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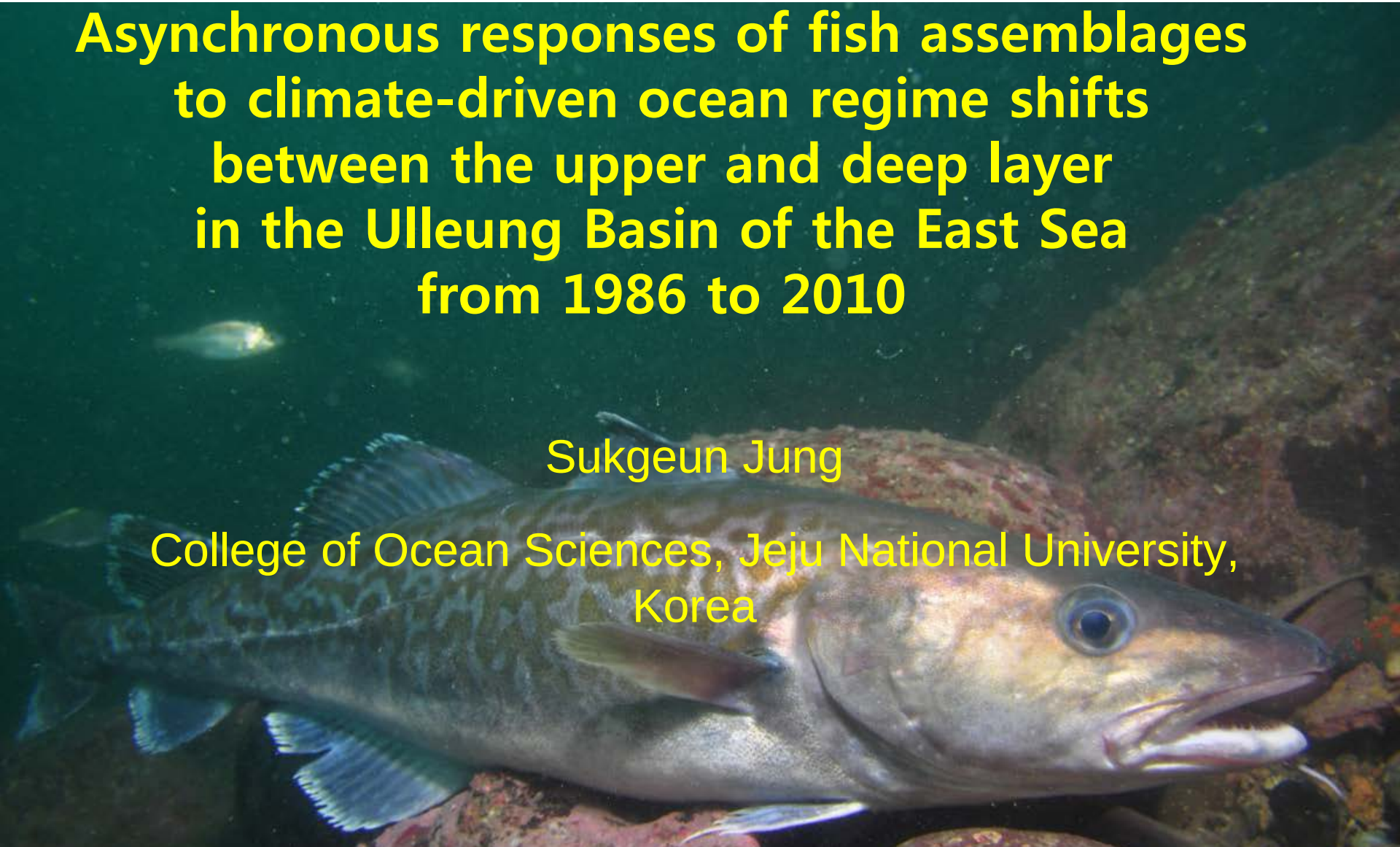
PICES S5 2014.10.23 09:25

Asynchronous responses of fish assemblages to climate-driven ocean regime shifts between the upper and deep layer in the Ulleung Basin of the East Sea from 1986 to 2010



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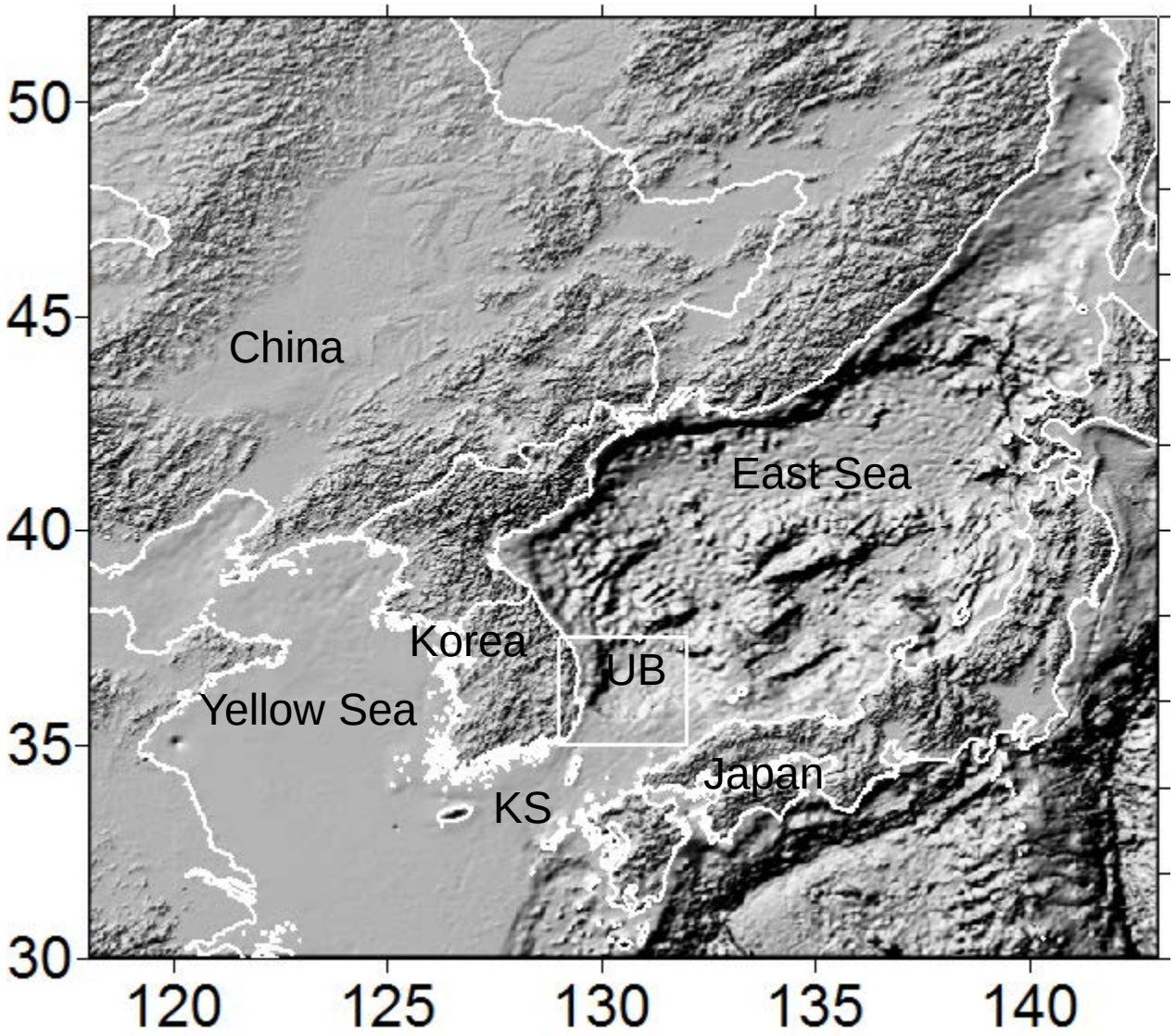
Study area


50
45
40
35
30
120
125
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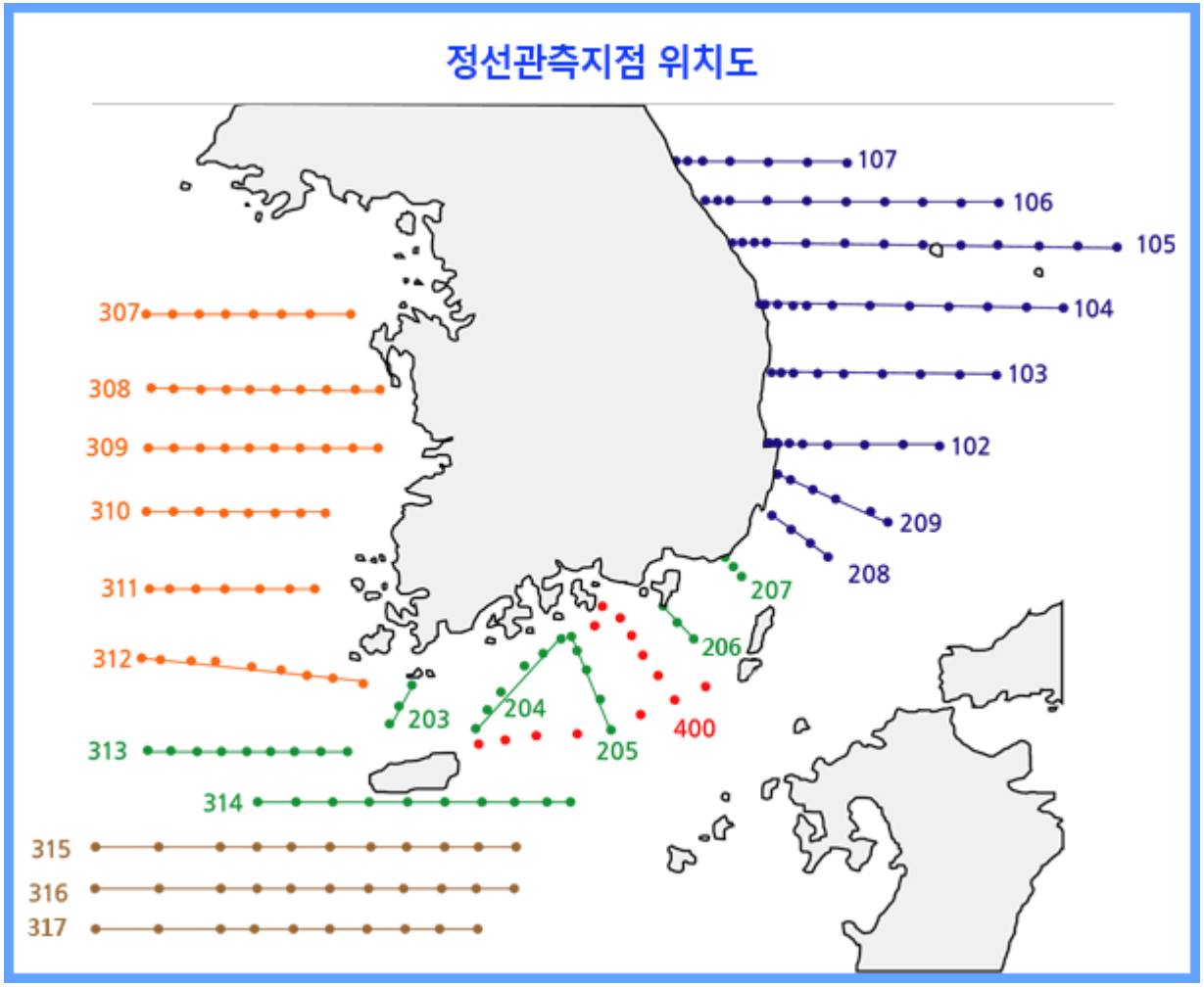
140
China
East Sea
Korea
UB
Yellow Sea
Japan
KS

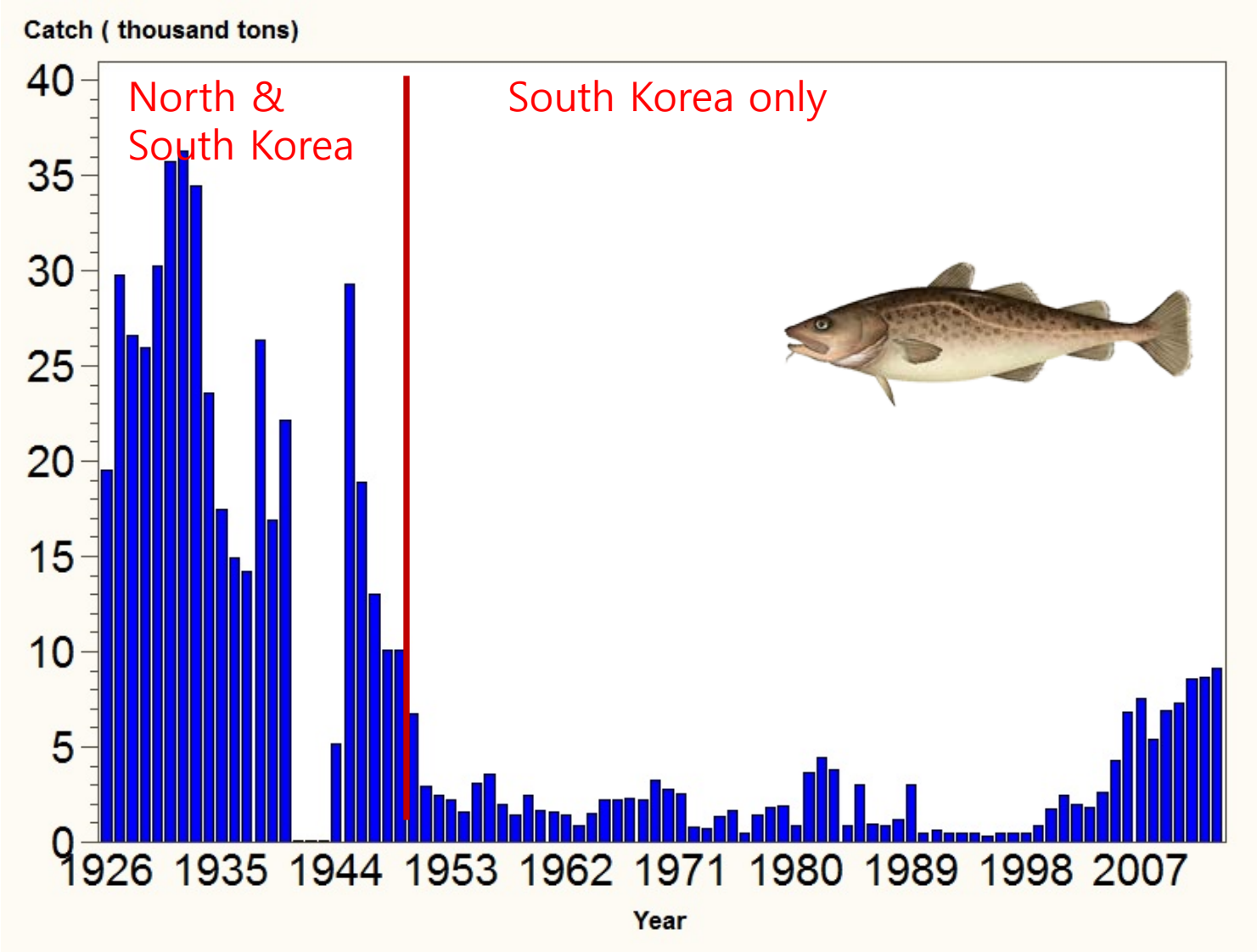
KODC Stations



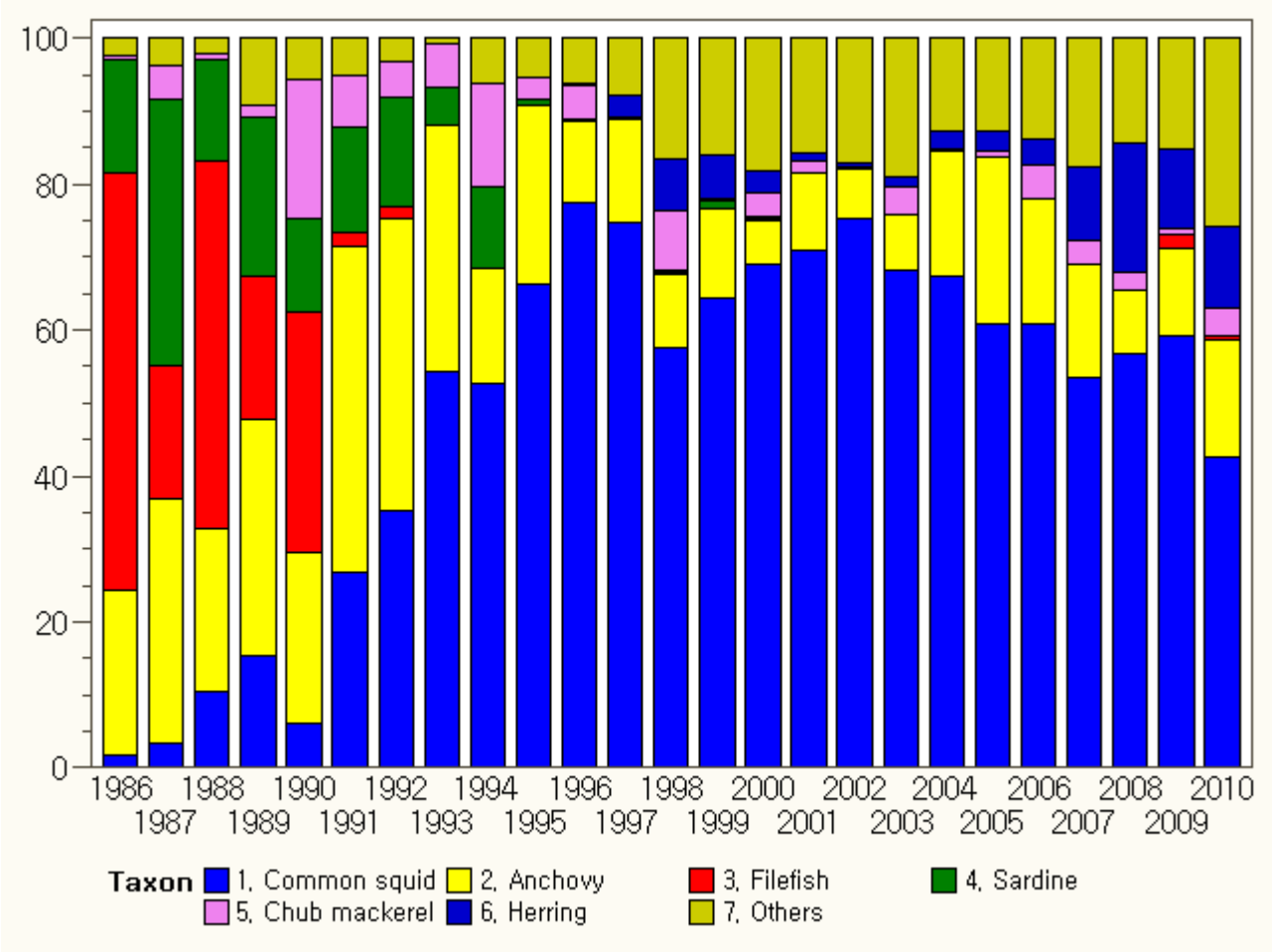
Background

- Past studies suggested that the basin-wide regime shift occurred in 1988-1989, impacting marine ecosystem and fish assemblages in the western North Pacific.
- However, the detailed mechanisms are still yet unclear.
- Most of past studies have focused on oceanographic conditions in the surface layer.

Annual catch of Pacific cod (*Gadus macrocephalus*) in Korean waters from 1926 to 2013



Composition in wet weight of fisheries catch



Fisheries in the Ulleung basin

- Dramatic shift observed in the early 1990s
  - Filefish and sardine dominated the commercial fish catches in 1986-1992
  - Common squid comprised >60% of the total catch in 1993-2010.
  - Increased catch of anchovy, chub mackerel, herring and cod

Objective

- To illuminate the mechanisms for this dramatic shift in dominant fisheries species in the Ulleung basin
- Focus on oceanographic conditions in the deep water < 100 m rather than the shallow, mixed layer

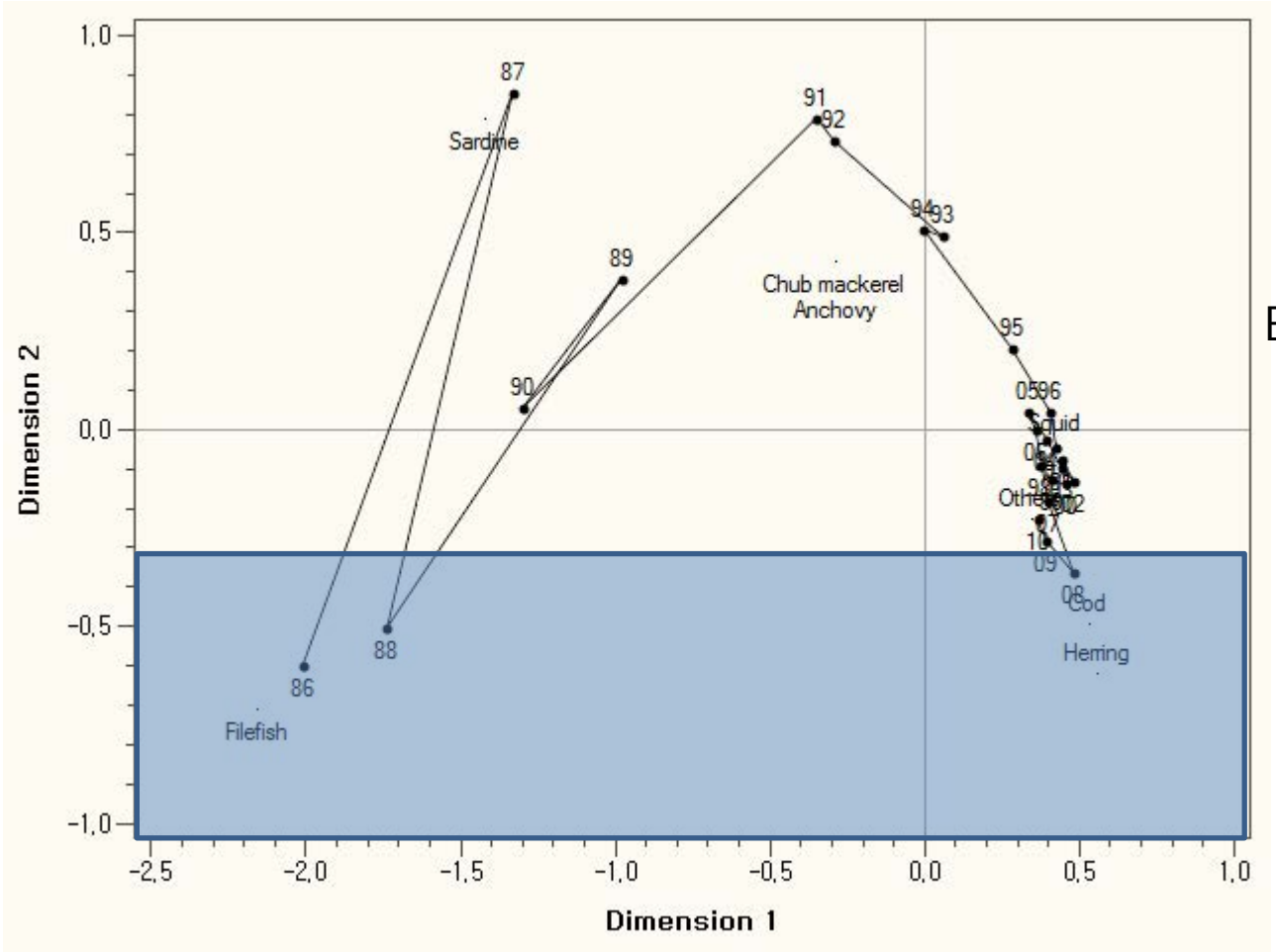
Data and Methods

- Depth-specific oceanographic conditions from 0 to 500 m (1968-2010)
  - temperature, salinity, dissolved oxygen and water density
- Volume transport (1968-2010)
  - Tsushima warm current
  - Korea Strait bottom cold water
- Fish
  - NFRDI fisheries data (1986-2013)

Corresponding Analysis

Surface water temperature (Warming)

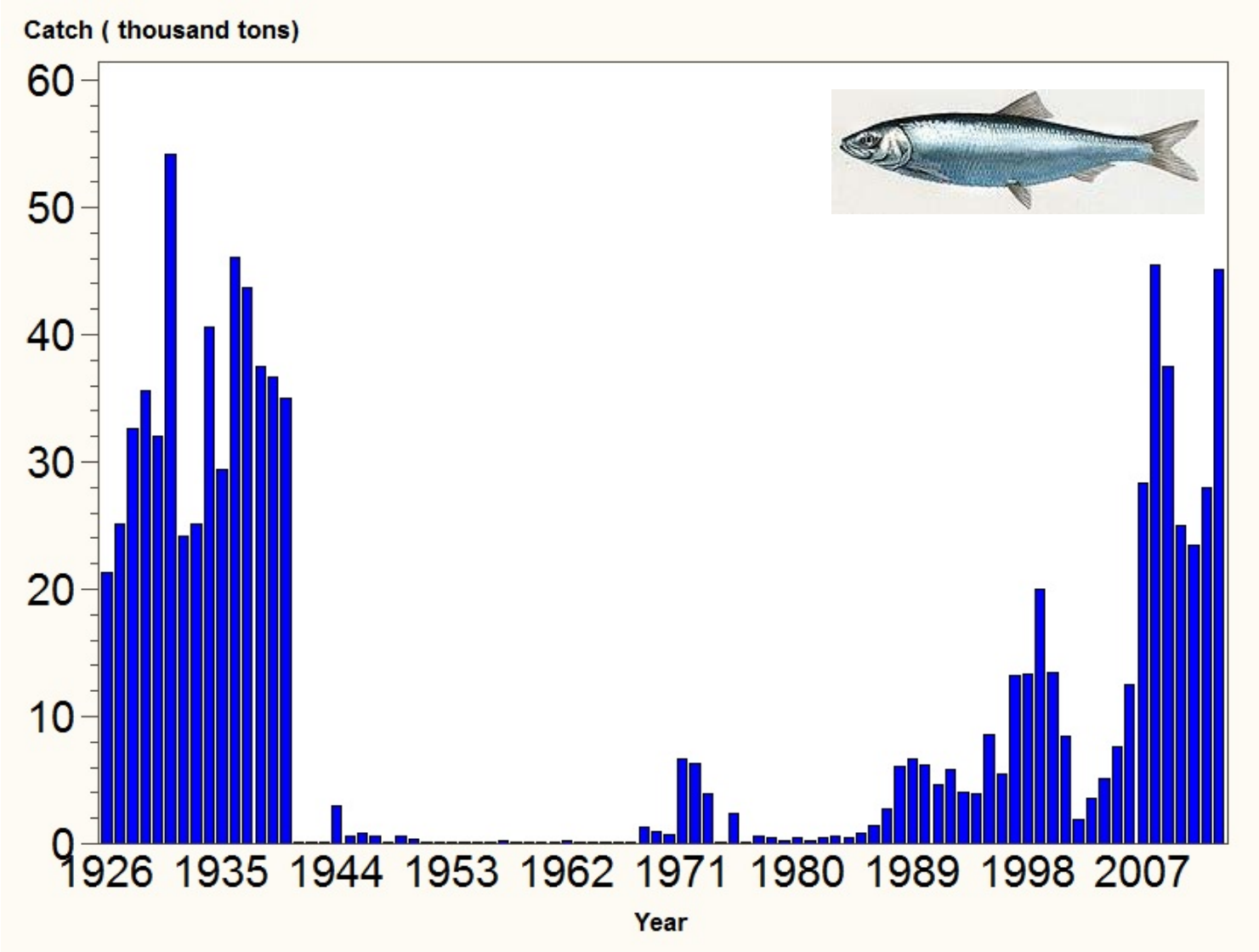
Depth



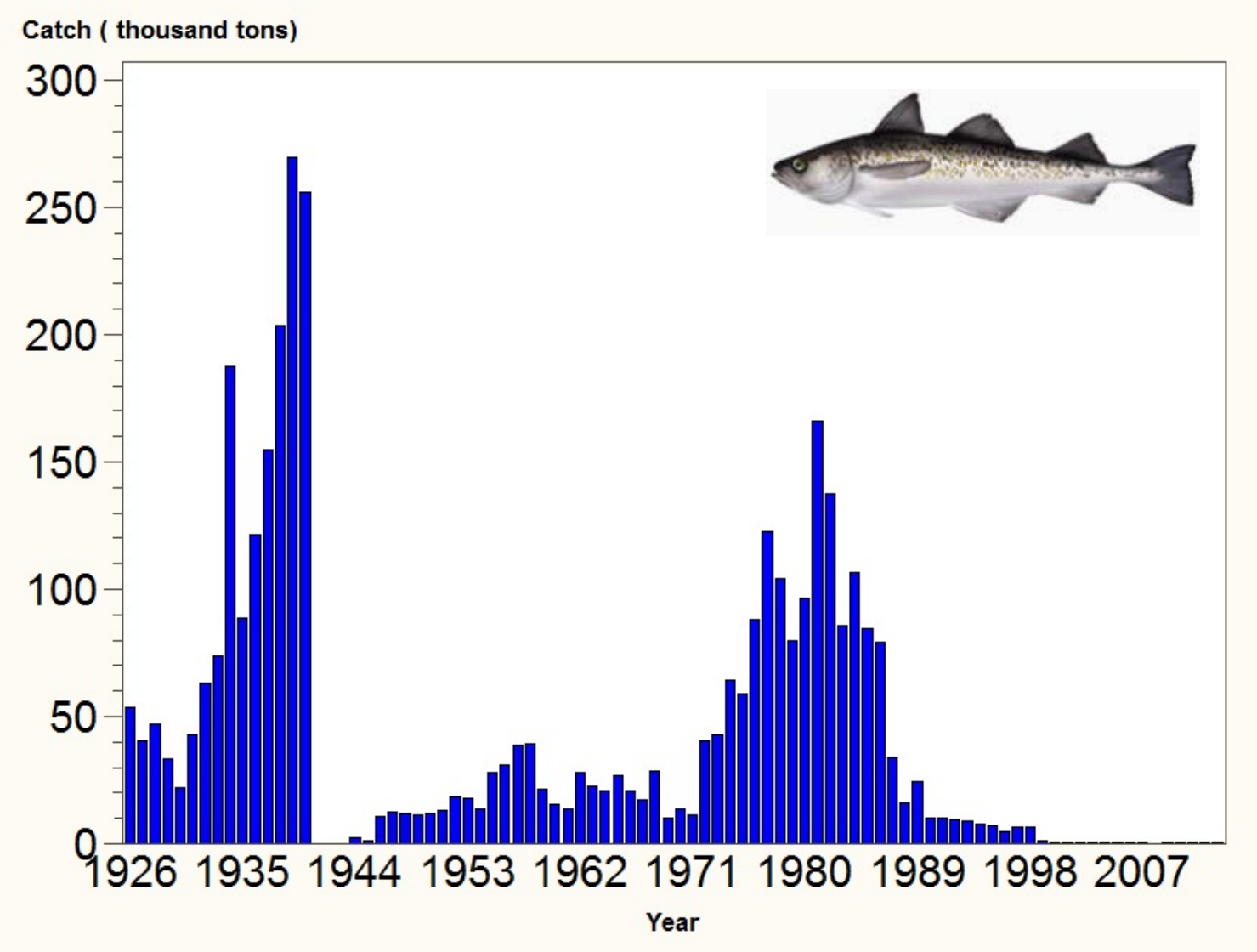
Epi-pelagic

Deep water

Annual catch of Pacific herring (*Clupea pallasii*) in Korean waters from 1926 to 2013



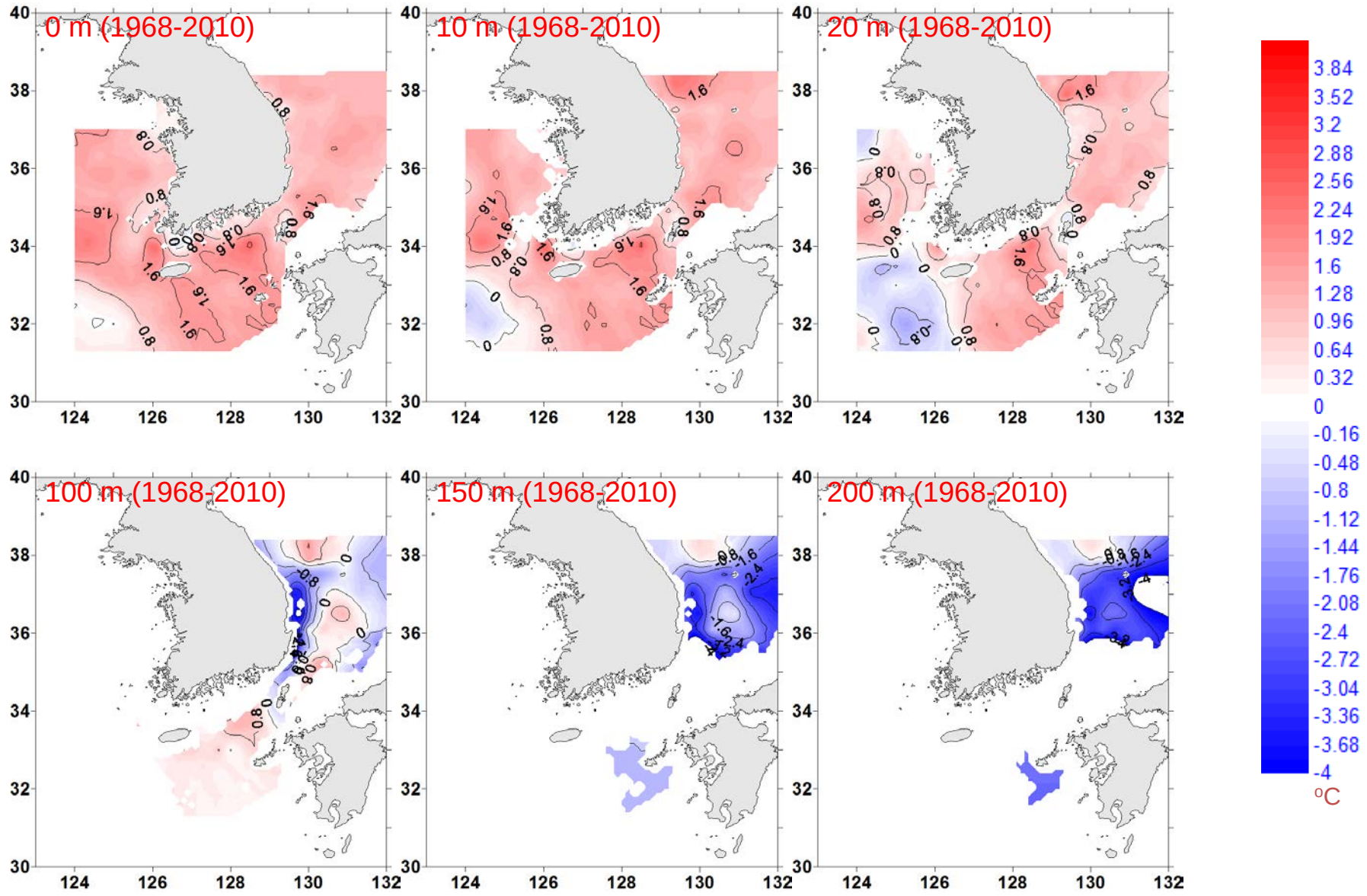
Annual catch of Alaska pollock (*Theragra chalcogramma*) in Korean waters from 1926 to 2013



Correlation coefficient between water temperature and Dim 1

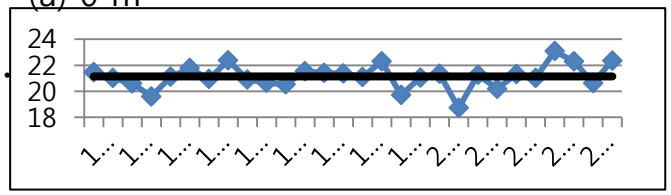
Depth (m)	Feb.	Apr.	Jun.	Aug.	Oct.	Dec.
0	-0.04	-0.13	-0.25	0.08	-0.05	-0.20
10	-0.24	-0.26	-0.39	-0.13	-0.08	-0.21
20	-0.26	-0.36	-0.13	-0.16	-0.05	-0.21
30	-0.28	-0.46	-0.01	-0.05	0.09	-0.26
50	-0.27	-0.41	0.10	0.18	0.28	-0.29
75	-0.17	-0.20	0.16	0.27	0.34	-0.11
100	-0.08	-0.04	0.33	0.35	0.44	0.21
150	0.23	0.19	0.42	**0.51**	**0.52**	**0.67**
200	0.44	0.43	0.50	**0.65**	**0.63**	**0.70**
300	0.25	0.02	0.10	0.29	0.14	**0.54**
400	0.17	0.15	0.08	0.07	0.10	0.51
500	-0.03	-0.23	-0.11	-0.13	-0.08	-0.44

Long-term change in Water Temperature (1968-2010)

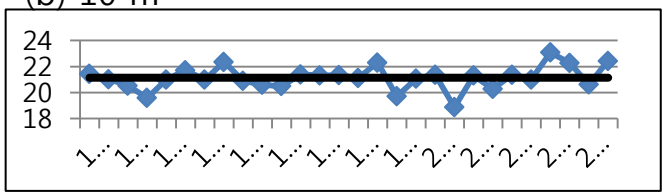


Oct. Temp.

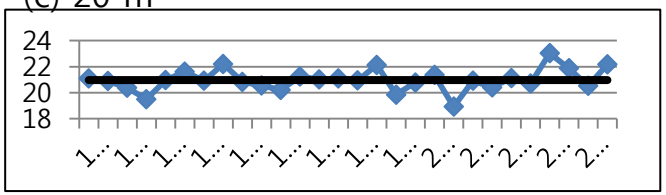
(a) 0 m



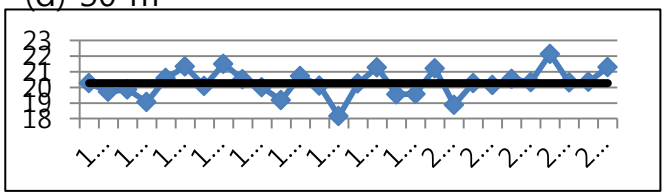
(b) 10 m



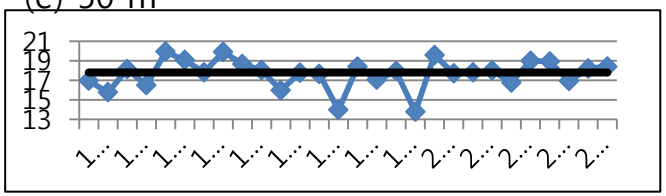
(c) 20 m



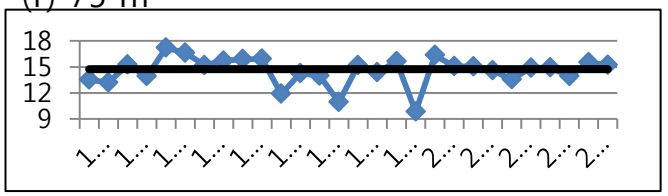
(d) 30 m



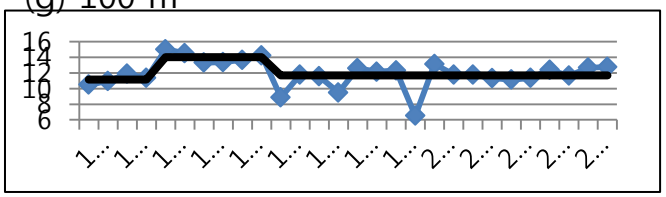
(e) 50 m



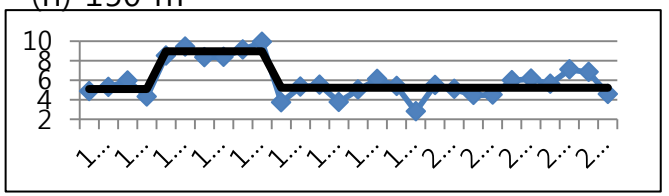
(f) 75 m



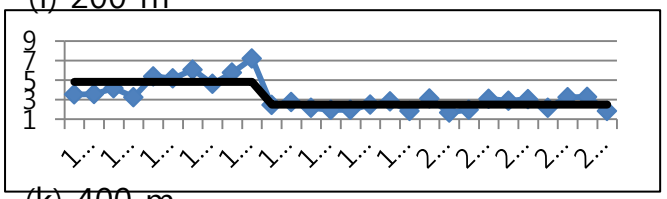
(g) 100 m



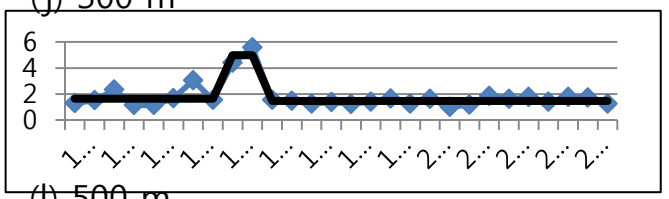
(h) 150 m



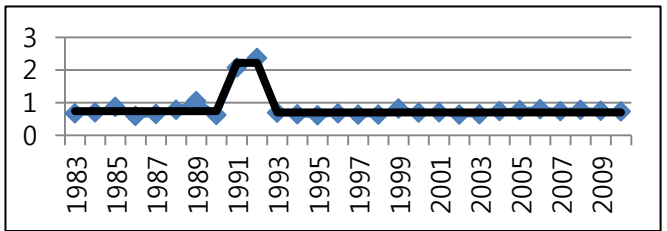
(i) 200 m



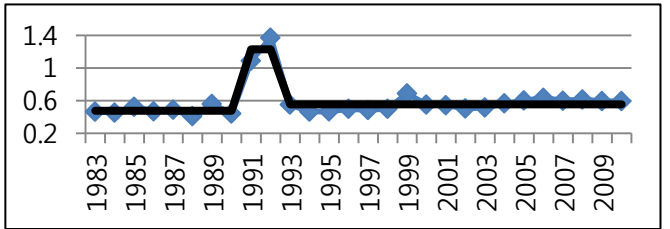
(j) 300 m



(k) 400 m



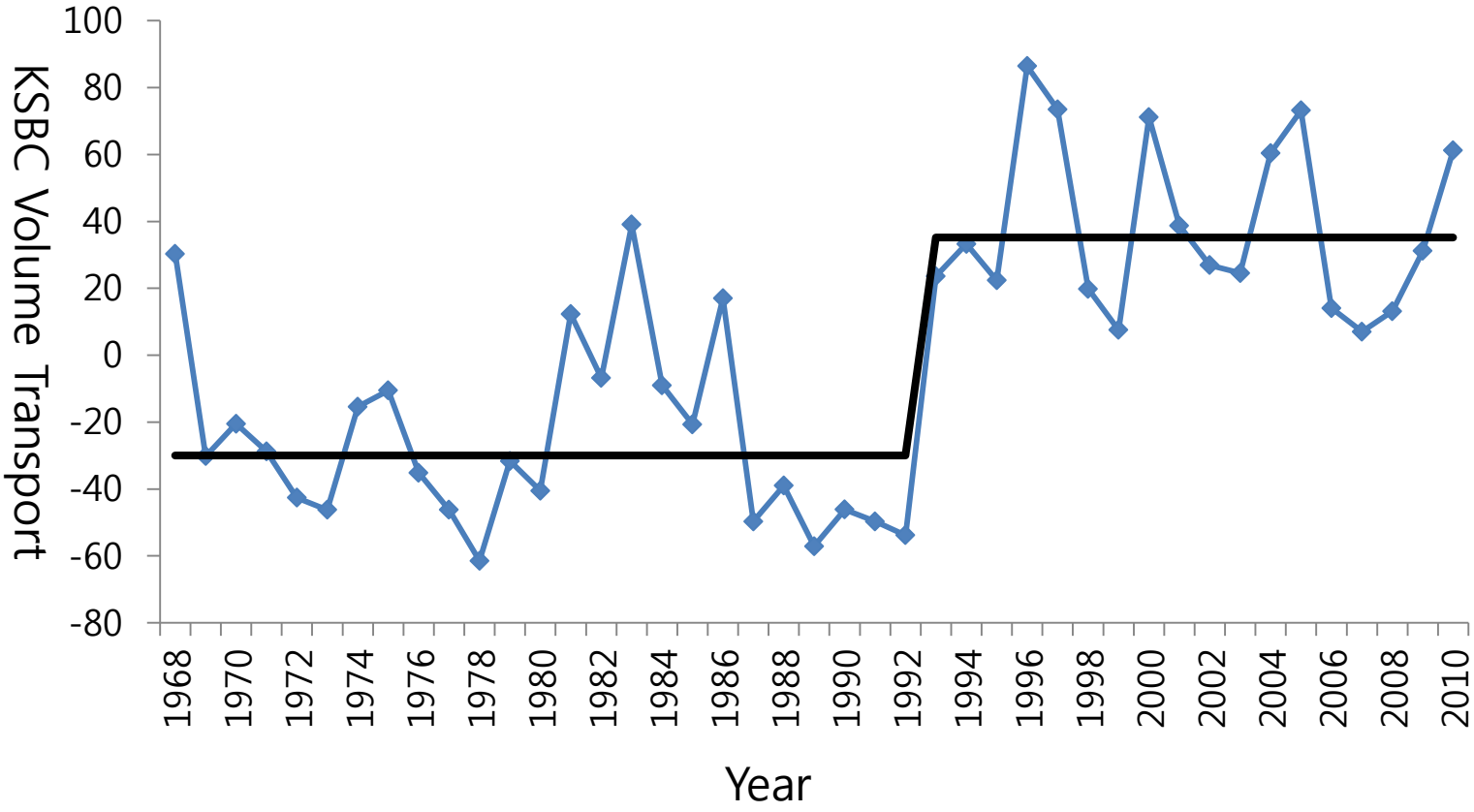
(l) 500 m



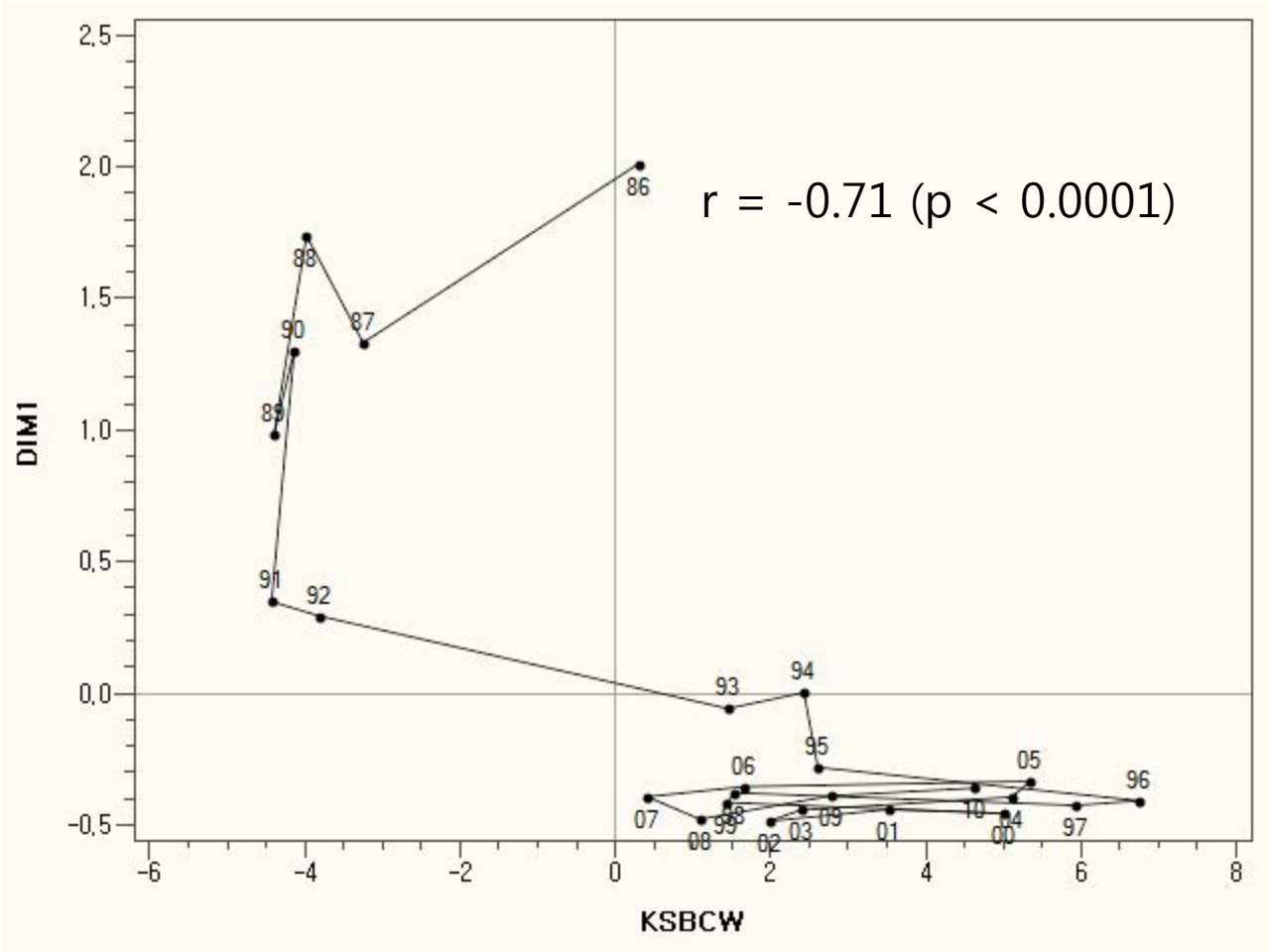
Shift detection

Factor / Depth (m)	Feb.	Apr.	Jun.	Aug.	Oct.	Dec.
Temperature						
0-30						
50		1988↑				
75		1988↑	1987↑			
100	1989↑1994↓	1987↑	1987↑	1987↑	1987↑1993↓	
150	1994↓	1987↑	1987↑1995↓	1987↑1992↓	1987↑1993↓	1993↓
200	1994↓	1987↑1994↓	1996↓	1987↑1992↓	1993↓	1993↓
300	1991↑1994↓	1991↑1994↓	1995↓	1990↑1992↓	1991↑1993↓	1990↑
400	1991↑1994↓	1991↑1994↓			1991↑1993↓	
500	1991↑1994↓	1991↑1994↓			1991↑1993↓	
Density						
0-75						
100	1989↓1994↑					
150			1995↑		1993↑	1993↑
200	1991↓1994↑		1995↑	1992↑	1993↑	1993↑
300	1991↓1994↑	1989↓	1991↓1995↑	1990↓	1991↓1993↑	1990↑
400		1988↓1993↑			1993↑	
500	1992↑	1990↑	1992↑	1991↑	1990↑	

KSBCW volume transport (Provided by Dr. Hanna Na)



Correlation between Dimension I and KSBCW volume transport



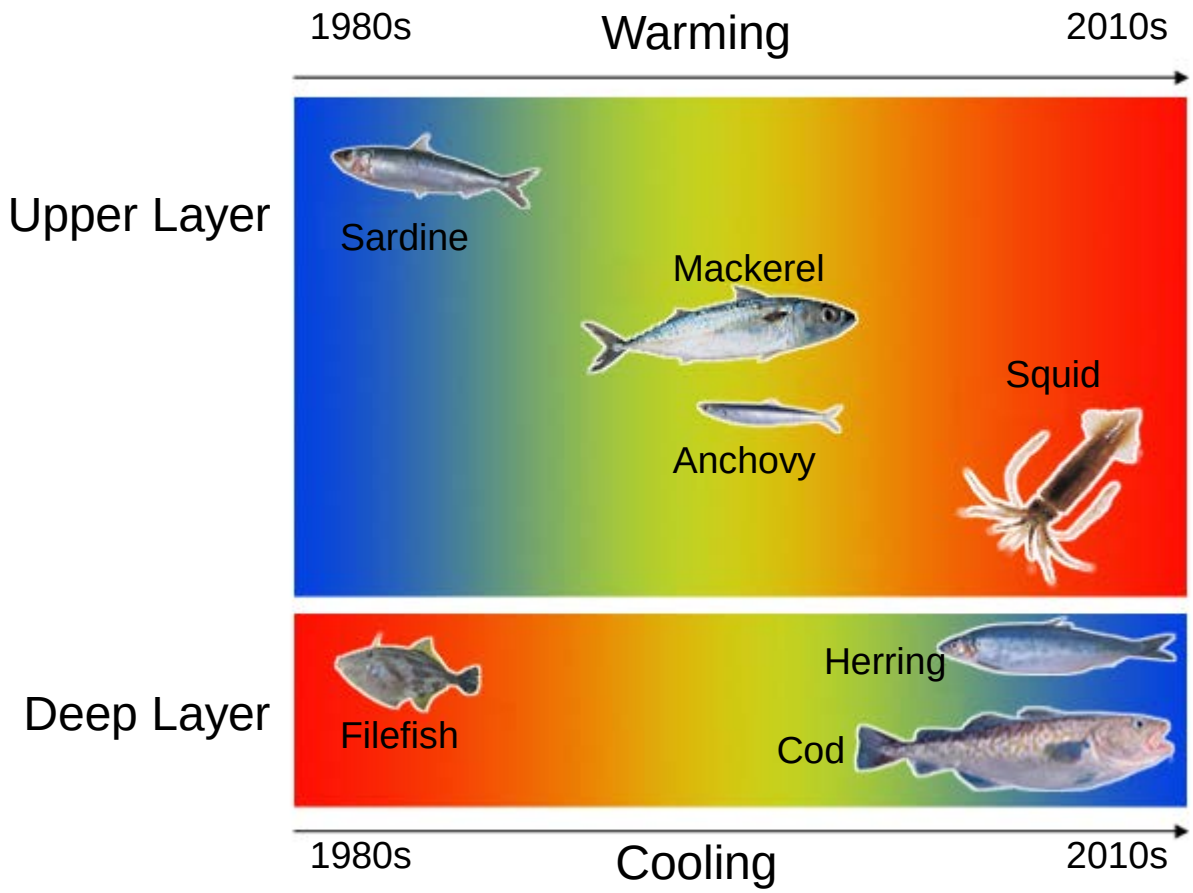
Conclusions 1

- Upper layer (50-100 m)
  - water temperature suddenly increased in 1987-1989
  - warm-water epi-pelagic species (anchovy, chub mackerel, and common squid) became dominant
  - Cold-water epi-pelagic species (sardine) nearly disappeared.

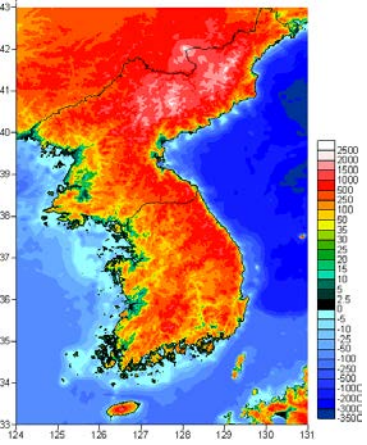
Conclusions 2

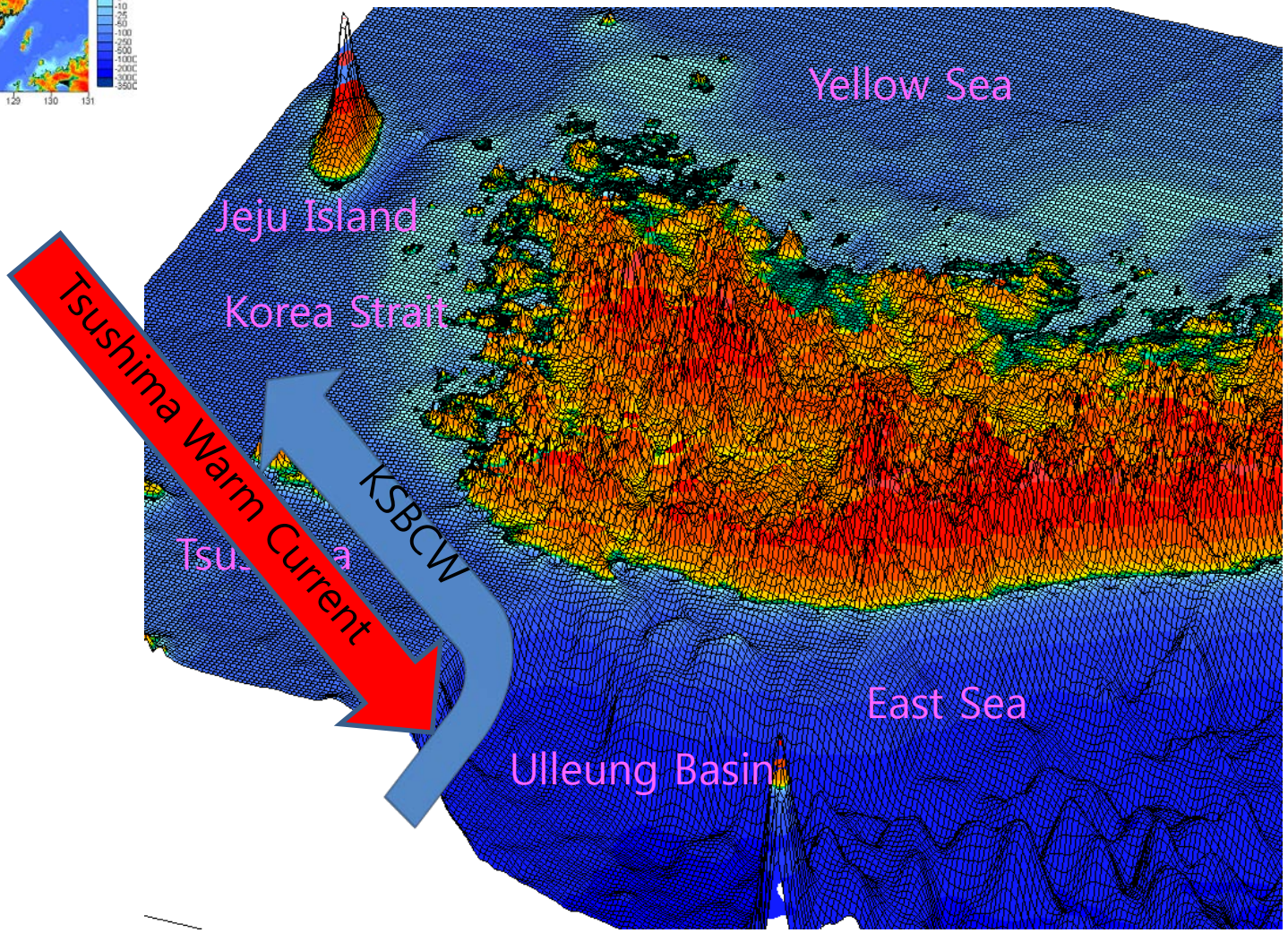
- Deep layer (100-500 m)
  - Korea Strait Bottom Cold Water displayed a sudden intensification in 1992-1993 and water temperatures decreased
  - Replacement of dominant bentho-pelagic species from filefish, warm-water species, to herring and cod, cold-water species.

Scheme of change in fish assemblage structure

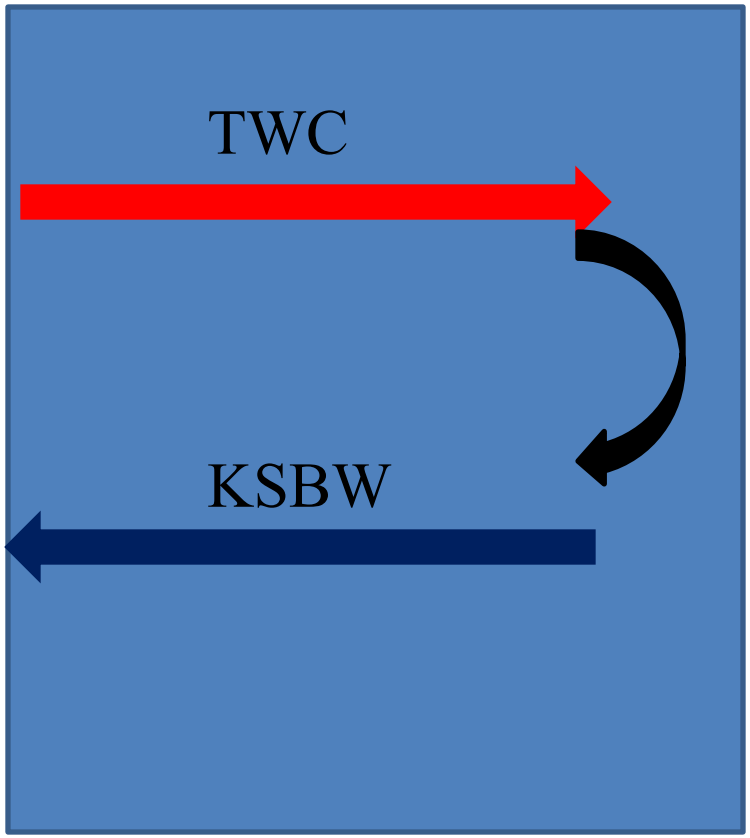


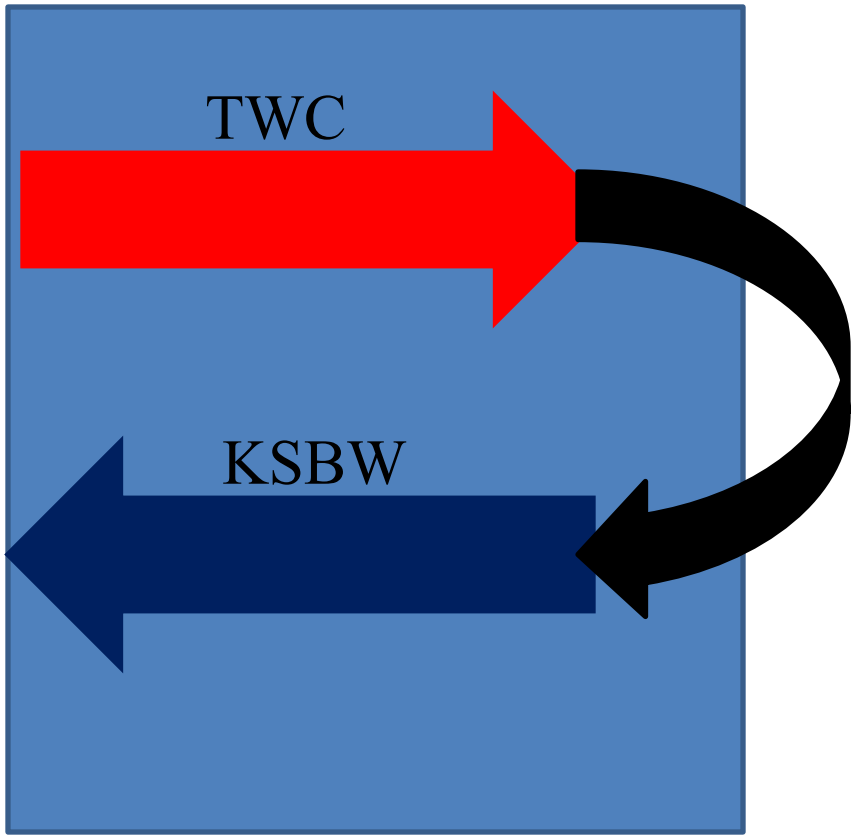
Physical Oceanography





Tsushima Warm Current (TWC) vs. Korea Strait Bottom Cold Water (KSBW)





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Asynchronous Responses of Fish Assemblages to Climate-driven Ocean Regime Shifts between the Upper and Deep Layer in the Ulleung Basin of the East Sea from 1986 to 2010

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Received 28 December 2013; Revised 20 January 2014; Accepted 26 February 2014

Abstract – Past studies suggested that a basin-wide regime shift occurred in 1988-1989, impacting marine ecosystem and fish assemblages in the western North Pacific. However, the detailed

south of Ulleung-do and Dok-do, in the eastern end of the South Korean Exclusive Economic Zone (EEZ), surrounded by two distinct basins (Japan and Yamato), and by shallow

Future works

- The time lag between the shifts in the upper and deep layer was 5-6 years.

- Possible time-lagged interactions between the upper and deep water oceanic shift observed in the UB, and also between the TWC and KSBCW

Acknowledgements

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