GeoCod

Geomatics for the Sustainable Management of Fish Stocks

La Geomatique au Service de la Gestion Durable des Stocks de Poissons

Fisheries mapping and interpolation

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GEOIDE

Goal

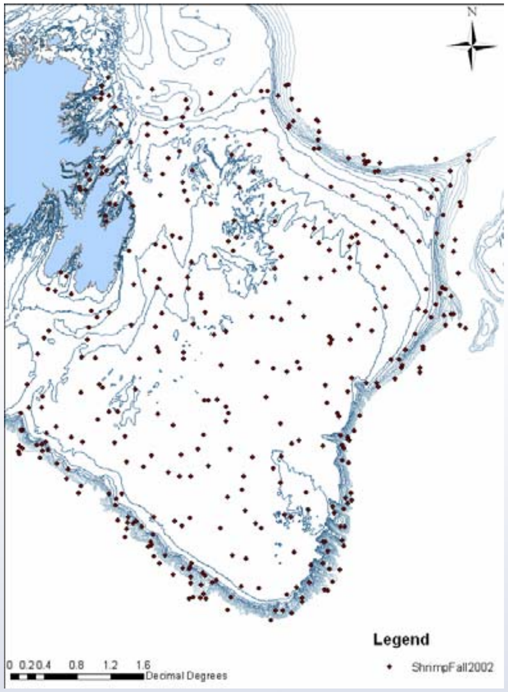
- Explore approaches to distribution characterization for species of interest in the NW Atlantic
- Factors to consider:
  - Descriptive power
  - Intuitive appeal
  - Utility for identifying change
  - Sensitivity to data skew
  - Sensitivity to sampling design

Data

- Species data
  - Trawl surveys (DFO Scientific Survey, NMFS)
    - catch weight (Kg)
    - catch number (individuals)
- Environmental data
  - CTD
    - Salinity (Bottom, surface)
    - Temperature (Bottom, surface)

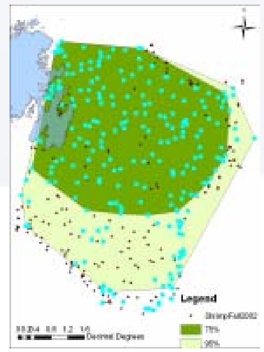
Data – Grand Banks subset

- Developed approach on shrimp and crab scientific survey data for region 3LNO (Grand Banks)

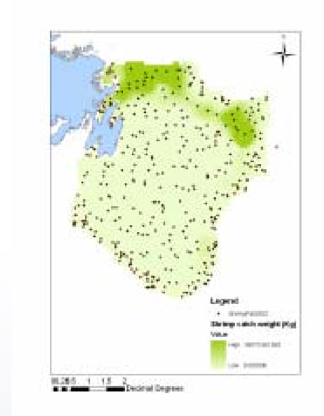


Spatial Characterization Methods

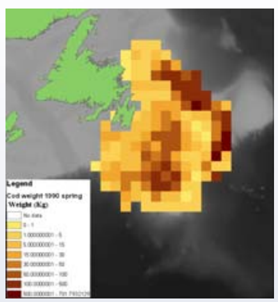
Minimum convex polygons

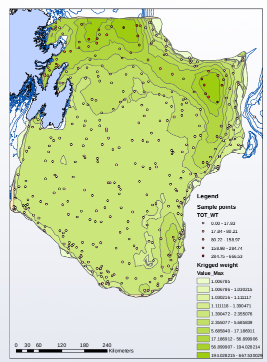


Kernel density estimation



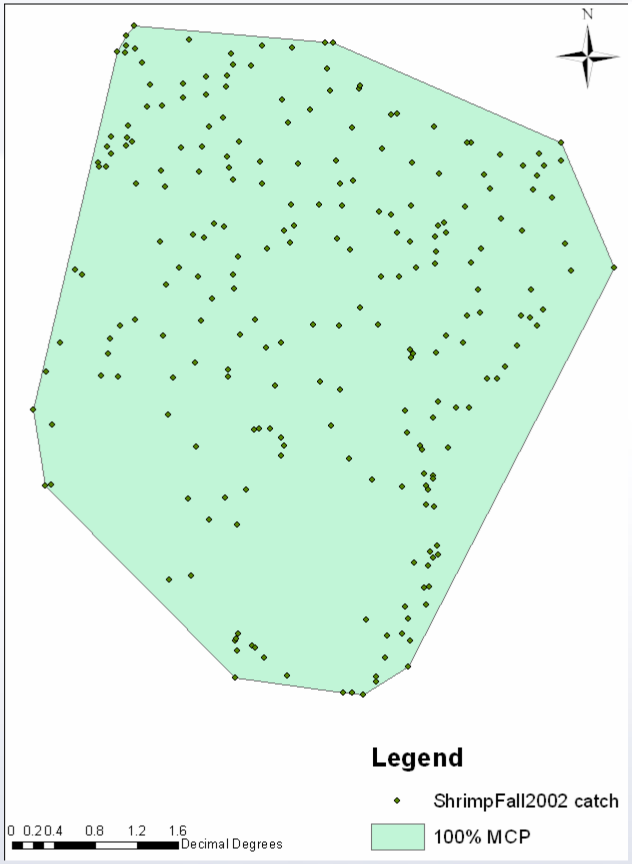
Kriging





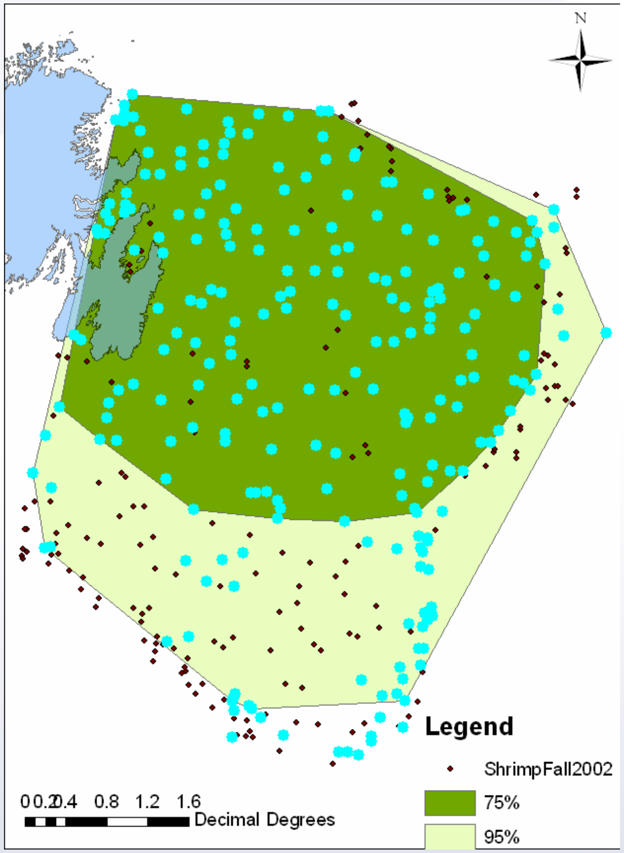
Minimum Convex Polygons (MCP)

- Polygon with smallest possible area surrounding positive catch points, with all outer vertices < 180°



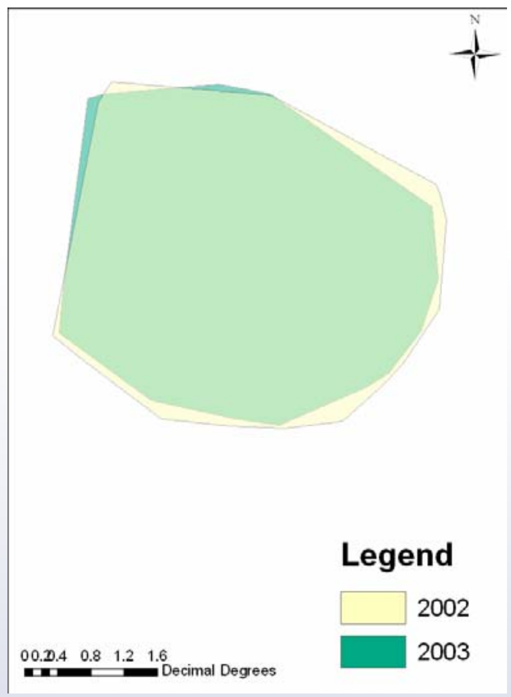
Minimum Convex Polygons (MCP)

- Proportion of points included may be varied to exclude Outliers and focus on distributioncore



Area change over time

- MCP allows for easy comparison of species range between years



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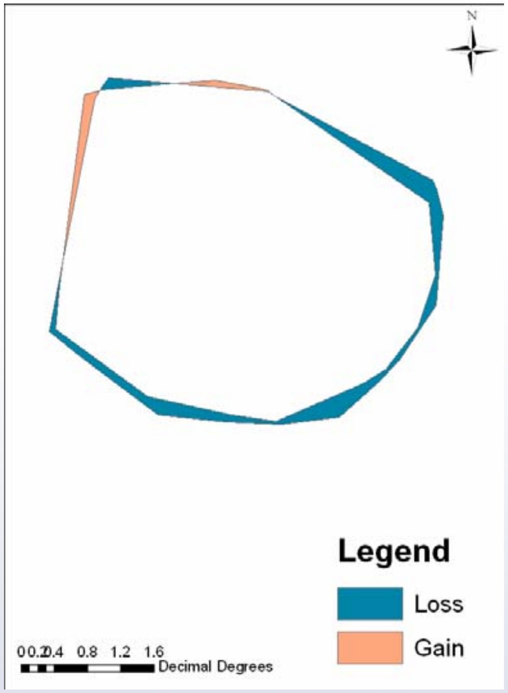
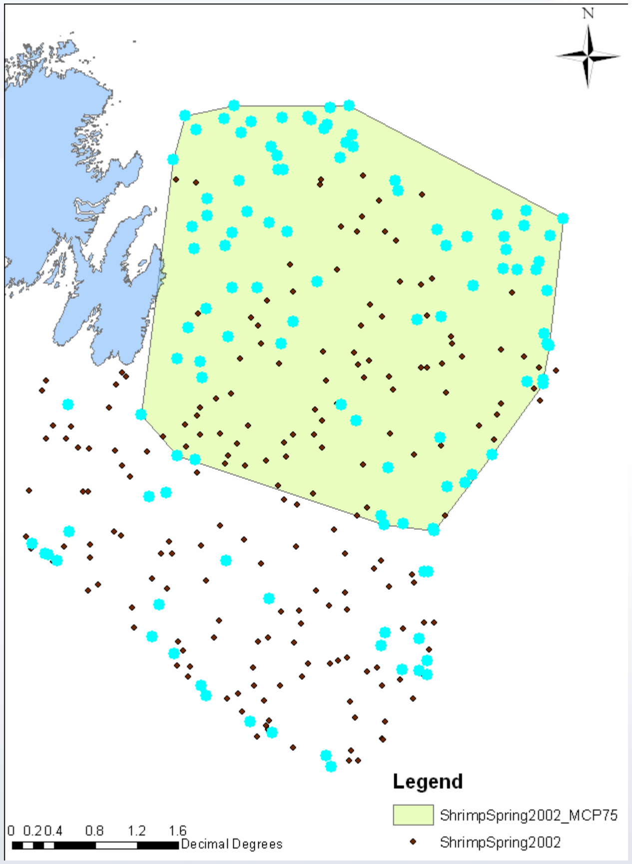


Area change over time

- MCP (100%) area changes in fall shrimp abundance, 1995-2005

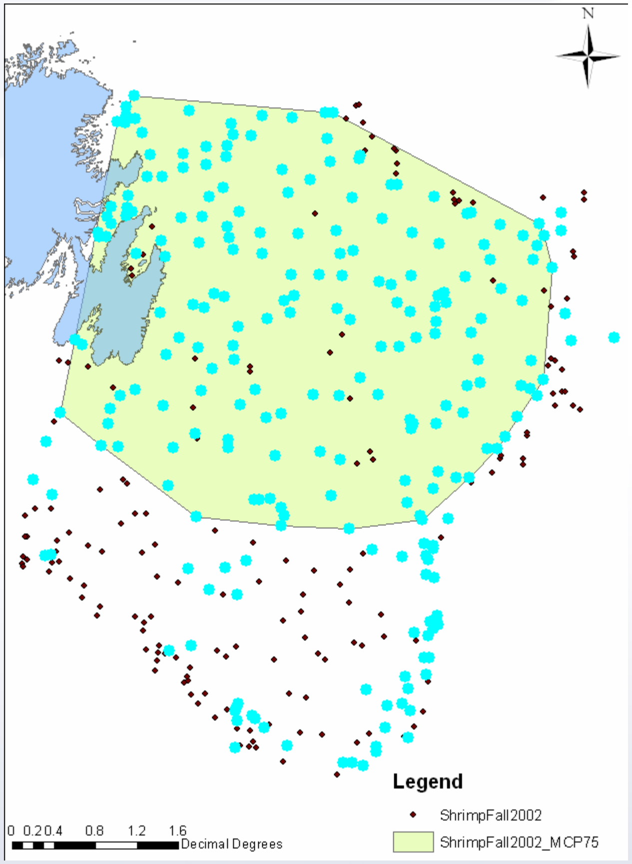
Minimum Convex Polygons (MCP)

- Strengths
  - Simplicity
  - Easy comparison across years
  - Intuitive appeal



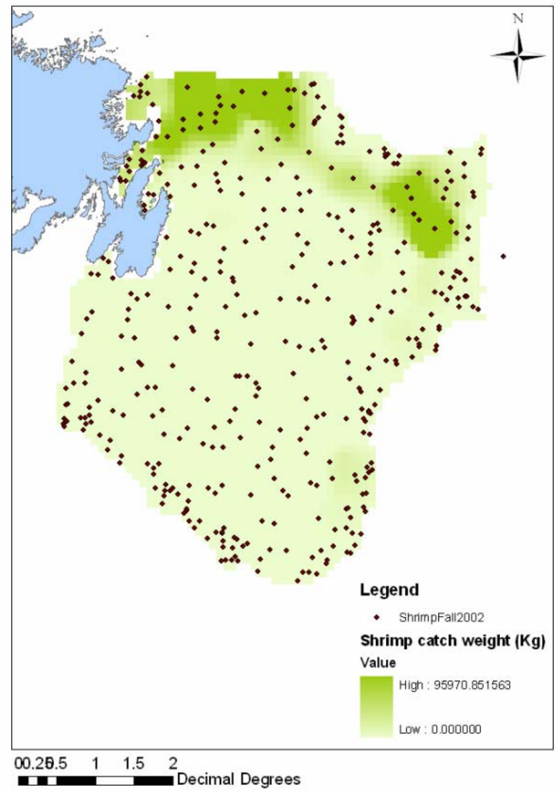
Minimum Convex Polygons (MCP)

- Weaknesses
  - sensitive to outliers
  - obscures intra-range variation in abundance
  - sensitive to differences in sampling effort and locational precision
  - difficulty capturing irregularly-shaped distributions



Kernel Density Estimation

- Produces probability density surface
- Gaussian kernel function at each data point
- 50 km bandwidth, 10 km cell



Kernel Density Estimation

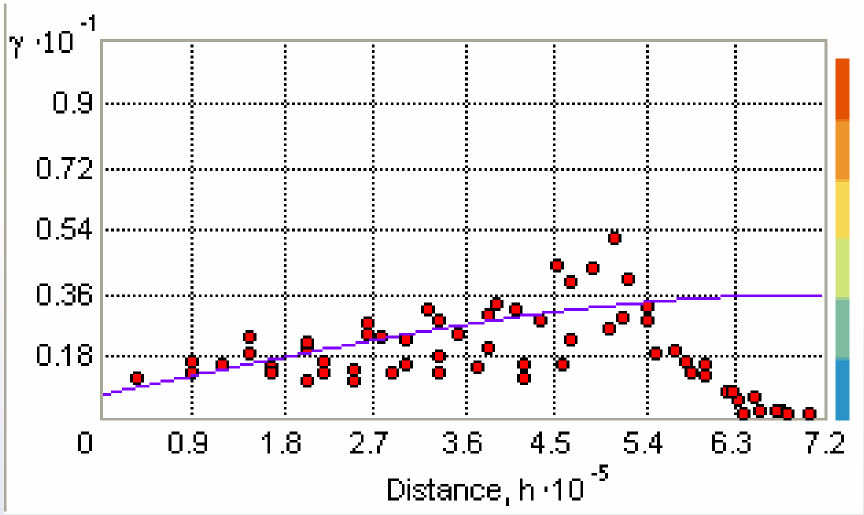
- Strengths
  - Incorporates magnitude (catch weight, number)
  - Easily implemented
  - Grid surface output
- Weaknesses
  - Doesn't account for spatial autocorrelation (density surface, not a spatial interpolation)
  - No estimation of uncertainty

Geostatistics

- Spatial dependence observed and modelled, then used to predict values at unsampled locations
- Two main components of geostatistics:
  - Variogram estimation
  - Kriging (interpolation)

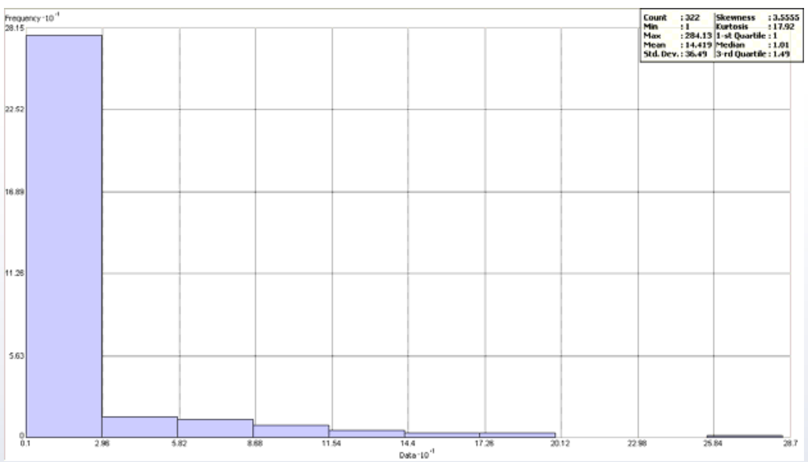
Geostatistics

- Assumptions
  - Spatial dependence
  - Stationarity
- Advantages
  - Anisotropy
  - Estimation error
  - Known to scientists
- Challenges
  - Complex trends
  - Right-skewed data

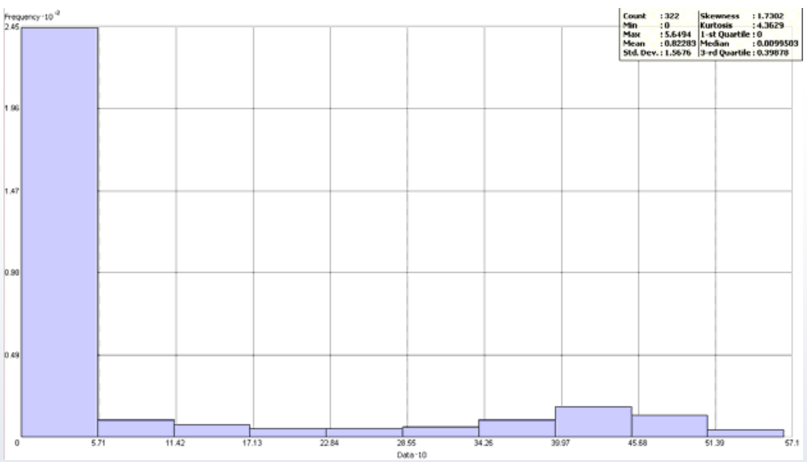


Geostatistics

- Log-transformation can be applied and log-normal kriging performed
  - However, log-transformation may not normalize fisheries data



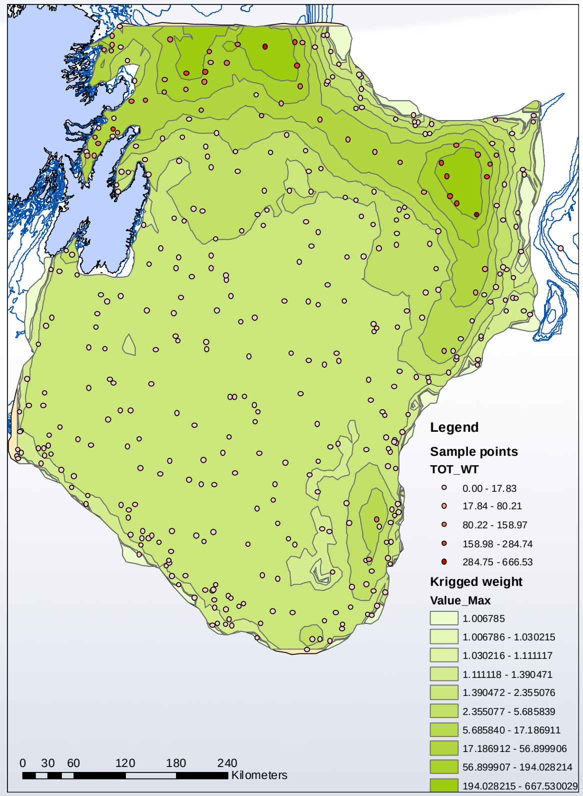
Shrimp catch weight
(Fall, 2004)



Transformed

Geostatistics

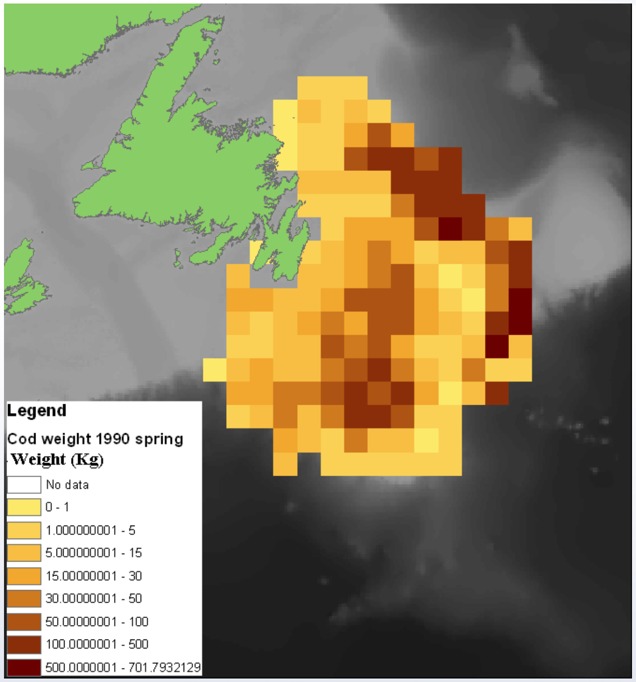
- Shrimp catch weight



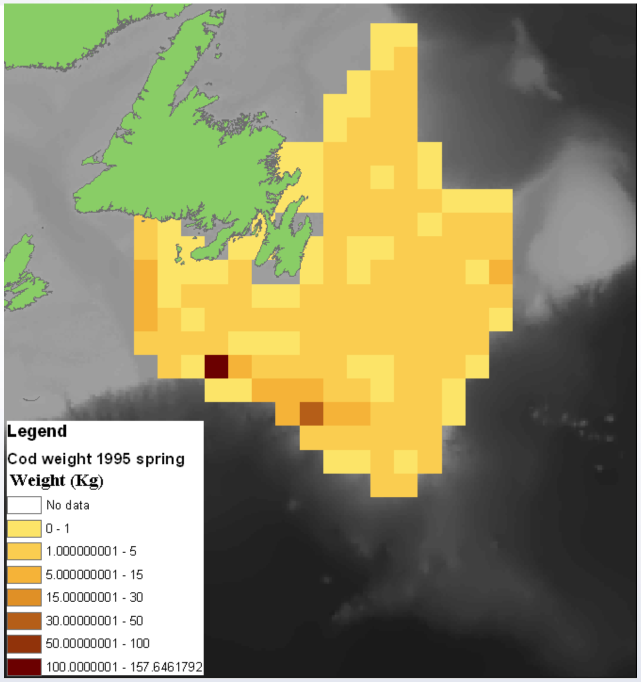
Fall 2002

Geostatistics

- Cod catch weight, spring (Apr-Jun)



1990



1995

Geostatistics

- Strengths
  - Accounts for spatial dependence structure, anisotropy
  - Can estimate uncertainty
  - Can incorporate prior knowledge

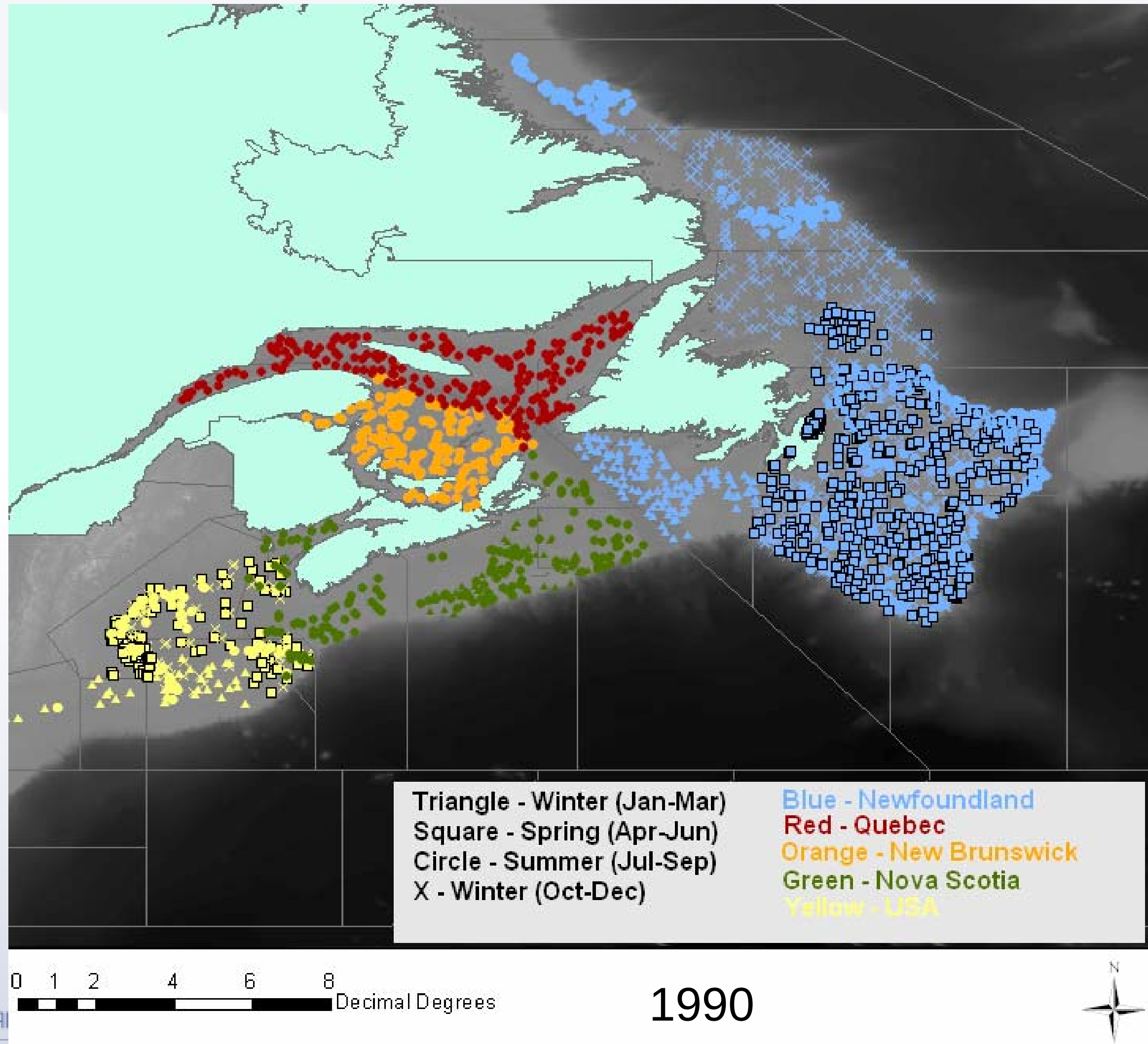
- Weaknesses
  - Less objective process
  - Complex implementation

Next step

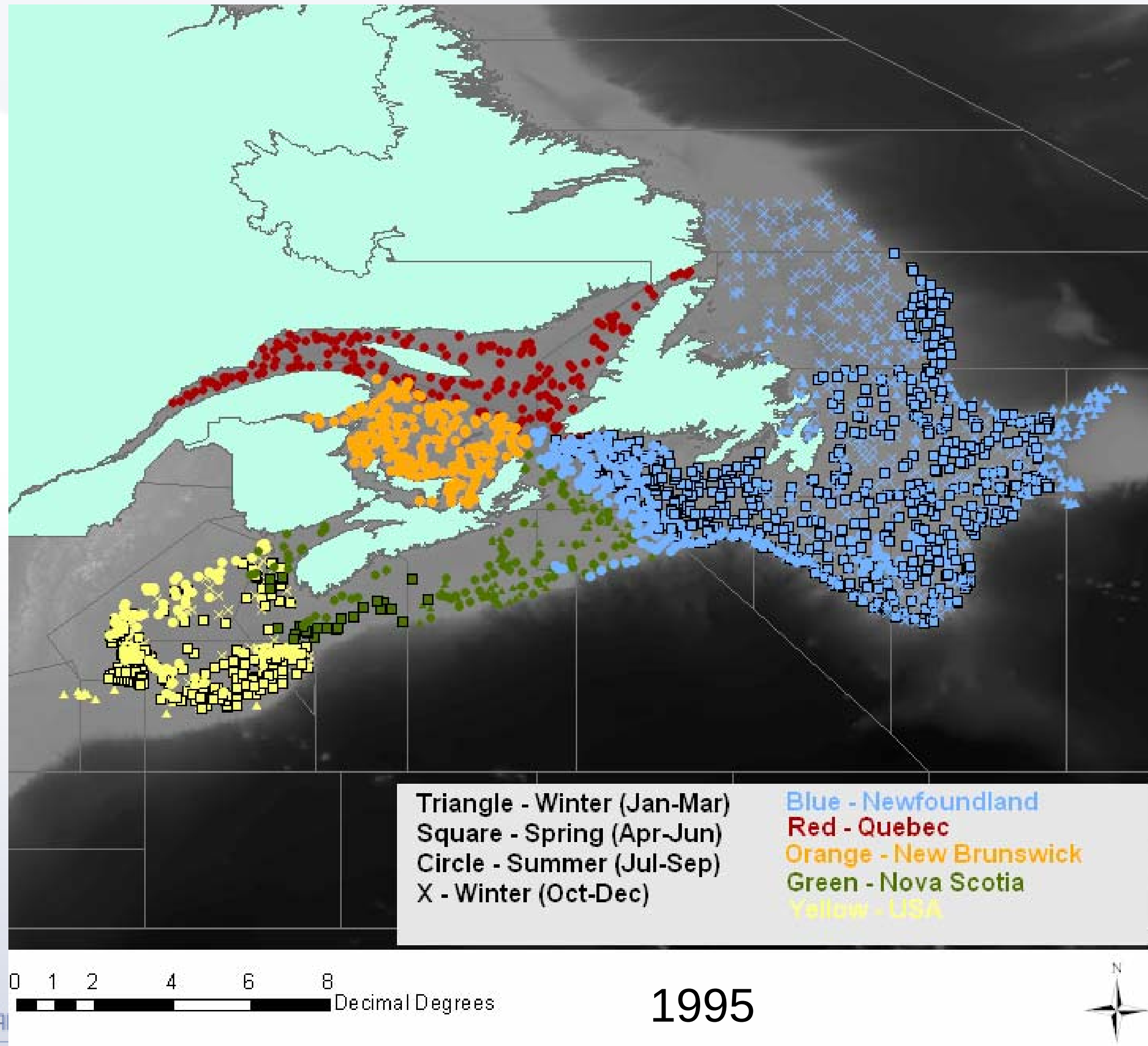
- Applying kriging to all study regions for all species of interest

- Challenges
  - Gear differences
  - Intra-annual temporal division
  - Lack of spatial continuity

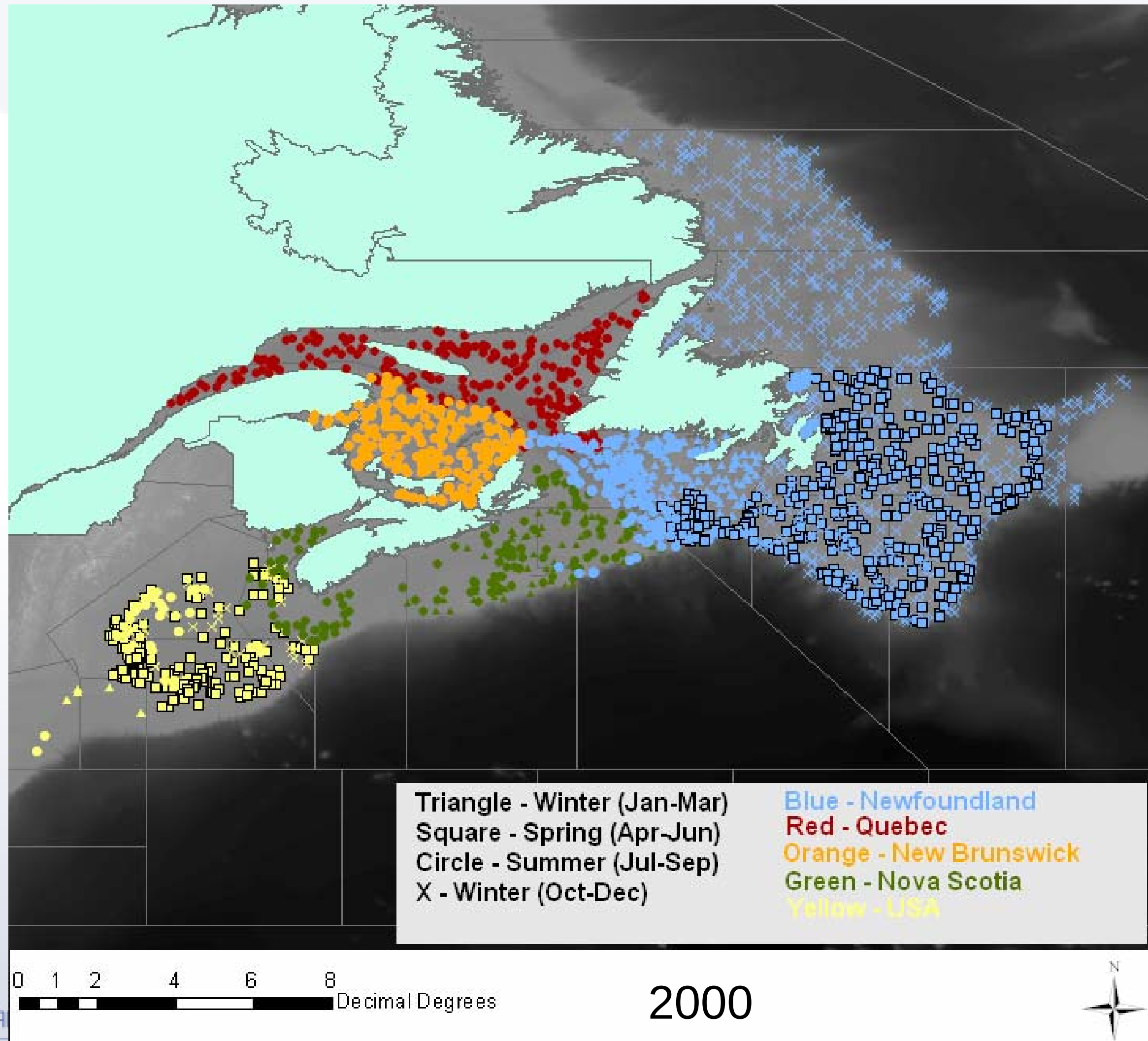
Seasonal division



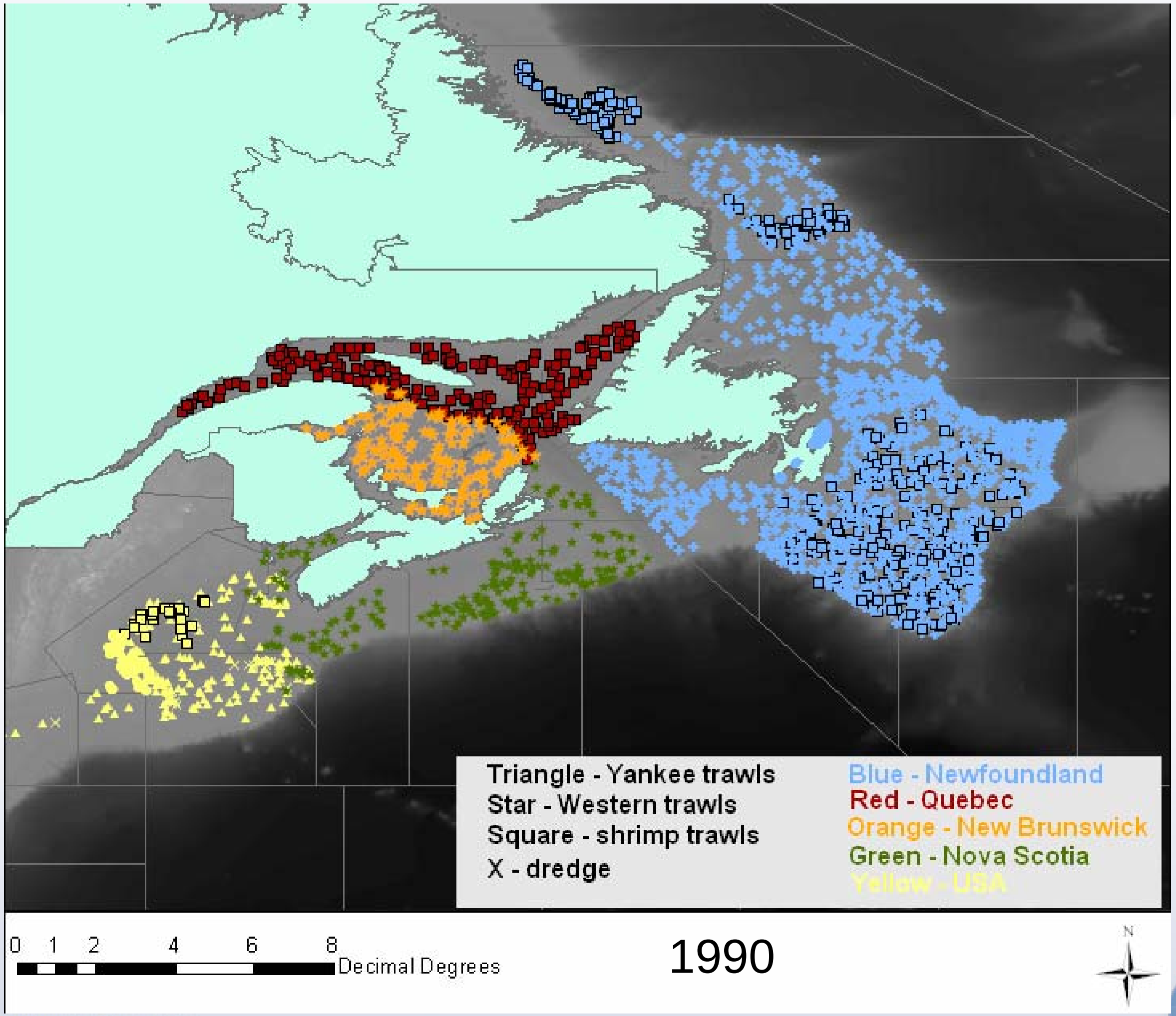
Seasonal division



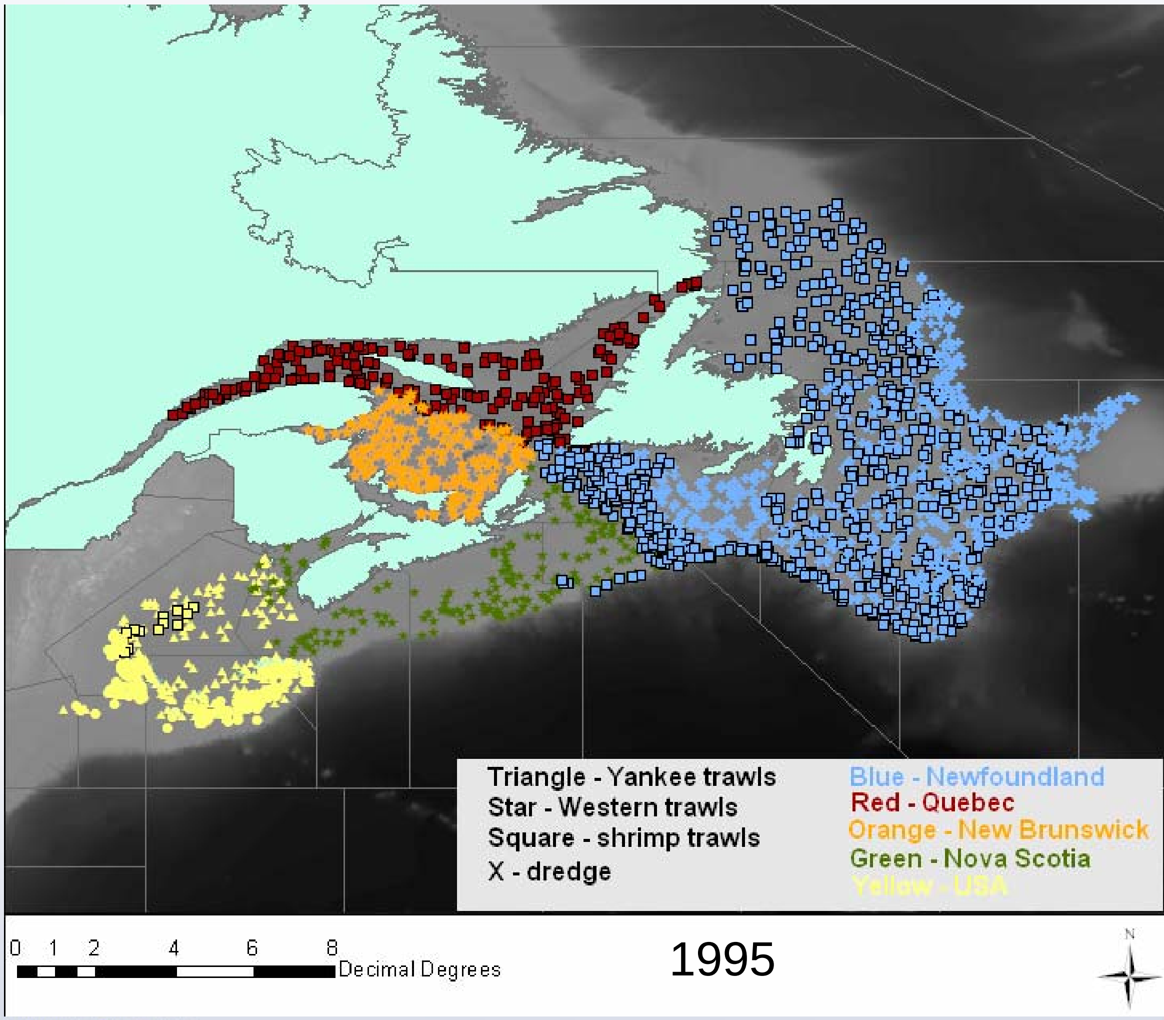
Seasonal division



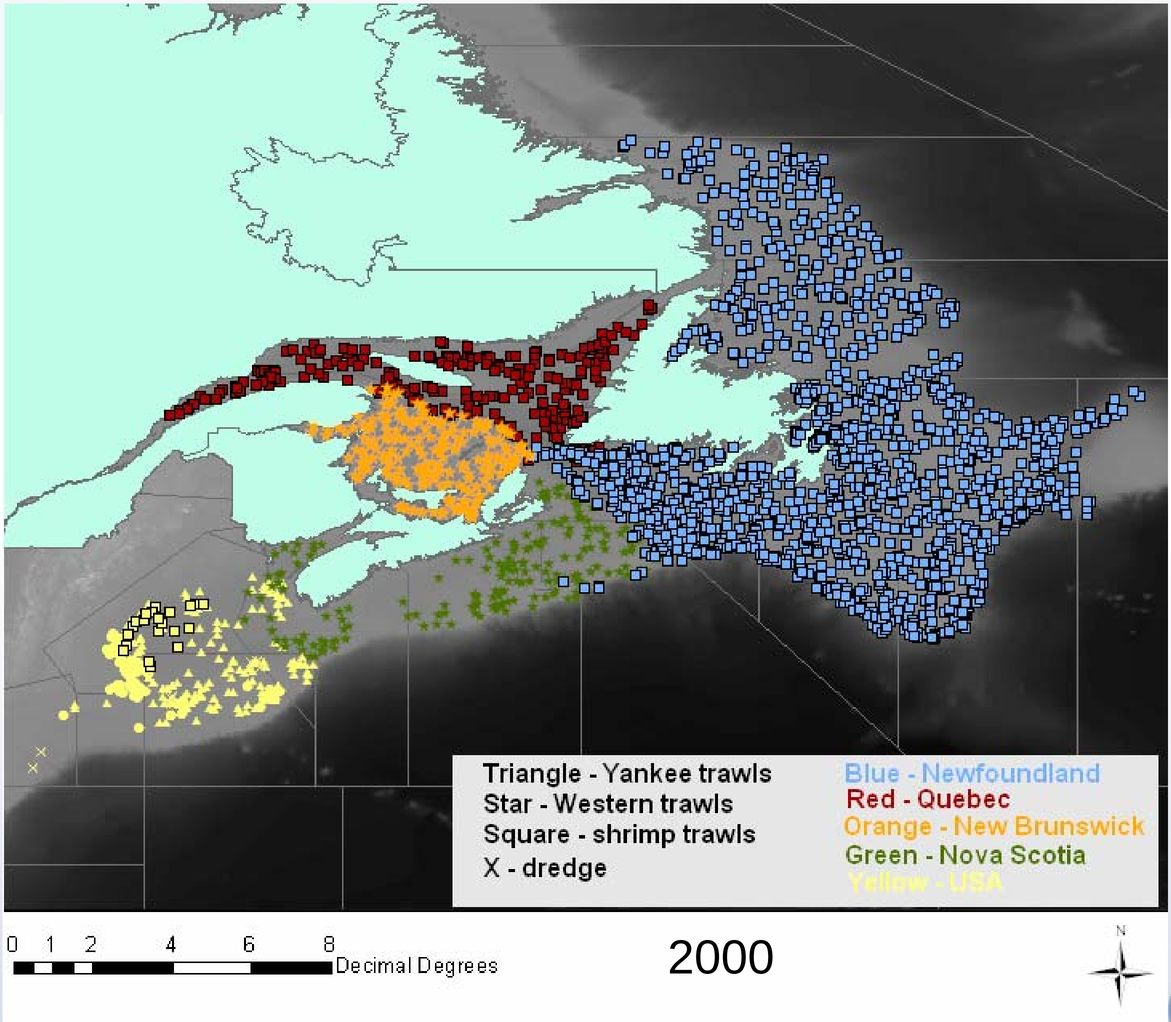
Gear differences



Gear differences



Gear differences



Gear differences

- Newfoundland
  - Otter trawls; Campelen shrimp trawl beginning 1995
- Nova Scotia
  - Yankee trawl 1970-81; Western trawl 1982-
- Quebec
  - Shrimp trawls (URI, Campelen)
- New Brunswick
  - Western trawl
- USA
  - Yankee trawl 36

Refinements to kriging approach

- Robust variogram estimators
  - Cressie (1980)
- Alternative measures of assessing fit
  - AIC (Akaike's Information Criterion)
  - GOF (Goodness of Fit)
  - Minimising function
- We invite your input!

Acknowledgements

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