Climate Variability Impact on North Sea Ecosystem

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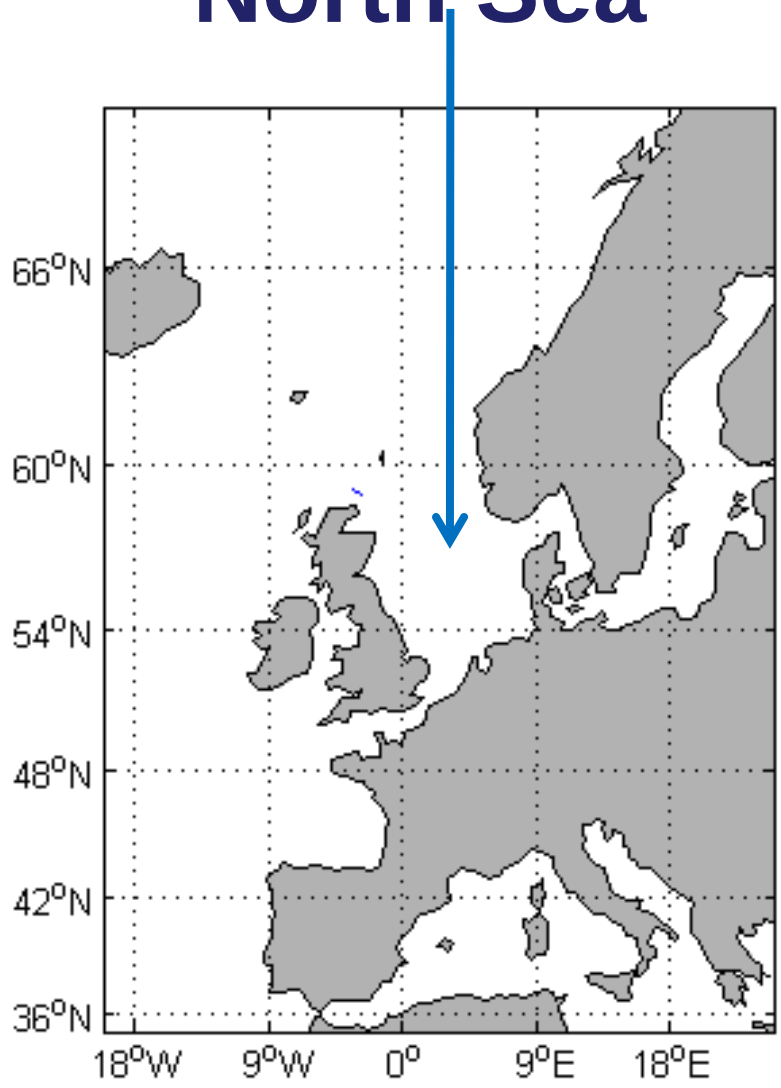
North Sea



Riparian countries:

United Kingdom, Belgium, Netherlands, Germany, Denmark, Norway

Catchment area

184 million people

Problems:

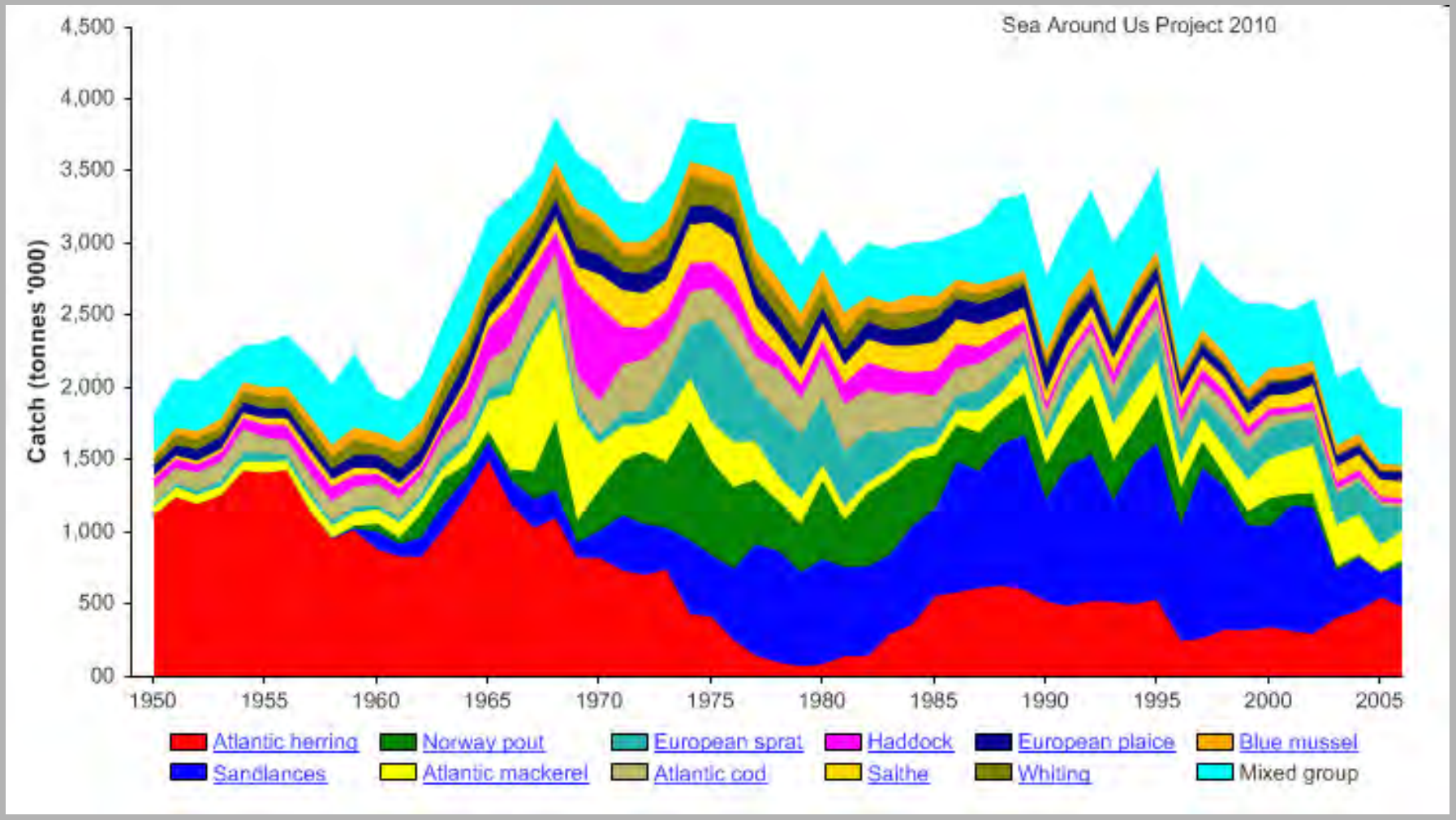
- overfishing
- important shipping lanes
- oil and gas exploitation
- tourism

Relatively **shallow** (average 90m), but Norwegian Trench 700m.

High flushing regime (1/3 annually)

Atlantic water input main factor affecting productivity

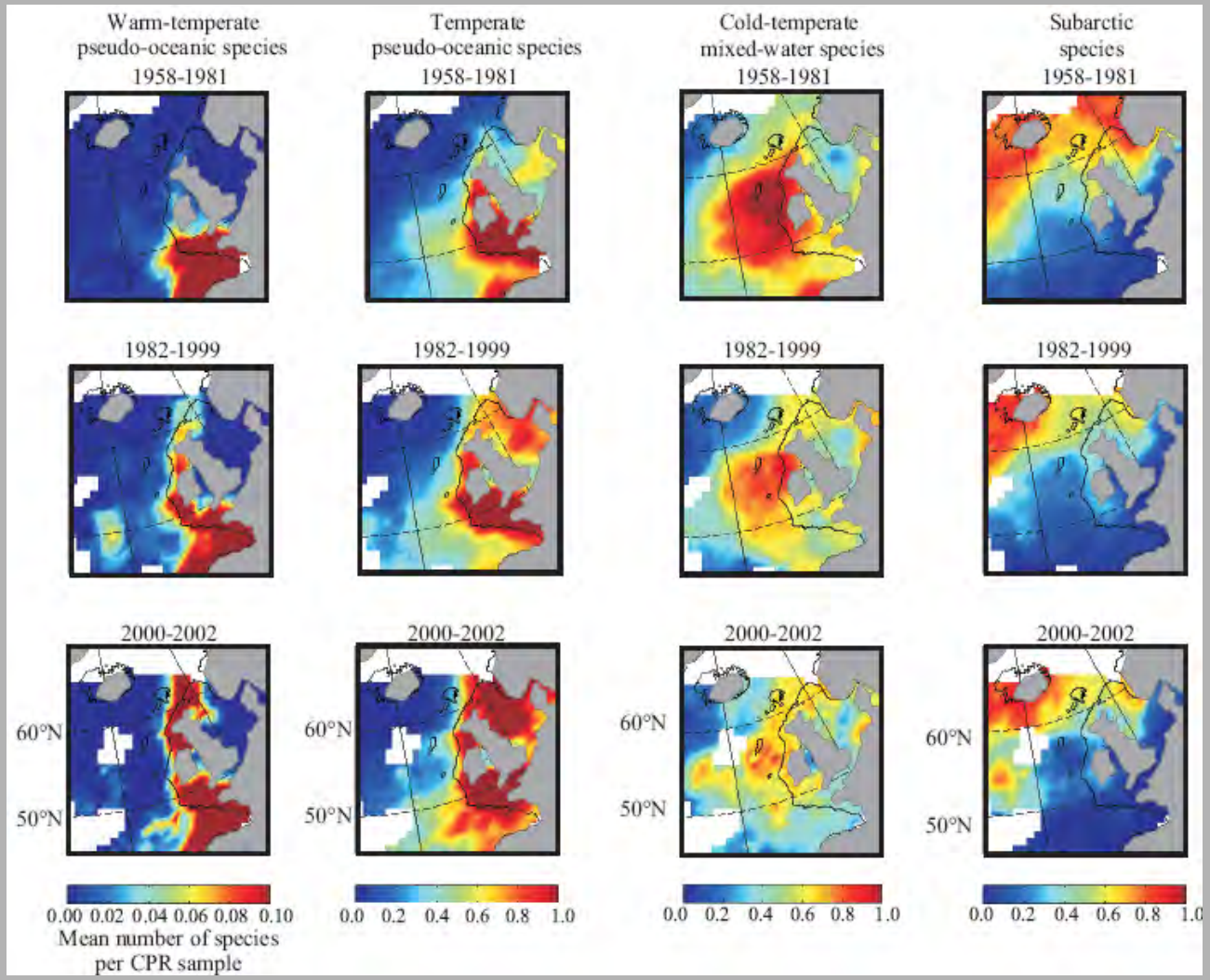
Landings by species in North Sea



Climate Forcing on North Sea

- Global Warming
- North Atlantic Oscillation (NAO - decadal)
- Atlantic Multi-decadal Oscillation (AMO)
- Contraction of Sub-polare Gyre (indirect forcing)

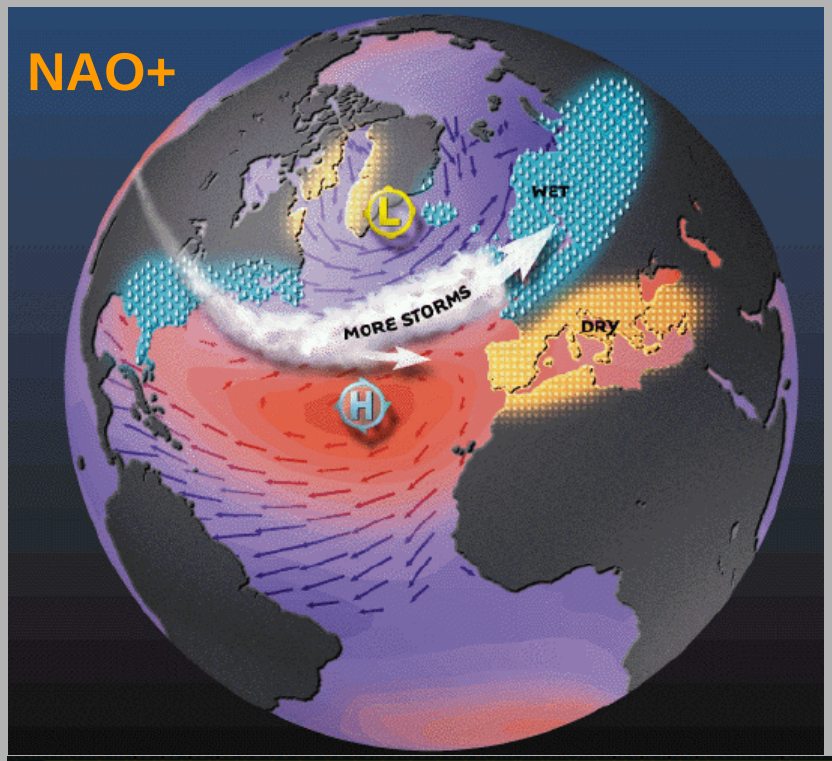
Global Warming

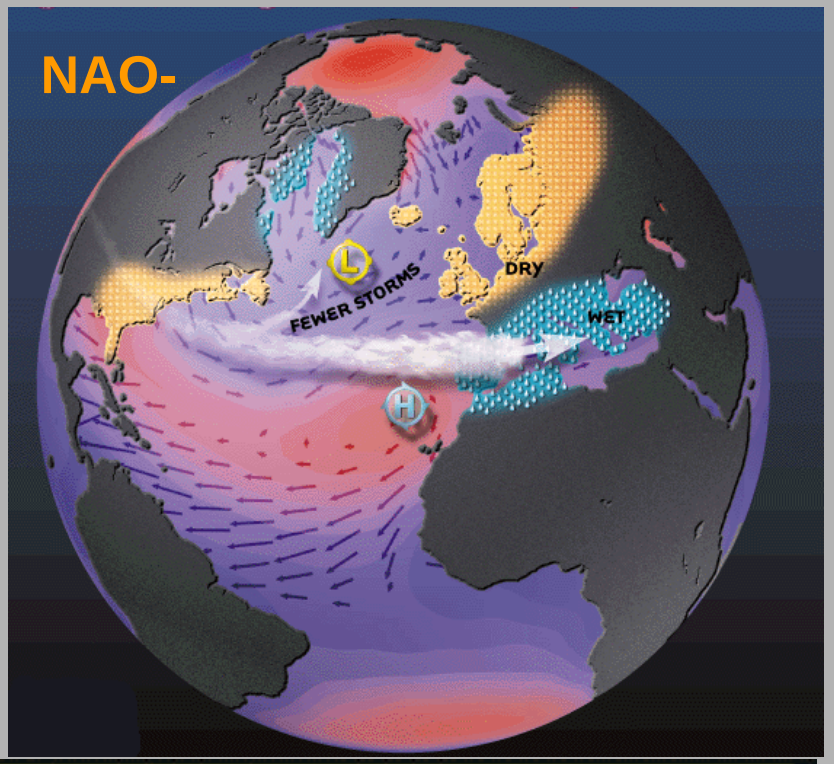


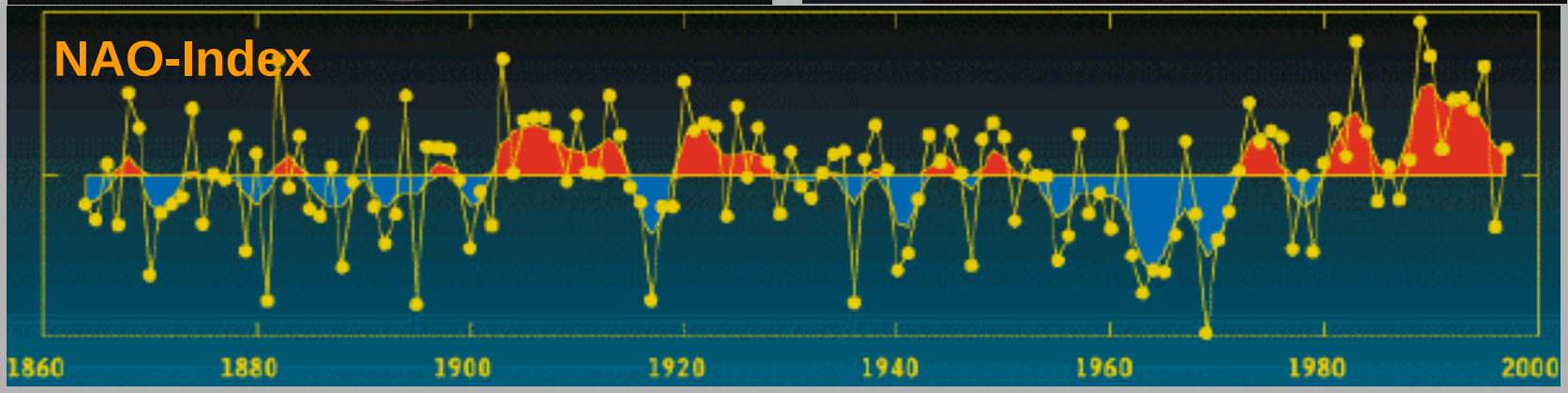
Decadal changes in distributions of Northeast Atlantic calanoid copepods

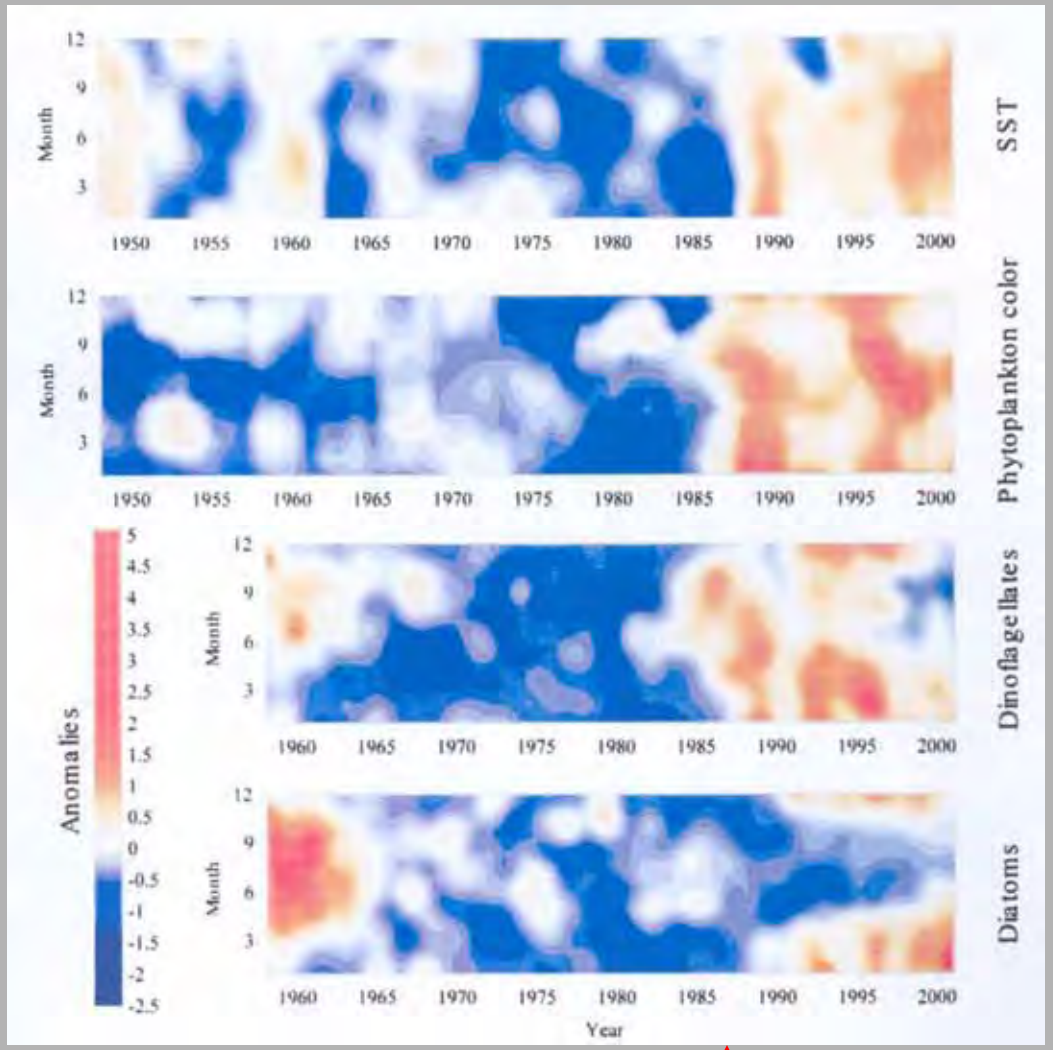
Beaugrand (2005)

http://www.ldeo.columbia.edu/res/pi/NAO/









SST

Phytoplankton colour

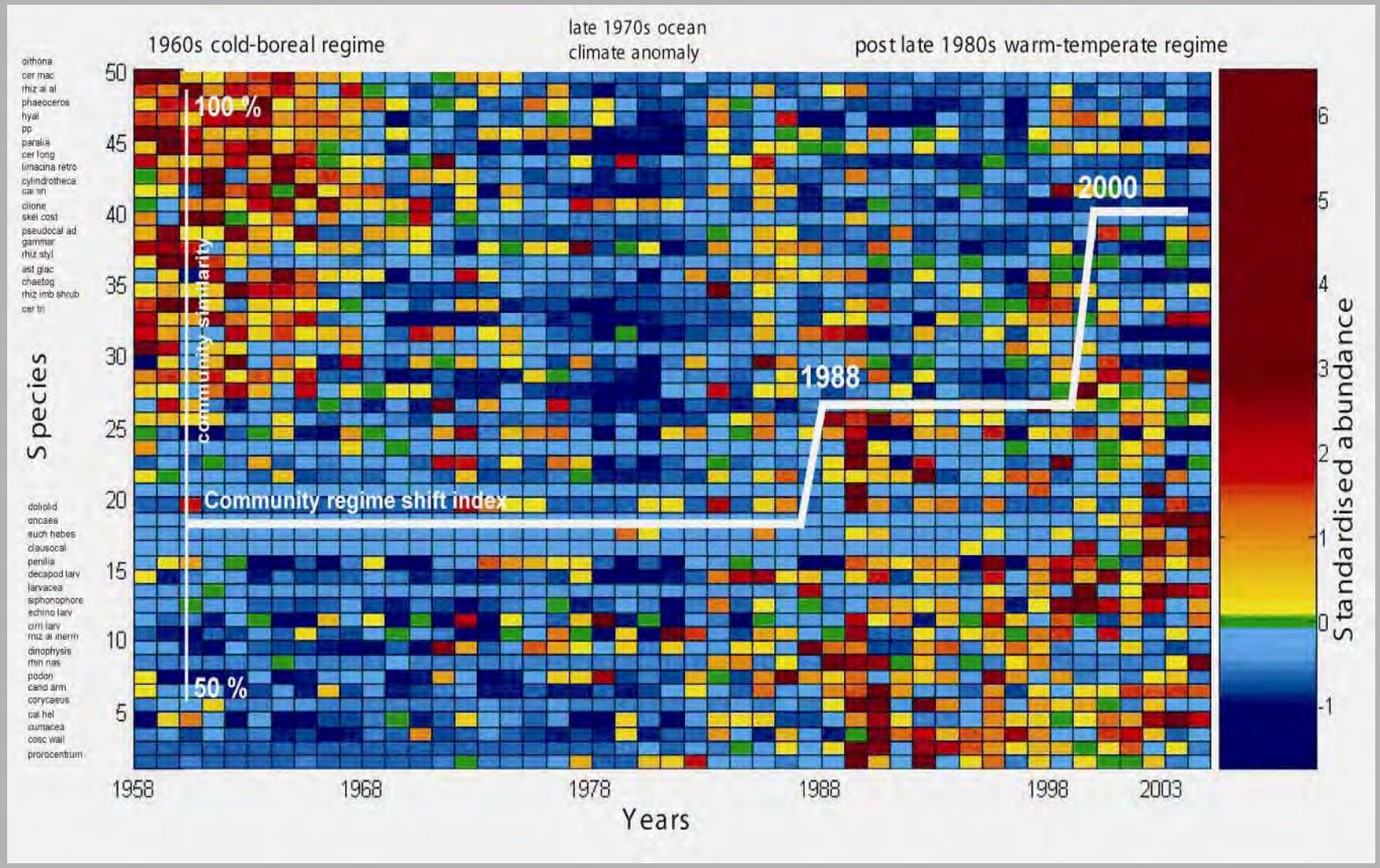
Dinoflagellates

Diatoms

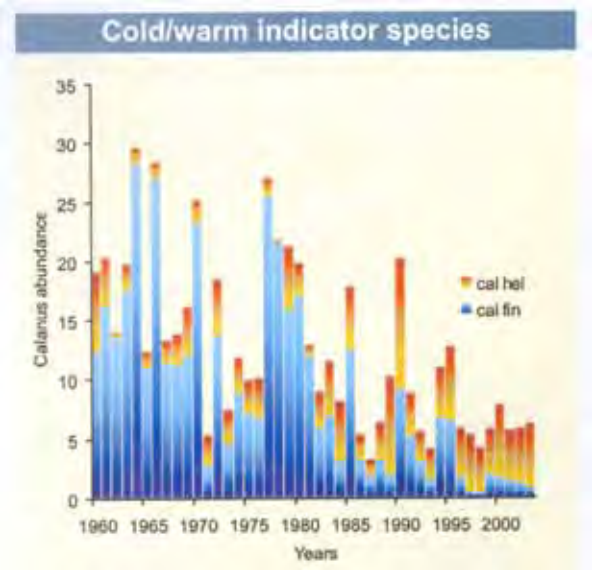
Central North Sea, anomalies:

Edwards and Johns 2006

Regime Shift Nordsee



Edwards et al., SAHFOS Techn. Rep. (2007) , CPR data

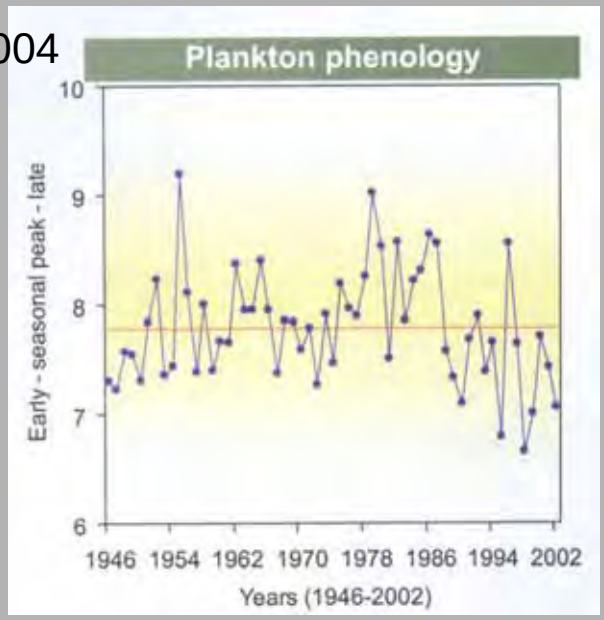


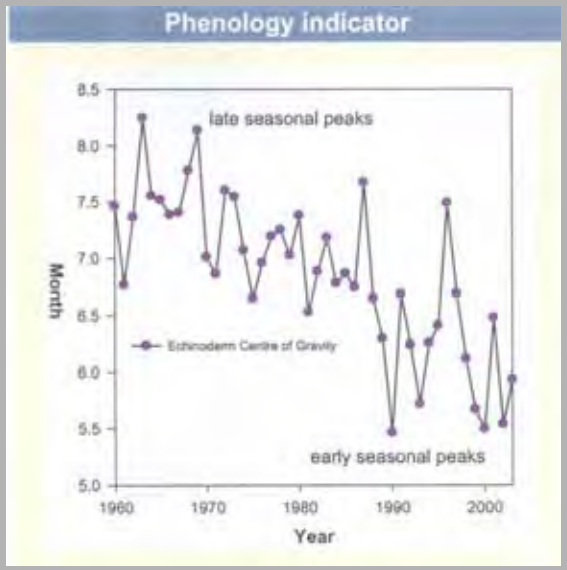
Calanus abundance

Edwards et al. 2005

Peak development of decapod larvae

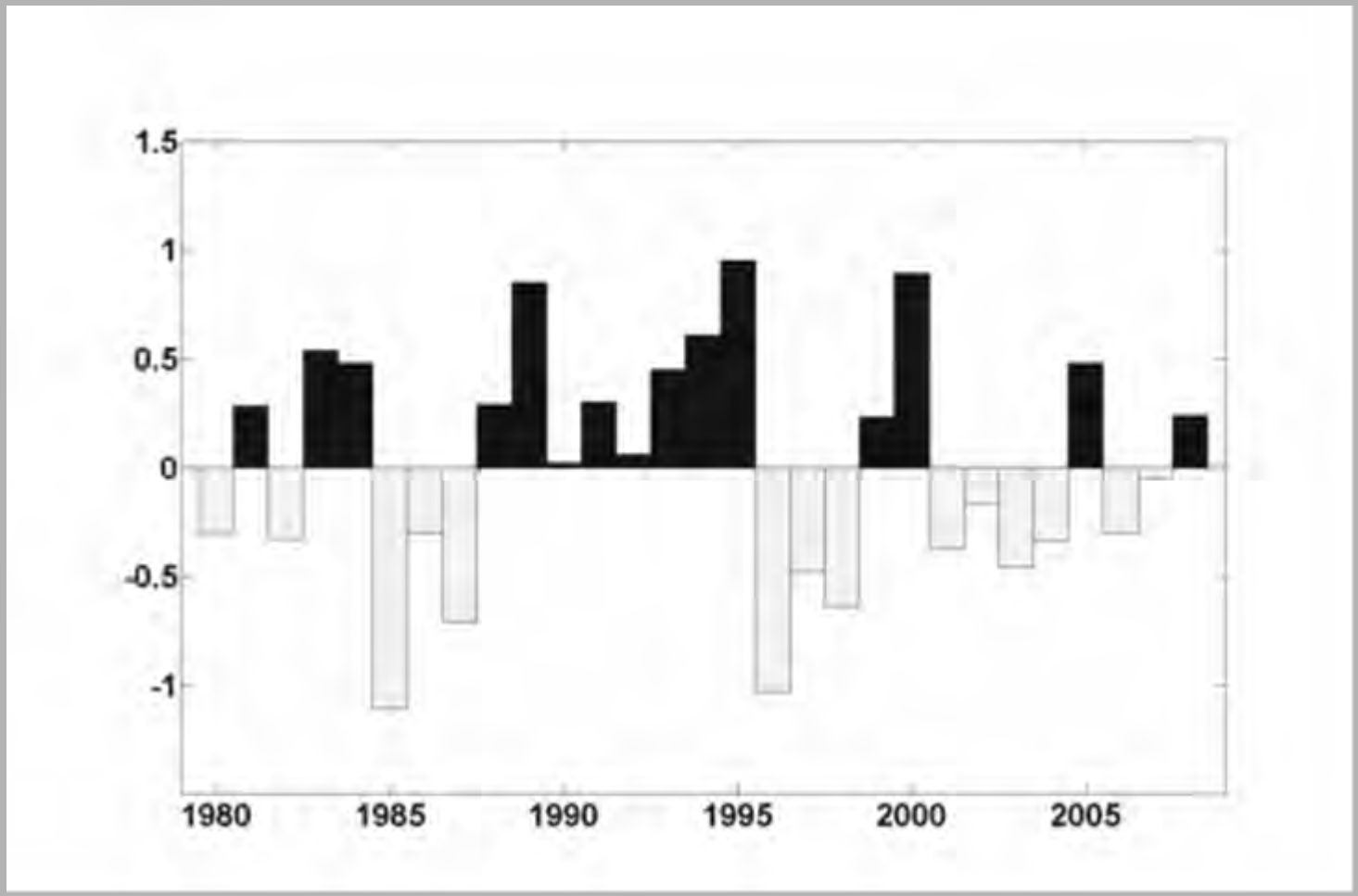
Edwards et al. 2004





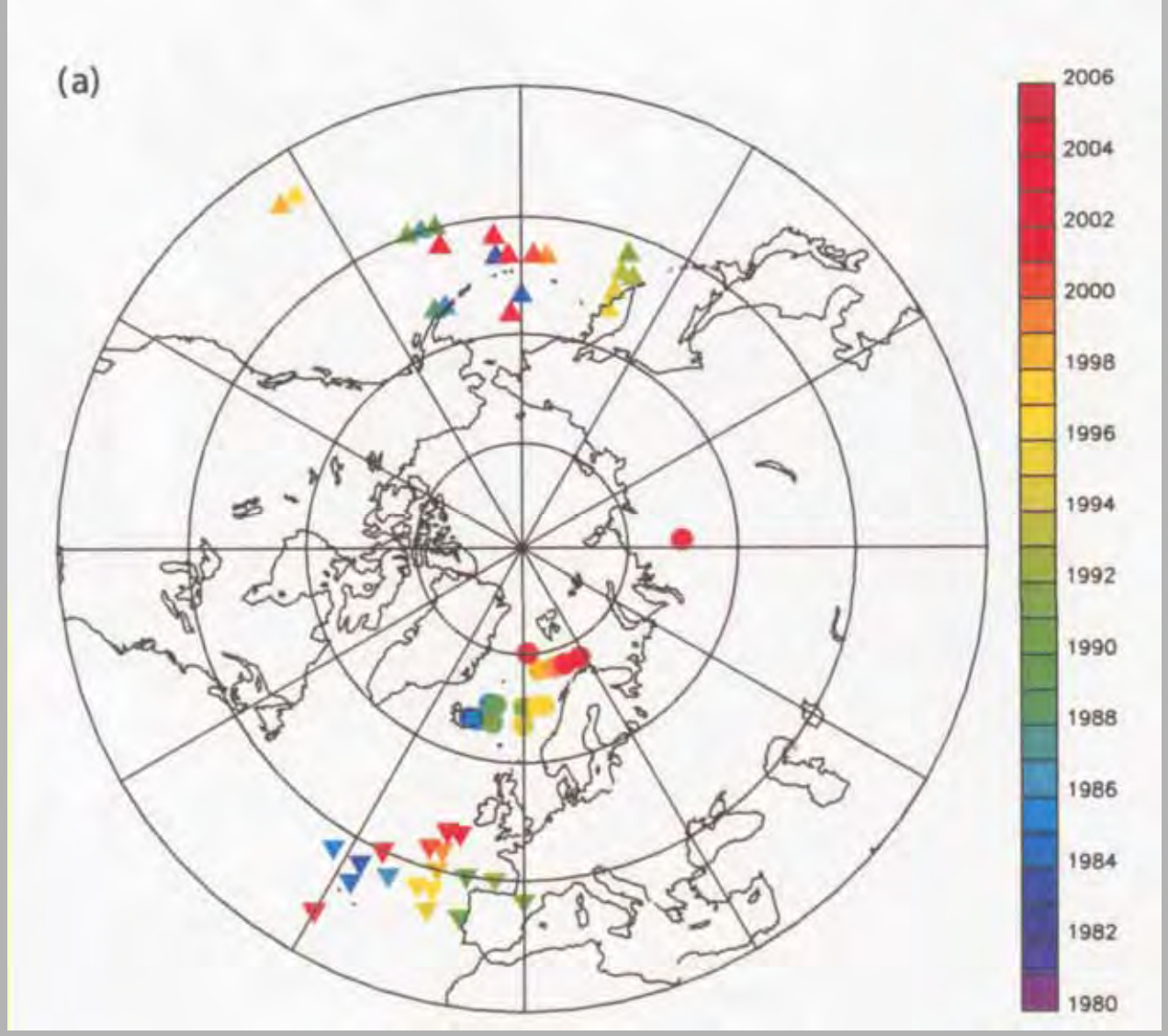
Annual peak seasonal abundance of echinoderm larvae

Edwards et al. 2005



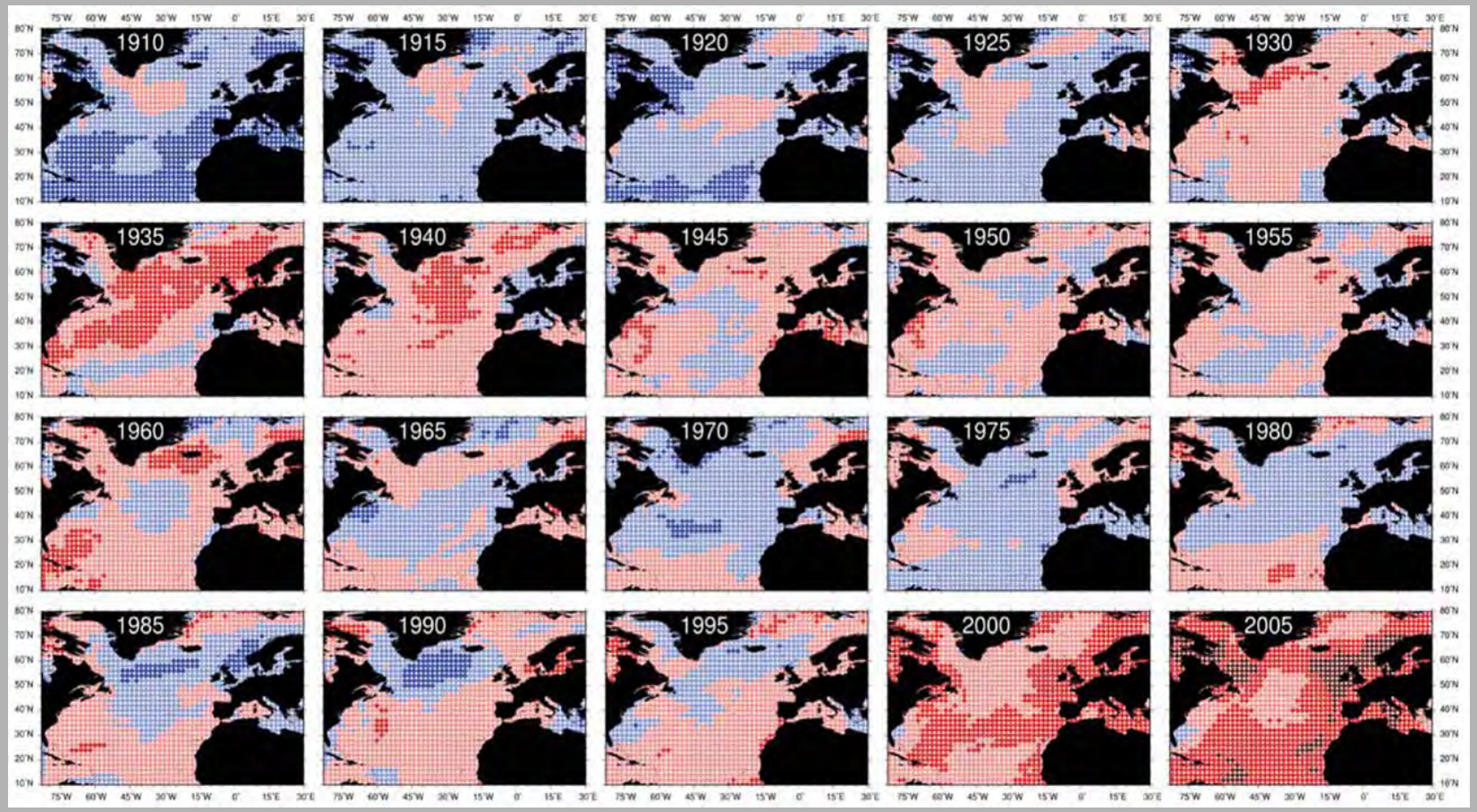
North Atlantic Oscillation

Dec - Feb



North Atlantic Oscillation: Changes of position of centers of action

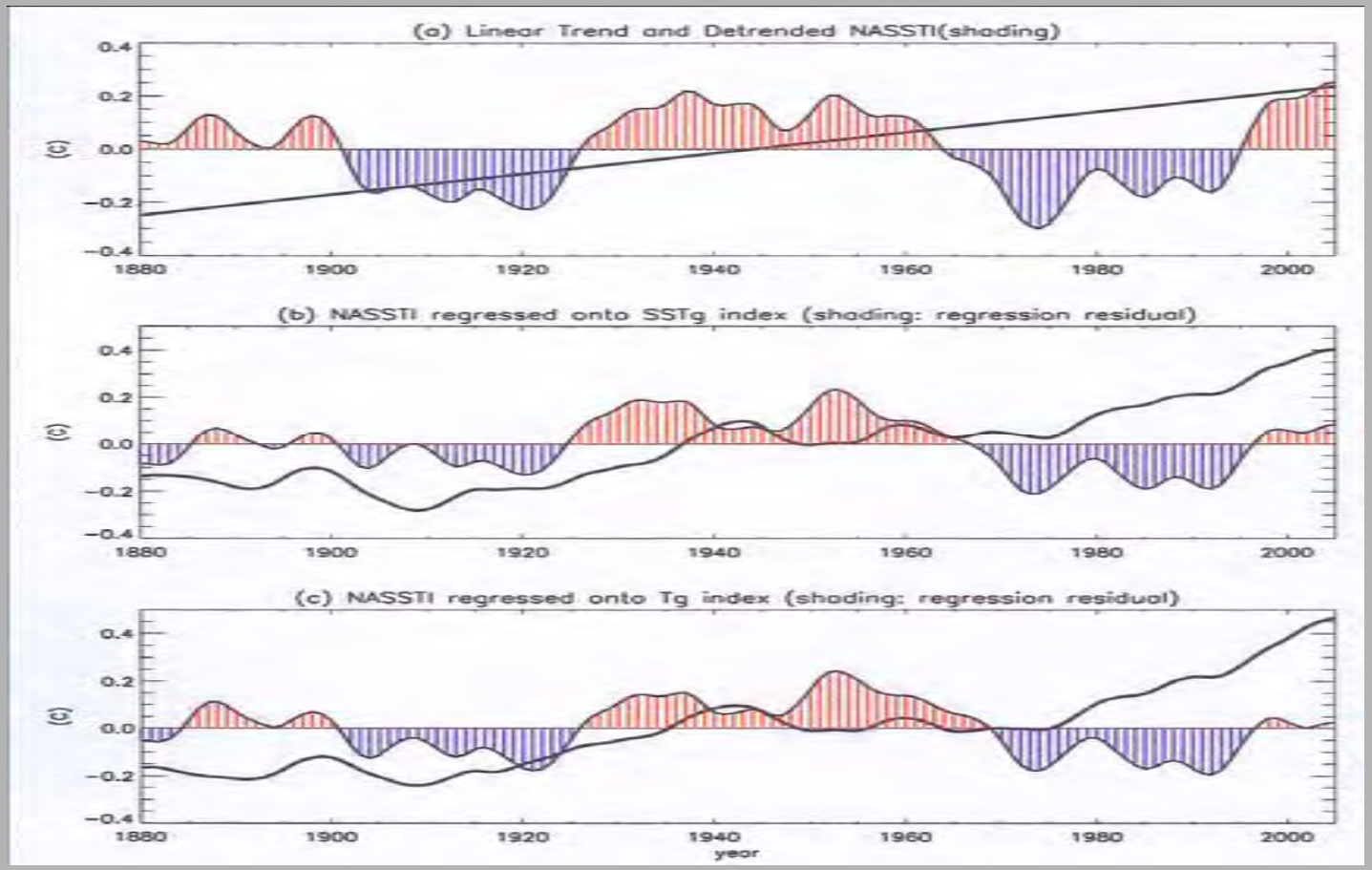
Zhang et al., GRL, 2008



Relative SST anomalies North Atlantic

ICES Zooplankton Status Report 2006/07 (O'Brien et al. 2008)

Atlantic Multidecadal Oscillation



Internal component - AMO (shaded) **(Ting et al. 2009)**

External component – Anthropogenic forcing (black line)

Hering

Clupea harengus

Sprotte

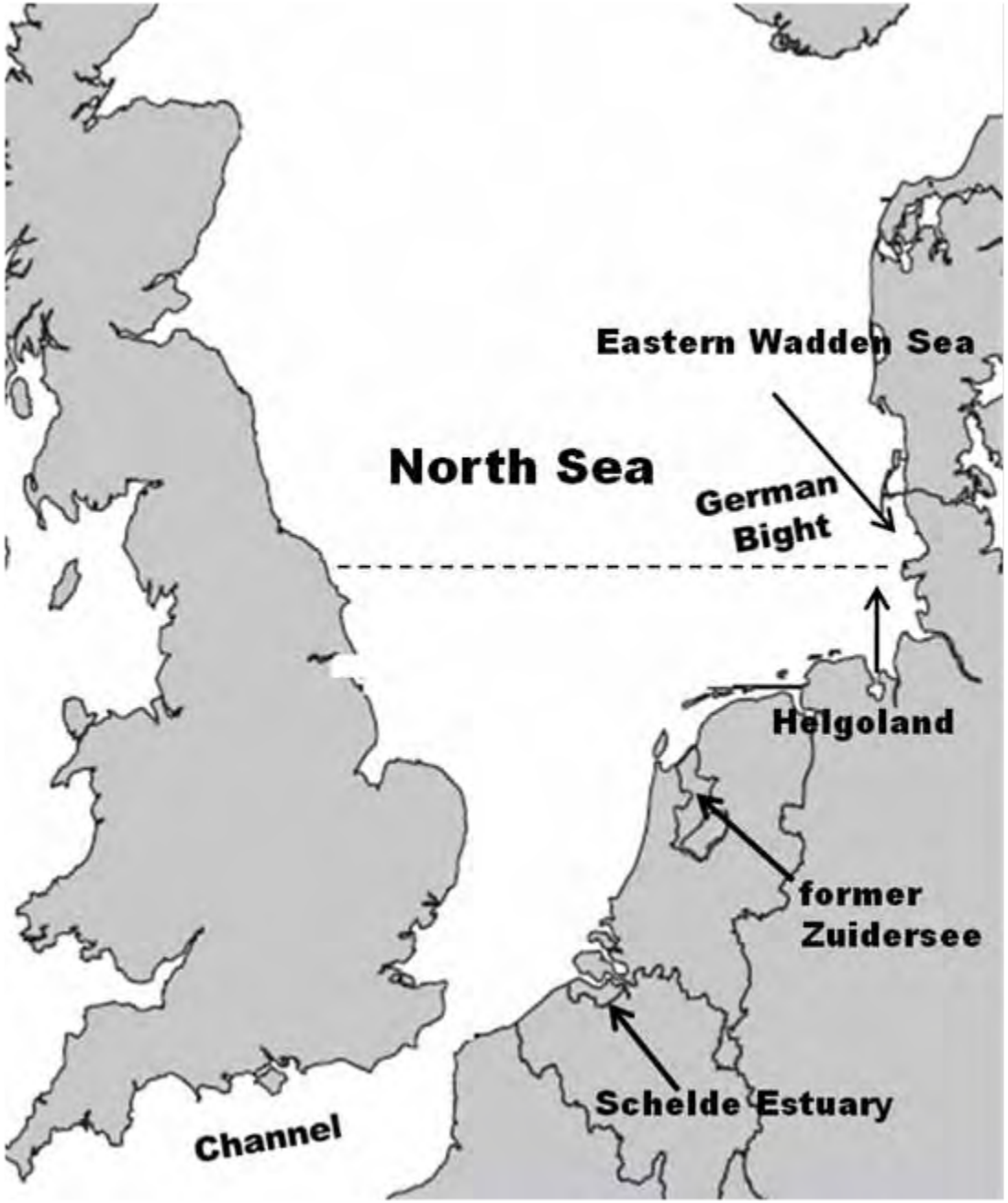
Sprattus sprattus

Sardine

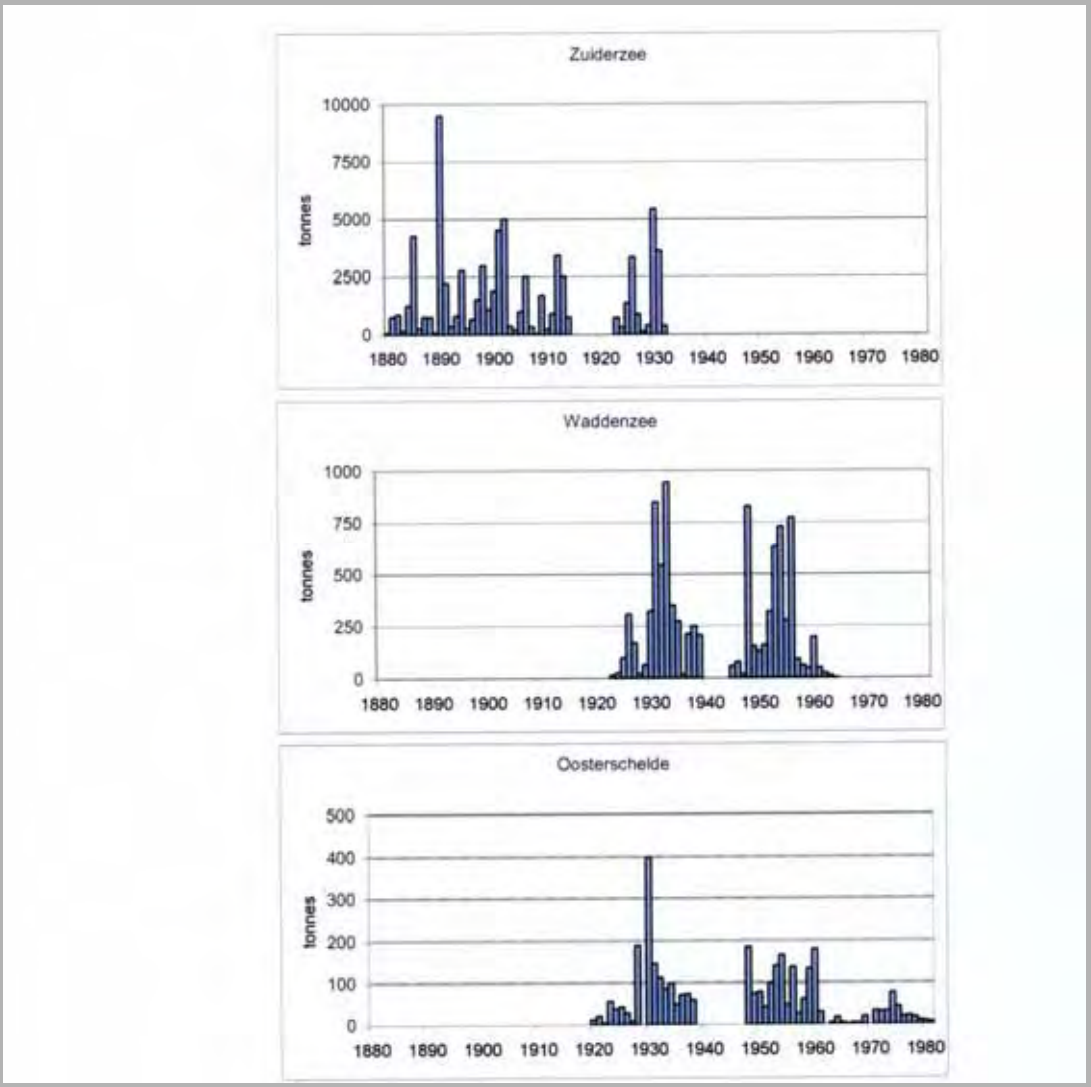
Sardina pilchardus

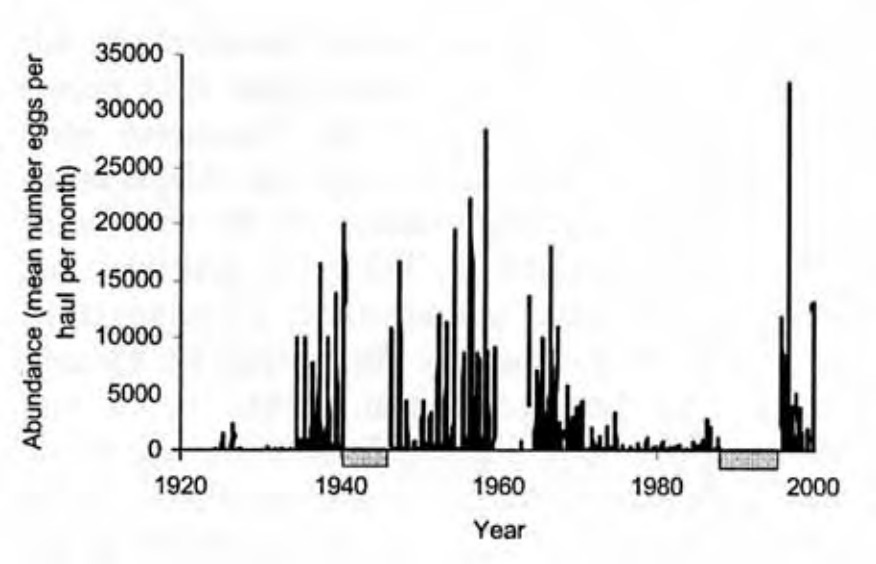
Sardelle (Anchovis)

Engraulis enchrasicolus

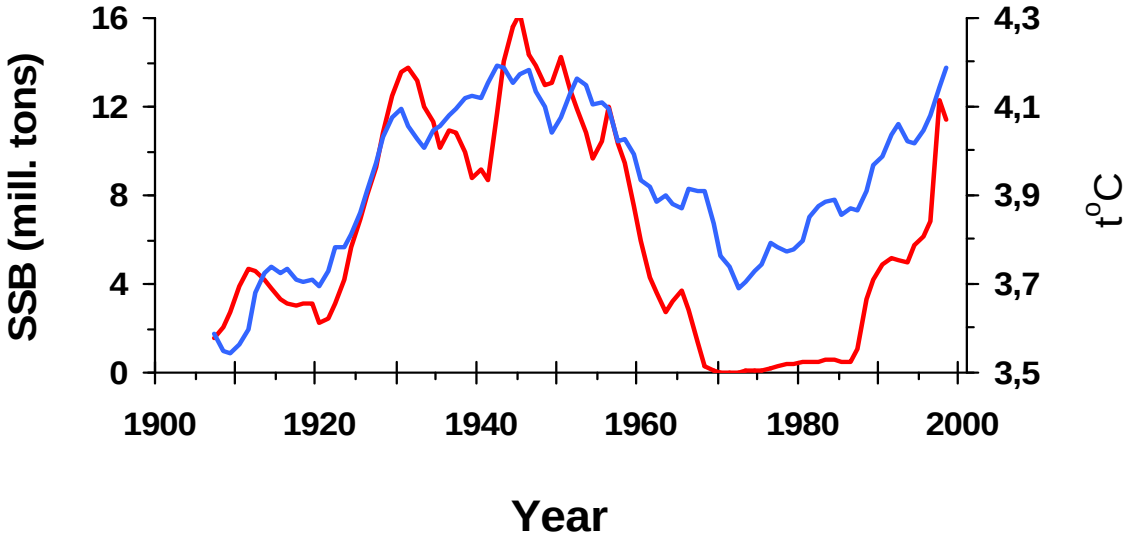

Eastern Wadden Sea
North Sea
German Bight
Helgoland
former Zuidersee
Schelde Estuary
Channel

Anchovy Fishery in Dutch Waters

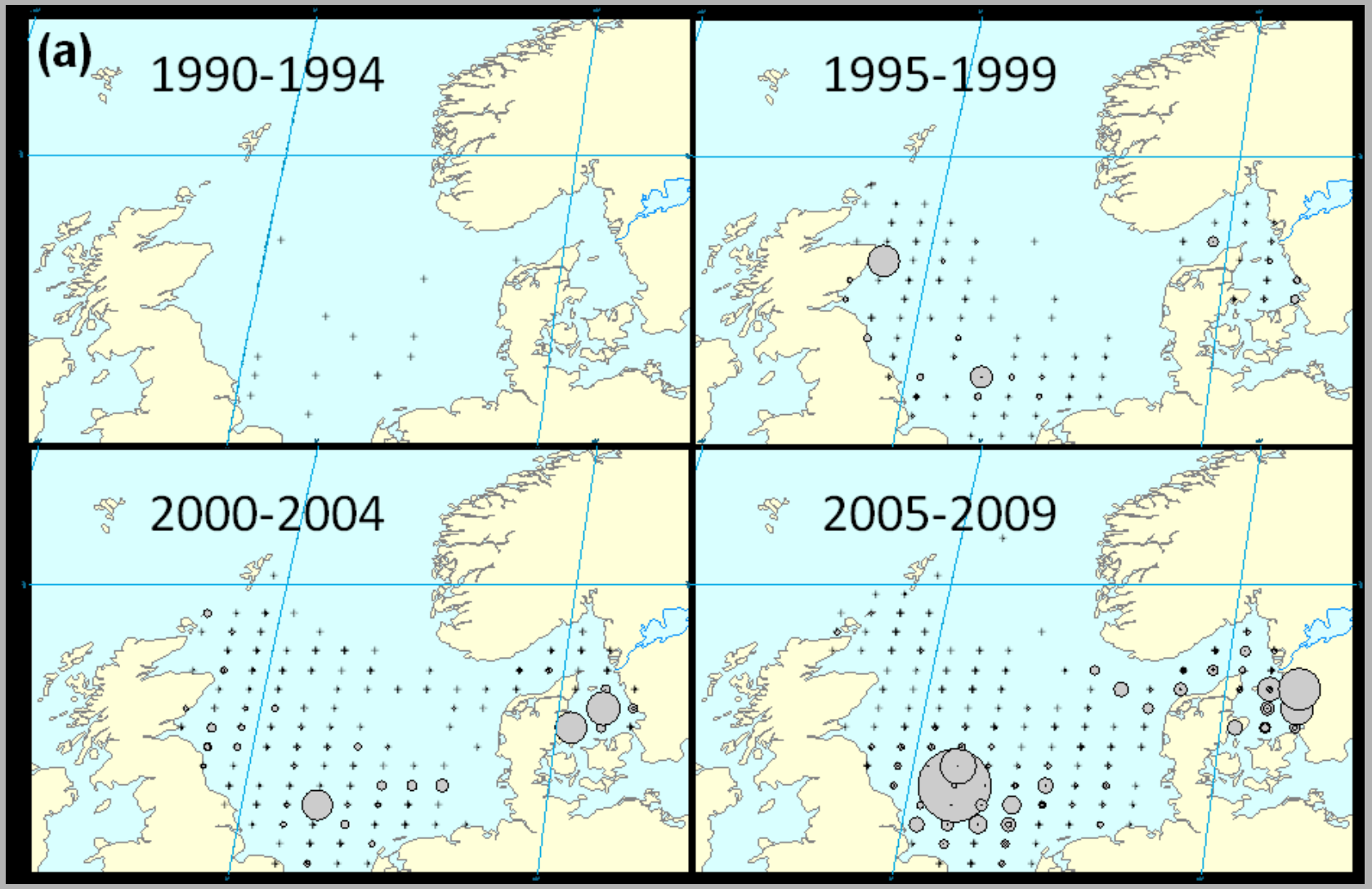




Sardine egg abundance English Channel

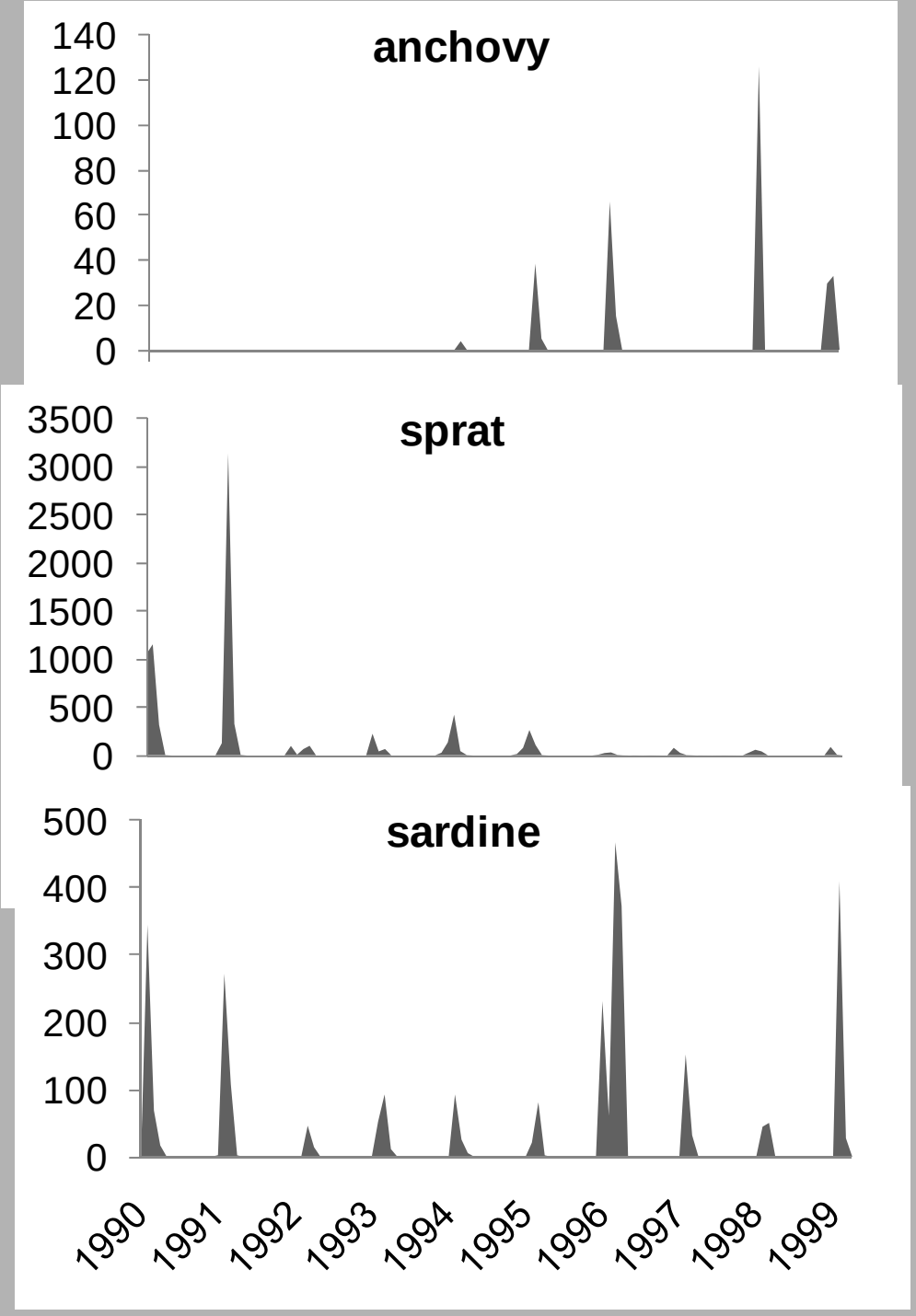


Spawning stock biomass of Norwegian spring-spawning herring and the longterm-averaged temperature (AMO) (Toresen and Østvedt 2000)



Anchovy Catches North Sea

Alheit et al., subm.



Larval Abundances

Helgoland Roads Series

Alheit et al., subm.

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North Sea fish on the move to cooler waters

Shift due to climate change, say researchers

Ian Sample, science correspondent
Friday May 13, 2005
The Guardian

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Global warming has forced fish stocks in the North Sea scores of miles north to cooler waters, according to a study by climate

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Anchovies abandon Bay of Biscay for warm British waters

By John Lichfield in Paris

The Independent

30th August 2003

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North Sea Undergoing "Ecological Meltdown" Due to Warming

North Sea faces collapse of its ecosystem

Fish stocks and sea bird numbers plummet as soaring water temperatures kill off vital plankton

The Independent (U.K.), Oct. 19, 2003

Inf. Fischwirtsch. Fischereiforsch. 50(4), 2003 163

Sind südliche Arten in Nord- und Ostsee auf dem Vormarsch?

Are southern species expanding into the North Sea and Baltic?

Wolfgang Weber, Institut für Seefischerei, Hamburg,
Claus-Christian Frieß, Institut für Ostseefischerei, Rostock.

ICES Journal of Marine Science, 53: 1003–1007. 1996

Short communication

The anchovy returns to the Wadden Sea

R. Boddeke and B. Vingerhoed

Vol. 284: 269–278, 2004 | MARINE ECOLOGY PROGRESS SERIES Mar Ecol Prog Ser | Published December 21

Long-term increases in prevalence of North Sea fishes having southern biogeographic affinities

D. J. Beare*, F. Burns, A. Greig, E. G. Jones, K. Peach, M. Kienzle,
E. McKenzie, D. C. Reid

Fisheries Research Services Seite 1 von 3

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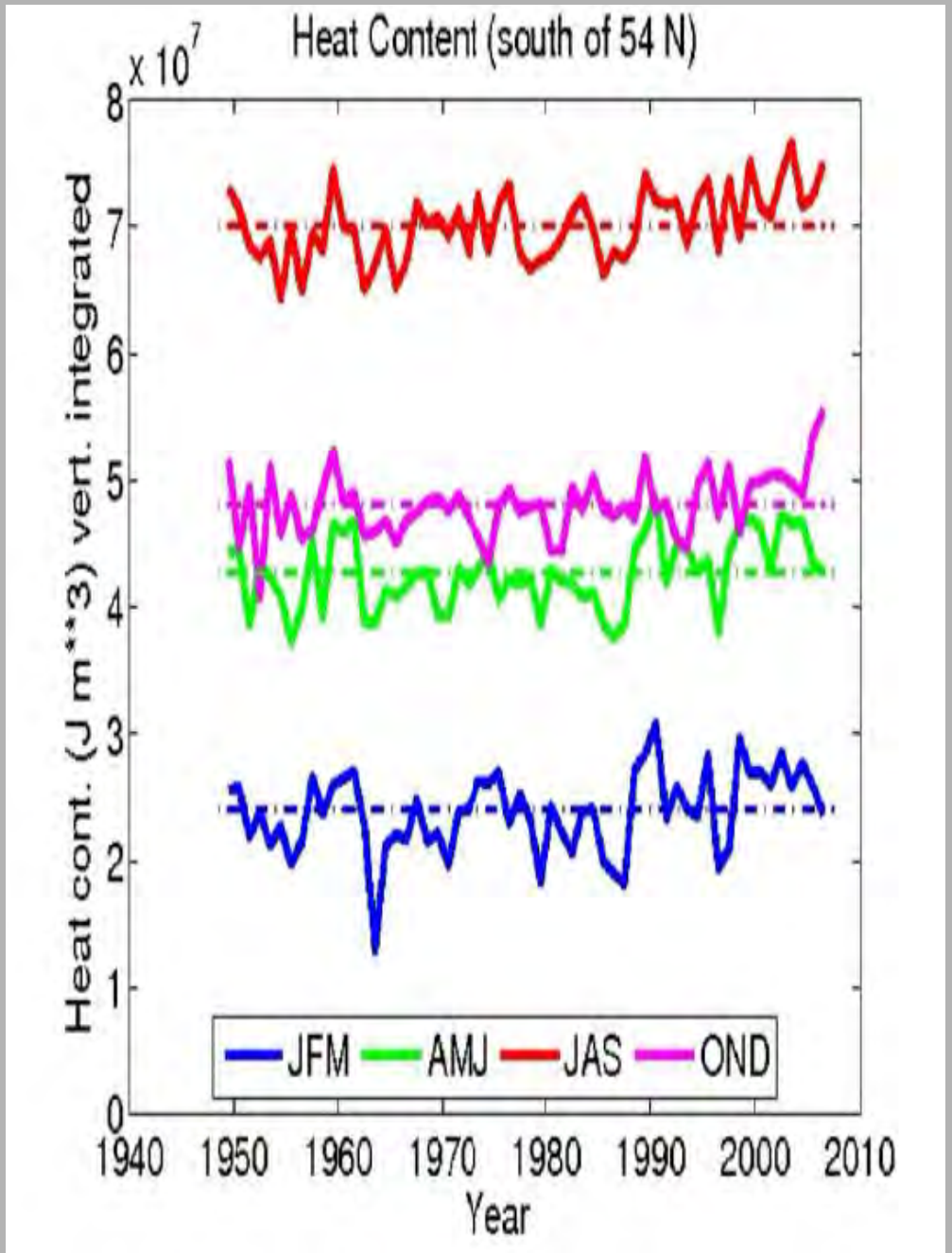
2003 News

Anchovies and Sardines Found in Scottish Waters
19 August 2003


Heat Content (south of 54 N)
x 10^7
Heat cont. (J m**3) vert. integrated
0
1
2
3
4
5
6
7
8
1940
1950
1960
1970
1980
1990
2000
2010
Year
JFM
AMJ
JAS
OND

Besteht für 1950 Aussicht auf eine Sardellenfischerei in der Nordsee?

Das Laichen der Sardelle an der deutschen Nordseeküste in den Jahren 1948/1949.

Dr. H. J. Aurich

Forschungsinstitut der Zentralanstalt für Fischerei. Biologische Anstalt Helgoland, List/Sylt,

Vom 27. 5. 1949 bis Ende Juli wurden im Plankton des Wattenmeeres bei List (Sylt) Eier und später auch Larven der Sardelle beobachtet. Die Regelmäßigkeit und Häufigkeit dieses Vorkommens, die bisher für die Deutsche Bucht nicht bekannt war, veranlaßte eine genaue Untersuchung der Verhältnisse, die folgendes ergab:

Das Laichgebiet.

Längs der ganzen deutschen Küste traten die Eier und Larven der Sardelle in einem 10—20 Sm breiten Band in großer Dichte auf. Dieses Band zog sich in geringem Abstand vor den Inseln von einem westlichen Kerngebiet des Laichens bei Borkum-Riff-Westerems[1]) entlang der ostfriesischen

Fischereiwelt (1950)

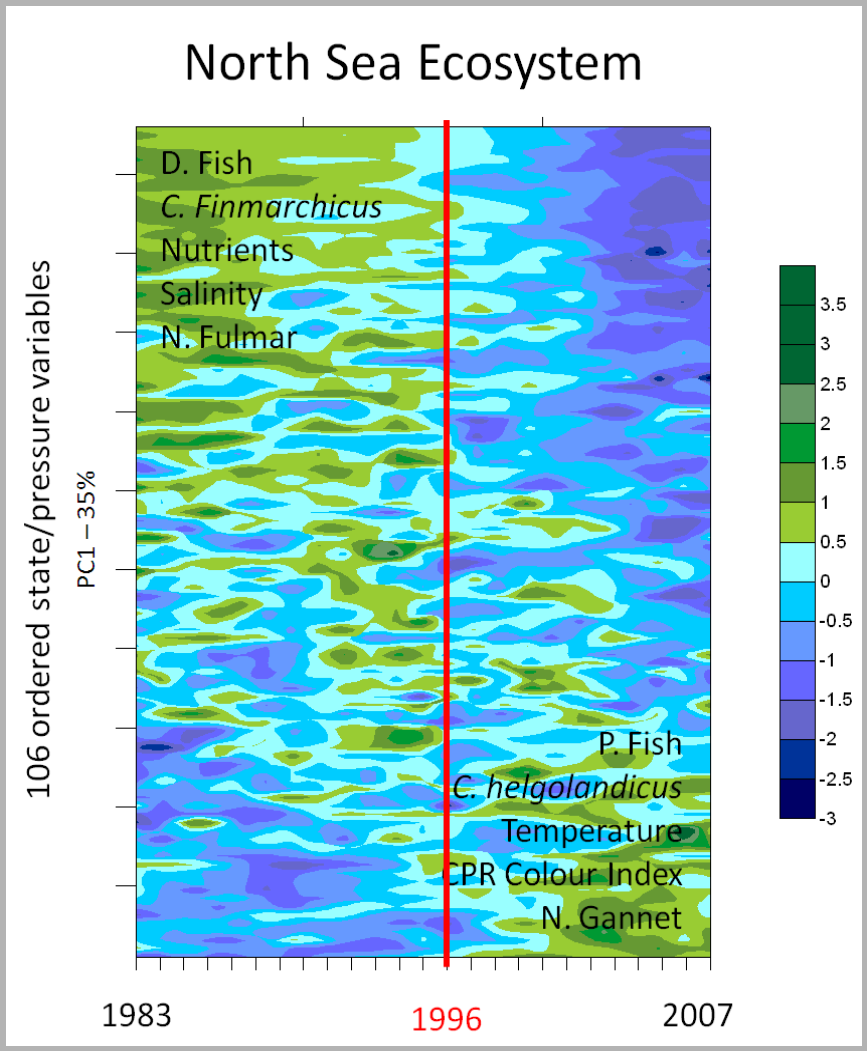
Verbreitung und Laichverhältnisse von Sardelle und Sardine in der südöstlichen Nordsee und ihre Veränderungen als Folge der Klimaänderung

Von Horst Joachim Aurich

Biologische Anstalt Helgoland, List auf Sylt
Forschungsinstitut der Bundesanstalt für Fischerei

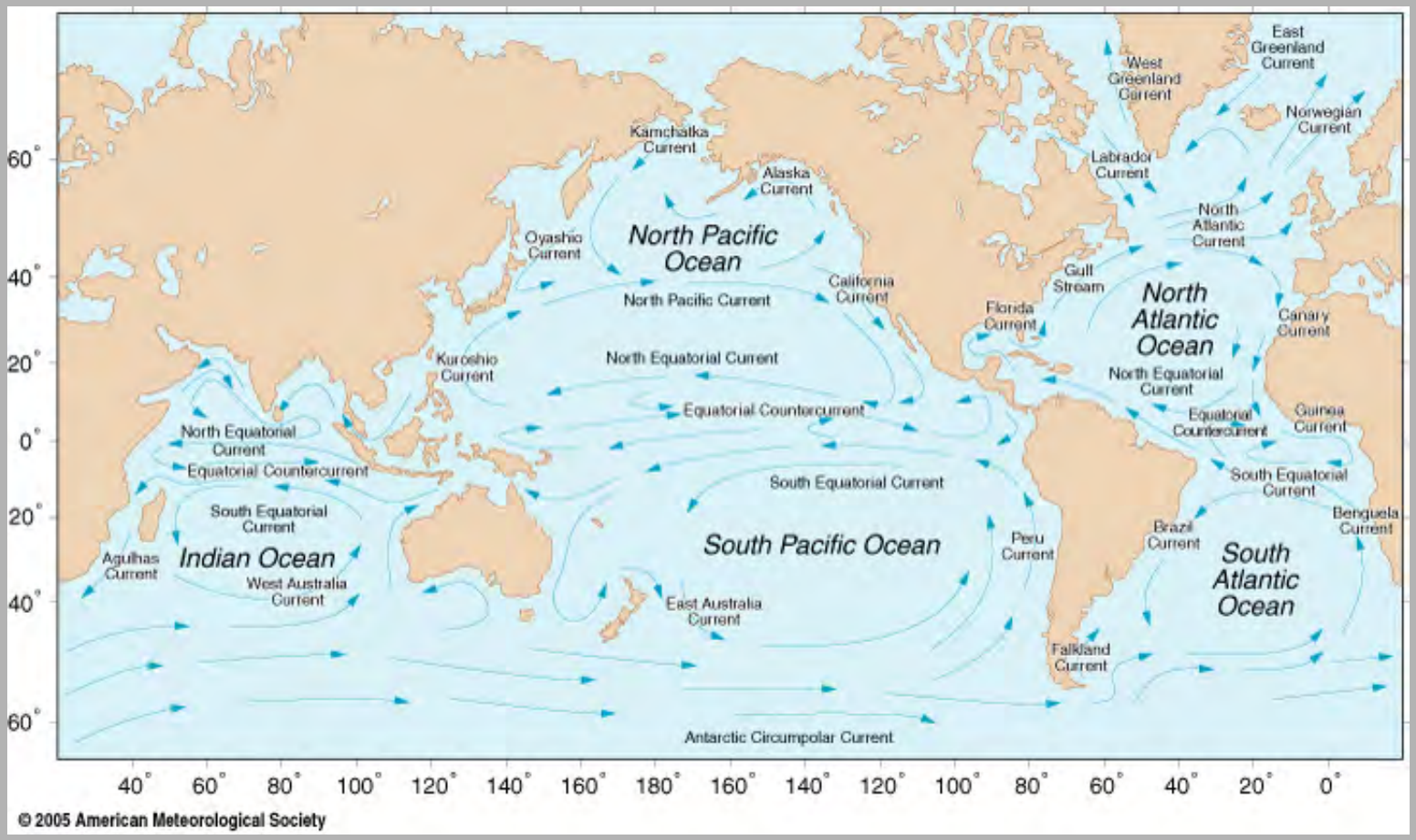
(Mit 7 Abildungen im Text)

Helgoländer Meeresunters. 4 (1953)



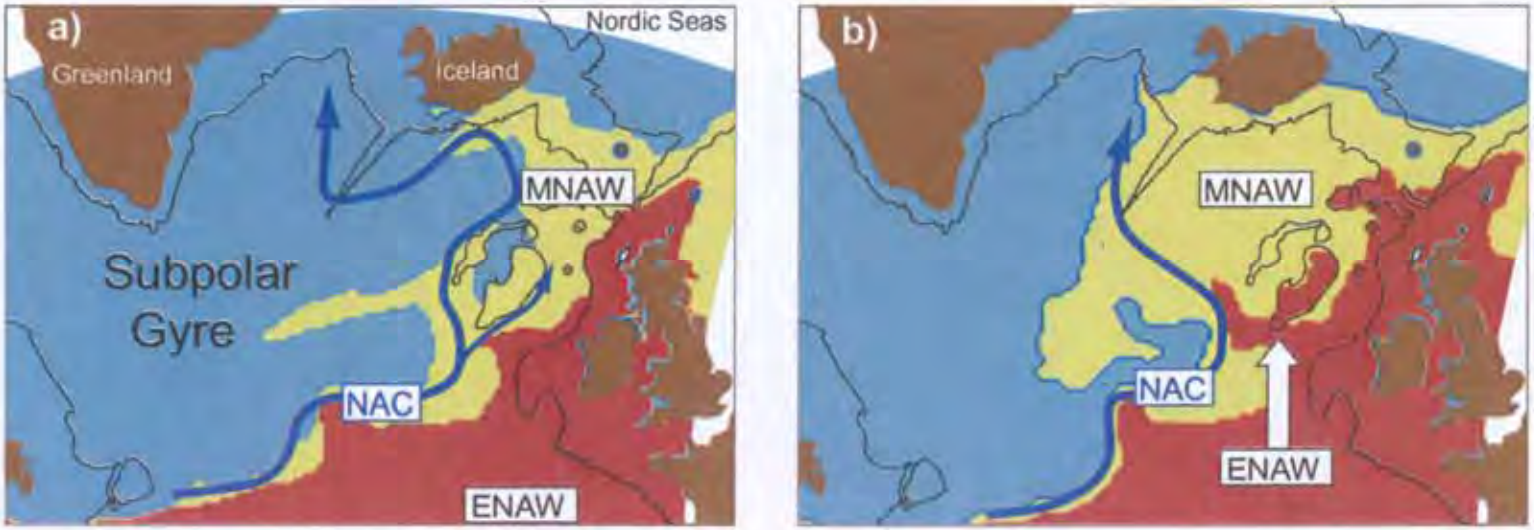
A composite and ordered plot of North Sea variable anomalies between 1983 and 2007.

ICES 2010



Source: http://oceanmotion.org/html/background/wind-driven-surface.htm

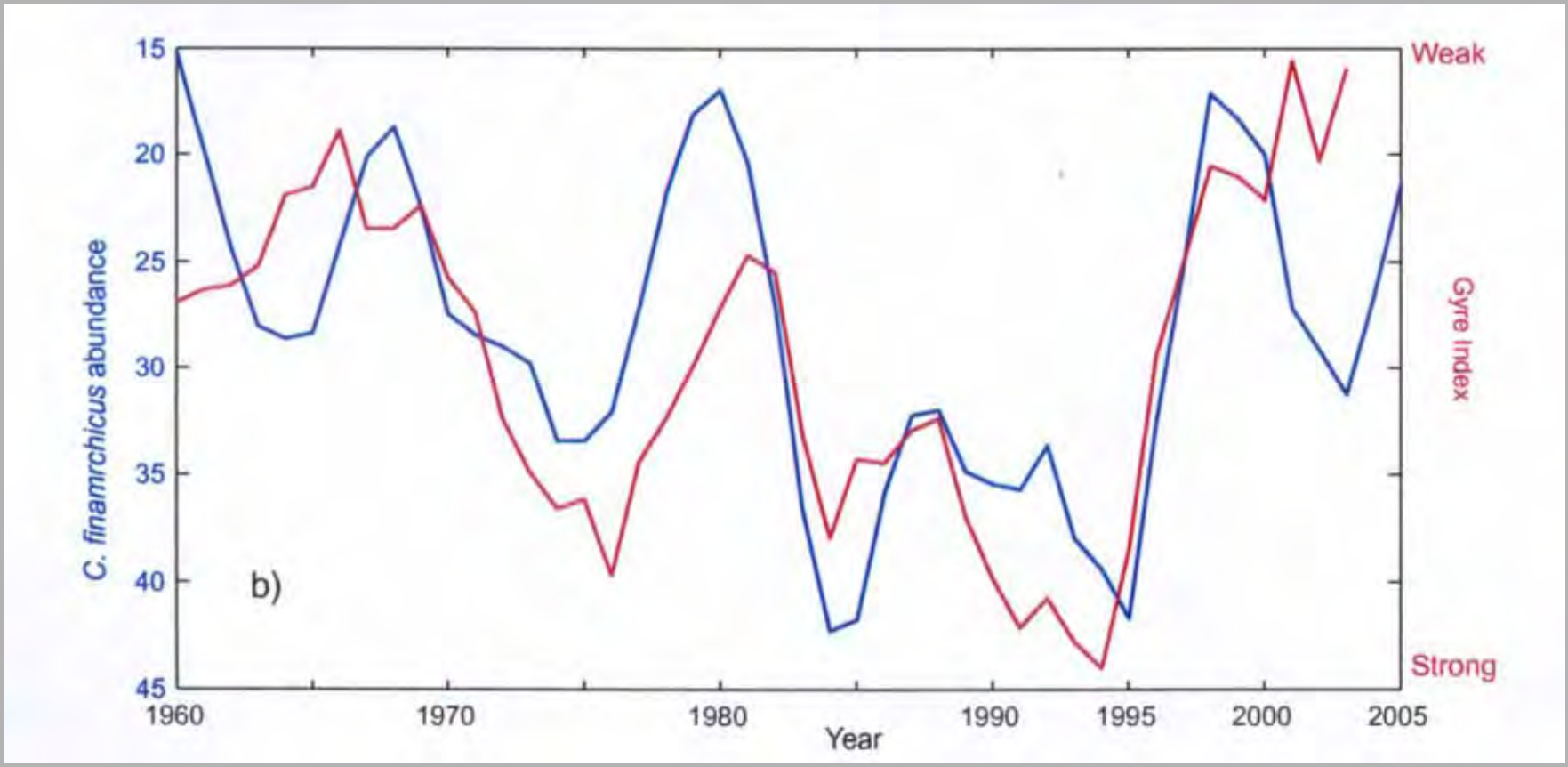
Subpolar Gyre



Upper layer temperatures.

above 9° ; below 7° ; MNAW intermediate temperatures

Hátun et al. 2009, PiO



Hátun et al. 2009, PiO

Conclusions

North Sea is heavily impacted by different climatic drivers.

- **Global Warming**
- **NAO (shift of NAO centers of action)**
- **contraction of sub-polar gyre**
- **AMO dynamics**

The connections between these different kinds of climate forces are not understood.

Big Question

Can this be modeled in a way to make reasonably reliable predictions/projections about fish population dynamics?