



FRCGC

Transformation of Zooplankton Community in the Western North Pacific with Warming Condition after the 1990s

Background

Retrospective studies have revealed decadal change lower trophic levels in various regions over the world. Next challenge is to synthesize the regional knowledge to obtain the global scale picture.

Sanae Chiba

FRCGC/JAMSTEC chibas@jamstec.go.jp

and Odate Project Members

GOAL



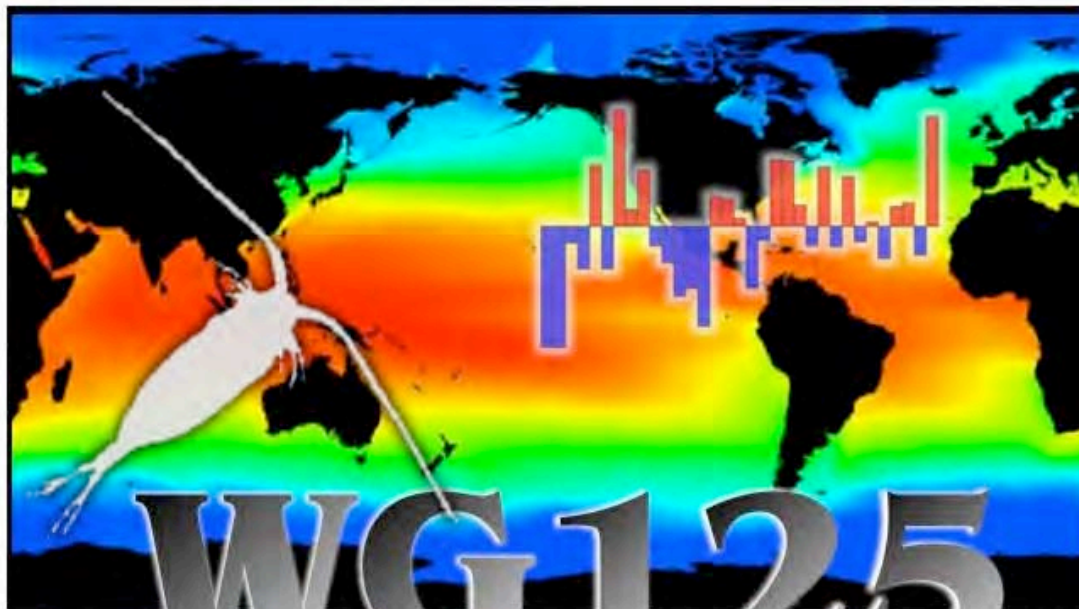
Summarize zooplankton responses to climate changes in the western North Pacific for the global comparison of zooplankton time-series (and understanding ecosystem responses to global change)

SCOR WG125

"Global Comparisons of Zooplankton Time Series"

<http://www.st.nmfs.gov/plankton/scor/>

["Welcome"] [About WG125] [The Time-Series] [Work-in-Progress]

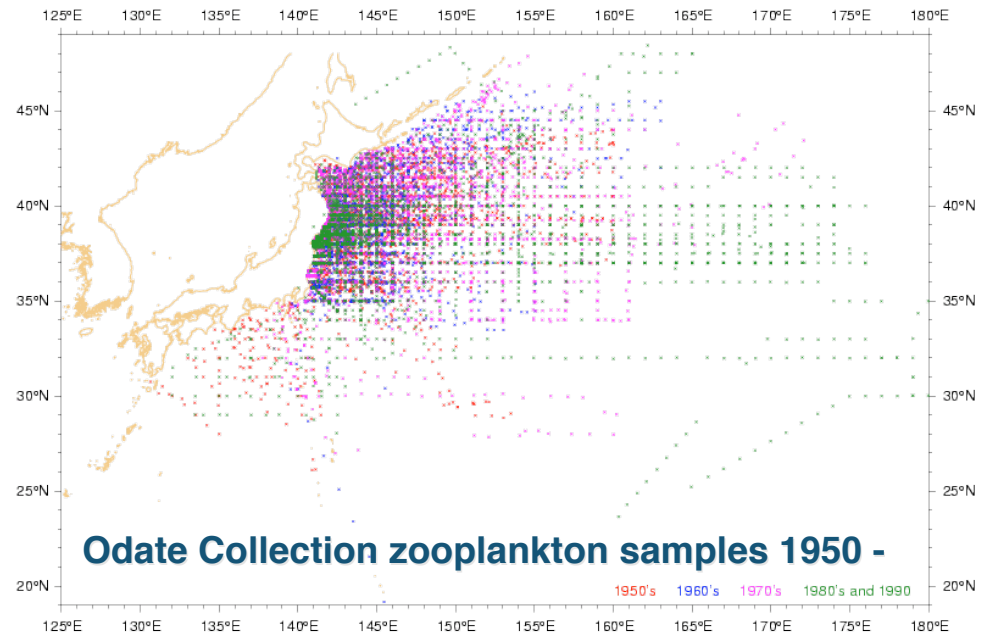
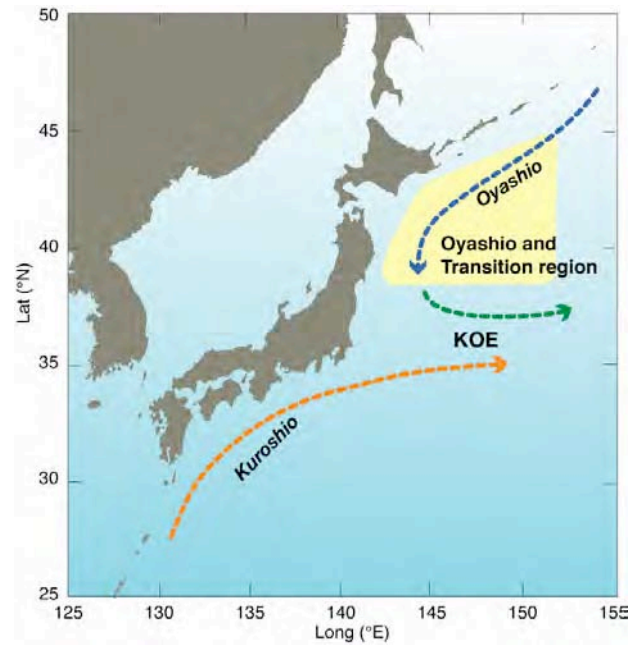
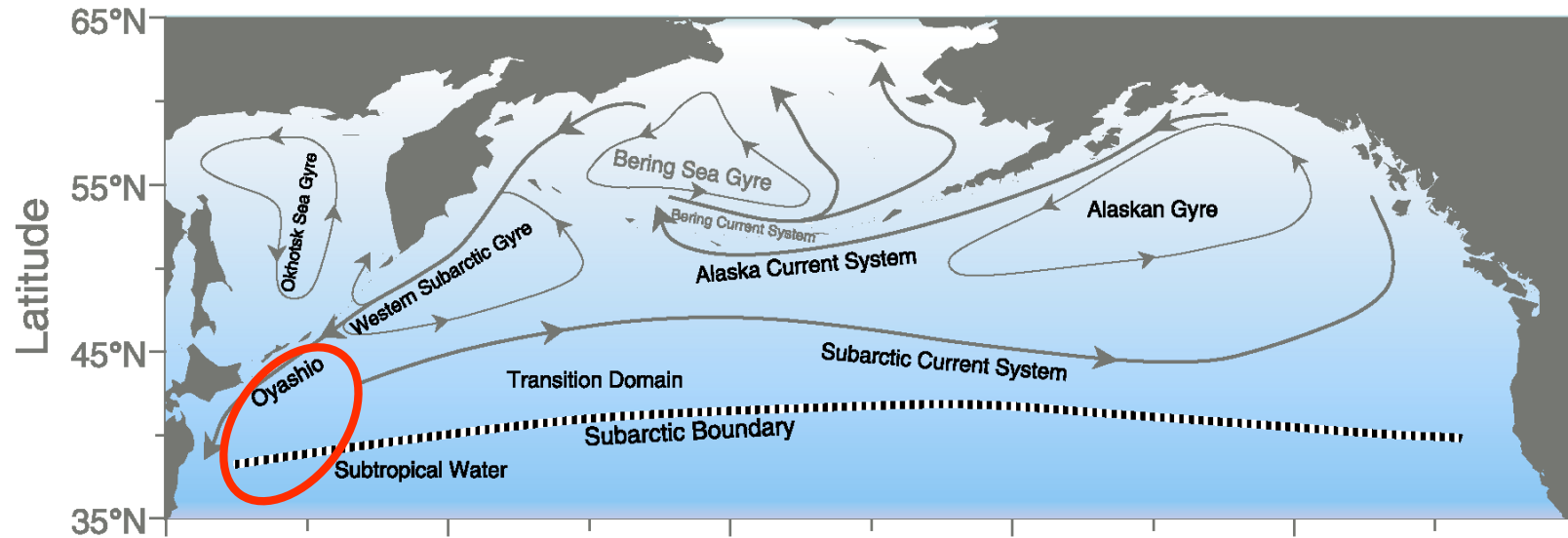


WG125.net

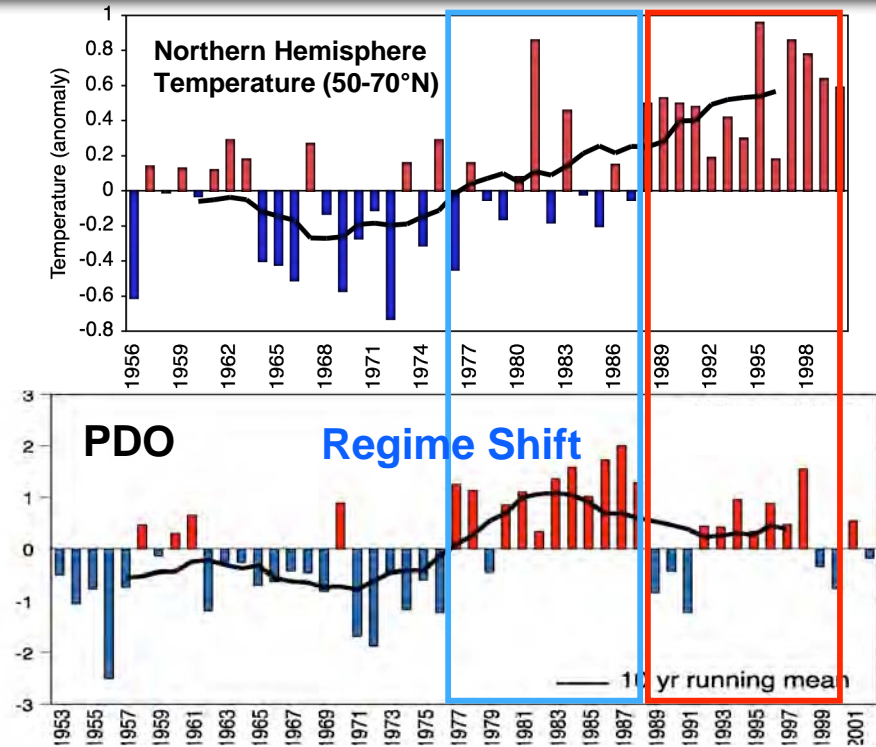


Welcome to the "work-in-progress" web page of the SCOR working group on Global Comparisons of Zooplankton Time Series. In addition to telling you about this working group and summarizing the participating zooplankton time series from around the world, this site serves as a communication point for members of the working group. You can navigate this site by selecting menu buttons from the top of each page.

Target region and Zooplankton time-series: Odate Collection



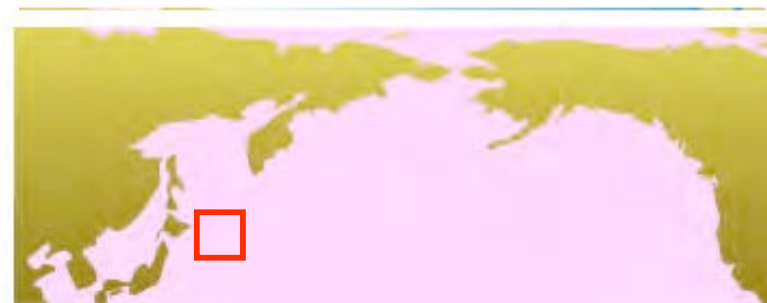
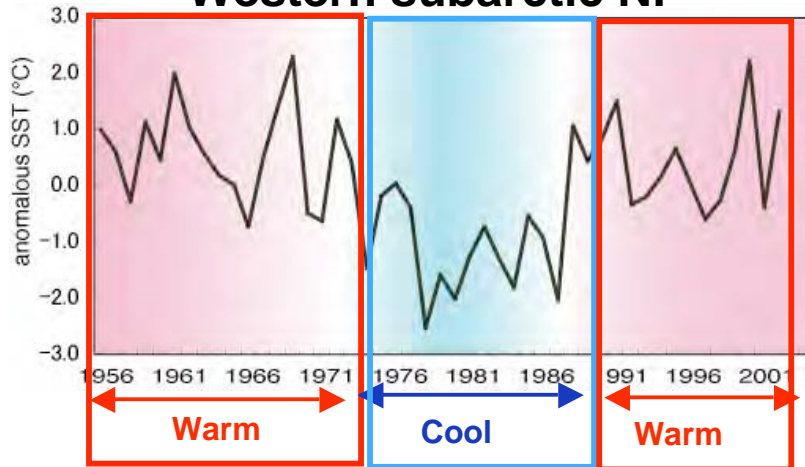
Warming condition in the 1990



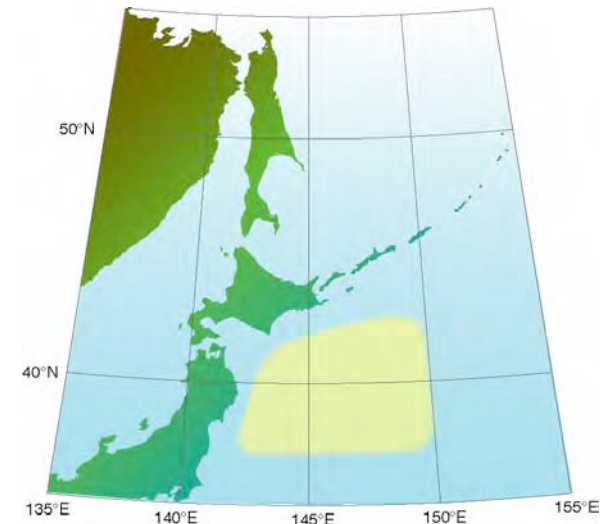
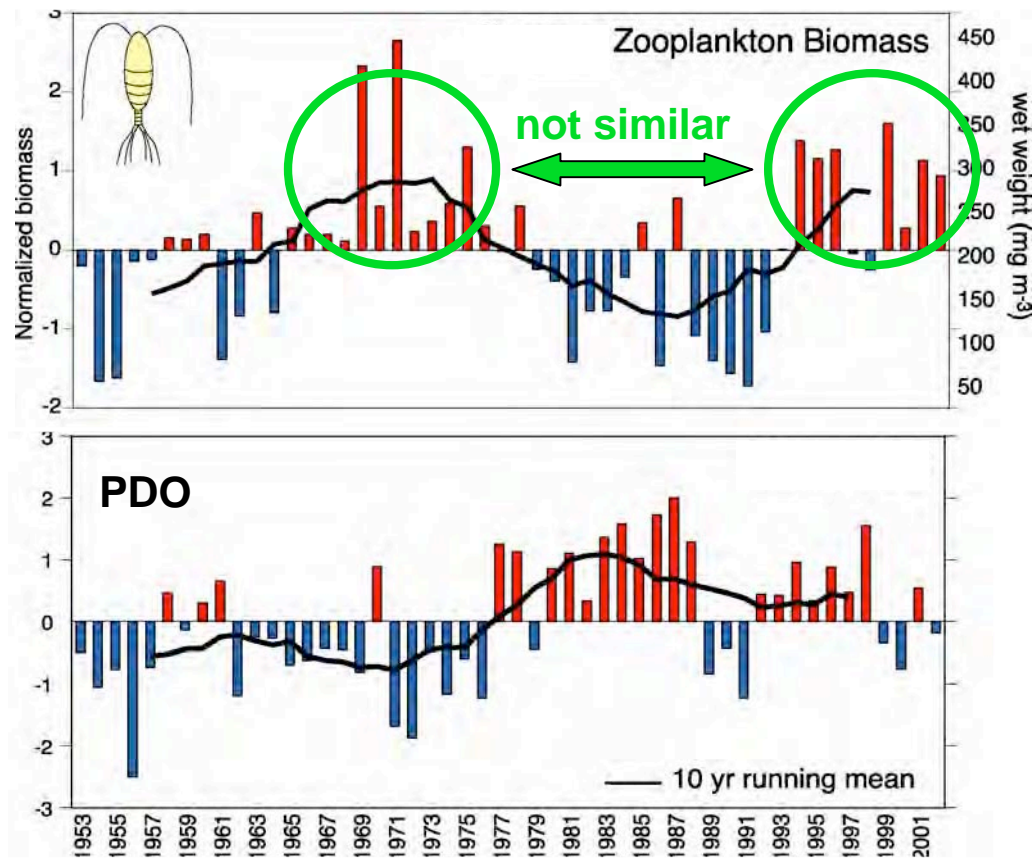
Q: How did zooplankton respond to warming condition in the 1990s

Key:
Seasonality
Community Structure

Western subarctic NP



Zooplankton Biomass change: Oscillation? -> No



**Oyashio Water
> 5°C at 100 m deep**

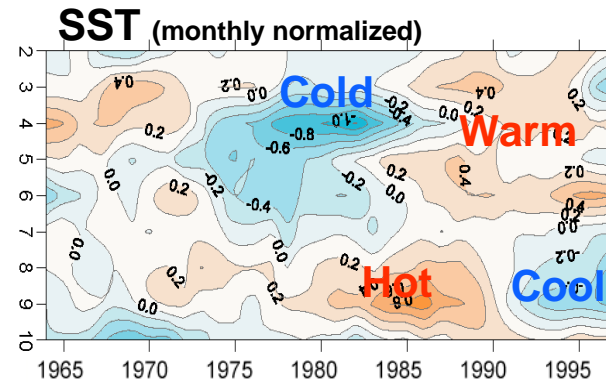
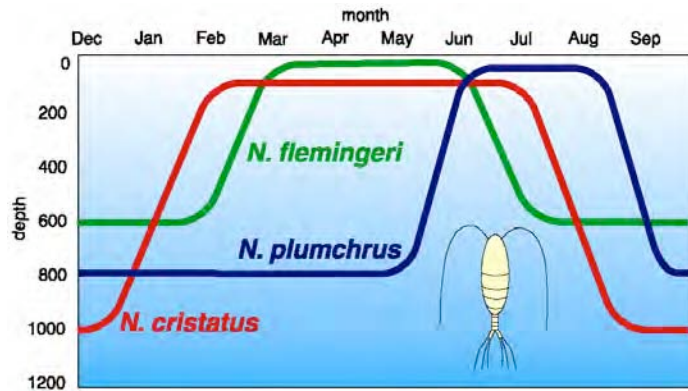
(Chiba et al, 2006, GCB)

FINDINGS

- **Changes in zooplankton after 1990**
 - Phenology**
 - Biogeography**
 - Community structure**
- **Change in the link to primary producers**
- **Change in seasonality in the surface mixed layer environment**



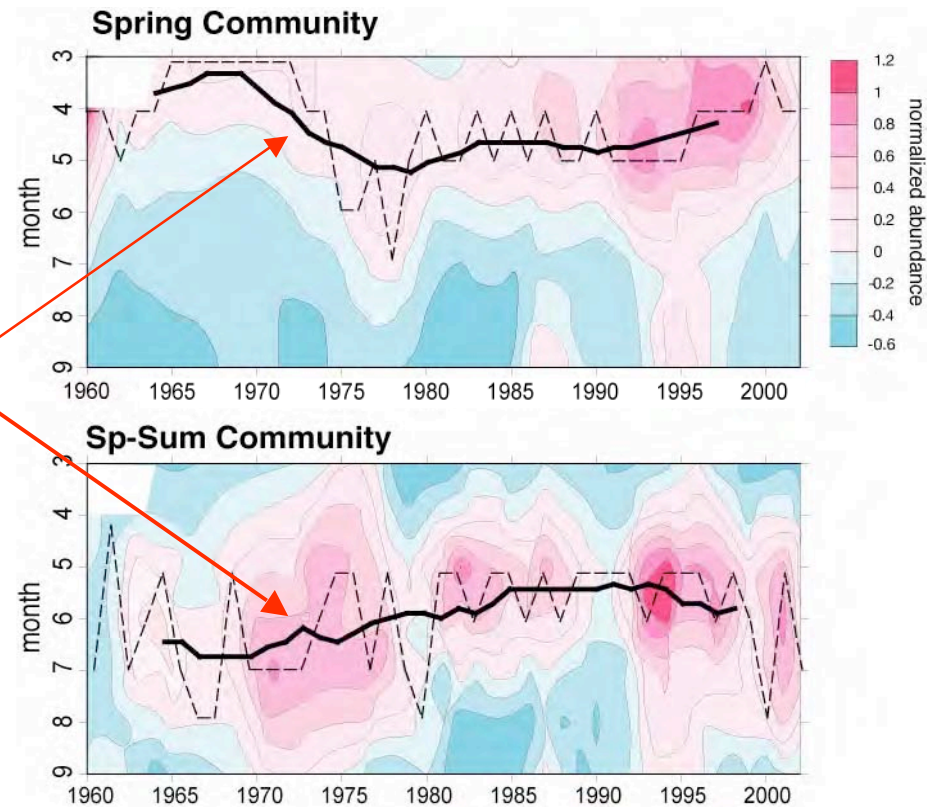
Zooplankton Phenology:



Seasonal and Interannual variation of Copepod abundance

In the 1990s productive season started early and lasted long

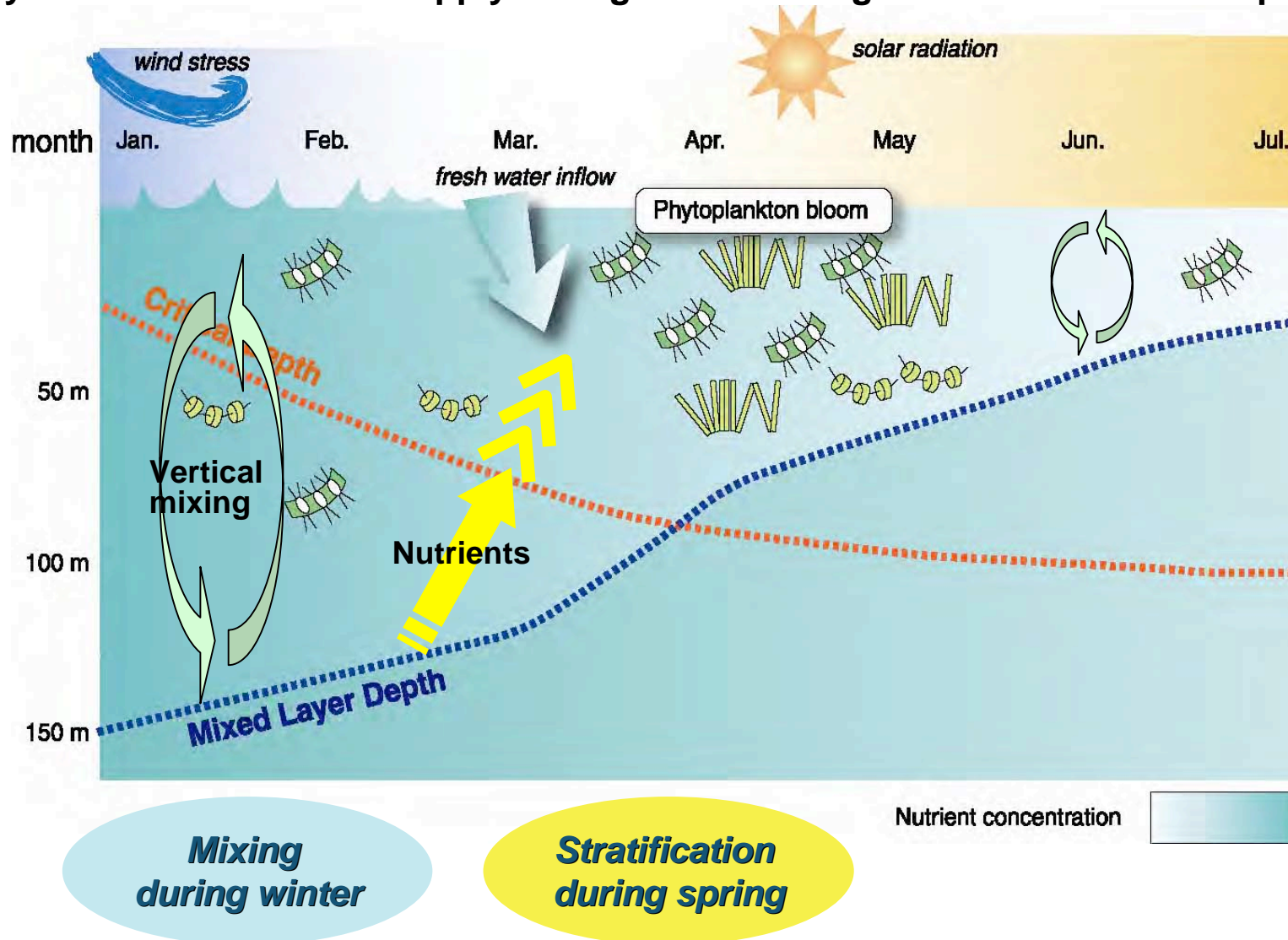
Timing of peak abundance



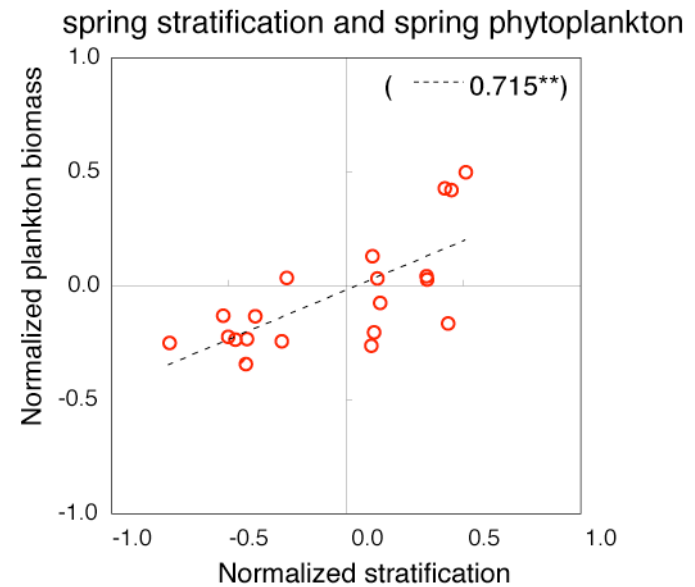
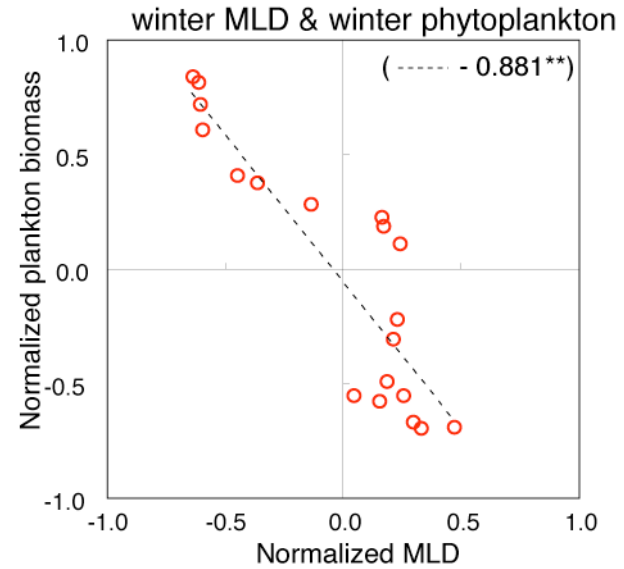
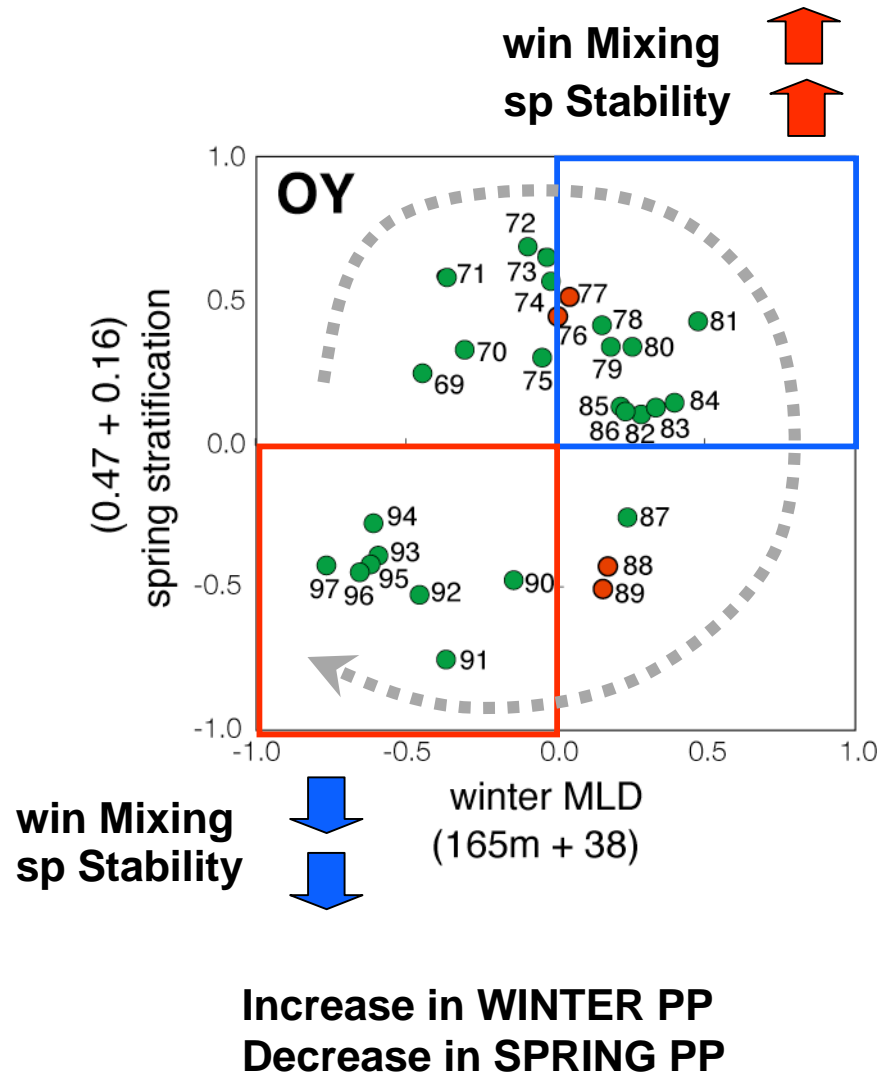
(Chiba et al, 2006, GCB)

Seasonal process of lower trophic level environments

Oyashio: Rich nutrients supply during winter and light-limited condition is prevailing

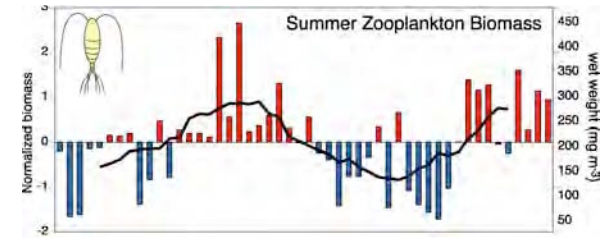
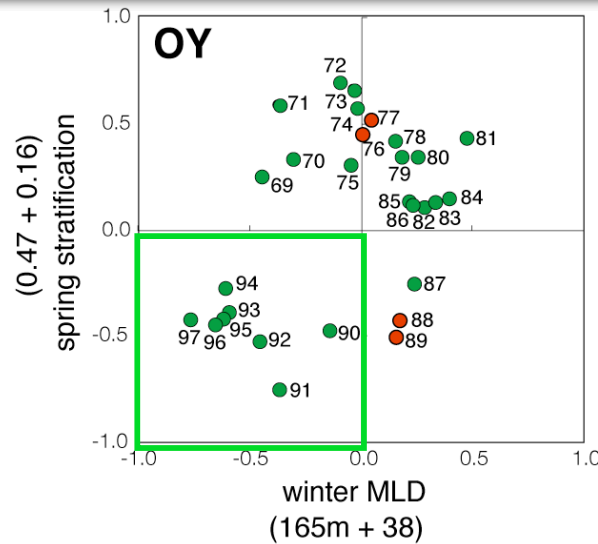


Seasonality in the Mixed Layer Environment

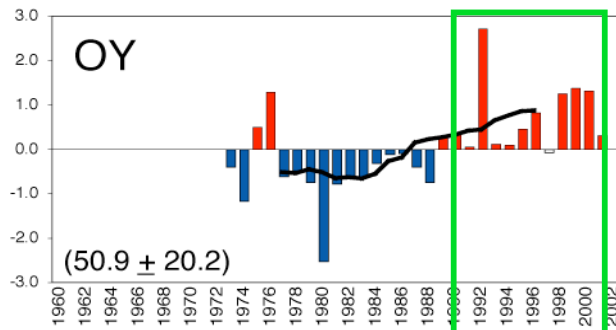


Note: Regime shift yrs indicated transition of seasonality

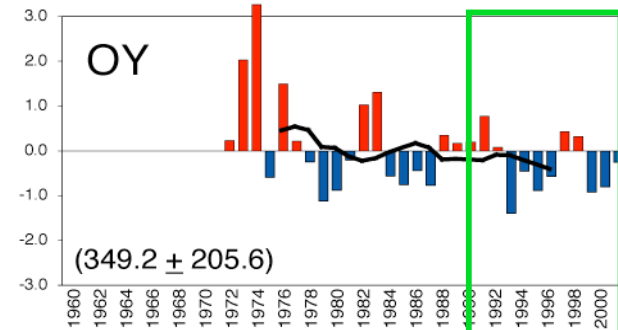
Seasonality in the Mixed Layer Environment



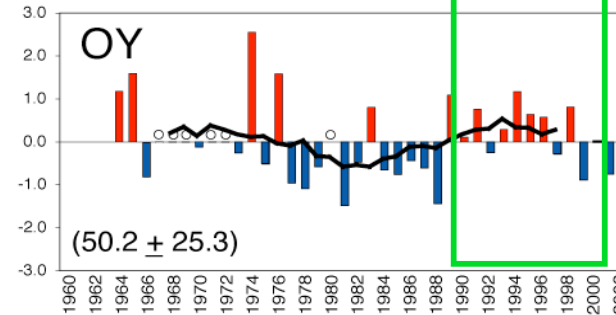
Winter Phytoplankton



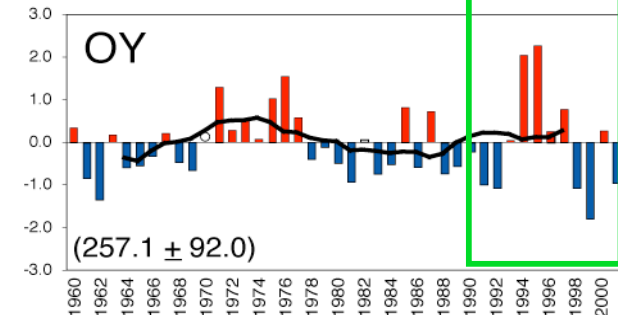
Spring Phytoplankton



Winter Zooplankton



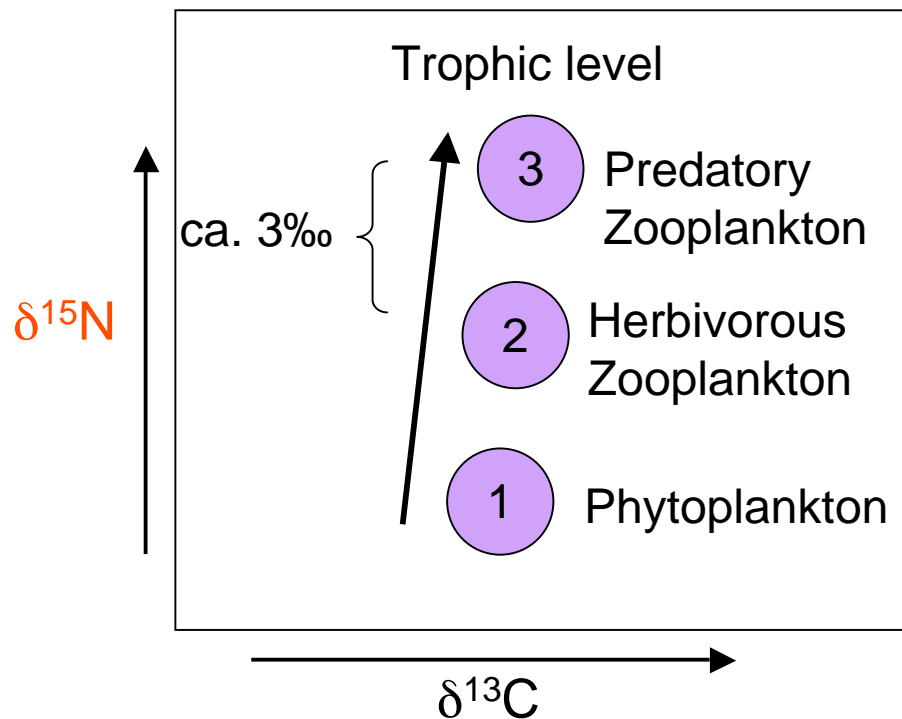
Spring Zooplankton



Bottom-up control in winter

Link not clear in spring (and in annual biomass)

What stable Isotope ratio of zooplankton implies....



$\delta^{15}\text{N}$

Proxy of trophic level
= switch of feeding strategy
== phytoplankton abundance
=== bottom-up control

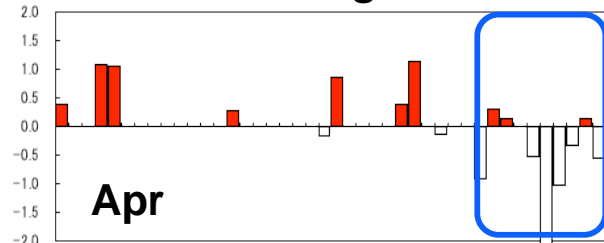
But be careful in the N-limited environment (increase), and existence of N_2 fixation phytoplankton (decrease).

Link to Primary Producers: Stable Isotope Analysis

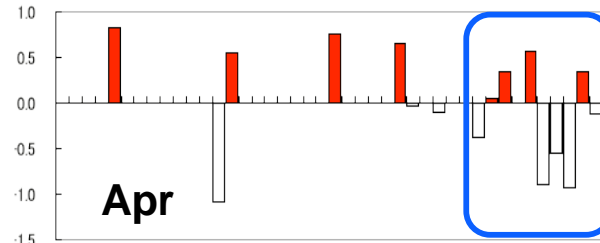


Time-series $\delta^{15}\text{N}$ of 3 *Neocalanus* species

N. flemingeri



N. cristatus



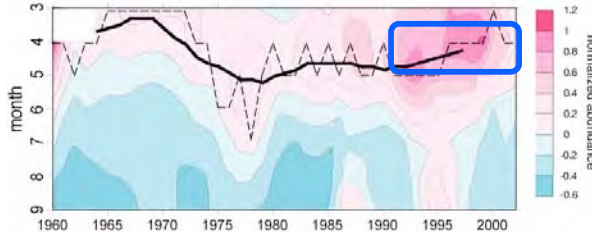
Apr

Apr

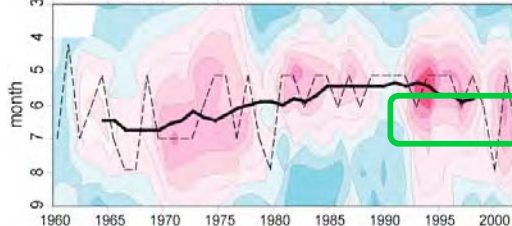
May

May

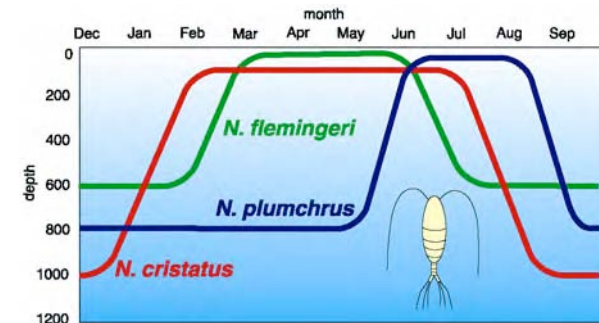
Spring Community



Sp-Sum Community



Bottom-up control in 1990s: phytoplankton availability might have improved range 0.3%~

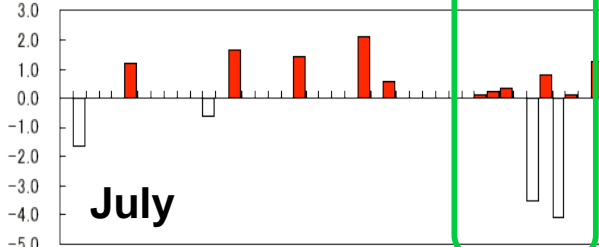
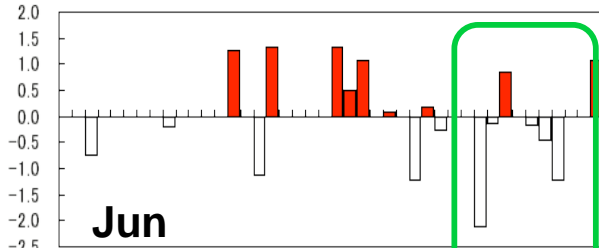
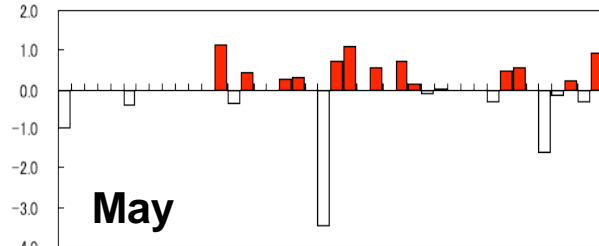


N. plumchrus

May

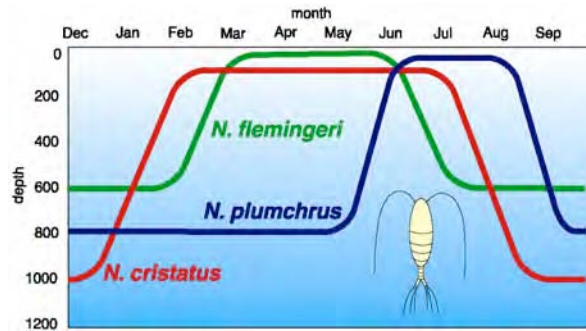
Jun

July



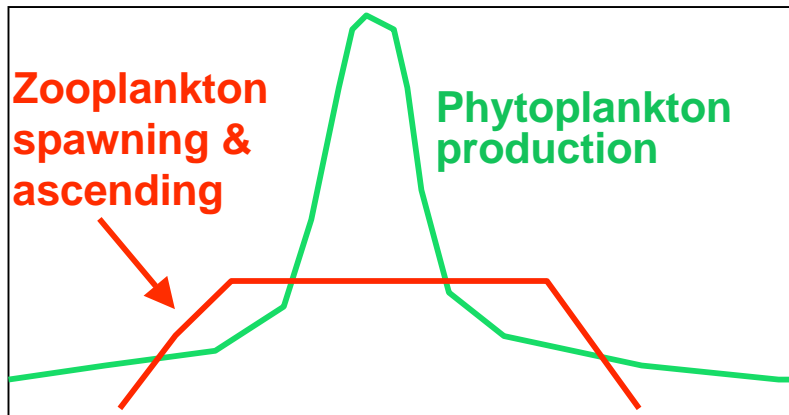
1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002

Link to Primary Producers: Match-Mismatch



Moderate but longer food supply might be better for production of copepod community

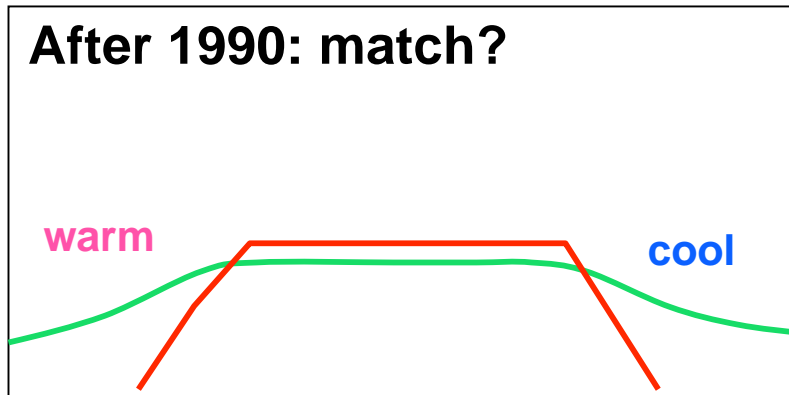
Before 1990: mismatch



Less successful

Zooplankton survival

After 1990: match?



Successful?

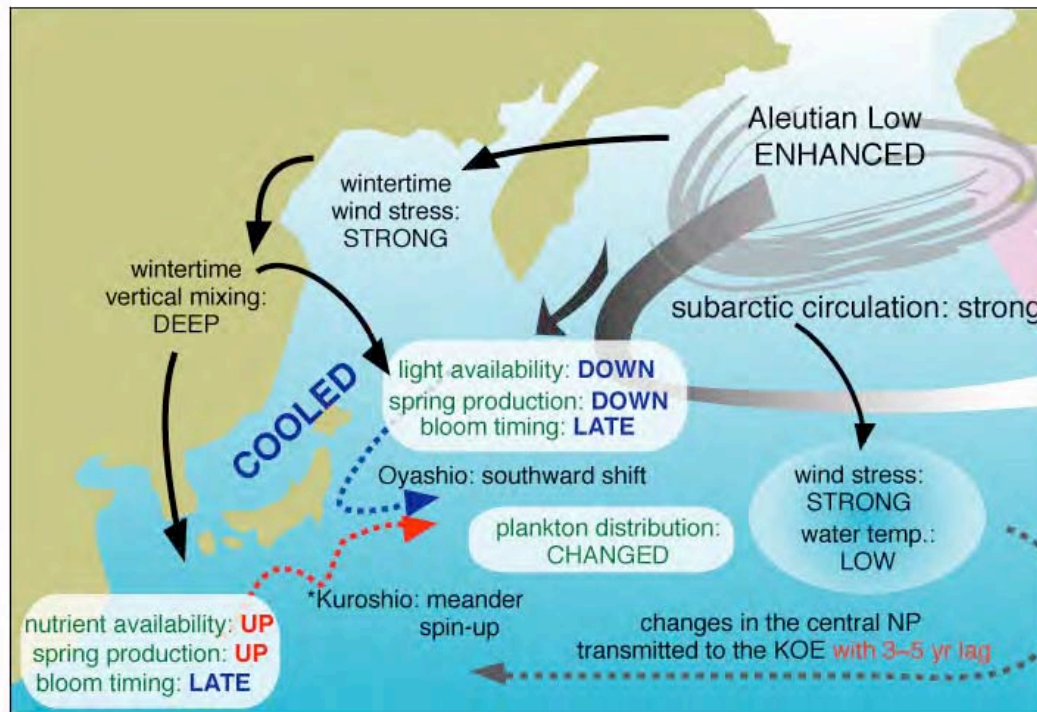


winter

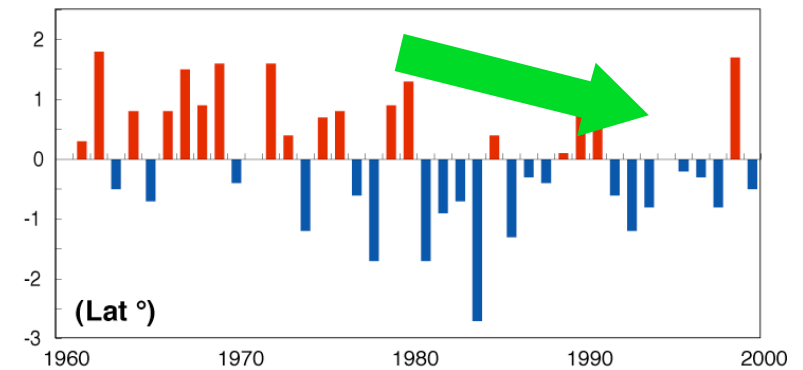
spring

summer

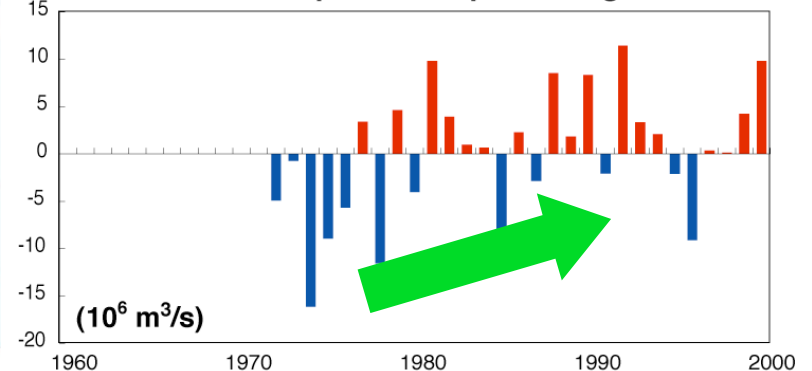
Dynamics of western boundary currents, Kuroshio & Oyashio, changed after the 1976/77 climate Regime Shift



Oyashio Southern Limit



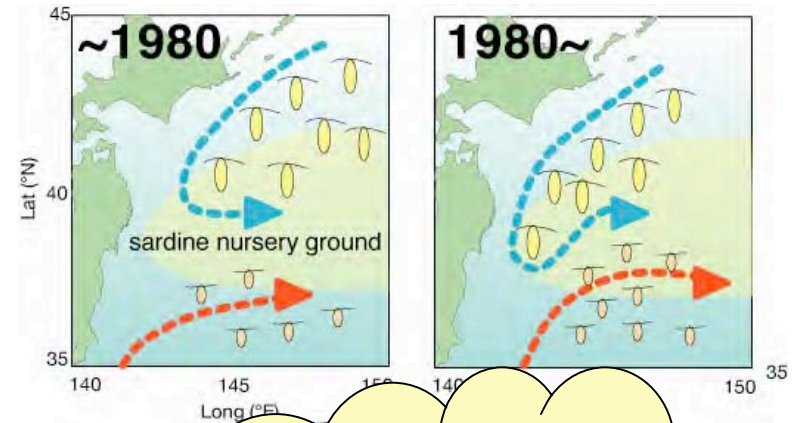
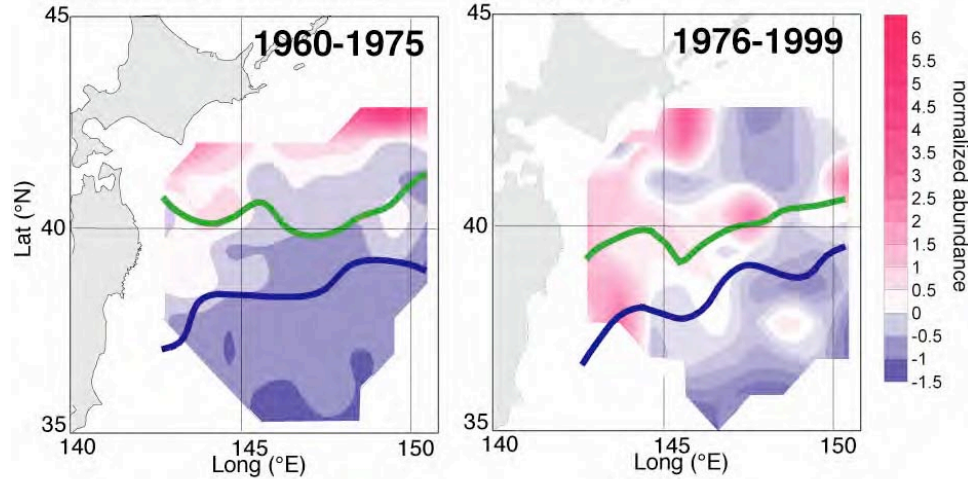
Kuroshio Geostrophic Transport along 137°E



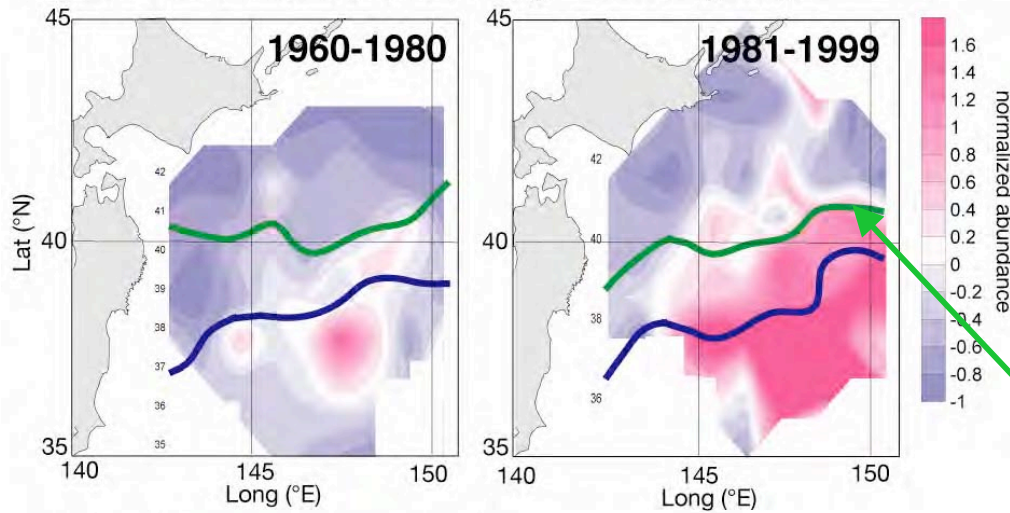
Kuroshio – Oyashio Dynamics & Biogeographical Change



Oyashio assemblage = PC1 group



Transition Zone assemblage = PC2 group

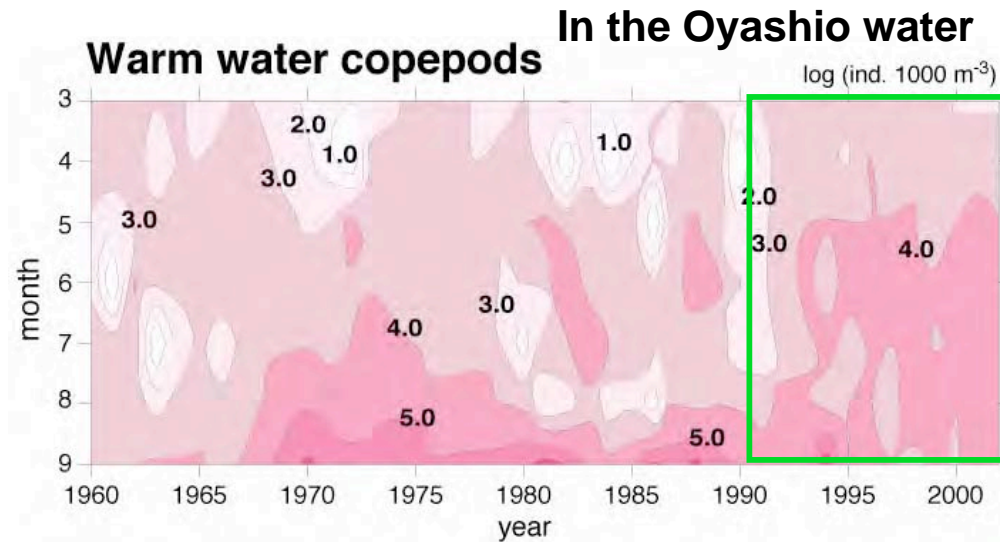


100m WT — 5°C — 10°C

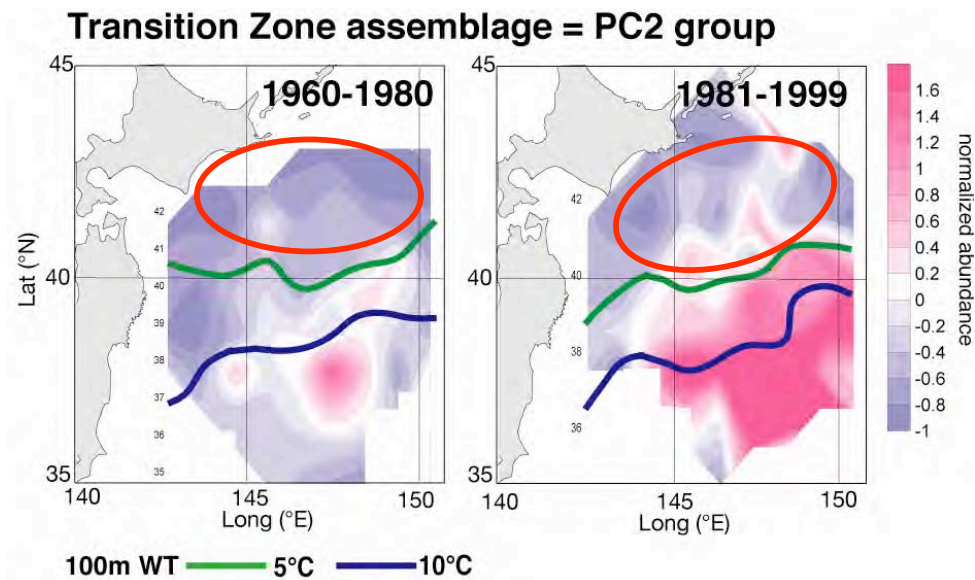
Increase of warm water copepod species in the Kuroshio-Oyashio Transition region

Approximate southern limit of Oyashio

Kuroshio – Oyashio Dynamics & Biogeographical Change



Increase of warm water copepod species in Oyashio



Summary

Warm winter and cool spring-summer condition elongated productive season of lower trophic levels although decrease in wintertime nutrients supply seemed to reduce annual phytoplankton biomass. Efficiency of phytoplankton consumption by zooplankton might improved.

Distribution of warm water copepod species (small, short life-cycle) shifted Northward due to change in the western boundary currents, resulting in changes in zooplankton community structure in the Oyashio.

Ecosystem structure in the subarctic western North Pacific altered after 1990.

and... what happened after 2000?

