Alternation of dominant fisheries species in the southwestern Japan/East Sea in relation to climat change since 1968

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Outline of Talk

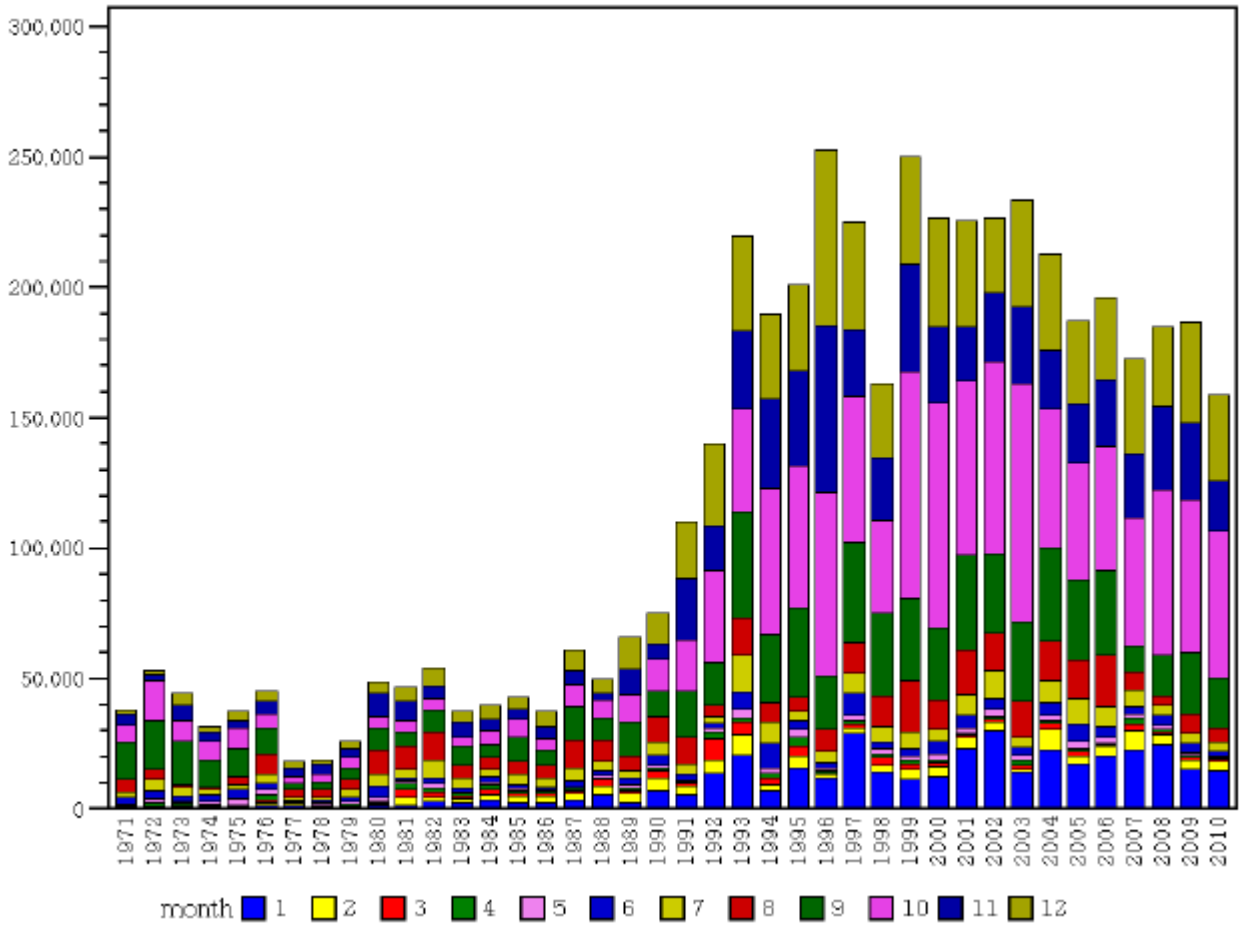
- Fluctuations of 5 dominant commercial fisheries species in the Korean side of the Japan/East Sea
- Role of the strength of the Tsushima Warm Current in determining recruitment of major fisheries species
- Vertical distribution of egg and Climate change
  - pelagic vs. demersal

Proposed long-term monitoring lines for NFRDI

Questions

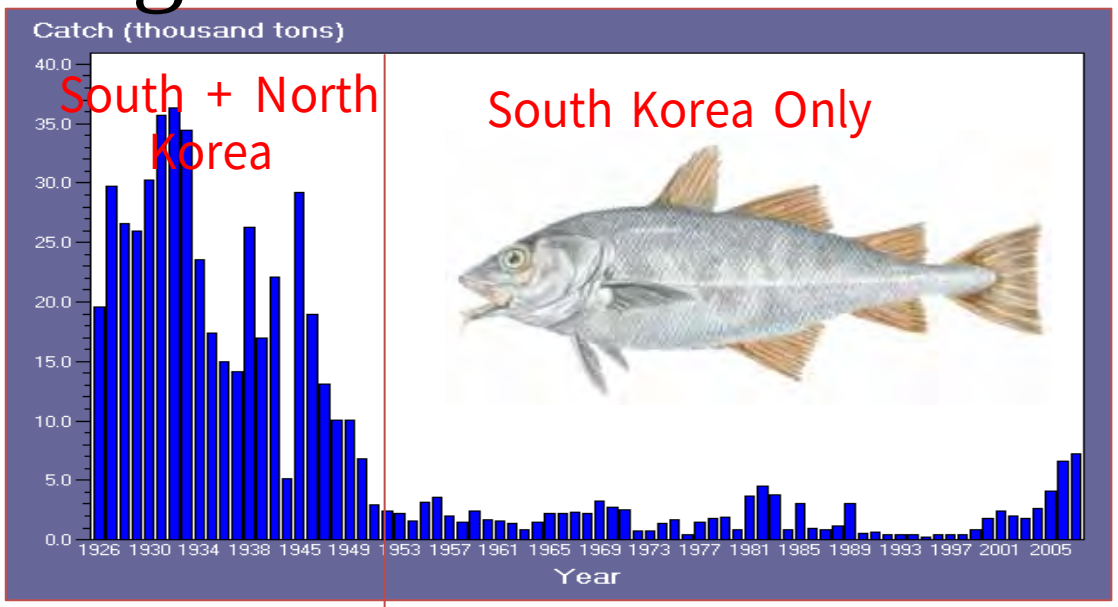
- Most fish species showing greater recruitment variability are caught along the Tsushima Warm Current
- Alternations of dominant fish species
  - Gadoids: Cod vs. Pollock
  - Clupeids: Herring vs. Sardine
  - Invertebrate: Common squid
- Roles of climate change

Landings of common squid in Korea 1971-2010, metric ton

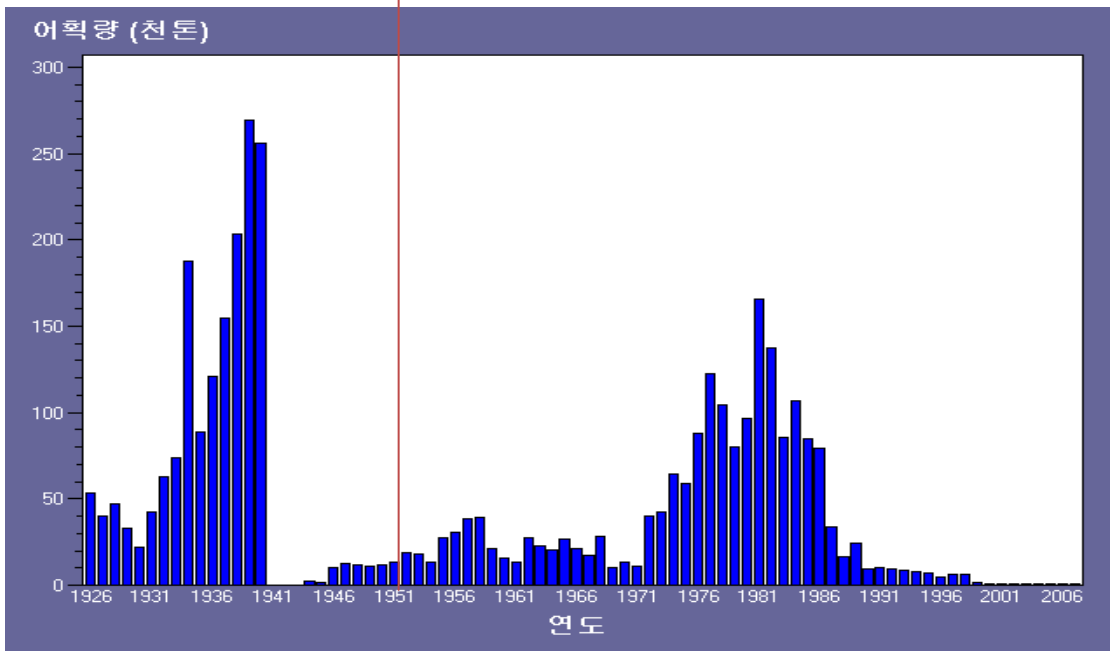


Landings of Pacific cod in Korea

Cod catch



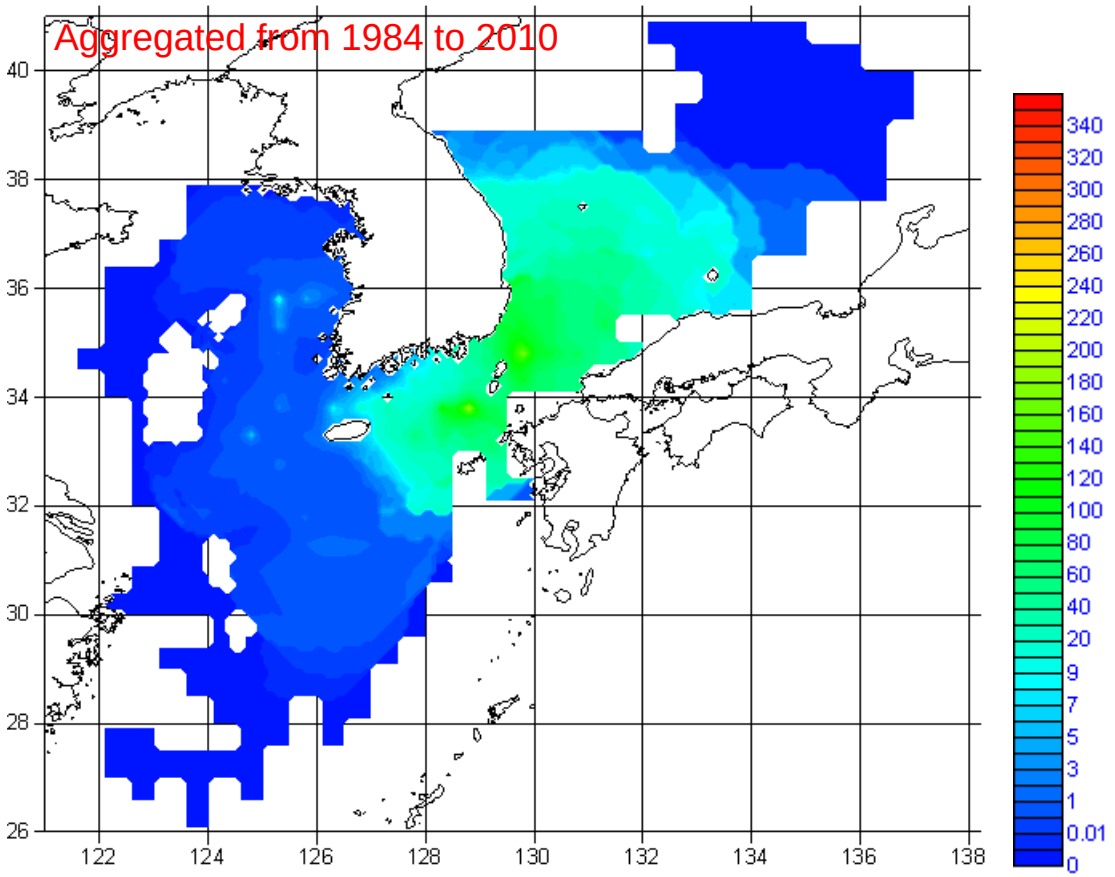
Pollock catch



Eggs

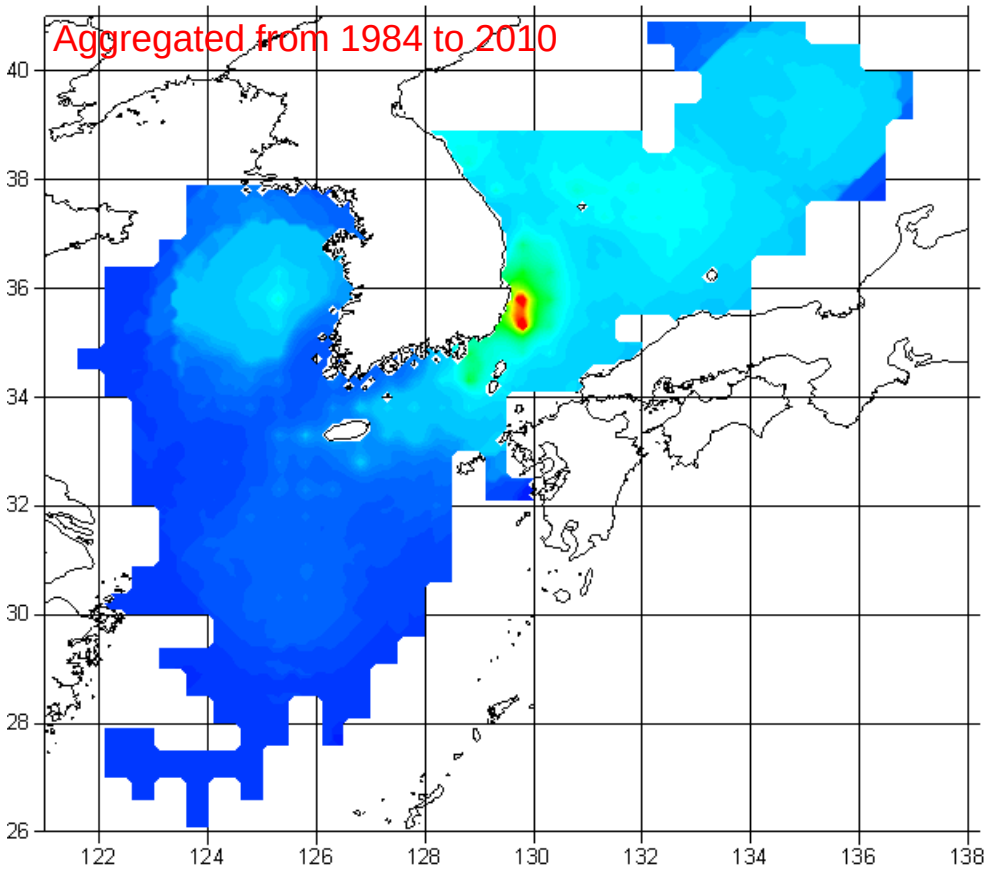
- Pelagic: pollock, sardine, common squid
  - Surface temperature could be important in hatching
- Demersal/Adhesive: cod, herring
  - Bottom temperature could be important in hatching

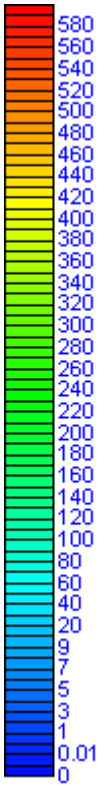
Sardine Mean catch level (1984-2010) based on location reports from fishing boats



kg km^{-2}

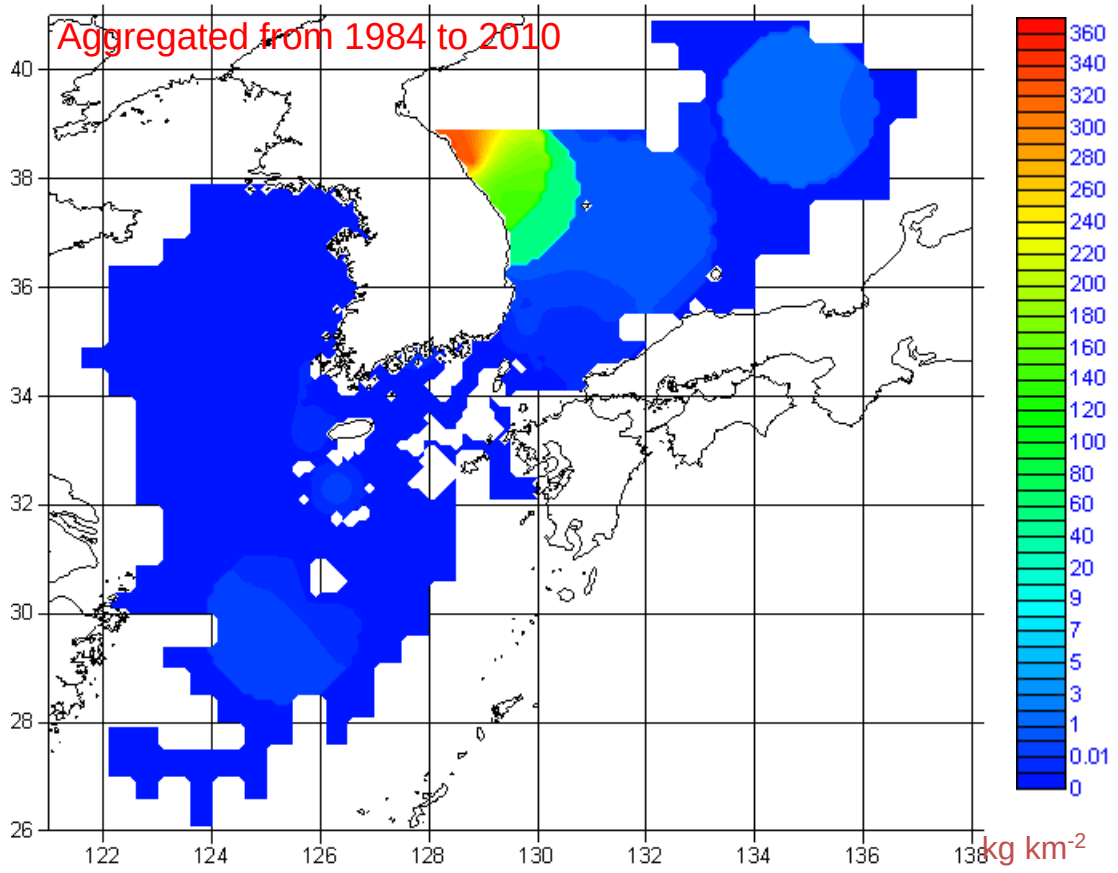
Squid Mean catch level (1984-2010) based on location reports from fishing boats





kg km^{-2}

Pollock Mean catch level (1984-2010) based on location reports from fishing boats



Cod, Mean catch level (1994-2008) based on location reports from fishing boats

East Sea

Yellow Sea

Main Spawning ground
(Jinhae Bay)

Spring migration

Winter migration

Korea Strait

※ Catch by gillnet is underrepresented.

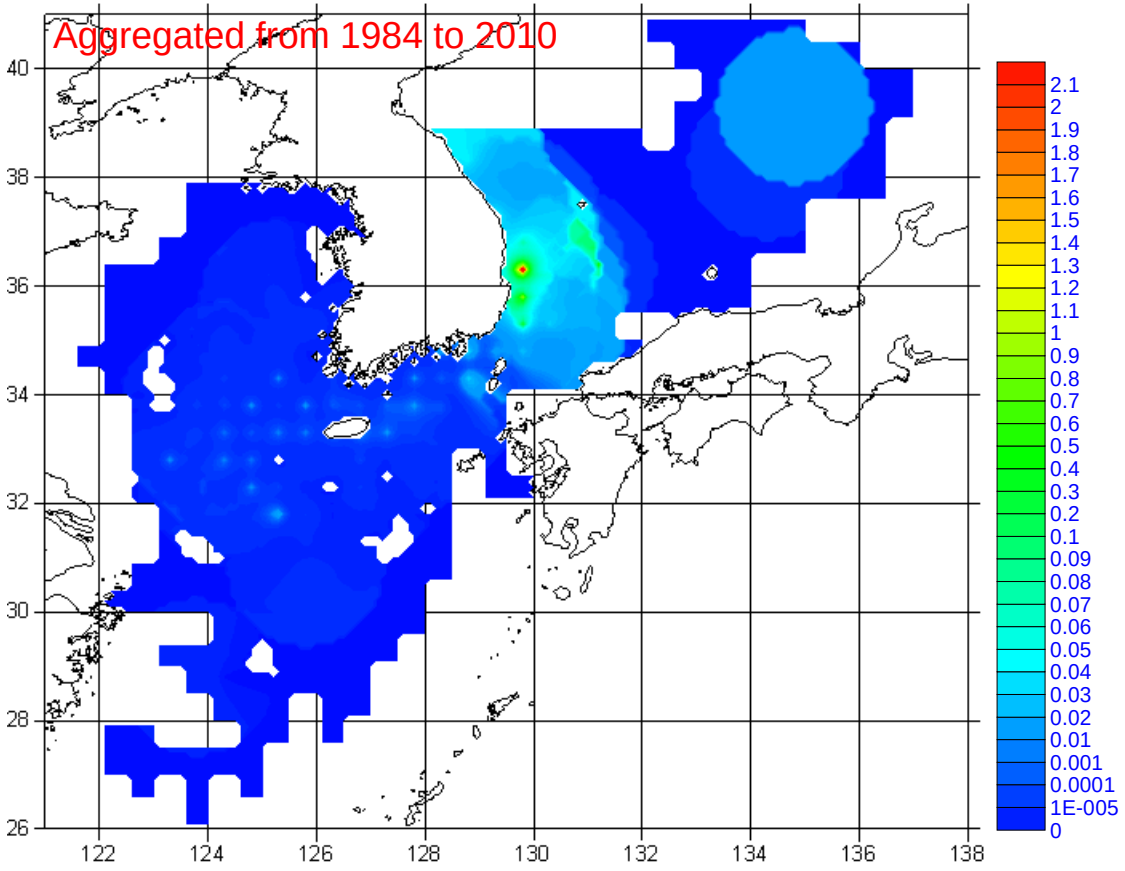
40
38
36
34
32
30
28
26

122
124
126
128
130
132
134
136
138

2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.001
0.0001
1E-005
0

kg km^{-2}

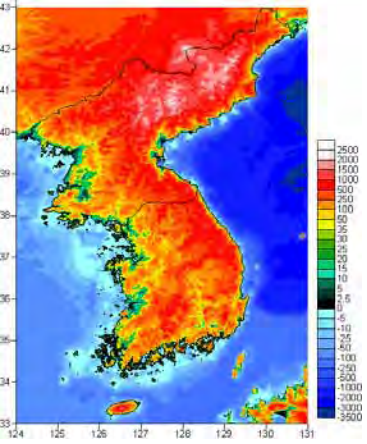
Herring, Mean catch level (1984-2010) based on location reports from fishing boats

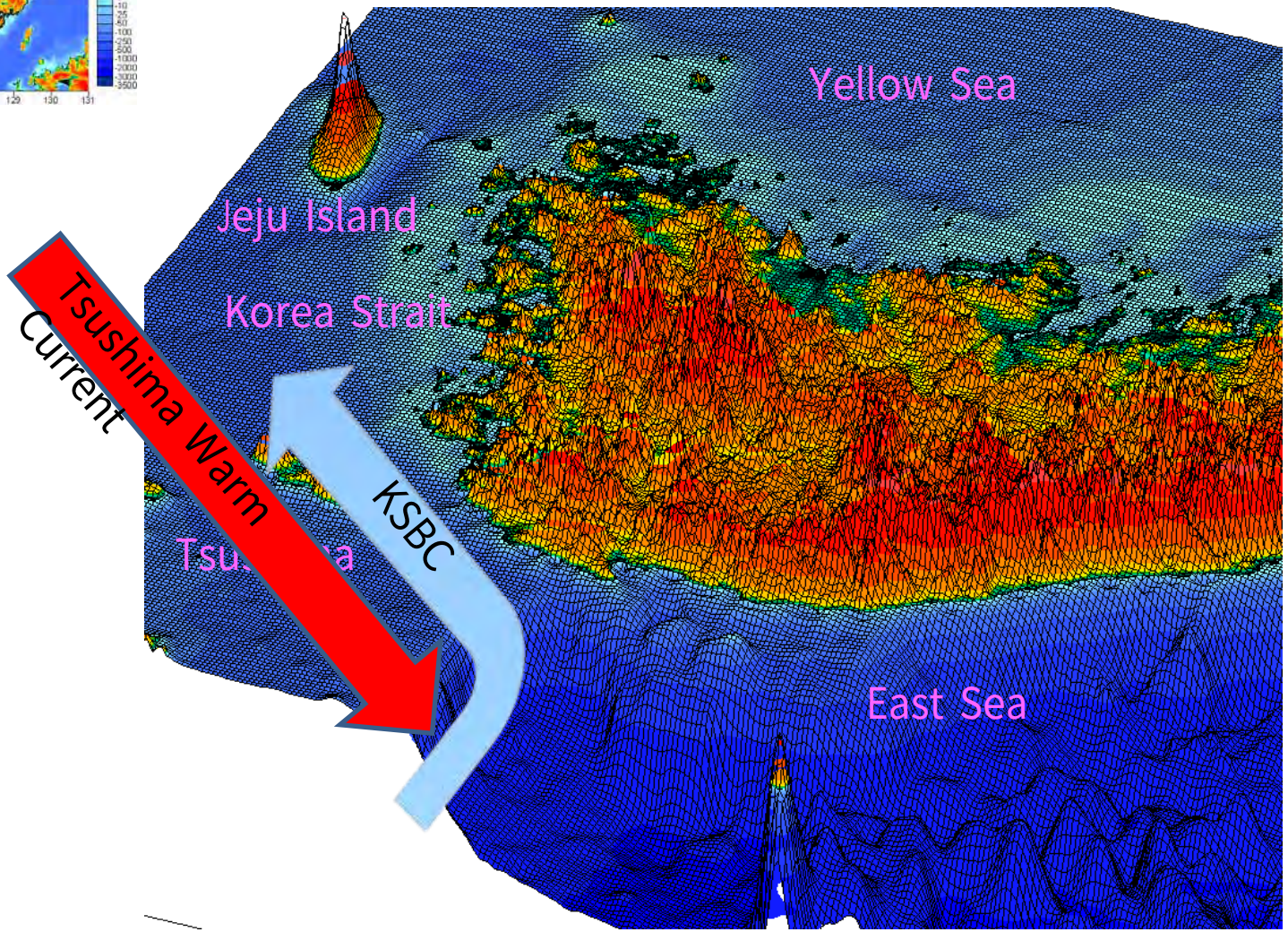


Generally spatially overlapped with Pacific cod.
Like cod, they spawn in shallow coastal areas.

kg km^{-2}

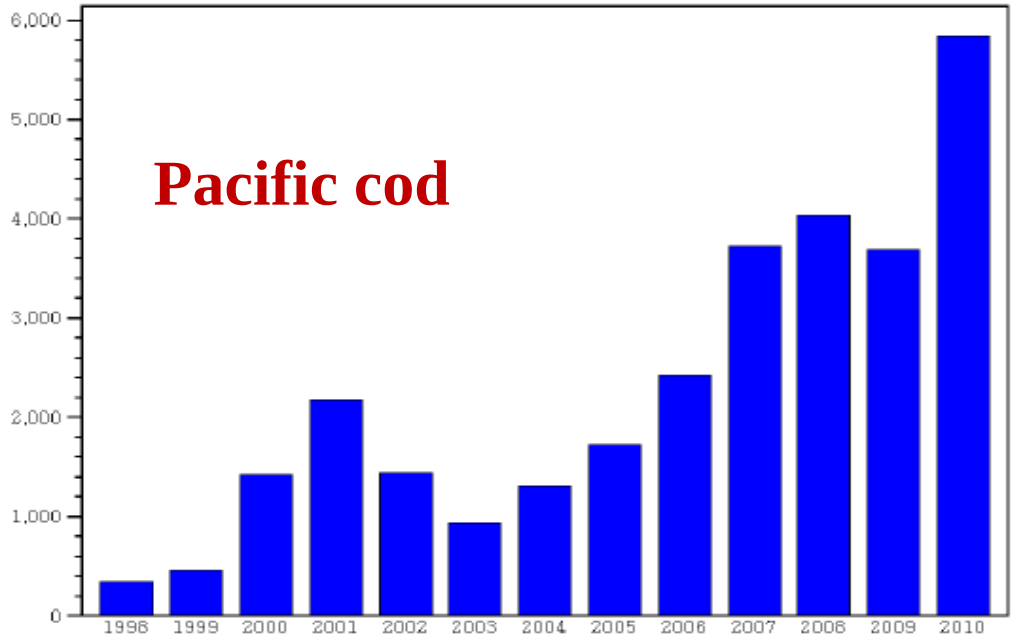
Topography

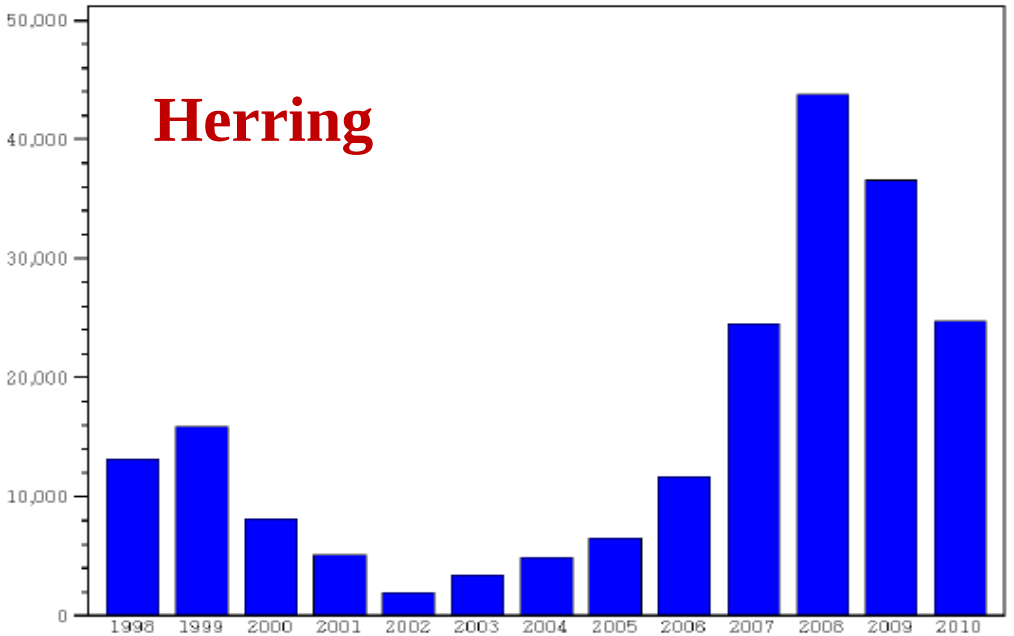



Yellow Sea
Jeju Island
Korea Strait
Tsushima Warm Current
KSBC
East Sea
North

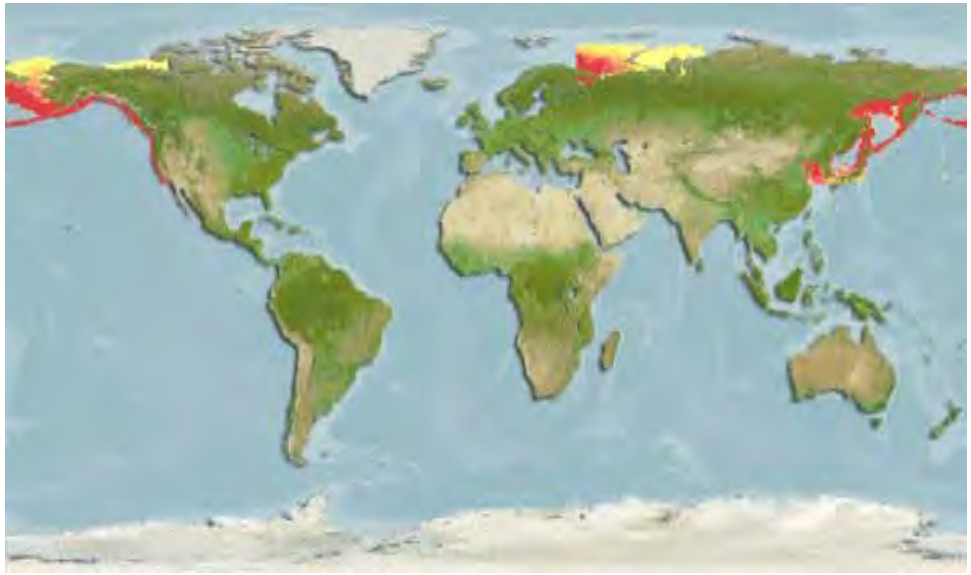
Landings of Pacific cod and Herring from the SW Japan/East Sea 1998-2010

Possible prey-predator interactions t





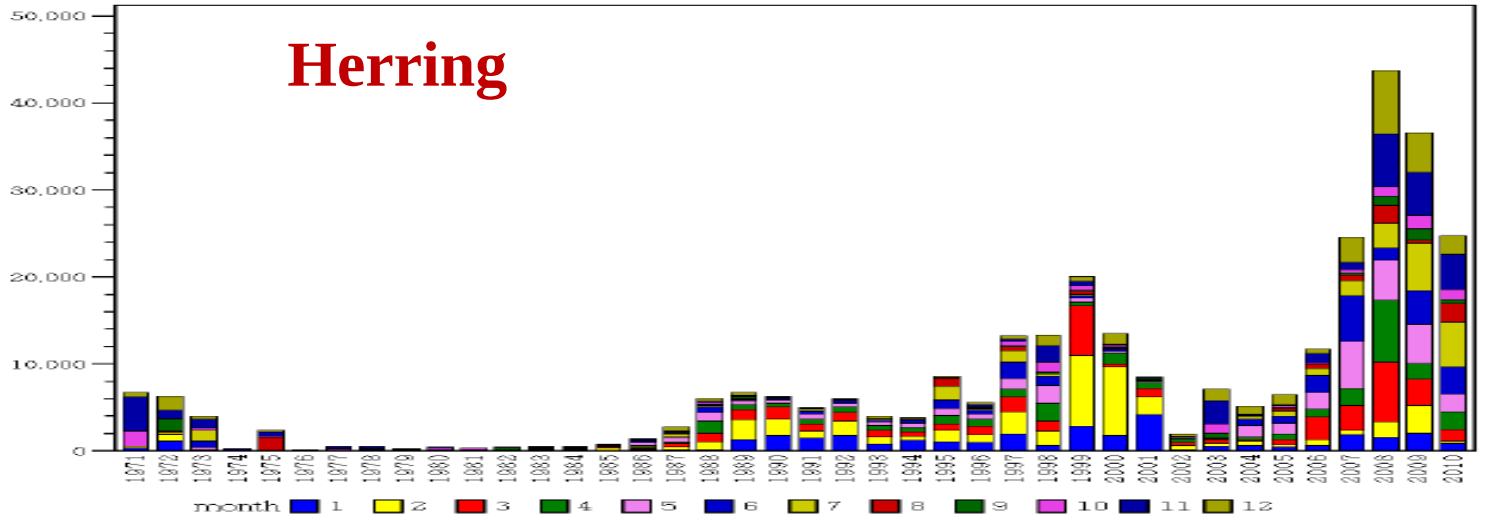
Distribution of Pacific cod and Herring

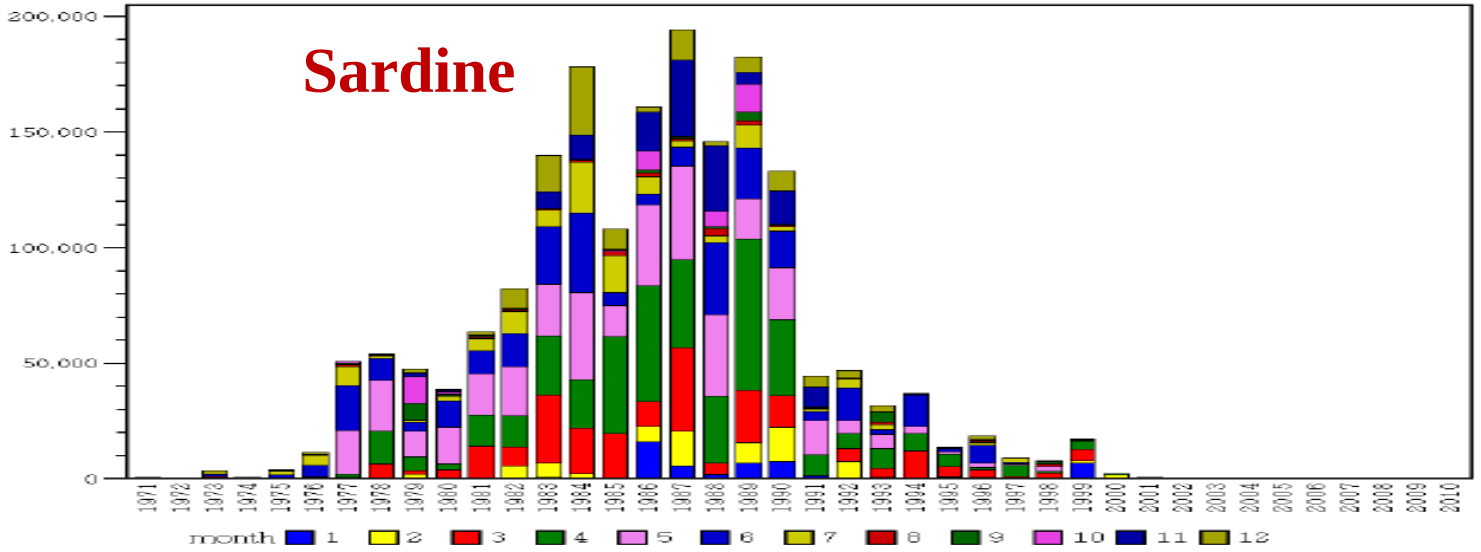


Species	Cod	Herring
Spawning Period	December-February	March-April

Prey-predator interaction with possible match-mismatch

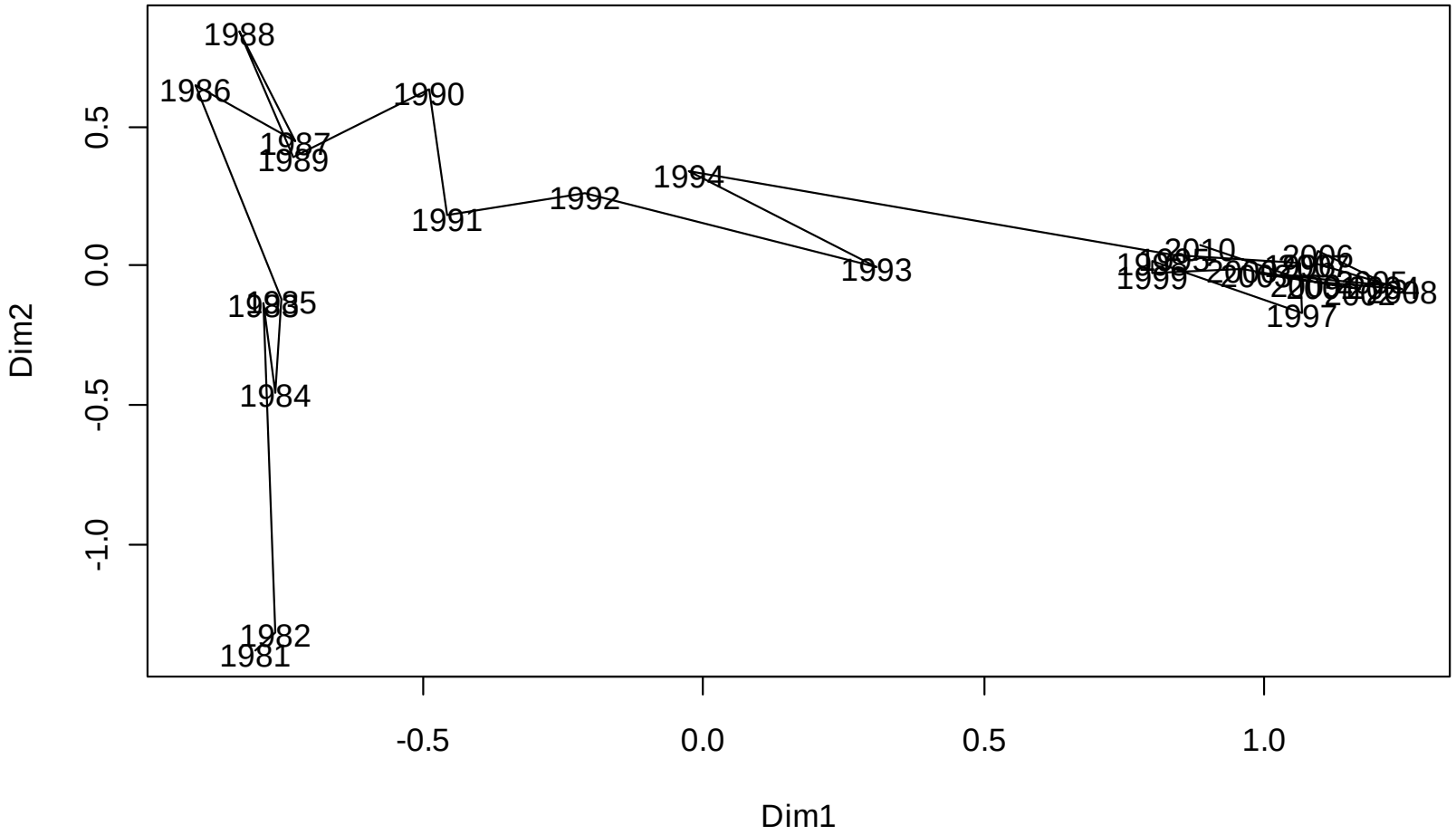
Landings of herring and sardine in Korea, 1971-2010, metric ton





Correspondence Analysis

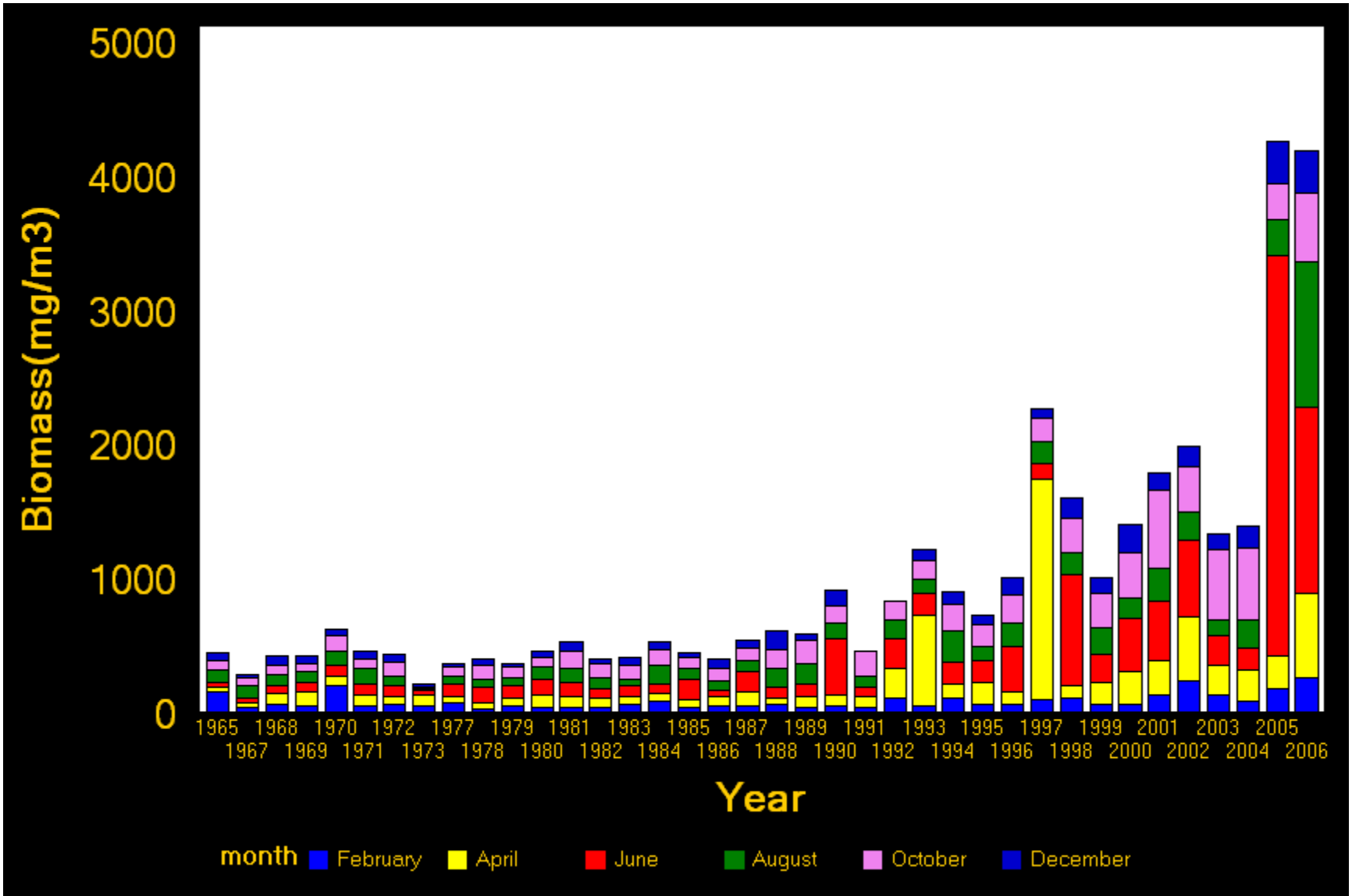
on species biomass composition of fish catch
by Korean fishing vessels in the Japan/East Sea
1981-2010



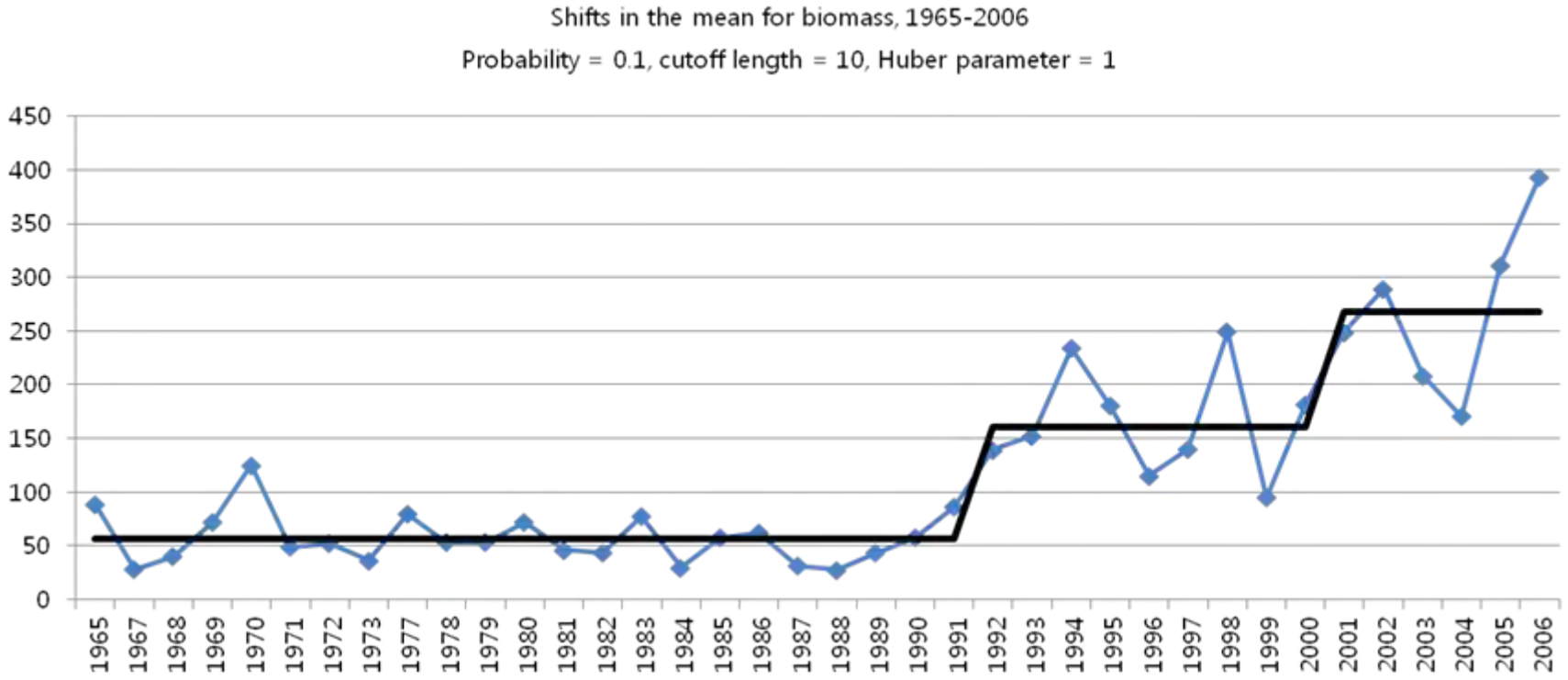
Major shift from 1987 to 1995

Meso- and macro-zooplankton biomass

KODC



Shift detection of zooplankton biomass in the southwestern JES

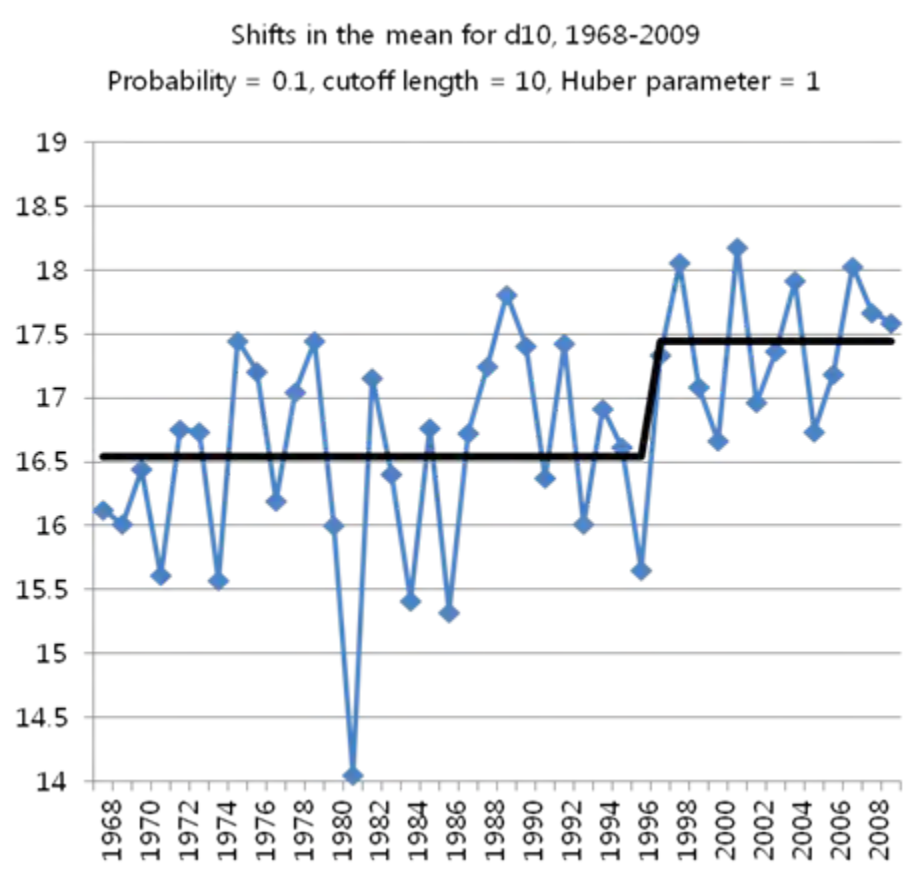


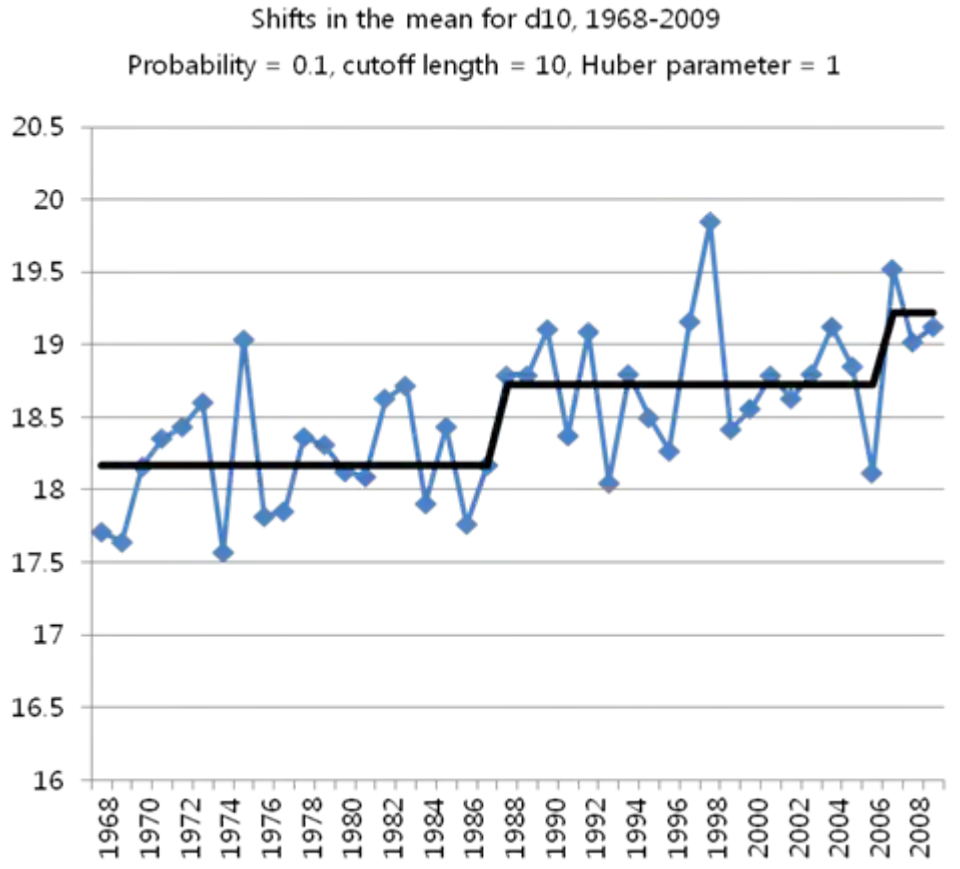
Major shifts in 1992 and 2001.

Bottom-up controls on recruitment of herring and cod?

Shift detection in 10-m Temp.

Japan/East Sea vs. Korea Strait

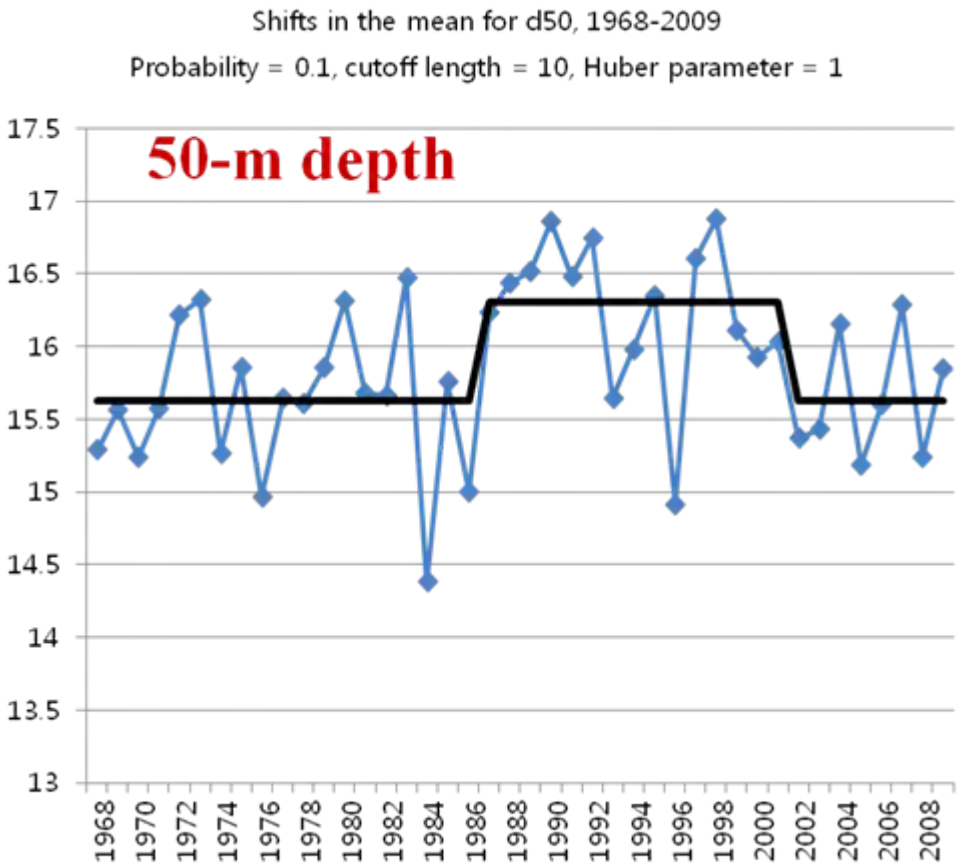




Warming trend, probably disadvantaging recruitment of pollock and sardine

Shift detection in Bottom Temp.

Japan/East Sea vs. Korea Strait



Recent cooling trend, opposite to the surface layer, probably favoring hatch and migration of herring and cod.

Water temperature and hatching rate of cod

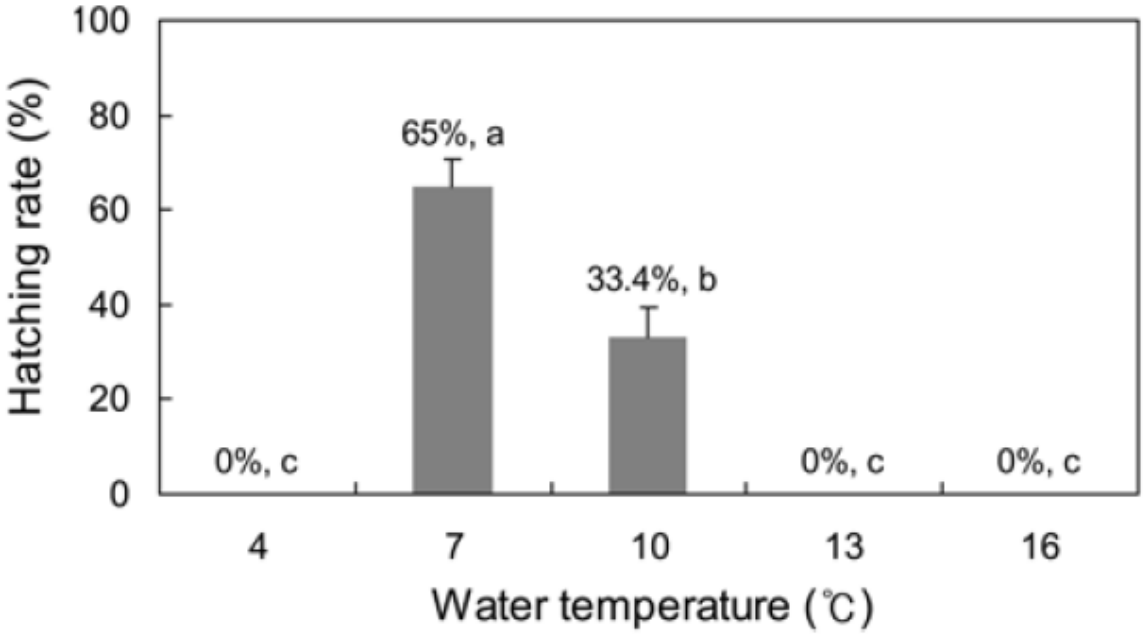
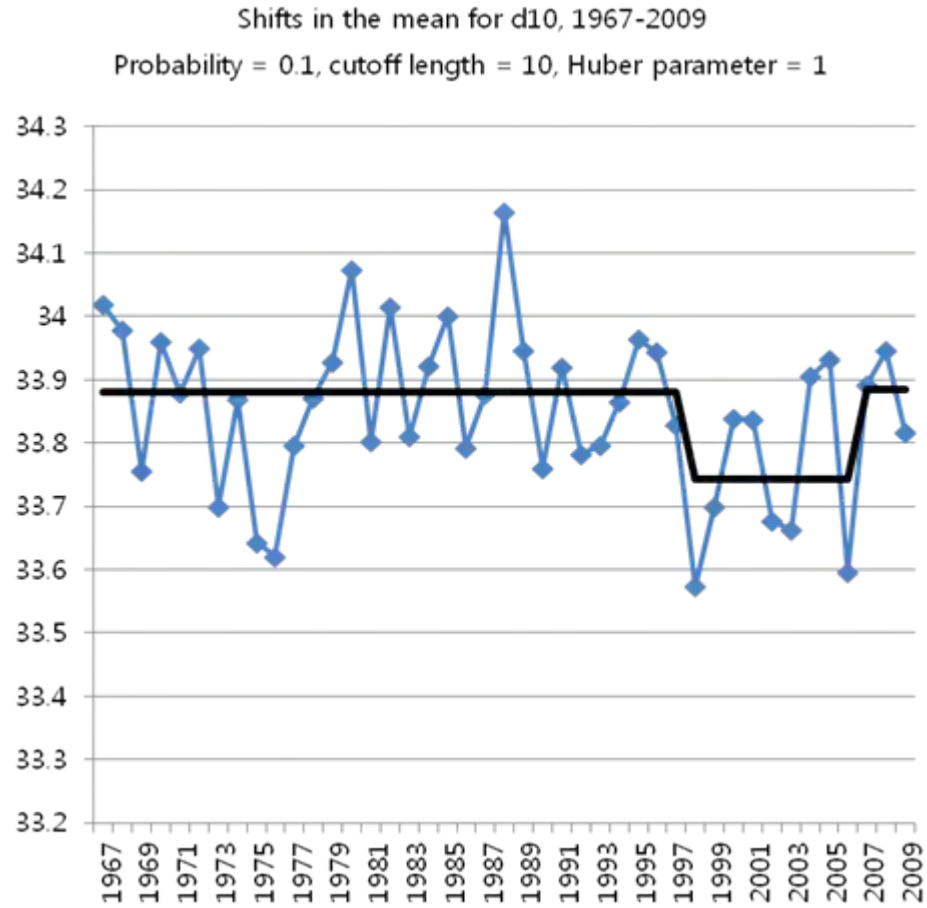


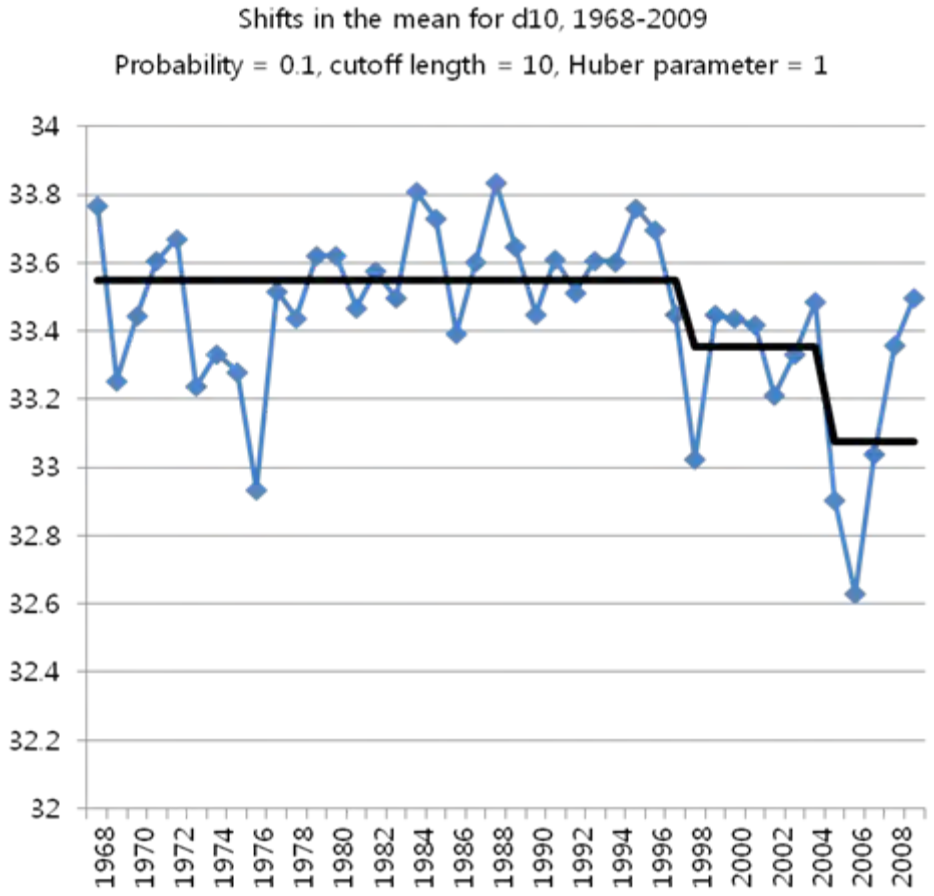
Fig. 5. Hatching rate of the fertilized eggs of Pacific cod *Gadus macrocephalus* at various water temperatures. Each value represents the mean±SD. Different letters indicate significant difference ($P<0.05$).

Lee et al. (2007)

Shift detection in 10-m Salinity

Japan/East Sea vs. Korea Strait

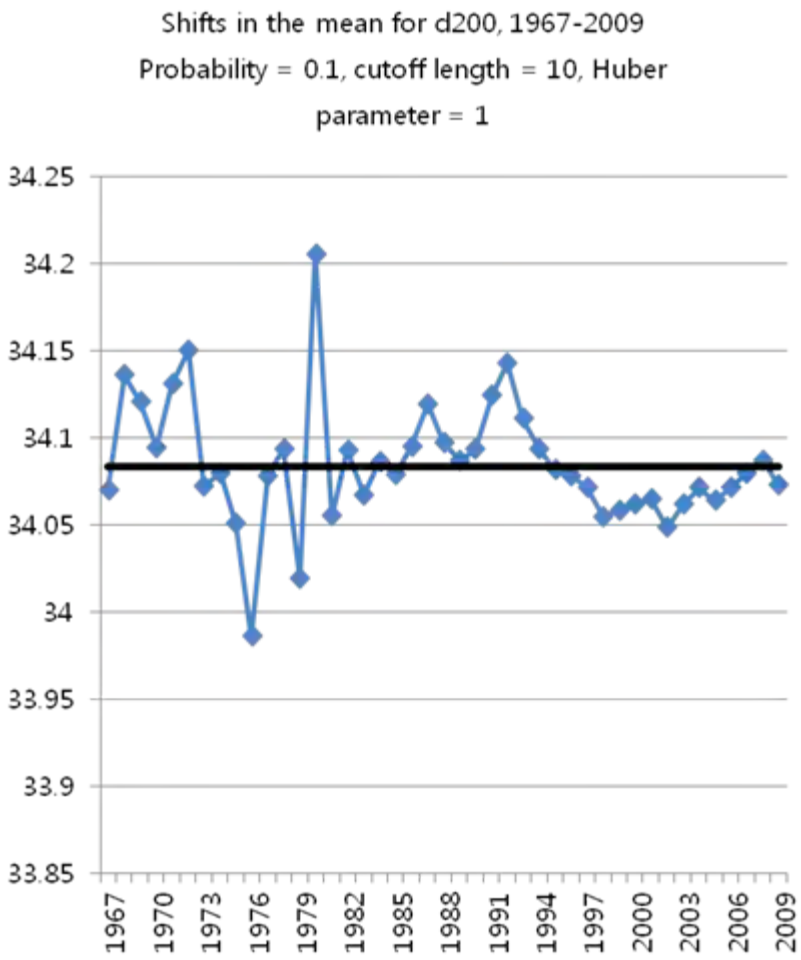


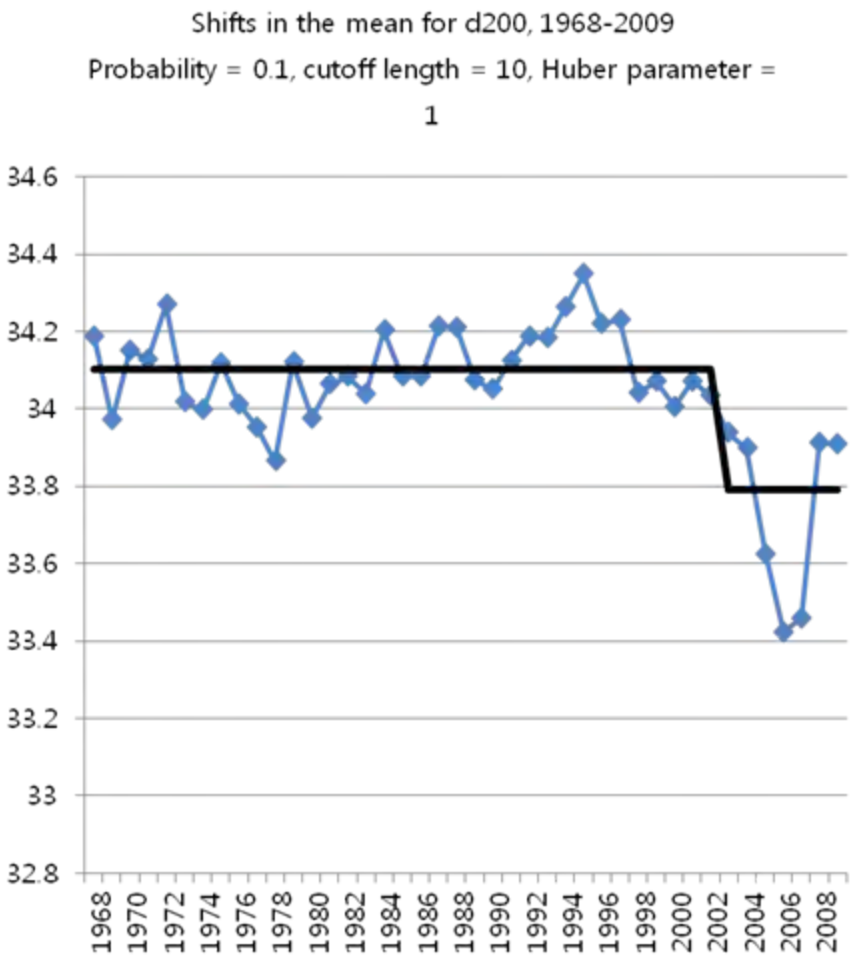


Recent decrease in salinity,
Possible relationship with the TWC strength?

Shift detection in Bottom Salinity

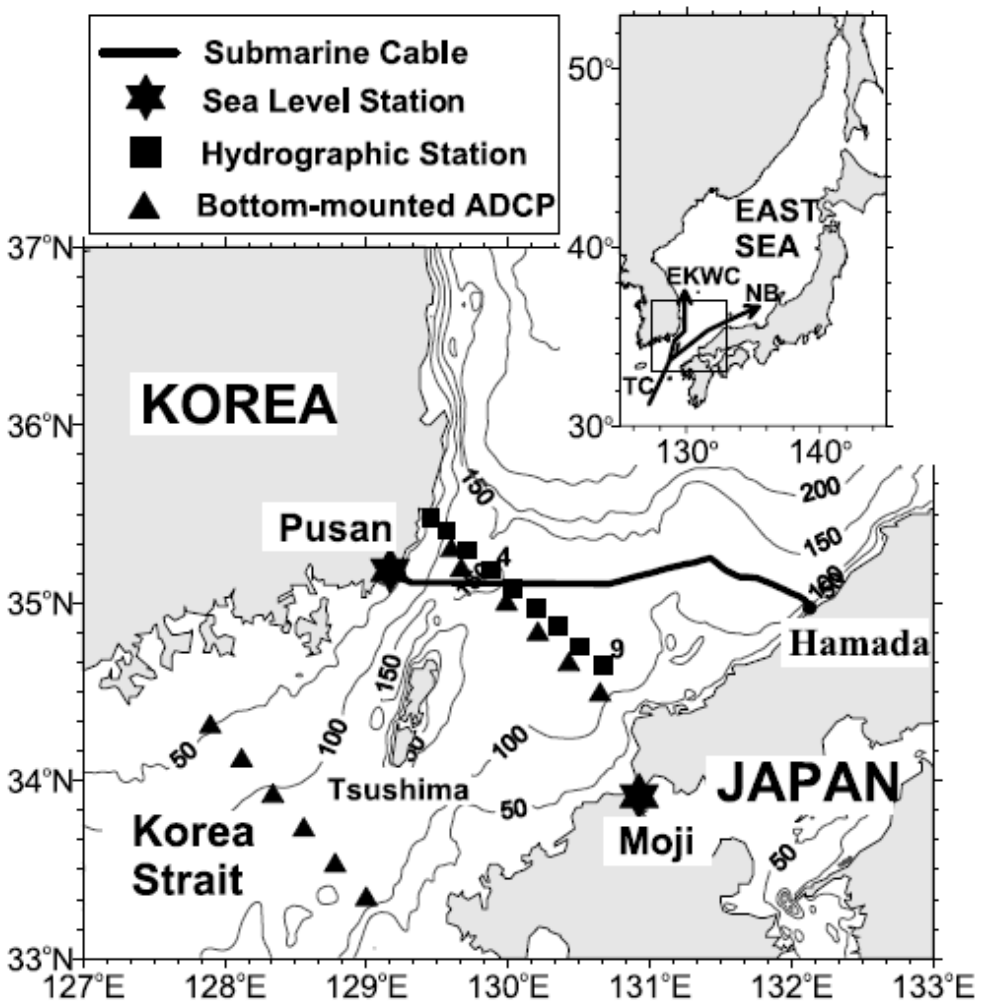
Japan/East Sea vs. Korea Strait





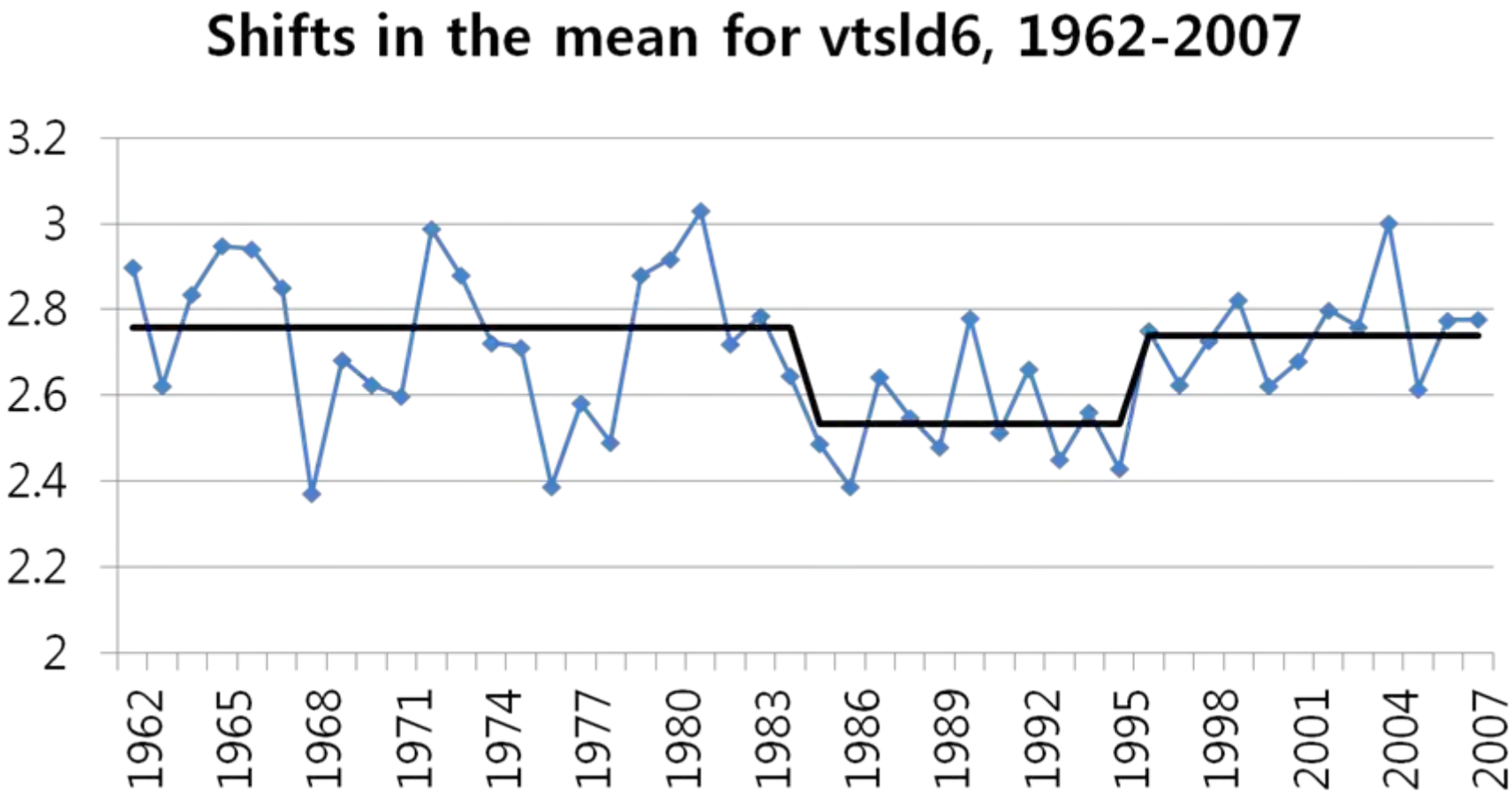
Recent decrease only in the Korea Strait

Volume Transport by the Tsushima Warm Current (1962-2008)



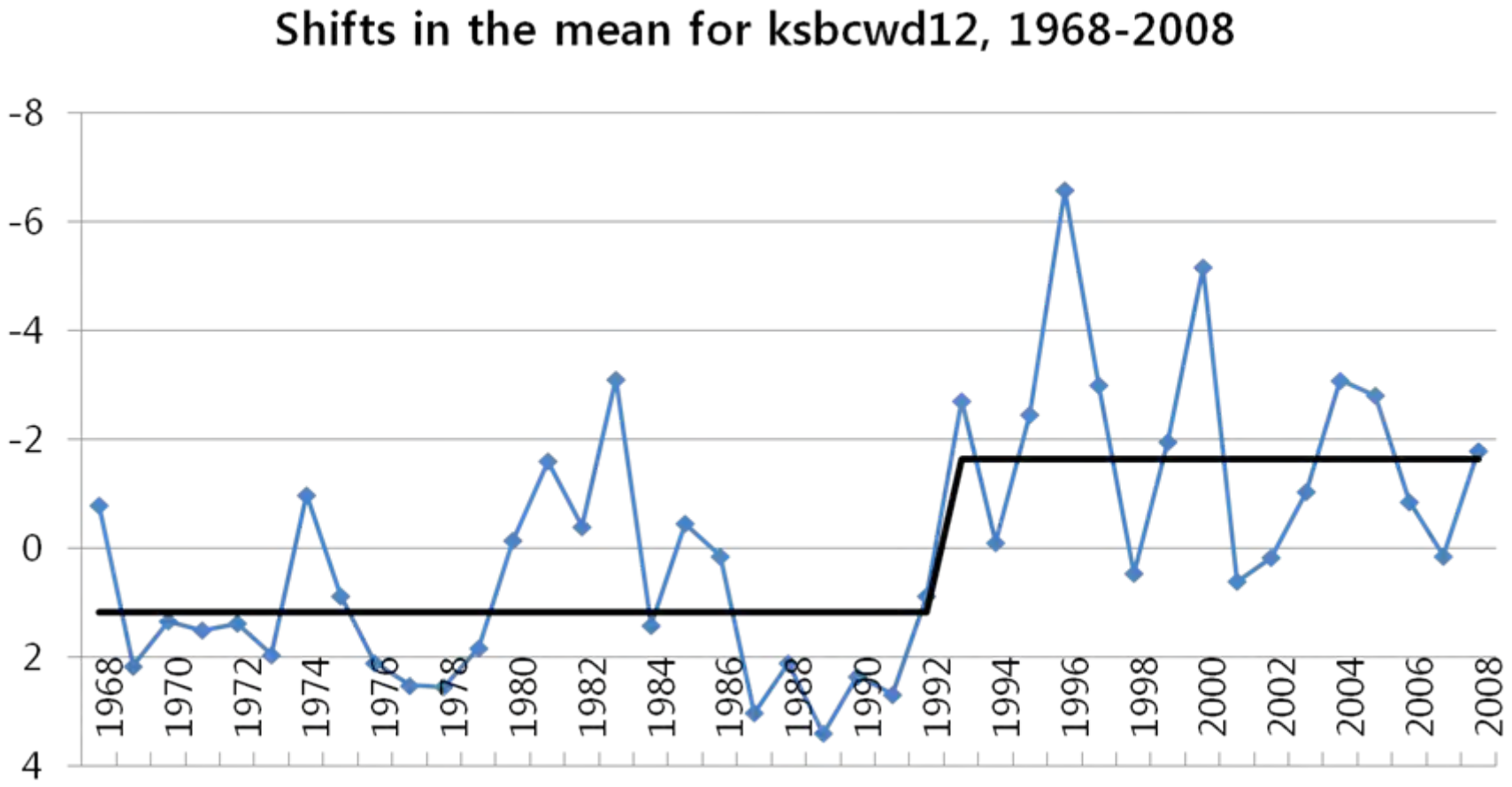
From Lyu & Kim. 2003. Absolute transport from the sea level difference across the Korea Strait. Geophysical Research Letters 30(6): 18-1 - 18-4.

Shifts in June TWC volume transport



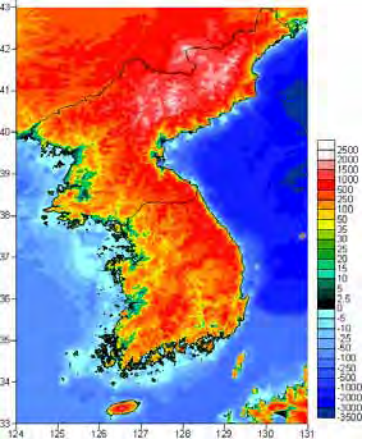
Courtesy of Hanna Na, Seoul National University

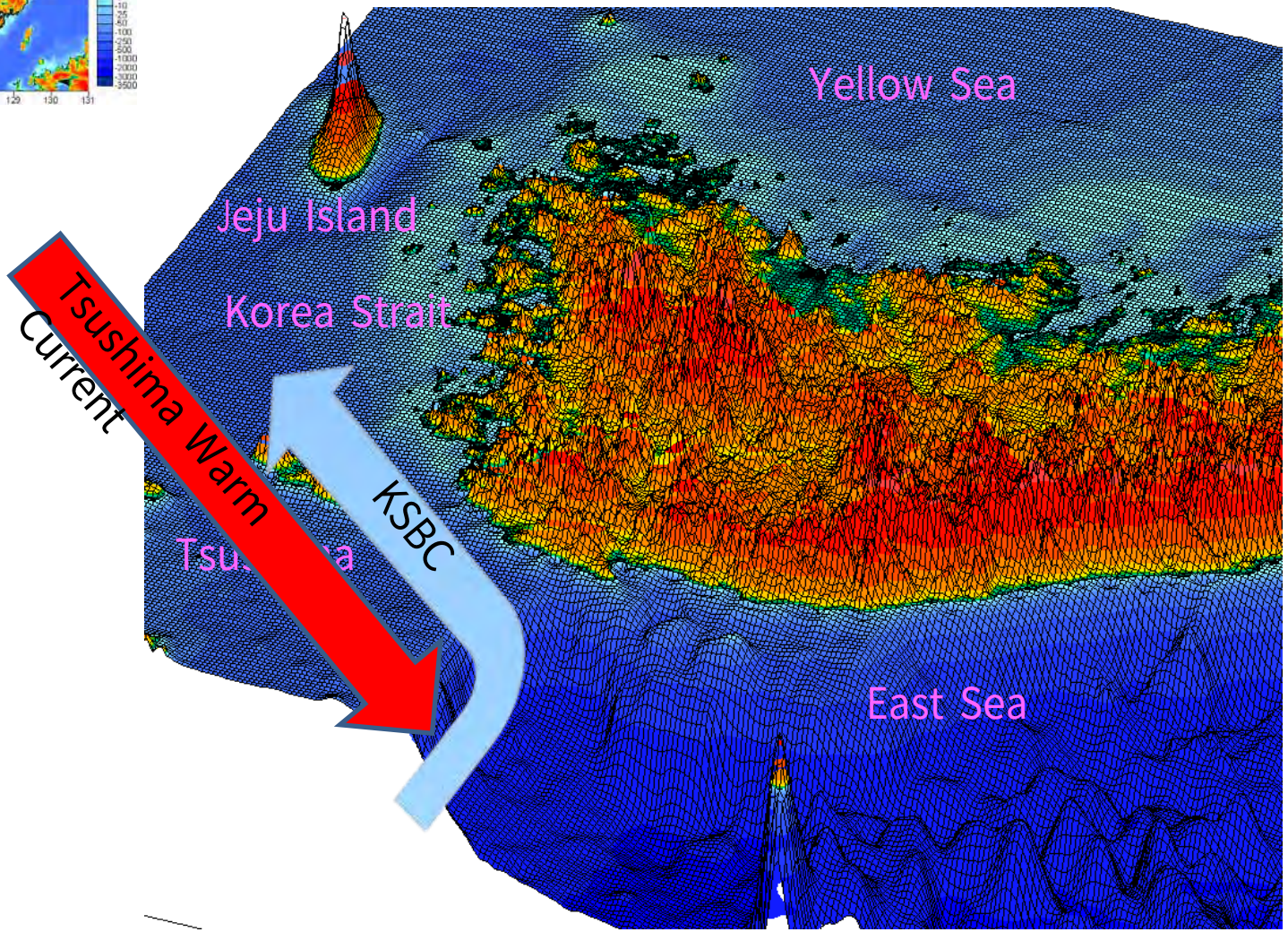
Shifts in Volume Transport of December KSBCW



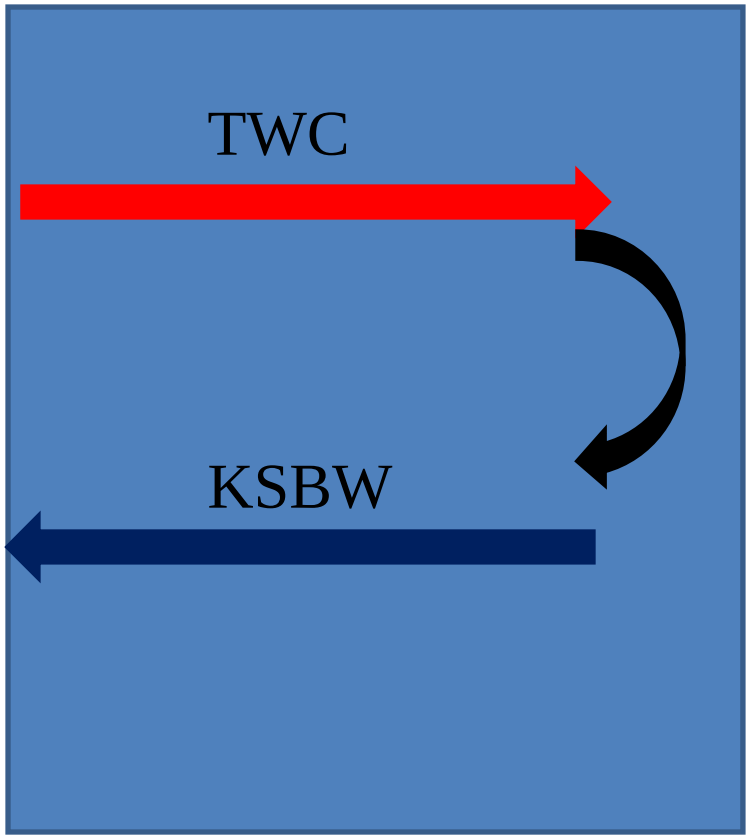
Courtesy of Hanna Na, Seoul National University

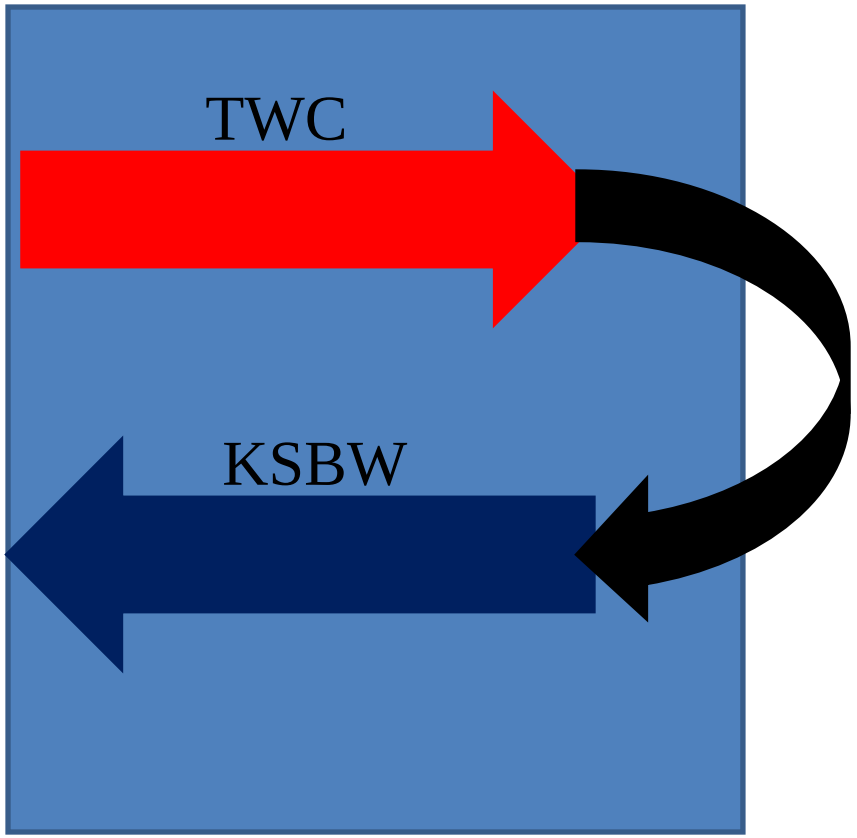
Topography



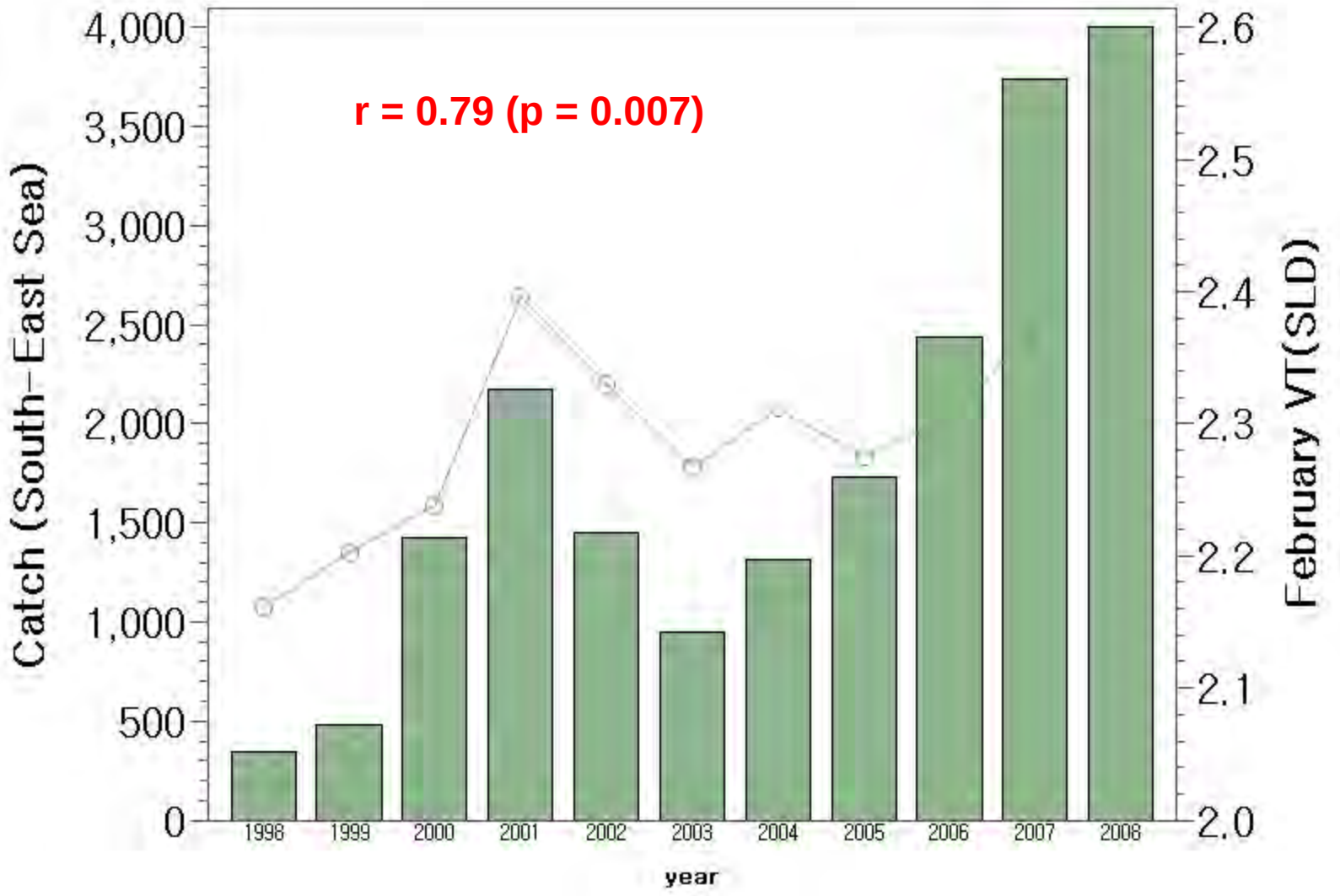

Yellow Sea
Jeju Island
Korea Strait
Tsushima Warm Current
KSBC
East Sea
North

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

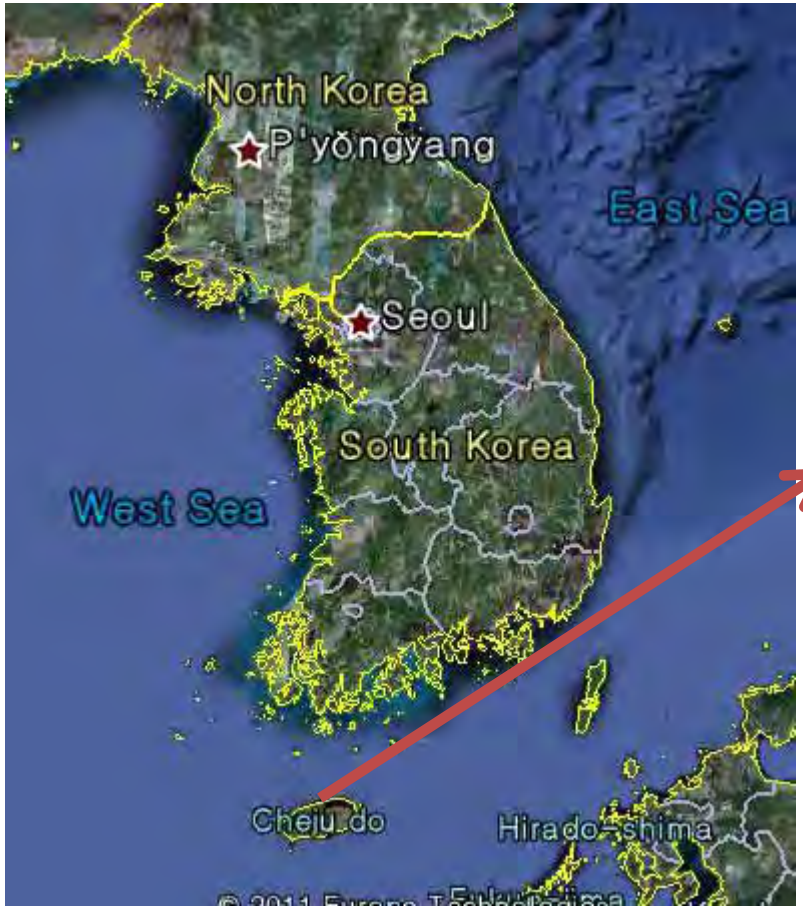




Catch of Pacific Cod in the spawning area vs. TWC volume transport in 2 yrs ago



Southward Expansion of Pacific cod to Jeju Island



Caught on September 9, 2011
Length = 32~35 cm (2 yrs old)

Conclusions

- Warming surface sea water does not necessarily mean warming bottom water.
  - Cooling bottom water can favor hatch and survival of demersal eggs and larvae of cod and herring
  - Warming SST could disadvantage hatch of pelagic eggs and southward extension of pollock
  - Warming SST could boost recruitment of common squid
- Intensity of the Tsushima Warm Current
  - Strengthened TWC can facilitate northward spring migration of cod and herring larva
  - Strengthened KSBCW can facilitate southward winter migration of cod and herring from the JES to the Korea Strait

Future works

- Improve reliability in estimation of volume transports of the TWC and KSBCW by applying general circulation models
- Regional comparisons
  - Gulf of Alaska, Bering Sea, Sakhalin and Primorye
    - Cod, pollock and herring
  - Japanese side of the Korea Strait
    - Migration routes of Pacific cod in the Korea Strait and the Japan/East Sea
  - Chinese side of the Yellow Sea
    - Spawning grounds of the Yellow Sea stocks of cod