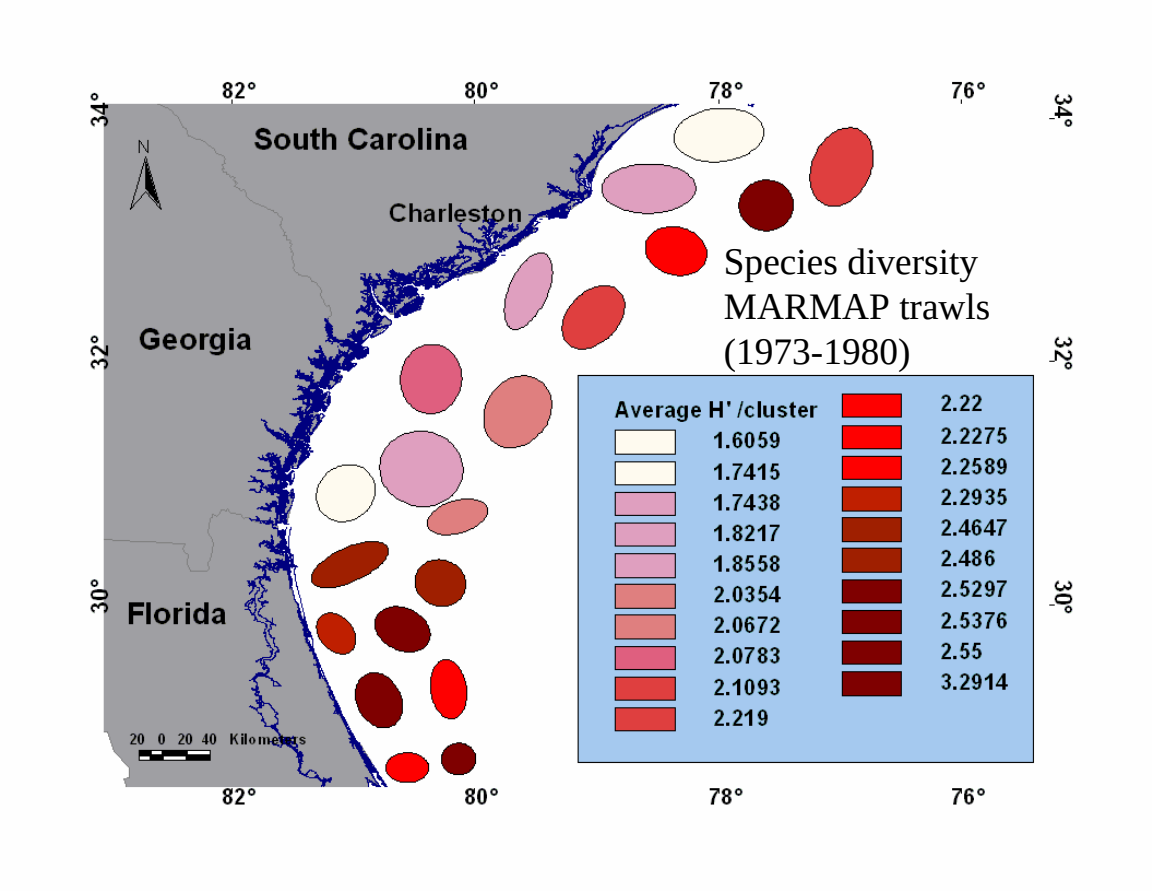
J. Jennings

Spatial Statistics

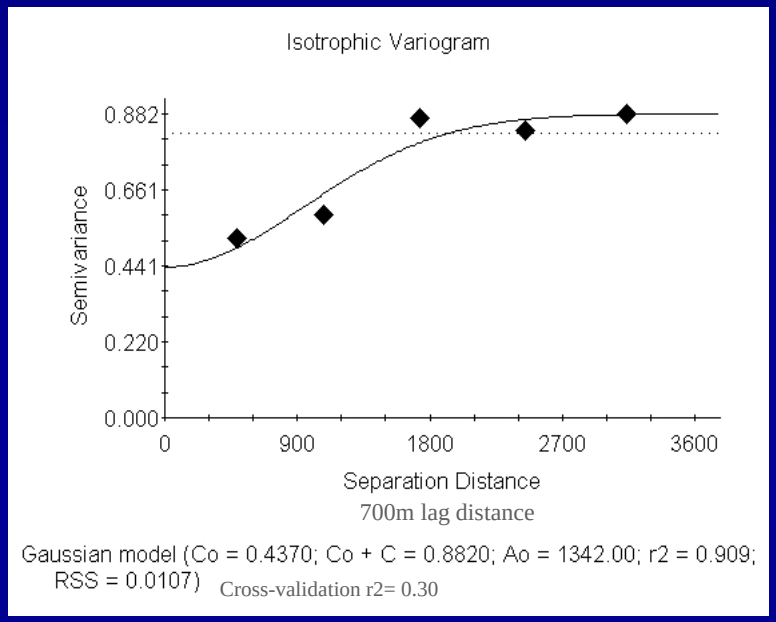
- Point patterns: relative location of individuals
  - nearest neighbor / k-means clustering
- Spatially continuous data: gradients and localized variability
  - spatial autocorrelation / kriging
- Areal data: discrete units
  - join-count / landscape metrics

Spatial statistics for point data

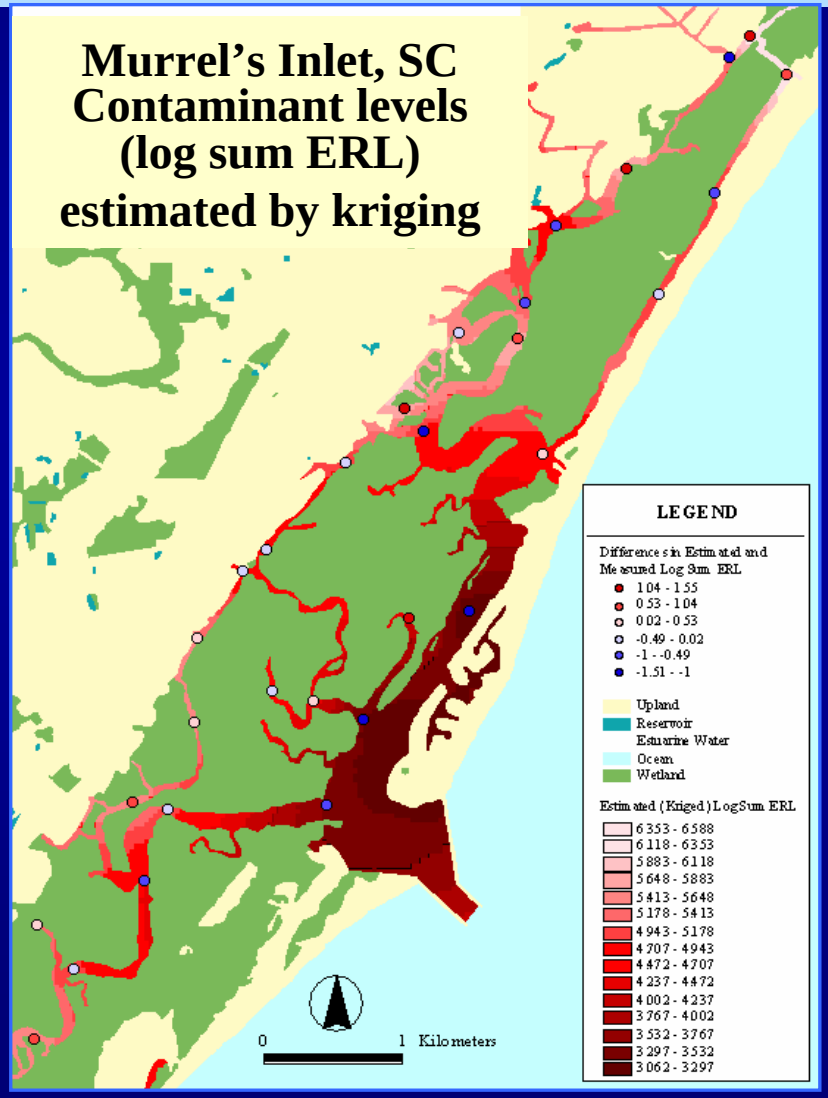
Spatial K-means clustering to differentiate regions based on H'
Darker ellipses indicate areas of higher diversity.



Geostatistics for modeling continuous data



A semivariogram models the behavior of a variable across space. Kriging interpolates that to unsampled locations.



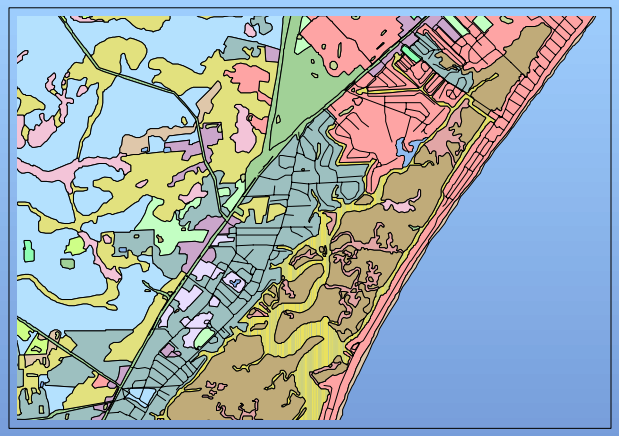
A Landscape Ecology Approach

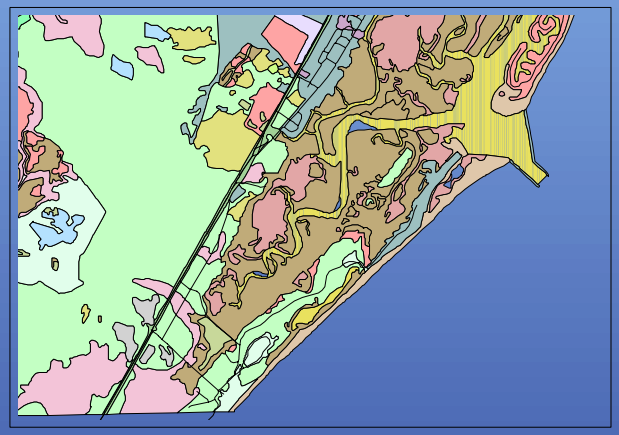
- Define landscape ‘elements’
  => eg. patches, networks

- And quantify landscape ‘structure’
  => the characteristics and arrangement of these elements

- To better understand landscape ‘processes’
  => how these elements interact

Landscape metrics





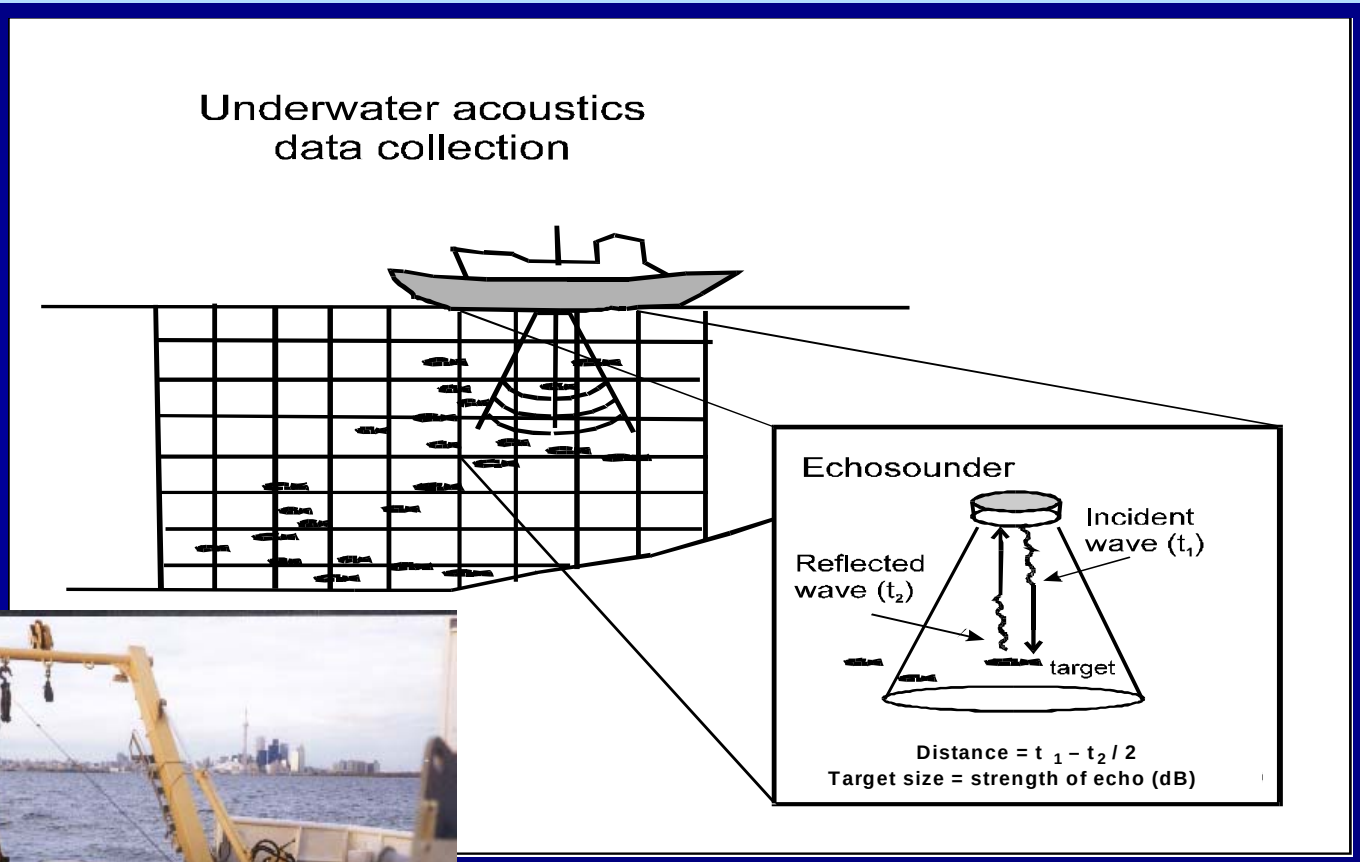
Nice maps….But, how does one landscape differ from another?

- Patch size / variability
- Landscape complexity
- Interspersion of patches
- Connectivity of landscape elements

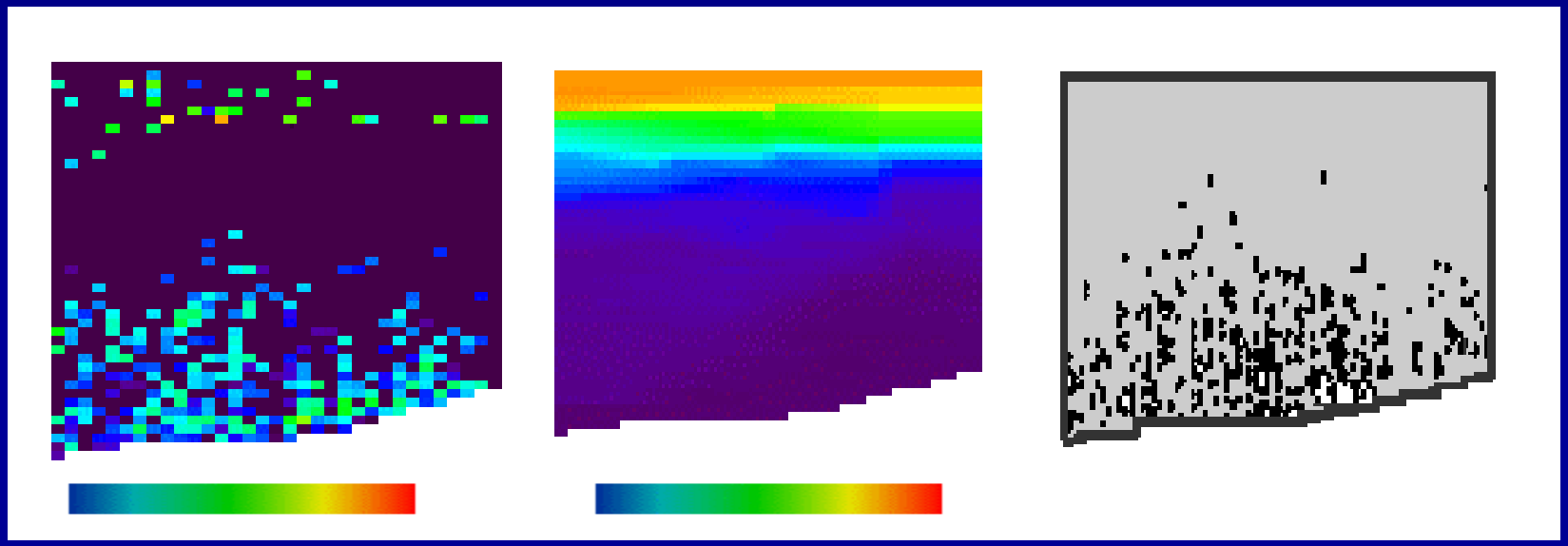
Patterns/structure in aquatic landscapes

- Bathymetry
- Diel vertical migration
- Thermal fronts/gradients
  - resource partitioning
- Schooling behavior
  - defense/feeding strategies
- Habitats
  - aquatic vegetation, reefs

Underwater acoustics to map structure



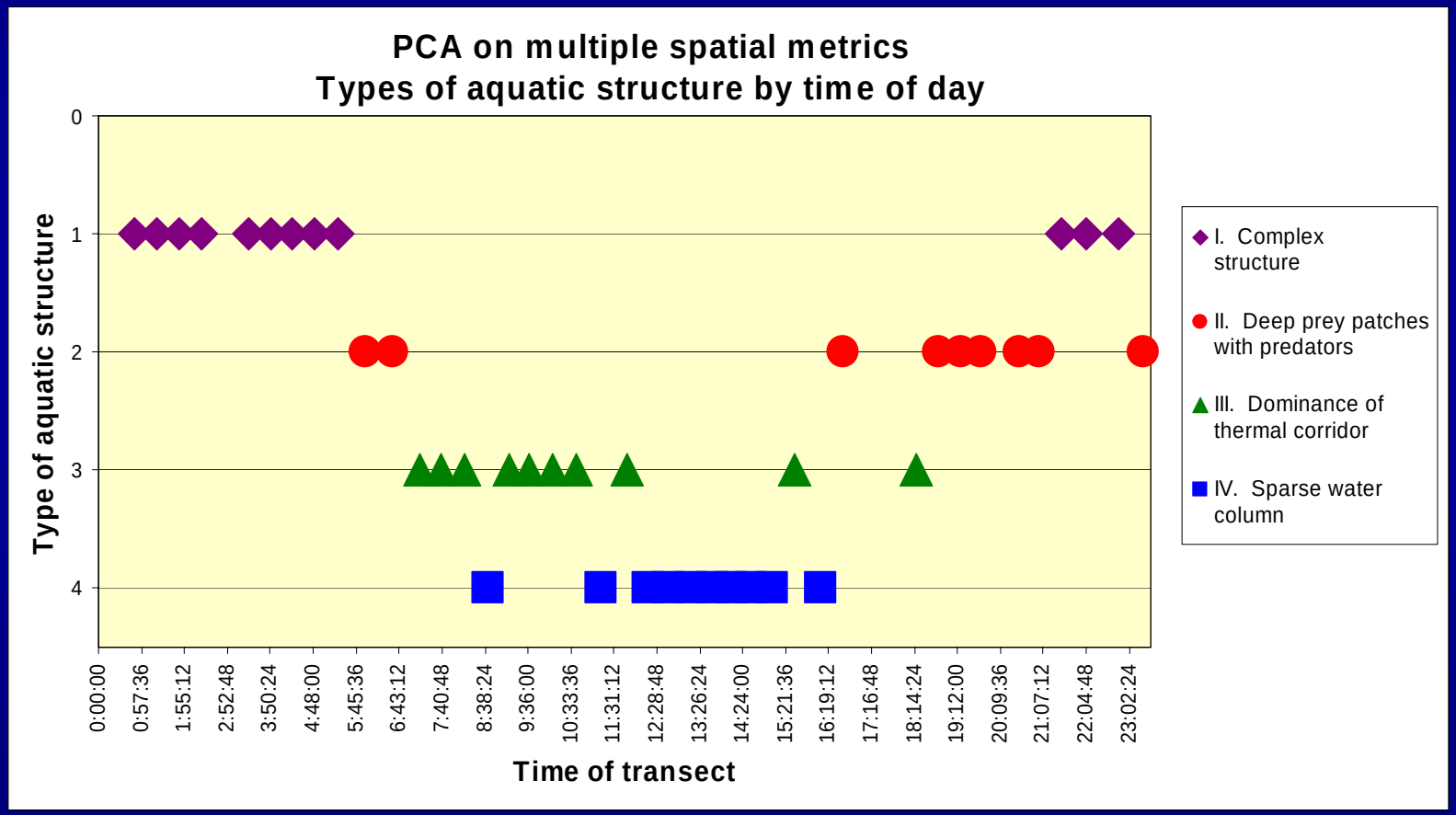
Mapping the water column



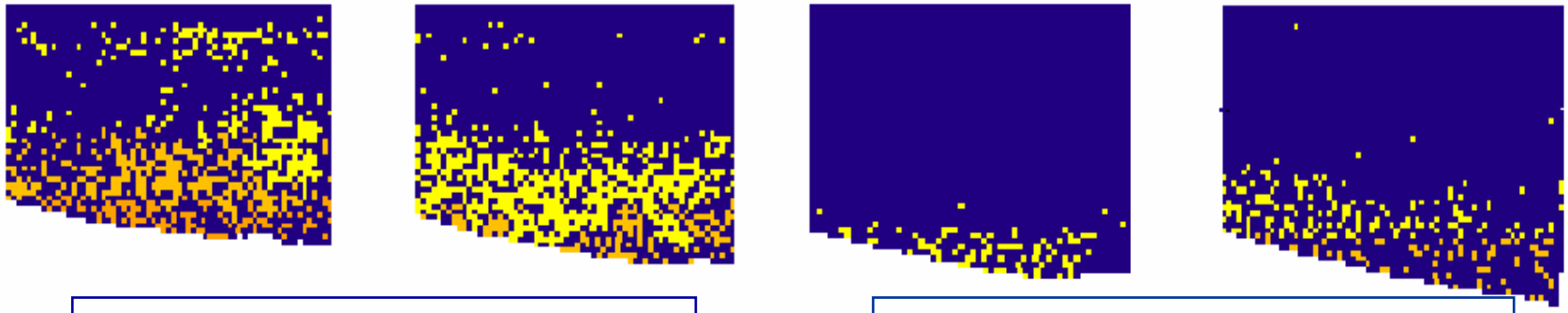
.001 #/m^3	.1 #/m^3	4° C	22° C	fish targets > 225mm
fish density		water temperature		predators

Quantify aquatic landscapes in <u>ecologically significant</u> terms.

Changes in aquatic structure with time of day



Transitional aquatic structure



Class I
3:20 am 4:20 am
Complex structure

Class II
7:45 pm 8:30 pm
Deep prey patches with predators

Spatial characteristics of biological and physical landscape elements distinguish one type of landscape from another.

Aquatic landscape structure

- The aquatic environment is a spatially structured landscape that can be quantified.
- Spatial characteristics distinguish one type of aquatic landscape from another.
- This spatial arrangement of resources may have ecological implications (eg. growth rates, predator avoidance).

Conclusions

- Application of spatial tools and statistics to support traditional statistics
- A spatial framework is beneficial in examining ecological processes