Changes in community structure, trophic link and phenology in lower trophic level ecosystem in the western subarctic North Pacific during 2001-2009

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Japanese Contribution:
Analysis of data taken < 170° E

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GOAL

To detect temporal variation of lower trophic levels responding to climatic forcing in the western subarctic North Pacific

... in terms of changes in plankton community structure, trophic links and phenology

... and discuss its implication in biogeochemical point of view
Data for Community Analysis: CPR 2001-2009

Zooplankton
- Neocalanus plumchrus
- Abundance
- Developmental stage composition
- (Mean copepodite stage)

Phytoplankton
- Diatom & Dinoflagellates

3 transects per year (Apr-May, Jun-July, Sept-Oct)
Data for Phytoplankton Phenology: Satellite Ocean Color

**Time-Series Surface Chl a**

Area Average Chl a
Feb 1st – August 31st, 2000-2009
Based on 10 days composite of 1° x 1° data

**Phenology**

Q-sum Analysis

Julian Day on which Q-sum reaches 40% of overall (Feb-Aug) Q-sum = timing of bloom peak
(based on the Gaussian curve fit analysis)
and that of 20% and 80% = beginning & end of bloom

**Graphs**

Q-sum Chl a (East)

- **2005**
  - 20%  
  - 40%  
  - 80%

- **2006**
  - 20%  
  - 40%  
  - 80%
Results: Phytoplankton Phenology
Results: Phytoplankton Phenology & Climate Index

PDO and Timing of Bloom Peak
(anomaly from 2000–2009 Mean)

ALPI and Timing of Bloom Peak
(anomaly from 2000–2009 Mean)

2005 Mar-May SST anomaly

2008 Mar-May SST anomaly
Results: Trophic Link (West)
(Anomaly from Yr-Mon mean)

**Copepod nauplius & diatom abundance**

- Diatom
- Nauplius

2004

\[ r = 0.944 \text{ (for Jun, Jul)} \]

**Copepod Mean Developmental Stage & nauplius abundance**

- Nauplius (Jun-Jul)
- N.plumchrus Mean Stage (CII-CV)(W)

2004

\[ r = 0.758 \text{ (for Jun, Jul)} \]

**Neocalanus development:**
- Early
Results: Trophic Link (West)

- Copepod nauplius & diatom abundance
  - Duration of Bloom
  - Np phenology
  - Link?
  - Np abundance

- Copepod Mean Developmental Stage & nauplius abundance
  - N.pumilus (Jun-Jul)
  - N.plumchrus Mean Stage (CII-CV) (W)

- N.plumchrus CII-CV Total
Results: Trophic Link (East)

Diatom dinoflagellates
X
nauplius

Nauplius X
Neocalanus development: Early

r = -0.957 (for Jun, Jul)
**Results: Trophic Link (East)**

- **Np phenology** (nauplius abundance) vs
- **Np abundance**
- $r = 0.905$ (for Jun, Jul)
Summary: Phenology and Trophic Links

PDO – Aleutian Low Dynamics

Cool-Warm anomaly

Cool yr => delayed bloom peak
Warm yr => early bloom peak

WEST

Bloom period shifted Early for 10 yrs

Diatom & copepod abundance (summer): decreased after 2004

Development timing of Neocalanus plumchrus: Early after 2004

EAST

Bloom peak shifted Late for 2000-2005, while bloom period became longer after 2006

Diatom, dinoflagellate & copepod abundance (summer): decreased after 2004

Development timing of Neocalanus plumchrus: Early after 2004

copepod abundance
Implication of phytoplankton phenology in biogeochemistry
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Decrease in winter CO$_2$ uptake

Decrease in Opal to CaCO$_3$ ratio flux at 5000 m

Sediment trap data

Changes in phytoplankton community & abundance in surface?

(Wakita et al. 2010, Tellus)
Implication of phytoplankton phenology in biogeochemistry

Decrease in Opal to CaCO$_3$ ratio flux at 5000 m

Decrease in Diatom Abundance

Delay in phytoplankton bloom

And... zooplankton roles?
Summary

Interannual Cool-Warm anomaly, which related to Pacific Decadal Oscillation determines Phytoplankton phenology.

Marked changes in lower trophic levels around 2004: phytoplankton, copepods nauplius abundance, and *Neocalanus* developmental timing.

Link between *Neocalanus* abundance and phytoplankton abundance & phenology are not clear.

Change in plankton community and phenology might have affect BCP function of these region.