



Impacts of climate change on the Arctic Ocean and adjacent seas

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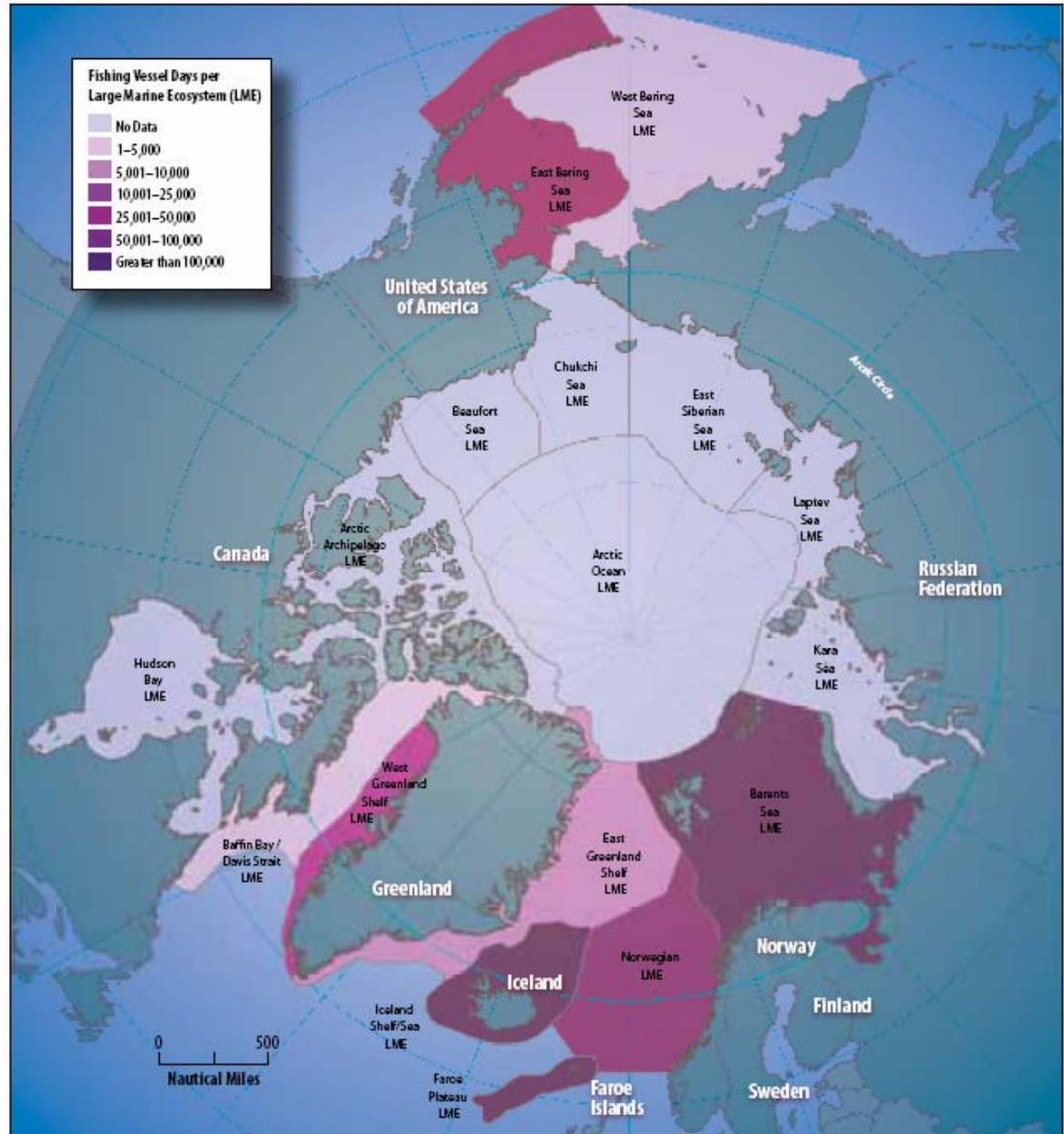
Main question for this talk:

- ***What criteria need to be fulfilled in order to get commercial fishing in the Arctic Ocean and the surrounding shelf seas in the future?***
- ***This is mainly a speculative talk including some facts***



Fishing Intensity

Arctic commercial fishing is regionally concentrated



Outline

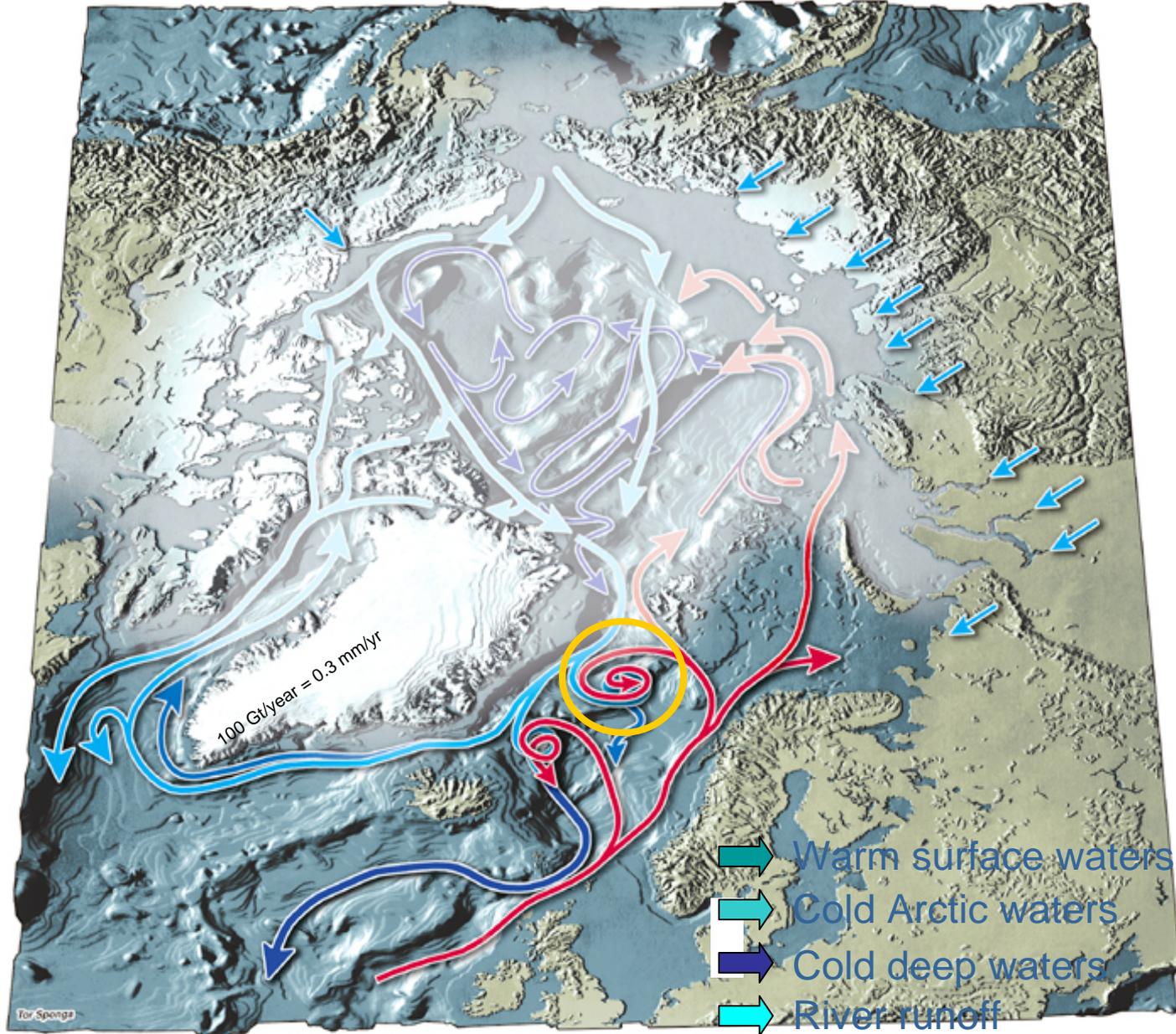
- **Climate development**
- **Climate impact on marine ecosystems**
- **What do we expect in the future**



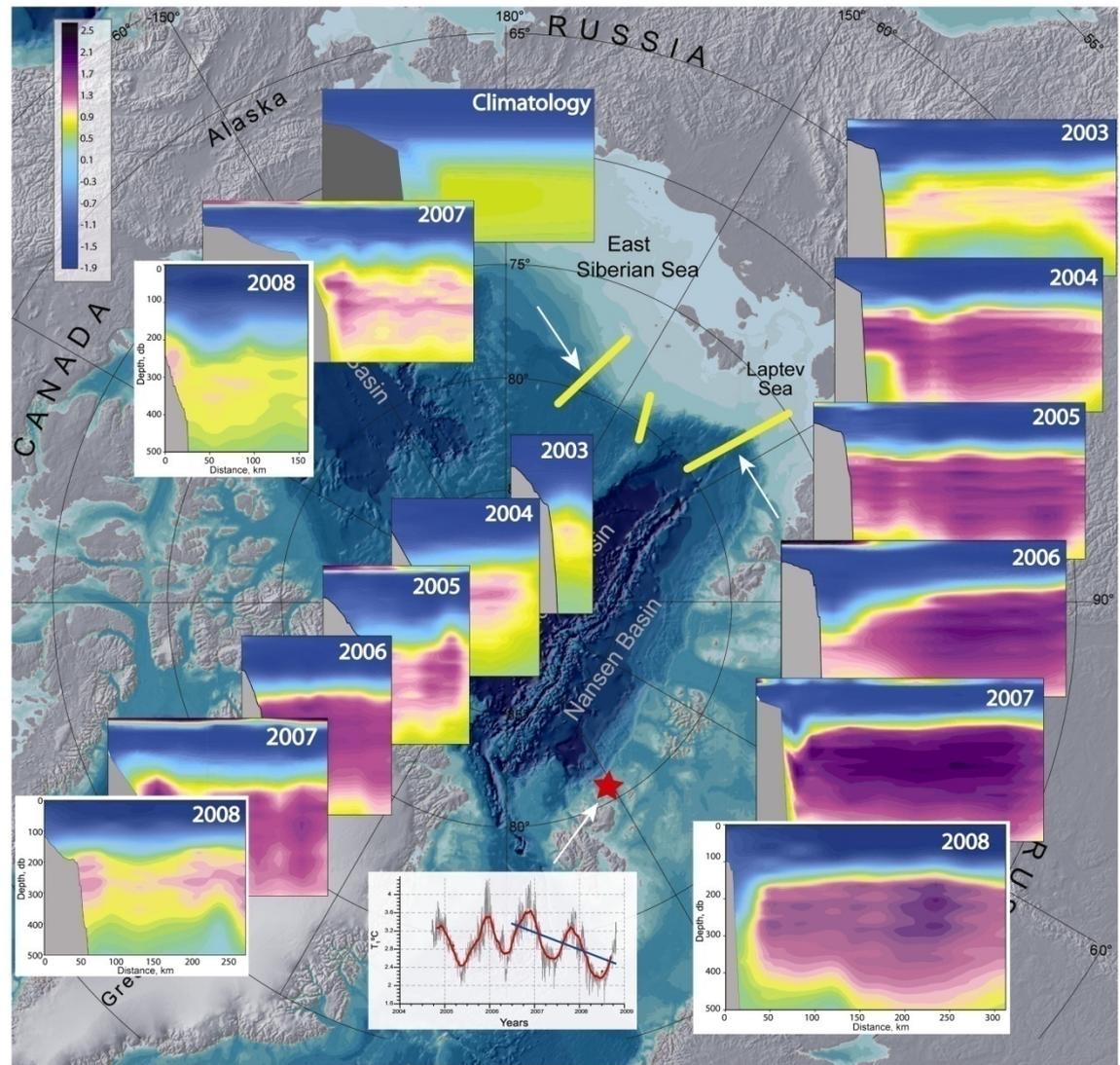
Climate development



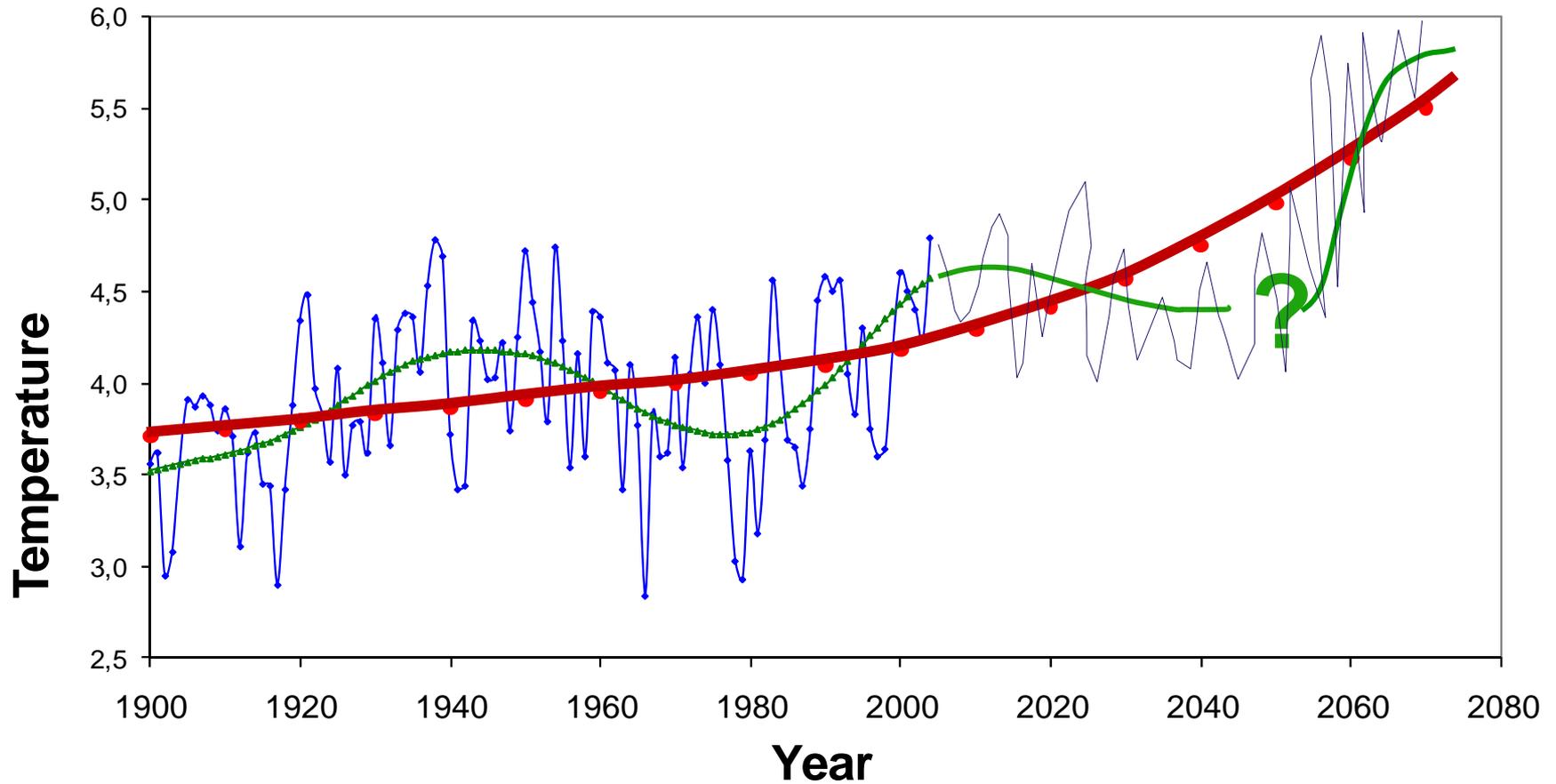
Arctic Climate System



Temperature development in the Arctic Ocean



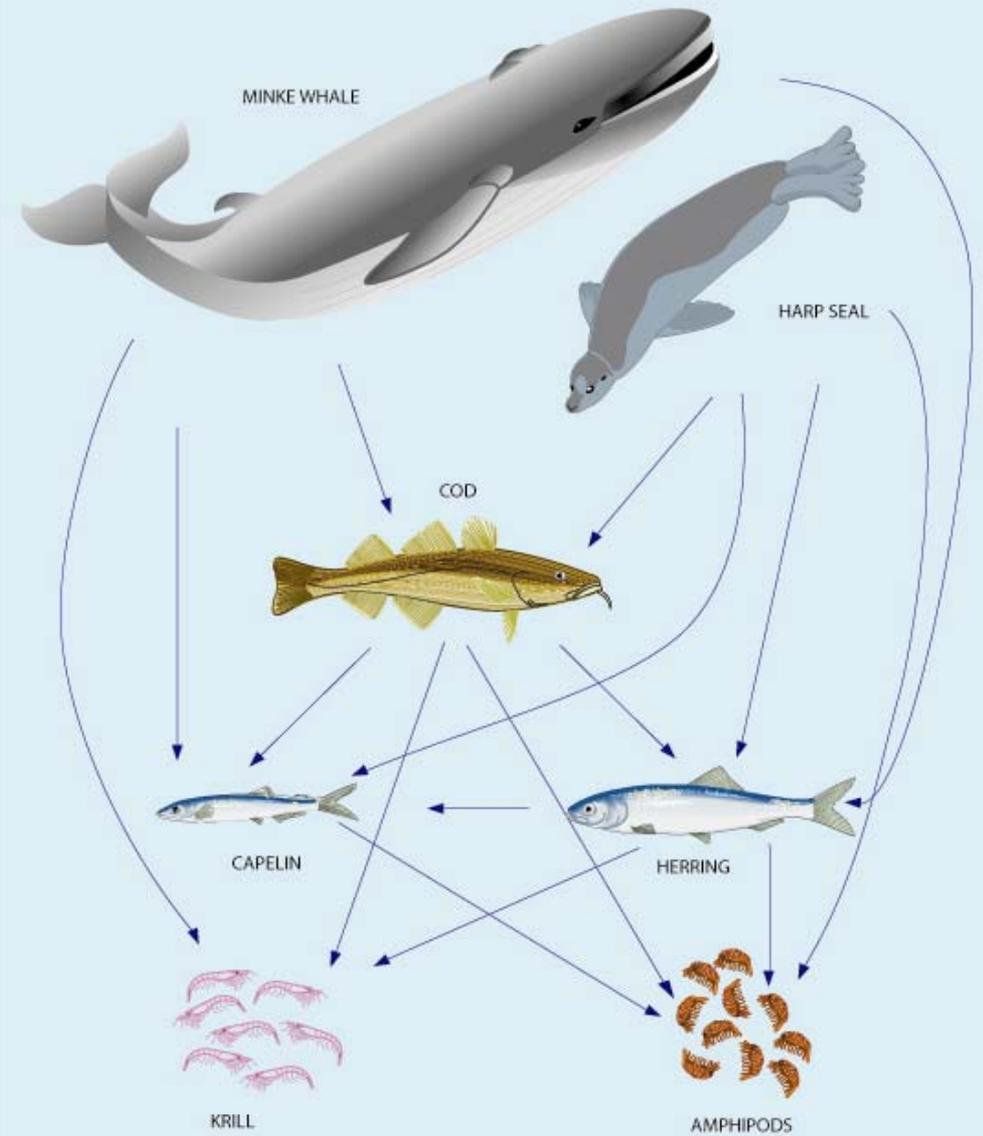
Possible temperature development

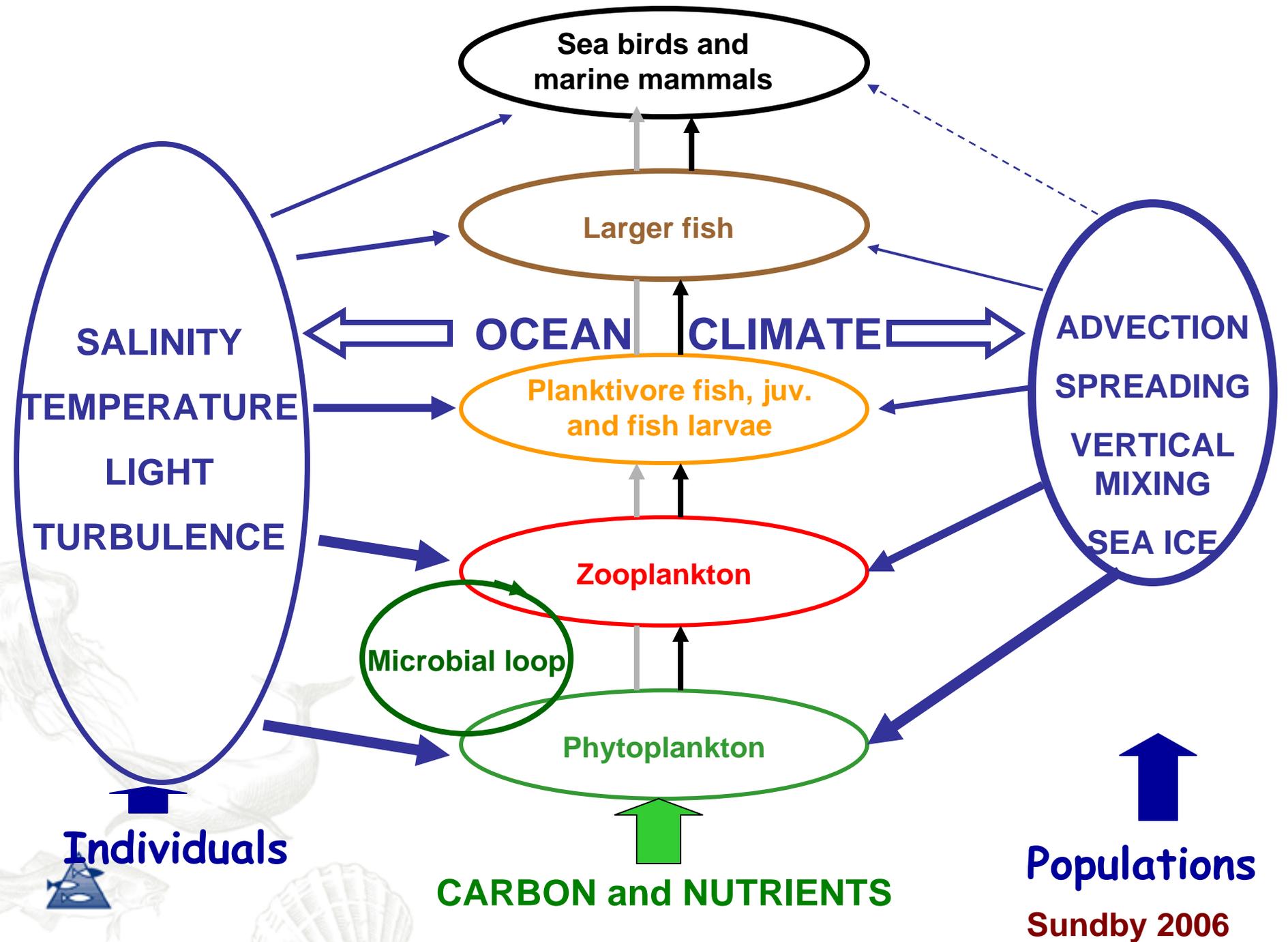


Climate impact on the marine ecosystems

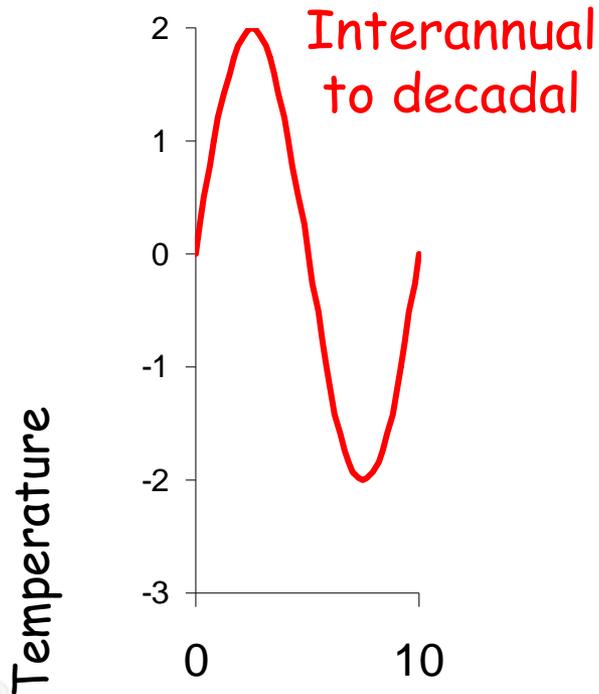


Example of interaction between species in an Arctic Ecosystem



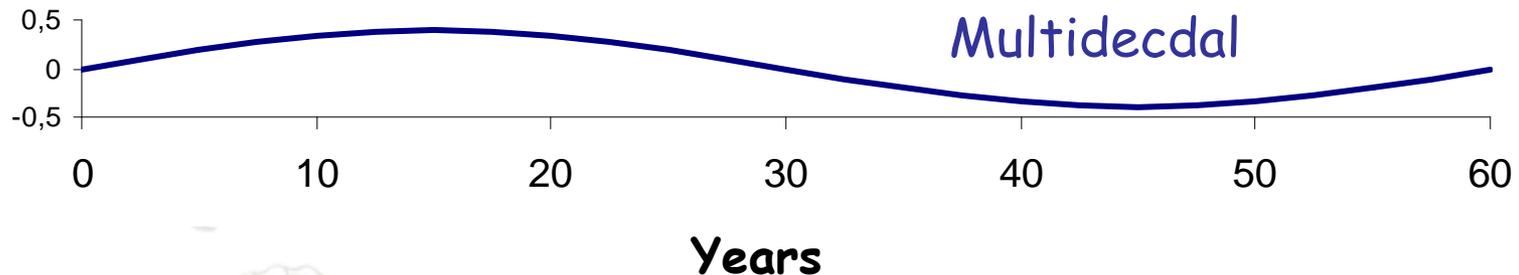


Climate effects on marine ecosystems vary with the periodicity



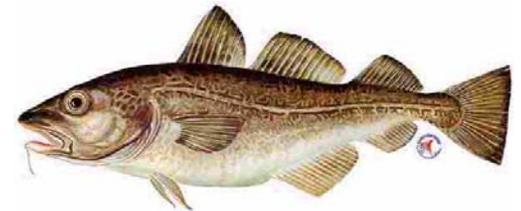
- Local production on lower trophic levels
- Fish recruitment and year-class strength

- Habitat extents of populations
- Production on higher trophic levels

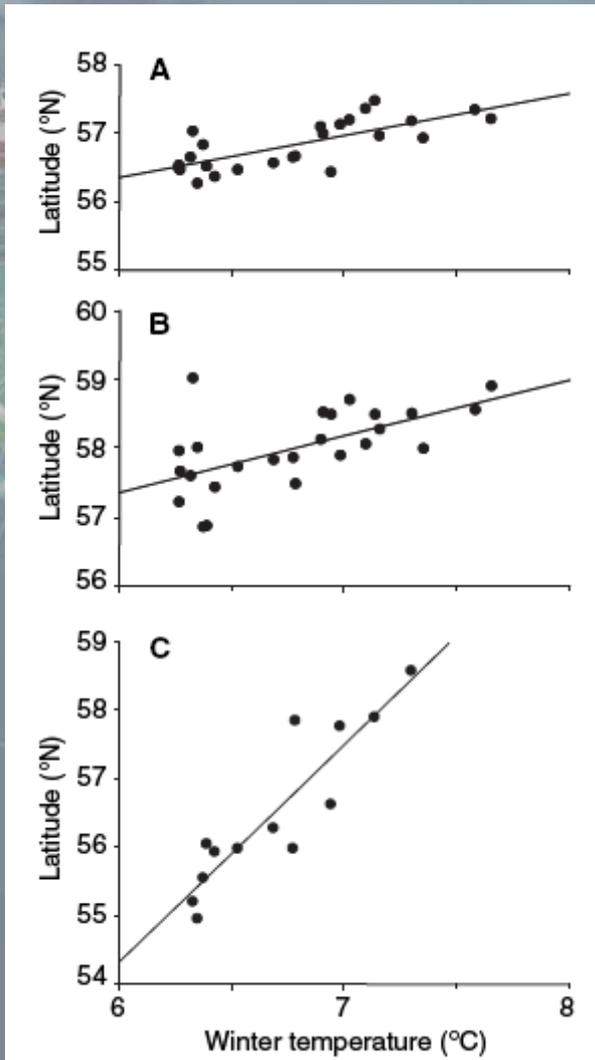


Climate impact on the ecosystem

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



Fish distributions shift toward the poles due to warmer sea temperatures



North Sea:

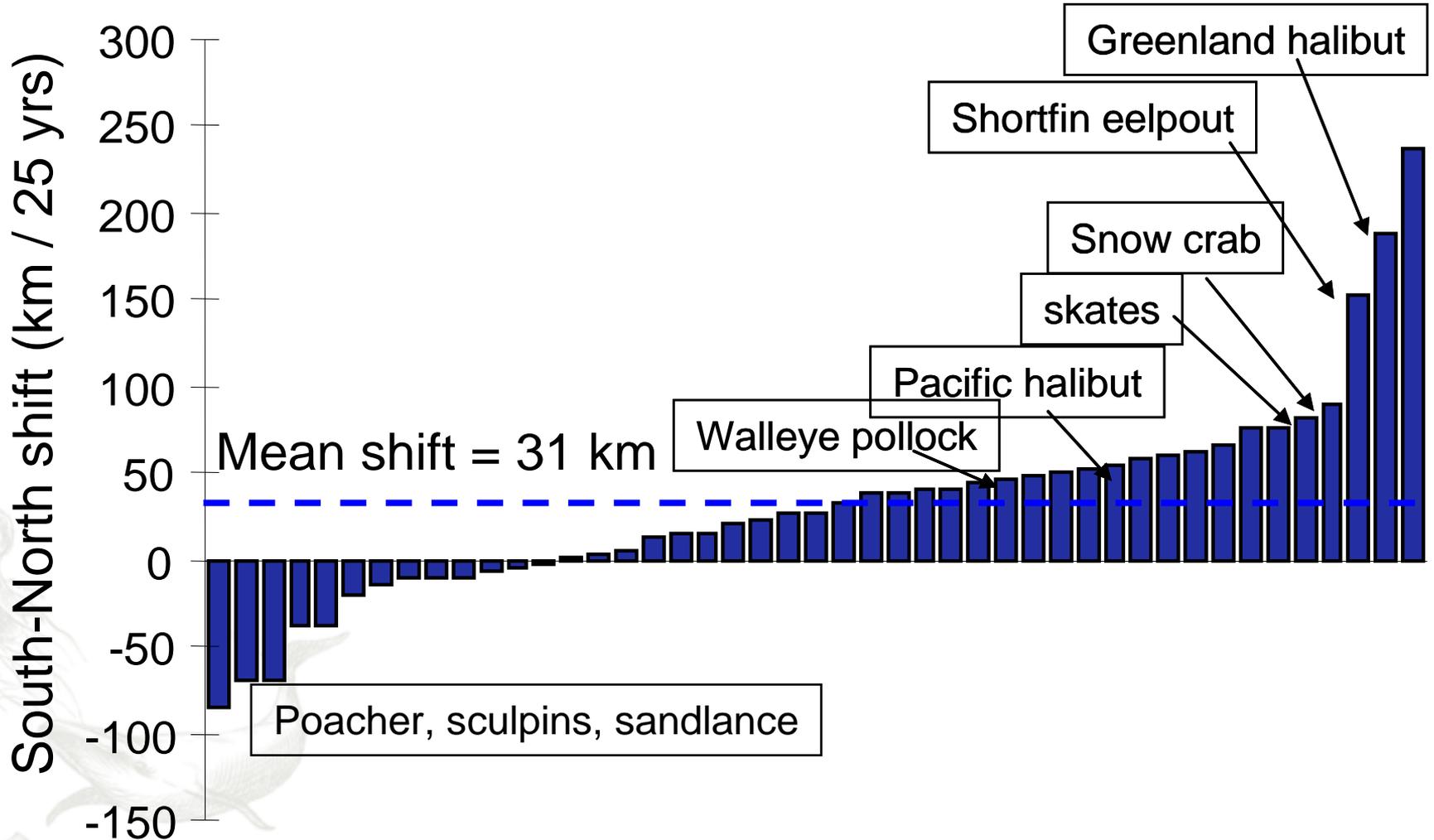
Mean latitude and winter sea temperature for

(a) cod

(b) anglerfish

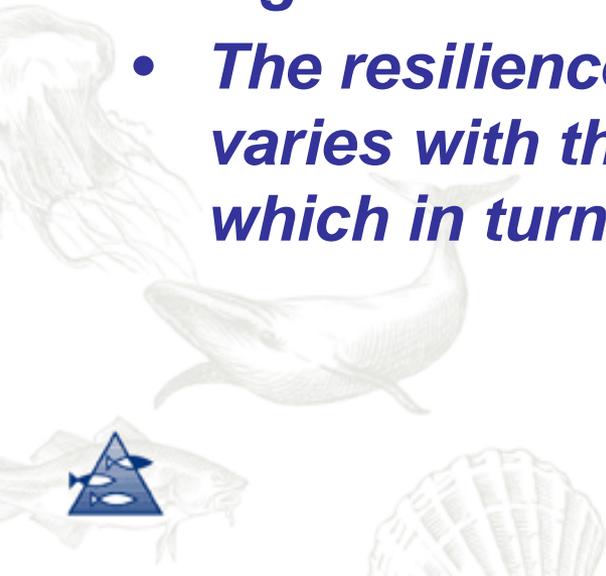
(c) snake blenny

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



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?**



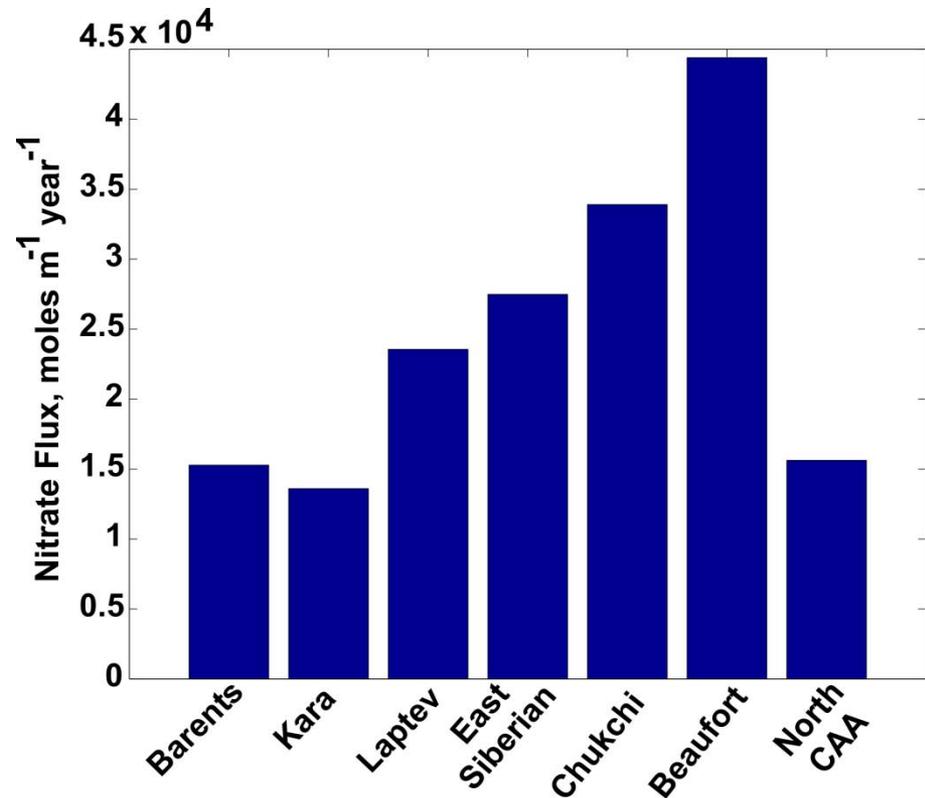
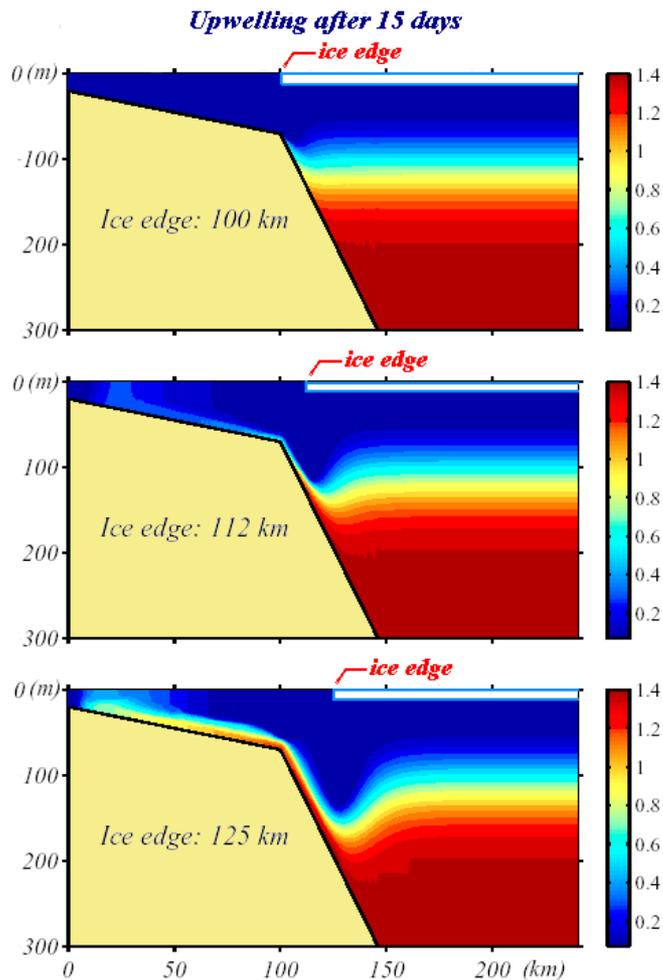


**Those who have knowledge,
don't predict.
Those who predict, don't have
knowledge.**

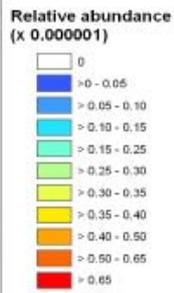
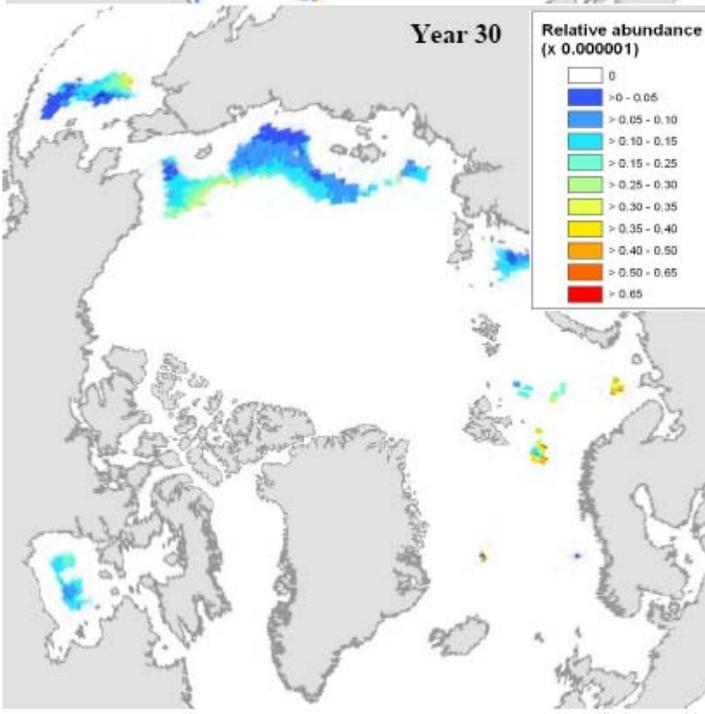
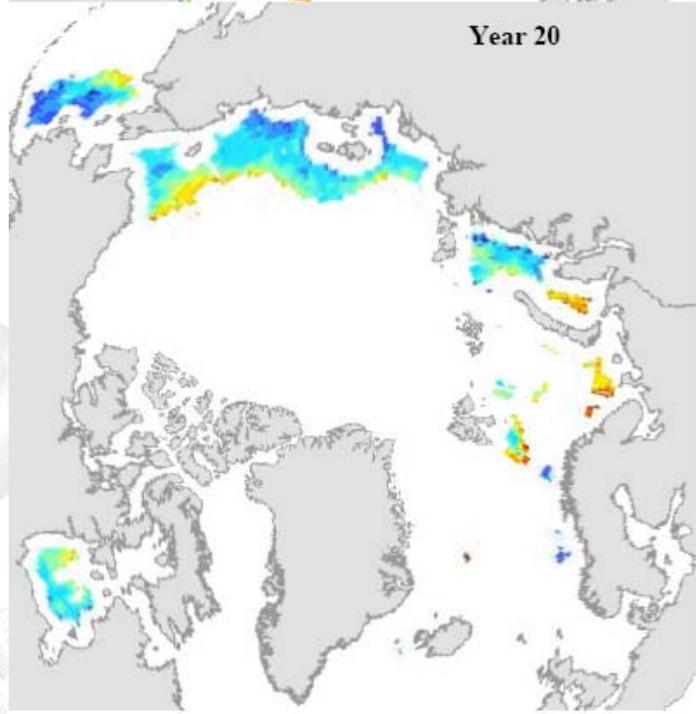
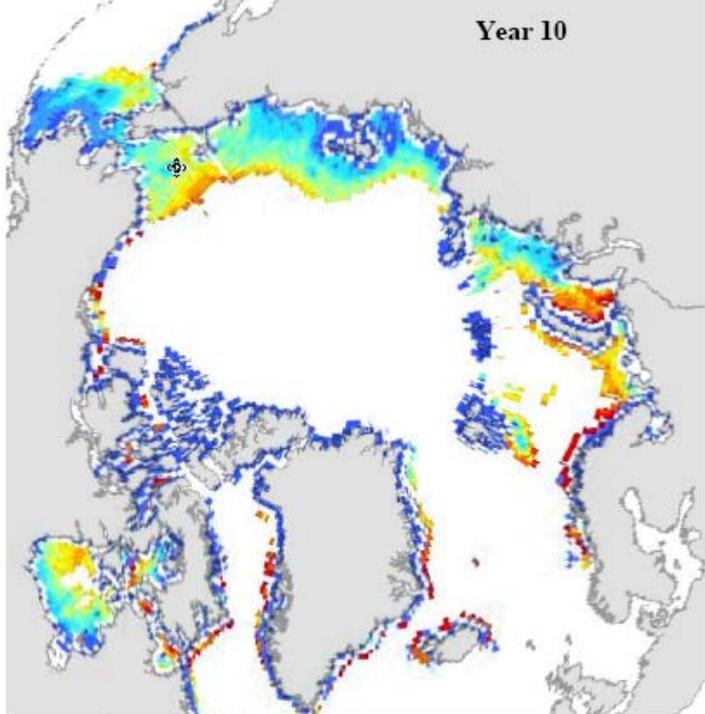
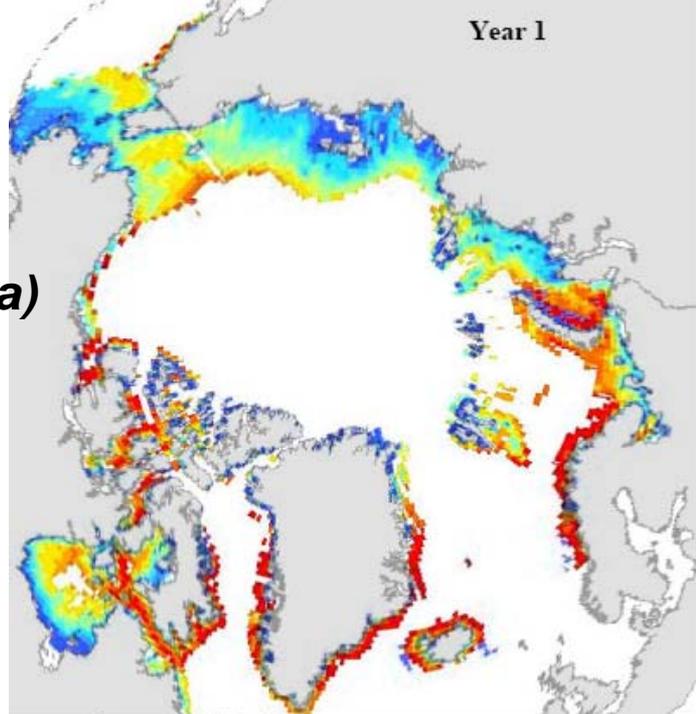
Lao Tzu, 6th Century BC Chinese Poet



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



Distribution of Polar cod (*Boreogadus saida*)

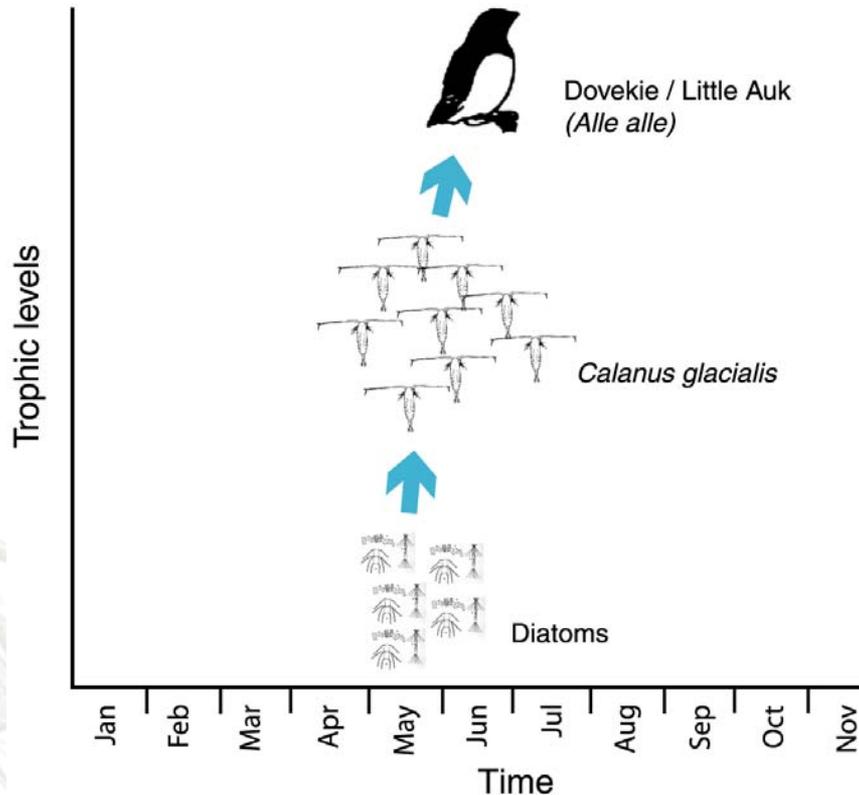


W. W. L. Cheung,
V. W.Y. Lam and
D. Pauly, 2008

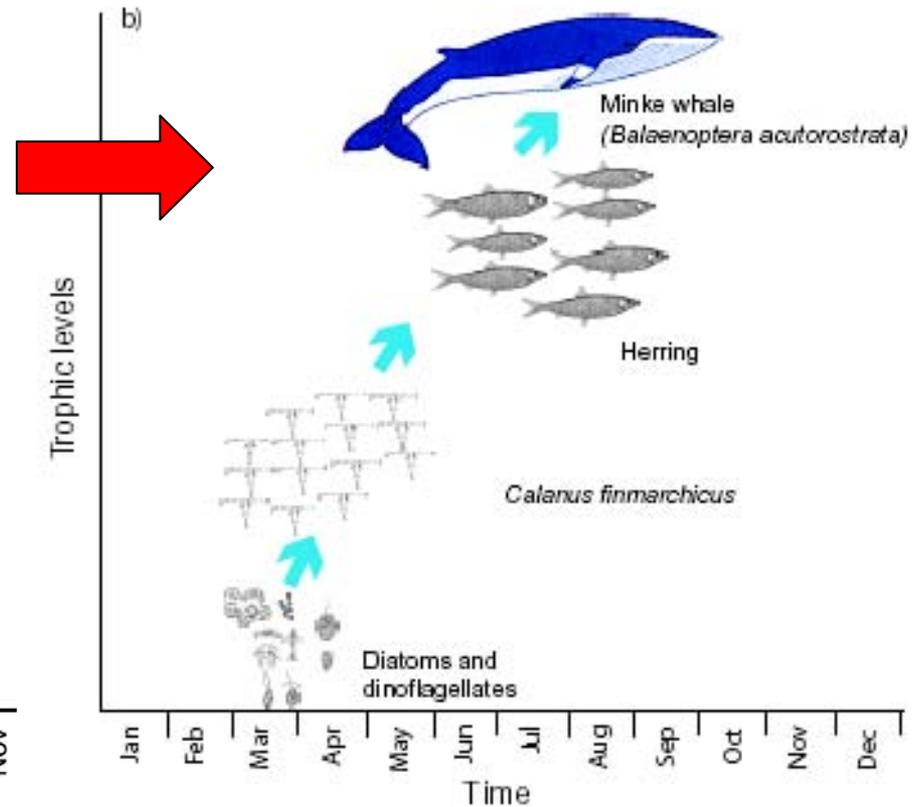


Changes in ecosystem function

Food web in Arctic water



Food web in Atlantic water

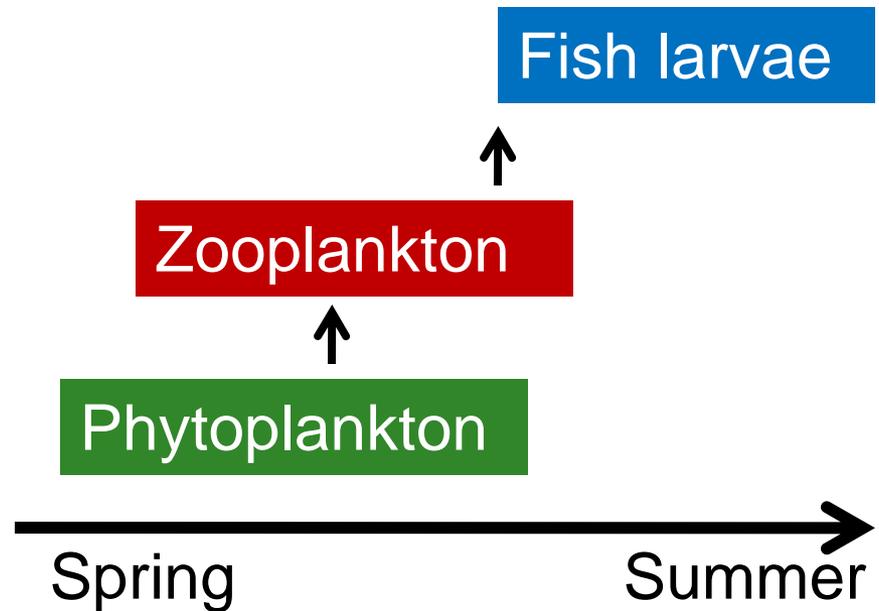


The food web changes may be far more dramatic for the higher compared to the lower trophic levels

Uncertainties

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

- *Consequences of “match/mismatch” between predator and prey*



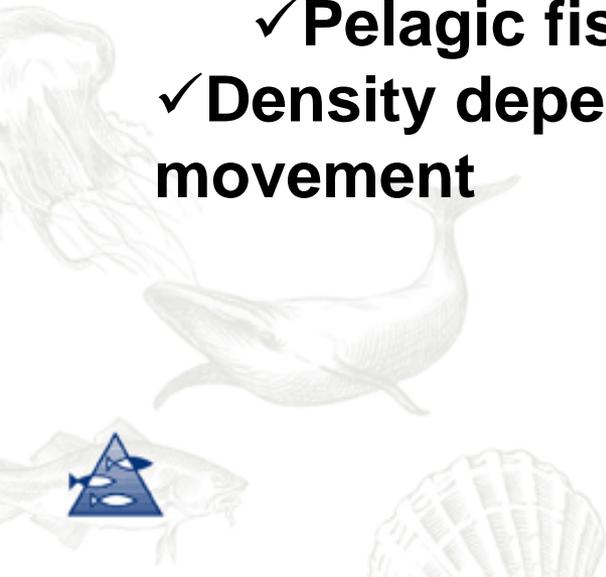
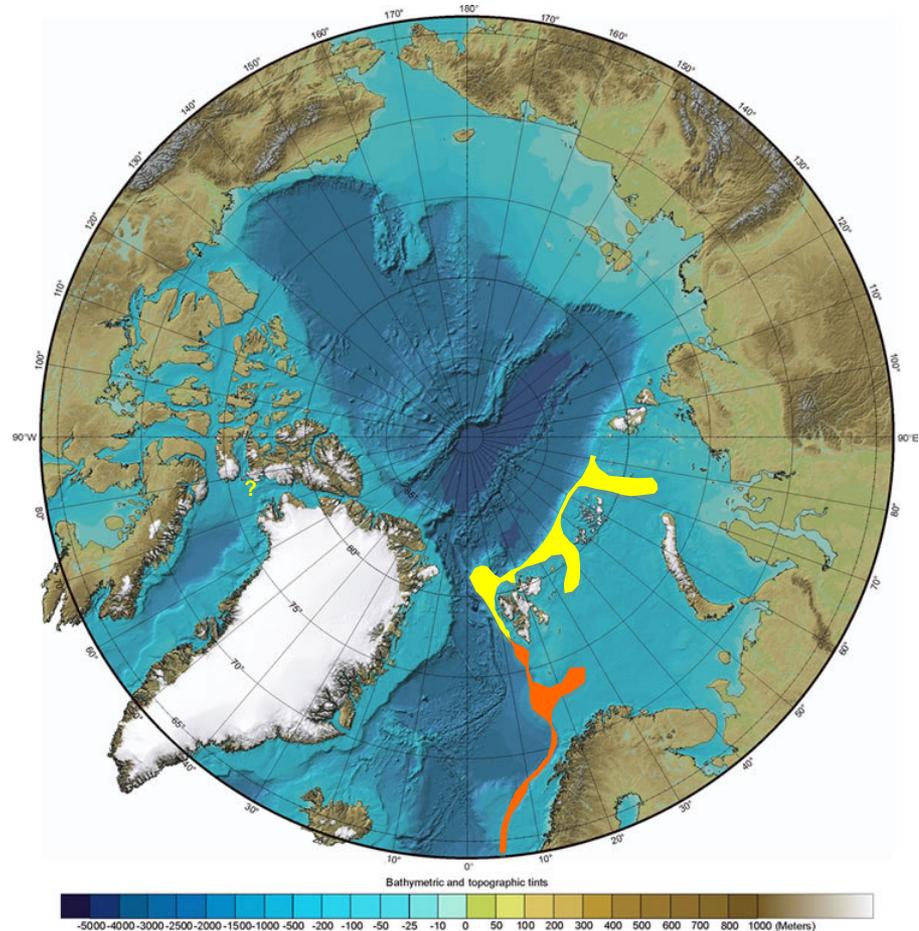
- *Competition when/if new species enter an ecosystem*



Different regimes

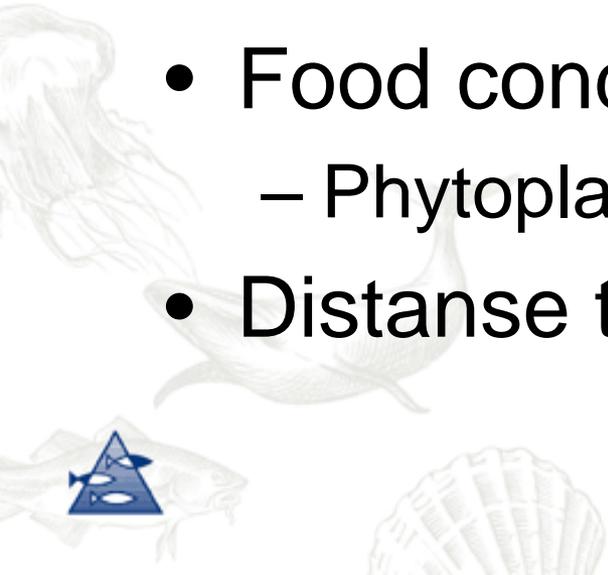
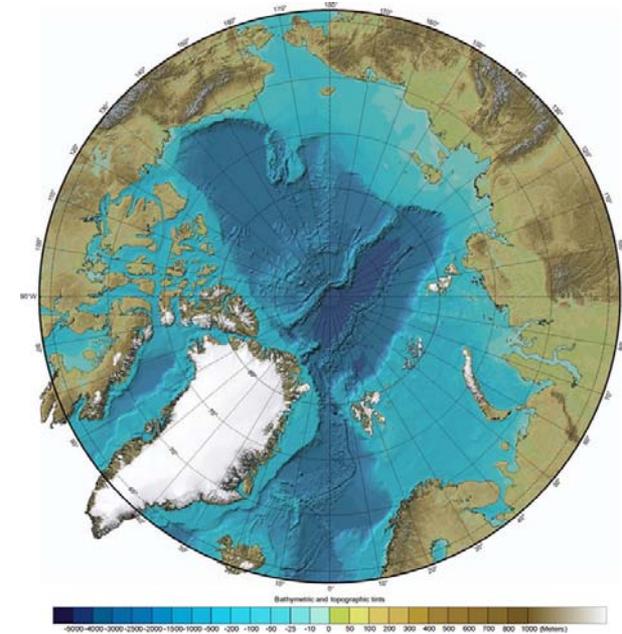
Impact on different ecosystems

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

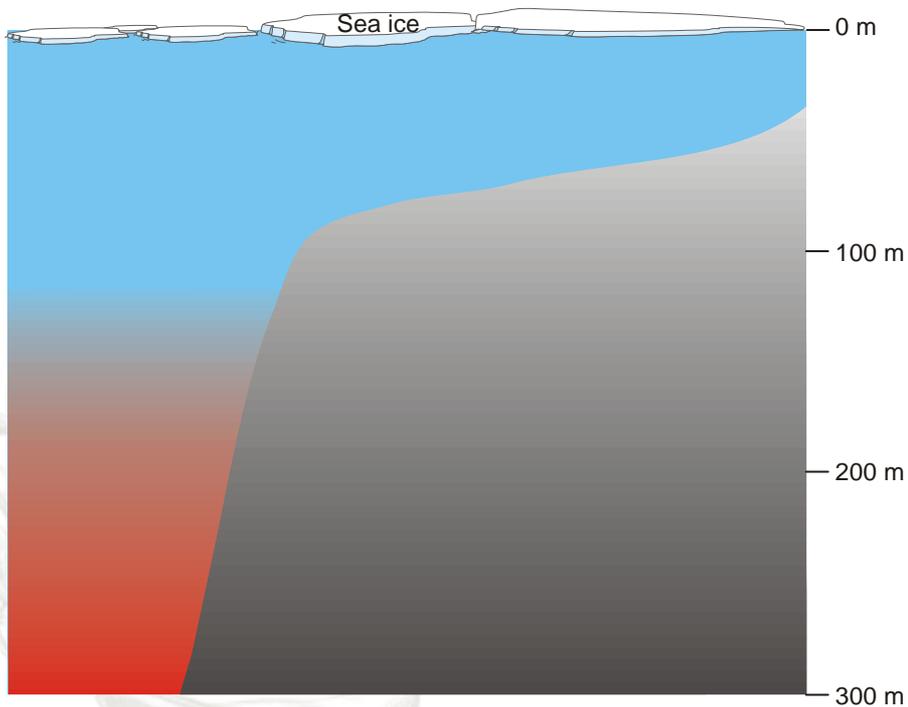


Criteria for establishing fish stocks in the Arctic Ocean

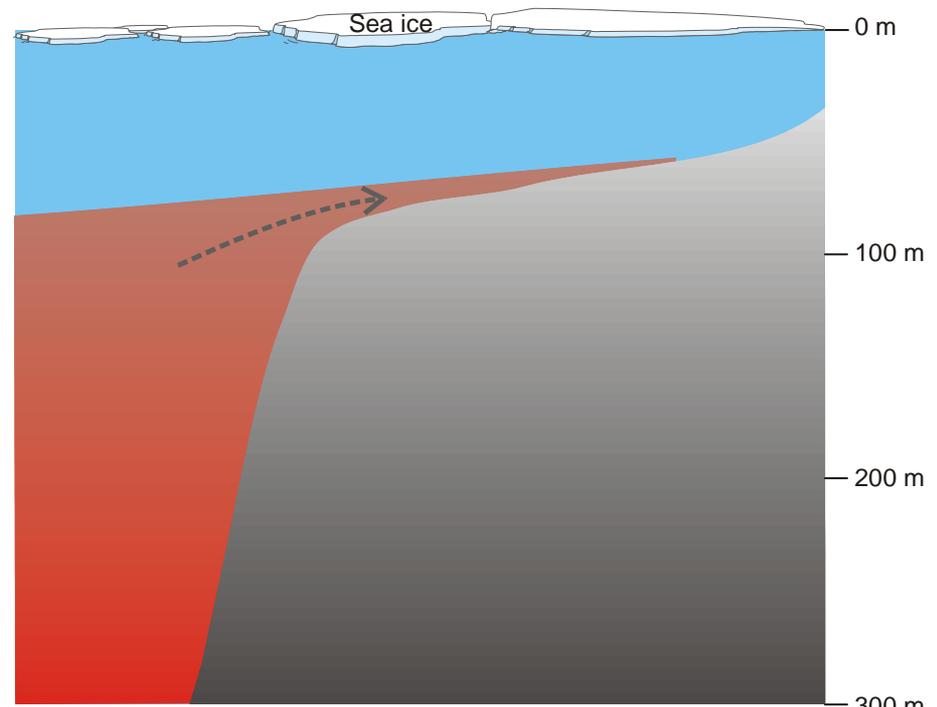
- Bottom topography
- Climatic conditions
 - Temperature and salinity
 - Sea ice distribution
- Food conditions
 - Phytoplankton and zooplankton
- Distance to spawning grounds



Atlantic water in the Arctic Ocean



To day



In the future??



From observation to commercial fishing

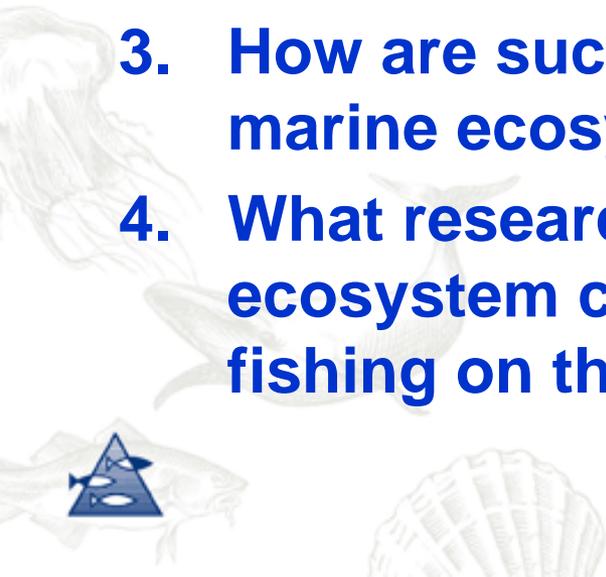
- There is a long way from observations of a few specimens to commercial fishing





Scientific perspectives on climate change and Arctic fisheries

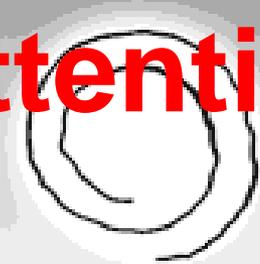
1. How will productivity of Arctic ecosystems change?
2. What species are most likely to migrate successfully to the Arctic to establish self-sustaining populations?
3. How are successful migrations likely to alter Arctic marine ecosystems?
4. What research is needed to understand these ecosystem changes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



Warming trend slowly alters Arctic way of life

Small text block containing the beginning of an article, mentioning 'Warming trend' and 'Arctic way of life'.

Thank you for paying attention



6-3-05 PHILADELPHIA MORNING NEWS, UNIVERSAL PRESS SYNDICATE.

