INSTITUTE OF MARINE RESEARCH

Ken Drinkwater

Marine Ecosystem Responses to the Warming of 1920s and 1930s in the Northern North Atlantic

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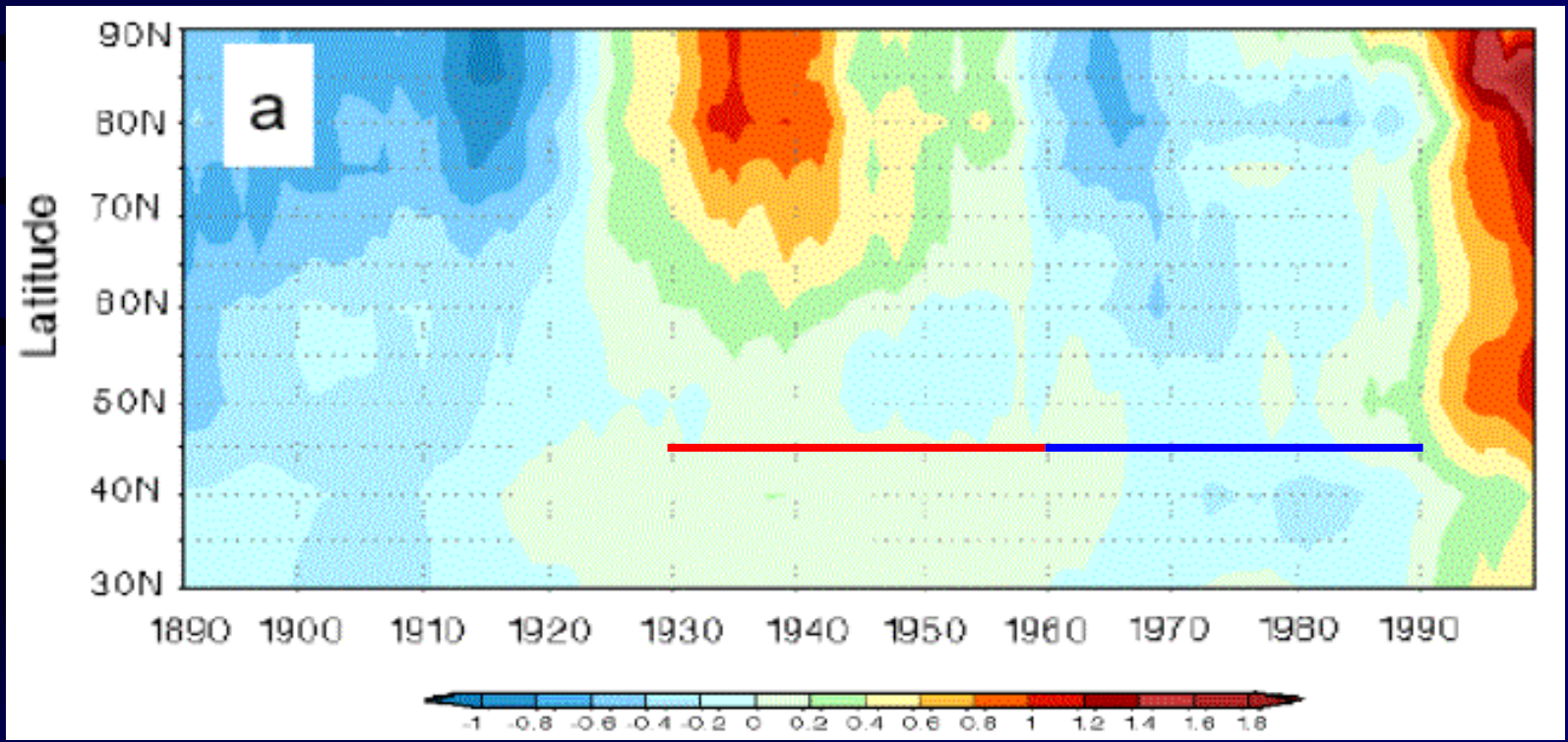
Bjerknes Centre
for Climate Research

Outline

- Warming
- Ecosystem Responses
  - Greenland, Iceland, Faroes, Barents Sea, Svalbard
- Comparison with 1990s

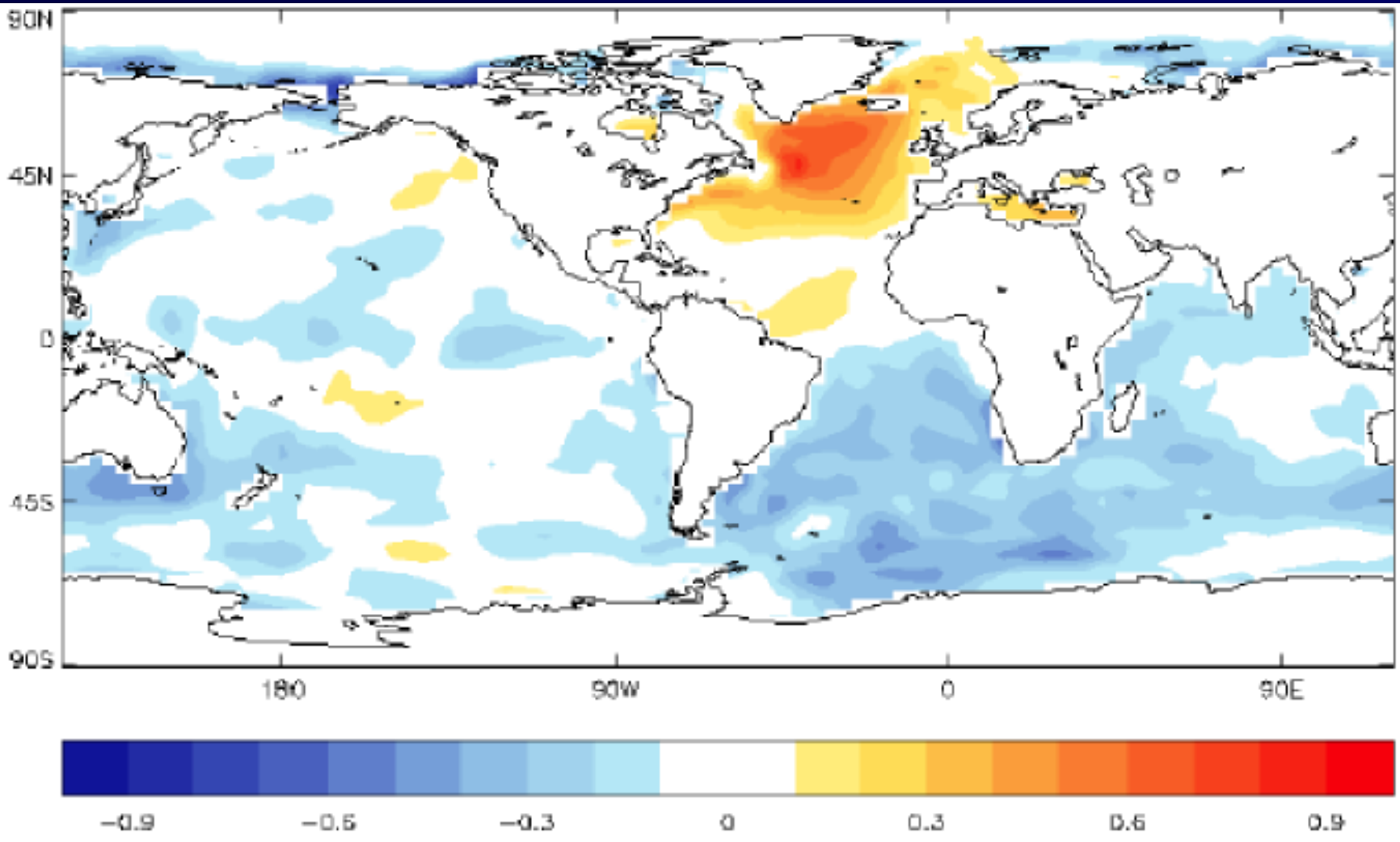
The 1920s and 1930s Warming

During the 1920s and 1930s there was rapid warming of the atmosphere and oceans primarily north of 60ºN that produced temperatures as warm or warmer than the present.



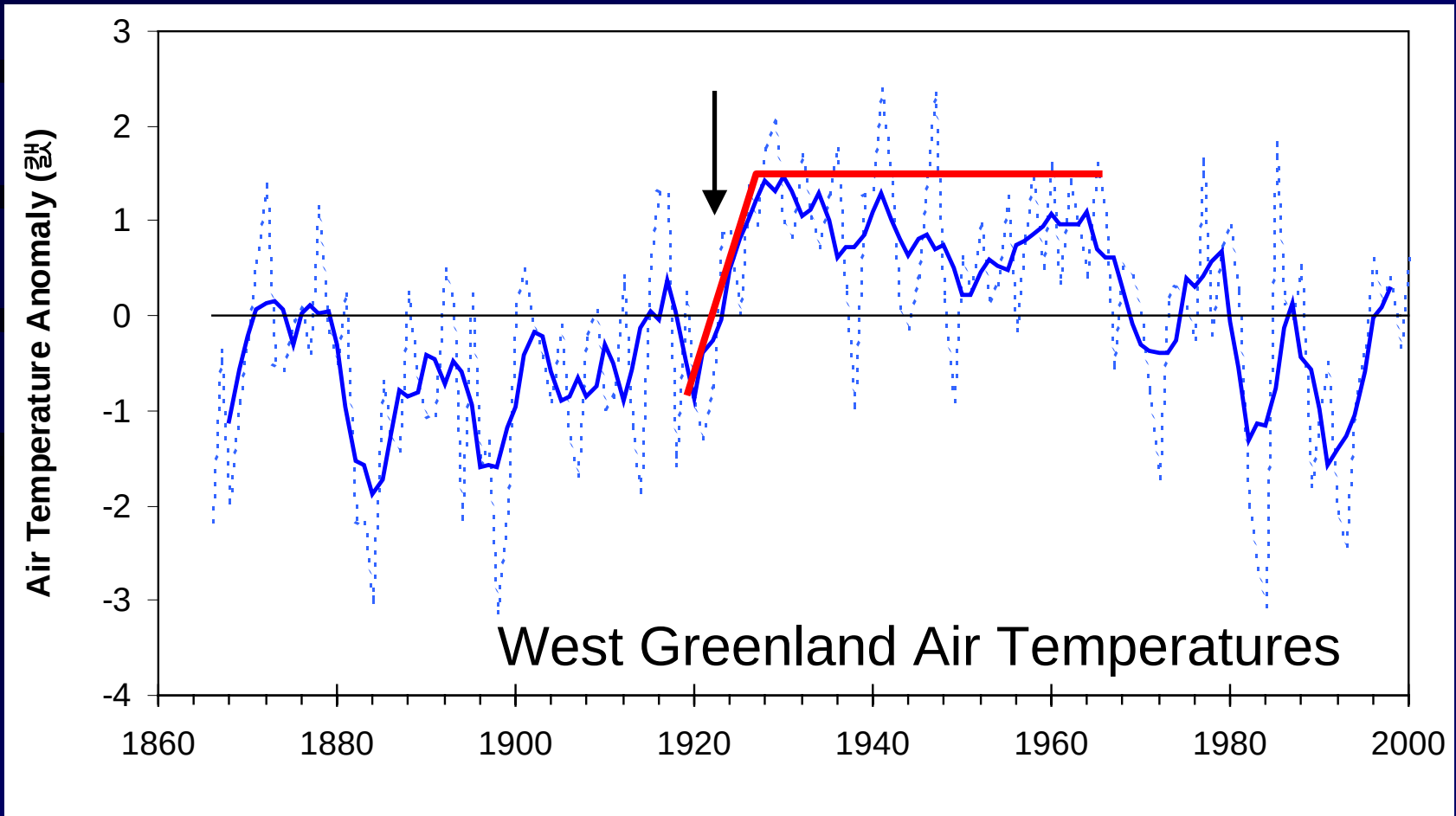
Johannessen et al. 2004. Tellus

Warming was concentrated in the Northern North Atlantic



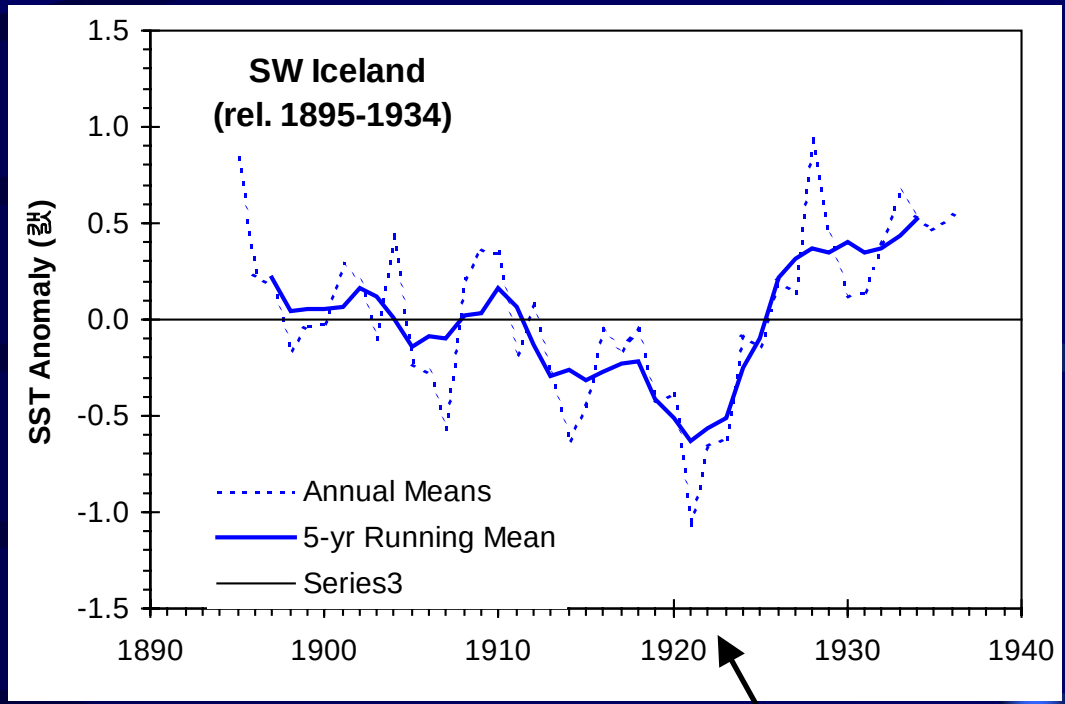
Sea Surface Temperature Change (1930-60 vs 1961-90)

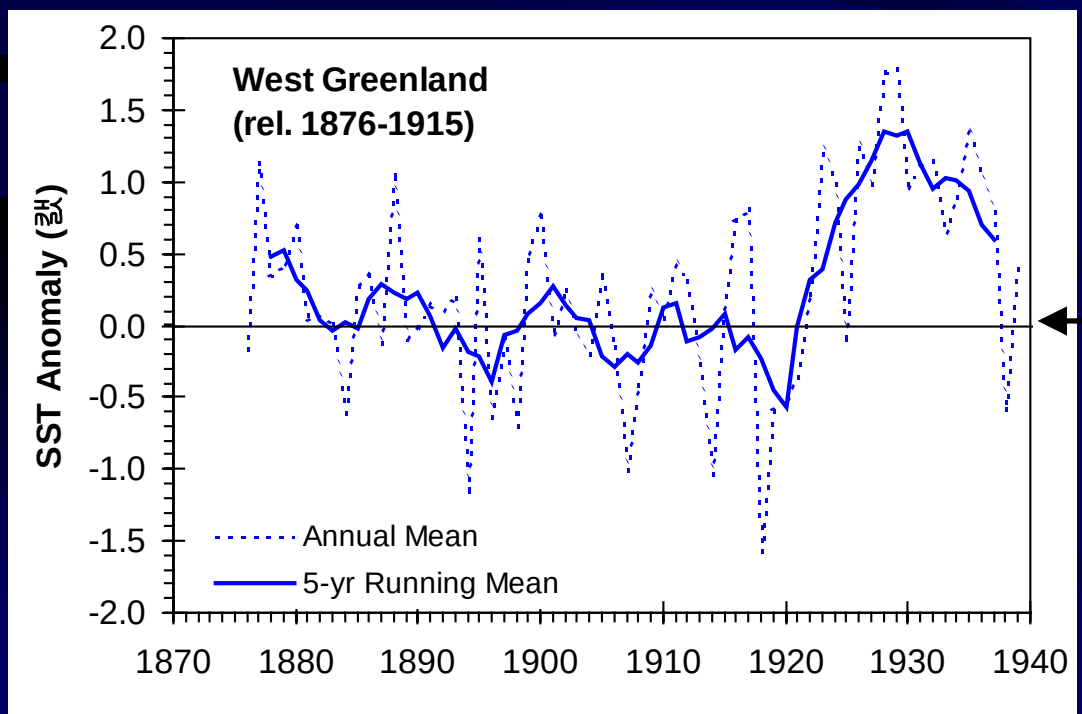
Large Air Temperature Changes were observed, e.g. West Greenland (Nuuk)

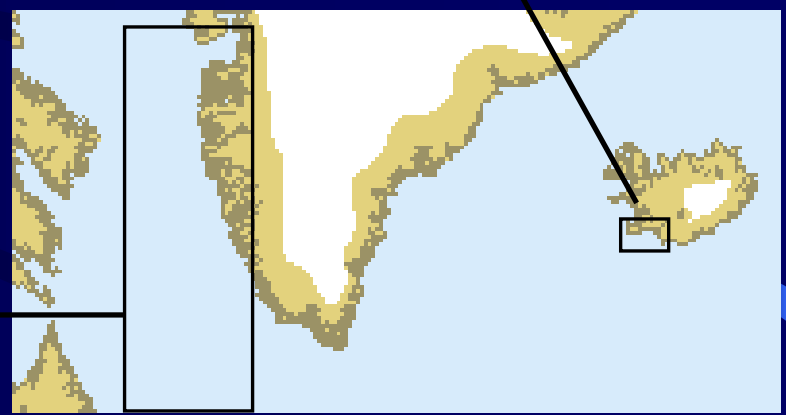


Ocean surface temperatures also rose dramatically.

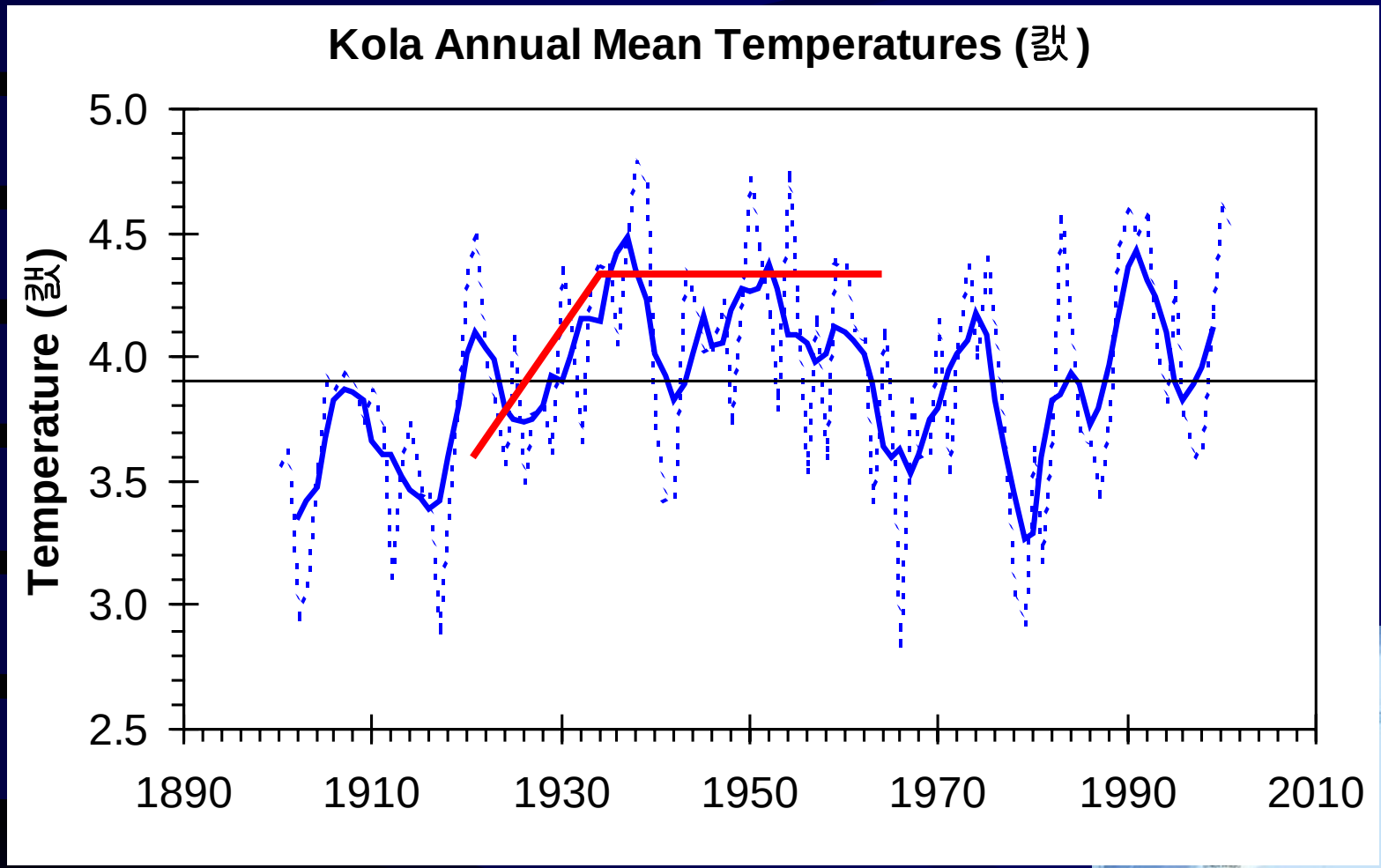
Thomsen, 1937



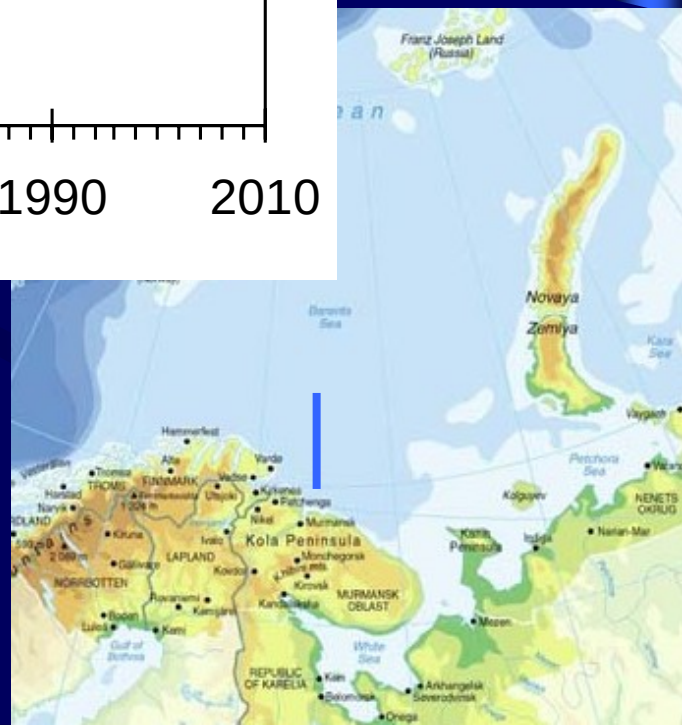




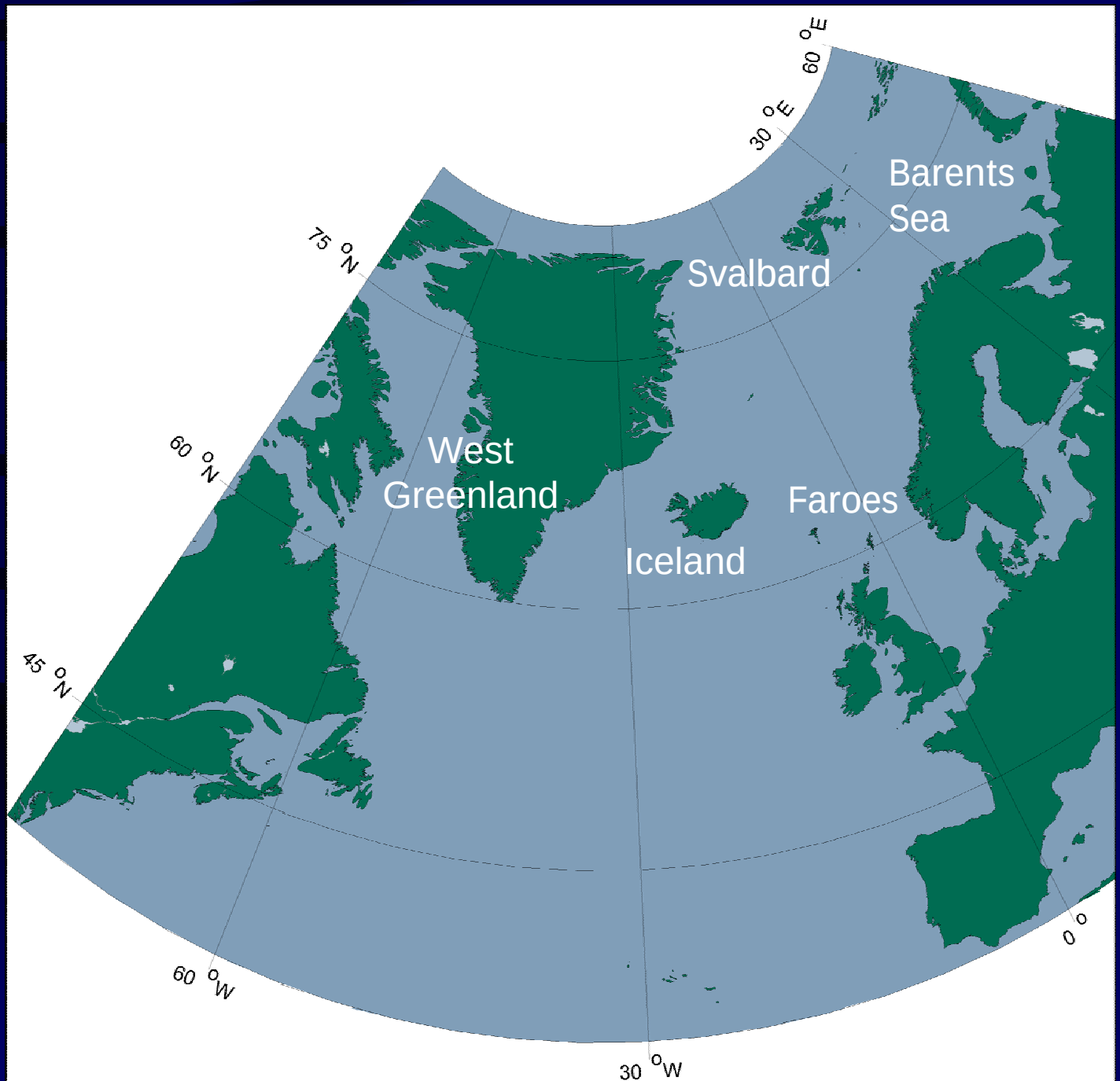
Smed, 1947

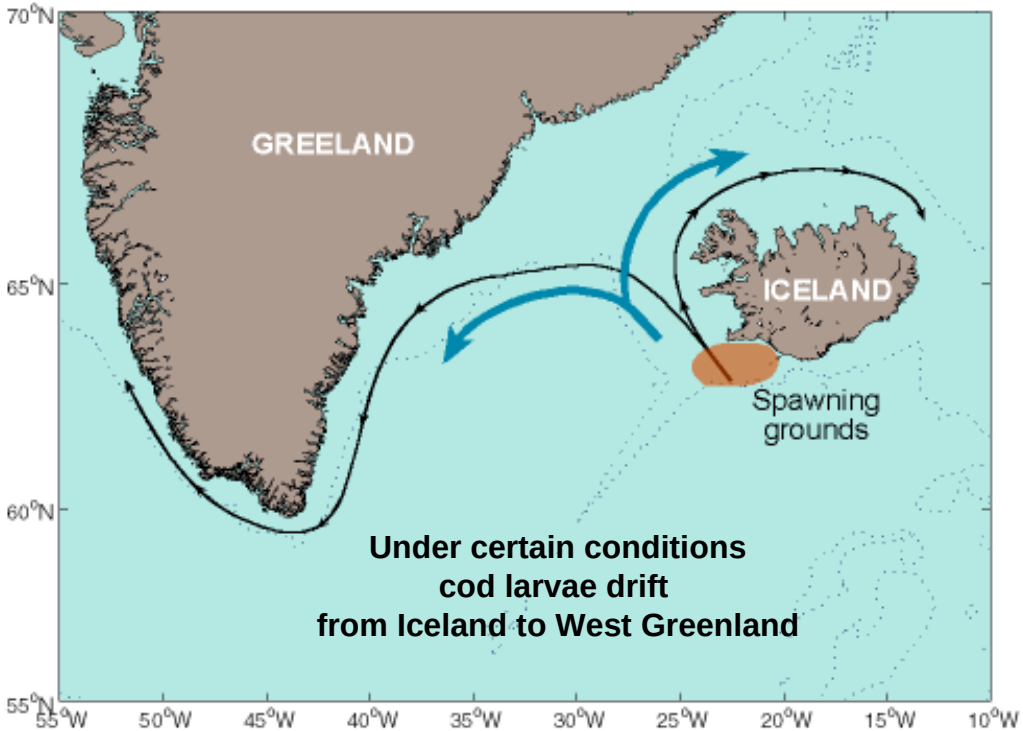


Kola Section



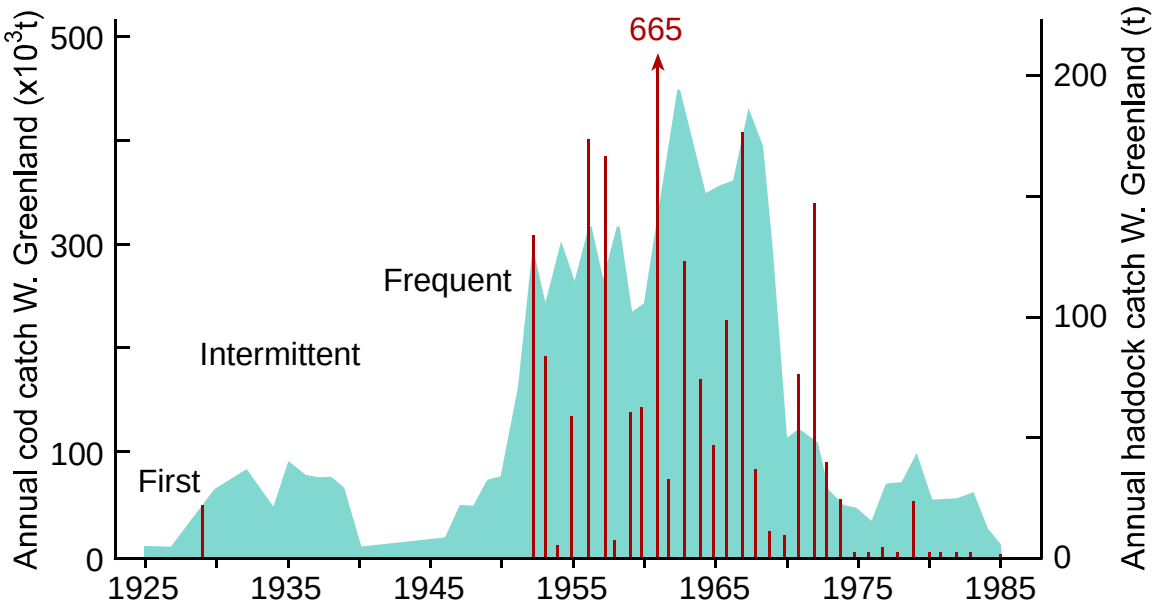
The Ecosystem Response


60 °E
30 °E
Barents
Sea
75 °N
Svalbard
60 °N
West
Greenland
Faroes
Iceland
45 °N
60 °W
30 °W
0 °



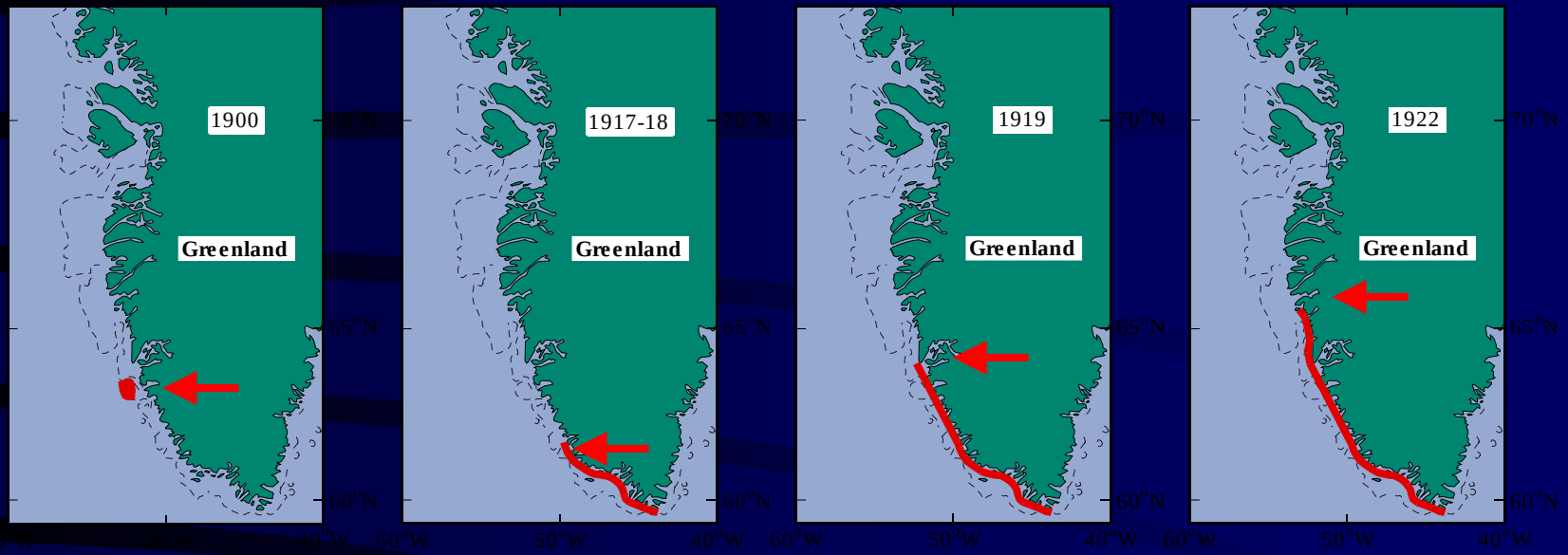
West Greenland-Iceland Connection for Atlantic cod

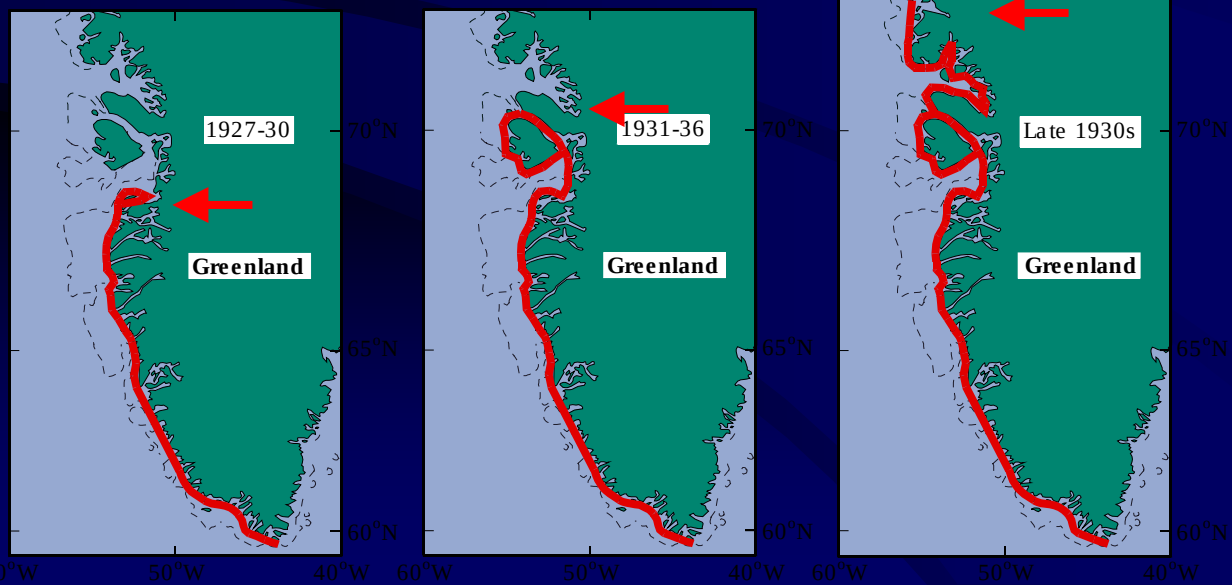
Conditions in 1920s resulted in the drift of larvae from Iceland to West Greenland and their survival.



West Greenland

In addition, the cod gradually spread northward.



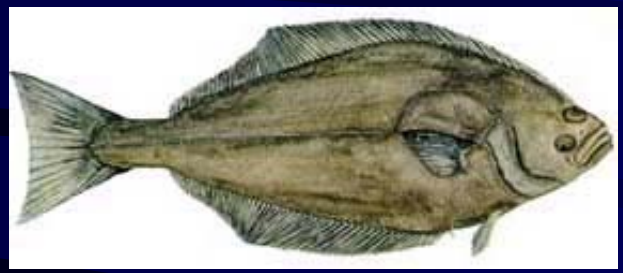


Hansen, 1940

It was not only cod that was effected

Other “warm water” species also spread northward:

Atlantic Herring



Atlantic Halibut

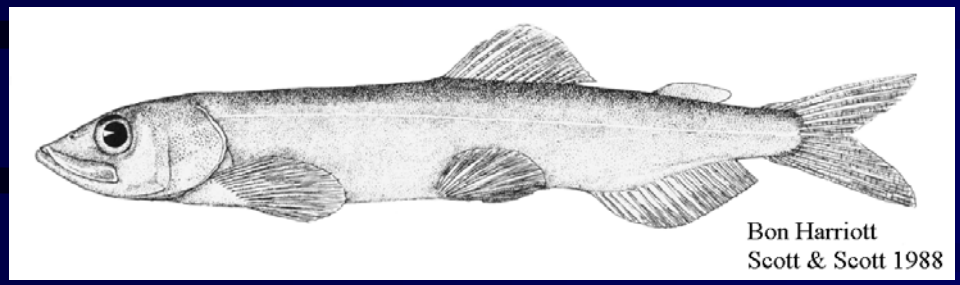
Migration patterns changes

White Whales

e.g. earlier arrival
and later departure

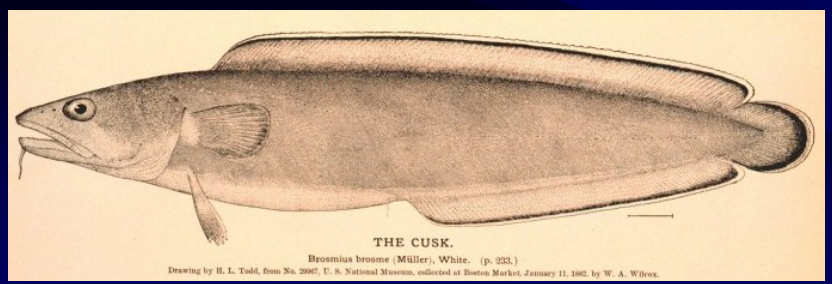
When temperatures cooled several “warm-water” species moved south or disappeared.

Cold-water species such as **capelin** did not migrate as far south and their abundance in southwestern Greenland decreased while they spread north as far as Thule.



Capelin

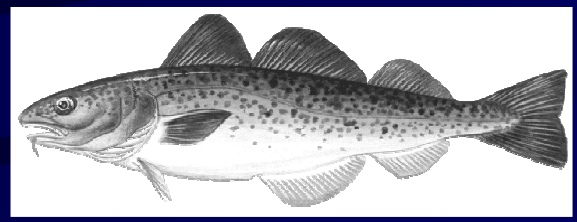
New immigrants came to Greenland including **cusk** (*Brosmius brosme*), **ling** (*Molva vulgaris*), **witch** (*Pleuronectes cynoglossus*) and the **jellyfish** (*Halopsis ocellata*) through advection from Iceland.



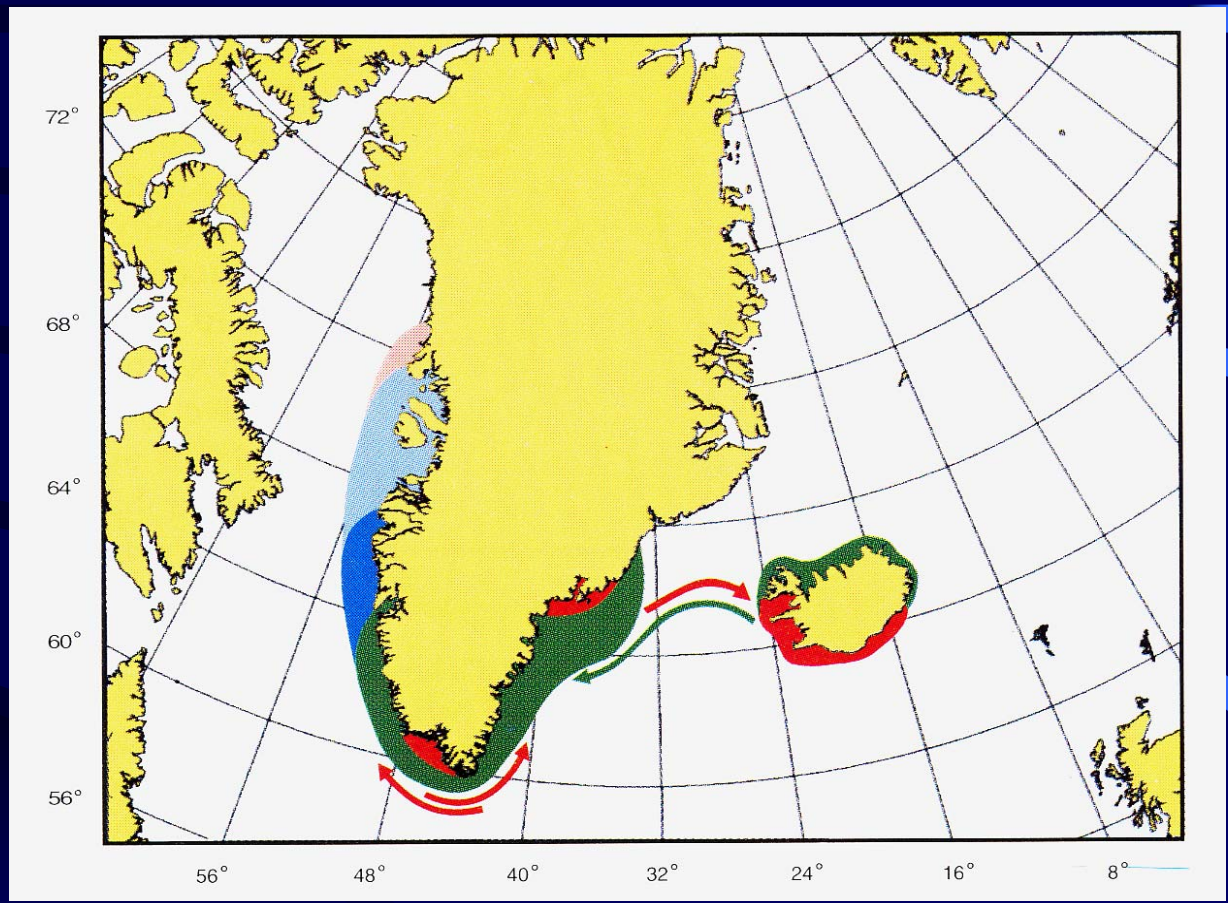
Cusk

Ling

Iceland

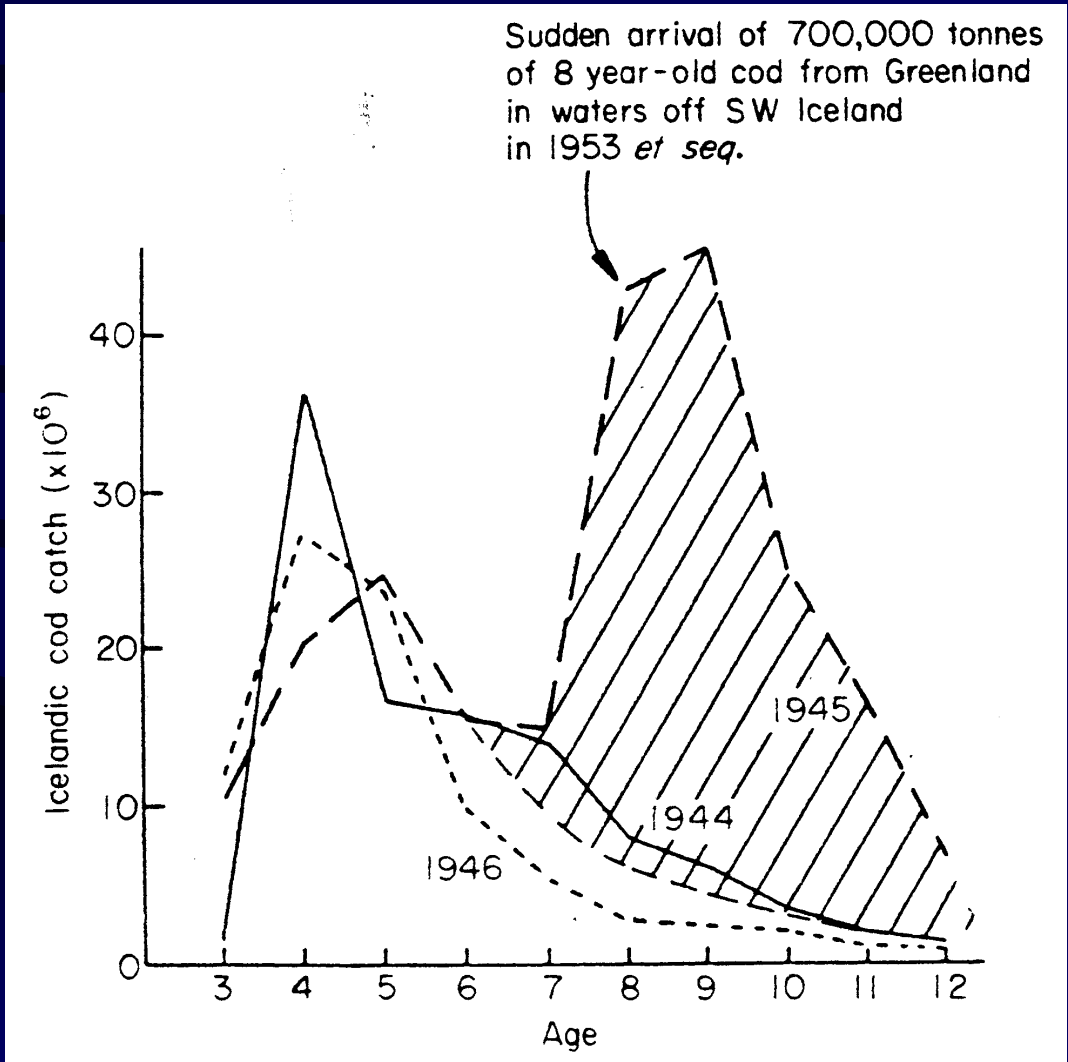


Atlantic cod spread northward to spawn along the north coast, thereby surrounding Iceland, whereas prior to the 1920s it was largely confined to the south coast. Capelin moved to the north coast but became scarce on the south coast, resulting a decrease in the condition of cod in the south.



Vilhjalmsson, 1997

Many of the cod that drifted as larvae to Greenland returned to Iceland as adults to spawn.



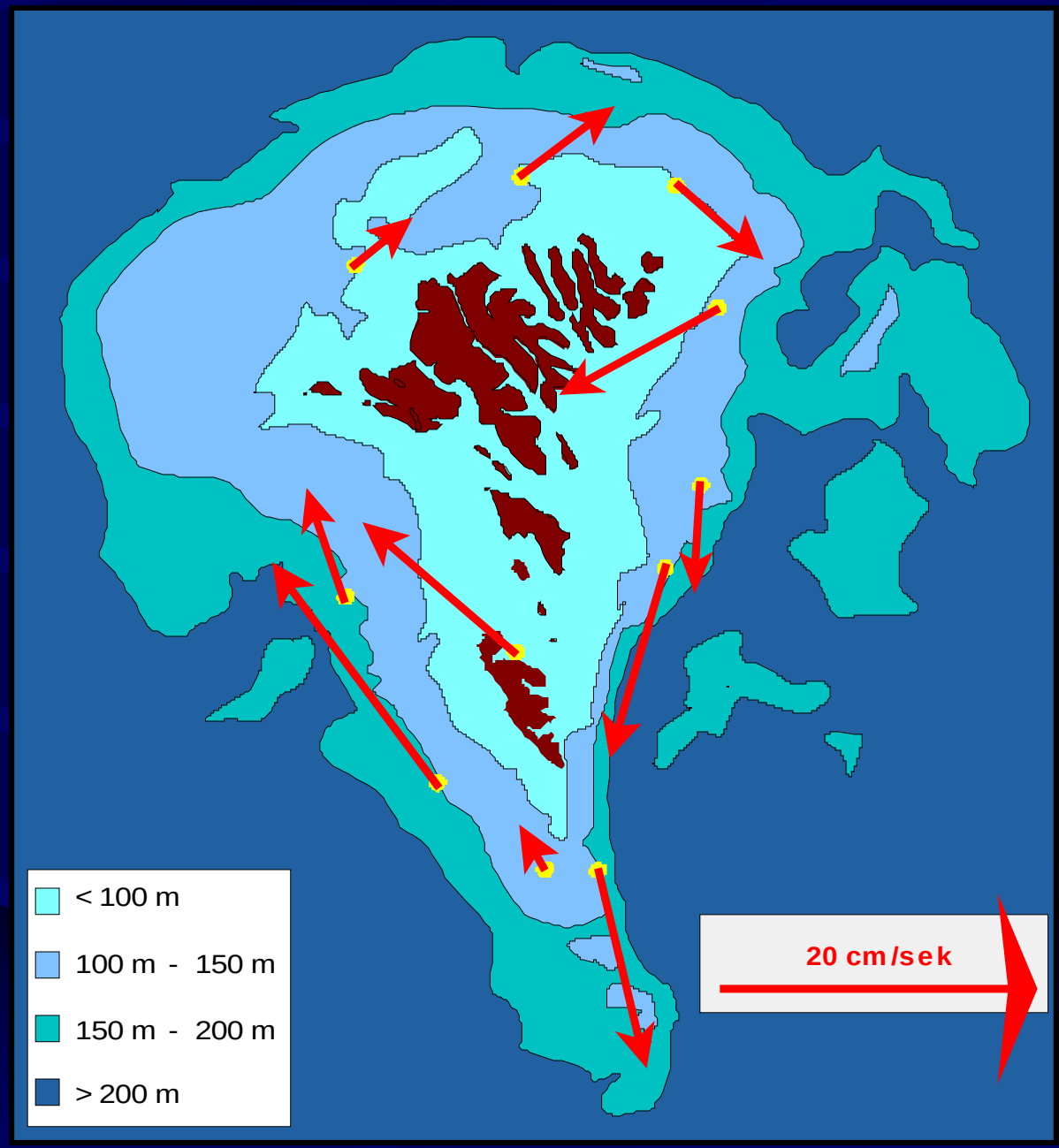
Basking Shark

Atlantic Mackerel

Several warm water species such as **basking sharks, tunny, mackerel, saury pike and sunfish** appeared occasionally and sometimes frequently in Icelandic waters whereas previously they were rare or absent altogether.

Faroe Islands

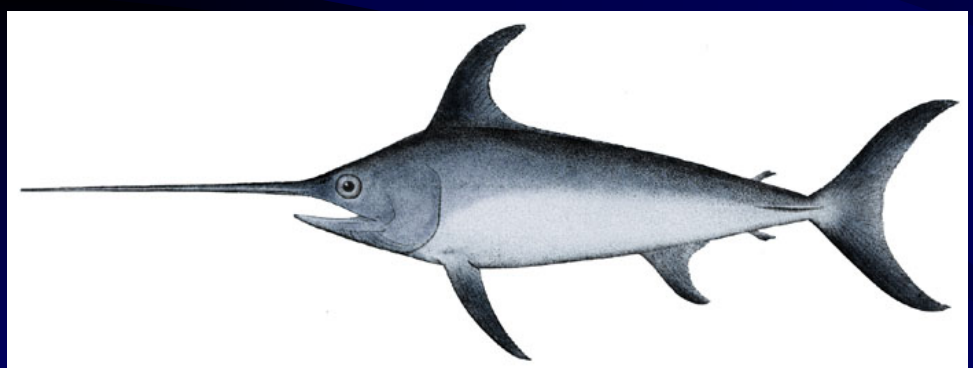
The Faroes Shelf is washed by temperate Atlantic waters.



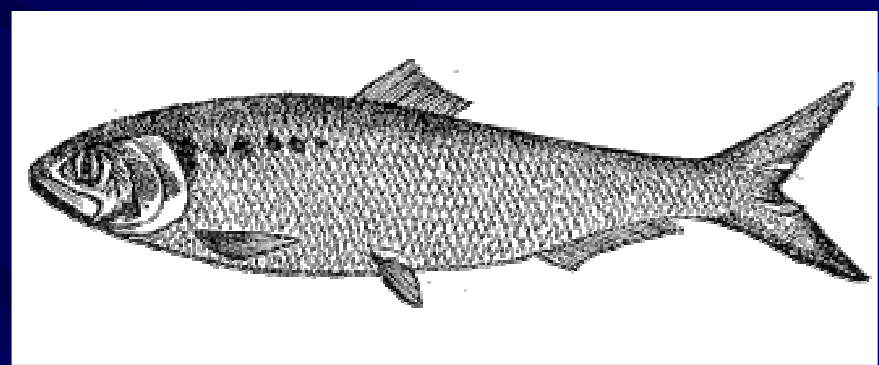
Courtesy of B. Hansen

Warmer water species such as the **Atlantic horse mackerel** invaded the Faroes in relatively large numbers during the 1930s.

In addition, several other warm-water species became occasional visitors to the Faroe Islands, including **swordfish** (*Xiphias gladeus*), **twaite shad** (*Alosa finta*) and **pollock** (*Pollachias pollachias*).

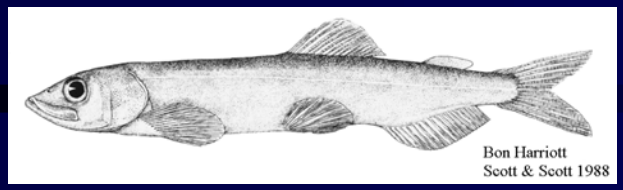


Swordfish



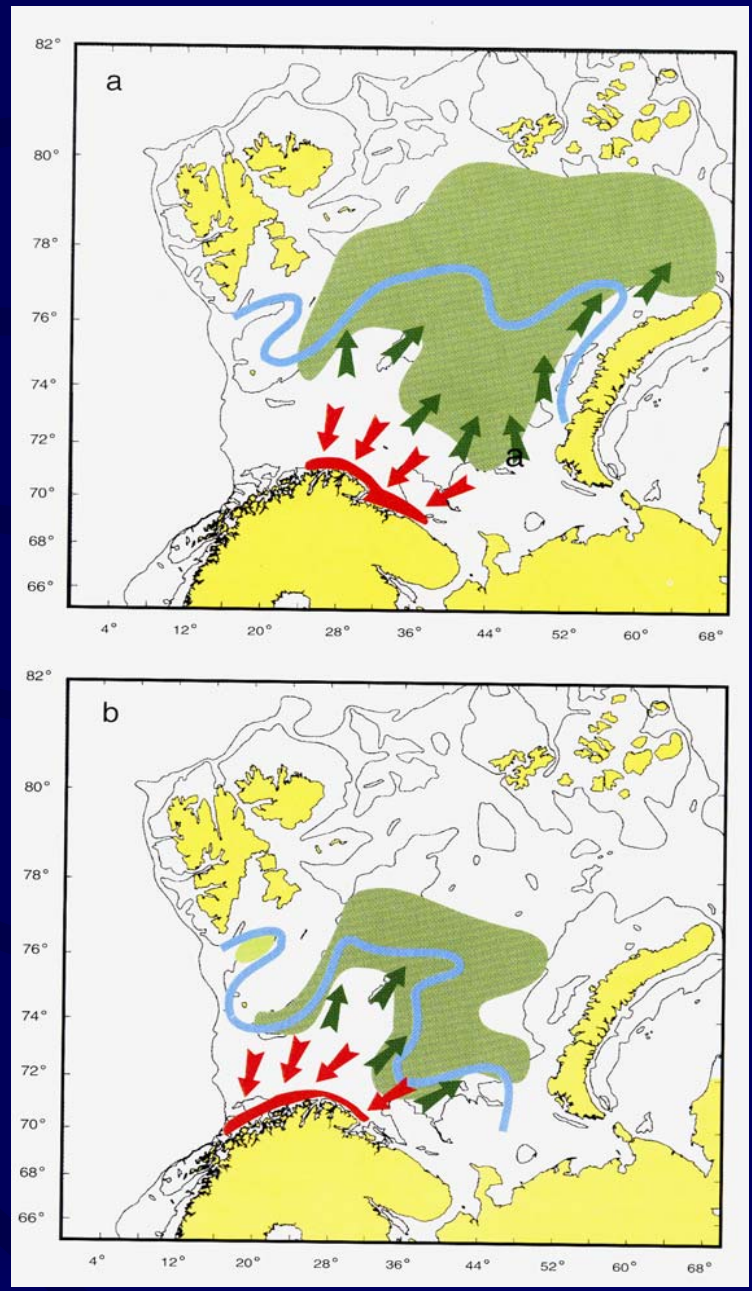
Twaite Shad

Barents Sea



Capelin feeding migration spread farther north and east following the movement of the Polar front in contrast with the migration patterns observed during cooler times.

Vilhjalmsson, 1997



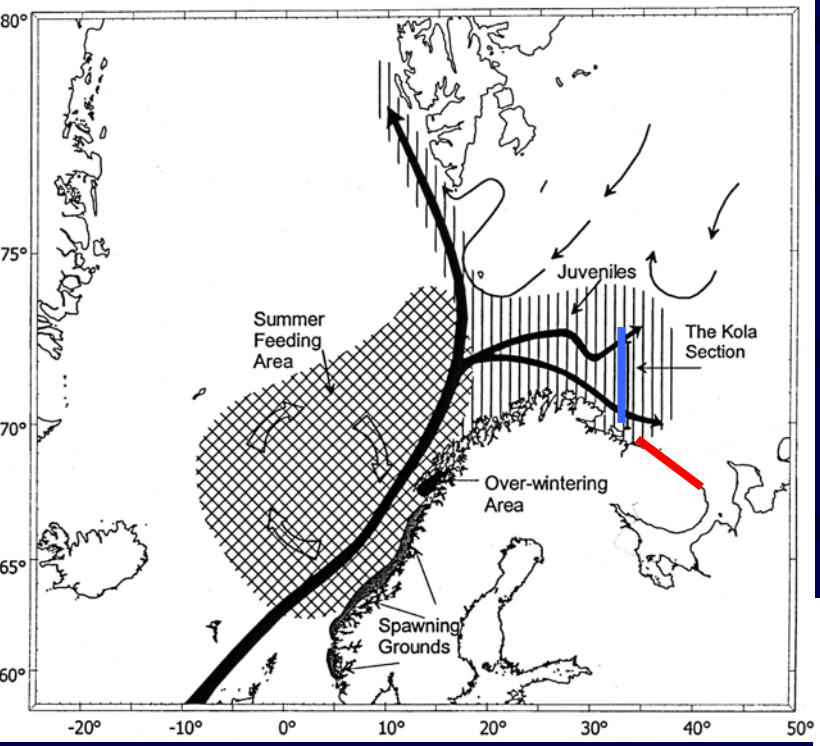
Barents Sea

Cod appeared in large quanties on Bear Island Bank resulting in the re-establishment of a cod fishery there after an absence of almost 40 years.

Cod also penetrated eastward to Novaya Zemlya, along with haddock.

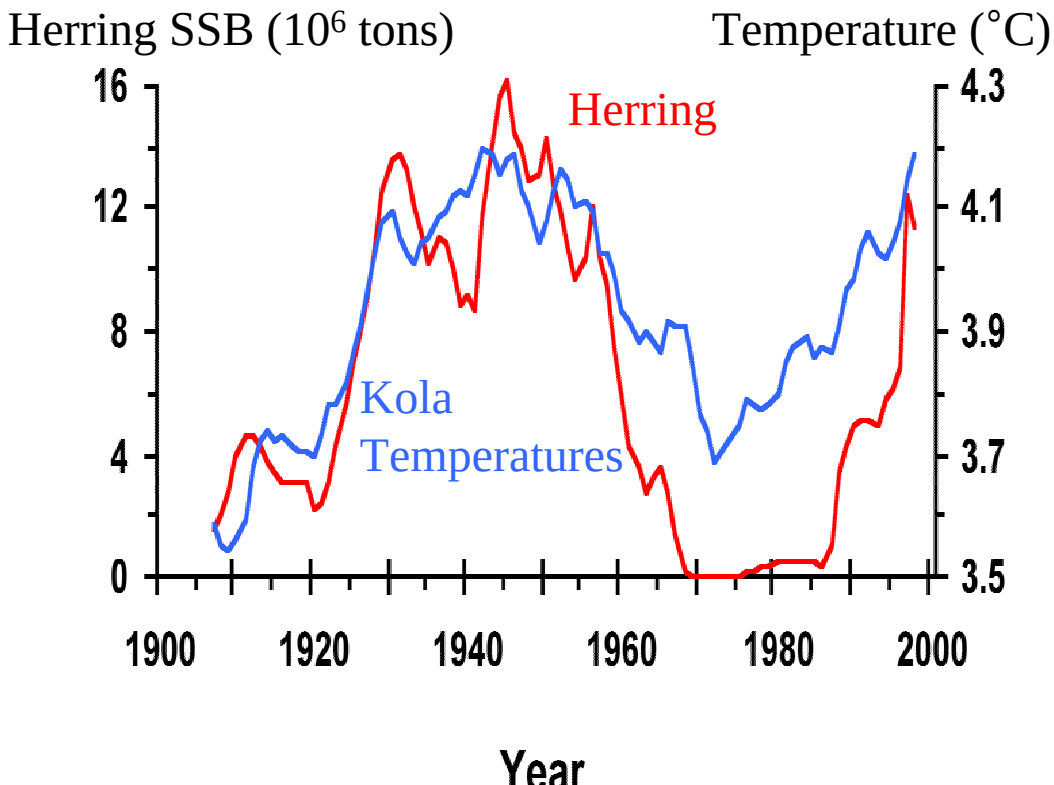
Atlantic Herring

The population of Norwegian spring spawning herring rose dramatically in parallel with the temperatures as recorded in the Kola Section.

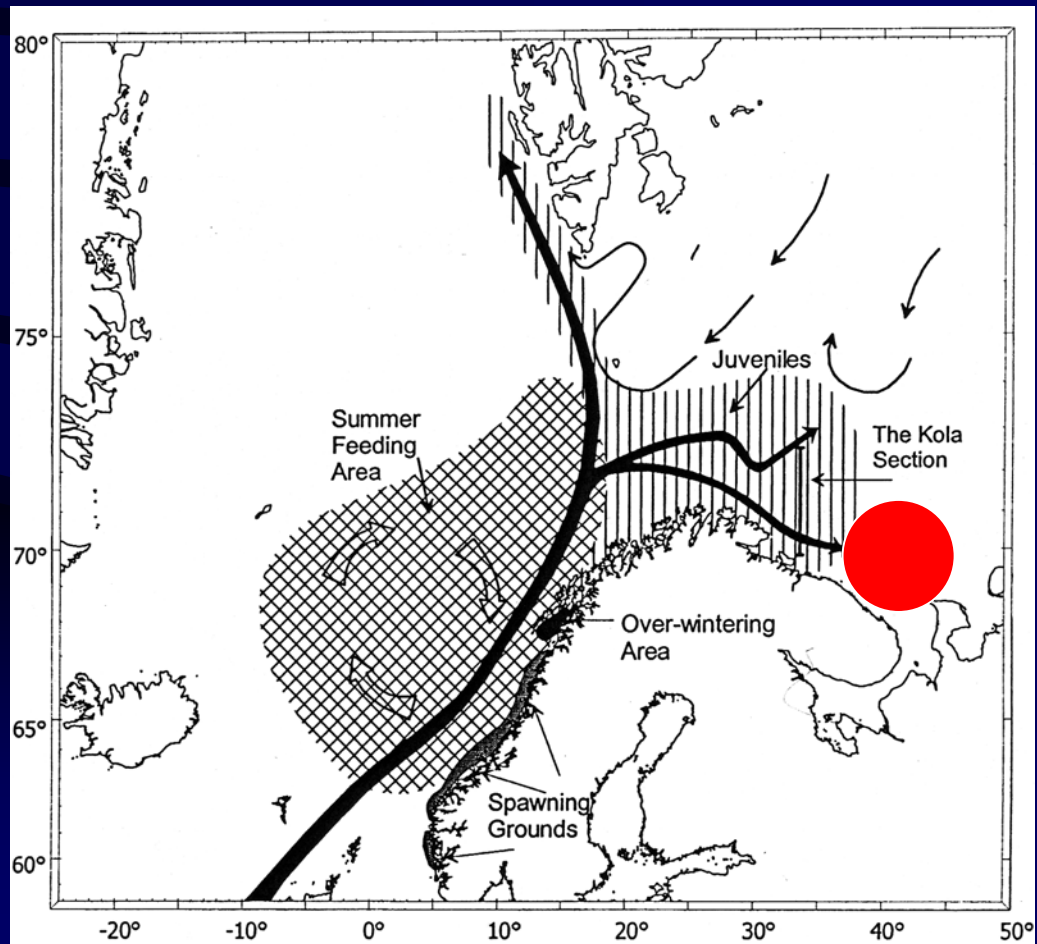


A herring fishery developed along the Murman coast where previously this species was almost unknown.

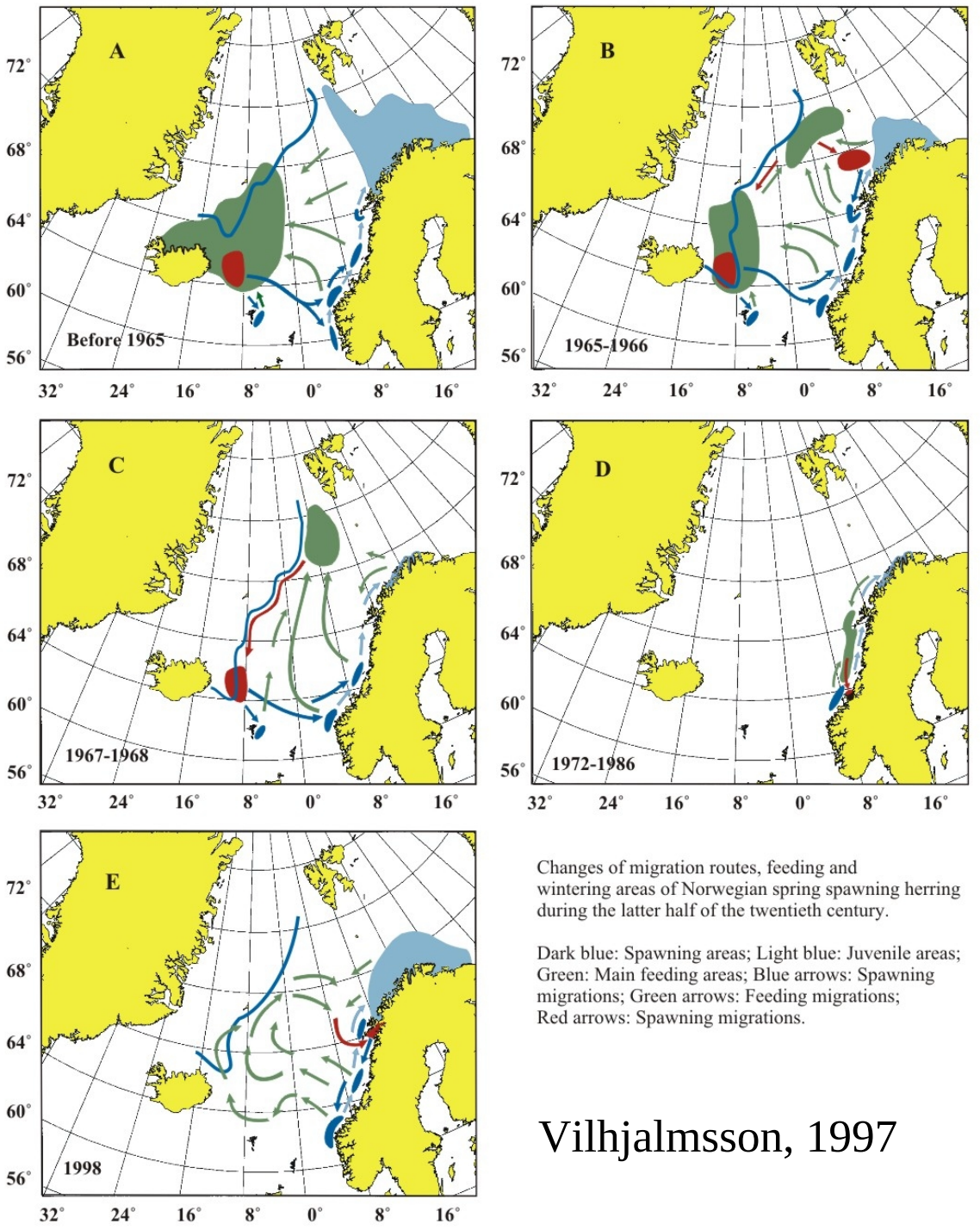
Toresen and Østvedt, 2000



Russian benthic studies revealed a retreat of Arctic species and an increase in the number of boreal species along the Murman coast such that the relative amount of boreal species doubled.



Atlantic Herring

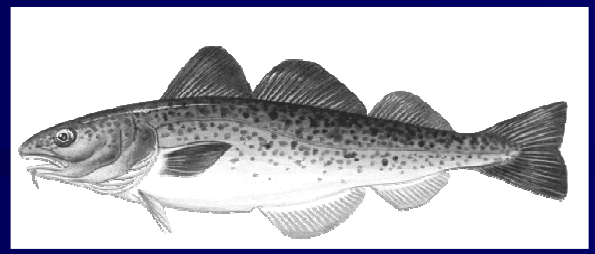


Changes of migration routes, feeding and wintering areas of Norwegian spring spawning herring during the latter half of the twentieth century.

Dark blue: Spawning areas; Light blue: Juvenile areas; Green: Main feeding areas; Blue arrows: Spawning migrations; Green arrows: Feeding migrations; Red arrows: Spawning migrations.

Vilhjalmsson, 1997

Svalbard



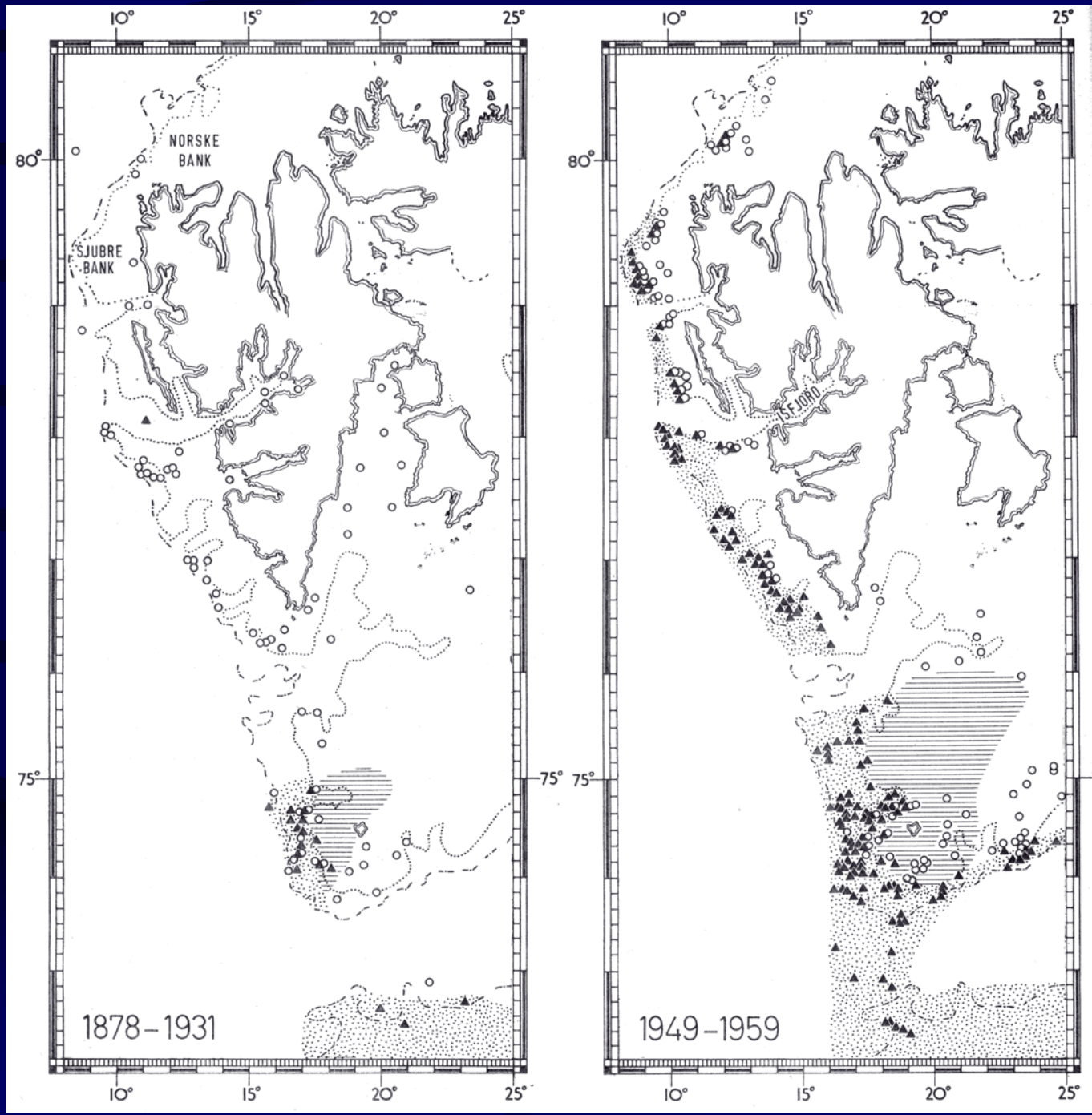
Atlantic cod spread northward into the area off West Svalbard in large numbers during the 1920s.

Comparison of benthos prior to the 1930s with those of the 1950s indicated that Atlantic species spread northward by approximately 500 km.

Benthic Species

○ Arctic

▲ Atlantic



Blacker, 1957

Conclusions

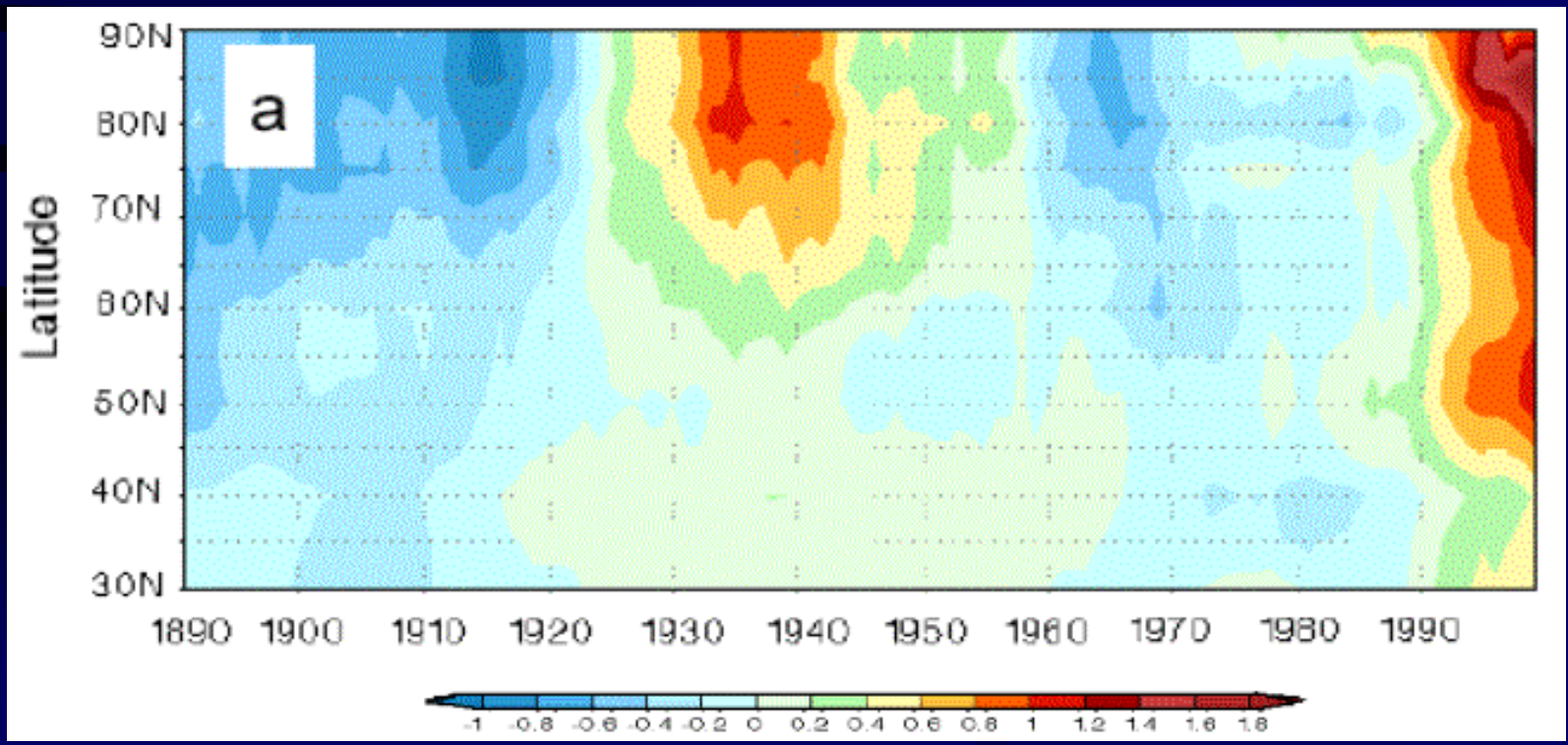
- Increased occurance of rare warm-water species
- Northward displacement of the distribution of major fish species
- Changes in migratory patterns
- Increased abundance of many species including cod, halibut and herring
- Changes in spawning locations
- Reports of changes in growth rates

Further Changes

- Although not discussed there were also reports of biological responses to warming in the 1920s and 1930s
  - In the English Channel (Southward 1963; Crisp 1965)
  - In the North Sea (Beverton and Lee, 1965)
  - In the Baltic (Segerstråle, 1957)
  - Off Labrador (Tånning, 1952)

Comparisons with the 1990s

- Similar amplitude of warming in the 1990s in the Northern North Atlantic but not yet as long in duration.



Comparisons with the 1990s

- History of heavily exploited stocks such as cod and herring.

- In spite of this we are beginning to see many similarities in the ecosystem responses.

This includes….

Comparisons with the 1990s

- Northward displacement of commercial and non-commercial species
  - In North Sea northward at rate of 7 km per year over 1990s, 7 times faster than on land (Allison, 2004)
- Increased occurance of rare warm-water species
  - Because warming extends farther south there have been tropical species observed in traditionally temperate regions

Comparisons with the 1990s

- Northward displacement of spawning sites
  - E.g. Atlantic cod off Norway (Sundby and Nakken, 2004)
- Changes in the migratory patterns
  - E.g. Norwegian spring spawning herring have moved back towards Iceland to feed.

The 1920s and 1930s warming provide strong evidence of bottom up effects although the mechanisms are unclear and most likely are related to food.