PICES 20th (2011)Annual Meeting, FISH/POC Topic Session (S4)

Khabarovsk, Russia, Oct. 20, 2011

Response patterns of the fish community in the Japan Sea to the climate regime shifts and identification of ecosystem indicators

Yongjun Tian and Hideaki Kidokoro

Japan Sea National Fisheries Research Institute,
Fisheries Research Agency (FRA), Niigata, JAPAN

Outline

- Variation pattern in the oceanographic conditions in the Japan Sea

  Features of the late 1980s climate regime shift

- Variability in the fish community structure

  Response pattern to the climate regime shift

- Recent changes in the ecosystem of the Japan Sea

  What's happening in indicator species?

- Summary

Data sets on TWC

1. Fisheries data sets

1) Japanese catch statistics: 54 taxa, 1964-2004 and estimated community indices (MTL, DI) (Tian et al., 2006, 2008)

2) Trawl data set: single- and pair-trawlers data sets (27 and 16 taxa respectively): 1975-2005 (Tian, 2009; Tian et al., 2008, 2011)

2. Biological data sets

1) Plankton: PM-line 1972-2004 (Tian et al., 2008)

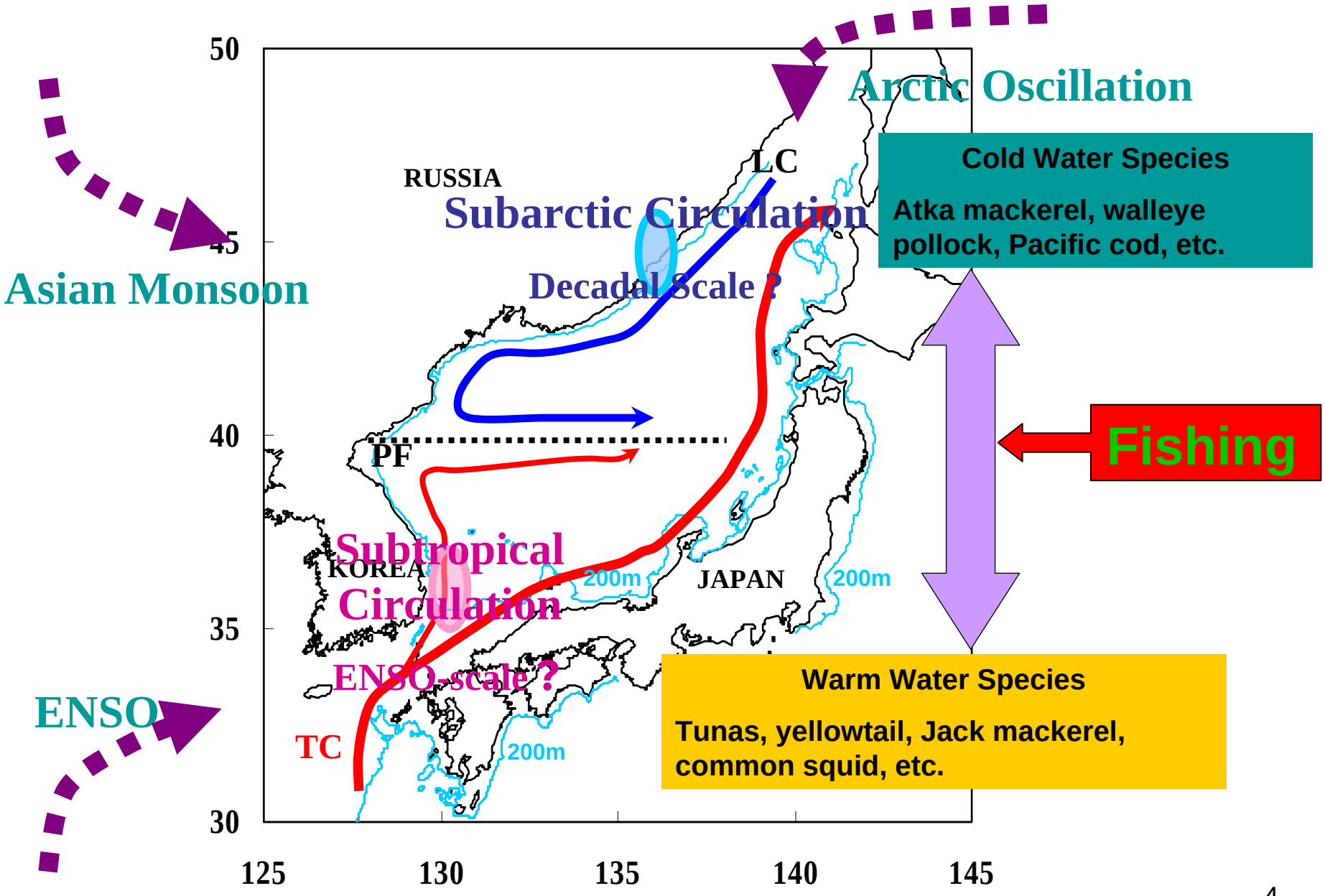
2) Life history parameters: condition factor, size composition: 1960s-2000s (small pelagic fishes) (Tian et al, 2010, PICES oral)

3) Mesopelagic fish: Biomass data from RV (1970s-2000s) (Fujino et al, in press)

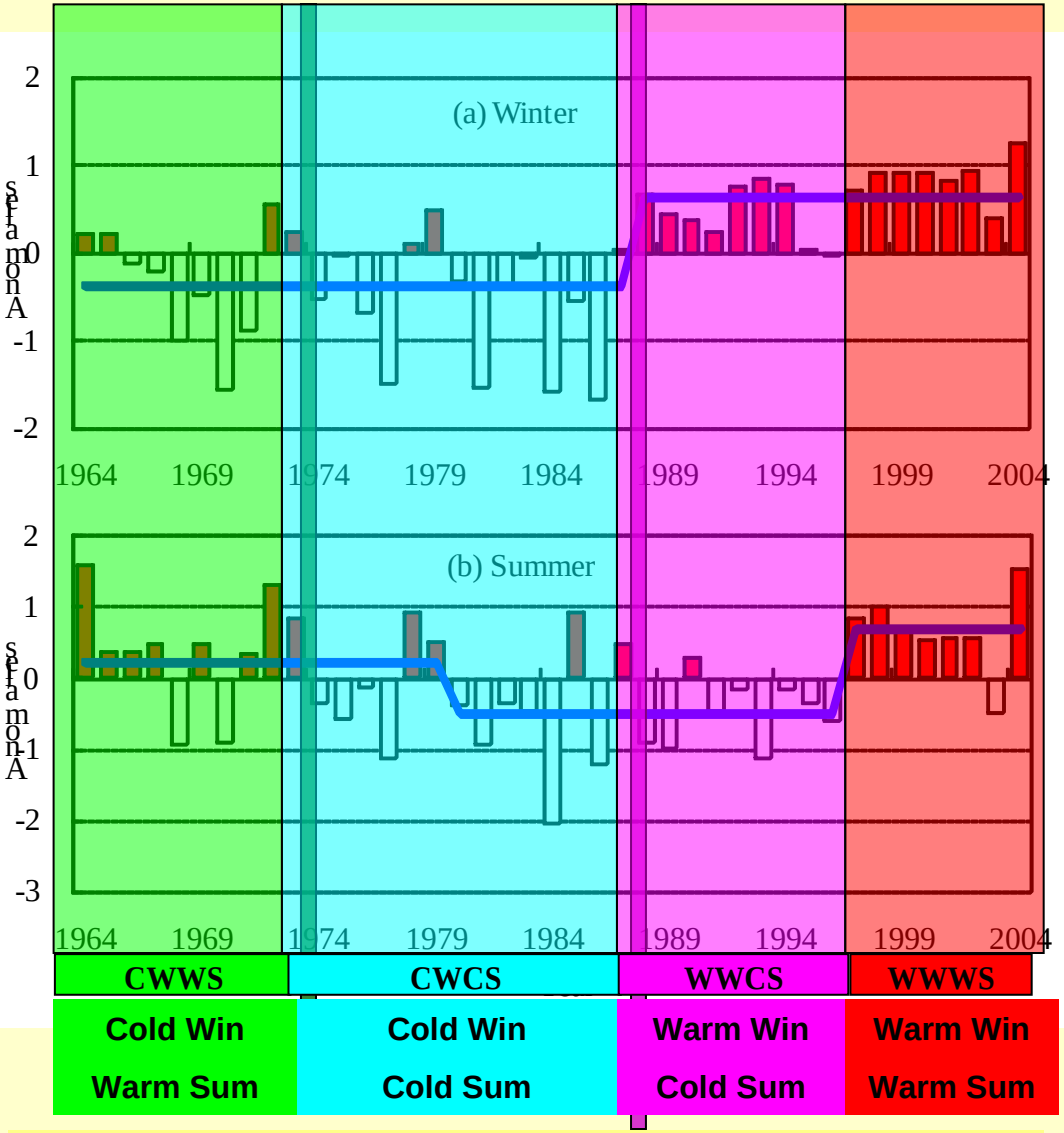
3. Climatic and physical indices

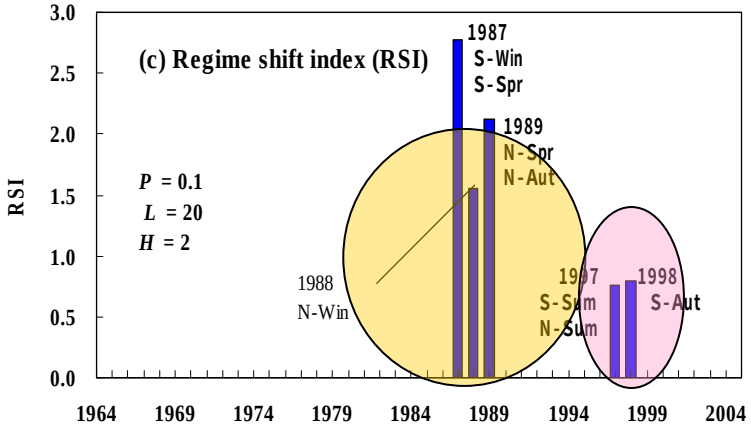
SST (1900-2000), WT (50m,200m: 1964-2004), MOI, AO,ENSO,etc

More than 100 time series were analyzed


Arctic Oscillation
Asian Monsoon
ENSO
RUSSIA
LC
Subarctic Circulation
Decadal Scale ?
PF
Subtropical
Circulation
ENSO-scale?
TC
KOREA
JAPAN
200m
200m
200m
Cold Water Species
Atka mackerel, walleye pollock, Pacific cod, etc.
Fishing
Warm Water Species
Tunas, yellowtail, Jack mackerel, common squid, etc.
50
45
40
35
30
125
130
135
140
145

50m WT: Indicator of Tsushima Warm Current





Winter WT:

regime shift around 1986/87

Summer WT:

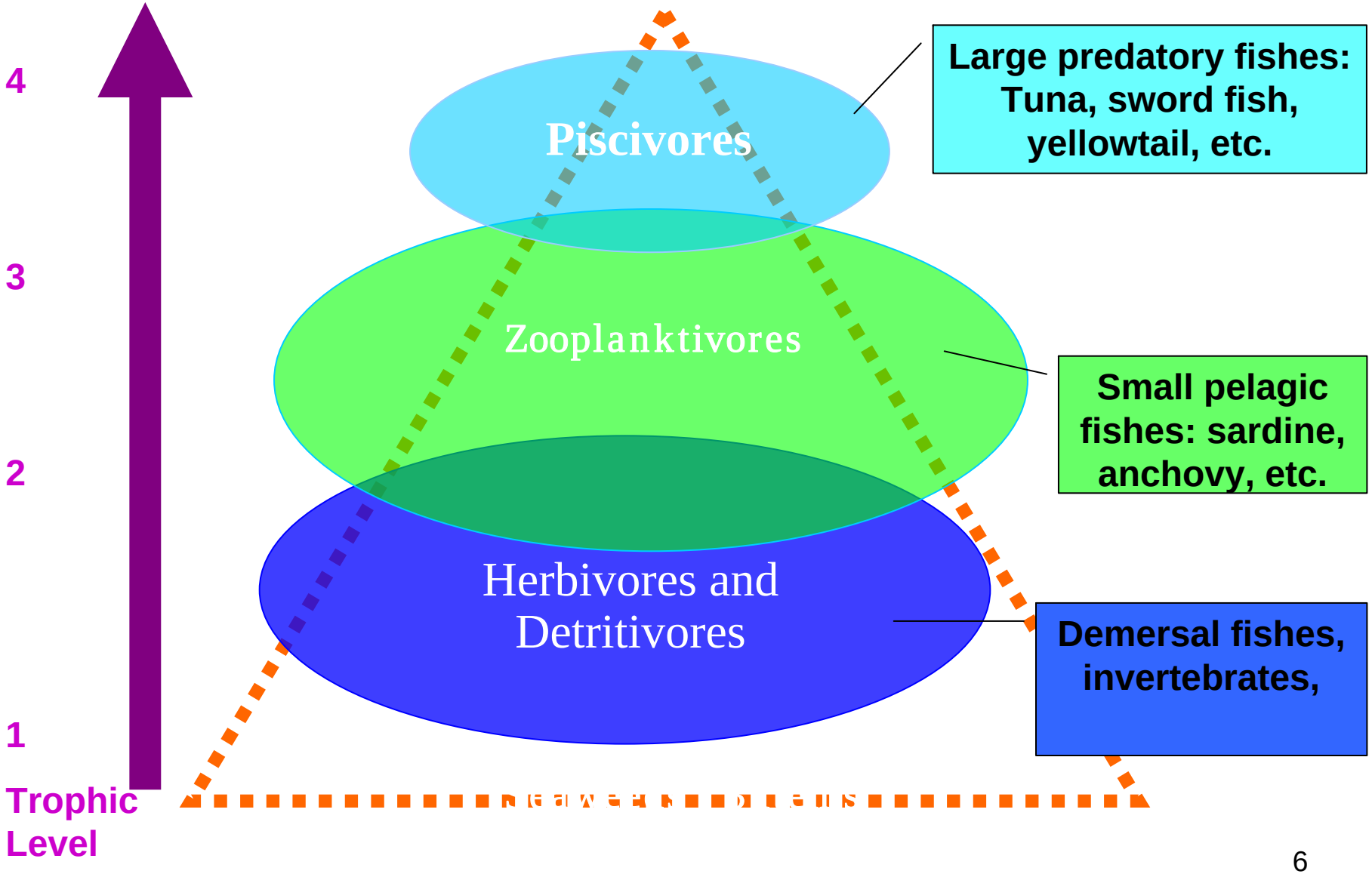
changes in early-1970s and mid-1990s

Variation patterns are different between winter and summer

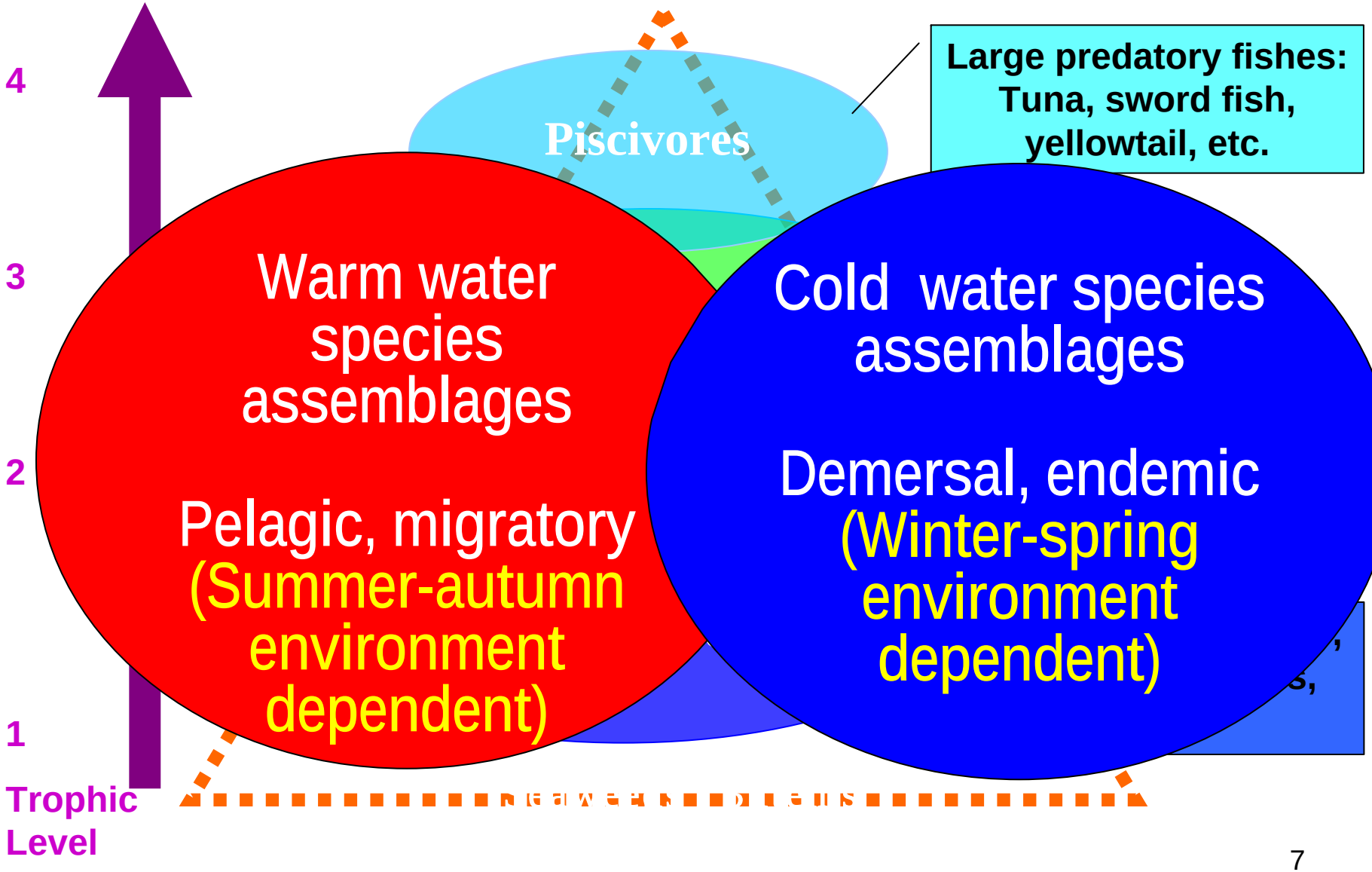
No evident change in the mid-1970s (1976/77), but change around 1973/74 in summer WT

Four periods: CWWS, CWCS, WWCS, WWWS. The cold regime started from 1974

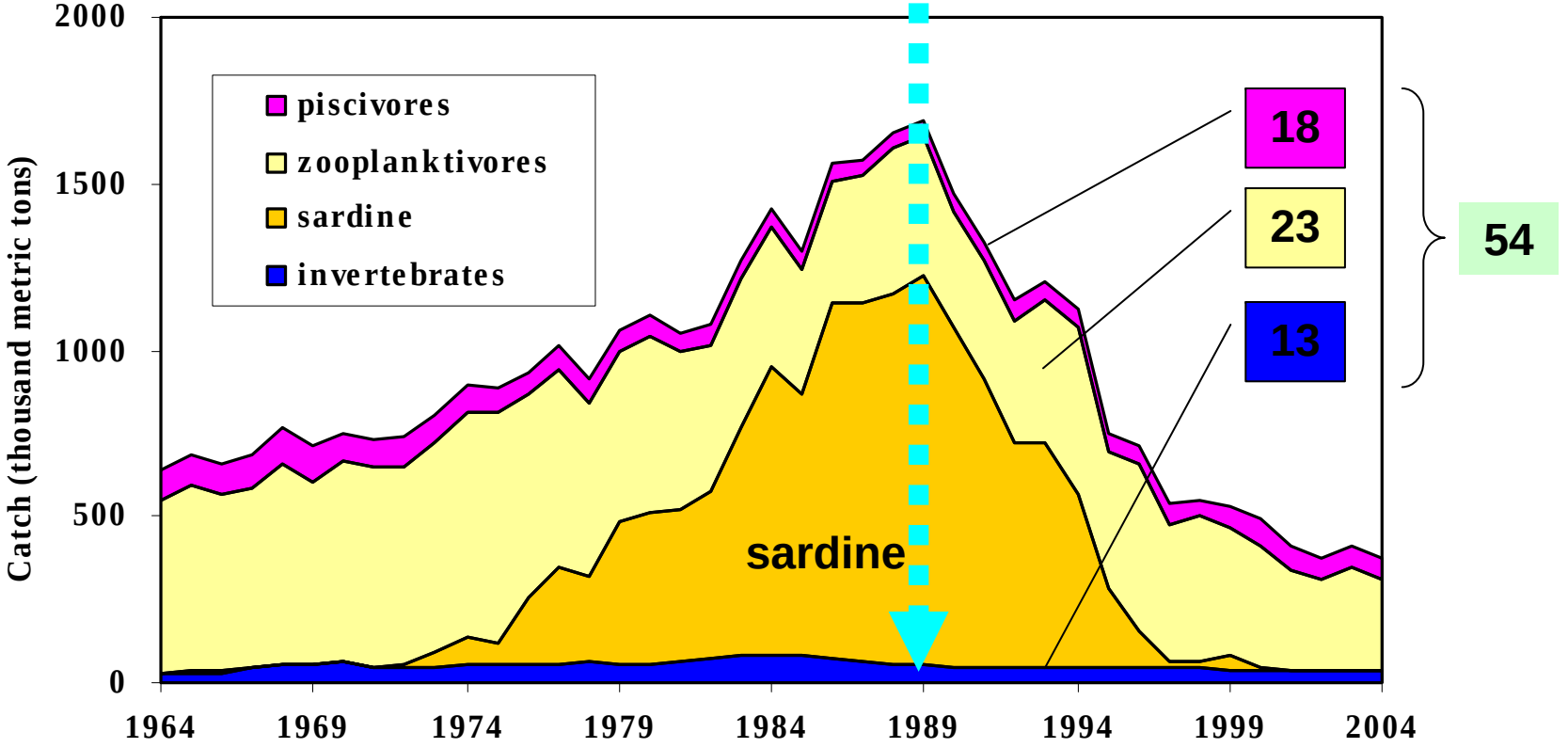
Fish Community Structure in the Japan Sea



Fish Community Structure in the Japan Sea



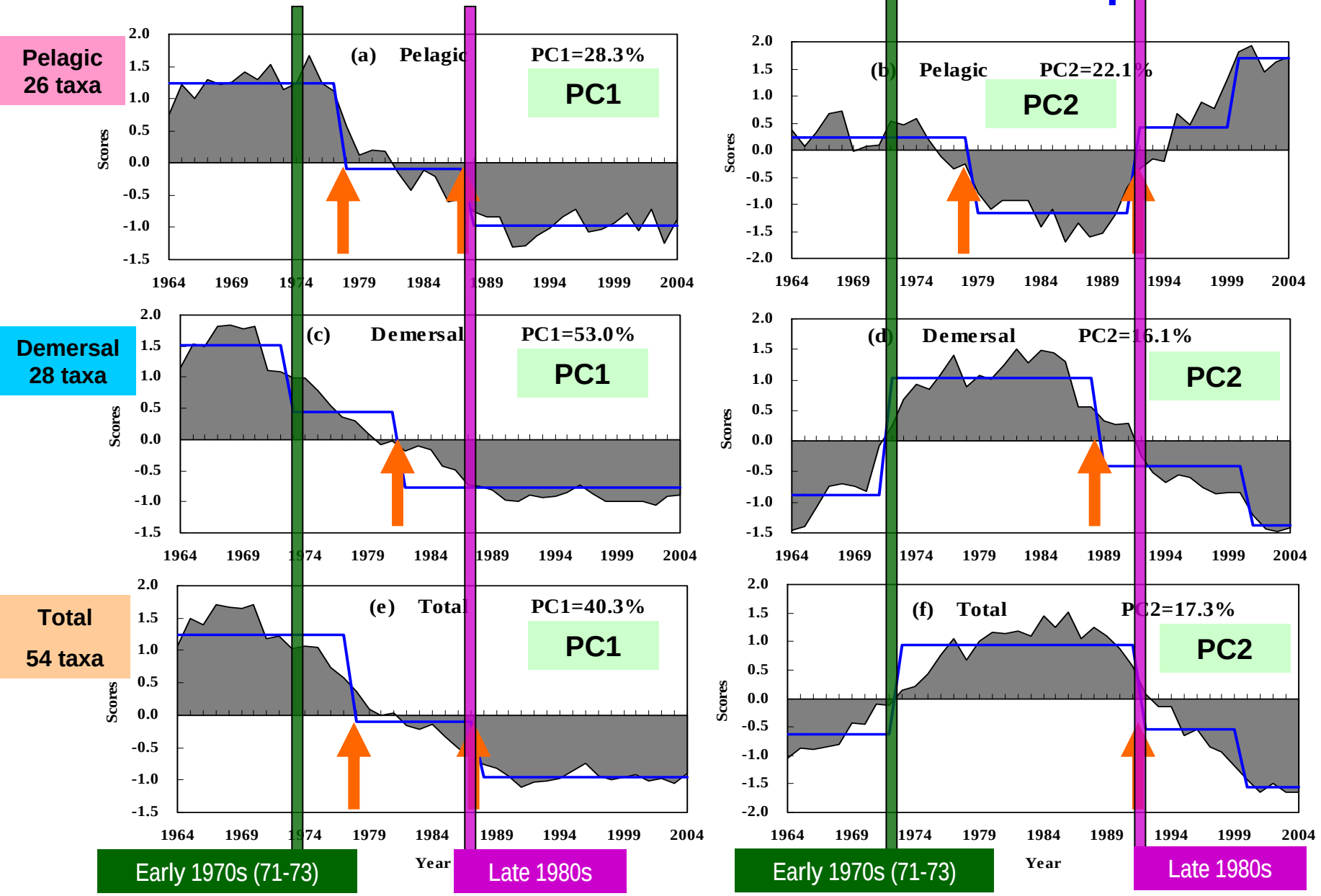
Catch Trend in the Japan Sea during 1964-2004 (54 species by trophic group)



These 54 species accounted for 91% of total catch in the Japan Sea.

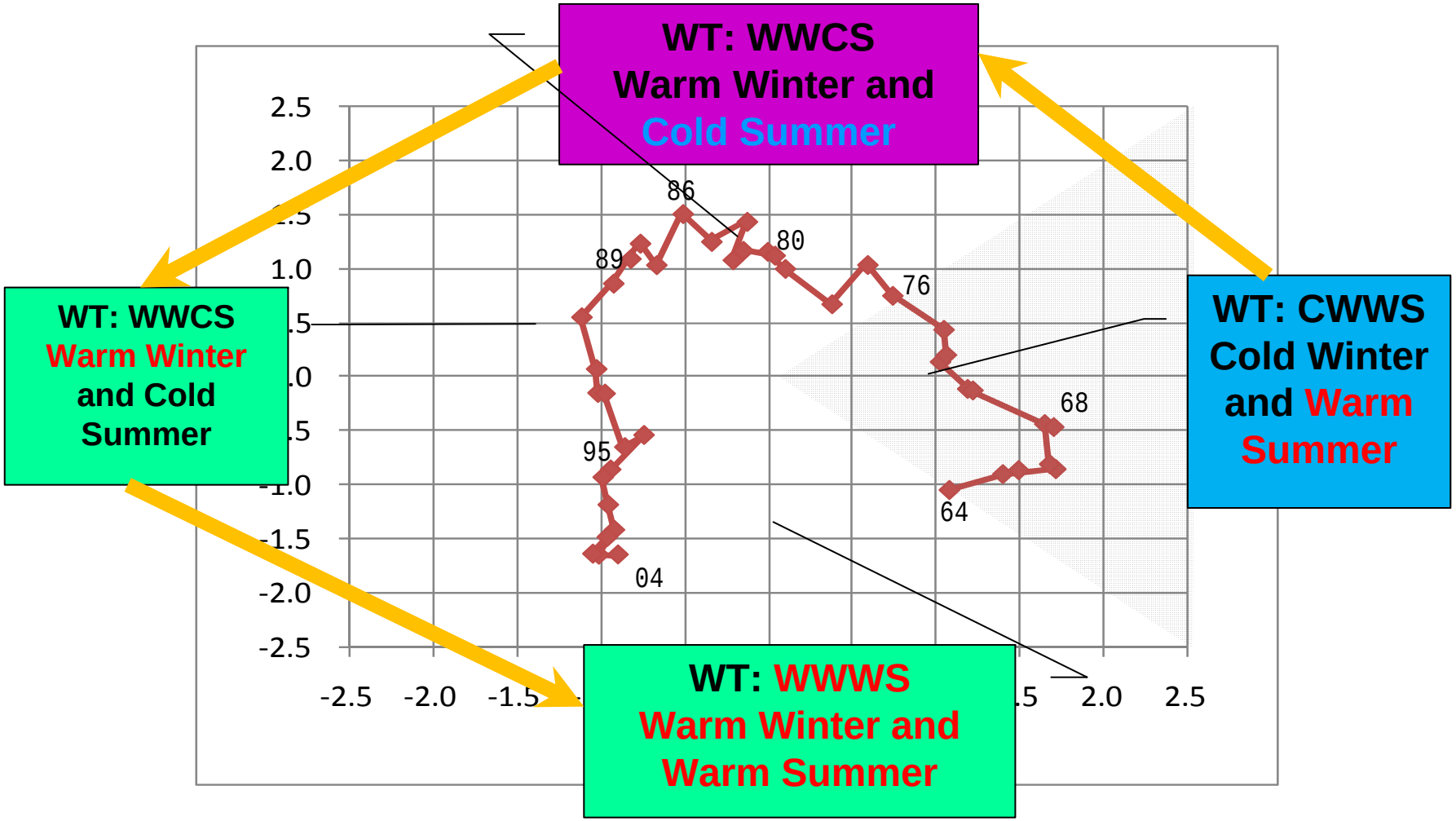
The small pelagic group (zooplanktivores) is dominant with large inter-annual variations, decreased abruptly since late 1980s with the collapse of sardine.

Variation Pattern from PCA for 54 Species



(Tian et al., 2008)

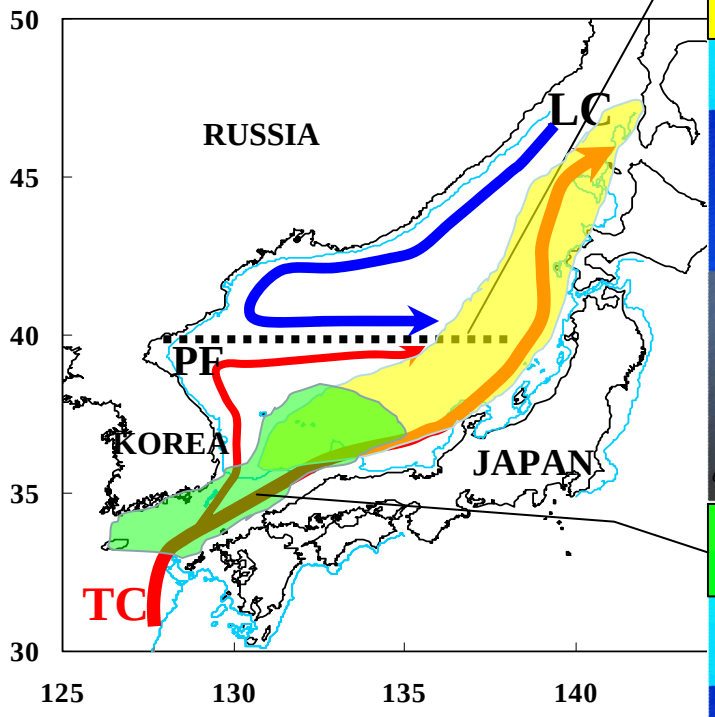
Phase Trajectory for PC1-2 of 54 Taxa



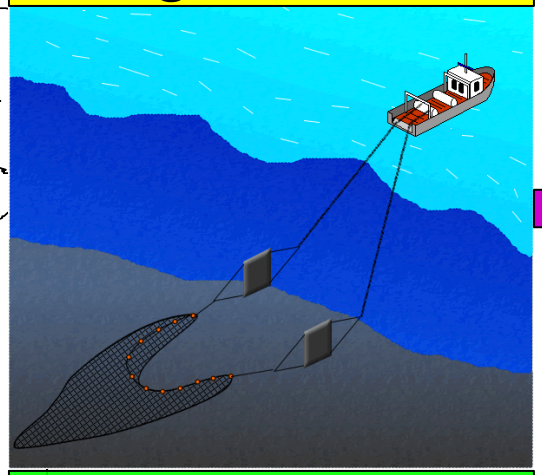
Phase change: 1964-75(shaded area), ’76-89(white area), ’90-95(shaded area) and ’96-04(white area).

Correspond to the variation pattern in water temperature

Two Trawl fisheries in the Japan Sea



Single Trawler

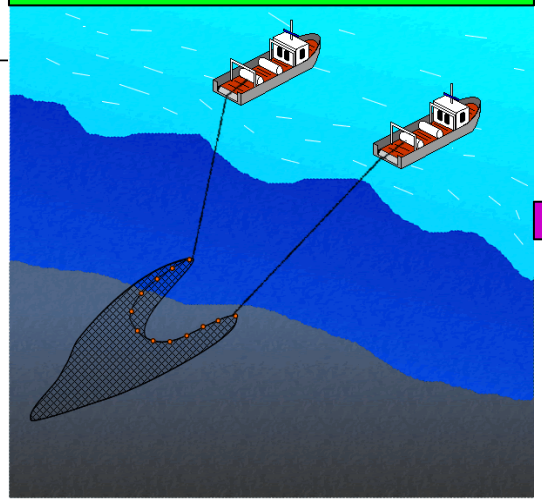


Deep offshore

Cold- and warm water species: 27 taxa

Atka mackerel, walleye pollock, Pacific cod, snow crab, pink shrimp, etc.

Pair Trawler



Continental shelf

Mostly Warm Water Species: 16 taxa

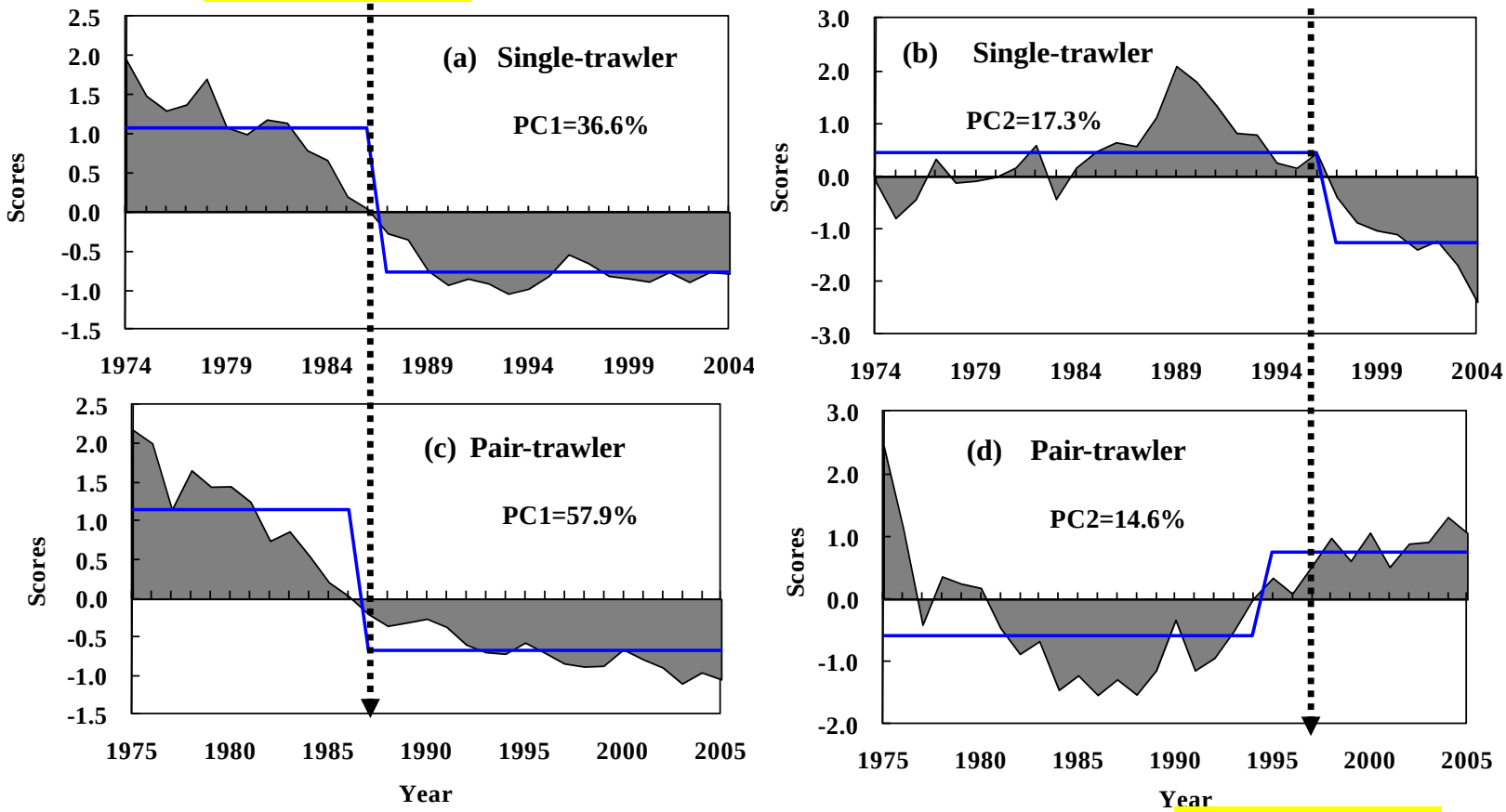
Seabream, flounder, largehead hairtail, Loligo squids, etc.

Fishing grounds, method and target species are different between the two fisheries.

PCA for the targets of the single- and pair-trawlers

PC1

PC2

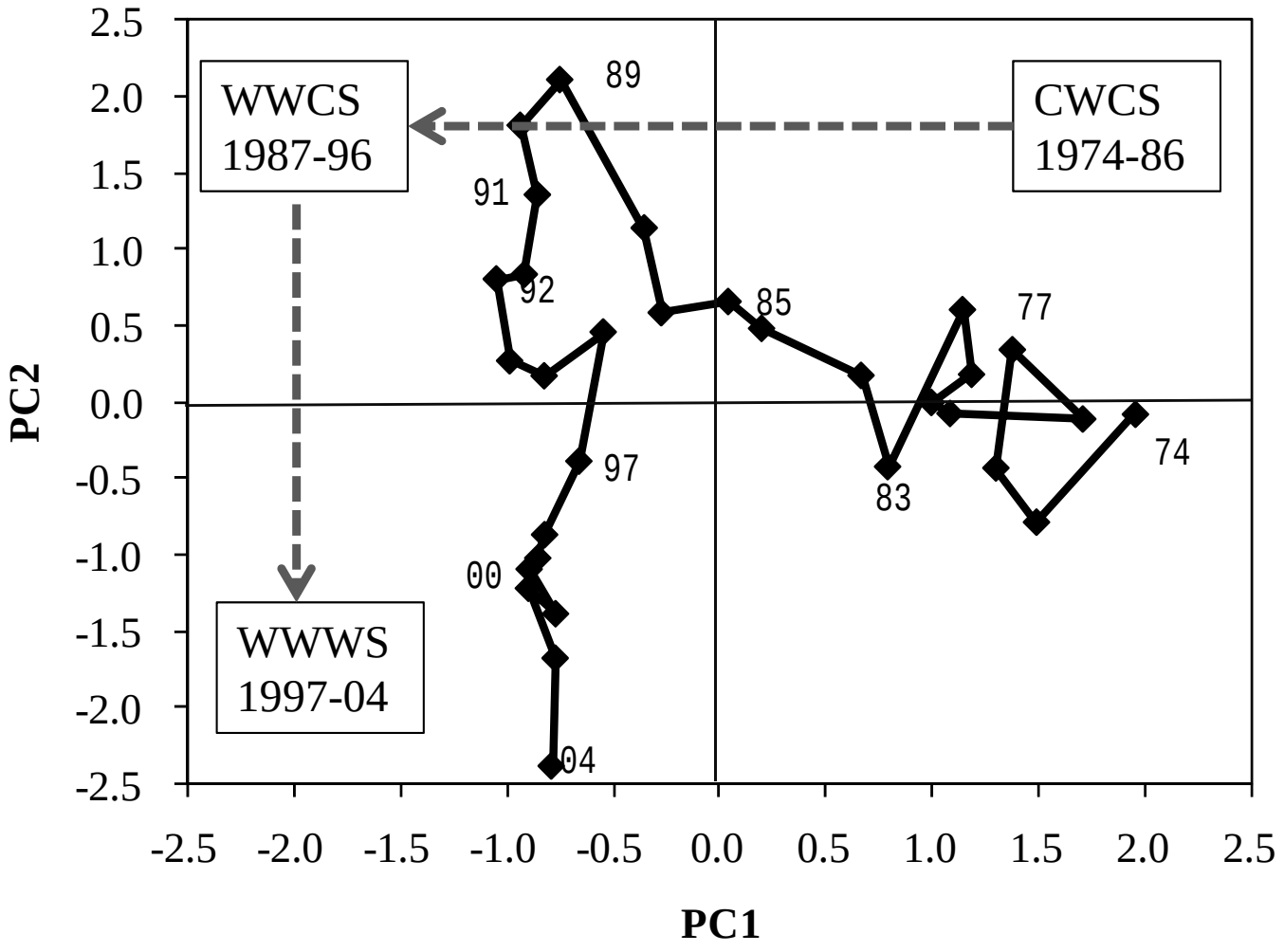


Late 1980s

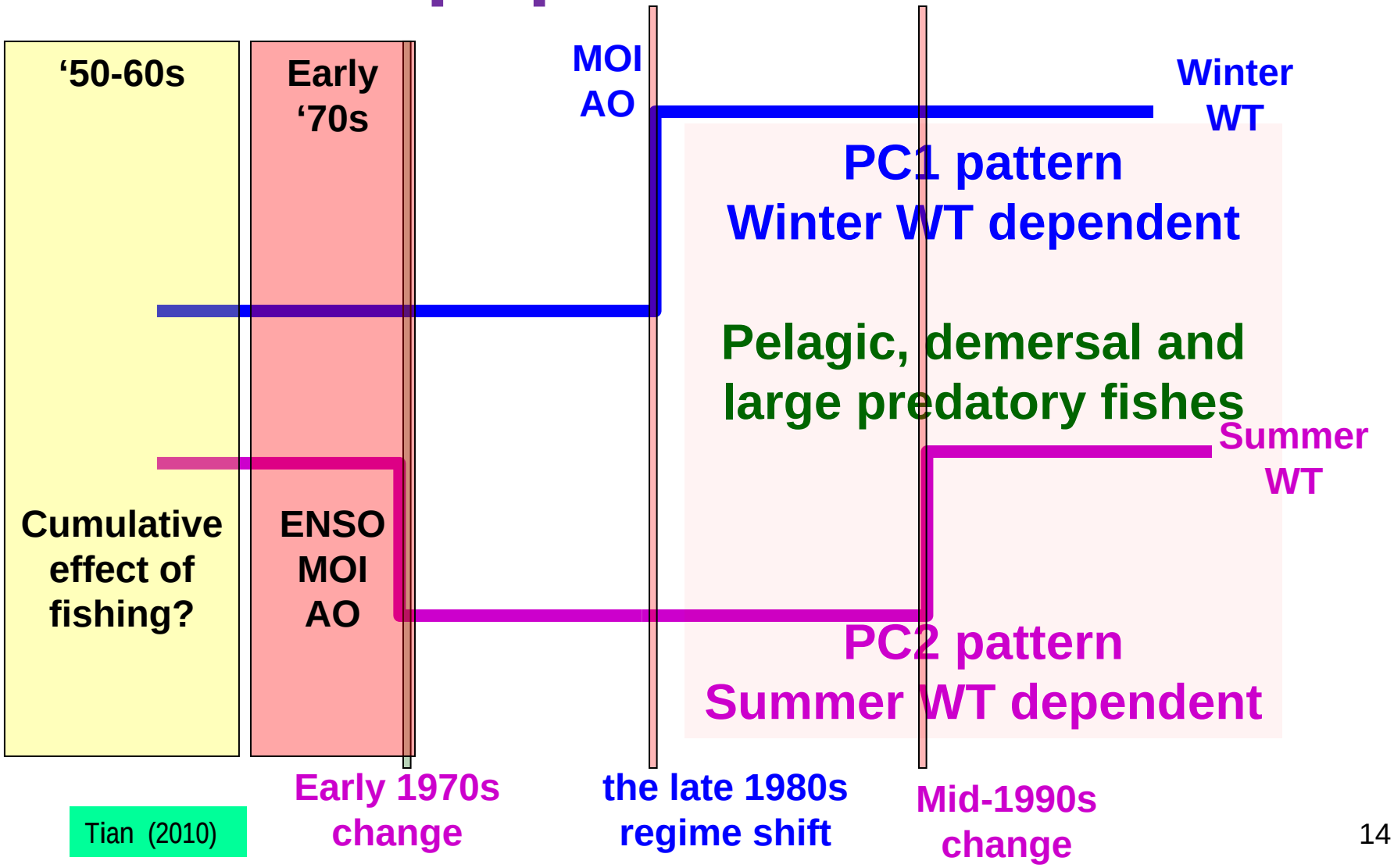
Mid-1990s

Tian et al., 2011

Phase Trajectory for PC1-2 for 27 targets of single-trawler

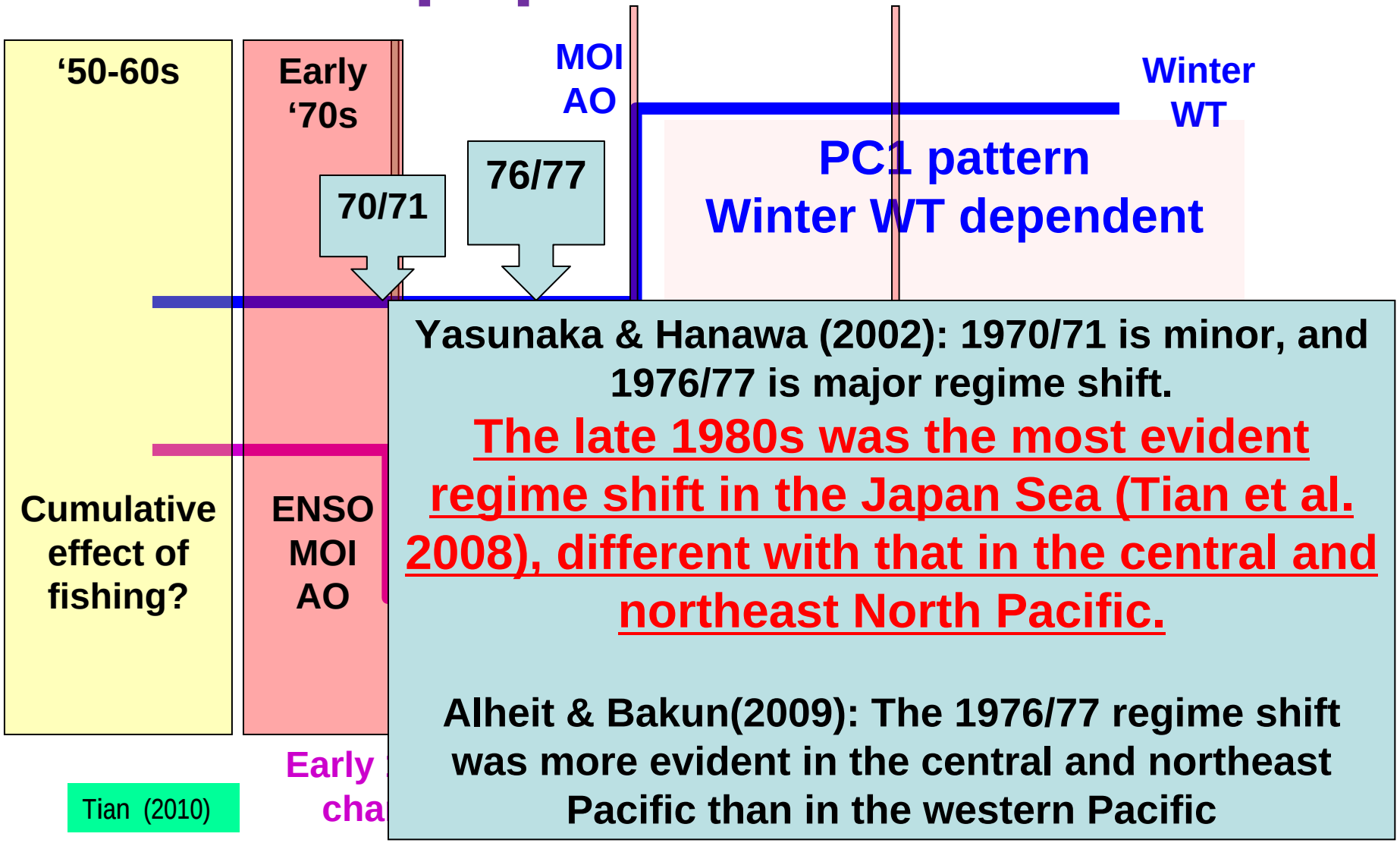


Concept of variation patterns in the fish populations in the TWC



Tian (2010)

Concept of variation patterns in the fish populations in the TWC



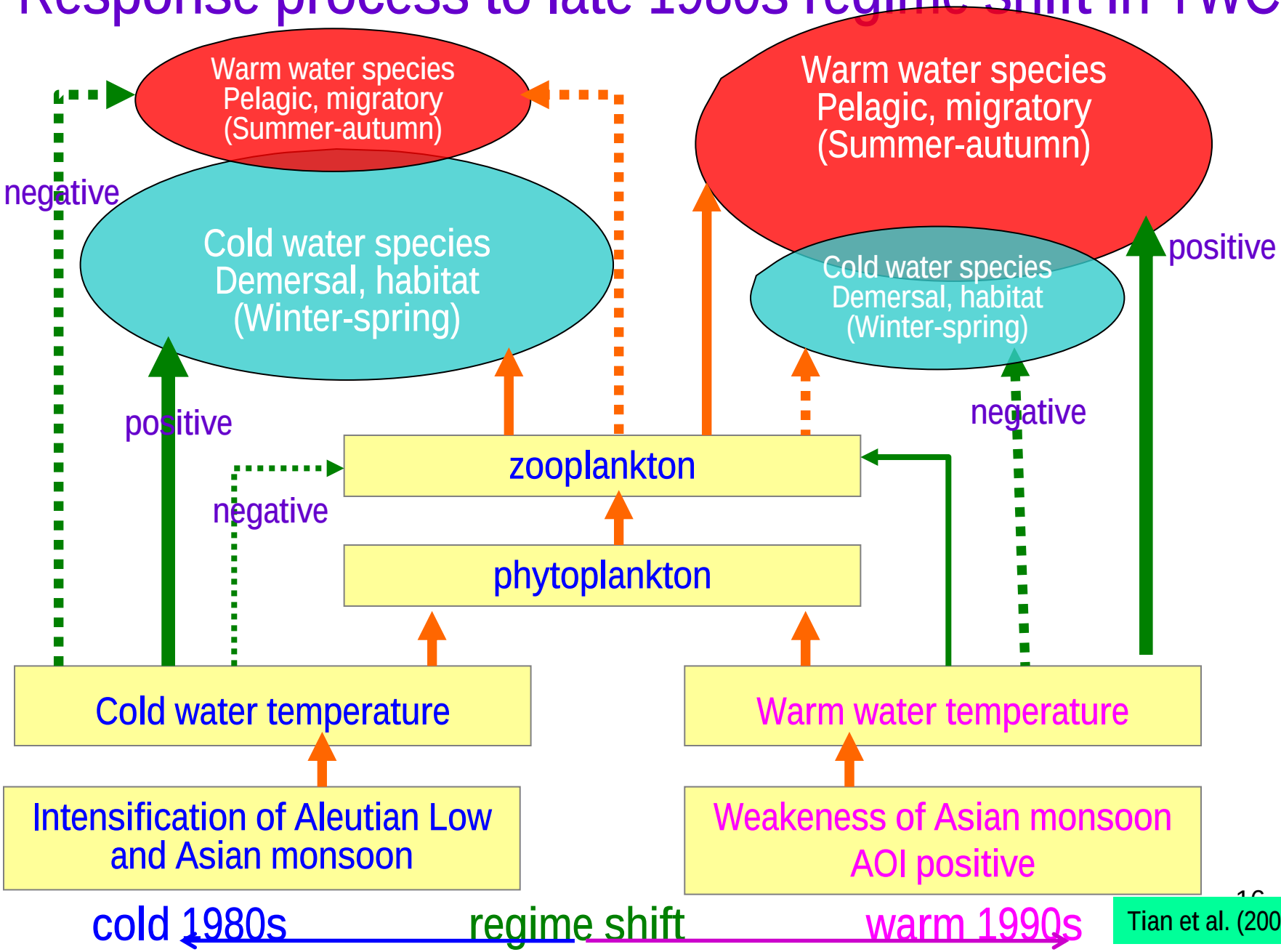
Yasunaka & Hanawa (2002): 1970/71 is minor, and 1976/77 is major regime shift.

The late 1980s was the most evident regime shift in the Japan Sea (Tian et al. 2008), different with that in the central and northeast North Pacific.

Alheit & Bakun(2009): The 1976/77 regime shift was more evident in the central and northeast Pacific than in the western Pacific

Tian (2010)

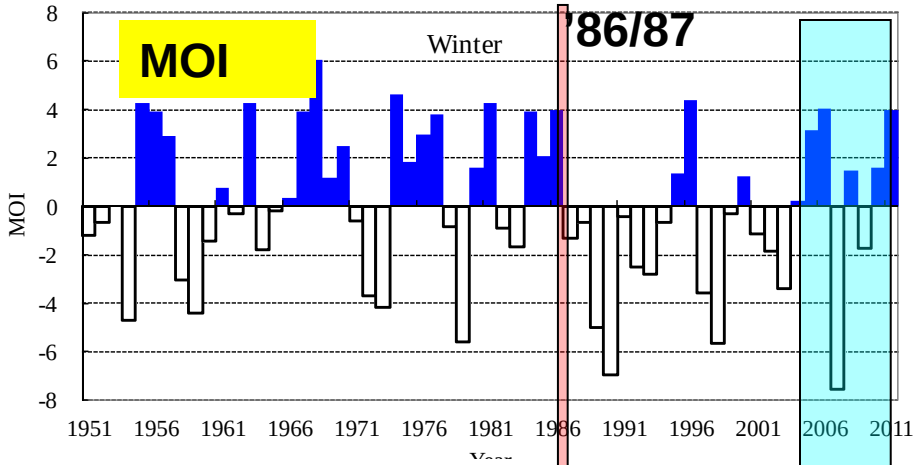
Response process to late 1980s regime shift in TWC

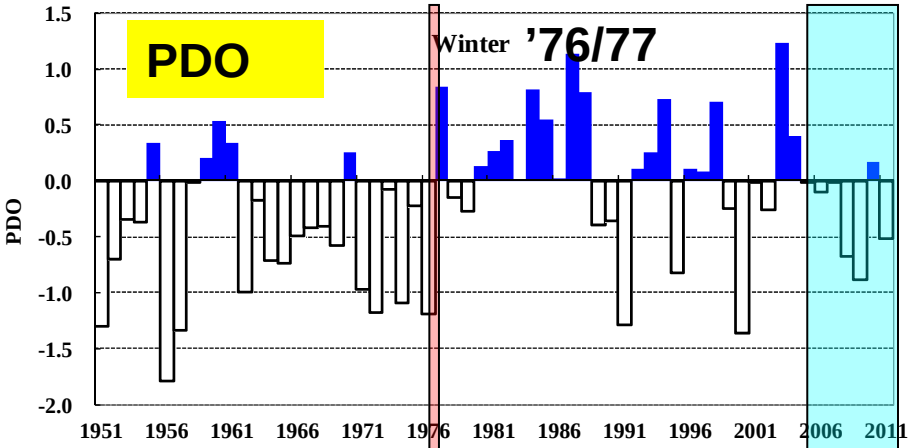


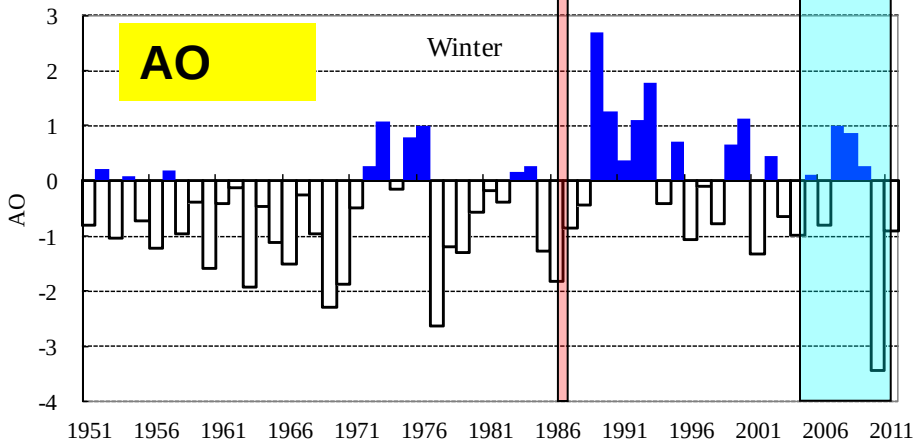
Tian et al. (2008)

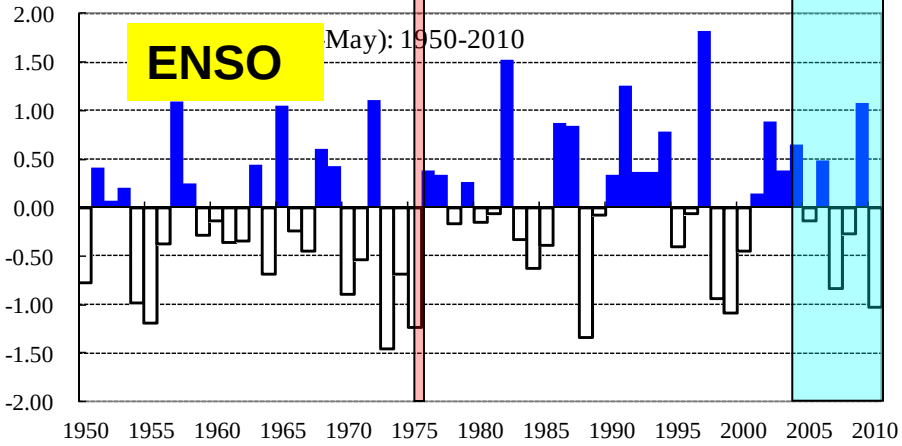
Response process to late 1980s regime shift in TWC

Climate index: 1951-2011



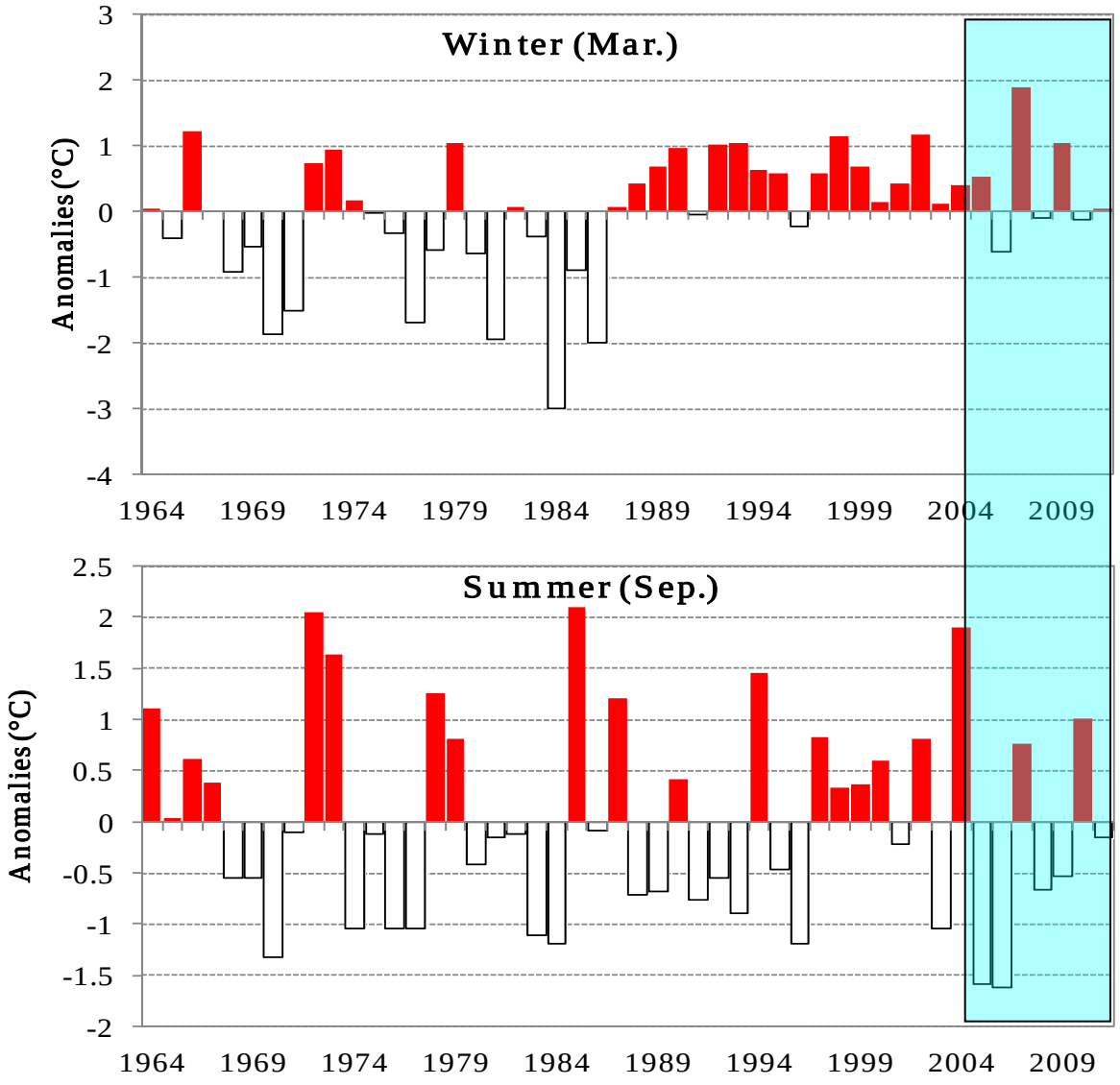






MOI: Strengthening around 2004; AO: negative in 2000s; PDO: negative around 2005; ENSO: La Nina trend around 2005.

TWC indicator: 50m WT(1964-2011)

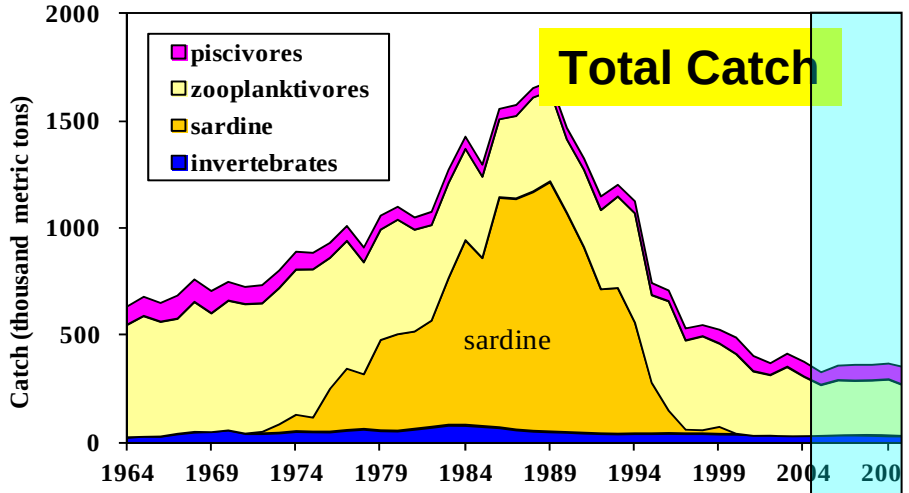


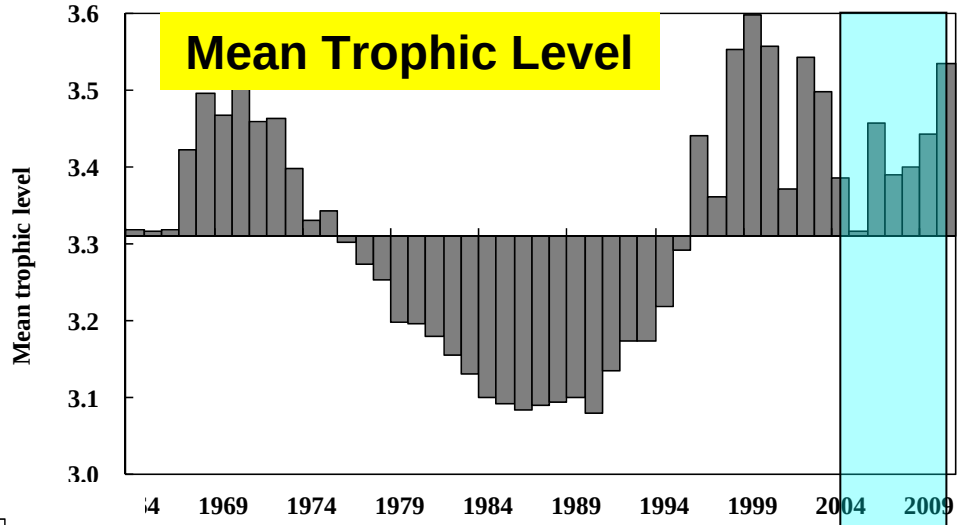
Strong warm winter trend, but cold years occurred since 2006.

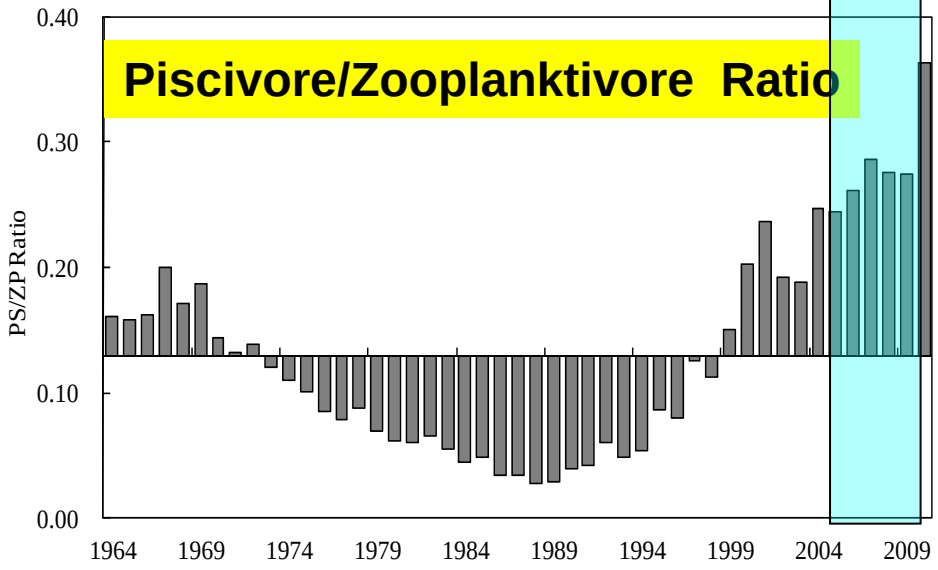
Evident cold summer trend since 2005?

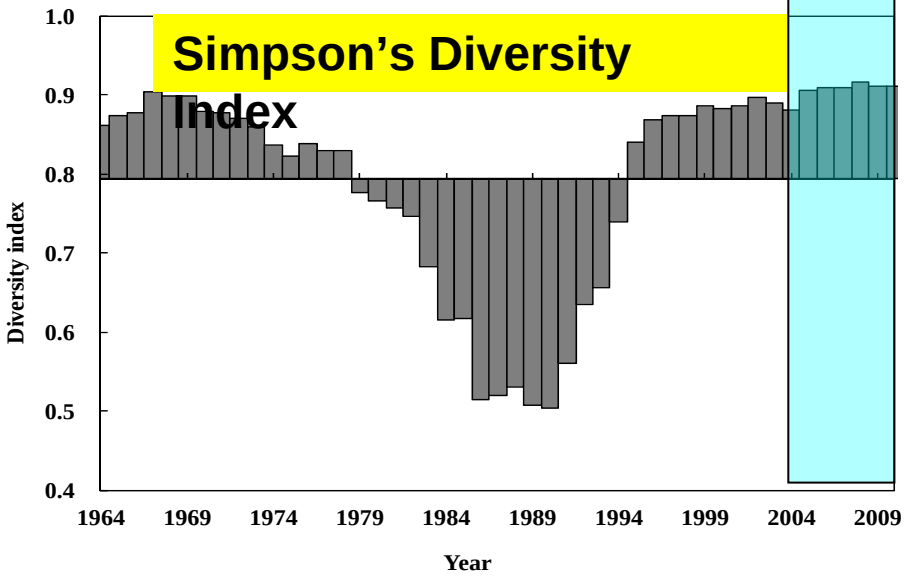
Community index: 1964-2010

updated from Tian et al. (2006)







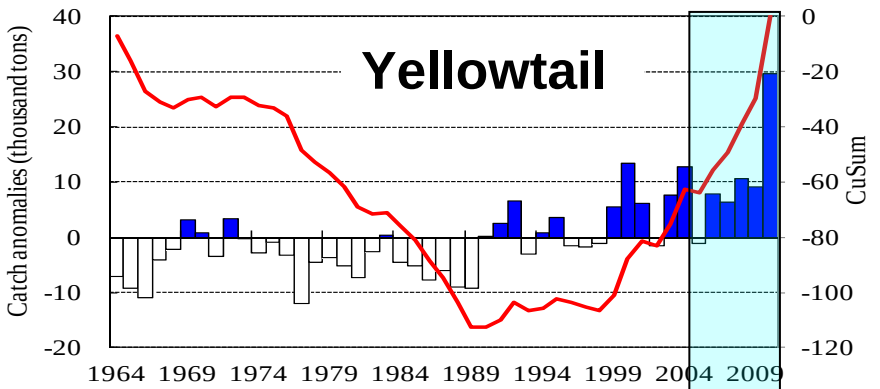


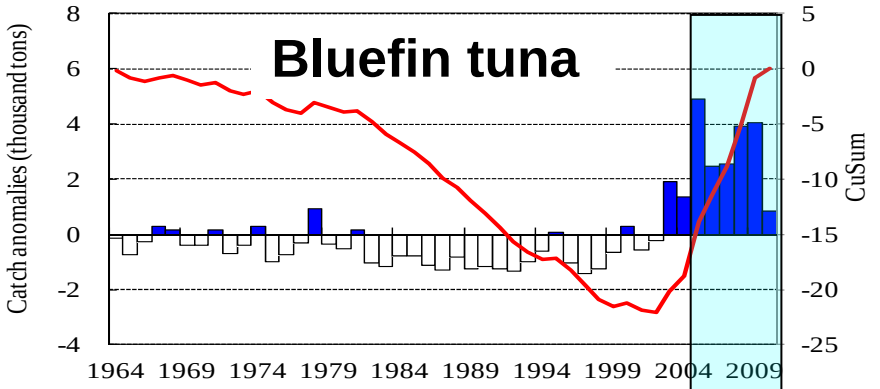
Selection of Indicator Species

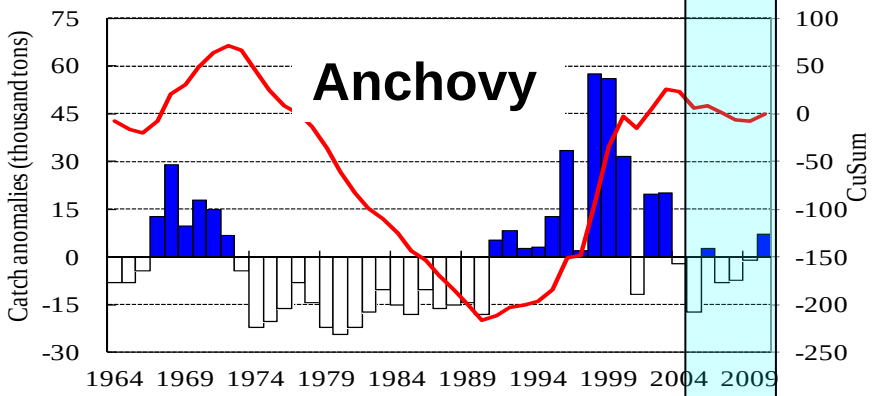
Species	Habitat	Prey-Predator	Fisheries	Current
Yellowtail	Pelagic	Predator	Set net	Warm-water
Bluefin tuna	Pelagic	Predator	Set net	Warm-water
Jack mackerel	Pelagic	Prey	Purse seine	Warm-water
Anchovy	Pelagic	Prey	Purse seine	Warm-water
(Sardine)	Pelagic	Prey	(Purse seine)	Cold-water
Pacific cod	Demersal	Predator	Bottom trawl	Cold-water
Snow crab	Demersal	Predator	Bottom trawl	Cold-water

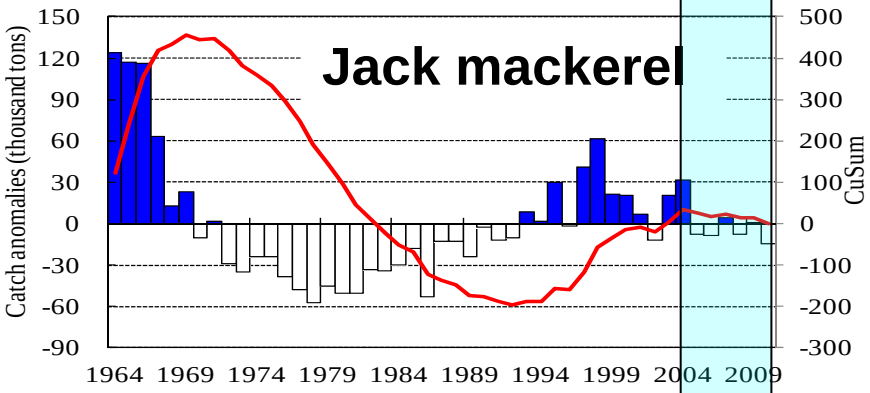
These 6(7) species are commercially important, representing different trophic level, different current system, and targets of different fisheries.

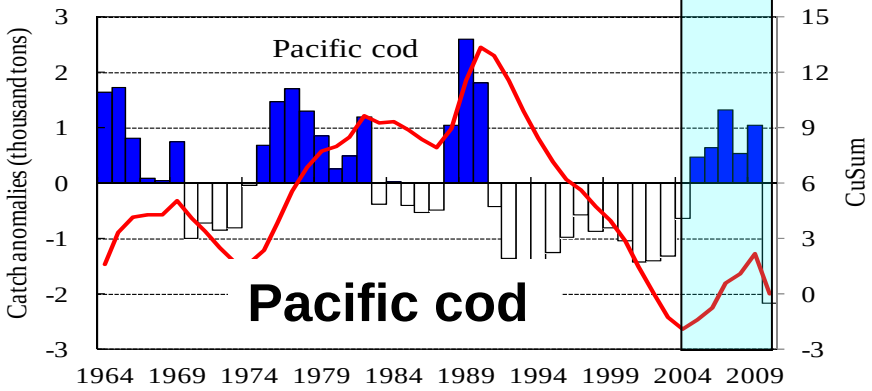
Indicator species during 1964-2010

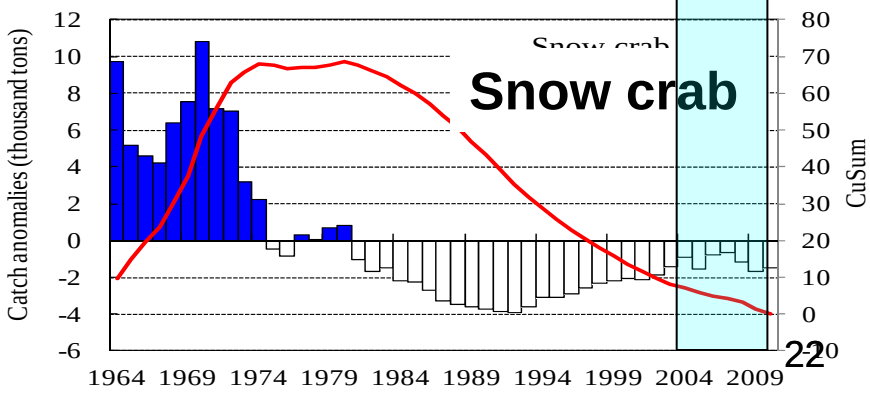




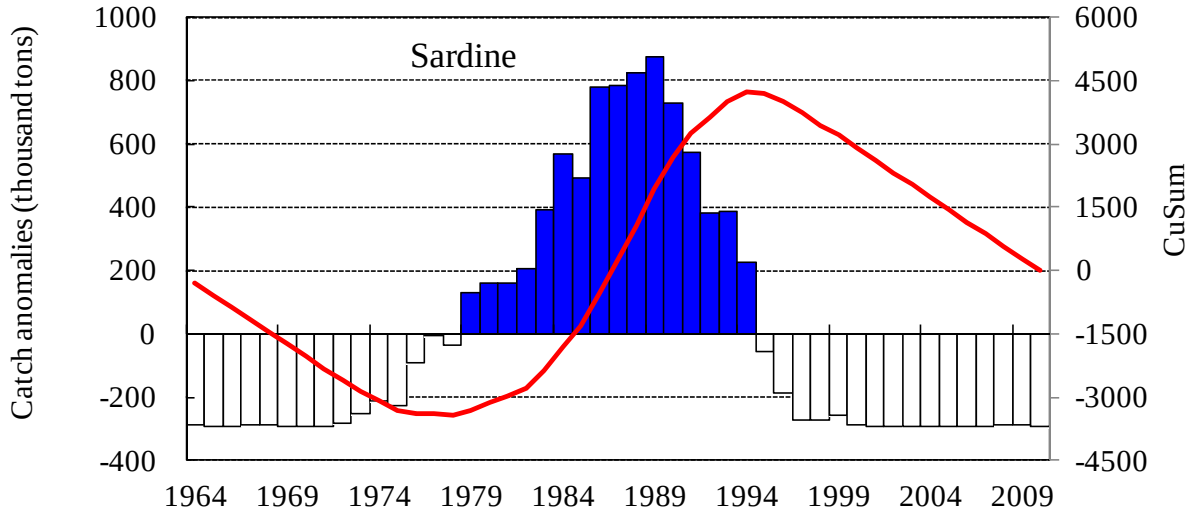




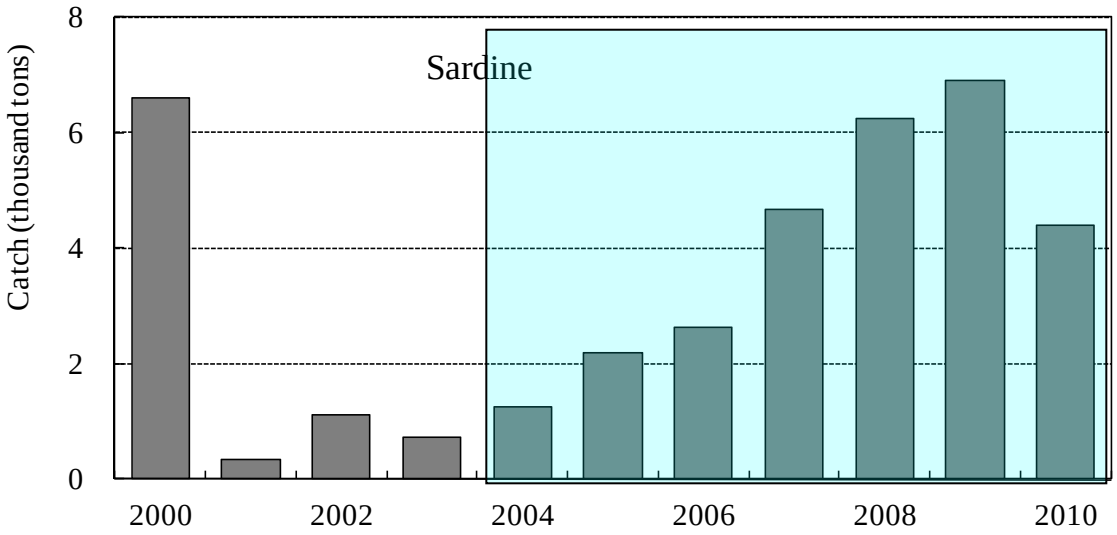




Japanese sardine in TWC: indicator ?



The sardine stock is still in a very low level after the collapse around 1989.



But, the catch in the Japan Sea (from set net and purse seine) is increasing since 2004 .

Summary

1. An oceanic regime shift from cold to warm water is identified in TWC region in the late 1980s and linked with global climatic changes.
2. The fish community structure in TWC changed largely with the late 1980s climate regime shift.
3. Response to climate regime shift is species-specific and the forcing is different.
4. A small number of indicator species showed recent changes occurred around 2004/05, and related to climate changes.
5. These indicator species are useful to identify the changes in the fish community, suggested a cold regime occurred in the TWC around 2004/05?