A bioeconomic perspective on fisheries management and climate change in the Arctic

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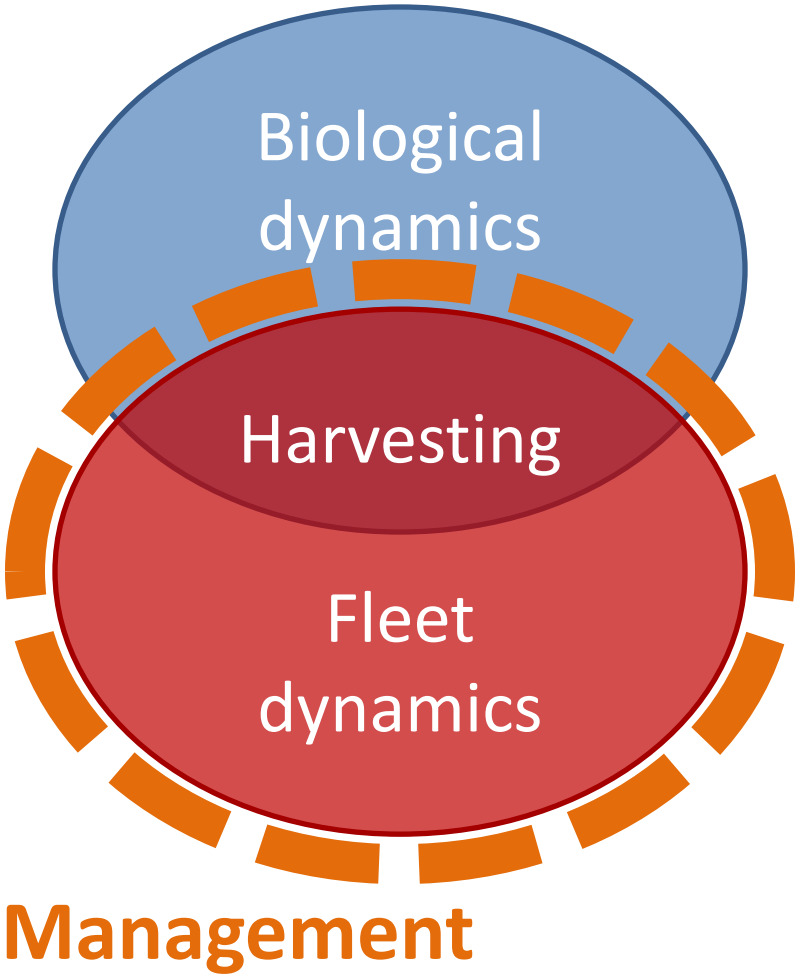
Bioeconomics

- Consider fish and fisher's behaviours
- Both fish and fisher are constrained by the state and dynamics of the environmental and the ecosystem
- The fishing activity is also constrained by markets and regulations

Basic Constraints

- Fishing is an economic activity with **economic**, **biological** and **environmental** constraints

- The economic activity is also constrained by **management** measures



Management objectives

- Open access fisheries may have undesirable externalities (market failures)
- Management may be needed to sustain profitable fisheries

- Does climate change alter the basic motivation for managing the fisheries?

Climate Change Strategies

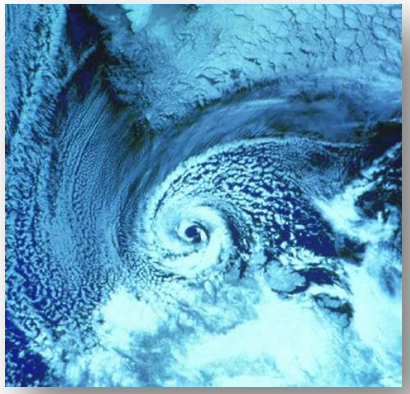
- Mitigation (including external costs)
  - Certain cost, uncertain benefits
  - Incentives to free ride
  - The problem of the commons
  - The prisoners dilemma
    (Are cooperative solutions realistic?)
- Adaptation (dealing with uncertainty)
  - Coping strategies, vulnerability
  - New management challenges?

Management challenges in fisheries

- Mitigation
  - Reduce carbon dioxide emissions from the fleet and fishing industry (taxation etc.)
- Adaptation
  - Changes in physical environment
  - Ecological changes
  - Market changes (costs of fishing, price on fish)
  - Demographics changes in the human population

Global warming may affect

- Ecosystem composition, performance and distribution
  - Growth rates and capacity levels
  - Migration patterns and seasonal profiles
- Economic activities
  - Cost of input factors in fishing
  - Weather conditions and uncertainties
  - Demand for fish products
  - Coastal livelihood and demographic composition



Polar low over the Barents Sea (1987)

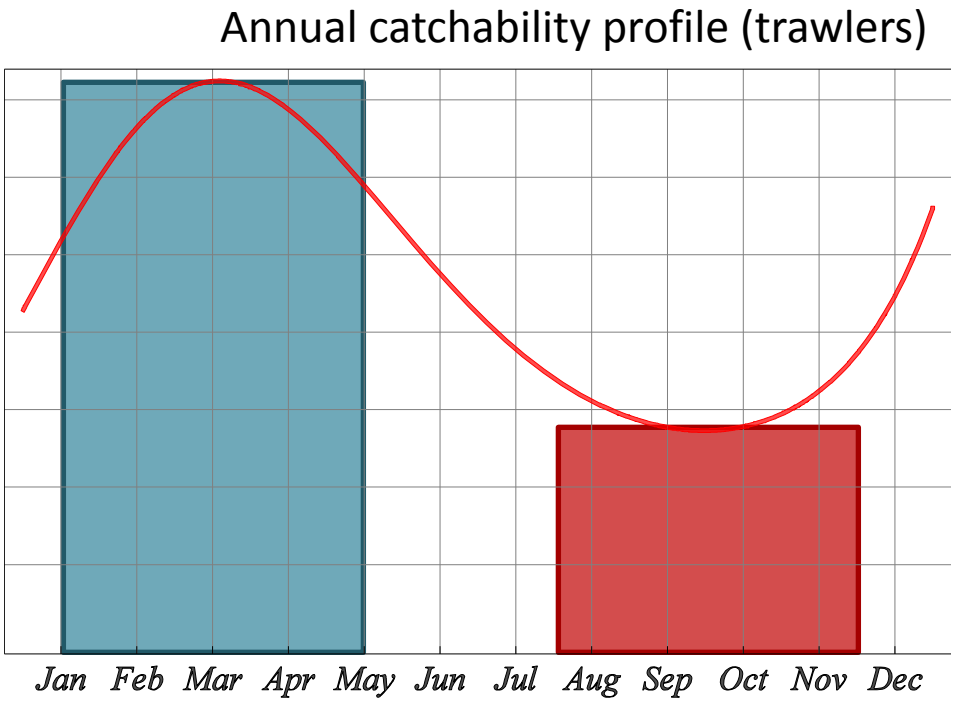
Characteristics of the Barents Sea Fisheries

- Few dominating fish species
- Significant within and between year (environmental and biological) fluctuations
- Ecosystem adaptations to changing environmental conditions

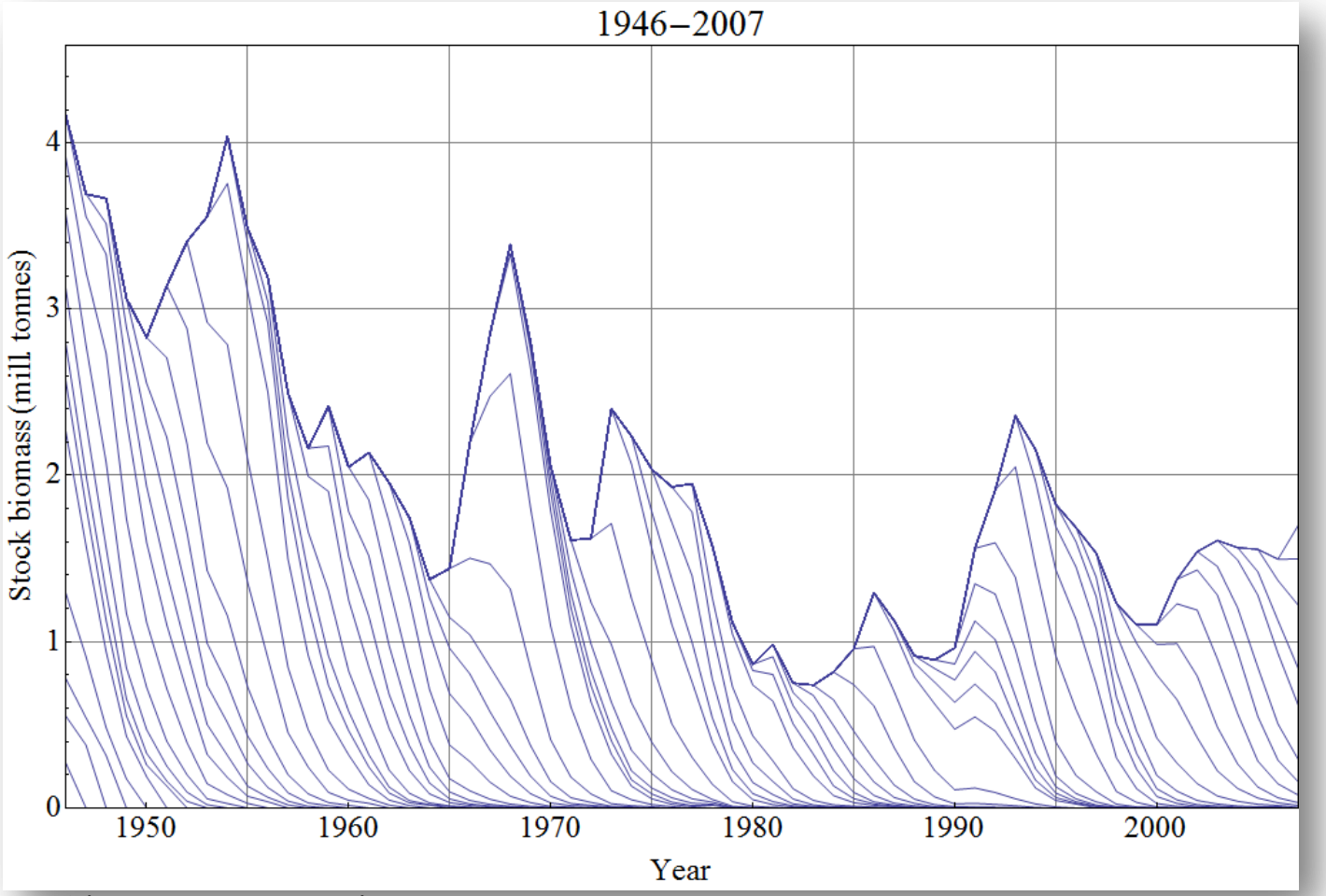
- Management Challenge: How to cope with fluctuations and uncertainties?

Within year fluctuations

- Adapting to seasonal fluctuations
- The differences are amplified by increased distance to fishing grounds in low season periods



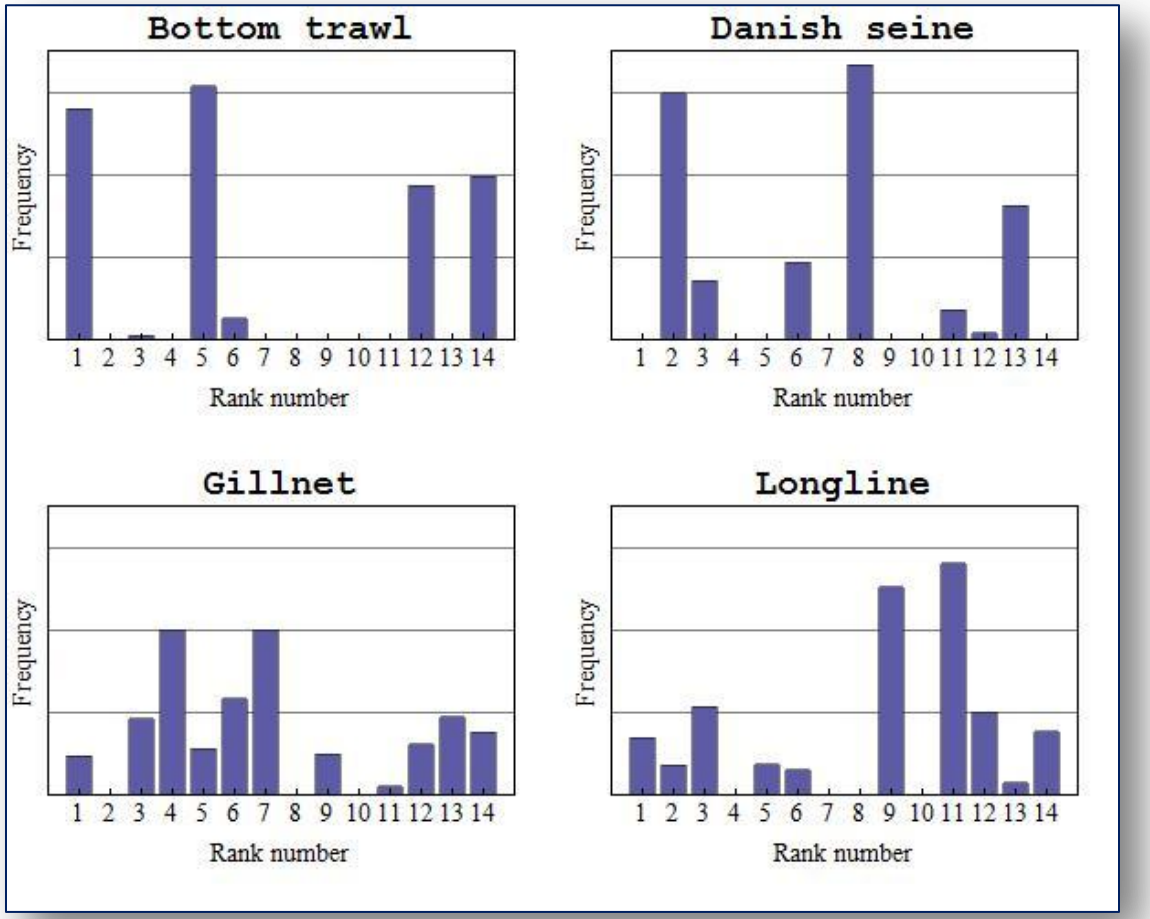
Between year fluctuations



Cod (ICES XSA estimates)

Heterogeneous fleet

Theoretical cod fleet performance each quarter of the period 1946-2004 on the basis of costs, prices and fishing technology of year 2000, and historical cod stock biomasses and age compositions



(Calculated on the basis of EconSimp2000)

The Barents Sea Cod Fishery

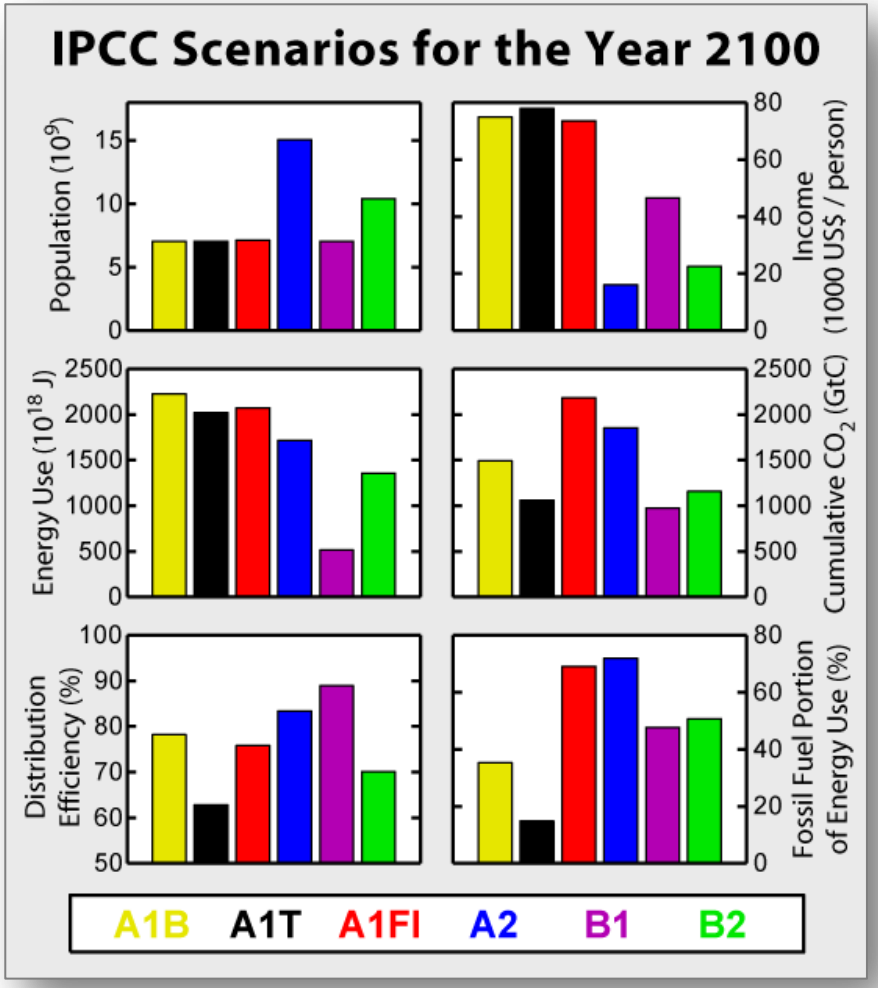
Bioeconomic Climate Change Model Studies

EU programmes	Study	Climate scenario
BASIS & BALANCE	• Alternative regional climate effects • Fully integrated climate-environment-ecosystem-economics impact model • Different management regimes	B2
ATP & ACCESS	• Harvest Control Rules • Spatially distributed scenario model • Fishers behaviour under changing costs	A1B

Climate scenarios

A1
Rapid economic growth.
A global population that reaches 9 billion in 2050 and then gradually declines.
Quick spread of new and efficient technologies
Extensive social and cultural interactions worldwide.
Three subsets based on their technological emphasis • A1FI - An emphasis on fossil-fuels (Fossil Intensive). • A1B - A balanced emphasis on all energy sources. • A1T - Emphasis on non-fossil energy sources

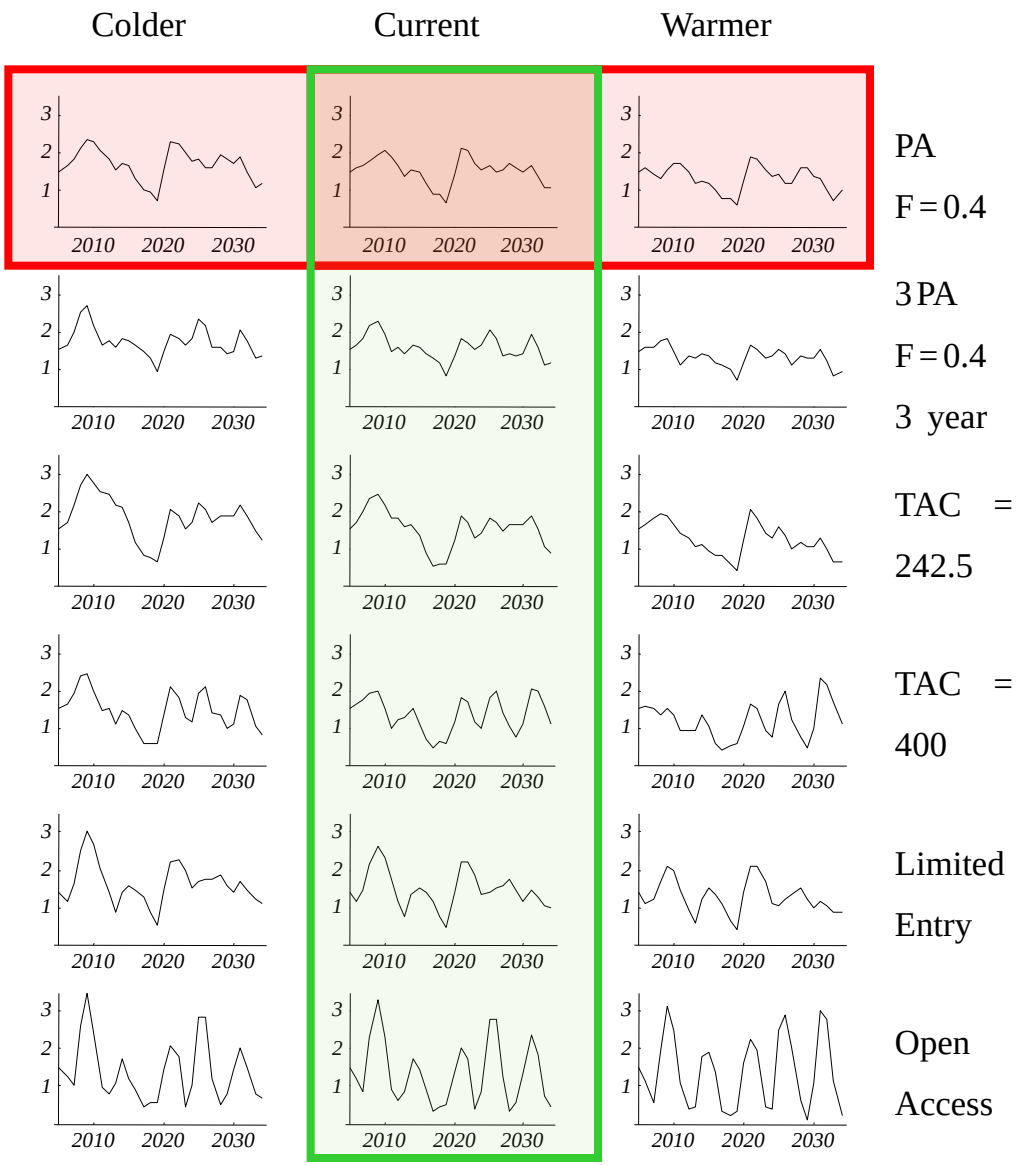
B2
Continuously increasing population.
Emphasis on local rather than global solutions to economic, social and environmental stability.
Intermediate levels of economic development.
Less rapid and more fragmented technological change than in A1 and B1.



B2-studies: Management regimes

	Quota	Fleet dynamics	Description
PA	Yes	Yes	Precautionary approach (reference regime)
3PA	Yes	Yes	Precautionary approach and the 3 year rule
LE	No	No	Limited entry
TAC1	Yes	Yes	Constant catch quota equal 242.5 thousand tonnes which is the actual Norwegian
TAC2	Yes	Yes	Constant catch quota equal 400 thousand tonnes
OA	No	Yes	Open access to common-pool resources

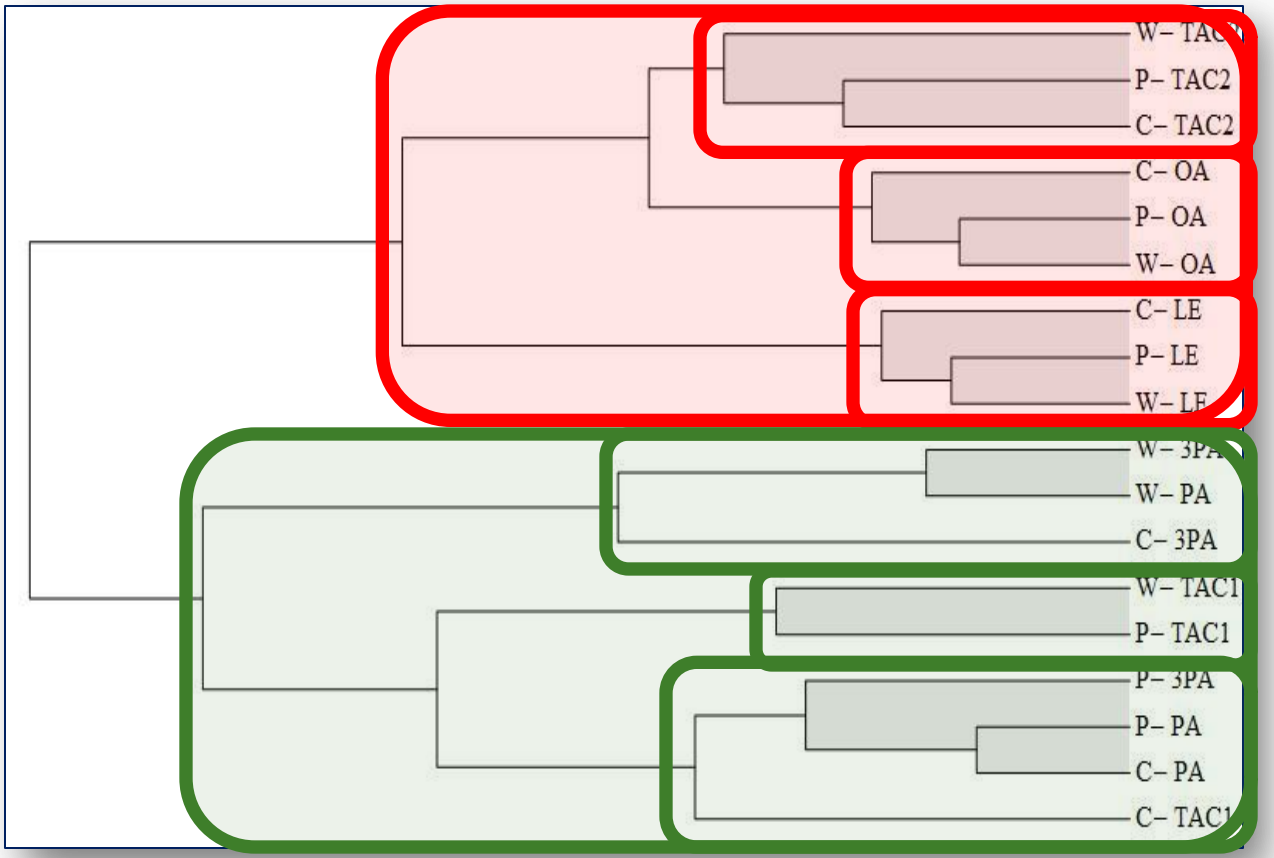
- Precautionary approach: *F < 0.4, SSB > 460 000 tonnes*
- 3 year rule: *Last year's TAC +/- 10%, combined with PA*



B2-studies: Resulting stock biomasses

The impact of choice of management regimes seem to be greater than environmental changes

Management regimes cluster indicators

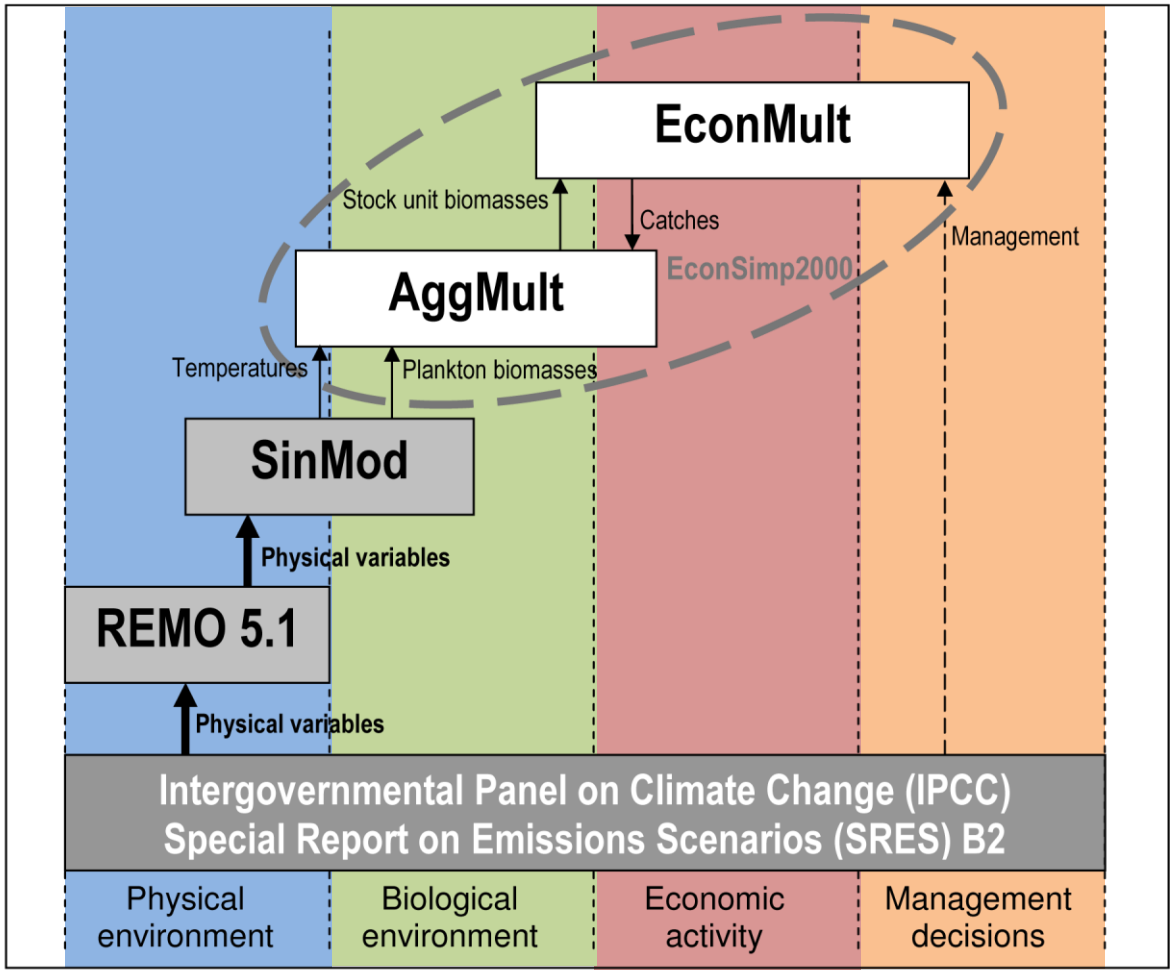


High fishing pressure

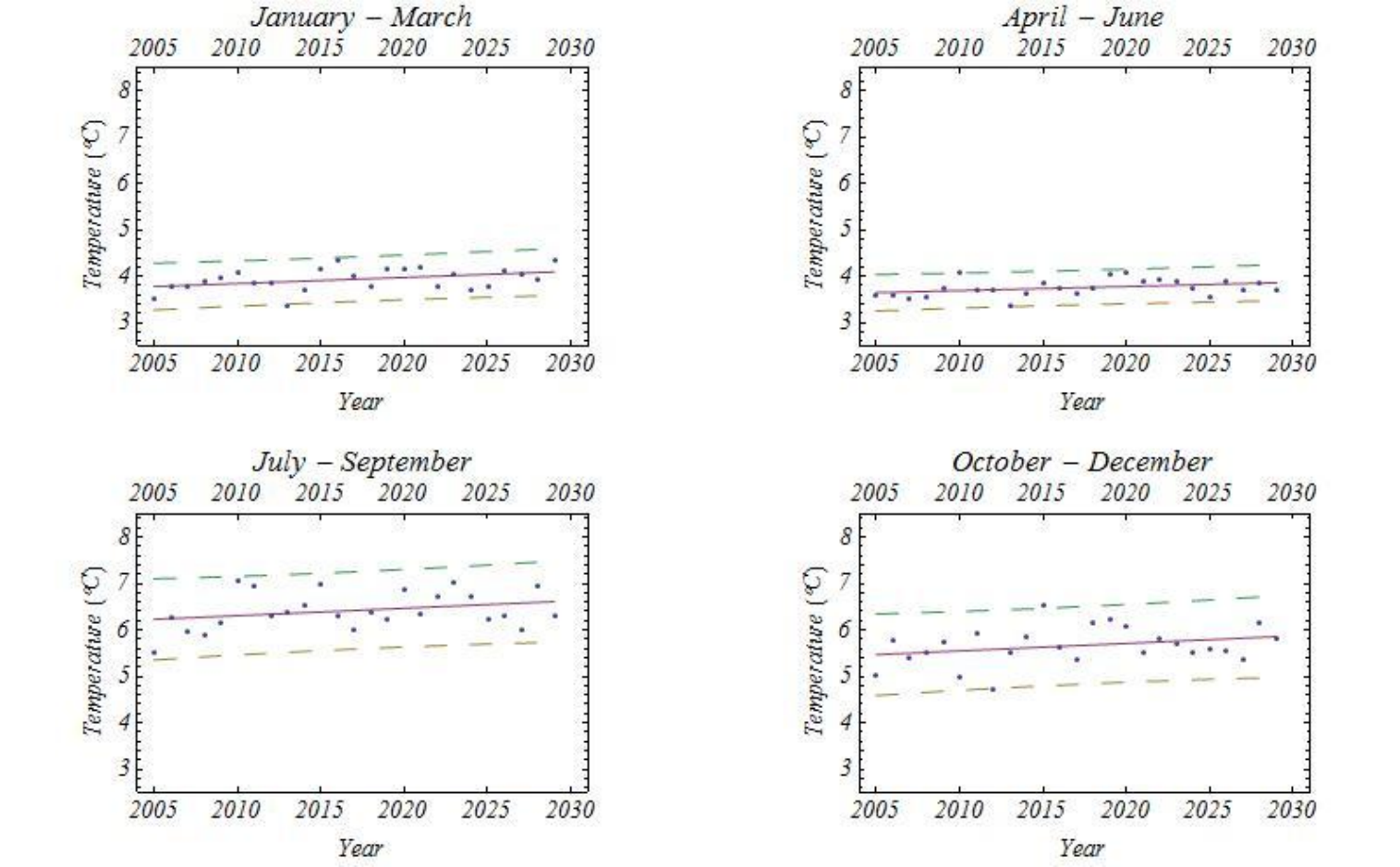
Fixed quotas

Low fishing pressure and HCR management

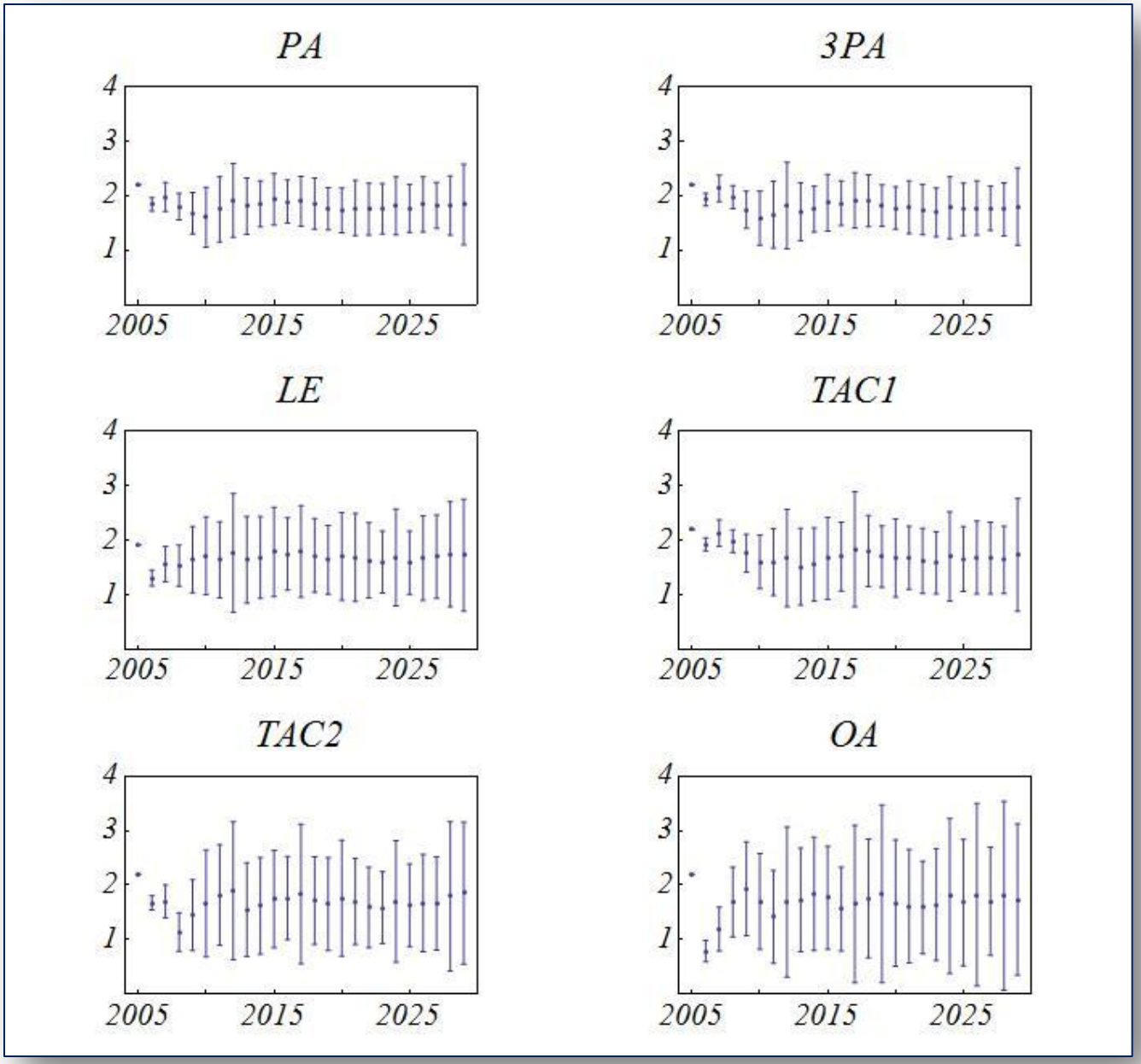
Full model integration



Ocean temperatures (SinMod)



(From SinMod runs based on Remo 5.1 and the B2 scenario)



(Each case based on 100 Monte Carlo simulations by EconSimp2000)

Error plots of estimated average stock biomasses related to different management regimes with stochastic inflow of young herring into the Barents Sea

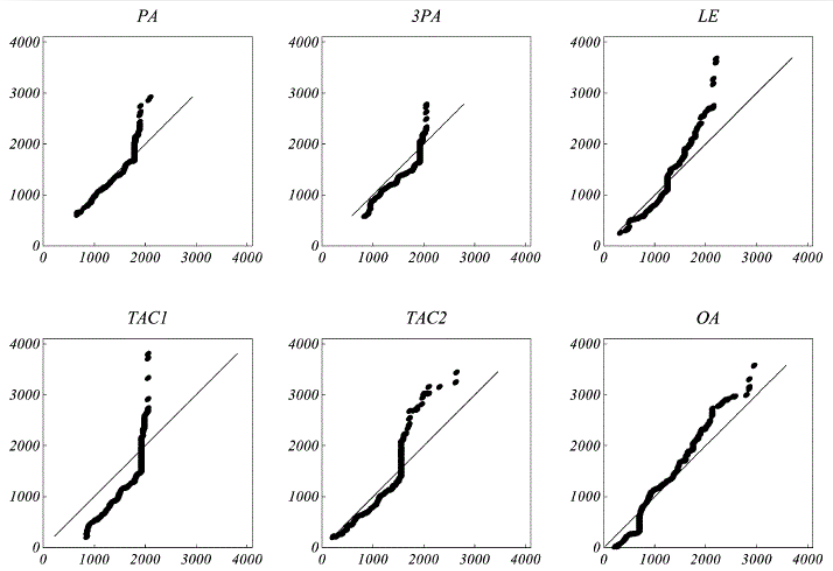


Fig. 4 Quantile plots of estimated stock biomass (in 1000 tonnes) the first (*horizontal axes*) and last (*vertical axes*) 5 years of the simulation period for each of the six investigated management regimes described in Table 2

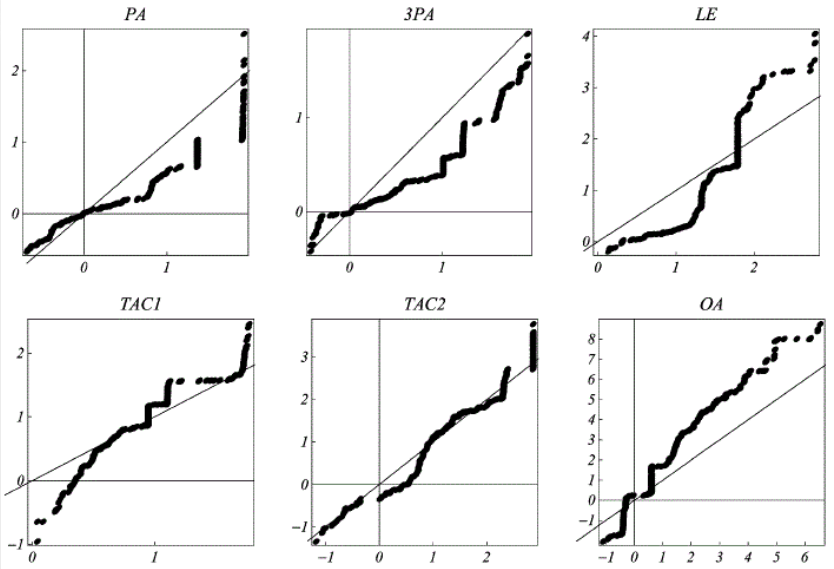
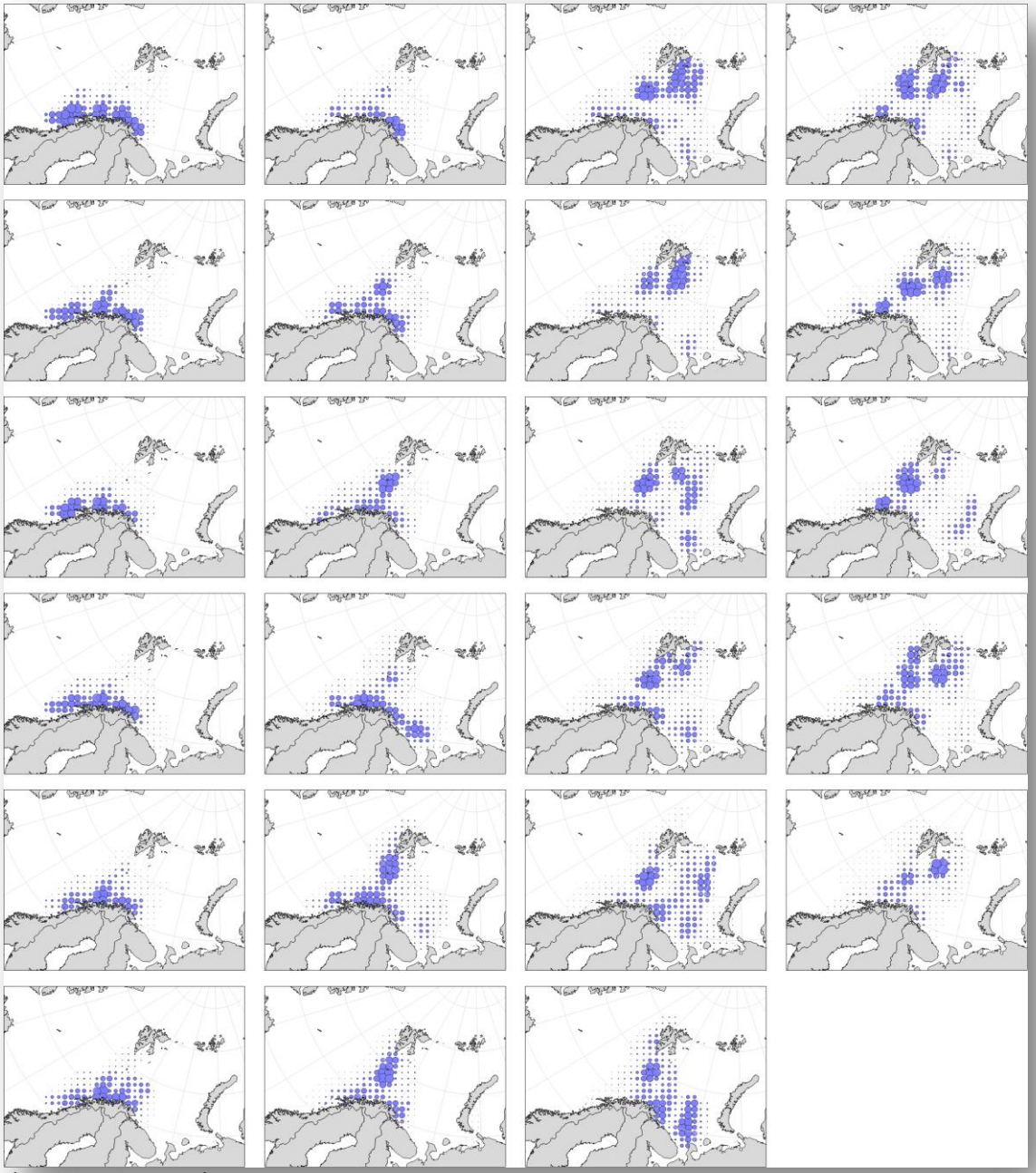


Fig. 5 Quantile plots of estimated total wage paying ability (bill. NOK) the first (*horizontal axes*) and last (*vertical axes*) 5 years of the simulation period for each of the six investigated management regimes described in Table 2

Current vs. future climate

- Increased biomass fluctuations (upper quantile plot)
- PA management reduces fluctuations
- OA benefits economically from increased fluctuations

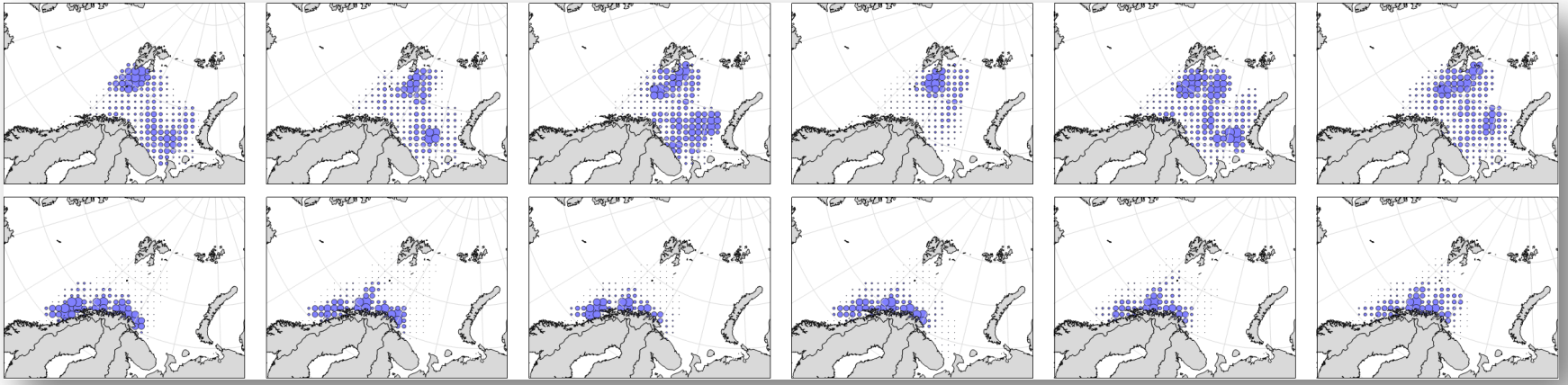


(FishExchange)

Spatial distribution: Any trends?

The system is characterised by migrations, cannibalism, recruitment variations and other fluctuations in time and space in it's normal state.

Cod surveys and catches 2004-2009



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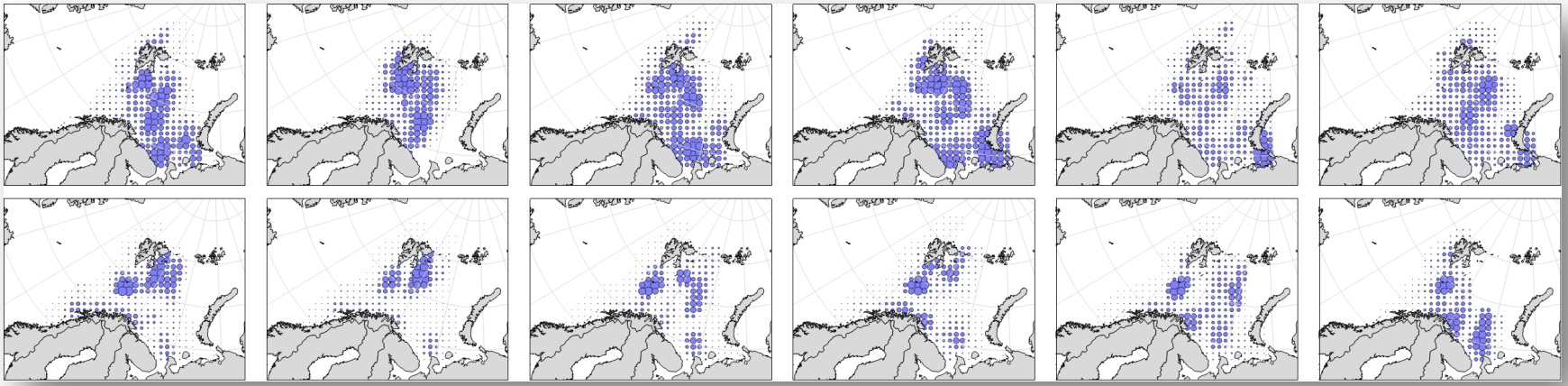

(FishExchange)

Overall conclusion

- Management decisions seem to have a greater impact than global warming
- A diverse fleet structure reduces the economic vulnerability of the Barents Sea fisheries
- HCR management adds an adaptive capacity to management, not yet fully utilised
- Changes in the spatial distribution of ecosystems may become the most pronounced effect of global warming