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## **Ecosystem approach to estimation of long-term yield of cod in the Barents Sea**

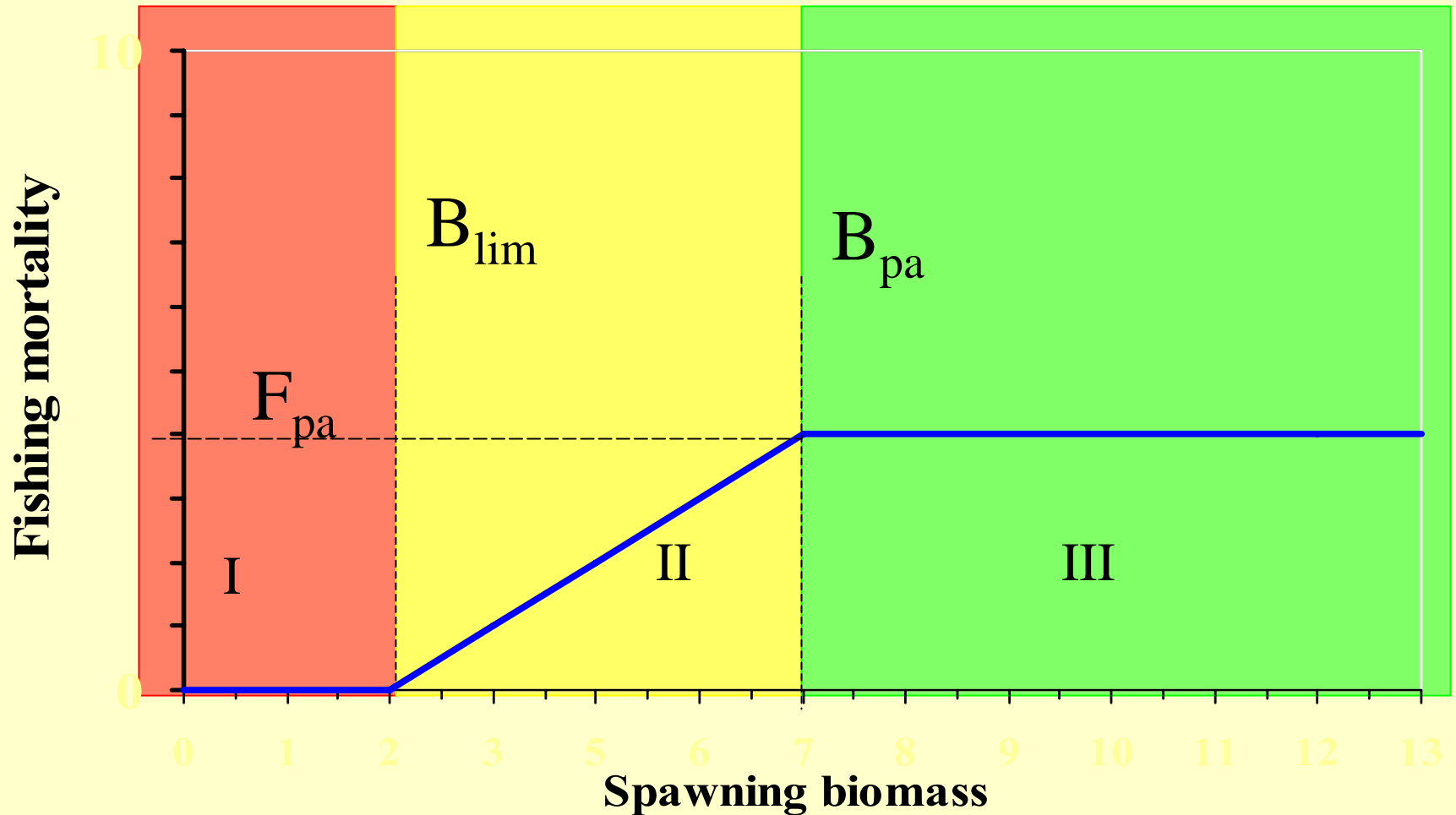
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# The scheme of stock harvest according to the concept of precautionary approach





## *Harvest efficiency of cod stock in the Barents Sea*

- **Is current harvest strategy good enough to ensure maximum sustainable yield of cod considering interannual variations in the ecosystem of the Barents Sea?**
- **Do the existing precautionary rules for deciding on TAC of cod correspond to the principals of rational harvest of this stock, taking into account natural fluctuations of the population?**
- **Is it possible to increase harvest efficiency of cod stock in the Barents Sea by improving the management strategy implementing ecosystem approach in harvest management without breaking the accepted precautionary principle?**



## *Purpose of the study*

**The purpose of this study is to ground methodical approaches to development of harvest strategy for cod in the Barents Sea that is based on estimates of long-term yield taking into account the effect of ecosystem factors on stock dynamics.**

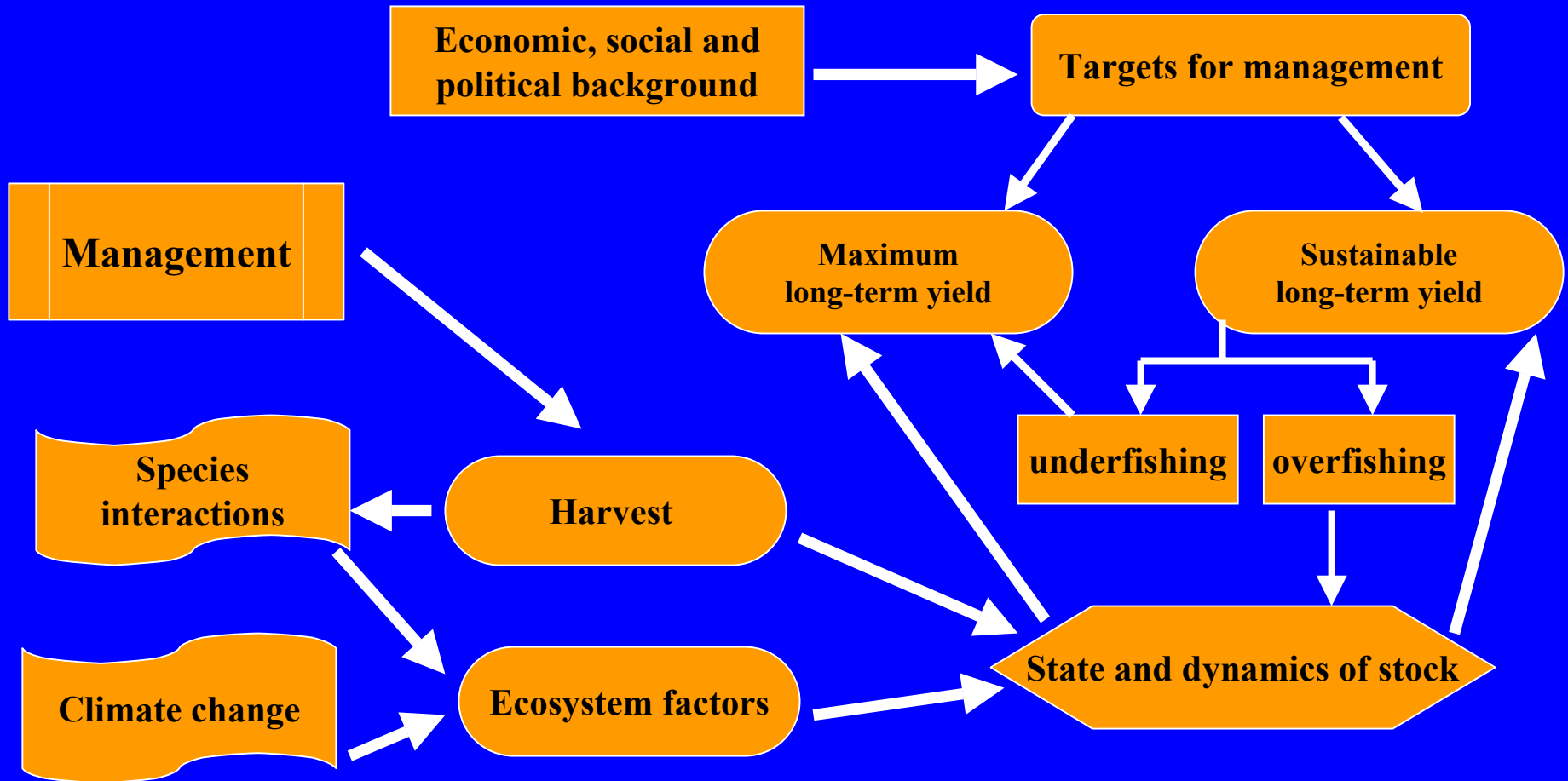


## *Stages of development of ecosystem based strategy for cod harvest*



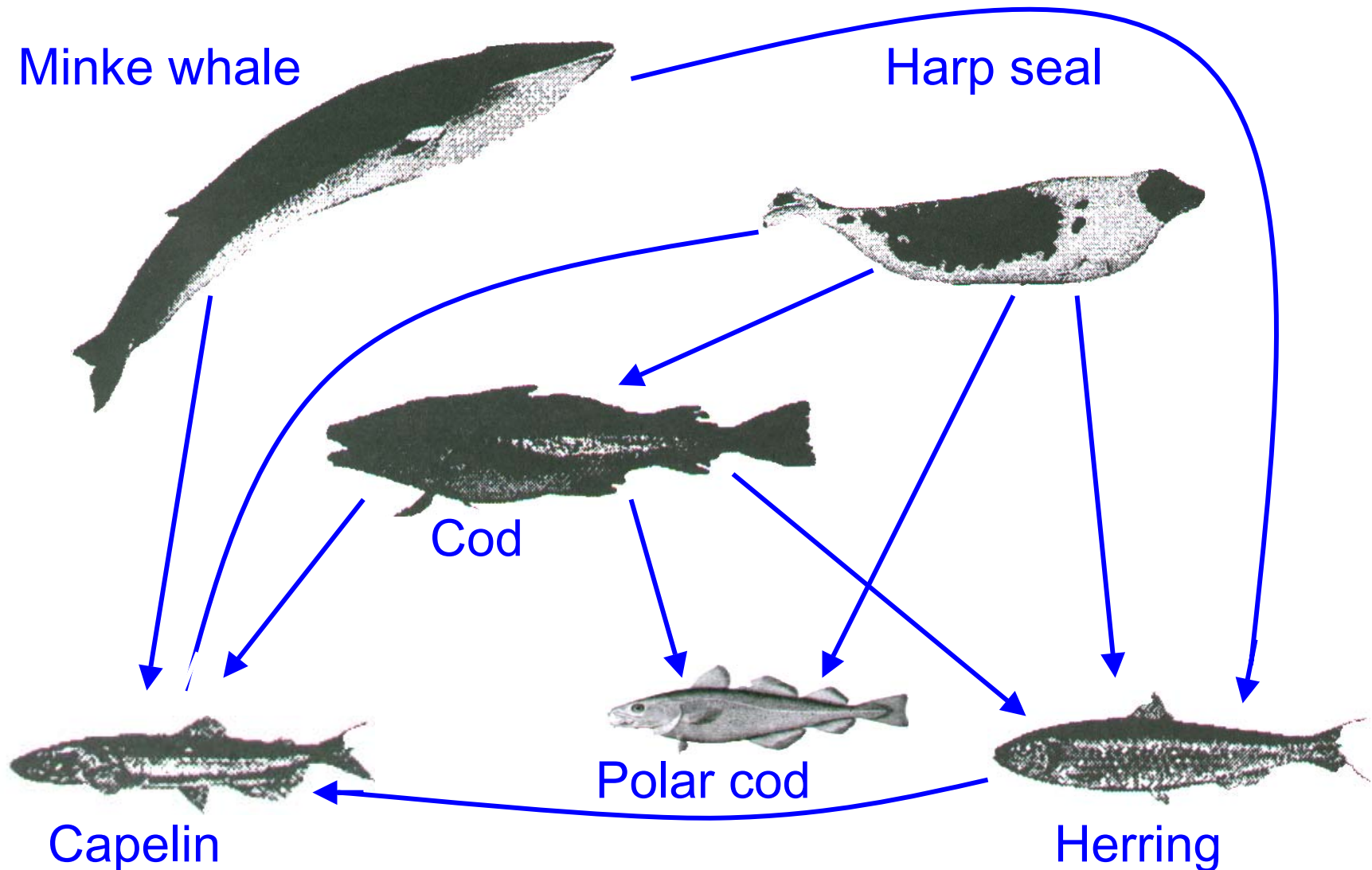
- 1. Define the management targets**
- 2. Specify ecosystem factors for simulation**
- 3. Develop models for stock management that take into account the effect of species interaction and ecosystem factors on stock dynamics**
- 4. Develop stochastic ecosystem scenarios for testing the harvest strategy**
- 5. Perform simulations of stock dynamics**
- 6. Develop rules for stock harvest that take into account the situation in the ecosystem**
- 7. Assess economic efficiency of the stock harvest using the developed strategies.**

# Setting and implementing the targets of long-term strategy for management of cod stock



The objective of ecosystem strategy for management of cod stock is to obtain a **Maximum long-term yield under set limitations of interannual catch dynamics**

# Scheme of species interactions used in model ecosystem analysis of cod stock dynamics in the Barents Sea





## *Models that expose interactions of cod and other species in the Barents Sea*

<b>Models developed at IMR</b>	<b>Models developed at PINRO</b>	<b>Joint models</b>
MULTSPEC AGGMULT Systmod Bifrost SeaStar GADGET	MSVPA CONCOD STOCOBAR CodCap	EcoCod





## *Ecosystem scenario for estimation of long-term yield of cod in the Barents Sea*



**Ecosystem scenario should be realistic, which means that it should expose interannual variations of ecosystem analysis.**

- **Ecosystem scenario should be based on dynamics of temperature conditions.**
- **Scenario of thermal conditions development should take into account year-to-year cycling of temperature dynamics in the Barents Sea.**
- **Stochastic temperature scenario should be based on historic data that can be selected in the following way:**
  - **- random selection;**
  - **- random selection in the given interval;**
  - **- in successive order combining warm, cold and moderate periods, based on data randomly selected in the given interval.**
- **The scenario of development of thermal conditions should determine scenarios of feeding resources dynamics for cod that are also based on historic data on capelin stock biomass and other prey species for cod in the Barents Sea.**



## ***Improvement of harvest control rules for cod based on ecosystem approach***

- **Simulations should be used to study the necessity to apply different approaches to the harvest management depending state of the ecosystem.**
- **Possible approaches to improvement of harvest control rules for cod stock:**
  - **- the rules of harvest intensity remain unchanged, but new values of biological reference points obtained with ecosystem based simulations are used;**
  - **- the existing scheme for calculation of TAC remains unchanged, but the values of biological reference points become variable depending on the situation in the ecosystem;**
  - **- new additional reference points and new scheme for stock management are applied.**



## *Conclusion*

- **Ecosystem approach to harvest management in the Barents Sea as well as precautionary approach should ensure long-term sustainable and plausible harvest of marine biological resources.**
- **The developed joint Russian-Norwegian 10-year research programme provides a good background for practical advice on optimising harvest strategy for cod in the Barents Sea based on ecosystem approach already in the nearest years.**
- **The method of stochastic scenario modelling should be used as methodical basis for the estimation of long-term harvest of cod should be.**



## *Main fields of further work (1)*

- **To solve theoretical problems related to implementation of ecosystem approach to harvest management of cod stock in the Barents Sea:**
  - *harmonisation of terms;*
  - *improvement of the concept;*
  - *development of methodology.*
- **To develop multispecies and ecosystem models:**
  - *harmonization of approaches to development of the models;*
  - *development of testing system for the models;*
  - *development of a joint multispecies model for the Barents Sea.*



## *Main fields of further work (2)*

- **To improve and expand database for ecosystem modelling:**
  - **improvement of the current system for collection of data;**
  - **involvement of unavailable at the moment historic data into model analysis;**
    - *revision of historic data at PINRO and IMR;*
    - *work on computerizing of PINRO historic data in electronic format;*
    - *solving the problem of access to primary data while working on joint models.*