The status of living marine resources in relation to climate

Harald Loeng
Outline

• Climate development
• Climate impact on marine ecosystems
• What do we expect in the future
Fishing Intensity

Arctic commercial fishing is regionally concentrated
Climate development
Arctic Climate System

- Warm surface waters
- Cold Arctic waters
- Cold deep waters
- River runoff

100 Gt/year = 0.3 mm/yr
Temperature development in the Arctic Ocean
Possible temperature development
Climate impact on the marine ecosystems
Example of interaction between species in an Arctic Ecosystem
Phytoplankton

Zooplankton

Planktivore fish, juv. and fish larvae

Larger fish

Sea birds and marine mammals

SALINITY TEMPERATURE LIGHT TURBULENCE

OCEAN CLIMATE

ADVECTION SPREADING VERTICAL MIXING SEA ICE

Microbial loop

Phytoplankton

Zooplankton

Individuals

Populations

CARBON and NUTRIENTS

Sundby 2006
Climate effects on marine ecosystems vary with the periodicity

- Interannual to decadal
  - Local production on lower trophic levels
  - Fish recruitment and year-class strength
  - Habitat extents of populations
  - Production on higher trophic levels

- Multidecadal
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

Mean shift = 31 km

South-North shift (km / 25 yrs)

Greenland halibut
Shortfin eelpout
Snow crab
skates
Pacific halibut
Walleye pollock
Poacher, sculpins, sandlance

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)*

Changes in ecosystem function

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
• Distance 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?
Thank you for paying attention