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Long-term changes in the condition factor of small pelagic fishes in the Japan Sea and the impact of the late 1980s regime shift

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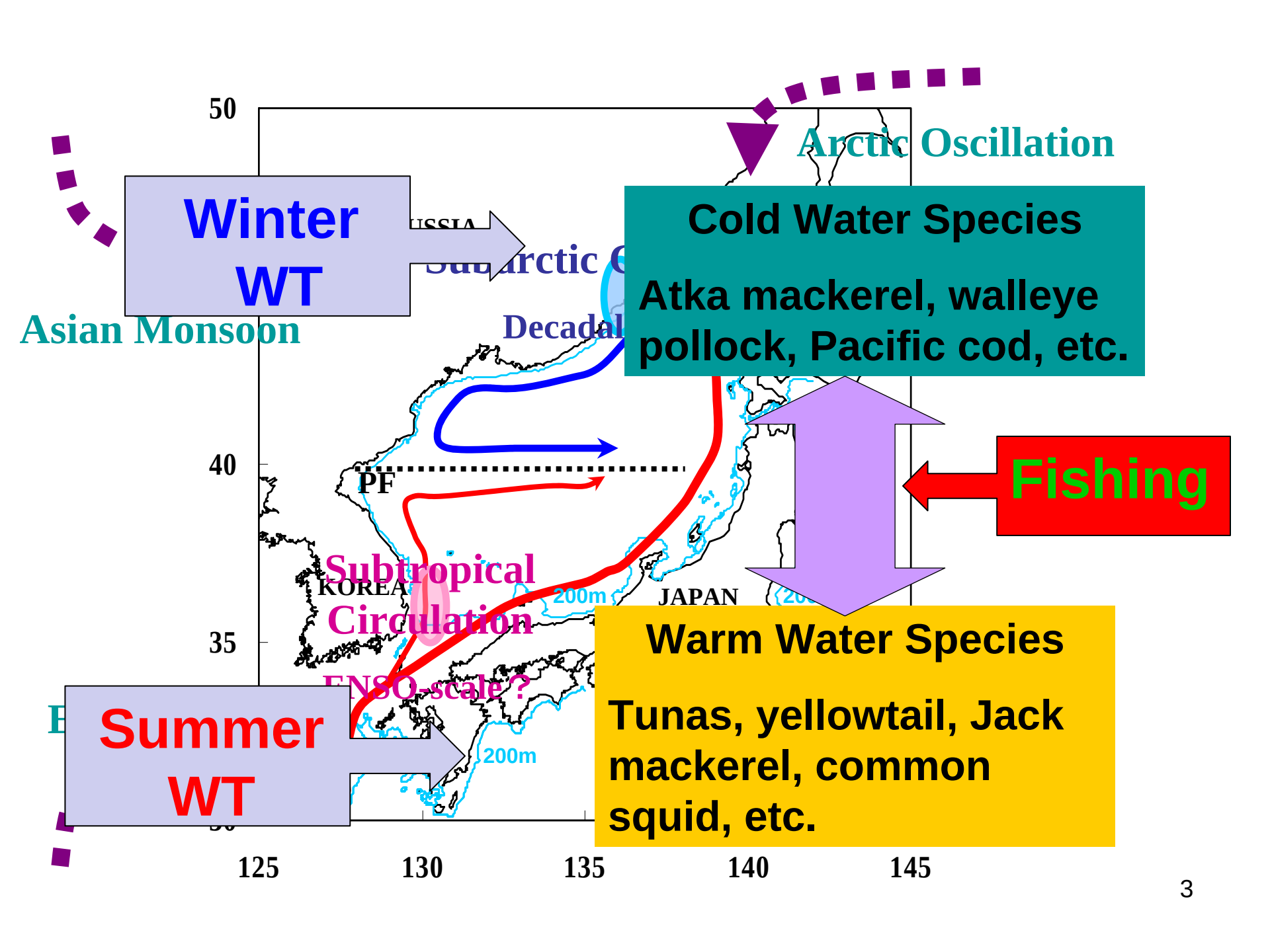
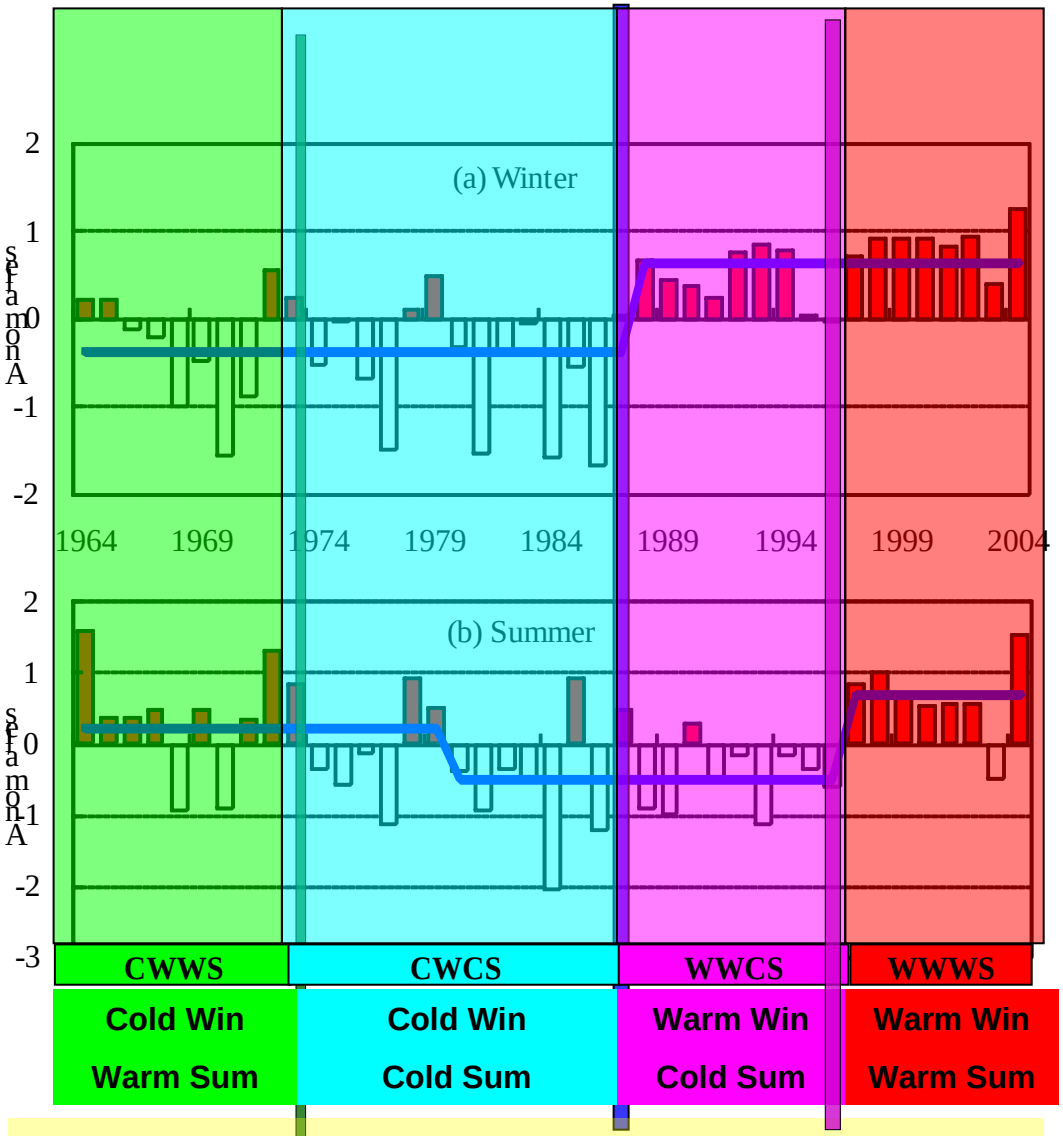
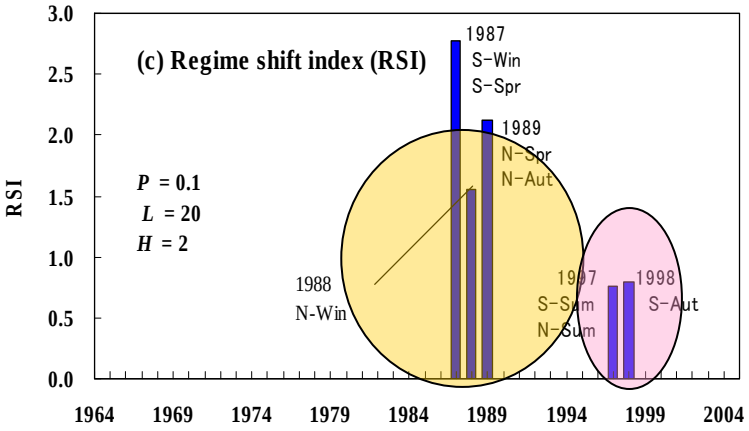
Outline

1. Backgrounds: the late 1980s climate regime shifts in TWC of the Japan Sea and response of the fish community.
2. Changes in the condition factor of five small pelagic fishes using long-term data sets
3. Possible mechanisms and conclusions


Arctic Oscillation
Winter WT
Asian Monsoon
Cold Water Species
Atka mackerel, walleye pollock, Pacific cod, etc.
Fishing
Subtropical Circulation
ENSO-scale ?
Summer WT
Warm Water Species
Tunas, yellowtail, Jack mackerel, common squid, etc.
PF
KOREA
JAPAN
200m
50
40
35
125
130
135
140
145

50m WT: Indicator of Tsushima Warm Current





Winter WT:

regime shift around 1986/87

Summer WT:

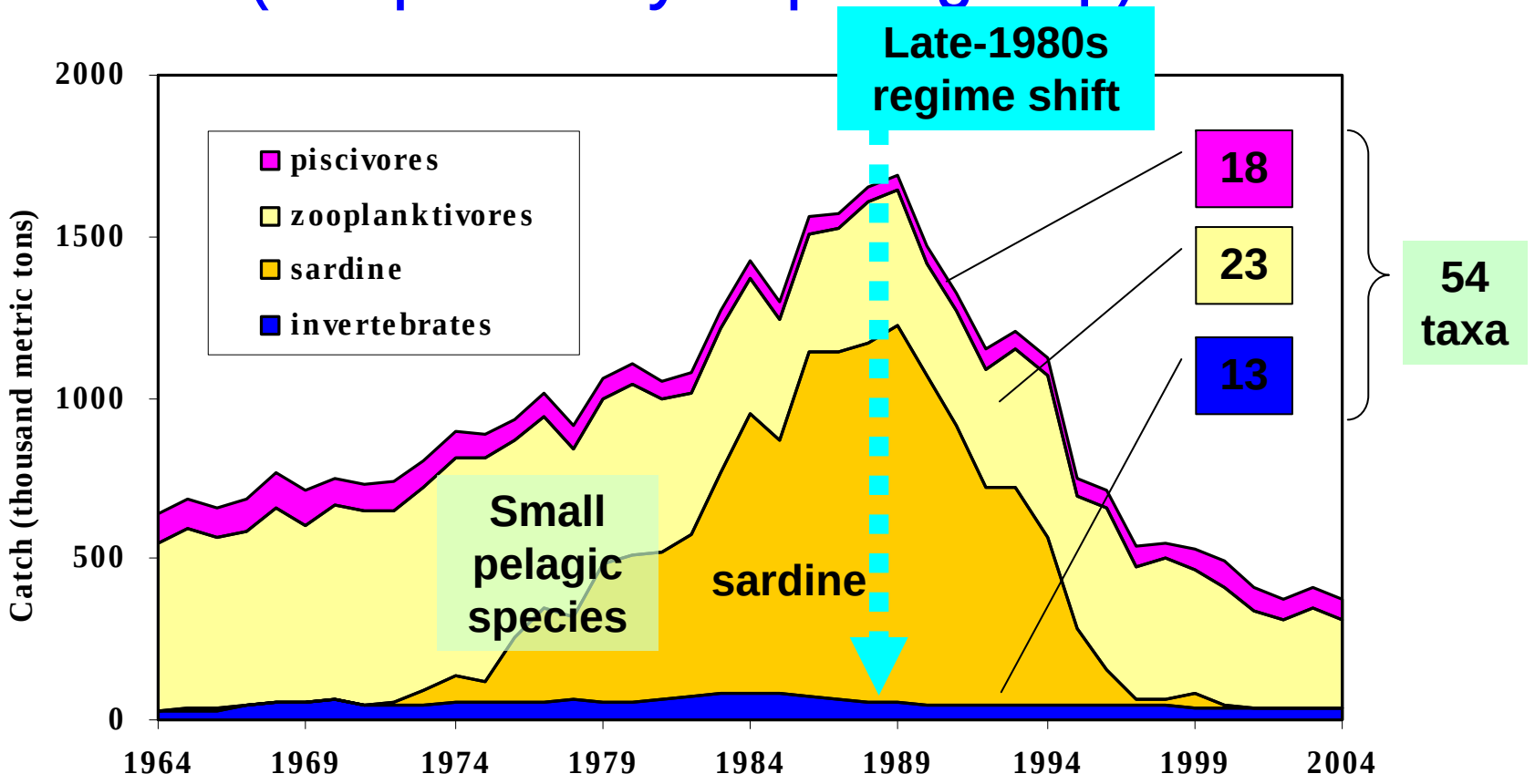
changes in early-1970s and mid-1990s

Variation patterns are different between winter and summer

Four periods

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

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



These 54 species accounted for 91% of total Japanese 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.

Response process to late 1980s regime shift in TWC

Our question: Does regime shift cause changes in the life history?

Understanding on life history changes in key-species is particularly important to confirm the ecological processes between and within trophic groups.

Long-term changes in the condition factor (CF) of 5 small pelagic species

Int… and Asian monsoon

AOI positive

cold 1980s ← regime shift → warm 1990s

Tian et al. (2008)

Data Number for 5 Small Pelagic Species

Species Name	Size Composion		Body Length - Body Weight (Gonad Weight, GW)	
	Data Period	Data Numb	Data Period	Data Number (N for GW)
Horse mackerel	1954.06-2004.03	963708	1956.09-2004.03	206964 (168965)
Chub mackerel	1953.01-2004.03	647602	1953.05-2004.03	163930 (146392)
Sardine	1952.12-2004.02	937867	1950.01-2005.09	961426 (898110)
Anchovy	1953.01-2002.09	268226	1949.12-2004.03	51032 (46099)
Round herring	1953.01-2001.09	125802	1949.05-2004.03	23853 (20790)

Data from biological measurements program for stock assessment

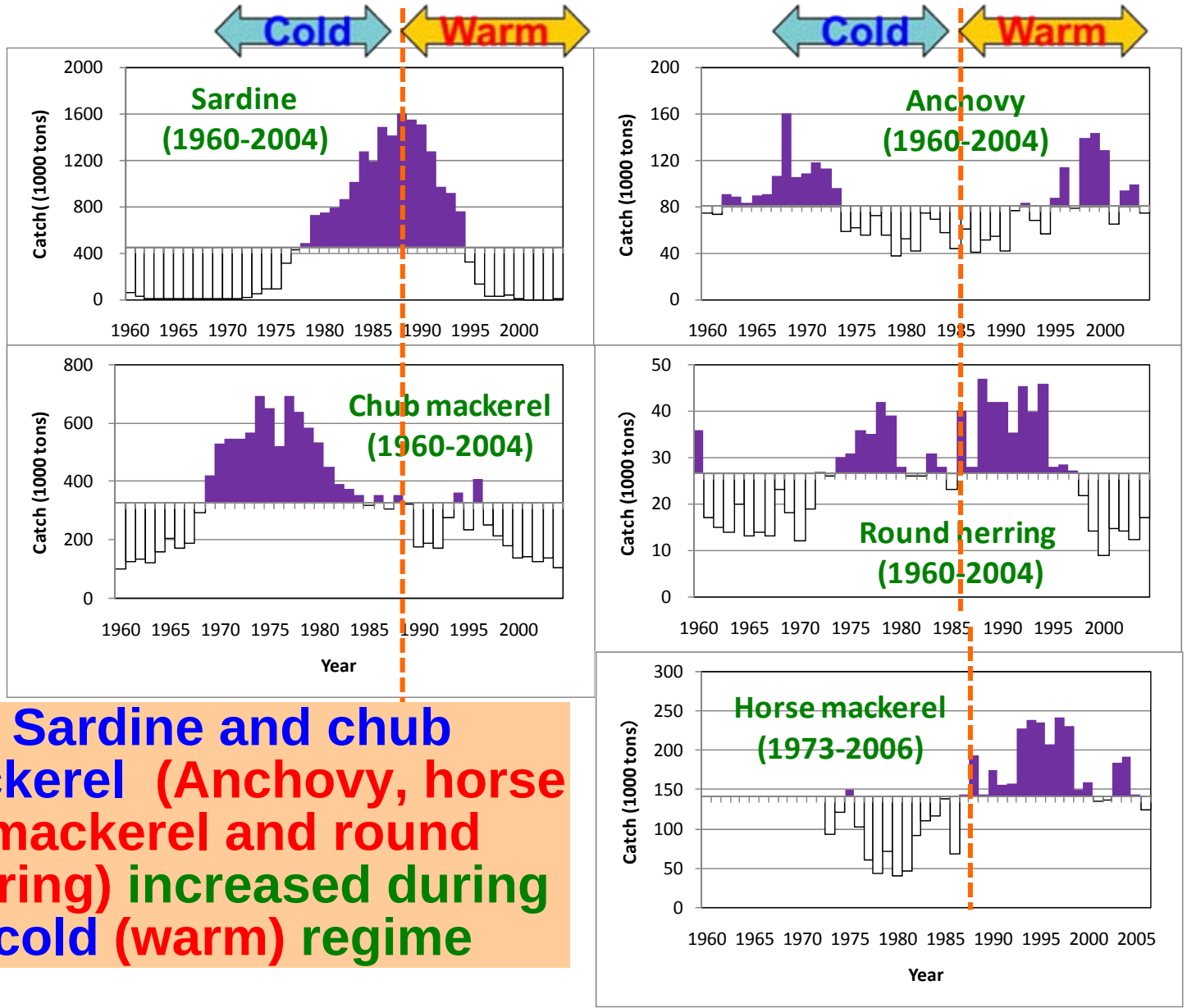
Data period: more than 50 years

Data number: 23,000 (round herring) – 960,000 (sardine)

Basic items: body length, body weight (BW), gonad weight (GW)

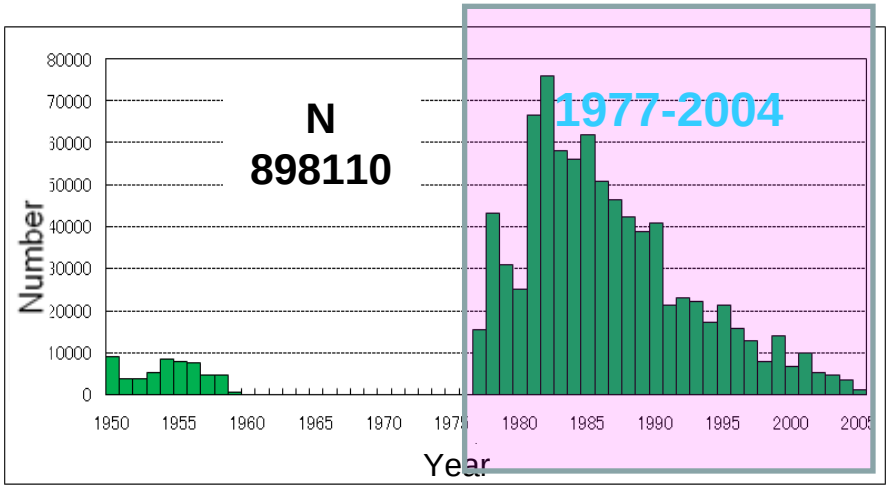
Condition factor (CF): BW/BL^3

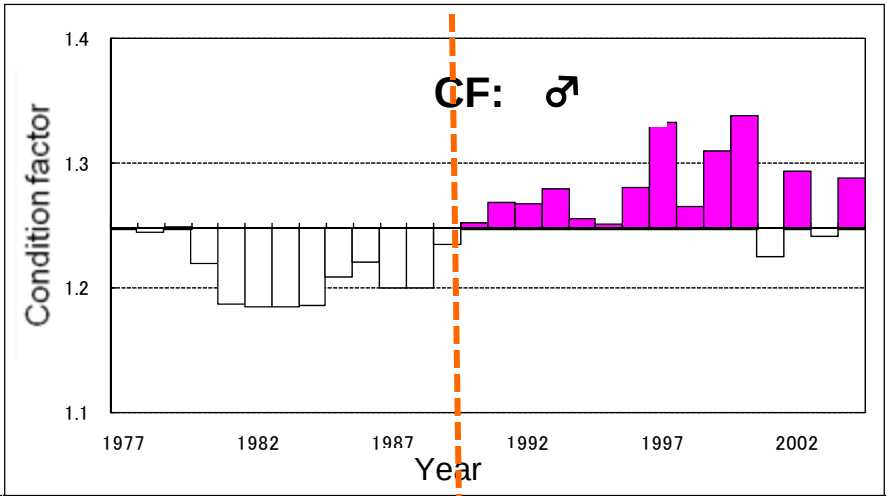
Catch trend of 5 small pelagic fishes

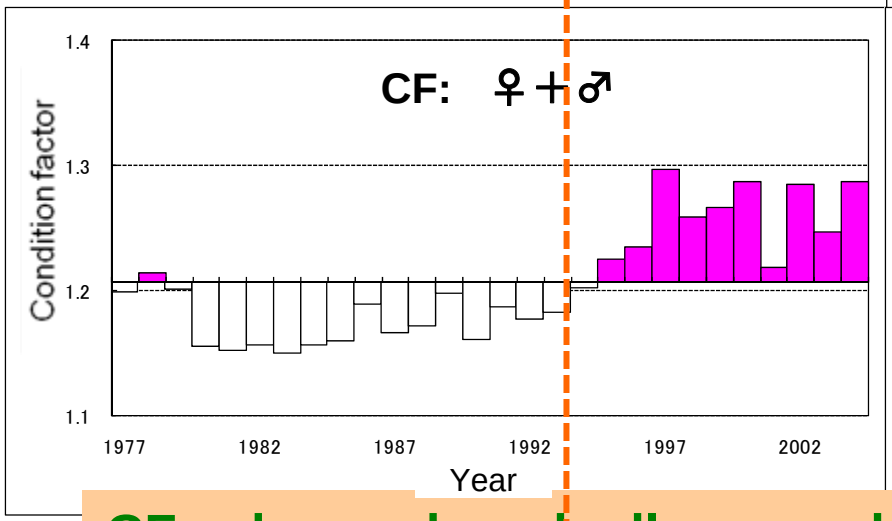


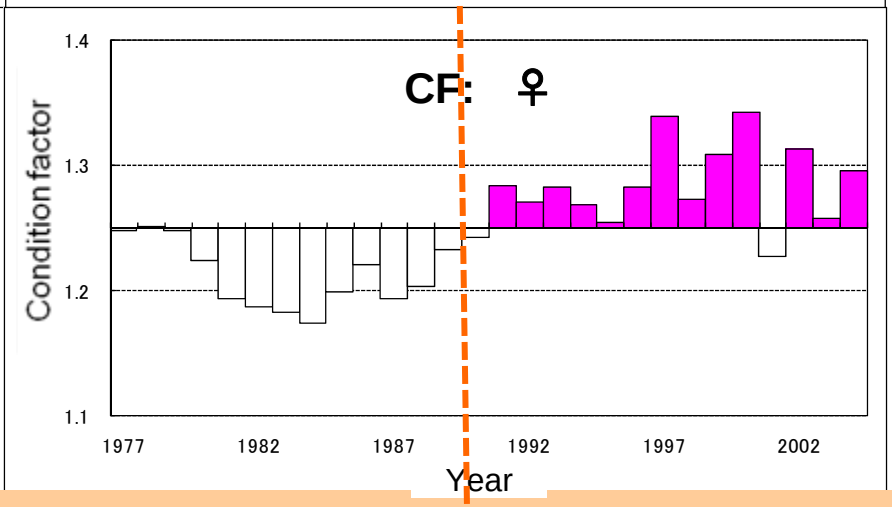
Sardine and chub mackerel (Anchovy, horse mackerel and round herring) increased during cold (warm) regime

Sardine : Condition Factor (CF)





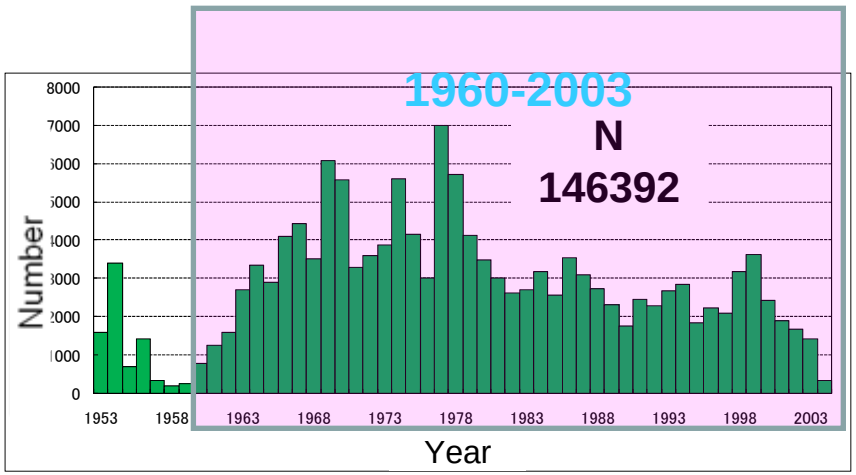


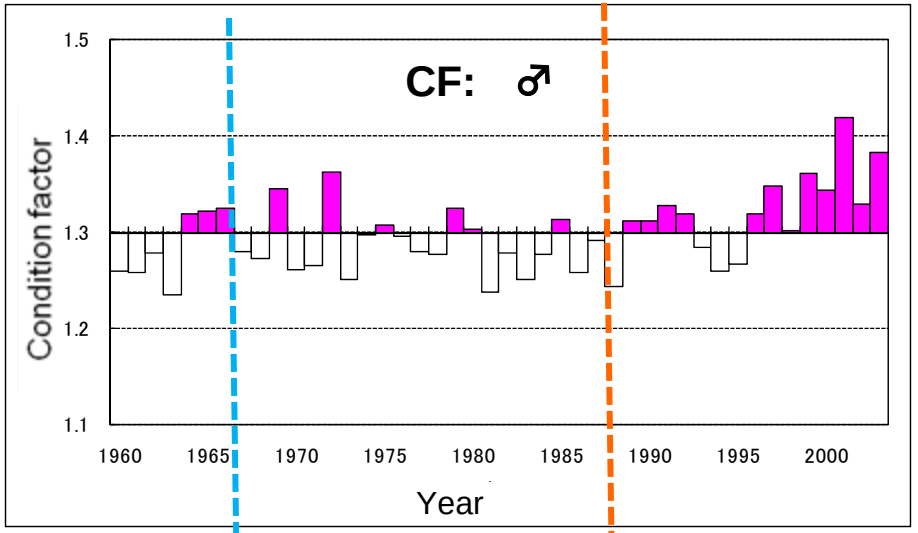


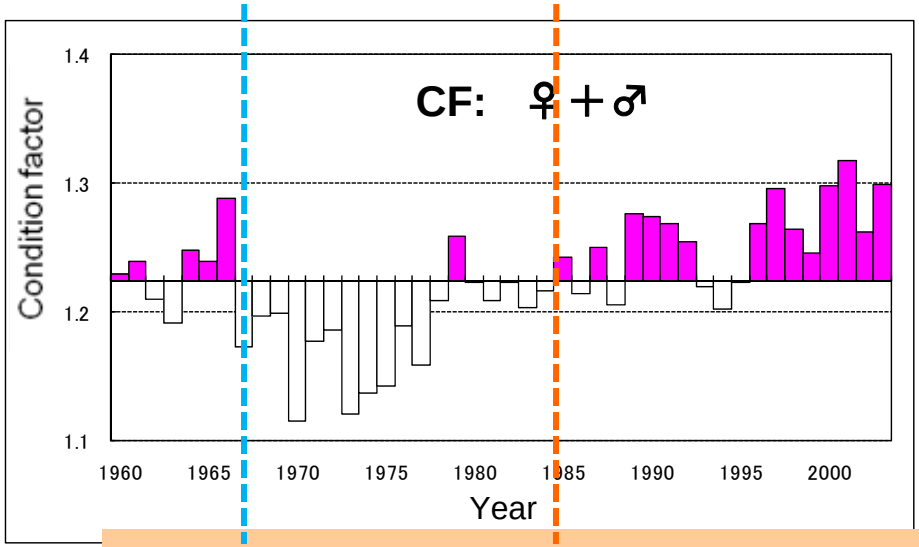
CFs changed markedly around 1989, became higher since 1990s.

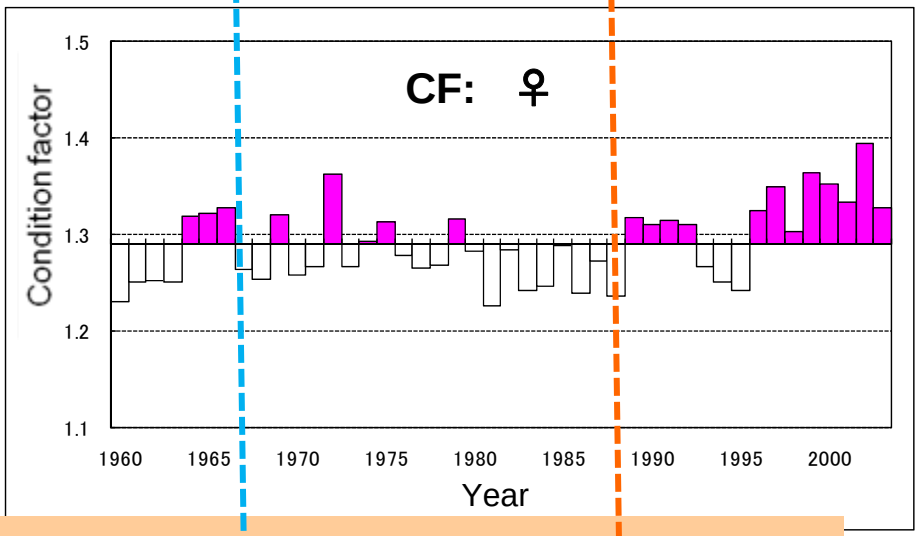
The CFs were lower during abundant 1980s, density effect?

Chub mackerel : CF



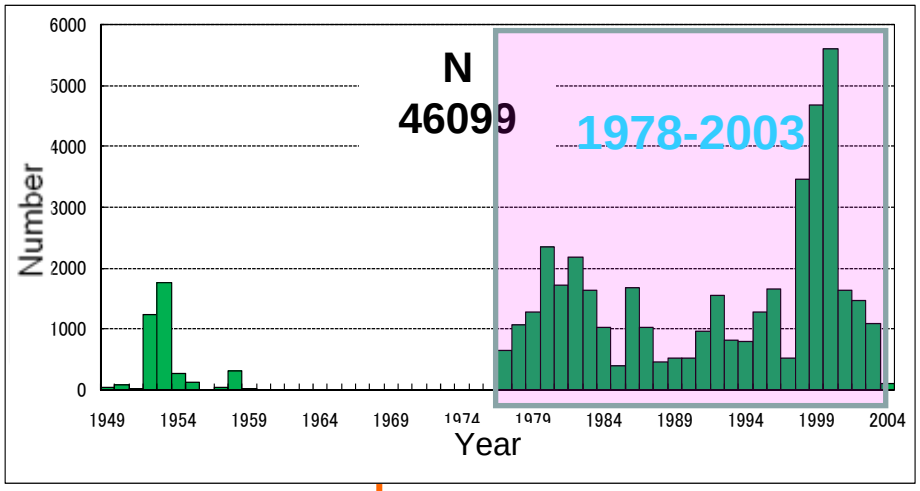


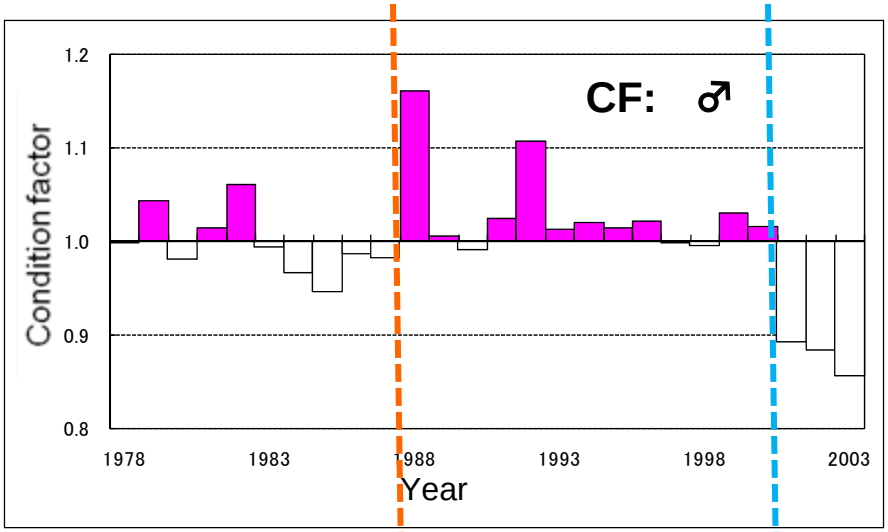


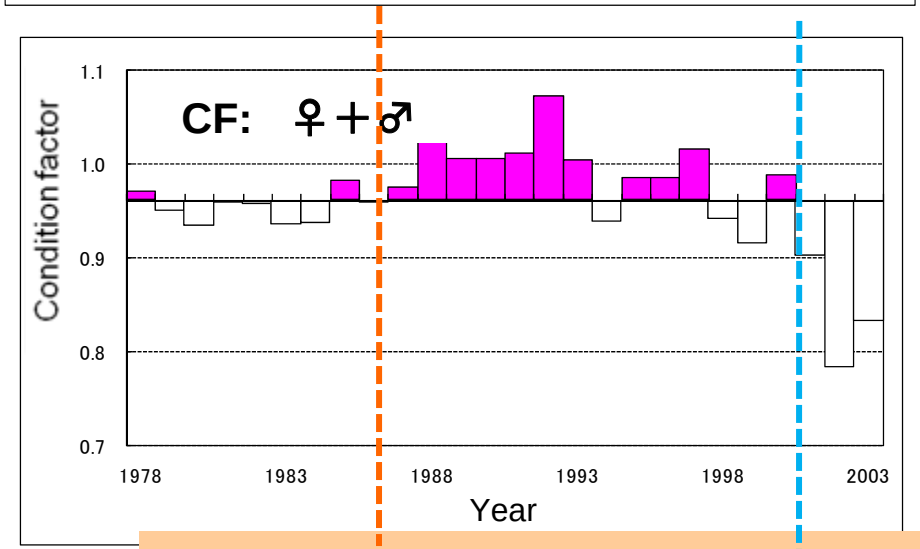


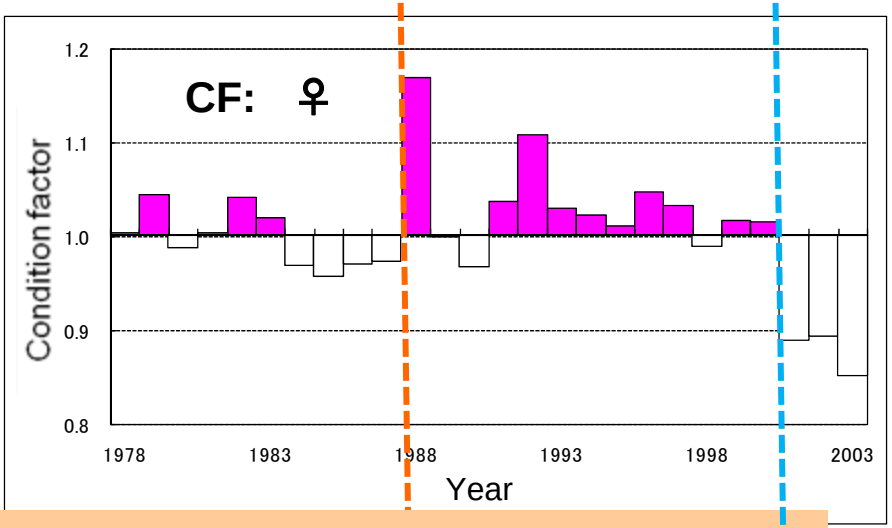
CFs changed largely around late 1980s. CFs were lower in 1980s but higher since 1990s. The pattern was same as sardine.

Anchovy : CF



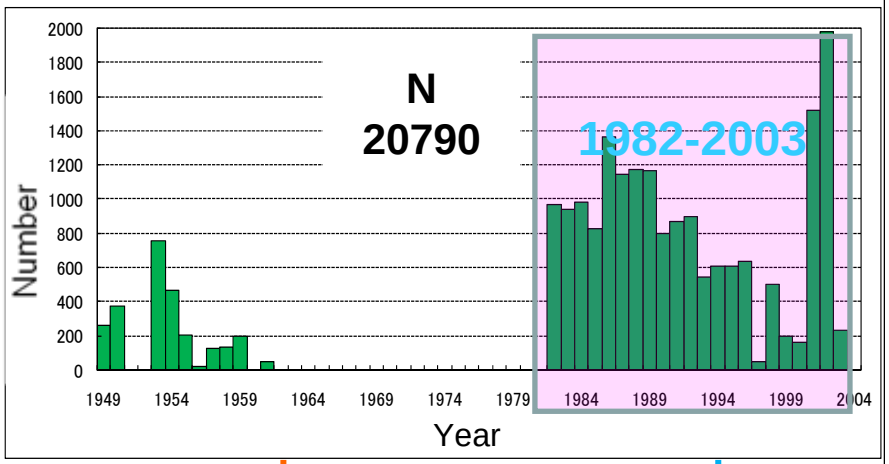


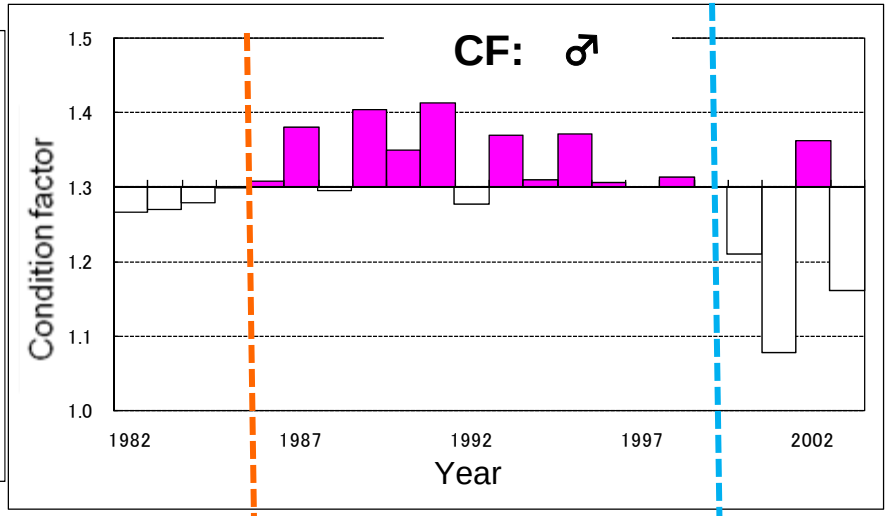


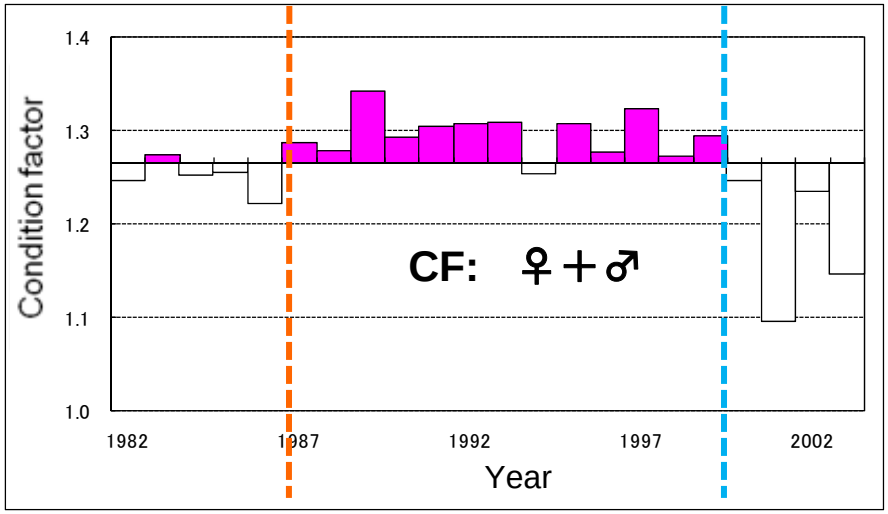


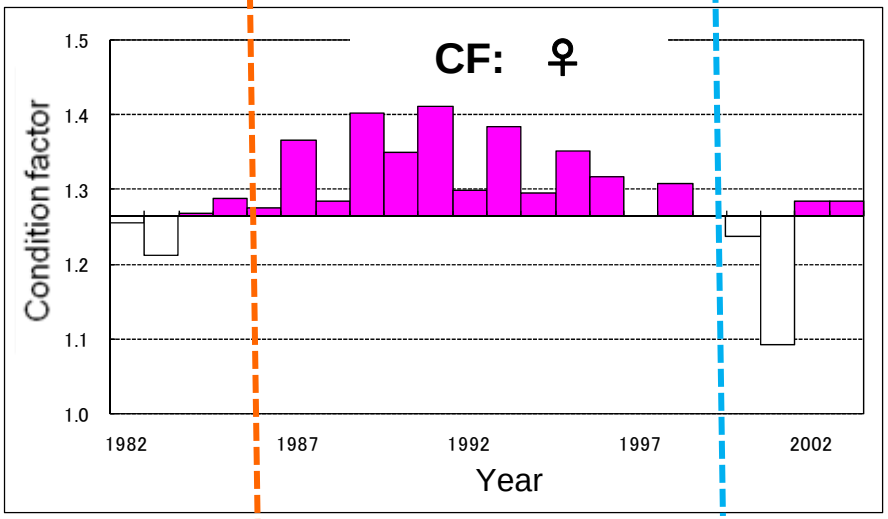
CFs changed around 1987 and also in 2001. CFs were higher during 1990s.

Round herring : CF



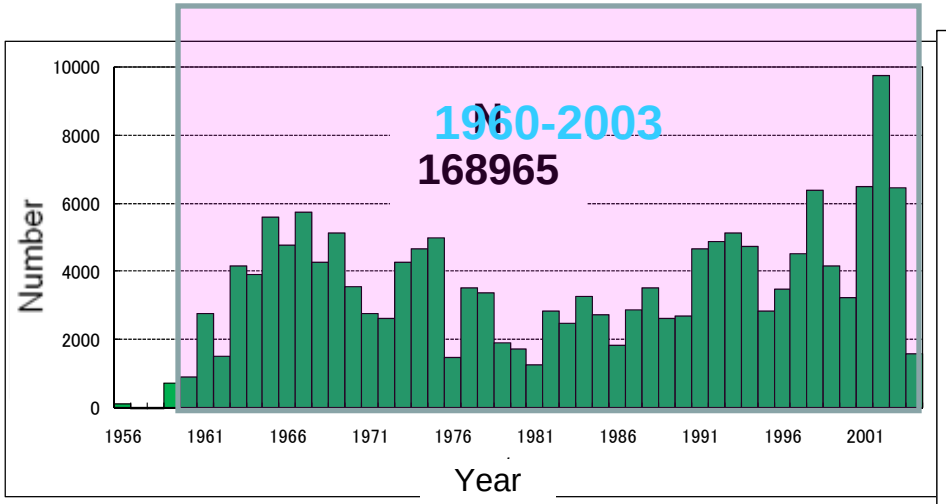


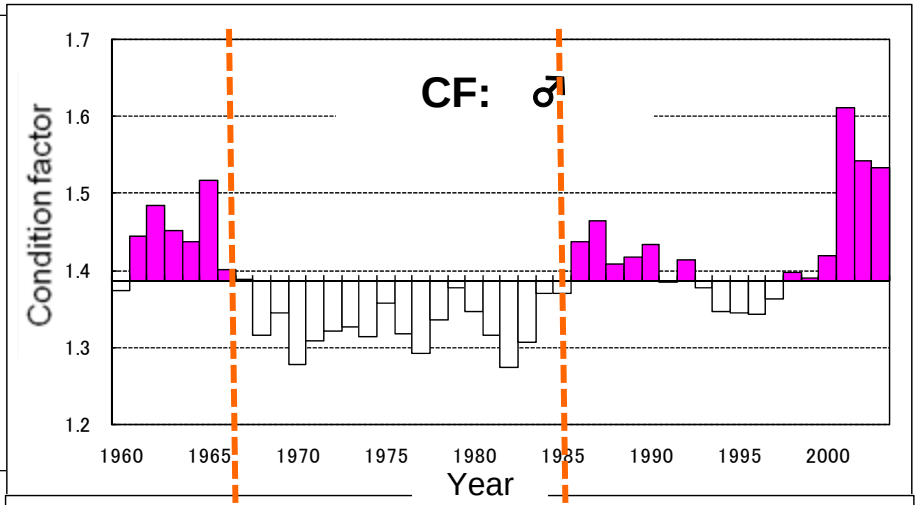


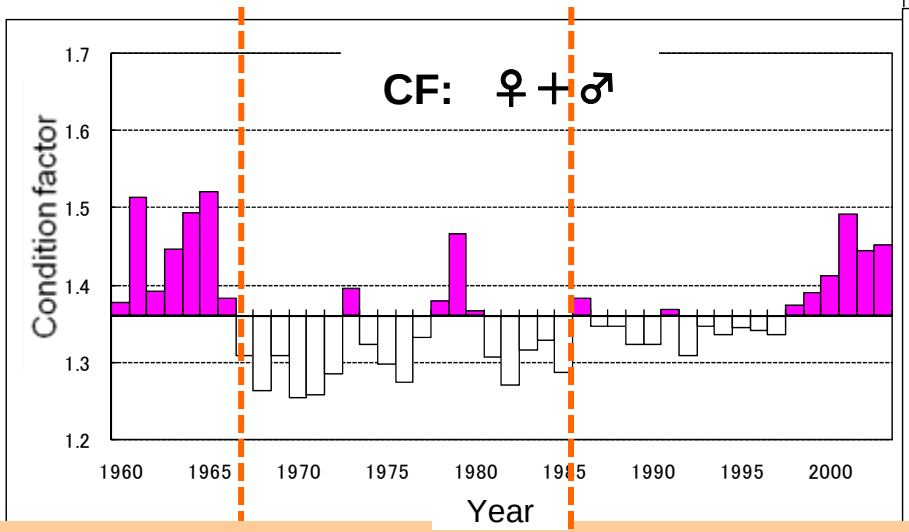


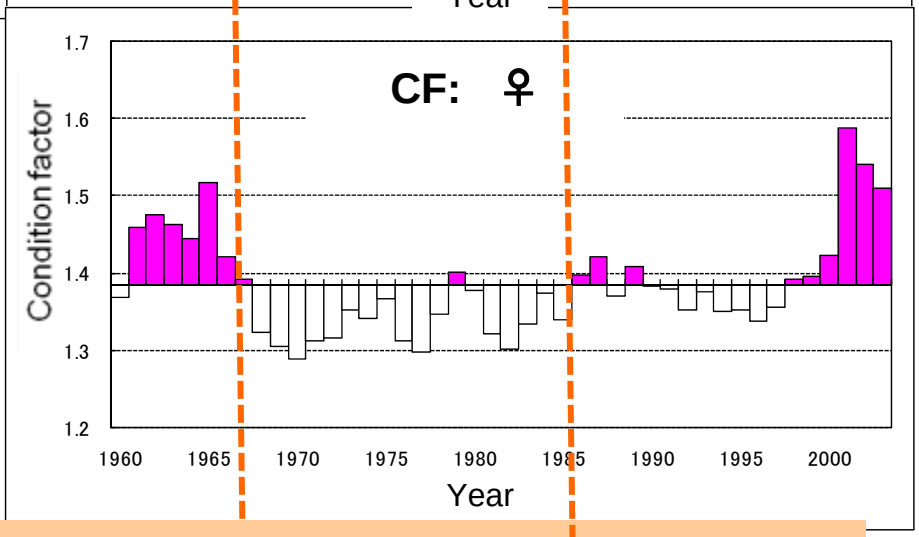
Variation pattern was generally similar to that in anchovy.

Horse mackerel : CF



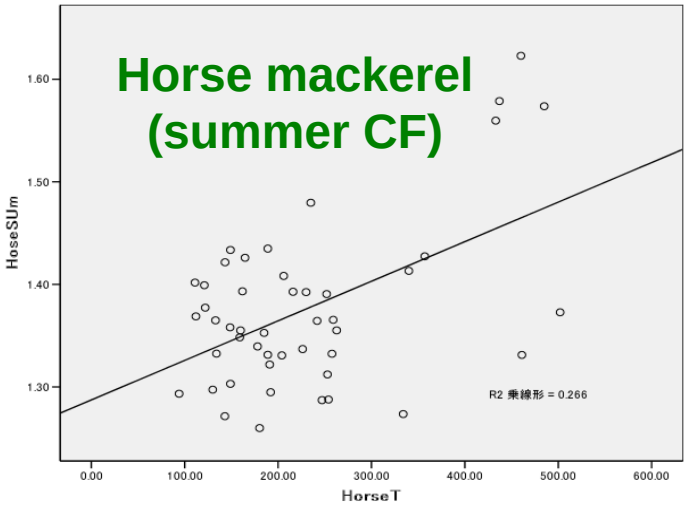


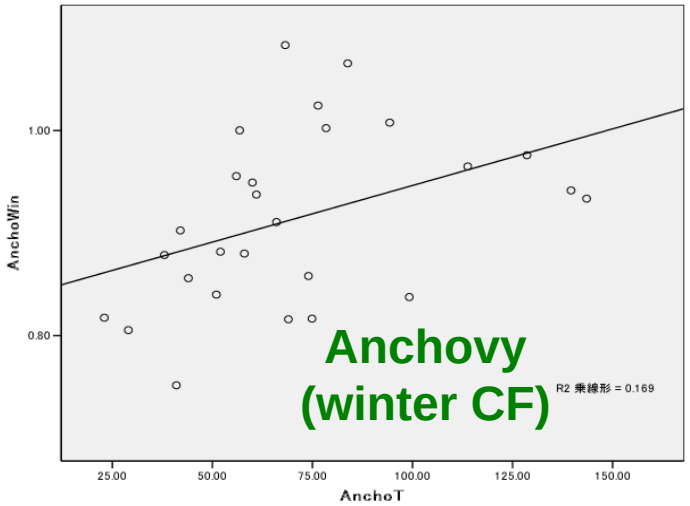


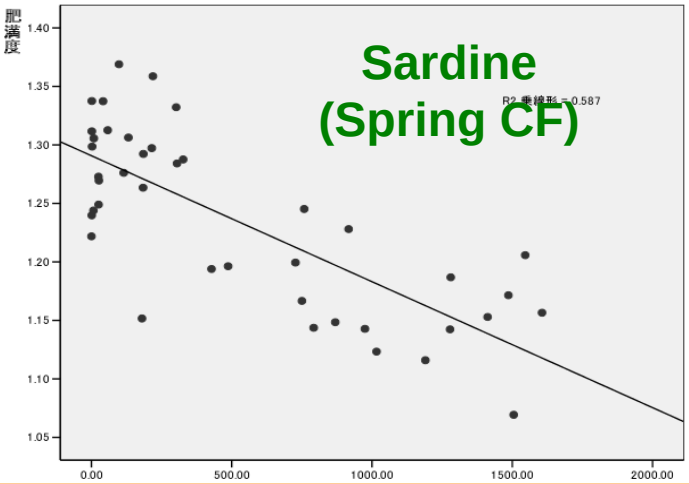


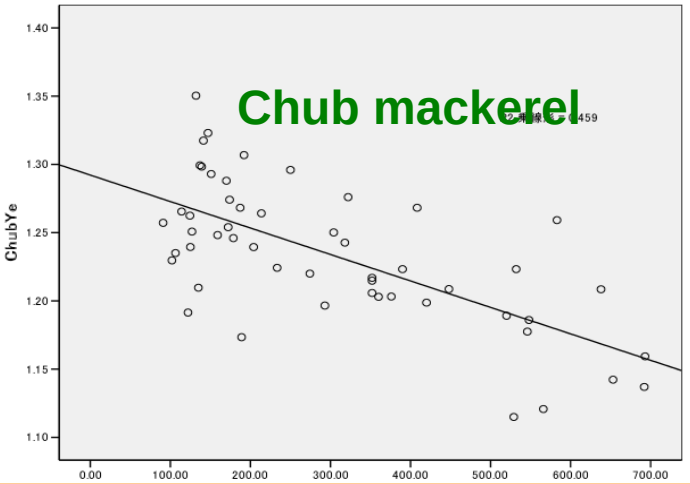
CFs were generally lower during 1966-1985, higher since 1986. The variation pattern corresponds well with winter water temperature.

Relationships between CF and catch



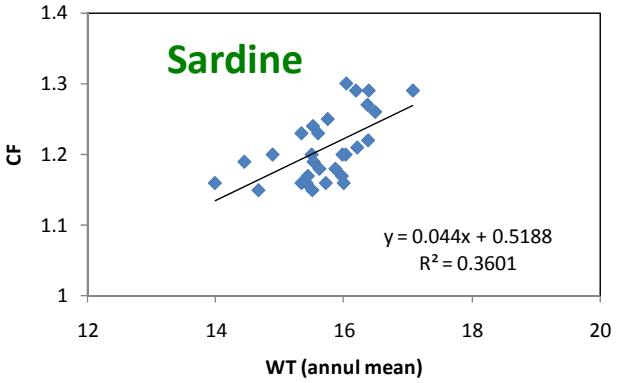


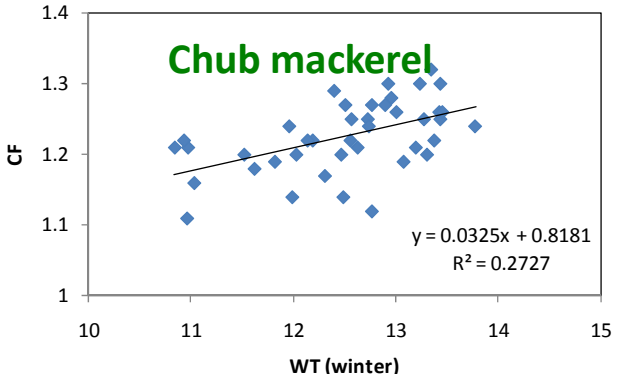


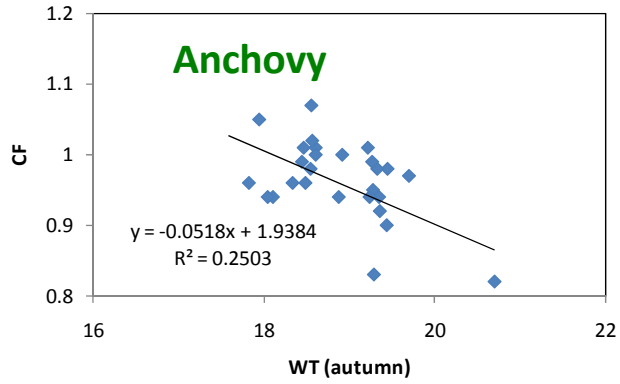


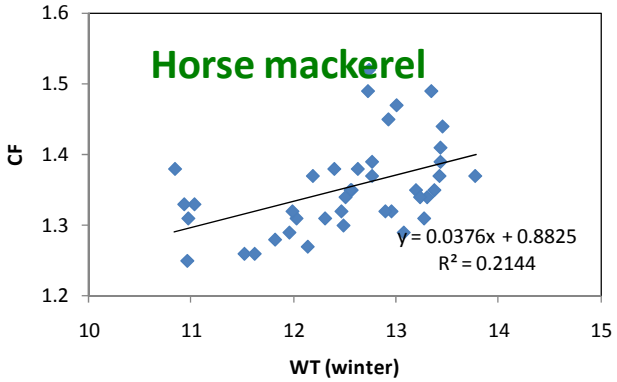
Positive correlations for horse mackerel and anchovy, but negative correlations for sardine and chub mackerel, density effects for sardine and chub mackerel ?

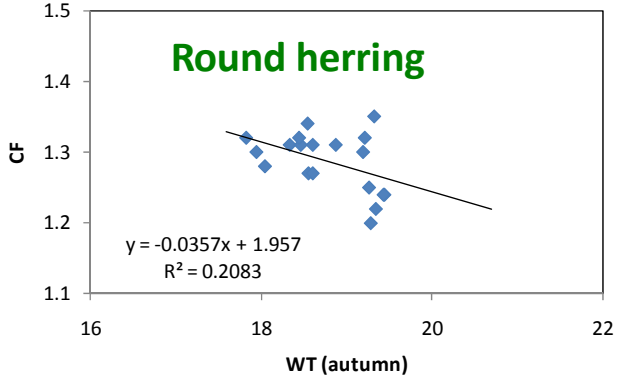
Relationships between CFs and WT







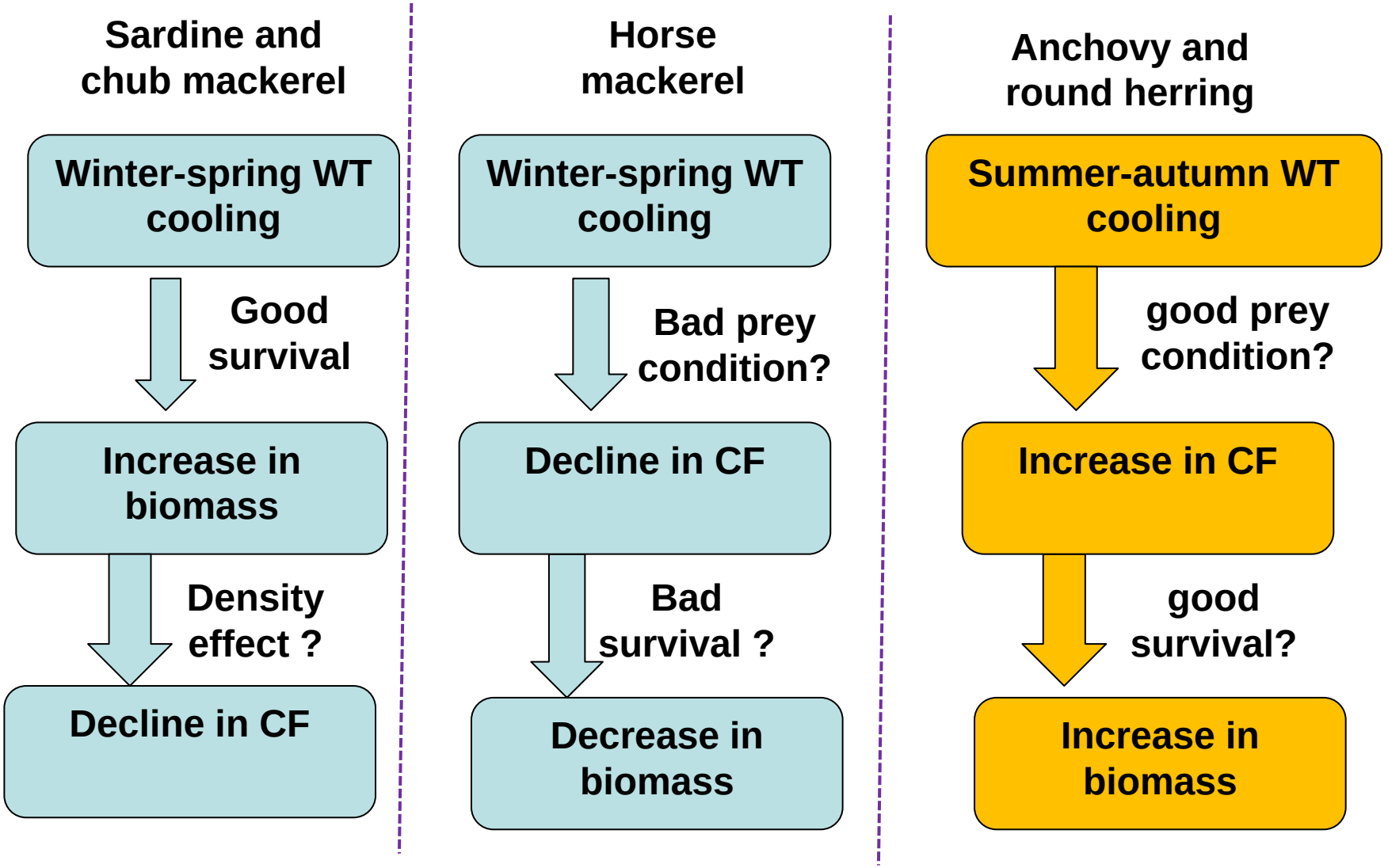




Significant correlations between CF and water temperature.

Positive correlation: sardine, chub mackerel and horse mackerel; Negative correlation: anchovy and round herring

Hypothetical process in CFs during cold regime

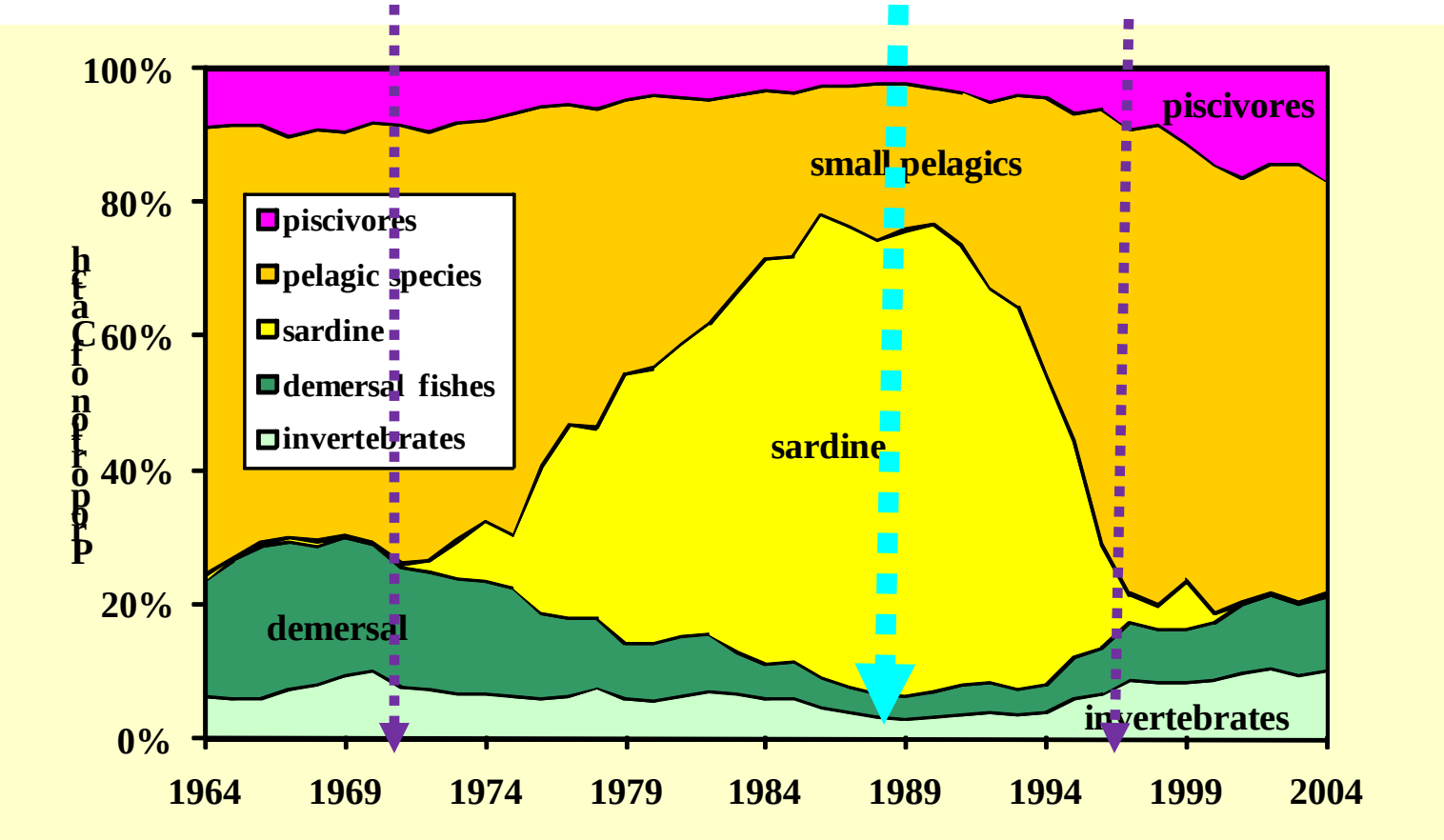


Process during warm regime is opposite to this pattern.

Summary

- **Long-term changes in CFs for five small pelagic fishes were examined.**
- **CFs of all 5 fishes changed around late 1980s: higher during 1990s but lower during 1980s. This indicated the impacts of the regime shift but the process was different by species.**
- **Density effects were identified in sardine and chub mackerel, other 3 fishes were probabaly affected by water temperature.**
- **Other life history parameters such as gonad index, age composition are also necessary to examine in future works to confirm the mechanism of response to the regime shift.**

Changes in proportion of total catch by group



Proportion of small pelagic species changed largely around the late 1980s with the rise and fall of sardine.

The structure of fish community changed in the late 1980s.