PICES ASC, Portland, Oregon, USA

October 23, 2010

Ecosystem Responses to Climate Forcing and Fishing between the Labrador Sea and the Norwegian/Barents Seas

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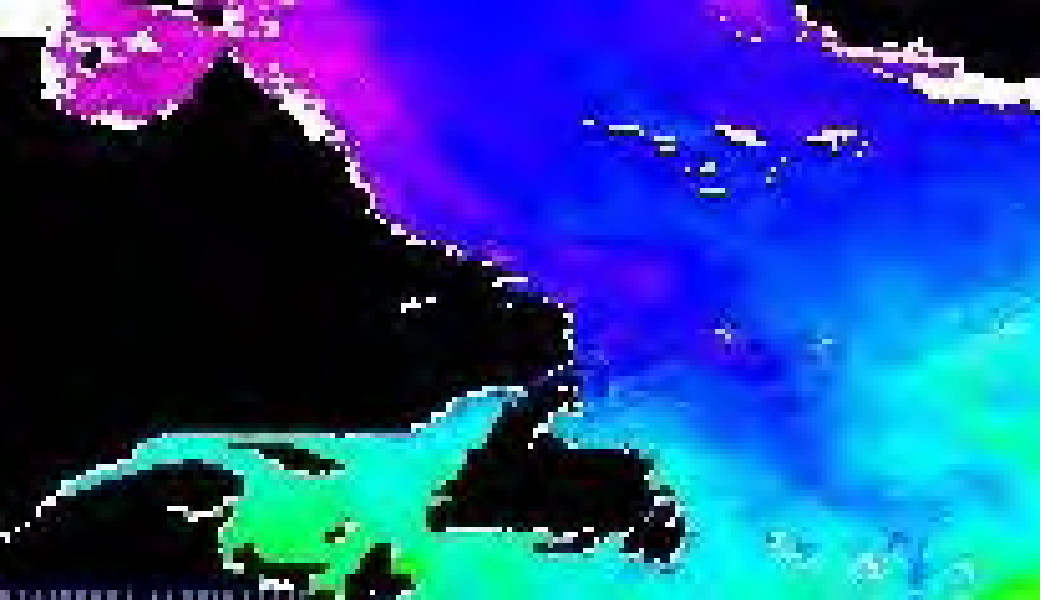
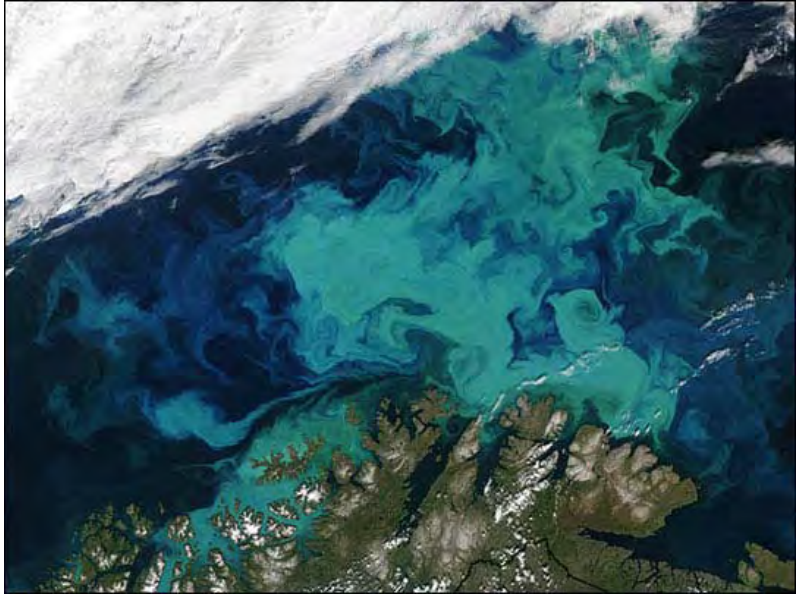


SSTs in the Labrador Sea



Coccolithophore Bloom at the eastern entrance to the Barents Sea

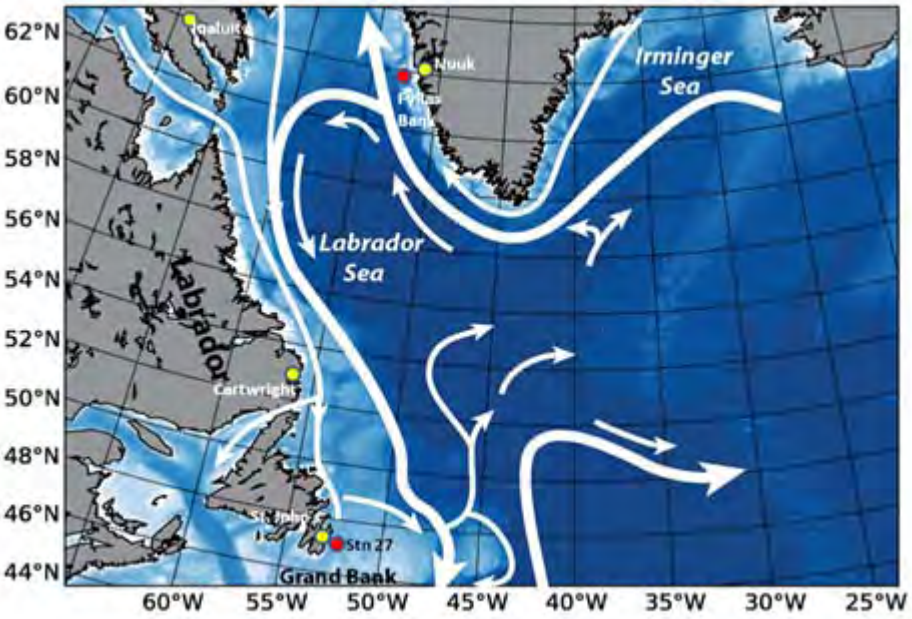
- From the NORway-CANada Comparisons of Marine Ecosystems (**NORCAN**) Project by **IMR** and **DFO** under **ESSAS**
- Special NORCAN volume in Progress in Oceanography to come out in 2011
- Comparative papers on physical oceanography, phytoplankton, zooplankton, capelin (3) and cod will be included.

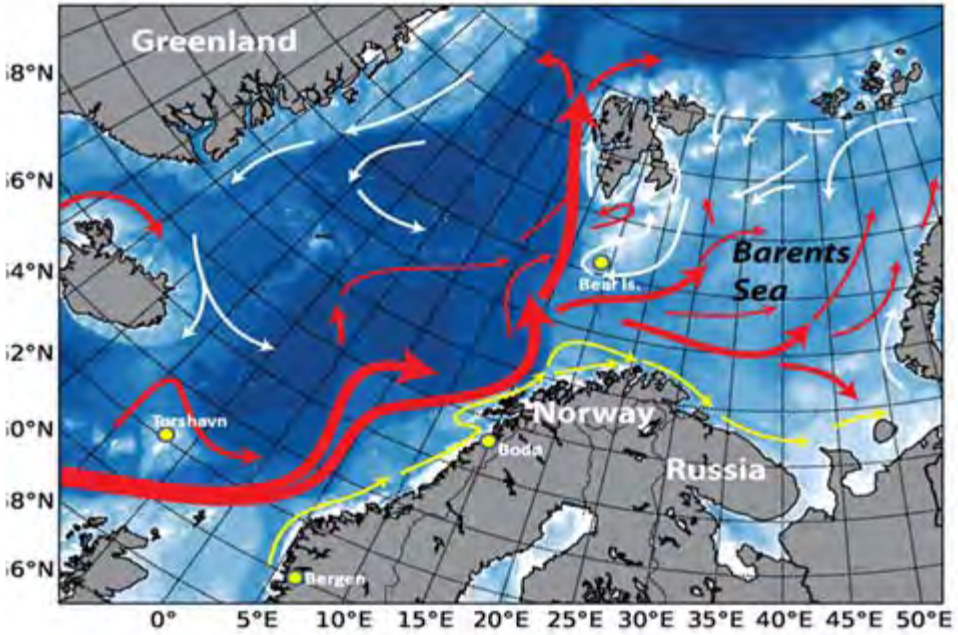
INSTITUTE OF MARINE RESEARCH

NORCAN

Ecosystem Studies of Sub-Arctic Seas
ESSAS

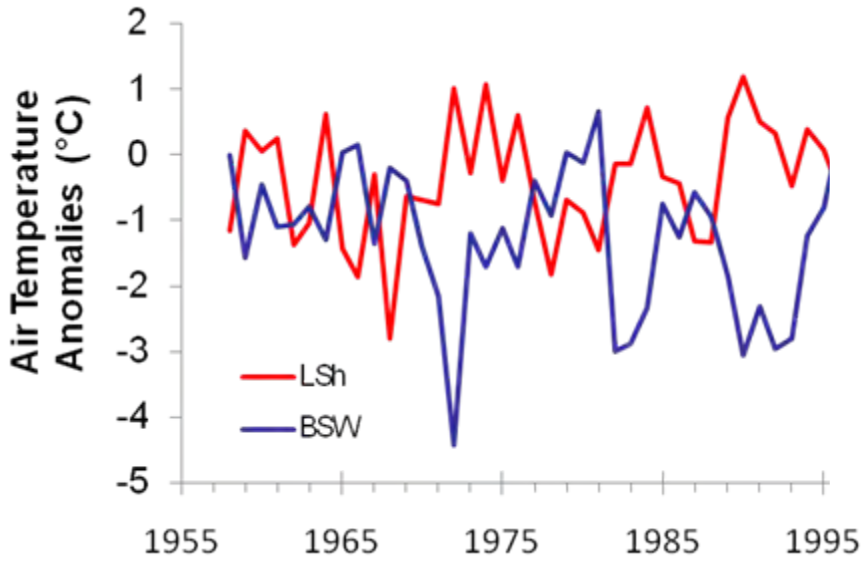
Background

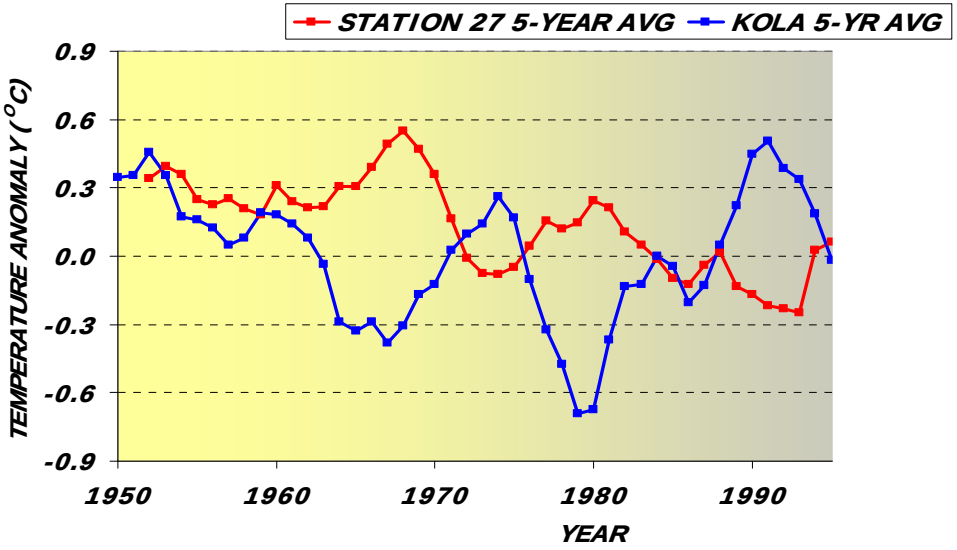




•**Currents**: Both advective systems. Norwegian/Barents seas are dominated more by warm currents from the south while Labrador Sea is dominated more by cold currents from the north.

Temperature Comparisons

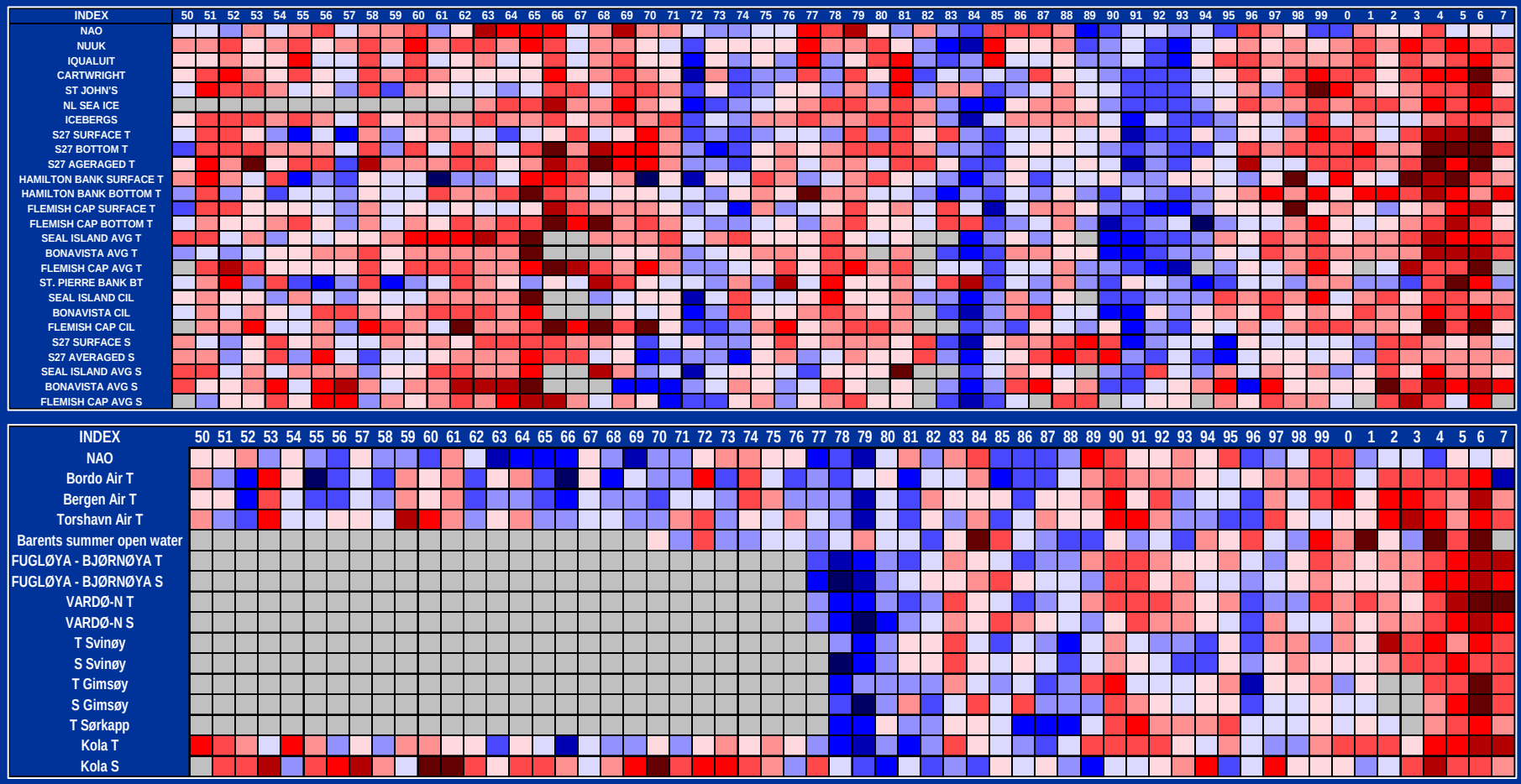




Past studies have documented the out of phase relationship between temperature conditions in Labrador with those in the Barents Sea associated with the NAO…

but recently both regions show warming sea tempertures.

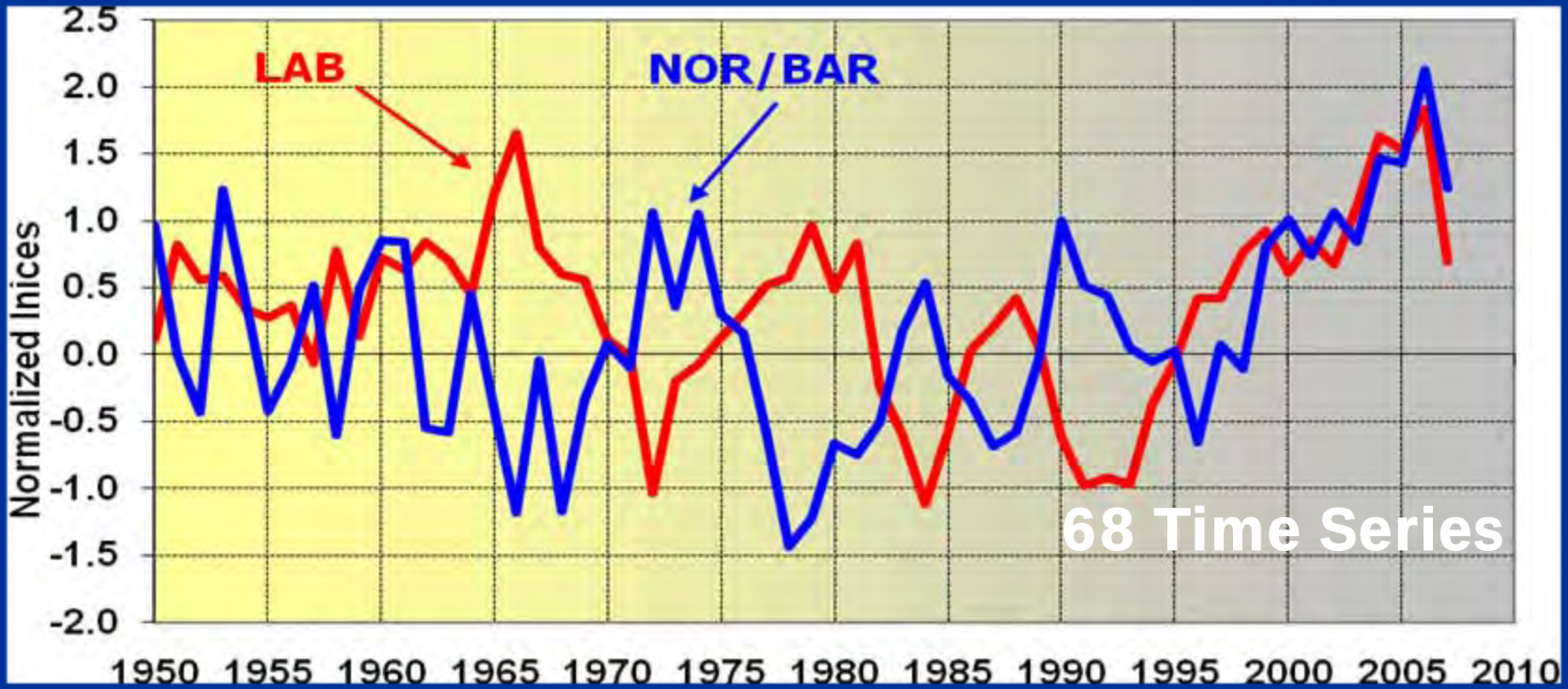
STANDARIZED CLIMATE ANOMALIES

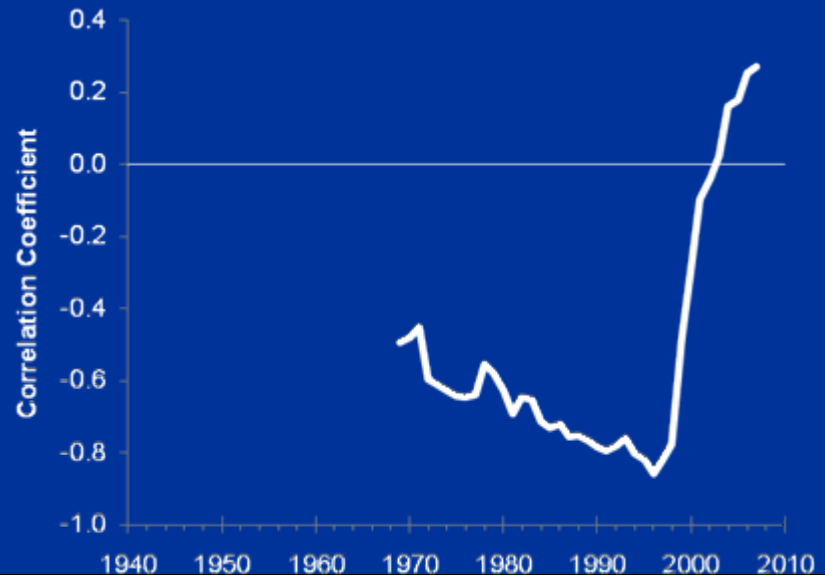


STANDARD DEVIATIONS

			← COLD/FRESH			WARM/SALTY →					
<-2.5	-2.5 to -2.0	-2 to -1.5	-1.5 to -1.0	-1.0 to -0.5	-0.5 to 0.0	0.0 to 0.5	0.5 to 1.0	1.0 to 1.5	1.5 to 2	2.0 to 2.5	>2.5

Standardized Climate Index





20-Year Running Correlation Coefficients of Standardized Climate Indices

Drinkwater et al., in press

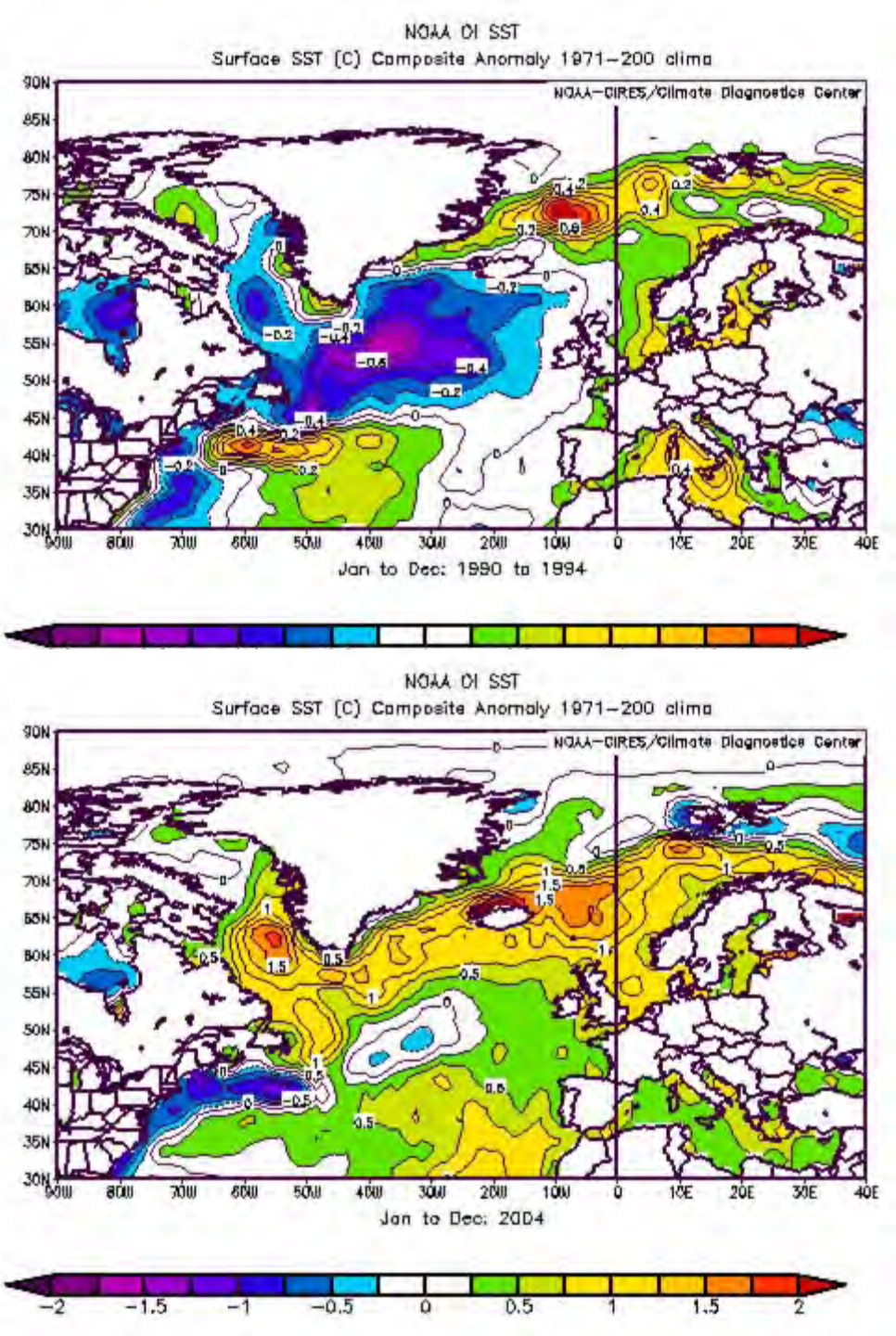
SST Anomalies in the North Atlantic during 1990-1994

HISTORICAL PATTERN- COLD IN WEST WARM IN EAST

NOAA Optimum Interpolation SST, NOAA-CIRES Climate Diagnostics Center

SST Anomalies in the North Atlantic during 2004

BROAD-SCALE WARMING

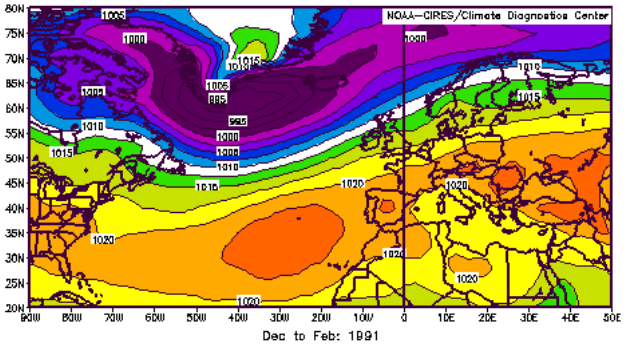


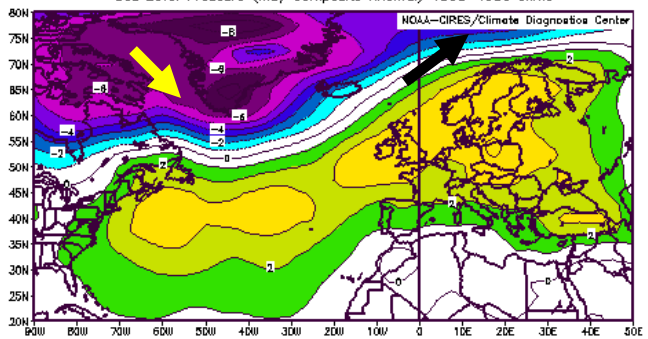
NORTH ATLANTIC WINTER SLP FIELDS

MEAN

ANOMALY

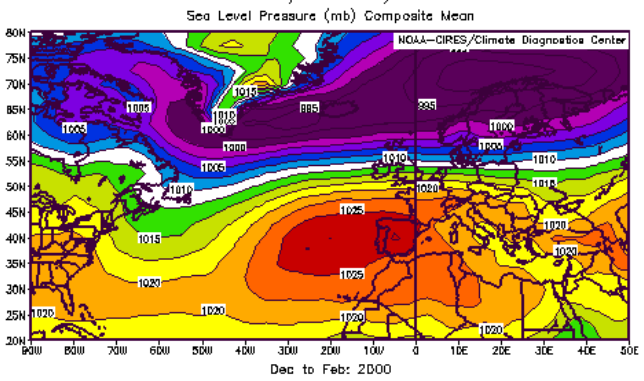
1991

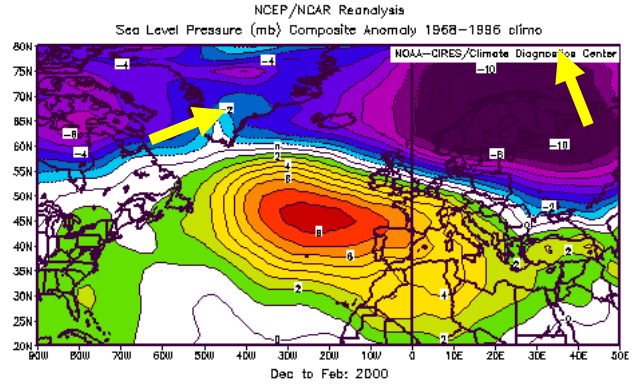




HISTORICAL PATTERN- COLD IN WEST WARM IN EAST

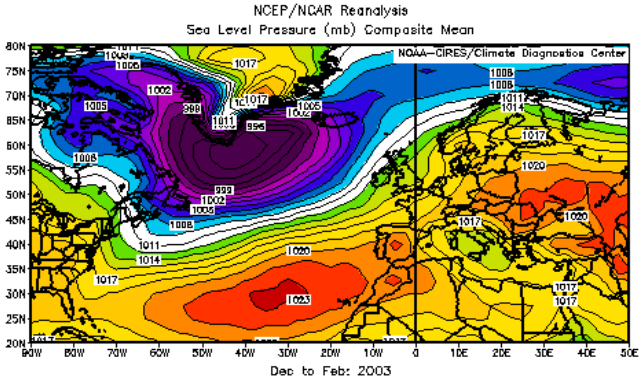
2000

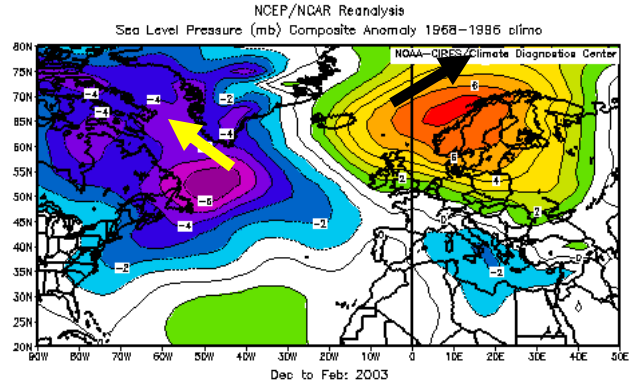




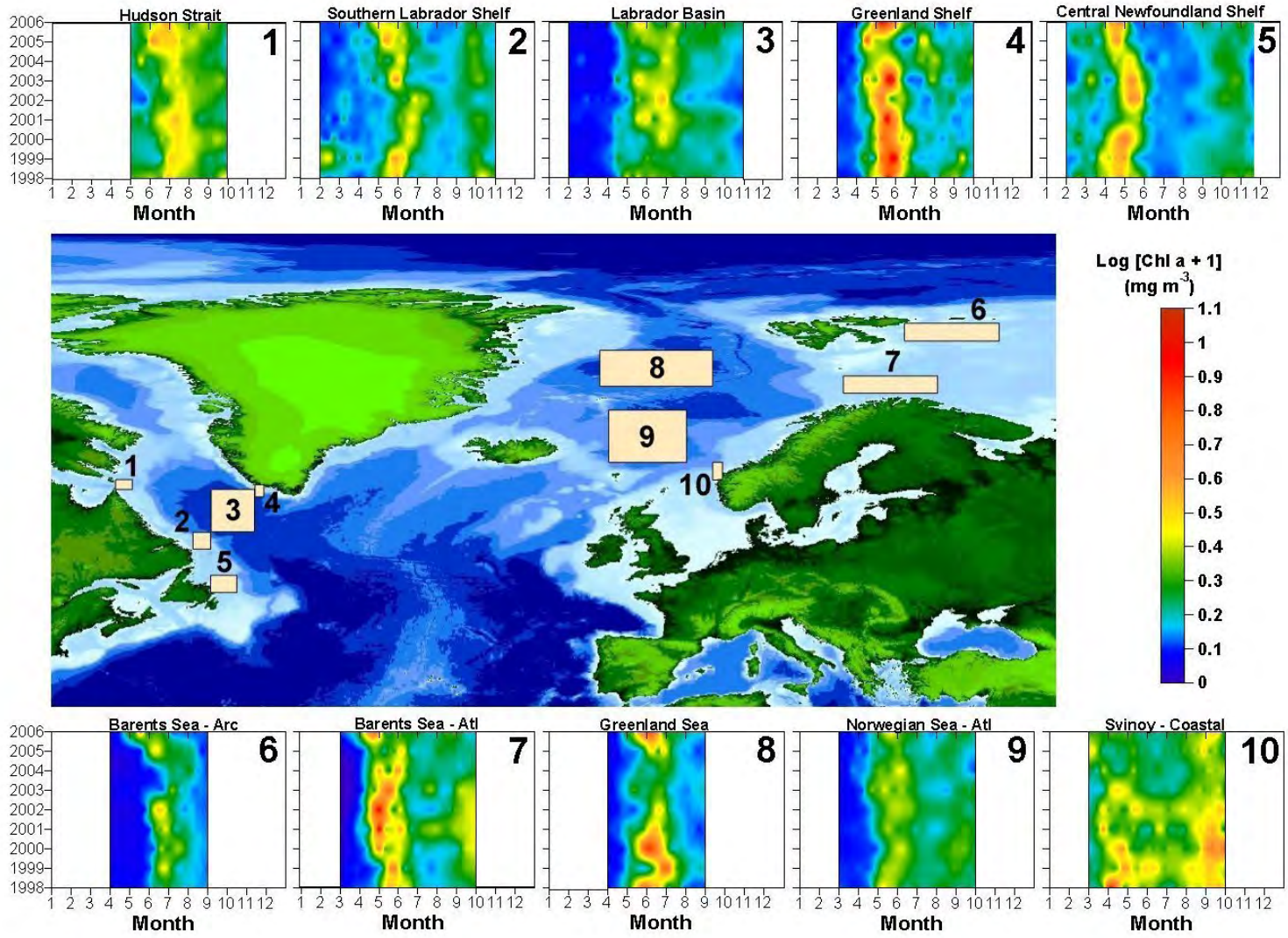
EASTWARD DISPLACEMENT

2003





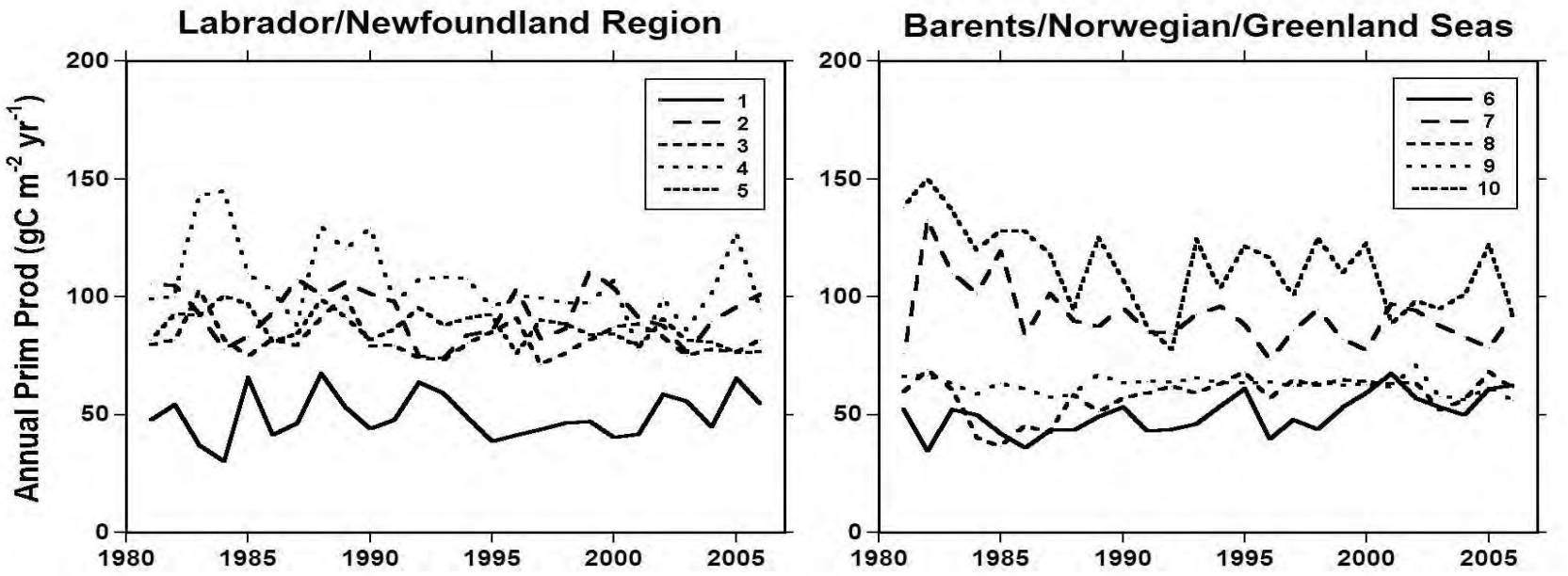
Chlorophyll-a Variability



Blooms starting earlier in recent years especially in higher latitudes.

Harrison et al., in press

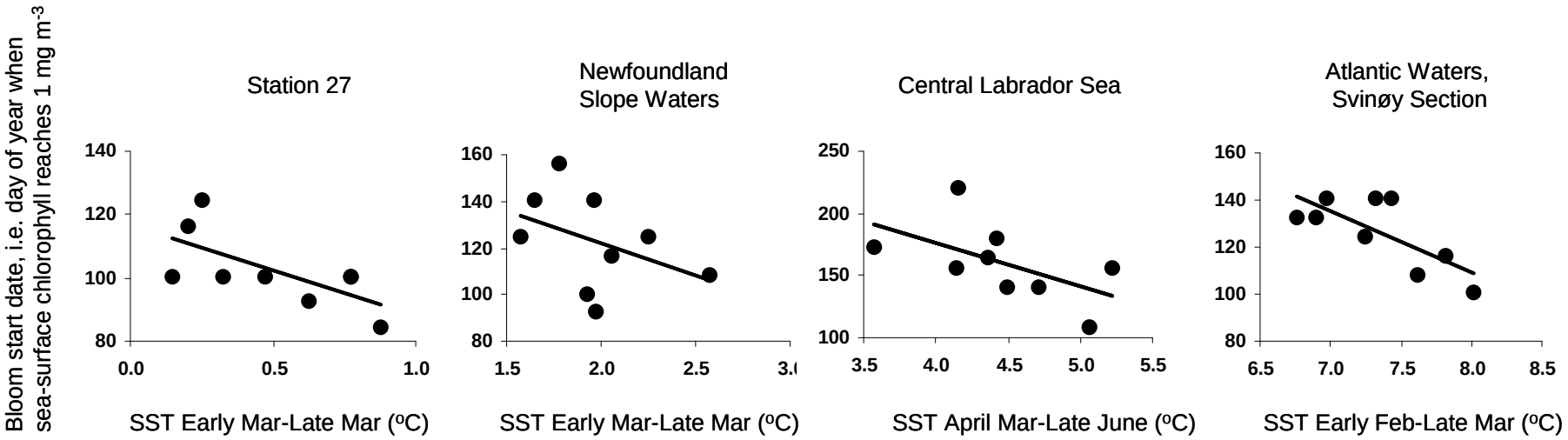
Primary Production



There was a slight (but not statistically significant) increase over time in primary production at the northern-most sites (northern Labrador Shelf, polar domain of the Barents Sea) and a decrease in the Norwegian coastal waters and Atlantic domain of the Barents sea: no temporal trends are apparent at the other sites. Overall, a slight negative trend in annual primary production for both Canadian waters and the eastern sub-arctic seas.

Harrison et al., in press

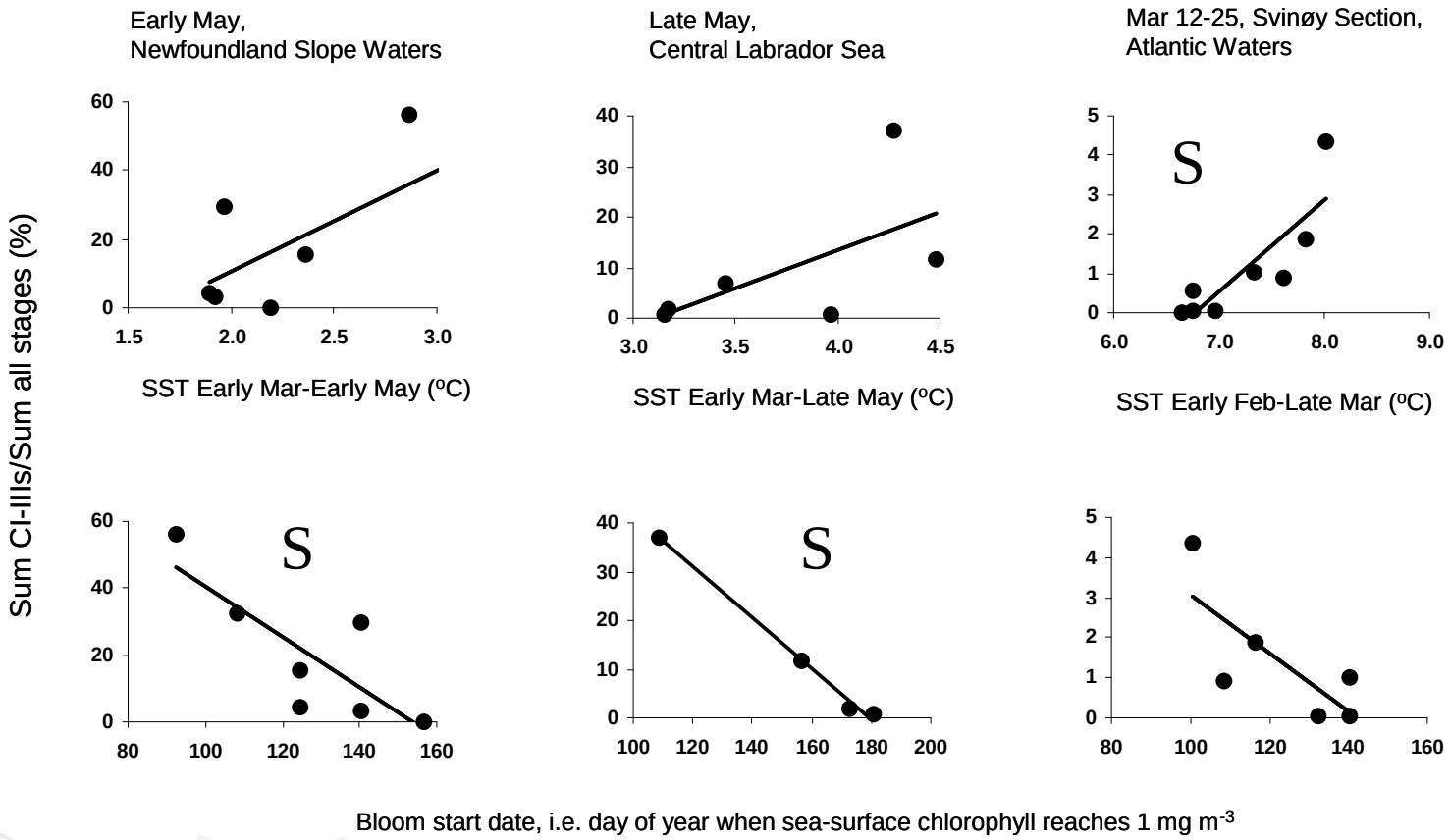
SSTs affect on Timing of Spring Bloom



Blooms start earlier during years with higher temperatures.

Head et al., in press

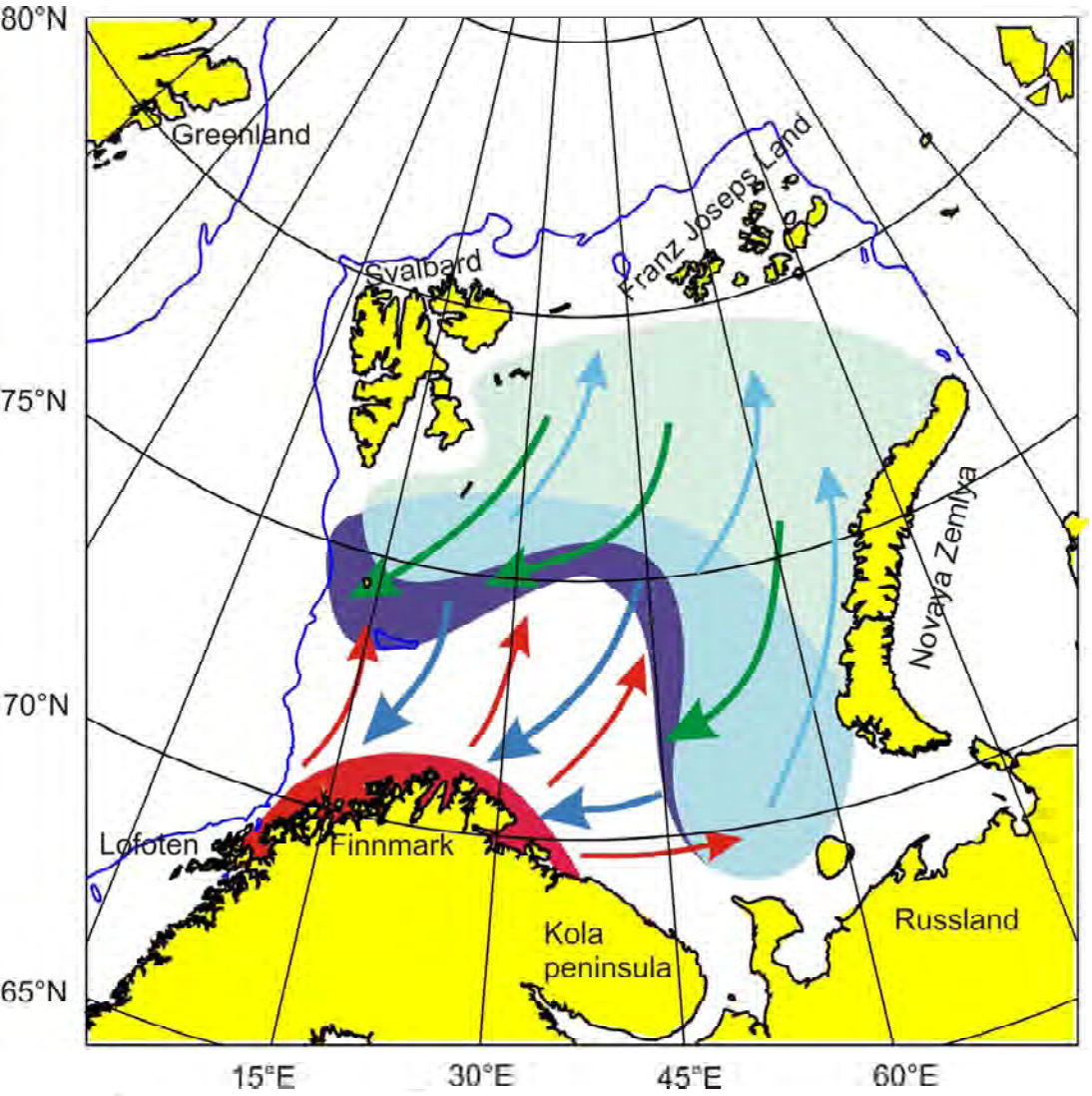
Zooplankton Responses



Tendency to have more young stages of *Calanus finmarchicus* in late April to early June with higher temperatures and an earlier bloom in several subareas of the two regions.

Head et al., in press

Capelin Distribution Barents Sea

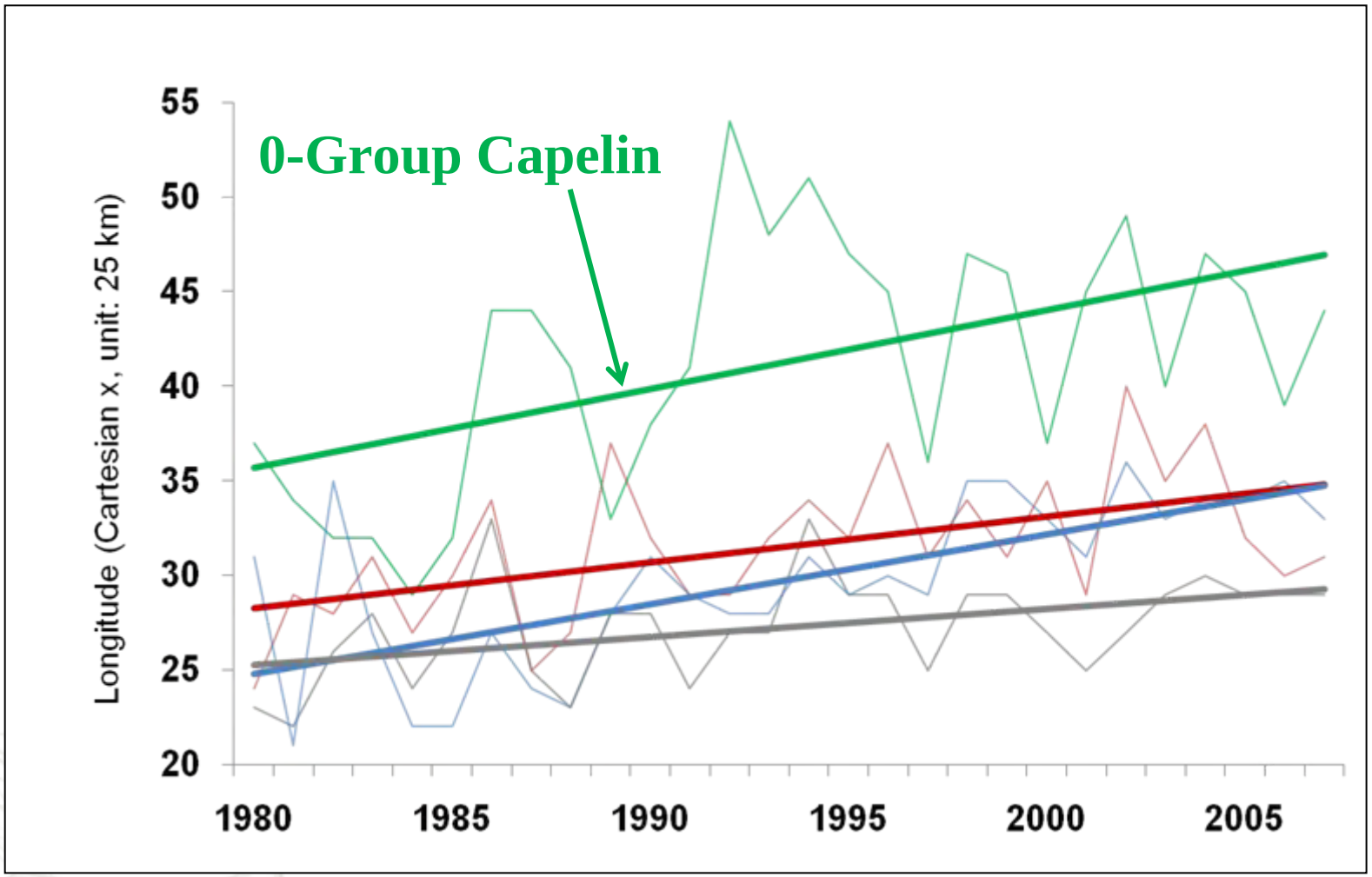


Areas
Red – Spawning
Dark Blue – Overwintering
Light Blue – Young feeding
Light Green – Adult feeding

Arrows
Red – Larval drift
Light Blue – Adult feeding Migration
Green – Winter migration
Dark Blue – Spawning Migration

Cascardden et al. a, in press

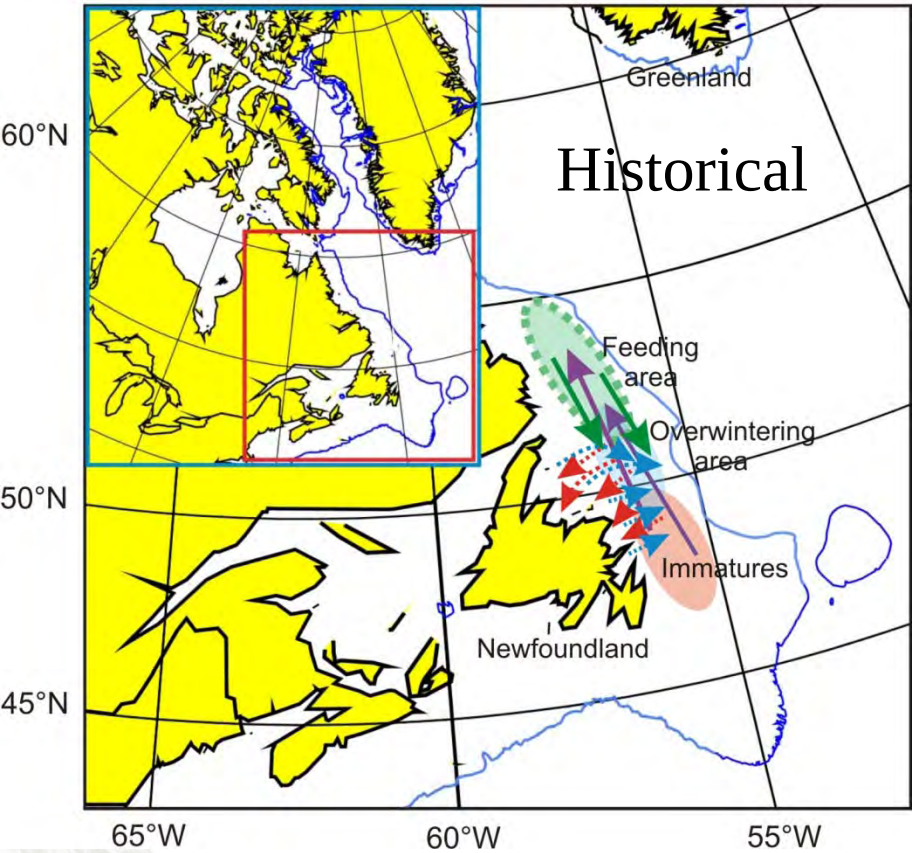
Capelin Distribution Barents Sea 2

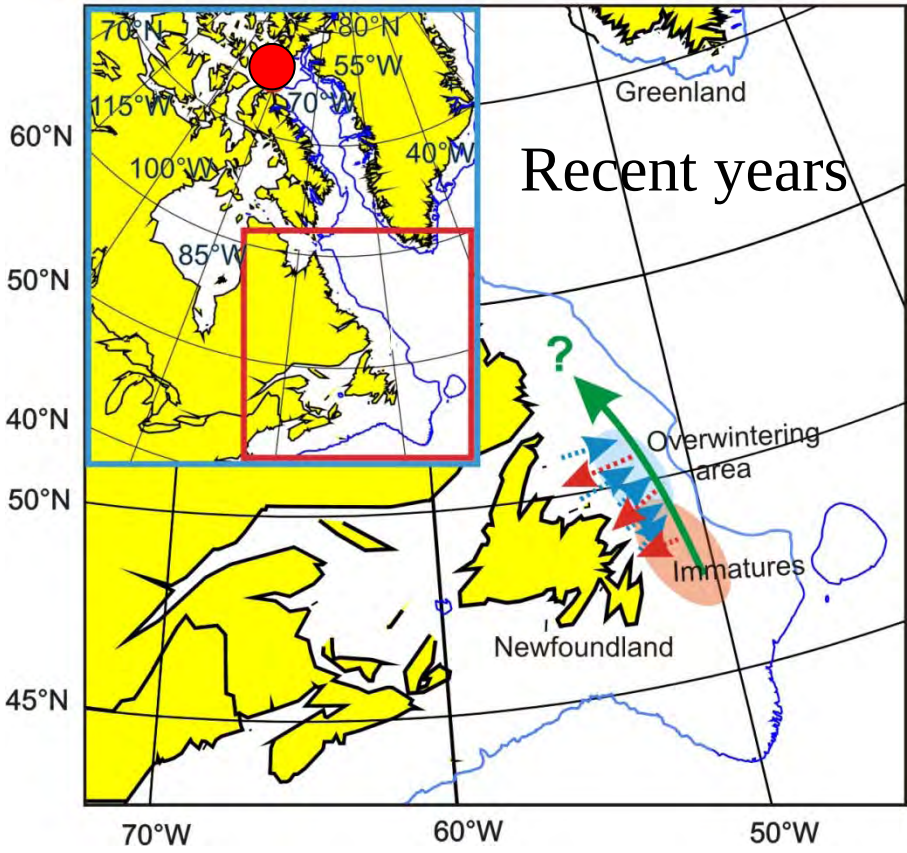


Distributional shift eastward of approx. 220 km.

Johansen and Stiansen (2009) Unpubl.

Capelin Distribution Newfoundland

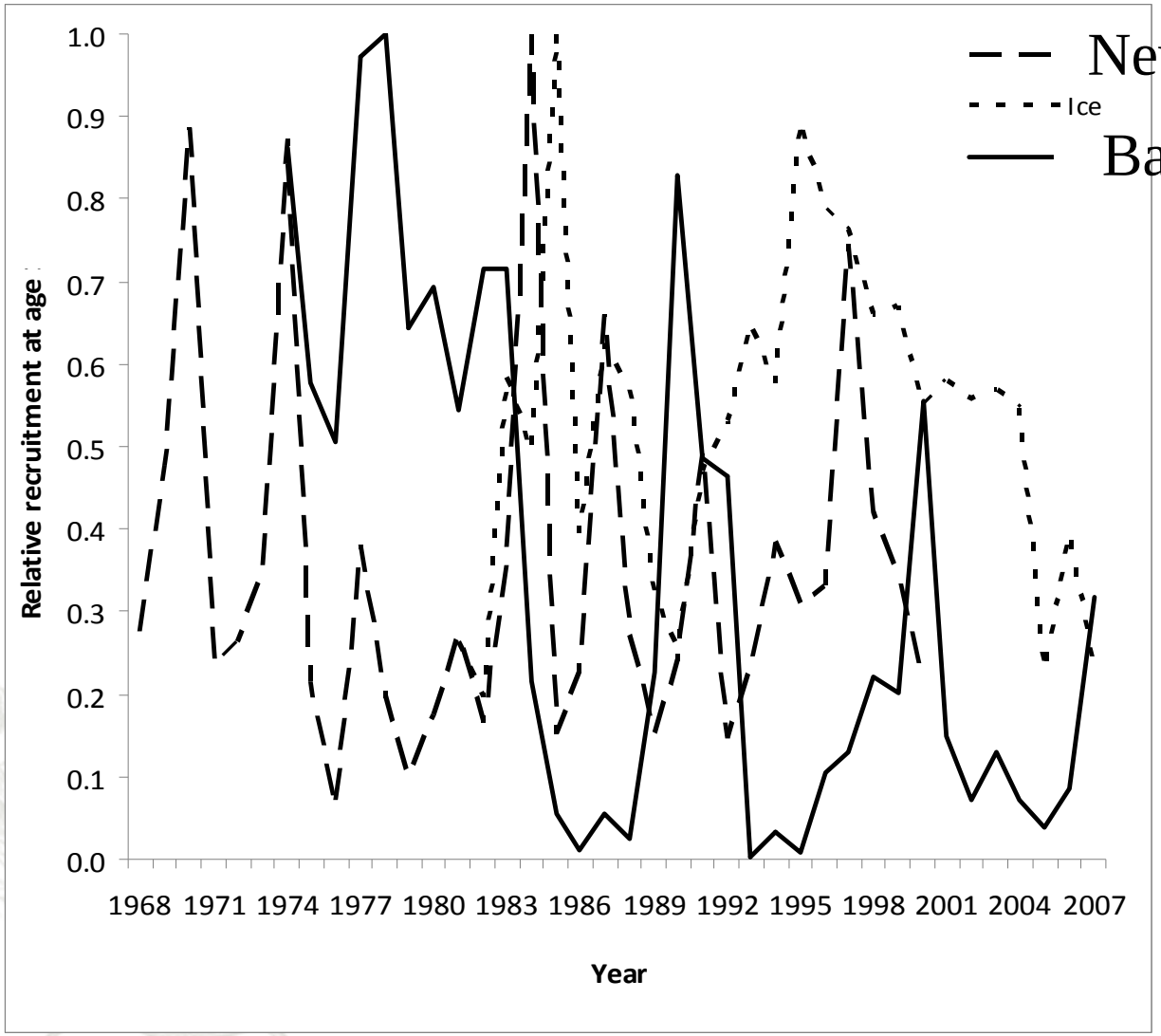




Arrows: red-migration of maturing capelin; blue-larvae to offshore juvenile areas; purple-maturing fish to feeding areas; green - movement to overwintering areas of maturing fish. In the inset, the red dot marks the location of Lancaster Sound where capelin were observed in seabird diets.

Carscadden et al. a, in press

Capelin Recruitment Responses

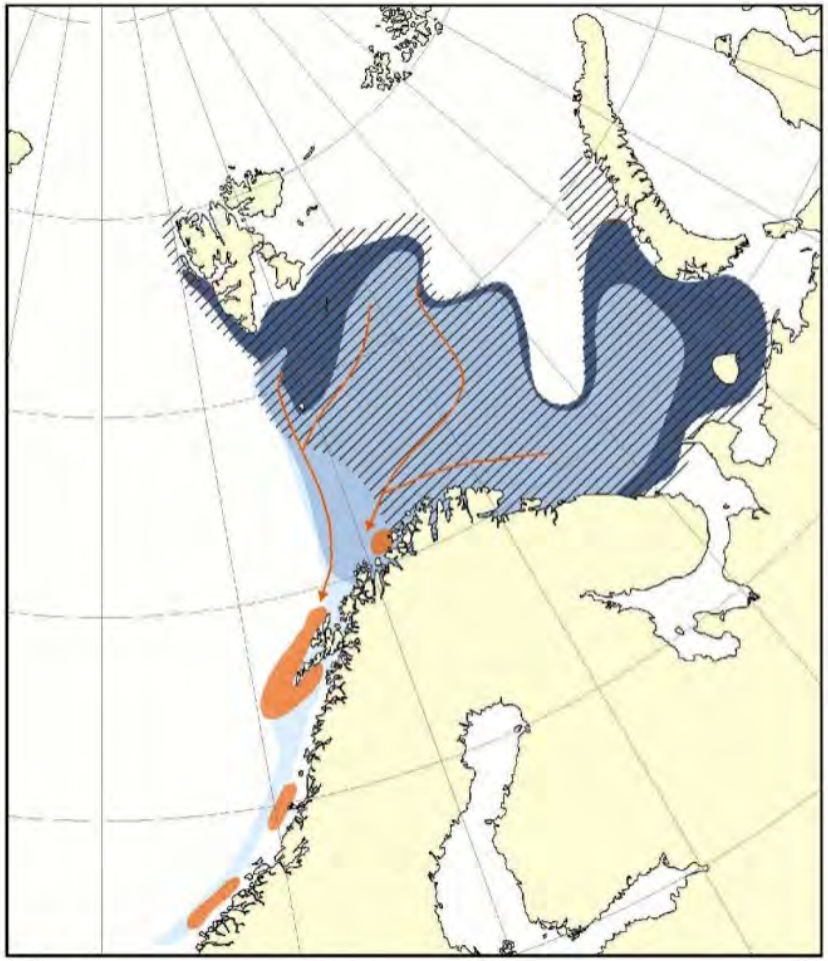


Barents Sea- SSB, herring predation, temperature (?)

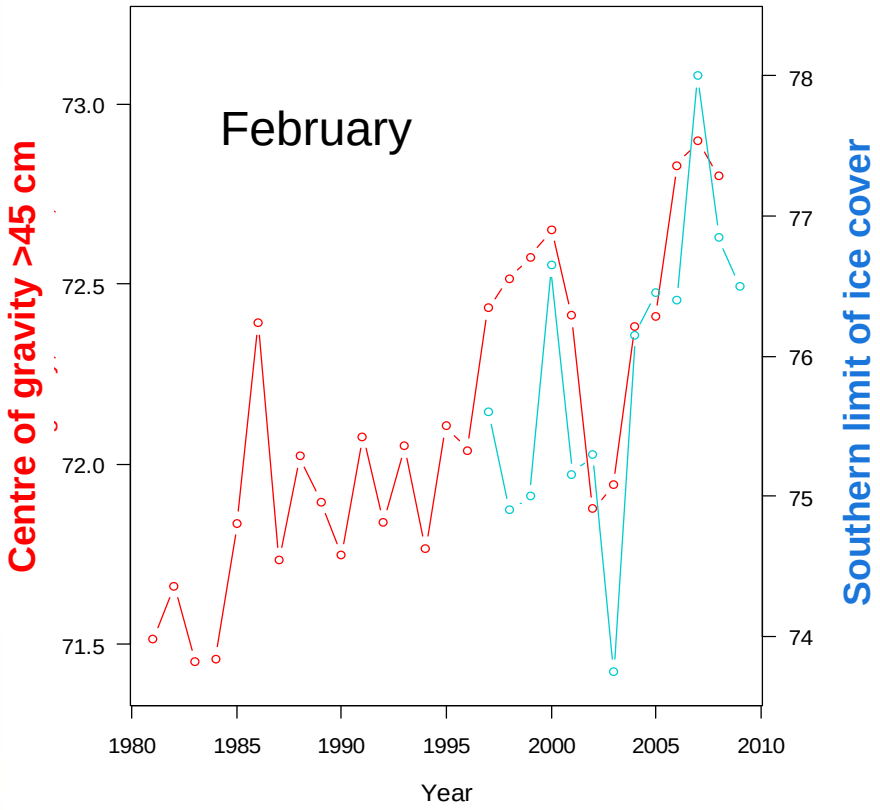
Newfoundland- Low abundance, no predation, winds, temperature (?)

Carscadden et al. b, in press

Cod Distribution Barents Sea

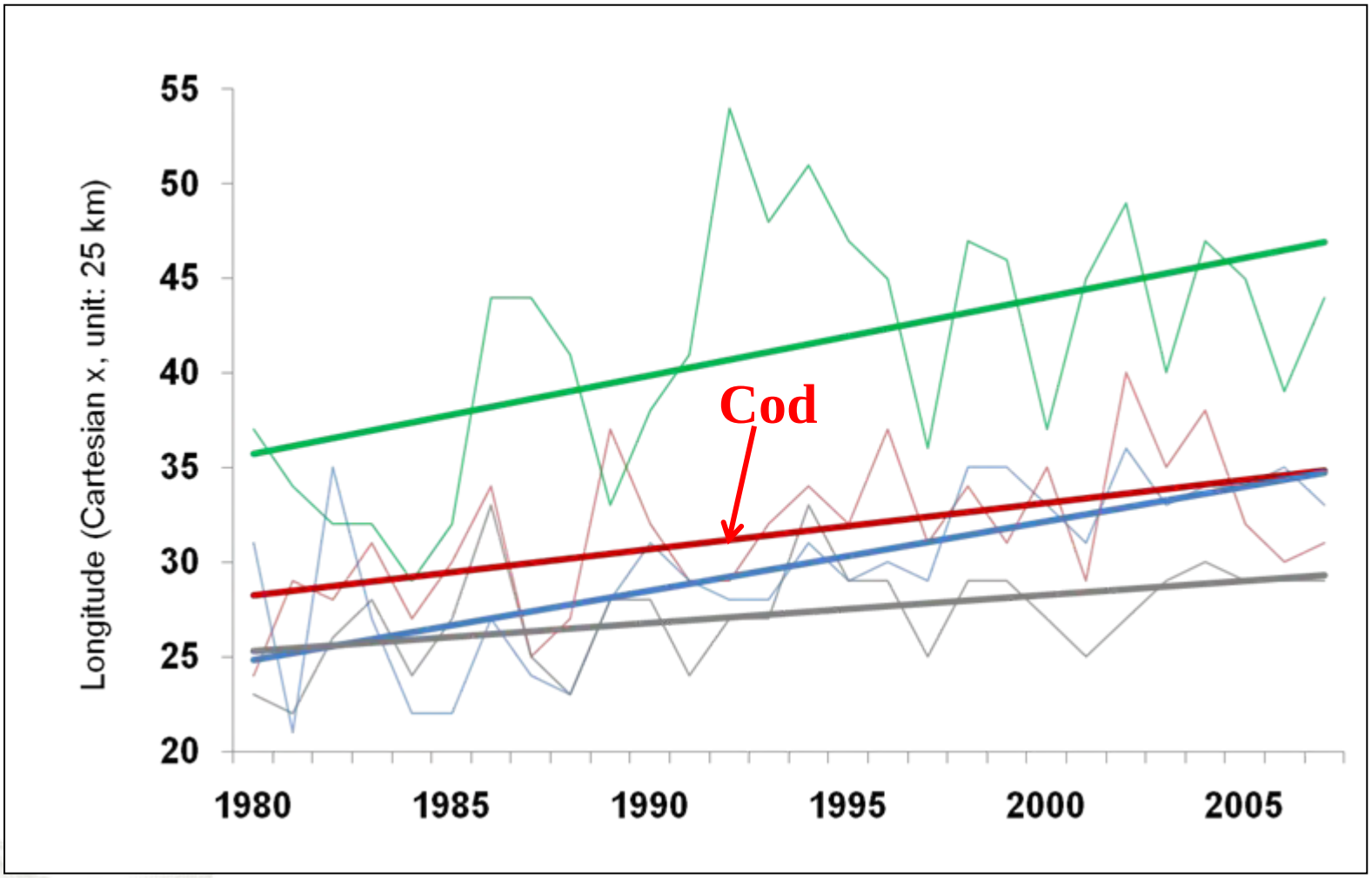


Wintering area
Feeding area
Nursery area
Spawning areas
Spawning migration



Johansen and Stiansen (2009) Unpubl.

0-Group Cod Distribution Barents Sea



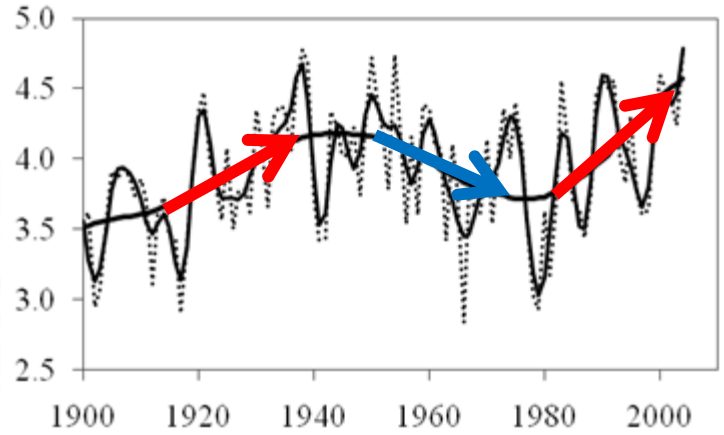
Distributional shift eastward of approx. 120 km.

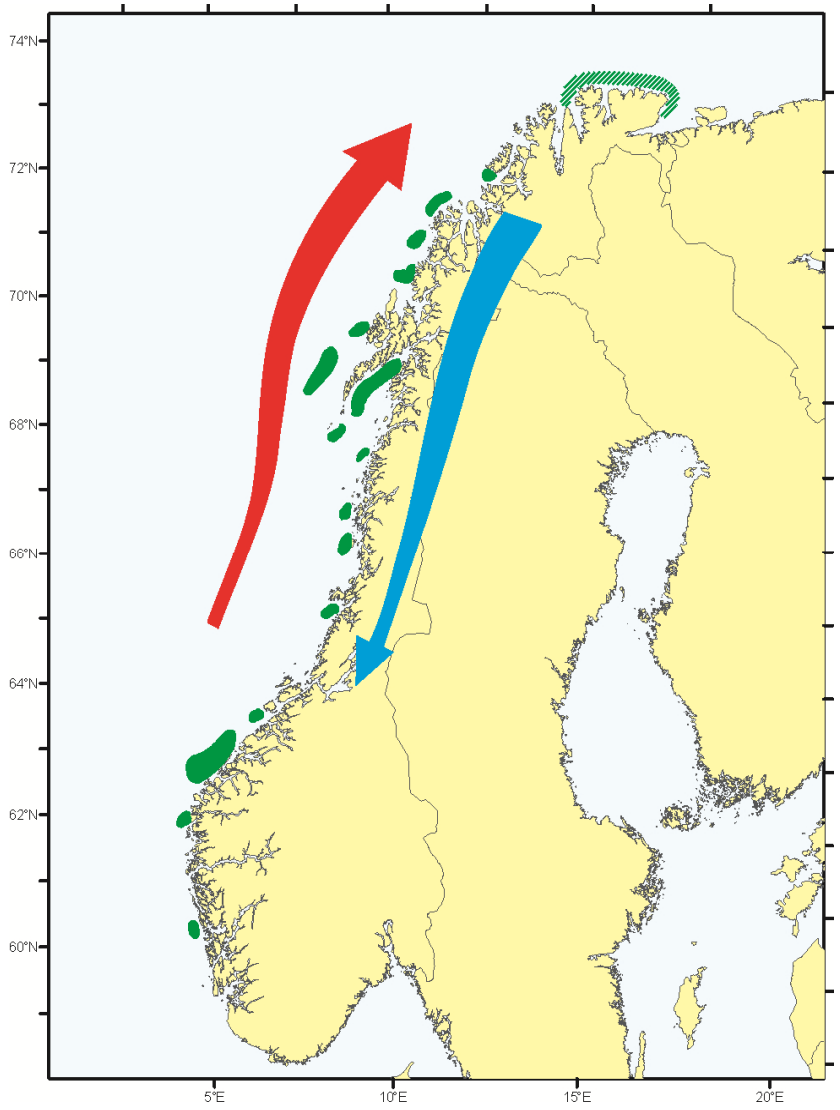
Johansen and Stiansen (2009) Unpubl.

Cod Spawning Sites

Warm periods
-NE Displacement
-Higher spawning biomass

Cold periods:
- SW Displacement
- Lower spawning biomass

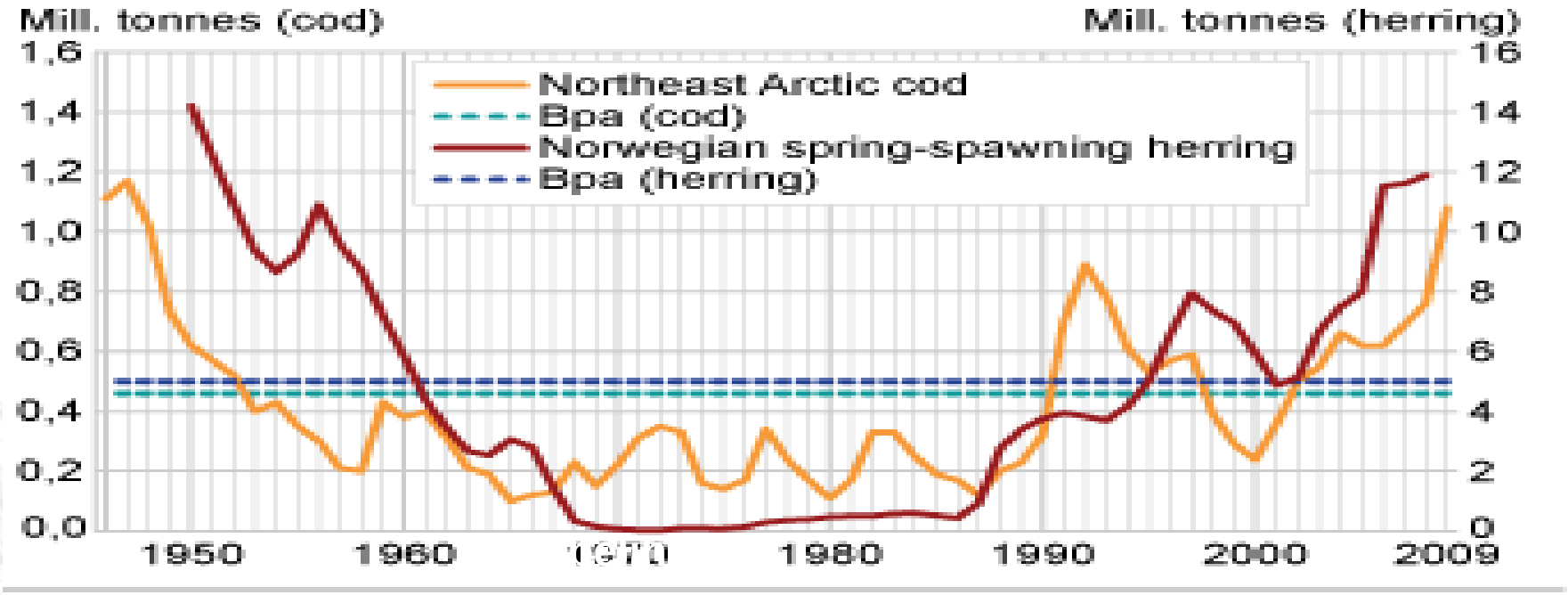




Sundby and Nakken (2008) IJMS

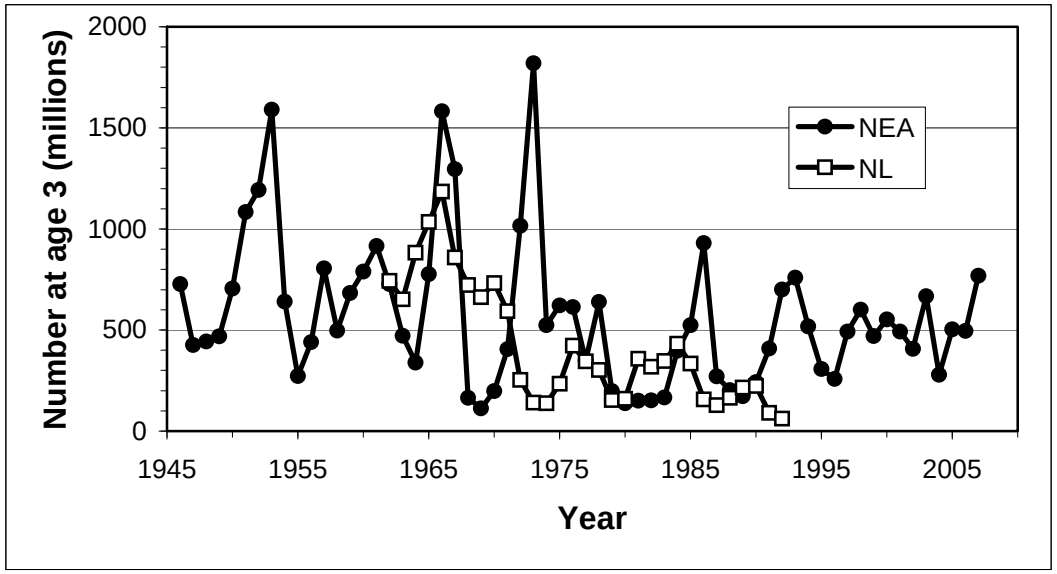
Cod Abundance

Size of spawning stock of Northeast Arctic cod and Norwegian spring-spawning herring, compared with the precautionary reference points (Bpa). 1946-2009. Million tonnes

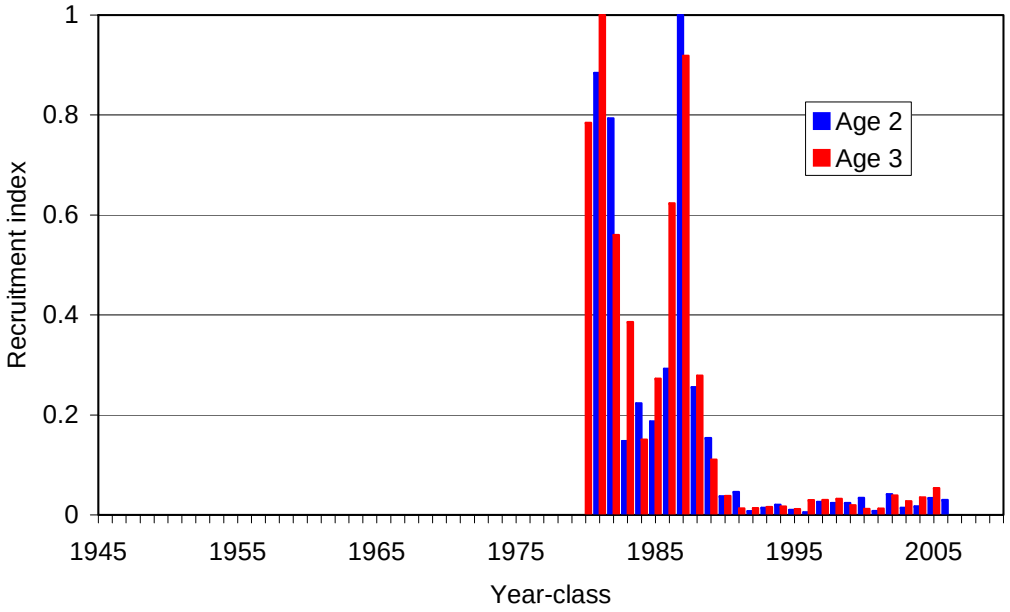


Source: Institute of Marine Research and ICES.

Cod Recruitment



Recruitment in NEA cod has been relatively stable for last decade or more.



Recruitment off Newfoundland has been very low since the collapse of the cod in the late 80s and early 90s.

Conclusions

- Recently both regions warming, increasing salinity, and reductions in sea ice coverage caused by changes in atmospheric pressure patterns and weakening of NAO forcing.
- Spring blooms occurring earlier, increased primary production in higher latitudes and lower in Norwegian Sea
- Abundance of early stage C. finmarchicus higher with earlier bloom and higher temperatures.

Conclusions 2

- Distributional shifts in capelin stocks, appears to be larger in Newfoundland/Labrador region although needs to have more data to confirm
- Distributional shifts in cod stock in Barents Sea and increase in abundance, some of which may have been helped by reduced fishing around 2000.
- Cod in Newfoundland/Labrador remain at very low levels.

Regime Shift or Not?

- Certainly see large-scale changes within North Atlantic from physics to fish
- Changes in distributional and abundance of major fish species
- I believe response primarily to plankton variability caused by climate variability, but fishing may also play a role
- Expect return to previous conditions if climate undergoes cooling (as observed in past)
- Would not consider recent events to be regime shift at this stage.


Thank you!