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The late-1980s regime shift in the ecosystem of Tsushima Warm Current in the Japan/East Sea: evidence of historical data and possible mechanisms

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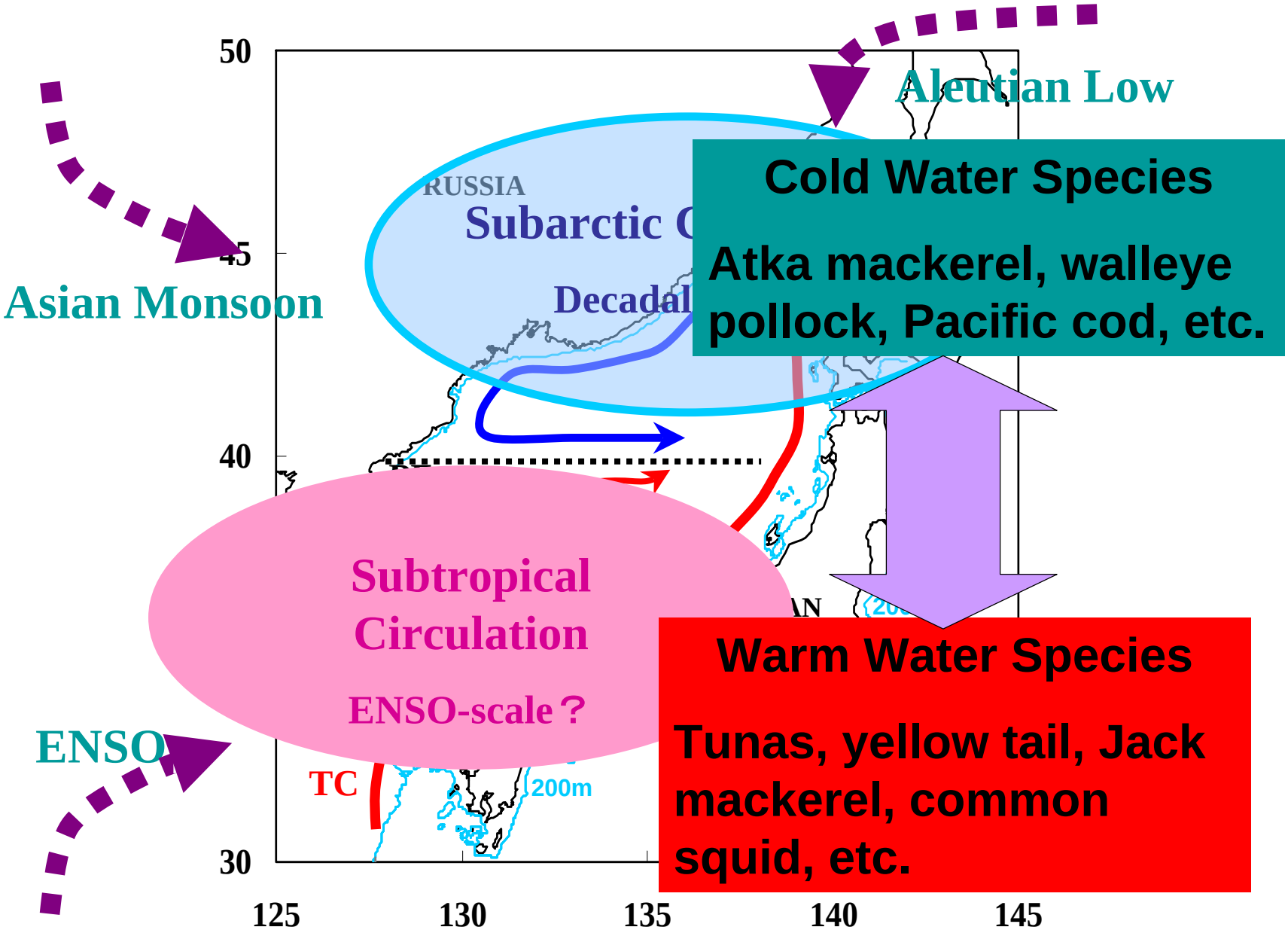
Outlines of This Study

1. Background and objectives
2. Data and methods
3. Late 1980s oceanic regime shift in TWC
4. Changes in plankton biomass
5. Variation patterns in fisheries production: analysis of fisheries statistics data (1964-2004)
6. Spatial-temporal variability in demersal fish assemblages: analysis of "Offshore Trawl Data (1974-2004)"
7. Summary and mechanisms of the late 1980s ecological regime shift in TWC


Aleutian Low
Asian Monsoon
ENSO
RUSSIA
Subarctic C
Decadal
Subtropical Circulation
ENSO-scale？
TC
200m
Cold Water Species
Atka mackerel, walleye pollock, Pacific cod, etc.
Warm Water Species
Tunas, yellow tail, Jack mackerel, common squid, etc.
50
45
40
30
125
130
135
140
145

TWO OBJECTIVES

1. To identify the regime shift in the ecosystem of TWC: from low trophic level plankton to fish community

2. To unravel the mechanisms whereby climatic and oceanic variability are linked to the ecosystem regime shift in TWC in late 1980s.

Data and Methods

1. Catch statistics: 1964-2004:

54 species items, 90% of total catches

2. Japan Sea Offshore Trawl Data Set

1974-2004: 27 demersal species, catches and CPUE with spatial resolution of 10 minutes

3. Plankton data set: PM Line 1972-2004

4. Oceanographic-climatic indices

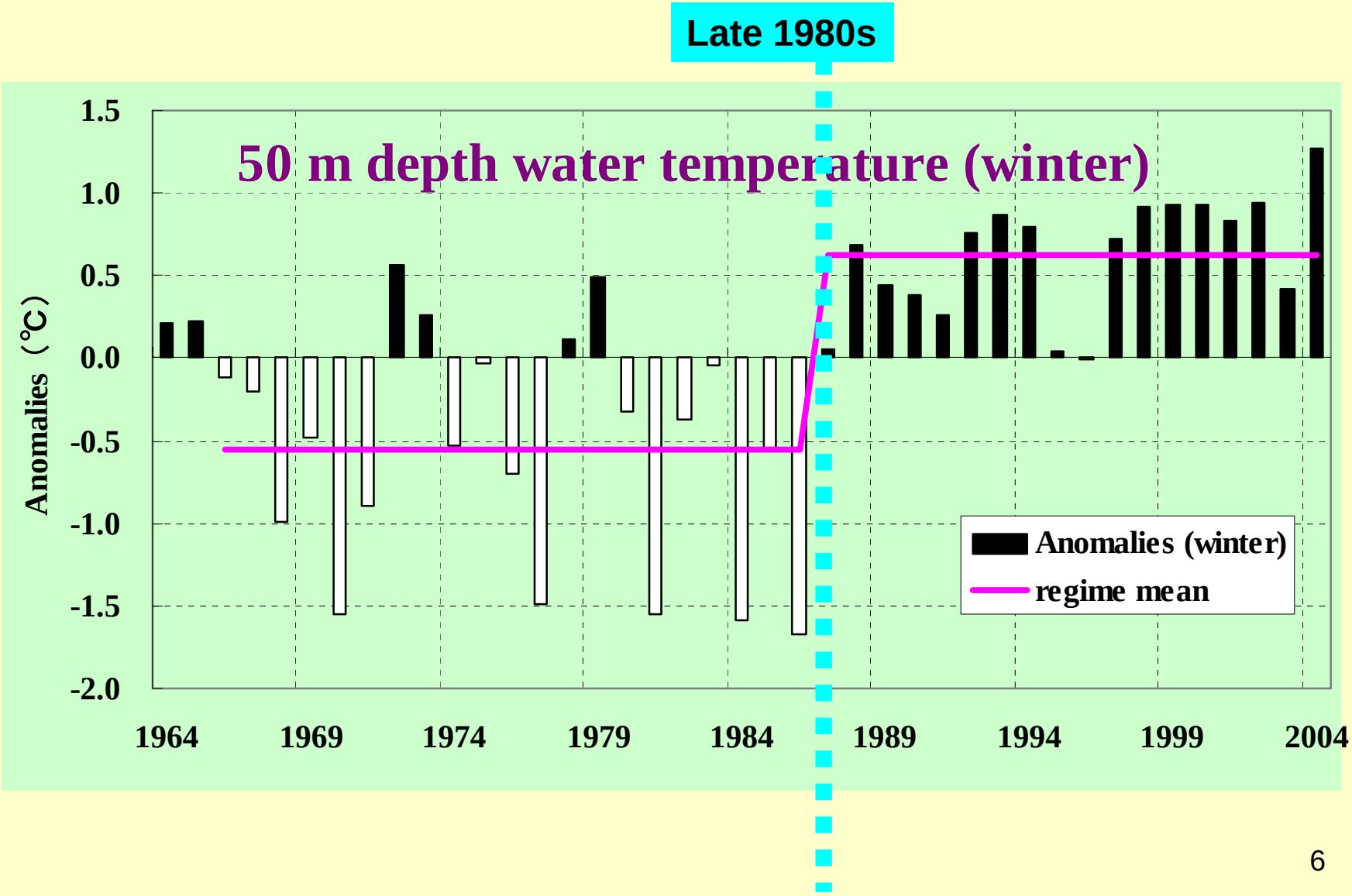
SST: 1°×1°grid data set from JMA, **1950-2004**

50 to 200 m depth WT: 1964- 2004:

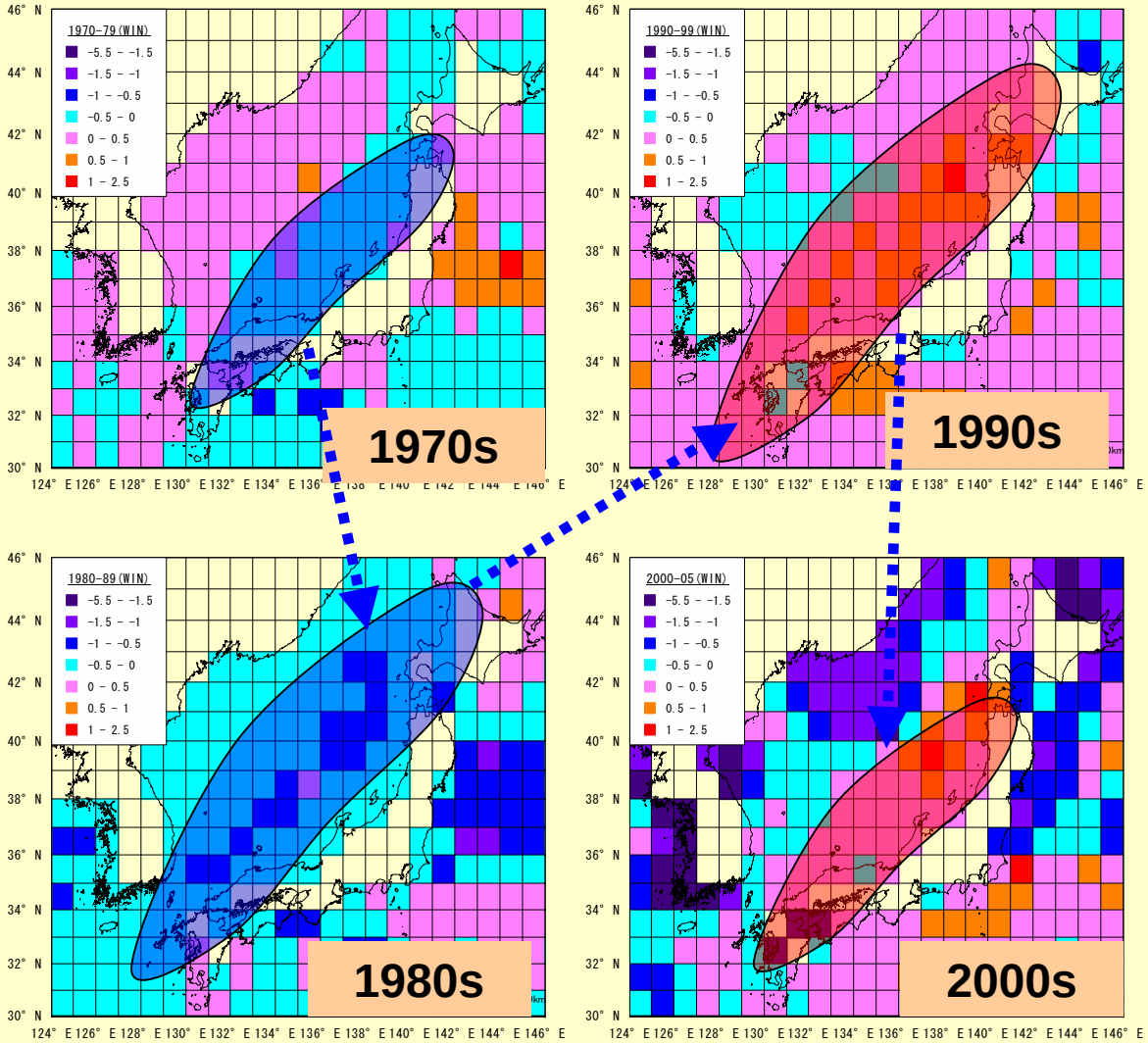
an indicator of Tsushima Warm Current

5. PCA Analysis and GIS Approach

Indicator of Tsushima Warm Current



Spatial differences in winter SSTs

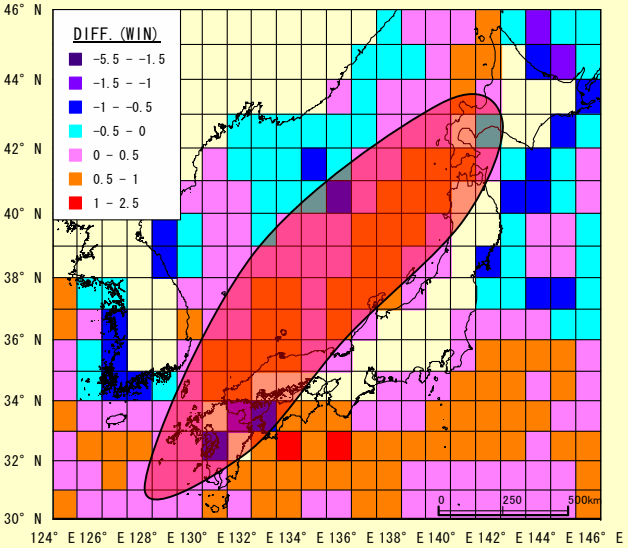


Regime difference:

mean of 1987-2004

-

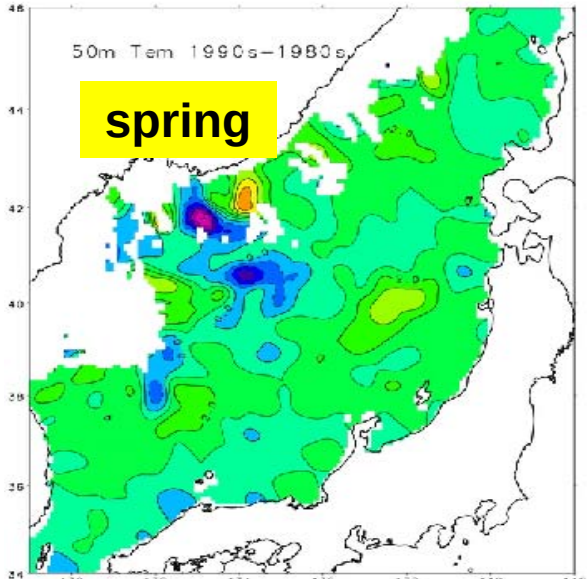
mean 0f 1976-86

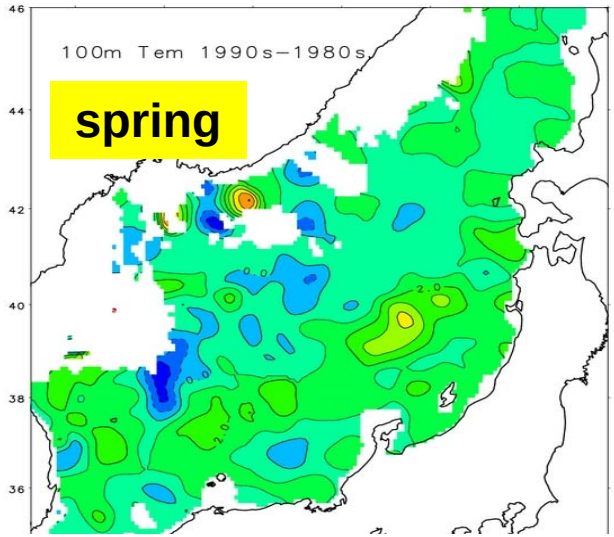


Decadal mean - 30 years (1970-1999) mean

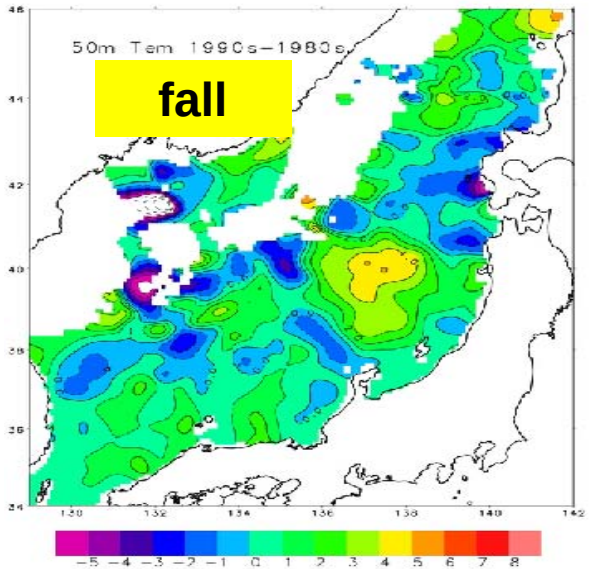
Spatial differences (1990s-1980s) in WT

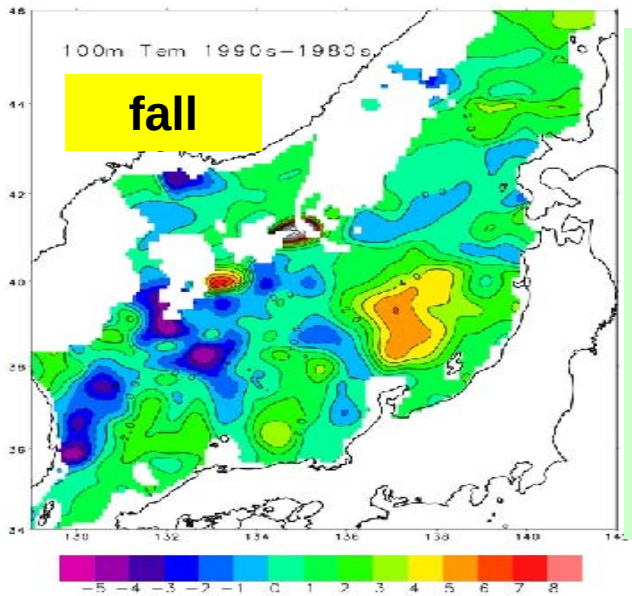
50m





100m





Note

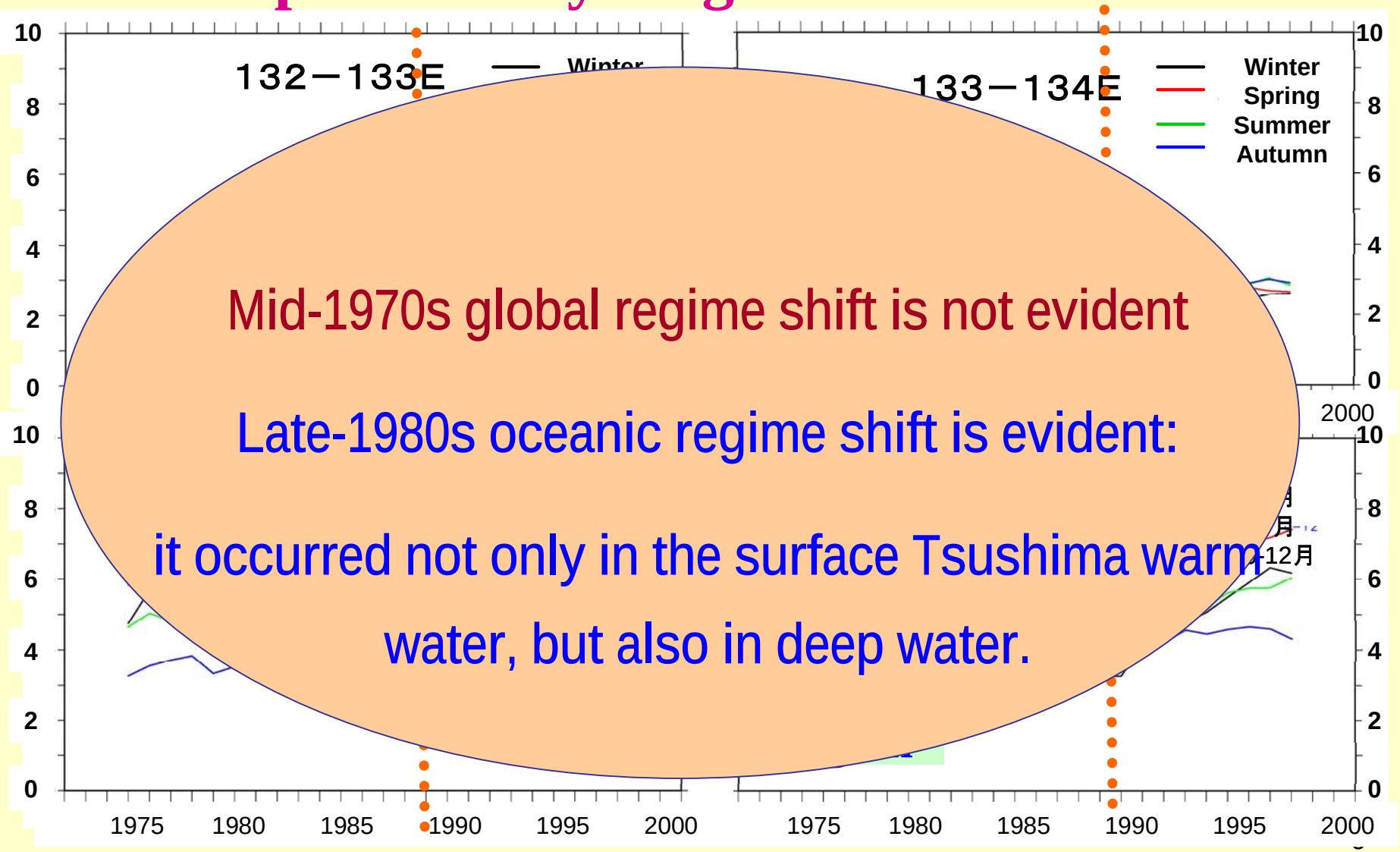
1980s :

1982-1988

1990s:

1989-1995

Yearly changes in 200m depth water temperature by longitude and season

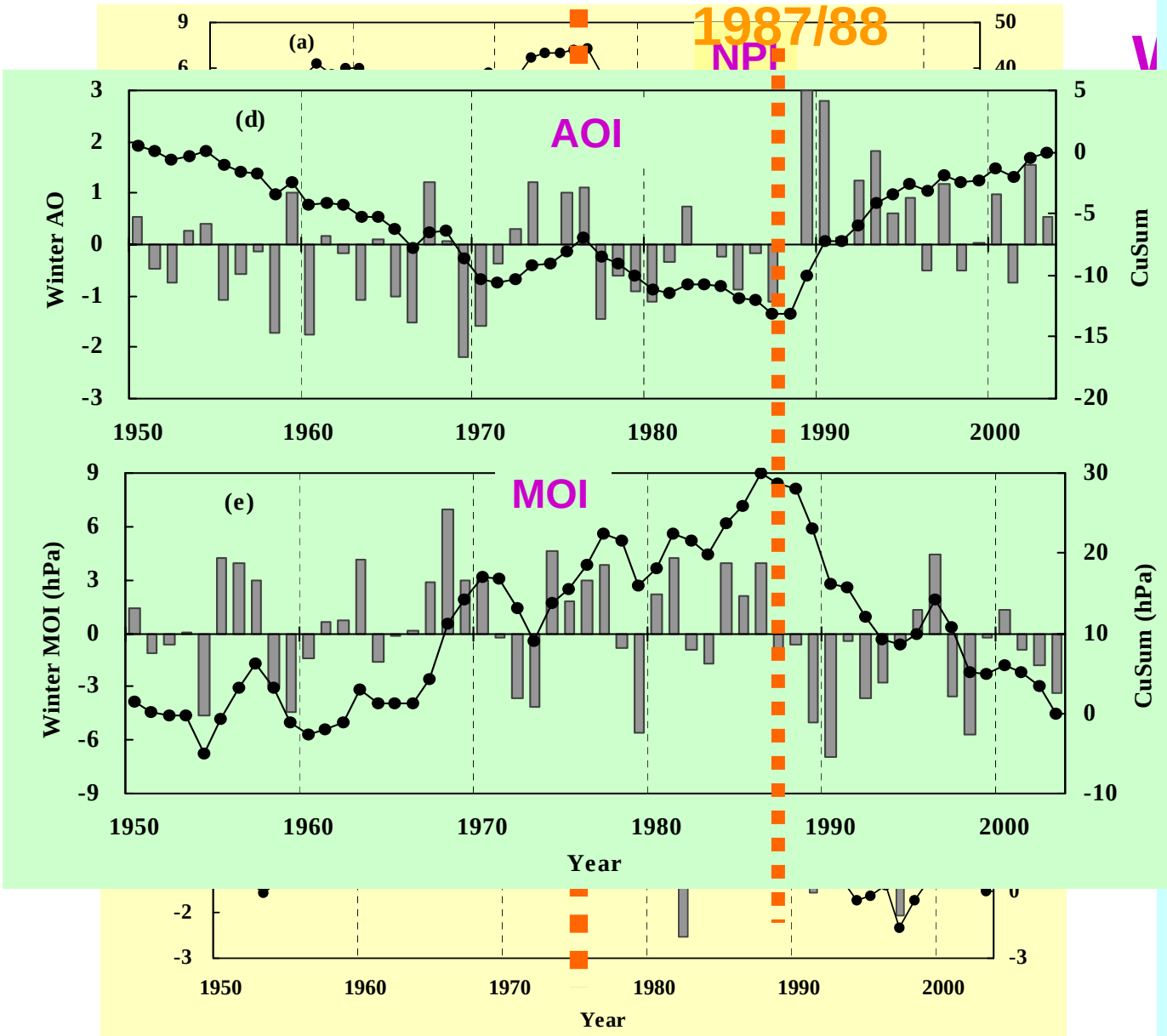


Mid-1970s global regime shift is not evident

Late-1980s oceanic regime shift is evident:

it occurred not only in the surface Tsushima warm water, but also in deep water.

Climate Indices



With late 1980s regime shift

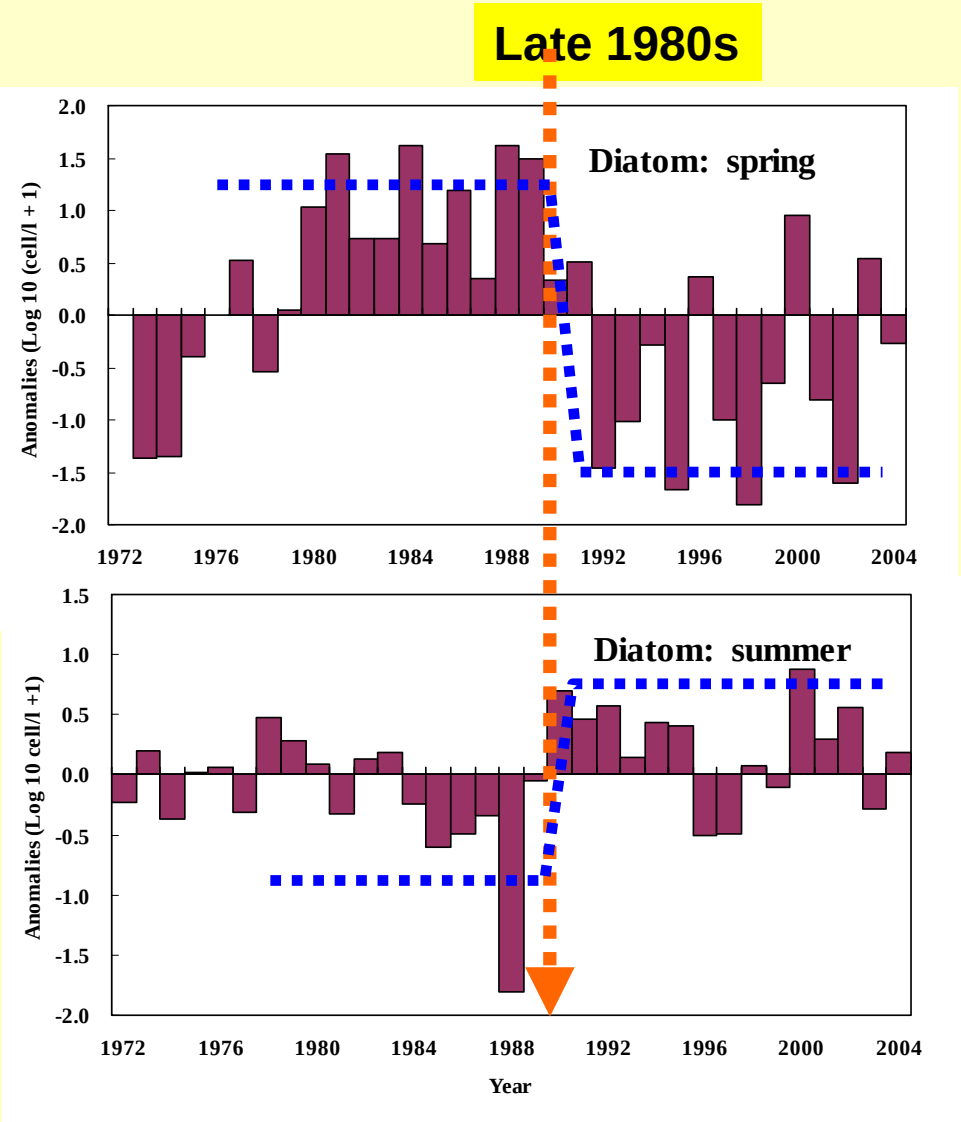
AOI positive

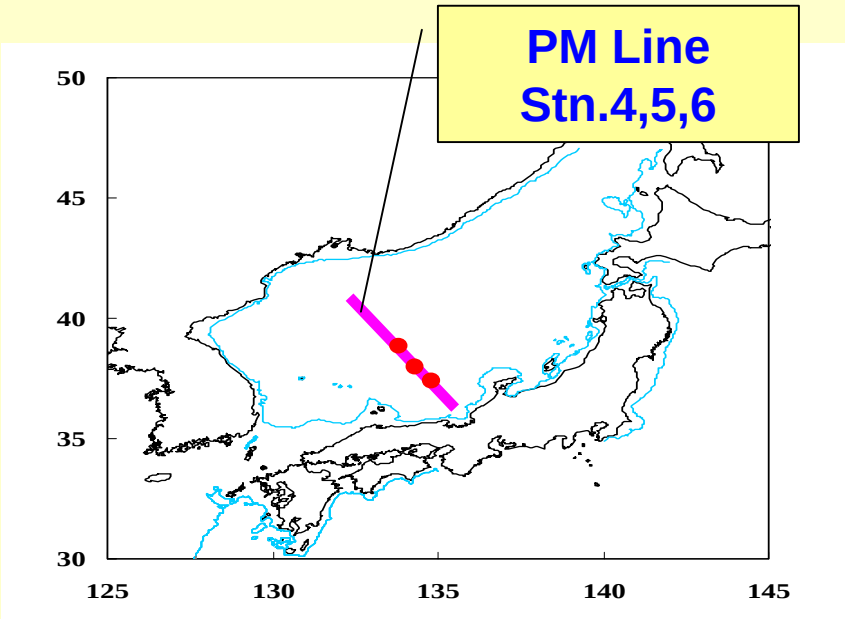
Weakeness of Asian monsoon

→

Increase of water temperature?

Phytoplankton (Diatom) : 1972-2004

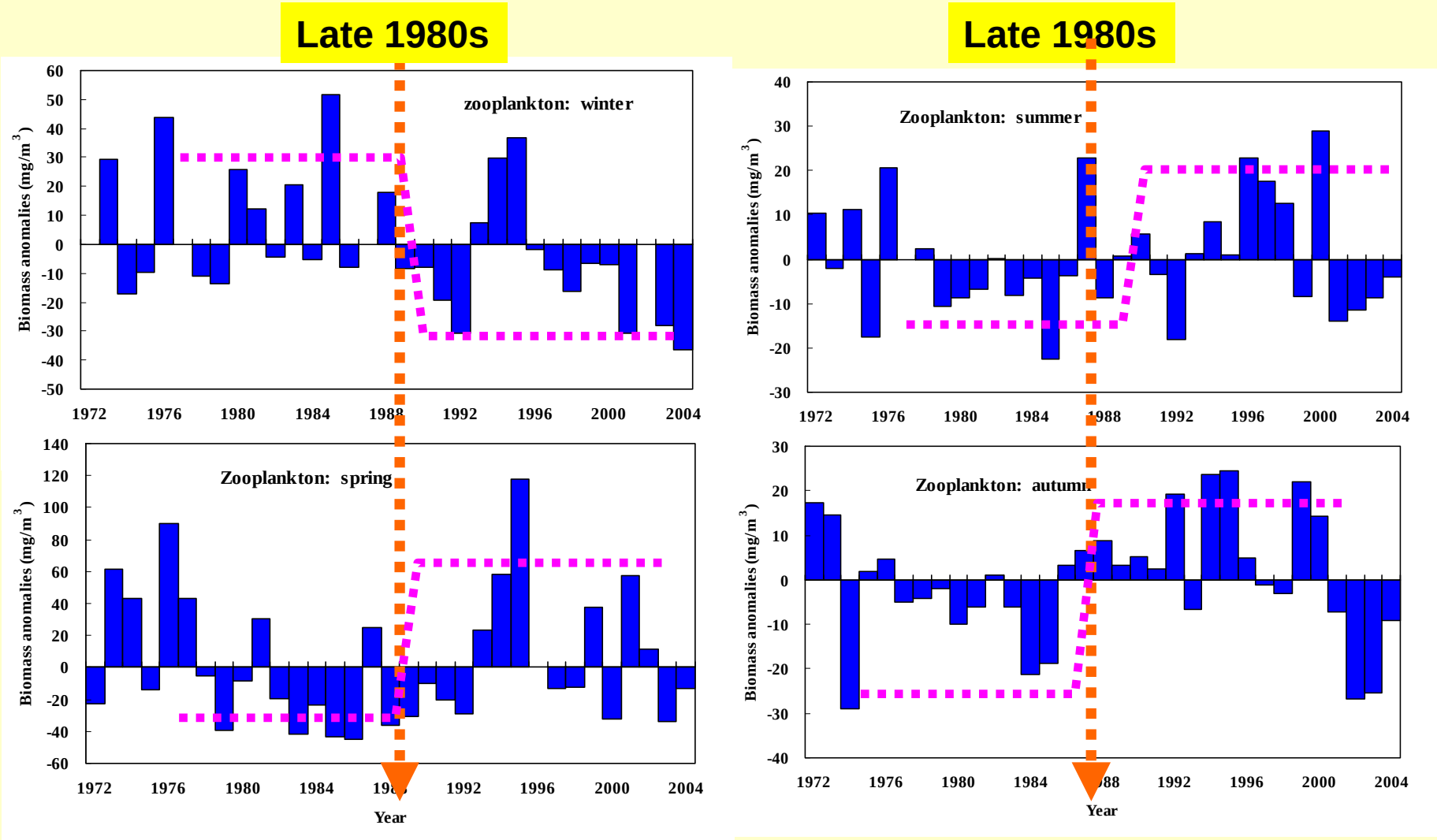




Decadal variability and abrupt change around late 1980s

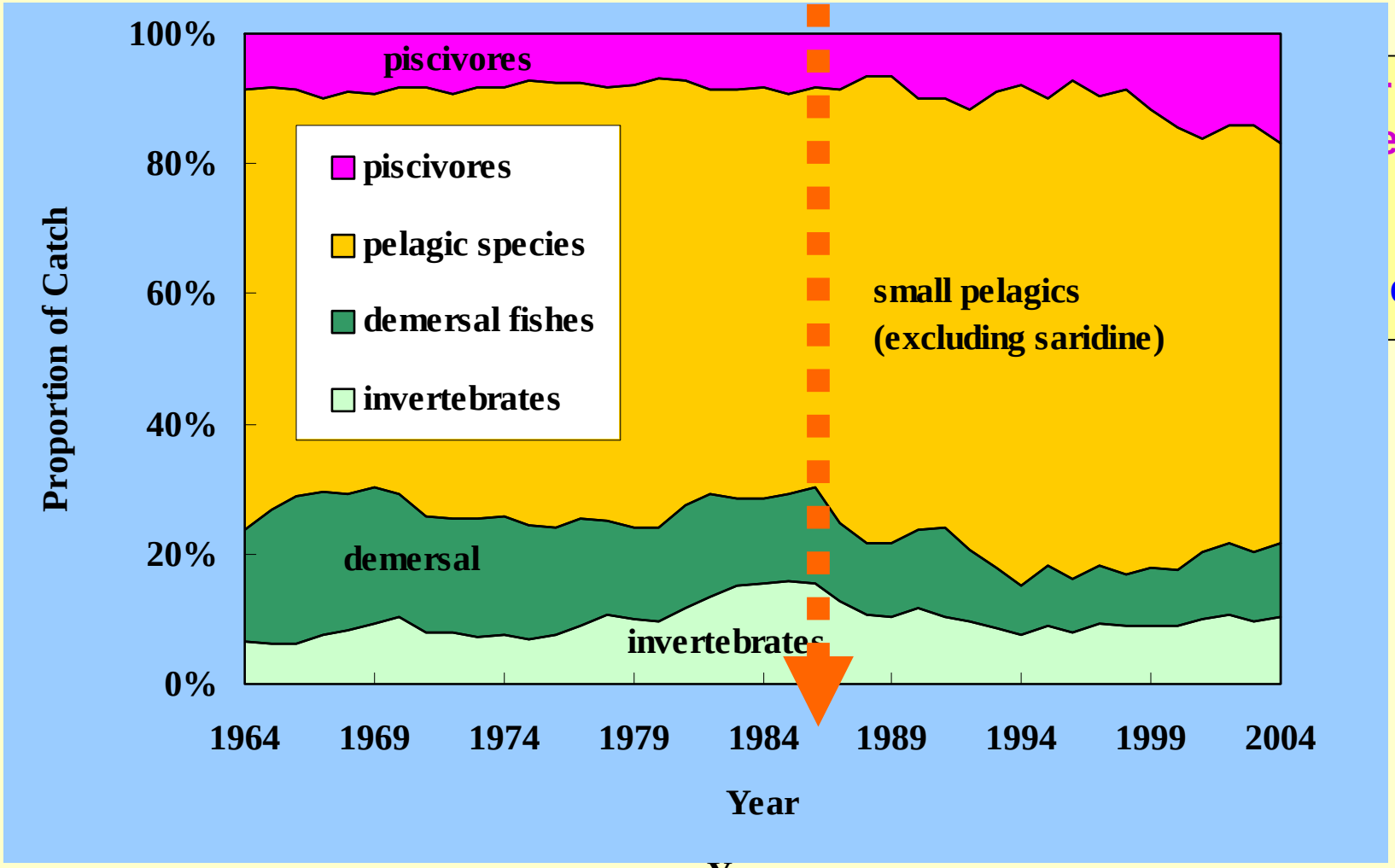
Different pattern in spring and summer reflecting different species composition ?

Zooplankton (Wet weight): 1972-2004



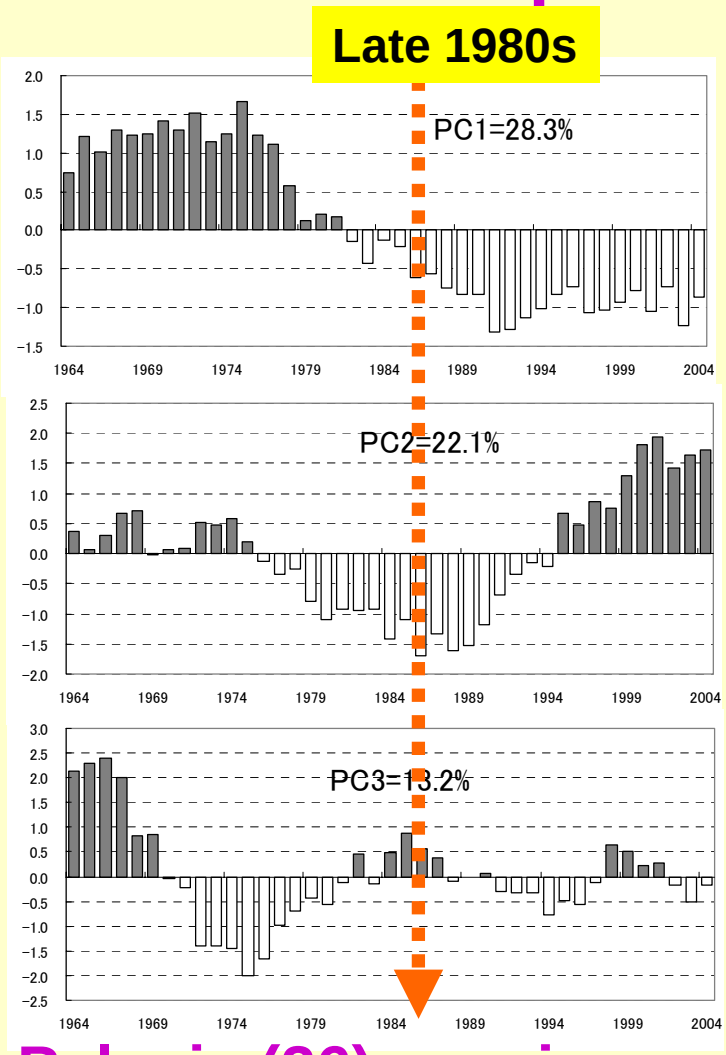
Large interannual and decadal variation: high (lower) during 1990s (1980s) except in winter

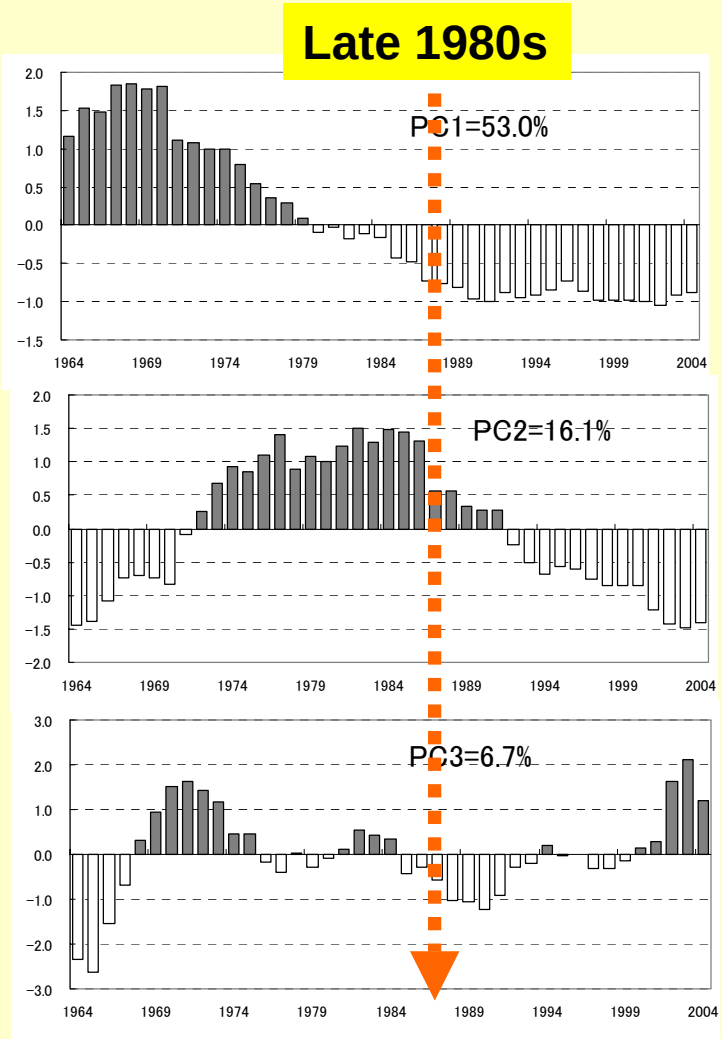
Catches Trend in the Japan Sea during 1964-2004



Year

PCAs of 54 species items: 1964-2004





Pelagic (26) species **Demersal (28) species**

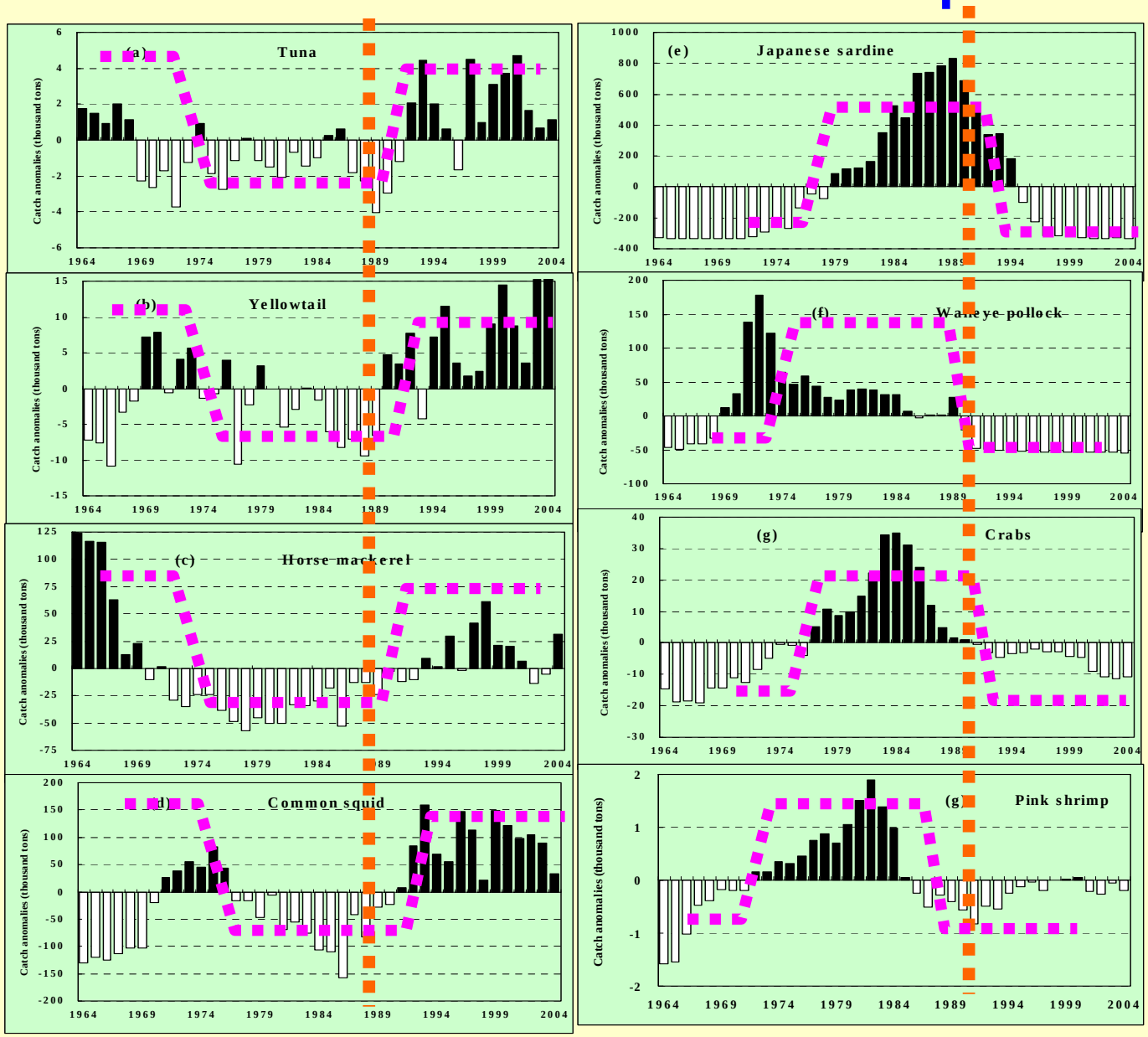
Warm water **64%<---- PC1-3--→76%** **Cold water**

Catch Trend of Indicator Species

Large fishes

warm water migratory Species

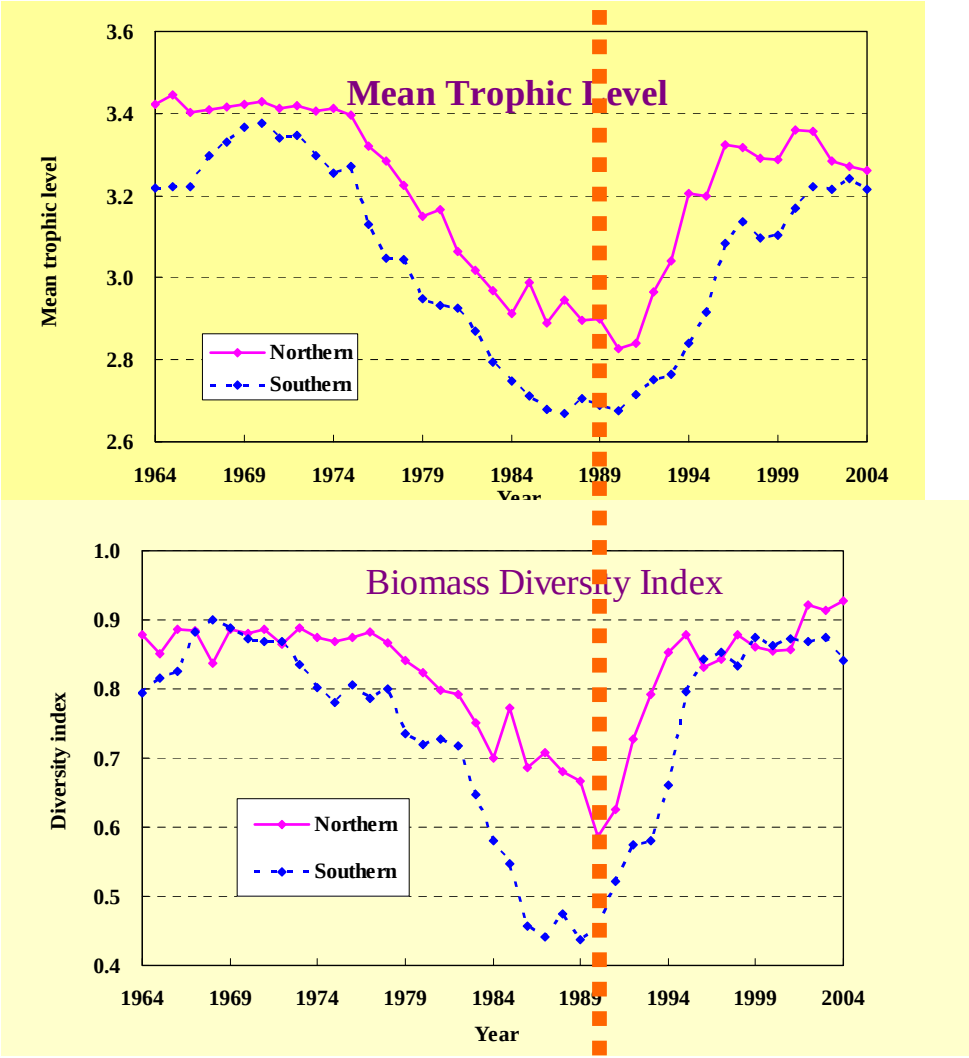
Small pelagic species



cold water or deep water demersal species

Community indices from 54 species

Mean Trophic Level and Simpson's Diversity Index



Decadal scale changes

Decreased during Mid-1970s-1980s

but increased during 1990s

Offshore Bottom Trawl : Target species

No	Japanese Name	Scientific Name	English Name	Depth (m)	Life span (years	Current
1	マダラ	*Gadus macrocephalus*	Pacific cod	200-300	>12	CW
2	スケトウダラ	*Theragra chalcogramma*	Walleye pollock	100-500	>11	CW
3	ホッケ	*Pleurogrammus azonus*	Arabesque greenling	<200	>8	CW
4	ハタハタ	*Arctoscopus japonicus*	Japanese sandfish	300-500	5	CW
5	サメ･エイ （アブラ	*Squalus acanthias*	Piked dogfish	150-180	>10	CW
6	ハツメ	*Esbastes owstoni*	Owenton's rockfish	190-300	>10	CW
7	ヒレグロ	*Glyptocephalus stelleri*	witch flounder	200-300	>12	CW
8	アカガレイ	*Hippoglossoides dubius*	flathead flounder	150-500	>10	CW
9	マガレイ	*Pleuronectes herzensteini*	brown sole	30-130	>10	CW
10	その他のカレイ	*Pleuronectidae*	other righteye flounder			CW
11	ホッコクアカエビ	*Pandalus borealis*	Pink shrimp	200-600	11	CW
12	ズワイガニ	*Chionoecetes opilio*	Tanner crab	200-500	>10	CW
13	ソウハチ	*Hippoglossoides pinetorum*	pointhead flounder	150-190	8	WW
14	ムシガレイ	*Eopsetta grigorjewi*	shotted halibut	<140	>10	WW
15	ヤナギムシガレイ	*Tanakius kitaharai*	willowy flounder	80-150	>10	WW
16	ニギス	*Glossanodon semifasciatus*	Deepsea smelt	<200	5	WW
17	ヒラメ	*Paralichthys olivaceus*	bastard halibut	<150	>10	WW
18	マダイ	*Pagrus major*	Silver seabream	<100	>10	WW
19	チダイ	*Evynnis japonica*	crimson seabream	30-130	>6	WW
20	キダイ	*Dentex tumifrons*	deepsea snapper	<200	>8	WW
21	エソ	*Synodontidae*	Lizardfish	<120	<4	WW
22	グチ (シログチ)	*Sciaenidae (Argyrosomus a*	Croaker	20-120	6?	WW
23	カナガシラ	*Lepidotrigla micropetera*	redwing searobin	70-140	6	WW
24	タチウオ	*Trichiurus japonicus*	Largehead hairtail	20-140	8	WW
25	アカムツ	*Doederleinia berycoides*	blackthroat seaperch	80-150	10 (Female)	WW
26	イカ類		Squids	<200	<2	WW
27	タコ類		Octopus	<200		WW
Total 27 speices items						

12 cold water species:

Deep water

Long-lived

Northern distribution

15 warm water species:

Coastal and continental shelf

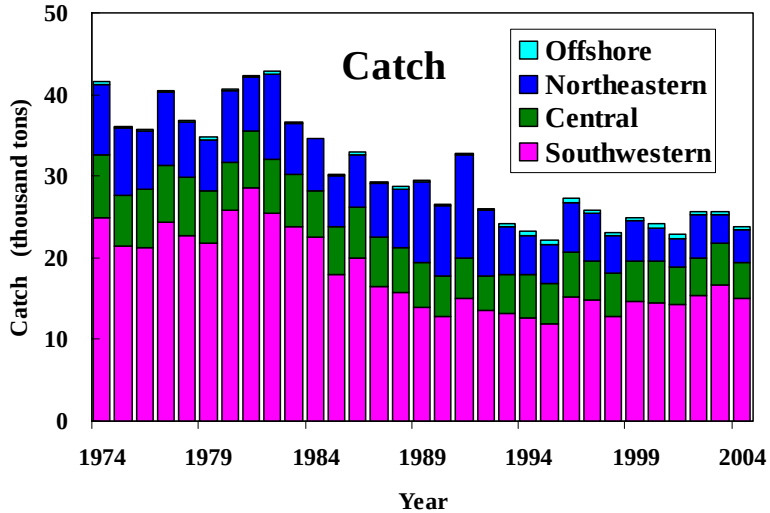
Short-lived

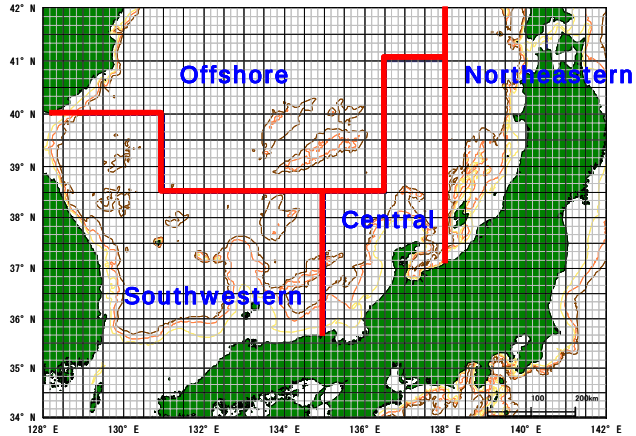
Southern distribution

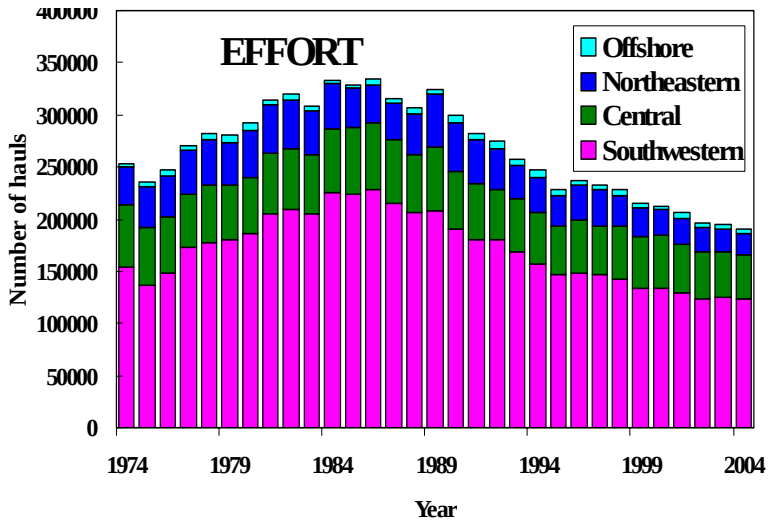
CW: Cold Water **WW: Warm Water**

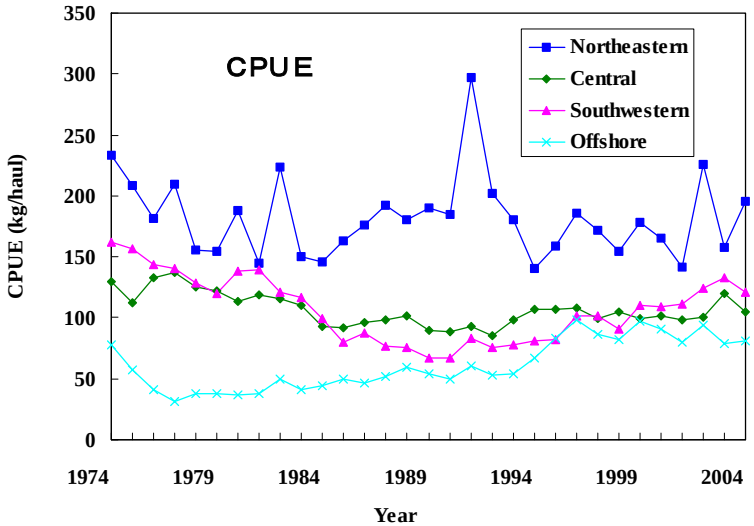
Nishimura (1969)

Offshore Bottom Trawl : Catch and CPUE

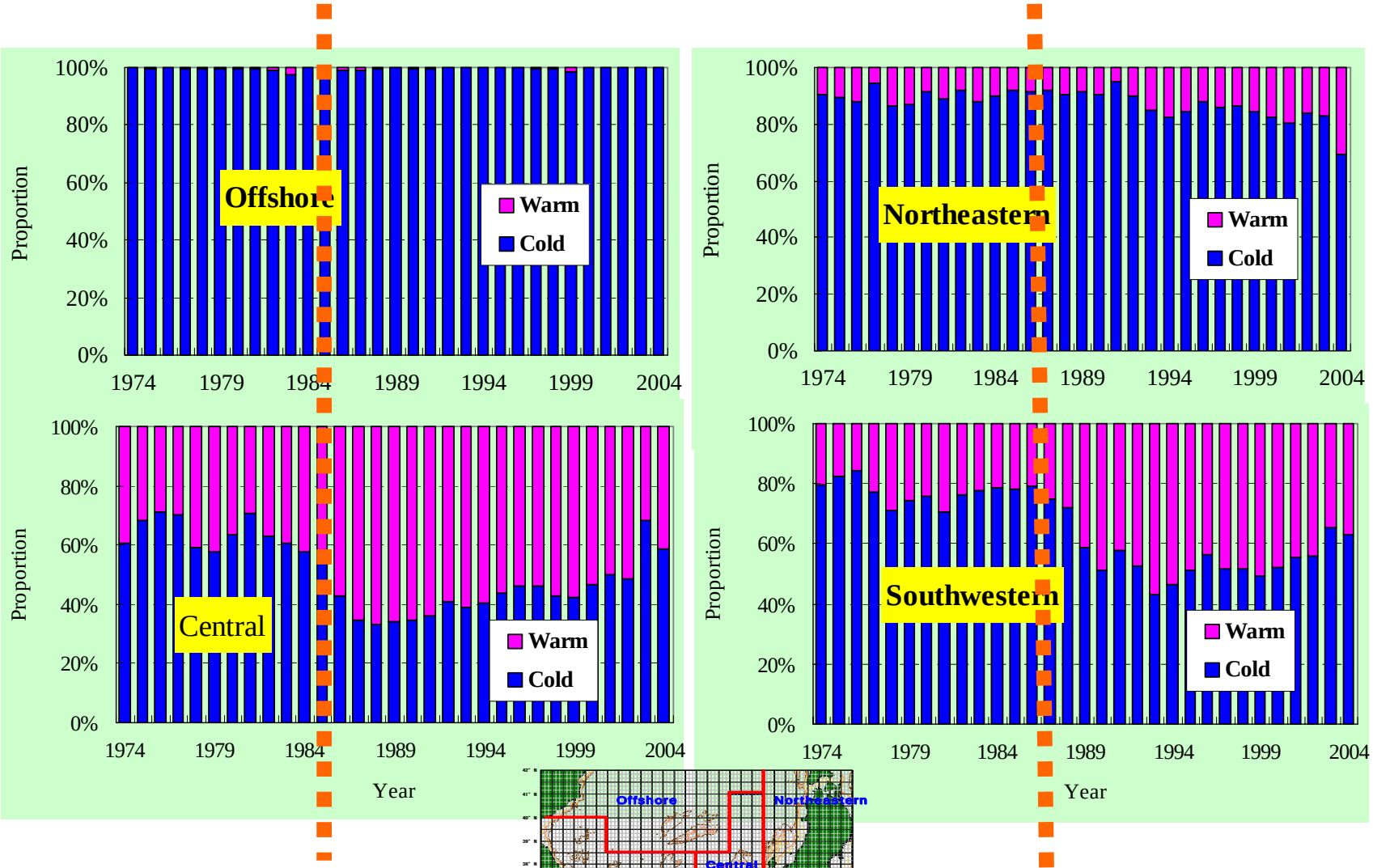


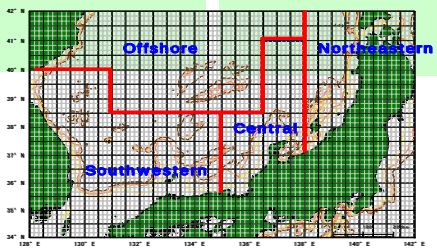




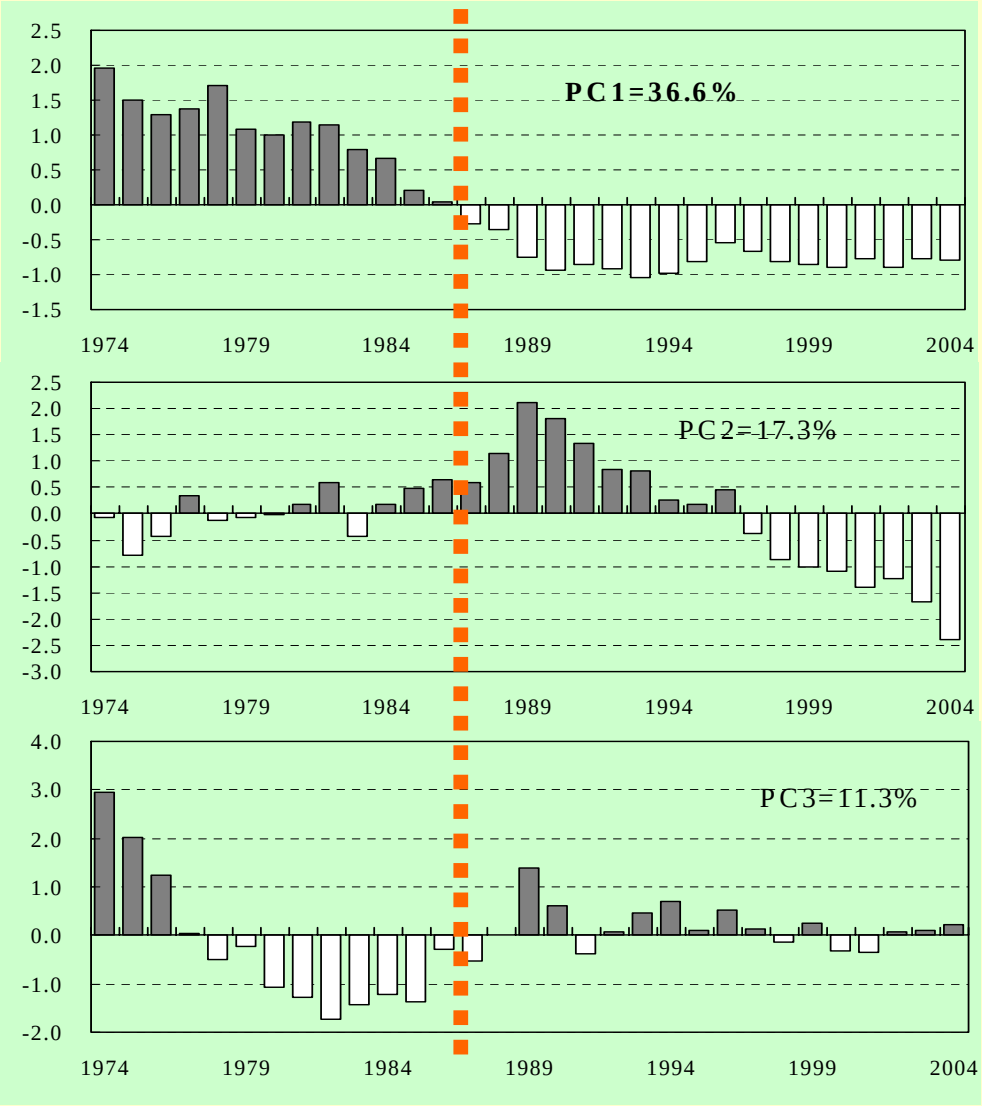


Changes in compositions





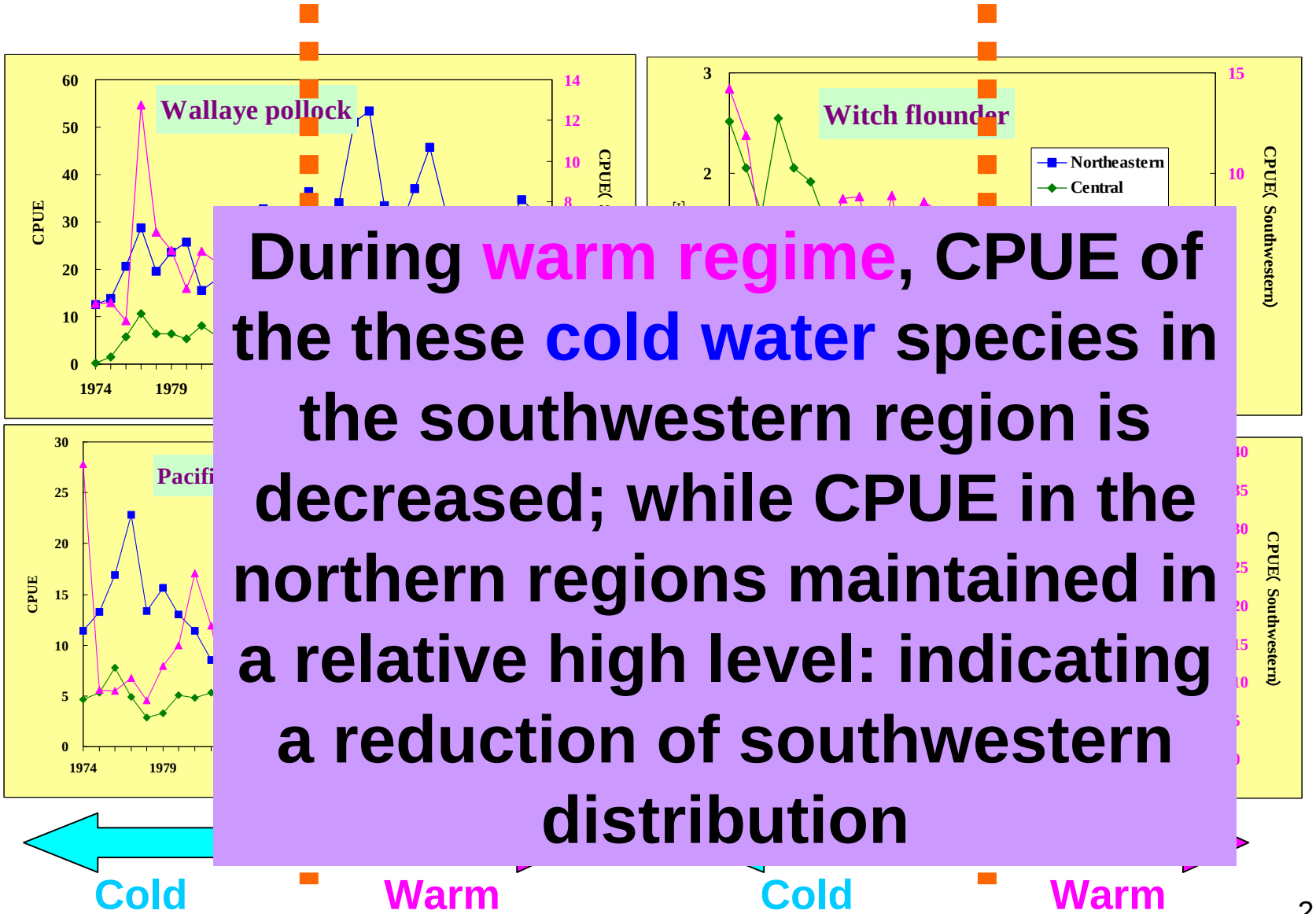
PCAs of demersal species from offshore trawl fisheries data during 1974-2004



PC1: changed around late 1980s

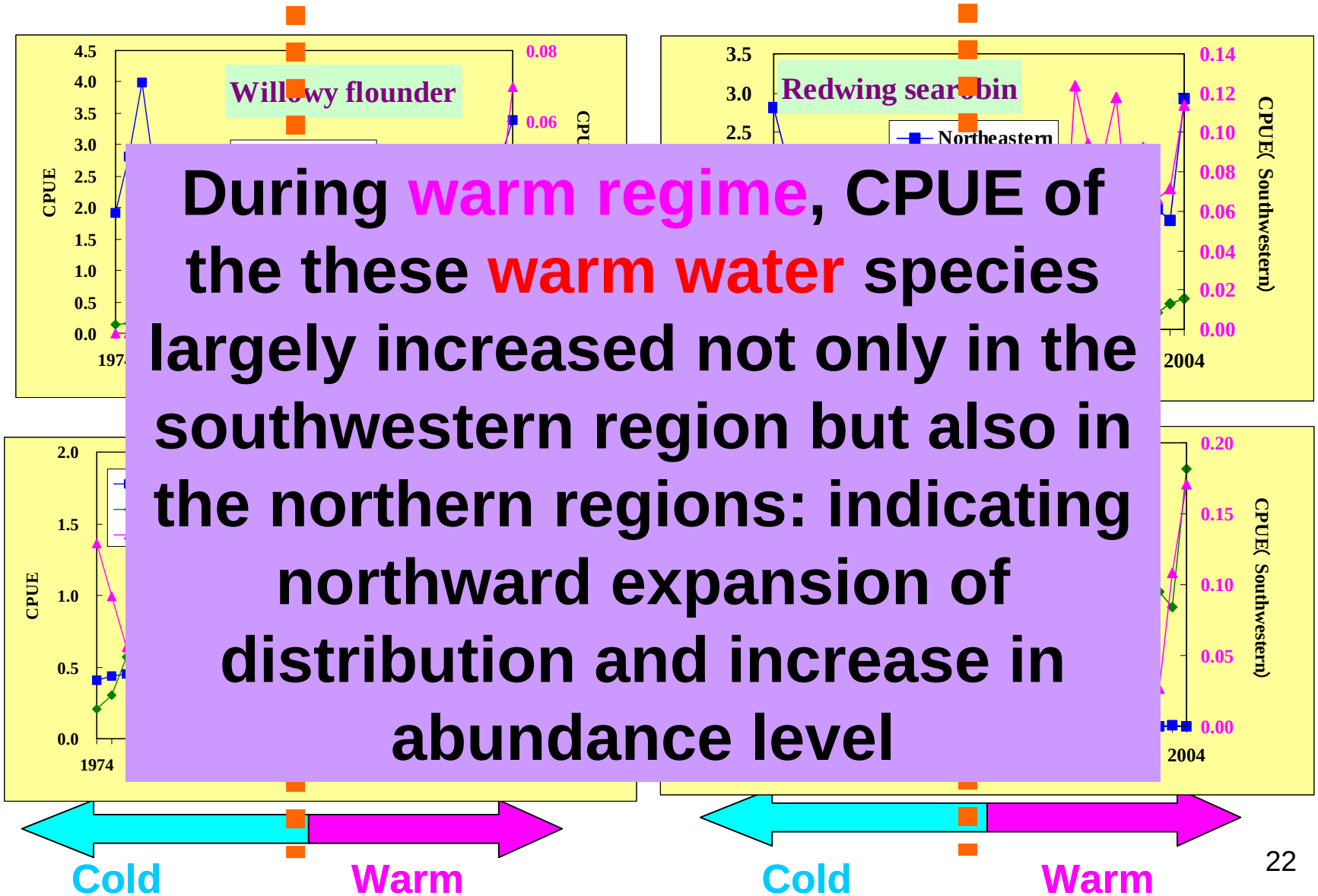
PC1-3: 65% of total variance

CPUE for four cold water indicator species



During warm regime, CPUE of the these cold water species in the southwestern region is decreased; while CPUE in the northern regions maintained in a relative high level: indicating a reduction of southwestern distribution

CPUE for four warm water indicator species



During warm regime, CPUE of the these warm water species largely increased not only in the southwestern region but also in the northern regions: indicating northward expansion of distribution and increase in abundance level

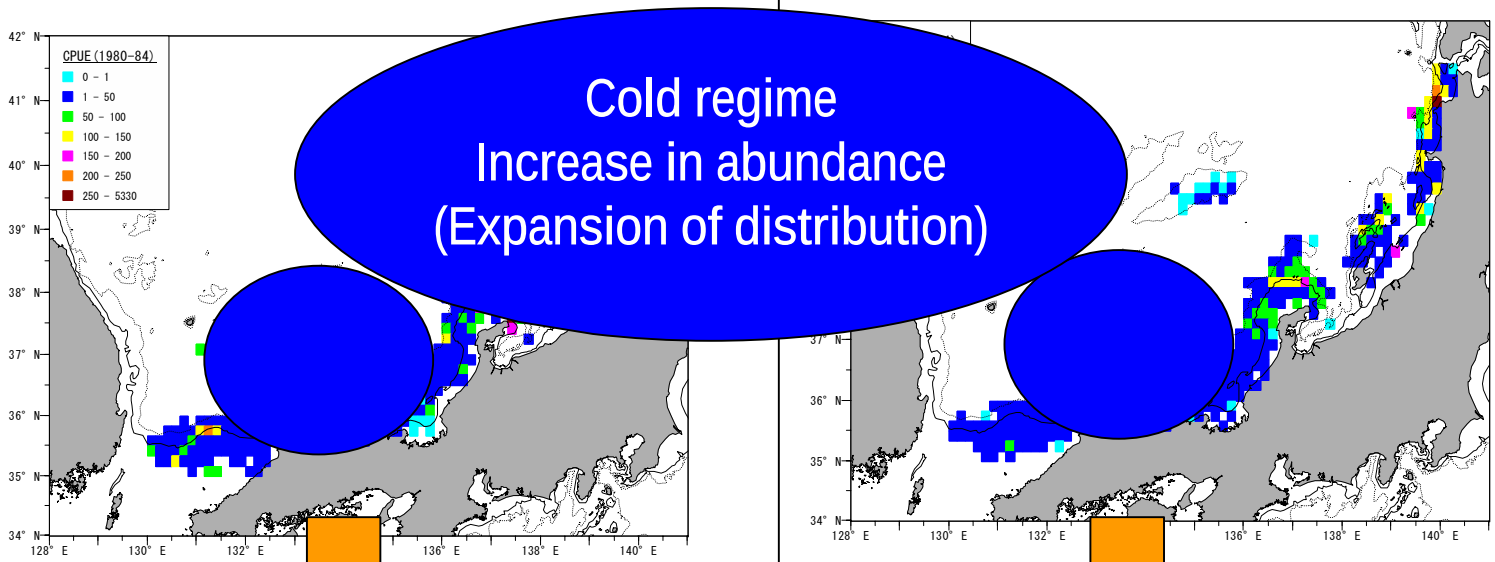
Walleye pollock

Cold water species

Pacific cod

1980s

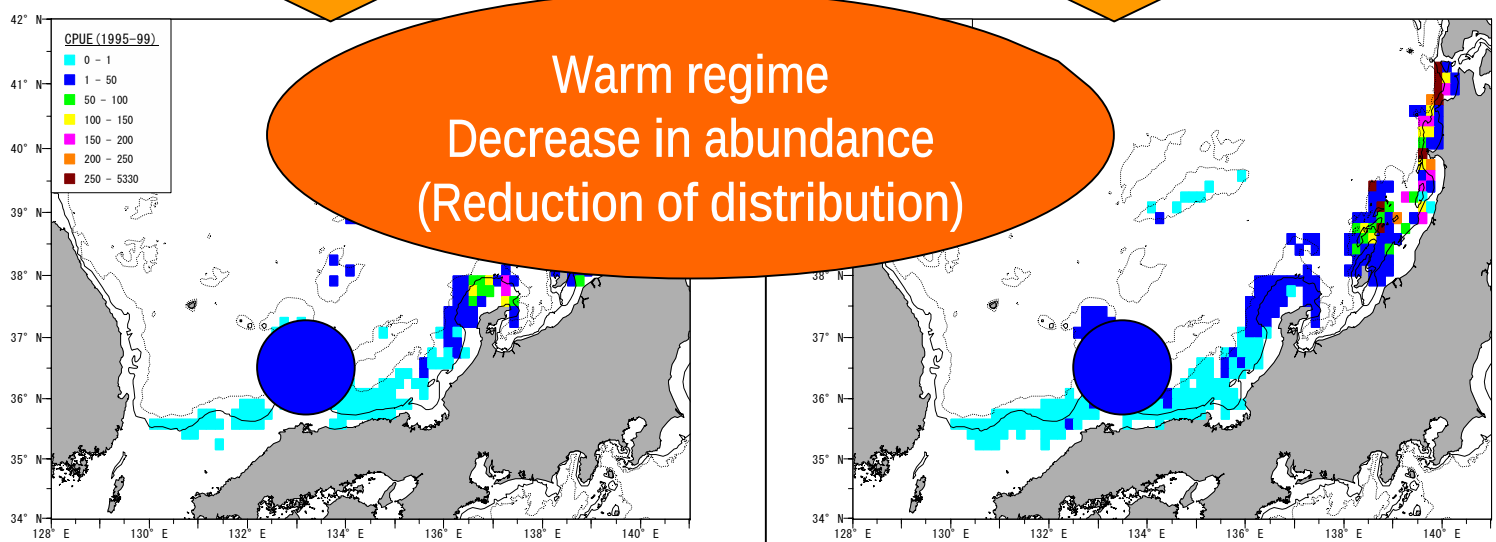
cold



Cold regime
Increase in abundance
(Expansion of distribution)

1990s

warm



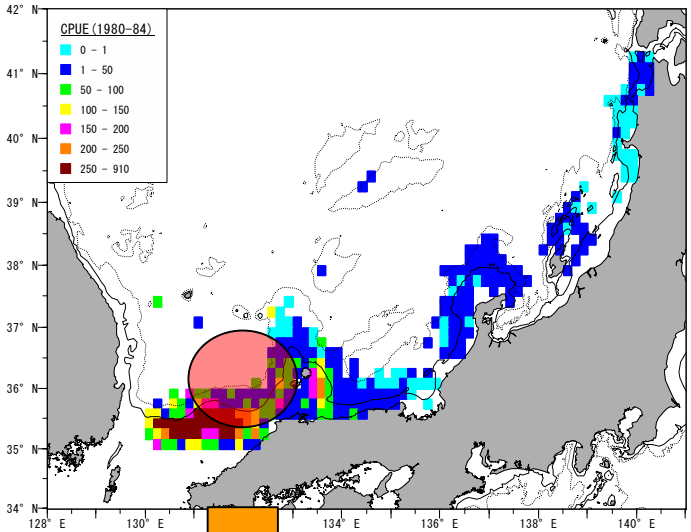
Warm regime
Decrease in abundance
(Reduction of distribution)

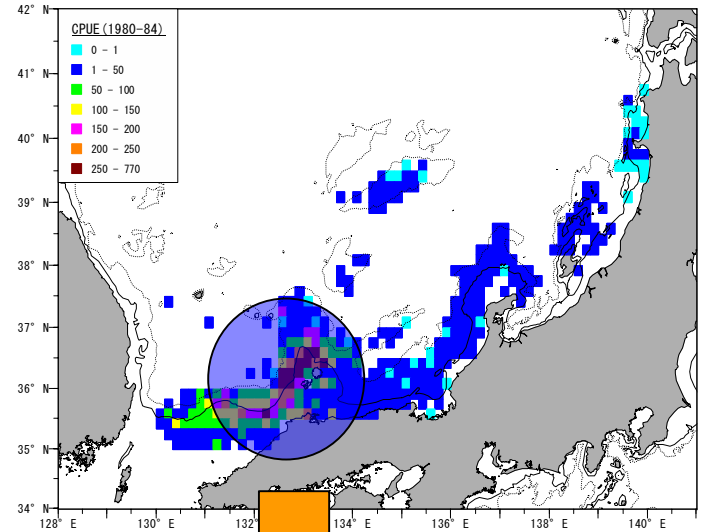
Warm water species
Pointhead flounder

Cold water species
Witch flounder

1980s

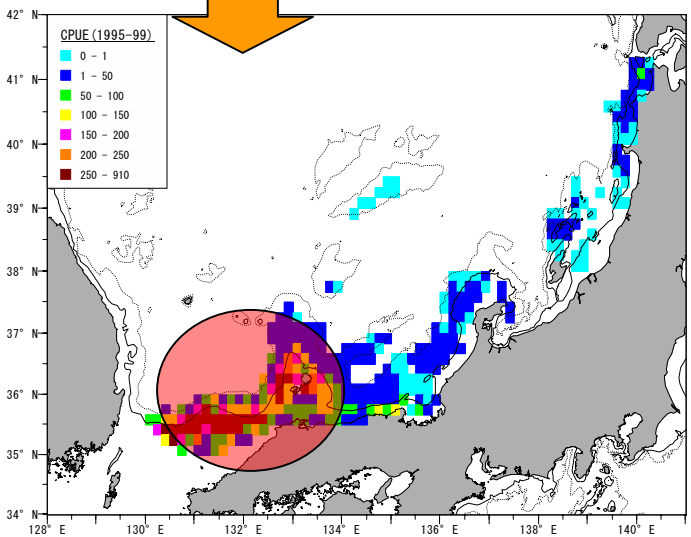
cold

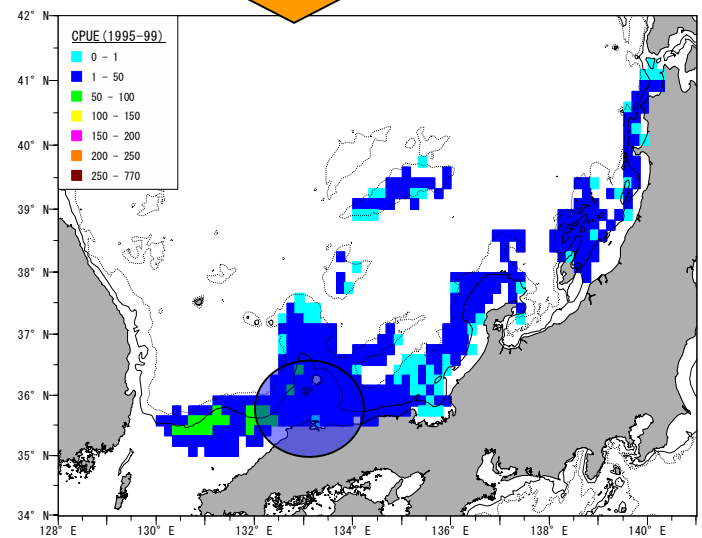




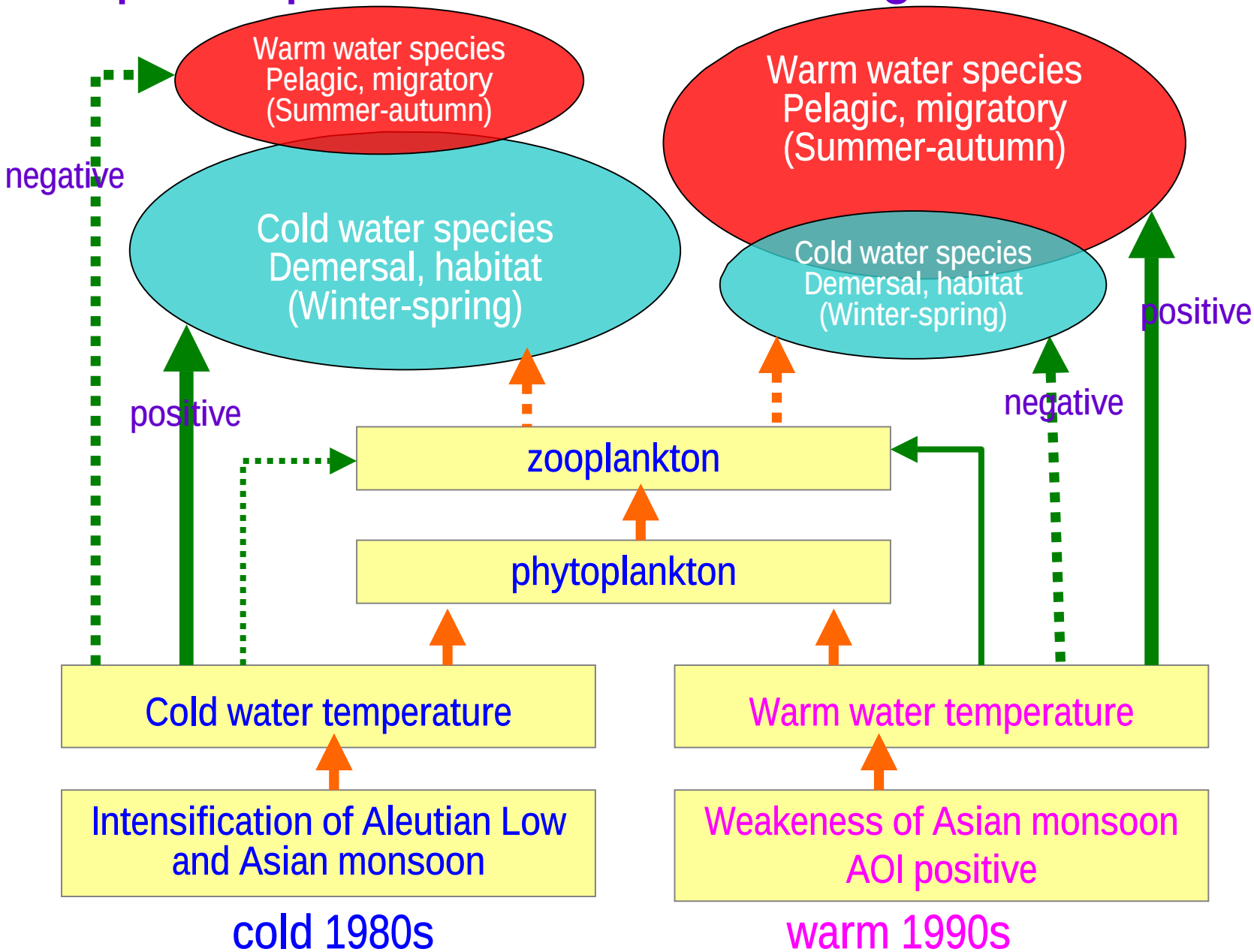
1990s

warm





Response process to late 1980s regime shift in TWC



Summary and Conclusions

1. An oceanic regime shift from cold to warm water is identified in TWC region in late-1980s and linked with global climatic changes.
2. Plankton biomass changed abruptly around late 1980s with decadal variability.
3. PCA and community indices suggested that the fish community in TWC changed around late 1980s.
4. Both the pelagic and demersal fish assemblages show decadal variation patterns and changed around late 1980s.
5. Response patterns are different between cold and warm water species: warm (cold) water species increased (decreased) their abundances and expanded (reduced) their distributions during the warm regime, and vice versa.
6. These suggested an ecosystem regime shift from low trophic plankton to high trophic fish communities, occurred in TWC in late 1980s, and is linked directly to the climatic-oceanic regime shift in the North Pacific.