European Platform for Biodiversity Research Strategy

Life on the Blue Planet - Biodiversity Research and the new European Policies
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Effects of Climate Change on Marine Biodiversity

Recommendations for Research

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Recommendations

To protect our Marine Biodiversity and Ecosystem Services, we need to:

(1) extend our marine monitoring efforts;

(2) extend our knowledge on the regional factors that determine the vulnerability and resilience of marine communities to climate change;

(3) extend our knowledge on sensitivities and adaptation capabilities of marine key species to climate change;

(4) develop “fit-for-purpose” models to project impacts and adequately manage our marine environment.

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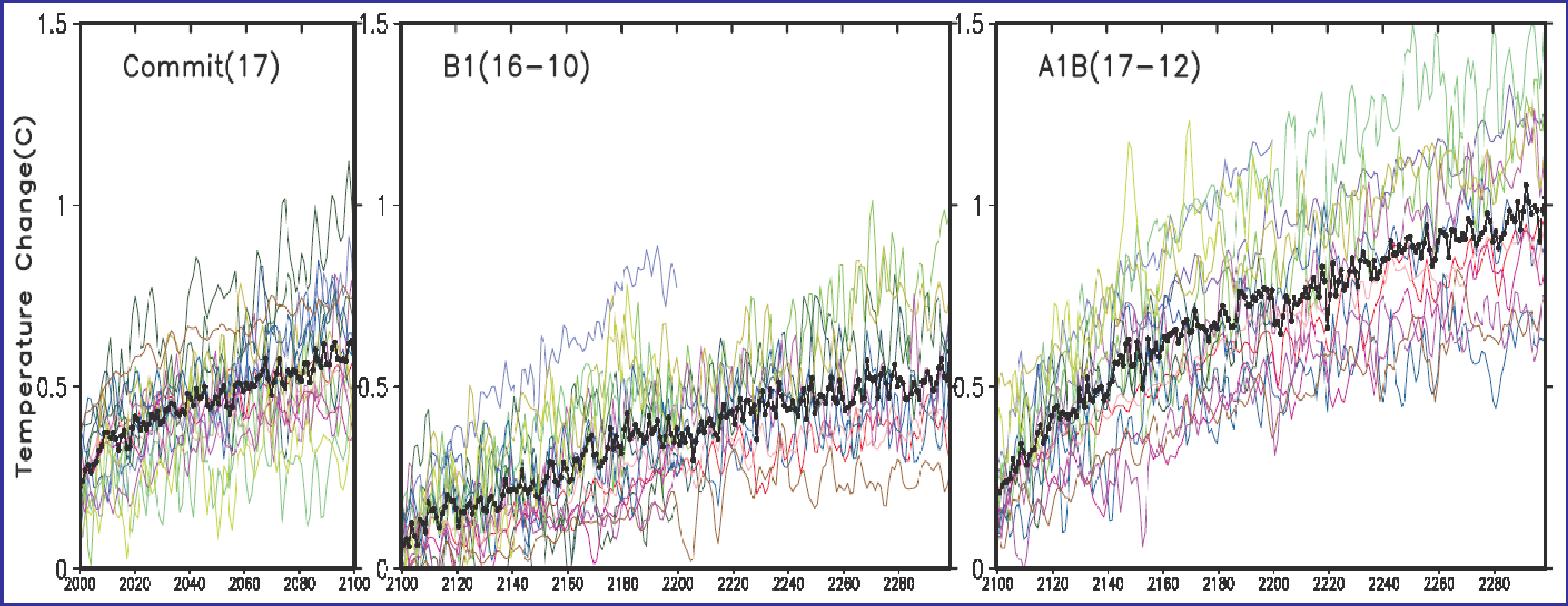
Long-term Trends



Change in Globally Averaged Surface Temperatures

as projected for 2000-2100 (relative to 1980-1999) and for 2100-2300 (relative to 2080-2099) by means of various models under different scenarios

IPCC 2007

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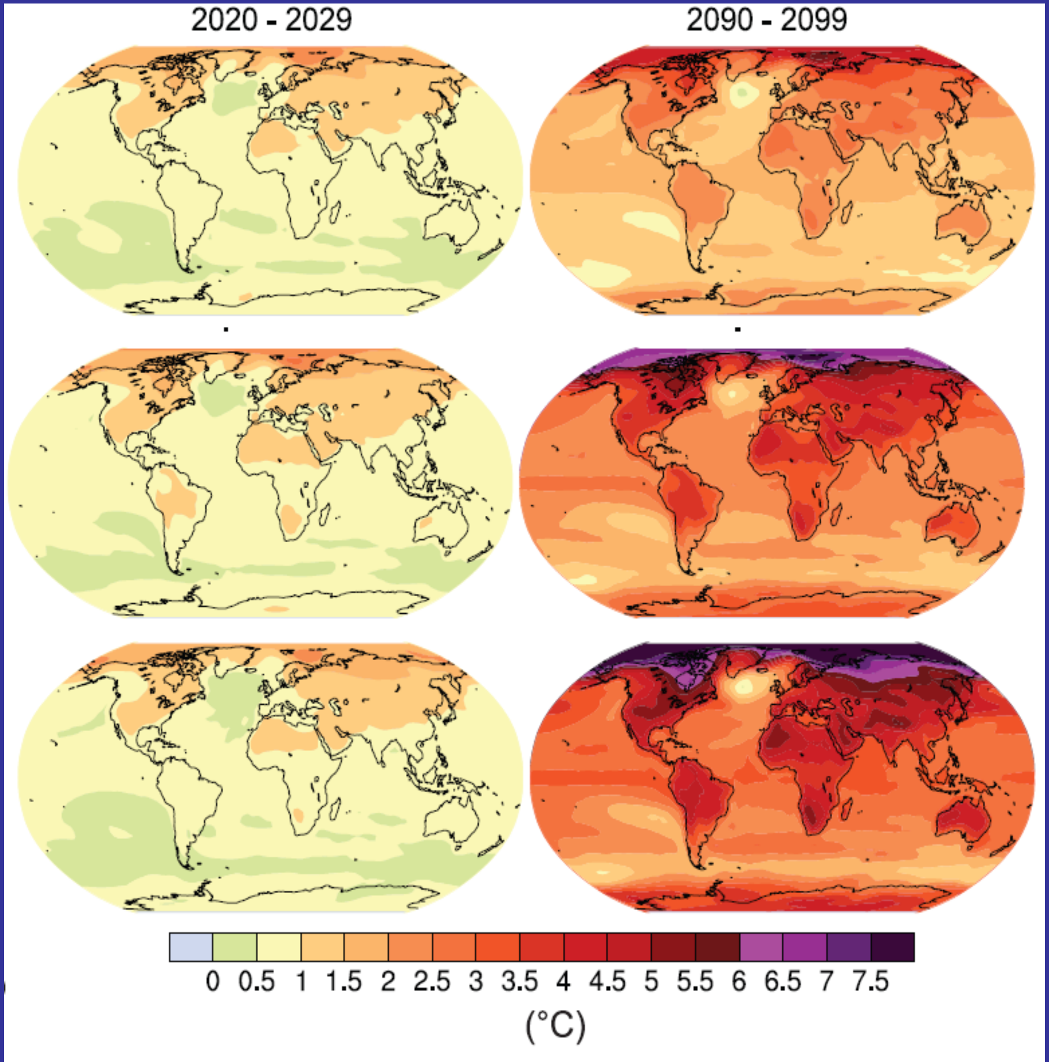
Regional Variations



Change in Globally Averaged Surface Temperatures as projected for 2020-2029 and 2090-2099 under different scenarios (relative to 1980-1999 average)

expected increase of 1ºC to 2ºC in southern Europe and 4ºC to 7ºC in northern areas by 2100

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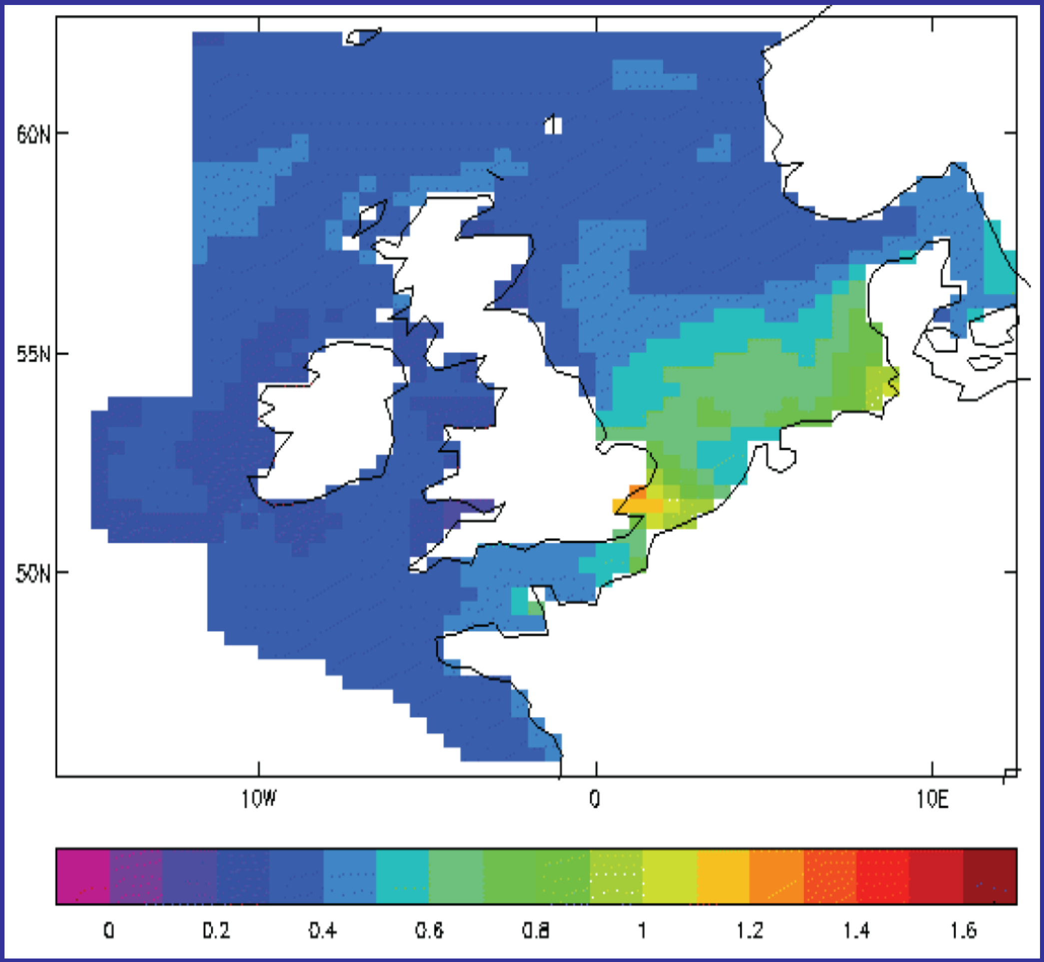
Means & Extremes

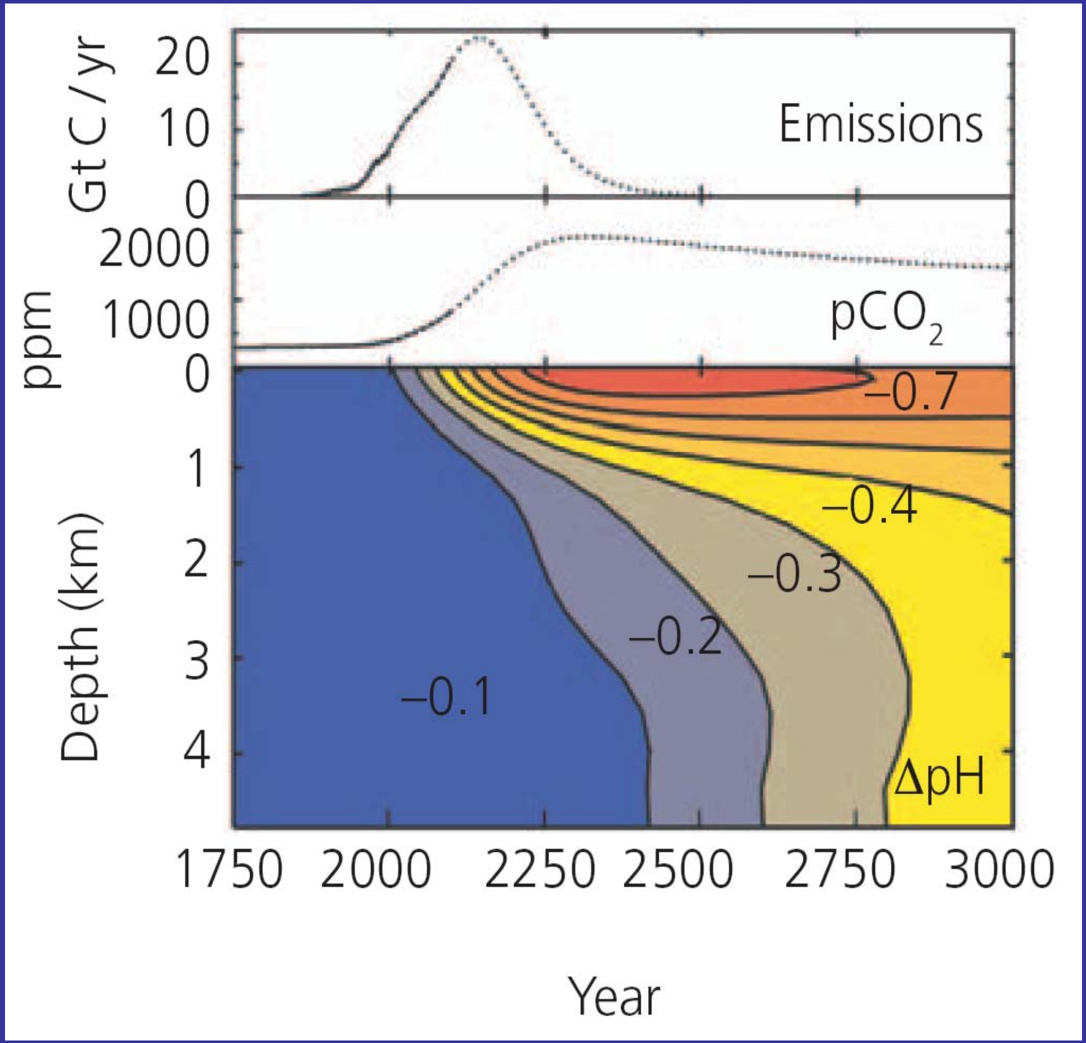


Storm Surges

change with respect to 1961-1990 in the 50-year return period extreme water level (m) in the North Sea due to changes in atmospheric storminess, mean sea level and vertical land movements for the period 2071 to 2100 under the A2 scenario

IPCC 2007, Lowe & Gregory 2005

Oceanic Acidification



Acidity
projected average change in ocean pH with depth due to release of CO_2 from human activities

a.o., Caldeira & Wicket 2003, The Royal Society 2005

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Arctic Ocean

shift from ice algae to phytoplankton will result in changes in primary production and food web structure

Regional Expectations

- ice-free Arctic during summer before 2100
- changes in circulation patterns, primary productivity & polar communities

a.o., Johannessen et al. 2004, Annan & Hargraeves 2006, Hegerl et al. 2006

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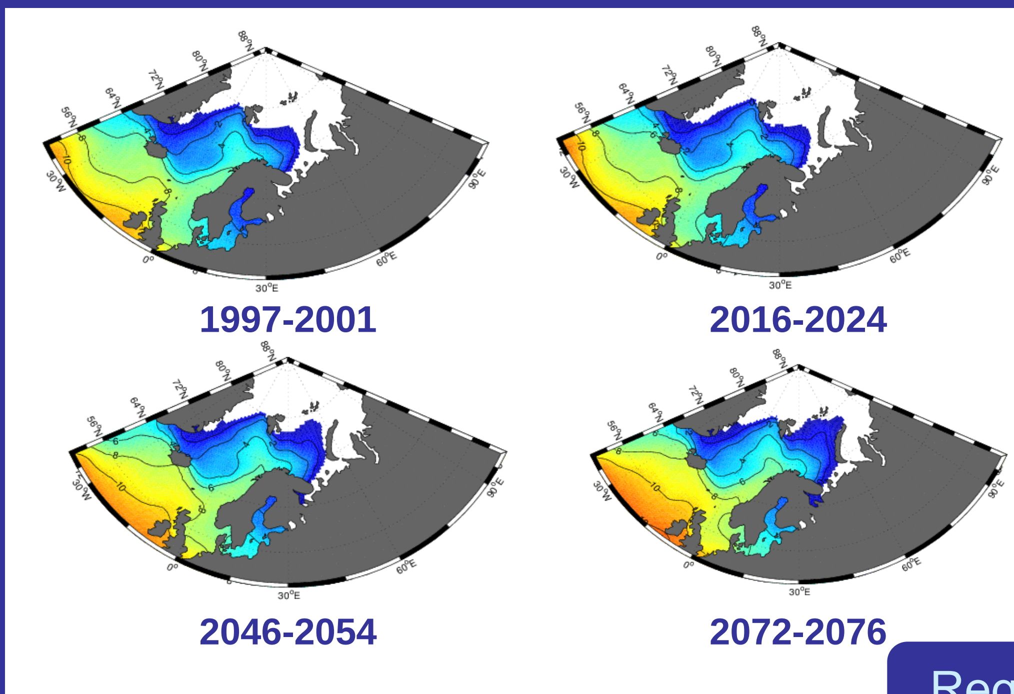
Barents Sea



continuation of observed increase in sea surface temperature (colors) and further decline in sea ice extent

Regional Expectations

- ice-free Barents Sea in March 2080
- 8-30% increase in primary productivity
- higher (commercial) fish stocks`

a.o., Slagstad & Wassmann 1996, Furvik et al. 2002, ACIA 2005, Drinkwater 2006, Ellingsen et al. 2006

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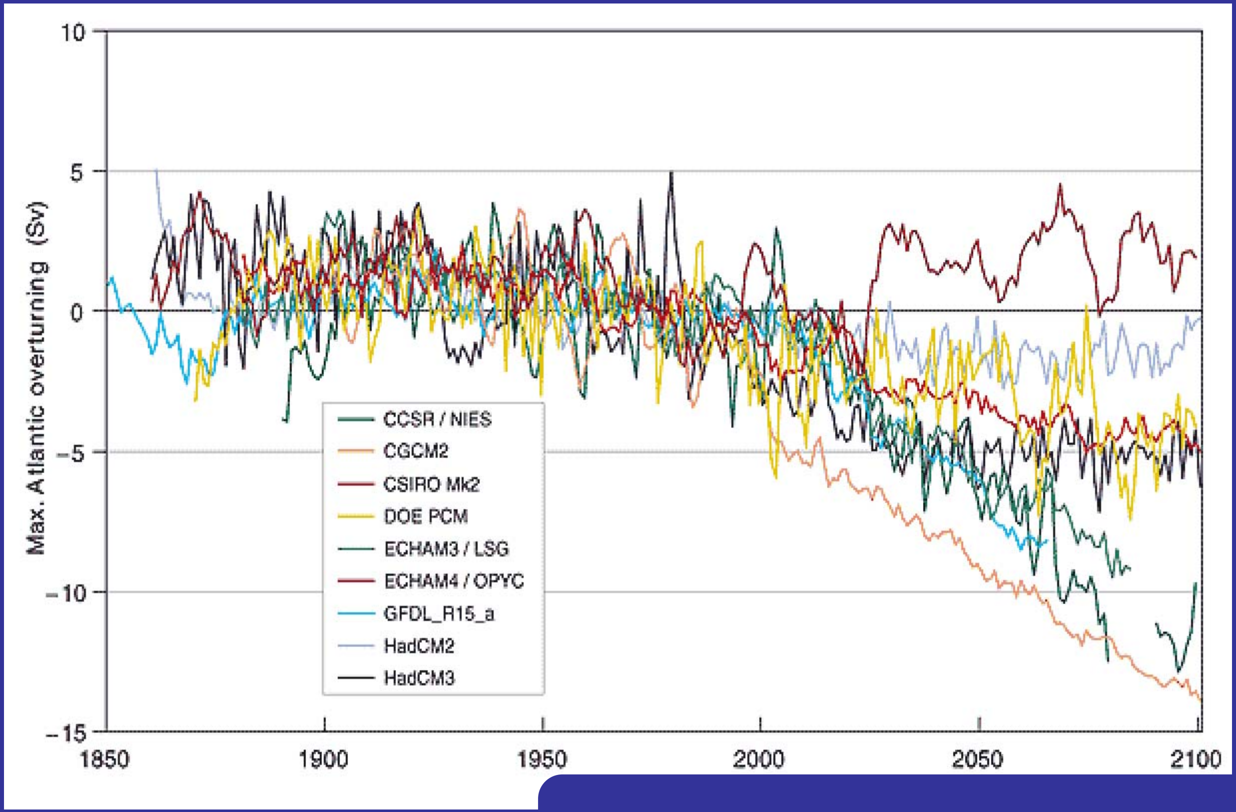
Nordic Seas



reduction of water-volume transport change of the Atlantic “conveyor belt” (Atlantic overturning) as predicted for a range of global warming scenarios relative to the mean of 1961-1990

Regional Expectations

- reduction in Atlantic overturning circulation
- shift from Arctic to Atlantic zooplankton species
- further northward movement of (commercial) fish

a.o., Furvik et al. 2002, IPCC 2007

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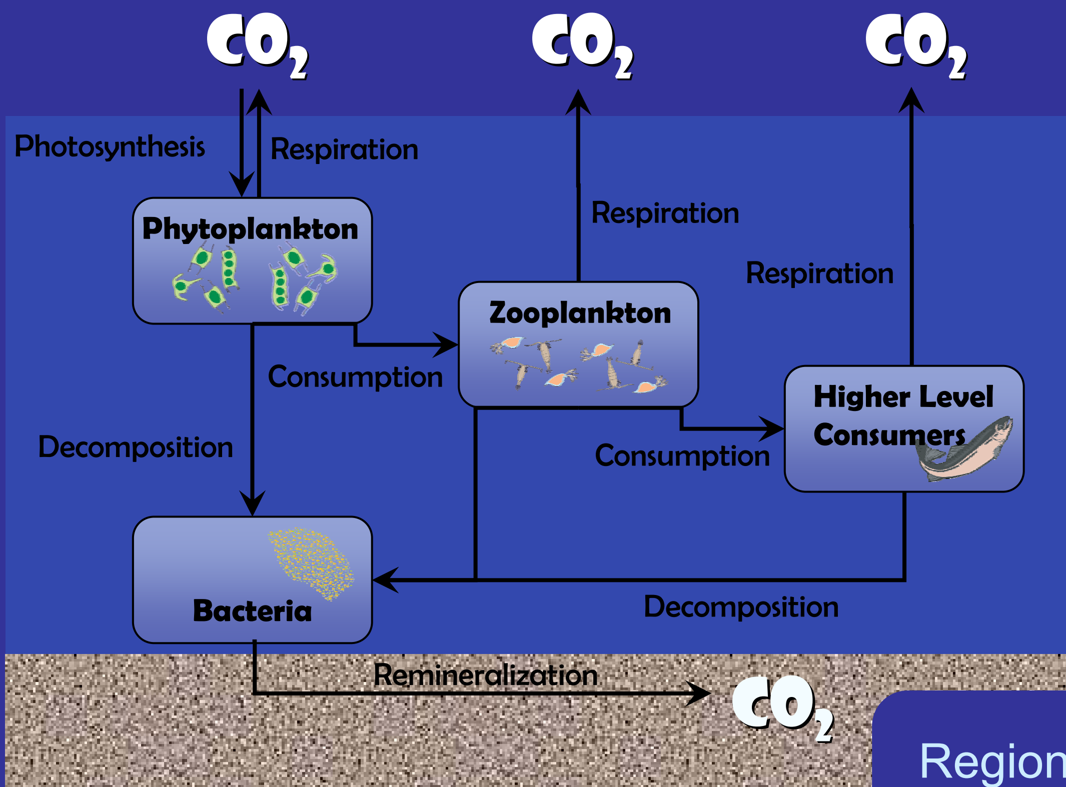
Northeast Atlantic



rising temperatures and increased acidification of the oceans may affect the downward transfer of carbon(dioxide) by means of the "biological pump"

Regional Expectations

- slowing down of thermohaline circulation
- changing efficiency of "biological pump"

a.o., The Royal Society 2005, IPCC 2007

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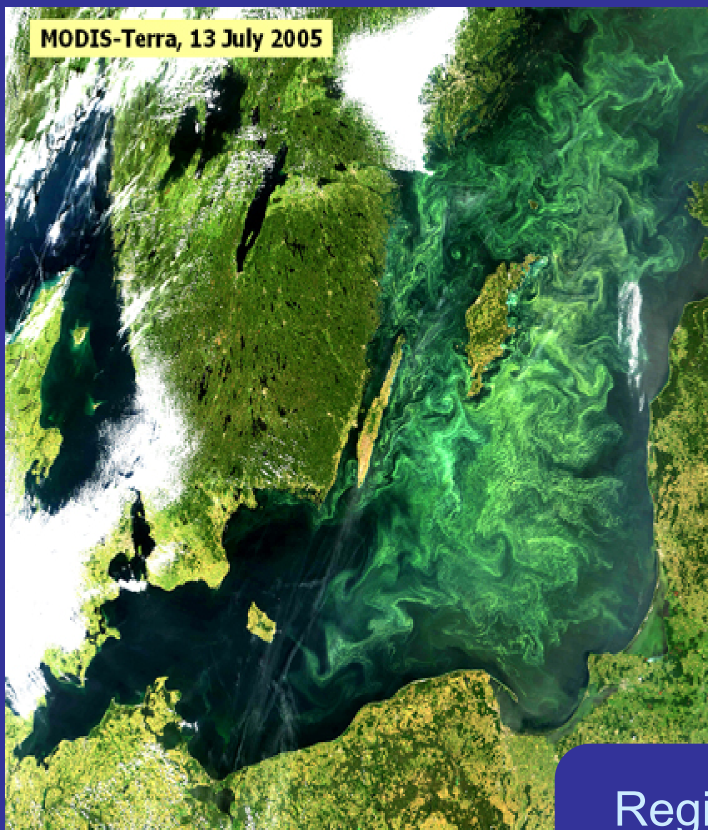
Baltic Sea



increasing windiness during late winter may increase nutrient (phosphate) availability resulting in blooms of potentially toxic blue-green algae (cyanobacteria) in summer

Regional Expectations

- 50 to 80% decrease in sea ice extent during winter
- enhancement of cyanobacteria blooms
- shift from marine to limnic species

a.o., Dippner & Ikauniece 2001, Janssen et al. 2004, Möllmann et al. 2005, Graham et al. 2006

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North Sea

Dutch fisherman anticipates changes in fish stocks and reconstructs his fishing gear to start fishing on squid and other southern species

Regional Expectations

- sea level rise of 2 to 86 cm
- reduction of indigenous fish stocks
- increase in southern (commercial) species
- (potential) flooding of low-lying coastal areas

a.o., Hulme et al. 2002, Van den Hurk et al. 2006

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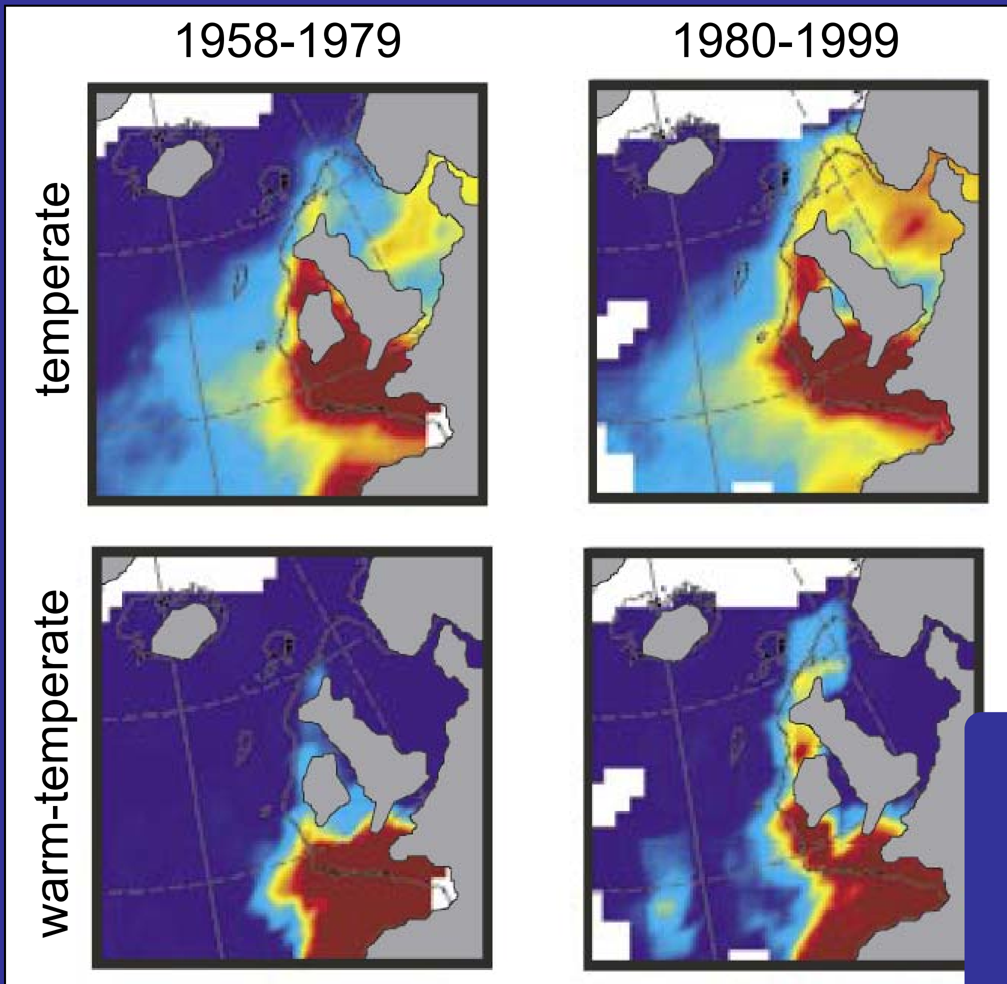
Celtic-Biscay Shelf



shifts in the distribution of plankton species as measured by means of the Continuous Plankton Recorder

Regional Expectations

- southern fish assemblages by 2025
- extinction of northern intertidal species in 25 years

a.o., Beagrand et al. 2002, Genner et al. 2004, Mieszowska et al. 2005, Southward et al. 2005

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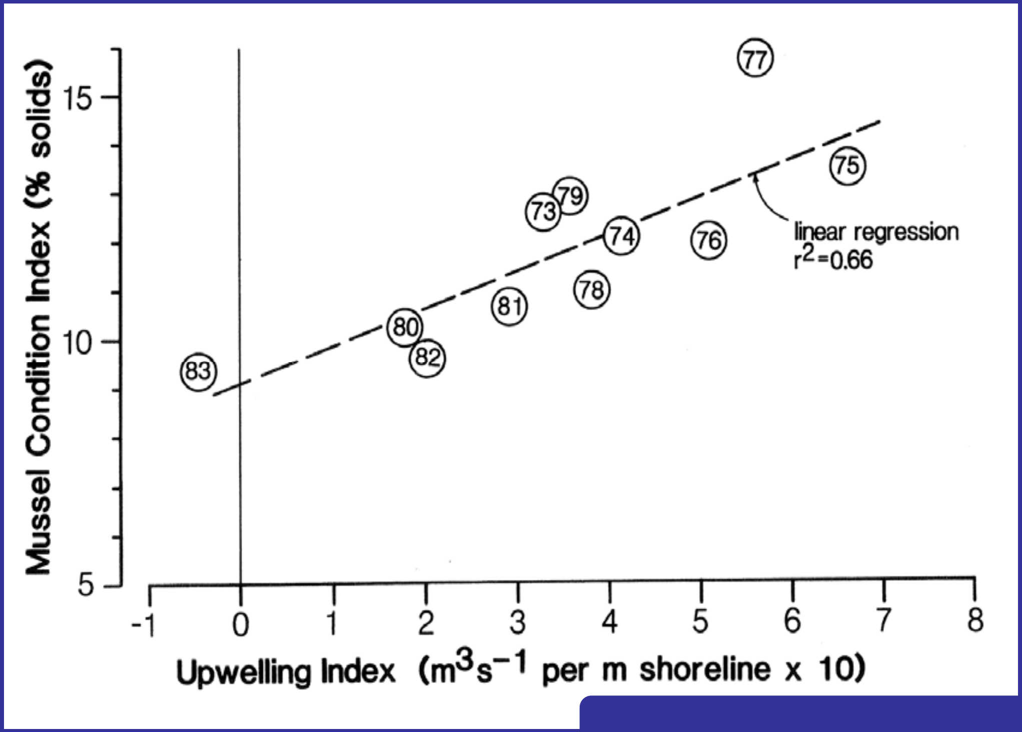
Iberian upwelling margin

Iberian upwelling margin



decrease in strength of upwelling may result in decrease of condition of cultured mussels

Regional Expectations

- decrease in quality of cultured mussels
- changes in retention-dispersion of larvae
- impact on beaches, infrastructures & urban facilities

a.o., Blanton et al. 1987, Cendrendo et al. 2005

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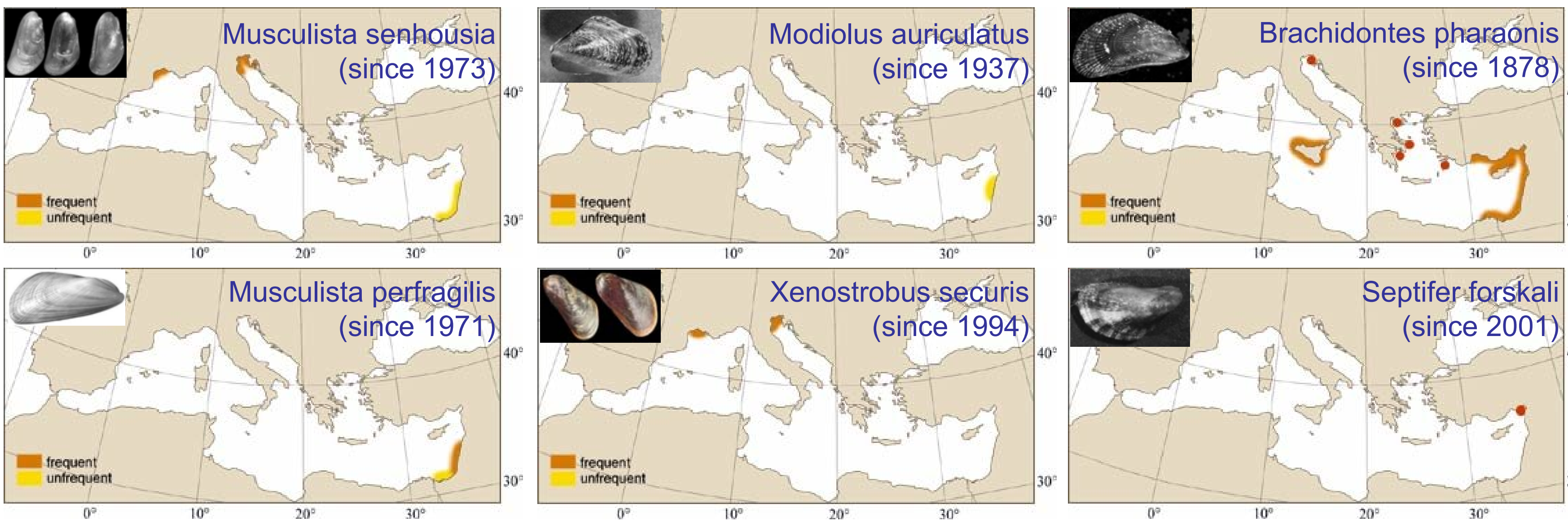
Mediterranean Sea

introduction and spread of non-indigenous mussels



Regional Expectations

- abrupt climate-driven temperature shifts
- shifts from endemic to ‘common’ species
- increased frequency of epidemiological events

a.o., Béthoux et al. 1990, CIESM 2002, Walther et al. 2002

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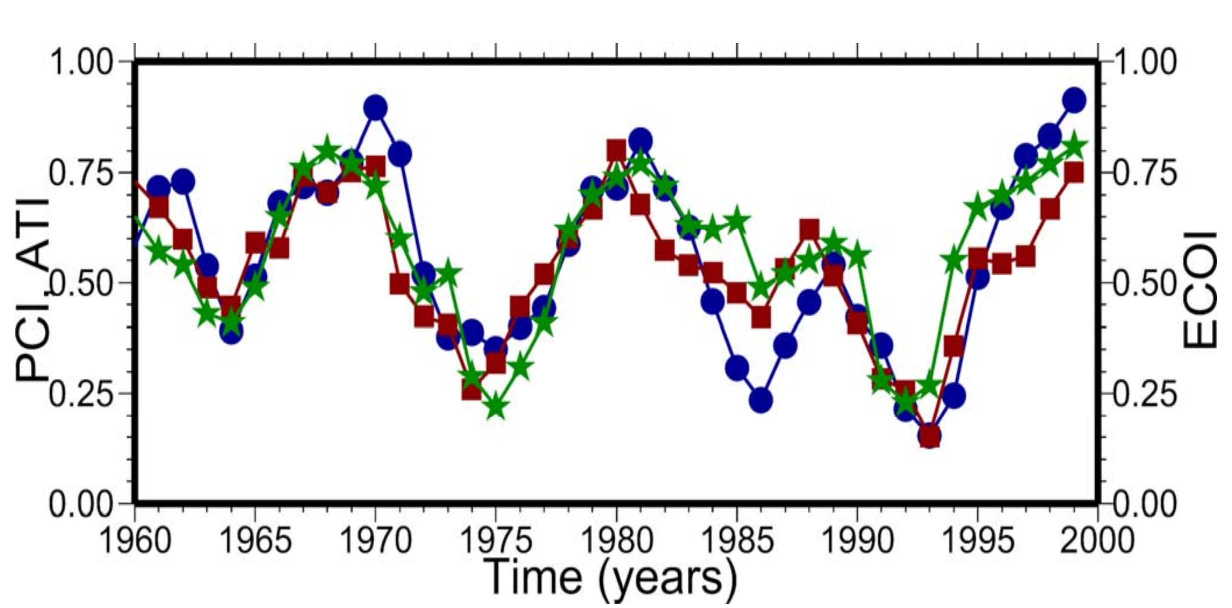
Black Sea



long-term variations of indices of atmospheric (ATI), physical climatic (PCI) and ecological (ECOI) conditions in the Black Sea between 1960 and 2000

Regional Expectations

- continuation of causal? relationship between atmospheric, physical climatic and ecological conditions

a.o., Oguz et al. 2006

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European Seas

Global Projections	Regional Expectations
Increase in temperature	Northern >> southern seas
Impacts on ecosystems	Enclosed >> open seas
Northward movements	Southern >> northern seas Open >> enclosed seas
Local shifts in species composition	From northern to southern species (all seas) From ice-bound to aquatic species (northern seas) From marine to freshwater species (Baltic Sea) From endemic to common species (Mediterranean)

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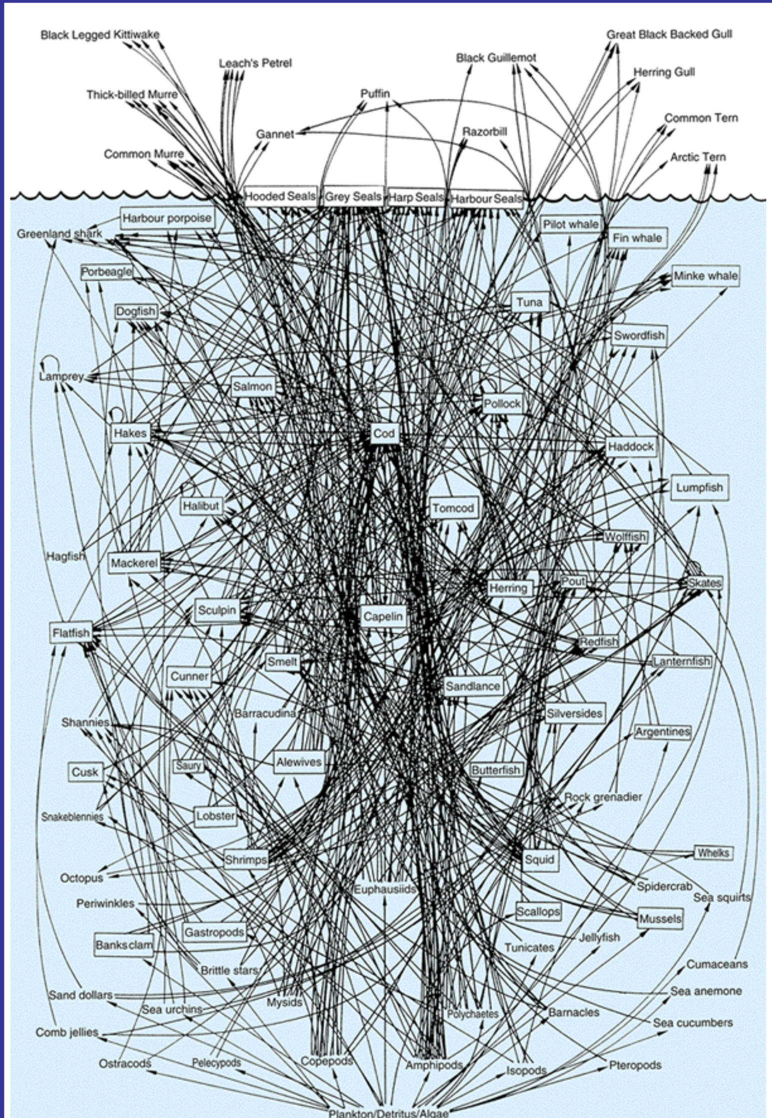
Gaps in Knowledge



A simplified food web for the Northwest Atlantic

Mechanistic relationships?
(e.g., dose-response, trophic interactions, threshold values, feedbacks)

Interactions with other drivers?
(e.g., coinciding effects of climate change, invaders, nutrient supplies & exploitation)

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Gaps in Knowledge

Adaptive capabilities vs. rate of change?
(e.g., reproductive strategies)

External forcing vs. internal dynamics?
(e.g., state of degradation)

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Gaps in Knowledge

Appropriate temporal scale?
(e.g., long-term means, seasonal dynamics,
episodic events)

Appropriate spatial scale?
(e.g., m^2-scale or tidal basin, source-sink,
connectivity between seas and oceans)

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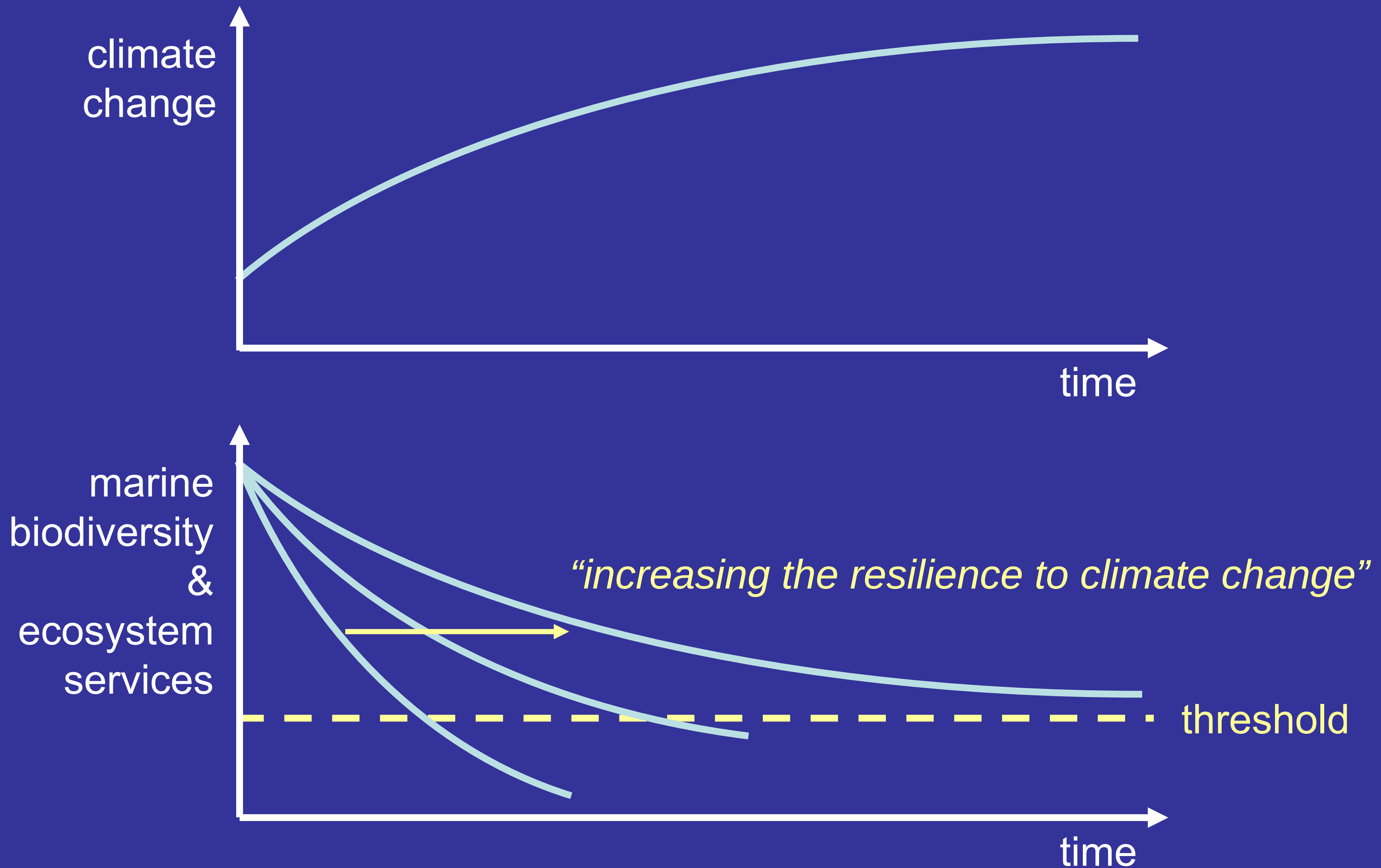
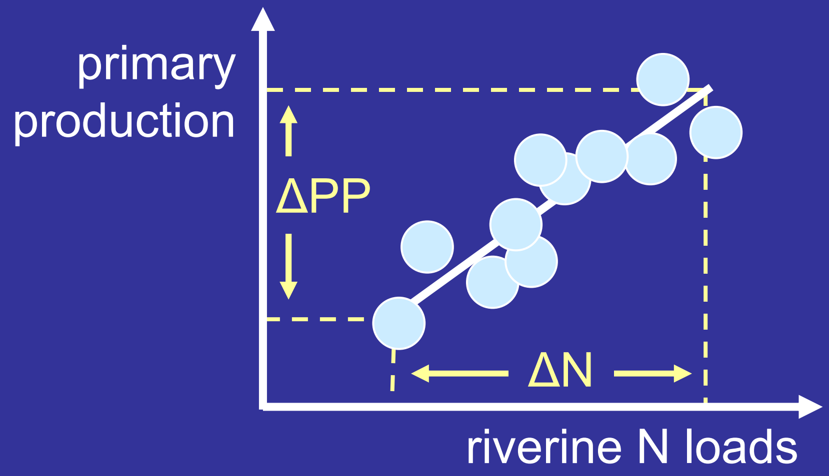
Example of a Conceptual Approach

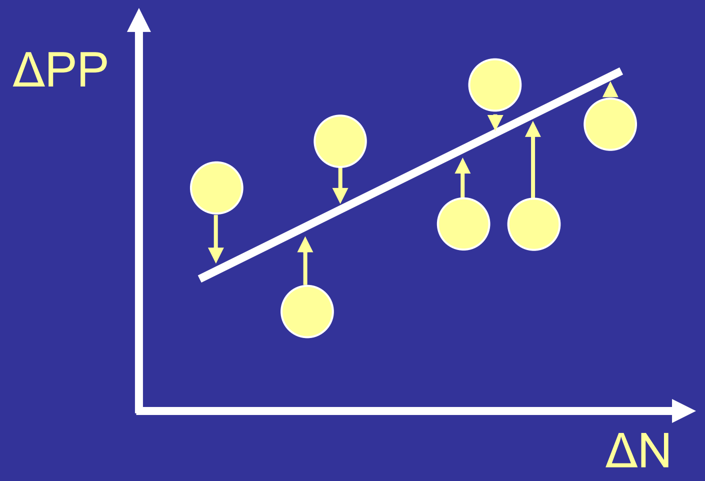


Marshall (2007) Port-Cros Symposium on Climate Change

Example of a Conceptual Approach



dose-response relationships
WITHIN systems
PP = f (N)



dose-response relationships
BETWEEN systems
ΔPP = f (ΔN) + residence time
+ depth
+ latitude
+ state of degradation
+ …..

Example of a Conceptual Approach

Interactions between Primary Production (Ecosystem Service)
& Primary Producers (Marine Biodiversity)

- Which taxonomic group (microalgae, macroalgae, seagrass)?
- Which functional group (diatoms, dinoflagellates, cyanobacteria)?
- Benthic or pelagic production?
- Mixed blooms or dominated by a single species?

The bottom line

- Which SPECIES mainly contribute to primary production?
- How sensitive are they to climate-related environmental factors?
- How well and how fast can they adapt to changing conditions?

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Recommendations

To protect our Marine Biodiversity and Ecosystem Services, we need to:

(1) extend our marine monitoring efforts
- appropriate spatial and temporal scale & resolution
- including all key processes
- including all relevant life phases of key species

(2) extend our knowledge on the sea-specific factors that determine the vulnerability and resilience of marine communities to climate change
- local drivers & structuring factors
- relationship between marine biodiversity and ecosystem services

(3) extend our knowledge on sensitivities and adaptation capabilities of marine key species to climate change
- consequences for species' interactions

(4) develop "fit-for-purpose" models to project impacts and adequately manage our marine environment
- identify limits and possibilities to enhance resilience to climate change

European Reports

- Hoepffner N, MD Dowell, M Edwards, S Fonda-Umani, DR Green, B Greenaway, B Hansen, C Heinze, JM Leppänen, E Lipiatou, E Özsoy, CJM Philippart, W Salomons, A Sanchez-Arcilla, W Schrimpf, C Schrum, A Theocharis, M Tsimplis, F Veloso Gomes, F Wakenhut, JM Zaldivar (2006) Marine and Coastal Dimension of Climate Change in Europe. EC - Joint Research Centre. EUR 22554 EN
- Philippart CJM, R Anadón, R Danovaro, JW Dippner, KF Drinkwater, SJ Hawkins, T Oguz, G O'Sullivan, PC Reid (2007) Impacts of Climate Change on European Marine and Coastal Environment. ESF - Marine Board Position Paper 9.

Acknowledgements

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- Organizers of EPBRS meeting

Thank you for your attention!