

# Long-term variation in the East Korean Warm Current and its impact on the bio-physical reaction in the southwestern region of the East/Japan Sea

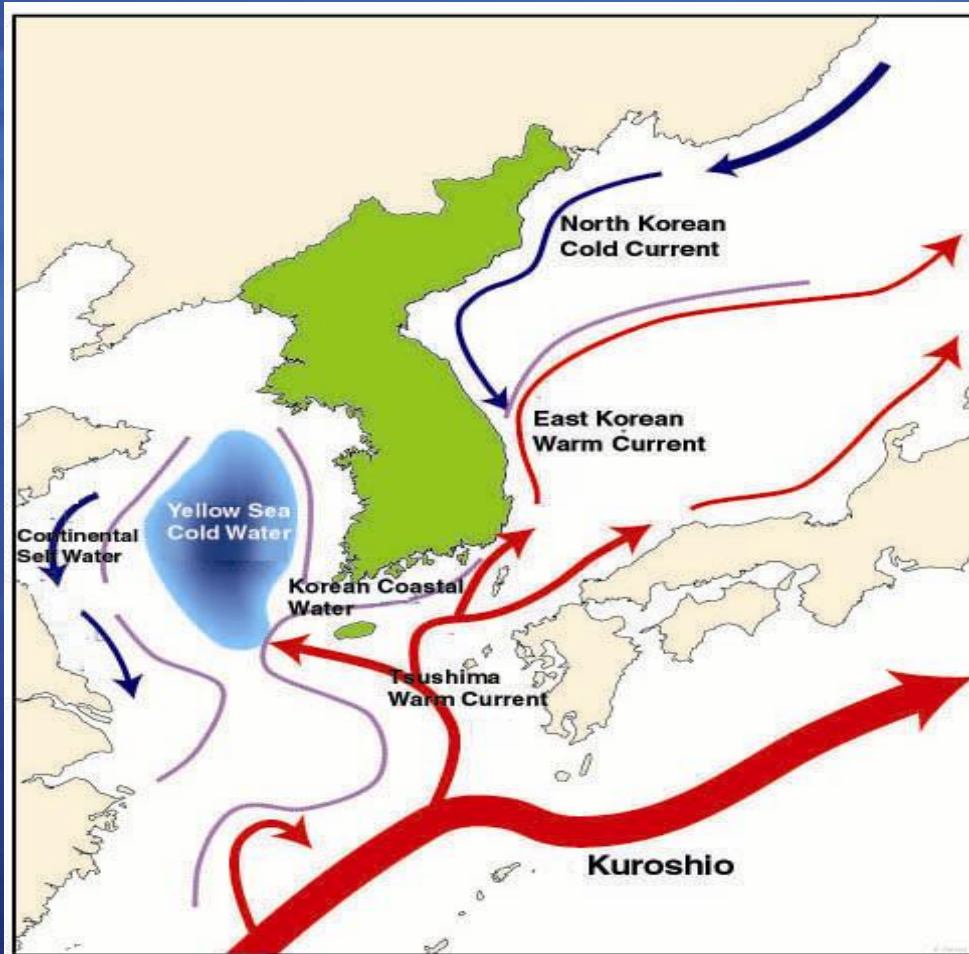
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## Schematic figure of current system around the Korea



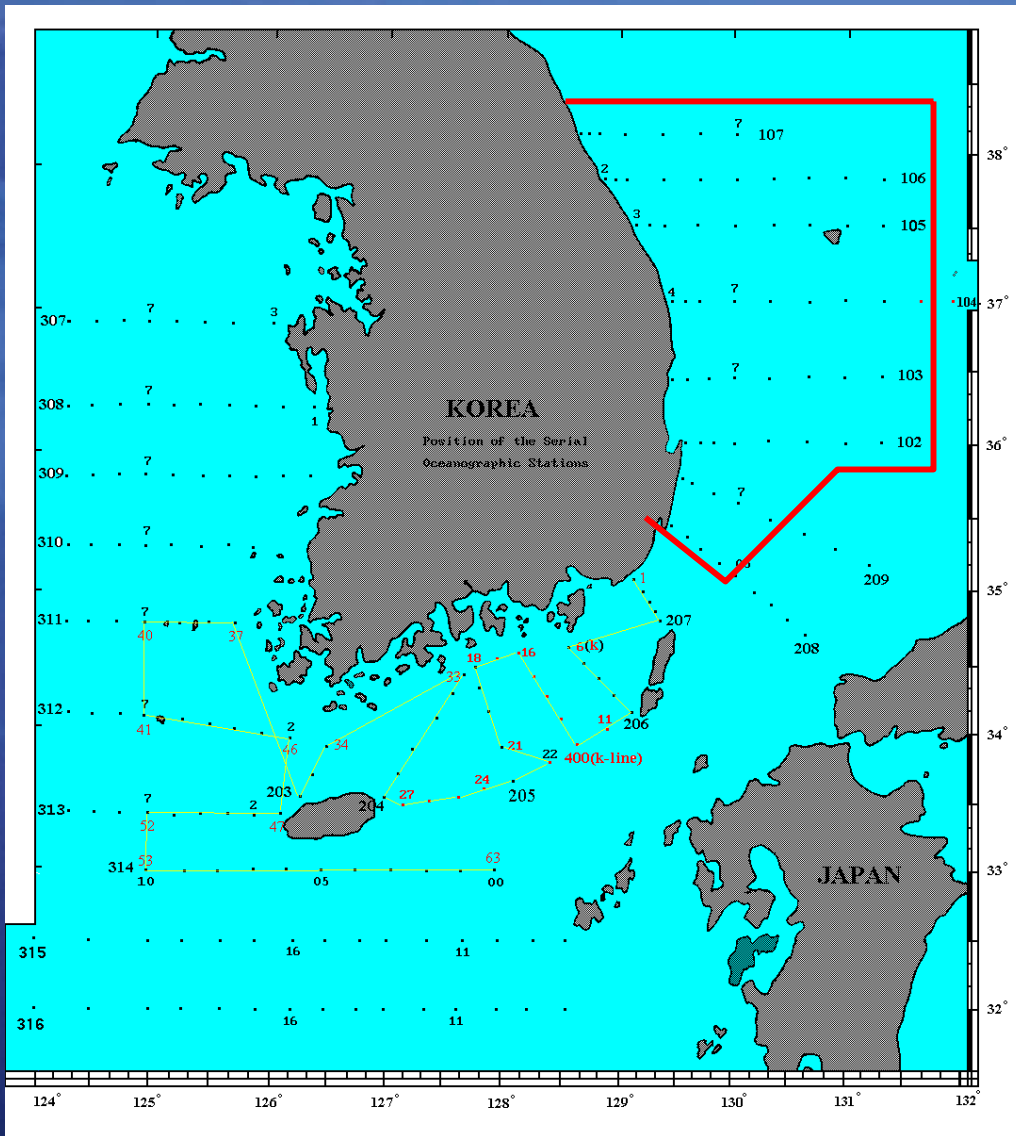
EKWC (East Korean Warm Current) is the branch of Tsushima Warm Current and flows along the Korean Coast. NKCC (North Korean Cold Current) intrudes southward along the Korean Coast.

Both currents predominate the oceanic, meteorologic and fisheries condition around the southwestern region of East/Japan Sea

## Objective of this research

- Long-term variation of surface temperature, surface salinity and zooplankton biomass in the southwestern region of East/Japan Sea.
- The temporal and spatial variation of the strength of East Korean Warm Current (EKWC) with a focus of physical phenomenon using EOF analysis.
- The impact of the Tsushima Warm Current on the representative fisheries species concerning with the regime shift.

# Serial Oceanographic Observation in the East/Japan Sea



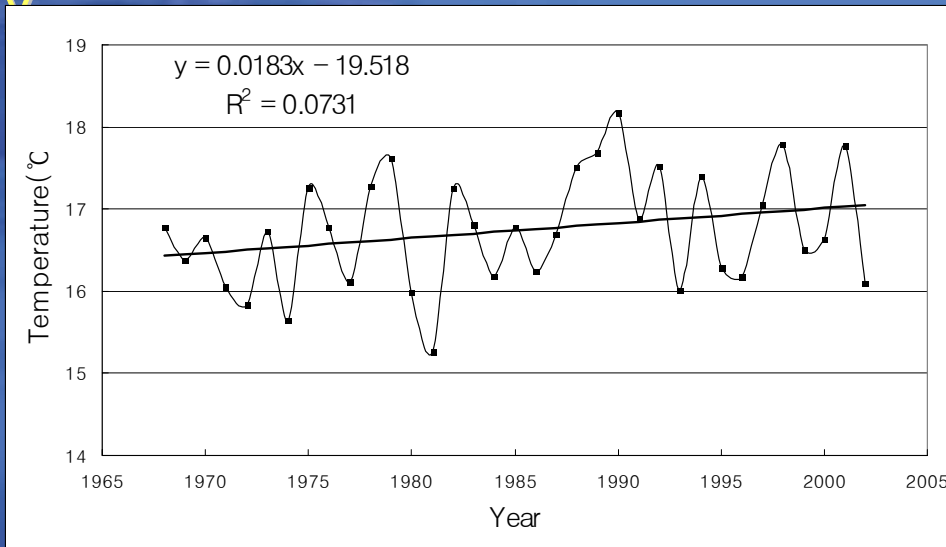
– The bimonthly (Feb., Apr., Jun., Aug., Oct., Dec.) serial observation has been carried out by NFRDI, Korea since 1921.

– The numbers of observation point are 8 line, 58 stations.

– The investigation items are temperature, salinity, DO on the standard depth and nutrients, zoo plankton, meteorological items, water color.

– In this study, we used the data of temperature, salinity and zoo plankton biomass since 1970.

# Long-Term Variation of Surface temperature and salinity

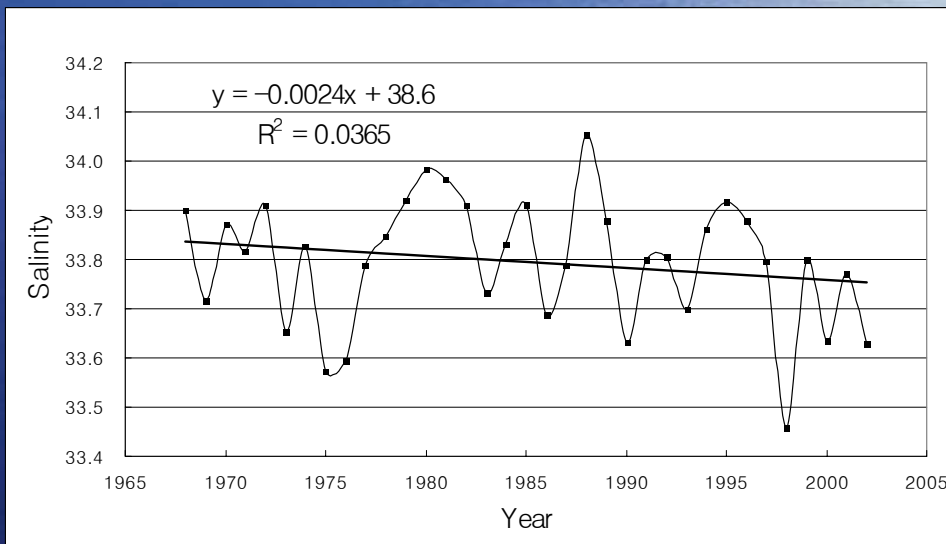


Annual mean surface temperature and salinity variations were averaged on 58 stations in the southwestern region of East / Japan sea from 1968 to 2002.

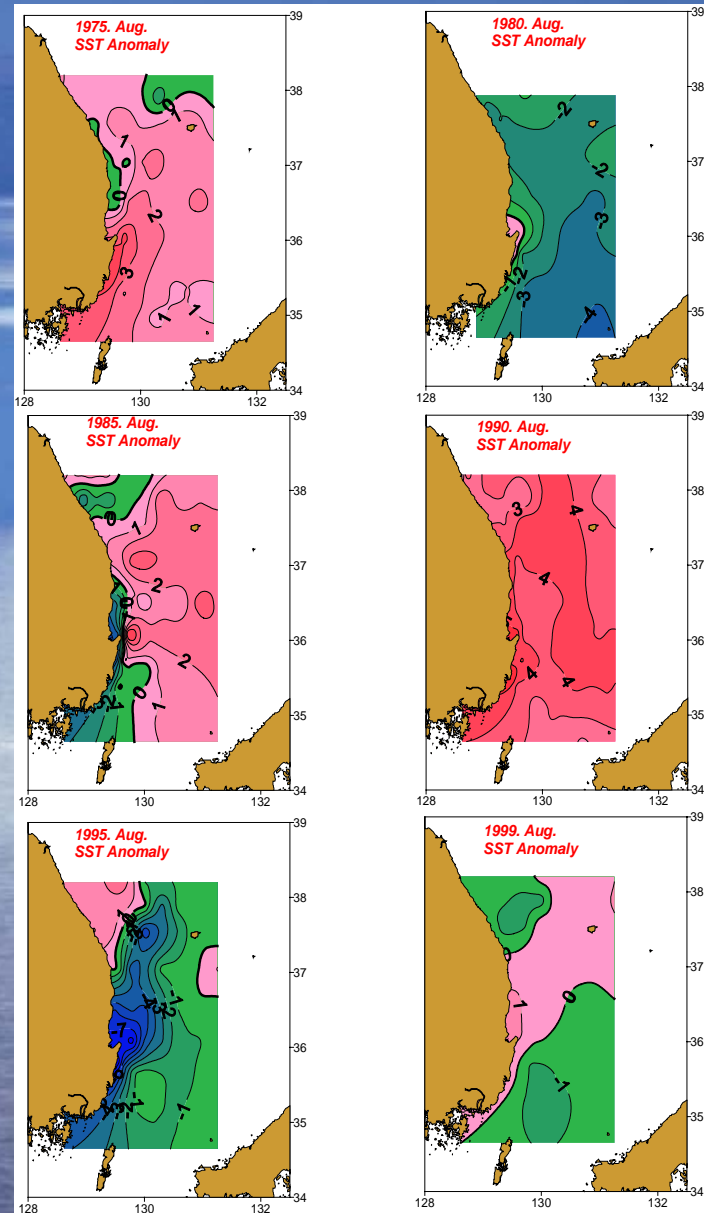
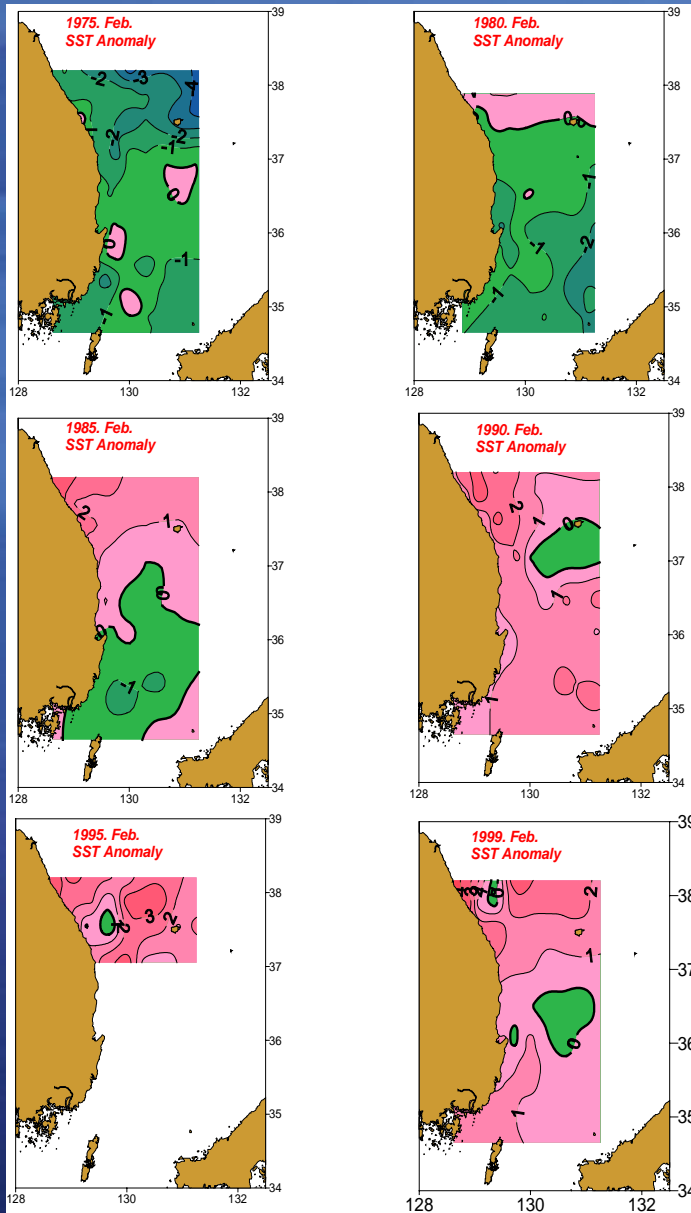
– Surface temperature increase  $0.02^{\circ}\text{C}/\text{year}$ . If this trend will be maintained, surface temperature will be increased  $2^{\circ}\text{C}$  100 years later.

– Surface temperature has a period about 2~3 years.

– Surface salinity decrease  $0.0025\text{psu}/\text{year}$ .



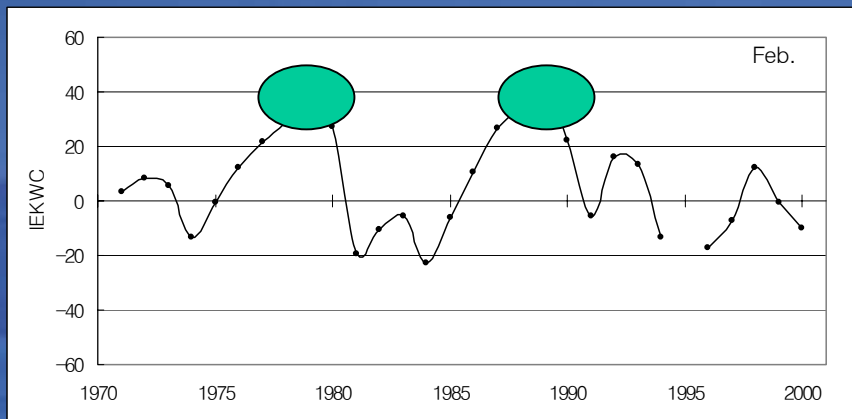
# Spatial and temporal variation of SST



# IEKWC(Index of East Korean Warm Current)

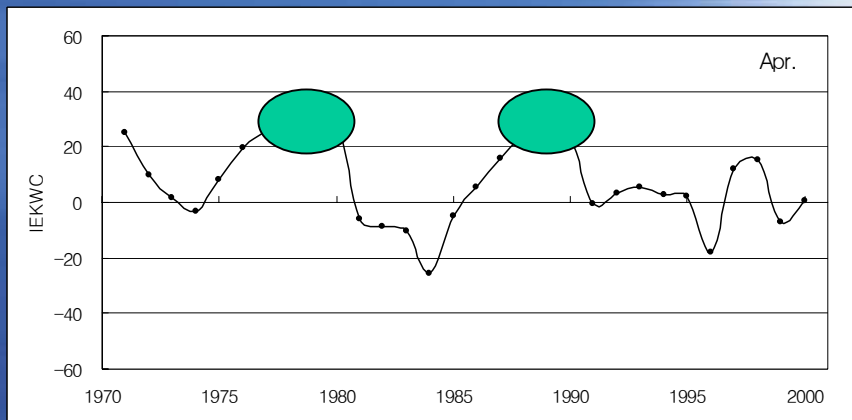
We decided on IEKWC by the distribution of temperature on 100m layer.(Moriyasu, 1972; Kawabe 1982)

- 1) Obtain the mean temperature on 100m layer at each investigated month by the serial oceanographic data during 1971~2000.
- 2) Compute the anomalies for the mean temperature
- 3) Analyze by EOF(Empirical Orthogonal Function)
- 4) IEKWC=sum of score from 1<sup>st</sup> to 3<sup>rd</sup> mode
- 5) If  $IEKWC > (\text{mean} + \text{standard deviation})$  : EKWC is strengthened
- 6) If  $IEKWC < (\text{mean} - \text{standard deviation})$  : EKWC is weakened
- 7) If  $(\text{mean} - \text{standard deviation}) < IEKWC < (\text{mean} + \text{standard deviation})$  : EKWC is normally maintained.



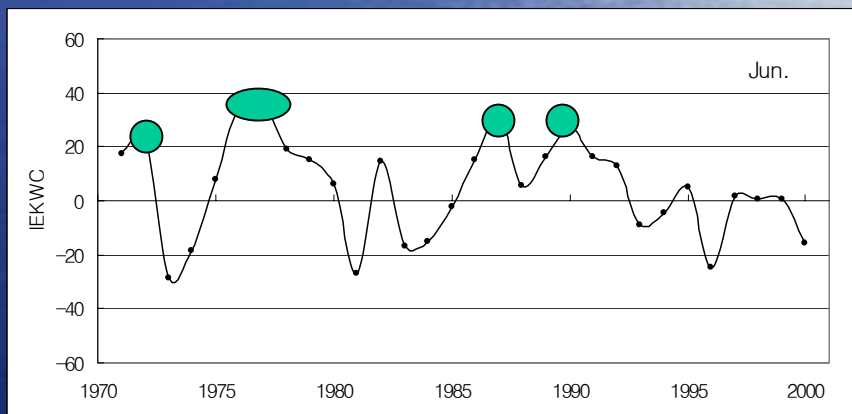
## February

- abnormal strong EKWC : 1978~1980, 1987~1989(>25)
- abnormal weak EKWC : 1974, 1984, 1994, 1996(<-12)



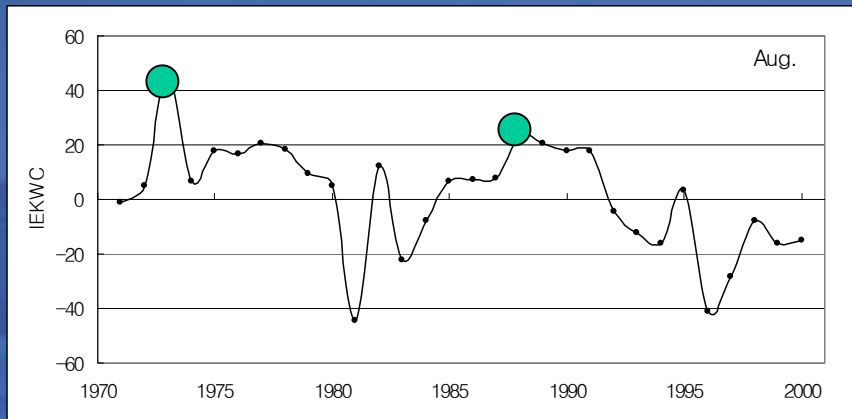
## April

- abnormal strong EKWC : 1971, 1977~1980, 1988~1990(>22)
- abnormal weak EKWC : 1982~1984, 1996(<-7)



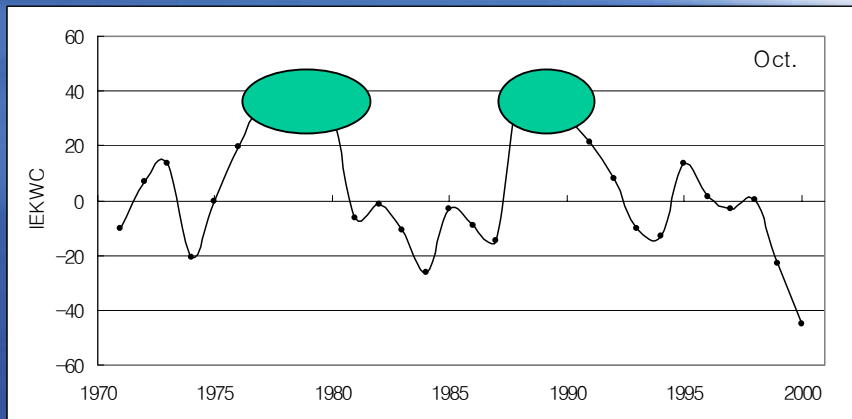
## June

- abnormal strong EKWC : 1972, 1976, 1977, 1987, 1990(>23)
- abnormal weak EKWC : 1973, 1974, 1981, 1983, 1984, 1996(<-13)
- Relative irregularity compared with Feb, Apr and predominant short-time scale fluctuation



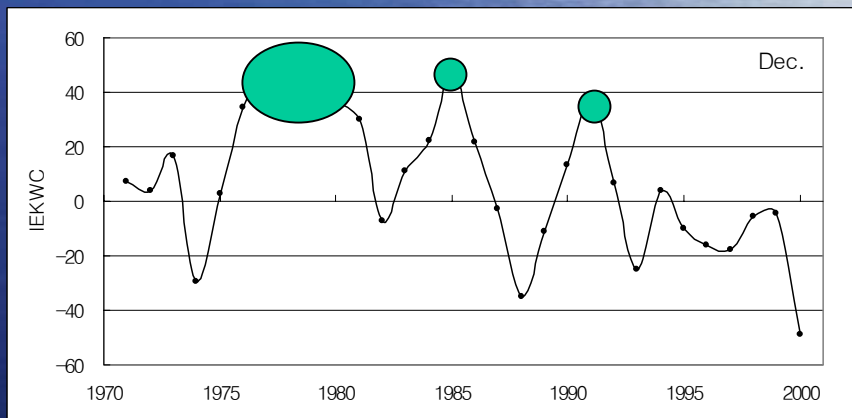
## August

- abnormal strong EKWC : 1973, 1988 (>21)
- abnormal weak EKWC : 1981, 1983, 1996, 1997(<-18)
- Relatively long time scale fluctuation (about 15yr)



## October

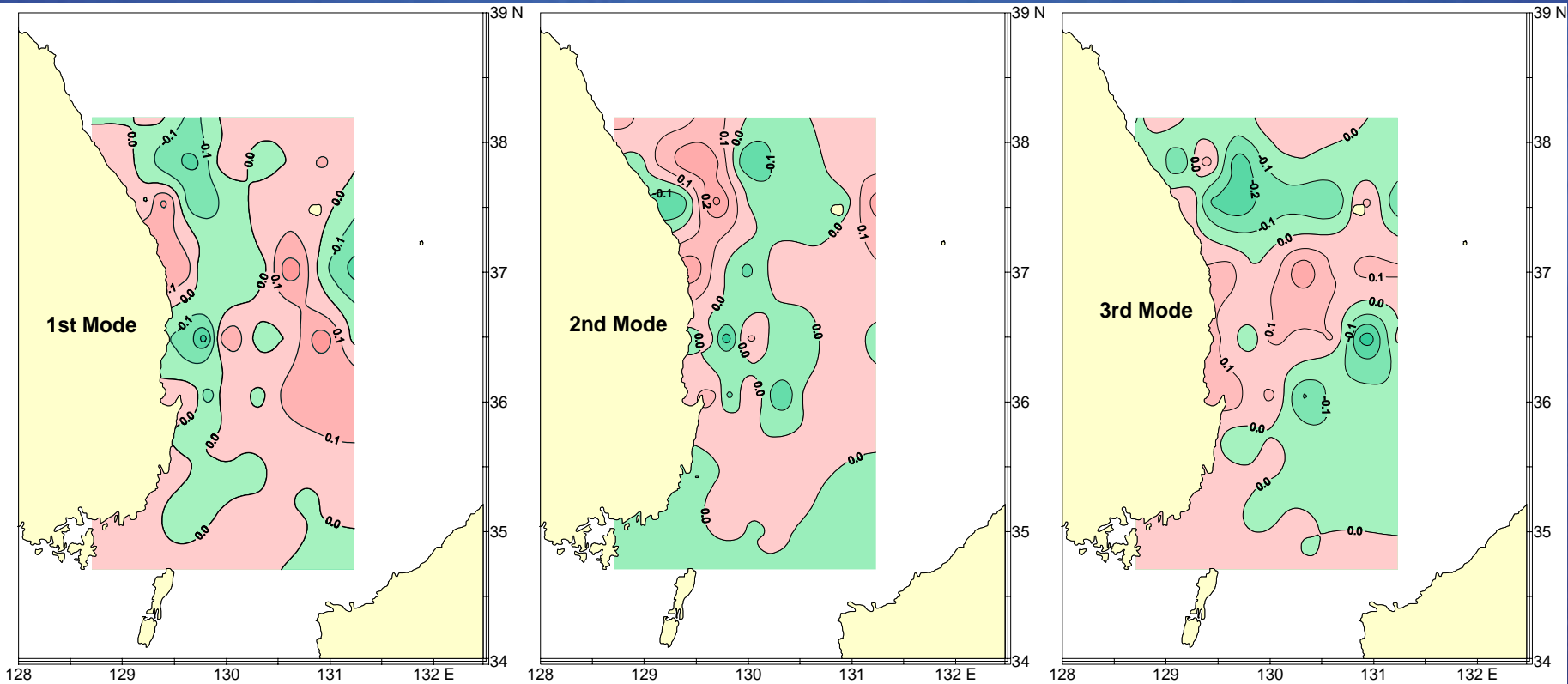
- abnormal strong EKWC : 1977~1980, 1988~1990(>26)
- abnormal weak EKWC : 1974, 1984, 1999, 2000(<-17)
- Similar variation on Feb, Apr and Jun.



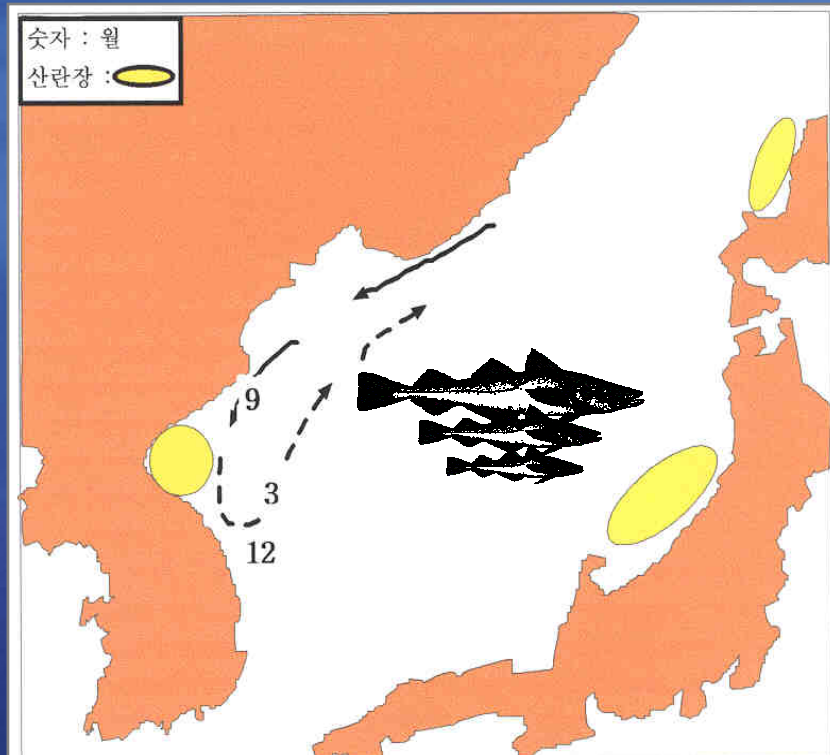
## December

- abnormal strong EKWC : 1976~1980, 1985, 1991(>34)
- abnormal weak EKWC : 1974, 1988, 2000(<-19)

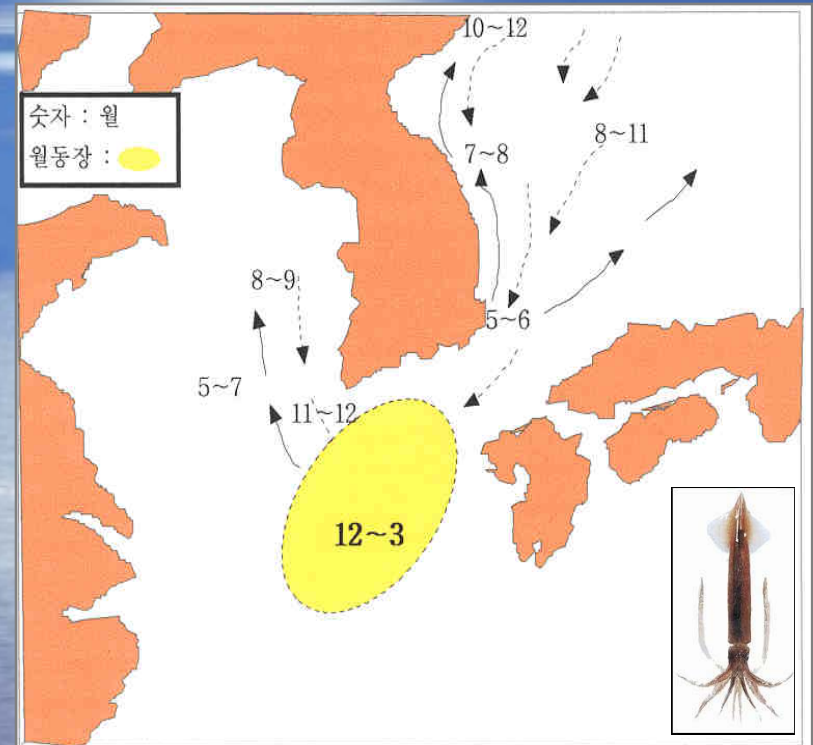
# Spatial distribution of the eigenvectors at each mode



# Representative fisheries species, Walleye Pollock and Squid, in the East / Japan Sea

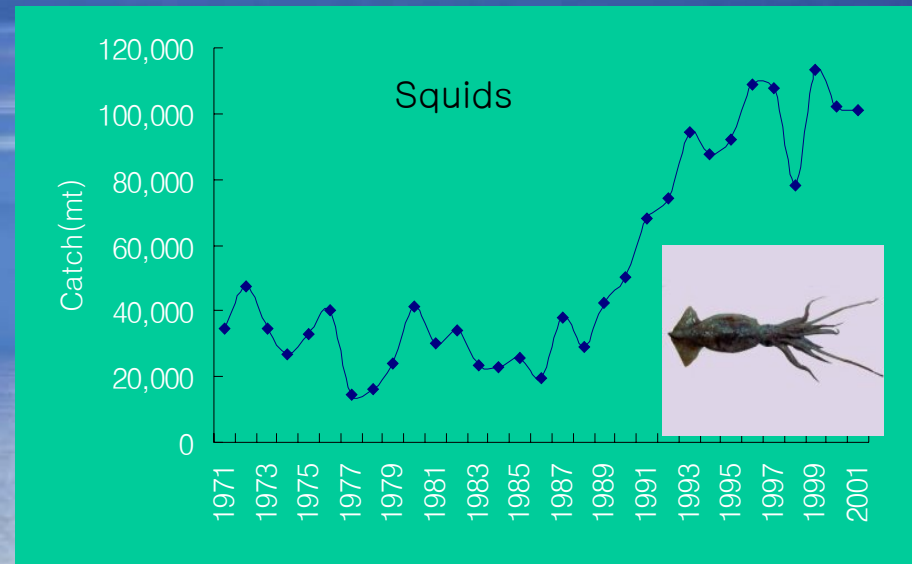
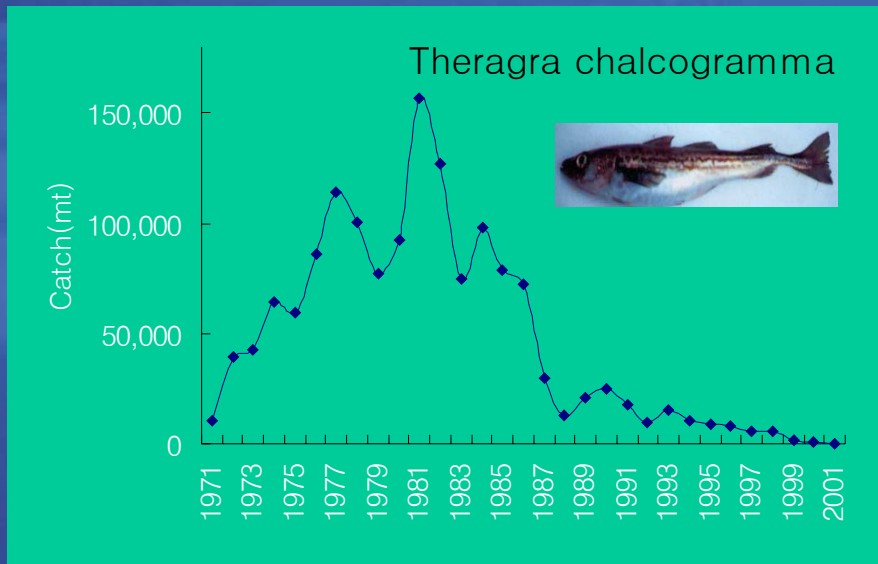


Walleye Pollock



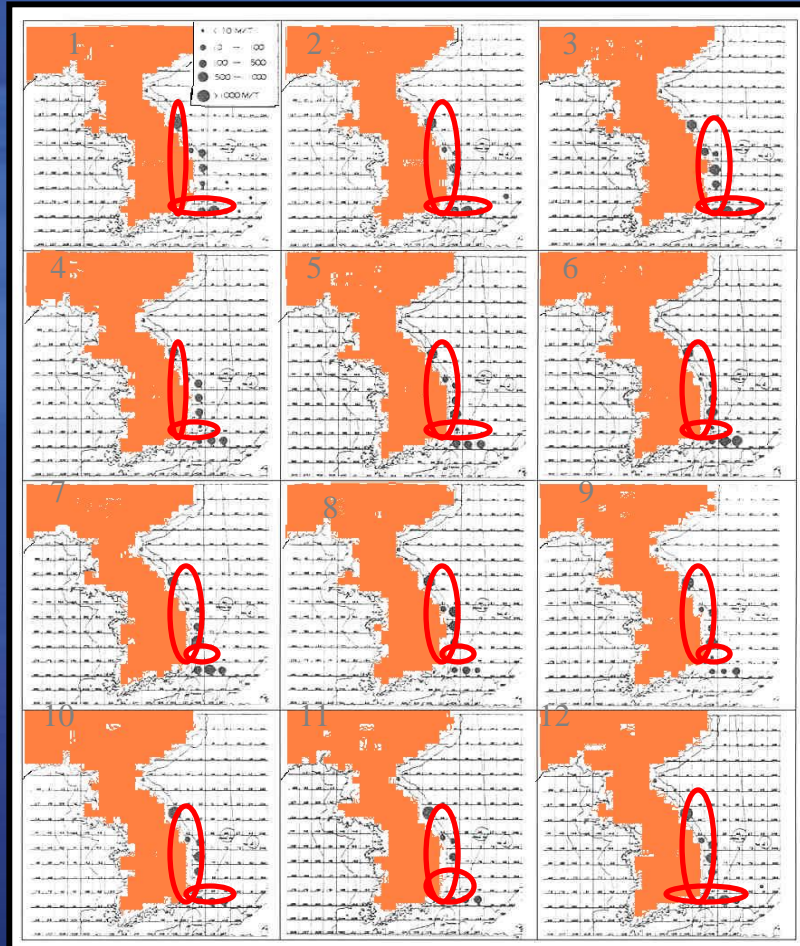
Squid

# Annual Catch of Major Species by Korean Fisheries in the East /Japan Sea

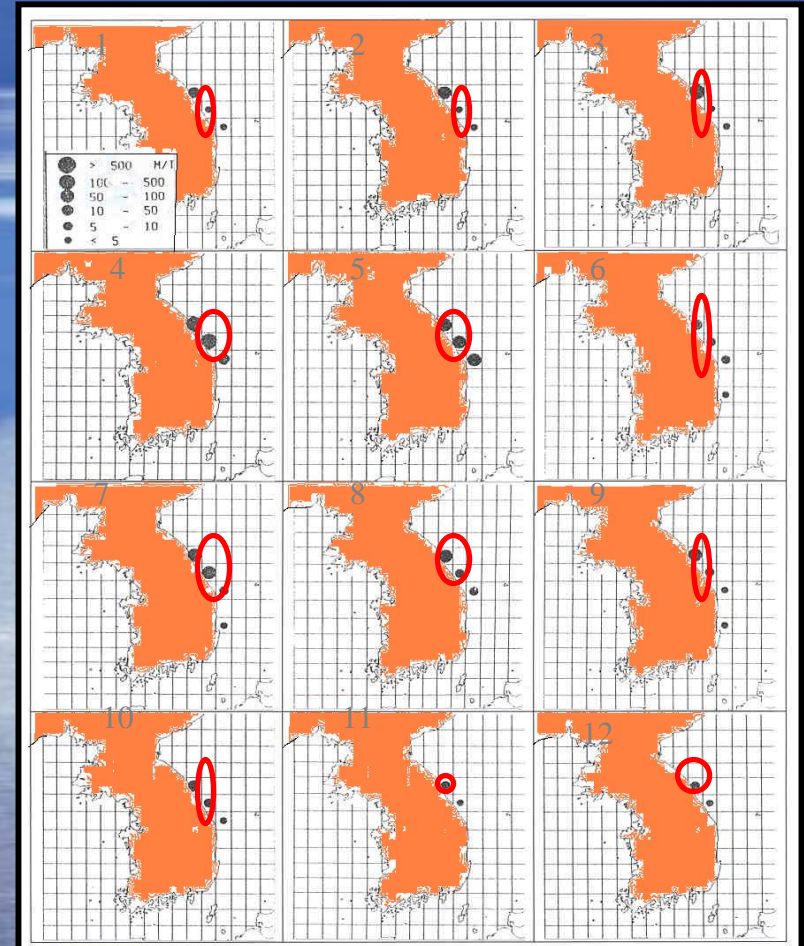


- In the Walleye Pollock case, the catch amount was continuously increased until the early 1980s and abruptly decreased from the mid 1980s.
- In the Squid case, we cannot find the significant catch variation until the mid 1980s and rapidly increased from the late 1980s.
- The sharply decrease of Walleye Pollock and increase of Squid closely correspond to the 1989 regime shift.
- The 1976/77 regime shift did not influence the fisheries resource variation.

# Changes of Walleye Pollock Fishing Grounds

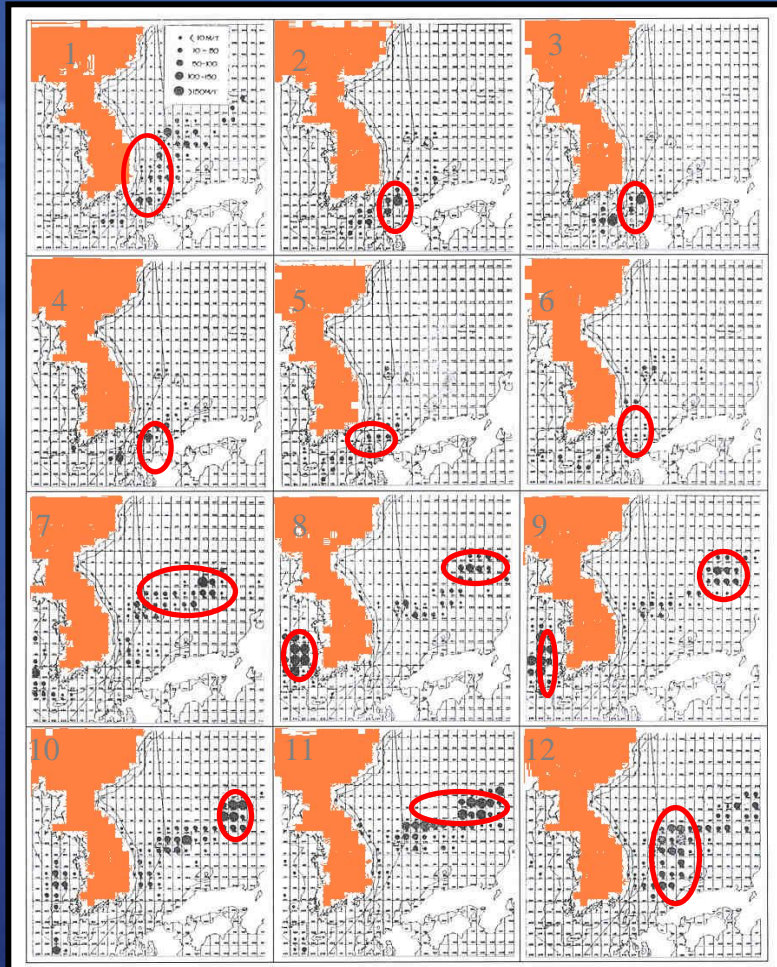


1981~1983

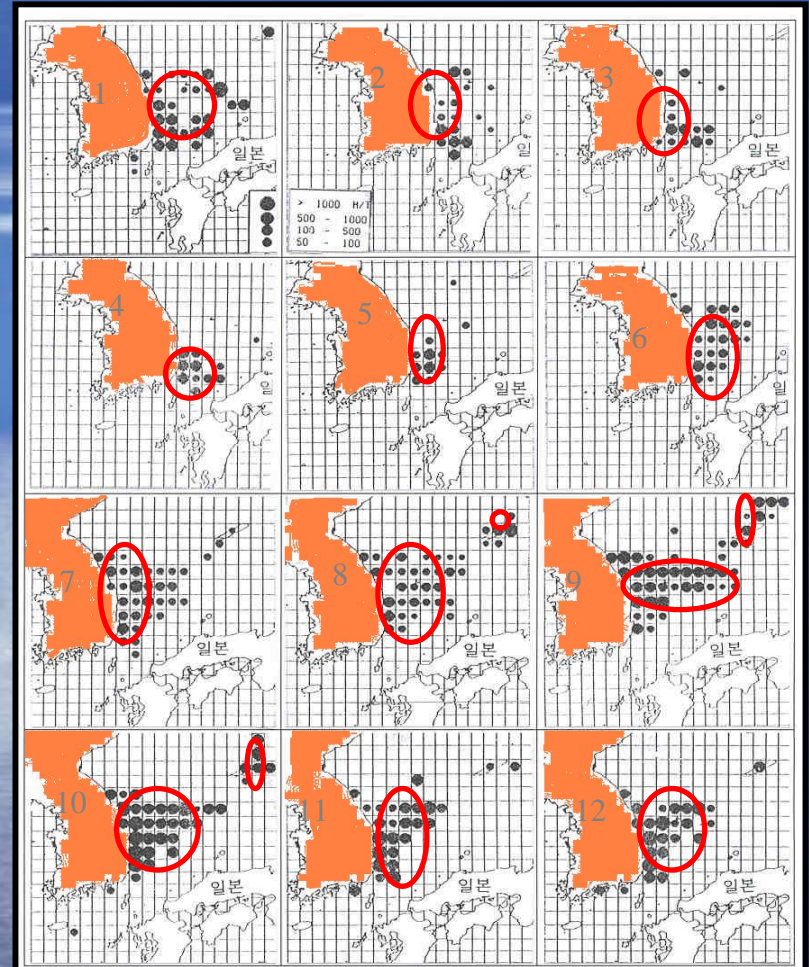


1994~1996

# Changes of Squid Fishing Grounds

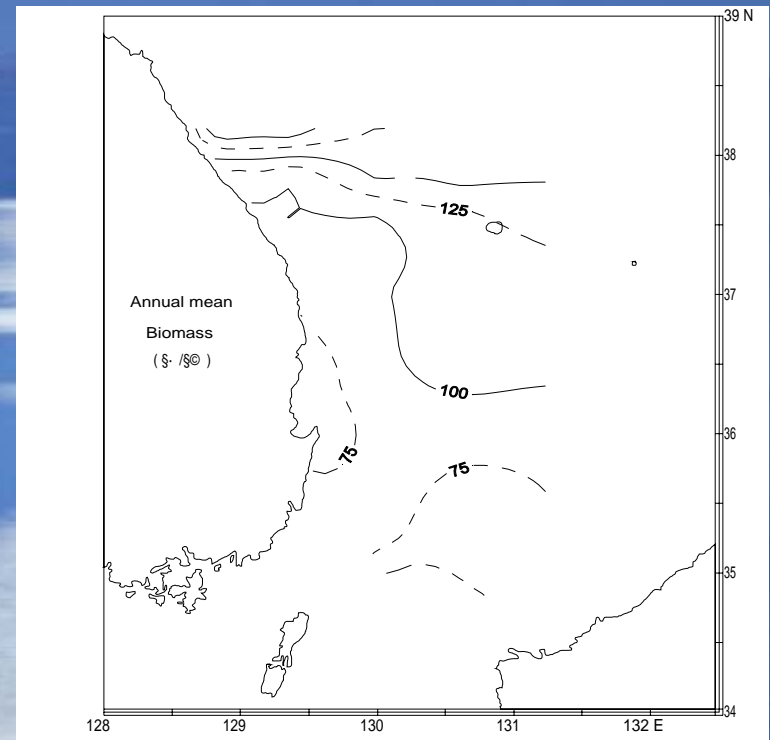
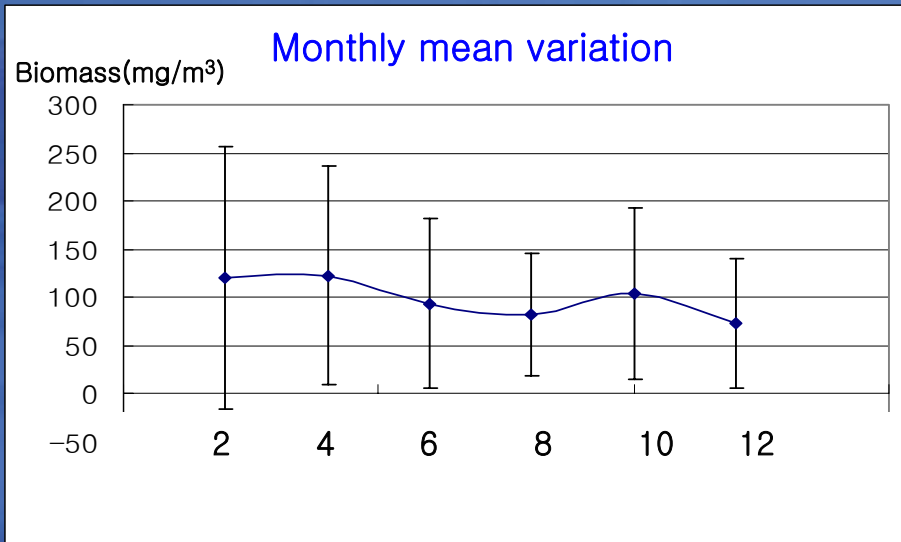


1981~1983

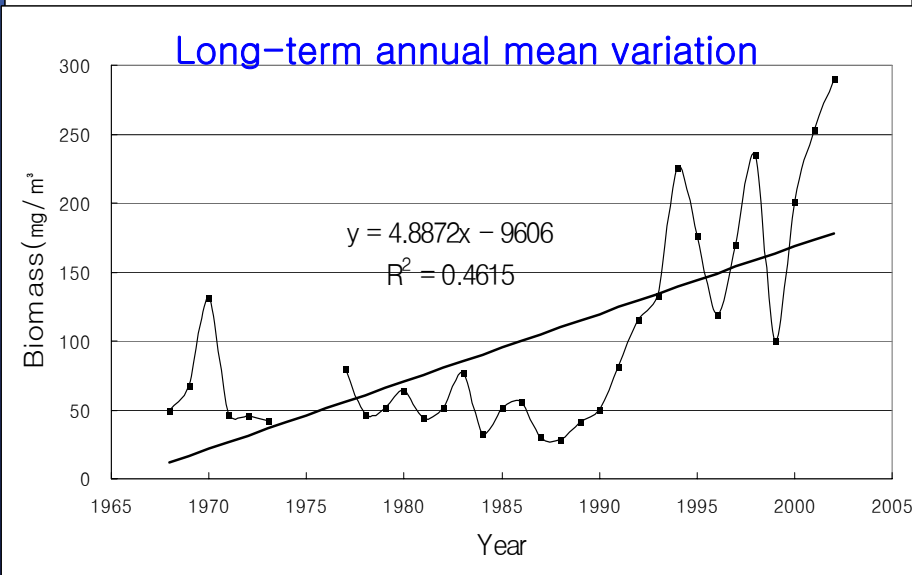


1994~1996

# Temporal and spatial Zoo plankton biomass variation



- The sharp increase appeared from the 1990s → the increase of biological production closely related to the late 1980s regime shift concerning with the strong EKWC.



# Conclusion and Discussion

1. Long-term variation of surface temperature in the southwestern region of the East/Japan Sea gradually increase  $0.02^{\circ}\text{C}/\text{yr}$ . On the other hand, surface salinity gradually decrease  $0.0025\text{psu}/\text{yr}$ .
2. Abnormal high IEKWC appeared in the late 1970s and late 1980s. → The EKWC influenced stronger in the southwestern region of East/Japan Sea → The 1976/77 and 1989 regime shifts are closely related to the strong EKWC.
3. Zooplankton biomass and catch amount of squid increased remarkably after the late 1980s. On the other hand, catch amount of Walleye Pollack sharply decreased after the mid 1980s. → the 1989 regime shift influences strongly in the ecosystem in the southwestern region of the East/Japan Sea. The 1976/77 regime shift did not influence the biological production, though it was associated with the strong EKWC.