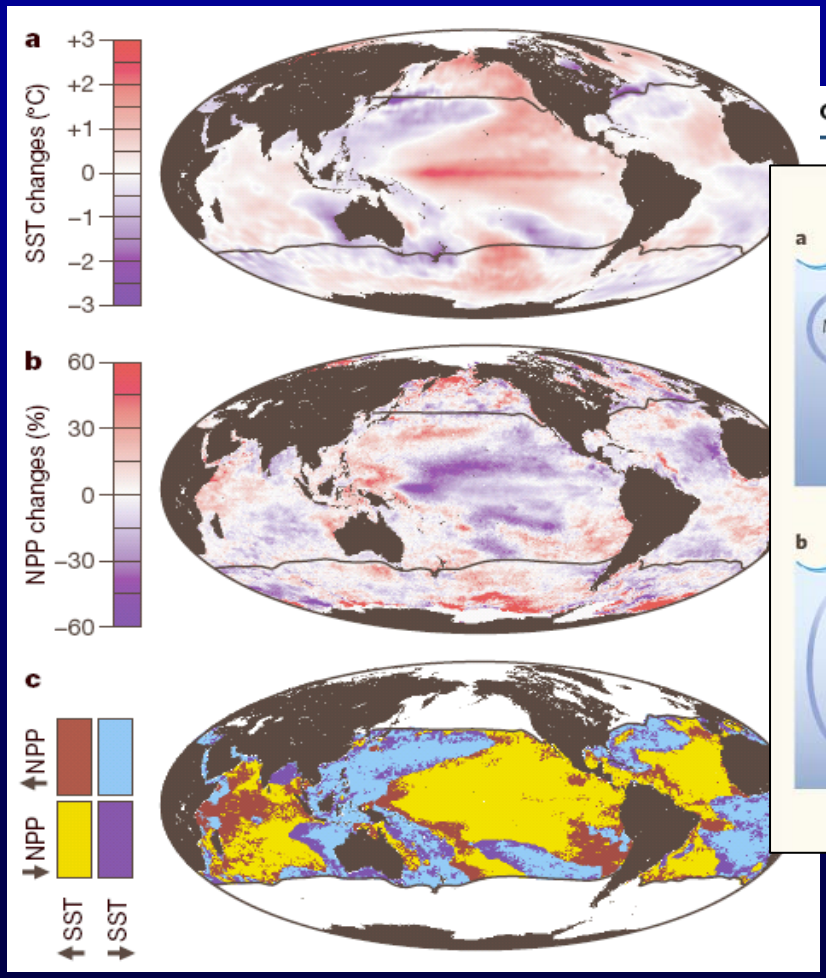
Climate change impacts – climate/fishing interactions

- **The overarching aim of the BASIN initiative is to understand and simulate the population structure and dynamics of broadly distributed and trophically and biogeochemically important plankton and fish species in the North Atlantic ocean to resolve the impacts of climate variability on marine ecosystems, and thereby contribute to ocean management.**

- Fish
- Basin scale issues
- Production
- Biogeography
- Life-cycle closure
- Fishing interference with climate
- Implications for Ecosystem Based Management

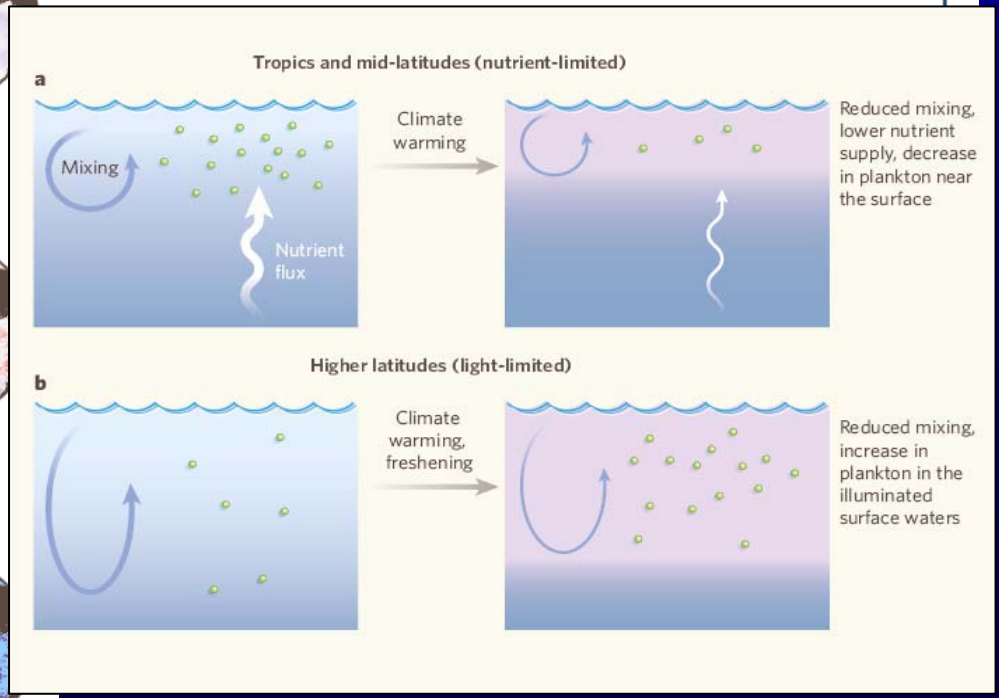
Basin meeting – Hamburg, Germany – 23-25 January 2007

Production



Behrenfeld et al. (2006) Climate-driven trends in contemporary ocean productivity *Nature* **444:** 752-755.

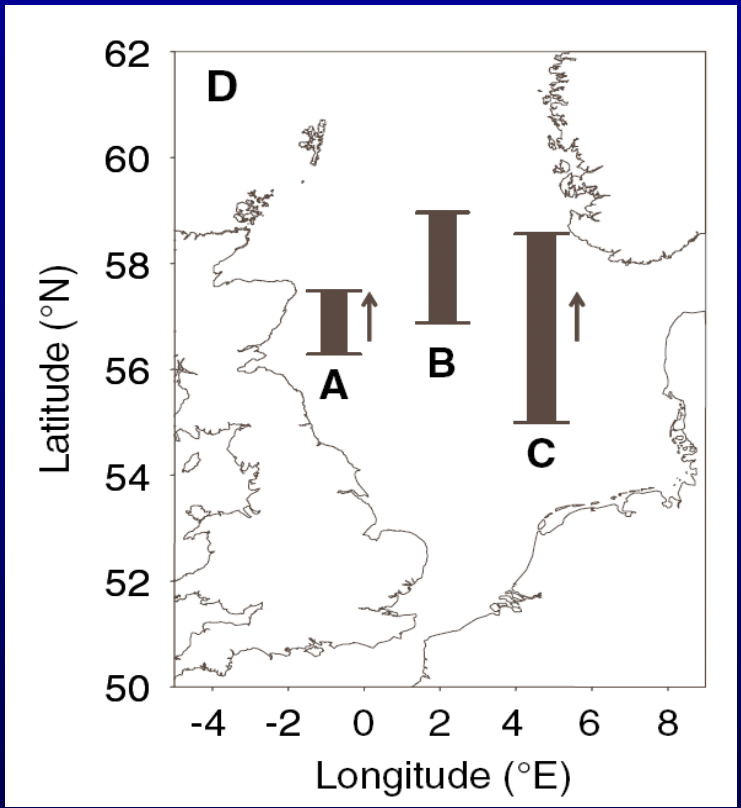
on: principal marine fishing areas in 2002



Dooney (2006) Plankton in a warmer world. *Nature* **444:** 695-696.

FAO (2004) The state of world fisheries and aquaculture (SOFIA) 2004 FAO Fisheries Department Rome. 153

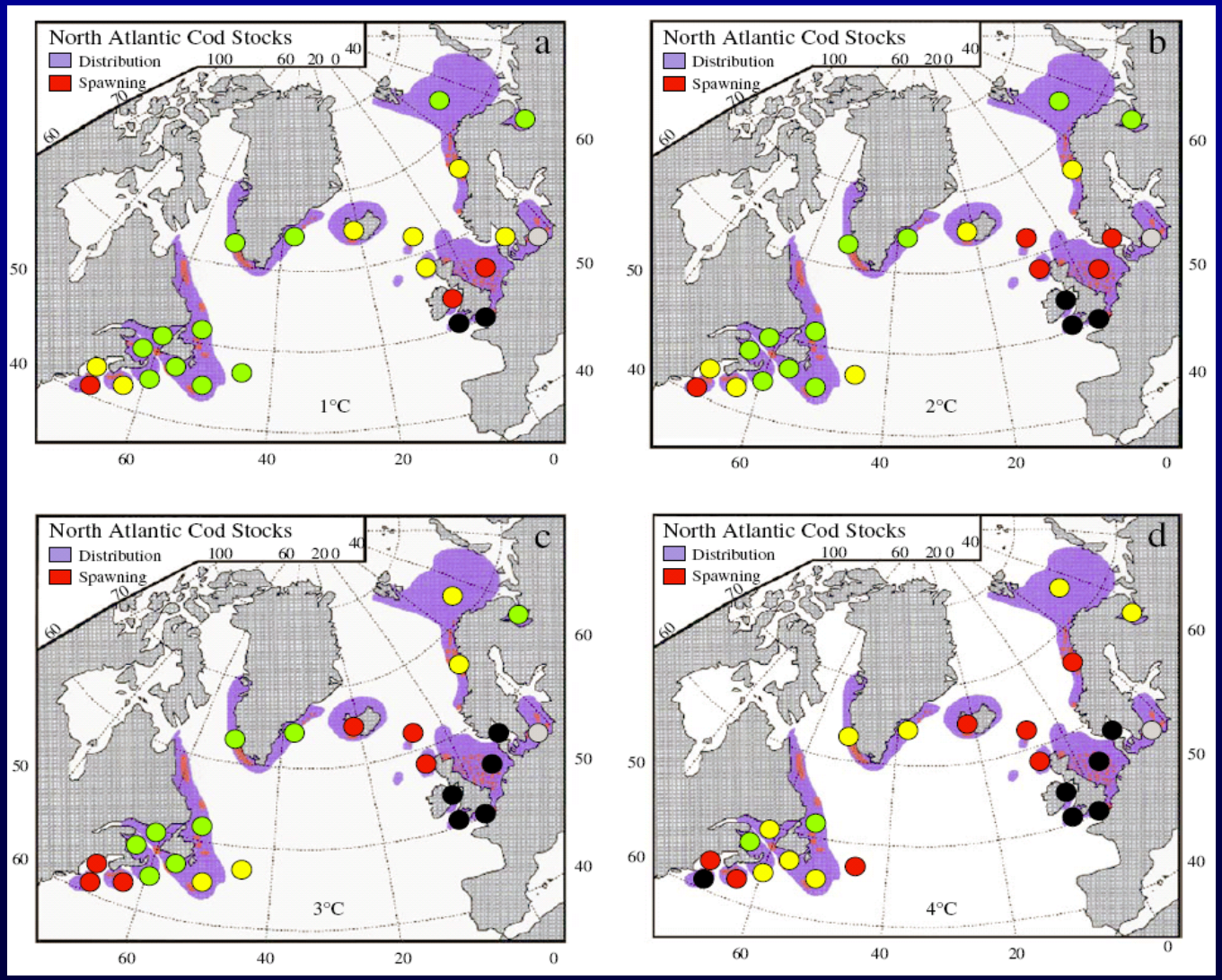
Biogeography



Perry et al (2005) Climate change and distribution shifts in marine species. *Science* **308:** 1912-1915.

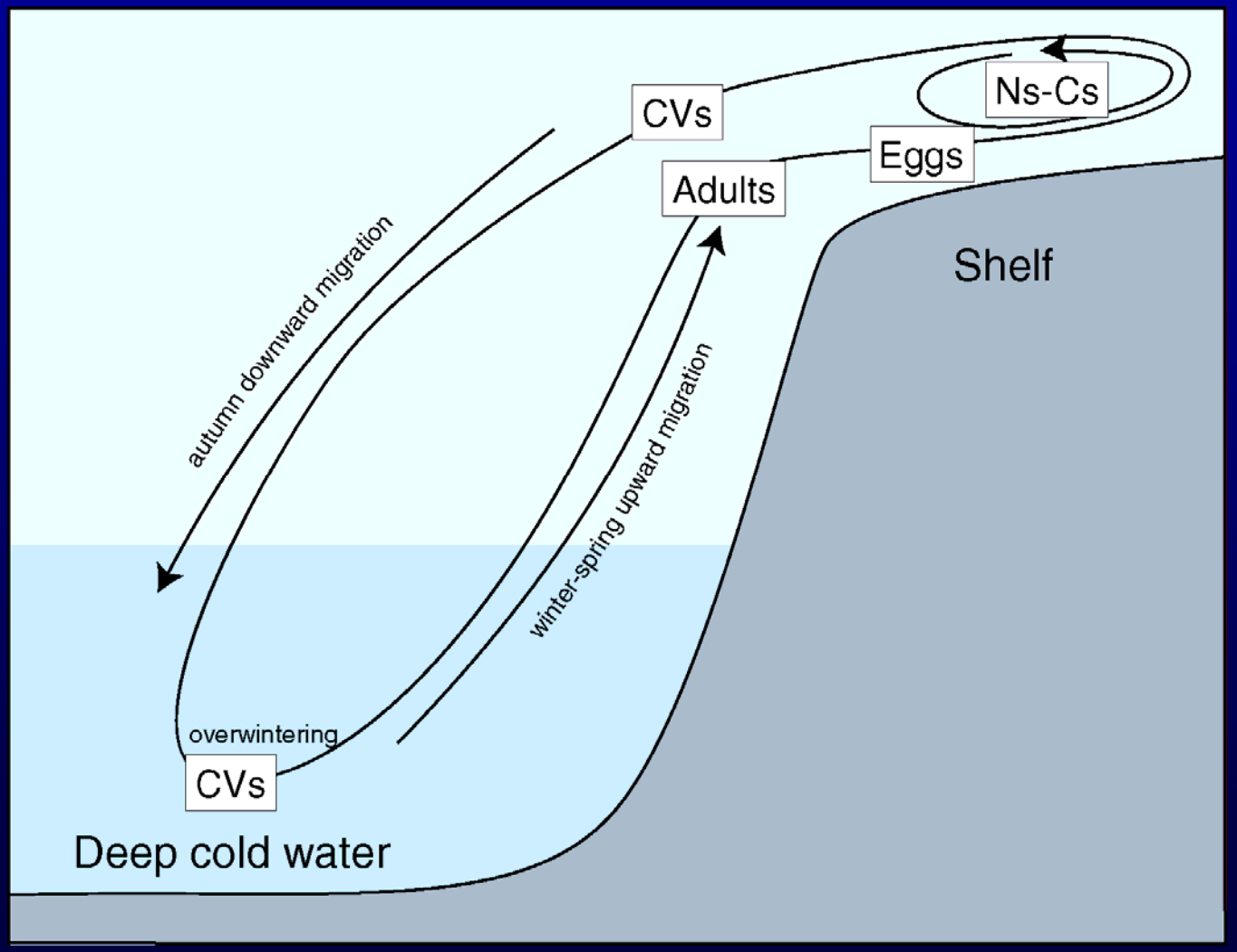
A cod (*Gadus morhua*)
B Anglerfish (*Lophius piscatorius*)
C snake Blenny (*Lumpenus lampretaeformis*)

Biogeography & production

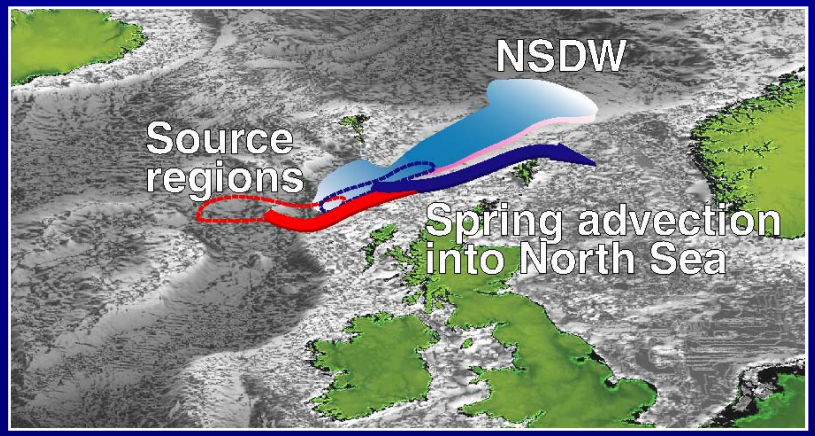


Drinkwater, K. F. (2005) The response of Atlantic cod (*Gadus morhua*) to future climate change. *ICES J. Mar. Sci.* **62:** 1327-1337.

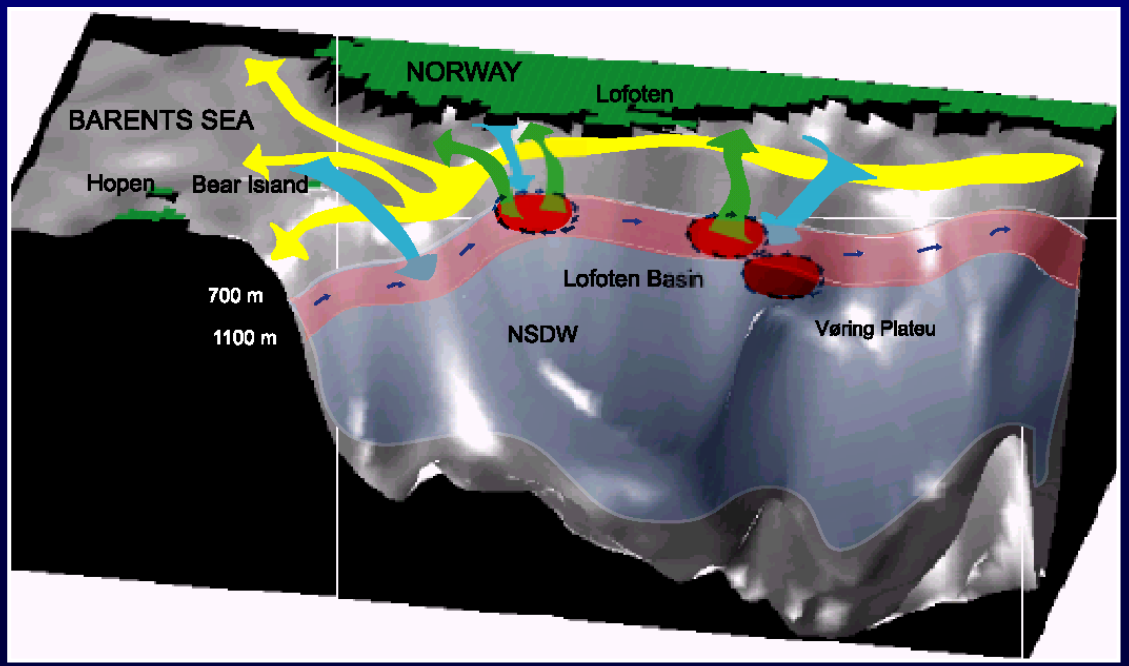
Cross slope life cycles - zooplankton



Cross slope life cycles - zooplankton

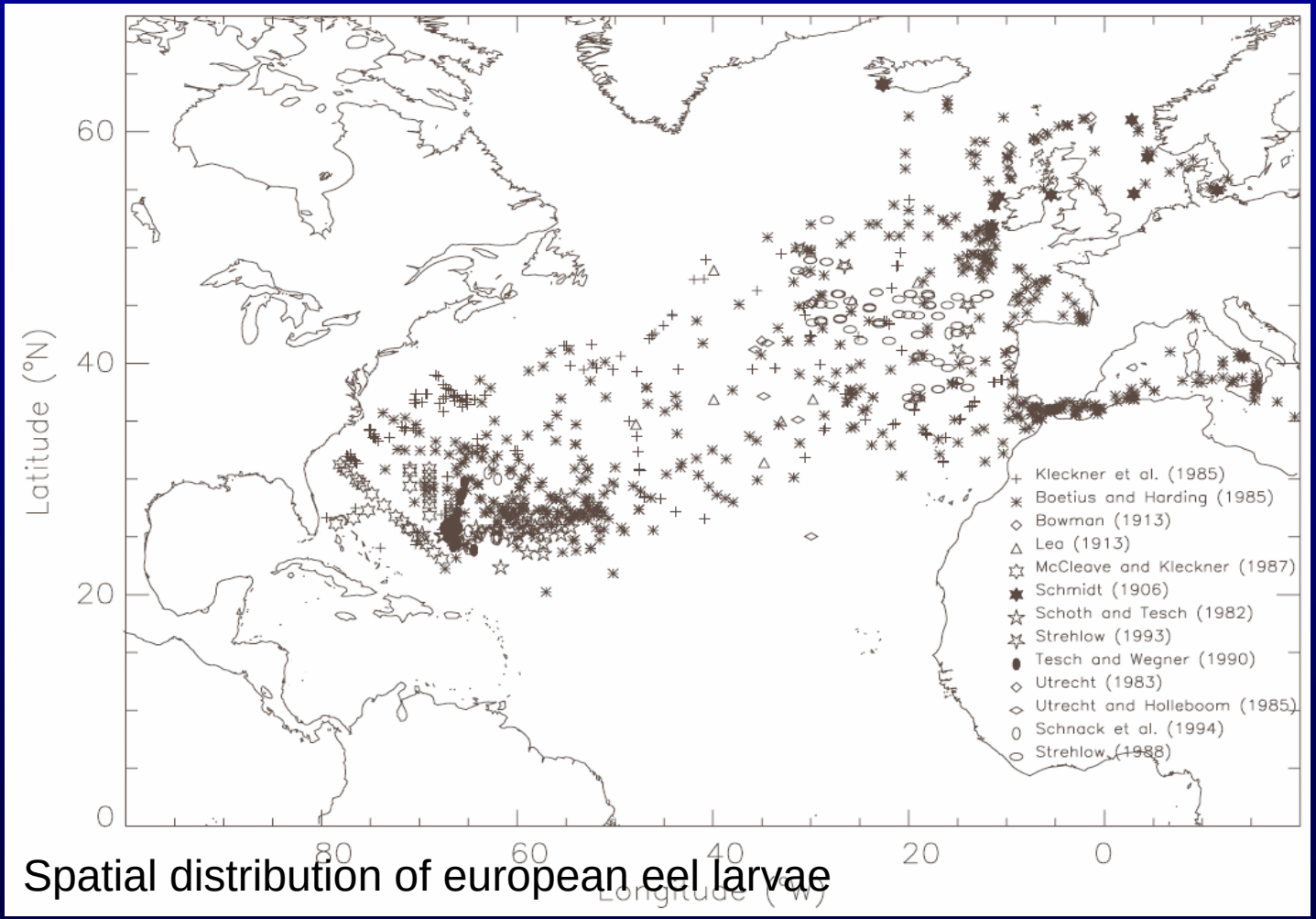


Pershing, et al. (2004) The influence of climate variability on North Atlantic zooplankton populations. *Marine ecosystems and climate variations*



Halvorsen,et al. (2003) Habitat selection of overwintering *Calanus finmarchicus* in the NE Norwegian Sea and shelf waters off Northern Norway in 2000-02. *Fish. Oceanogr.* **12:** 339-351.

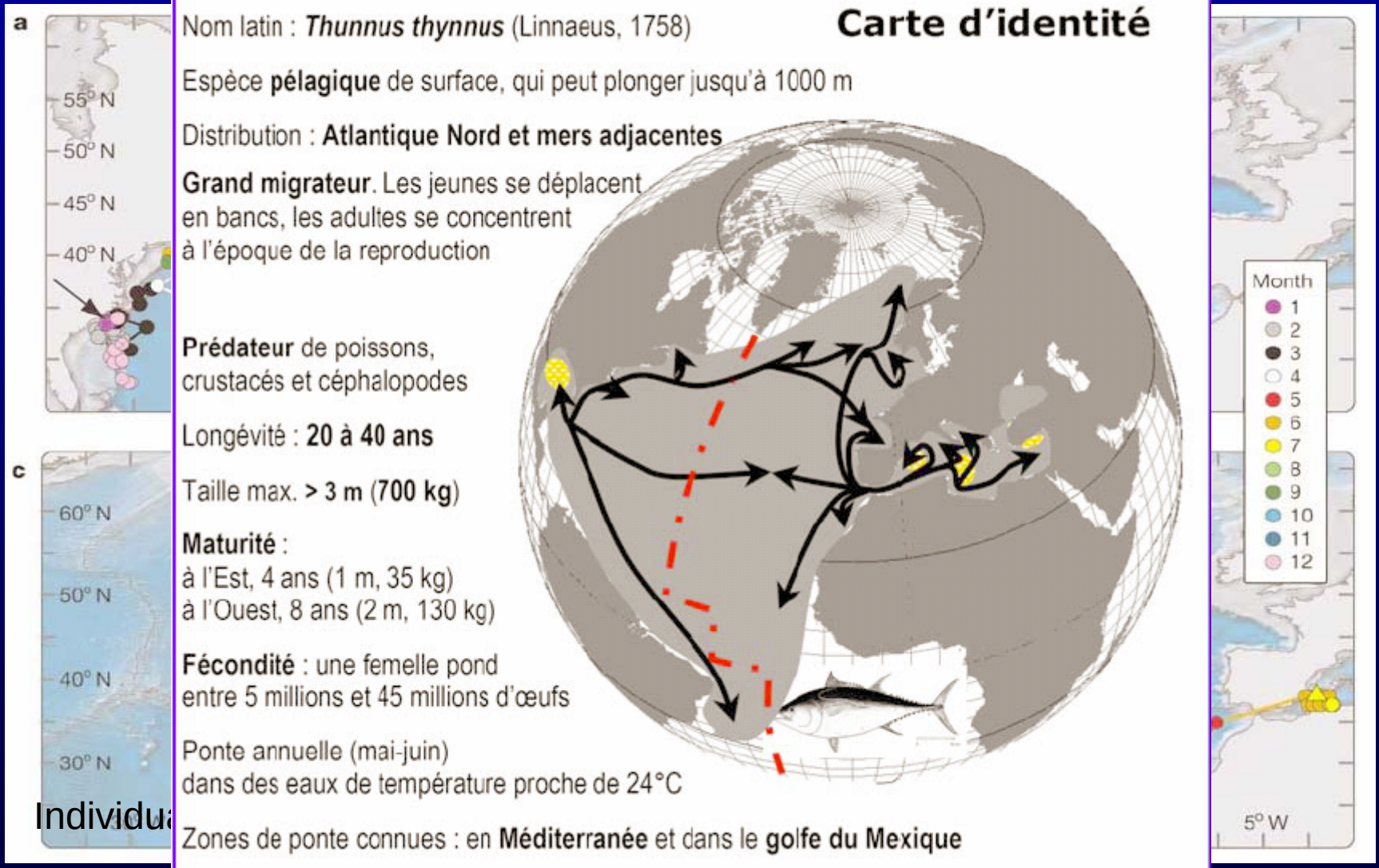
Cross slope life cycles - fish



Spatial distribution of european eel larvae

Kettle, A. J. and Haines, K. (2006) How does the European eel (*Anguilla anguilla*) retain its populations structure during larval migration across the North Atlantic Ocean? *Can. J. Fish. Aquat. Sci.* **63:** 90-106.

Cross slope life cycles - fish



Nom latin : ***Thunnus thynnus*** (Linnaeus, 1758)

Carte d'identité

Espèce **pélagique** de surface, qui peut plonger jusqu'à 1000 m

Distribution : **Atlantique Nord et mers adjacentes**

Grand migrateur. Les jeunes se déplacent en bancs, les adultes se concentrent à l'époque de la reproduction

Prédateur de poissons, crustacés et céphalopodes

Longévité : **20 à 40 ans**

Taille max. **> 3 m (700 kg)**

Maturité :
à l'Est, 4 ans (1 m, 35 kg)
à l'Ouest, 8 ans (2 m, 130 kg)

Fécondité : une femelle pond entre 5 millions et 45 millions d'œufs

Ponte annuelle (mai-juin) dans des eaux de température proche de 24°C

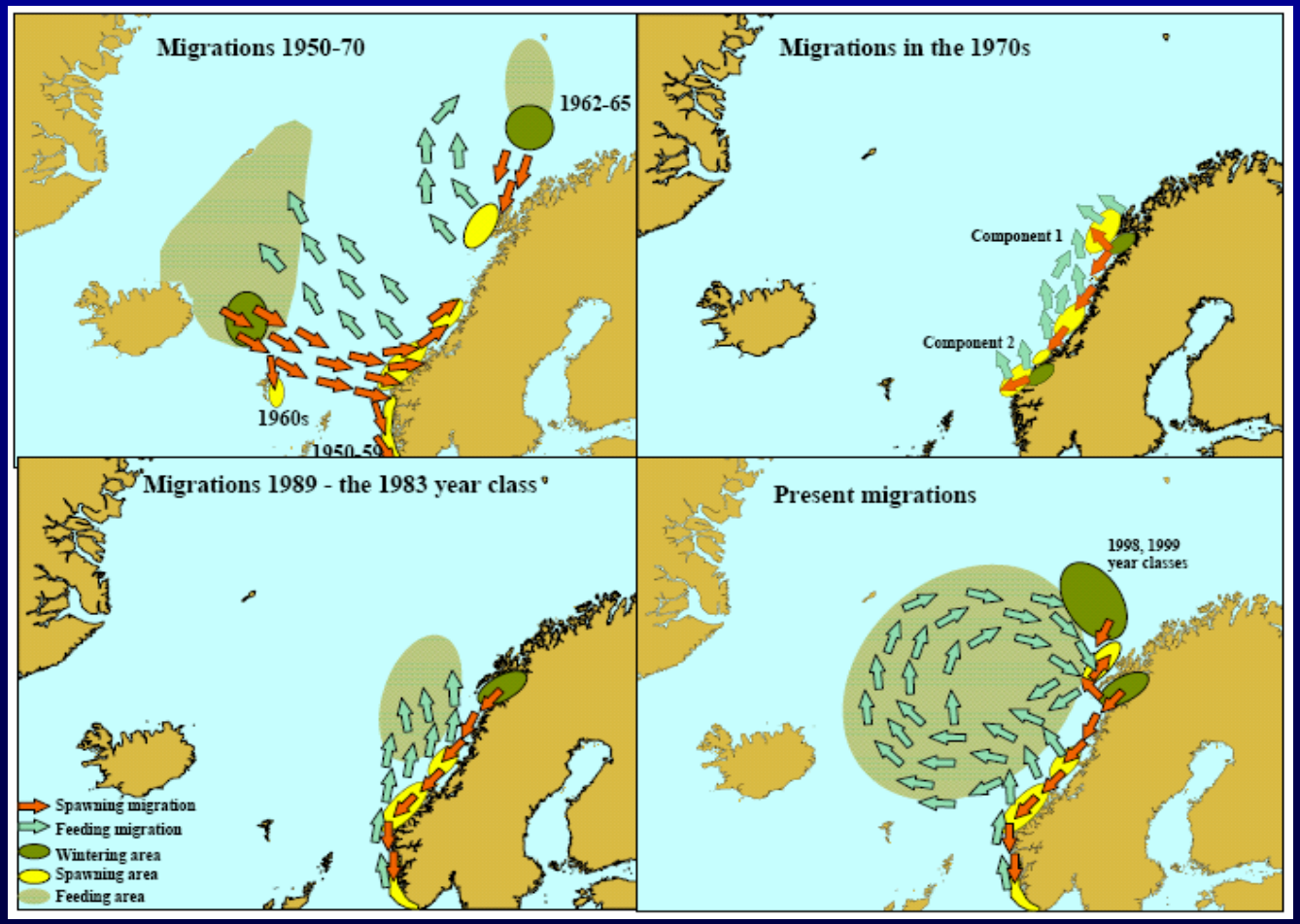
Zones de ponte connues : en **Méditerranée** et dans le **golfe du Mexique**

Individu

Block, B. A., et al. (2005) Electronic tagging and population structure of Atlantic bluefin tuna *Nature* **434:** 1121-1127.

Institut Français de recherche pour l'exploitation de la mer

Cross slope life cycles - fish



ICES (2006) Report of the study group on regional scale ecology of small pelagics (SGRESP). *ICES CM* **2006/LRC:05:** 106pp.

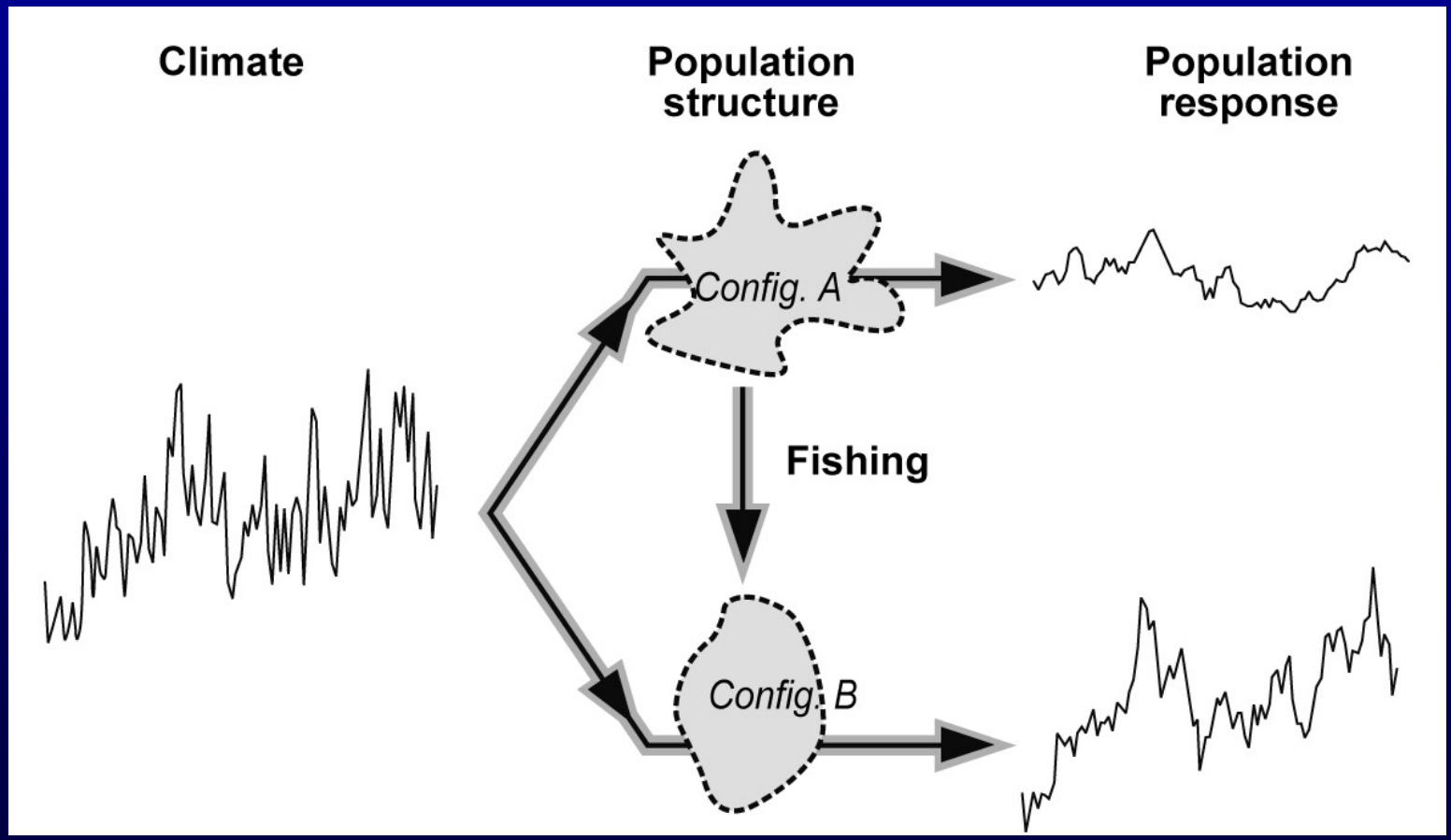
Cross slope life-cycle – key points

- Life-cycle closure
- Link-between basin-scale circulation and regional coasts
- Energy/carbon transfer through active biological movements
- Well documented case studies

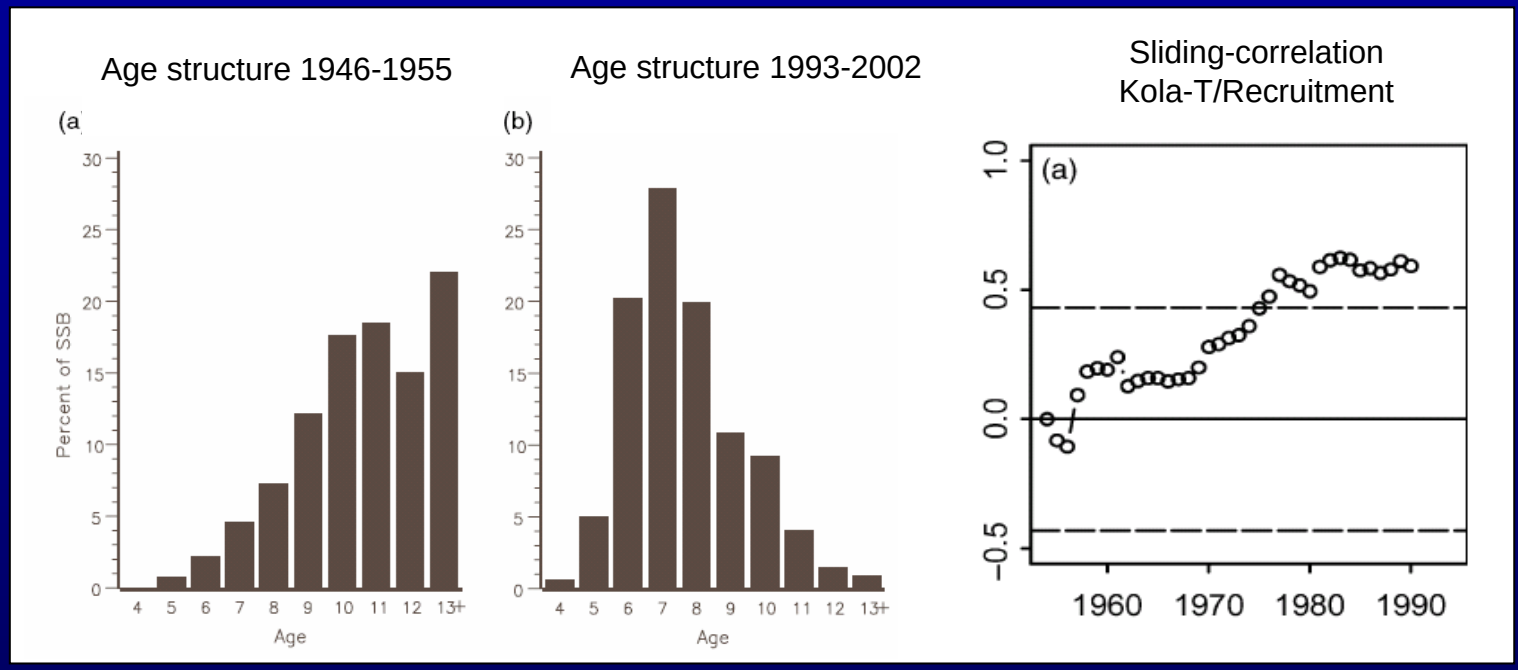
Interacting effect of climate and fishing

- Populations
  - Alteration of demographic structure
  - Alteration of meta-population structure
  - Habitat loss, spatial shifts and range
  - Changes in life-history traits
- Communities and ecosystems
  - Erosion of top predator populations
  - Reduction in species diversity
  - Increasing turnover rates

Filtering of climatic signals by populations



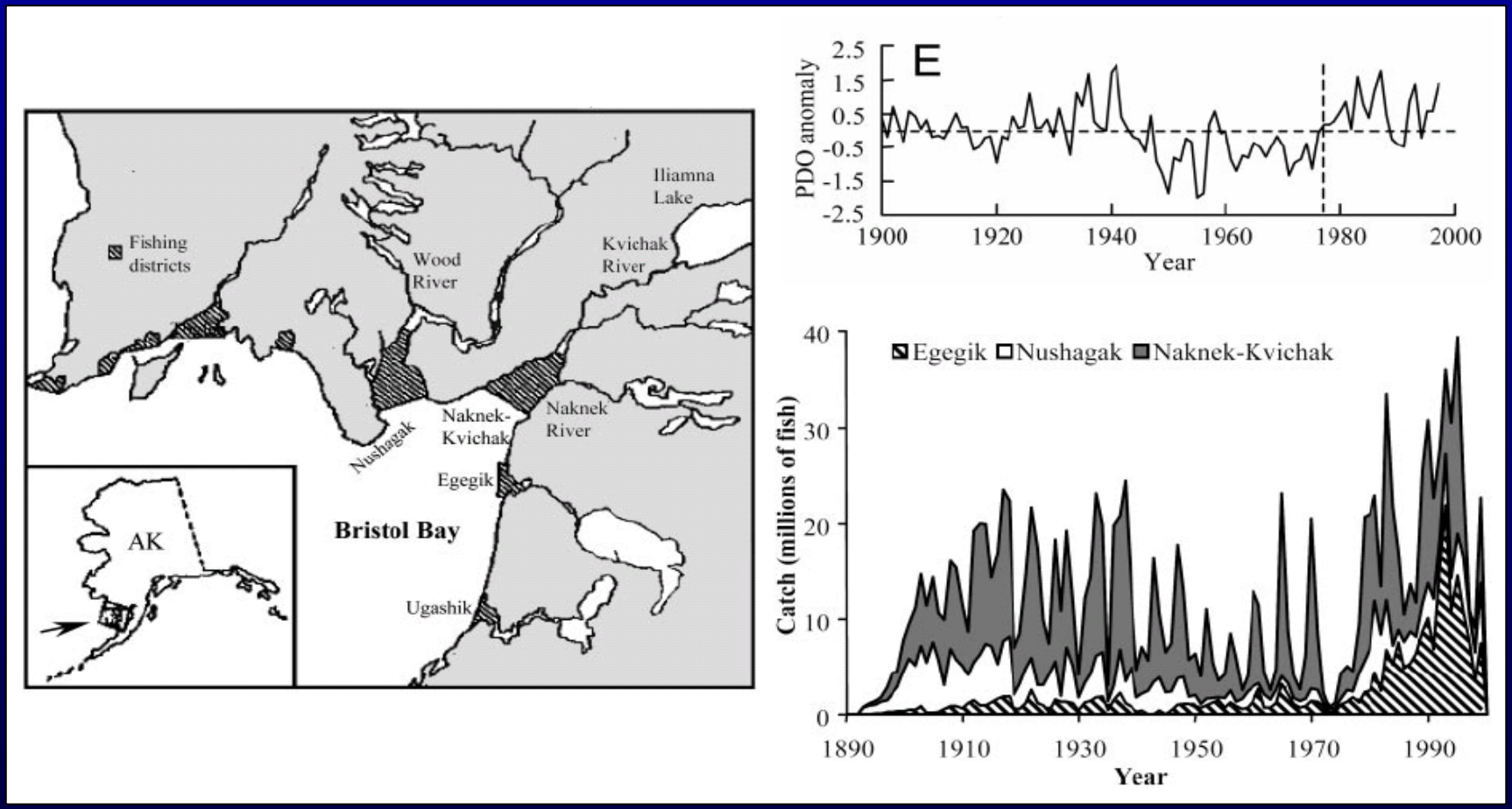
The Case of NE-arctic cod



- Parental effects: Fecundity, Egg viability, Spatial and temporal extent of spawning depend on the age-structure of the spawning population,
- The likelyhood of ‘mismatch’ situations is increased when age-structure has shrunk

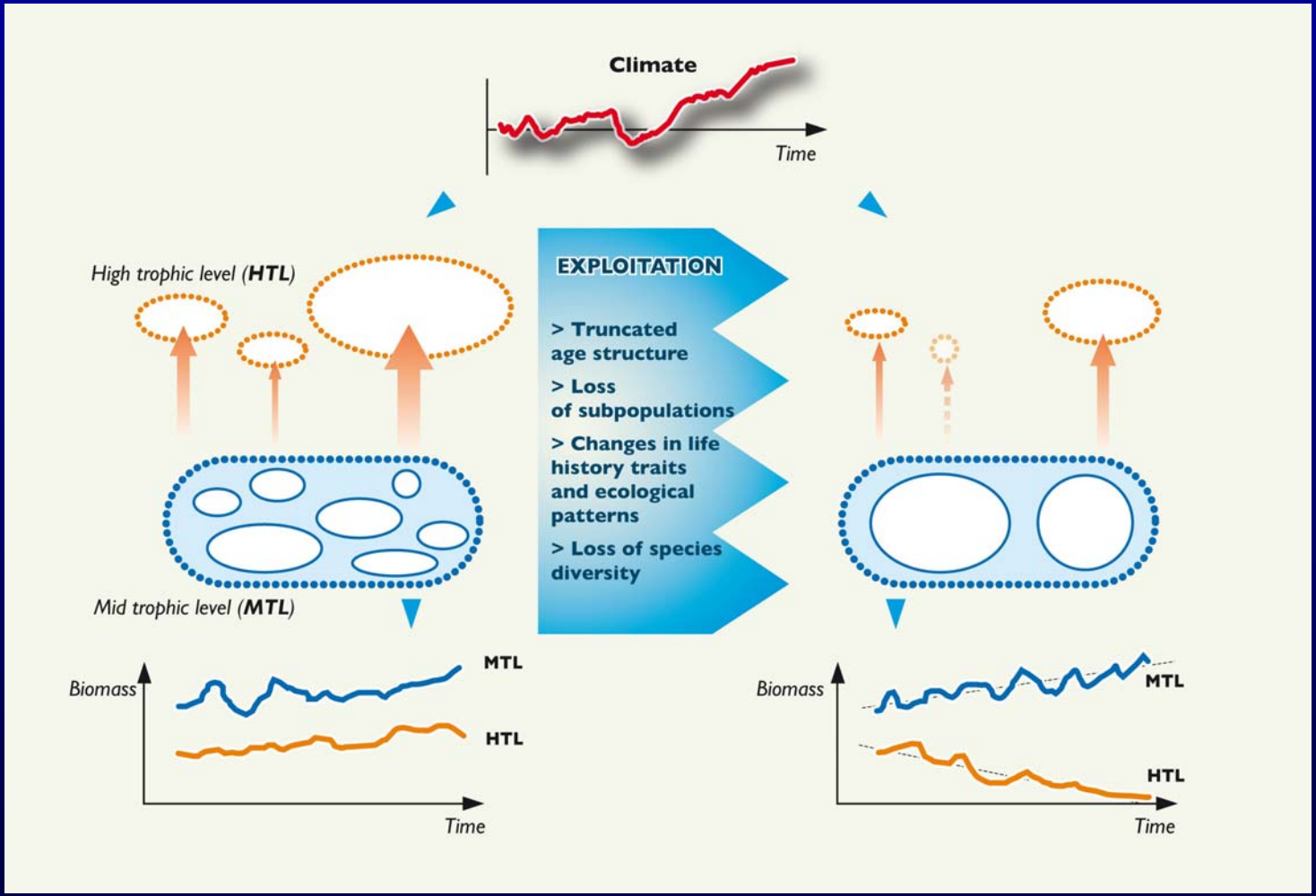
Ottersen, G., Hjermann, D. O. and Stenseth, N. C. (2006) Changes in spawning stock structure strengthen the link between climate and recruitment in a heavily fished cod (*Gadus morhua*) stock. *Fish. Oceanogr.* **15:** 230-243.

Buffering capacity through multiple spatial units



Hilborn, R., Quinn, T.P., Schindler, D.E. and Rogers, D.E., 2003. Biocomplexity and fisheries sustainability. Proceedings of the National Academy of Science USA, 100(11): 6564-6568.

Effects of exploitation on Community and ecosystem response to climate



Perry, R. I., Cury, P., Brander, K. M., Jennings, S., Möllman, C. and Planque, B. (submitted) Sensitivity of marine systems to climate change and fishing: concepts, issues and management responses. *J. Mar. Sys.*

Ecosystem Approch to Fisheries Management

- Don’t be mislead by the various terms (AEF, EBM, EBFM, etc.) and there definitions
- Ecosystem Approach is not about ecosystems only, it is about systems (physical, biological, economic, social, political)
- Management is about human activities
- >50% of the move to ecosystem approach is about human related issues:
  - How to set common goals between stakeholders,
  - How is decision making operating,
  - How to transfer and share information,
  - How to enforce regulations,
  - How can management success be evaluated
- Need to think of the use of Basin results in this context, NOW

Some concluding remarks

- BASIN is a unique opportunity to study and model life-histories which span open ocean and shelf and often large areas over the NA Ocean,
- The response of widely distributed species to oceanic changes in the N. Atlantic can be affected through many pathways (changes in production, biogregraphy, life-cycle),
- Exploitation (fishing) does and will alter the way ecosystems respond to climate
- The move to Ecosystem Approach will require explicit consideration of the human dimension from the start of the project.