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Ecosystem dynamics and fisheries management in the Barents Sea

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Crucial changes in the Barents Sea ecosystem are induced by harvesting and development fisheries management

1. The sharp reduction of marine mammals in XIX century.

Management measures were introduced but this was too late.

2. The over-exploitation of demercial stocks of fish by trawl fisheries (1950-1960ies)

Technical regulation management measures were introduced.

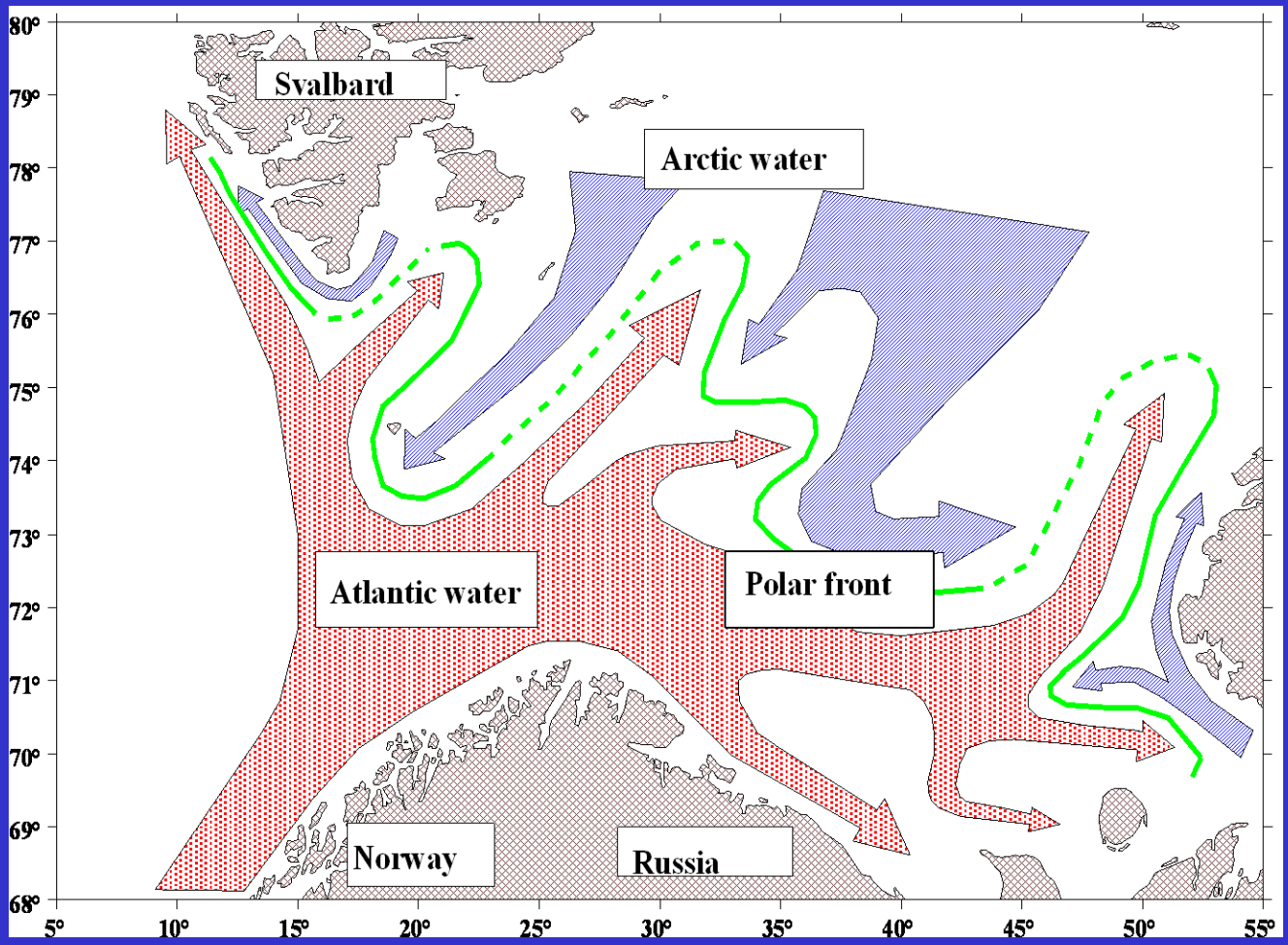
3. The extending of harvesting from top predators to the intermediate trophic level (fisheries of capelin, polar cod, shrimp) (1970-1980ies).

Single-species oriented fisheries management system was introduced that includes both TAC and technical means for the protection of juveniles.

4. Dependence of ecosystem stability in the Barents Sea on fisheries management (since 1980ies).

Development of the multispecies and ecosystem approaches to fisheries management

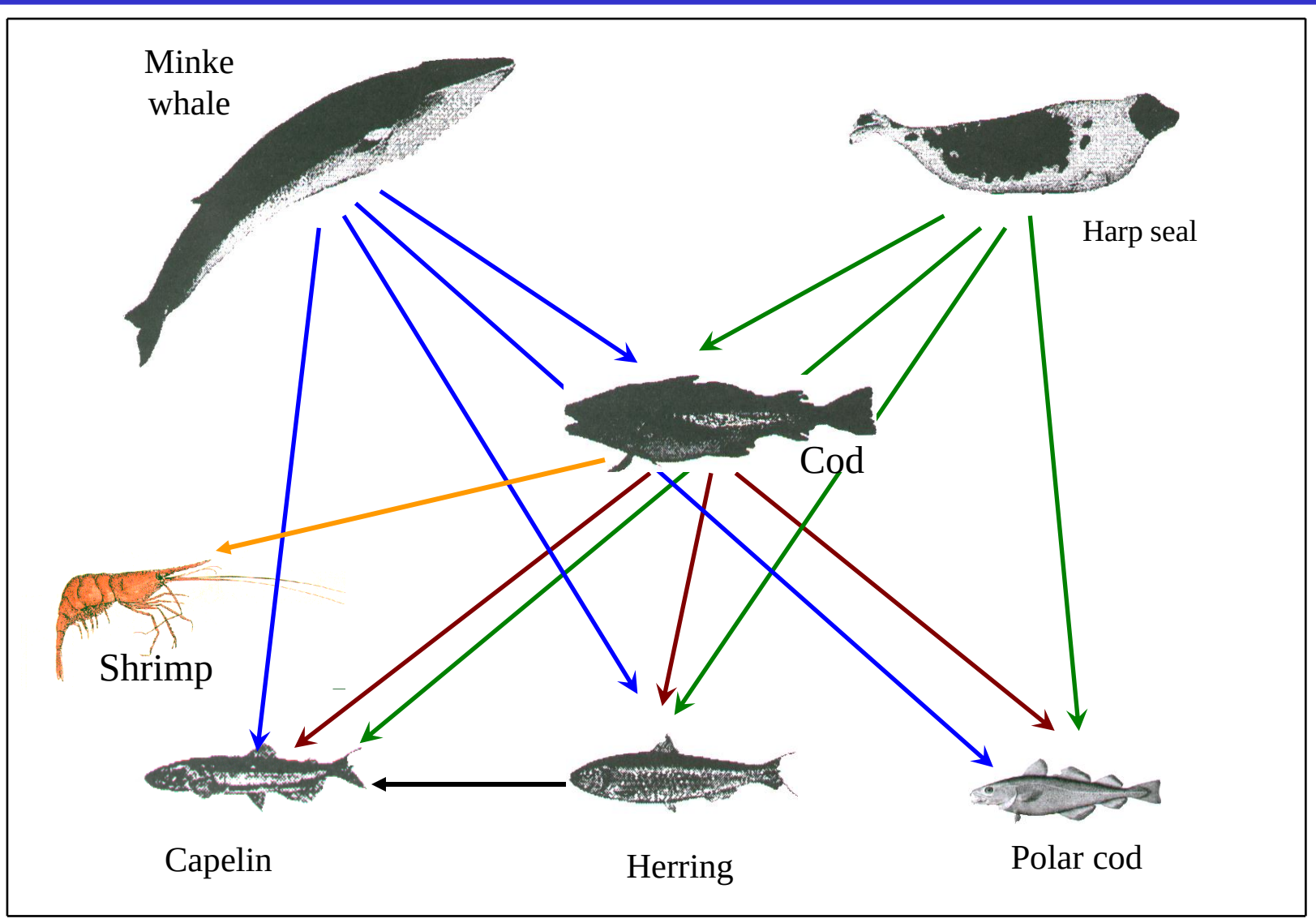
Main features of the circulation of the Barents Sea



Composition and distribution of species in the Barents Sea depends considerably on the position of the polar front

Variation in the recruitment of most species has been associated with changes in the influx of Atlantic waters into the Barents Sea

Trophic interactions of the main commercial species in the Barents Sea



Management of the fisheries in the Barents Sea

Monitoring researchers

Catch statistics

ICES WG

ACFM

Joint Russian-Norwegian Fishery Commission

Cooperation between IMR and PINRO on implication of ecosystem information for fisheries management in the Barents Sea

1. Joint report

   The state of the Barents Sea ecosystem, with expected situation and considerations for management

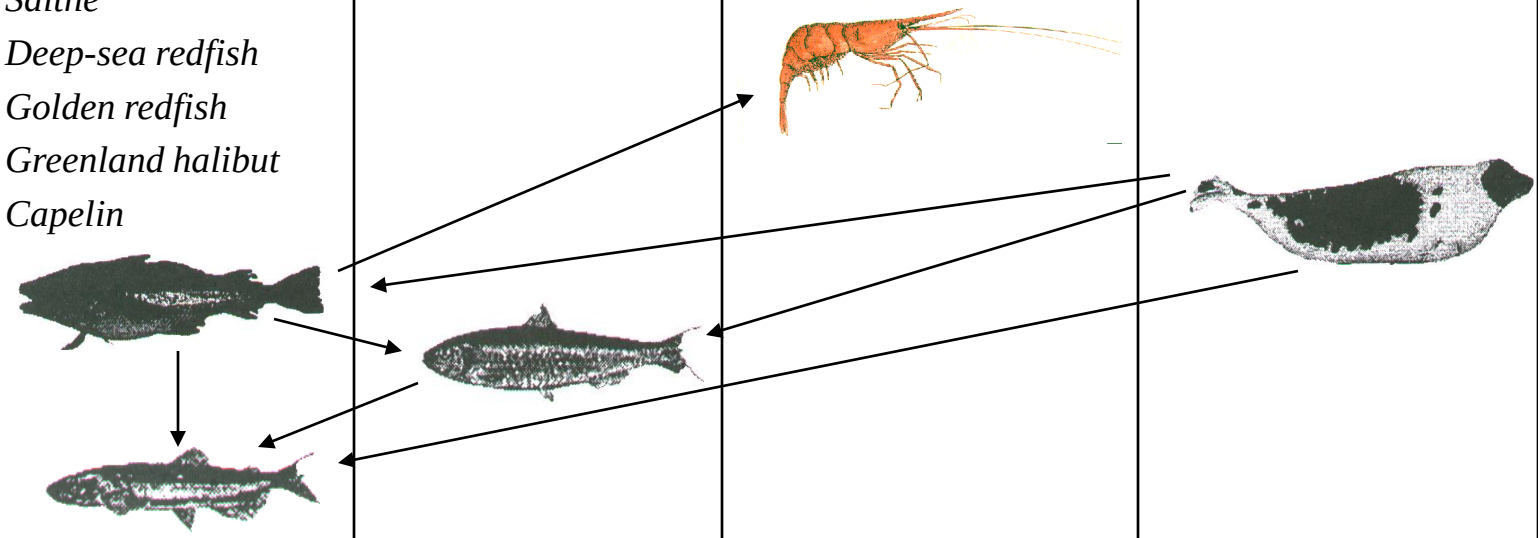
2. Joint project

   Optimal long-term harvest in the Barents Sea Ecosystem

   The project is divided into two phases, where during the first phase (2005-2007) empirical relations will be used to evaluate prospects for long-term yield of cod and during the second phase other species will be included (2008-2014).

ICES WG responsible for the stock assessments and management advice for the commercial species in the Barents Sea

AFWG	WGNPBW	WGPAND	WGHARP
Cod *Haddock* *Saithe* *Deep-sea redfish* *Golden redfish* *Greenland halibut* *Capelin*	*Herring* *Blue whiting*	*Shrimp*	*Harp seals*



The arrows shows interspecies interactions

Our knowledge base

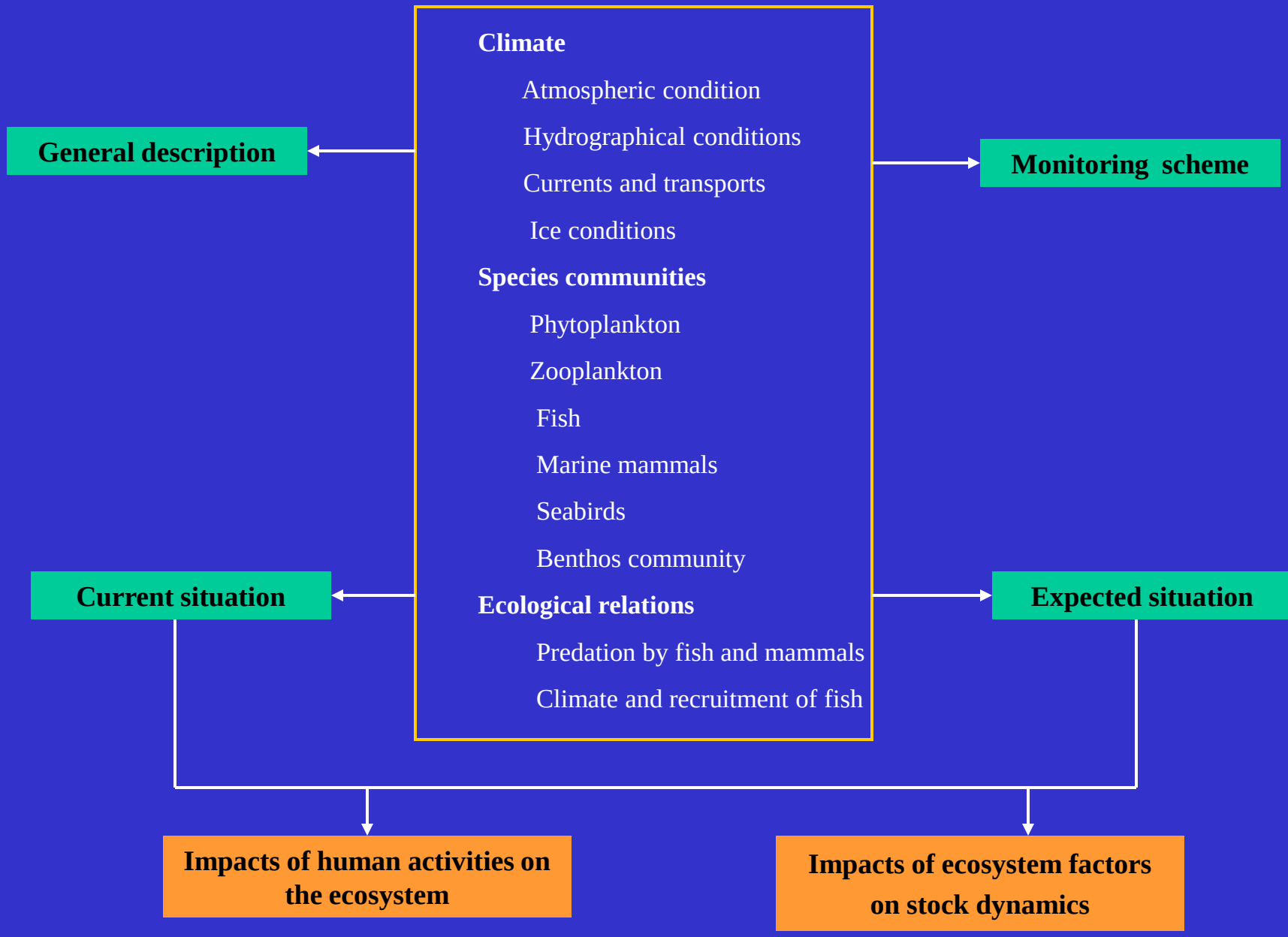
IMR and PINRO
36 co-authors
122 pages

General part
- Climate, plankton, fish, mammals, benthos, interactions

Present part
- Climate, plankton, fish, mammals, benthos, interactions

Monitoring
Pollution
Fishery impact

Structure of ecosystem report for the AFWG



Methods and tools to implication of ecosystem information in the Barents Sea fisheries management

1. Qualitative estimations of ecosystem impact on population parameters commercial species
2. Statistical models
   - *Recruitment of commercial fish*
   - *Growth of fish*
   - *Natural mortality (cannibalism)*
3. Multispecies models
   - *EcoCod*
   - *Bifrost*
   - *Gadget*
   - *STOCOBAR*
4. Numerical models for simulation the drift of fish eggs and larvae
5. Including data on cod predation into stock assessment of cod and haddock.
6. Including data on cod predation into estimation of TAC for capelin

Using ecosystem information in prognosis of stock dynamics in the Barents Sea

Short- and medium-term prognosis

Prediction of NEA cod stock parameters by STOCOBAR model

Prediction of recruitment by regression models

Expected stock parameters based on qualitative analysis of ecosystem impact

Long-term prediction

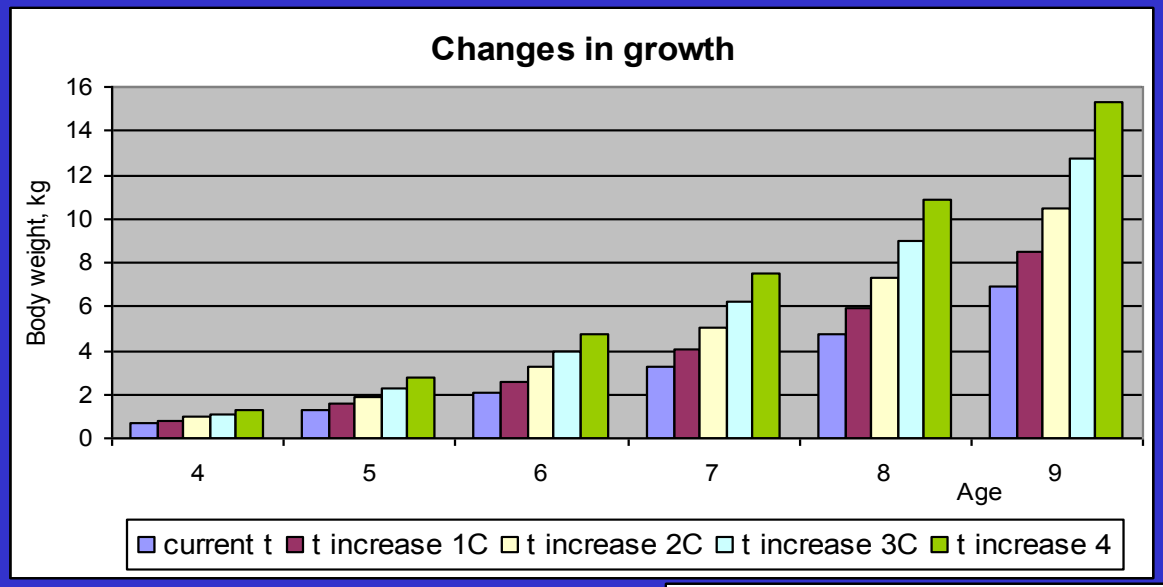
Effect of long-term changes in climate on cod abundance and distribution

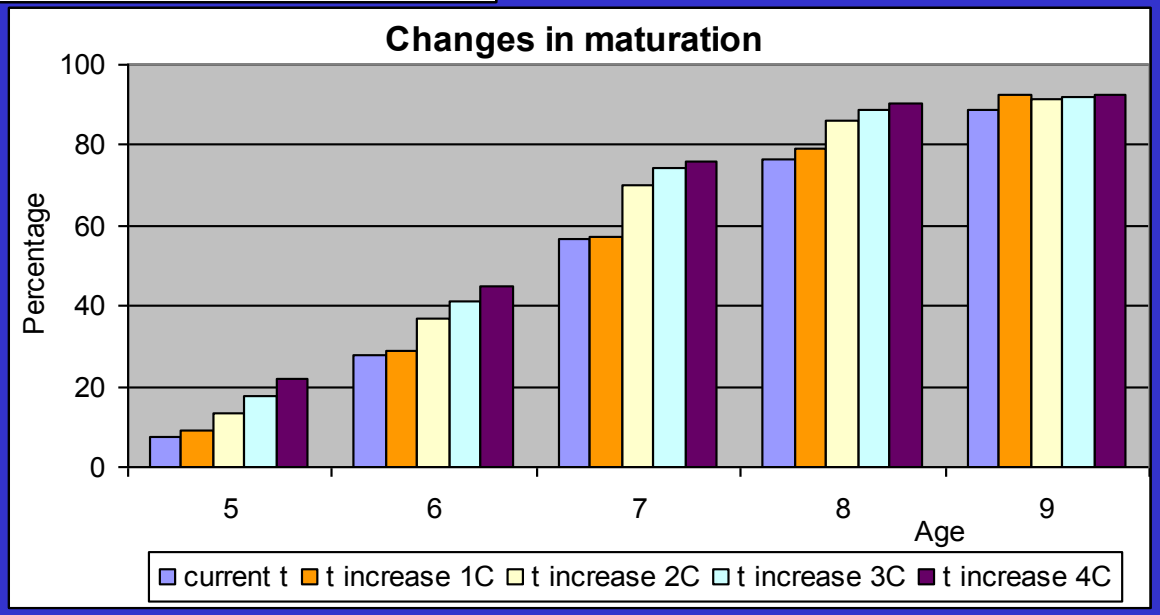
Model analysis consequences of changes in marine mammals abundance for fish stock dynamics in the Barents Sea

Expected changes in the abundance of the cod stocks with a temperature increase of 1-4 C above current levels (by K. Drinkwater, 2005)

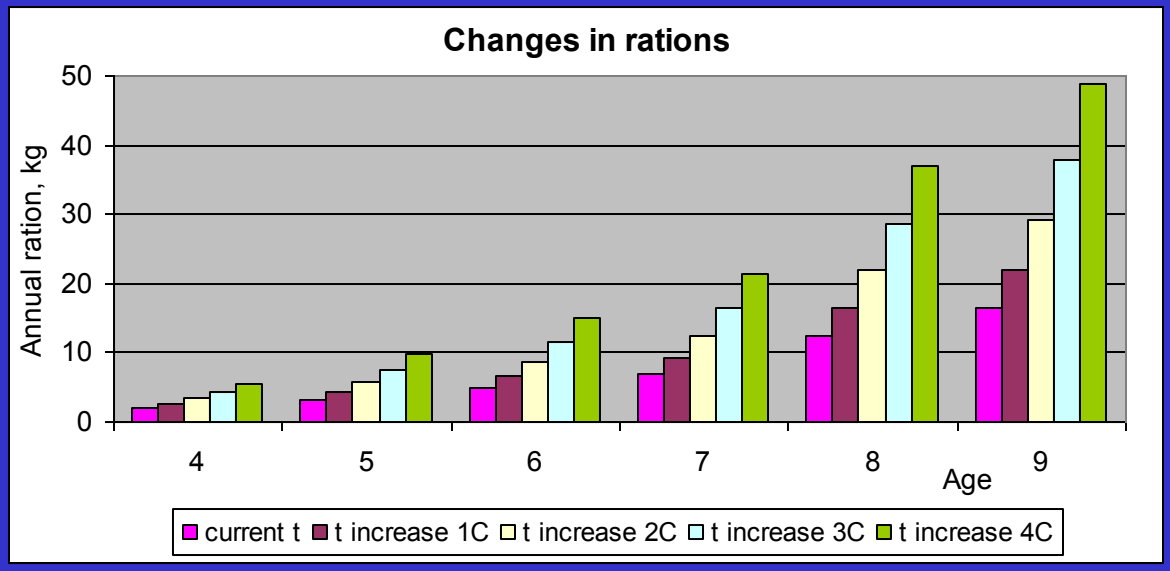
Area	+1C	+2C	+3C	+4C
Barents Sea	Increase	Increase	No change	No change
North Sea	Decrease	Decrease	Collapse	Collapse
Newfoundland	Increase	Increase	No change	No change
Greenland	Increase	Increase	Increase	No change
Faroes	No change	Decrease	Decrease	Decrease
Iceland	No change	No change	Decrease	Decrease
Irish Sea	Decrease	Collapse	Collapse	Collapse
Celtic sea	Collapse	Collapse	Collapse	Collapse
Georges Bank	Decrease	Decrease	Decrease	Collapse

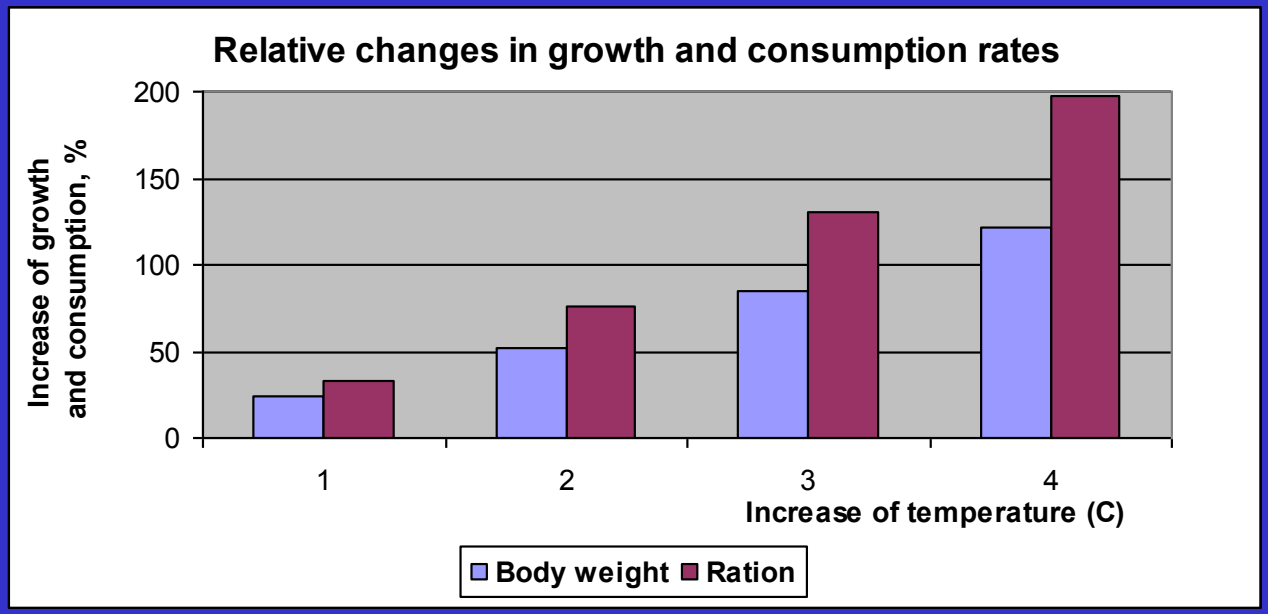
Expected changes in the growth and maturation rates of the cod with a temperature increase of 1-4 C above current levels (results of STOCOBAR simulations)



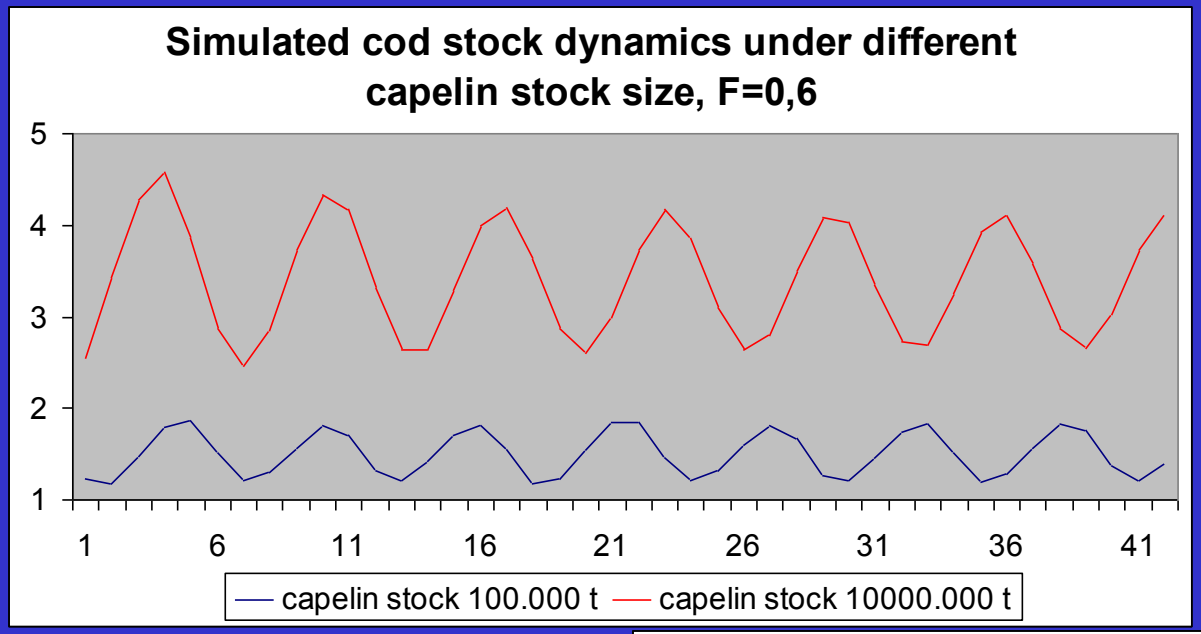


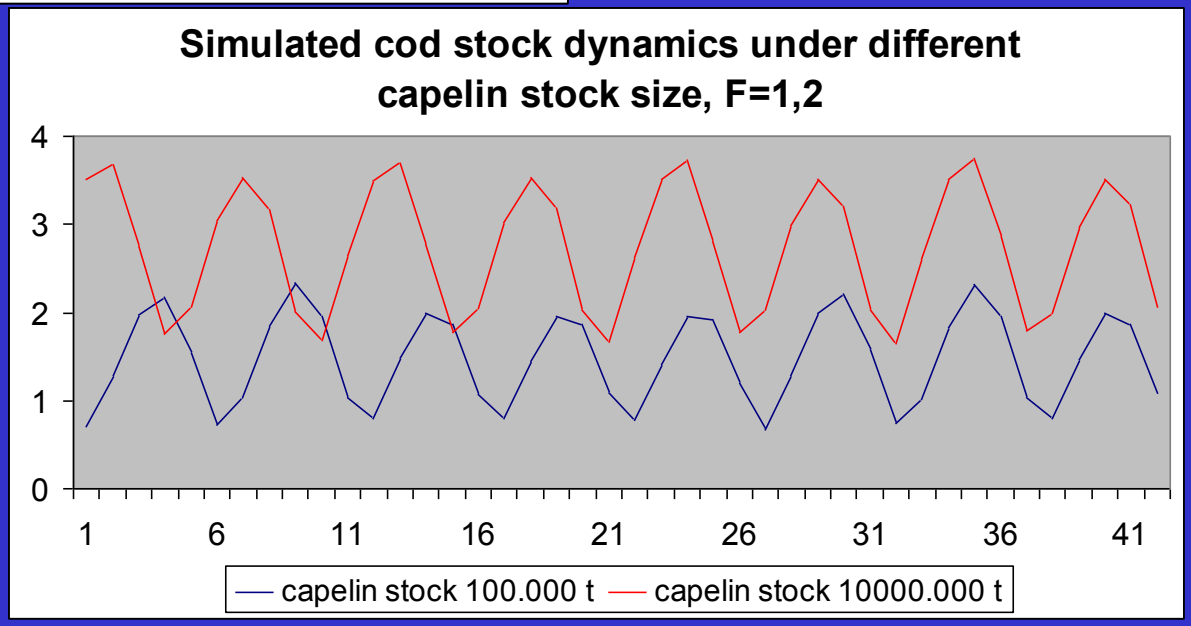
Expected changes in the consumption rate of the cod with a temperature increase of 1-4 C above current levels (results of STOCOBAR simulations)





Optimization of harvesting strategy in an ecosystem context





Preliminary results from the joint IMR-PINRO project

Optimal long-term harvest in the Barents Sea Ecosystem

1. Exploratory runs of EcoCod with dependent growth, maturation and cannibalism of cod from ecosystem driving forces has revealed that fishing mortality should be decreased from the present value in order to achieve maximum long-term yield.

2. Outputs from STOCOBAR demonstrate that under ecosystem shifts connected with sharp changing in temperature and capelin stock size the limit reference points in the cod harvest control rules should be to change in order to achieve maximum long-term yield.

3. Both models demonstrates that current harvesting regulation for cod in the Barents Sea is not optimal from the ecosystem prospects

CONCLUSIONS

1. Nowadays the large-scale fisheries in the Barents Sea is one of the main factors determined the state and dynamics of ecosystem in the area.

2. History of the harvesting in the Barents Sea is learning that unregulated fishery or non-adequate management measures to lead not to depletion of target stocks only but may to create a treat to ecosystem stability.

3. The joint IMR-PINRO researches on incorporation of ecosystem considerations in management advice at the ICES and under request of Fishery Commission provide a scientific background for the implementation of ecosystem approach to fishery management in the Barents Sea.