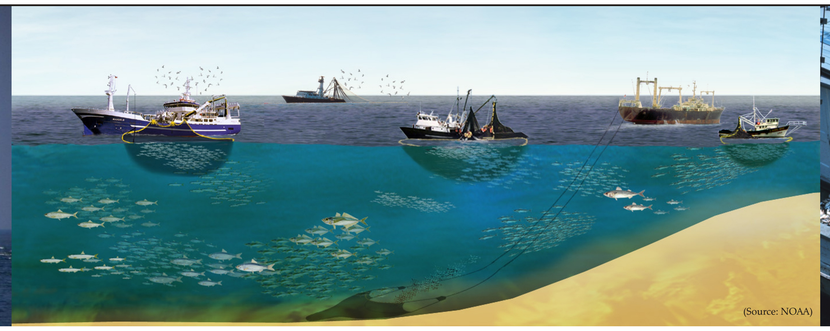




GeoCod : Geomatics for the Sustainable Management of Fish Stocks

GeoCod: La géomatique au service de la gestion durable des stocks de poissons

Rodolphe Devillers[1,2,3], Mir Abolfazl Mostafavi[2,3], Marie-Josée Fortin[4], George Rose[5], Stewart Fotheringham[6], Geoff Meaden[7], Valérie Carette[2,3], Scott Schoonbaert[1] & Matthew Windle[5]

1 Department of Geography, Memorial University of Newfoundland
2 Département des Sciences Géomatiques, Université Laval
3 Centre for Research in Geomatics (CRG), Université Laval
4 Department of Zoology, University of Toronto
5 Chair of Fisheries Conservation, Marine Institute and Department of Biology, Memorial University of Newfoundland
6 National Centre for Geocomputation, National University of Ireland at Maynooth, Ireland
7 Department of Geographical and Life Sciences, Canterbury Christ Church University, England

INTRODUCTION

More than 71% of the world's surface is covered by oceans. Canada has the world's longest coastline and the second largest continental shelf. About 23% of its population lives in coastal communities, many depending on the sea to make a living. Canada's oceans generate a considerable number of jobs and economic activity.

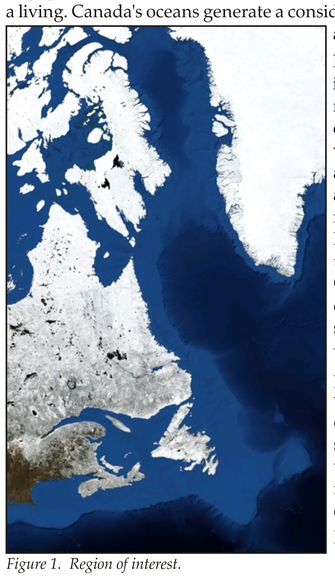


Figure 1. Region of interest.

However, fisheries worldwide are increasingly threatened by over-fishing, changes in ocean use, and climate change. About 70% of the world's fisheries are currently fished at or above their productive capacity, and many are depleted or are under reduced production regimes. International organisations such as the Food and Agriculture Organisation (FAO) predict that the demand for seafood will soon exceed supply.

With seafood being a major source of protein for more than a billion people worldwide, there is an urgent need to develop tools that provide timely synthesis of fish production in the world's oceans, recognizing the impacts of both environmental changes and direct human perturbations.

PROBLEMS

- High data heterogeneity:
  - Different data sources, formats - Different data structures (e.g. vector vs. raster)
  - 2D vs. 3D data
  - Different semantic/classification
  - Irregular sample distribution in space and time
  - Different sampling methodologies
  - Different scales
- Correlation between several variables

OBJECTIVES

GeoCod's objective is to develop a spatial decision-support system that will enable fishery managers in the Northwest Atlantic to (1) gain an integrated understanding of changing marine ecosystems and (2) to provide support for the development of new fisheries and ocean policies.

Specific objectives:

- To integrate heterogeneous fisheries and environmental data into a single data model.
- To use spatial statistics to analyze the variations in abundance and distribution of cod, capelin, snow crab and shrimp in relation to fisheries and climate change.
- To develop spatio-temporal visualisation tools to help decision-makers gain better insight into dynamic relationships between species distributions/abundances and the environment.

APPROACH

Data sources → **Integration and management** → **Analysis** → **Visualisation/understanding**

- **Oceanographic** (Temperature, salinity, dissolved nutrients, bathymetry, ...)

Figure 2. Water analyses using a CTD (Source: NOAA).

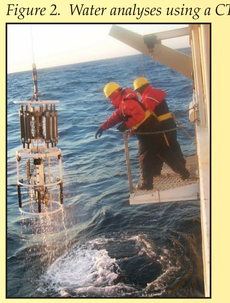


Figure 3. CTD temperature data in 2004.

- **Biological** (Scientific surveys, Fisheries observer program, ...)

Figure 4. Fisheries research.

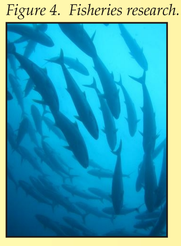
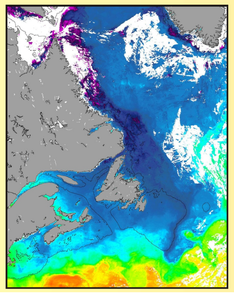


Figure 5. Commercial fishing operations.

- **Remote Sensing** (Primary productivity, sea-ice, ...)

Figure 6. Sea-surface temperature (source: DFO).



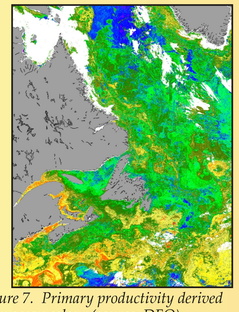
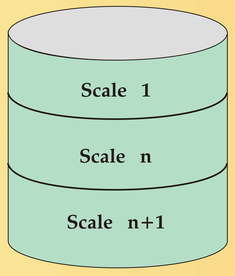


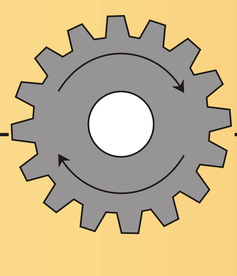
Figure 7. Primary productivity derived from ocean colour (source: DFO).

Spatial, Temporal and Semantic Integration



Interpolation
- stratified kriging

Spatial statistics
- local (Moran/Getis)
- geographically weighted regressions (GWR)



Cod catches, Grand Banks of Newfoundland.

a.

b.

c.

Figure 8a; 8b; 8c. Spatio-temporal visualisation of fisheries (source: Rose, 2006).

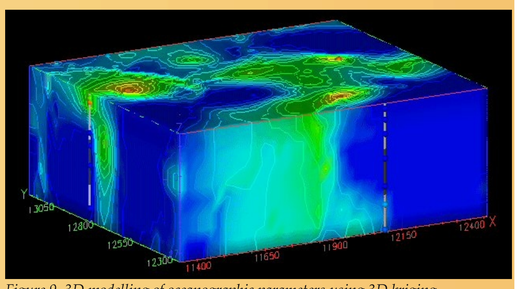


Figure 9. 3D modelling of oceanographic parameters using 3D kriging (source: EVS).

ANTICIPATED RESULTS

Several results are anticipated from this project:

- greater precision in the time-series of fisheries surveys and stock assessments on which harvest rates are based;
- preliminary indication of trophic relationship variations in marine ecosystems in the study area;
- enhanced understanding of fisheries and potential effects of ecosystem-level environmental and climate changes on fish stock distribution as well as indirect effects on stock assessments;
- more timely integration of fisheries and climate data into an analytical geospatial system;
- more timely and readily available representation of data to industry and government managers and decision-makers to assist management in decision-making towards sustainable fisheries.

CONCLUSIONS

By integrating various environmental and fisheries data and using different geomatics approaches, the GeoCod project aims to develop a "big picture" of the recent distribution and abundance of fish stocks and their relationships with fisheries and environmental changes in the NW Atlantic region. Having this big picture will improve our understanding of fish stocks dynamics and provide advice for more sustainable fisheries.

REFERENCES

Rose, G.A. 2006. "The Newfoundland Fisheries: An Ecological History"
Breakwater Books (*in press*).