JEJU NATIONAL UNIVERSITY

PICES FUTURE OSM S5 2014.04.16 18:05-18:25

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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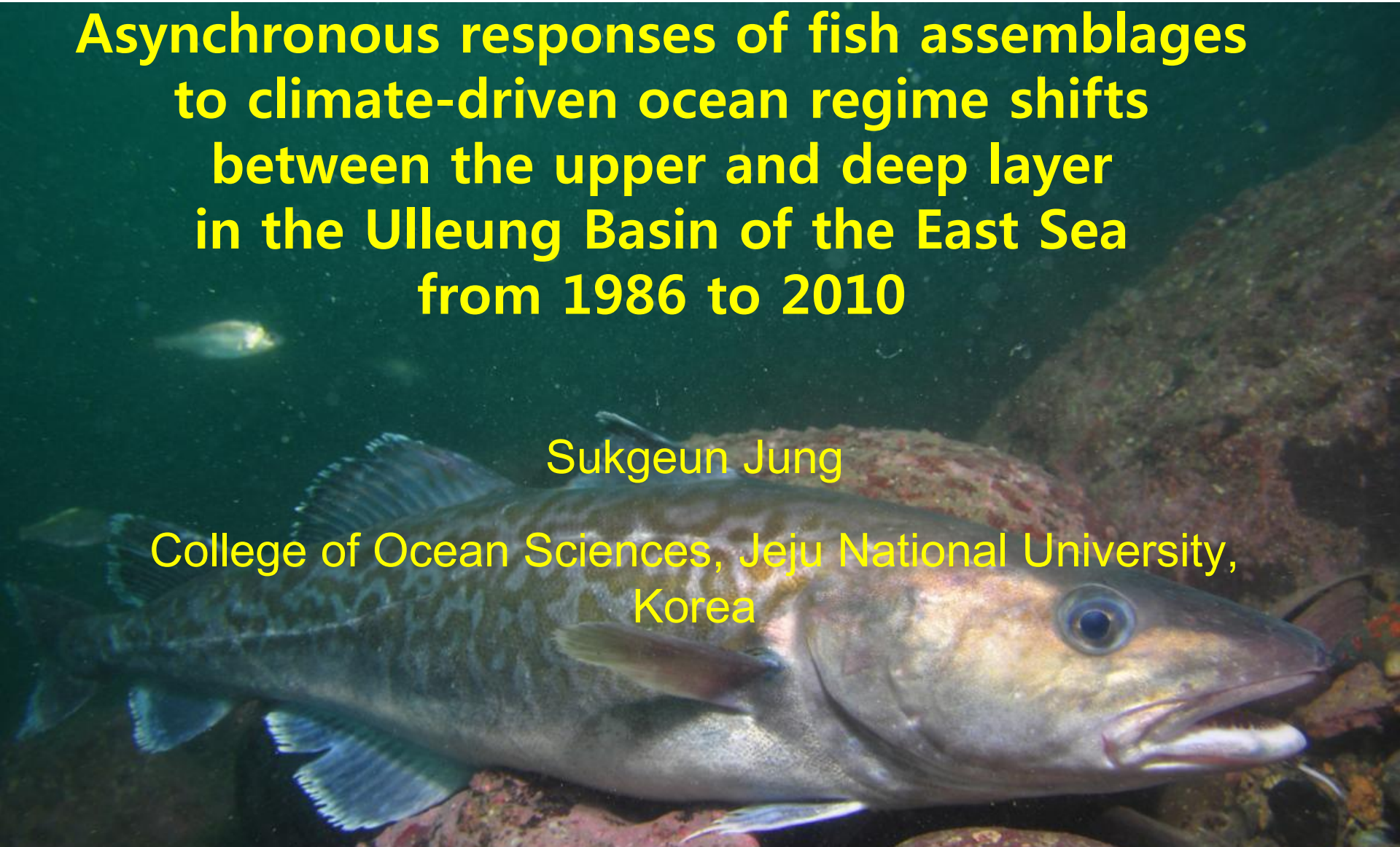
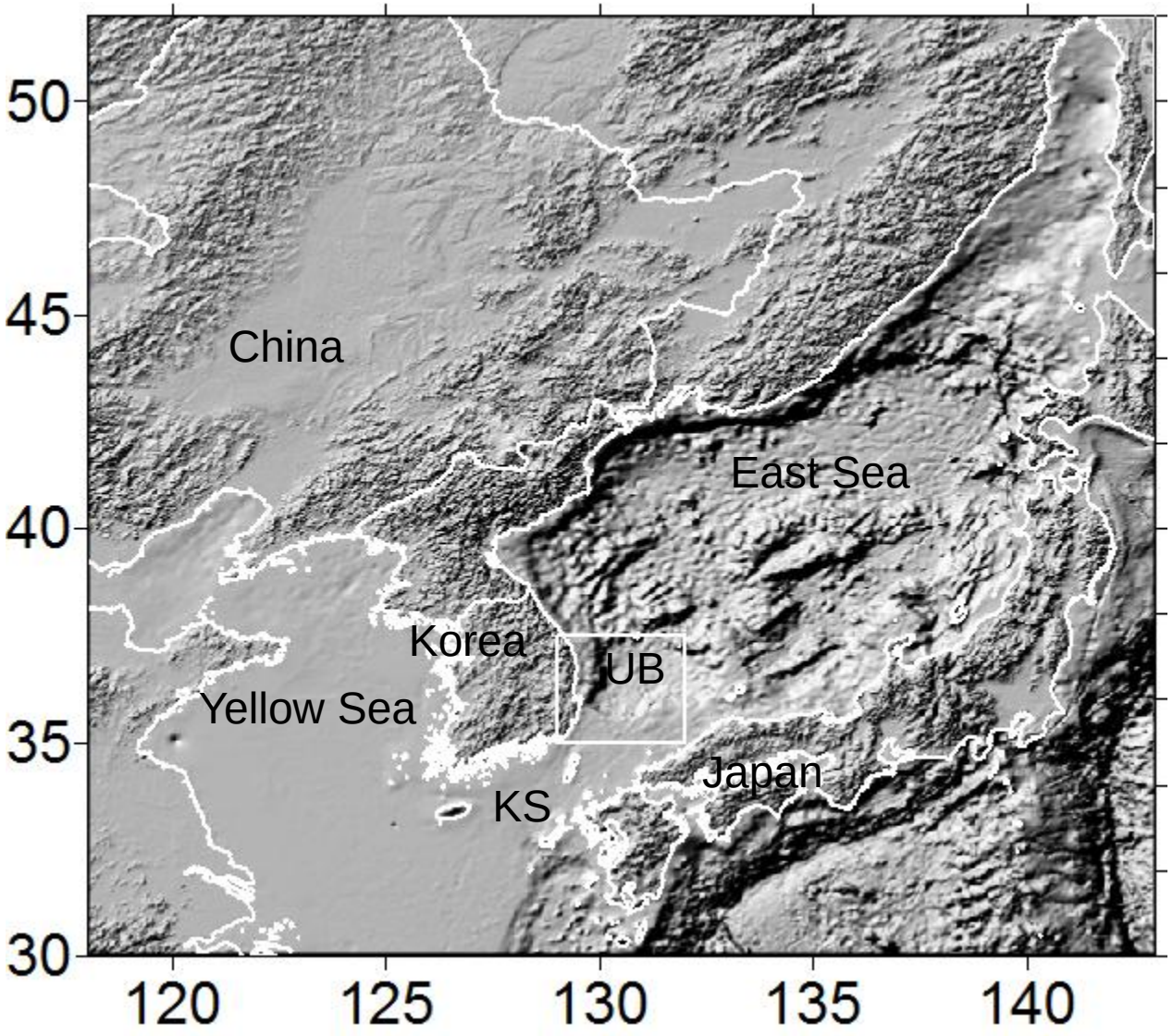


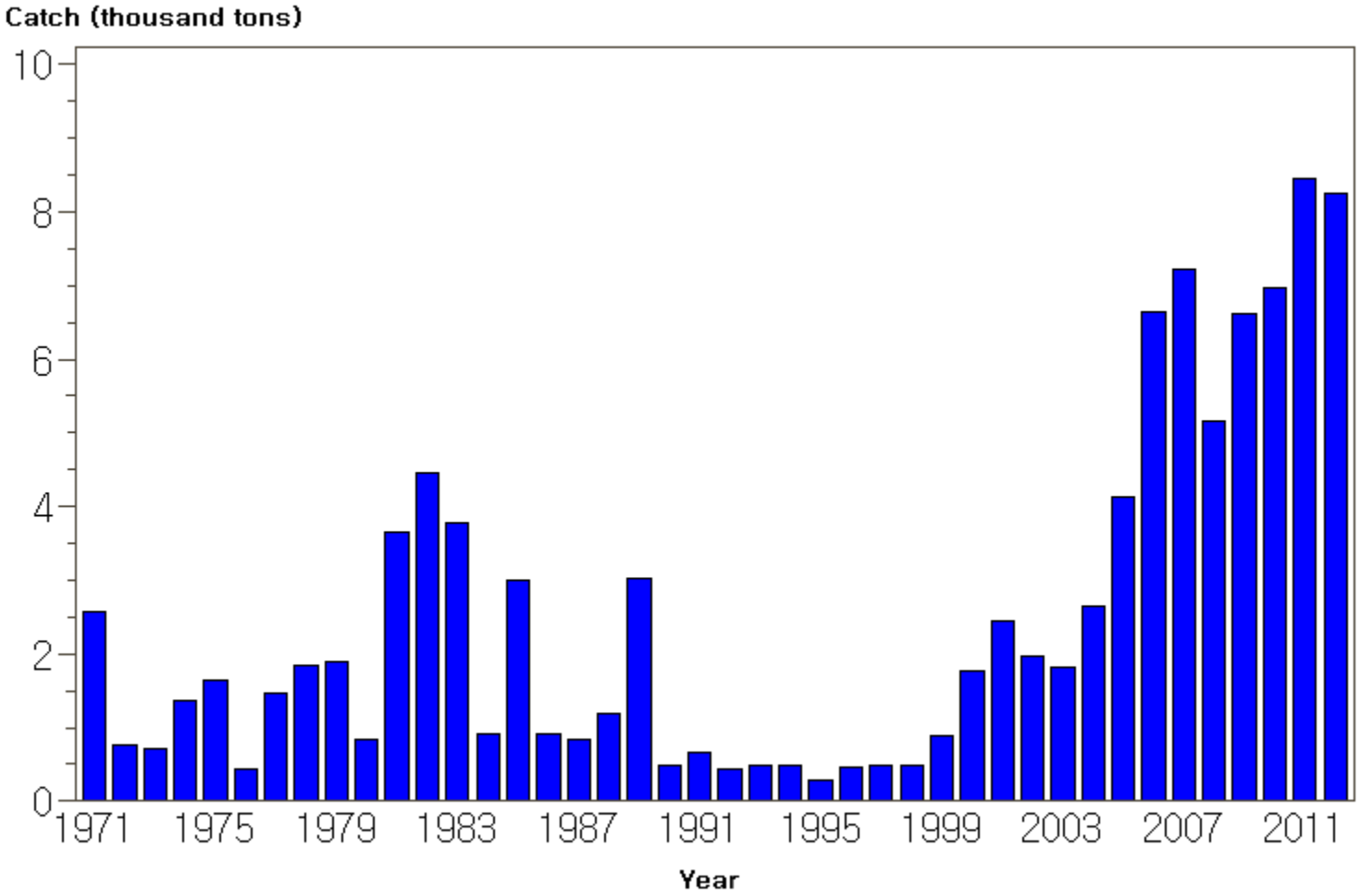
Study area


50
45
40
35
30
120
125
130
135
140
China
East Sea
Korea
UB
Yellow Sea
Japan
KS

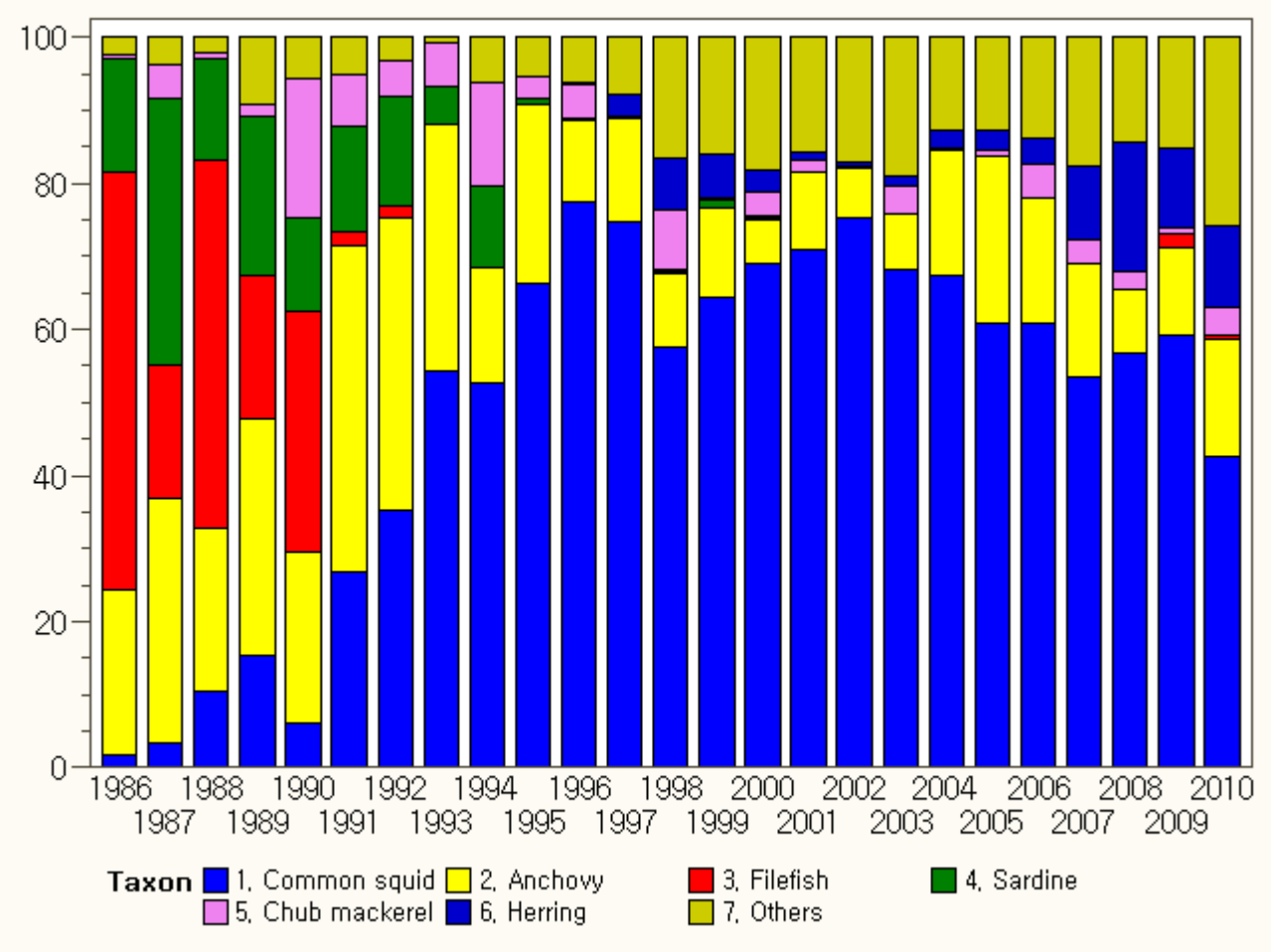
Background

- 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.

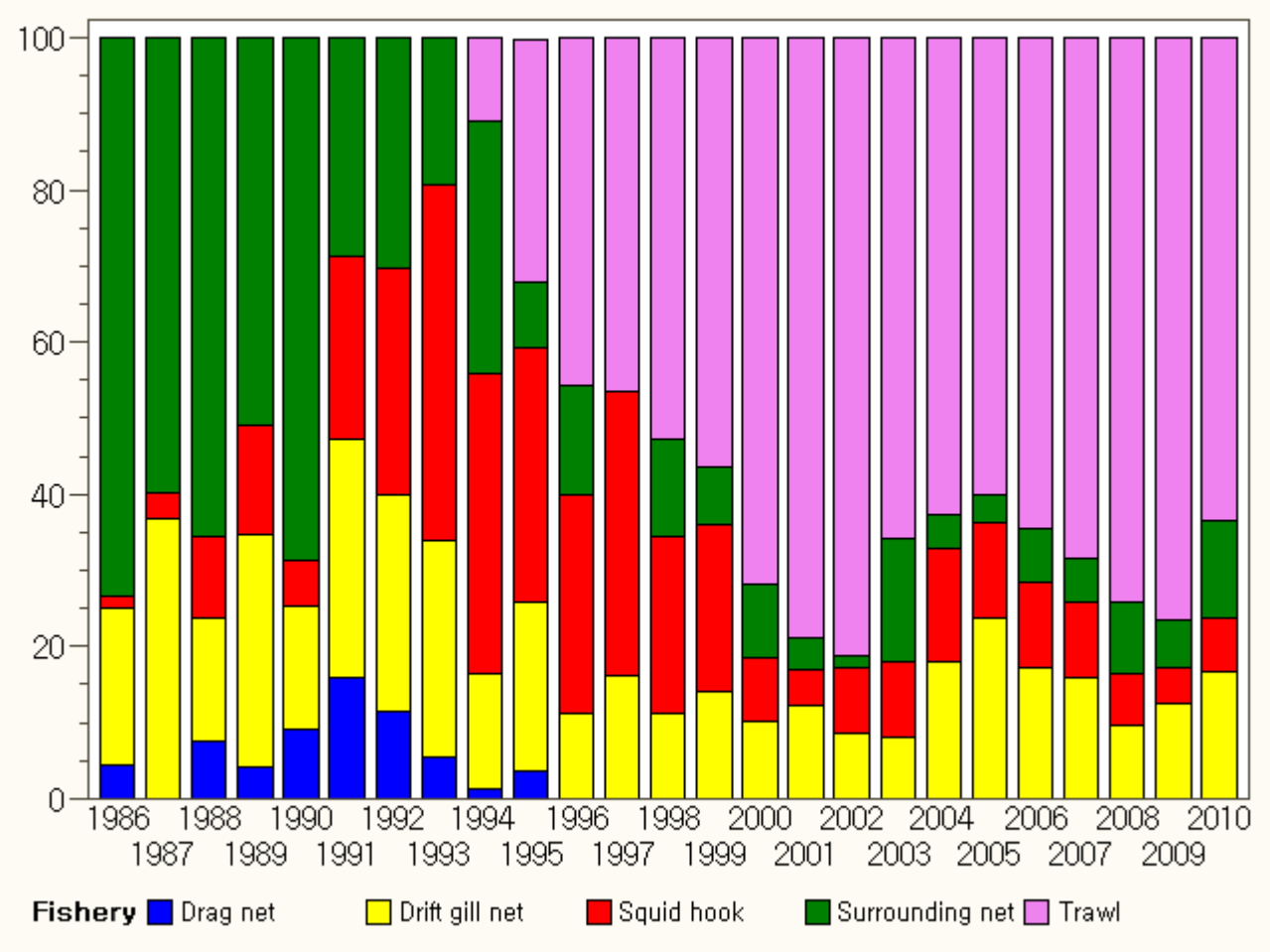
Annual catch of Pacific cod (*Gadus macrocephalus*) in Korean waters from 1971 to 2012



Composition in wet weight of fisheries catch



Composition in wet weight of fisheries catch by fishing type



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

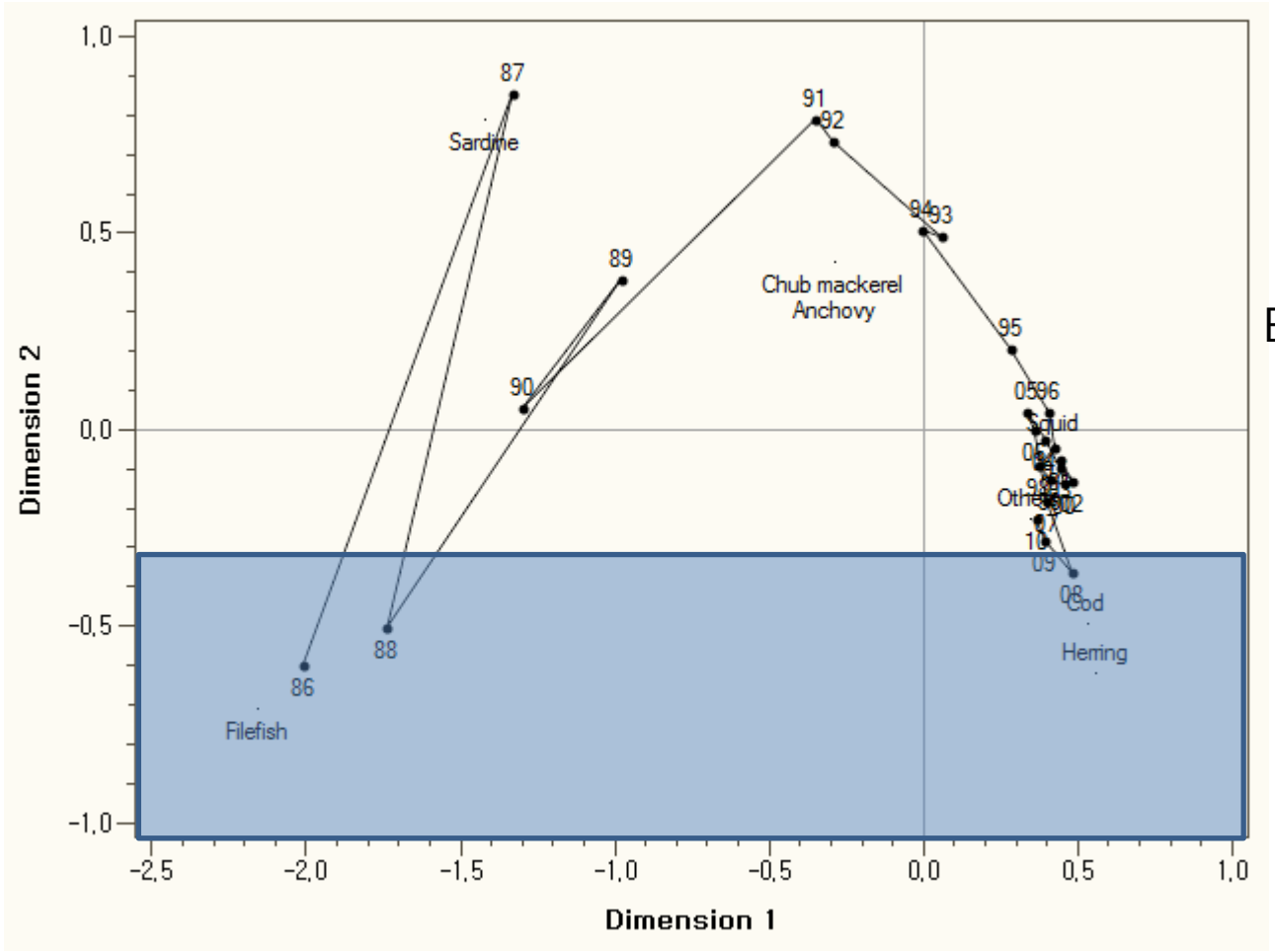
Data and Methods

- 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 (1986-2010)

Corresponding Analysis

Surface water temperature (Warming)

Depth

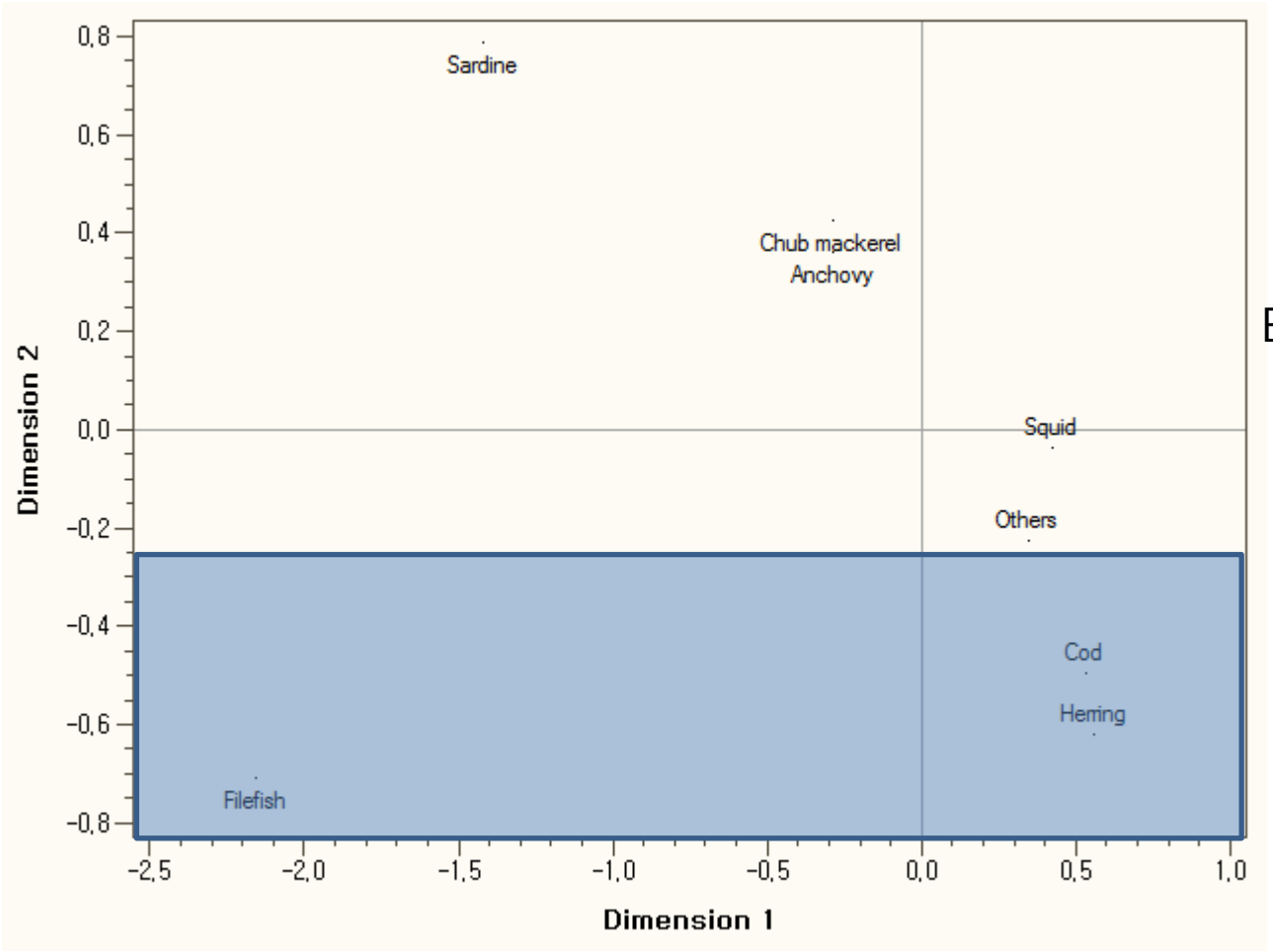


Epi-pelagic

Deep water

Corresponding Analysis

Depth



Epi-pelagic

Deep water

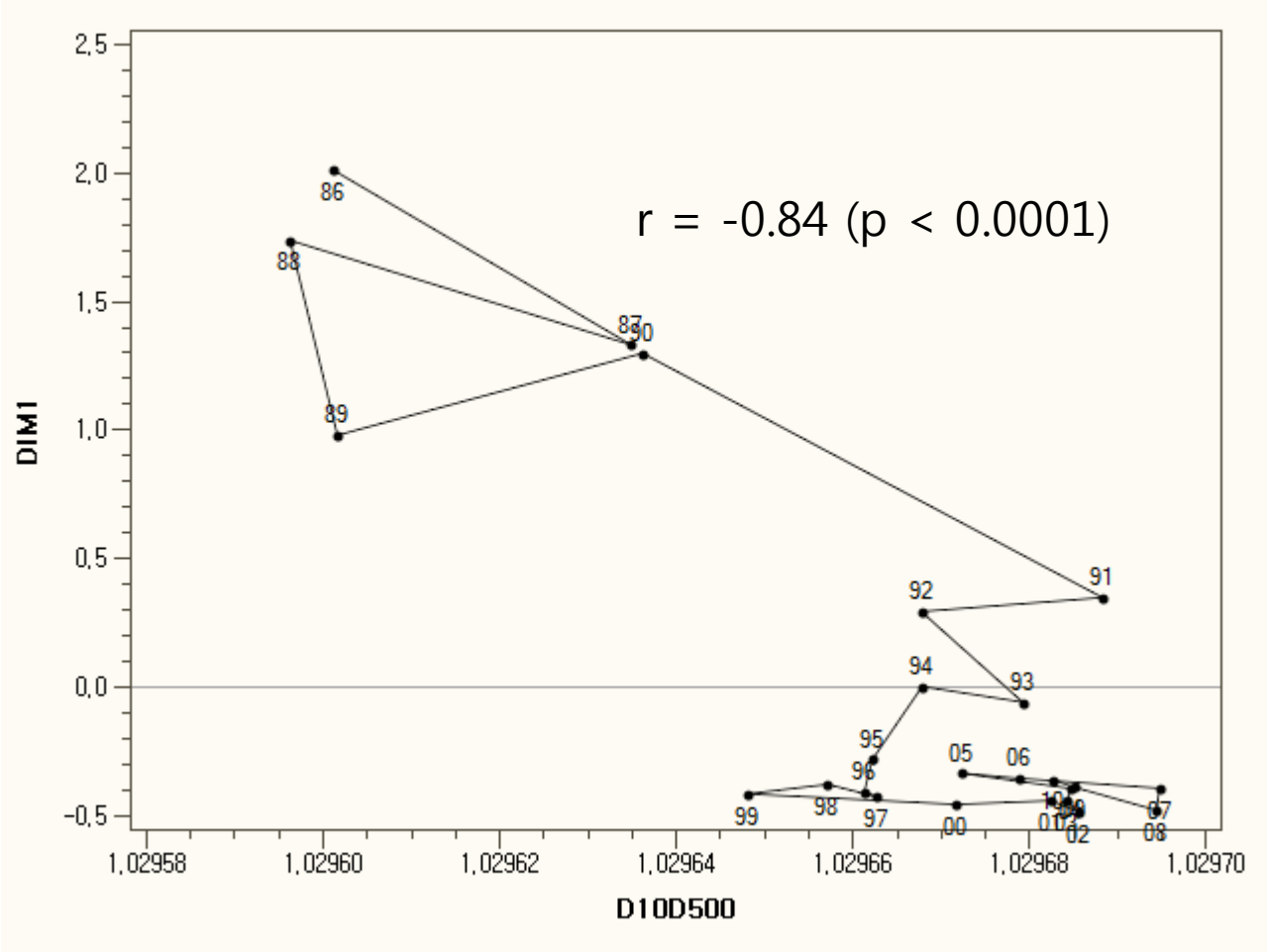
Correlation coefficient between water density and Dim 1

Depth (m)	Feb.	Apr.	Jun.	Aug.	Oct.	Dec.
0	0.19	0.19	0.29	0.01	0.33	0.32
10	0.30	0.29	0.41	0.22	0.32	0.31
20	0.30	0.38	0.26	0.24	0.30	0.32
30	0.31	0.44	0.20	0.14	0.18	0.36
50	0.32	0.45	0.05	-0.06	-0.17	0.39
75	0.29	0.31	0.02	-0.16	-0.30	0.23
100	0.23	0.18	-0.20	-0.23	-0.45	-0.10
150	-0.16	-0.14	-0.40	-0.40	-0.44	**-0.69**
200	-0.42	-0.45	**-0.53**	**-0.59**	**-0.60**	**-0.75**
300	0.20	**0.53**	0.48	**0.61**	0.39	-0.09
400	-0.37	**-0.61**	**-0.52**	-0.40	**-0.67**	**-0.78**
500	**-0.68**	**-0.65**	**-0.68**	**-0.54**	**-0.84**	**-0.75**

Correlation coefficient between water temperature and Dim 1

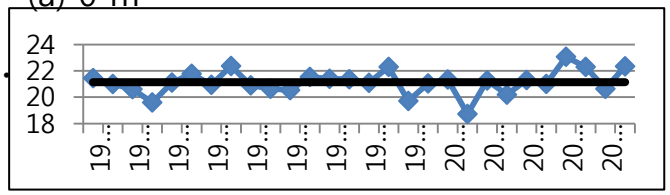
Depth (m)	Feb.	Apr.	Jun.	Aug.	Oct.	Dec.
0	-0.04	-0.13	-0.25	0.08	-0.05	-0.20
10	-0.24	-0.26	-0.39	-0.13	-0.08	-0.21
20	-0.26	-0.36	-0.13	-0.16	-0.05	-0.21
30	-0.28	-0.46	-0.01	-0.05	0.09	-0.26
50	-0.27	-0.41	0.10	0.18	0.28	-0.29
75	-0.17	-0.20	0.16	0.27	0.34	-0.11
100	-0.08	-0.04	0.33	0.35	0.44	0.21
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

8-a

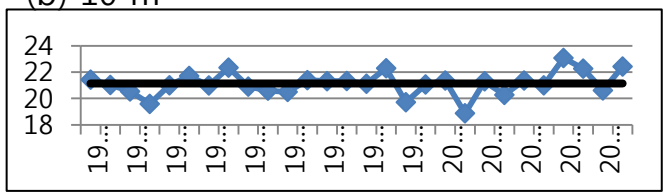

r = -0.84 (p < 0.0001)
DIMI
D10D500
2,5
2,0
1,5
1,0
0,5
0,0
-0,5
1,02958
1,02960
1,02962
1,02964
1,02966
1,02968
1,02970
86
88
87
90
89
91
92
94
93
95
96
99
98
97
05
06
00
02
08

Oct. Temp.

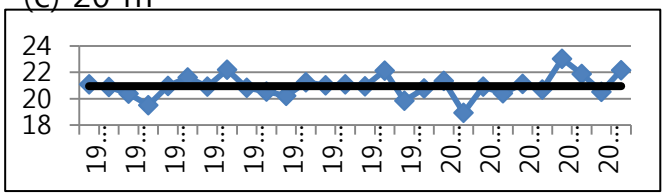
(a) 0 m



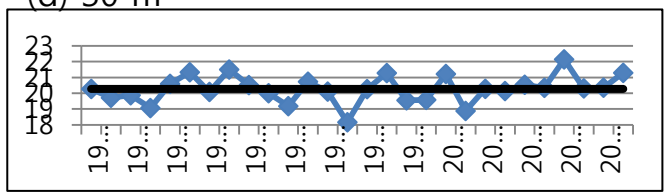
(b) 10 m



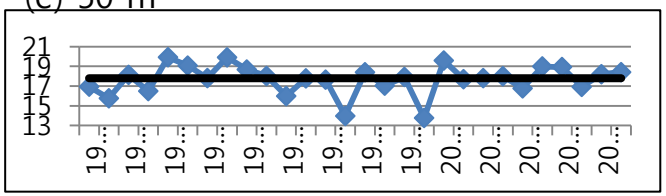
(c) 20 m



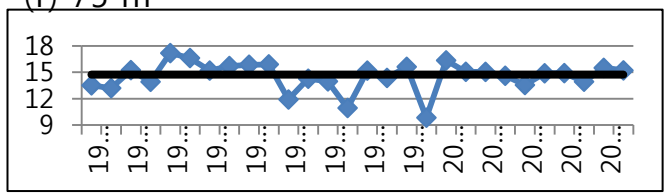
(d) 30 m



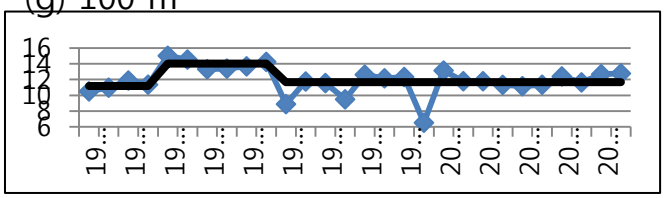
(e) 50 m



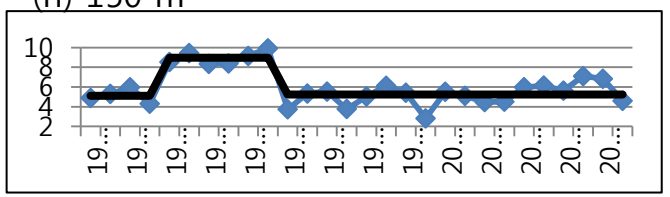
(f) 75 m



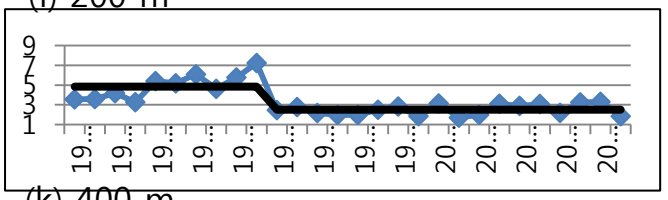
(g) 100 m



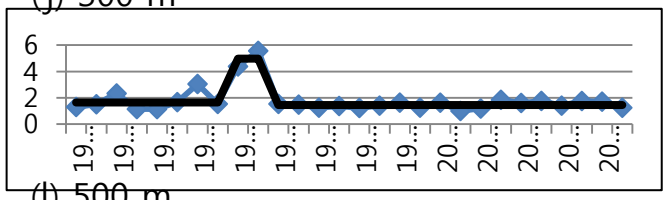
(h) 150 m



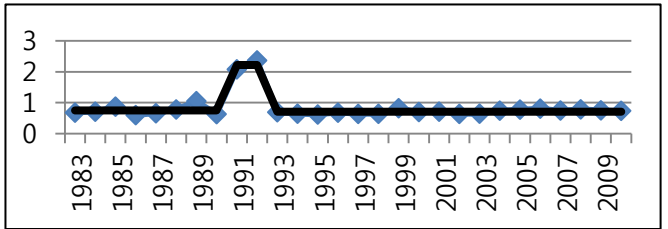
(i) 200 m



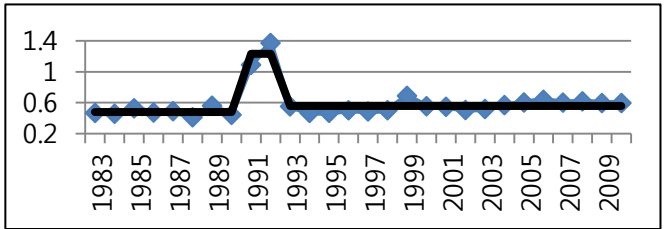
(j) 300 m



(k) 400 m

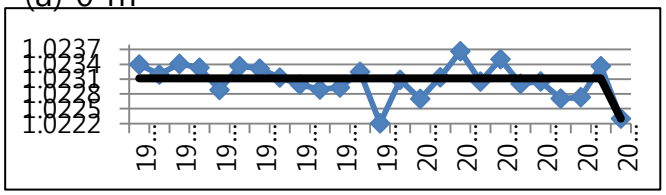


(l) 500 m

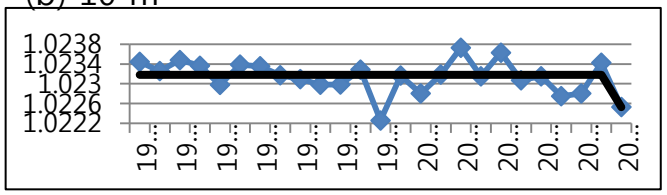


Oct.
D

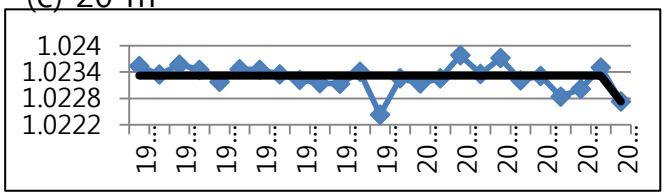
(a) 0 m



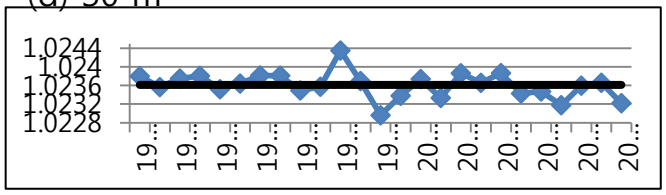
(b) 10 m



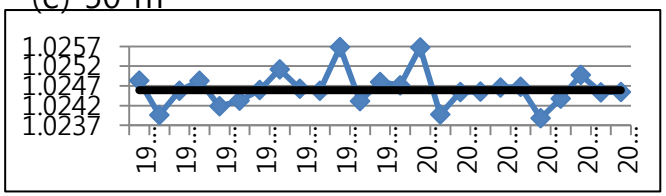
(c) 20 m



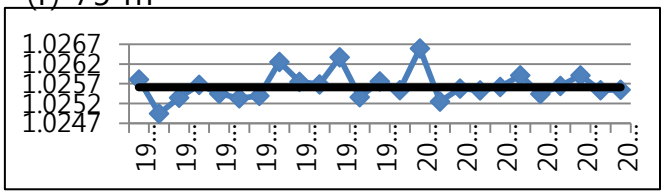
(d) 30 m



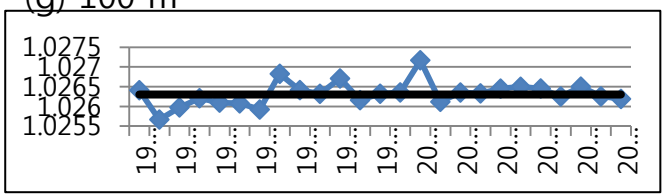
(e) 50 m



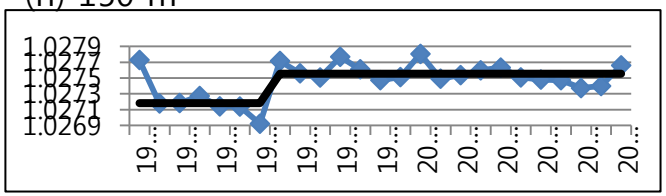
(f) 75 m



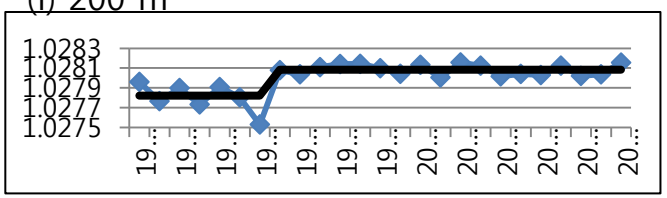
(g) 100 m



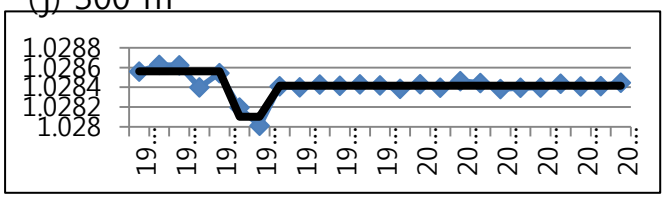
(h) 150 m



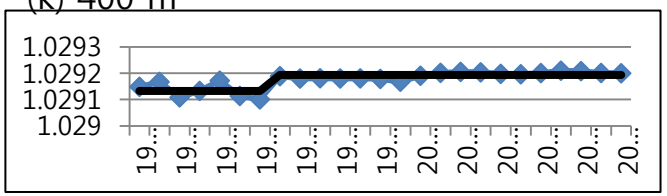
(i) 200 m



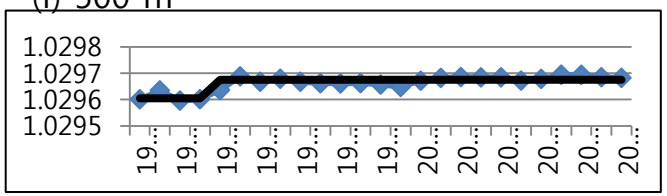
(j) 300 m



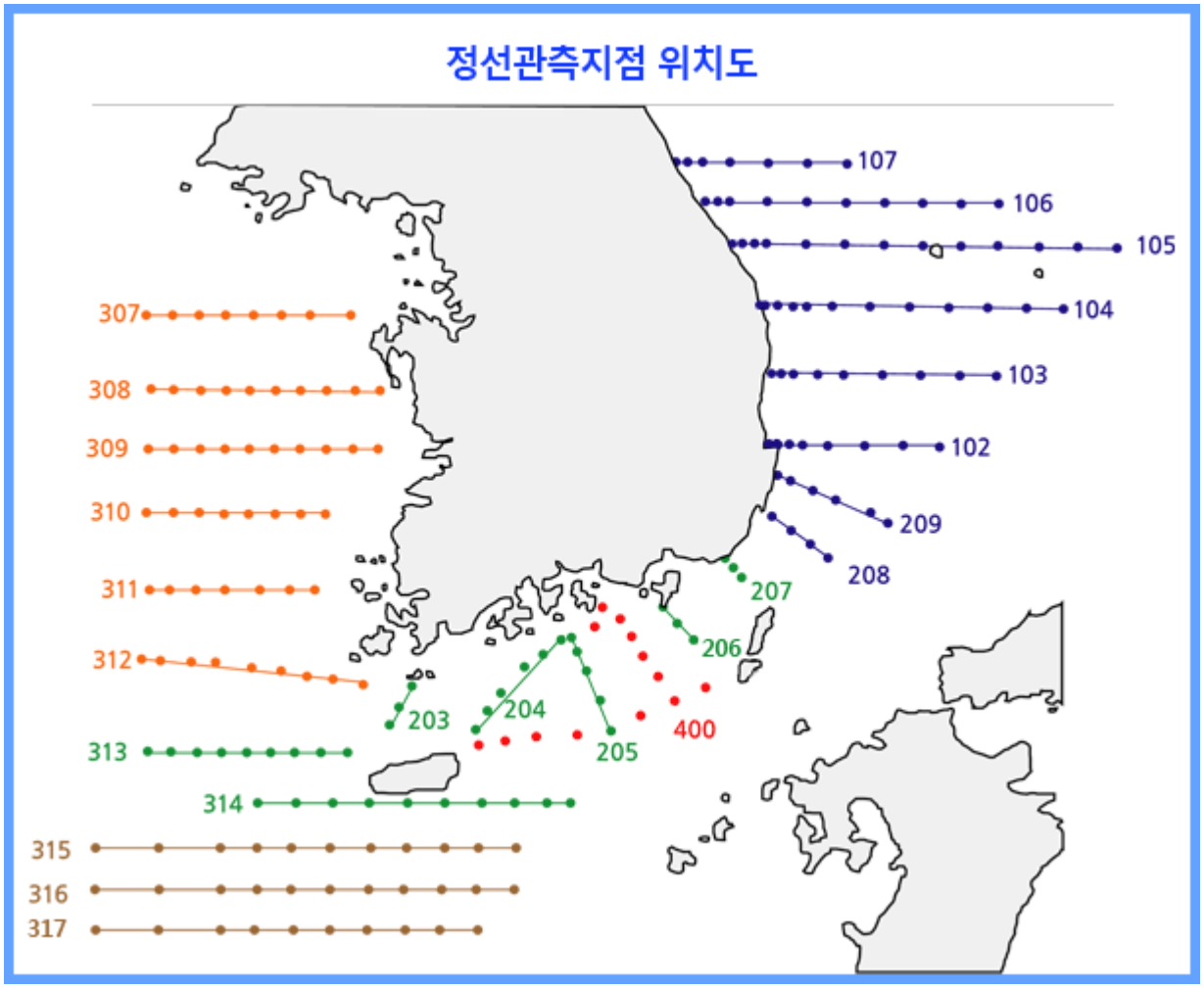
(k) 400 m



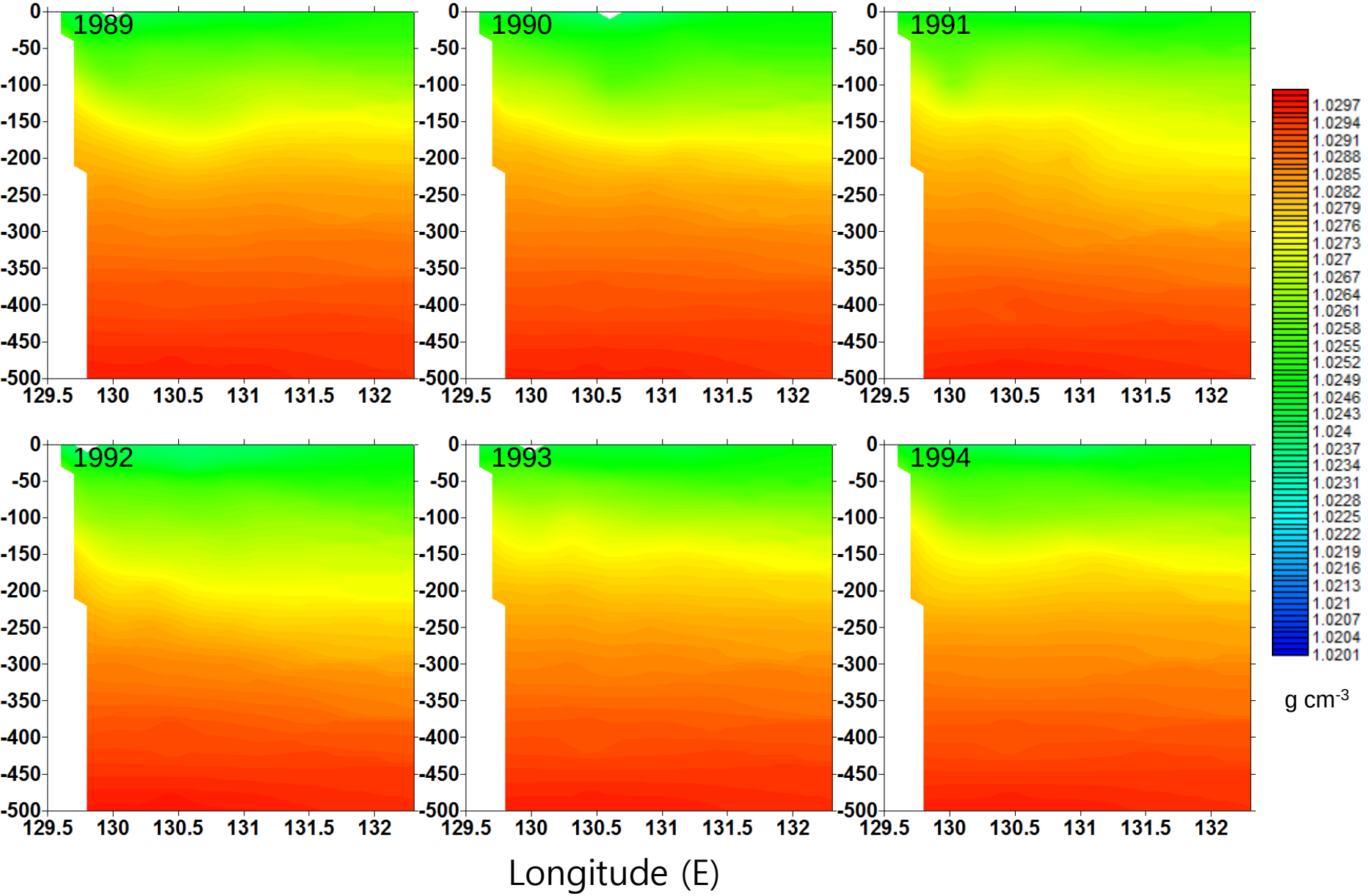
(l) 500 m



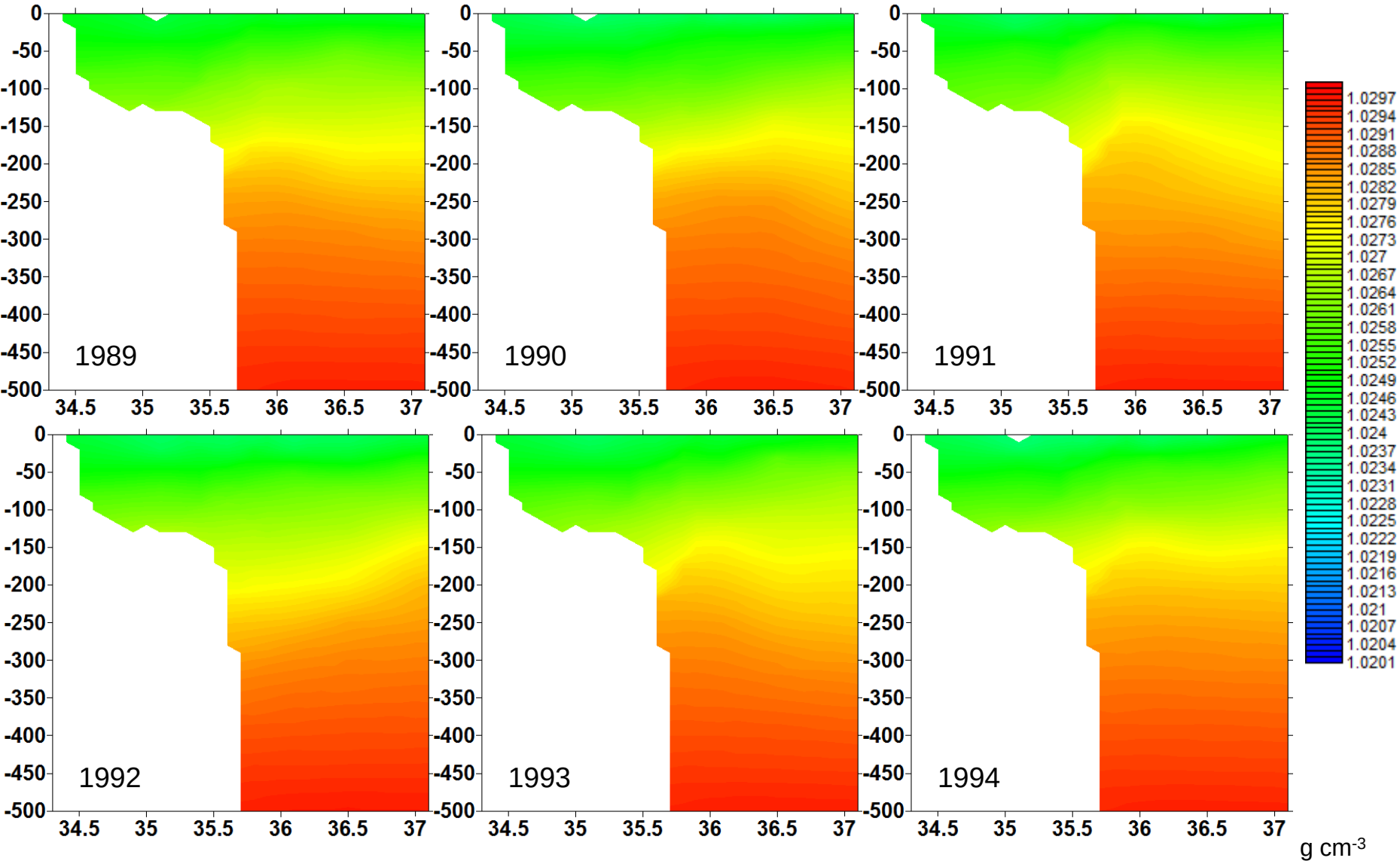
KODC Stations



KODC Line 102 (36º13’ N) Density Annual mean (1986-1991)



KODC NS Line 130.9 E Density Annual mean (1989-1994)



Latitude (N)

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)

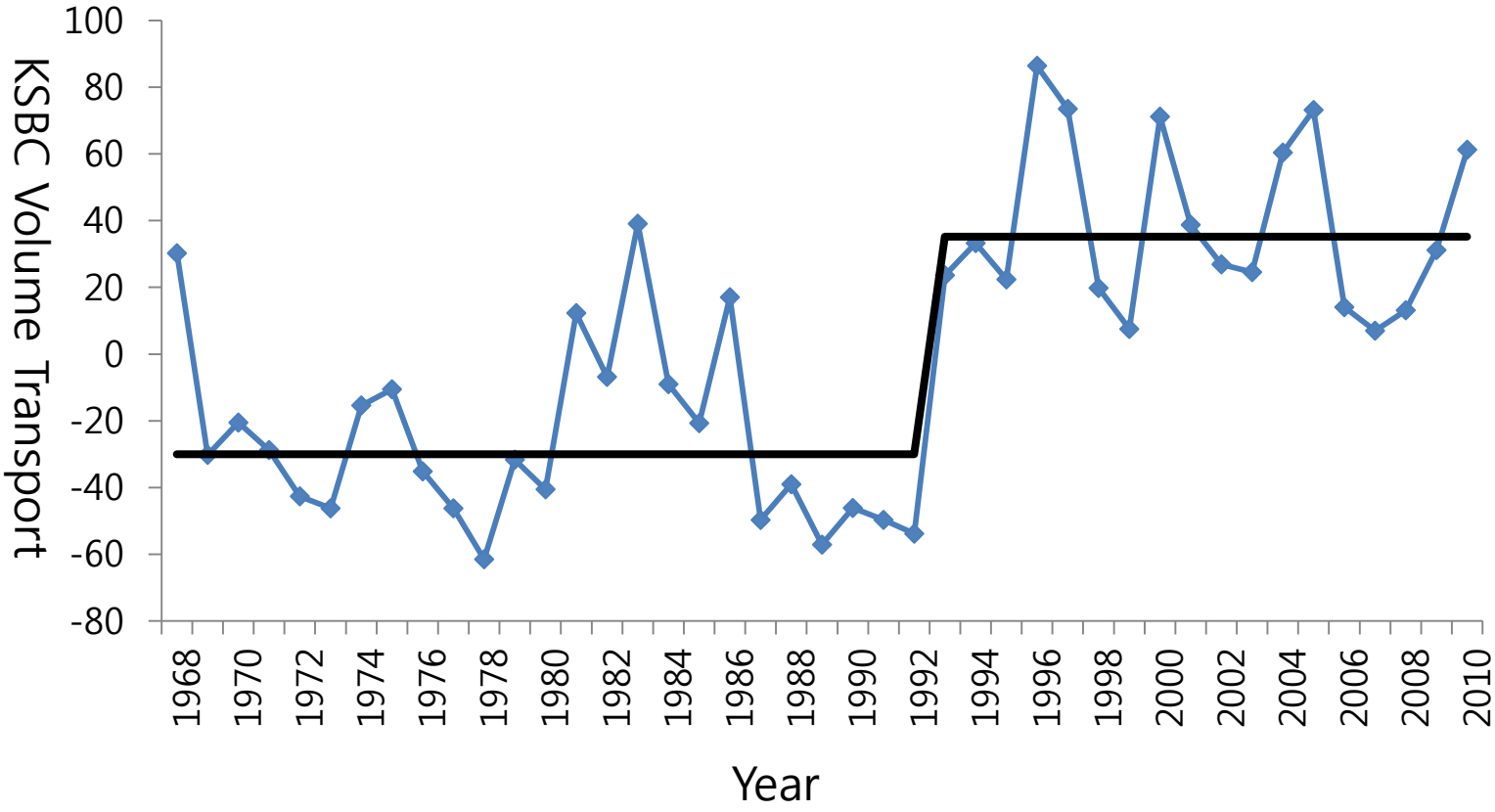
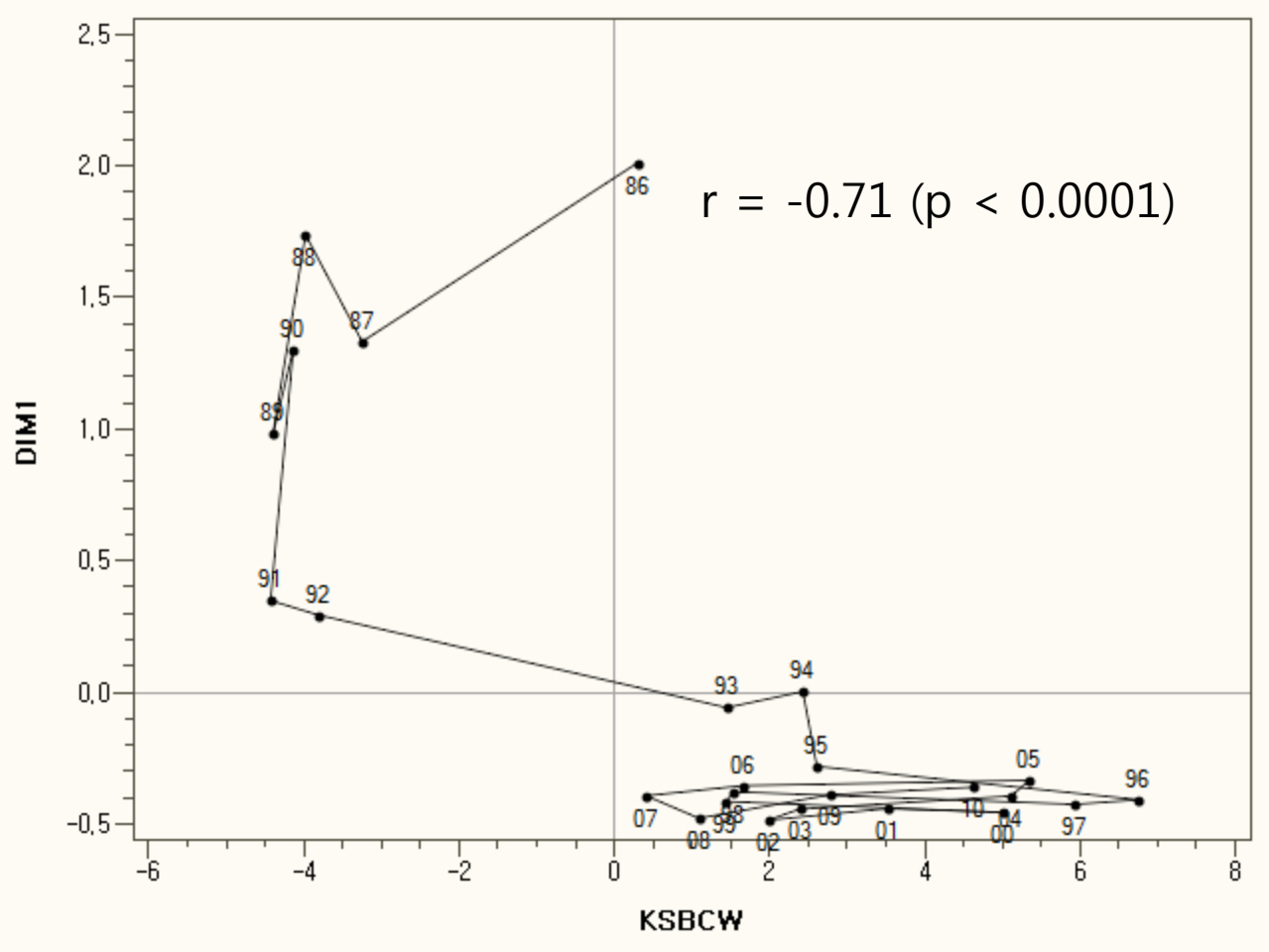


Fig. 8-b


r = -0.71 (p < 0.0001)
DIMI
KSBCW
2,5
2,0
1,5
1,0
0,5
0,0
-0,5
-6
-4
-2
0
2
4
6
8
86
88
87
90
89
91
92
93
94
95
06
05
96
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98
02
03
09
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04
97

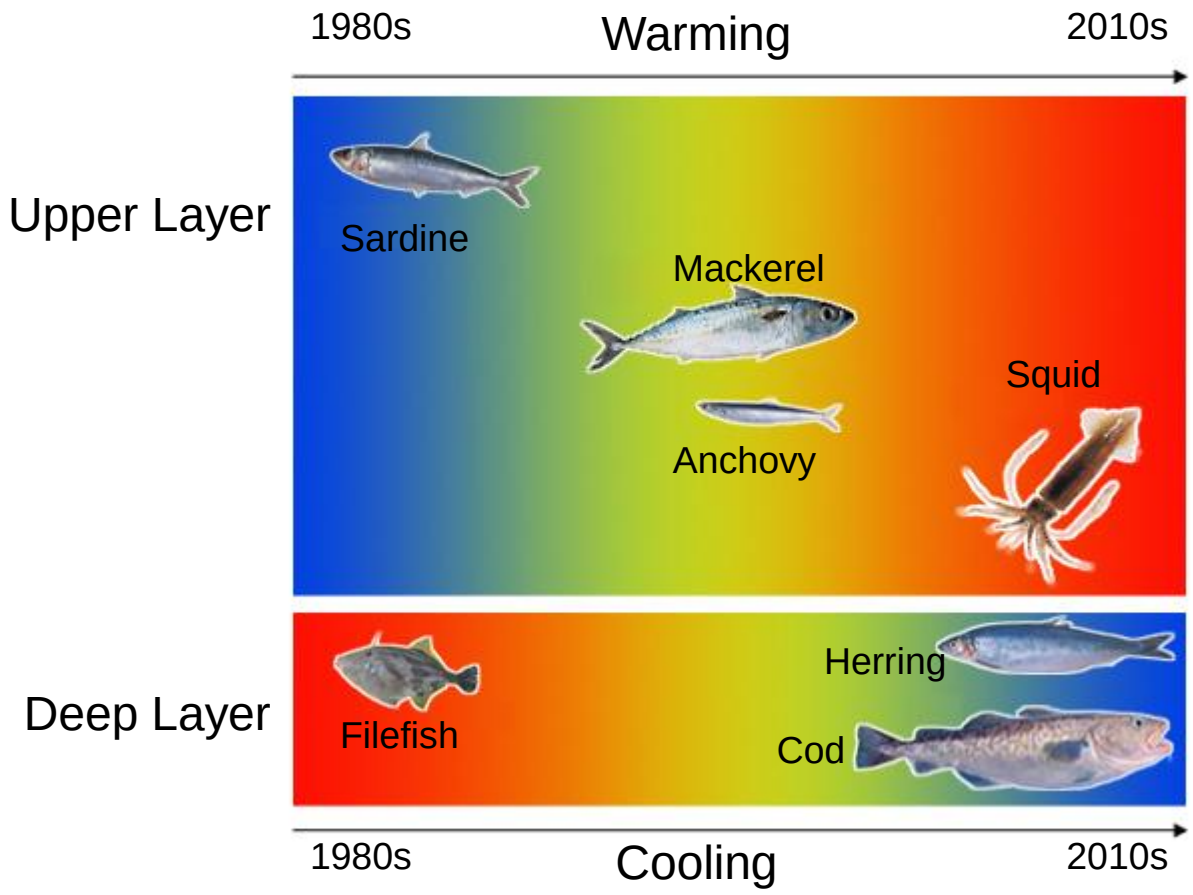
Conclusions 1

- 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

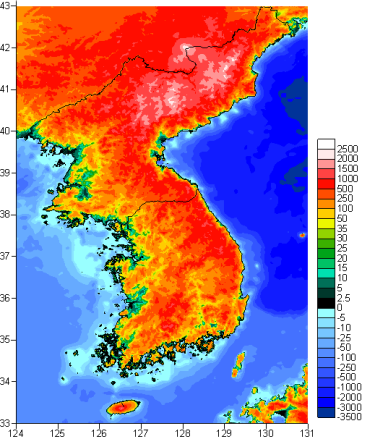


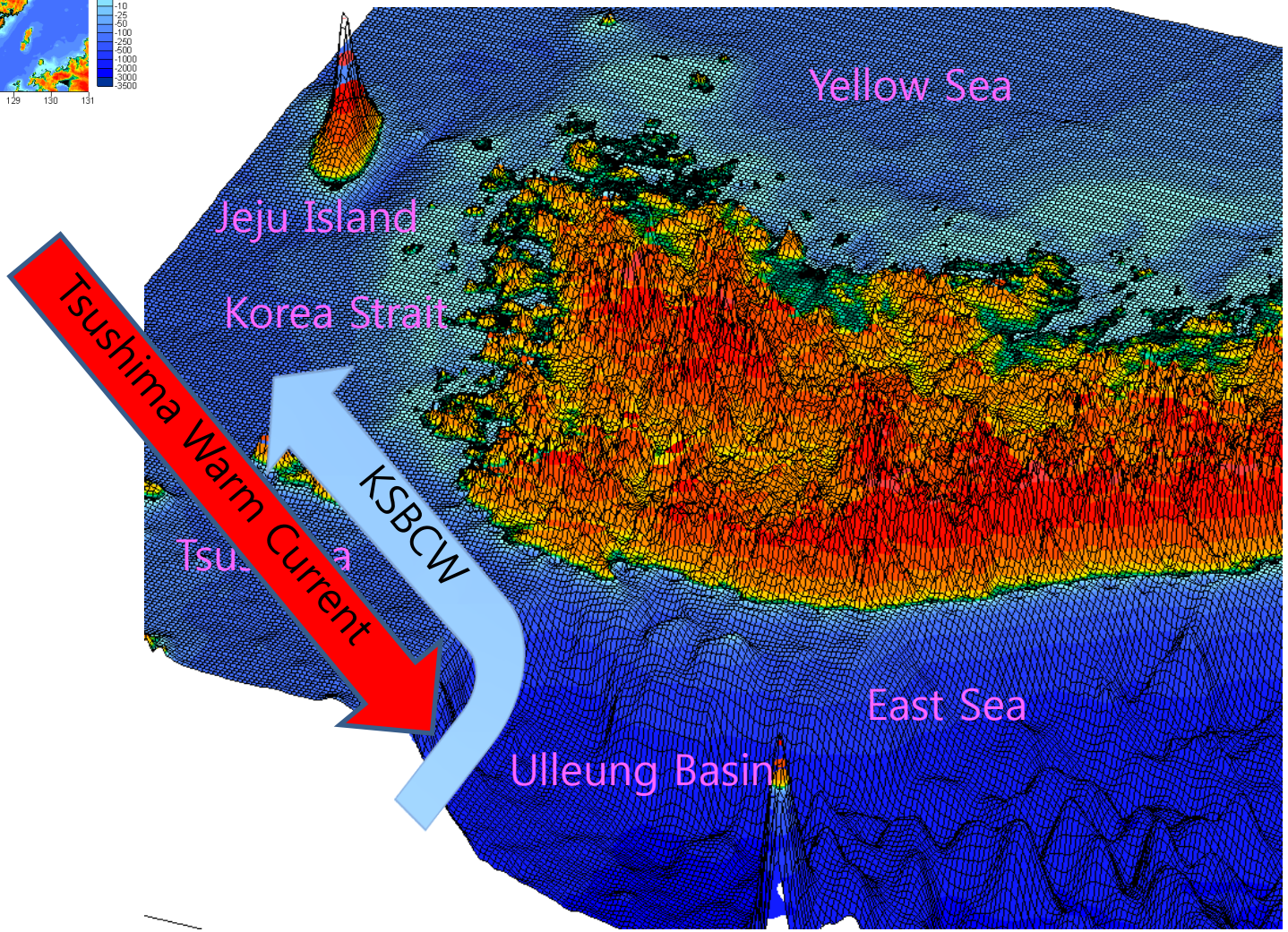
Future works

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

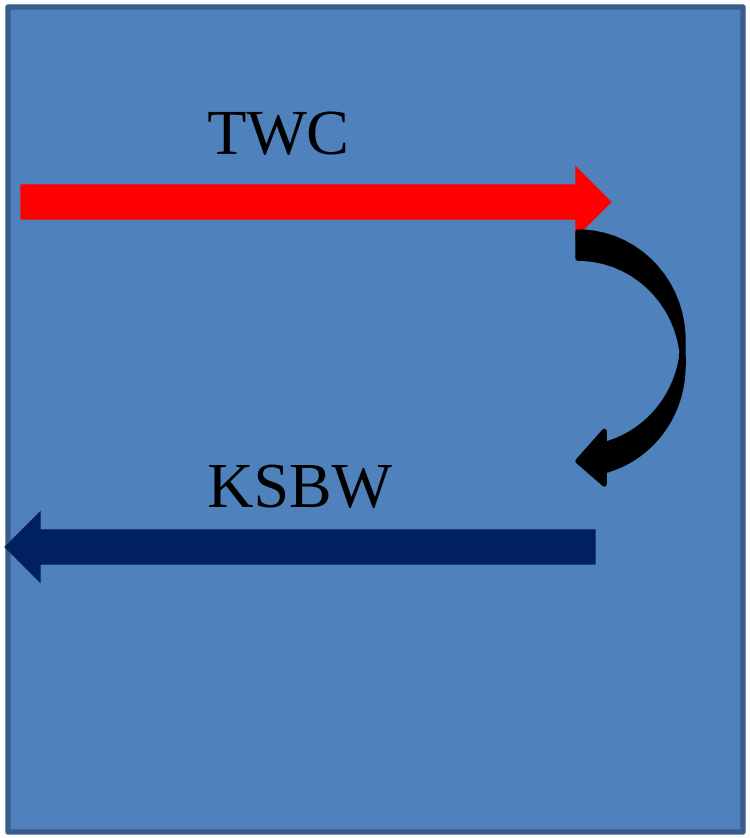
- Possible time-lagged interactions between the upper and deep water oceanic shift observed in the UB, and also between the TWC and KSBCW

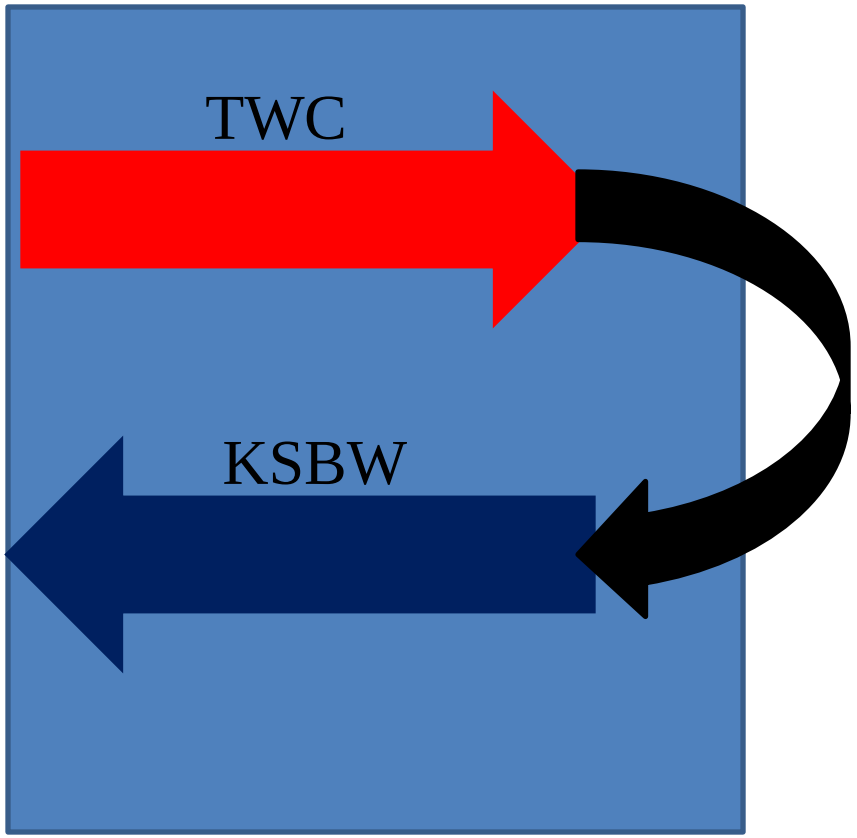
Physical Oceanography





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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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

울릉분지 100m이하 해수온도 3~4도 떨어졌다

〈1990년대 초반〉

정석근 제주대 교수 분석

지구온난화는 기온 상승뿐만 아니라 바다 온도에도 영향을 미친다. 실제로 한반도 인근 해수면 온도는 20세기 후반 약 40년 동안 1.31도나 올랐다. 그런데 해수면이 데워지면 대류현상으로 바다 전체 온도도 올라갈 것이라는 일이다.

해수온도의 급격한 변화는 이 지역의 주요 수산물 종류도 바꿔 놓았다.

우선 수심 100~200m 지점의 경우 1990년 이전에는 해수온도 12도 안팎에서 서식하는 말쥐치가 우세했지만 해수온도가 내려가면서 2~10도 해수에서 서식하는 청어나 대구가 많

울릉분지

울릉분지는 독도와 울릉도 남부에서 대한해협 북부, 그리고 동쪽의 일본 분지와 야마토분지에 접해 있는 깊이 2300m의 해저 분지다. 울릉분지 상층부 바다에는 따뜻한 쓰시마 난류의 한 흐름인 '동한난류'가 대한해협을 지나 북쪽으로 흐르고, 하층부 바다에서는 반대로 북쪽에서 흘러온 찬 해수가 울

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