



# Baltic NEST food-web model

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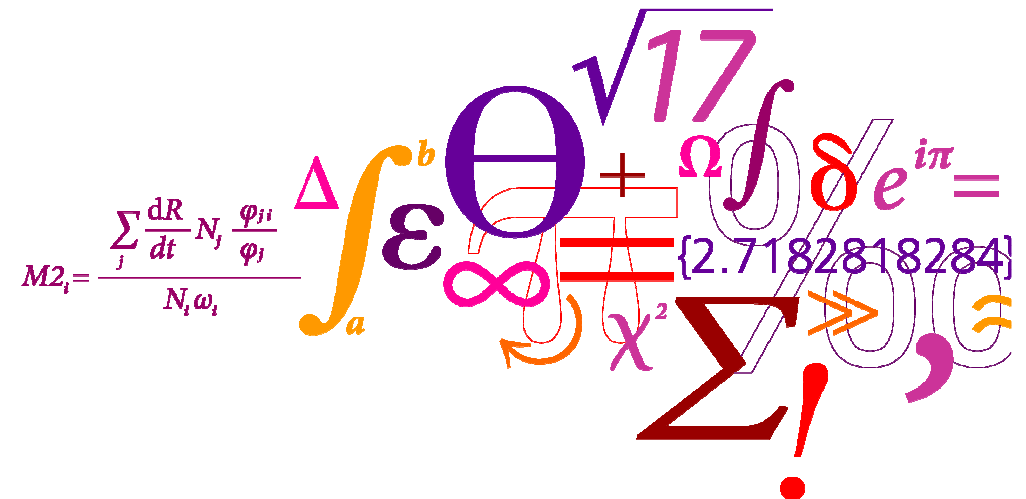
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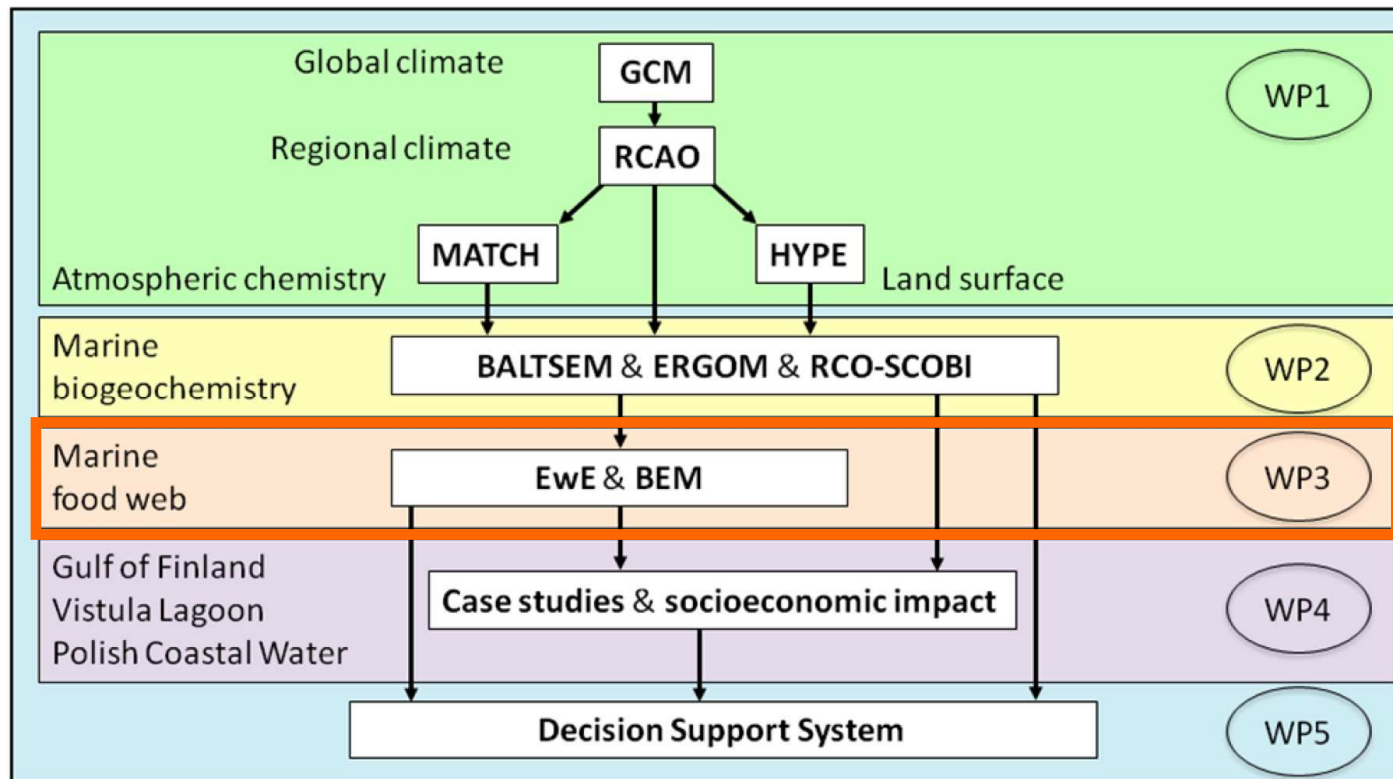


DTU Aqua

National Institute of Aquatic Resources

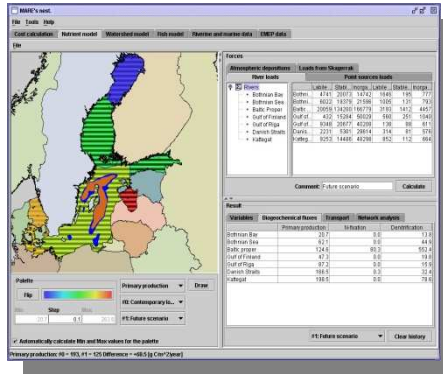
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# ECOSUPPORT – Advanced modeling tool for scenarios of the Baltic Sea ECOsystem to SUPPORT decision making

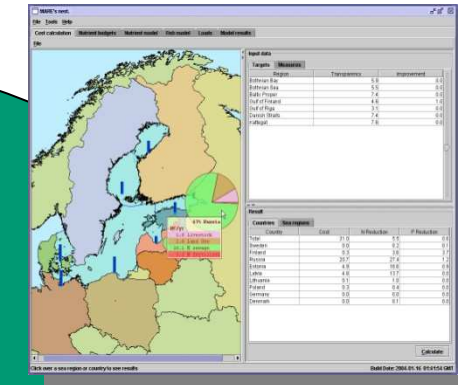


## Atmospheric emissions and load

### Marine modeling

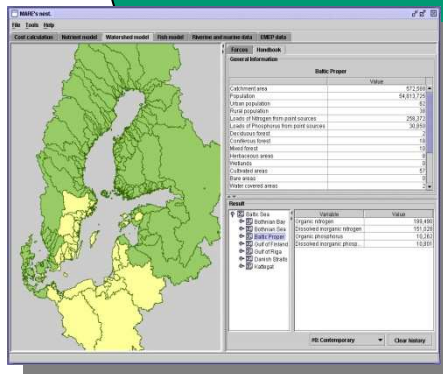


### Cost minimization model

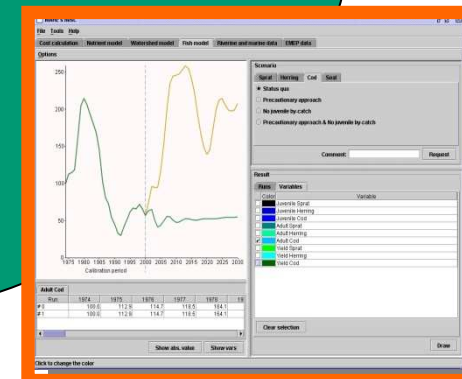


NEST DSS builds on  
six different models

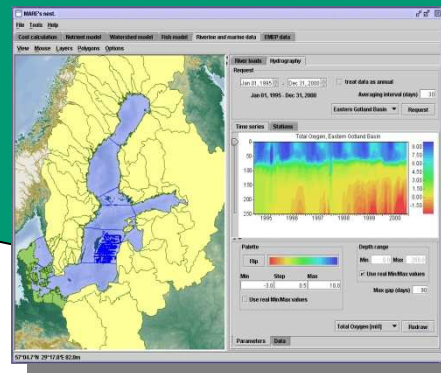
### Drainage basin modeling



### Fishery management

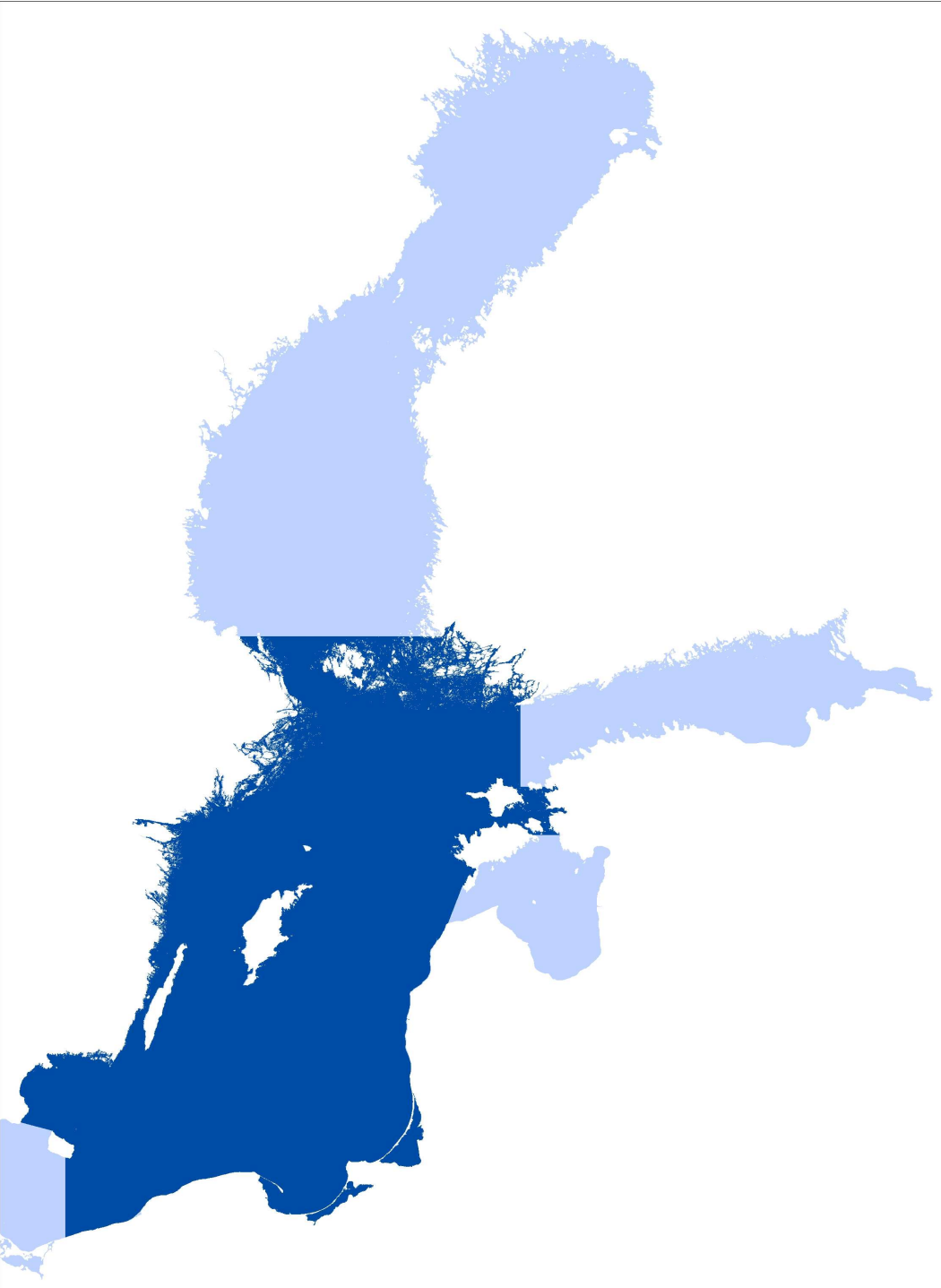


### Marine and runoff data

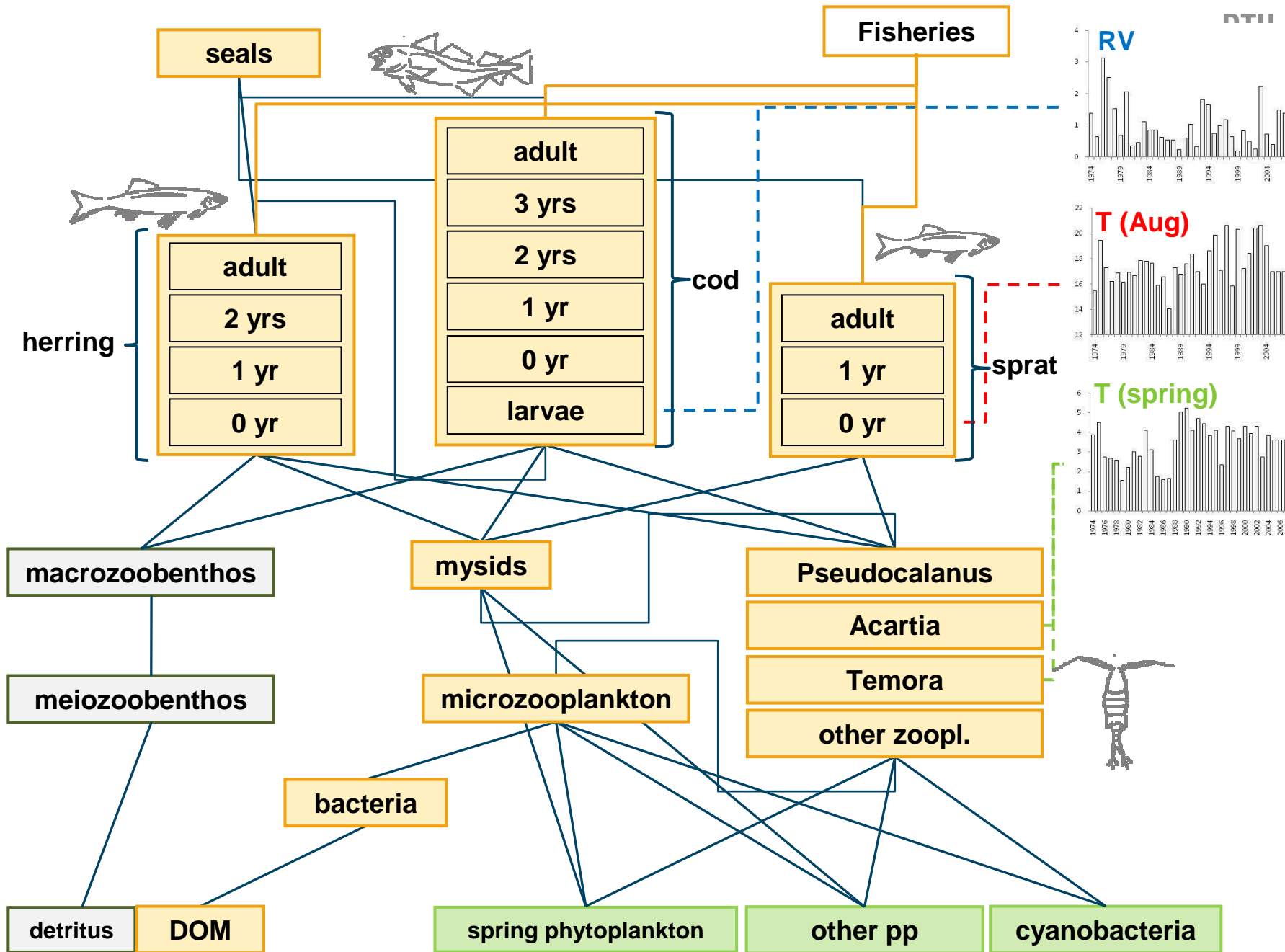


## Nest food web model

- A Baltic Proper food web model incorporating groups from phytoplankton to fishery (based on [Harvey et al., 2003](#))
- Aim to create a model that is able to:
  - Reproduce historical (1974 ->) dynamics (e.g. regime shifts) and past food web interactions
  - Analyse fishery impact
  - Quantify responses to environmental variation and indicate potential changes in food-web interactions to future changes in climate and nutrient load (2007-2100) → [linkage to biogeochemical models](#)



- An Ecopath with Ecosim-approach ([www.ecopath.org](http://www.ecopath.org))
  - Ecopath (mass-balance)
$$P = M_p + F + M_{other} + BA + migration$$
$$C = P + Unass. food + R$$
  - Ecosim (simulation)
  - ENA plug-in routine
- Central Baltic Sea
- 28 functional groups (26 living, 2 detritus)
- 3 fishing fleets
- Multi-stanza groups for 3 main fish species

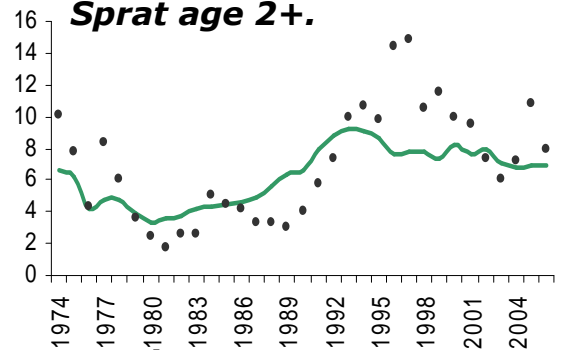
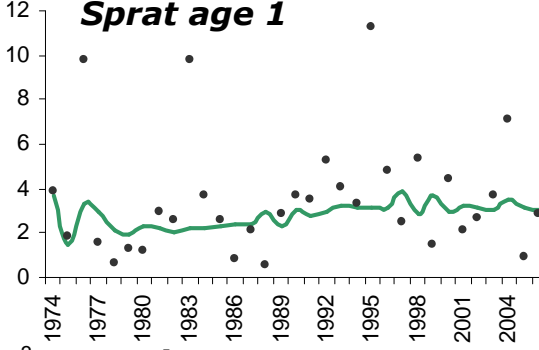
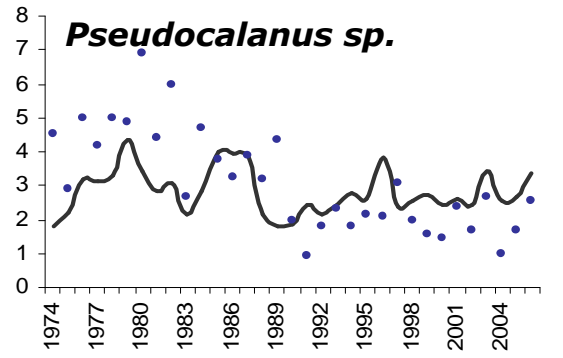
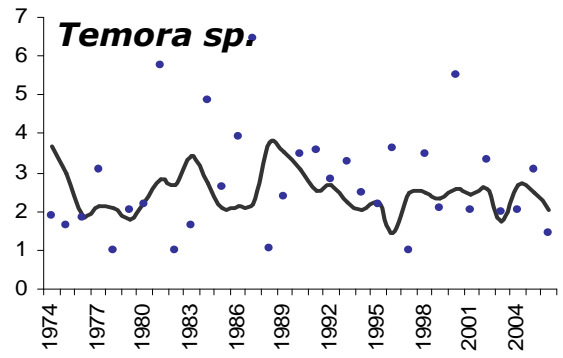
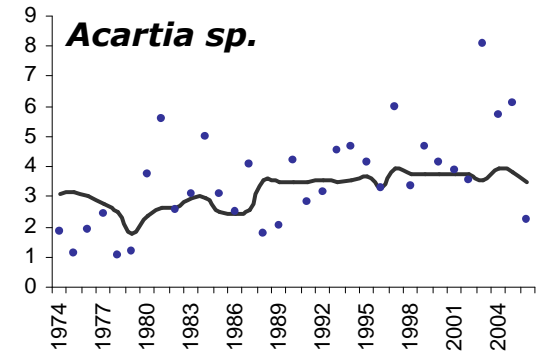


Forcing Factor or time series used for fitting	Season	Impacted group	Type of impact/function
<b>Mean temperature from 0-10m at August</b> <i>(MacKenzie et al., 2004)</i>	<b>Summer</b>	<b>Sprat</b>	<b>Proxy of eggs production</b>
<b>Mean temperature from 0-50m at March-May</b>	<b>Spring</b>	<b>Acartia sp; Themora sp</b>	<b>Search rate of given group</b>
<b>Cod RV</b> ( <i>Cod reproductive volume</i> <i>Plikshs et al., 1993</i> )	<b>Annual</b>	<b>Cod</b>	<b>Proxy of eggs production</b>
<b>Biomass_Acartia_Spr</b>	<b>Annual</b>	<b>Acartia sp</b>	<b>Calibration data</b>
<b>Biomass_Temora_Spr</b>	<b>Annual</b>	<b>Temora sp</b>	
<b>Biomass_Pseudo_Ann</b>	<b>Annual</b>	<b>Pseudocalanus sp</b>	
<b>Biomass_Sprat 1</b>	<b>Annual</b>	<b>Sprat Age 1</b>	
<b>Biomass_Ad. Sprat</b>	<b>Annual</b>	<b>Sprat Age 2+</b>	
<b>Biomass_Herring 1</b>	<b>Annual</b>	<b>Herring Age 1</b>	
<b>Biomass_Herring 2</b>	<b>Annual</b>	<b>Herring Age 2</b>	
<b>Biomass_Ad. Herring</b>	<b>Annual</b>	<b>Herring Age 3+</b>	
<b>Biomass_Cod 2</b>	<b>Annual</b>	<b>Cod Age 2</b>	
<b>Biomass_Cod3</b>	<b>Annual</b>	<b>Cod Age 3</b>	
<b>Biomass_Ad. Cod</b>	<b>Annual</b>	<b>Cod Age 3+</b>	
<b>F_Sprat 1</b>	<b>Annual</b>	<b>Sprat Age 1</b>	<b>Fishing mortality (F) – impact on biomass</b>
<b>F_Ad. Sprat</b>	<b>Annual</b>	<b>Sprat Age 2+</b>	
<b>F_Herring 1</b>	<b>Annual</b>	<b>Herring Age 1</b>	
<b>F_herring 2</b>	<b>Annual</b>	<b>Herring Age 2</b>	
<b>F_Ad. Herring</b>	<b>Annual</b>	<b>Herring Age 3+</b>	
<b>F_Cod 2</b>	<b>Annual</b>	<b>Cod Age 2</b>	
<b>F_Cod3</b>	<b>Annual</b>	<b>Cod Age 3</b>	
<b>F_Ad. Cod</b>	<b>Annual</b>	<b>Cod Age 3+</b>	

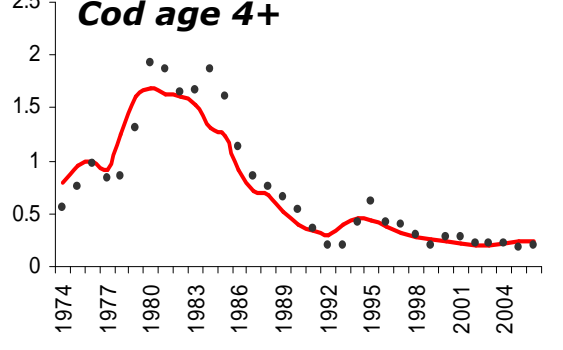
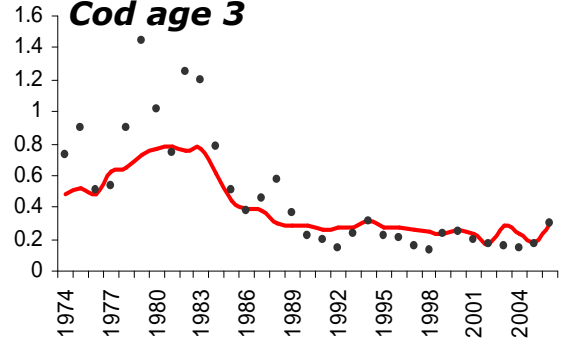
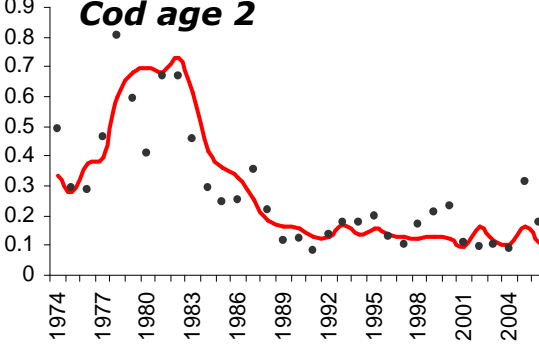
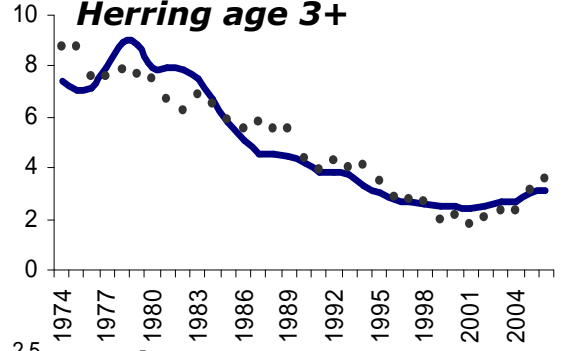
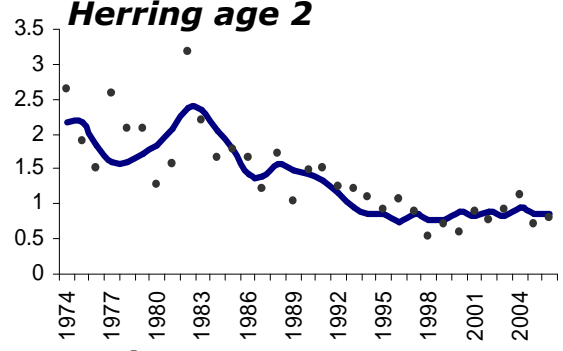
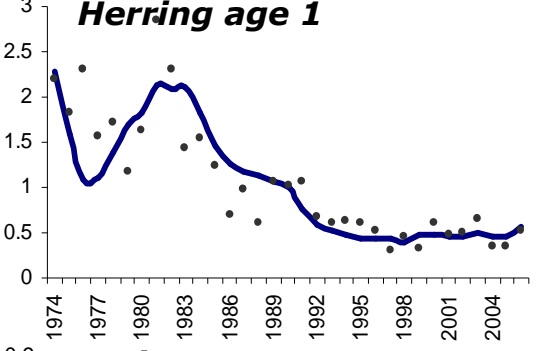
# Environmental Data

- Cod Reproductive Volume
- Salinity (Cod, zooplankton)
- Temperature (Zooplankton, Sprat, Herring)
- O<sub>2</sub>, H<sub>2</sub>S (Cod, Zoobenthos)
- Nutrients (PP)
- PP (PP)

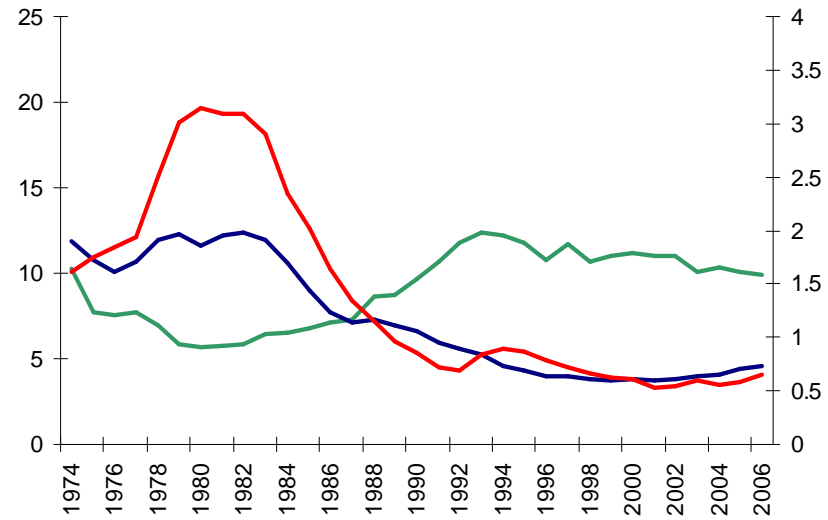
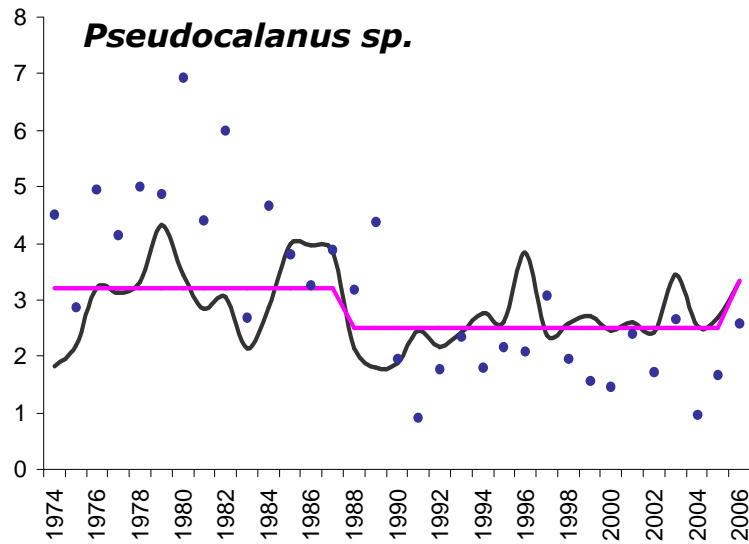
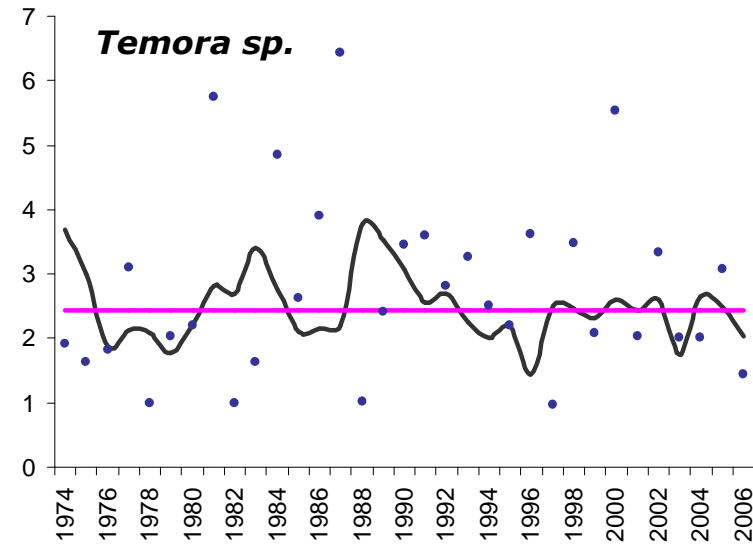
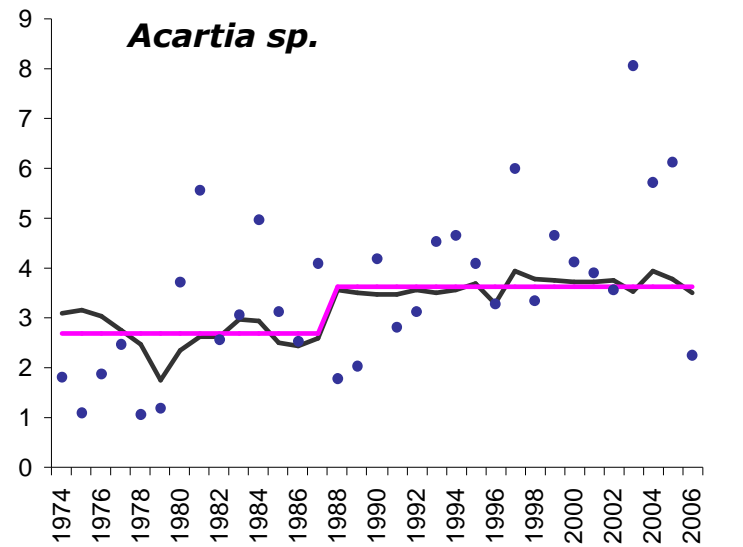




X-axis: year  
Y-axis: relative biomass

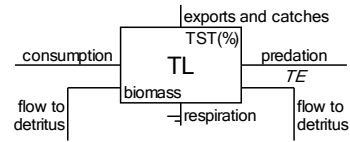
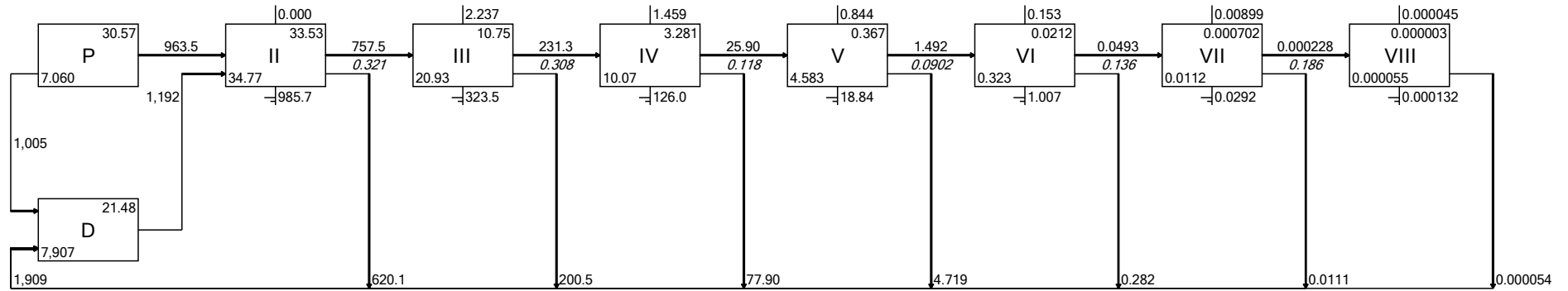


# Results - STARS on zooplankton, Fish biomass dynamic



— Model data    — Mean STARS    • Observed data    — SPRAT    — HERRING    — COD

# Results - Lindeman Spine



# Ecological Network Analysis, indicators of food-web changes in the Baltic Sea

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# Material and Method - indices

1. Total System Throughput (**TST**)

2. Ascendency (**A**)

3. Development capacity (**C**)

4. Redundancy (**R**)

5. Specific Overhead ( **$\emptyset/TST$** )

Network Indices

6. Finn's Cycling Index (**FCI**)

7. Mean Path Length (**MPL**)

8. Proportional Flow to Detritus (**PFD**)

Recycle  
and Structure

9. Fish in Balance index (**FiB**)

10. Primary Production Required (**PPR**)

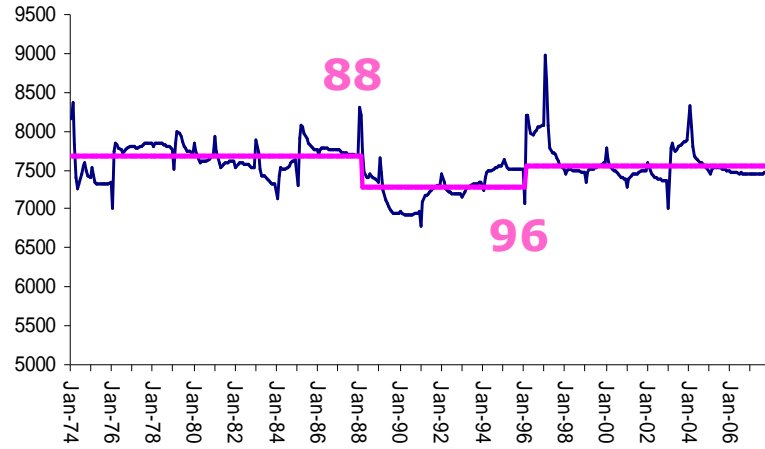
11. Mean Trophic Level of Catch (**mTLc**)

12. The Total Production / Total Biomass ratio  
(**ToTP/ToTB**)

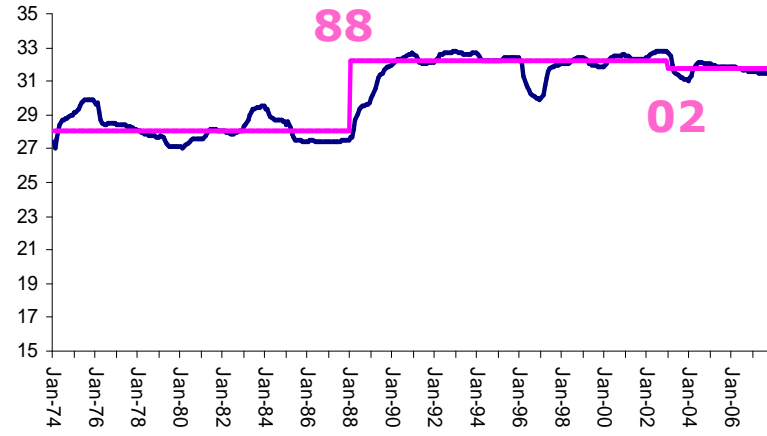
Fisheries effect  
and  
Biomass diversity

# Results STARS

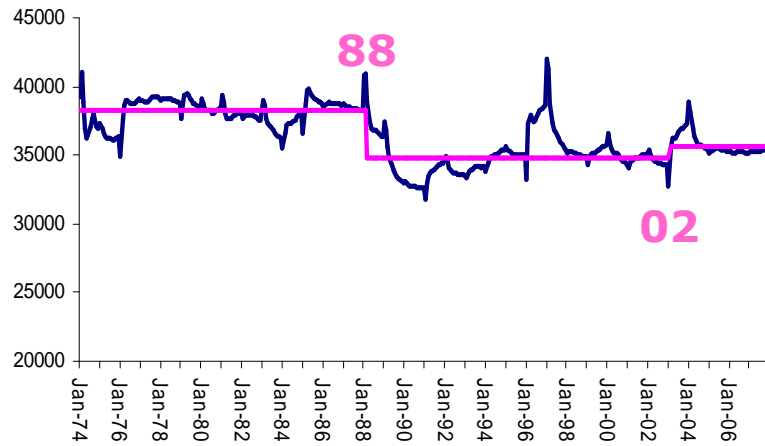
## TST



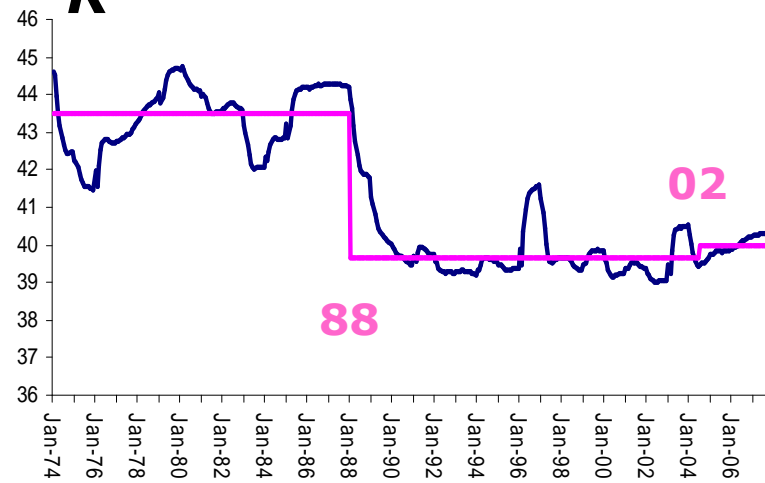
## A



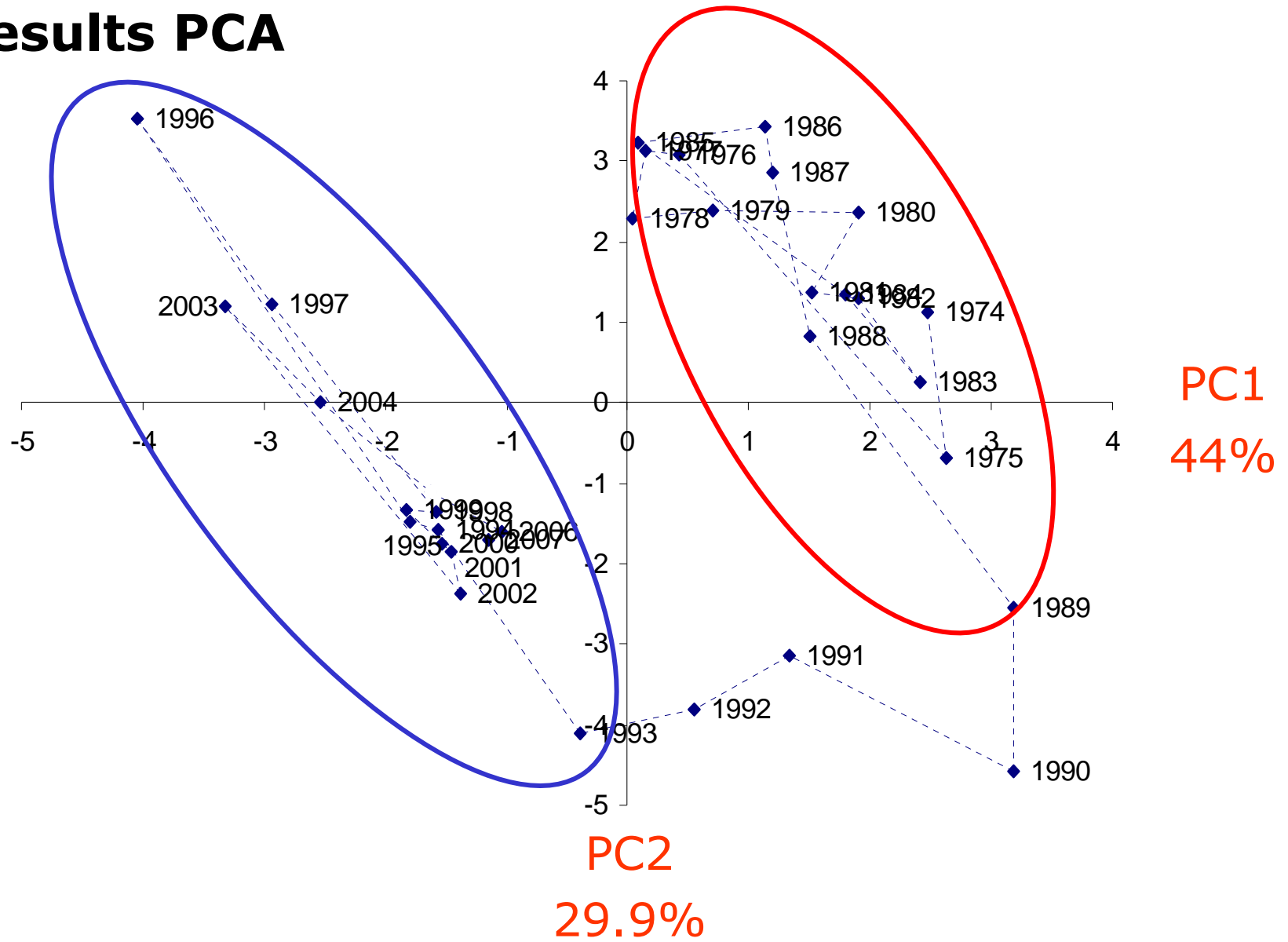
## C



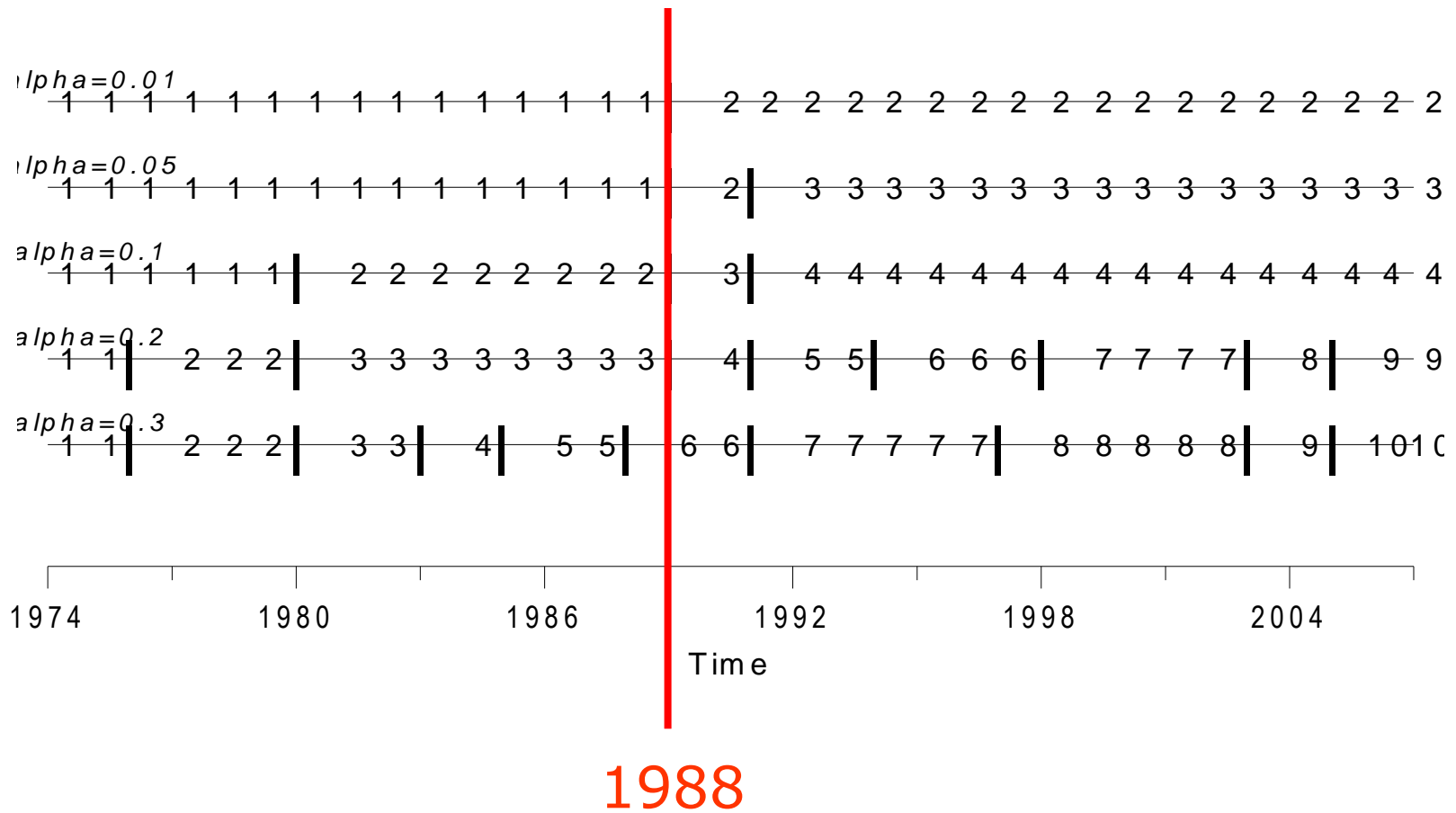
## R



# Results PCA



# RESULTS Chronological Clustering





# Conclusions

- i) the regime shift phenomenon in the Baltic Sea in the late 1980s can be reproduced by the model and is reflected by the ENA indices
- ii) two different ecosystem states can be described:
  - a) the first between 1974 to 1989
    - higher resilience, more flexible with high  $mTLc$  and high fishing pressure
  - b) second from 1993 to ...
    - more stressed, less resilient, with high fishing pressure on lower TL and higher system turnover
- iii) Ecological Network Analysis could be the useful tool to describe the food-web and ecosystem properties, supporting and complementing the Integrated Assessments (IA) of the Baltic Sea

# Thank You

## Acknowledgements and Funding:

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Baltic NEST Institute  Baltic Nest  
Institute

Advanced tool for scenarios of the Baltic Sea  
ECOsystem to SUPPORT decision making

