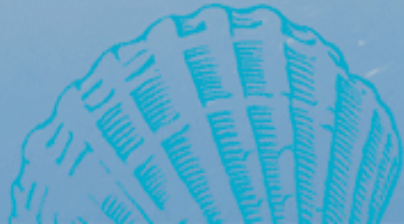
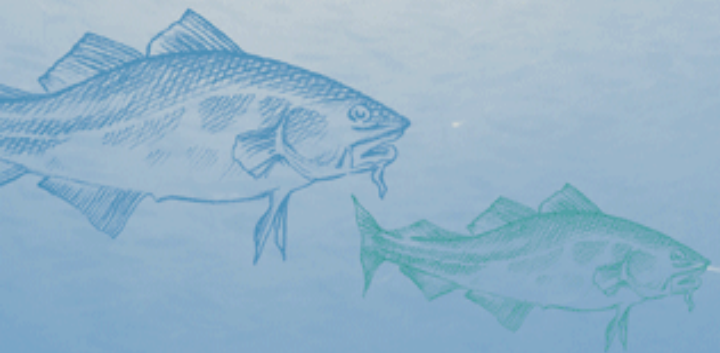




HAVFORSKINGSINSTITUTTET
INSTITUTE OF MARINE RESEARCH



Biodiversity of and changes related to harvestable fish resources

Invited talk, Arctic Frontiers
2010

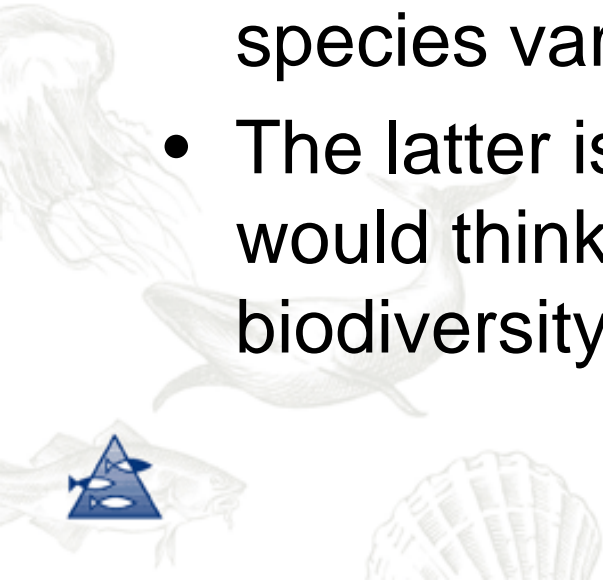
Part III Biodiversity under
change

Harald Gjøsæter



What is biodiversity?

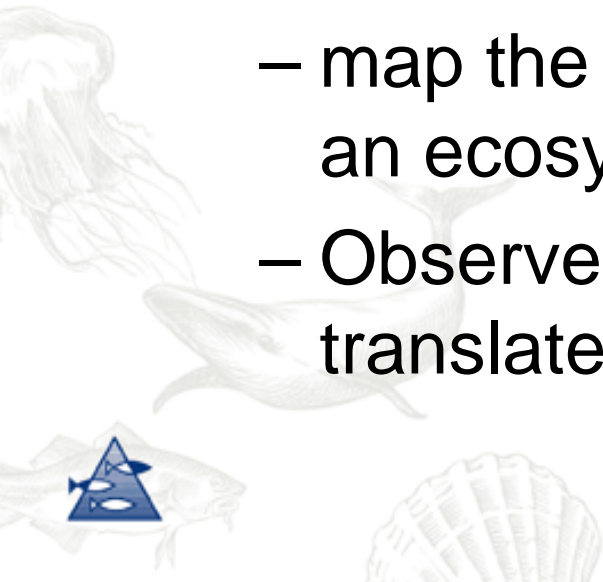
- “The diversity of life on earth, consisting of genetic diversity, species diversity and ecosystem diversity” (Nelson education)
- Several, similar definitions exist
- Most definitions take account of both within-species (genetic) variation and among-species variation
- The latter is probably what most people would think of when they hear or use the term biodiversity





Can it be measured, if so - how?

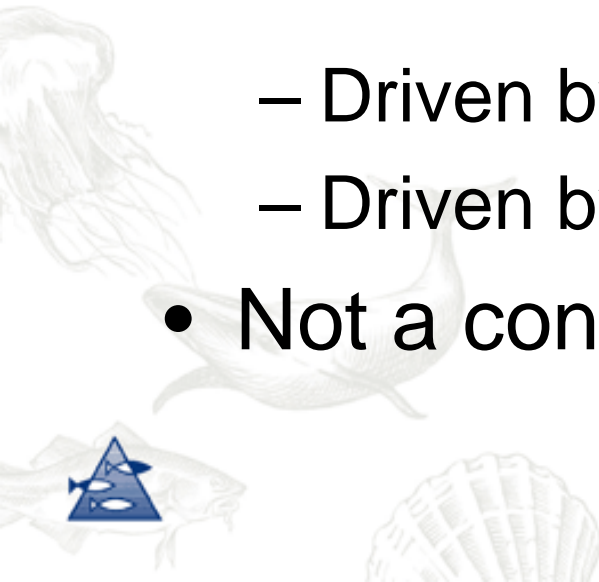
- Species diversity or “richness”:
 - count the number of species within a geographic area
 - Several diversity indices etc statistics exist
- Genetic diversity:
 - map the genome of the various species in an ecosystem or
 - Observe how changes in genotypes translates into changes in phenotypes





Not a constant characteristic

- Biodiversity changes
 - Over time
 - Long-term changes (no dinosaurs nowadays)
 - Short-term fluctuations
 - Between areas
 - Driven by environmental factors
 - Driven by anthropogenic factors
- Not a constant property of an ecosystem





Difficult to monitor

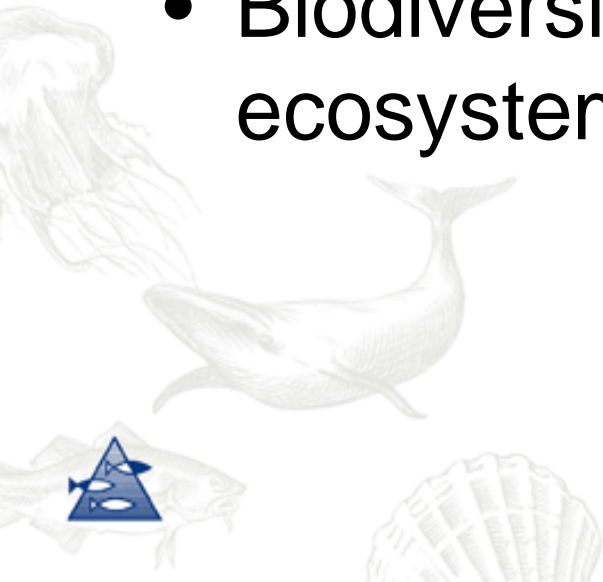
- Biodiversity changes are difficult to measure and to oversee
 - Because the present biodiversity is only partly known, and the past biodiversity is hardly known at all
 - This is true for species diversity but even more true for genetic diversity within species





Reversible - irreversible

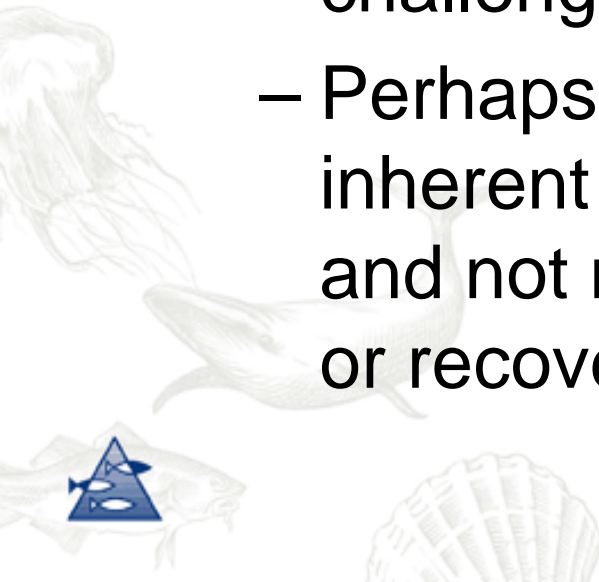
- Biodiversity changes on a global scale are irreversible, since this implies species extinction (on the species level) or loss of genetic information (on the genetic level)
- Biodiversity changes on a local scale or ecosystem scale are reversible





Indicator of health

- Biodiversity is used as a an indicator of ecosystem health: when the biodiversity is high the ecosystem is healthy, if it is low the ecosystem is unhealthy
 - But the usefulness of this practice may be challenged
 - Perhaps a changing biodiversity is an inherent quality of all natural ecosystems, and not necessarily a sign of degradation or recovery?





Biodiversity of fish

- Numerous papers in high-profile scientific journals in recent years claim that the biodiversity of harvested fish populations are degraded over the years, and that the harvesting is the main reason for these changes





Effects of harvesting

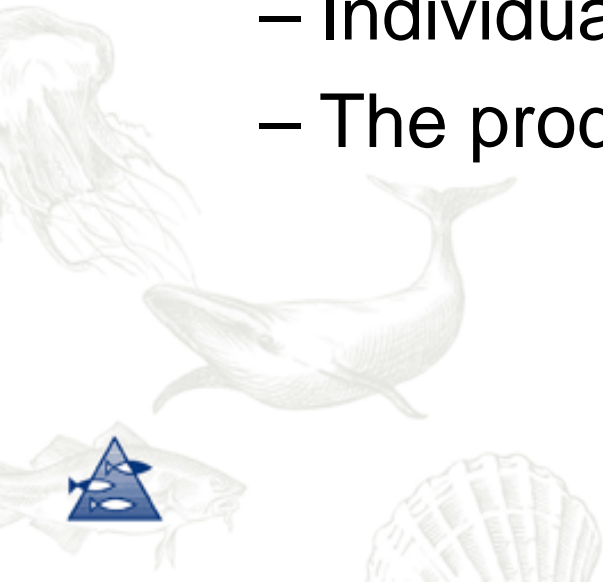
- Harvesting from an ecosystem inevitably changes the ecosystem in various ways
- This is true whether the harvesting is done in a sustainable manner or not





Effects of harvesting

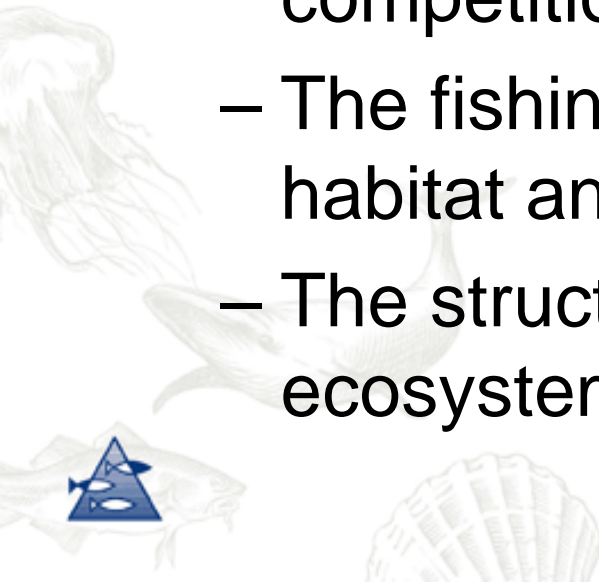
- The fish stock being harvested will undergo changes
 - The stock size will be reduced
 - Mean size and mean age will be reduced
 - The natural mortality will be reduced
 - Individual growth will increase
 - The production will increase





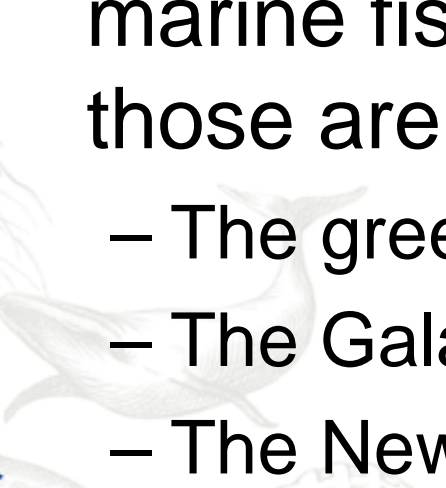
Effects of harvesting

- The ecosystem the stock is a part of will also undergo changes
 - Prey species might get lower natural mortality
 - Predator species might get less food
 - Stocks at the same trophic level might get less competition
 - The fishing operation might affect bottom habitat and un-commercial bycatch species
 - The structure and functioning of the ecosystem might be changed





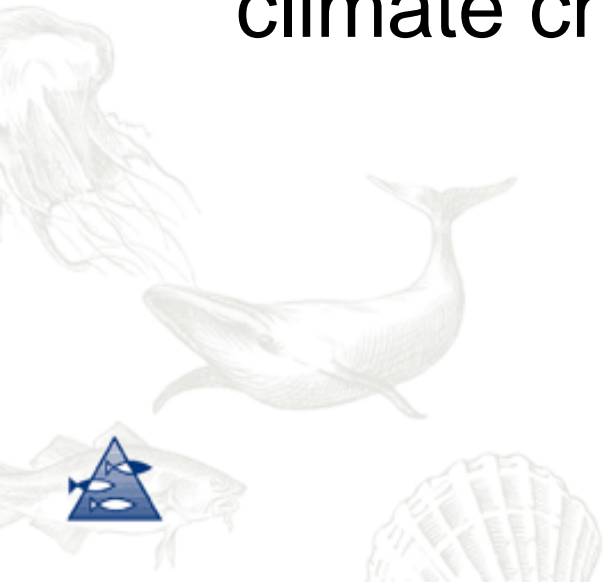
Fish extinction

- Despite the 1,550,000 hits on a google-search with the keywords “marine fish” and “extinction” there are few examples of extinction of marine fish
 - Dulvey et al 2003, list 53 species of marine fish as extinct, but only 3 of those are extinct on a global scale:
 - The green wrasse (Mauritius)
 - The Galapagos damsel
 - The New Zealand greyling
- 



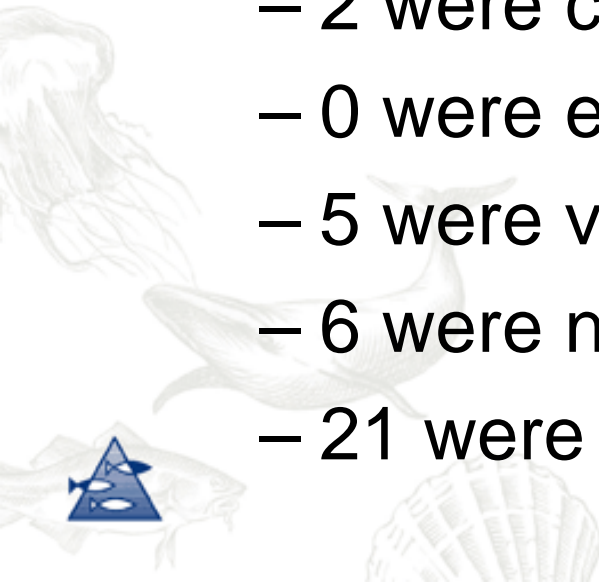
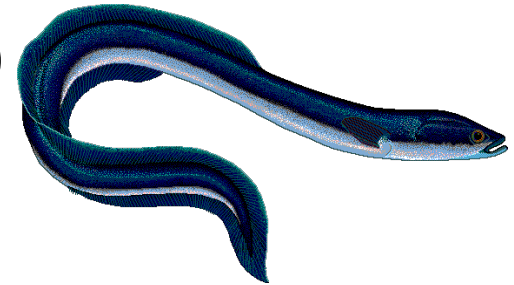
Extinct marine fishes

- For the local extinct species, Dulvey et al. 2003 claim that about 55% were due to exploitation, and 37% to habitat loss/degradation.
- Other causes included invasive species, climate change, pollution, and disease



Extinct species in the Arctic?

- The Norwegian Biodiversity Information Centre NBIC in 2006 published a red list of endangered species, based on IUCN-criteria. Of marine fish:
 - 0 species were regionally extinct (re)
 - 2 were critically endangered (cr)
 - 0 were endangered (en)
 - 5 were vulnerable (vu)
 - 6 were near threatened (nt)
 - 21 were “data deficient species” (dd)



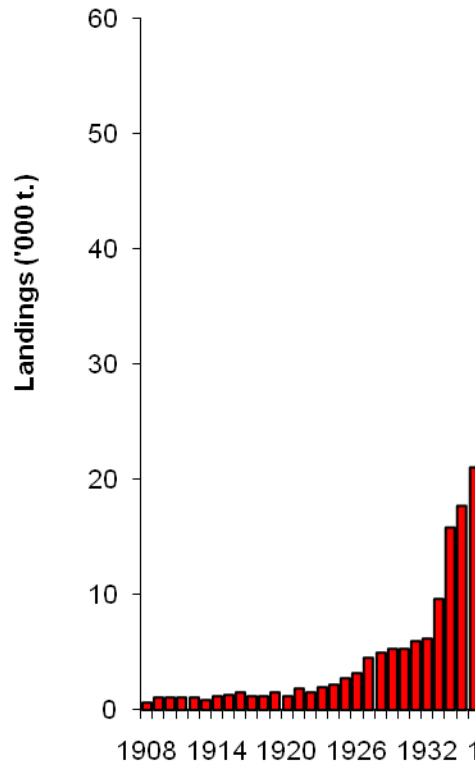
Red-list species in the Barents

- Two of the vulnerable species are found in the Barents and Norwegian Seas, the deep-sea or golden redfish (*Sebastes marinus*) and the beaked redfish (*Sebastes mentella*)
- Both species has been commercially exploited for a long period, and overexploitation was probably a major reason for the stock decline

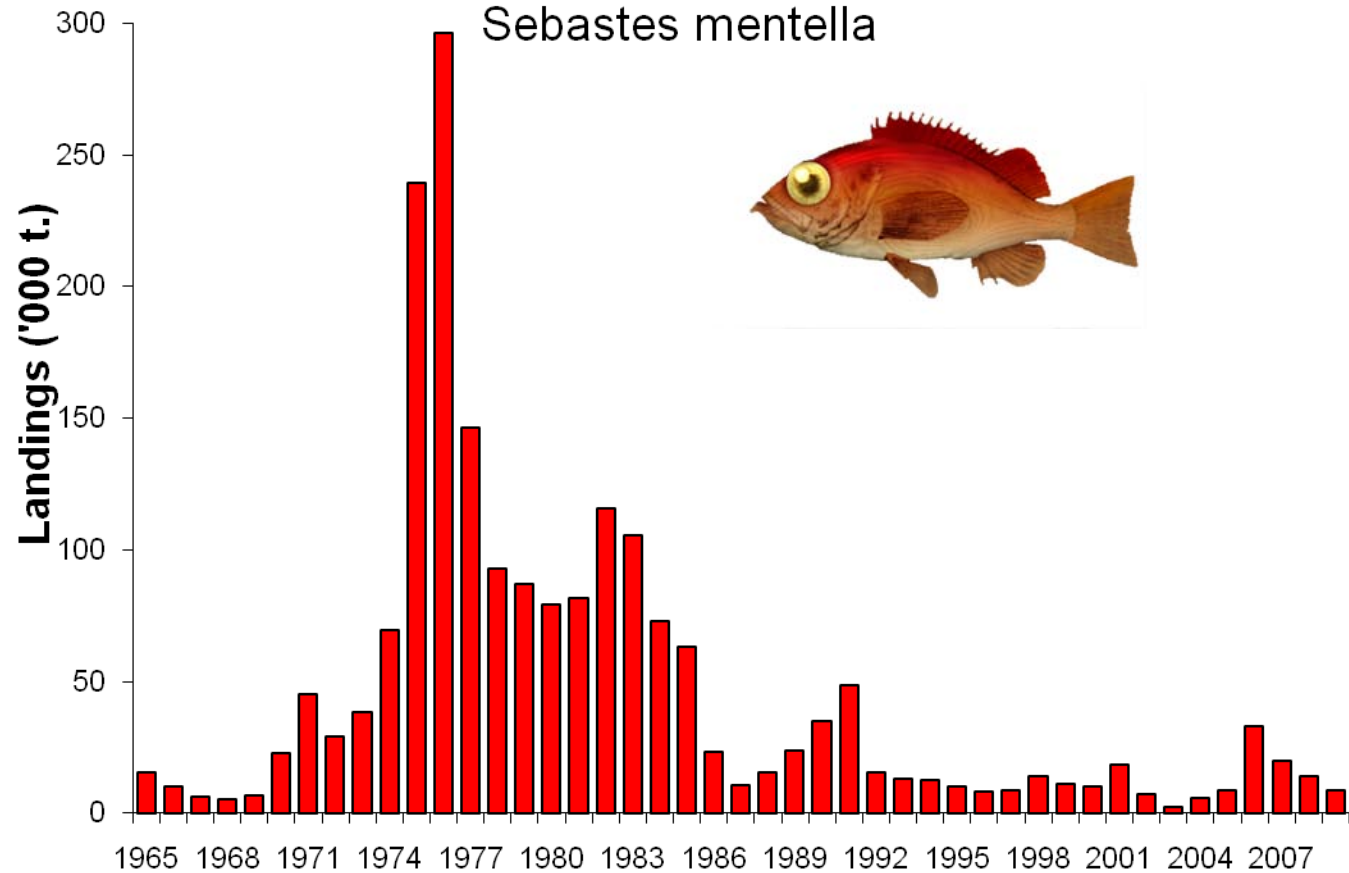




Sebastes marinus



Sebastes mentella





Within-species diversity

- Harvesting affects the species
 - Age/length at maturity
 - Selection pressure towards early maturation
 - Behavior
 - Selection pressure to avoid gears used
 - Size
 - Large individuals removed
 - Growth
 - Less competition – higher growth





Within-species diversity

- Controversy: phenotypic plasticity vs irreversible genetic change (so called evolution)
 - Some claim that the observed changes are genetic and irreversible
 - Others that they are genetic but reversible
 - And some claim that the rate of genetic change is so slow that it is in either case negligible compared to phenotypic plasticity





Within-species diversity

- Whatever the reason for the observed changes, are they harmful to the stock and should be avoided?
 - Positive effects
 - Increased individual growth and production
 - Negative effects
 - Parental effects on offspring survival: young, small parents – low survival of eggs and larvae
 - Changes in trophic structure
 - Lower utilization of original food base





Summing up

- Both inter- and intra-specific biodiversity
- Varies in the wild, but may be amplified by anthropogenic effects
- No examples of extinction of commercially exploited fish species in the Arctic, but some are vulnerable and need protection
- All exploited species undergo changes that involves loss of intraspecific variation





Thank you for your attention