Understanding the role of the YS Bottom Cold Water (≤10˚C) on the survival strategy of *Euphausia pacifica* throughout the hot summer

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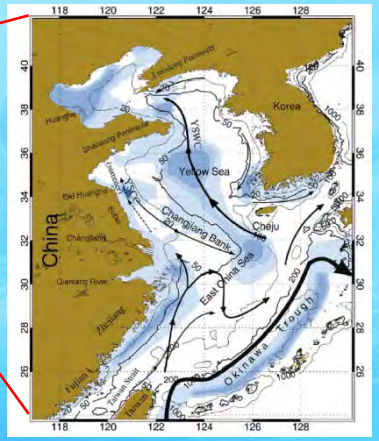
Backgrounds

- Yellow Sea is one of highly productive Large Marine Ecosystems in the world ocean
  - total catch is 5%(3 million tons/yr) of global catches(FAO)



- Direct/indirect impact of human activities (land reclamation, pollution, overfishing, high activity of aquaculture, etc) from four countries (China, South Korea, North Korea, Japan).

- Become recognized the importance of YS on regional climate change/ fishery production/biodiversity
  - UNDP/GEF YSLME project
  - WWF YSEPP program

Backgrounds

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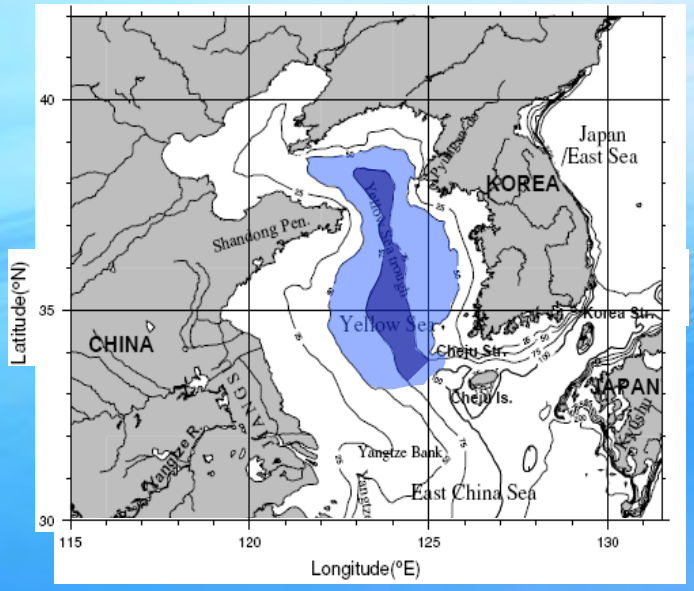
- YS has a unique physical feature called YSBCW (≤10°C) which forms through winter cooling and mixing and it is persistently observed in the deep central region of Yellow Sea during summer.

- It provides a refuge (i.e. over-summering sites) for some organisms (i.e. *Euphausia pacifica*) to survive through the hot summer (>20° C in surface).

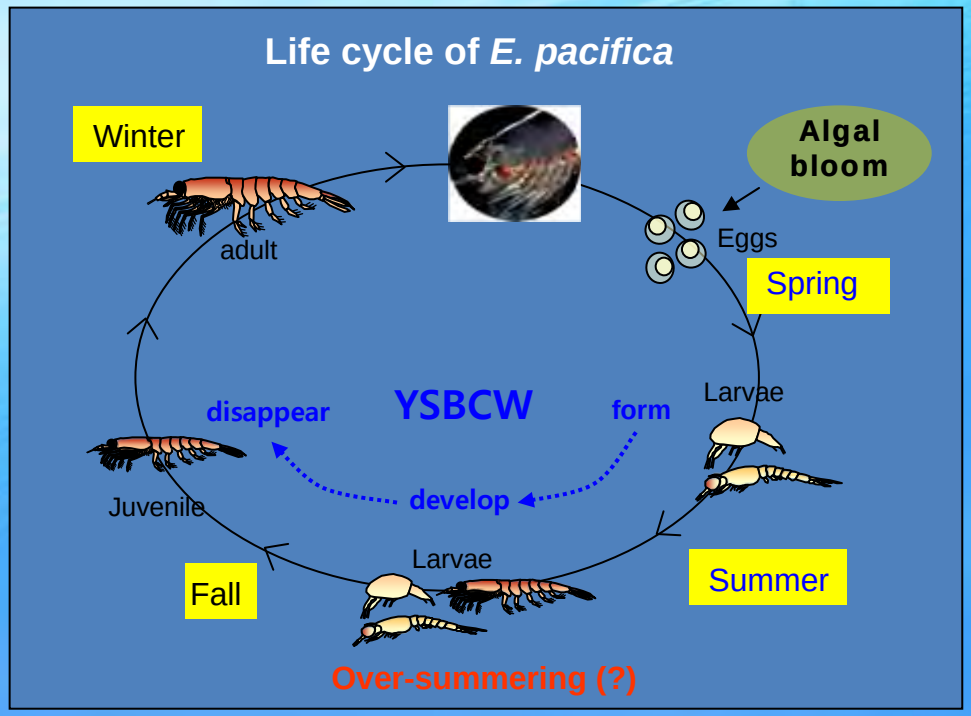


- *Euphausia pacifica* is one of key species in YS because of the highest biomass among zooplankton and major prey for fishes (anchovy, sardine, etc.)

Objective

✓ Understand the role of YSBCM on *Euphausia pacifica* survival through the hot summer

- Does *E. pacifica* utilize YSBCM as an overwintering refuge ?
- If they do, how ? Lower metabolism, hibernate, shrinkage….



Field Sampling

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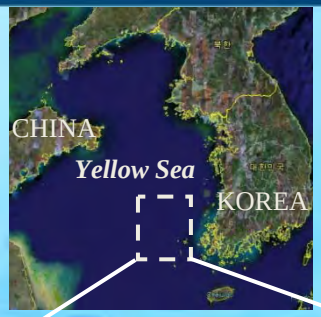
Field works – April & August '10

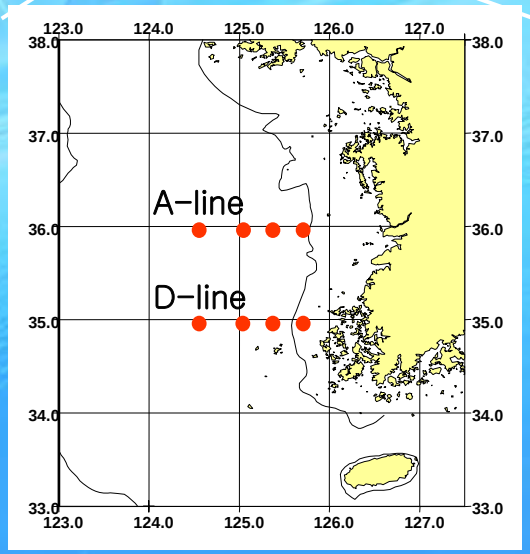
- Net sampling : vertical tow from bottom (~5m) to surface using conical net (mouth diameter 1m, mesh 330μm)

- 24hr. sampling (every 3hrs) using open-closing net

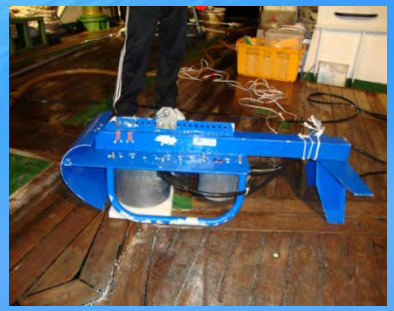
- Acoustic : 200 kHz split-beam transducer (BioSonics, USA)

- CTD: Temperature, salinity ,and Chl- a





Net sampling



Acoustic transducer

Sample Analysis

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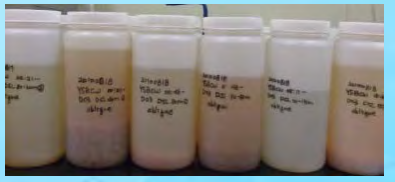
Analysis in the lab.



✓**Preserved samples**

- Sorted and enumerated *E. pacifica* with development stages:
  egg, nauplii, calyptopis, furcilia, juvenile, and adult

- Gut content analysis using SEM

✓**Frozen samples**

- Lipid extracts
- Total lipid and lipid class analysis (TLC-FID)
- Fatty acid analysis (GC-FID & GC-MSD)

Vertical profiles of Temp/Sal/Chl-*a* – Spring 2010

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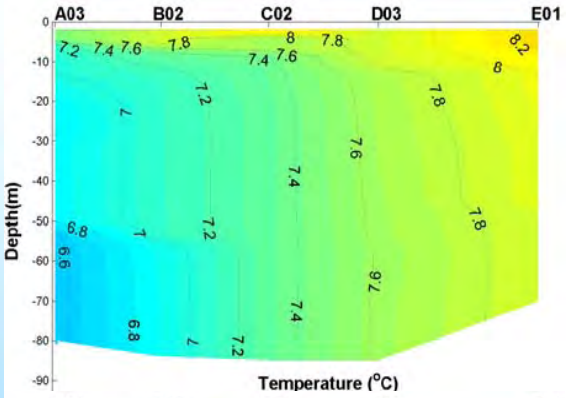
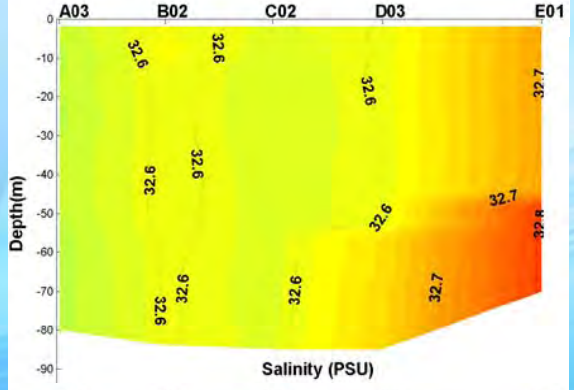
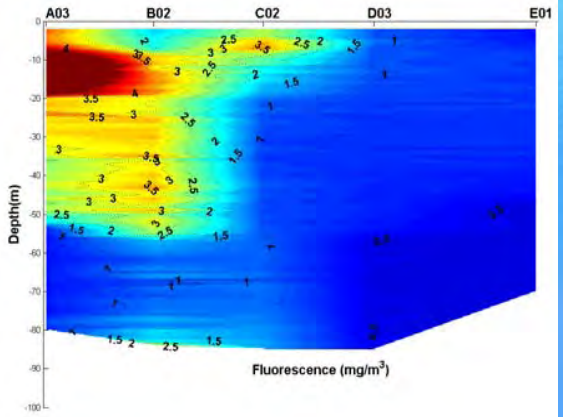
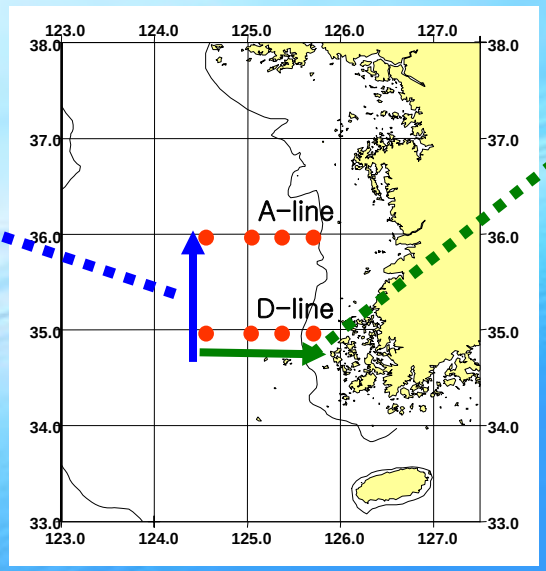
North ← South



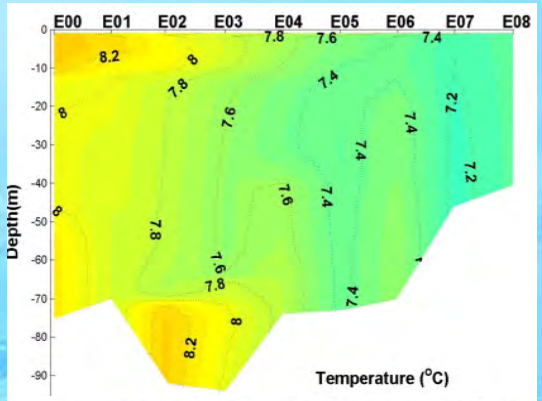


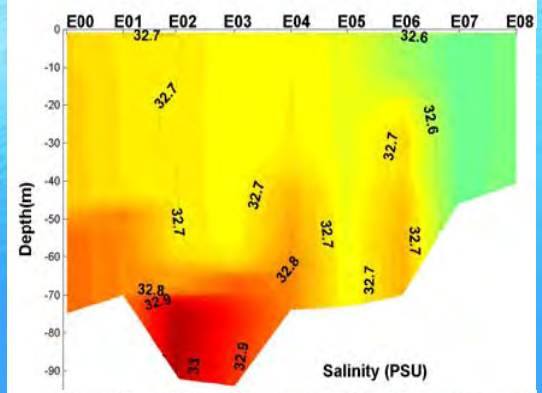


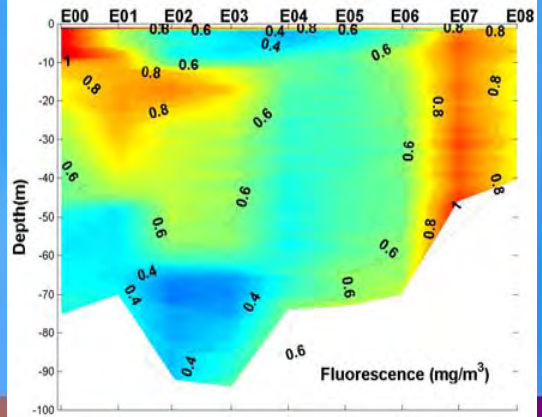
- Water masses well mixed
- High Chl-a in the middle of YS



Central → Coastal







Vertical profiles of Temp/Sal/Chl-*a* - Summer 2010

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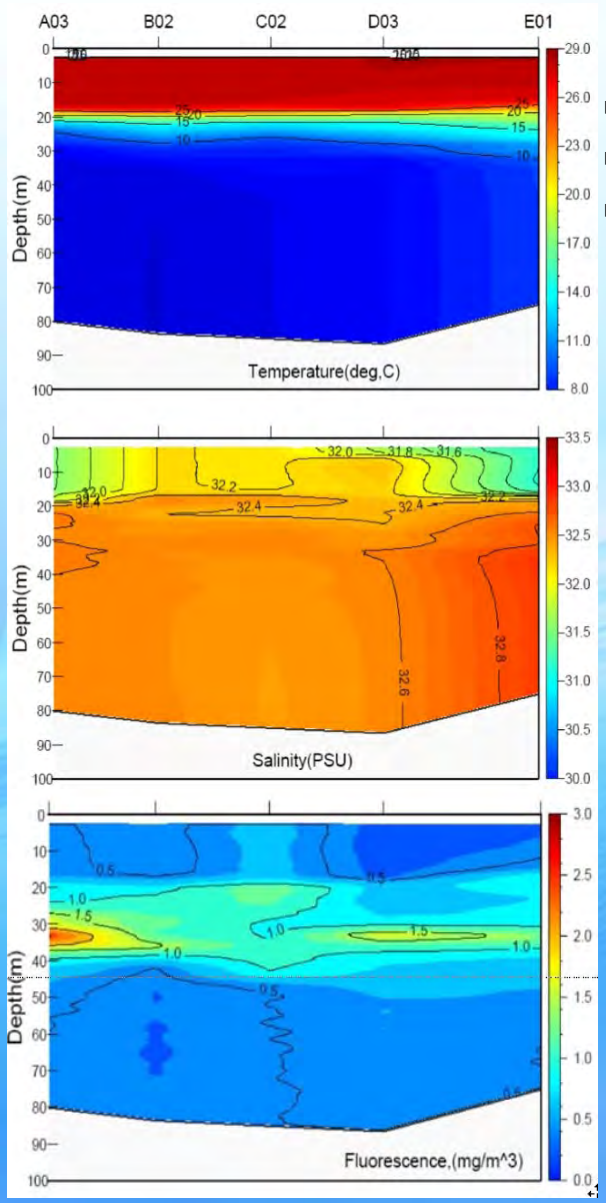
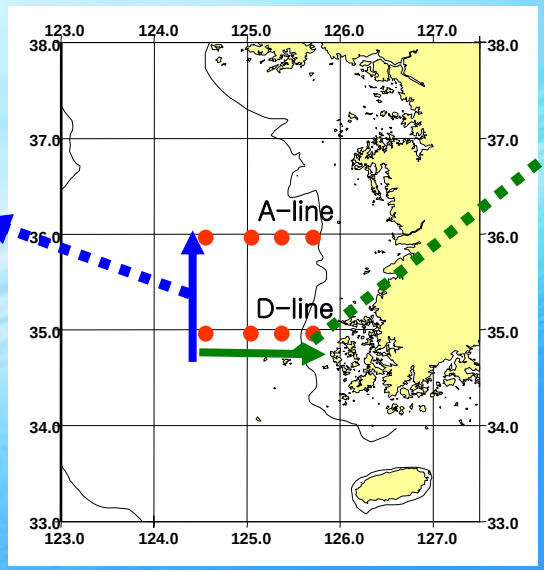
North ← South



- Water masses - well stratified
- YSCM - well developed
- Chl-*a* Max – just below thermocline



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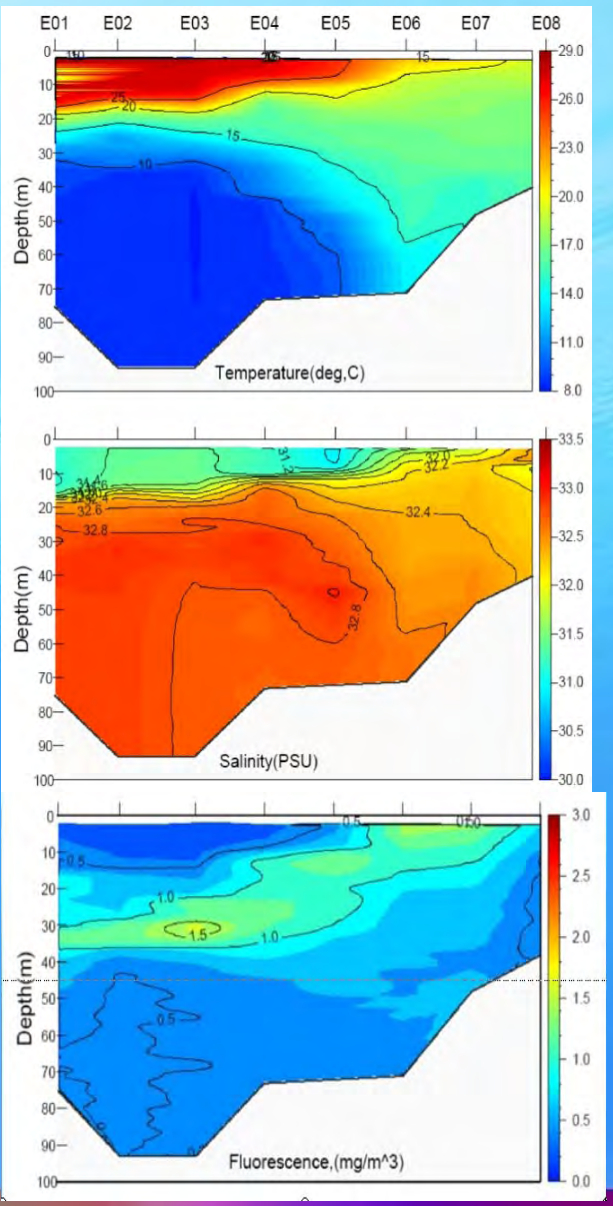
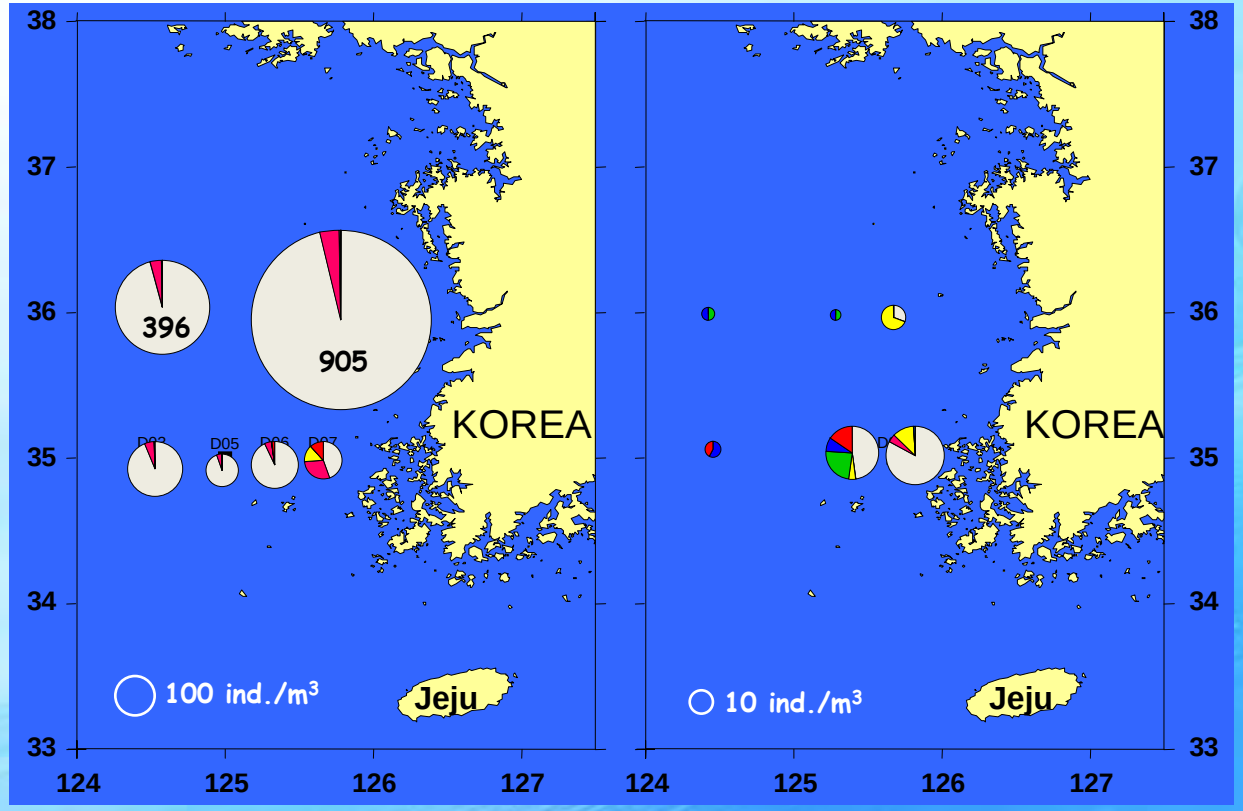


Spatial distribution of *E. pacifica*



spring	summer
• Predominant eggs and nauplii • Appearance of large adults (~20mm) (especially, gravid females) in the coast	• A few individuals collected • Most of them is early stage (furcilia and juvenile) and small adults (<10mm) • Some eggs found only in the coast

Diel vertical migration (Spring vs. Summer)

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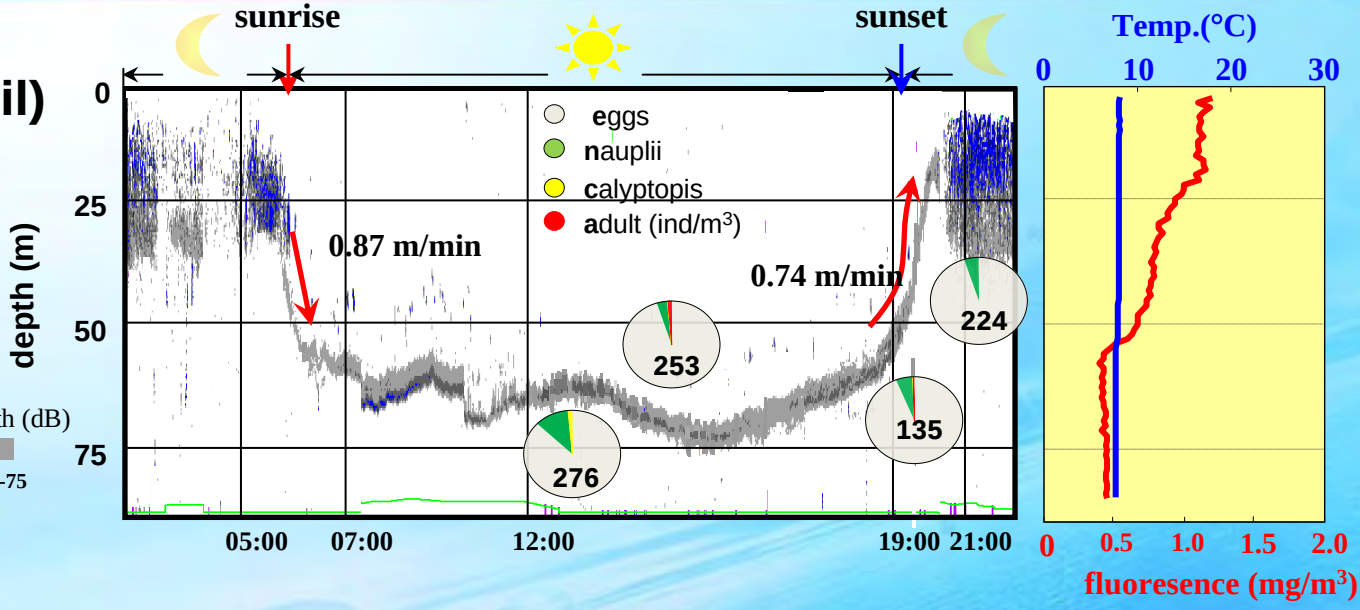
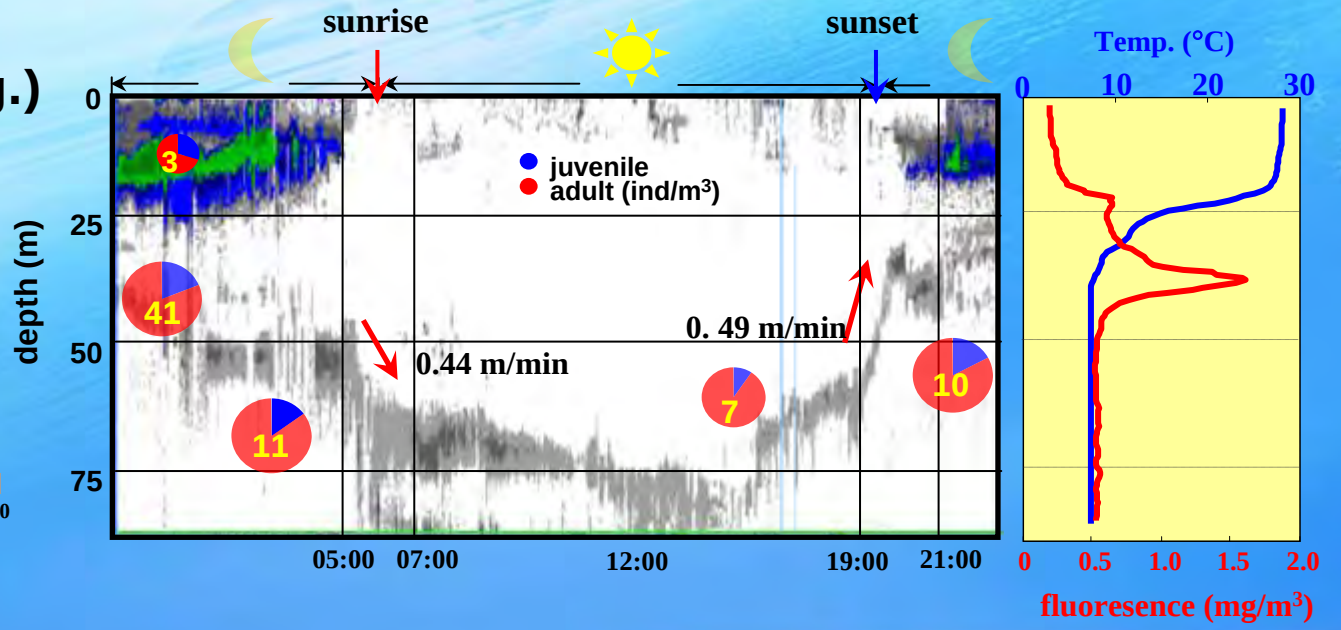
Spring (April)



volume backscattering strength (dB)

-40 -46 -52 -58 -63 -69 -75

Summer (Aug.)



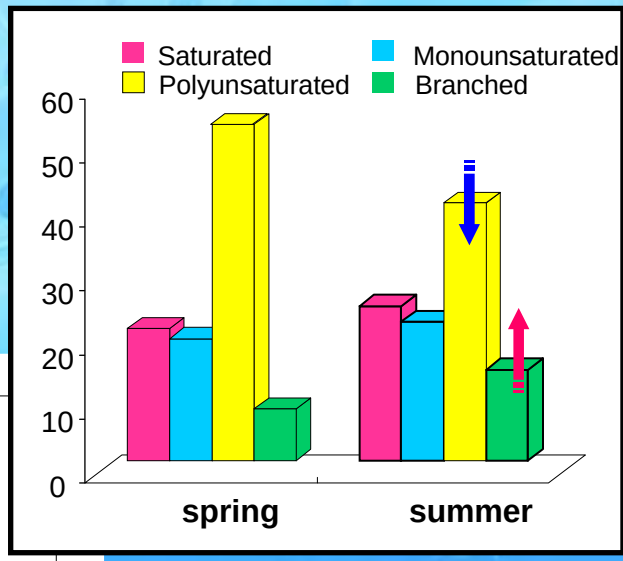
-45 -51 -57 -62 -68 -74 -80

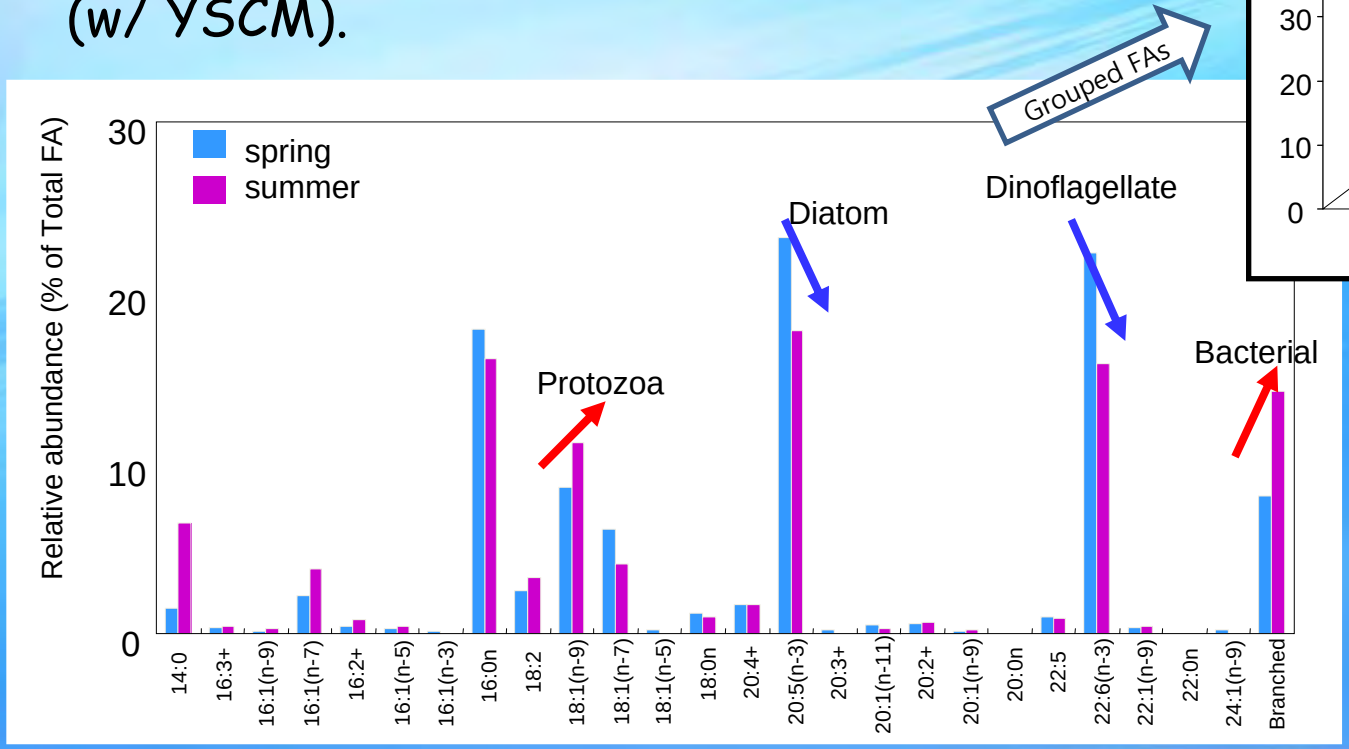
dB

Lipid content and composition

- Lipid contents (5.4 ~ 7.4 % DW) and class compositions in *E. pacifica* were not significantly different between spring vs. summer.

- Algal origin fatty acid markers (20:5(*n*-3) , 22:6(*n*-3), PUFA) were abundant in the spring (no YSCM), while microbial origin fatty acid markers were abundant in the summer (w/ YSCM).





Gut contents

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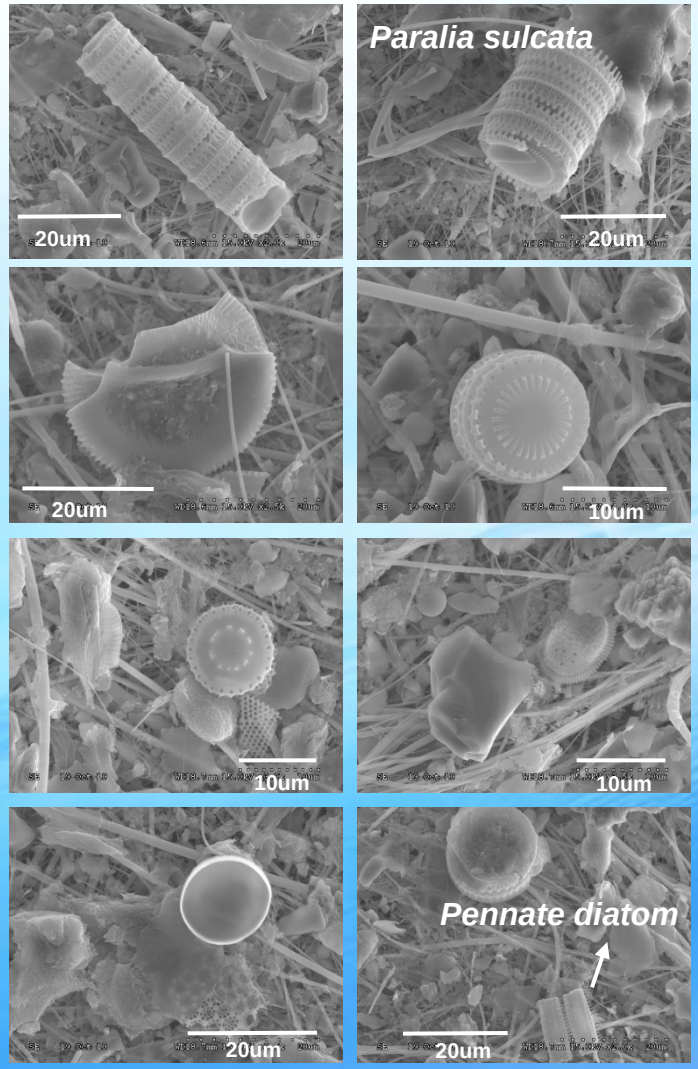
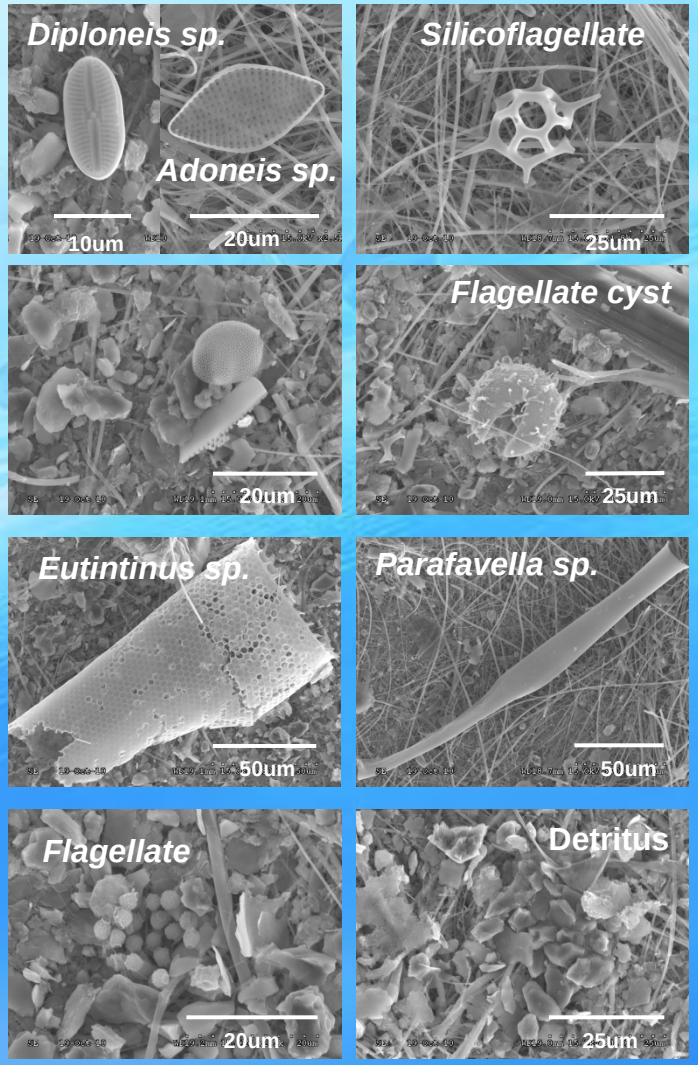
Spring



Almost diatoms

Summer



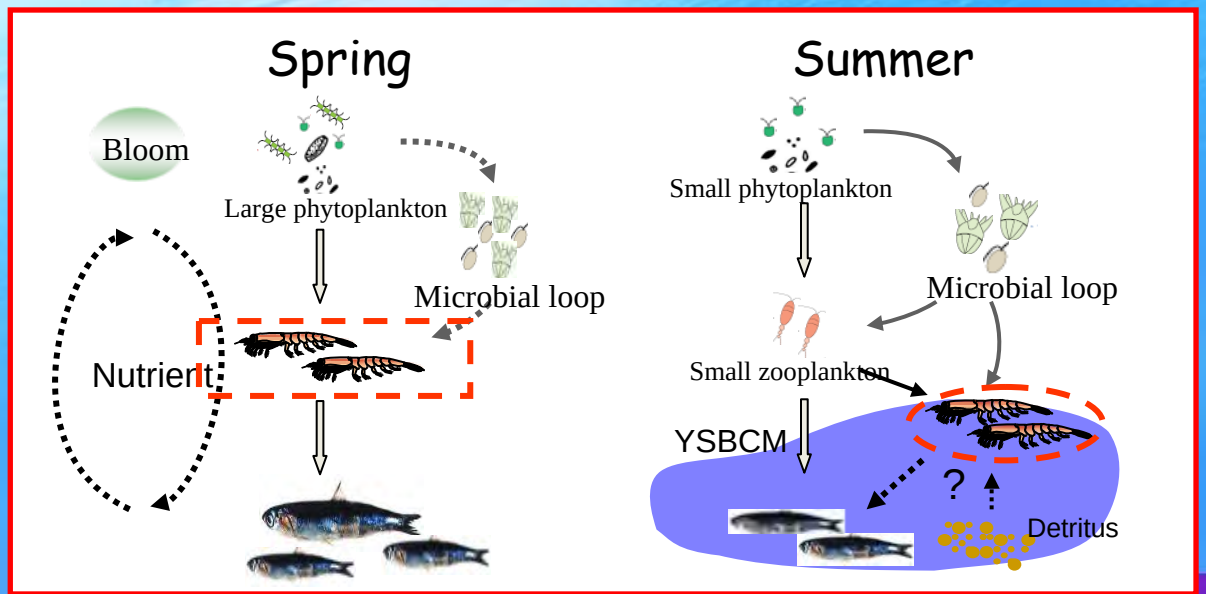
Some diatoms, dinoflagellates,
Protozoa, and detritus

Findings

- Major spawning occur in spring.
(even it was weak during summer, still some spawning activity occurred in the coastal region)

- Strong DVM was detected in spring and summer but DVM depth was limited to below thermocline during summer.

- Krill is herbivorous (mainly diatom) in spring but in summer, it is omnivorous because it could feed on any particles sized from 10 to 200um (protozoa, detritus, dinoflagellate, diatom, etc).



Questions raised

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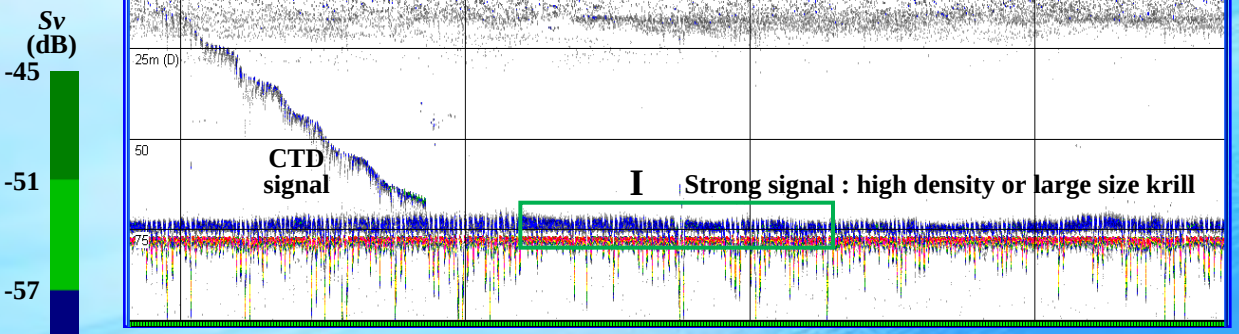
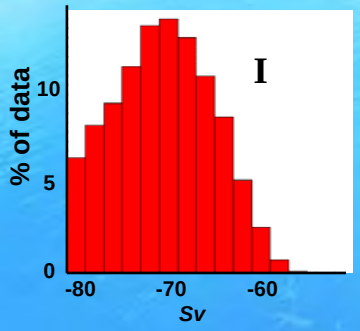
Where are most of adult *E. Pacifica* during summer ?

- Based on acoustic signals, they were condensed near the bottom (2-3m above bottom)
- Also they were spatially very patched.
- In order to confirm this, we need different sampling devices !

A05/day-time





A06/day-time