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# Food-web modelling supporting ecosystem-based management

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# 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 ->) food web dynamics
  - Include fishery impact
  - Quantify responses to environmental variation and indicate potential **changes in food-web interactions to future** climate change (2007-2100) → linkage to biogeochemical models
- Currently **the model is** parameterized only to fit fish biomasses

# Modelling approach

- An Ecopath with Ecosim-approach ([www.ecopath.org](http://www.ecopath.org)) employed, where:

- Ecopath (mass-balance)

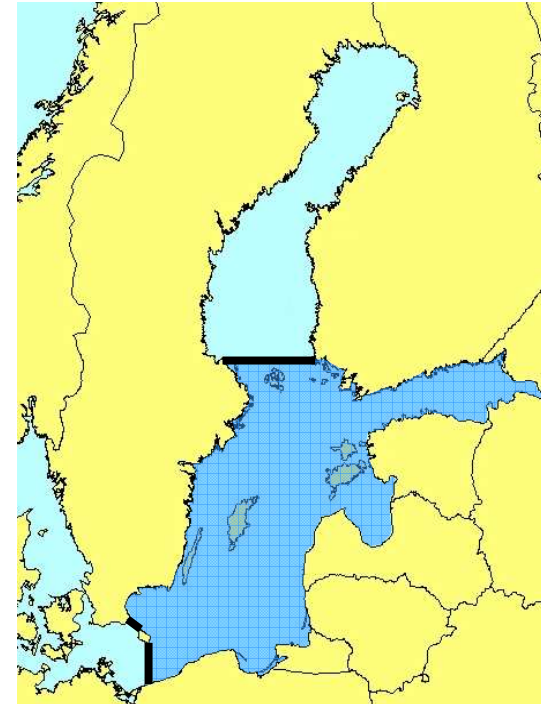
$$P = M_p + F + M_{other} + BA + migration$$

$$C = P + Unass. food + R$$

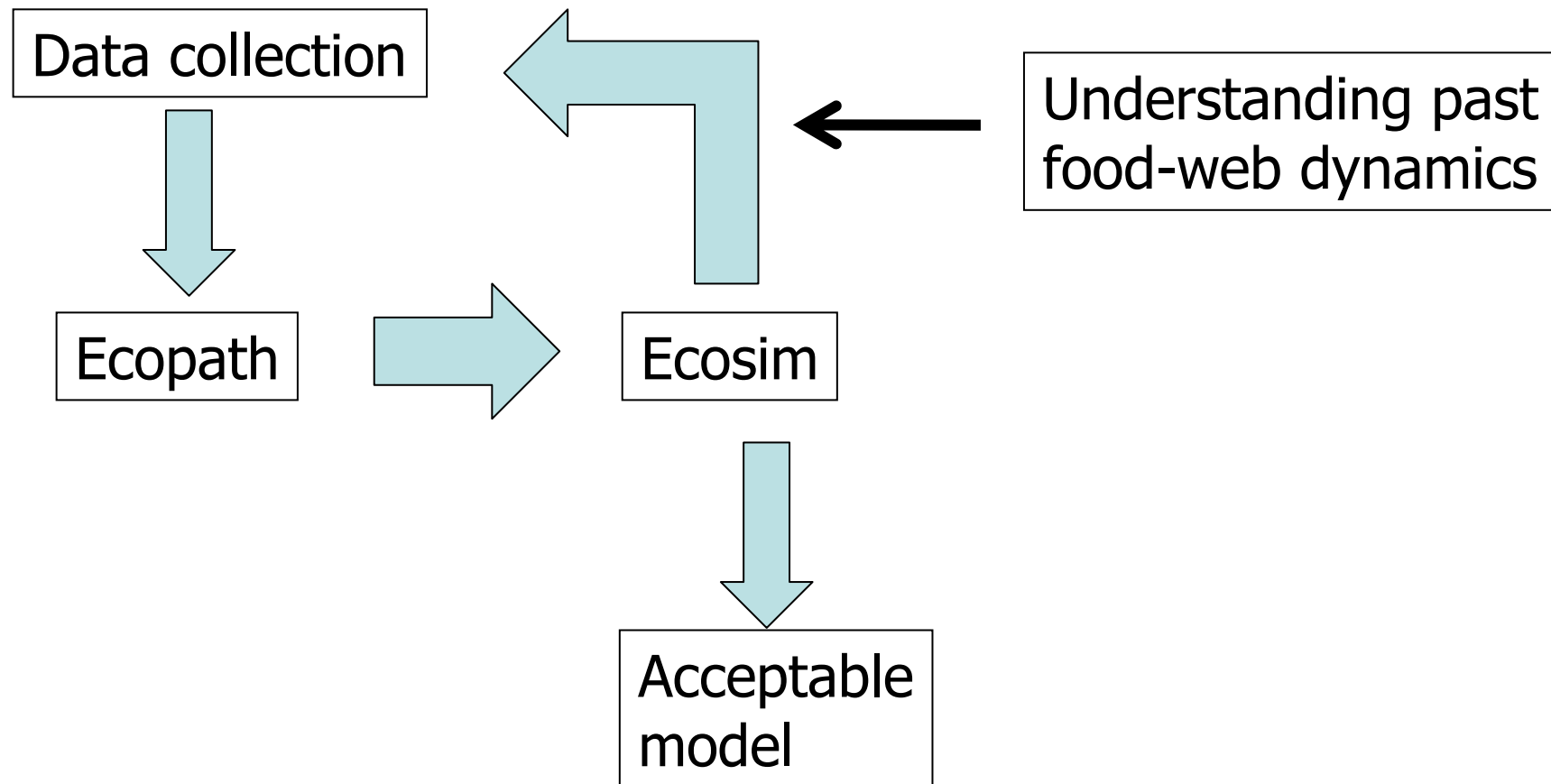
- Ecosim (simulation)

$$\frac{dB_i}{dt} = f(B) - M_i \cdot B_i - F_i \cdot B_i - \sum_{j=1}^n c_{ij}(B_i B_j)$$

- 28 functional groups (23 living, 3 fleets, 2 detritus)
- Multi-stanza groups for 3 main species



# Process of the current model



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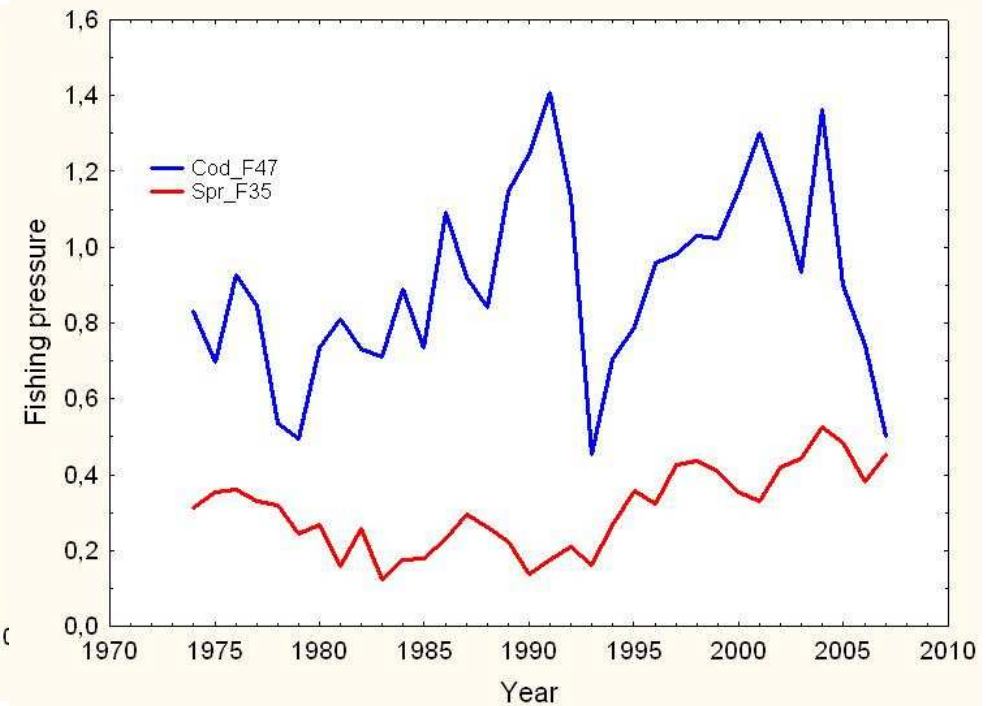
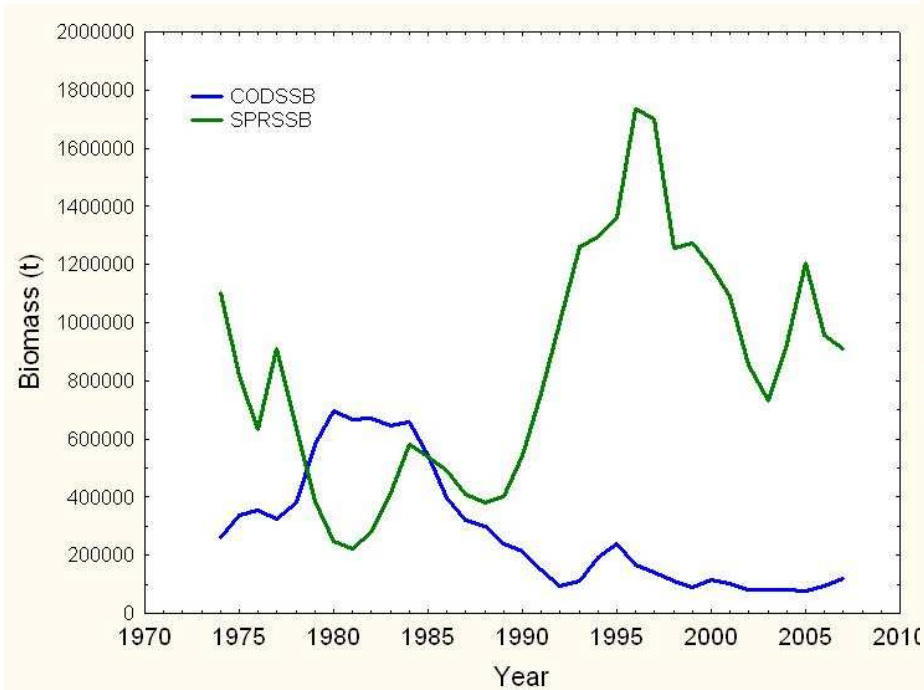
# Background and data analysis

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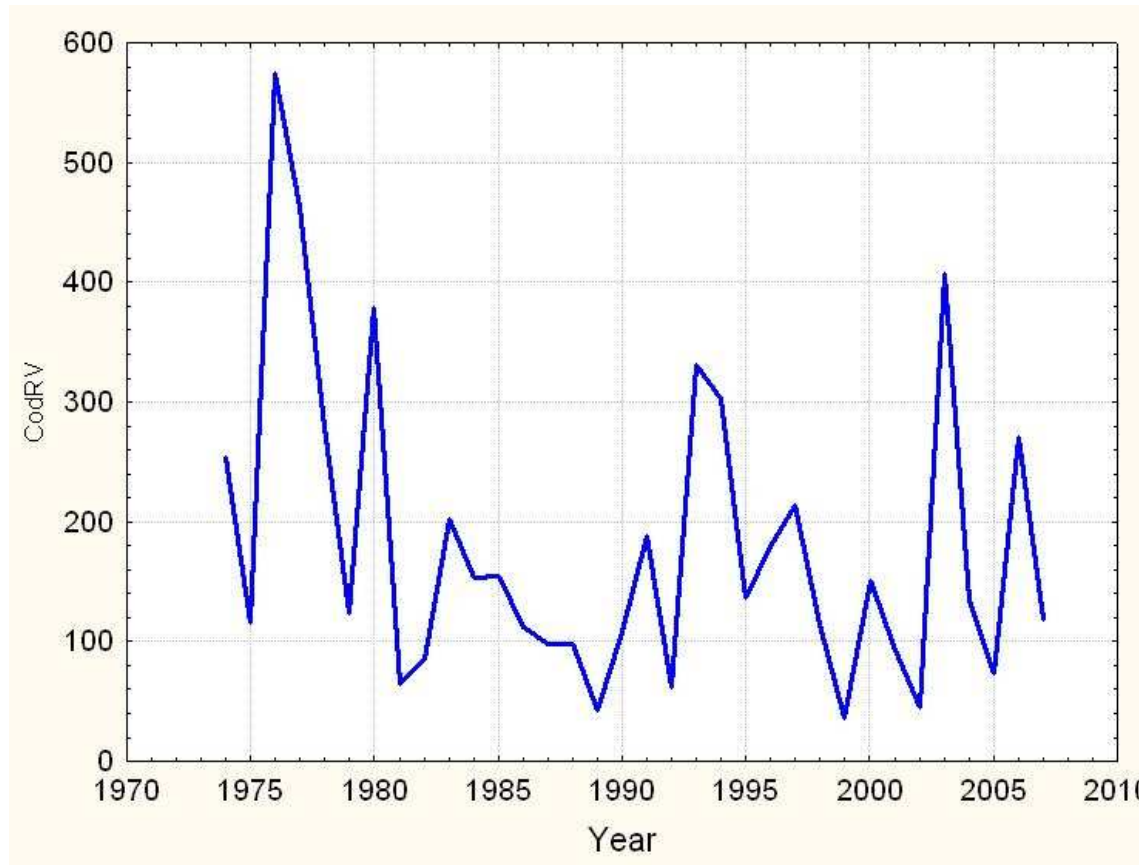


# Cod and Sprat

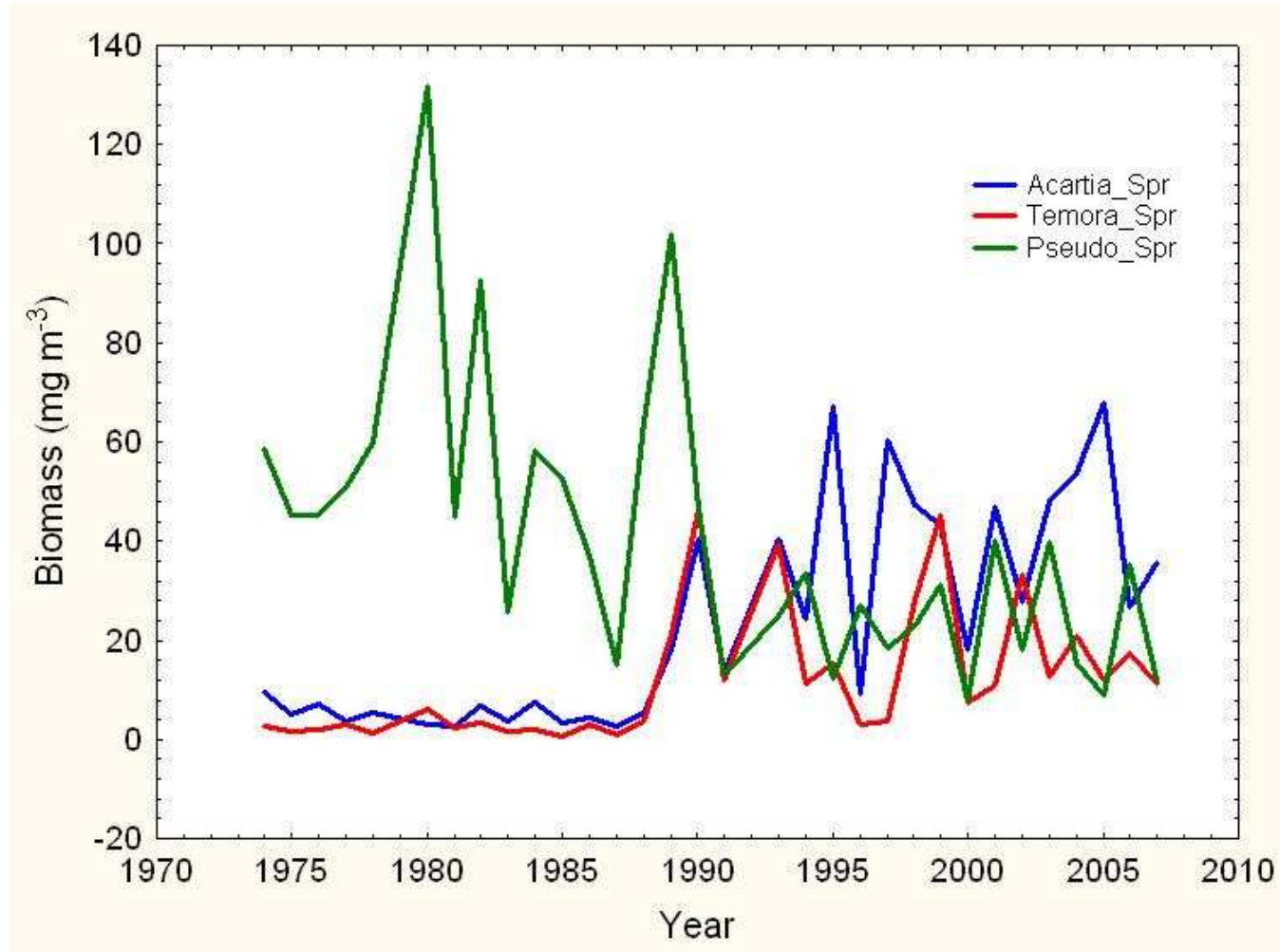


# Cod reproductive volume

>11 psu & >2mg O<sub>2</sub> l<sup>-1</sup> MacKenzie et al 2000)

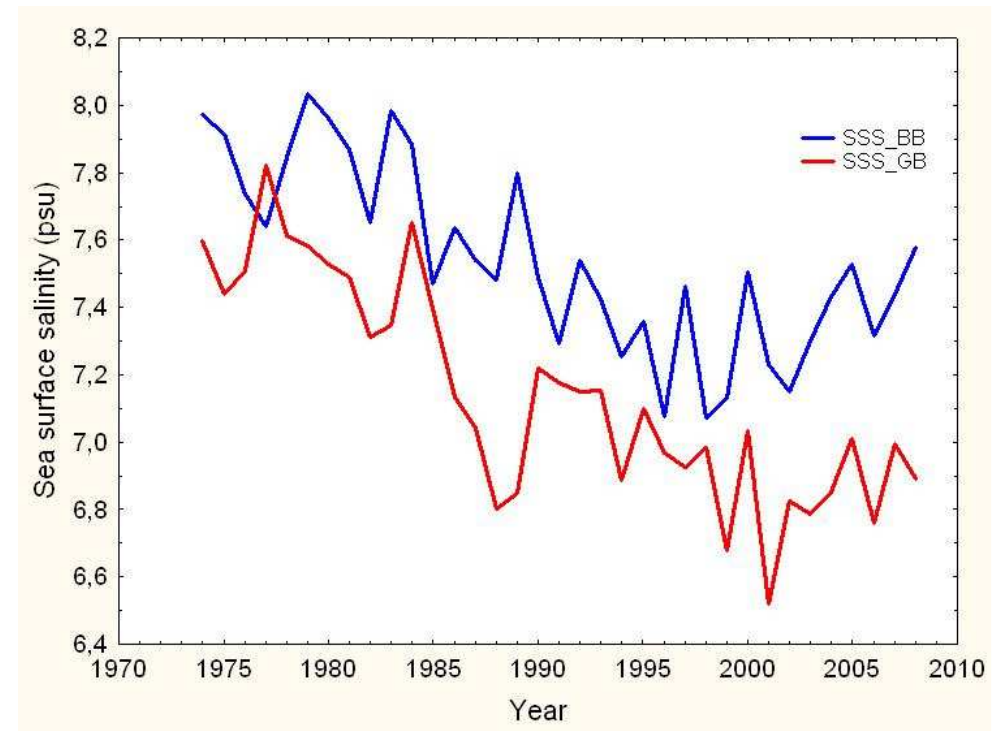
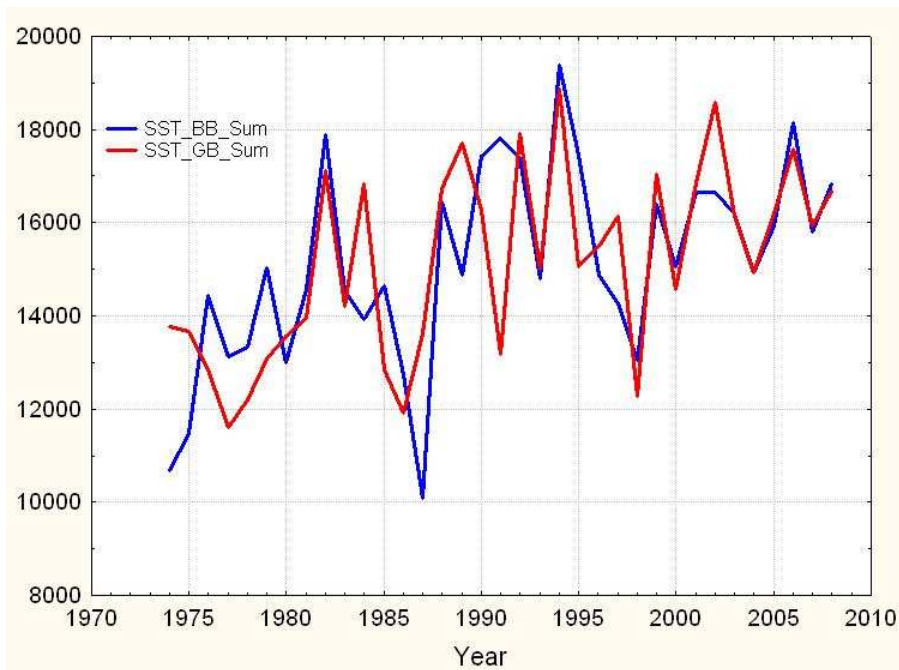


# Changes in zooplankton





# Temp and salinity



# Methods: Statistics

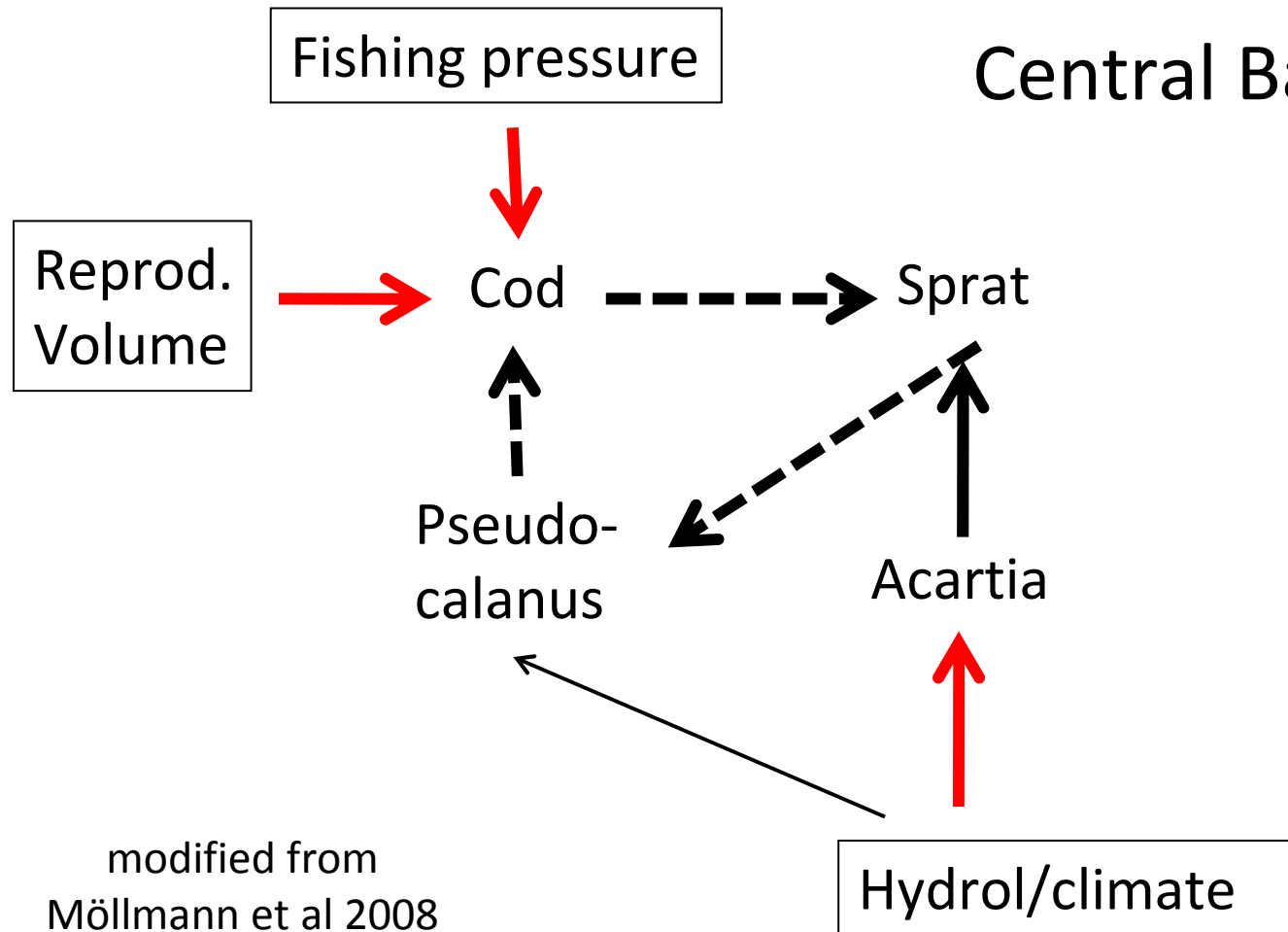
- Generalized Additive Model (GAM)
- Tested for homogeneity, autocorrelation, colinearity, outliers
- Analyses are performed within the HELCOM/ICES working group of the Integrated Assessments of the Baltic Sea

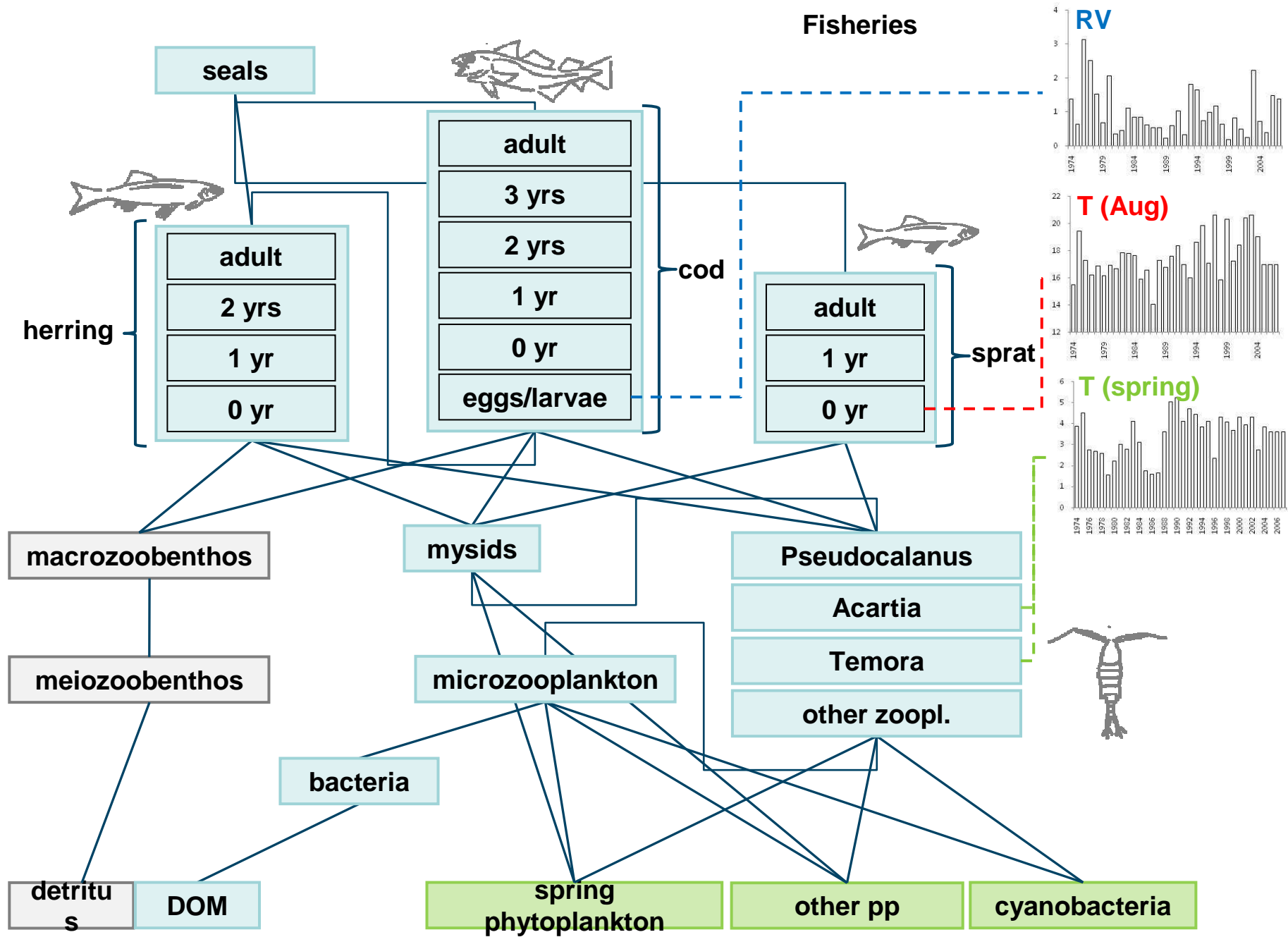
# Statistical results

Response var	Expl. var	Adj R2
<b>Phytoplankton</b>		
Summer Chl a	Chla (spr), Temp,, Tot zoopl	0.43**
<b>Zooplankton</b>		
Spring <i>Acartia</i> spp	Chla (spr), Temp (60m), Sprat	0.64***
Spring Pseudocal.	Chla (spr), Sal, Sprat	0.72***
<b>Fish</b>		
Cod recruit	Cod SSB, Cod weight, RV	0.88***
Sprat recruit	Tot zoopl, NAOwin, sal (60-80m)	0.56***

# Ecosystem Interactions

## Central Baltic Sea





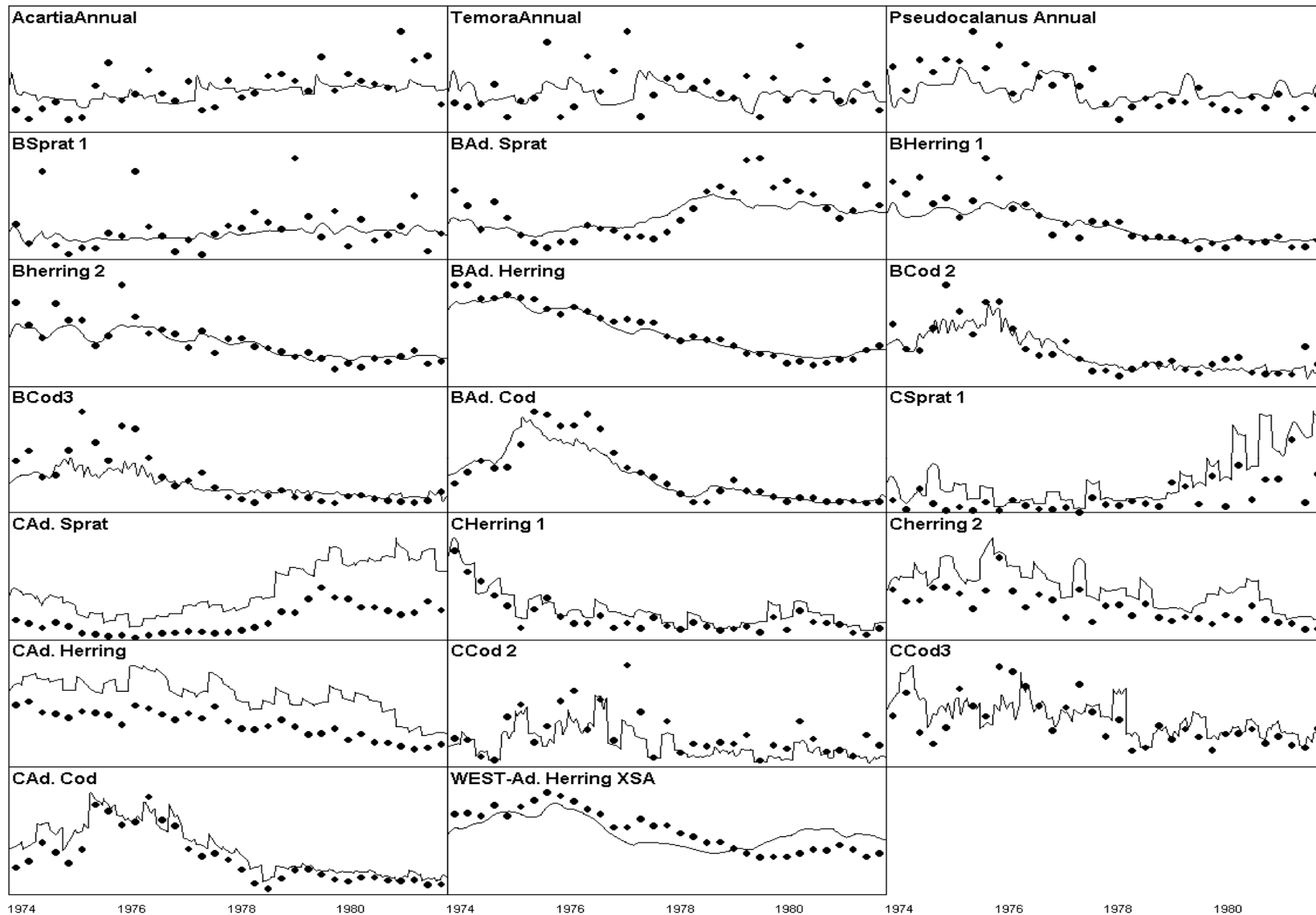
# Time series data

## *Drivers:*

- Fishing mortality rates
- RV
- Temp. in Aug. (Sprat)
- Temp in spring (Zoopl)
- Salinity (Pseudocalanus)
- PP (?)

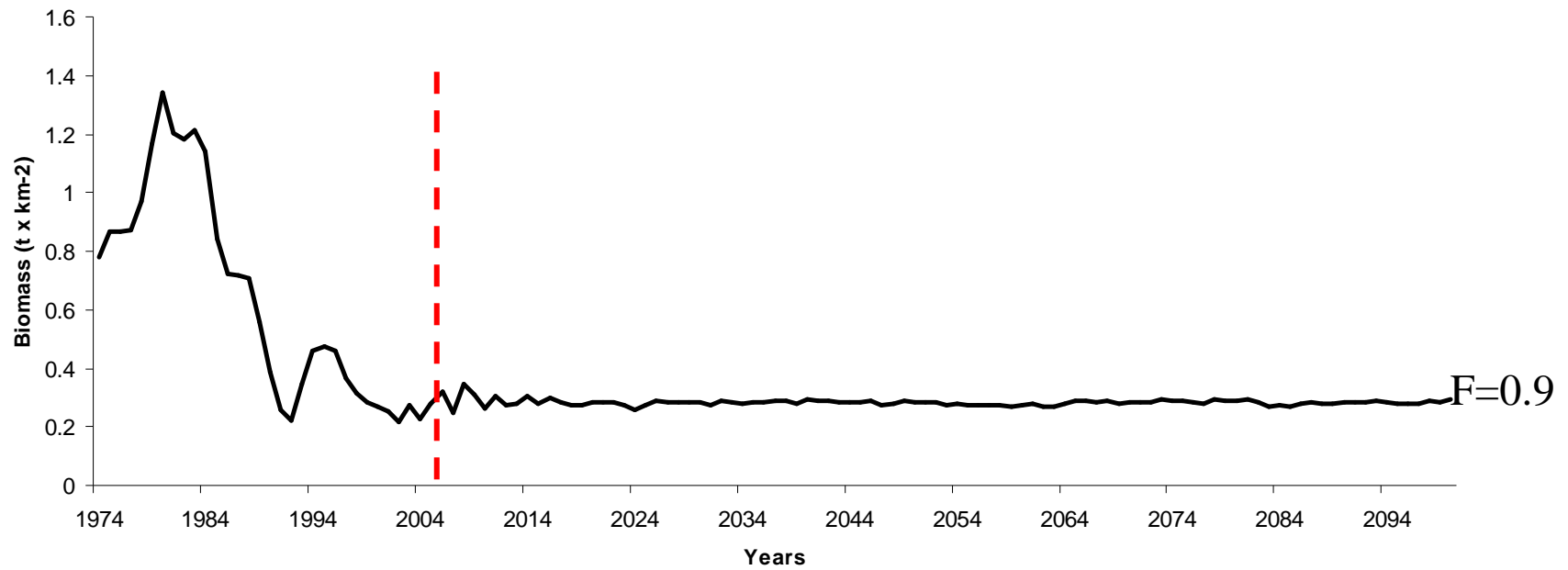
## *Validation:*

- Biomass (absolute) of
  - Phytoplankton
  - Zooplankton
  - Fish
  - WEST (Mean weight at Stock)
- Landings
- Diets



# Simulation scenario

## Fisheries and Climate Change on Cod biomass



**Scenarios**

**Fishing**

**Climate**

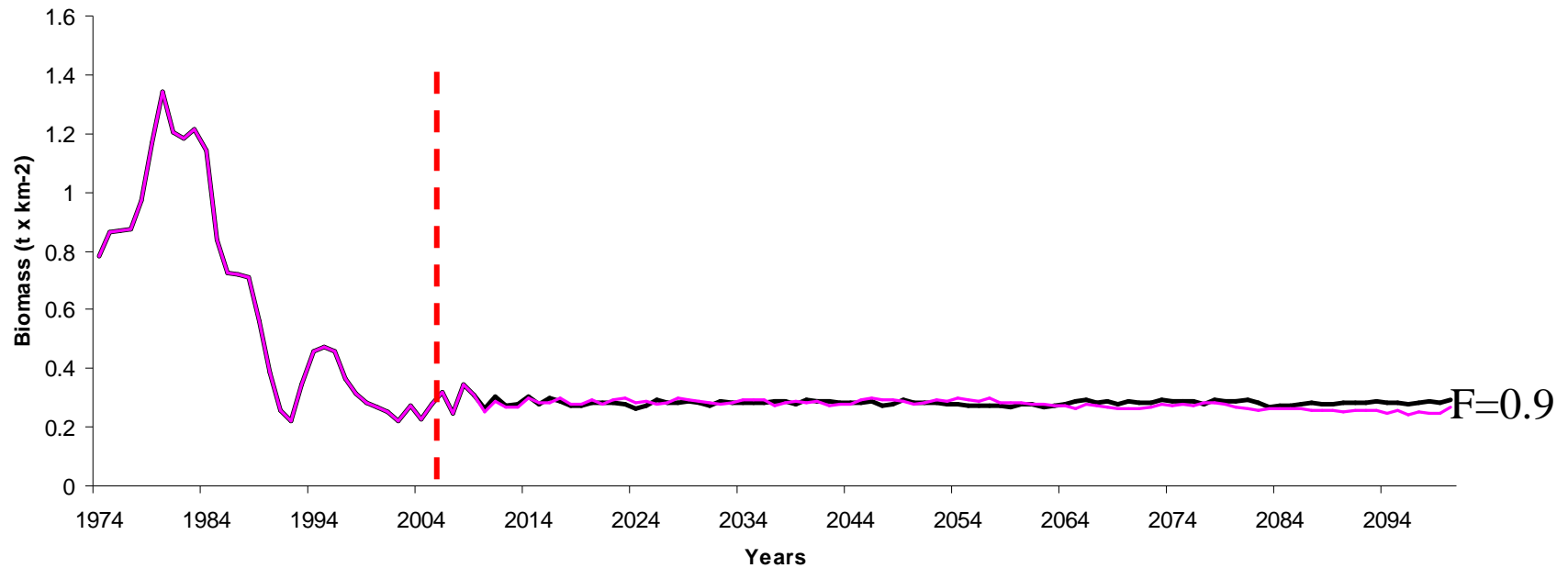
BAU=means

no CC



# Simulation scenario

## Fisheries and **Climate** Change on Cod biomass



**Scenarios**

**Fishing**

**Climate**

BAU=means

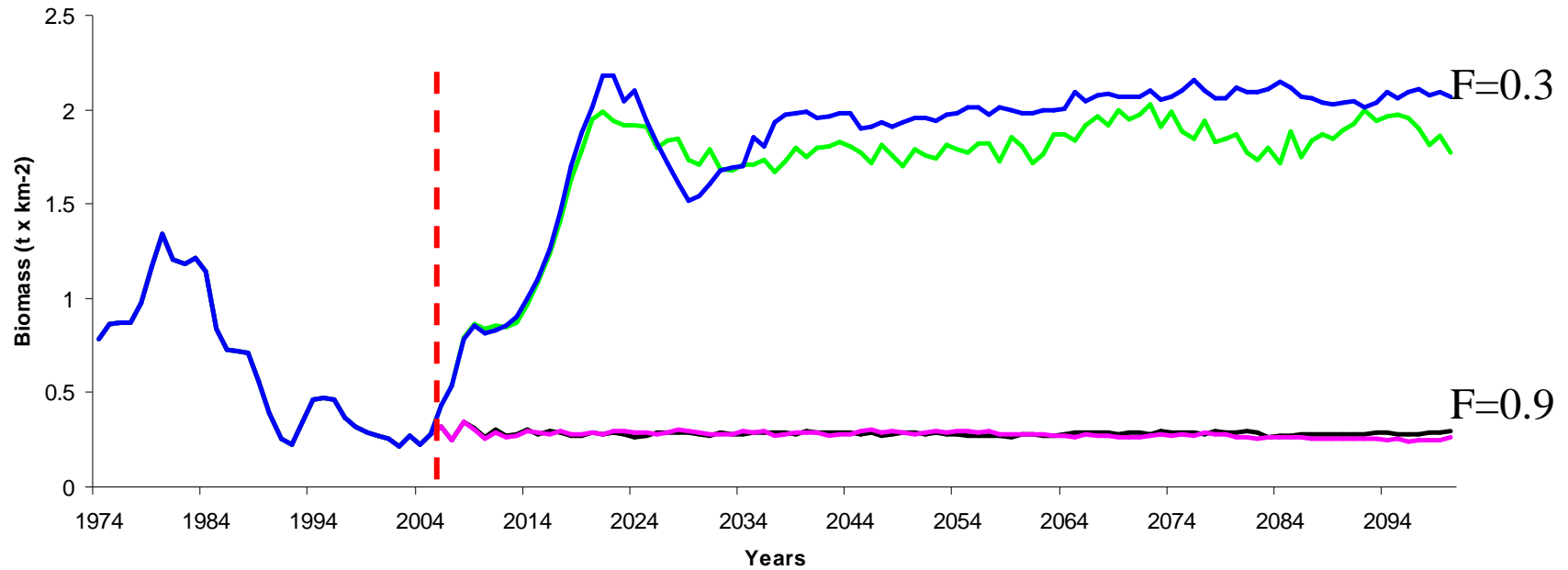
no CC

BAU=means

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# Simulation scenario

Fisheries and Climate Change on Cod biomass



**Scenarios**

**Fishing**

**Climate**

**BAU=means**

**no CC**

**BAU=means**

**CC**

**F=0.3**

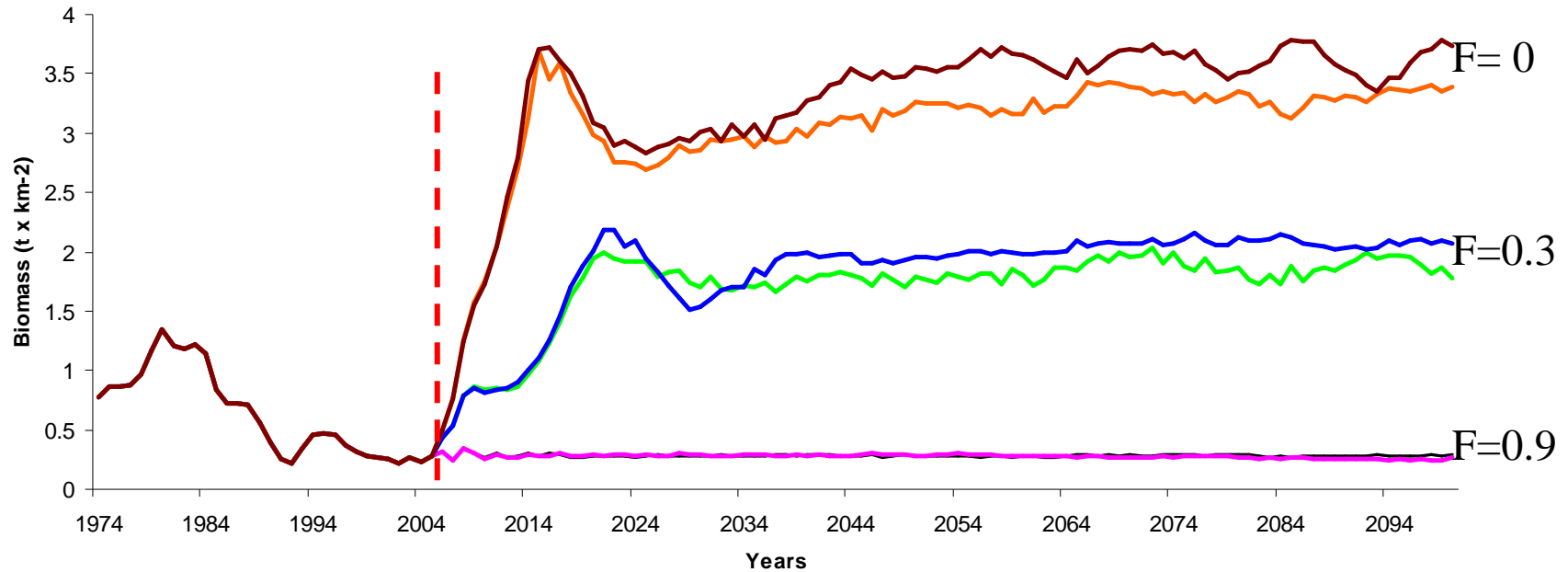
**no CC**

**F=0.3**

**CC**

# Simulation scenario

## Fisheries and Climate Change on Cod biomass



**Scenarios**

**Fishing**

**Climate**

BAU=means

no CC

BAU=means

CC

F=0.3

no CC

F=0.3

CC

F=0

no CC

F=0

CC

# Next steps

- Finalise the Ecosim
- Heavily testing/sensitivity analysis
- Discuss the link to biogeochemical models
  - RV, salinity, temp, oxygen
  - Phytoplankton, grazing
- ...