COUNTRY: NORWAY

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Project title:

ECOBE – Effects of North Atlantic Climate Variability on the Barents Sea Ecosystem

Source of Information:

Dr Geir Ottersen, August 2003

Project Manager:

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Project Goal:

Understand and quantify the impacts of Arctic climate variability on trophic transfer and ecosystem structure of the Barents Sea in order to improve the prediction of growth and recruitment on key fish species.

Project Description:

The project addresses how Arctic climate variability and change influence biomass production and trophic transfer in Barents sea ecosystem. The population of copepods in the Norwegian Sea, particularly the *Calanus finmarchicus*, plays a key role in the transformation of biomass from lower to higher trophic levels in the Arctic. The advection of copepod-rich water from the Norwegian Sea into the Barents Sea is hypothesized to be of great importance to the Barents Sea biomass production. The first emphasis will be on analyses of a large variety of time series from hydrography, currents, zooplankton, to 0-group fish, in addition to paleo data on water mass properties. The second emphasis will be on development of a model system that integrates and quantifies the effects of climate variability on biomass preduction and trophic transfer from copepods to fish recruitment. The model results will be evaluated against time series on abundance and distribution of 0-group fish. The project is an interdisciplinary approach with 7 partner institutions.

Website:

http://ecobe.imr.no/

System Types Studied:

Northern Norwegian Shelf
Barents Sea

Target Organisms:

Gadus morhua (cod)
Mallotus villosus (capelin)
Clupea harengus (Norwegian spring-spawning herring)
Melanogrammus aeglefinnus (haddock)
Calanus finmarchicus

Physical Processes Examined:

Ocean climate fluctuations: sea temperature; wind mixing; turbulence; vertical stability; light conditions; advection of water masses

Key Questions, Hypotheses and Issues:

- Explore the linkages between large-scale weather patterns, such as the NAO, and the regional and local climate, and investigate how such patterns cascades into spatio-temporal changes in the ocean climate parameters that are of importance for biomass production.
- Explore the effects of ocean climate and circulation on the production and advection of Calanus finmarchicus onto the northern Norwegian Shelf and the Barents Sea.
- Develop an integrated model system based on first-principles physics and biology to simulate distribution, transport, growth and survival of fish larvae from the spawning areas in spring to 0-group distribution in autumn when year-class strengths are largely determined.
- Develop egg production models for the key fish species, with special focus on Arcto-Norwegian cod, Arcto-Norwegian haddock and Norwegian spring-spawning herring, based on the combined effects of food abundance and temperature on gonad production and maturation.
- Develop a trophodynamic model system that integrates the models described above to simulate growth and recruitment of Barents Sea fish stocks.

Participating Institutions:

Aalesund University College
Geophysical Institute, University of Bergen
Institute of Fisheries and Marine Biology, University of Bergen
Institute of Marine Research, Bergen
Nansen Environmental and Remote Sensing Centre, Bergen
Physical Institute, University of Oslo
Bjerknes Centre for Climate Research

Duration:

2003-2006

Budget:

50,030,000 NOK

Funding Agency:

Research Council of Norway

Project title:

CLIMAR – Climate and Production of Marine Resources

Source of Information:

Dr Geir Ottersen, August 2003

Project Manager:

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Project Description:

From a stock size of >12MT in the mid-20th century, the Norwegian spring spawning herring was driven almost to extinction in the early 1970's, with significant social, economic and ecological consequences. The stock began to recover in the 1990's, but with radically different seasonal migration patterns from those prior to the collapse. There is provisional evidence for a link between the stock collapse and an abrupt change in North Atlantic climate that occurred in the mid- 1960's.

This project will analyse available long term time series of herring growth and abundance in relation to climate, hydrography and biological production at lower trophic levels. The project will seek a process orientated oceanographic and ecological justification for the statistical relationship between herring and climate, and develop state-of-the-art mathematical models to aid prediction of the consequences of climate changes in the future.

The project will comprise three interlinked tasks, split into smaller sub-tasks:

1. Historical data analysis

   assemble the oceanographic and plankton data from surveys in the 1960's – 1990's which have not been fully analyses,

   assemble data from the 1930's to the 1990's on herring individual weight,

   conduct statistical time series analyses f the hydrographic, plankton and fisheries data to identify trends, and covariance between climatic factors, plankton and the characteristics of the herring stock.

2. Targeted process studies
   i) obtain large scale data on interannual variability in *Calanus* production, herring migration and feeding in relation to water mass distribution and circulation,

   explore the relationship between migration and feeding of herring and the temporal and spatial characteristics of *Calanus* production,

   relate interannual variability in *Calanus* production and herring feeding to climate.

3. Development of ecological models
   i) simulate the 3-dimensional ocean circulation, temperature, salinity, and primary production of the Nordic Sea using an existing hydrodynamic model, for contrasting climate phases in the second half of the 20th century, and for possible future climate scenarios,
   ii) analyse the numerical results to gain insight and to quantify the differences in the marine climate (circulation, temperature, salinity, primary production) between the simulated periods of contrasting climate phases and for future climate scenarios,
   iii) develop a 3-dimensional population dynamics model of *Calanus*, driven by output from the circulation model, to simulate patterns of production and abundance under the contrasting climate phases,
   iv) develop an individual based model of herring feeding and migration for coupling to the *Calanus* population model, to simulate the fluctuations in condition and migration patterns of herring in the Nordic Seas under contrasting phases of climate,
   v) evaluate the performance of the models by comparison with historical data, and conduct prognoses of the likely state of the *Calanus*-herring ecosystem under possible future climate scenarios.

System Types Studied:

Ecosystem of the Nordic Seas (Norwegian, Icelandic and Greenland Seas)

Target Organisms:

Clupea harengus (Norwegian spring-spawning herring)
Calanus spp.

Physical Processes Examined:

Climate variability
Ocean circulation

Key Questions, Hypotheses and Issues:

1. Establish the processes which constitute the coupling between climate fluctuations and the growth and migration patterns of the Norwegian spring spawning herring in the Nordic Seas.
2. Develop models of the oceanography, plankton food web, and fish growth and migration that will allow a quantitative analysis of the climatic factors involved, and prognoses of the consequences of future climate scenarios.

Number of scientists and fte:

6

Participating Institutions:

Institute of Marine Research
University of Bergen
University of Oslo

Duration:

2003 – 2006

Budget:

14,305,000 NOK

Funding Agency:

The Research Council of Norway

Project title:

ADAPT – Adaptation to the Ecosystem: Co-evolution of Life Histories and *Calanus* and Herring in the Norwegian Sea (ADAPT)

Source of Information:

Dr Geir Ottersen, August 2003

Project Manager:

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Project Description:

At present, there exists a conceptual model of the effects of the physical and seasonal environment in the Norwegian Sea on the feeding behaviour, vertical and horizontal migrations, growth and life cycle of *Calanus finmarchicus* and herring, and also of the effects of these two populations upon each other. ADAPT aims at exploring this model in detail, and move from a conceptual to a numerical model of the adaptation of these two populations to the environment and each other. ADAPT will also challenge the conceptual model by analysis of field data for the hydrography-phytoplankton-*Calanus* and the *Calanus*-herring interactions. The quality of the numerical model will be studied by comparison with the field data. An adaptive model of several trophic levels in a large-scale ecosystem has not been attempted before. A numerical simulations model of hydrodynamics, phytoplankton, zooplankton and fish will be valuable for later studies of the impact on environmental variation and change.

System Types Studied:

Norwegian Sea ecosystem

Target Organisms:

Calanus finmarchicus
Clupea harengus (Norwegian Spring-Spawning herring)

Key Questions, Hypotheses and Issues:

ADAPT aims at quantifying the effects of the physical environment and the other biological population for the evolutionary adaptation of the populations of *Calanus finmarchicus* and Norwegian spring spawning herring in the Norwegian Sea. The project consists of two parts, which through filed work and modelling, respectively, both will address these two sub-goals:

- Demonstrate the effects of the seasonality and physical environment on the life histories and spatial behaviour of *C. finmarchicus* and herring
- Quantifying the effect of the other adaptive population on the behaviour and life history of the same two populations.

Number of scientists and fte:

6

Participating Institutions:

Institute of Marine Research, Bergen
University of Bergen
University of Oslo

Duration:

2003-2006

Funding Agency:

The Research Council of Norway