Techniques for forecasting climate-induced variation in the distribution and abundance of chub mackerel in the Northwestern Pacific

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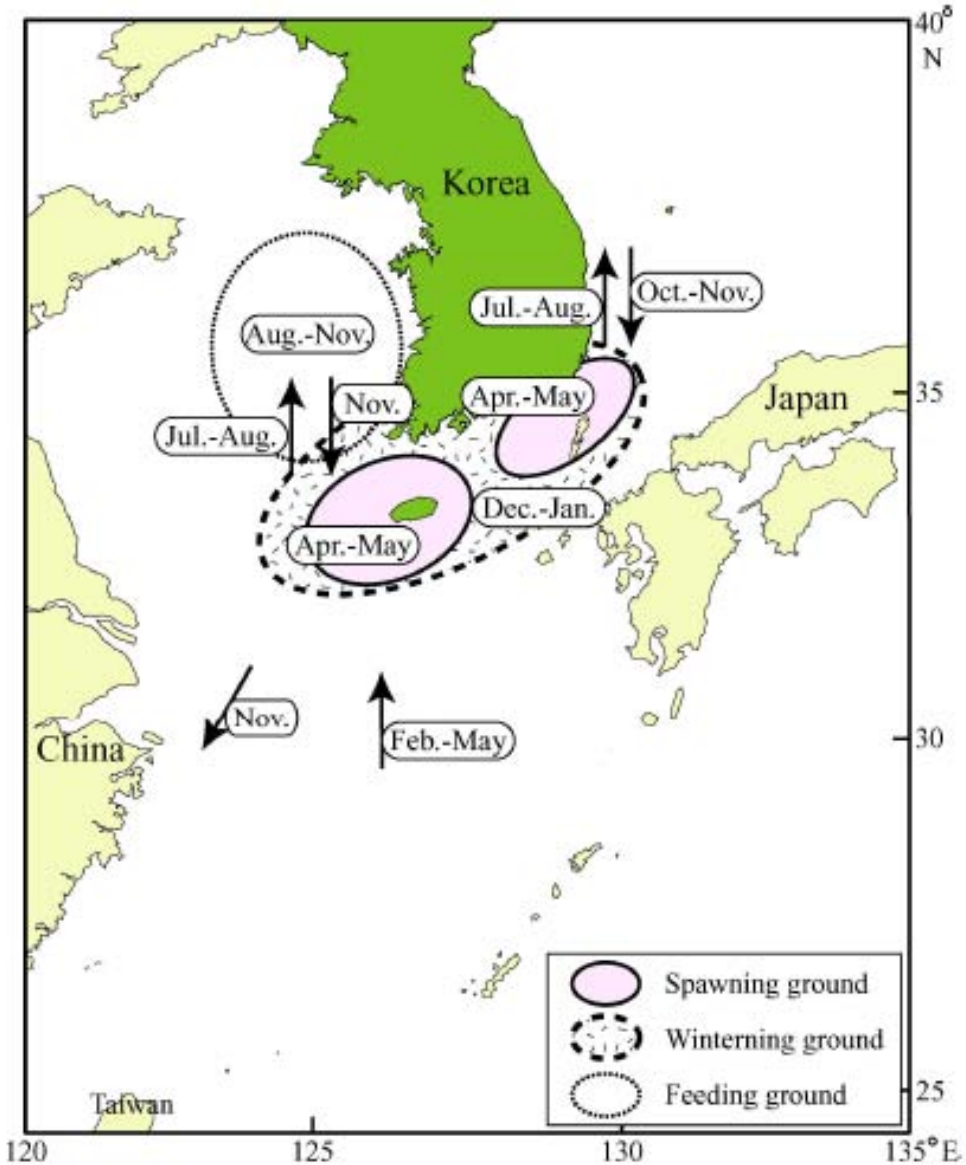
Migration route of chub mackerel in Korean waters



Objectives

- Detect decadal and interannual climate signals of the East China Sea
- Characterize fluctuations in catch
- Determine the impact of climate signals on fluctuations of chub mackerel stocks

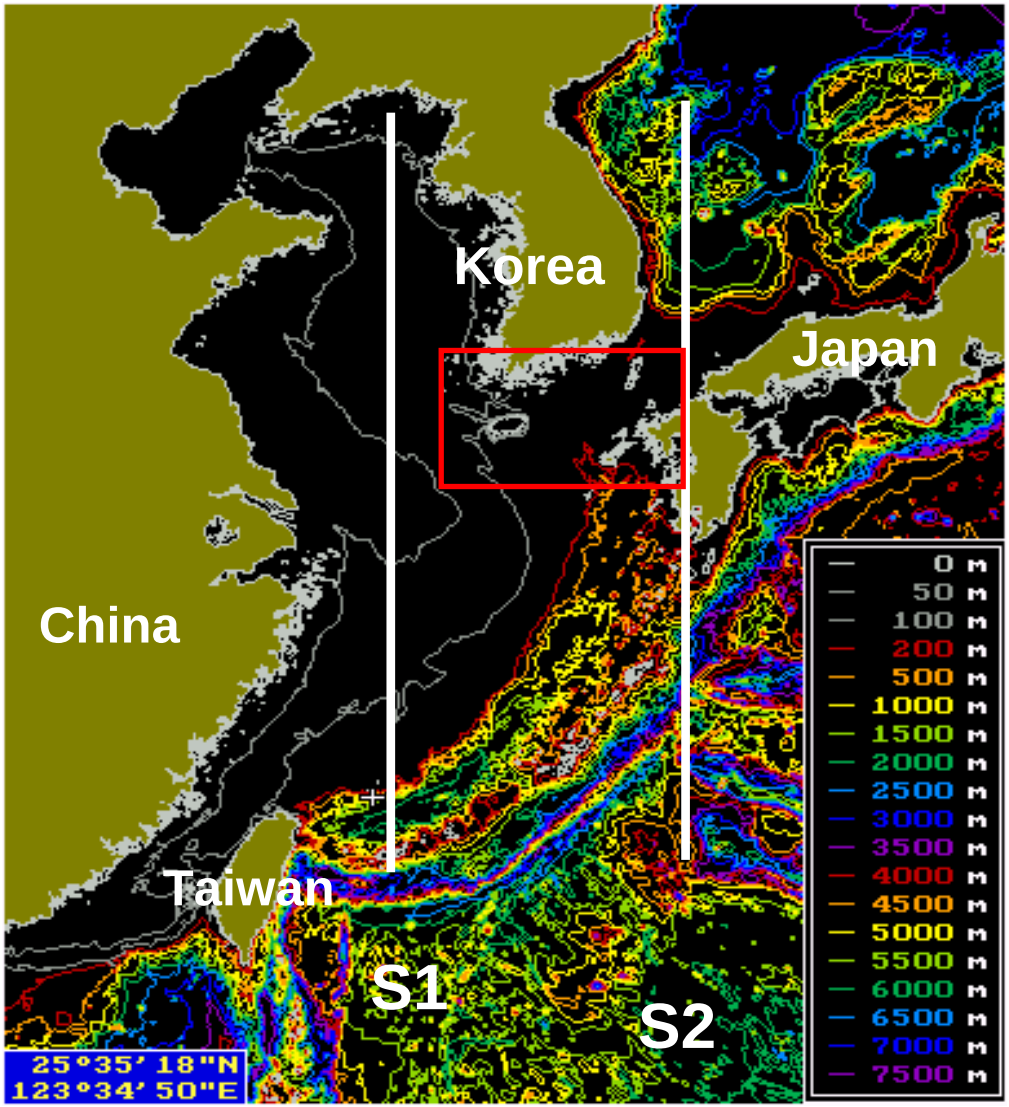
Data and Methods

Fishery Data:

- Total landing data by country from FAO:
  China, Japan, Korea, and Taiwan
- Fishery locations of Korean and Japanese Purse Seines
- Recruitment, Spawning Biomass, Biomass

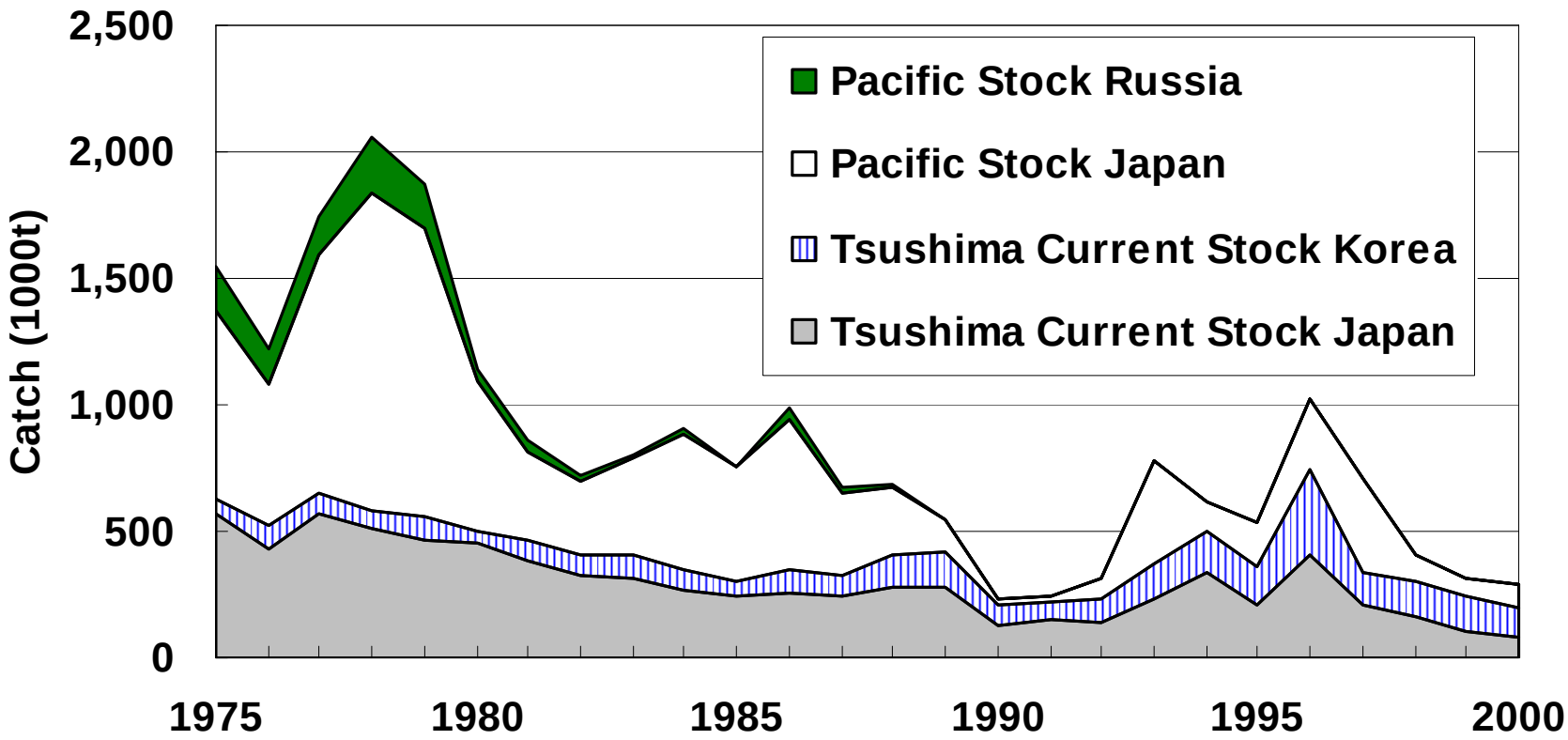
Environmental Data:

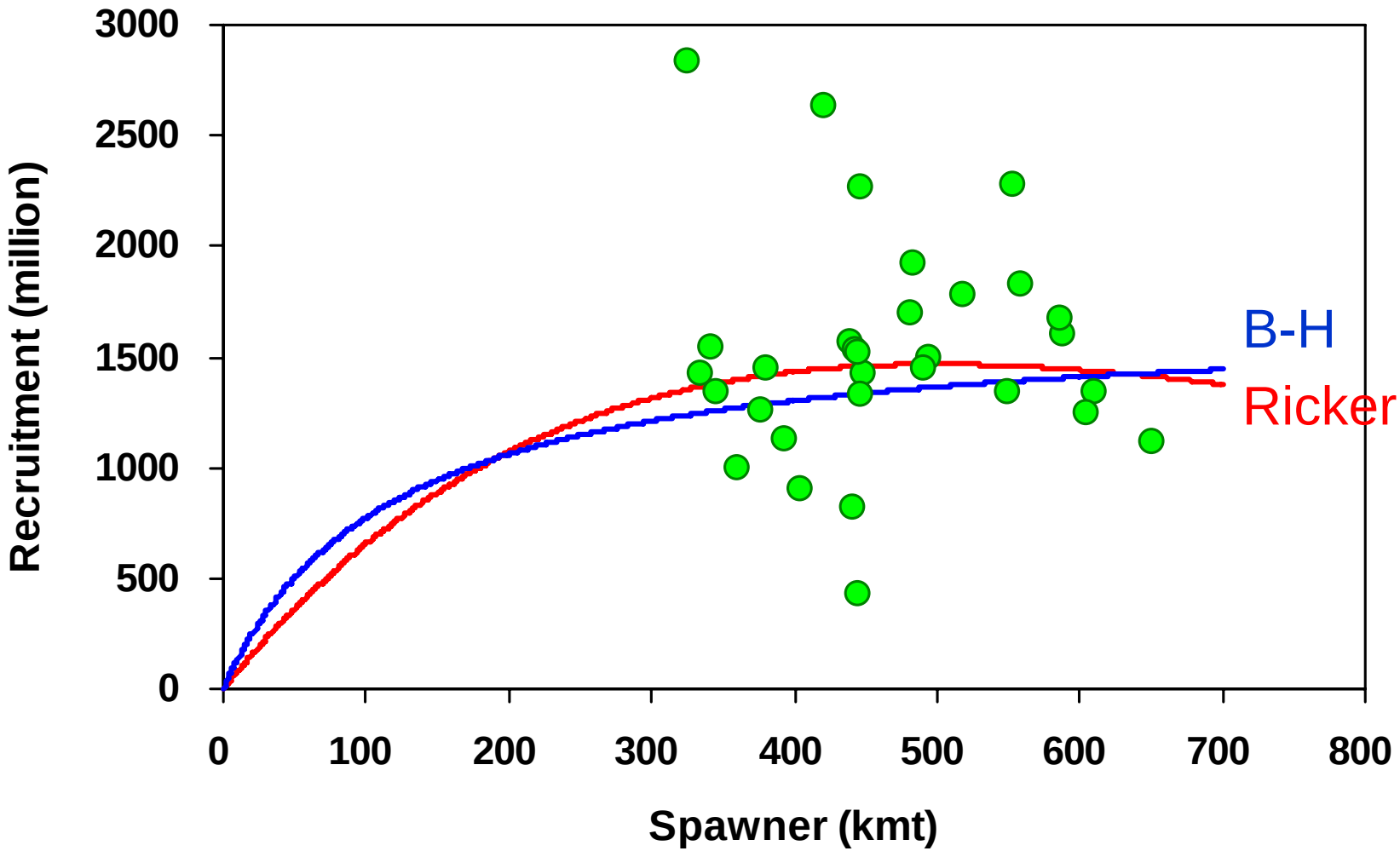
- Temperature, salinity at 0 m and 50 m depth (32-35^{o}N, 125-131^{o}E)
- 123^{o}E (S1) and 131^{o}E (S2) meridional lines - temperature
- Wind data using the IPCC model
- PDO and SOI

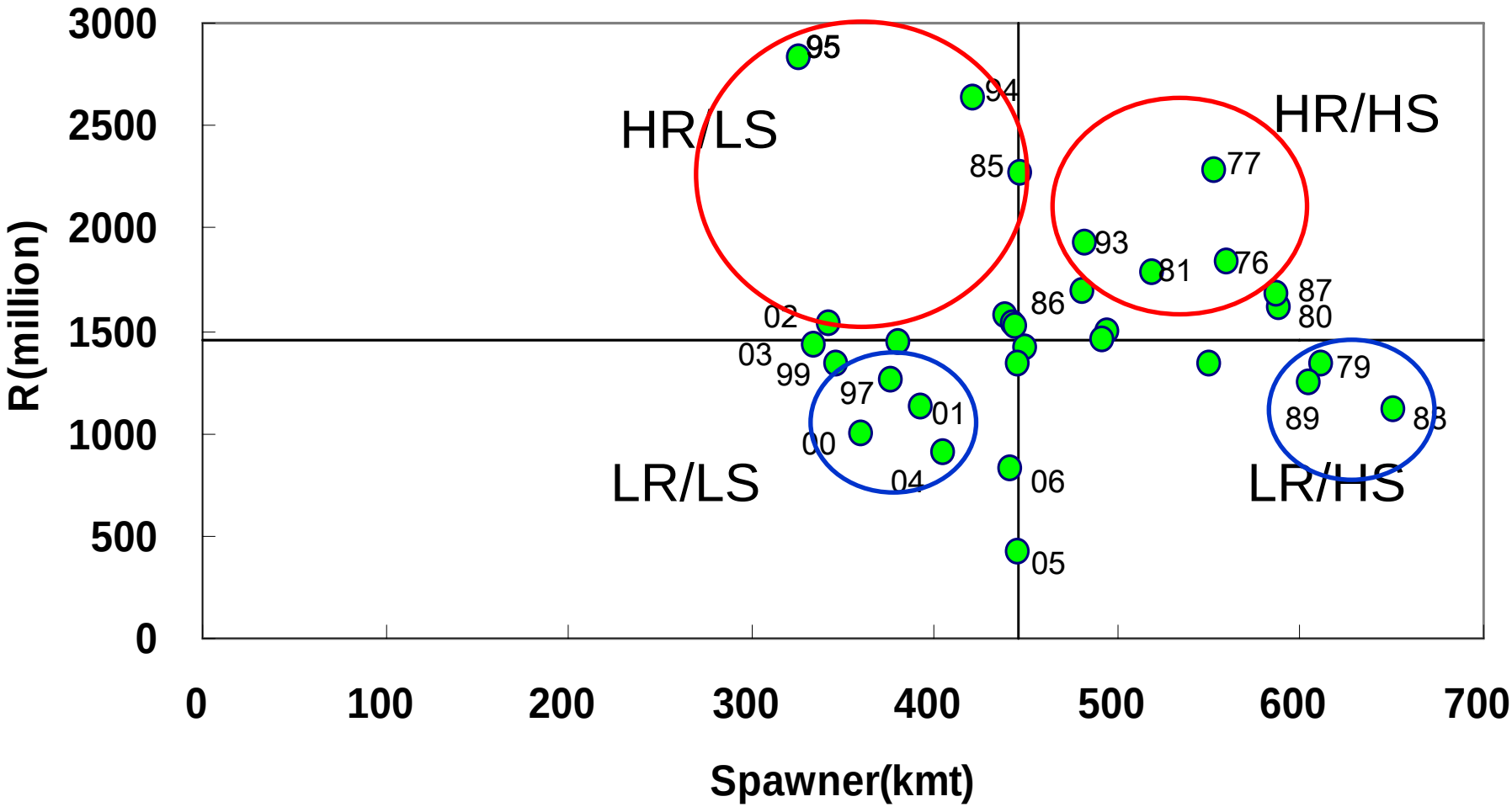

Korea
Japan
China
Taiwan
S1
S2
25°35' 18"N
123°34' 50"E
0 m
50 m
100 m
200 m
500 m
1000 m
1500 m
2000 m
2500 m
3000 m
3500 m
4000 m
4500 m
5000 m
5500 m
6000 m
6500 m
7000 m
7500 m

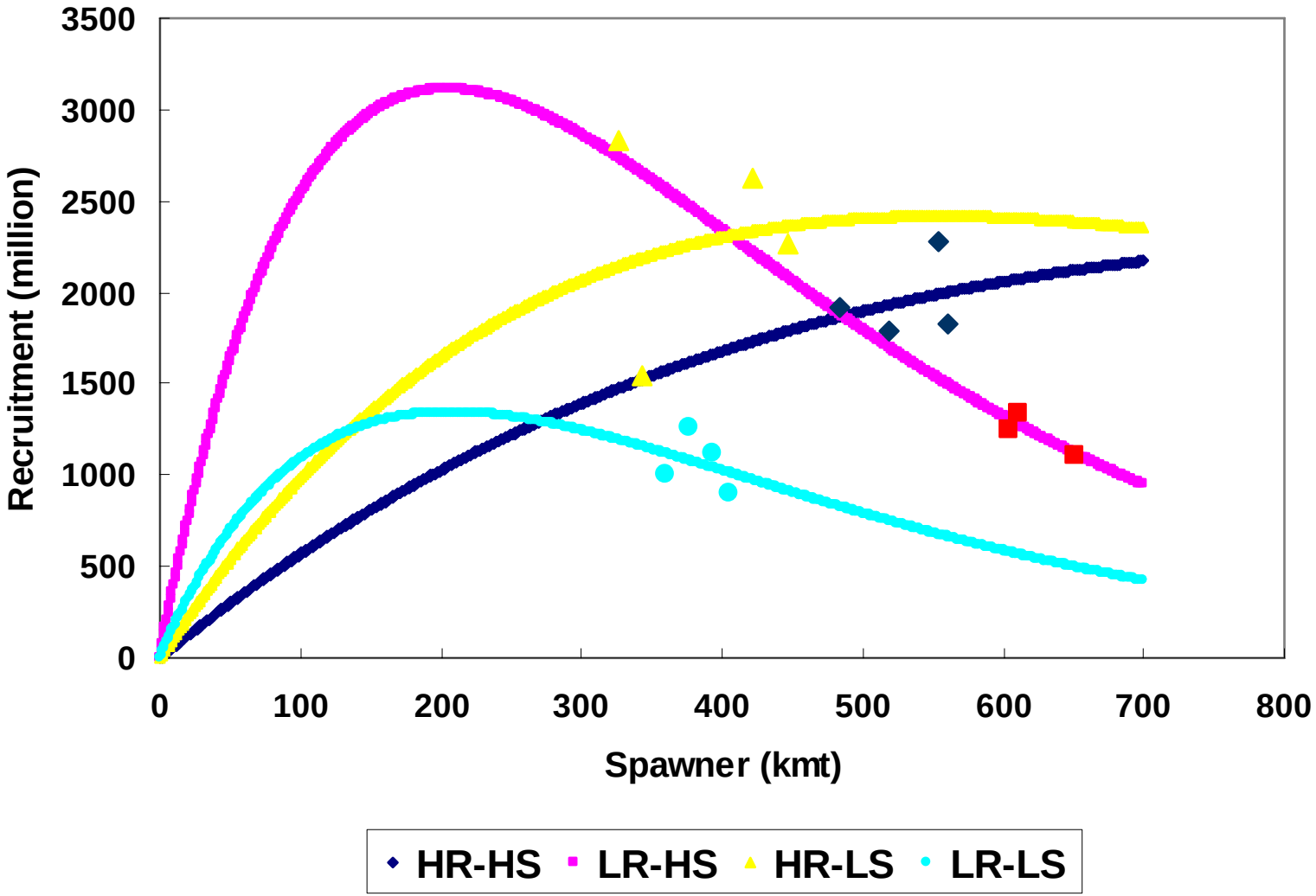
Results

1. Catch trend of chub mackerel

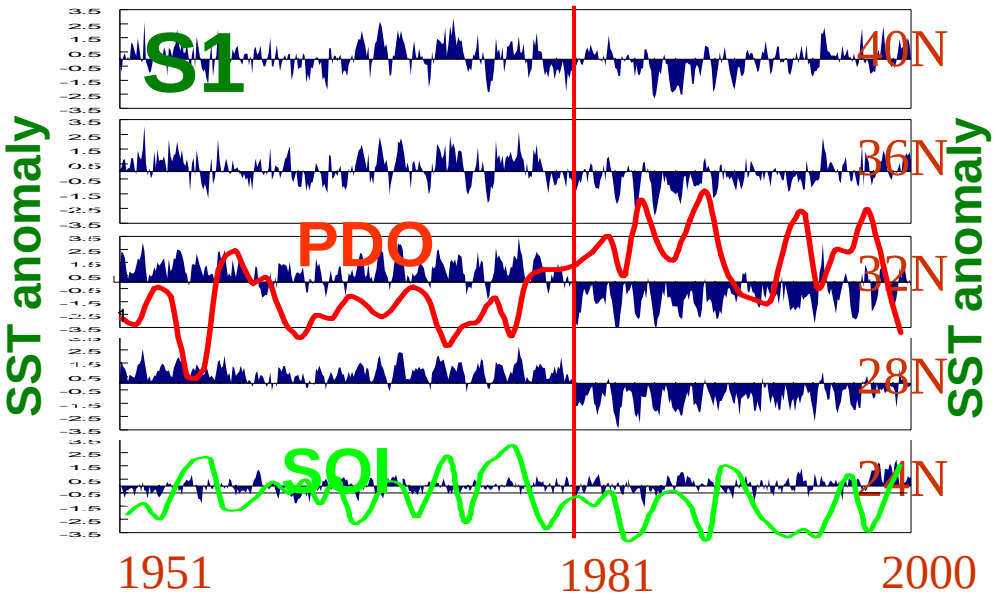


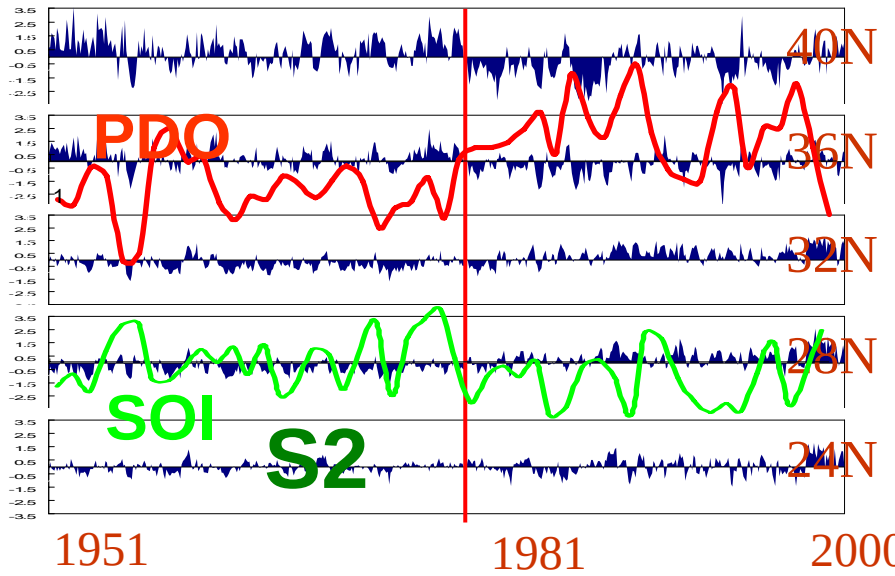

Recruitment (million)
3000
2500
2000
1500
1000
500
0
0
100
200
300
400
500
600
700
800
Spawner (kmt)
B-H
Ricker


3000
2500
2000
1500
1000
500
0
R(million)
0
100
200
300
400
500
600
700
Spawner(kmt)
HR/LS
HR/HS
LR/LS
LR/HS
95
94
85
77
93
81
76
87
80
86
02
03
99
97
01
00
04
06
05
79
89
88

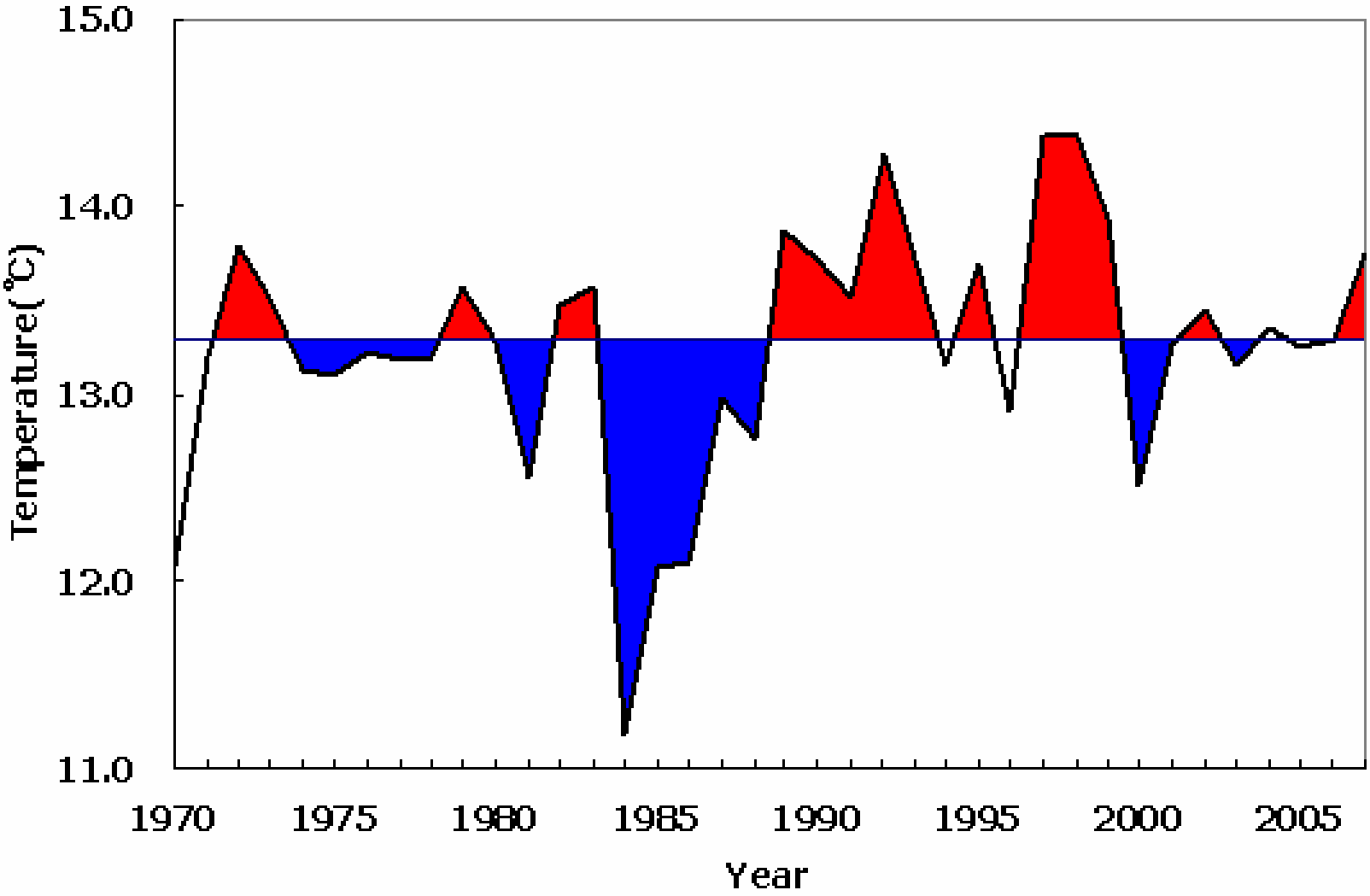

Recruitment (million)
3500
3000
2500
2000
1500
1000
500
0
0
100
200
300
400
500
600
700
800
Spawner (kmt)
HR-HS
LR-HS
HR-LS
LR-LS

2. Relationship between climate indices and catches of chub mackerel

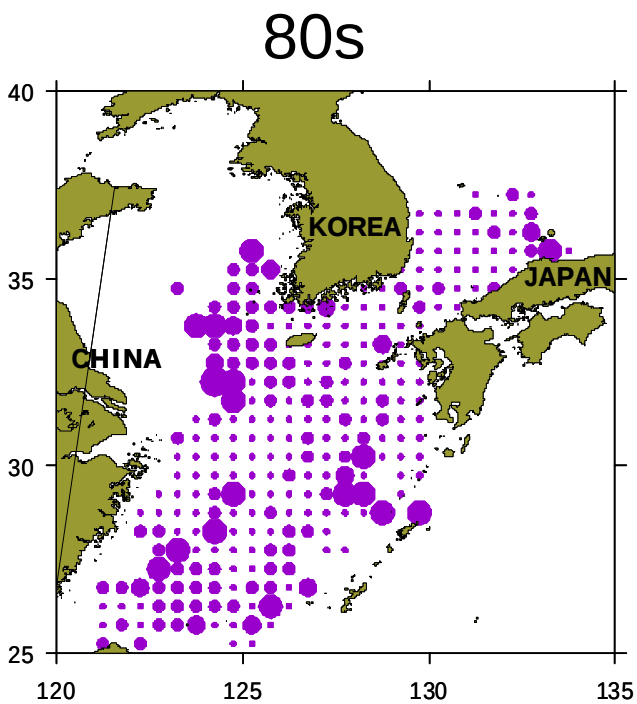


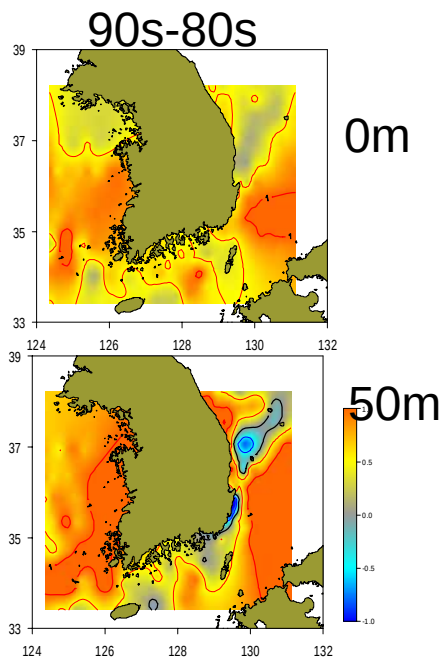


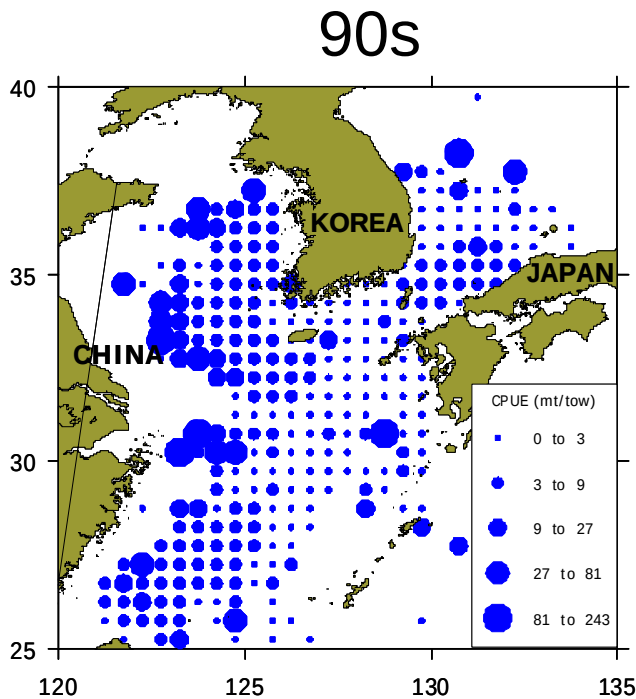
- There is evidence of inverse phase relationships in SST anomalies between S1 and S2
- A quasi-decadal signal in SST anomaly seems to have a link with PDO: patterns in PDO and SST were opposite before and after 1981.


15.0
14.0
13.0
12.0
11.0
Temperature(℃)
1970
1975
1980
1985
1990
1995
2000
2005
Year

3. Distribution of chub mackerel and Seawater Temperature



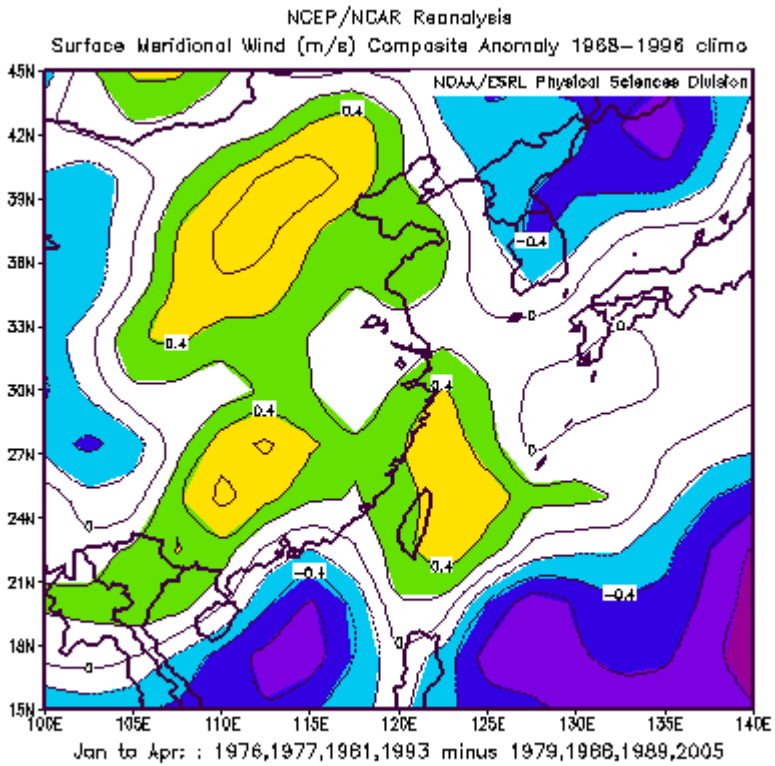




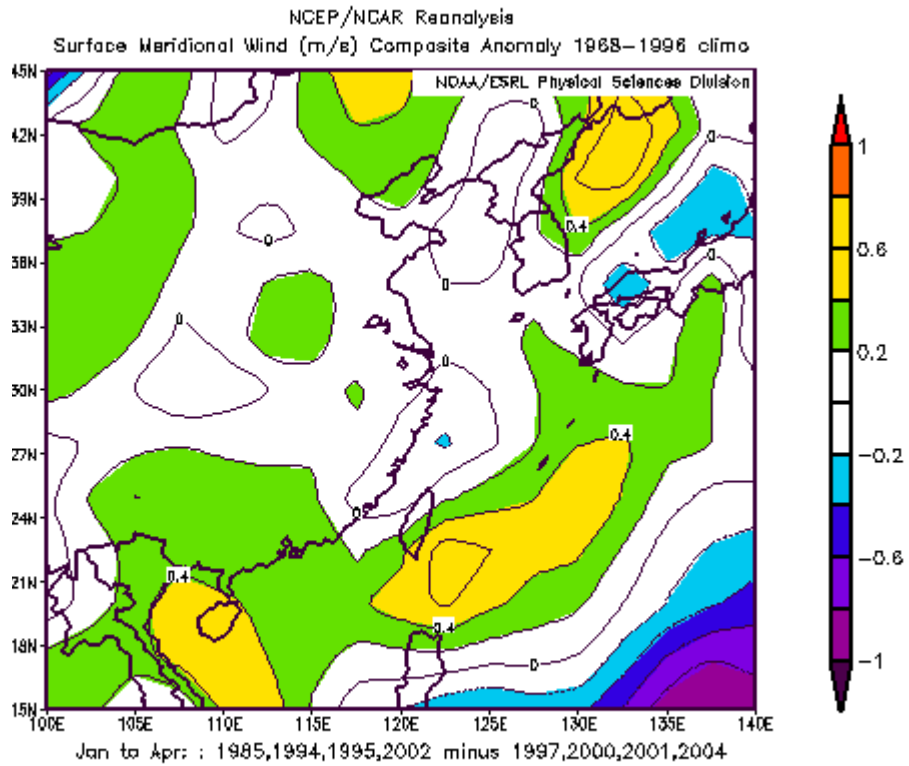
- More fishing activities were found in the southern YS, EJS, and the northern Taiwan area during the warm periods (’90s).
- Due to the SST increase in the 1990s, the habitat of chub mackerel seemed to expand to the north.

4. Recruitment, Spawner and Wind

HR/HS – LR/HS



HR/LS-LR/LS



- Recruitment is higher when the winds are greater from the south across the shelf break of the East China Sea northeast of Taiwan.
- This sense of the winds that should produce greater flow of open ocean water (greater fraction of the Kuroshio) into the East China Sea, and higher salinity

Conclusions

- A quasi-decadal signal was observed within SST anomalies in the Northwestern Pacific, including the East China Sea.

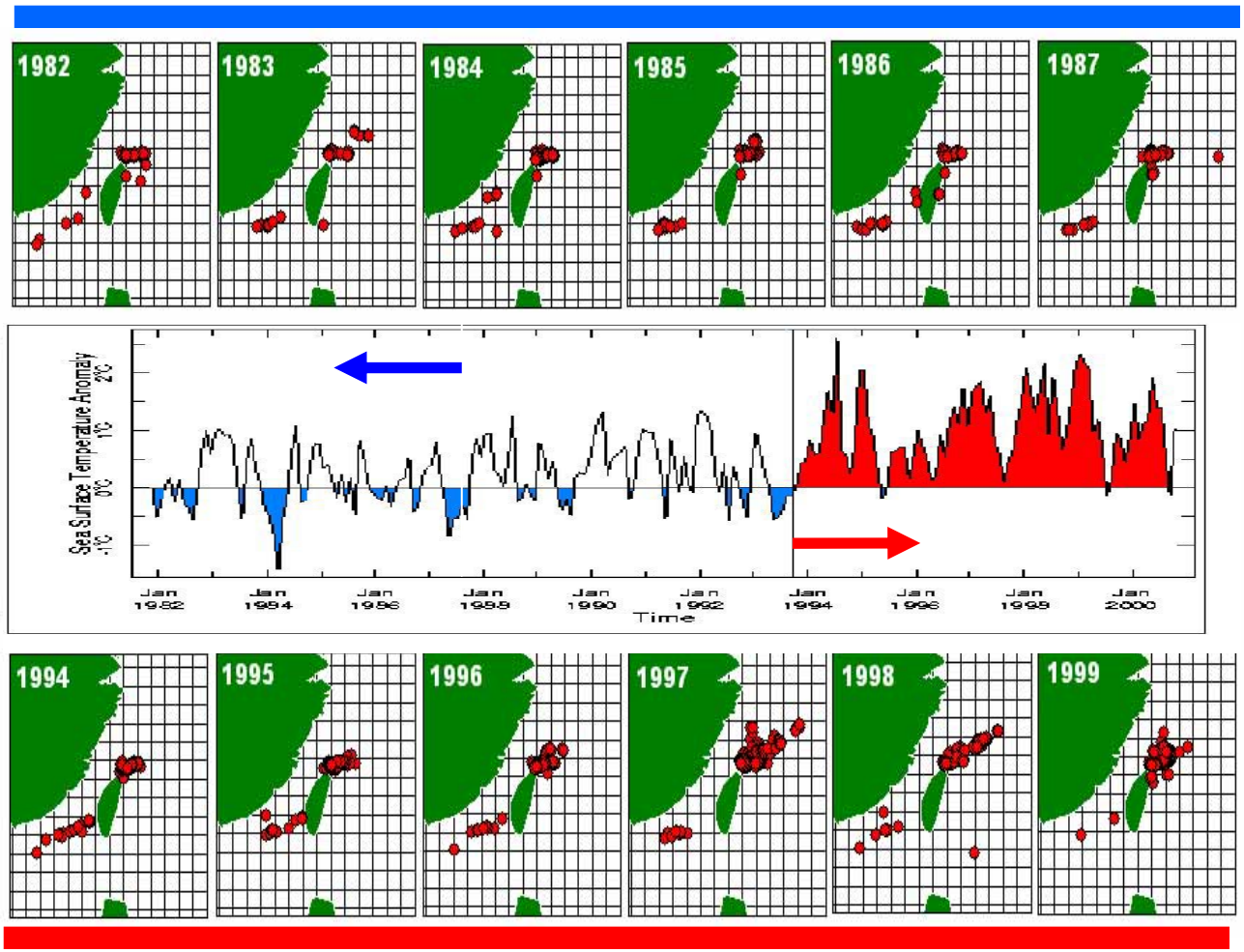
- Catch fluctuations track the quasi-decadal variability in the SST anomaly and ENSO signals.

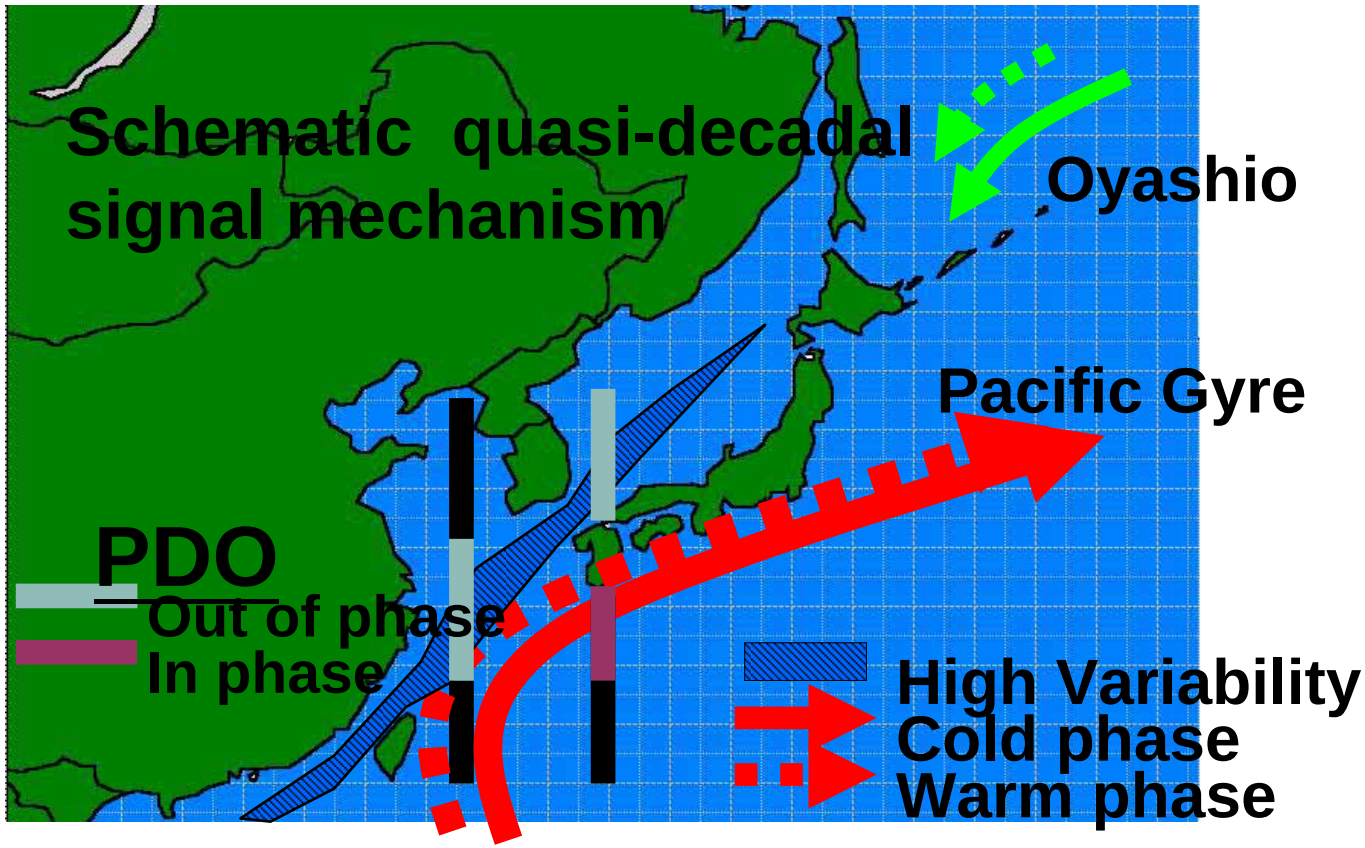
- The fishery location shifts to the north during the warm phase.

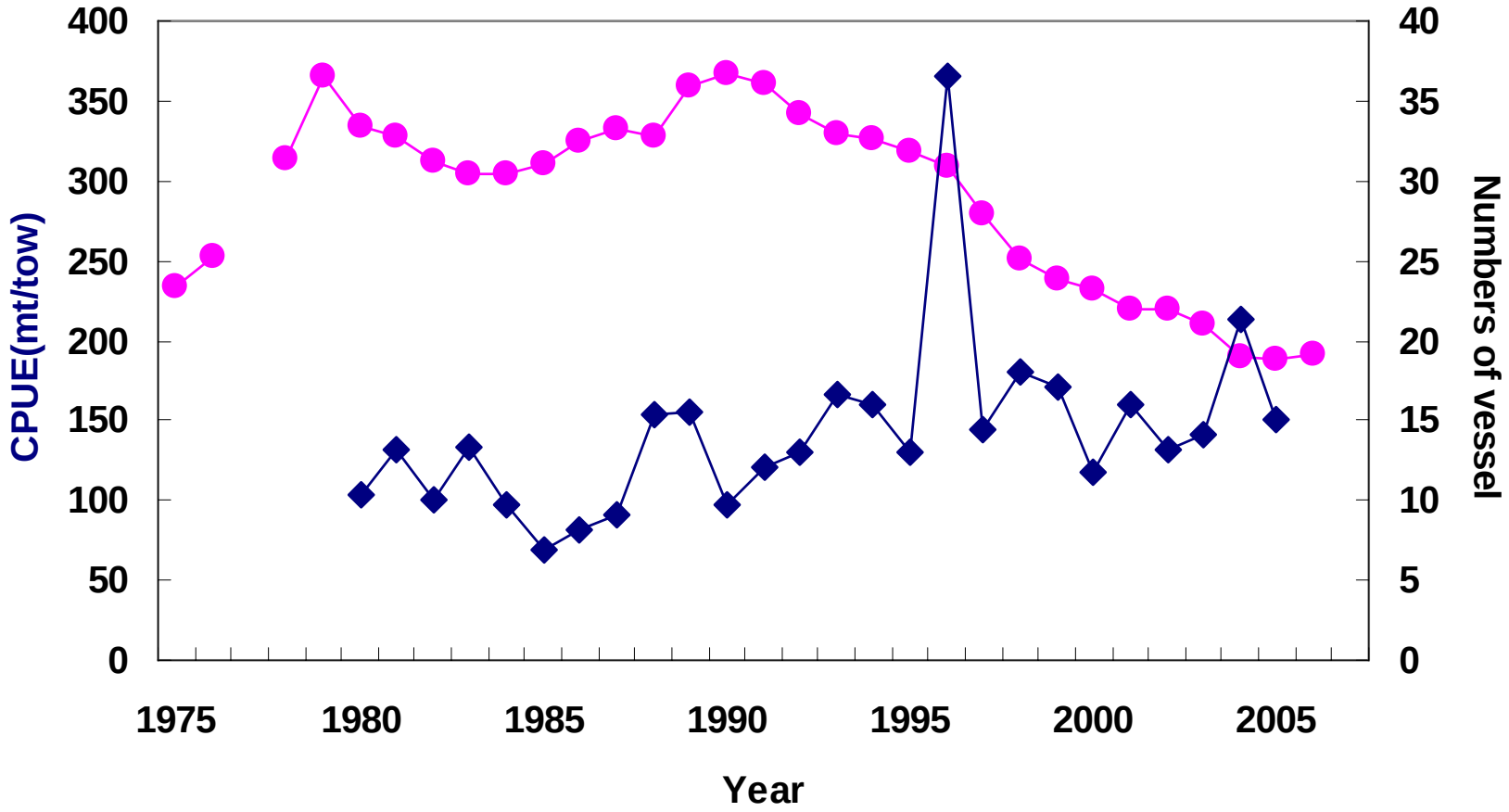
- When Tsushima current is strong, chub mackerel larvae are advected into Korean waters, which confirms the relationship between salinity and recruitment success of this species.

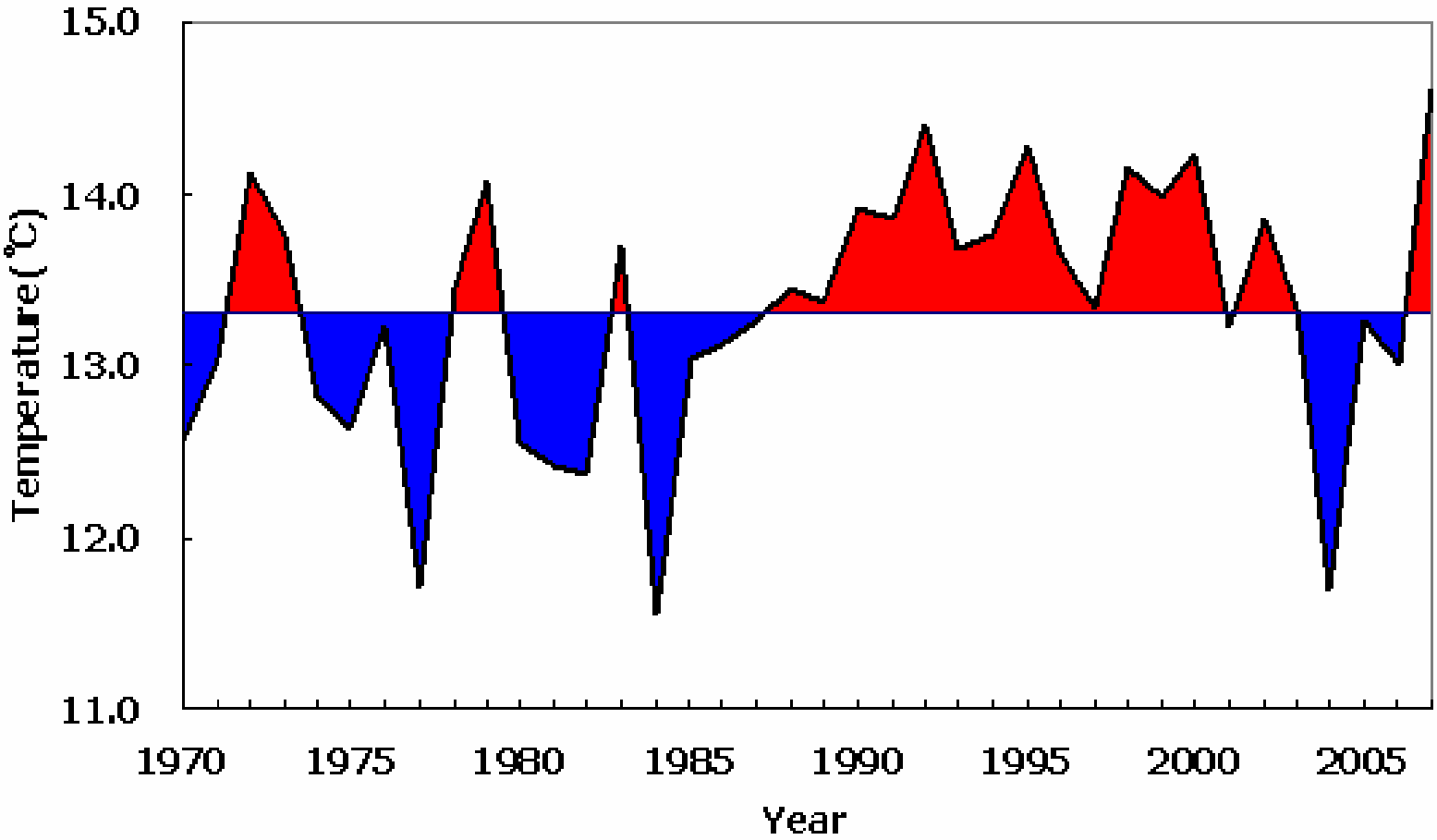
Thank you

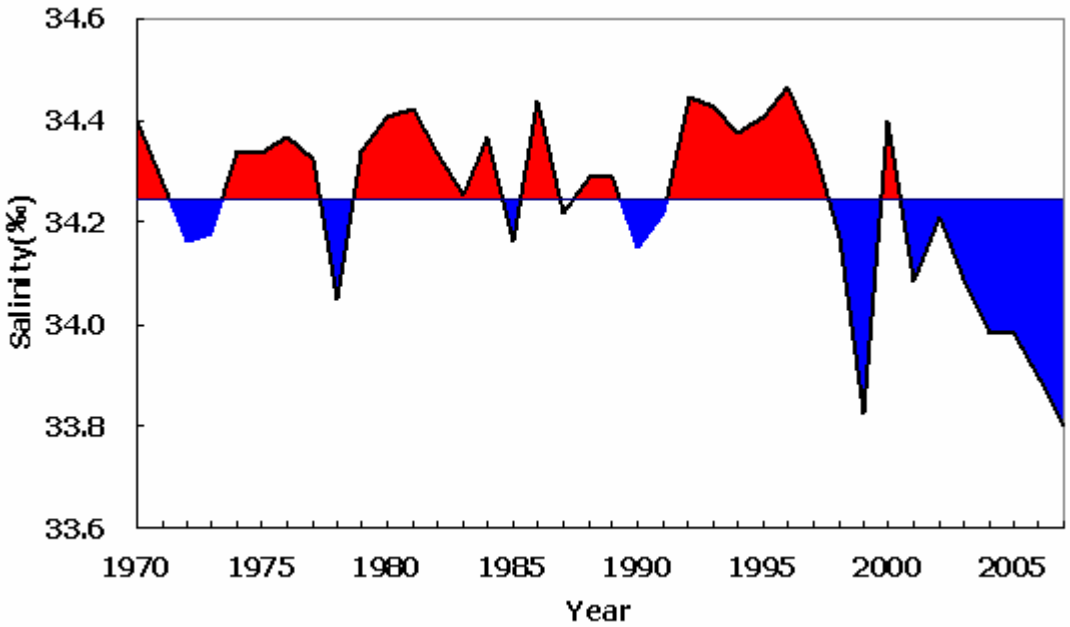
3. Distribution of chub mackerel and Sea Surface Temperature

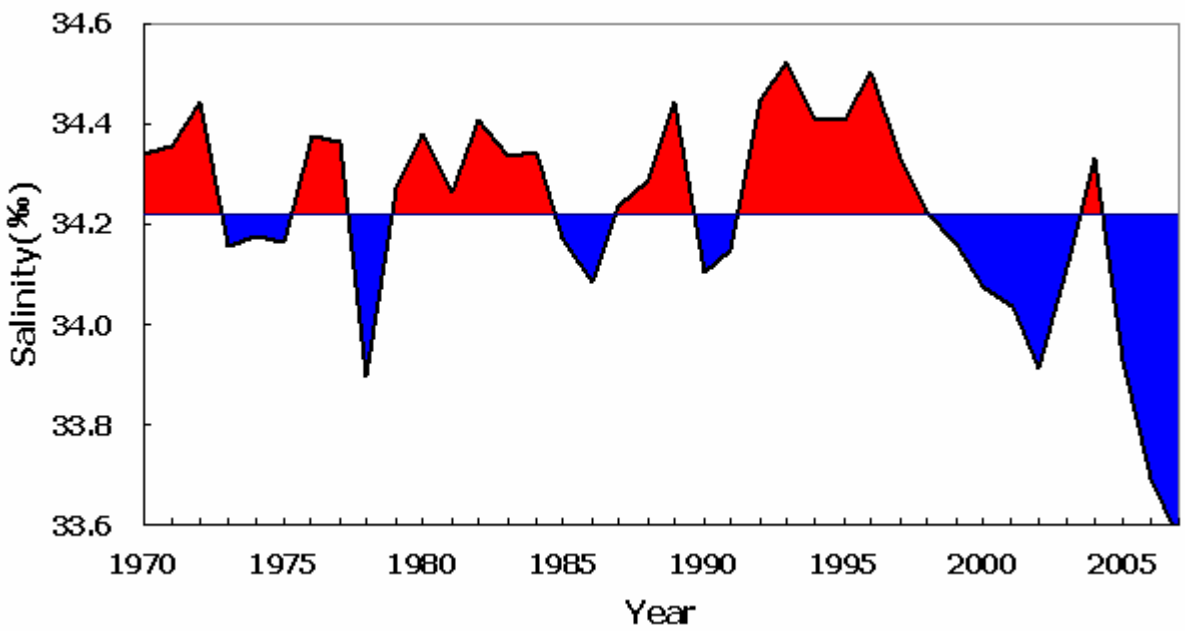



Schematic quasi-decadal signal mechanism
Oyashio
Pacific Gyre
PDO
Out of phase
In phase
High Variability
Cold phase
Warm phase


CPUE(mt/tow)
Numbers of vessel
Year
400
350
300
250
200
150
100
50
0
40
35
30
25
20
15
10
5
0
1975
1980
1985
1990
1995
2000
2005


15.0
14.0
13.0
12.0
11.0
Temperature(℃)
1970
1975
1980
1985
1990
1995
2000
2005
Year


34.6
34.4
34.2
34.0
33.8
33.6
Salinity(‰)
1970
1975
1980
1985
1990
1995
2000
2005
Year


34.6
34.4
34.2
34.0
33.8
33.6
Salinity(‰)
1970
1975
1980
1985
1990
1995
2000
2005
Year