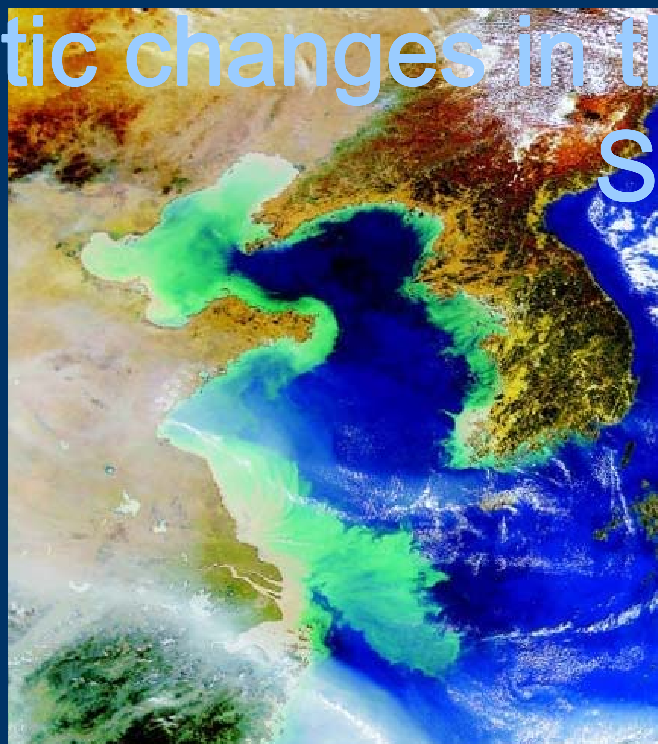
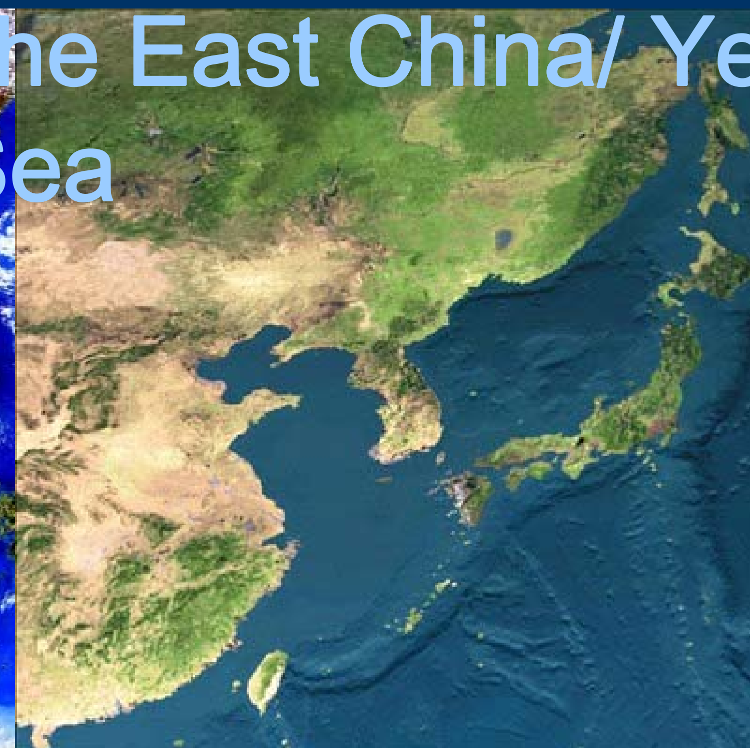
Variations of zooplankton and oceanographic condition in response to climatic changes in the East China/ Yellow Sea





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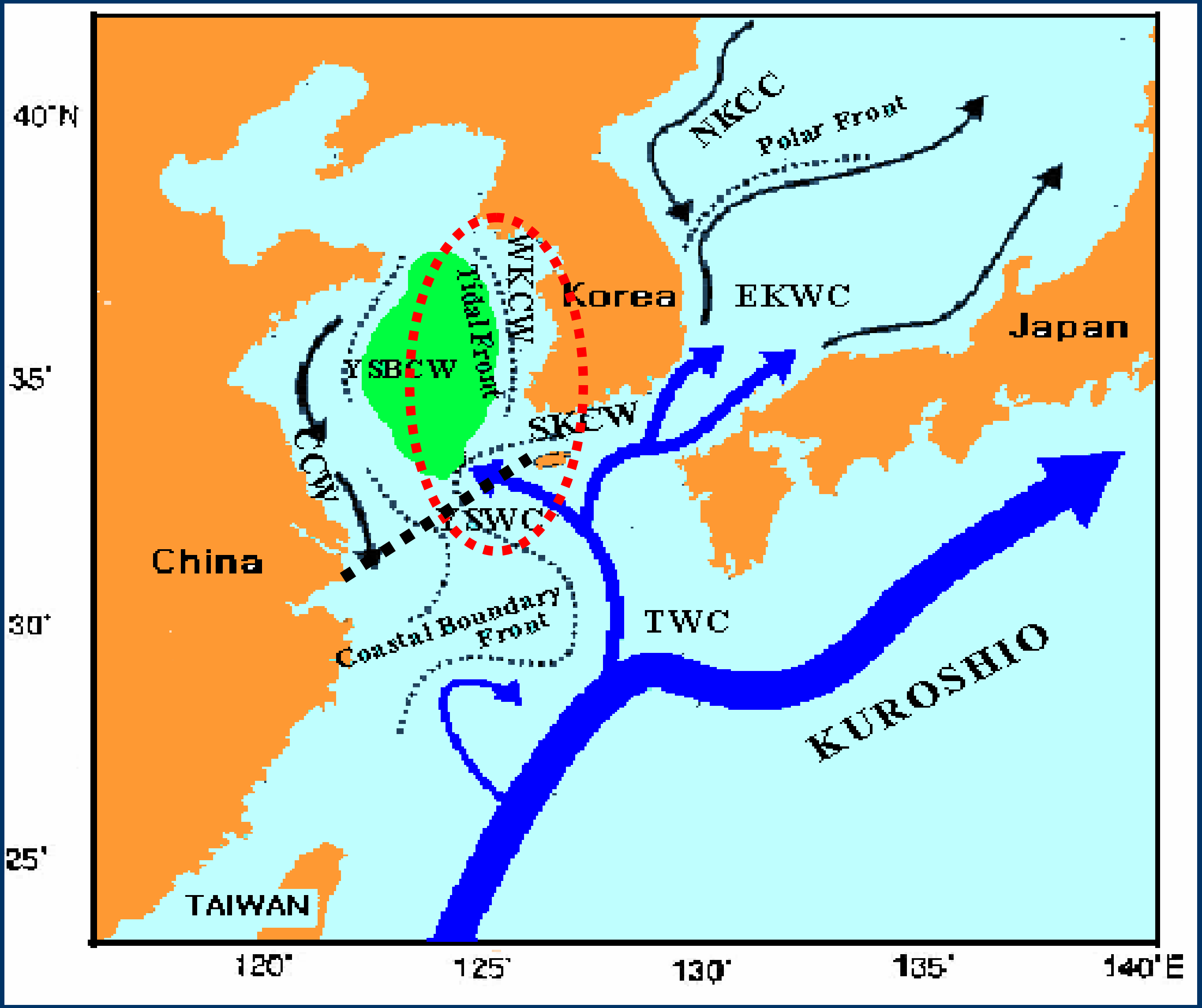


Contents

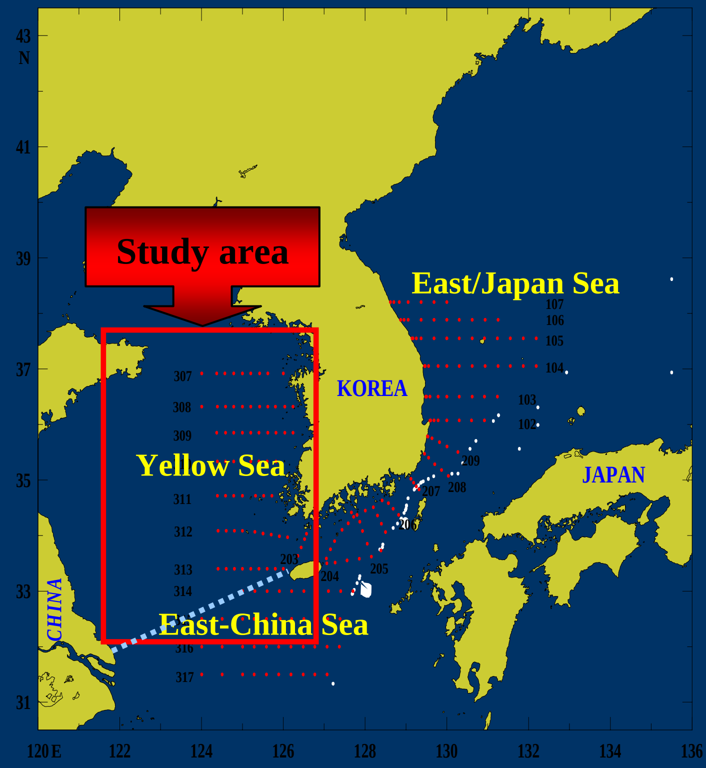
- Background and Objective
- Material and Method
- Results
  - Yellow and East China seas
  - Long-term change of Yellow Sea
- Conclusion

❑ Background and Objective

- Regime Shifts occurred in 1976/77, 1989 and 1997/98 responded to climatic changes in the North Pacific
  - Marine ecosystem have shifted to a different state responded to regime shifts
  - Regional variations in fisheries and marine ecosystem responses to regime shifts
- To know the teleconnection between Yellow and East China seas
- And the effect of regime shift on basin-scale processes and ecosystem with the Yellow Sea

❑ Material and Method

- Data:
  - Yellow and East China seas
    - Temperature and salinity: February and August, 1995~2004
    - Zooplankton biomass: February and August, 1995~2004
    - Abundance of major four zooplankton groups: February and August, 1995~2004

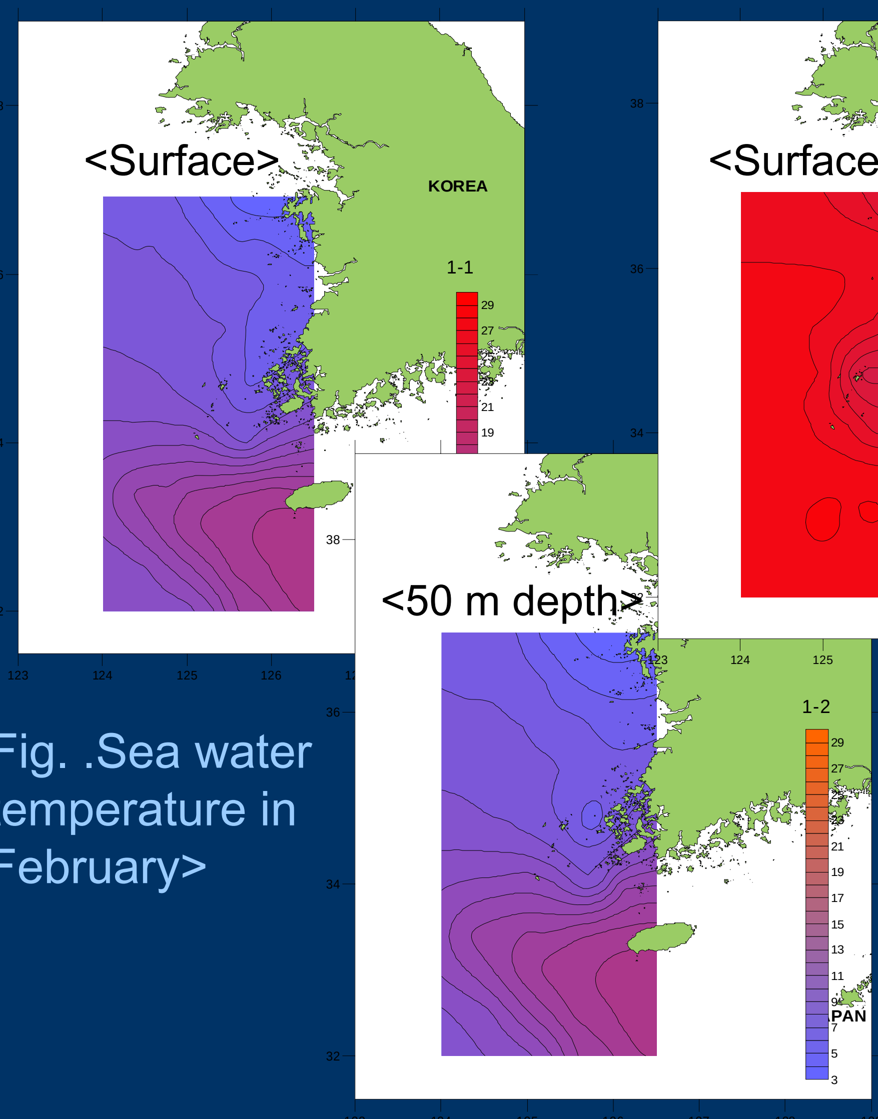


- Yellow Sea:
  - Temperature and salinity: 1965/67~2004
  - Zooplankton biomass: 1965/67~2004
  - Abundance of major four zooplankton groups: 1978~2004
  - ❖PI: 1978~88, PII: 1989~97, PIII: 1998~2004

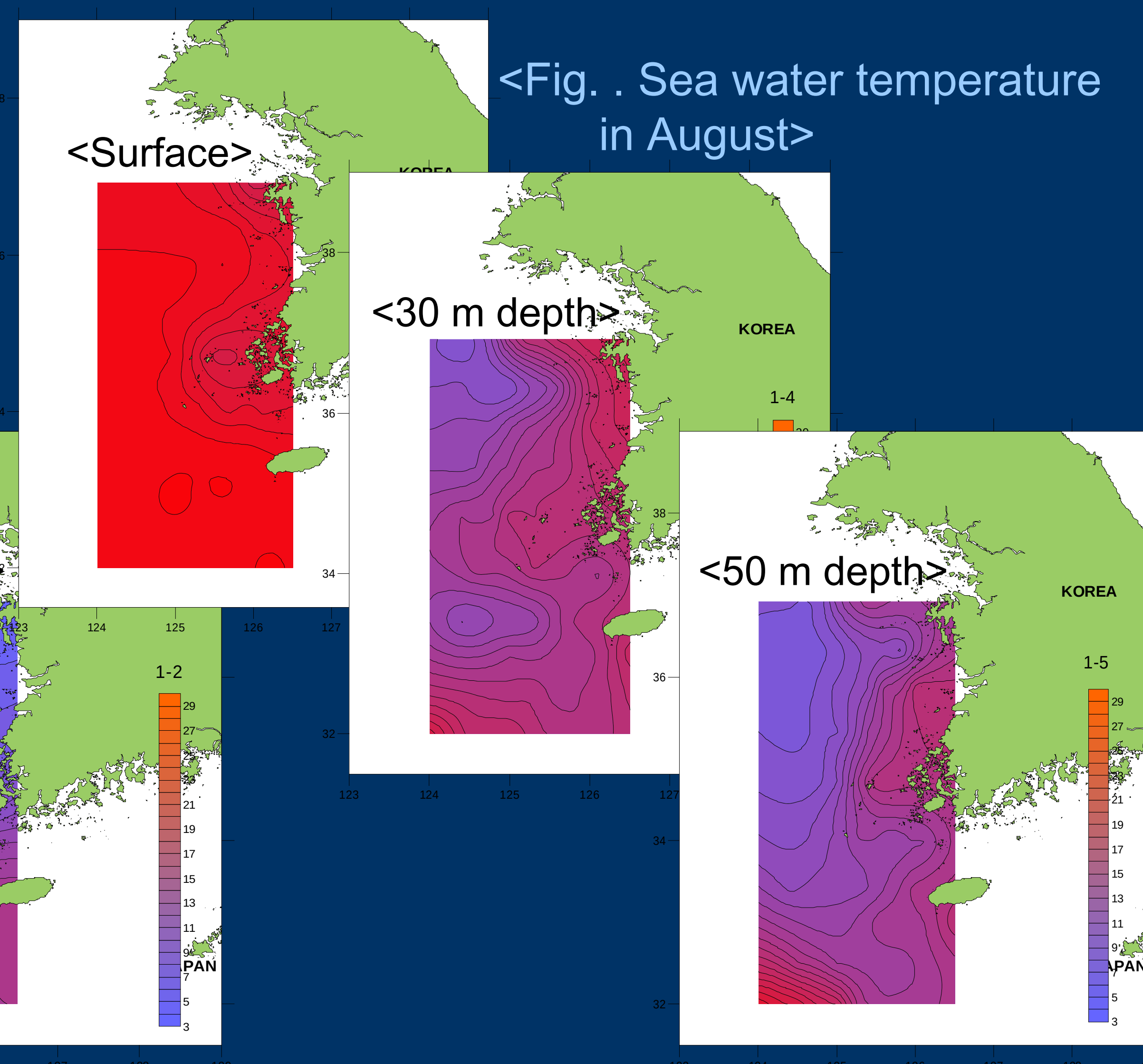
➢ Statistics: PCA(Principal Component Analysis), T-test

❑ Result I-Yellow and East China seas

I. Distributional patterns of mean temperature, Salinity and Zooplankton during 1995~2004



<Fig. .Sea water temperature in February>



<Fig. . Sea water temperature in August>

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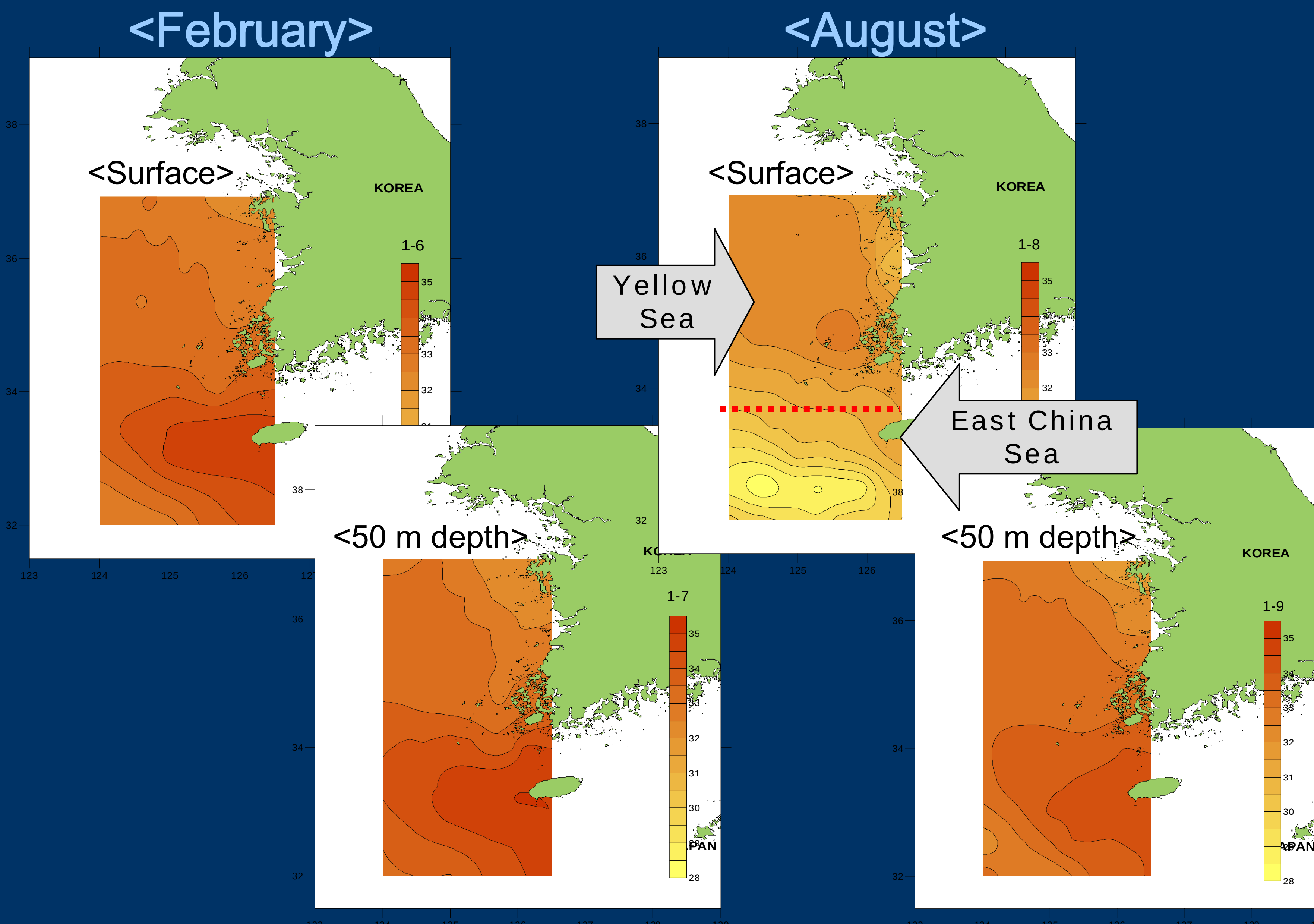
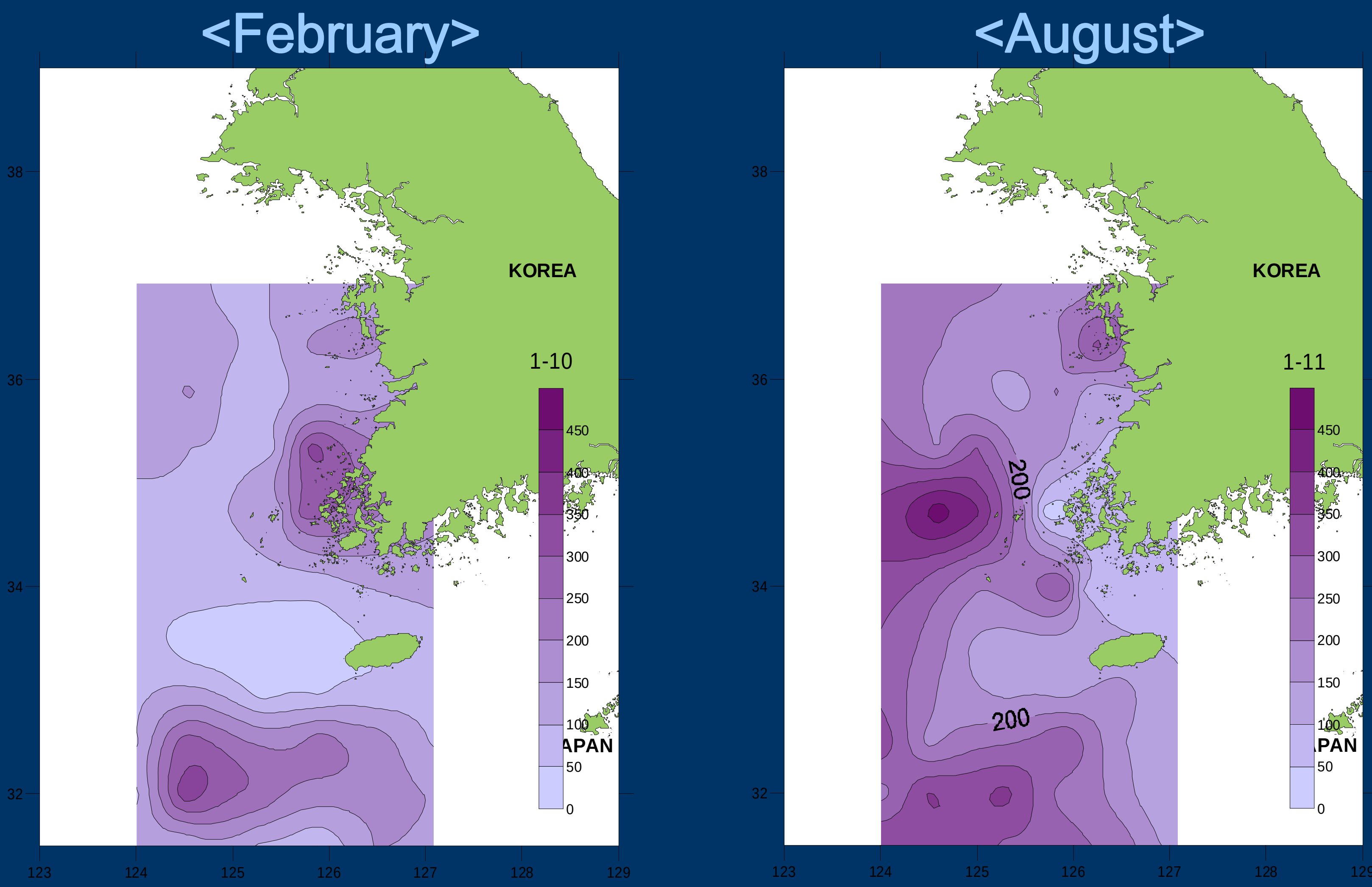
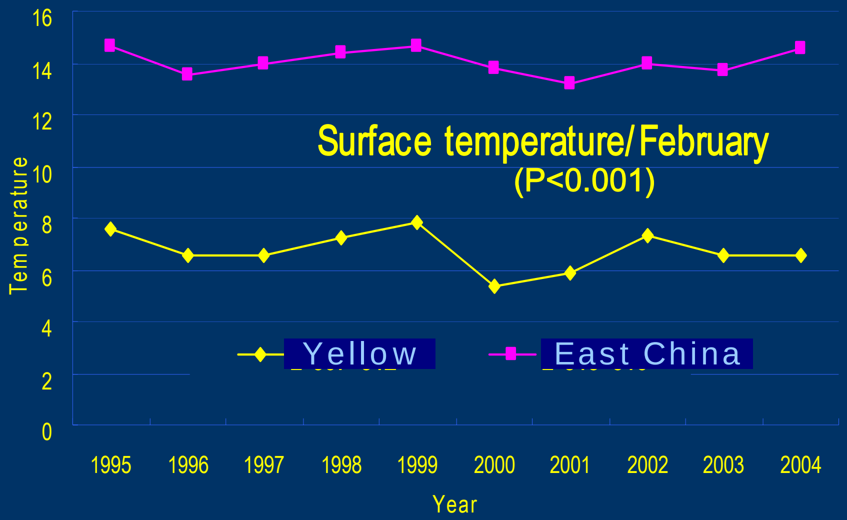


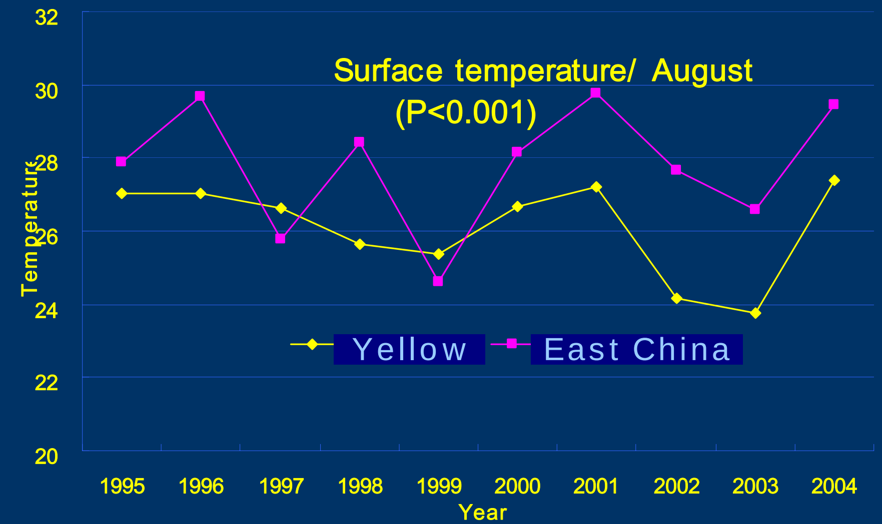
<Fig. . Sea water salinity in February and August>

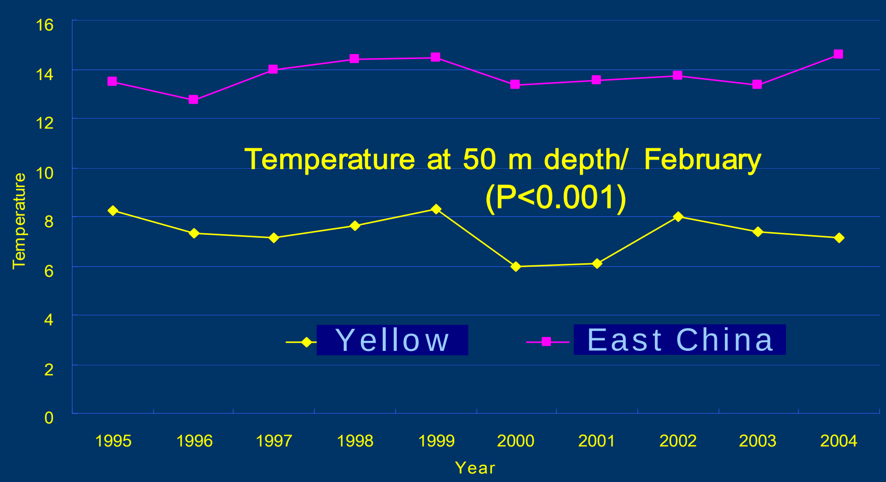


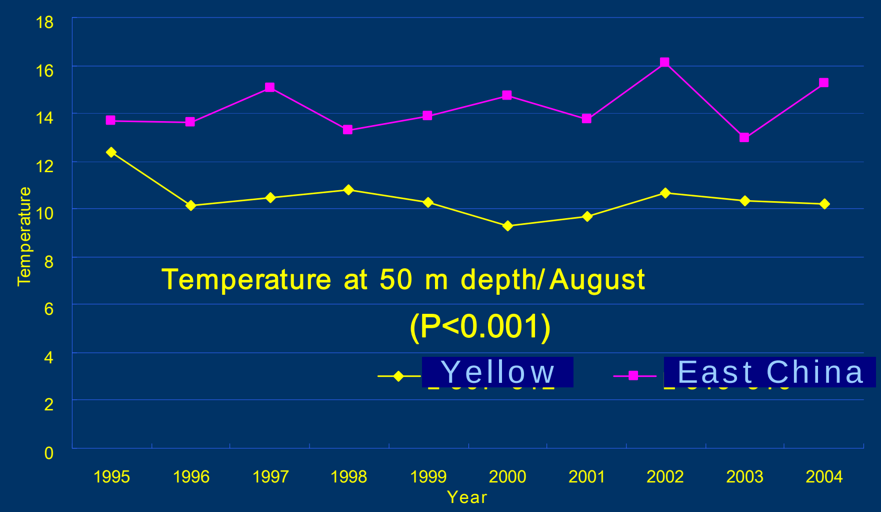
<Fig. . Zooplankton biomass in February and August>

II. Comparison of Yellow Sea with East China seas

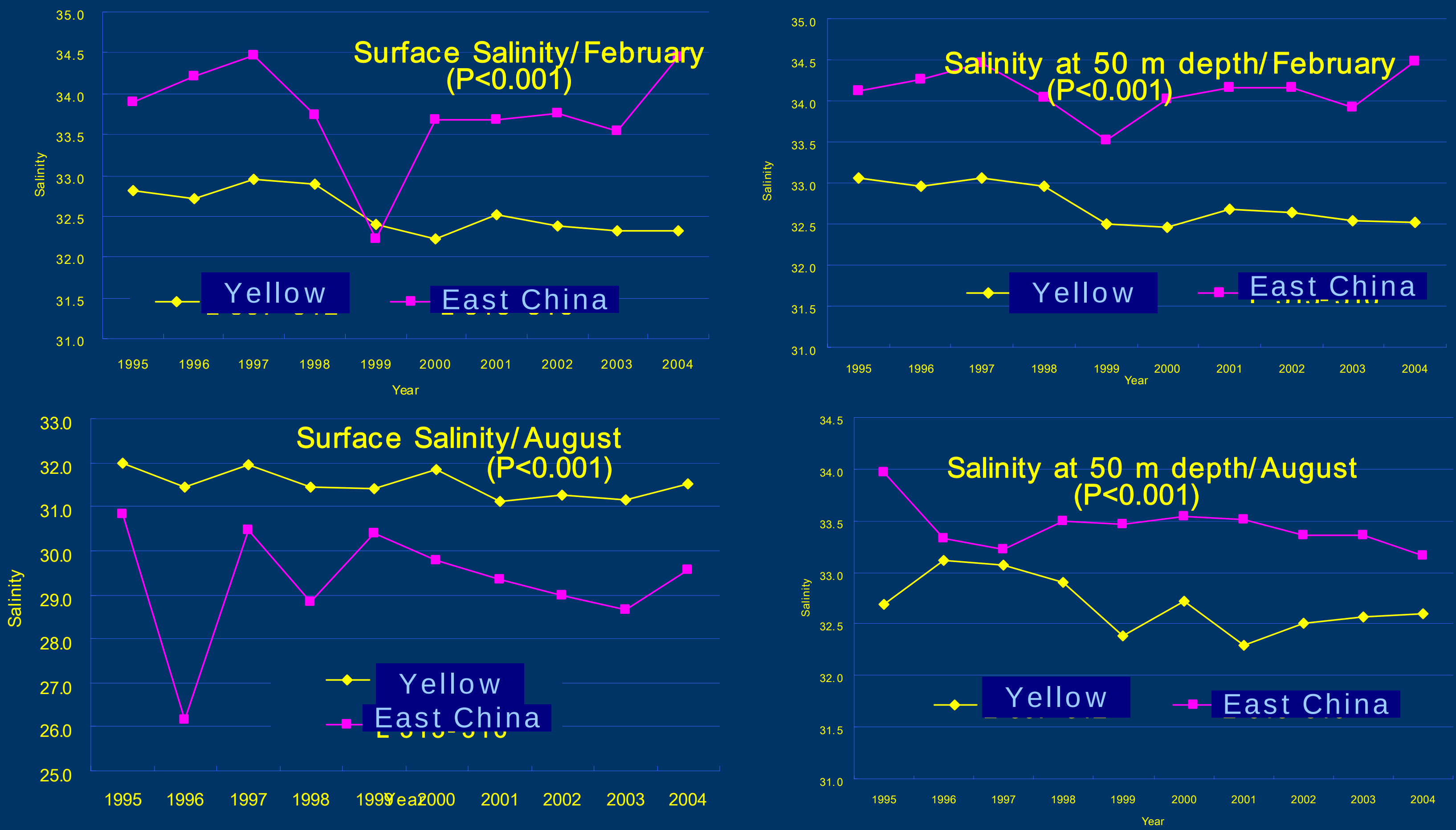








<Fig. . Comparison of sea temperature between Yellow and East China seas in February and August>



<Fig. . Comparison of sea salinity between Yellow and East China seas in February and August>

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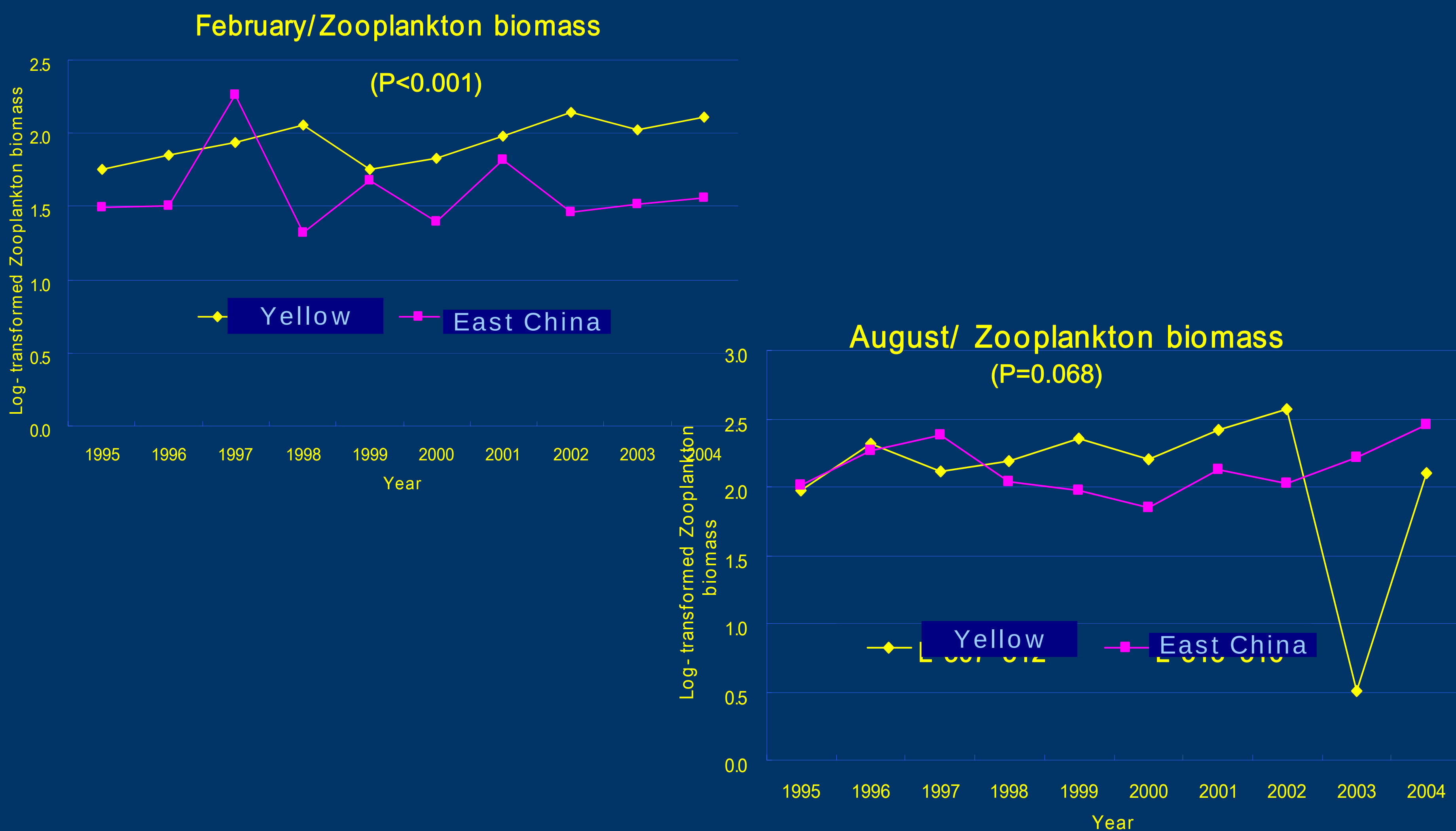
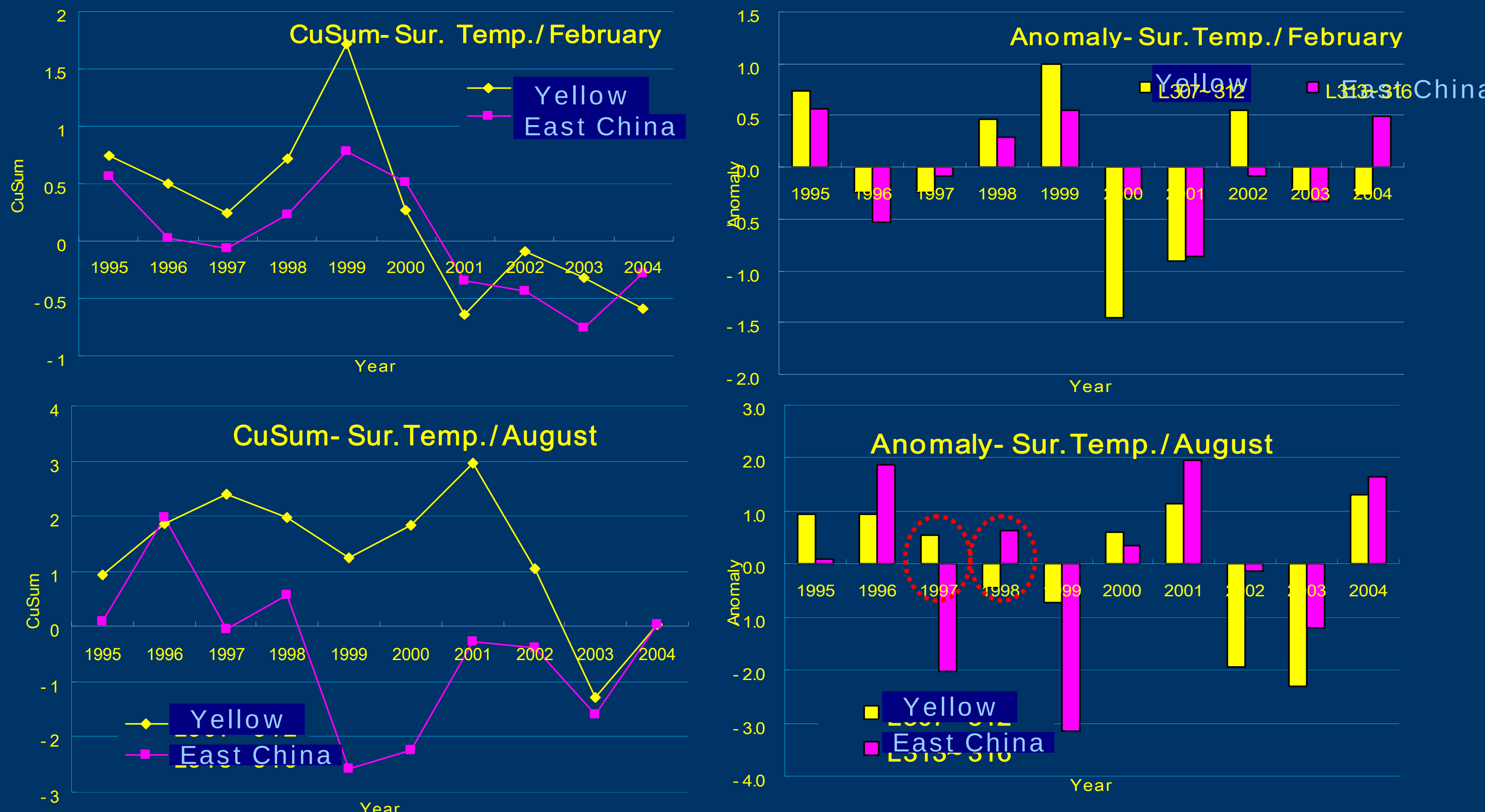
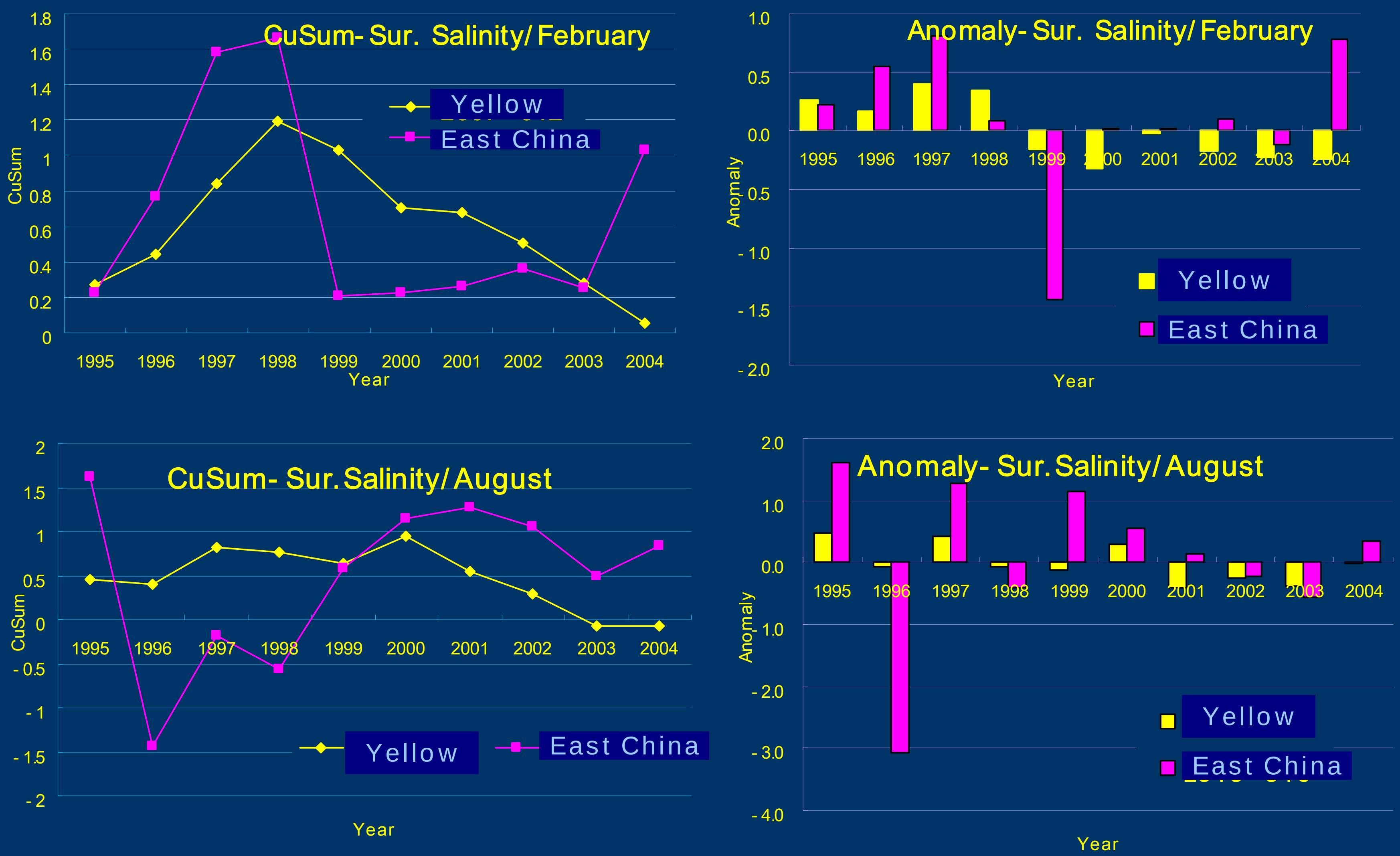


<Fig. . Comparison of zooplankton biomass between Yellow and East China seas in February and August>

III. Long-term trend of Yellow Sea and East China seas



<Fig. . Long-term trend of sea water temperature in February and August in the Yellow and East China seas>



<Fig. . Long-term trend of sea water salinity in February and August in the Yellow and East China seas>

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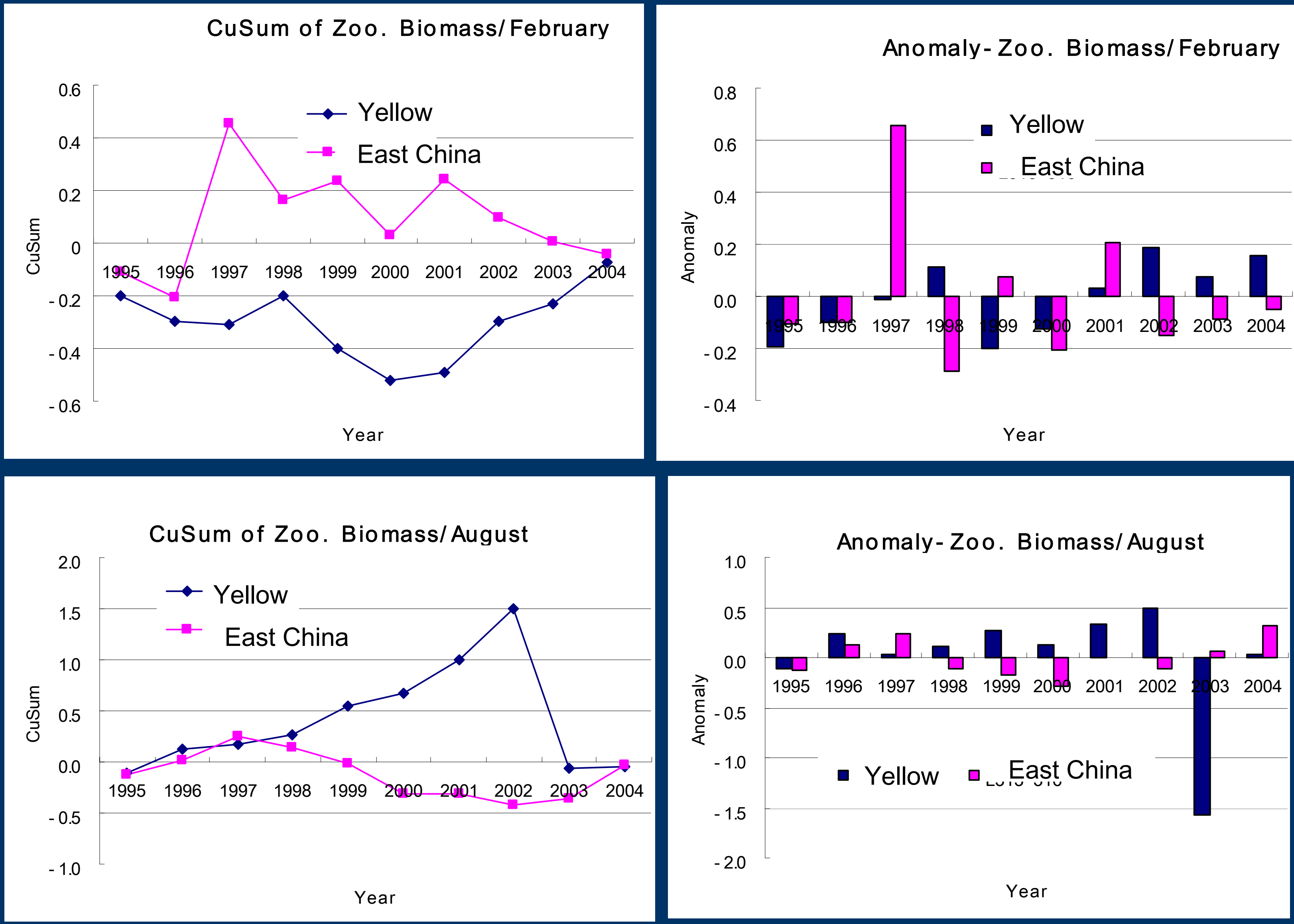
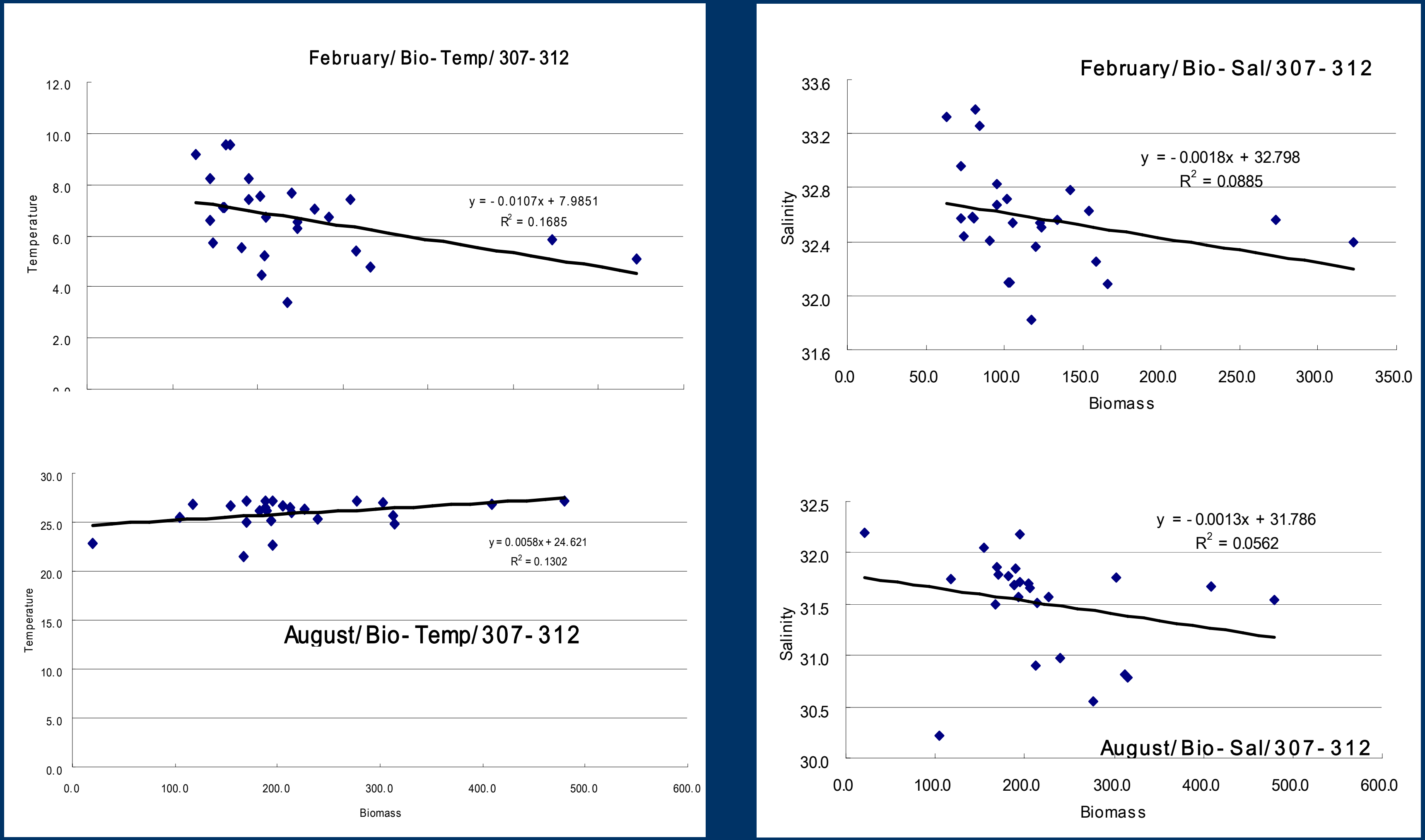


<Fig. . Long-term trend of zooplankton biomass in February and August in the Yellow and East China Sea>

IV. Relationship between zooplankton biomass and environmental factors



<Fig. . Relationship between zooplankton biomass and environmental factors, temperature and salinity in February and August in the Yellow Sea, p<0.05>

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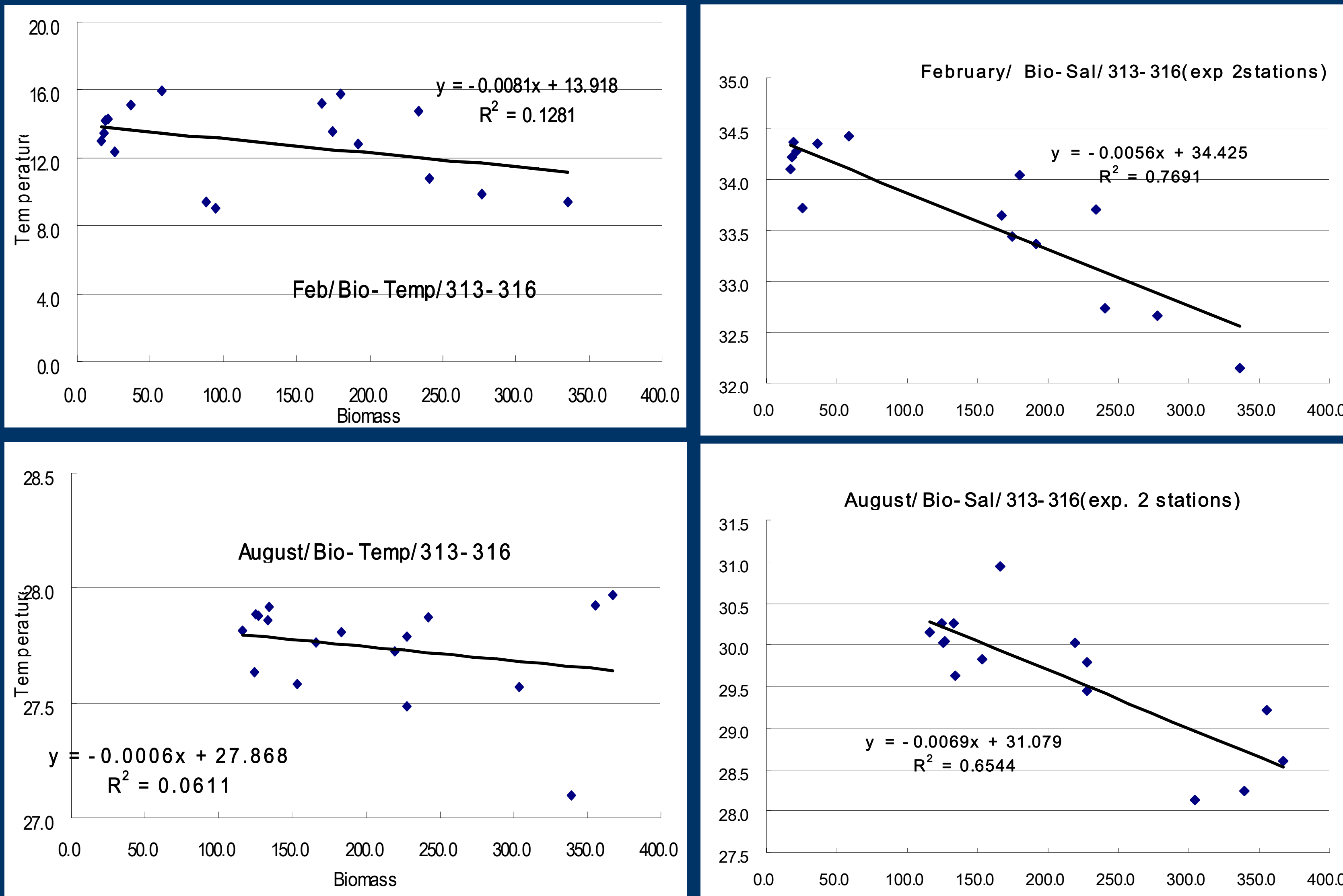
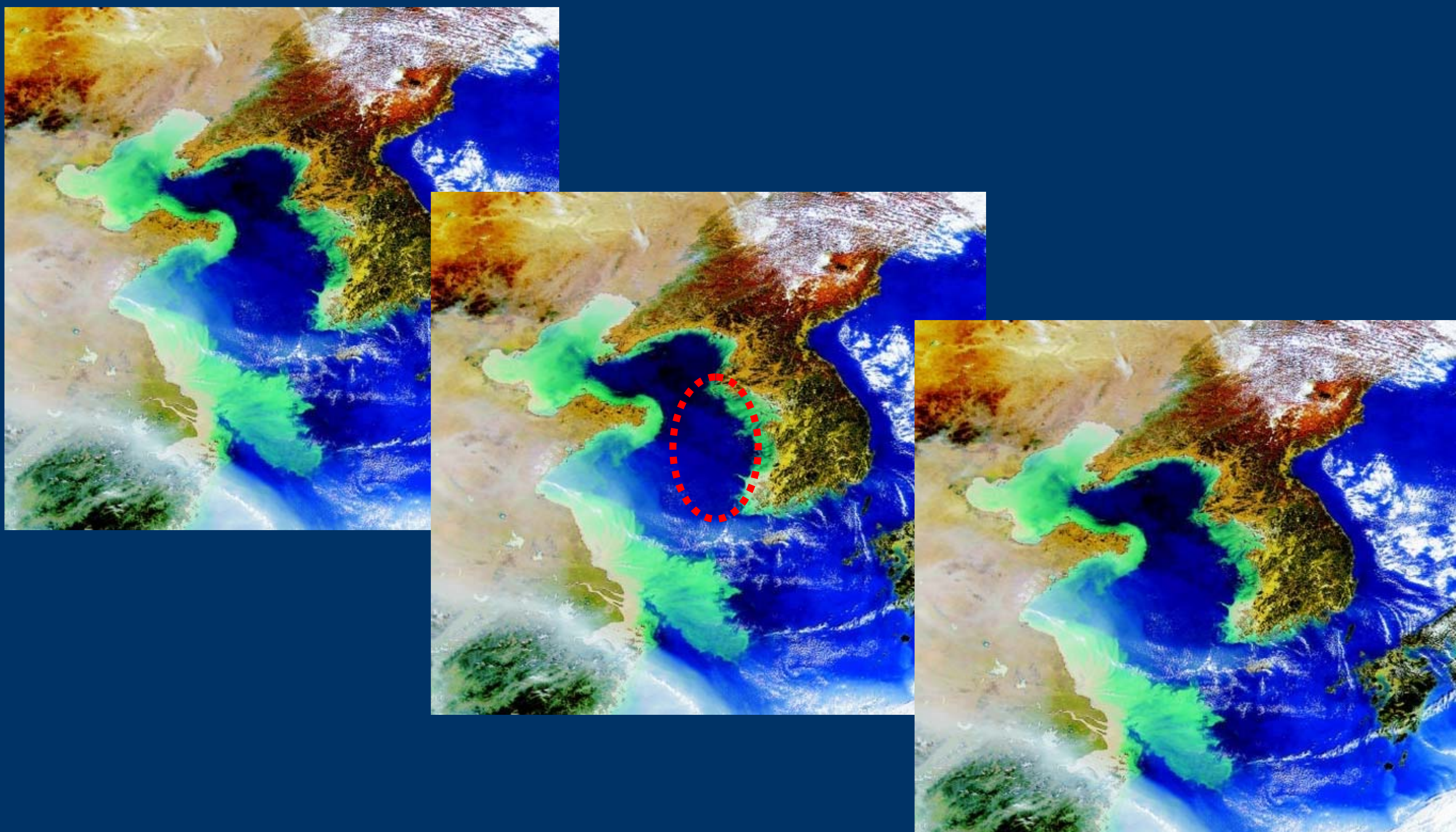


<Fig. . Relationship between zooplankton biomass and environmental factors, temperature and salinity in February and August in the East China Sea, $p<0.05$>

Conclusion-I

- The yellow and East China seas were strongly bounded by temperature and salinity. But they showed similar cha nging pattern.
- Salinity showed decreasing trend after 1999 in both seas.
- The zooplankton biomass was closely related with salinity in the East China Sea. It seems that the East China Sea is influenced by low saline water from Yangtze River

❑ Result II-Yellow Sea



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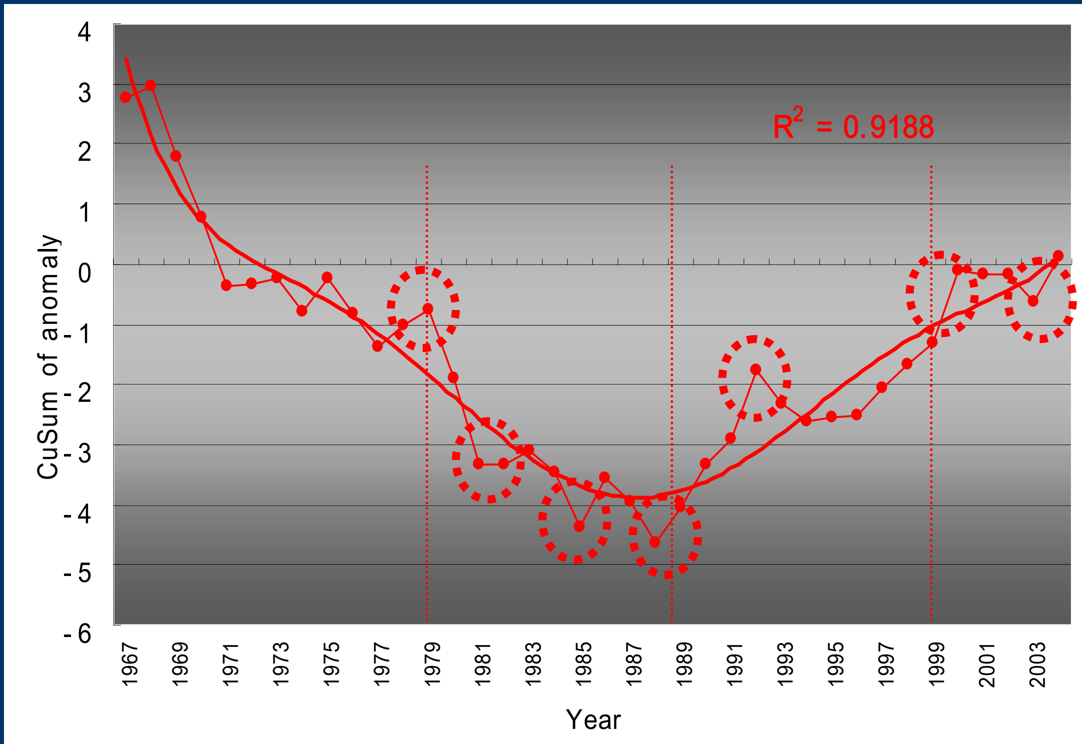
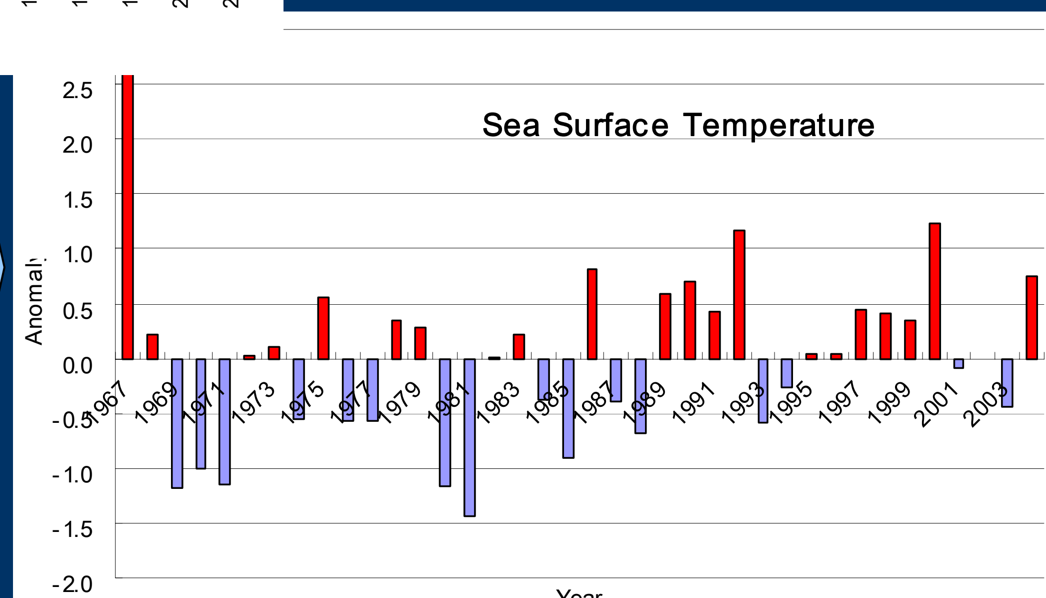


<Fig. . Cumulative sum plots for annual mean anomalies of sea surface temperature from 1967 to 2004 In the eastern area of Yellow Sea, P<0.05>

<Fig. . Long-term change of annual mean anomalies of sea surface temperature from 1967 to 2004 In the eastern area of Yellow Sea>



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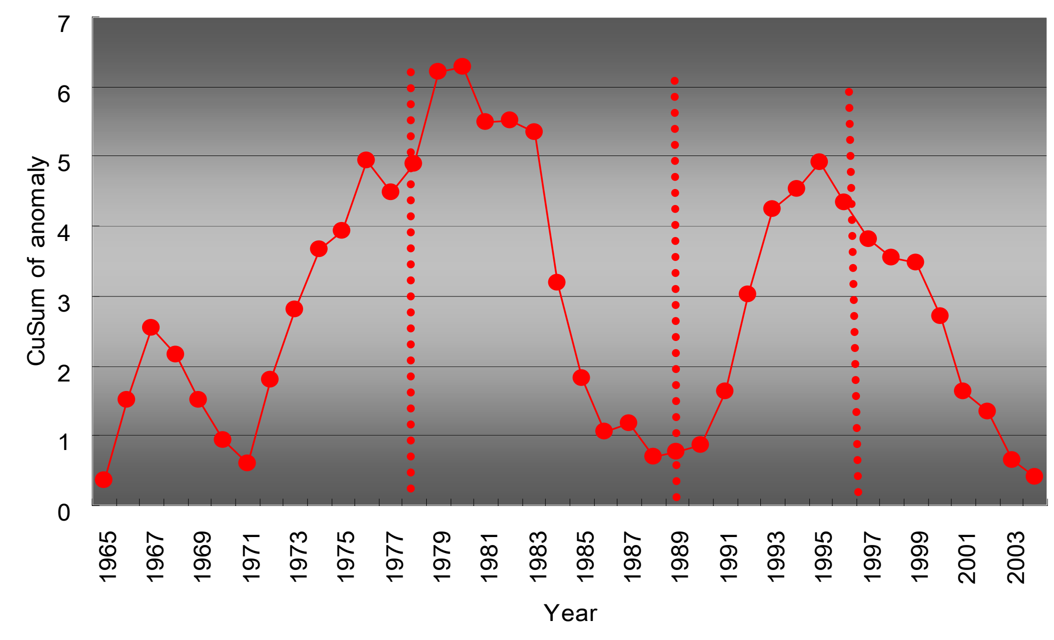
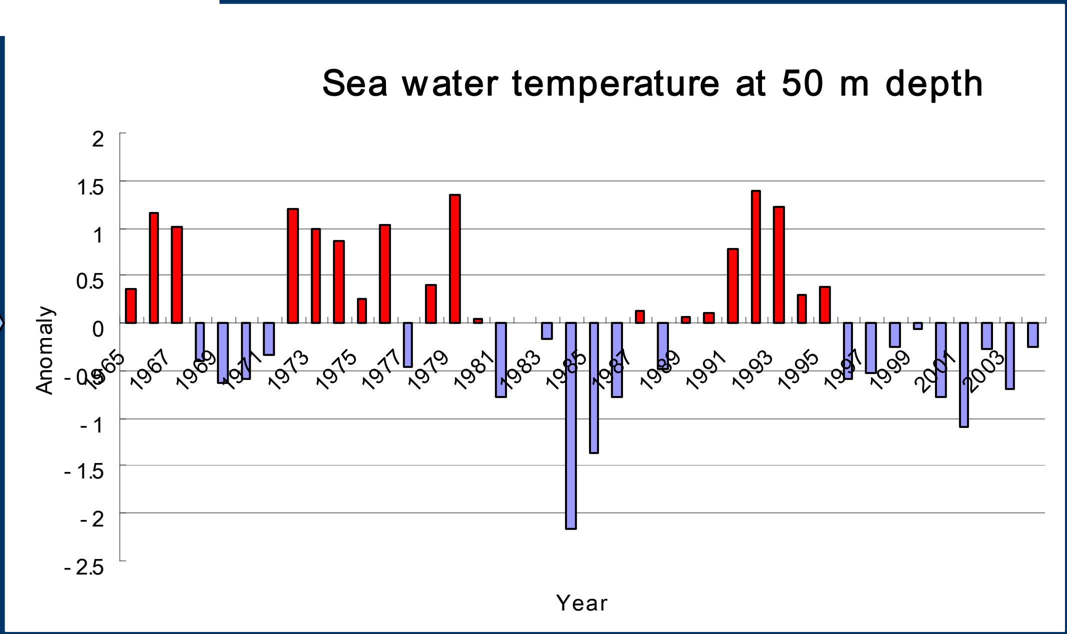
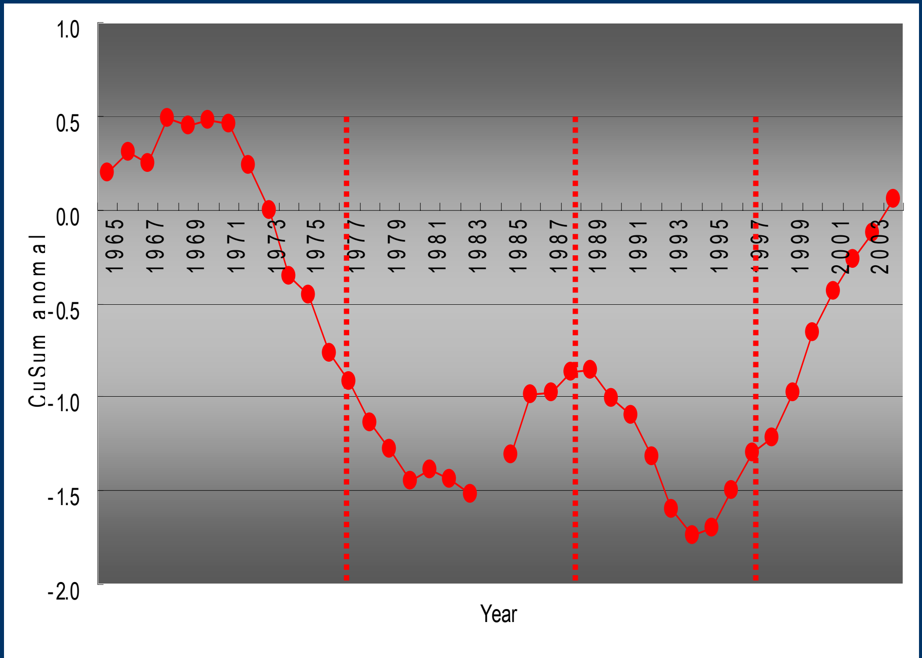


<Fig. . Cumulative sum plots for annual mean anomalies of sea temperature at 50 m depth from 1967 to 2004 In the eastern area of Yellow Sea>



<Fig. . Long-term change of annual mean anomalies of sea temperature at 50 m depth from 1967 to 2004 In the eastern area of Yellow Sea>



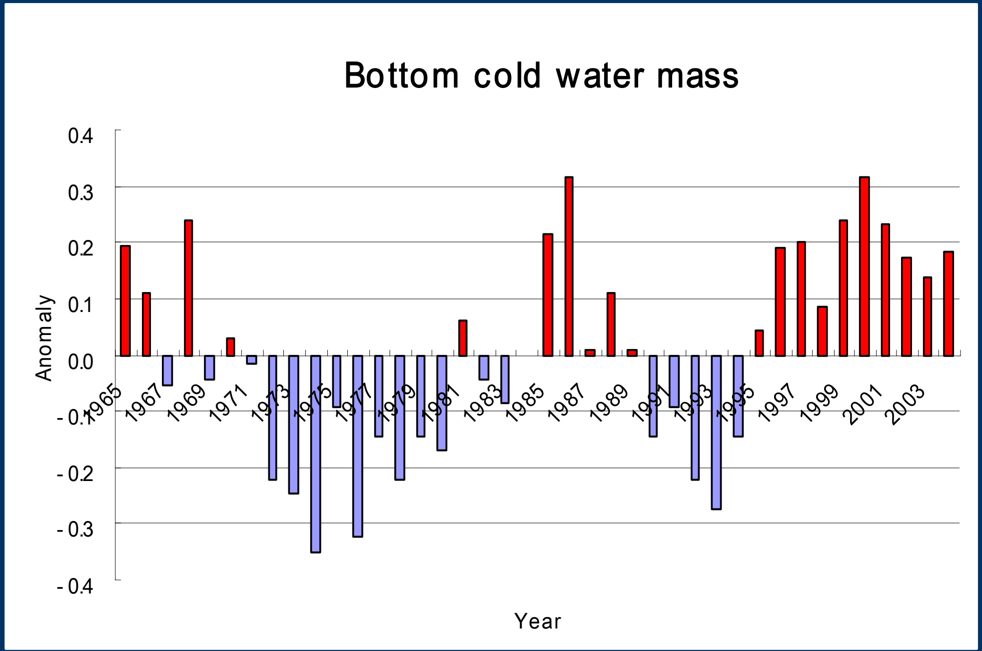


Fig. . Cumulative sum plots and long-term change for mean anomalies in August of index of bottom cold water mass from 1965 to 2004 in the eastern area of Yellow Sea. Index of bottom cold water mass is calculated by dividing the station number showed the low temperature less than 10°C by the total number of surveyed stations.

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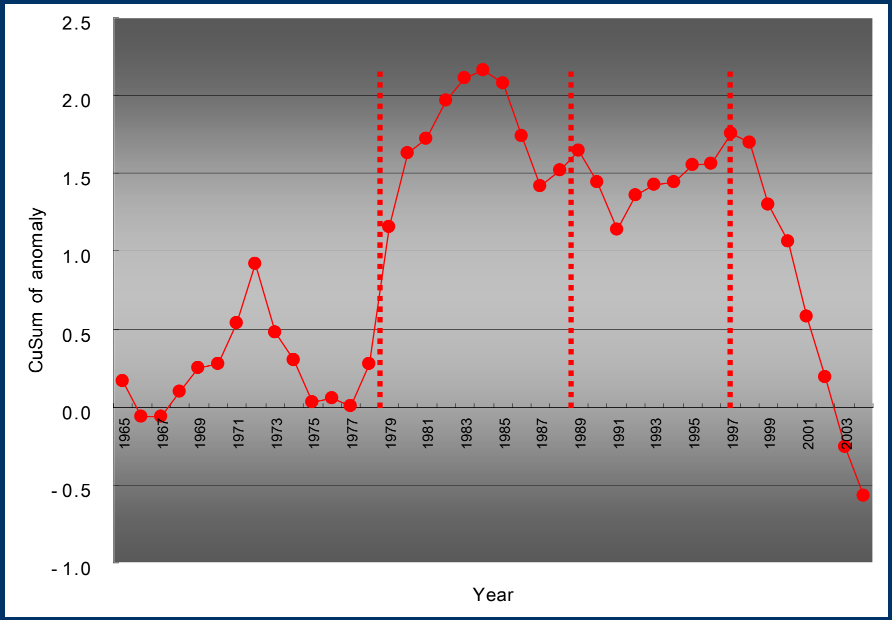
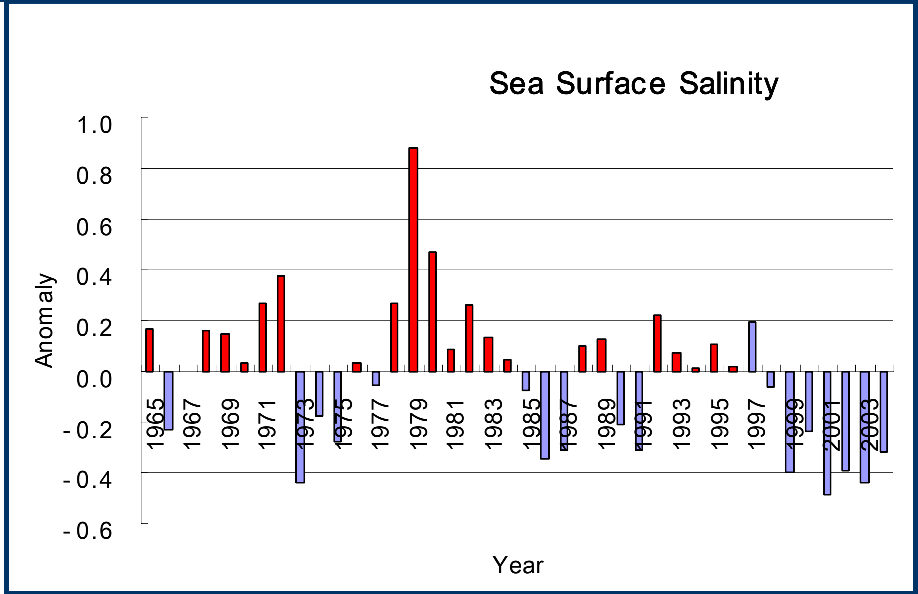
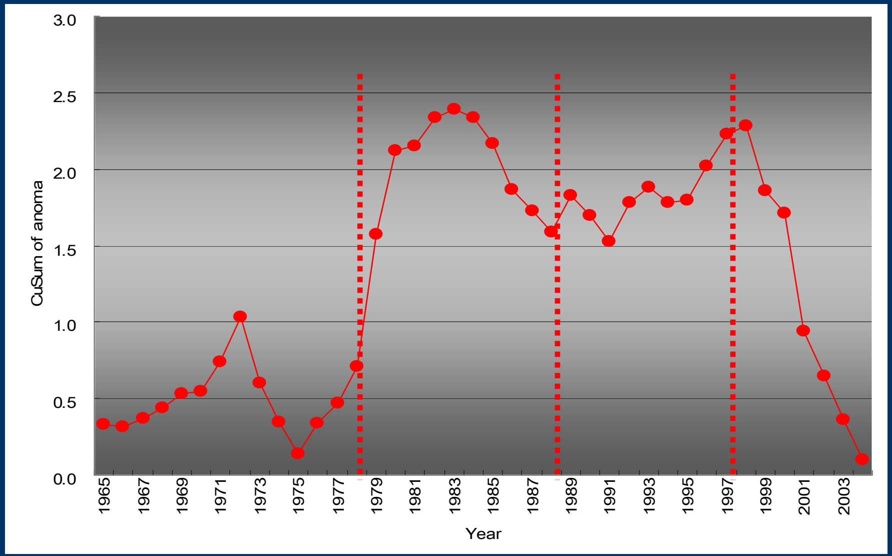
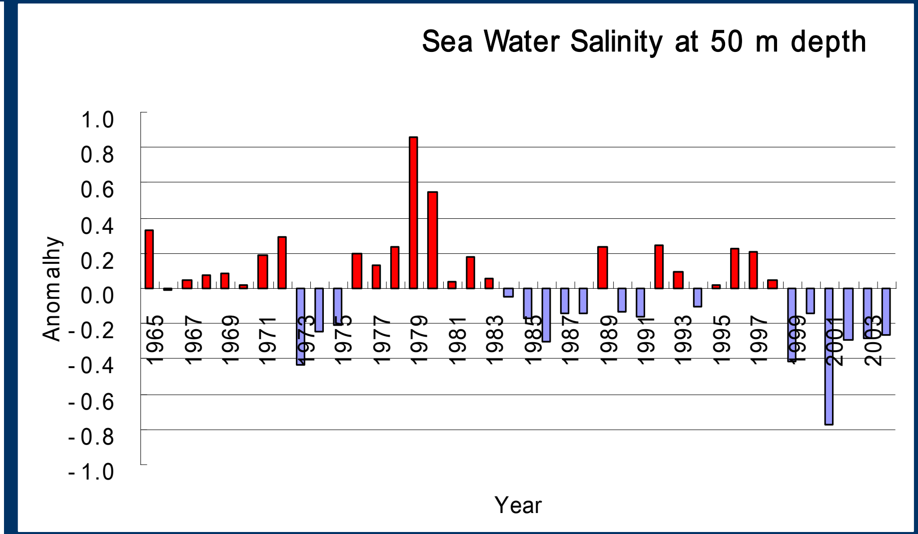
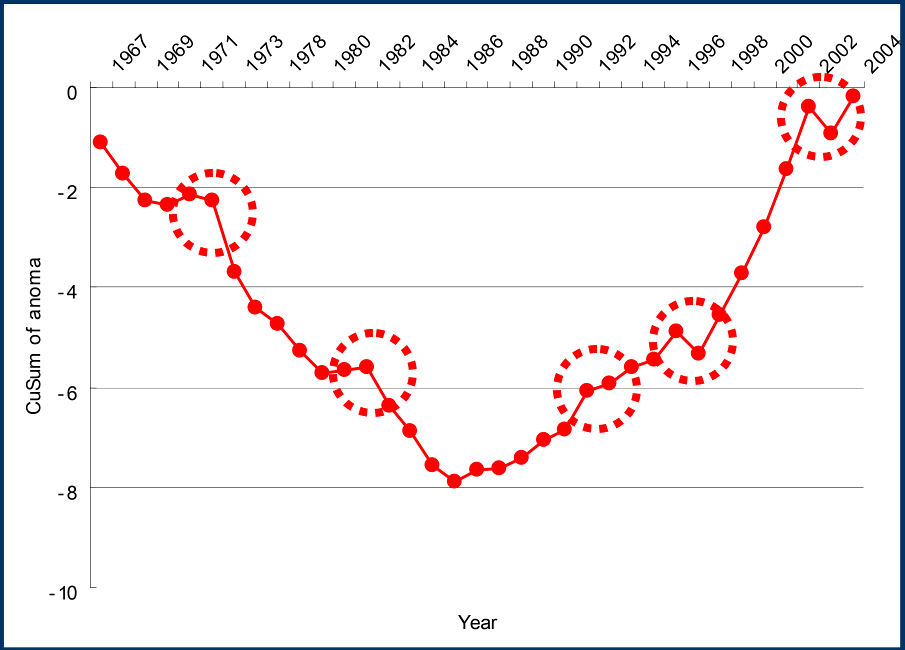








<Fig. . Cumulative sum plots and long-term changes of annual mean anomalies of salinities at surface and 50 m depth from 1965 to 2004>



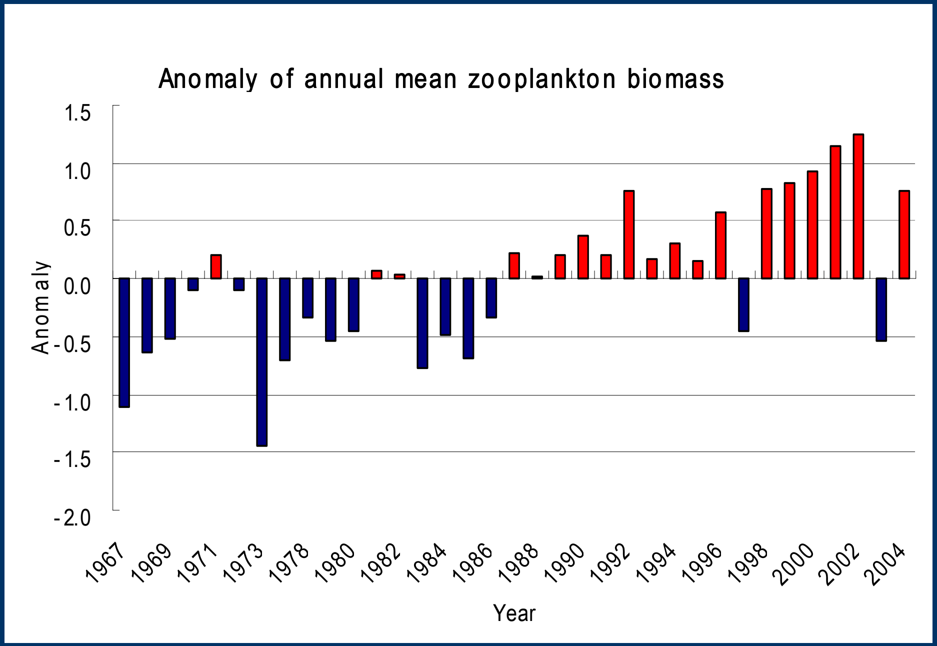


Fig. . Cumulative sum plots and long-term change of annual mean anomalies of zooplankton biomass from 1967 to 2004 in the eastern area of Yellow Sea.

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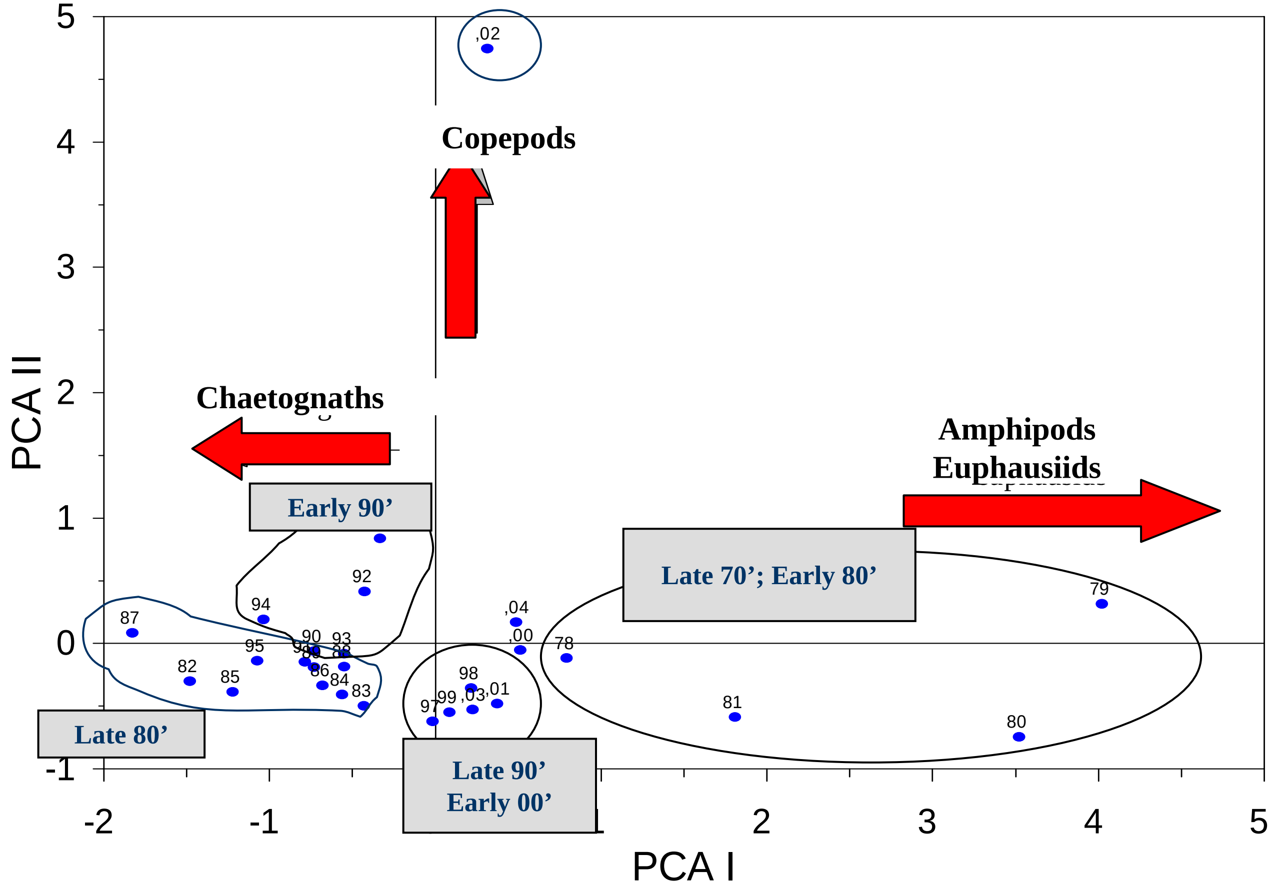

Fig. . Principal component ordination of 27-yr four major zooplankton groups, copepods, amphipods, chaetognaths and euphausiids, in the eastern area of Yellow Sea.

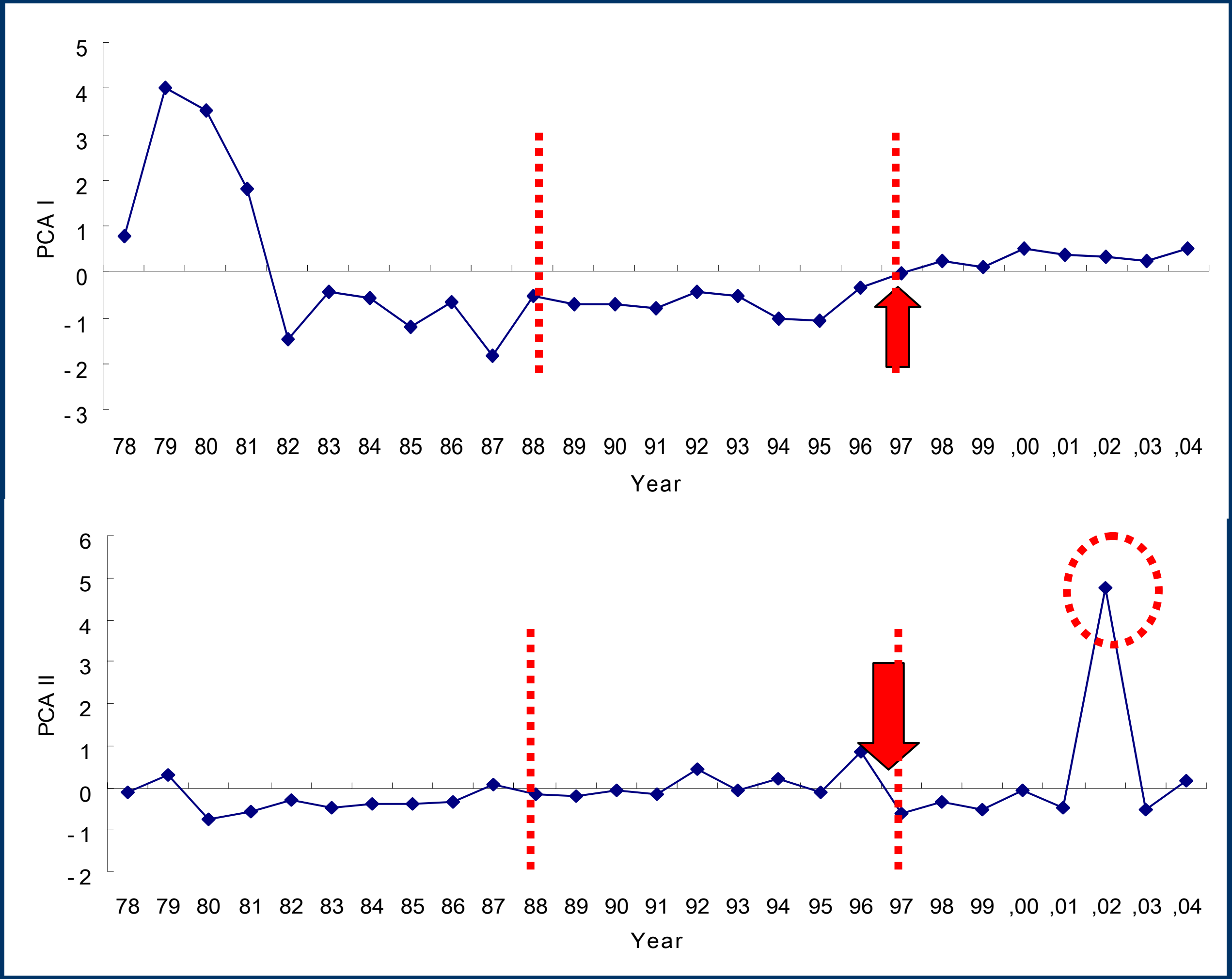

Fig. . Long-term changes in 1st and 2nd principal component calculated from 27-yr four major zooplankton groups, copepods, amphipods, chaetognaths and euphausiids, in the eastern area of Yellow Sea. 1st and 2nd principal component explain 44.34% and 25.67% of the total variability, respectively.

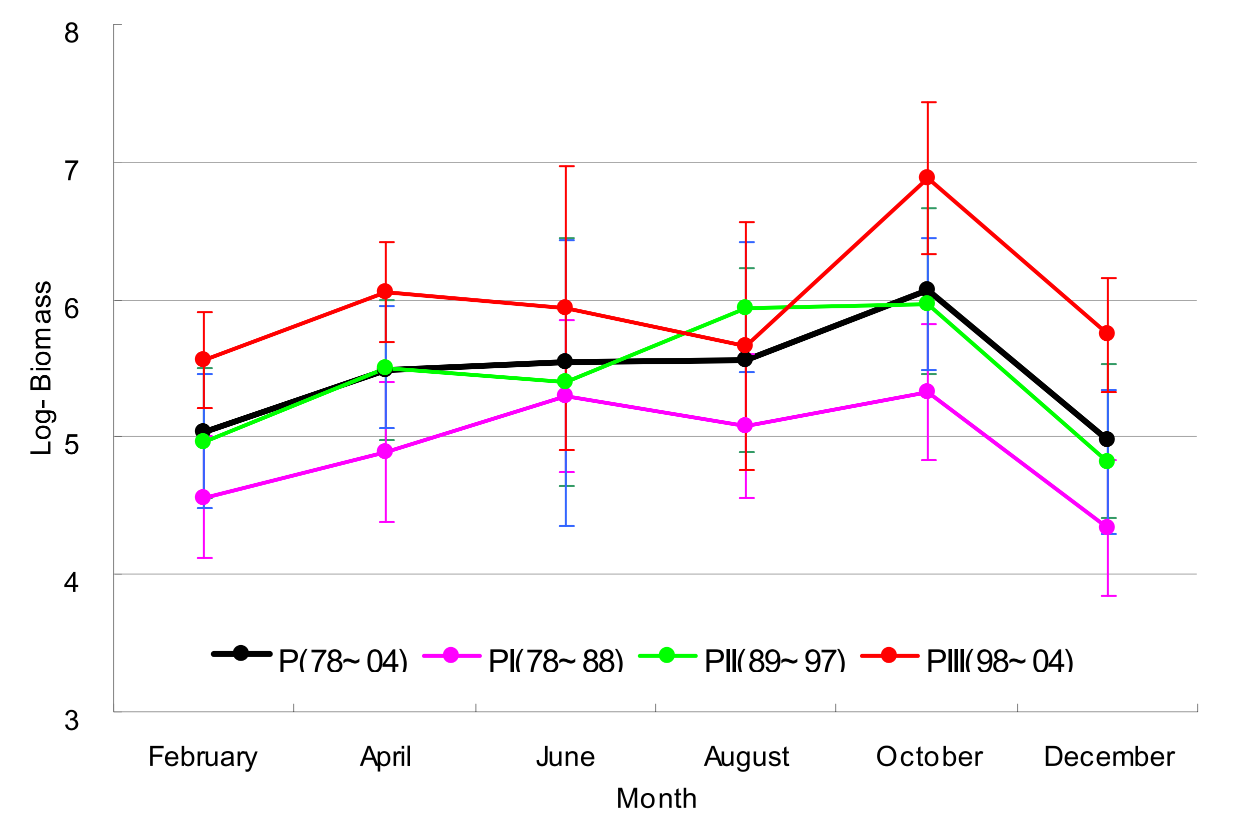

Fig. . Seasonal variations in zooplankton biomass in each period separated by regime shifts.

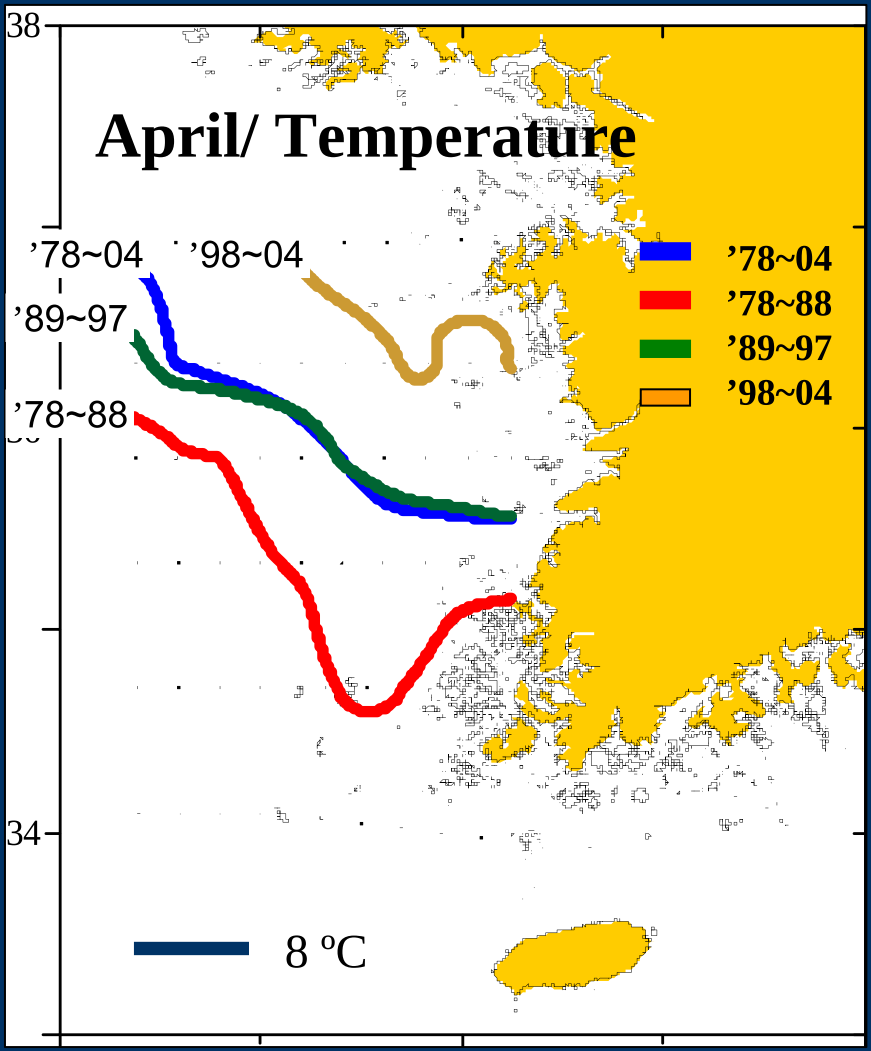

Fig. . Geographical distribution of mean surface temperature in April in each period separated by regime shifts.

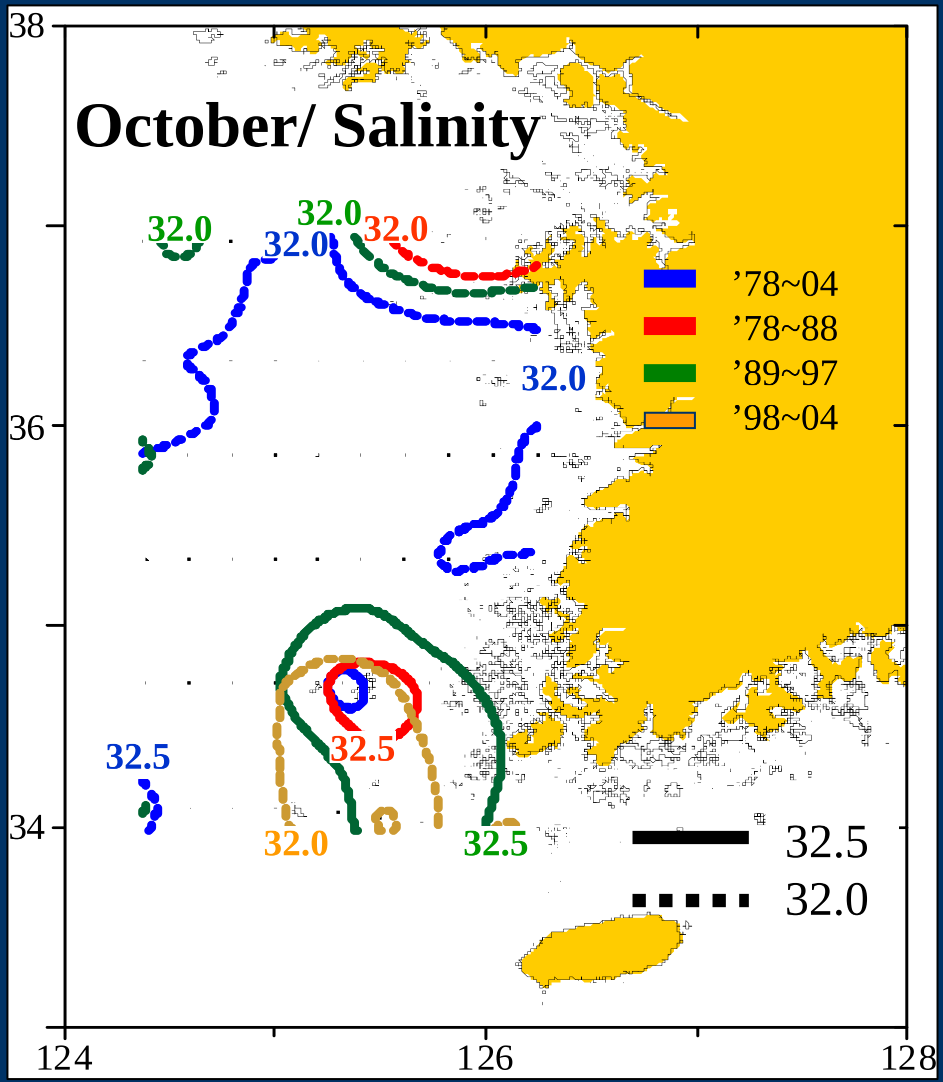

Fig. . Geographical distribution of mean surface salinity in October in each period separated by regime shifts.

Conclusion-II

- **Sea surface temperature** increased after the late 1980's. **Water temperature at 50m depth** showed about **15 years cycles. Index of bottom cold water mass** in August showed cycle.
- Temperature and zooplankton biomass showed response to some El Nino events.
- **Salinity** dramatically increased after 1977/78 and kept steady to 1997/1998. And then it sharply decreased.
- **Peaks of zooplankton biomass** in April and October during period III(1998~2004) is closely related to warm temperature and low saline water, respectively.

Thank you for your attention!!!!