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Listen to the ocean

Dealing with uncertainty when developing socio-economic scenarios for North Atlantic fisheries futures

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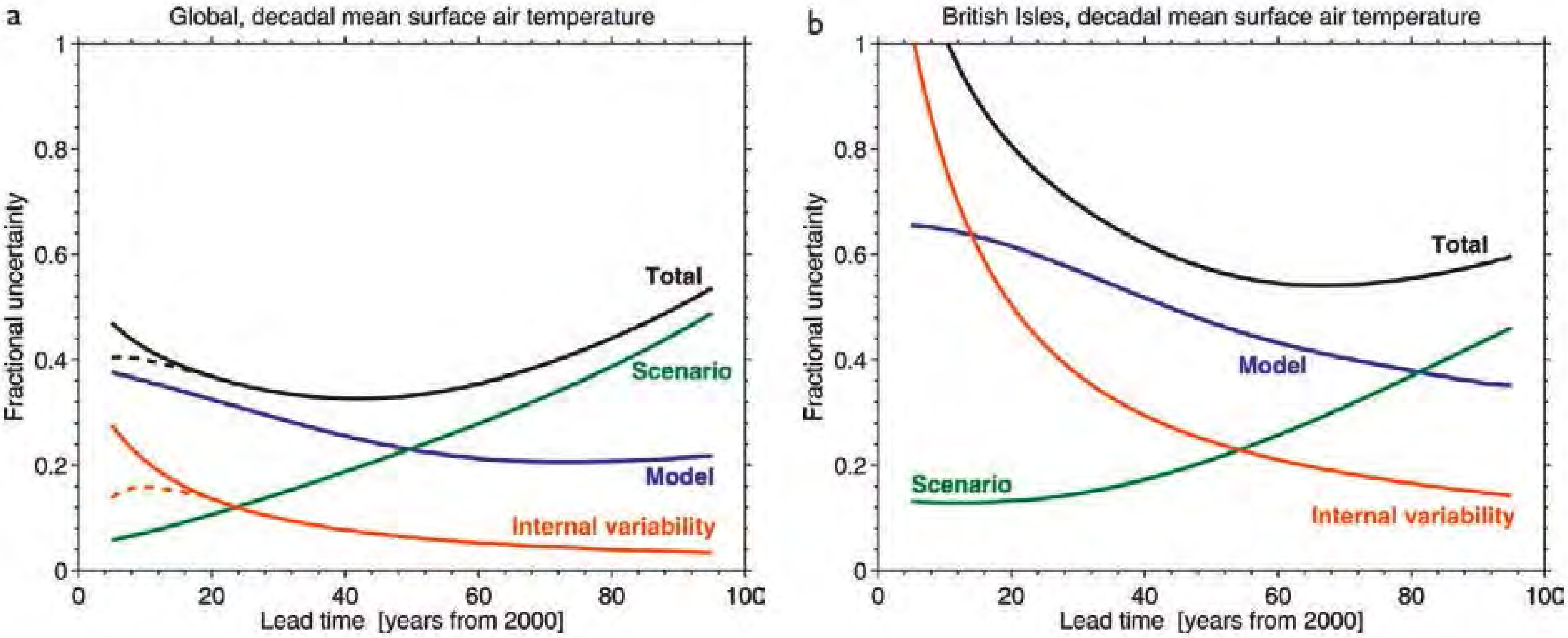
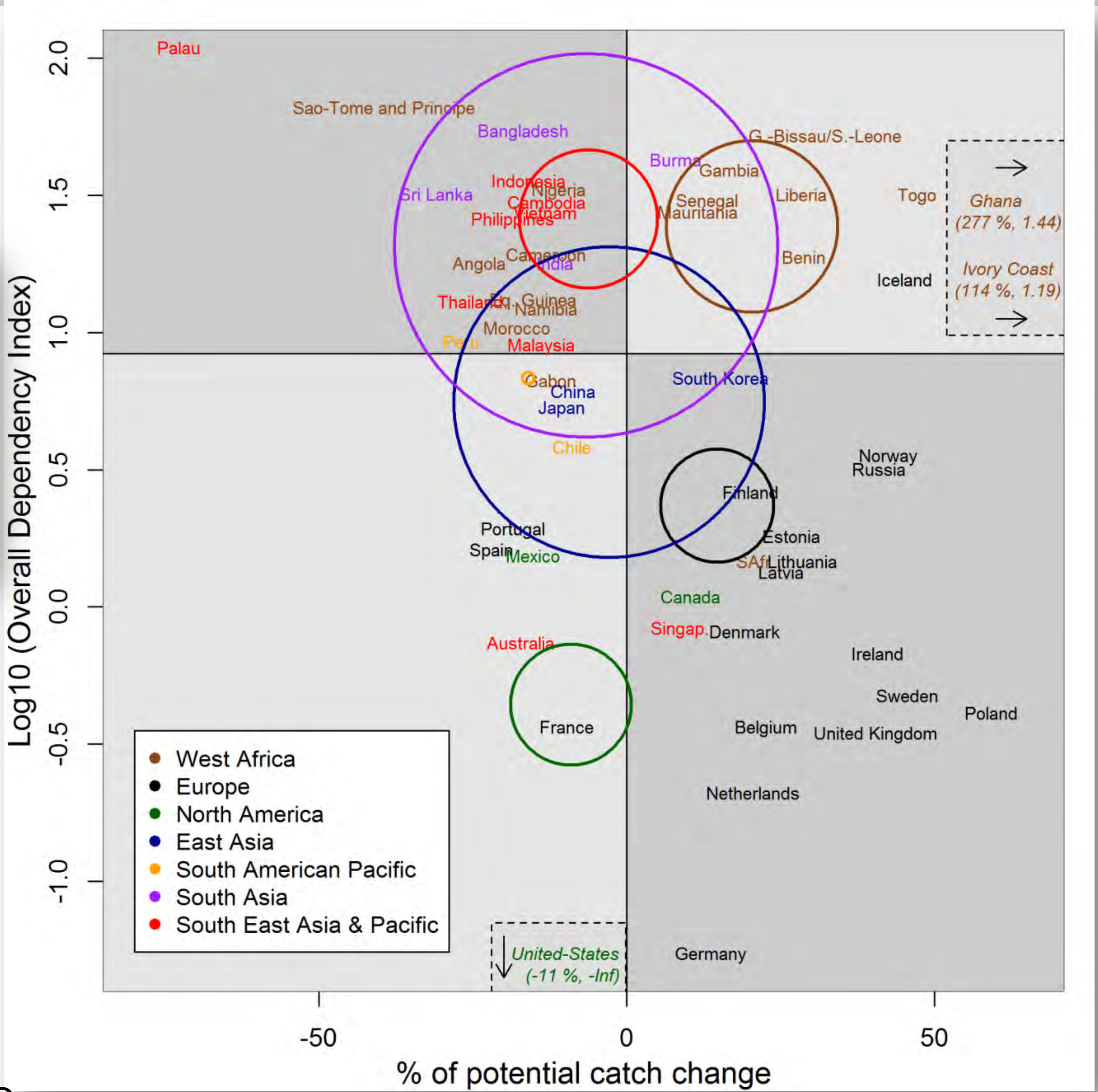
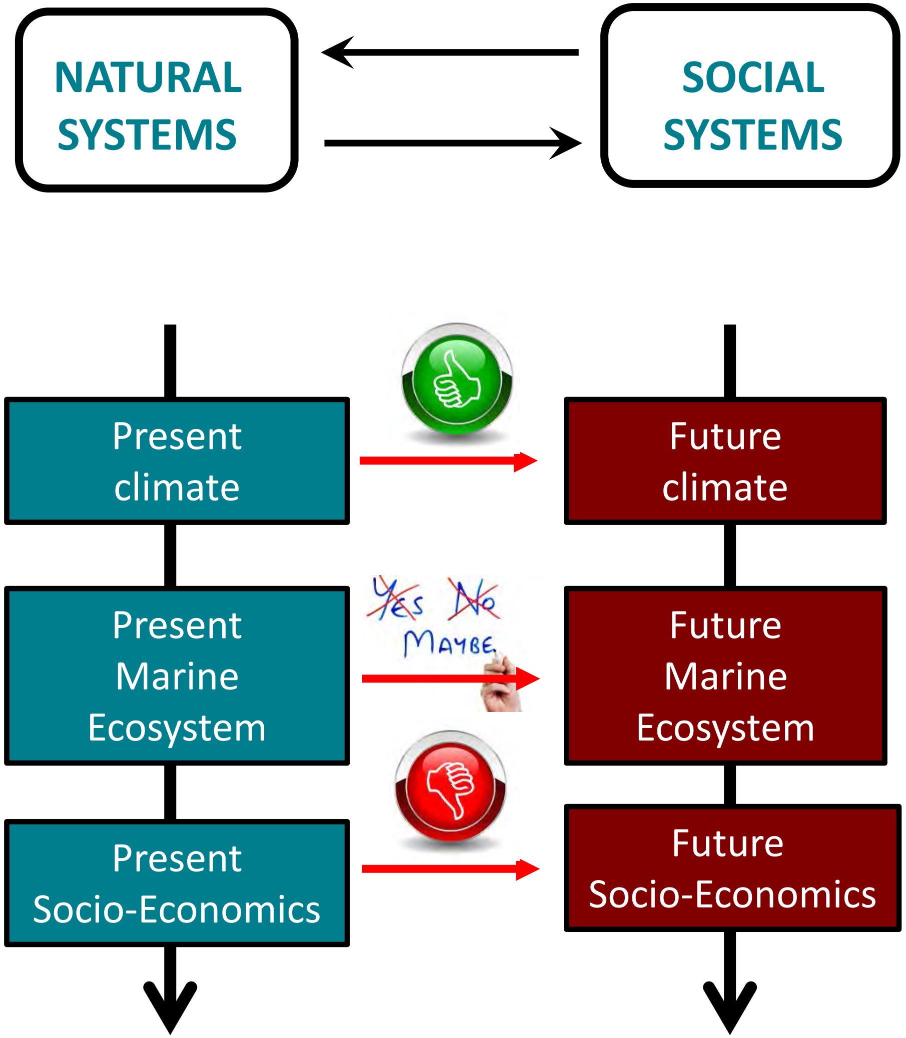


Hawkins and Sutton 2009

Responses **(Social, political, economic, behavioural)**



Barange et al. 2014. Nature CC



NATURAL SYSTEMS

SOCIAL SYSTEMS

Present climate

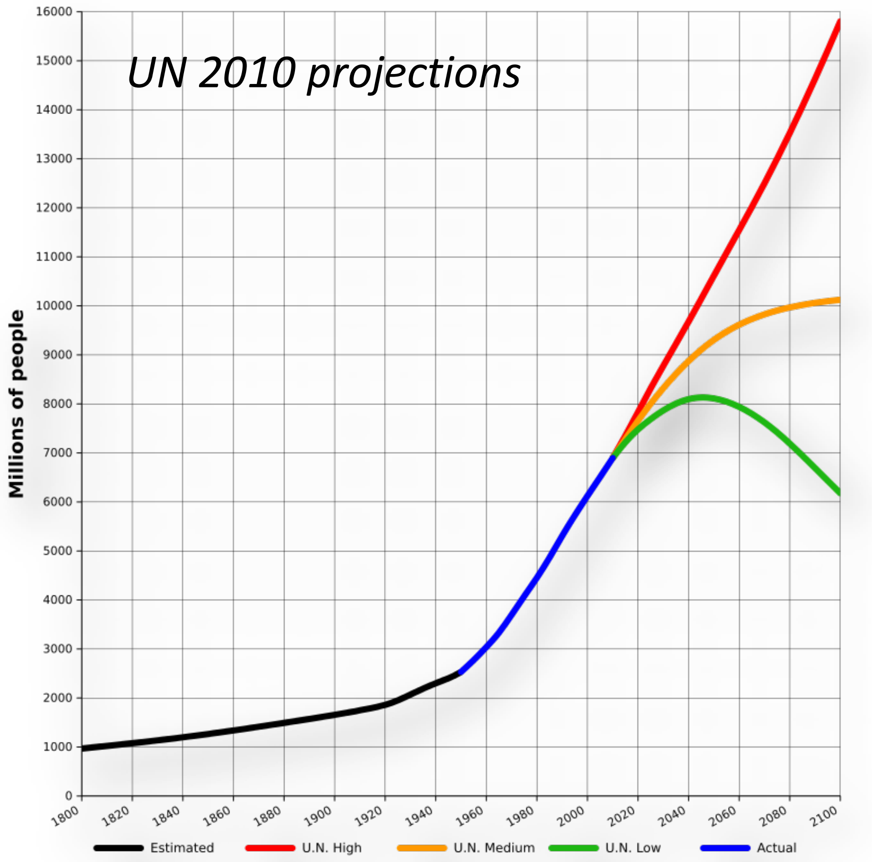
Present Marine Ecosystem

Present Socio-Economics

Future climate

Future Marine Ecosystem

Future Socio-Economics



Global protein supply (kg/cap/yr)

	1969	1979	1989	1999	2009
Meat (kg/cap)	26.6	30.1	33.1	38.1	41.8
Fish (kg/cap)	10.7	11.4	13.4	15.6	18.2
Total (kg/cap)	37.3	41.5	46.5	53.7	60

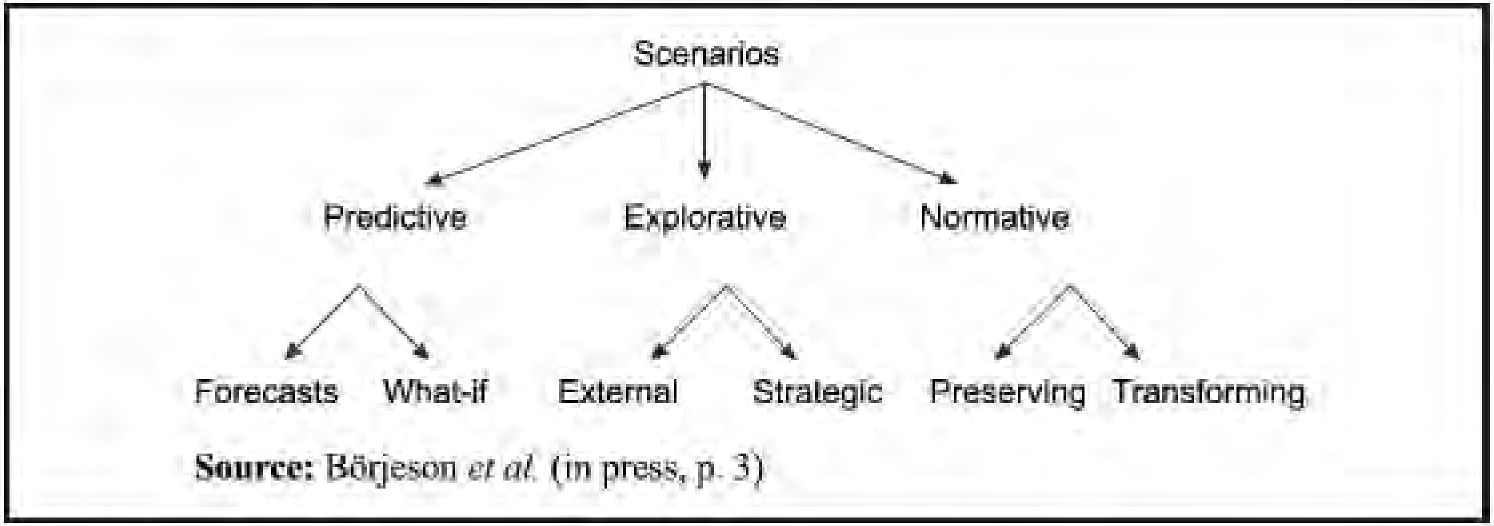
Bene et al. 2015. Food Security (in press)

Present Socio-economics

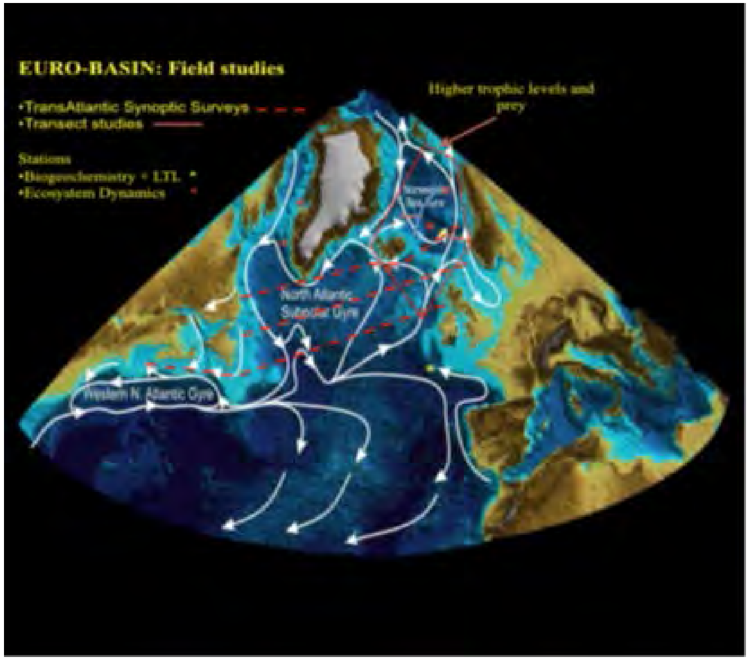
Future Socio-economics

- Generic scenarios
- Data-driven scenarios

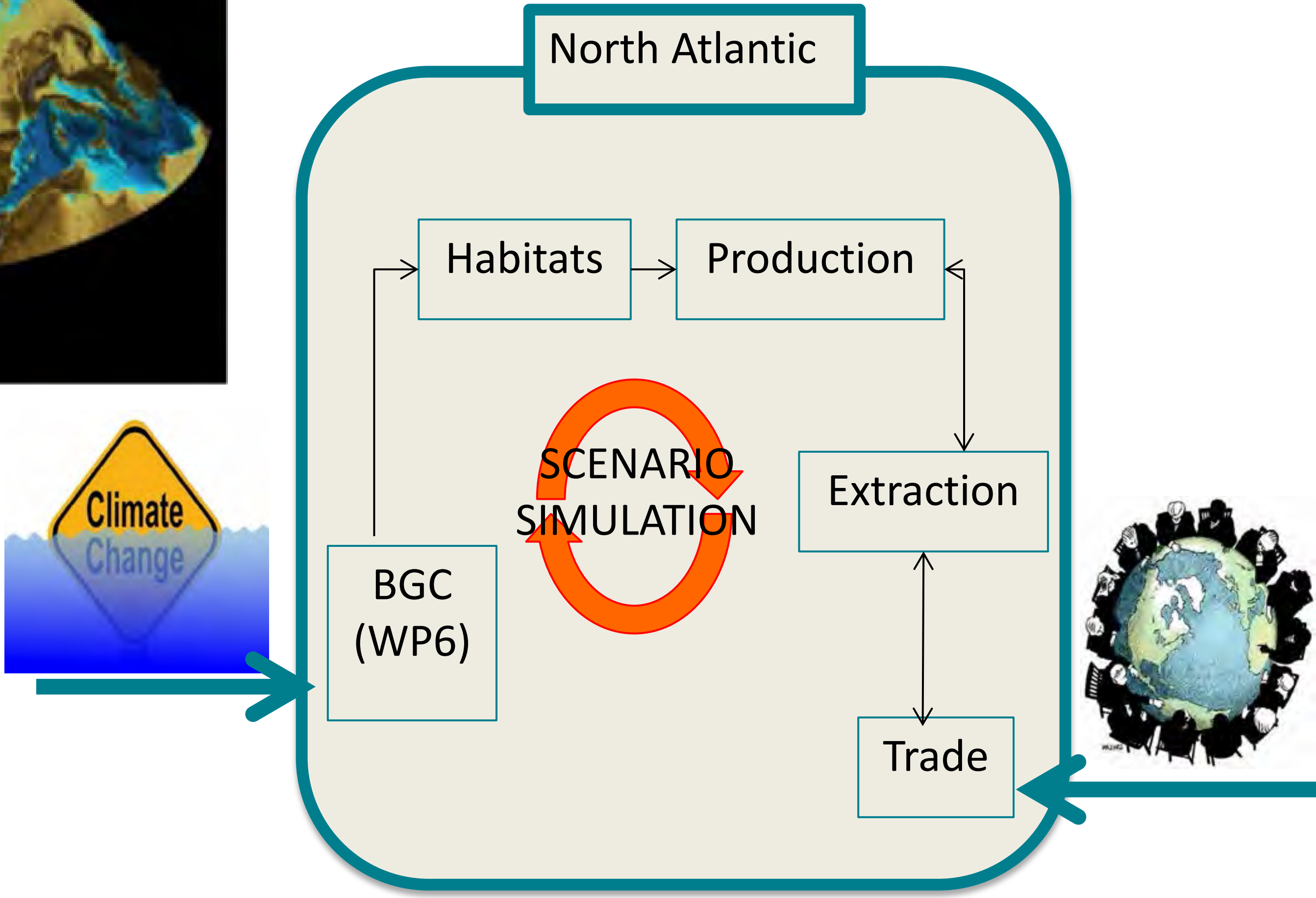
Figure 1 Borjeson scenario typology



Source: Börjeson *et al.* (in press, p. 3)



EURO-BASIN
BASIN SCALE ANALYSIS, SYNTHESIS AND INTEGRATION



North Atlantic

Habitats

Production

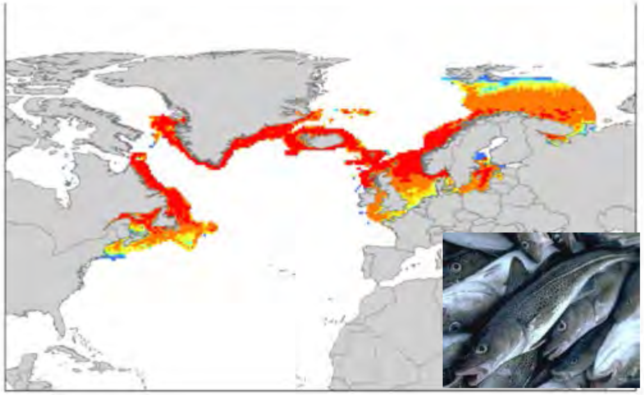
SCENARIO SIMULATION

Extraction

BGC (WP6)

Trade

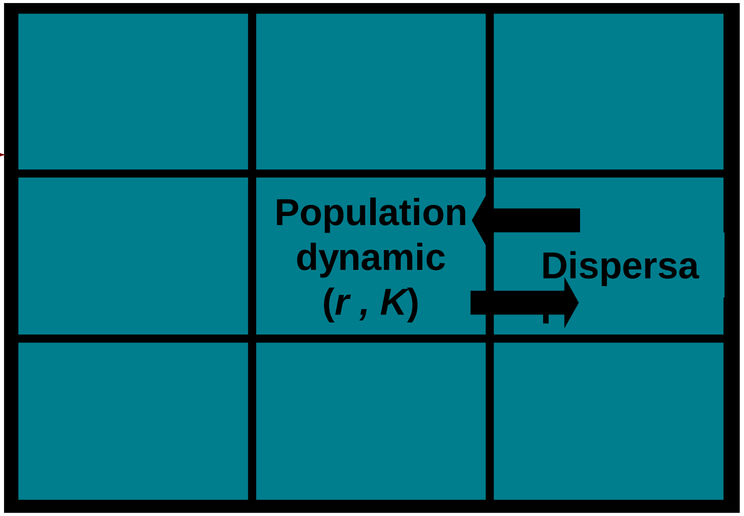
Step 1. Predict the distribution and production of key fish stocks based on climate change projections



- P(occurrence) by:
- Temperature
- Depth limits
- Habitats
- Distance from sea-ice

Global climate change ocean projections

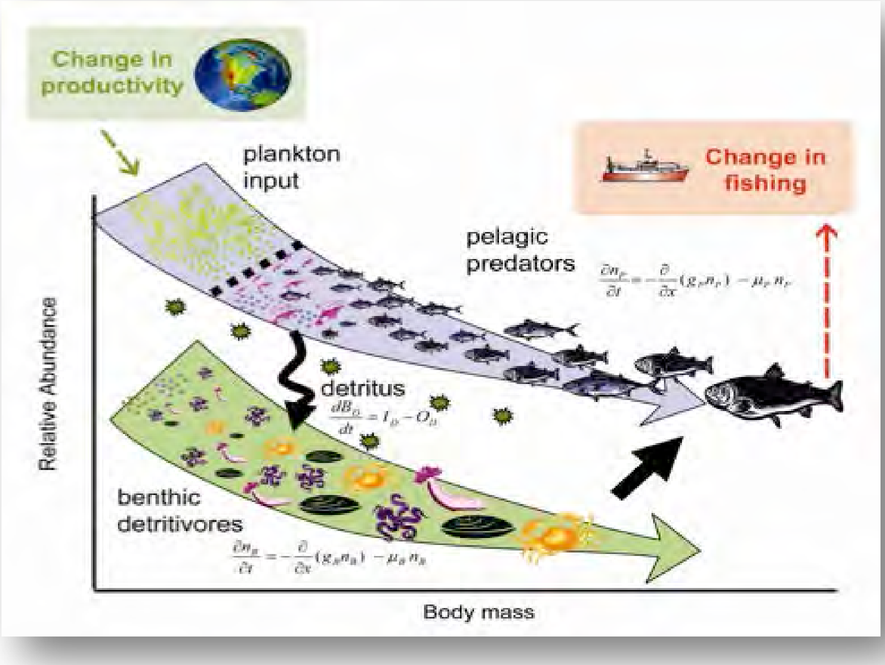
Population Dynamics

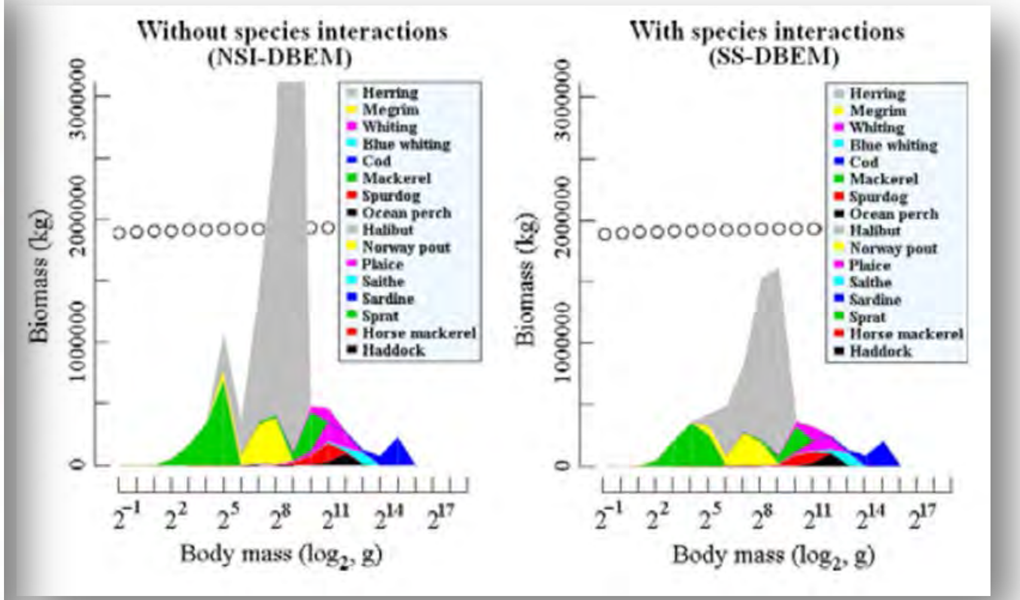


Predicted future species distribution

Catch potential (t)

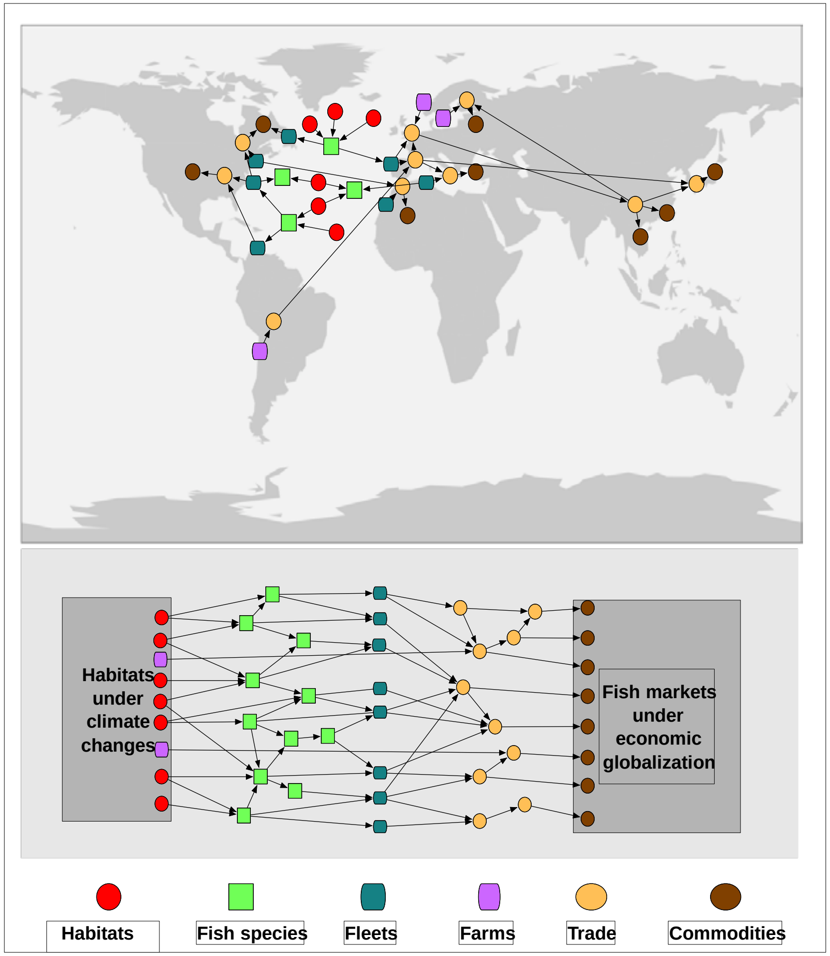
Step 1. Predict the distribution and production of key fish stocks based on climate change projections



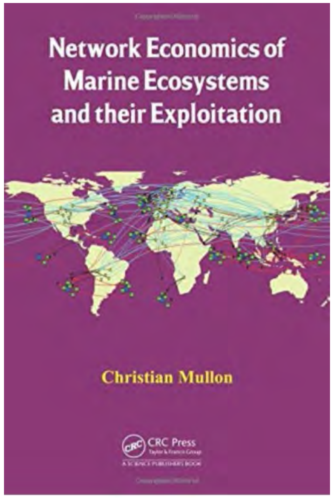


Fernandes, J., W. Cheung, S. Jennings, M. Butenschon, L. de Mora, T. Froelicher, M. Barange, A. Grant (2013). Modelling the effects of climate change on the distribution and production of marine fishes: accounting for trophic interactions in a dynamic bioclimate envelope model. Global Change Biology 19: 2596–2607

Step 2. Develop a bio-economic model of fish commodities in the North Atlantic




Network Equilibrium
Mullon C. et al. 2009.Ecological modelling. 220

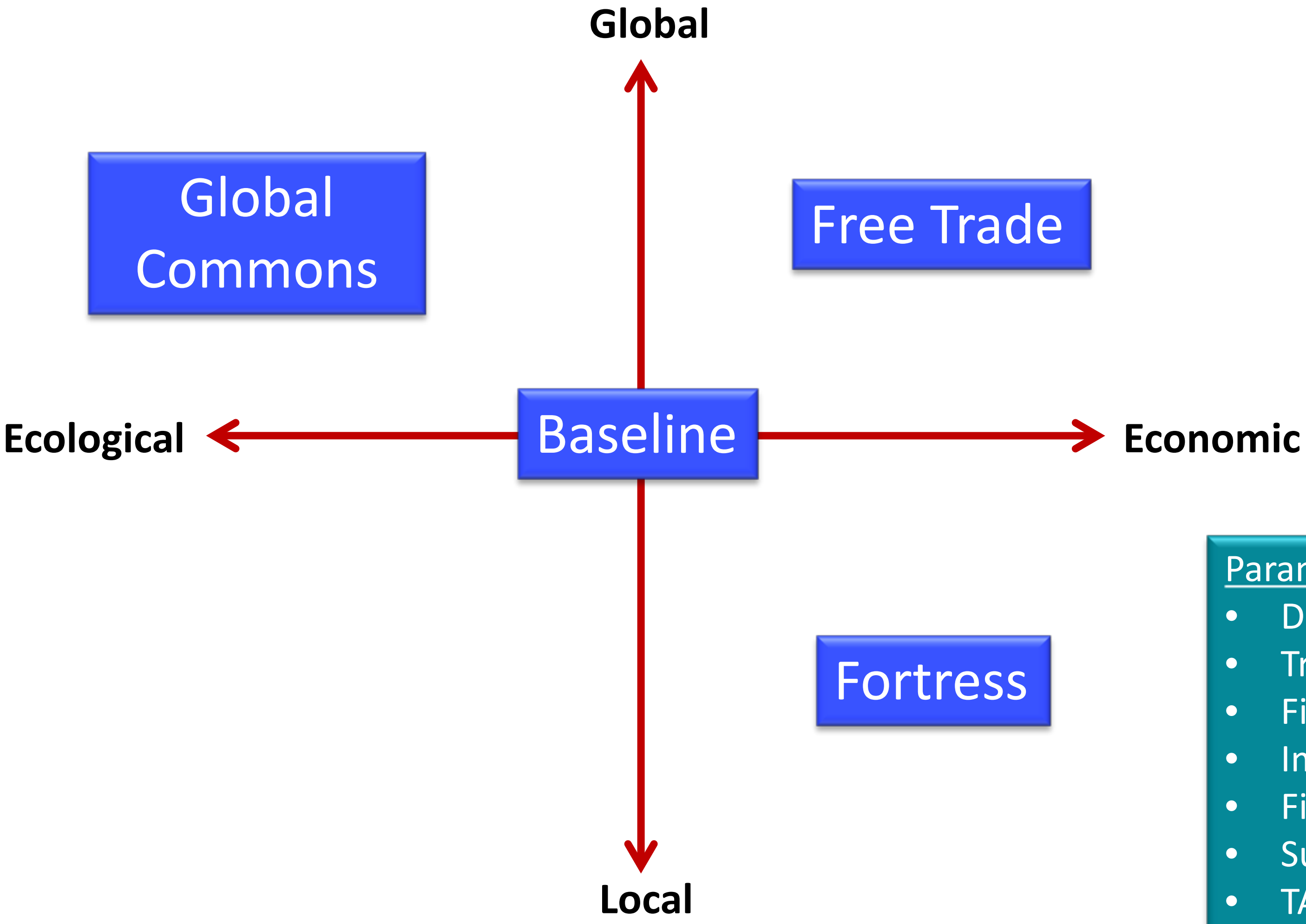

Network Economics of Marine Ecosystems and their Exploitation

Christian Mullon

CRC Press

- 19 fish stocks
- 11 fishing systems
- 4 aquaculture systems
- 12 fish commodities
- 11 geographical areas
- 22 political nodes
- 23 trade systems
- 67 markets

Step 3. Simulations will be run for 30 to 50 years in a scenario-oriented perspective



Parameters
- Demand in/out EU
- Trade costs
- Fishing costs
- Import/Export costs
- Fishing efficiency
- Subsidies
- TAC
- Farming efficiency

MSY-based exploitation scenarios

↑

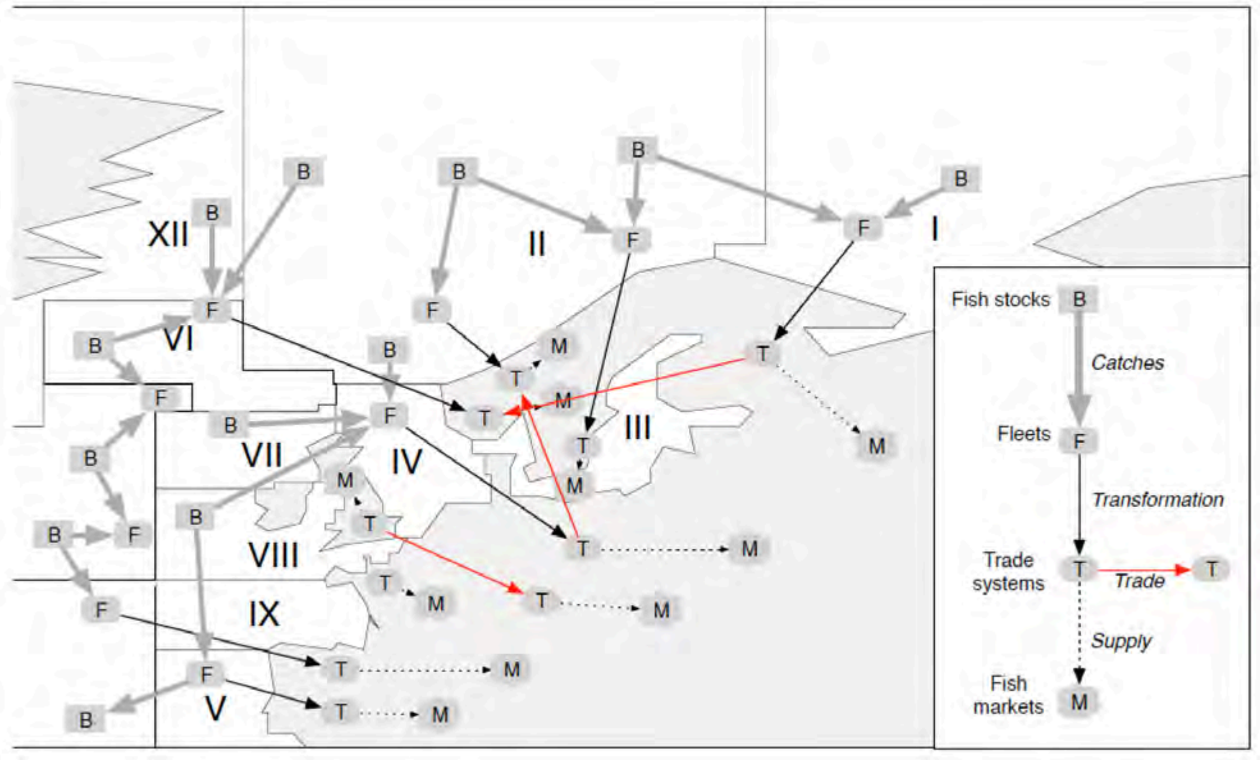
Dynamic Bioclimate Envelope (DBEM) + Size Spectrum Model (SS)
Fernandes et al. 2013, GCB

↑

Phys./ biol. Models ERSEM-MEDUSA

↑

Global Climate Models (2050)



IPCC 4 A1B
IPCC 5 RCP 2.6
IPCC 5 RCP 8.5

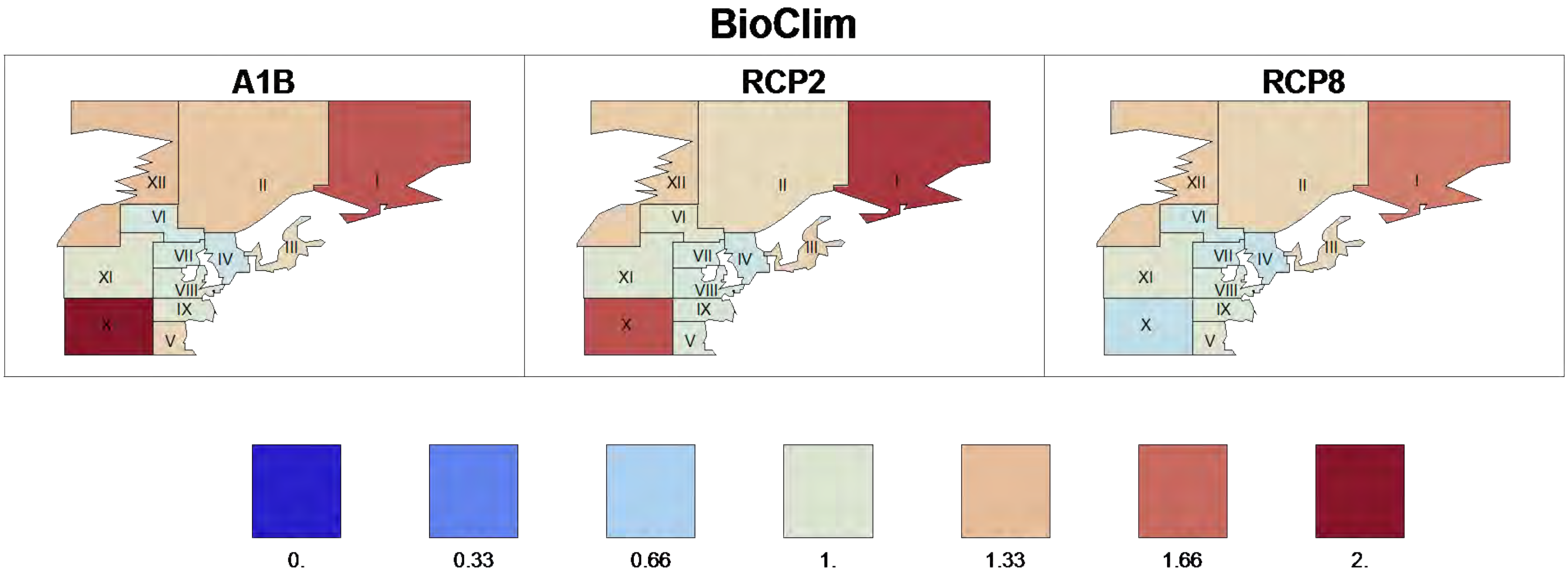
X

Global Commons

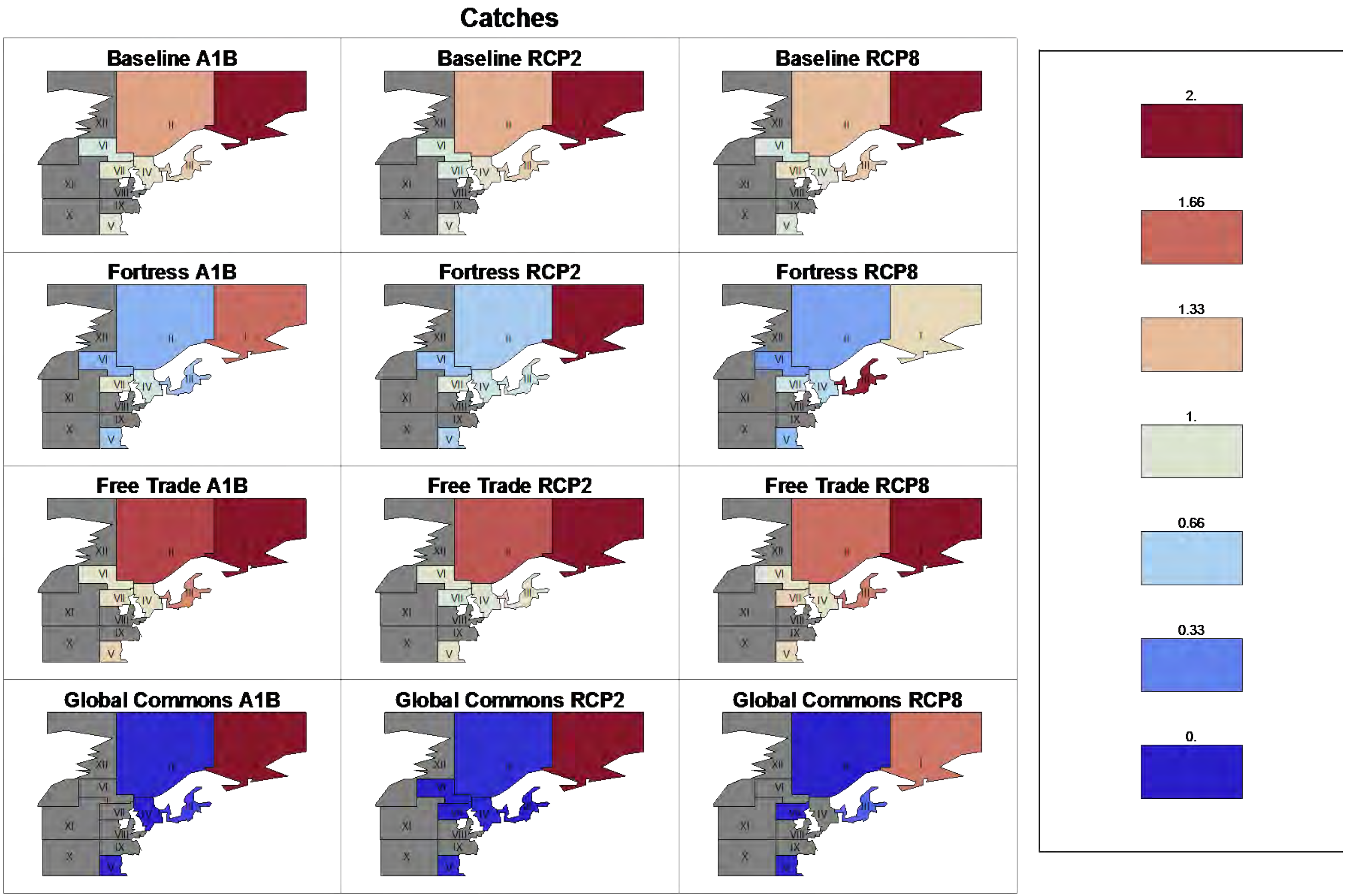
Free Trade

Fortress

(Carrying Capacity 2030s ref. to 2010s)



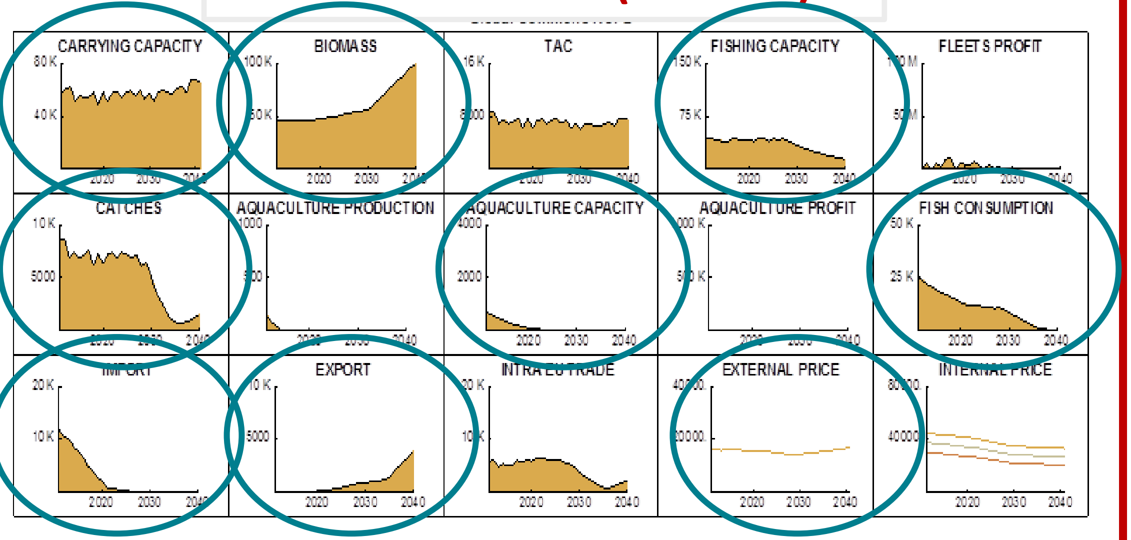
Catches (Change 2030s vs. 2010s)

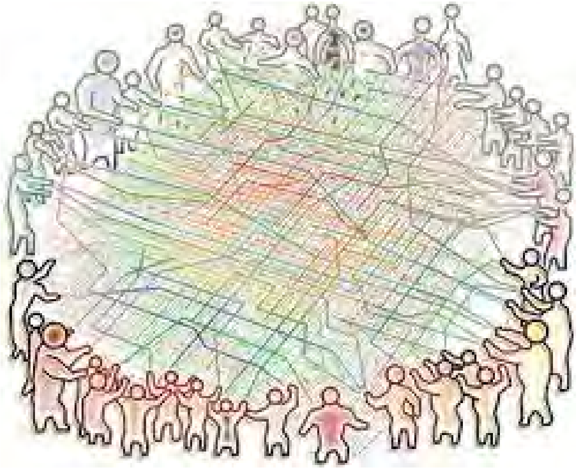


Mullon, C., et al. Bio-economic scenarios for North-East Atlantic fisheries pathways by the mod 21st century. (under review)

Global

Global Commons (RCP 2.6)





Ecological

Economic

Under the Global Commons scenario the environment is protected. This could lead the rebuilding of fish stocks or the development of export industries. Ecological sustainability is achieved, but socio-economic sustainability is not secured.

Local

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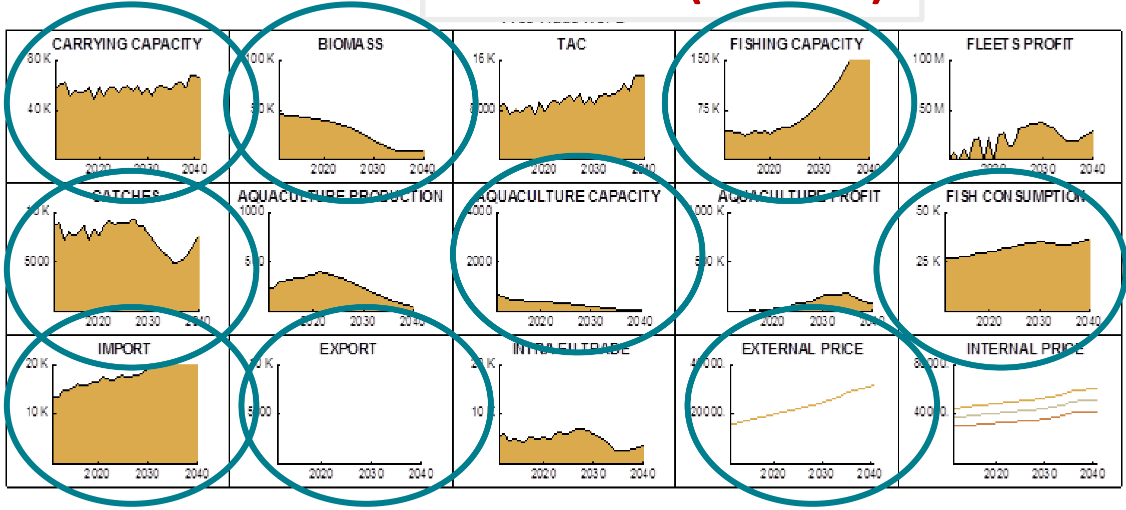
Mullon, C., et al. Bio-economic scenarios for North-East Atlantic fisheries pathways by the mod 21st century. (under review)

Global

Free Trade (RCP 2.6)



Ecological **Economic**

Under the Free Trade scenario the opening of international trade could lead the system to an unpredictable state. There is endangering of local stocks and fleets due to the high increase of the demand for fish. Economic indicators are positive but no long-term sustainability is assured.

Local

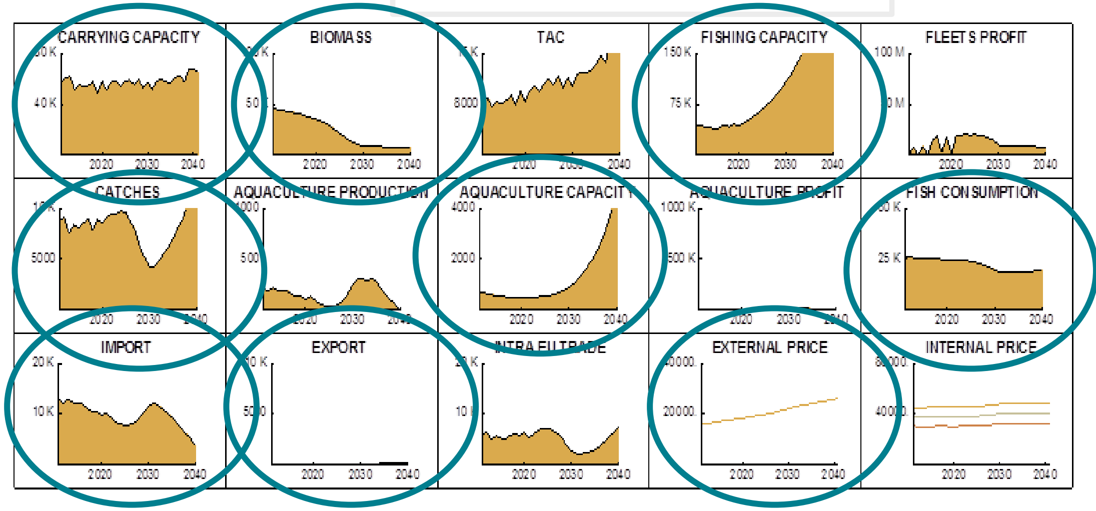
Mullon, C., et al. Bio-economic scenarios for North-East Atlantic fisheries pathways by the mod 21st century. (under review)

Global

Under the **Fortress scenario** there is overfishing, endangering of stocks, development of aquaculture. Development of aquaculture is artificial and due to subsidies despite marine fisheries do not meet the demand for fish products. Industrial structures are supported, but do not achieve long-term stability.

Ecological **Economic**

Fortress (RCP 2.6)



Local

Conclusions

- The system is **more sensitive to governance changes than to climatic change**, at least at the horizon of 2040.
- Climate changes tend to result in a latitudinal drift of populations towards northern parts of the basin.
- An important driver of change for the future of the North Atlantic and the European fishing fleet appears to be the **interplay between wild fisheries and aquaculture**.
- Restrictions to **international trade are not as important as are relaxations of protection** means such as total allowable catch limits.
- The scenarios demonstrate that the **viability and profit of fisheries industries is highly volatile** across scenarios.
- Our conclusion is thus that this modelling experiment has resulted in a coordinated assessment of bio-economic modelling tools towards the development of objectives for future basin scale governance of the North Atlantic with stakeholders

Mullon, C., F. Steinmetz, G. Merino, J. Fernandes, W. Cheung, M. Butenschon, M. Barange (submitted). *Quantitative pathways for North-East Atlantic fisheries based on climate and bio-economic modelling scenarios.*

SUSTAINABILITY

Prediction, precaution, and policy under global change

Emphasize robustness, monitoring, and flexibility

By Daniel E. Schindler* and Ray Hilborn

Schindler and Hilborn 2015. Science 347

Present Socio-Economics → Future Socio-Economics

“Scenario planning is used in many disciplines to assist policy development in situations with deep and irreducible uncertainties”

“In contrast, forecasts narrowly limit uncertainties to those associated with a single potential outcome that is assumed to be predictable; policy developed under this premise will prepare us poorly for the unpredictable”

Thank you