

Trophic Interactions between Zooplankton and Fish under the Influence of Physical Processes



GLOBEC
Germany

Project Goal:

“Clarification of trophodynamic interactions between zooplankton and planktivorous fish in relation to reproductive success under the impact of physical forcing”

1st Phase: 2002 - 2005

2nd Phase: 2005 - 2007

Areas of investigation

- **Baltic Sea – focus on Bornholm Basin**
- **North Sea – focus on German Bight**

- **80 scientists and technicians**
- **7 institutions**
- **12 PhD projects**
- **13 Diploma projects**



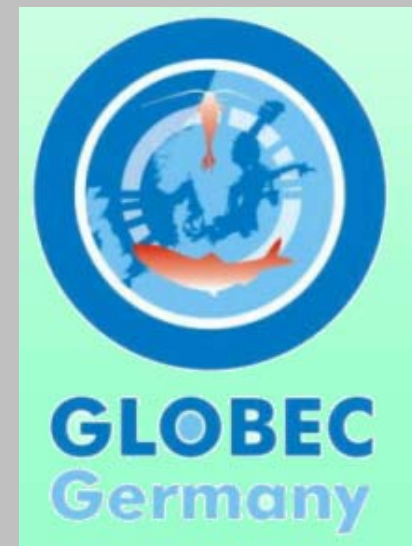
Impact of Climate Variability on Pelagic Ecosystem of central Baltic Sea

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Impact of increase of NAO index in late 1980s

- Baltic Sea
- North Sea
- NW Mediterranean
- European lakes



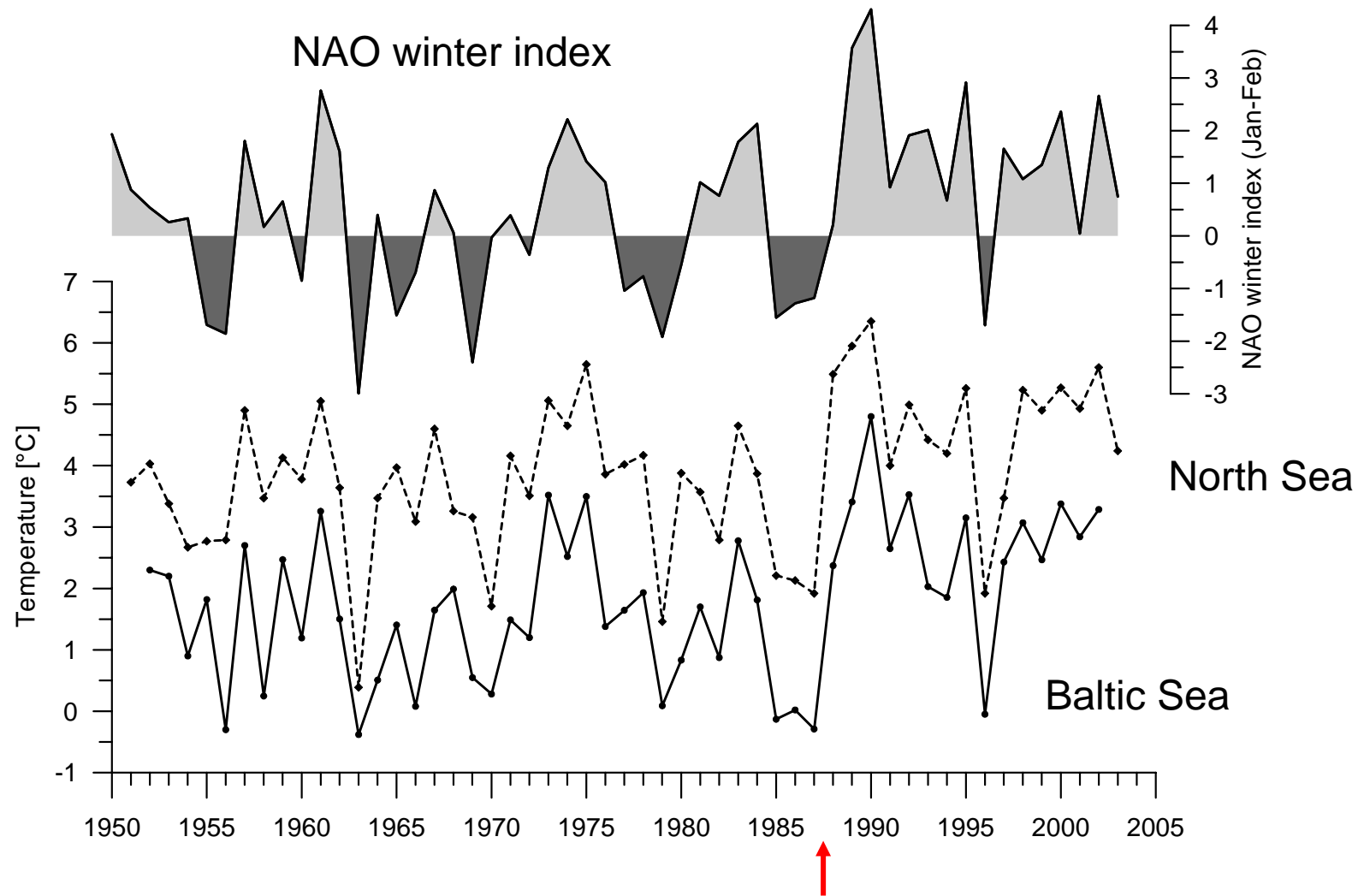
Definition

climatically induced

Regime Shift

Changes in marine system function that are relatively abrupt, persistent, occurring at a large spatial scale, observed at different trophic levels and related to climate forcing

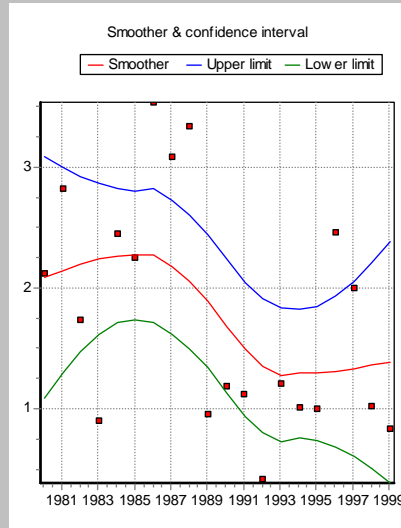
deYoung, Harris, Alheit, Beaugrand, Mantua, Shannon. 2004. Progr. Oceanogr. 60



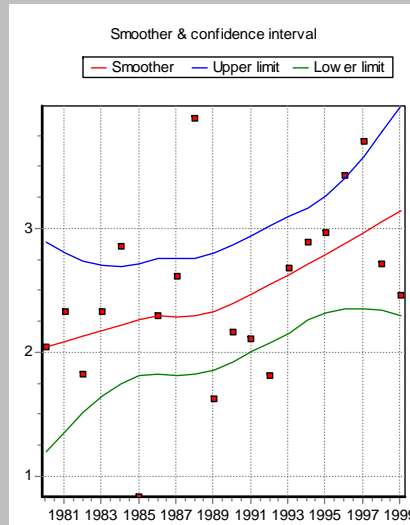
NAO winter index, annual temperature minimum in the Intermediate Winter Water (IWW) of the Bornholm Basin, Station K2, (solid line) and annual SST anomalies at Helgoland Roads (dashed line)

Alheit et al. 2005

Baltic Sea

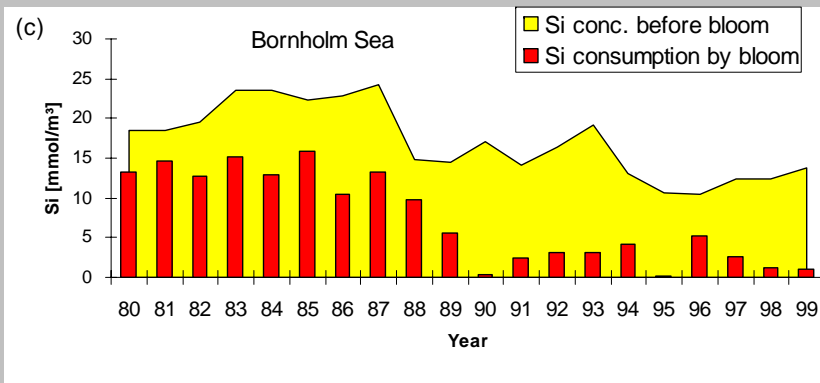


Diatoms



Dinoflagellates

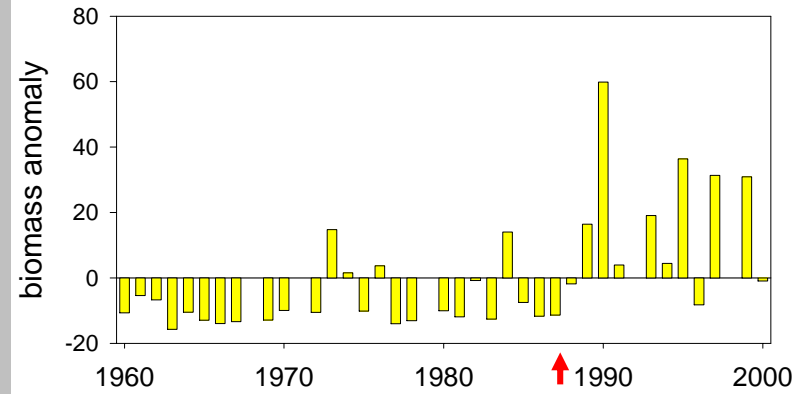
Wasmund and Uhlig 2003



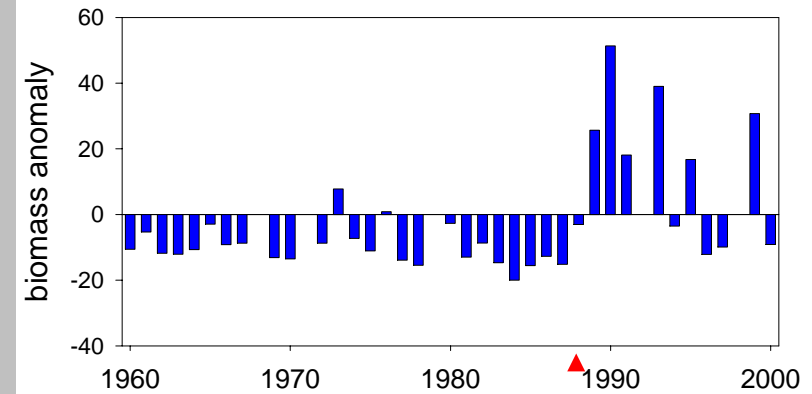
Silicate

Wasmund et al. 1998

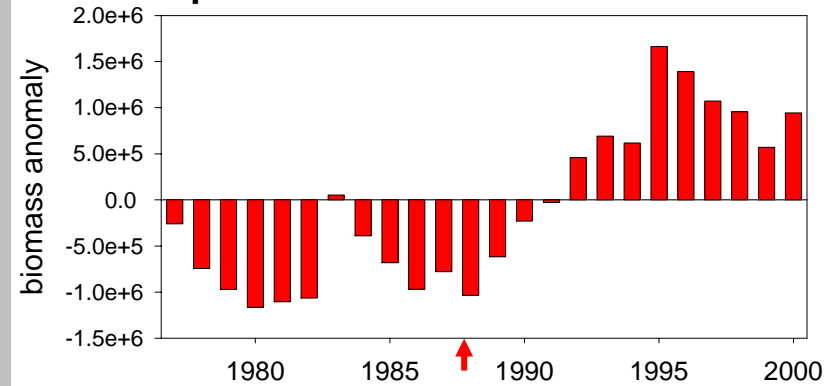
Acartia



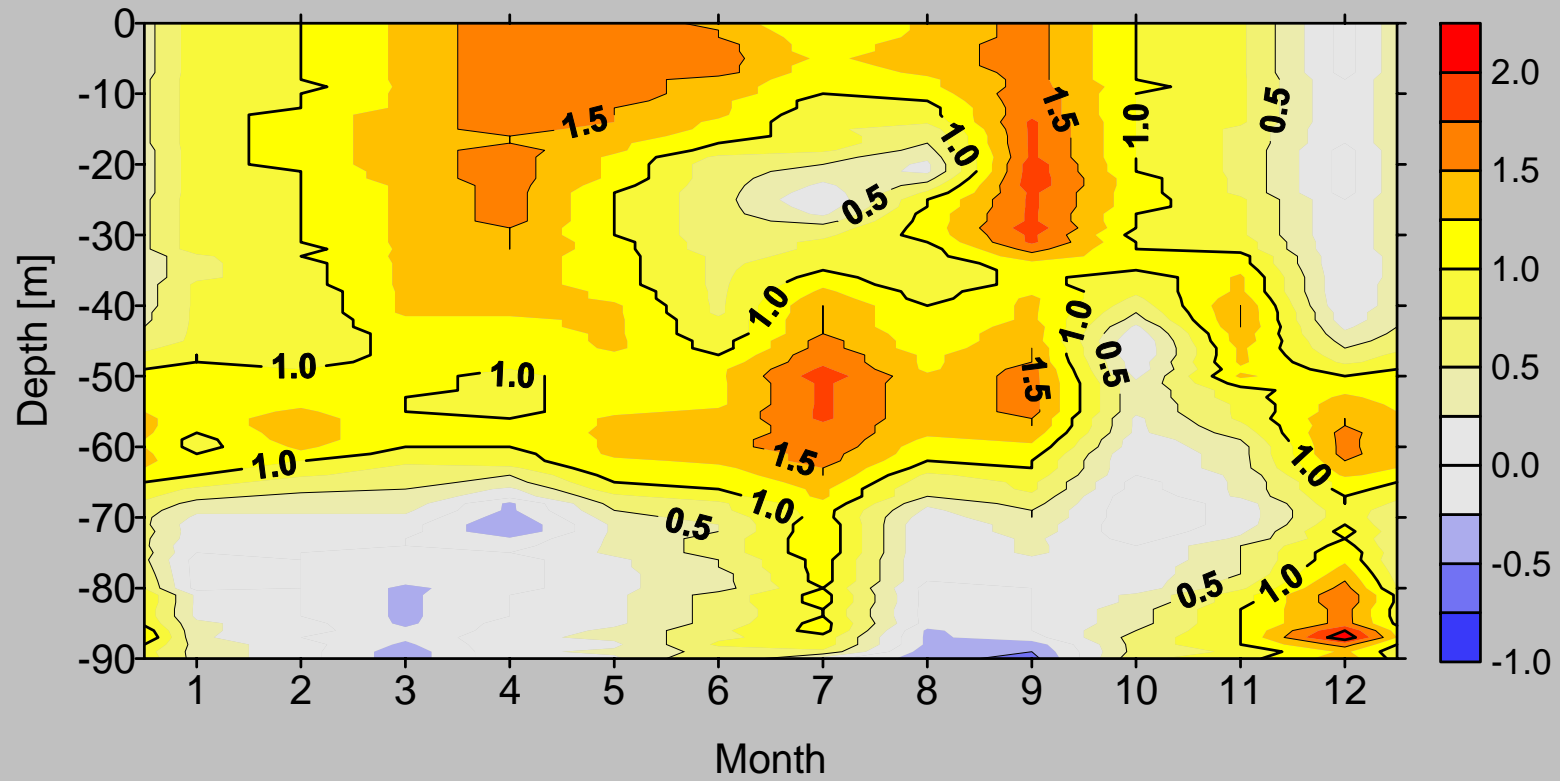
Temora

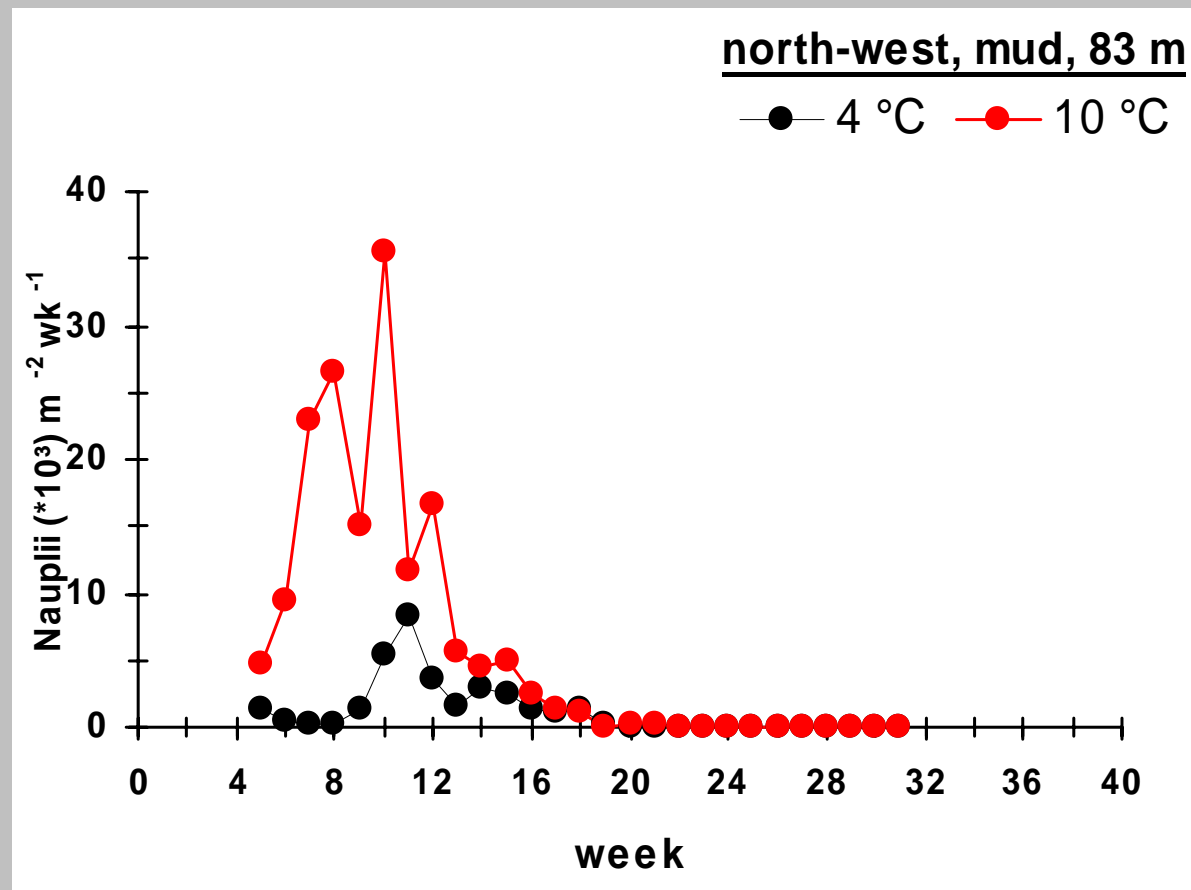


Sprat



Monthly mean temperature difference [°C] in the central Bornholm Basin
between the periods 1970-1987 and 1988 - 2003

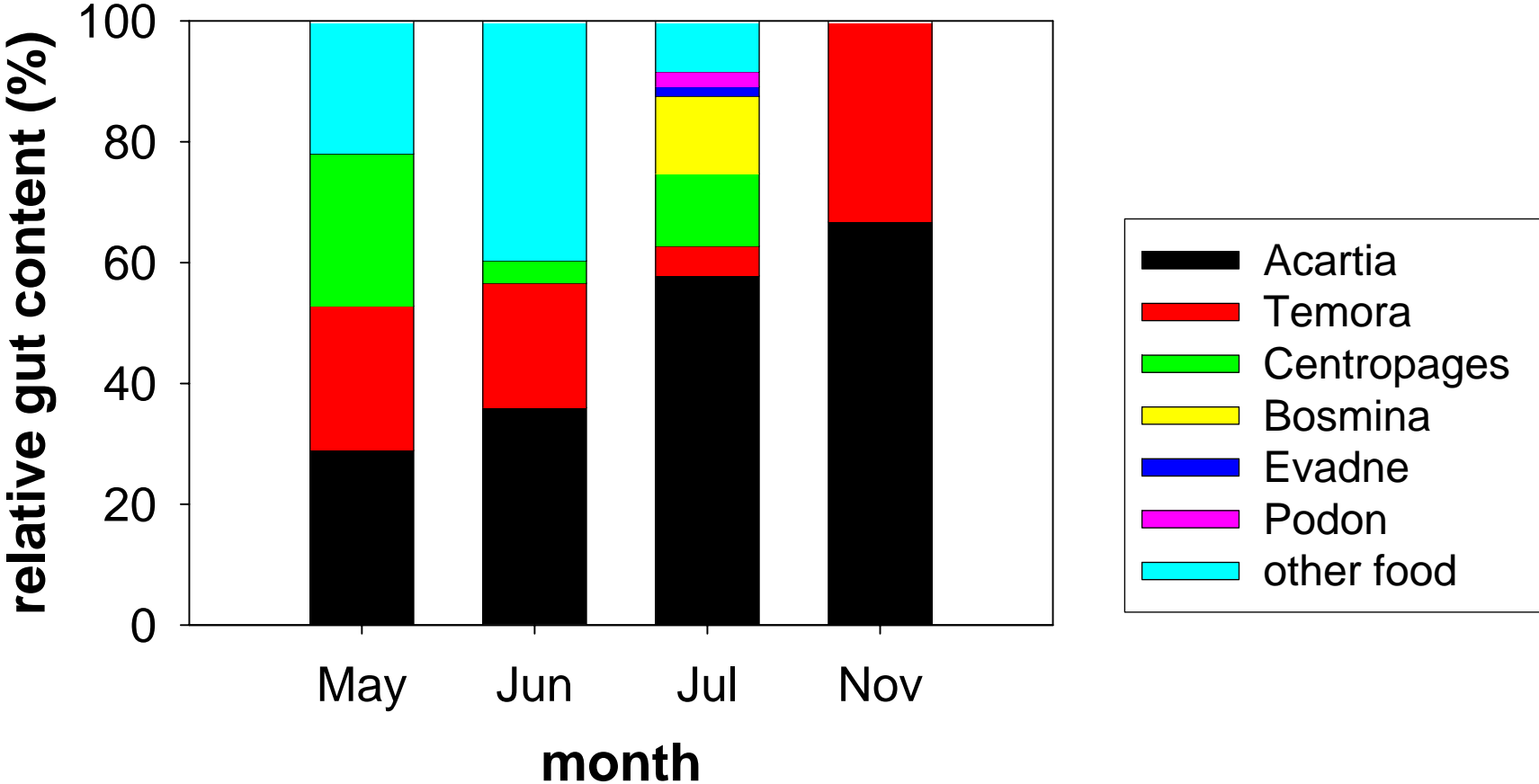




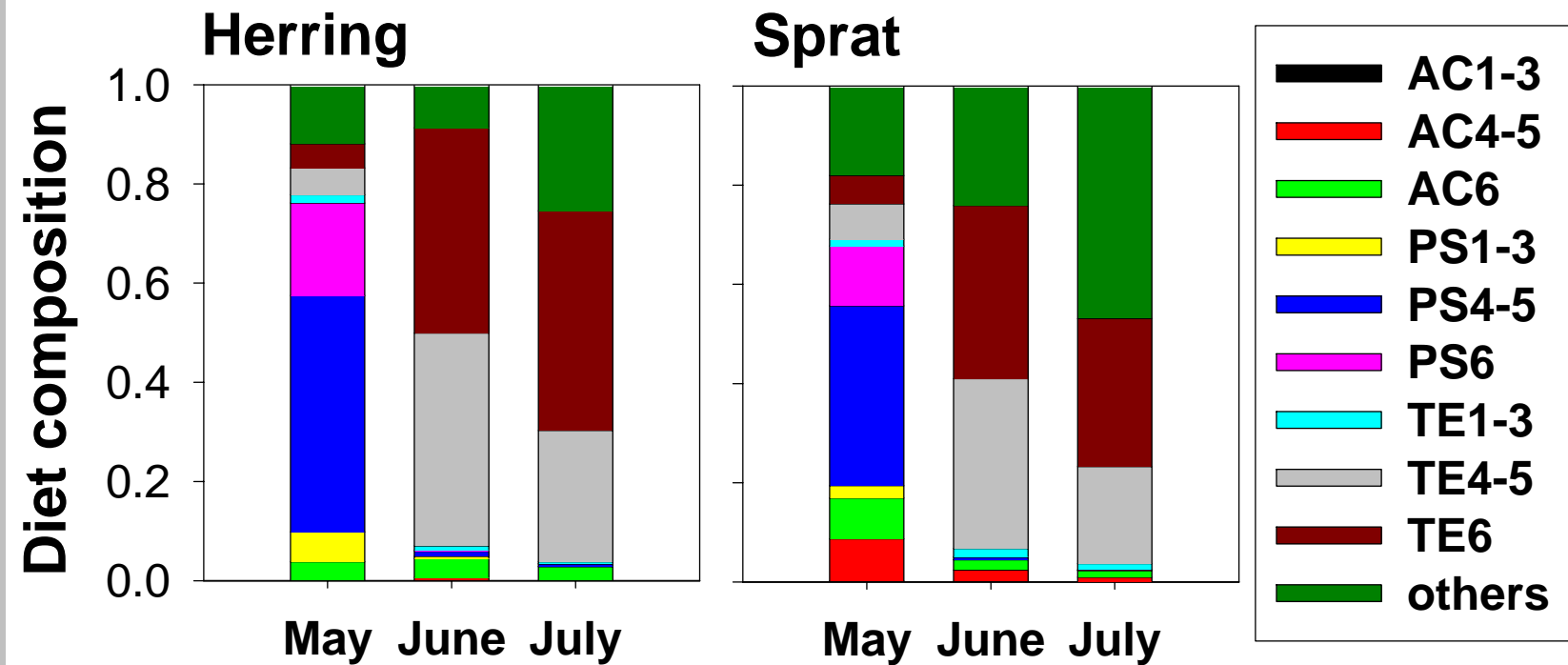
Hatching of *Acartia* spp. nauplii from sediments of Bornholm Basin

Dutz et al. 2004

gut content of sprat larvae



Herring & sprat diet



AC-*Acartia* spp.; PS-*Pseudocalanus* sp.; TE-*Temora*

Regime Shift Scenario

Baltic Sea

Winter NAO ↑

Water Temperature ↑

spring convection reduced

hatching of resting eggs enhanced

sprat egg survival enhanced

Diatoms ↓

changed food chains ?

Dinoflagellates ↑

Acartia ↑

Sprat larvae ↑

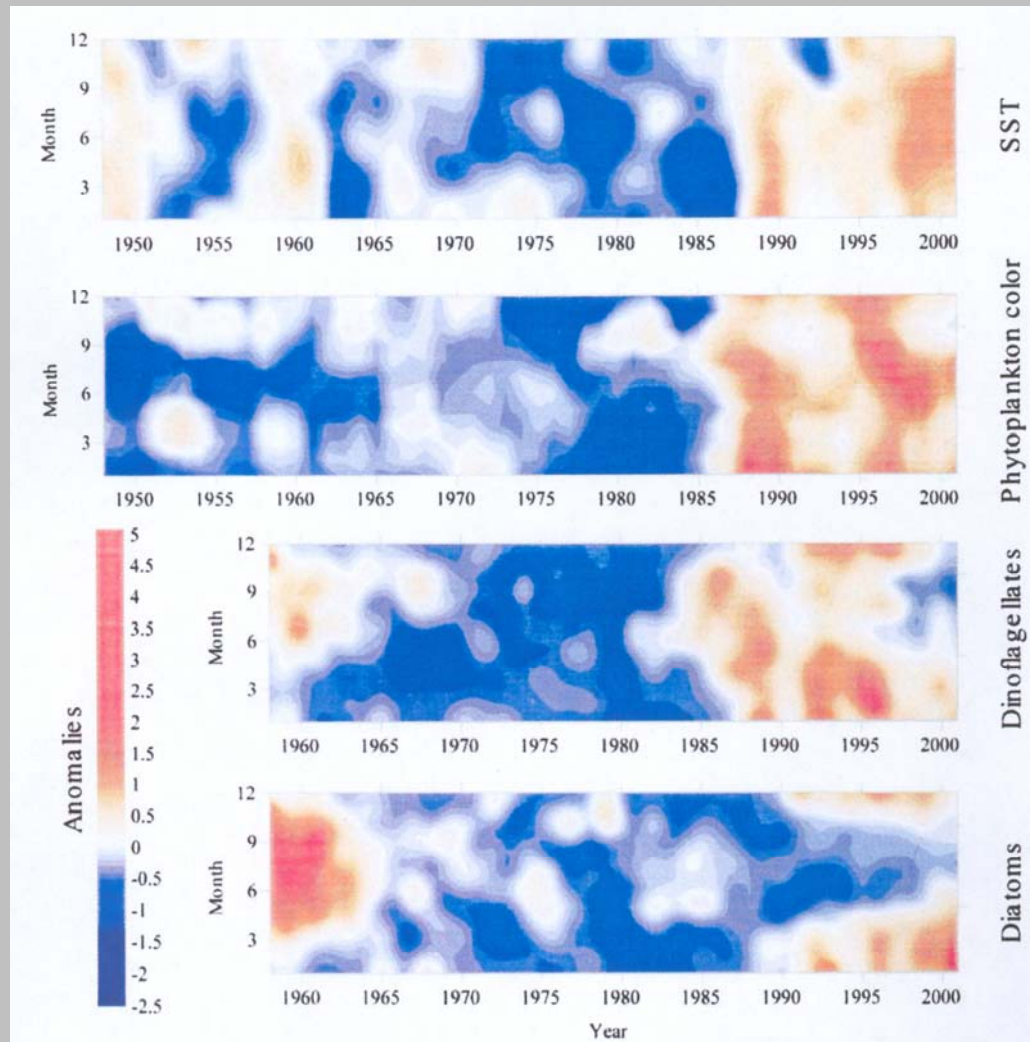
Sprat Stock ↑

Temora ↑

summer inflows enhance hatching of resting eggs

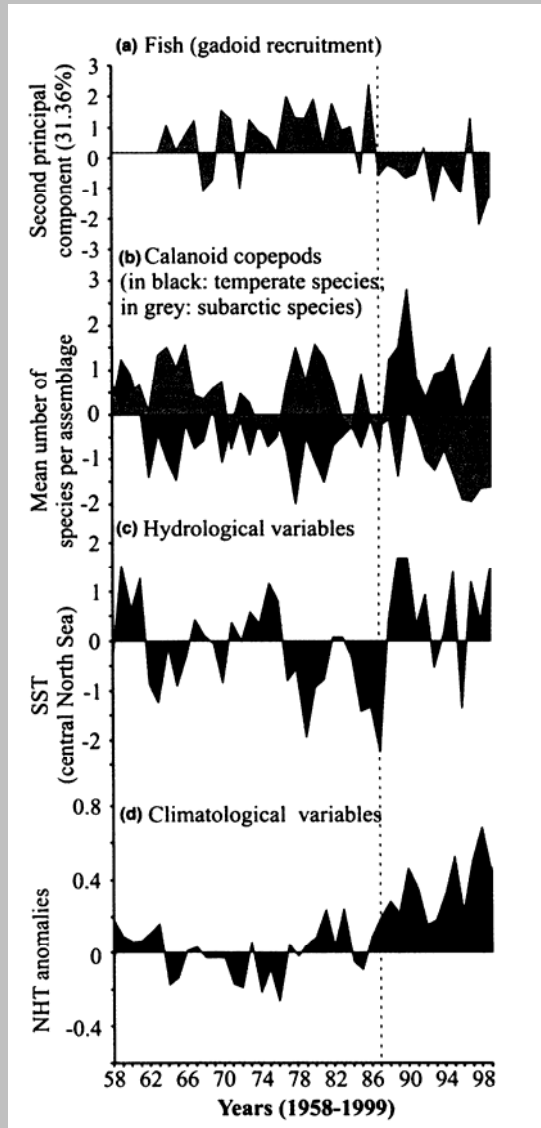
Alheit, in press

North Sea



Central North Sea, anomalies: SST, phytoplankton colour, dinoflagellates, diatoms

Edwards and Johns 2006



Gadoid recruitment

North Sea

Calanoid copepods

SST

Northern hemisphere temperature anomalies

Long-term changes, North Sea
Beaugrand 2004

Mediterranean Sea

Correlation: NAO index and

a - atmospheric pressure

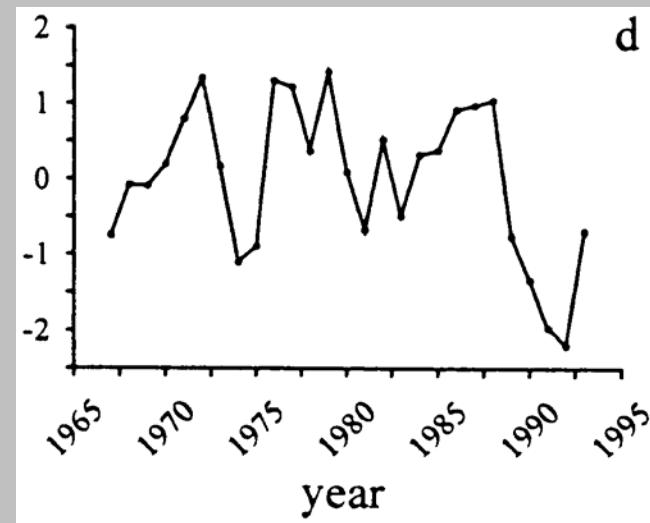
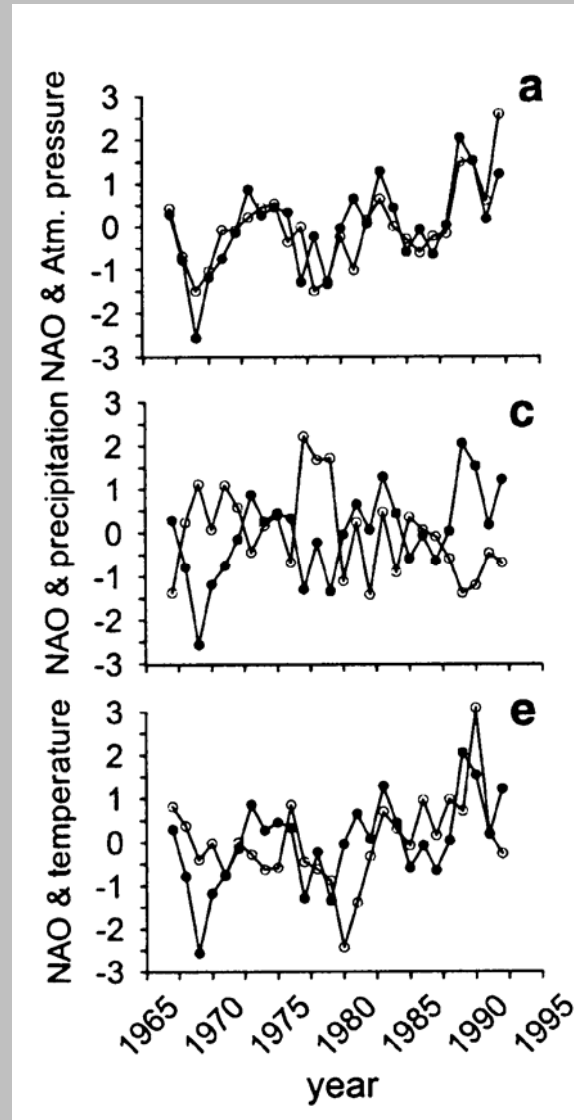
c - precipitation

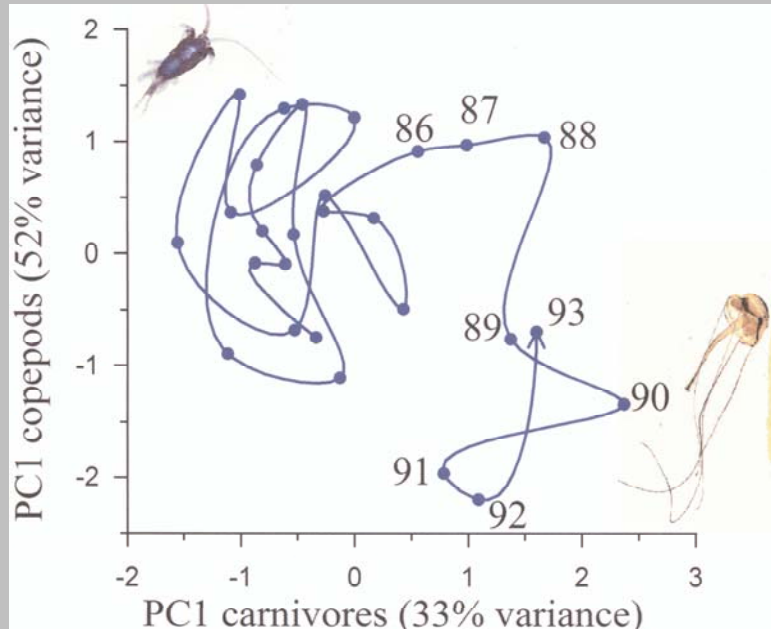
e - SST

Molinero et al., Oecologia, 2005

Copepod variability (PC1), Ligurian Sea

Molinero et al., LO, 2005





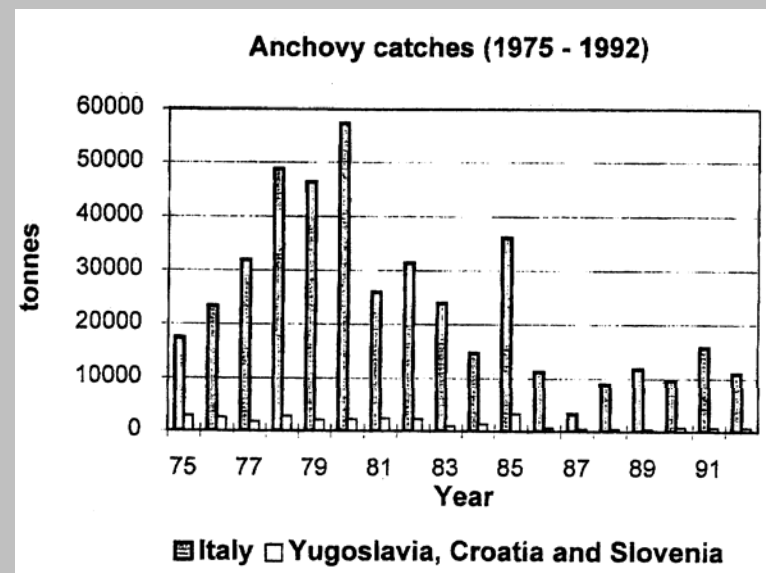
Mediterranean Sea

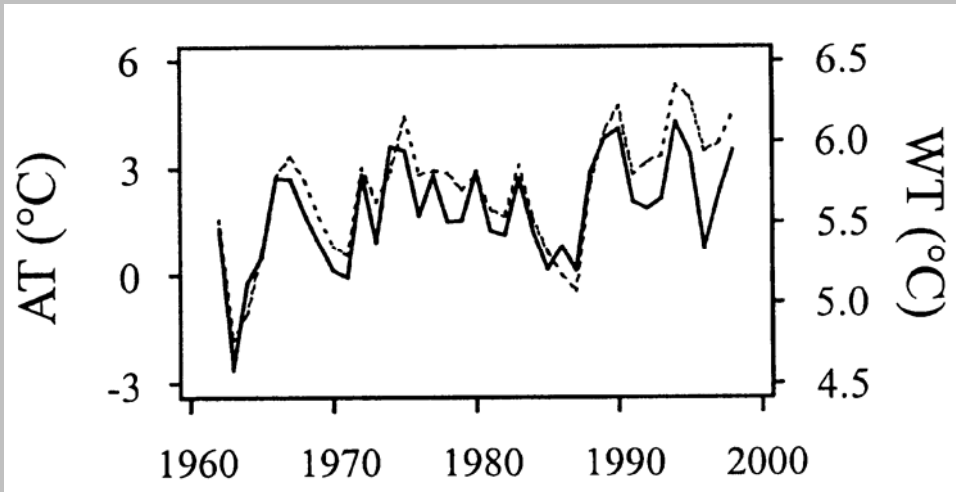
Link between copepods and jellyfish

Molinero et al., LO, 2005

Anchovy catches, Adriatic Sea

Cingolani et al., 1996





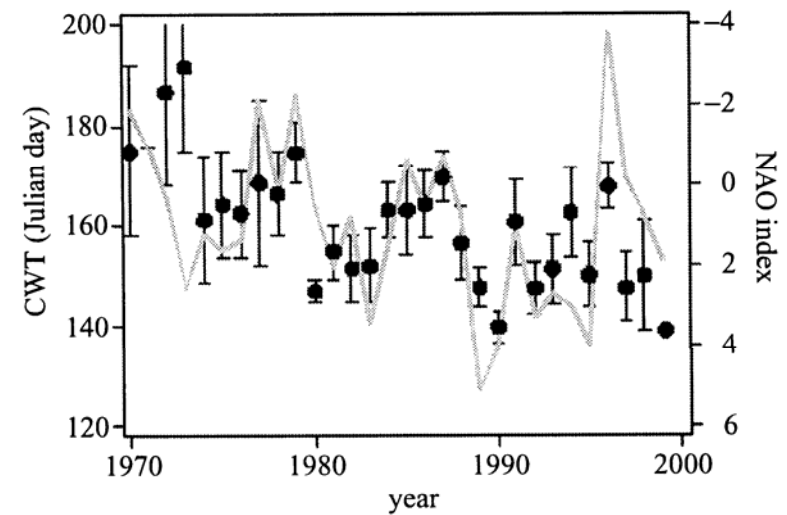
Lakes

Lake Constance: average winter air T and average annual water T

Straile 2003

NAO index and timing of clearwater phase in 28 European lakes

Straile 2001



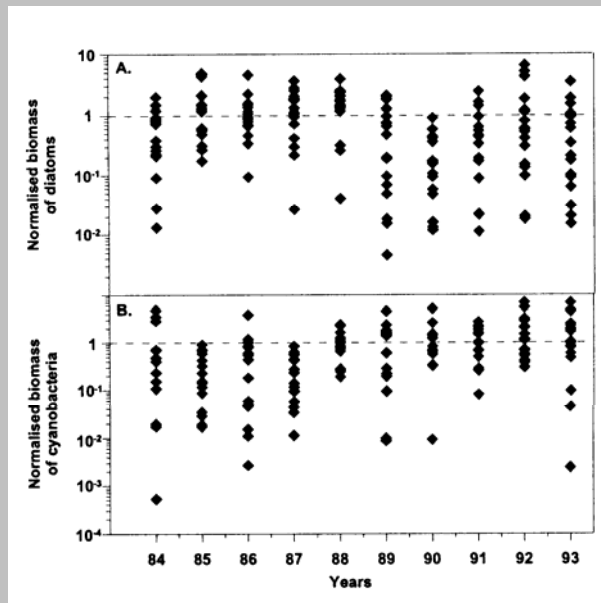
Lakes

17 Swedish lakes

A. Mean diatom biomass

B. Mean cyanobacterial biomass

Weyhenmeyer et al. 2002



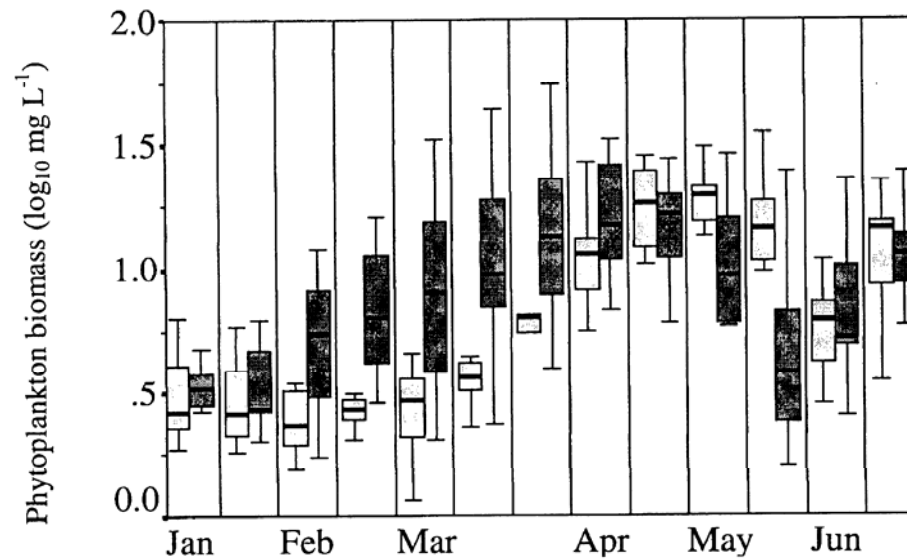
Lake Müggelsee

Phytoplankton
biomass

light: 1979-1987

dark: 1988-1998

Gerten and Adrian 2000



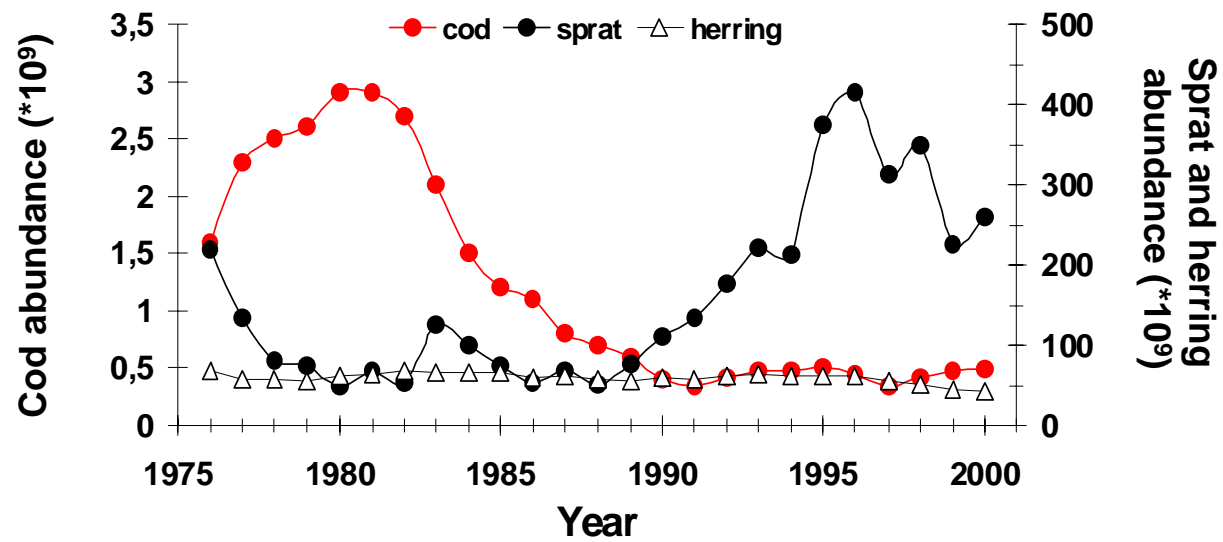
Regime Shift → late 1980s

Changes in marine system function that are relatively abrupt, persistent, occurring at a large spatial scale, observed at different trophic levels and related to climate forcing

<u>Changes in</u>	<u>Baltic</u>	<u>North Sea</u>	<u>NW Mediterranean</u>	<u>Lakes</u>
Physics	yes	yes	yes	yes
Phytoplankton	yes	yes	yes	yes
Zooplankton	yes	yes	yes	yes?
Fish	yes	yes	yes	?
Regime Shift	yes	yes	yes	?



Background: Regime shift in the Baltic ecosystem



Köster et al. (2003)