Regional differences in responses of meso-zooplankton to long-term oceanographic changes in Korean sea waters

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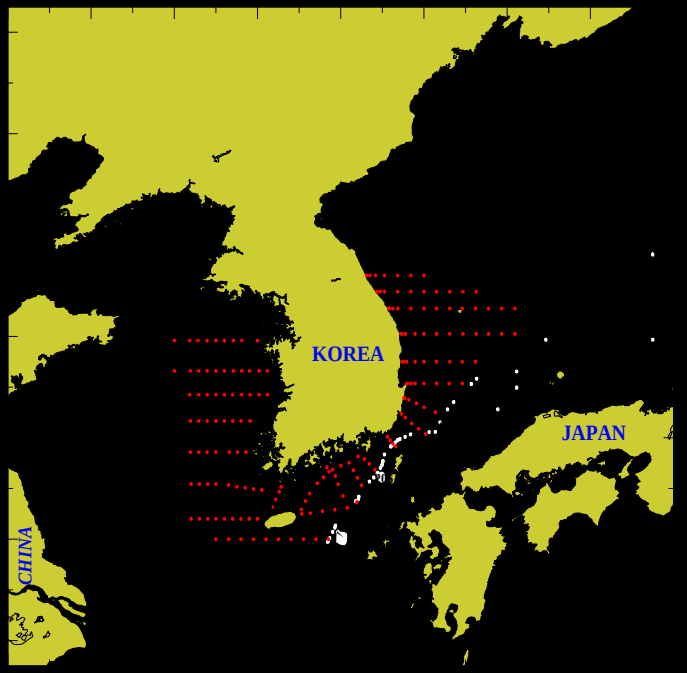
Outline

- **To understand responses of marine ecosystems to climate change in the Northwestern Pacific**
- **To understand regional differences in meso-zooplankton responded to long-term oceanographic condition**
- **Possible regime shift in 1997/98**

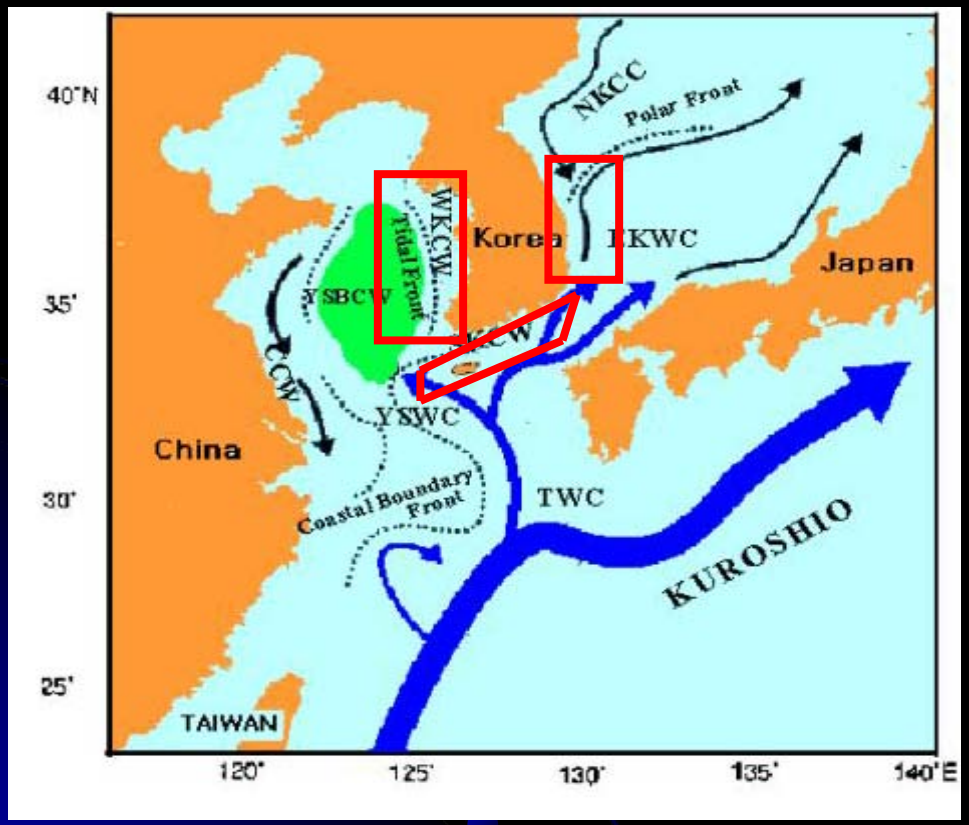
Data

- **NFRDI, Korea**
  - **Water temperature and salinity at 10m depth(1967-2006)**
  - **Zooplankton: vertical tows by NORPAC net with 0.33 mesh size and 0.45m mouth**
    - **Biomass (1967-2006)**
    - **Abundance of four zooplankton assemblages (1978-2006)**



● Schematic diagram of oceanic currents in Korean sea waters with characteristics

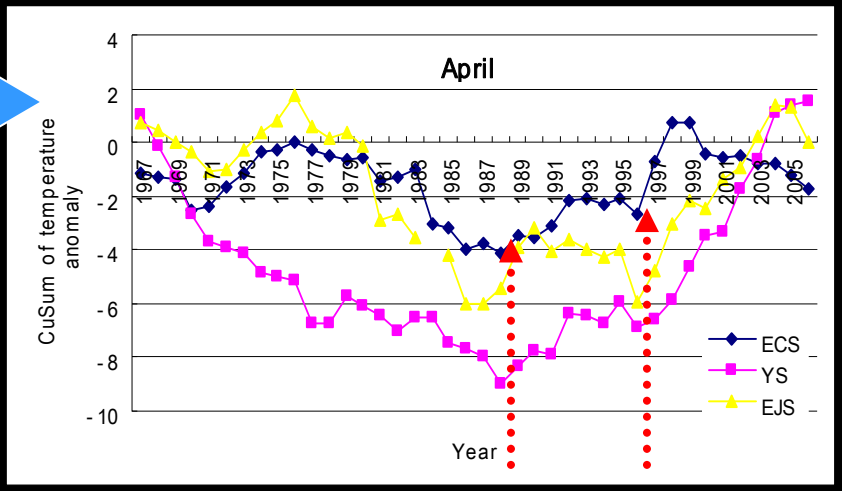
- 3 distinct sea regions (East/Japan, East China and Yellow seas)

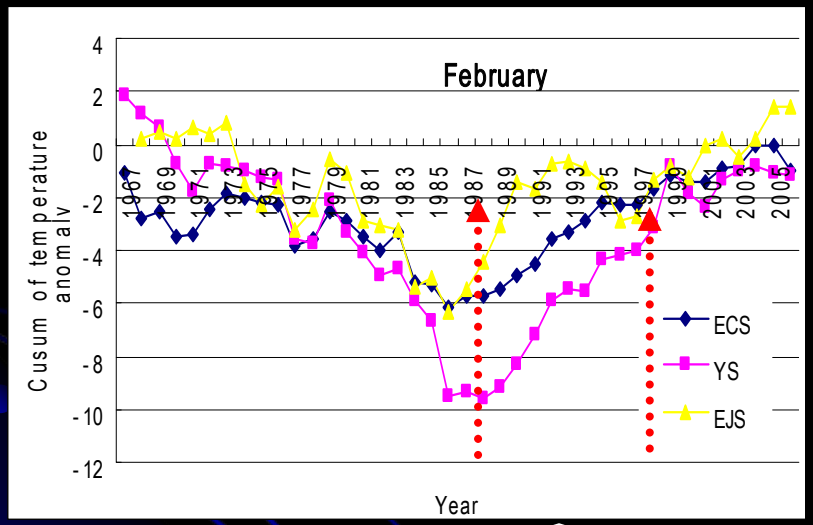


- East/Japan Sea (EJS): a deep basin weakly influenced by the Tsushima Warm Current and the Liman Cold Current
- East China Sea (ECS): the intermediate sea between East/Japan and Yellow Seas
- Yellow Sea (YS): a semi-closed sea mainly controlled by riverine discharged

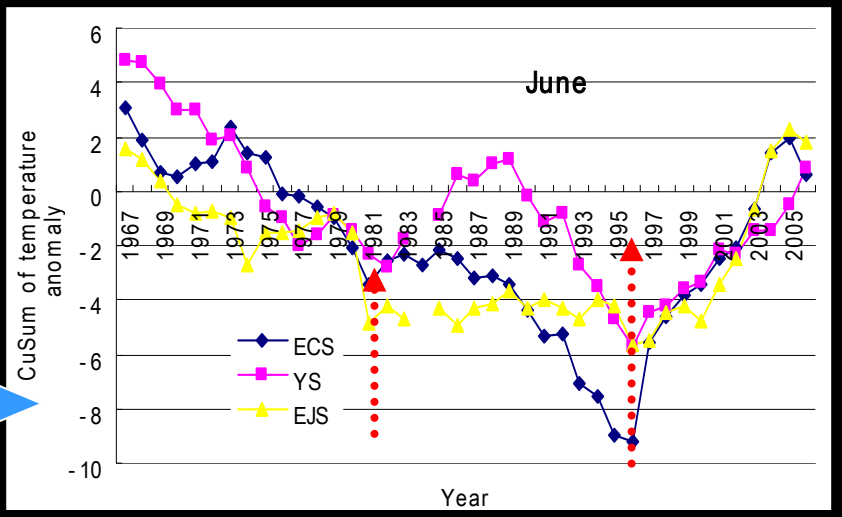
Long-term changes in sea water temperature at 10 m depth

Yellow, East/Japan Seas

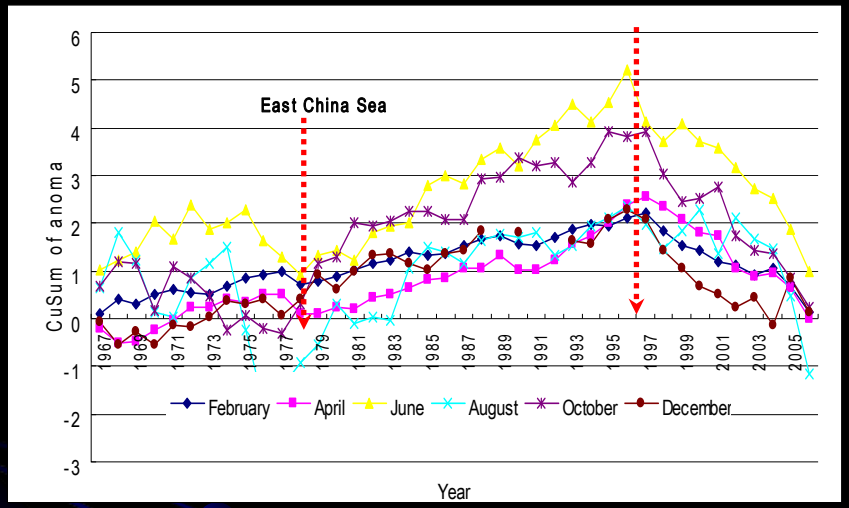




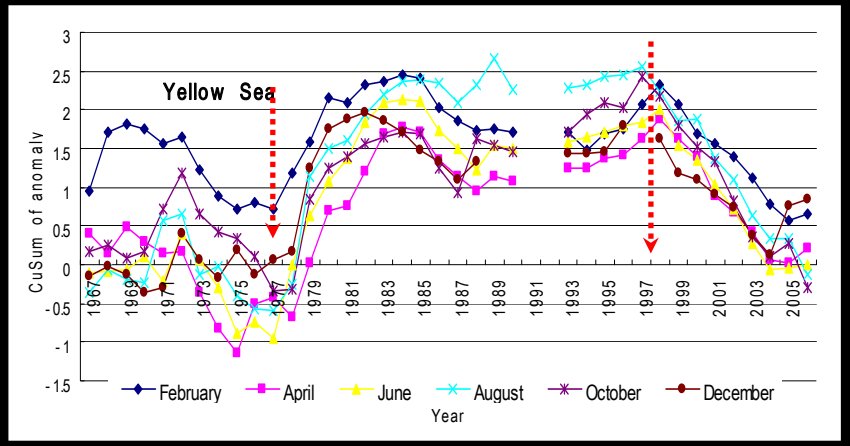
All three Seas



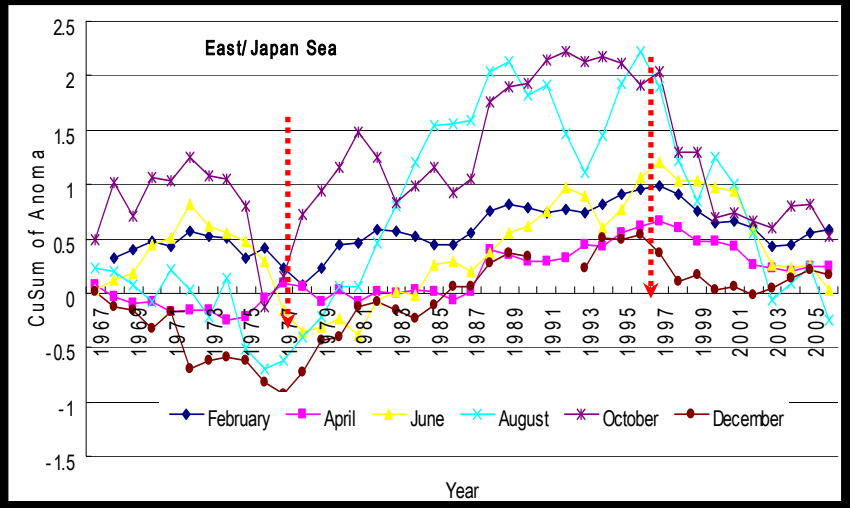
Long-term changes in sea water salinity



June, October

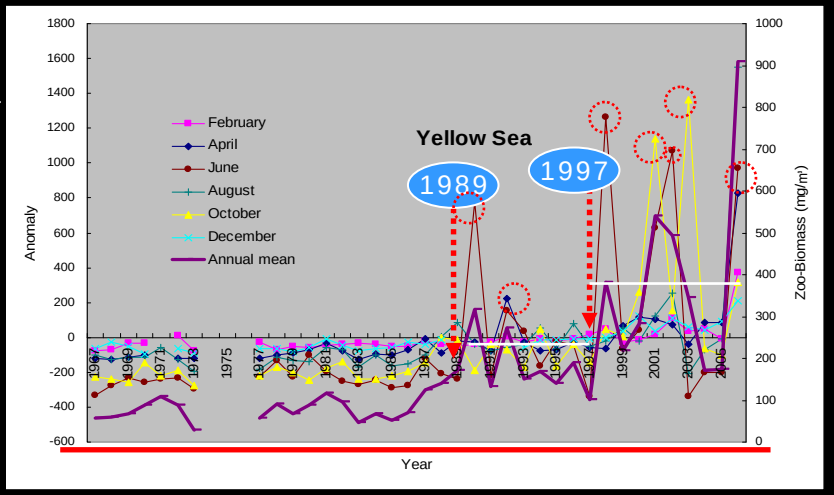


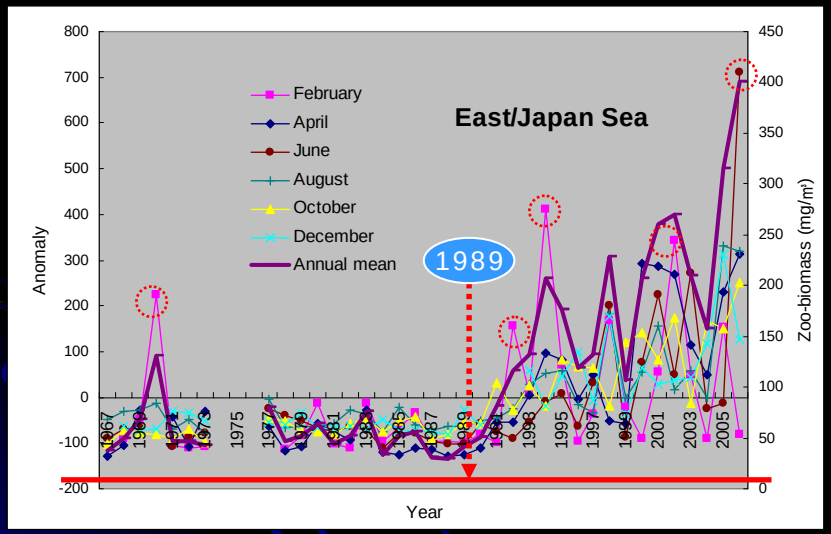
August, October



Long-term changes in meso-zooplankton biomass

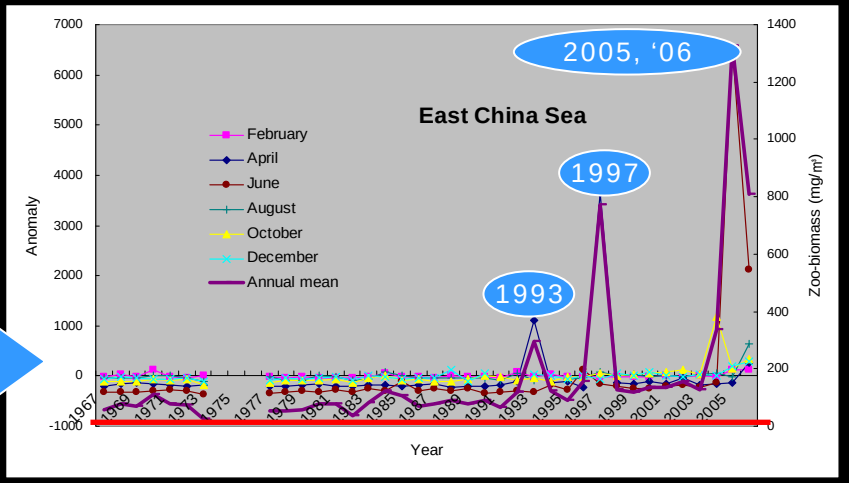
April/ April, October



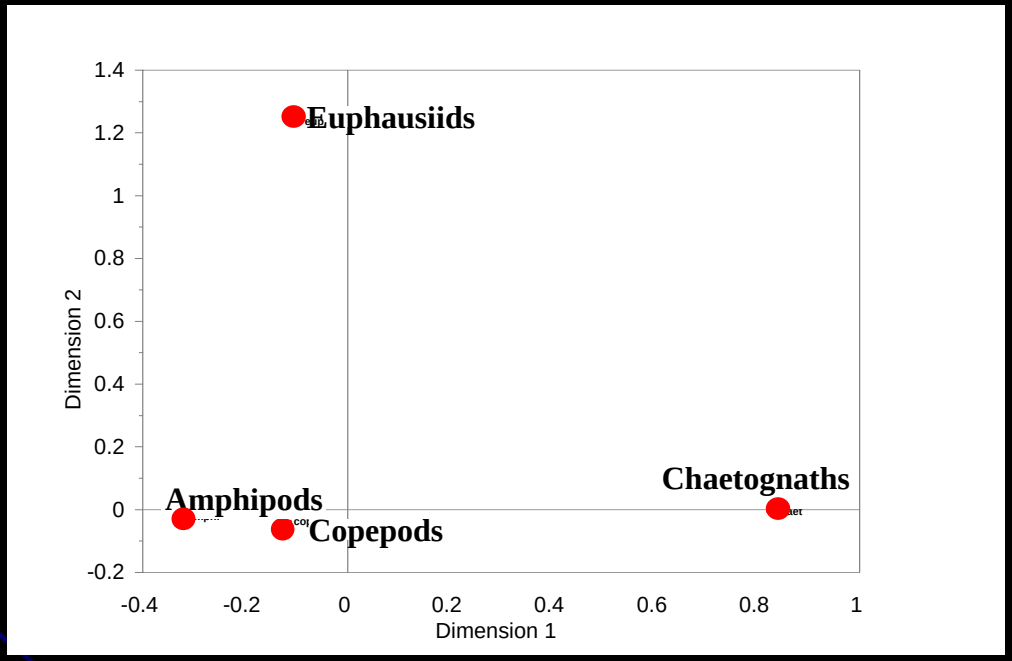


February, April, June

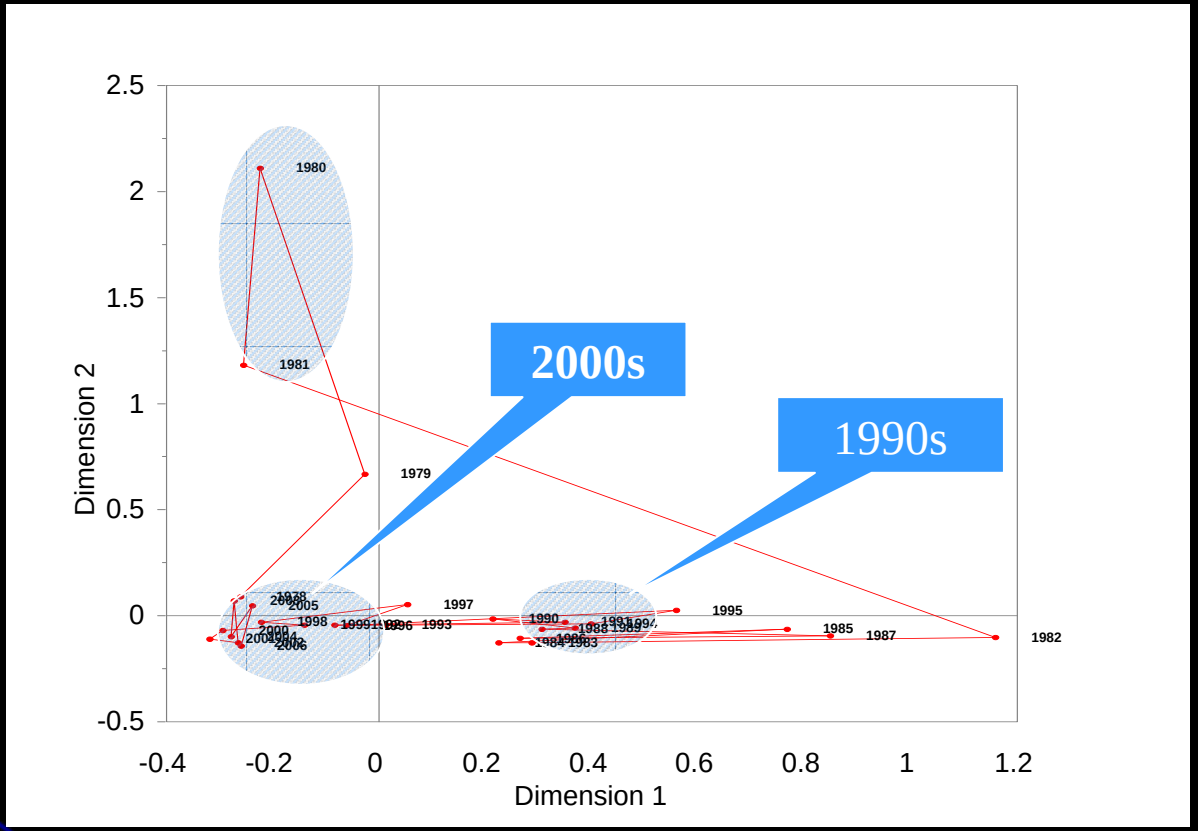
April/June



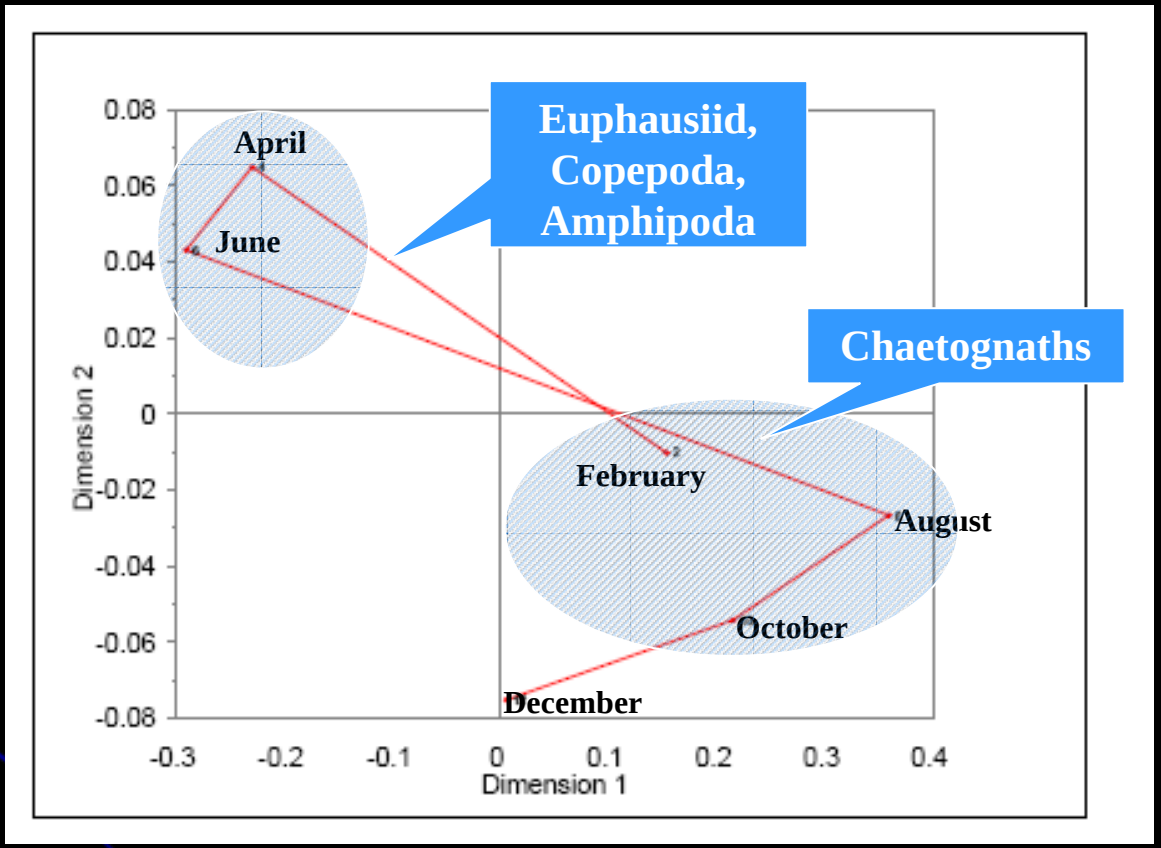
Long-term changes in four zooplankton assemblages



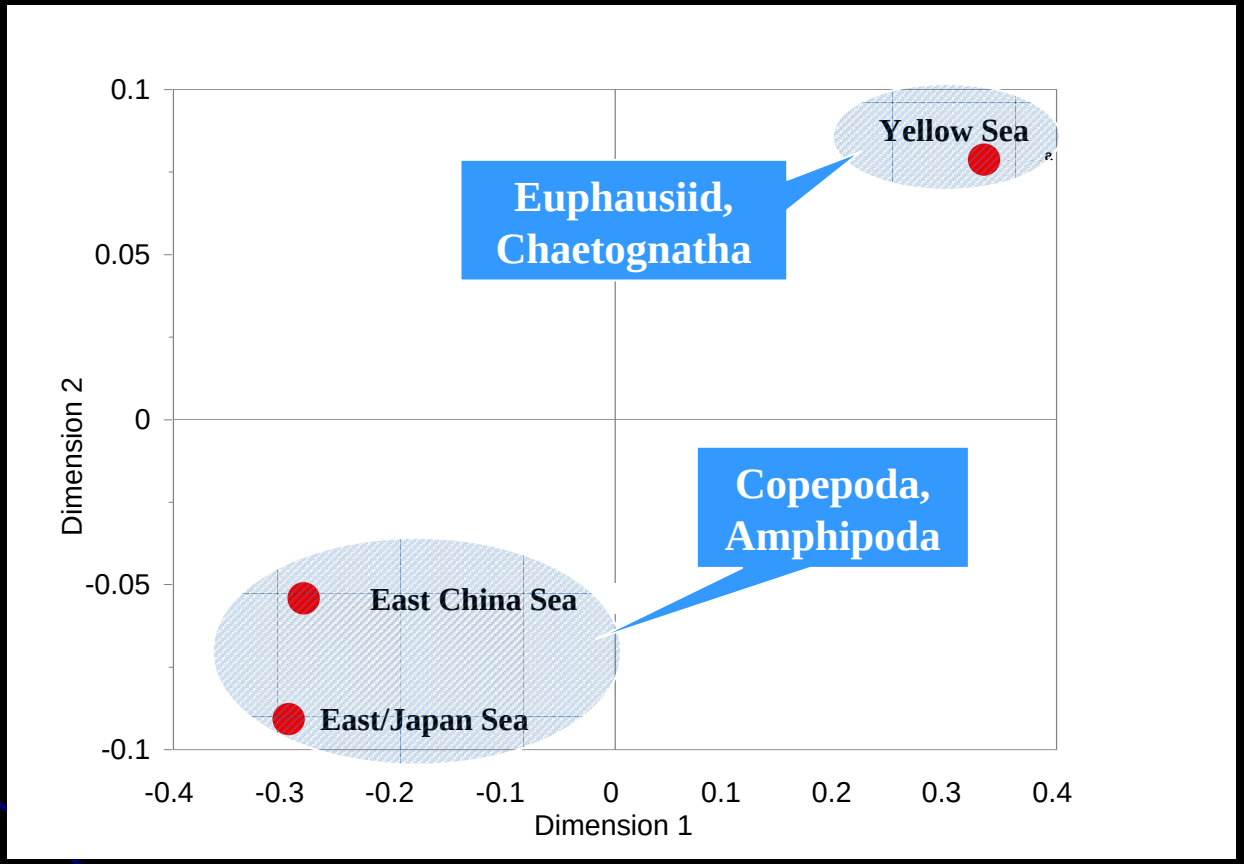
<Ordination of four zooplankton assemblages (Copepoda, Amphipoda, Euphausiid and Chaetognatha) caclulated by Multiple Correspondence Analysis. >



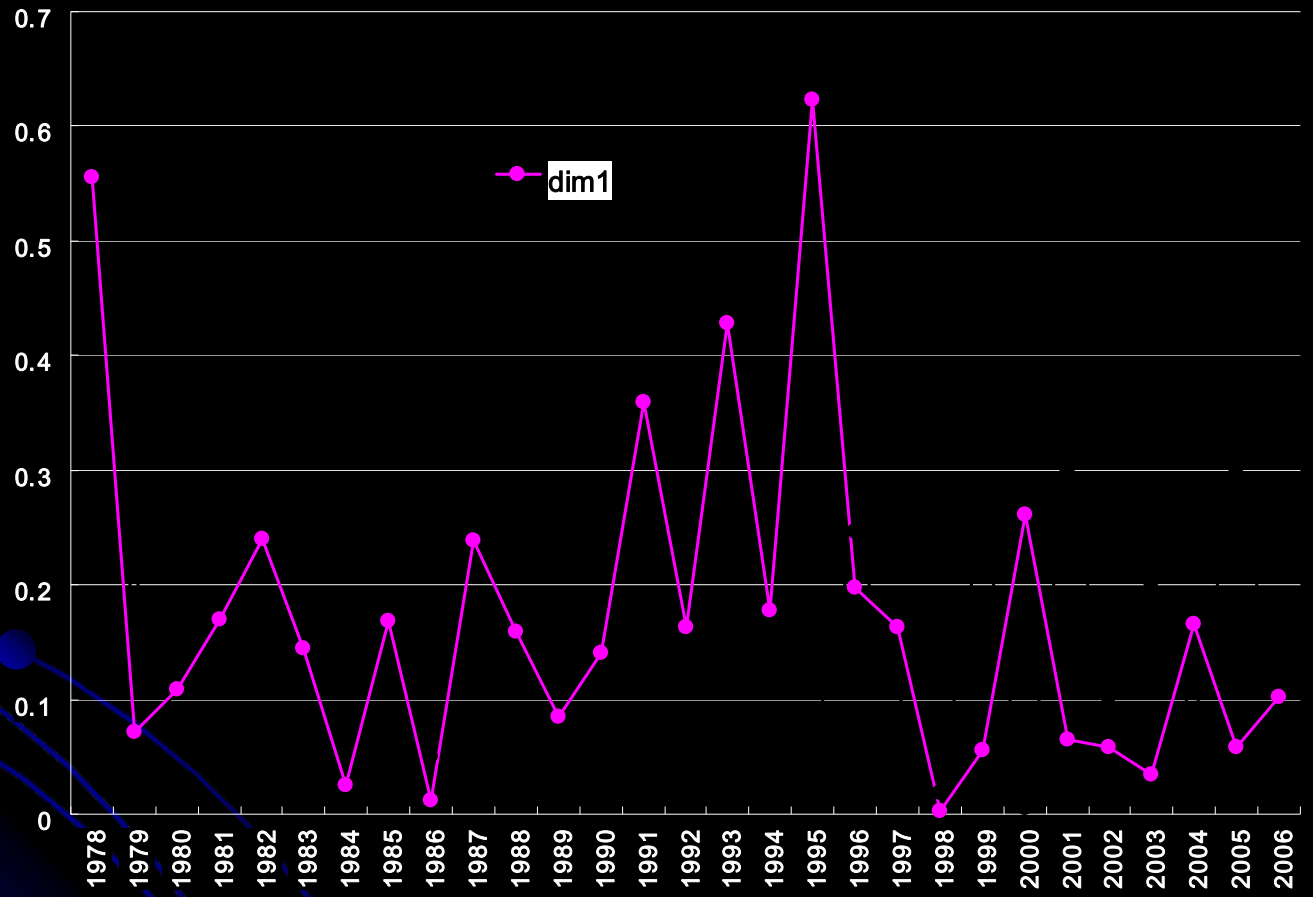
<Ordination of year from 1978 to 2006 calculated with 29-yr four zooplankton assemblages (Copepoda, Amphipoda, Euphausiid and Chaetognatha) caclulated by Correspondence Analysis >



<Ordination of month calculated with 29-yr four zooplankton assemblages (Copepoda, Amphipoda, Euphausiid and Chaetognatha) by Correspondence Analysis >



<Ordination of seas calculated with 29-yr four zooplankton assemblages (Copepoda, Amphipoda, Euphausiid and Chaetognatha) by Correspondence Analysis >



<Distance between East China and East/Japan Seas>

Conclusion

- Extending the warming period
  - February (to late 1980s)

    April (after 1989)

    June (after 1997)
- Decreasing trend in salinity after 1997
- Occur episodic events in zooplankton biomass after the early 1990s, in particular April and June
- More close between both seas, East China and East/Japan Seas in four zooplankton assemblages after 1997

Summary

Period	Sea	Temperature	Salinity	Zoo-Biomass
Late 1970s- late 1980s	East/Japan	Dec in 2, 4/ S in 6	Increase	-
	East China	Dec in 2, 4, 6	Increase	-
	Yellow	Dec in 2, 4/ I-D in 6	Increase	-
1990- late 1990s	East/Japan	Inc in 2,4/ D in 6	Increase	Inc. in 2, 4, 6
	East China	Inc in 2,4/ D in 6	Increase	Inc. (episodic events on 4, 6 in 1993, 1997)
	Yellow	Inc in 2,4/ D in 6	Increase - Steady	Inc. in 4, 6
After late 1990s	East/Japan	Inc in 2 (weak), 4, 6	Decrease	Inc. in 2, 4, 6
	East China	Inc in 2 (weak), 4, 6	Decrease	Inc. (episodic events on 6, 2005, 2006)
	Yellow	Inc in 2 (weak), 4, 6	Decrease	Inc. in 6, 10

Four Zooplankton Assemblages

- **Similarity among seas**
  - Similar East China Sea to East/Japan Sea
  - Differ Yellow Sea
  - Euphausiid and Chaetognaths in Yellow Sea
  - Copepoda and Chaetognaths in East China and East/Japan Seas

- **Long-term change between East China and East/Japan Seas**
  - **Similarity is gradually increased after 1997 in dimension I**

- **Others**
  - In 1980 and 1981, strongly positively relate to Euphausiids
  - In 1982, strongly positively relate to Chaetognaths
  - In the 1990s, weakly positively relate to Chaetoganths
  - In 2000s, positively relate to Copepods and Amphipods