ECOSUPPORT

Data Integration and Modelling Workshop

Oct. 14, 2009
SMHI, Norrköping, Sweden

Agenda

1300-1320 Markus and Brian : Welcome, aim and technical details

Climate-hydrography-NPZD models

1320-1330 NN: RCAO
1330-1400 Bo, Kari, Thomas: Introduction into BALTSEM, RCO-SCOBI, ERGOM; current status

Fish and foodweb models
1400-1445 Brian, Anna, Maciej: single and multi-species, Planfish, Ecopath

1445-1500 Coffe Break

WP4 Case studies – data needs
1500-1520 WP4 participants

1520 -1800 Discussion (next slide)

Discussion Topics (see Invitation)

Topics for discussion at the workshop will be:

-general orientation on the data demands and inputs and output variables for climate, oceanographic, biogeochemical, fish and foodweb models

- -horizontal and vertical resolutions/scaling;
- -temporal resolution/scaling

-how to store and exchange output data for later use in other models

-uncertainties of different model types; consequences of passing outputs from one model to be used as forcing variables in other models

-assemble-averaging approaches

-"round-abouts" (solution fixes) for situations when preferred data are not available

-other

Meeting Outputs (Objectives)

Need answers to following questions:

-what kind of data are needed to run fish and foodweb models in wp3 & wp4?

-which climate-biogeochem. models are able to provide those data?

-which scenarios (CO_2, nutrients, fishing, etc.) is the project going to run?

-data formats, storage, delivery times.

Where will the data be stored?

What kind of formats, etc.?

When will they be available?

Data Requirements

Hindcasted data for earlier years (1900 – present)

-should be able to "predict" past independent observations so we have confidence with future

Scenario outputs for future years (e. g., ca. 2000-2100)

-climate, nutrient, fishing scenarios

ECOSUPPORT Approach

-will combine different models and outputs to enable modelling of entire Baltic foodweb

-to be used for scenario simulations of how Baltic Sea foodweb will respond to changes in forcings such as:

- -climate
- -nutrient loading (eutrophication, oligotrophication)
- -fishing

Similar work being done within ICES WG Integr. Assessment of Baltic (co-chairs: Anna Gårdmark, Christian Møllman, Thorsten Blenkner)

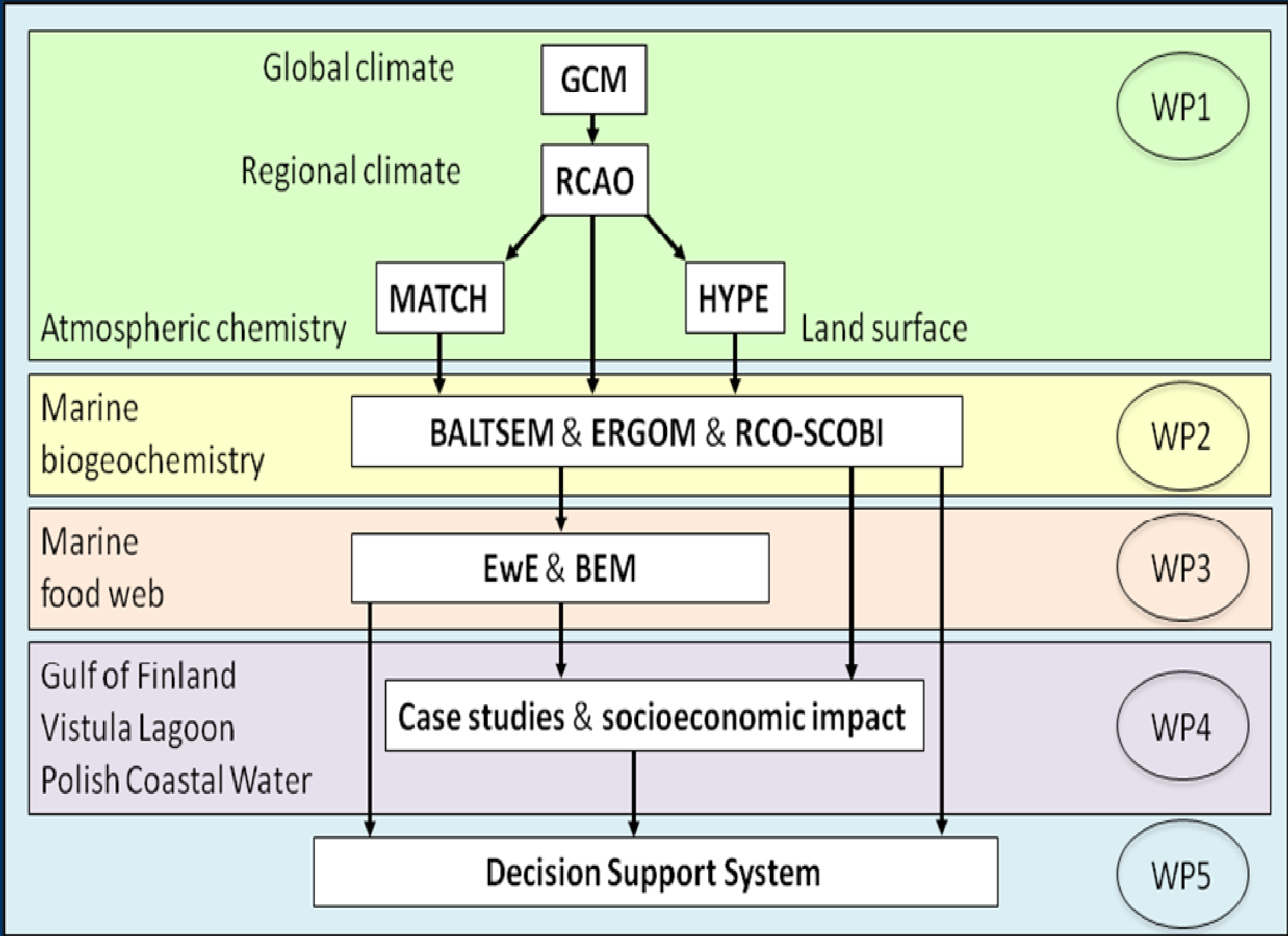
Available Models

Climate

Physical oceanographic-biogeochemical (lower trophic levels of food web)
-"NPZD"

Foodweb and fish populations

ECOSUPPORT Model Hierarchy



Available Models

Climate

-RCAO/ECHAM5/A1B
-RCAO/ECHAM5/A2

-RCAO/HadCM3/A1B
-RCAO/HadCM3/A2 or B2

= 2 different regionalized versions of global climate models (GCMs)
-each will be used for 2 different IPCC CO_2 emission scenarios

Available Models

Climate

Physical oceanographic-biogeochemical (lower trophic levels of food web)
-"NPZD"

-BALTSEM (BNI model)
-ERGOM (IOW)
-RCO-SCOBI (SMHI)

-each will be forced by climatic-oceanographic data from the
2x2 combination of climatemodels and CO_2 emission scenarios

Available Models

Climate

Physical oceanographic-biogeochemical (lower trophic levels of food web)
-"NPZD"

Foodweb and fish populations

-Ecopath/Ecosim (BNI, DTU-Aqua) – entire foodweb from nutrients-PP-ZP-fish
-MSVPA/SMS (DTU-Aqua) – hydrography-fish
-BALMAR (DTU-Aqua, Uni. Hamburg) – hydrography-ZP-fish
-PLANFISH (SBF) – hydrography-ZP-fish

-bioclimatic envelope modelling (GU) – emphasis on physiological tolerances to T, S, O_2, pH for mapping species ranges

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Modelling Approaches within ECOSUPPORT WP3 and WP4

WP3

-single-species

-multi-species models (age- and non-age stuctured)

- -MSVPA
- -Planfish
- -Baltmar
- -Ecopath/Ecosim

-varying levels of complexity, links to ecosystem and species-species interactions

WP4 (Vistula Lagoon, G. Finland cases)

-hydrographiy and lower trophic levels (NPZD)

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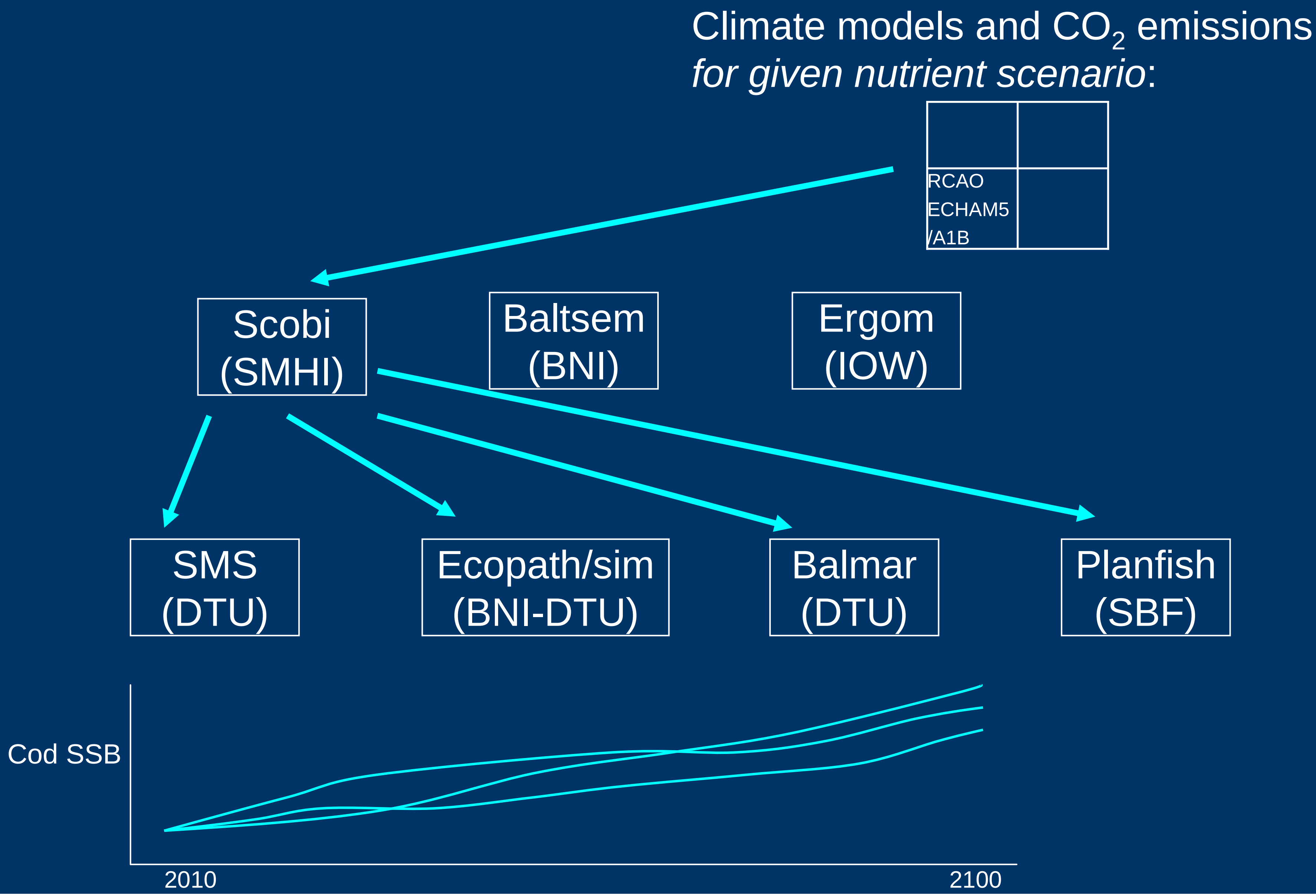
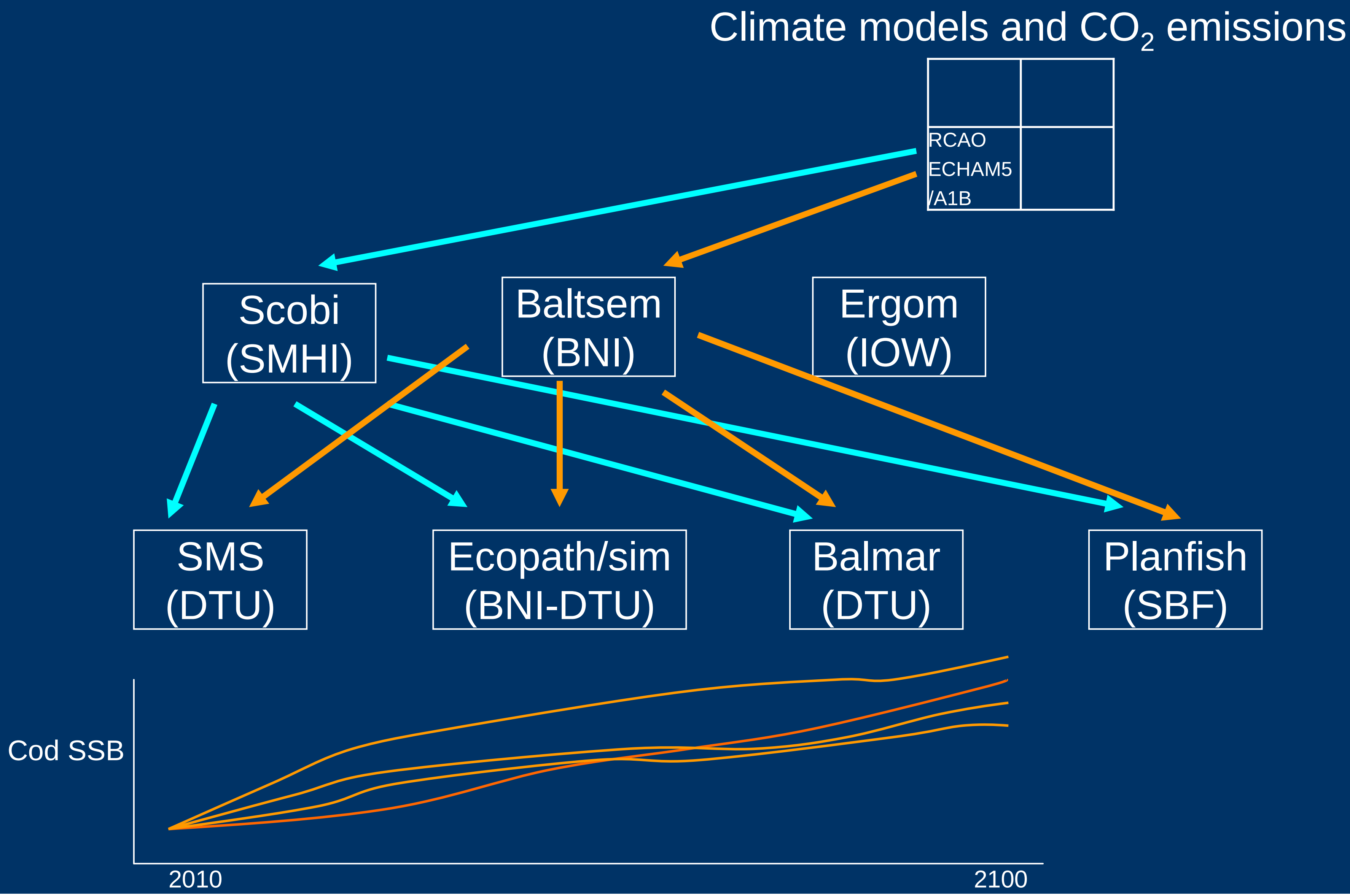
Inter-Linking Models within ECOSUPPORT



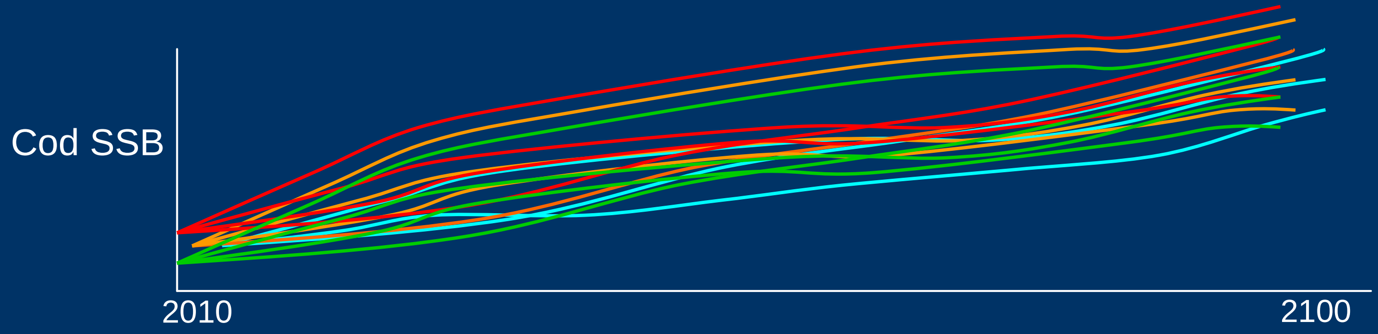
Inter-Linking Models within ECOSUPPORT



Model Outputs

-for a given CO_2, nutrient and fishing scenario, have following time series:

-2 climate models x 3 NPZD models x 4 foodweb/fish models = 24 time series



Or:

-(ens. avg. output from climate-NPZD model combination) x 4 foodweb/fish models = 4 time series

How to Make it Work

-need standard set of variables for input to our fish and foodweb models

-reproductive volume for cod by month and basin
-temperature at specific depths at specific months for sprat
and herring recruitment

-temperature at specific months and depths to force fish feeding and growth rates

-abundances of a few key ZP species for fish feeding, etc.

Selection of Forcing Variables for Fish/Foodweb Models in ECOSUPPORT

Dep. Var.	Forcing var.	depth	area	Temporal resolution (month, season?)	Time period needed
Cod recruitment	Reproductive volume	Defined by vertical profiles of salinity and oxygen (physiological thresholds to be provided)	Bornholm, Gdansk, Gotland Arkona Basins	Monthly;	1900-2100 (1850-2100)
xxx					
xxx					
xxx					
xxx					

-has been prepared in spring 2009 and circulated to WP1 and WP2

Main Conclusions from Workshop, Oct. 14 (1 of 6)

Climate models:
-suggest using A2 and A1B emission scenarios
-ECHAM5 A2, A1B (2 scenarios nos. 2 and 3), HADCM3 A1B
-all models at 50 km resolution
-run all 4 with RCAO to produce climate forcing output variables for hydrographic-NPZD models

Hydrography-NPZD models
-much progress already made; some preliminary runs done
-is possible to produce main input variables for fish and foodweb models from 3 models
-only 1 model (ERGOM) can produce data for particular species ("Pseudocalanus"; "Acartia/Temora")

-may be only possible for limited combination of scenarios if want full transient time series

Main Conclusions from Workshop, Oct. 14 (2 of 6)

Hydrography-NPZD models
-need some key validation datasets, especially for zooplankton (time series, seasonality
-suggestion for compiling 1-2 datasets that could be used for model validations

Fish-foodweb models
-several available with different structures, assumptions, complexities and data needs
-some work already done to produce some projections for some combinations of climate and fishing

WP4 (G. Finland, Vistula Lagoon)
-require hydrography and lower trophic level data
-can use ERGOM outputs

Main Conclusions from Workshop, Oct. 14 (3 of 6)

Future scenarios – which ones?

-climate models and CO_2 -ECHAM5 A2, A1B (2 scenarios nos. 2 and 3), HADCM3 A1B

-nutrients: 2 scenarios will be BSAP and business-as-usual (“bau”)
-can also do “worst-case” scenario if time permitting and for some npzd models

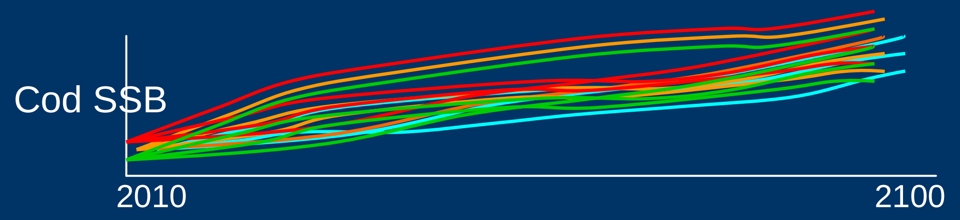
-fishing – status quo and high-low extremes for 3 different species (cod, herring, sprat)

Main Conclusions from Workshop, Oct. 14 (4 of 6)

Data issues – validation, formats, biases, etc.

Application of ensemble averaging

-2 climate models x 3 NPZD models x 4 foodweb/fish models = 24 time series



Or:

-(ens. avg. output from climate-NPZD model combination) x 4 foodweb/fish models = 4 time series

-use outputs from all climate models as inputs to all npzd models.
-check outputs. Then decide whether to use ensemble average of npzd outputs or use individual models as inputs to fish-foodweb models.

Main Conclusions from Workshop, Oct. 14 (5 of 6)

Model biases
-use hindcasts in control period to callibrate models and check for biases.
-include notes about biases when providing datasets so others are aware

Data formats
WP2 and WP4 – individual formats because datasets are big
WP3 – ascii

-all output data placed on ECOSUPPORT homepage
-need to develop file structure, filenaming and folder structure for output files to WP3
-to be done in correspondance between leaders of WP1-3

Main Conclusions from Workshop, Oct. 14 (6 of 6)

Data timing

-November 2009 - RCAO data available for input to hydrogr-NPZD models

-January 2010 – first hindcast data available; several iterations will be produced as models improve and get feedback from data users

-month 18 (late summer 2010) - scenario outputs available

-participants should use hindcast data as it becomes available to become acquainted with datasets/formats and for validation/comparison with fish/foodweb models.

ECOSUPPORT Activities, DTU Aqua

Mainly involved in WP2 (reproductive volume estimates) and WP3

WP2 – cod reproductive volume data and validation

WP3

-coordination of WP3

-identification of variables and scallings required for input to fish and foodweb models

-yesterday's workshop

-development of validation datasets

-cod spawner biomass and fishing mortality now available from early 1920s-present (Eero et al. 2008 CJFAS)

-development of several types of fish-climate models

-single-species and multi-species models (cod, sprat, herring)

-MS models with spatially-explicit fishery activities

-foodweb models (climate-zoopl.-fish-fishing)

-foodweb models via collab. with BNI using Ecopath/Ecosim (climate-PP-ZP-fish-fishing)

Environmental Forcing in Fish Population Models

Typical models for understanding past variations or for making future projections exclude ALL environmental and ecosystem forcing of population dynamics!

-i. e., reproduction, growth, feeding, all are stochastic processes with no dependance on ecosystem state

e. g., ICES has recently held a workshop on how to incorporate env. forcing in fish Models (June 2007)

Report of the Workshop on the Integration of Environmental Information into Fisheries Management Strategies and Advice (WKEFA)

ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer

18–22 June 2007

ICES Headquarters, Copenhagen, Denmark

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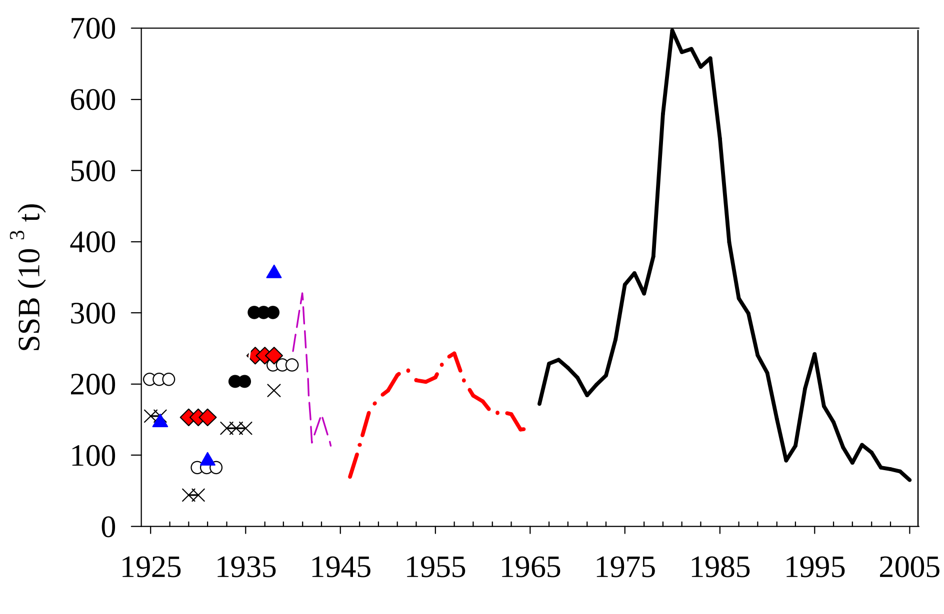
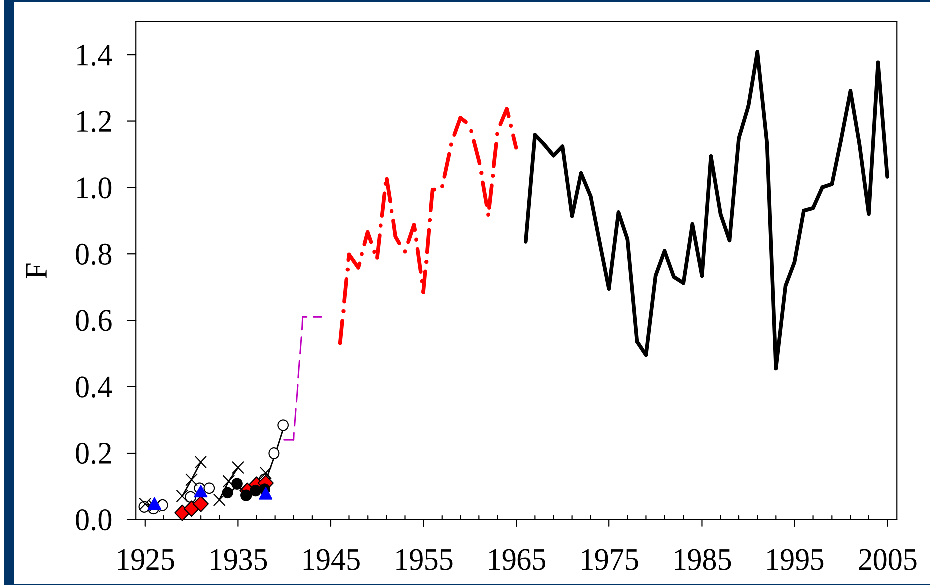
Reconstruction of Cod Population Dynamics

Population dynamics of cod in the Central Baltic during the 2nd part of the 20th century (Margit Eero et al. 2008 CJFAS)

Spawning stock biomass



Fishing mortality



Back to the 1940s: VPA based construction, before: catch curve analysis, cpue, egg abundance and estimates from analysing landings in north-eastern areas

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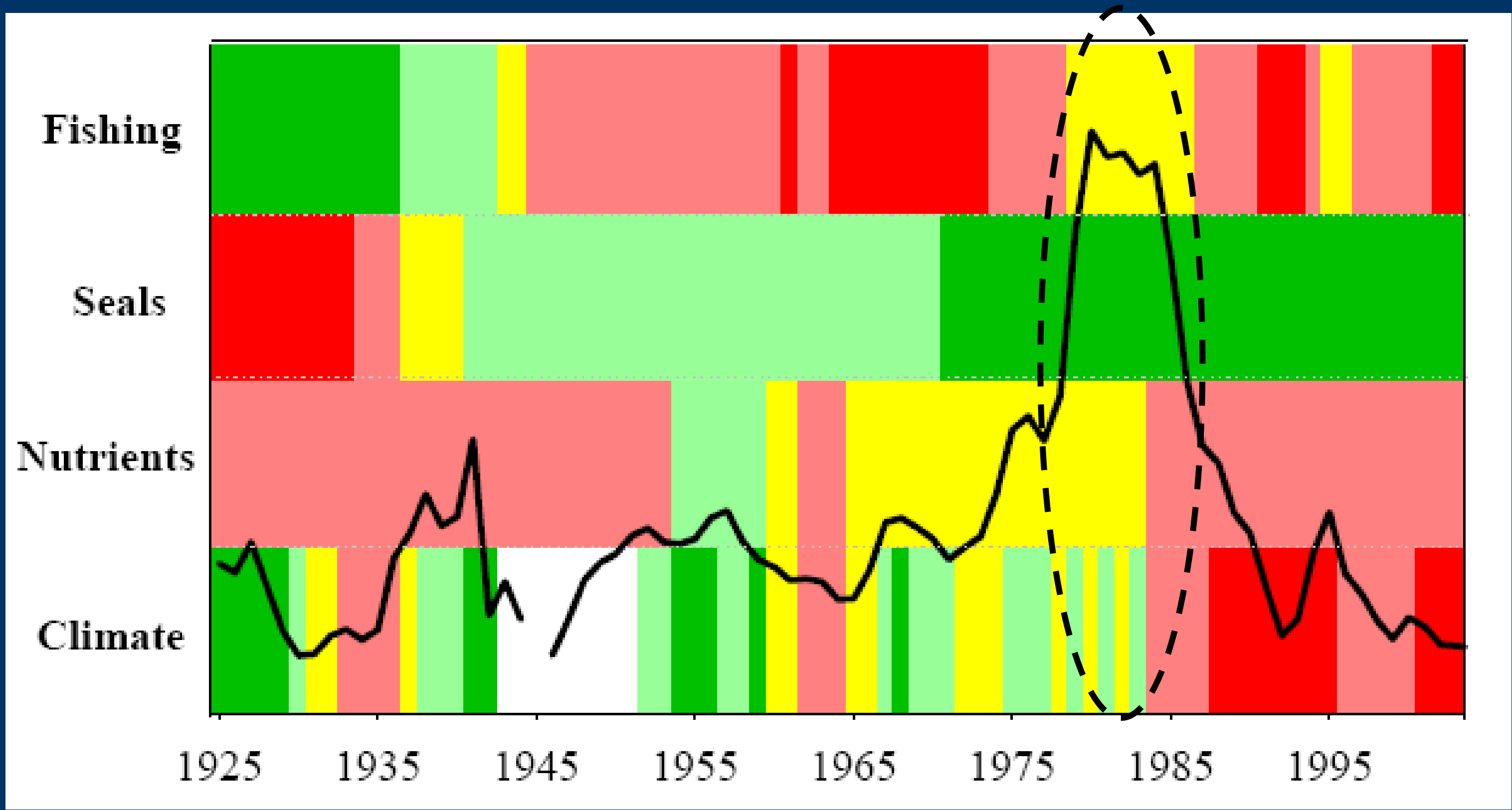
Forcing Factors for Cod in 20th Century

Population dynamics of cod in the Central Baltic during the 2nd part of the 20th century (Margit Eero et al. 2008 CJFAS)



The line represents cod spawning stock biomass.

Green colours represent favourable impacts on cod, red detrimental and yellow neutral.

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Overview of Fish and Foodweb Models

Increasing complexity

Model	Description/category	Ecosystem Links			Ref.
		Env. var.	Plankton	Fish	
Regression, GAM – cod, sprat, herring	SS; age structured	T, S, O2	-	-	Köster et al. 2003; MacKenzie and Köster 2004; Heikinheimo 2008; Cardinale et al. 2009; Köster et al. 2009; etc.
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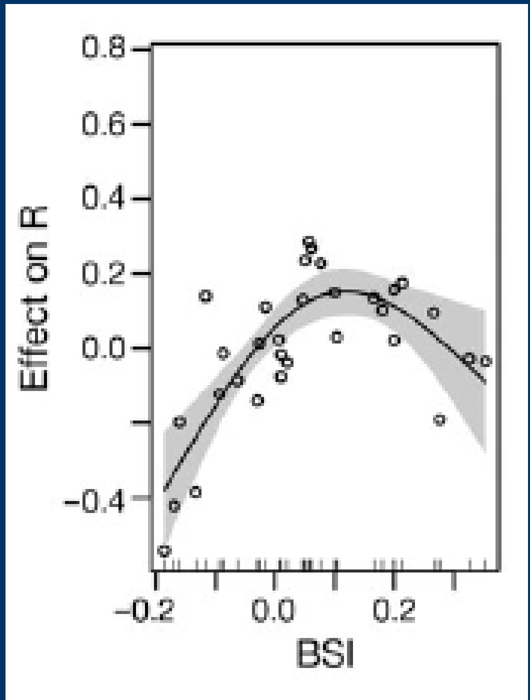
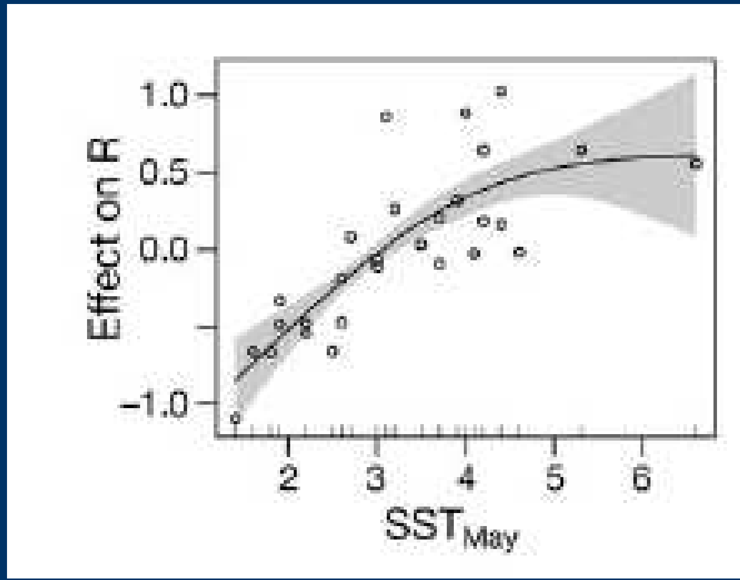
Ecopath/ecosim	Age-structured, foodweb	T, S, O2	PP, Pseudo., Acartia, Temora, zoobenthos	Cod, herring, sprat	Blenkner, et al.

Climatic Impacts on Baltic Herring Recruitment 1974-2005



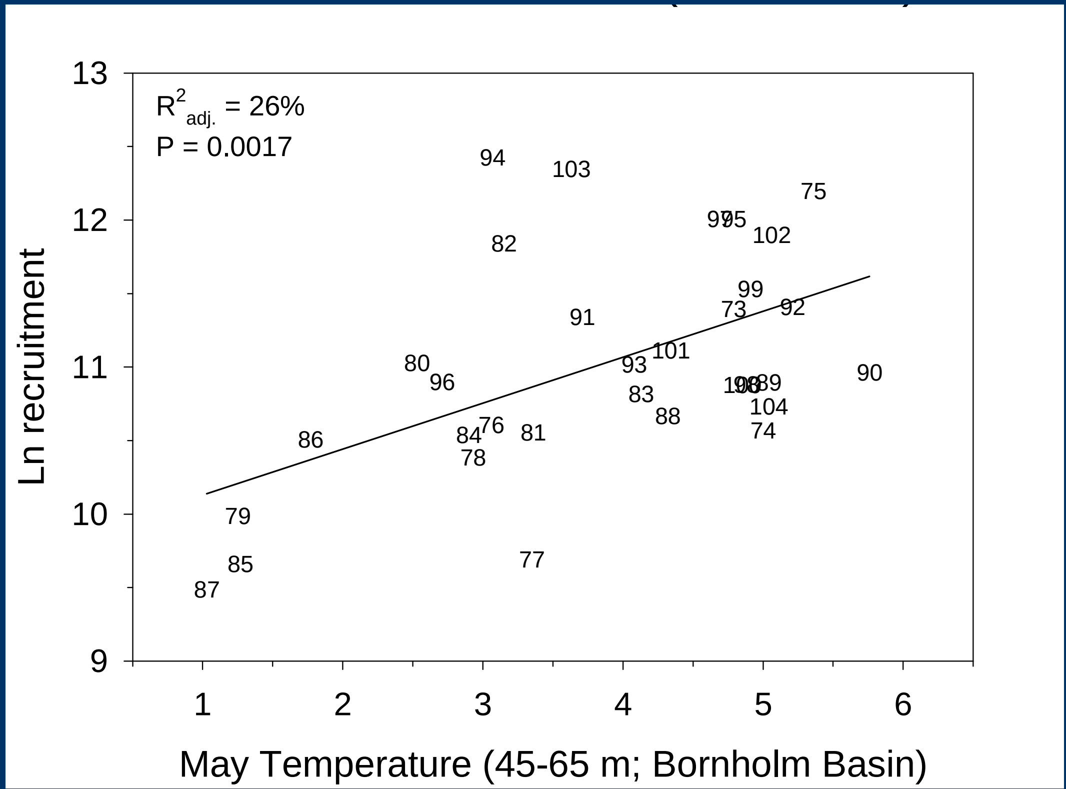
C. Baltic herring



G. Riga herring

Cardinale et al. 2009
MEPS

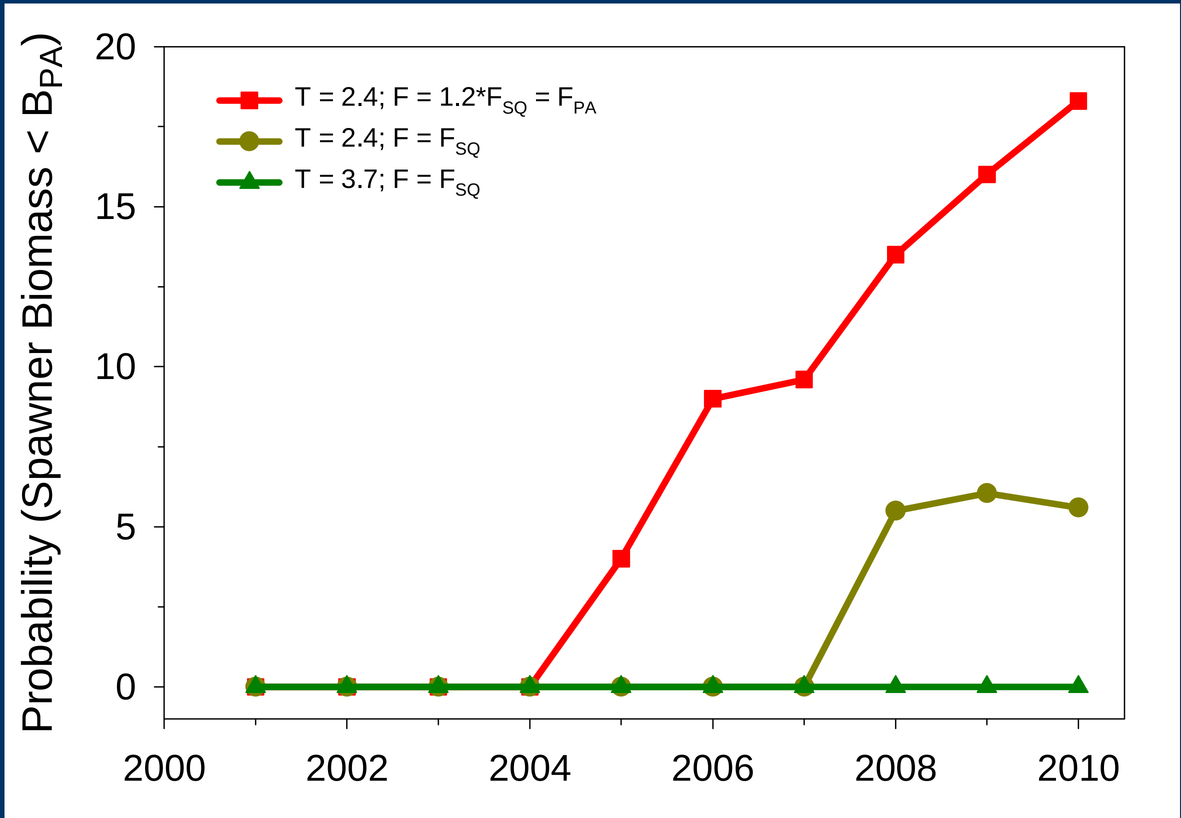
Temperature – Recruitment Relationship for Baltic Sprat 1973-2004



-warm temperature promotes growth and survival of eggs and larvae, partly via zooplankton community

MacKenzie & Köster 2004 Ecology
MacKenzie et al. 2008 CJFAS

Management Application: Risk of Stock Collapse under Different F and Climate Scenarios



Mean T - SD, Fpa

Mean T - SD, Fsq

Mean T, Fsq

Risk of a stock decline increases in cold climate *even at precautionary fishing levels (F_{PA}).*

MacKenzie & Köster 2004 Ecology

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Example: Climate Change and Baltic Cod

-projections assuming

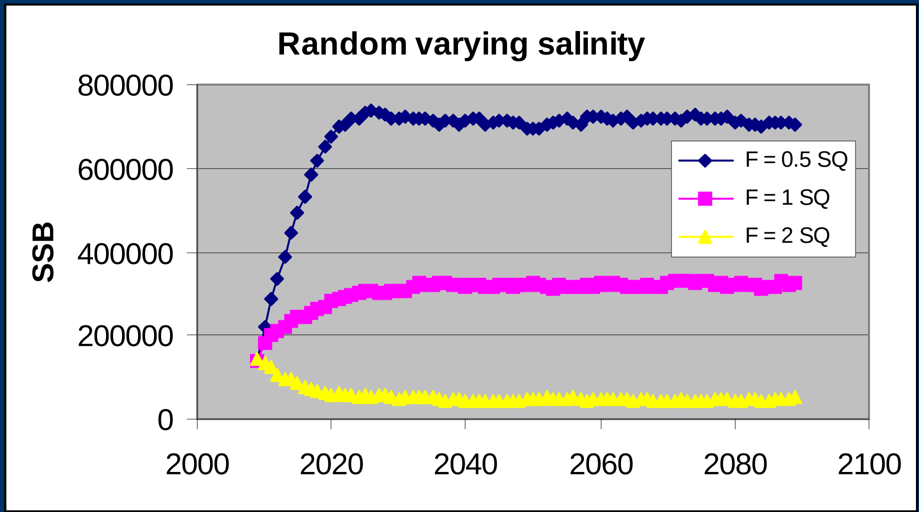
-cod recruitment is f(salinity) (Heinkinheimo 2008)

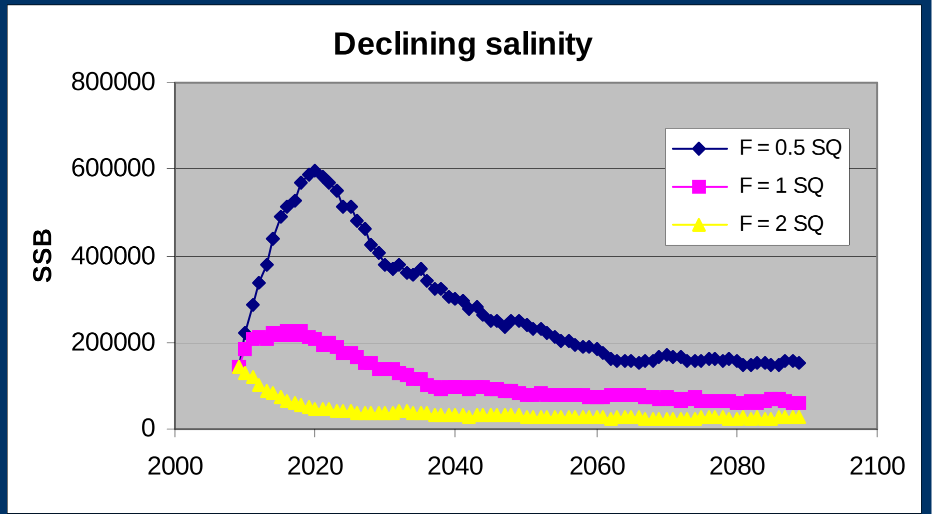
-assume salinity remains stable with random variations, or will decrease (Meier 2006; BACC 2007)

-combine with status quo or reduced fishing mortality:

	Lo F	Hi F
Cons. S		
Decl. S.		

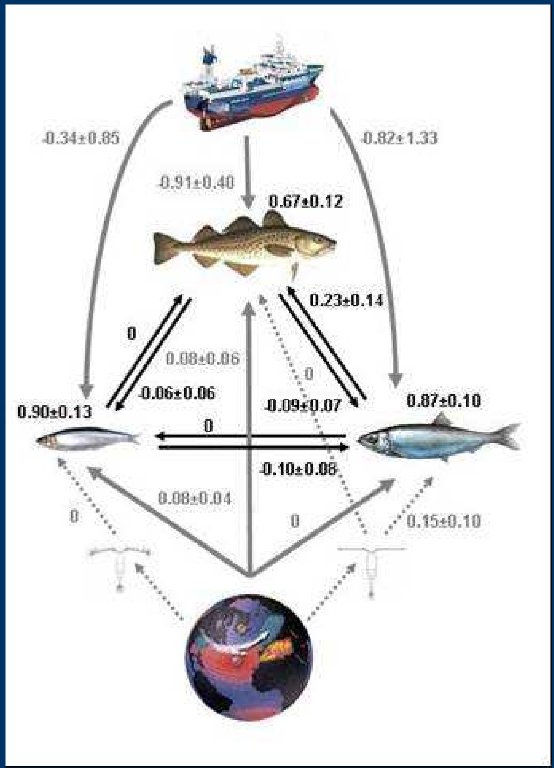
Projected Cod Biomass for Average and Declining Salinity



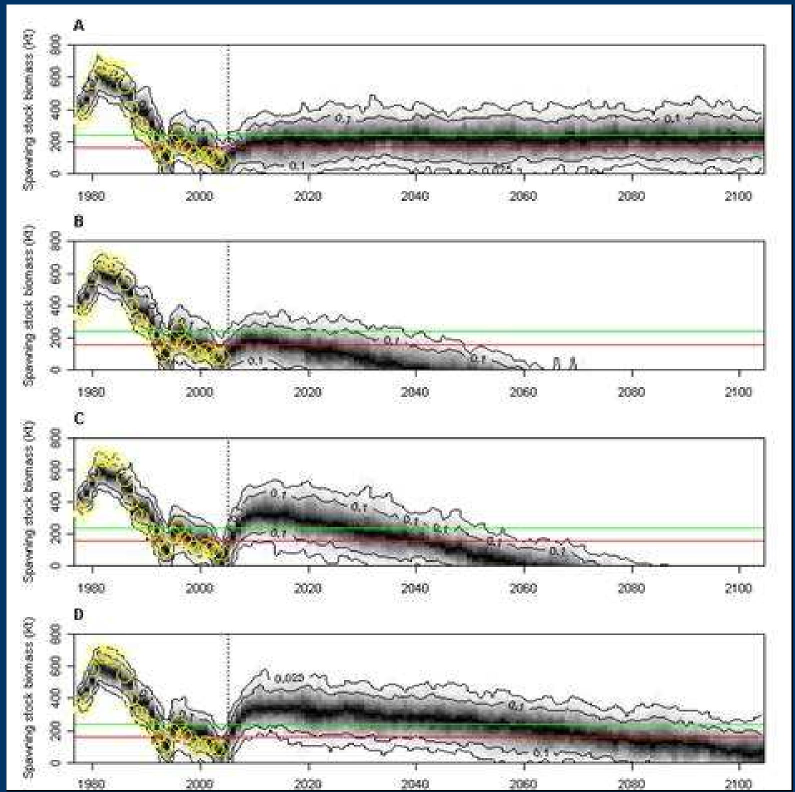


Climate and Fishing Impacts on Baltic Fish Species

Climate-foodweb-fishing links



Cod SSB projections as f(F, sal.)



Lindegren et al. In prep.

Coming Activities

Develop with WP1 and WP2 data sharing formats and procedures within ECOSUPPORT

Continue interpretation of how climate and anthropogenic factors affected Baltic Fish pops. in 20th century

- -roles of climate, fishing, eutrophication, seals
- -understand how these forcings might affect cod in future scenarios

Reproductive volume analyses based on model hindcasts

- -validations, comparisons of outputs from different models

Continue developing fish models for climate projections

- -collab. with BNI via Ecopath/ecosim
- -incorporate more env. info. into foodweb and species interaction models

Incorporating Ecosystem Forcing into Fish Models

Examples

-based on effects of env. on recruitment, feeding, growth, survival

Links Fish - Environment

Increasing complexity

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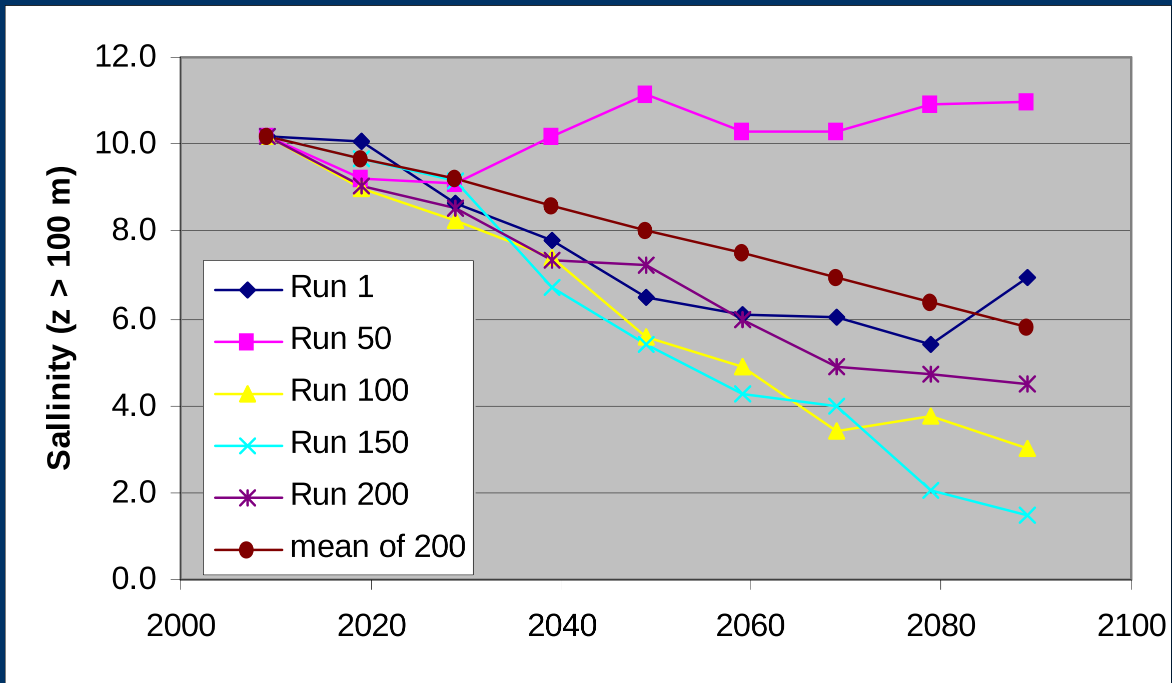
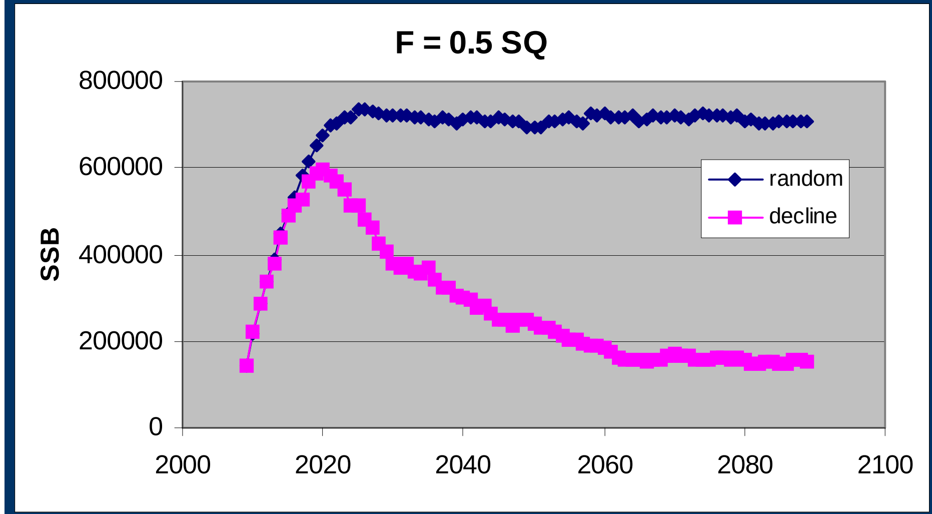
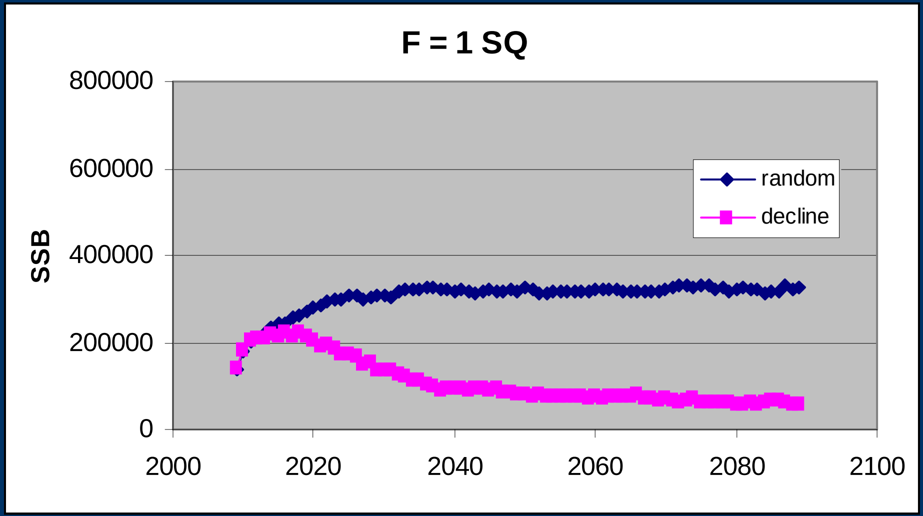
Uncertainty of Projected Salinity

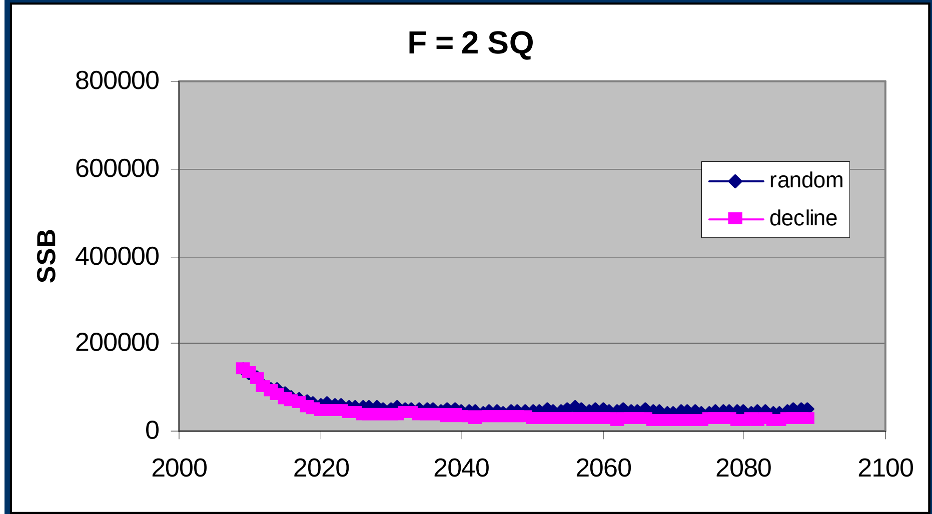
-assume 50% decline with random variability of rate of decline
-assume past variability = 0.4



Projected Effects of Salinity and F on Baltic Cod Spawner Biomass







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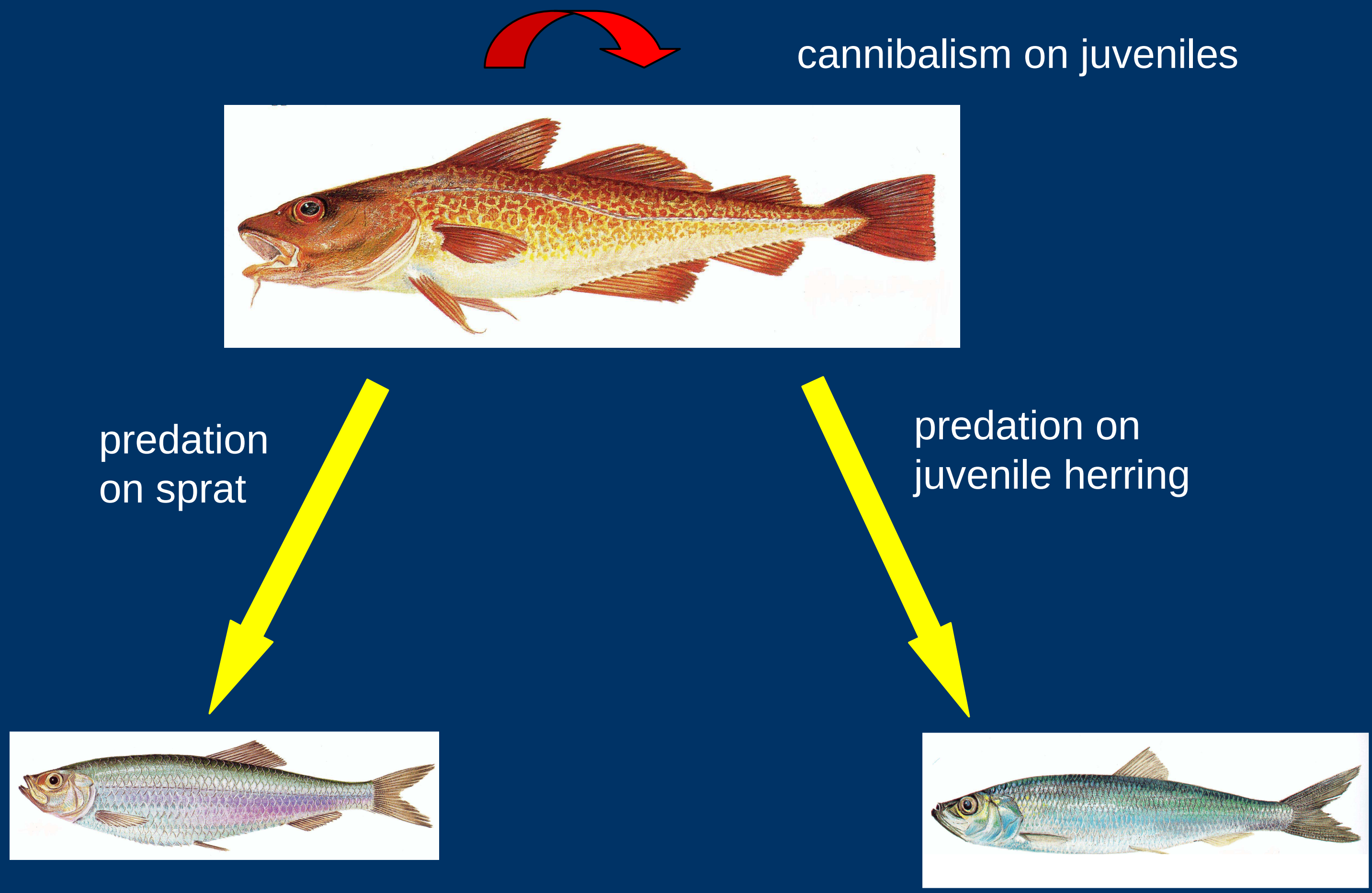
Species Interactions: Cod & Clupeids in the Baltic

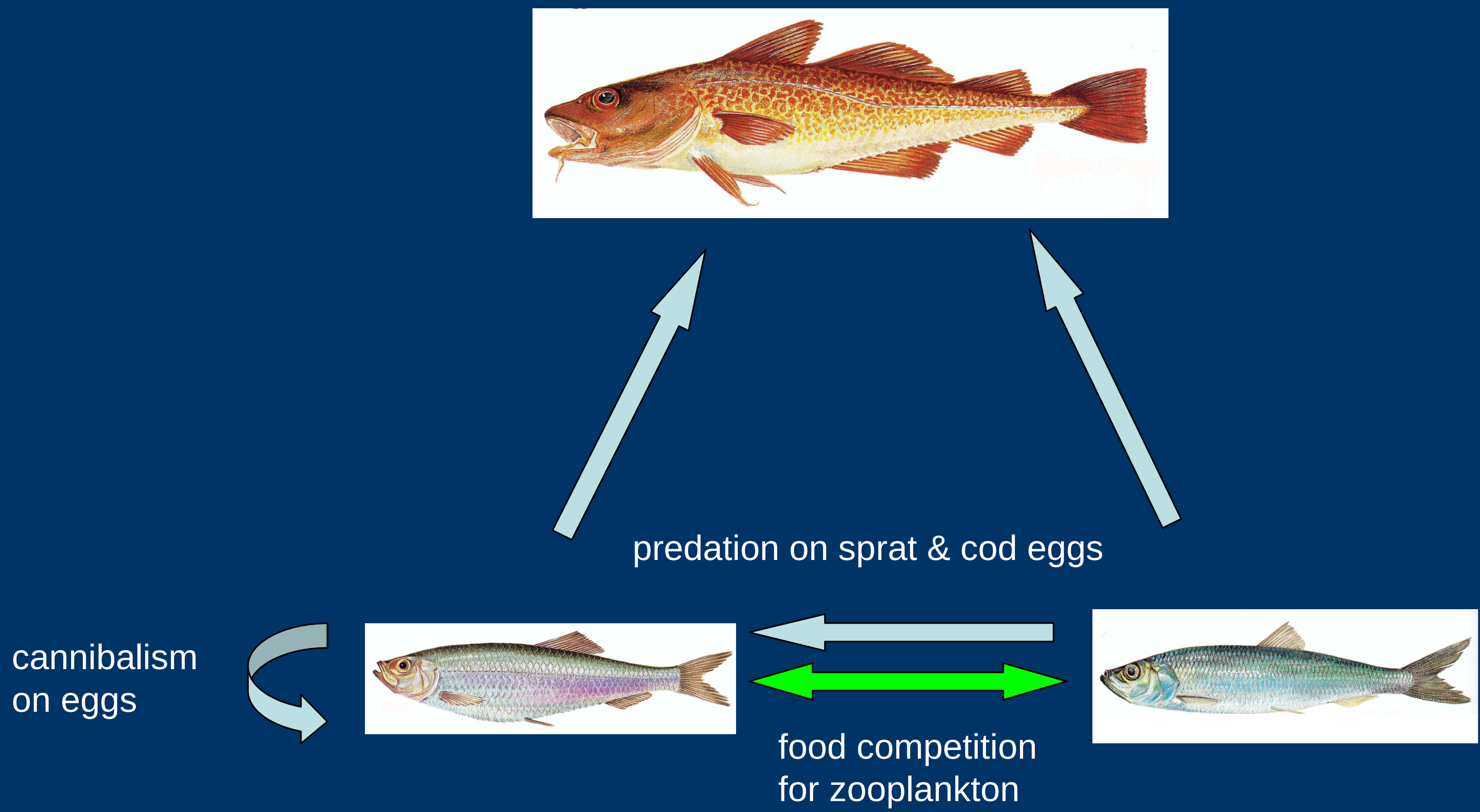
-predator-prey spatial distributions, stomach analyses



All interactions being modelled in ICES stock assessment.

Köster, Uzars, Plikshs, Möllmann, Neuenfeldt et al.

Species Interactions: Cod & Clupeids in the Baltic



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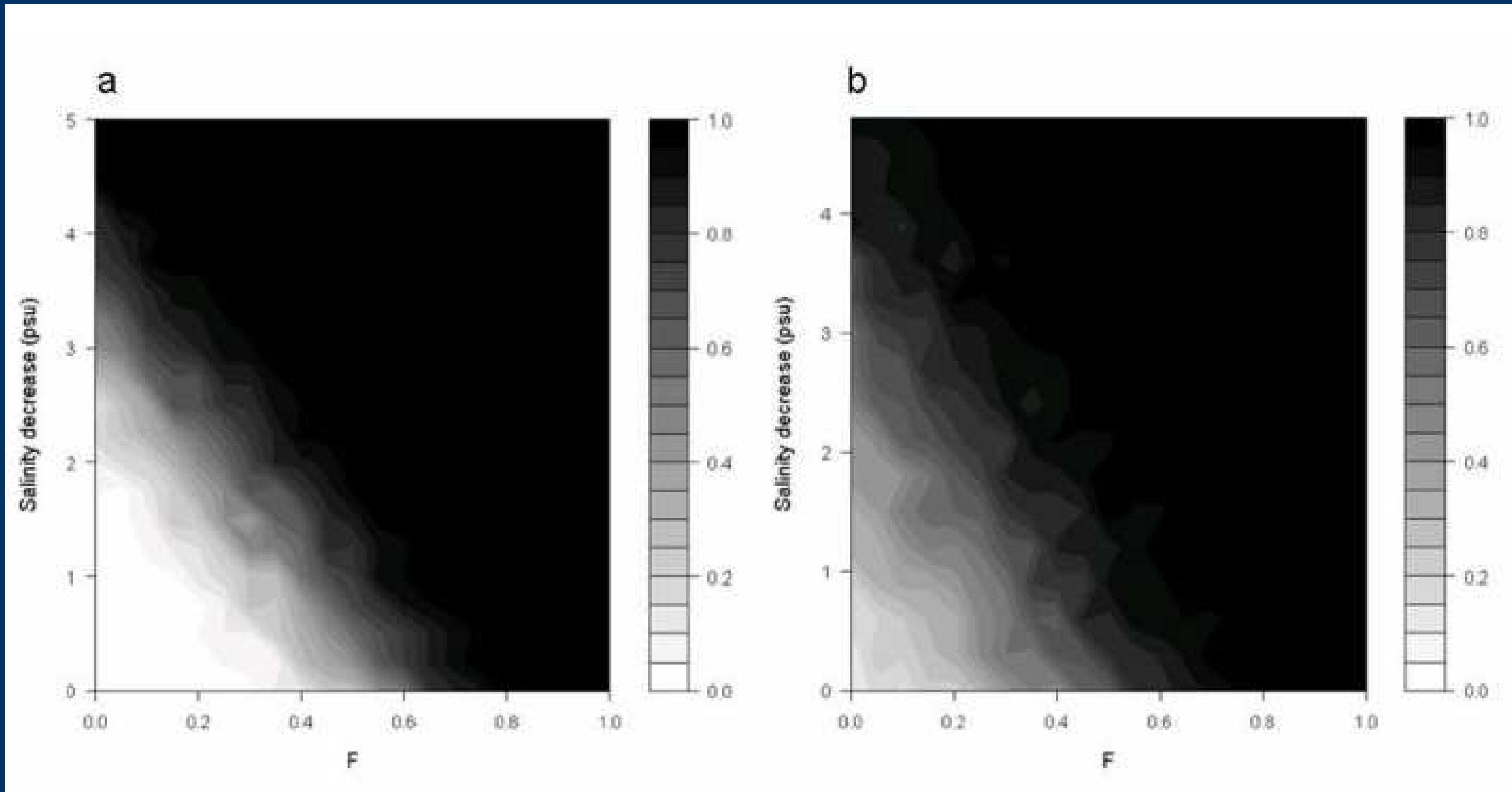
Interactions: Climate-Fishing Effects on Baltic Cod



Lindegren et al. In prep.

Planfish – Anna

Ecopath/Ecosim – Maciej

WP4??

Scenario Combinations

2 climate models x 3 NPZD models x 4 foodweb/fish models = 24 time series!!

x 2 CO_2 emission x 2 nutrient loading scenarios x 2 fishing scenarios

= 192 time series

For each fish species (cod, herring, sprat)!

Ensemble Averaging
Within a Given Scenario Combination

Simple average
- all or some models?

Weighted average
- all or some models?
- how to weigh?
  - performance against past indep. observations (validation success)?

Dealing with Uncertainties

Will use approach of "ensemble averaging" across model outputs
-same approach applied in climatology, IPCC, etc.

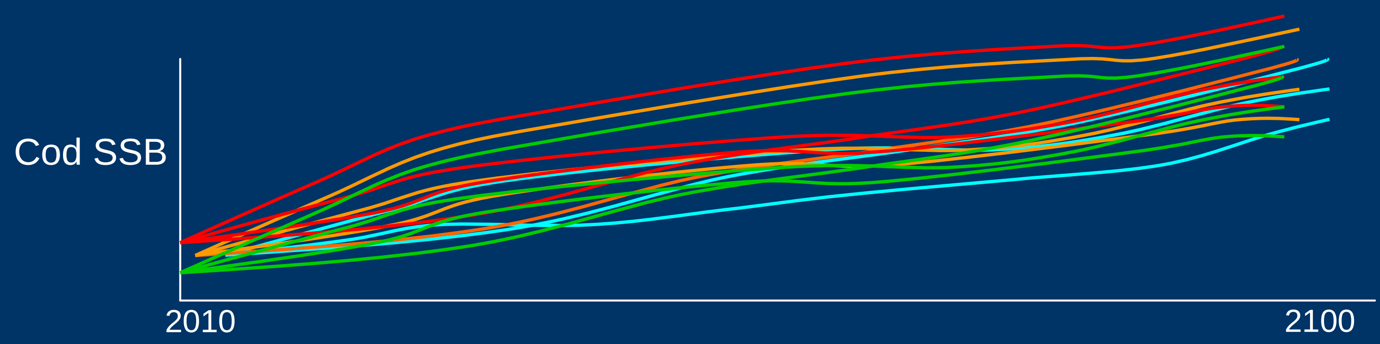
-calculate average and uncertainty (variability) for same set of forcings but with different models

-for a given CO2, nutrient and fishing scenario, have following time series:

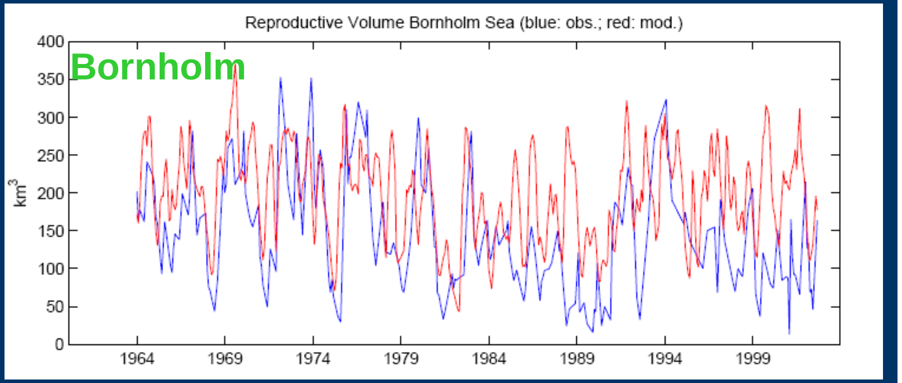
-2 climate models x 3 NPZD models x 4 foodweb/fish models = 24 time series

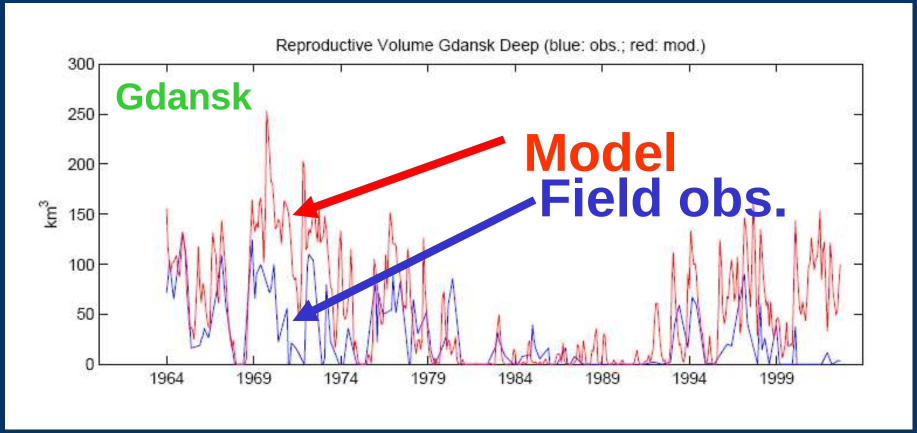
or

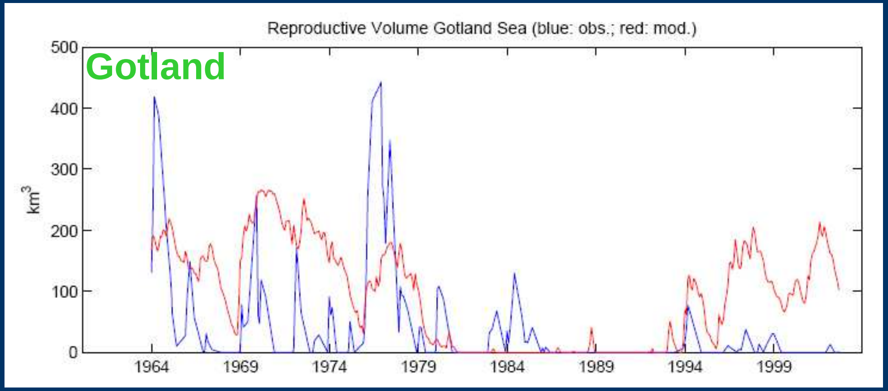
-2 climate models x avg. NPZD models x 4 foodweb/fish models = 8 time series



Modelled (IOW) and Field Estimates of Cod Reproductive Volume







UNCOVER

-main variations seem to be in both series in most areas, but some systematic differences also present and causes need to be identified.

Model Validation and Projection Strategy

Selection of variables
for biology based on
existing relationships

-hindcasted using
Models

-how good are the hindcasts??

-validation/comparison
with observations

Model Validation and Projection Strategy

Selection of variables
for biology based on
existing relationships

-hindcasted using
Models

-how good are the hindcasts??

-validation/comparison
with observations

-projections for future using
Models and given CO2 emissions

Agenda (prelim.)

Climate models – current status

Oceanographic-NPZD models – current status

Fish and foodweb models – current status
-data requirements

-single-species and multi-species models - Brian
-Planfish – Anna
-Ecopath/Ecosim – Maciej

Discussion of data outputs from climate-hydrogr.-ecosystem models and data requirements for fish/foodweb models

Foodweb-Fish related Workpackages

WP2: Impact on Baltic Sea nutrient cycles, autotrophs and zooplankton

2.1 Model validation of biogeochemical processes
2.2 Validation of the long-term biogeochemical variability
2.3 Scenario simulations of biogeochemical cycles

WP3: Impact on the foodweb

3.1 Process validation of foodweb models
3.2 Scenario simulations of the food web
3.3 Quantification of uncertainty of future food web projections