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.

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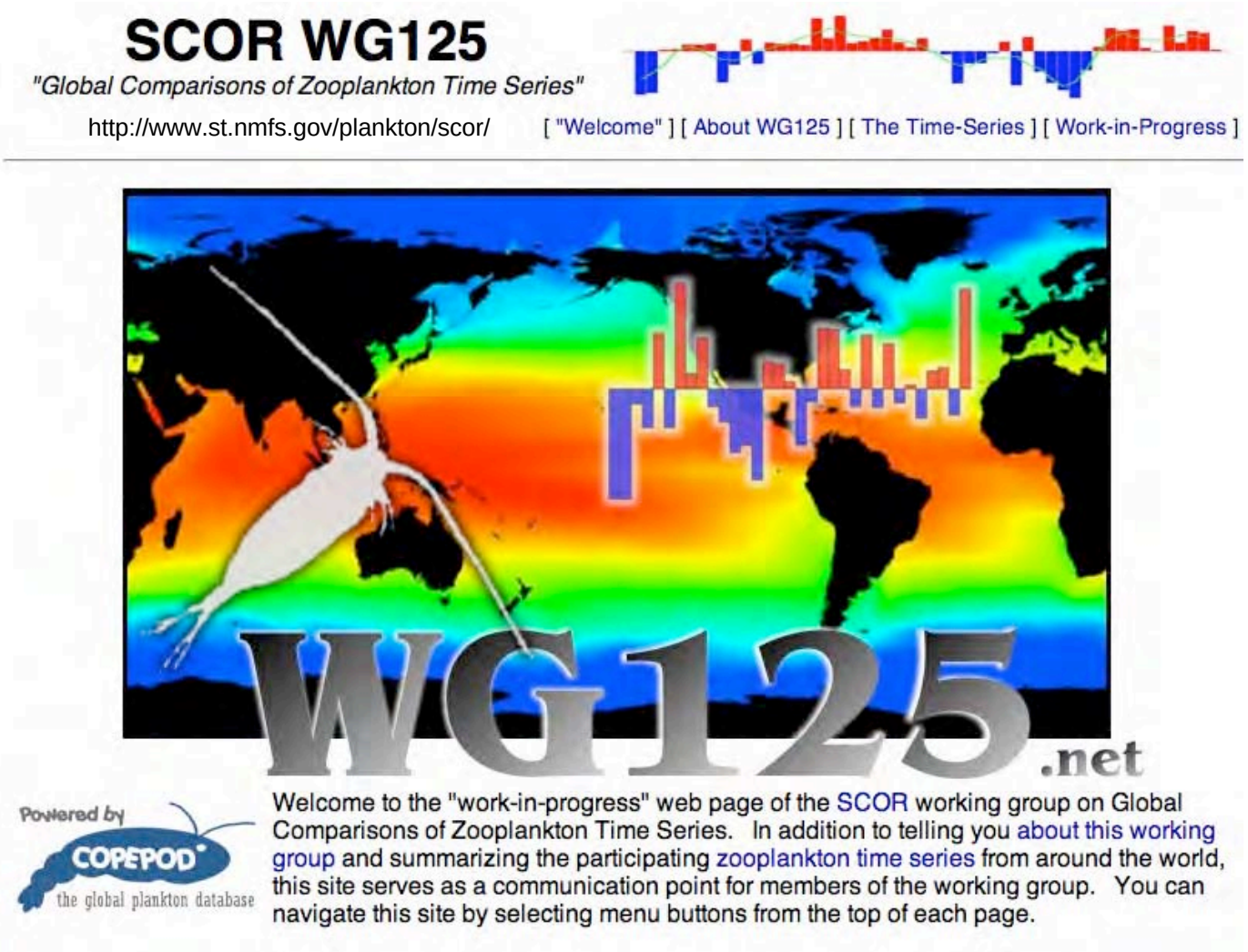
and Odate Project Members

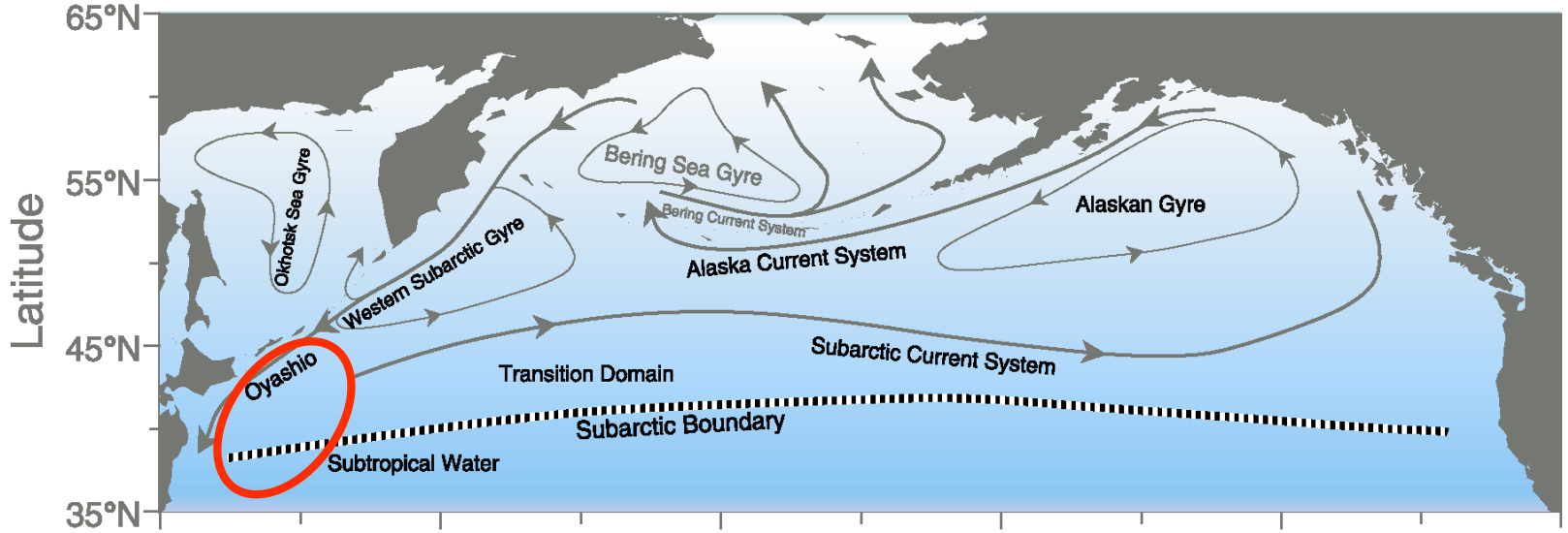
4th Zooplankton Production Symposium, 2007 May, Hiroshima

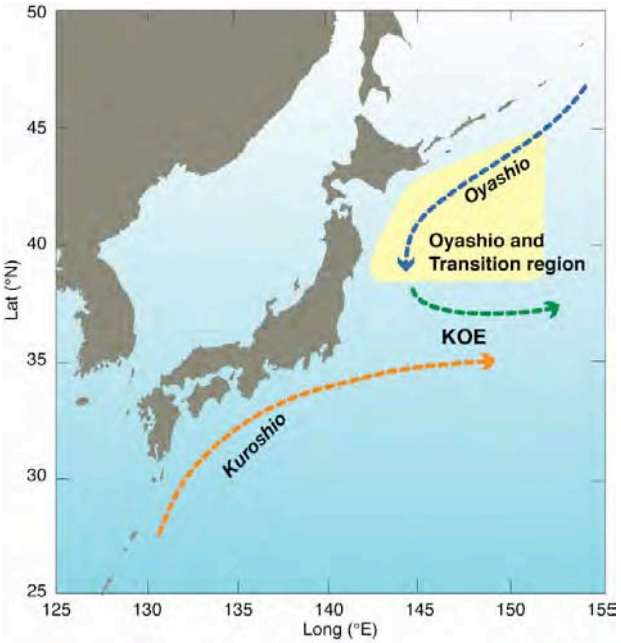
GOAL

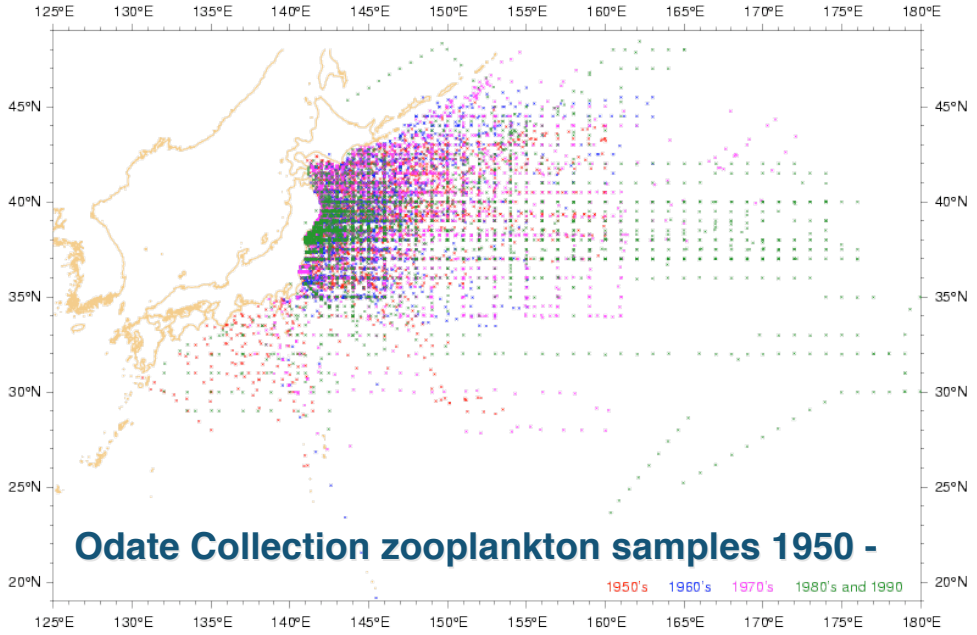
Summarize zooplankton responses to climate changes in the western North Pacific for the global comparison of zooplankton time-series (and understanding ecosystem responses to global change)



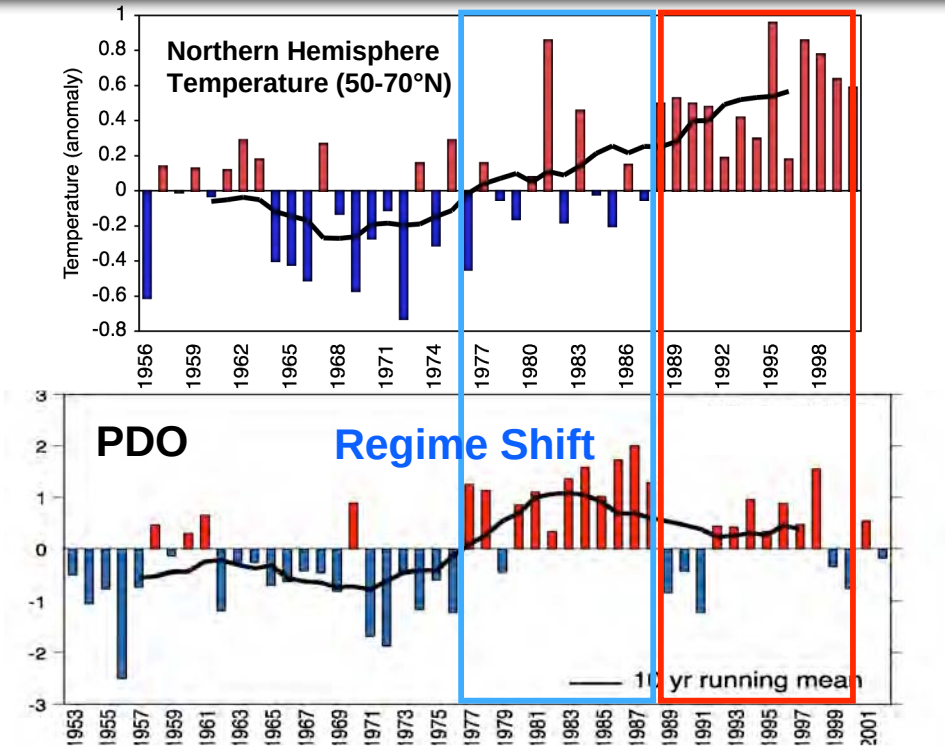
Target region and Zooplankton time-series: Odate Collection





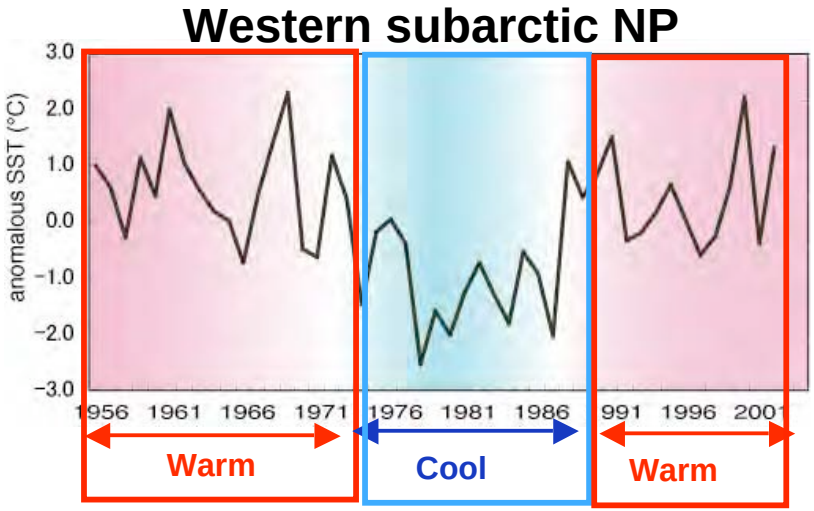


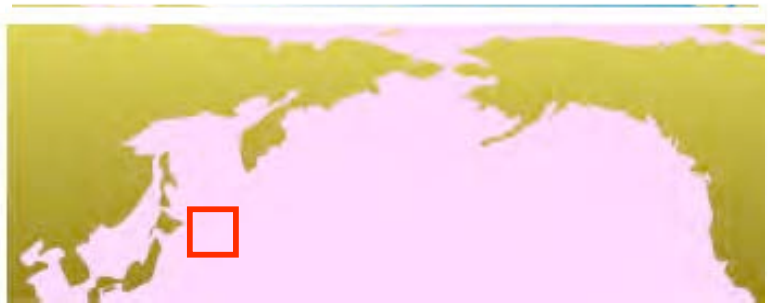
Warming condition in the 1990



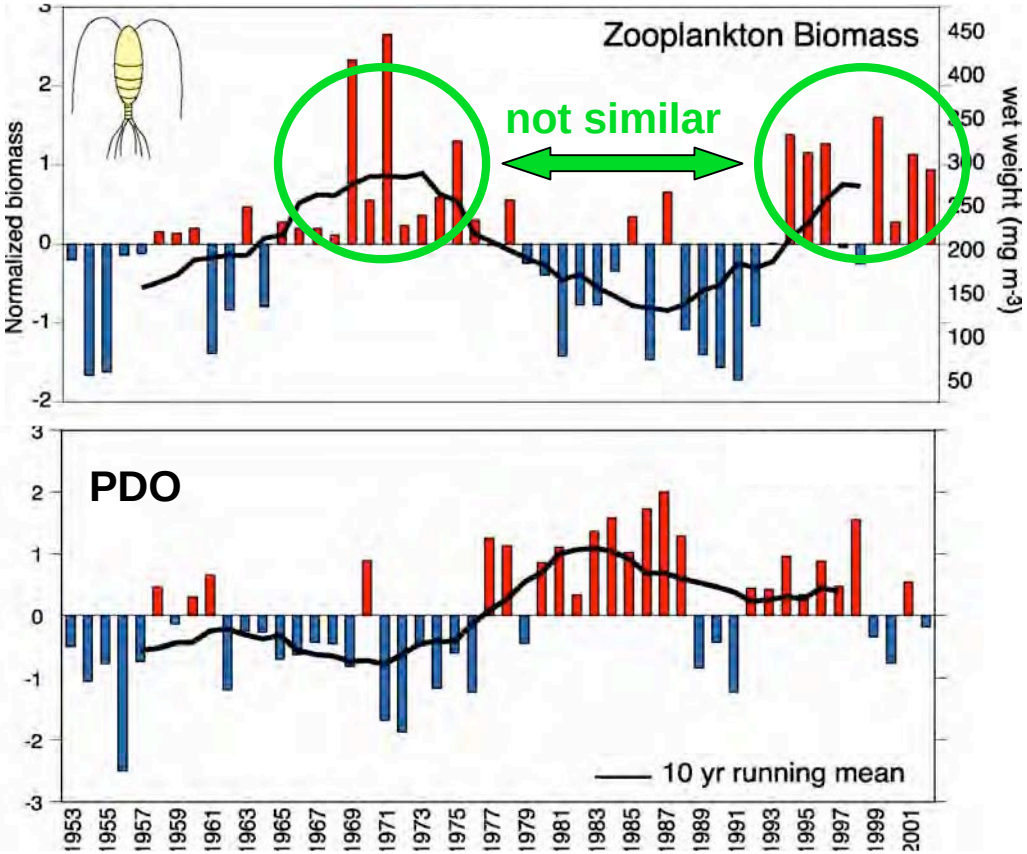
***Q:** How did zooplankton respond to warming condition in the 1990s*

Key:
Seasonality
Community Structure

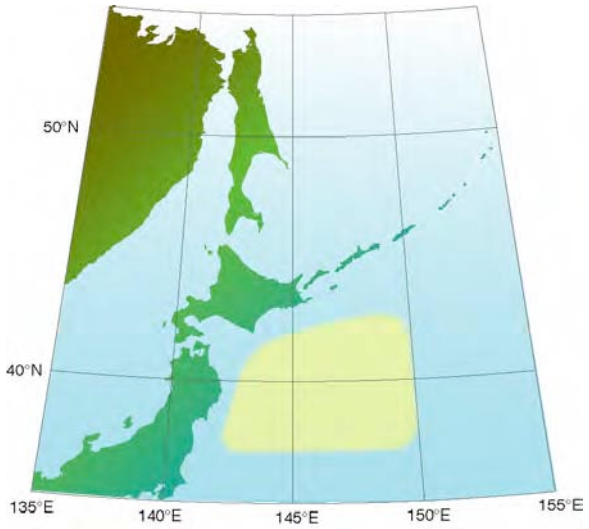




Zooplankton Biomass change: Oscillation? -> No



(Chiba et al, 2006, GCB)

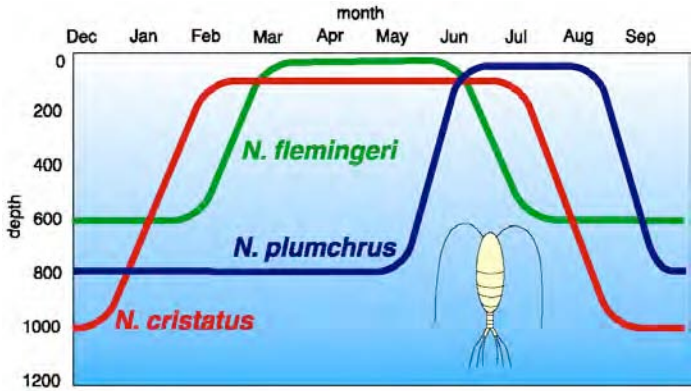


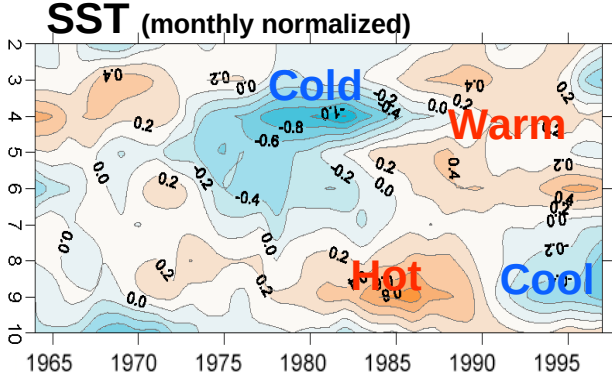
Oyashio Water
> 5°C at 100 m deep

FINDINGS

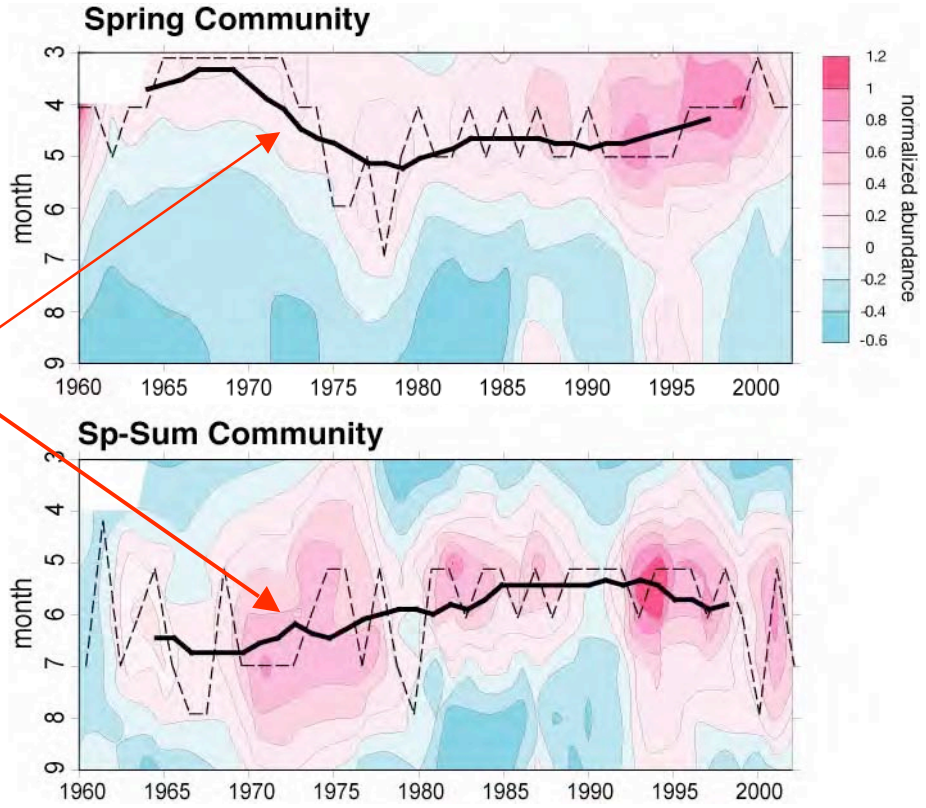
- **Changes in zooplankton after 1990**
  - **Phenology**
  - **Biogeography**
  - **Community structure**
- **Change in the link to primary producers**
- **Change in seasonality in the surface mixed layer environment**

Zooplankton Phenology:





Seasonal and Interannual variation of Copepod abundance



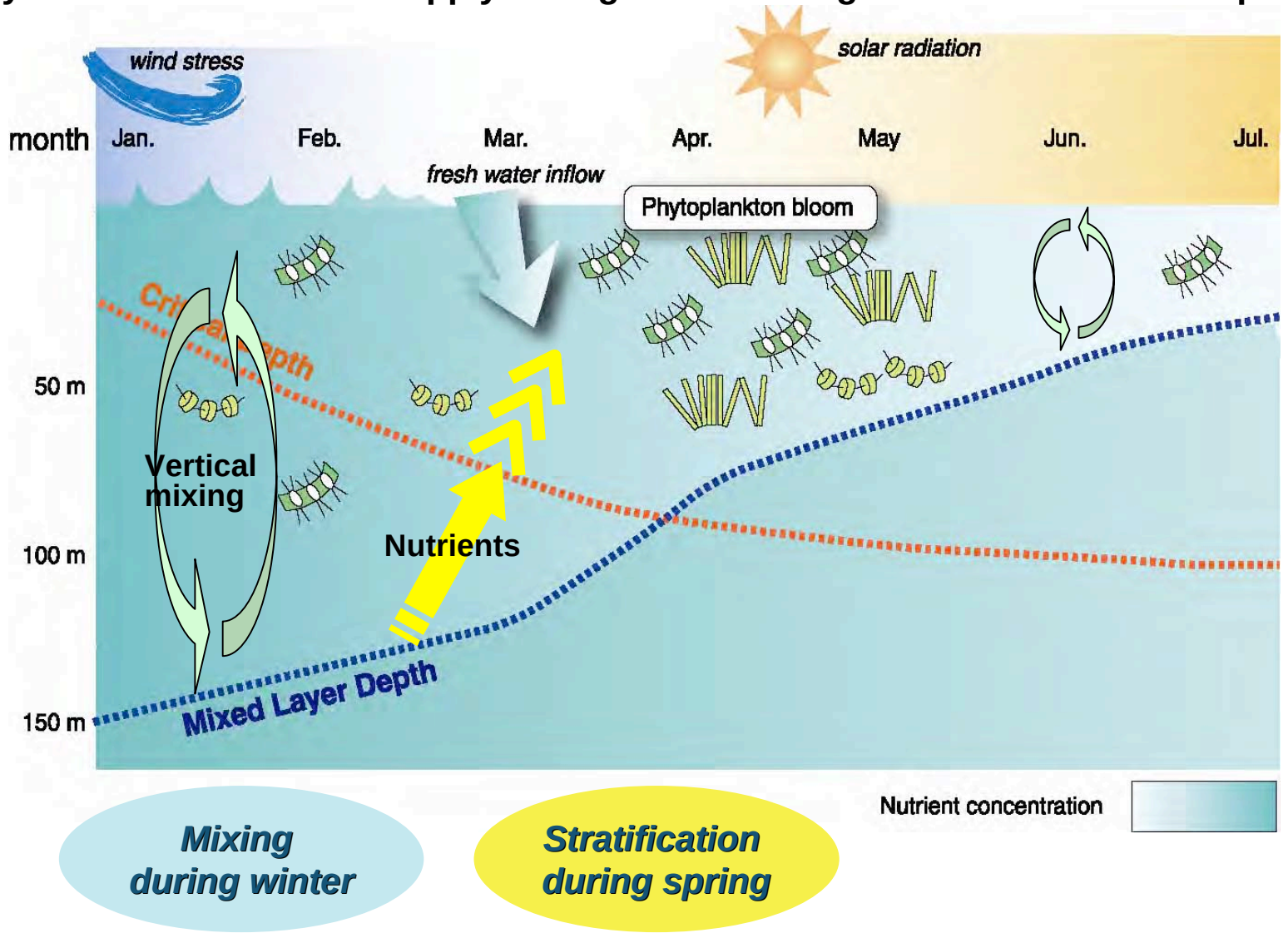
Timing of peak abundance

In the 1990s productive season started early and lasted long

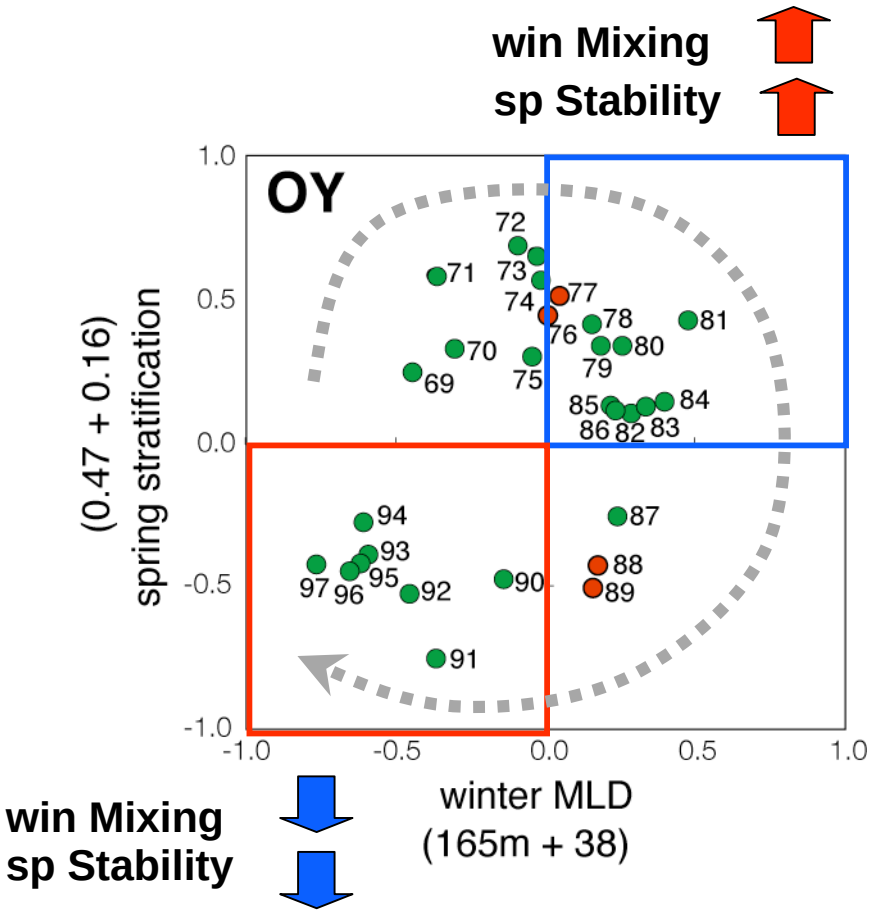
(Chiba et al, 2006, GCB)

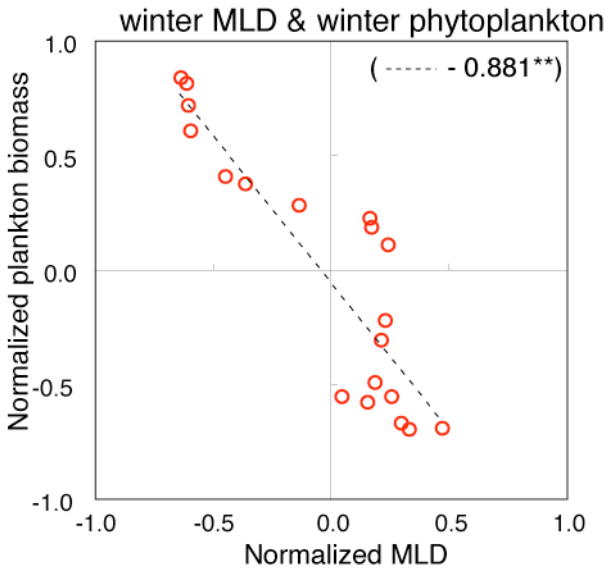
Seasonal process of lower trophic level environments

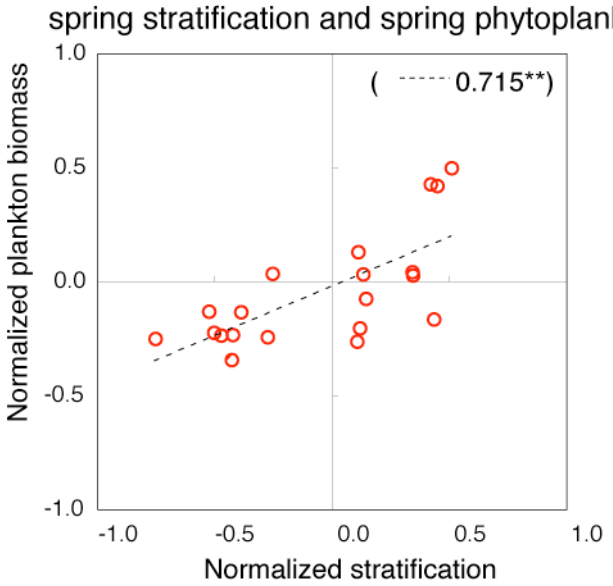
Oyashio: Rich nutrients supply during winter and light-limited condition is prevailing



Seasonality in the Mixed Layer Environment



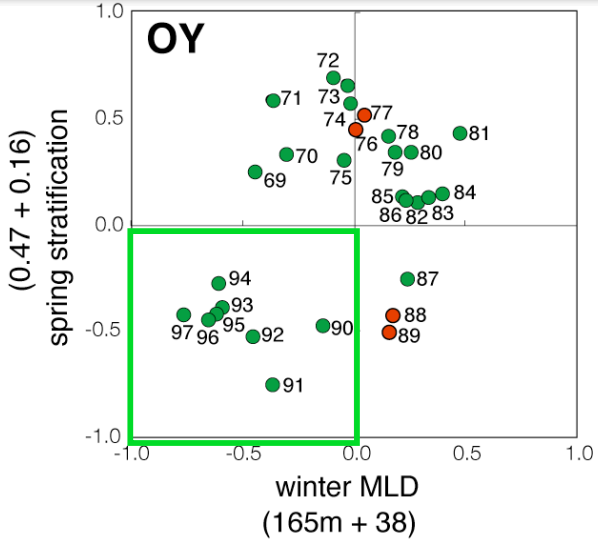


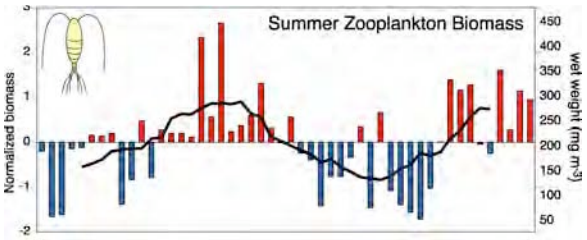


Increase in WINTER PP
Decrease in SPRING PP

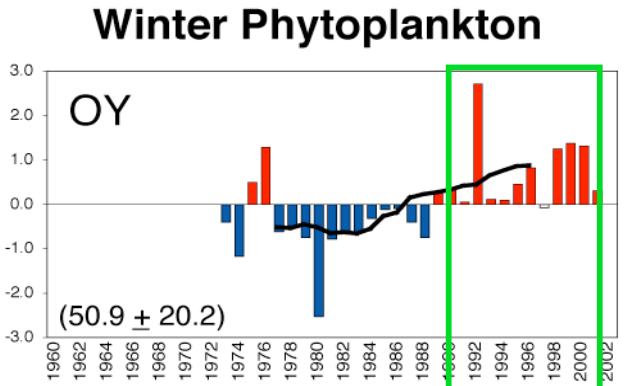
Note: Regime shift yrs indicated transition of seasonality

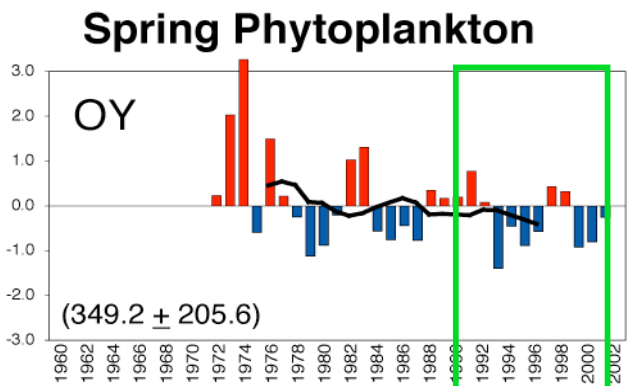
Seasonality in the Mixed Layer Environment

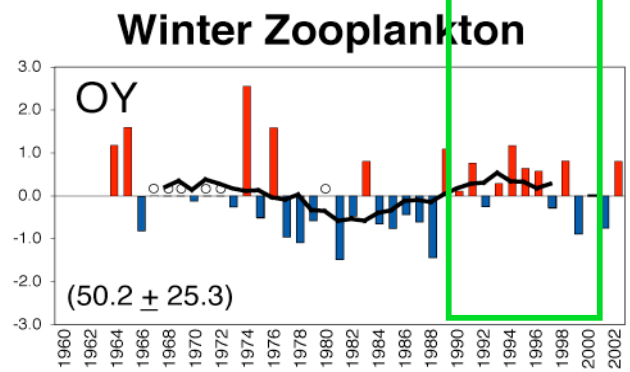


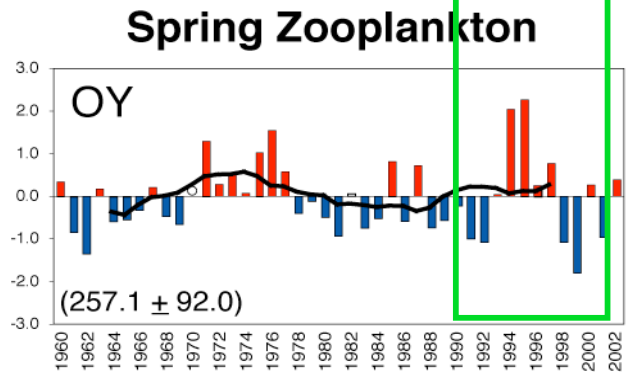


Bottom-up control in winter



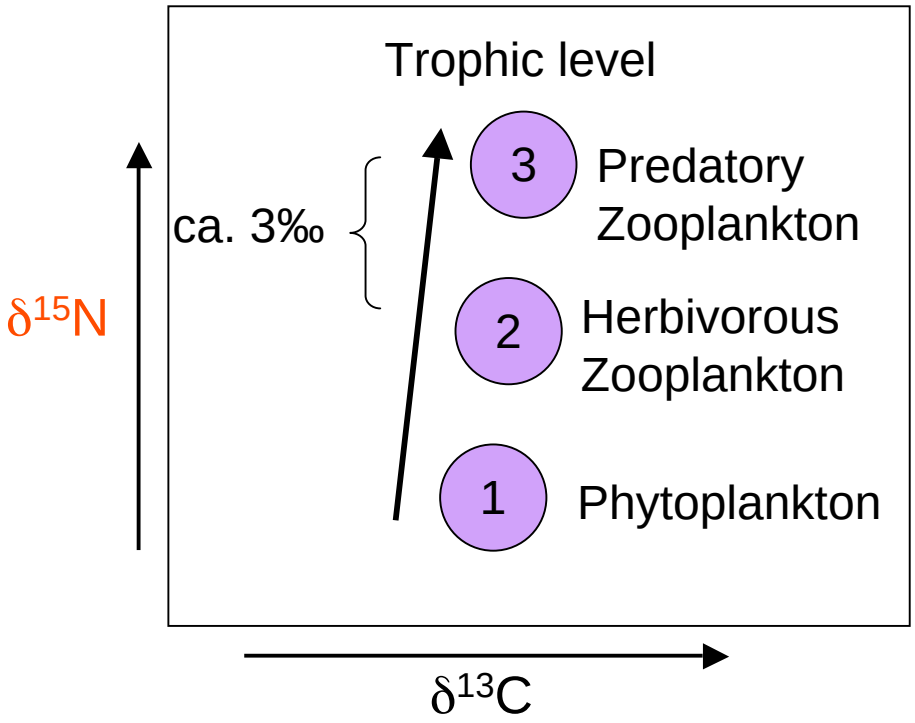






Link not clear in spring (and in annual biomass)

What stable Isotope ratio of zooplankton implies….



$\delta^{15}N$

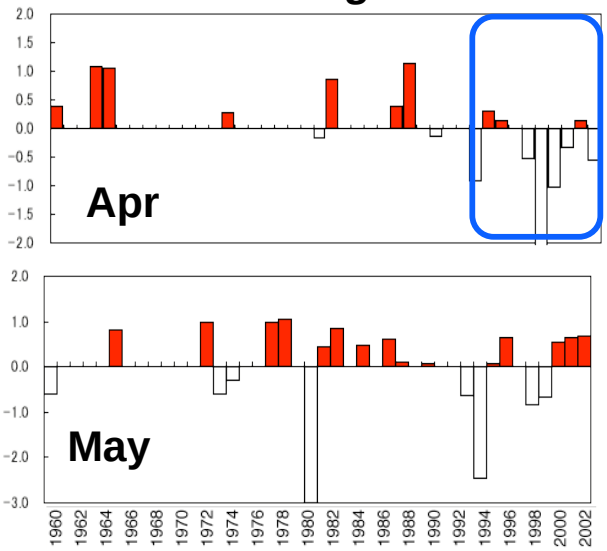
Proxy of trophic level
= switch of feeding strategy
== phytoplankton abundance
=== bottom-up control

But be careful in the N-limited environment (increase), and existence of N^2 fixation phytoplankton (decrease).

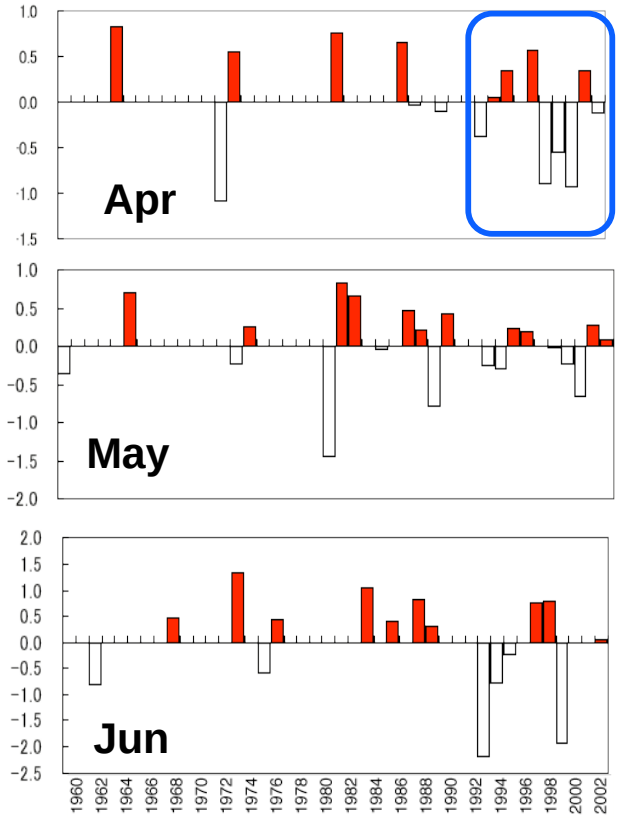
Link to Primary Producers: Stable Isotope Analysis

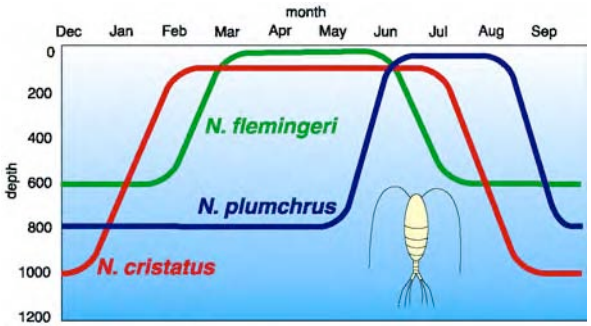
Time-series $\delta^{15}N$ of 3 *Neocalanus* species

N.flemingeri

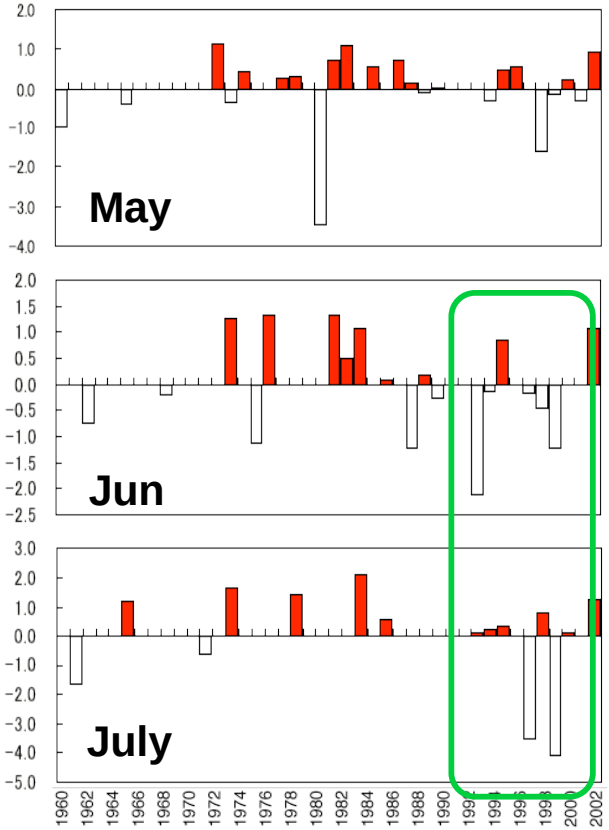


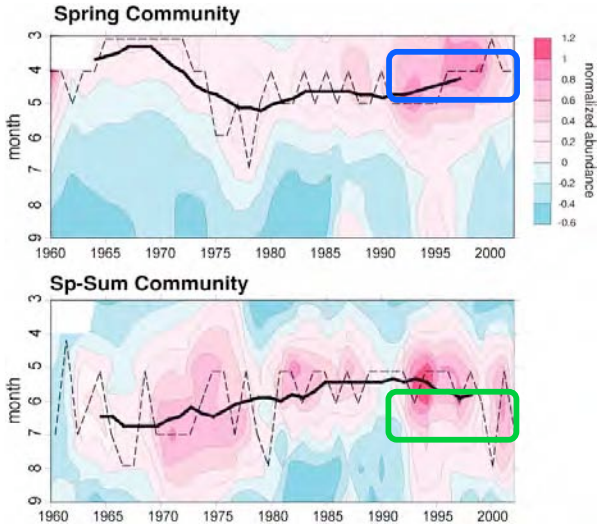
N.cristatus





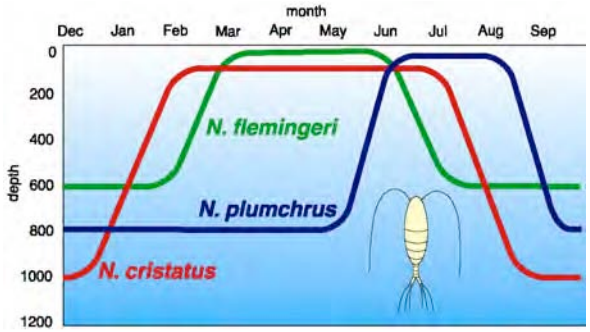
N. plumchrus





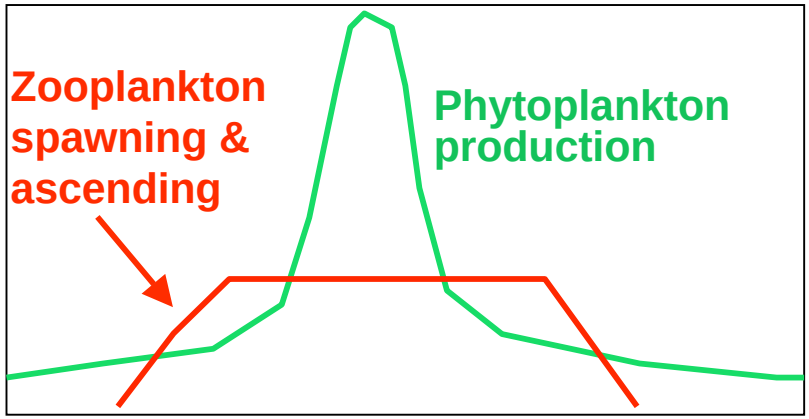
Bottom-up control in 1990s: phytoplankton availability might have improved range 0.3%~

Link to Primary Producers: Match-Mismatch

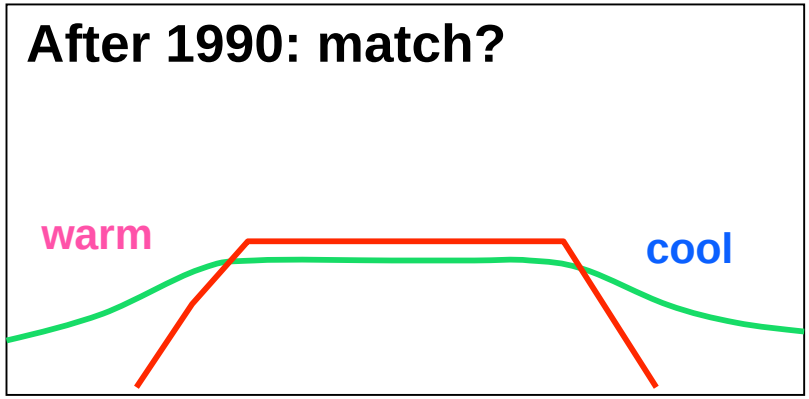


Moderate but longer food supply might be better for production of copepod community

Before 1990: mismatch



After 1990: match?



winter **spring** **summer**

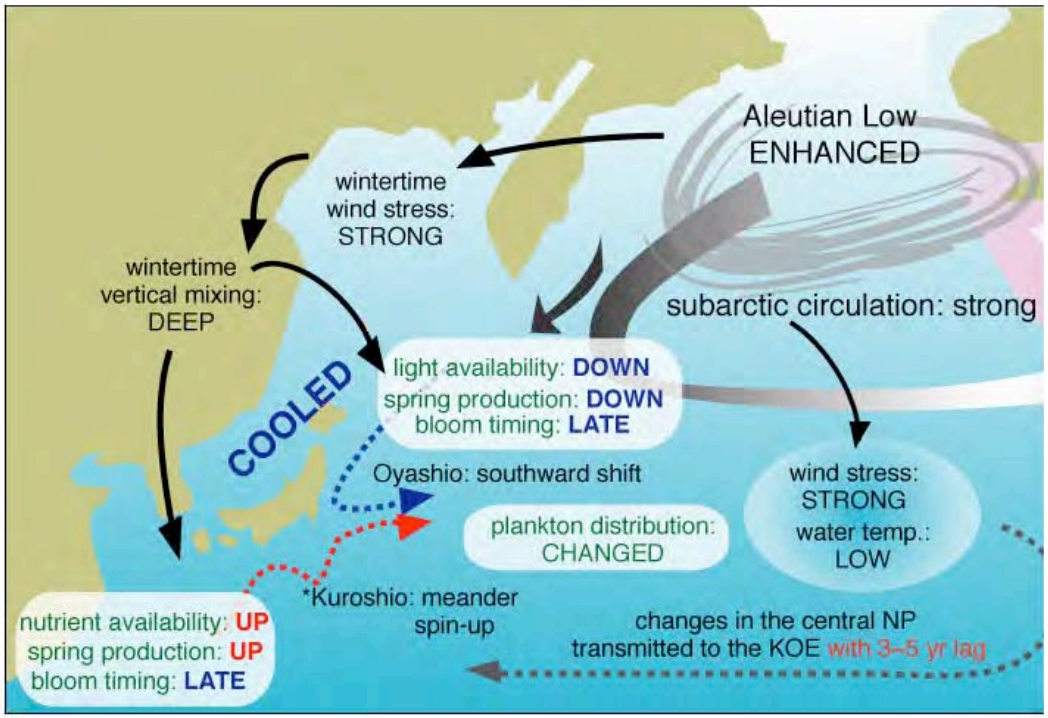
Less successful

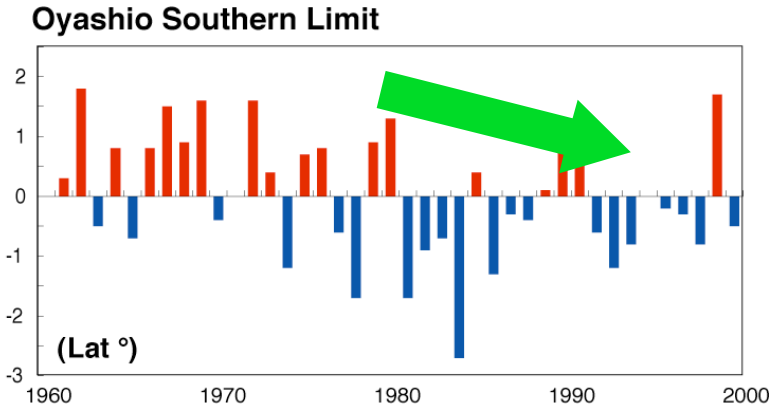
Zooplankton survival

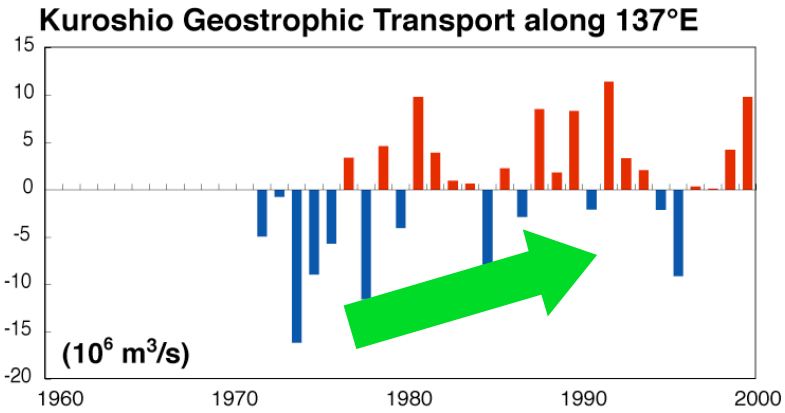
Successful?

Kuroshio – Oyashio Dynamics & Biogeographical Change

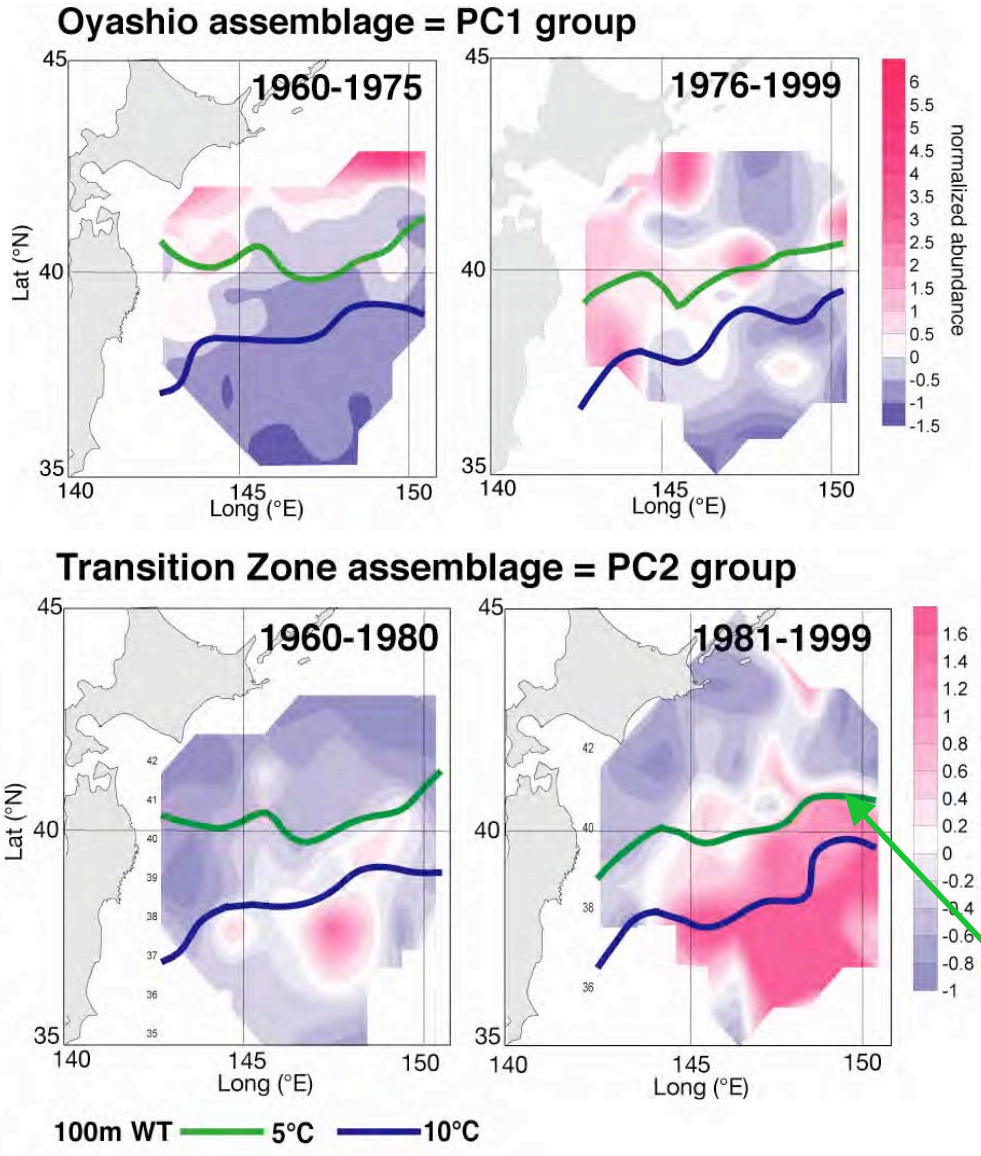
Dynamics of western boundary currents, Kuroshio & Oyashio, changed after the 1976/77 climate Regime Shift

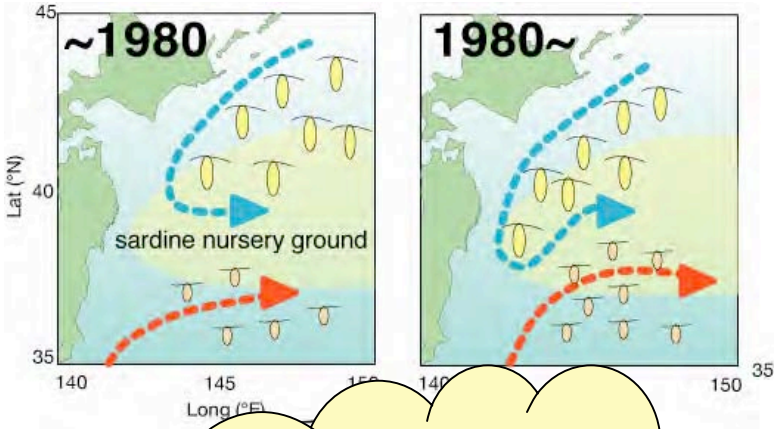






Kuroshio – Oyashio Dynamics & Biogeographical Change





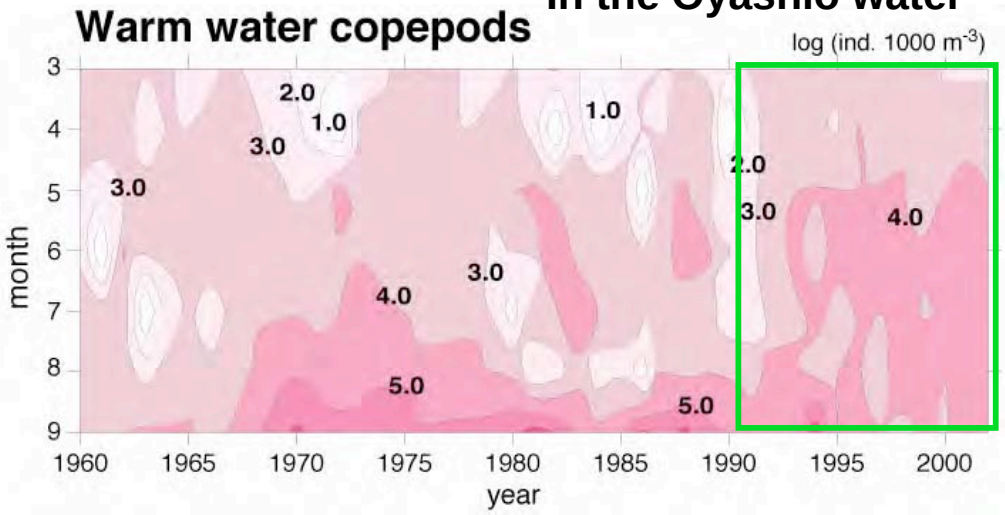
Increase of warm water copepod species in the Kuroshio-Oyashio Transition region

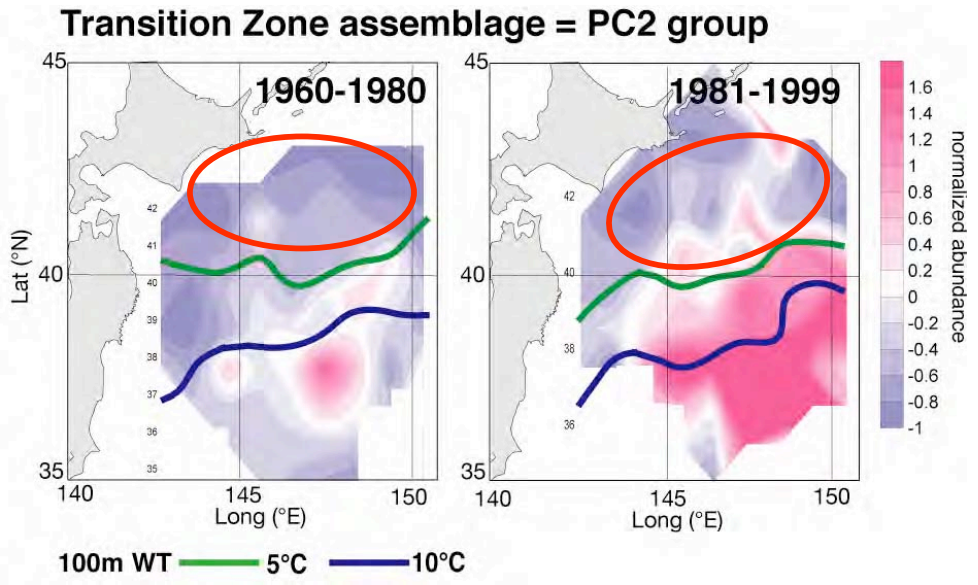
Approximate southern limit of Oyashio

Kuroshio – Oyashio Dynamics & Biogeographical Change

Increase of warm water copepod species in Oyashio

In the Oyashio water





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?