The status of living marine resources in relation to climate

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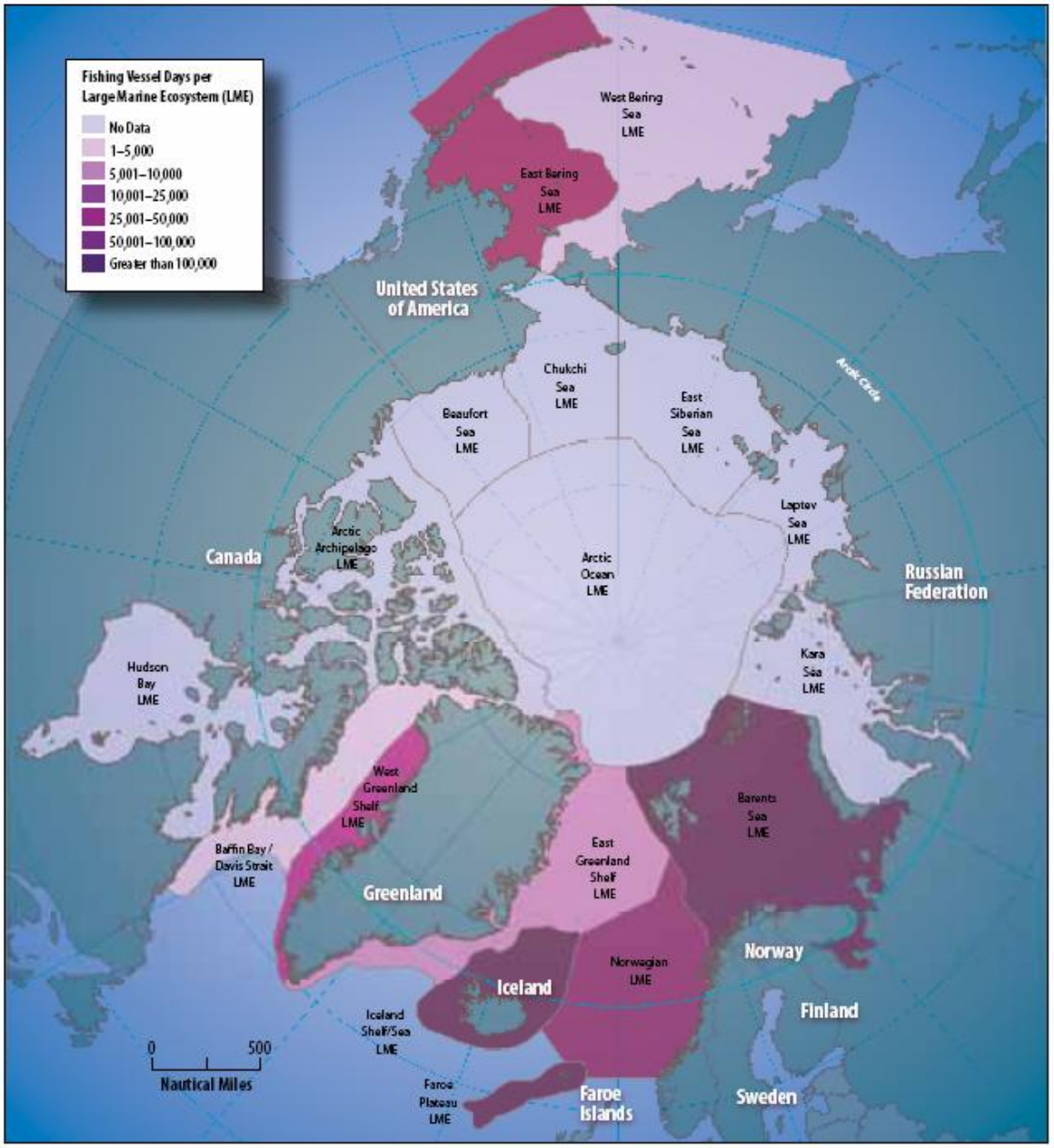
Outline

- Climate development
- Climate impact on marine ecosystems
- What do we expect in the future

Fishing Intensity

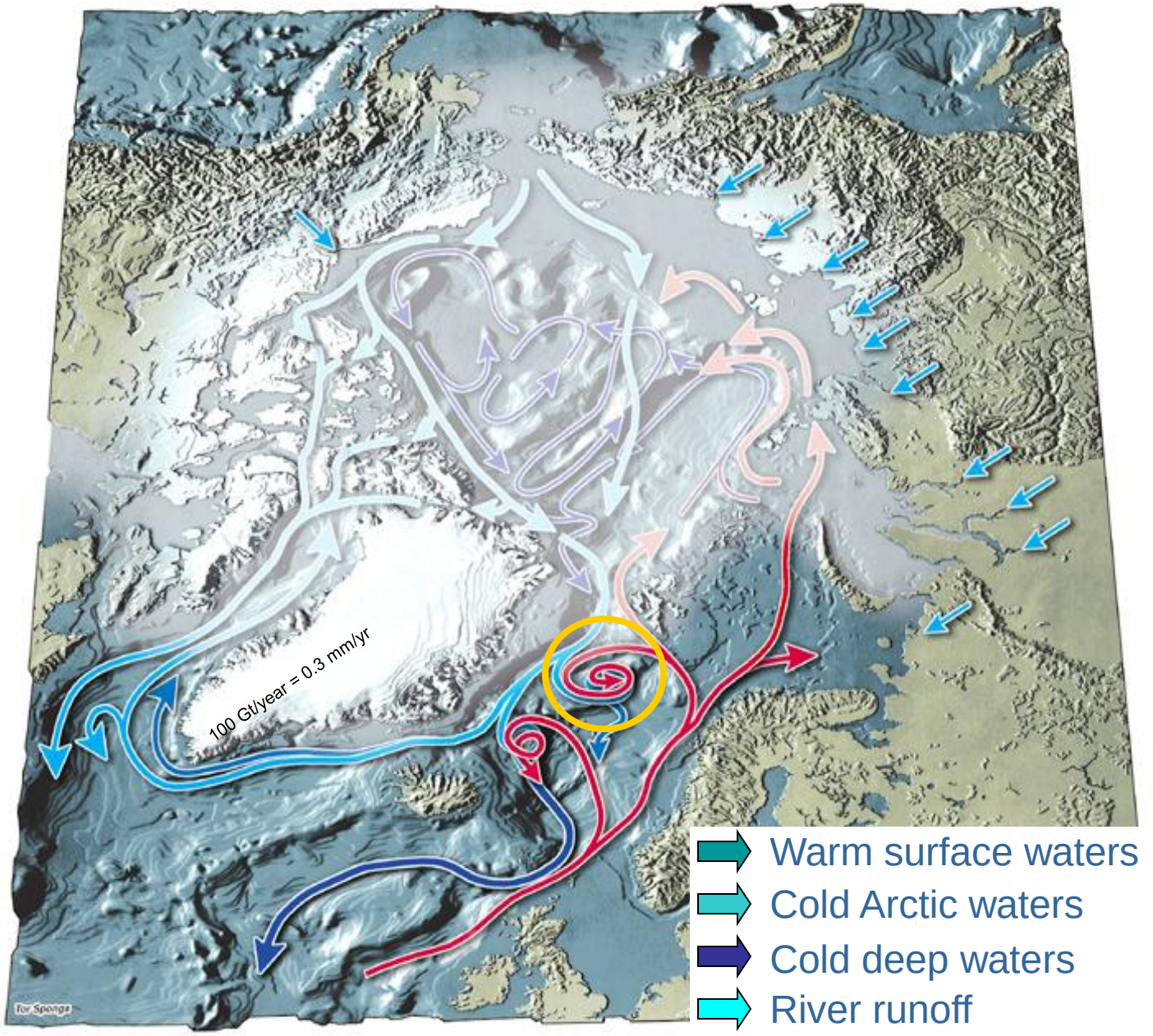
Arctic commercial fishing is regionally concentrated



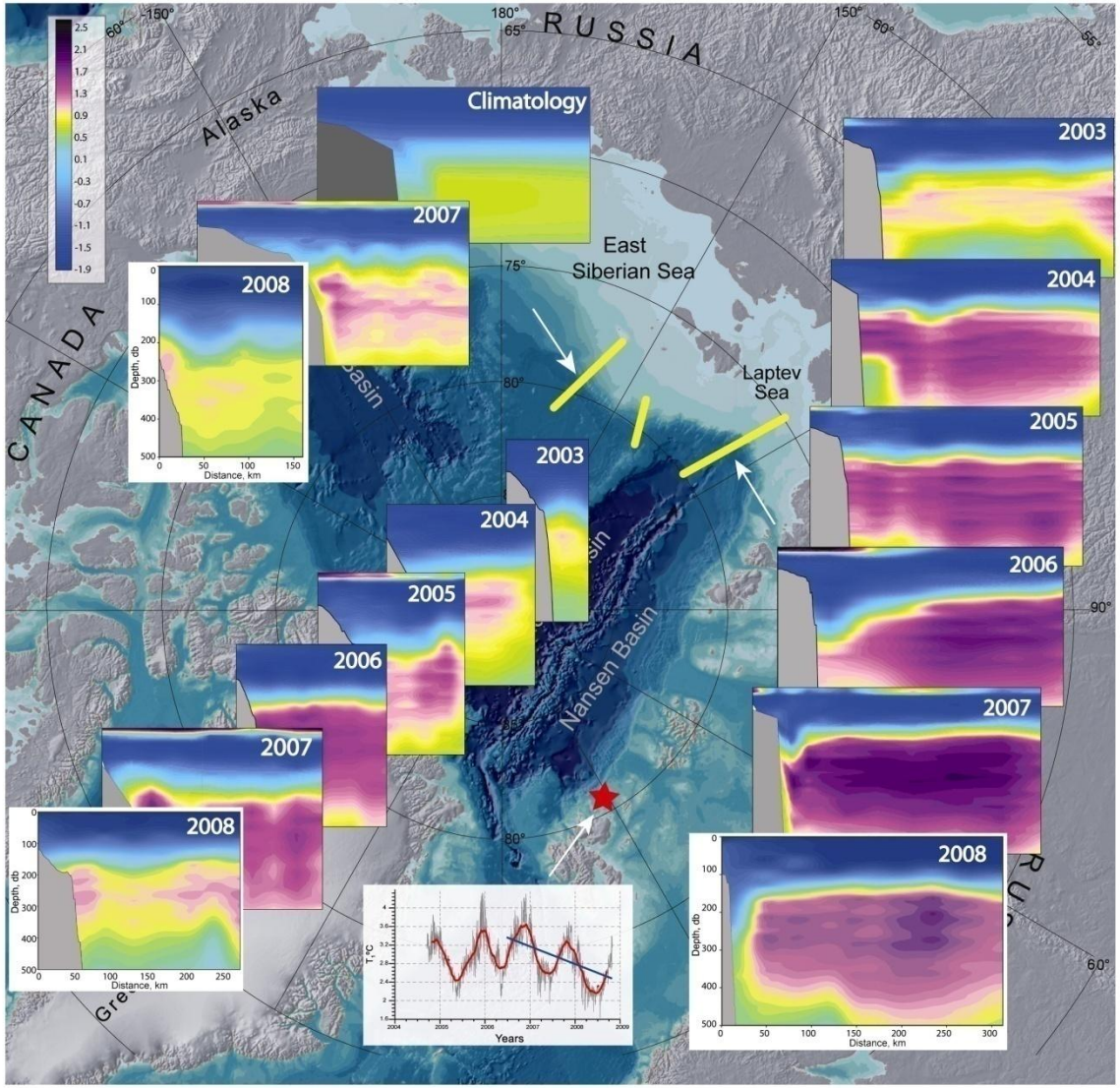
Map 5.3 Fishing vessel activity. *Source: AMSA*

Climate development

Arctic Climate System

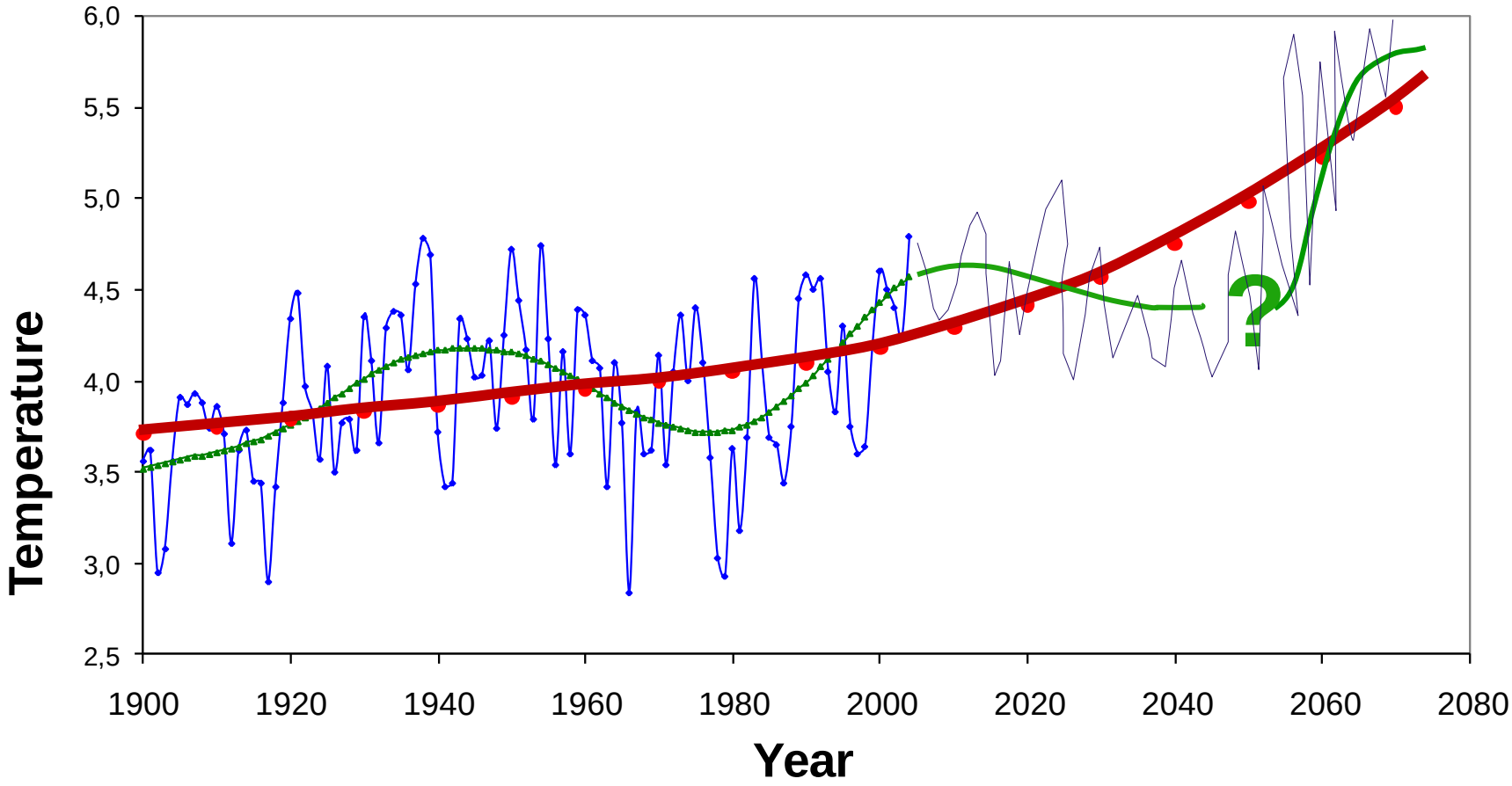


Temperature development in the Arctic Ocean



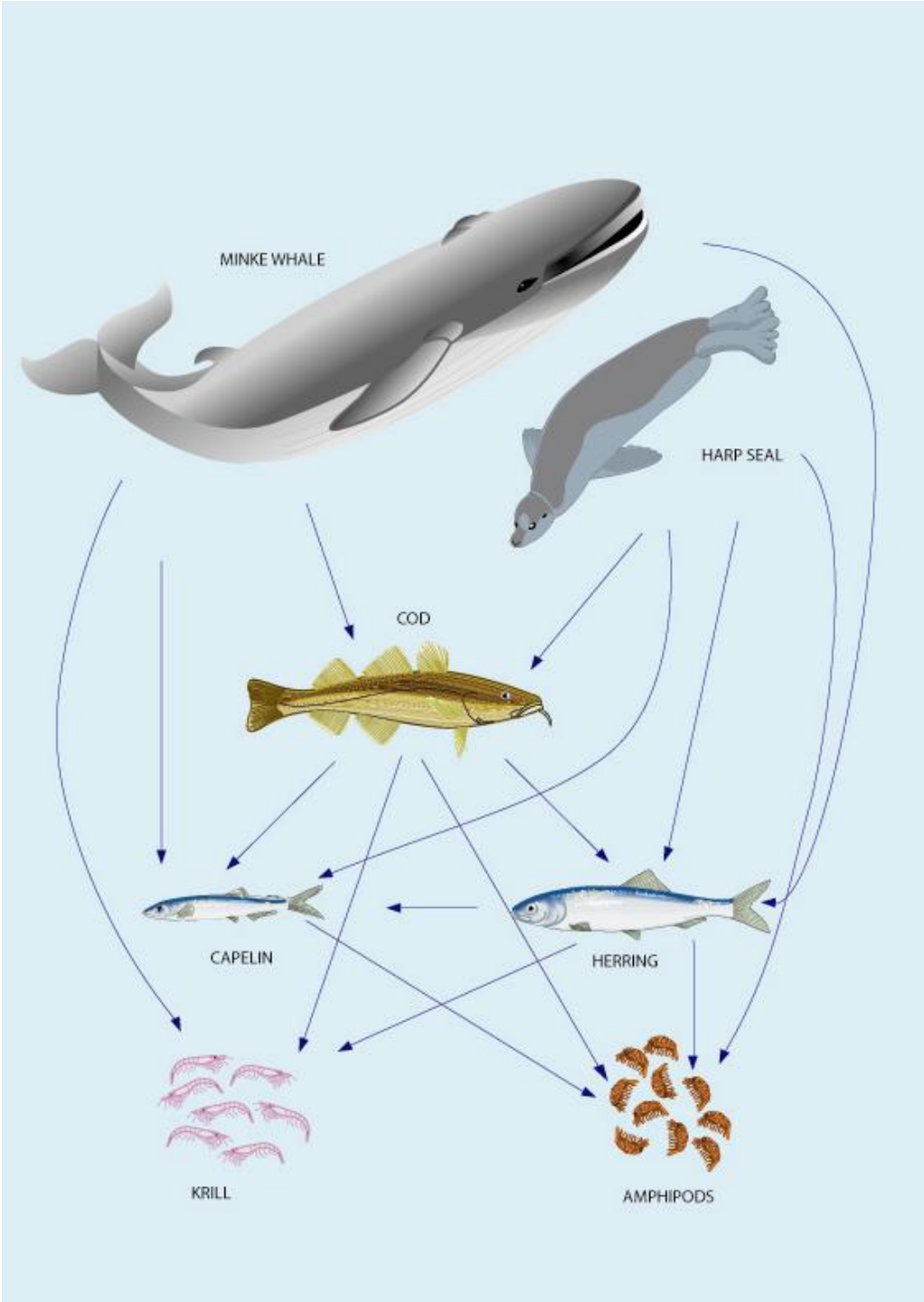
Igor Polyakov, pers.com

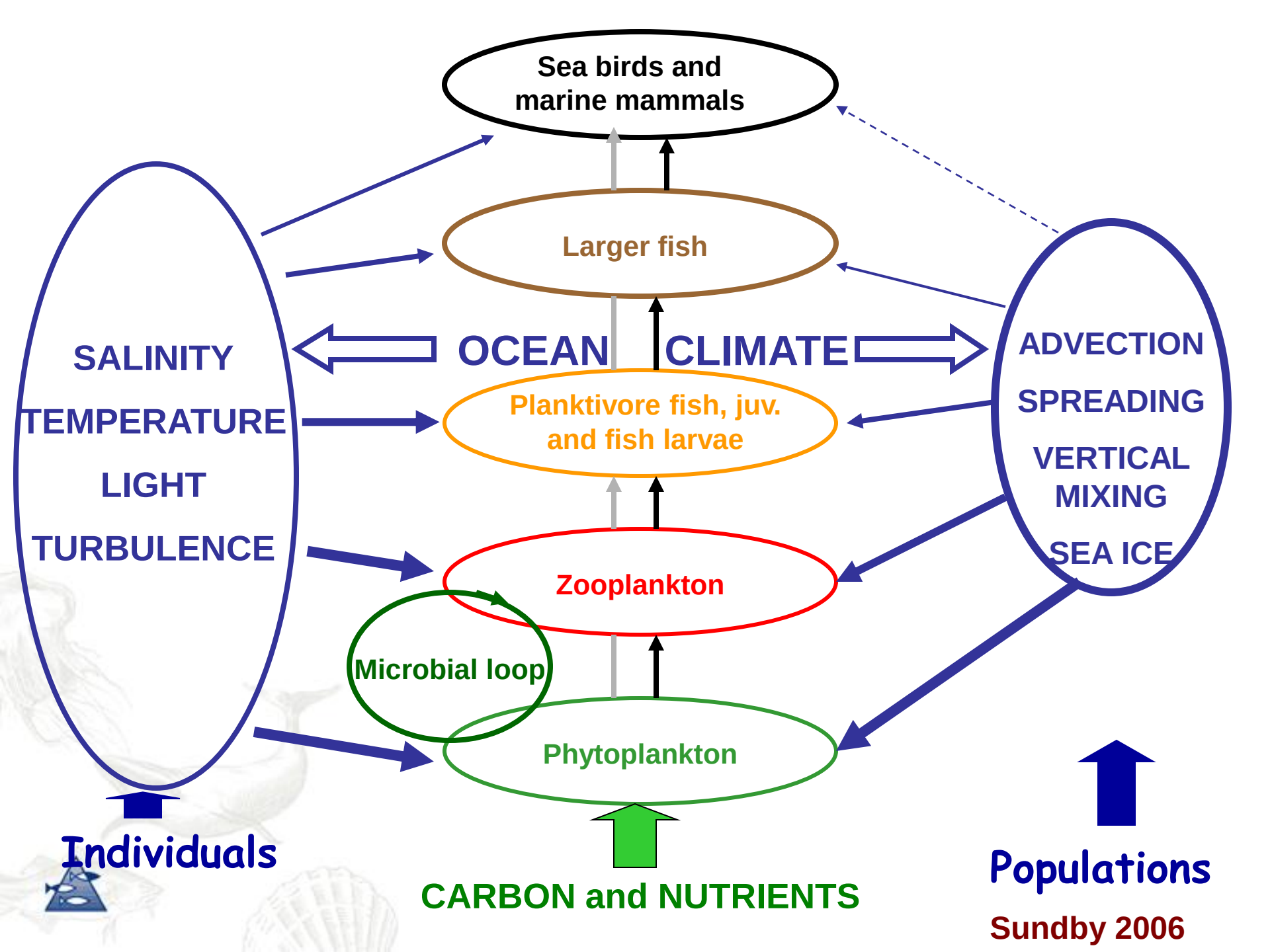
Possible temperature development



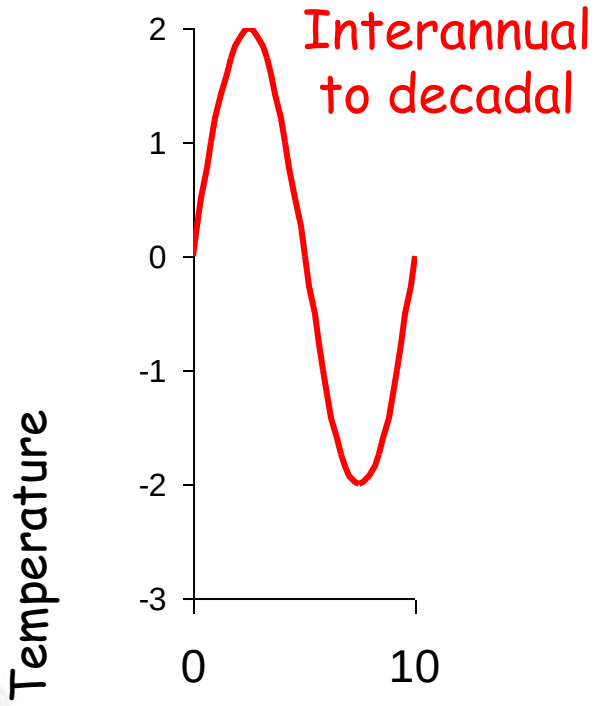
Climate impact on the marine ecosystems

Example of interaction between species in an Arctic Ecosystem



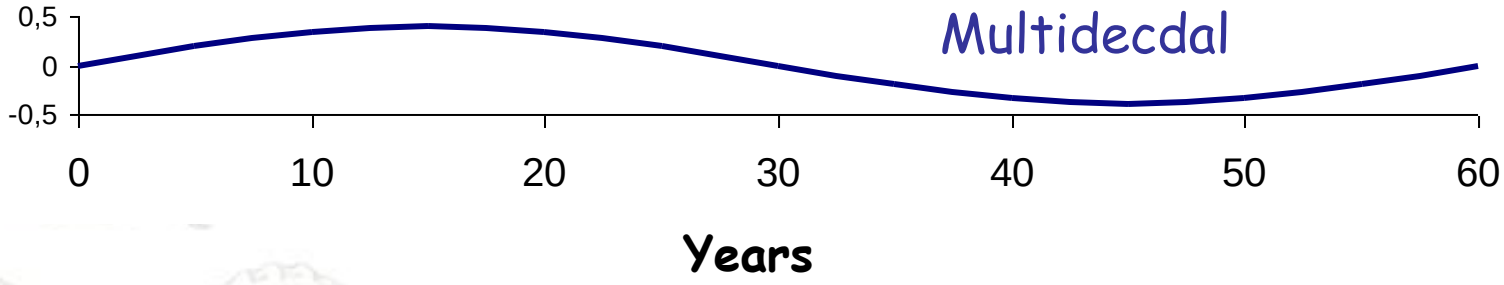

Sea birds and marine mammals
Larger fish
SALINITY
TEMPERATURE
LIGHT
TURBULENCE
OCEAN
CLIMATE
ADVECTION
SPREADING
VERTICAL MIXING
SEA ICE
Planktivore fish, juv. and fish larvae
Zooplankton
Microbial loop
Phytoplankton
Individuals
CARBON and NUTRIENTS
Populations
Sundby 2006

Climate effects on marine ecosystems vary with the periodicity



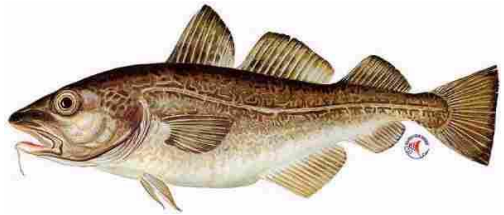
- **Local production on lower trophic levels**
- **Fish recruitment and year-class strength**

- **Habitat extents of populations**
- **Production on higher trophic levels**

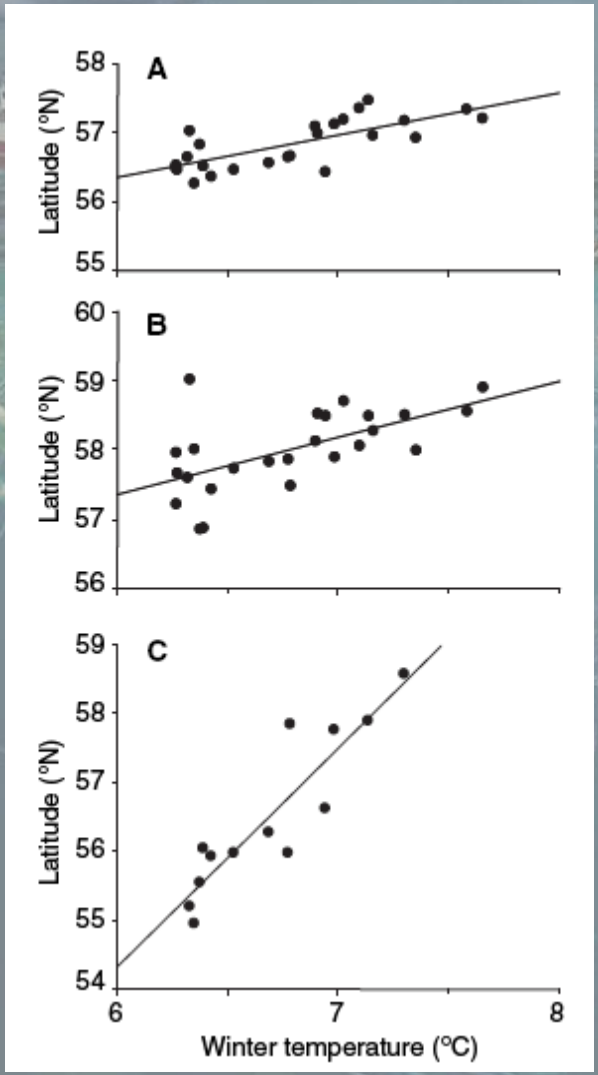


Climate impact on the ecosystem

- Plankton
- Fish stocks
  - Individual growth
  - Recruitment
    - ***Distribution***
    - ***Migration***
- Marine mammals



Fish distributions shift toward the poles due to warmer sea temperatures



North Sea:

Mean latitude and winter sea temperature for

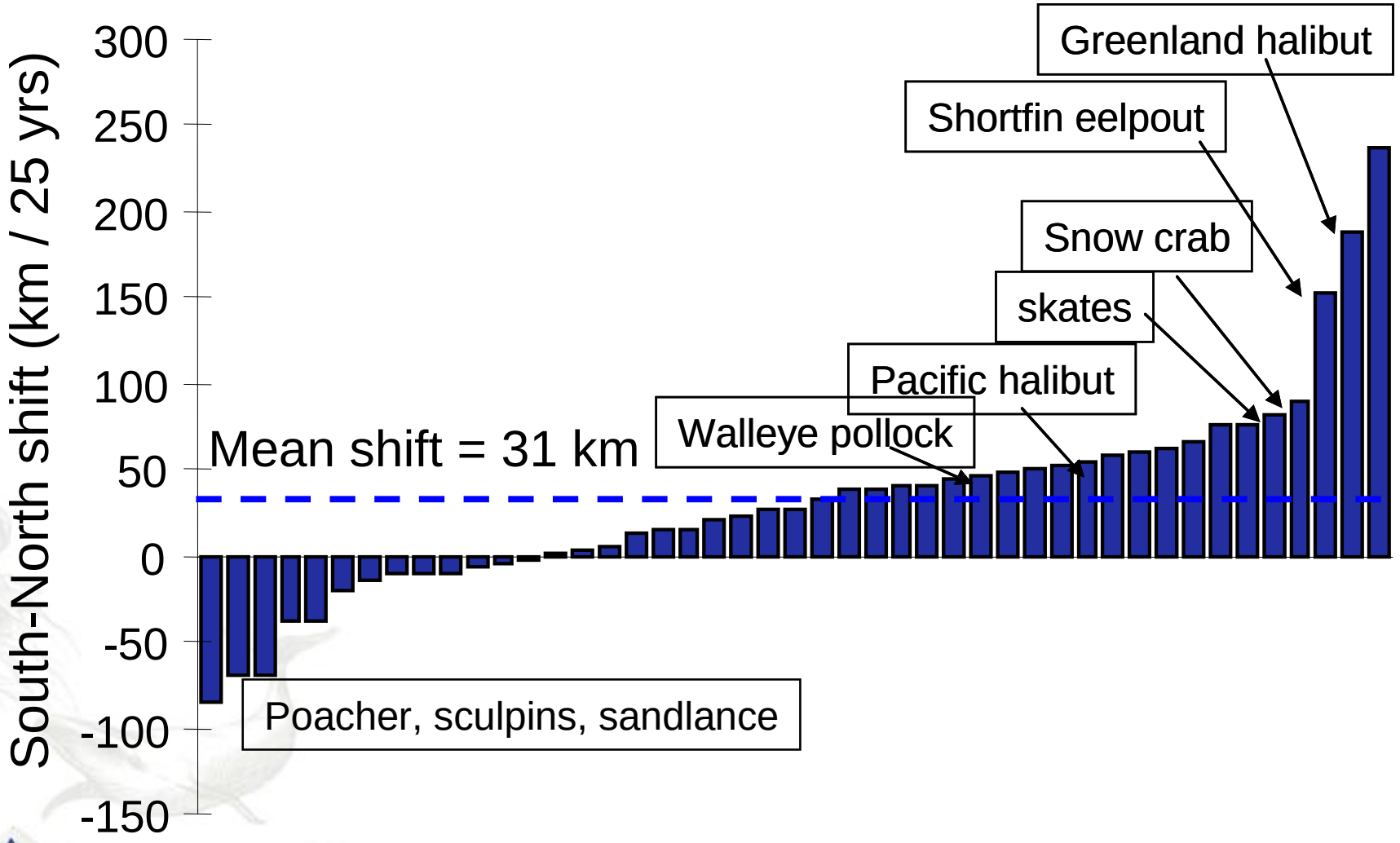
(a) cod

(b) anglerfish

(c) snake blenny

A. Perry et al. 2005. Science

Shift in distribution of species in the Bering Sea 1982-2006



Mueter and Litzow, 2008

Conclusions (so far)

- ***Climate variables influence marine population directly and indirectly through the food web.***
- ***The response of marine ecosystems to climate signals varies with the periodicity of the climate signal.***
- ***The resilience of fish stocks to fishing pressure varies with the productivity in the ecosystem which in turn varies the climate forcing.***

What do we expect in the future?

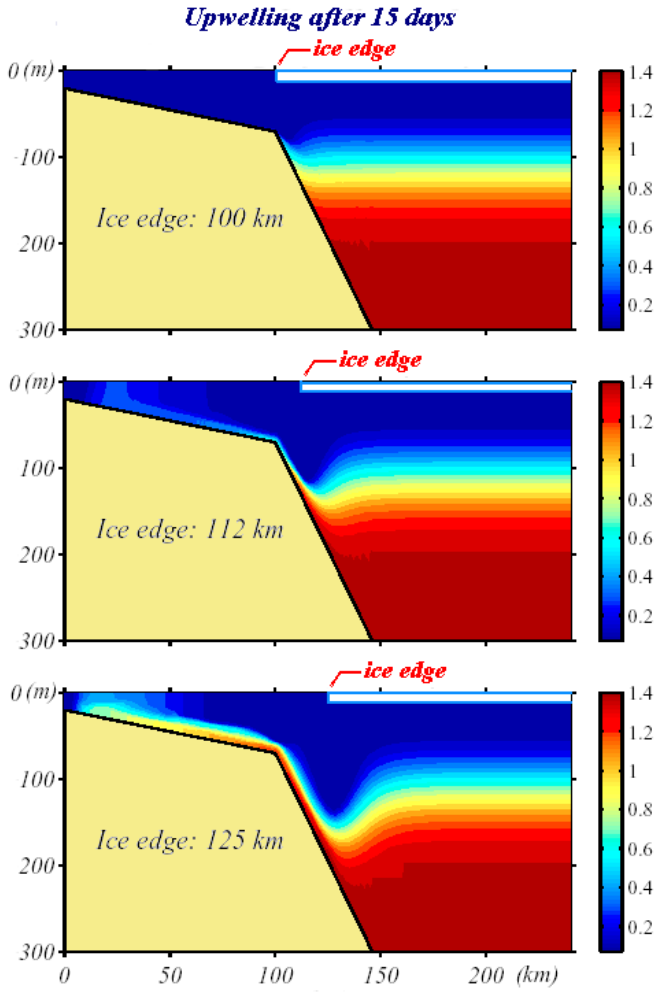
Those who have knowledge, don't predict.
Those who predict, don't have knowledge.

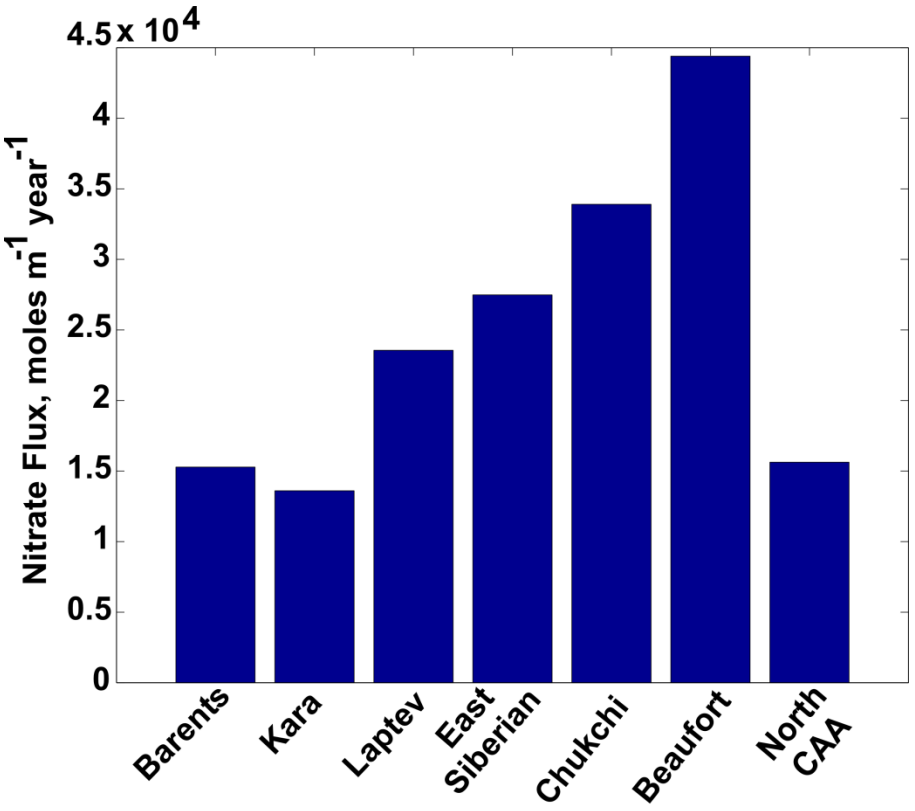
Lao Tzu, *6th Century BC Chinese Poet*

Forecasting is the art of saying what will happen, and then explaining why it didn't!

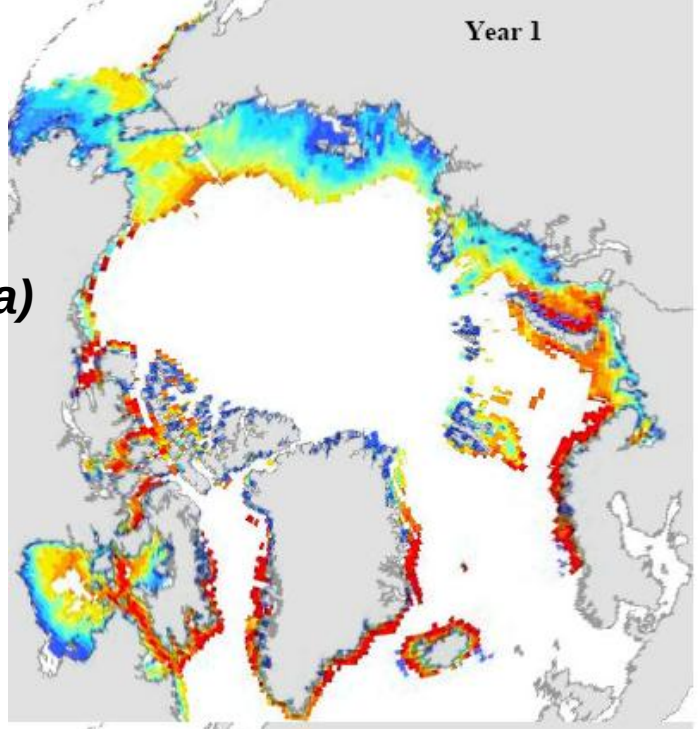
Anonymous

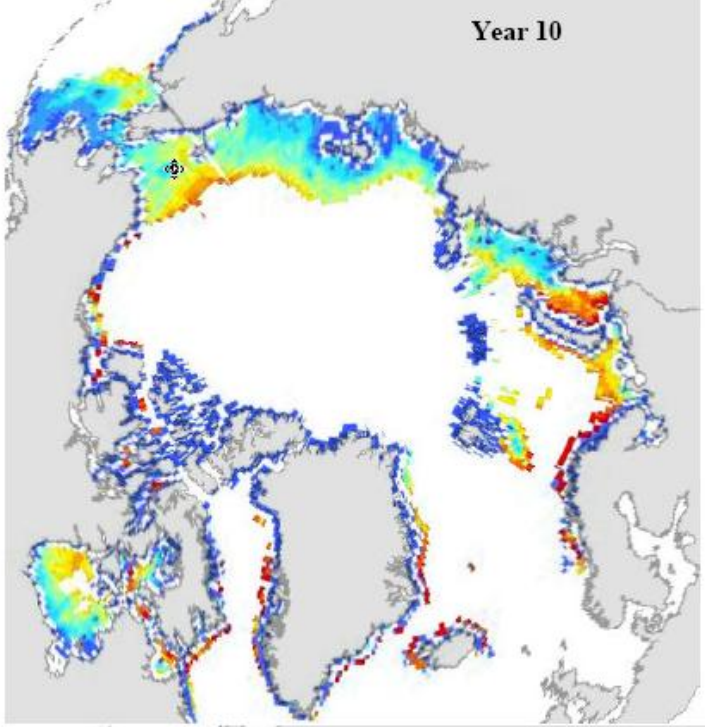
Possible changes in the Arctic Ocean (after Eddy Carmack 2004)

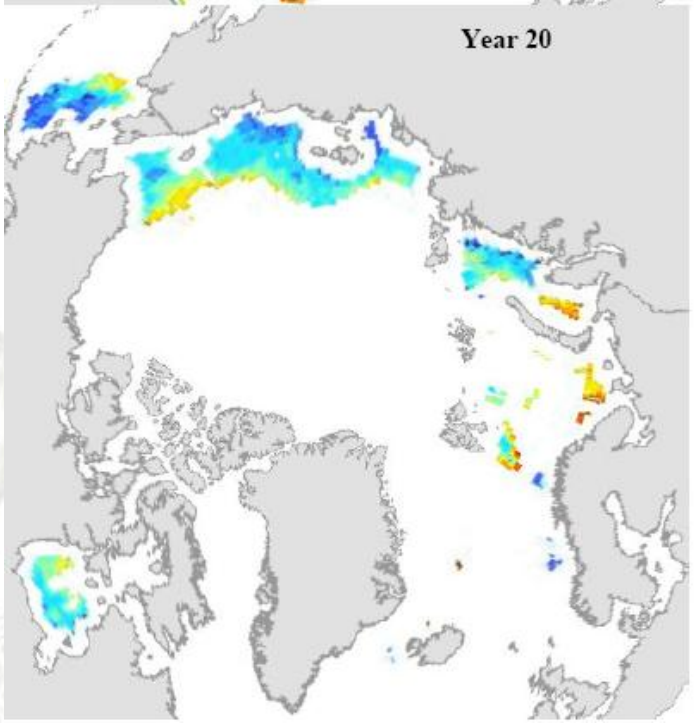


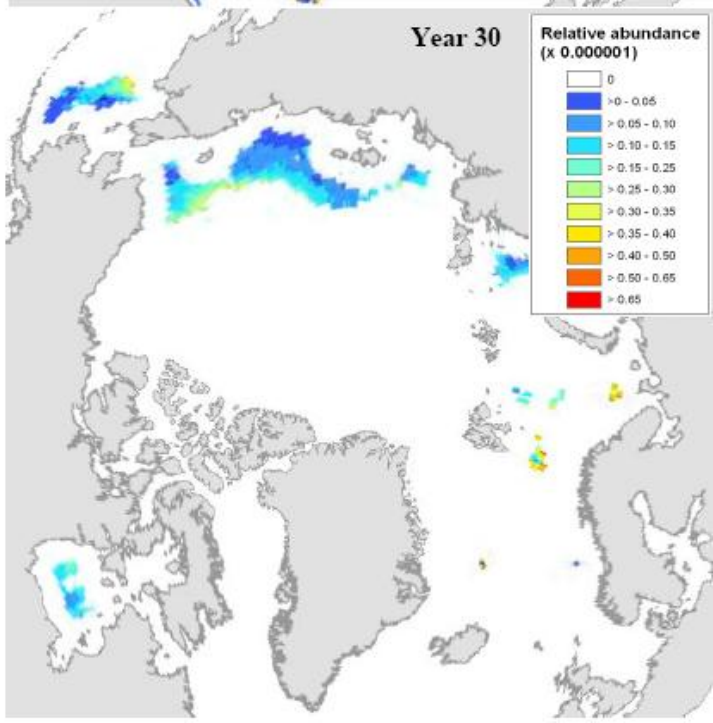


Distribution of
Polar cod
(Boreogadus saida)







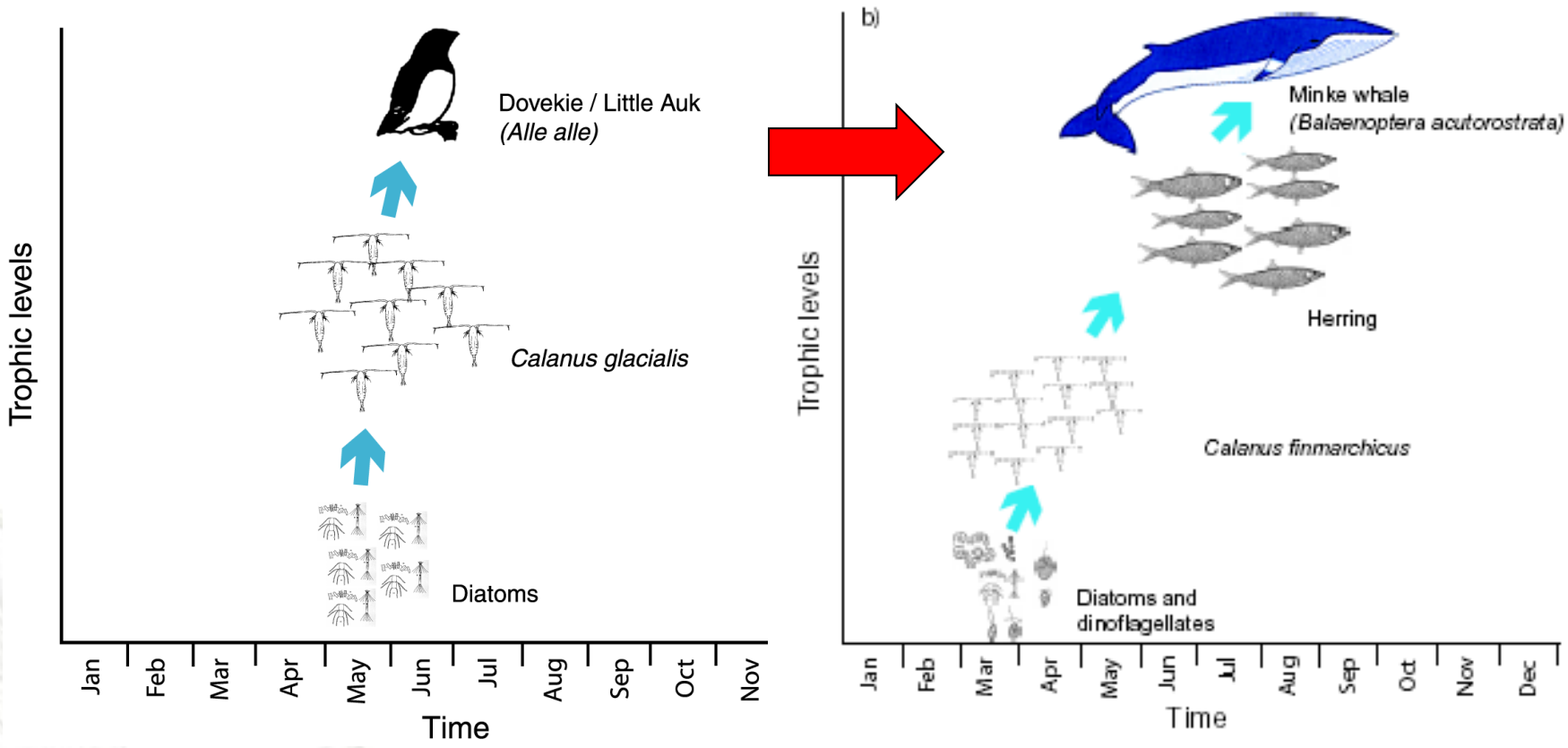


W. W. L. Cheung,
V. W.Y. Lam and
D. Pauly, 2008

Changes in ecosystem function

Food web in Arctic water

Food web in Atlantic water



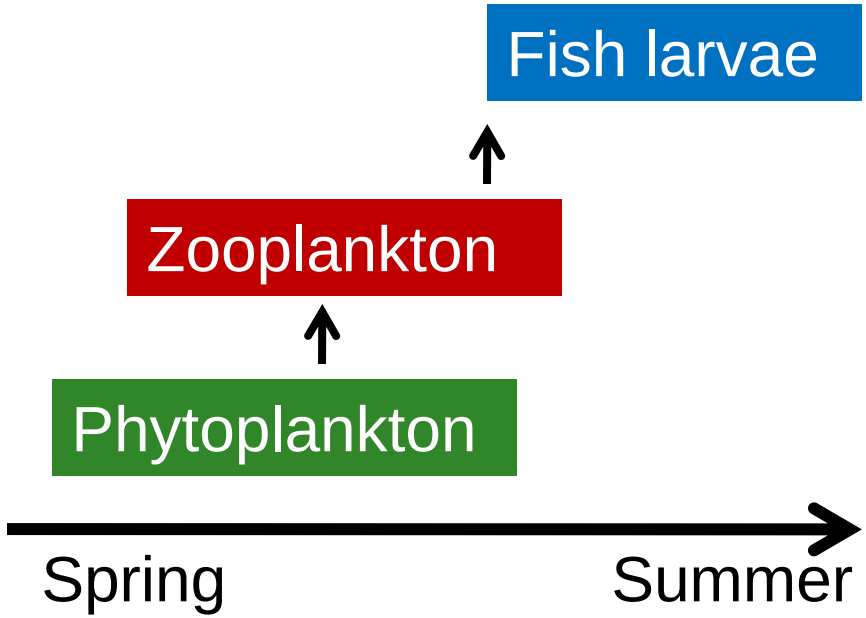
The food web changes may be far more dramatic for the higher compared to the lower trophic levels

Falk-Petersen et al. 2007

Uncertainties

- ***The ability of marine organisms to adapt to climate change***

- ***Consequences of "match/mismatch" between predator and prey***

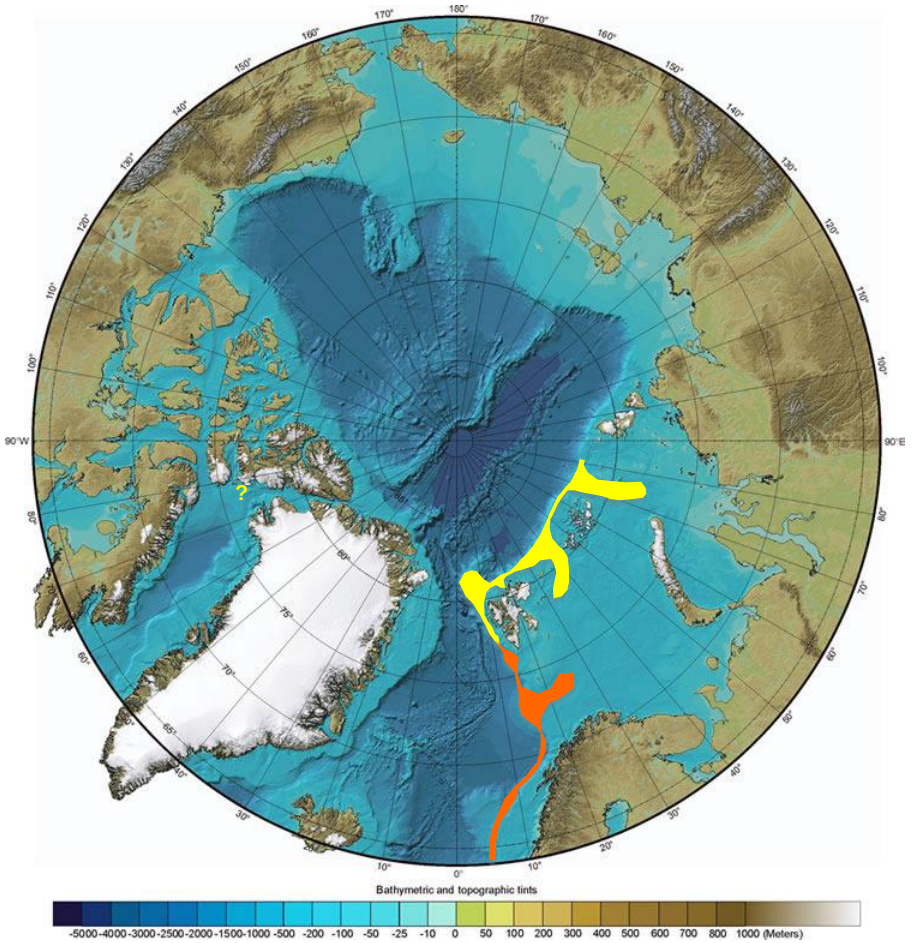


- ***Competition when/if new species enter an ecosystem***

Different regimes

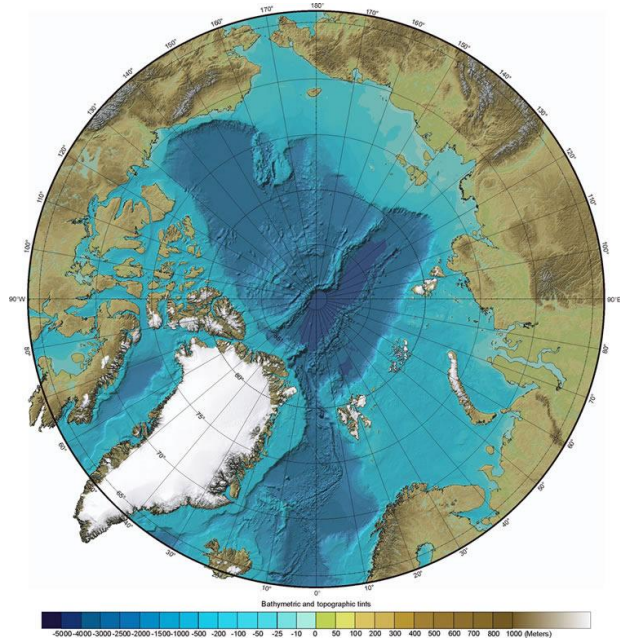
Impact on different ecosystems

- ✓Ice related systems
- ✓Shallow water system
- ✓Deep water system
  - ✓Pelagic fish
- ✓Density dependant movement



Criteria for establishing fish stocks in the Arctic Ocean

- Bottom topography
- Climatic conditions
  - Temperature and salinity
  - Sea ice distribution
- Food conditions
  - Phytoplankton and zooplankton
- Distanse to spawning grounds



From observation to commercial fishing

- There is a long way from observations of a few specimens to commercial fishing

Scientific perspectives on climate change and Arctic fisheries

1. How will productivity of Arctic ecosystems change?
2. What species are most likely to migrate successfully to the Arctic to establish self-sustaining populations?
3. How are successful migrations likely to alter Arctic marine ecosystems?
4. What research is needed to understand these ecosystem changes and the impacts of commercial fishing on them?


Warming trend slowly alters Arctic way of life
Thank you for paying attention
AUTH
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