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Interannual-decadal variability of demersal fish community in the Japan Sea: Impacts of climate regime shifts and trawl fishing with recommendations for ecosystem-based management

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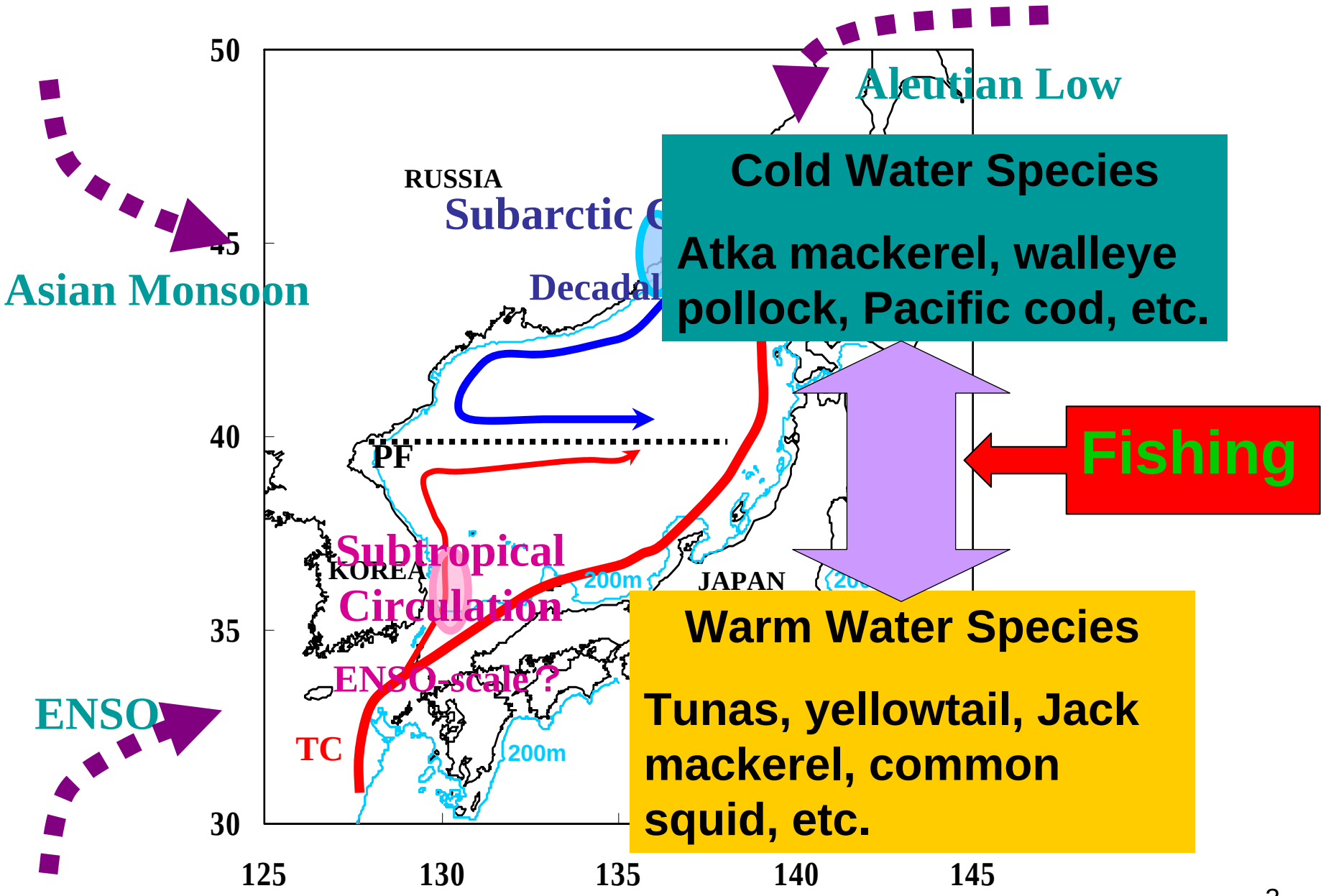
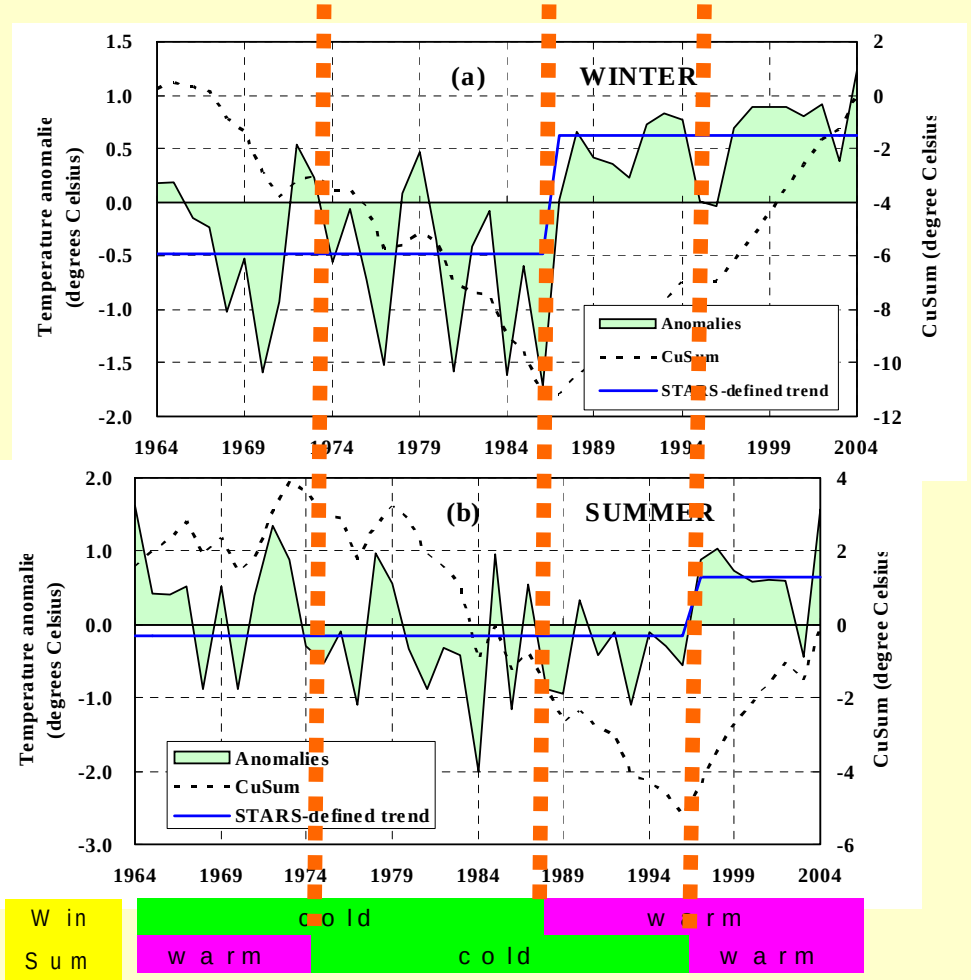
Outline of This Study

1. Backgrounds: the late 1980s regime shift in TWC
2. Objectives, data and methods
3. Variation patterns in demersal fish community: analysis of two trawl fisheries data sets in TWC
4. Impacts of regime shift and fishing
5. Conclusions


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

Water temperature at 50m: indicator of Tsushima Warm Current (TWC)



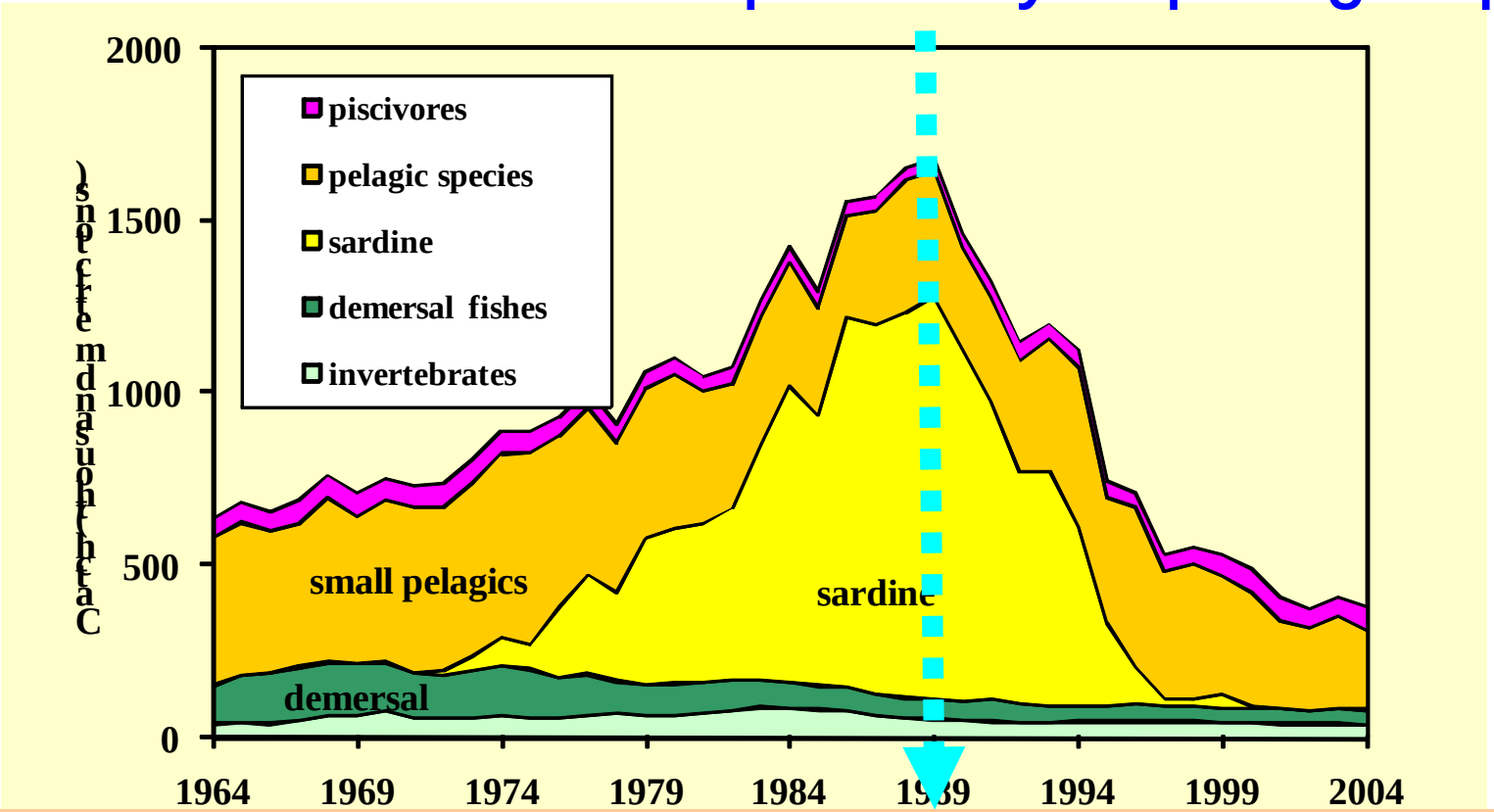
Winter WT: regime shift around 1986/87

Summer WT:

step change around mid-1990s

Winter and summer variation pattern are different

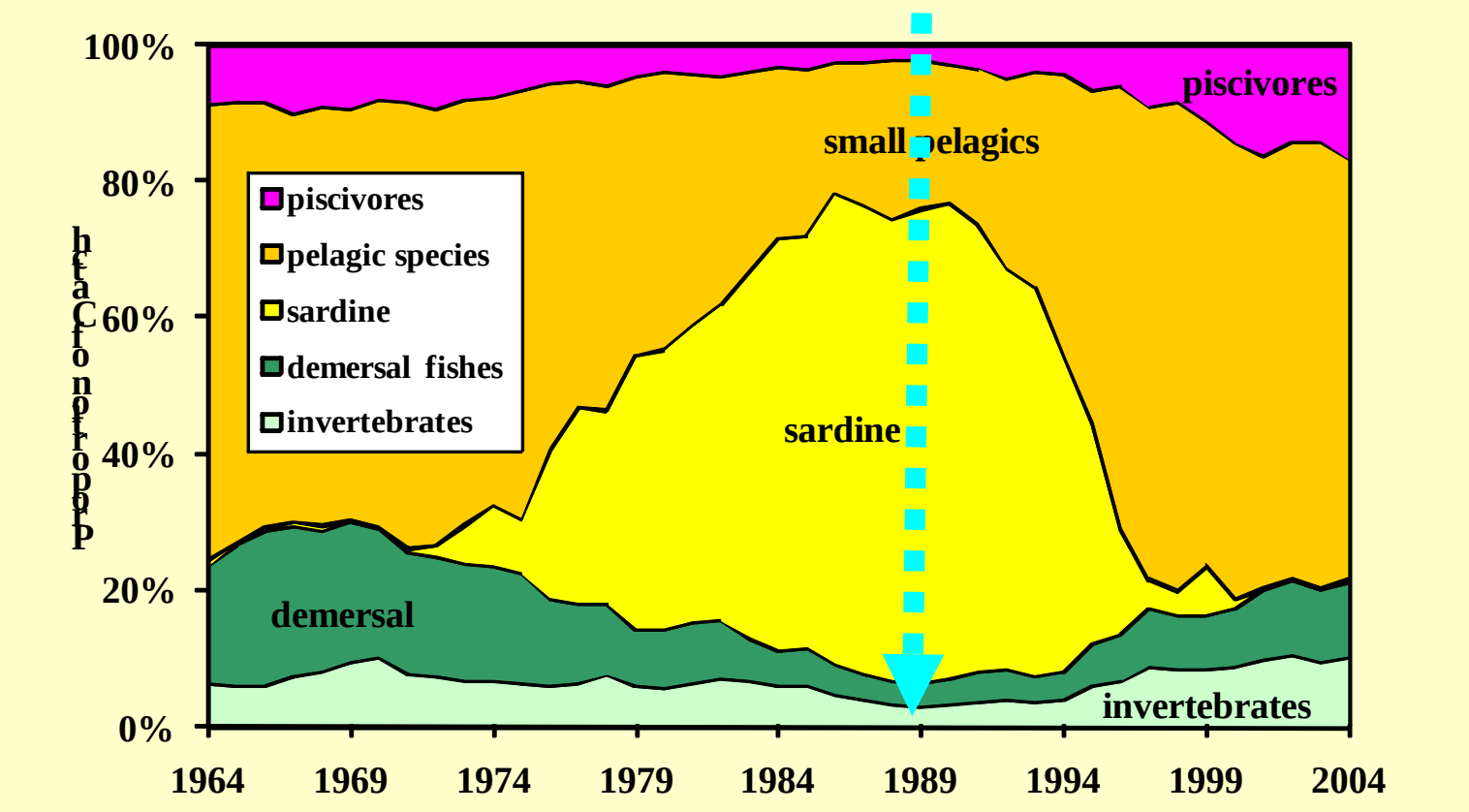
Catch Trend in the Japan Sea during 1964-2004 (Fisheries statistics: 54 species by trophic group)



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

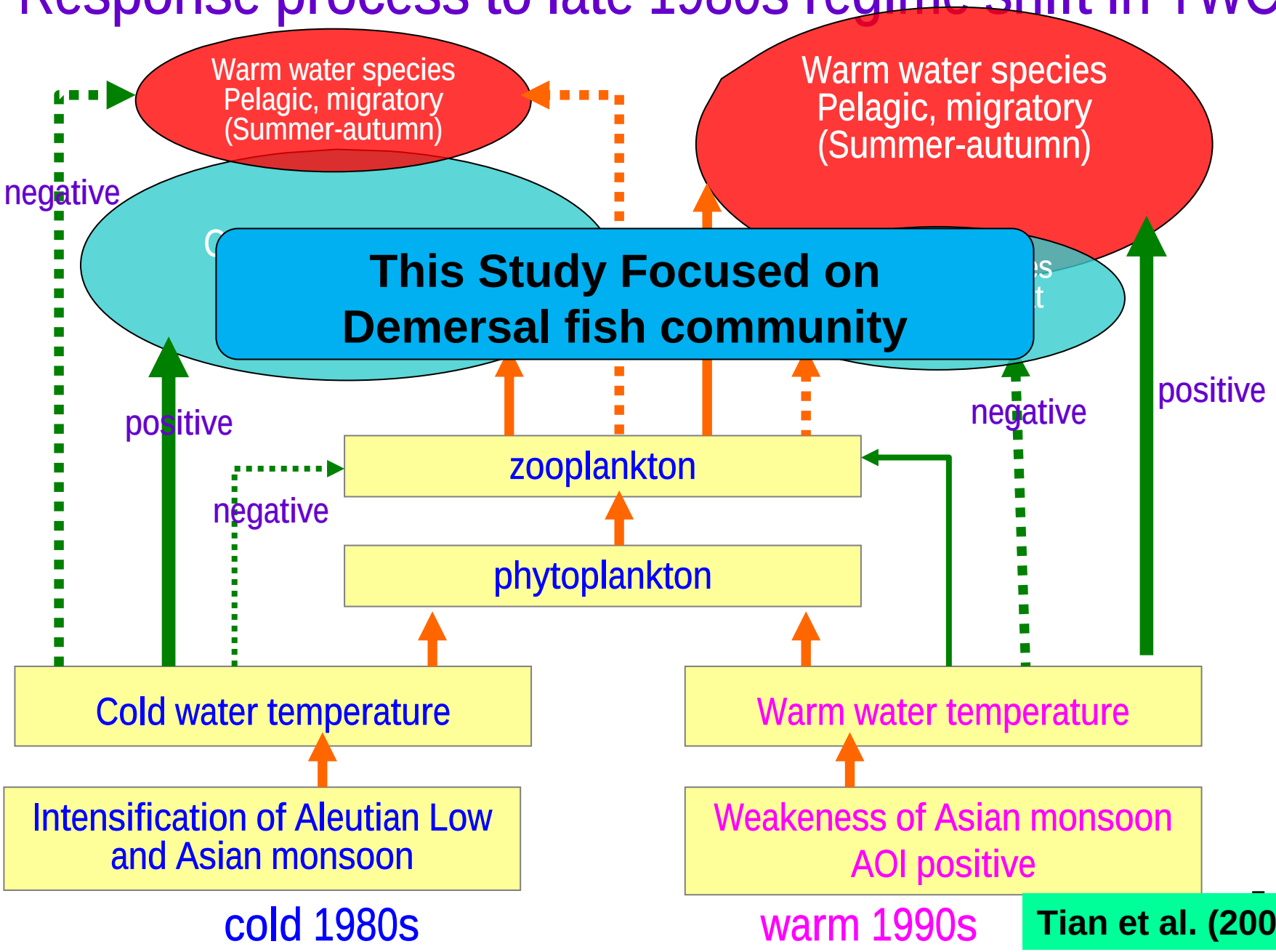
The small pelagic group (zooplanktivores) is dominant with large inter-annual variations, decreased abruptly since late 1980s with the collapse of sardine.

Changes in proportion of total catch by group



Proportion of large fishes (piscivores) and demersal species (fishes and invertebrates) increased largely since the late 1980s; whereas the small pelagic group (zooplanktivores) decreased with the collapse of sardine.

Response process to late 1980s regime shift in TWC



OBJECTIVES

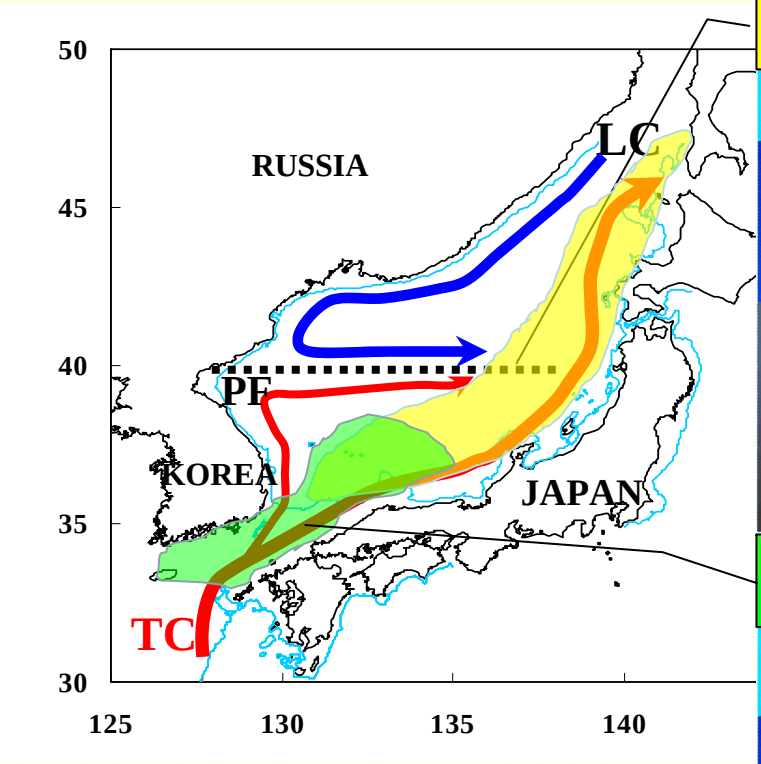
1. To identify the
demers
2. T
deme
1980 pan Sea
3. To assess the impact of trawl fishing on the variability of dermasal fish assemblages

Final Goal
To understand the function and structure of the demersal fish community toward ecosystem-based fisheries management

Data and Method

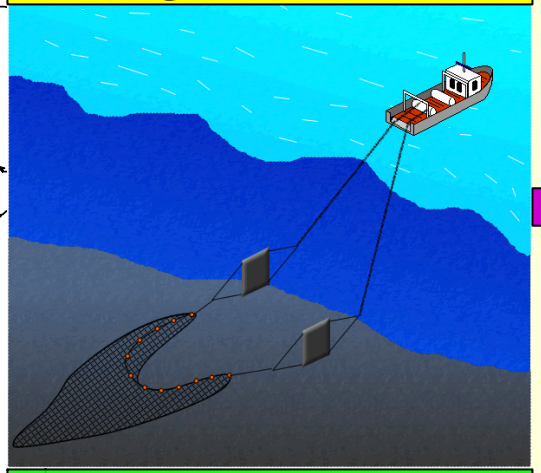
1. Two bottom trawl data sets in Japan Sea
   Single –trawler: 1974-2004: 27 target species
   Pair –trawler: 1975-2005: 11 target species
   catch, effort
2. **50m depth WT time series: 1964-2006**
3. **Principal Component Analysis (PCA)**
4. **Regime shift detection: STARS method by Rodionov (2004)**

Two Trawl fisheries in the Japan Sea



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

Single Trawler

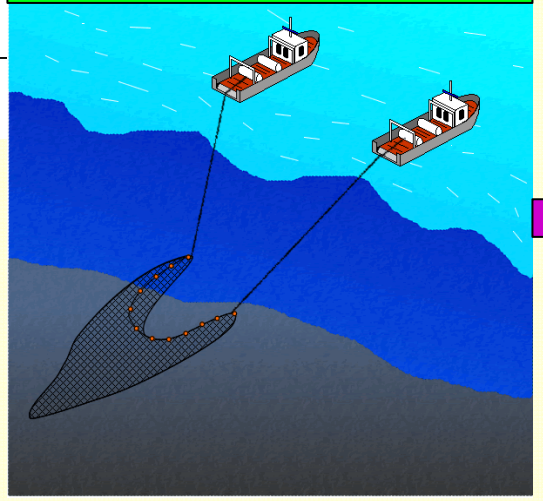


Deep offshore

Cold- and warm water species

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

Pair Trawler



Continental shelf

Mostly Warm Water Species

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

Single-trawler : 27 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

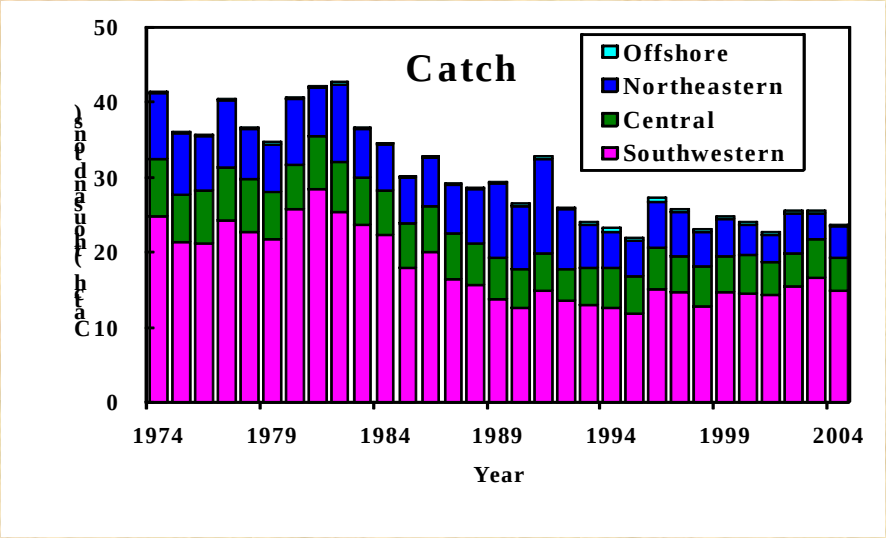
Southern distribution

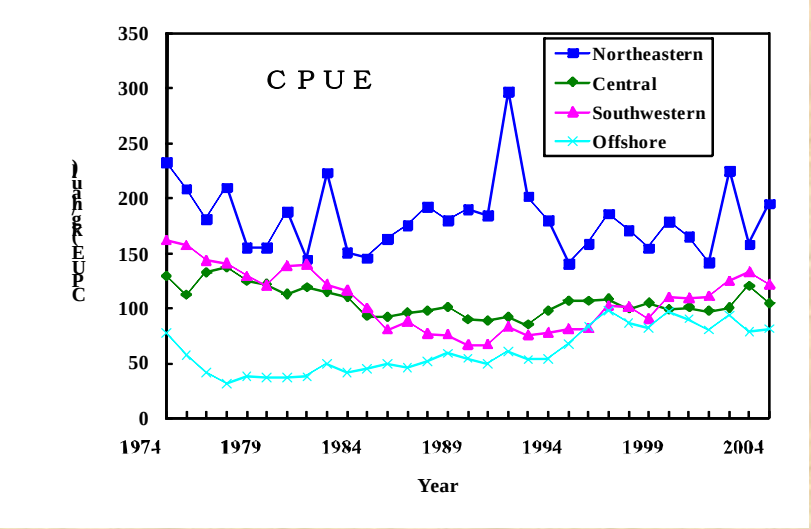
CW: Cold Water
深海冷水性種

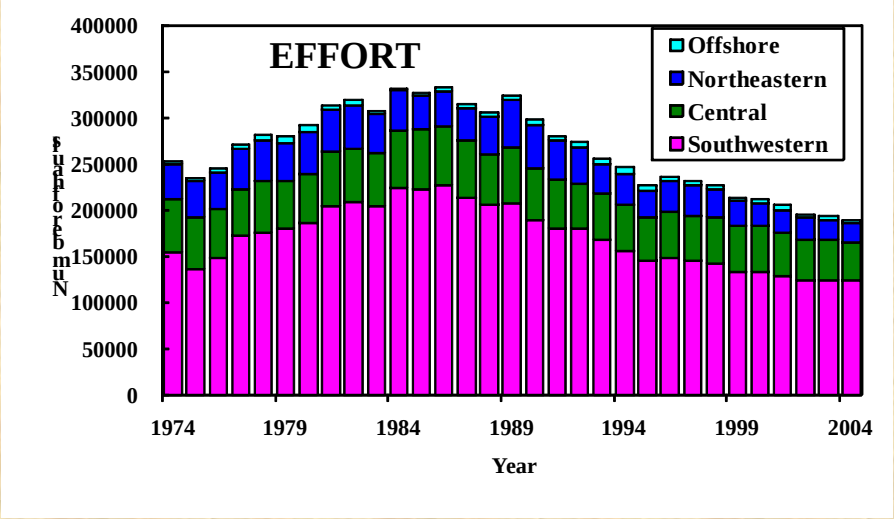
WW: Warm Water
浅海暖水性種

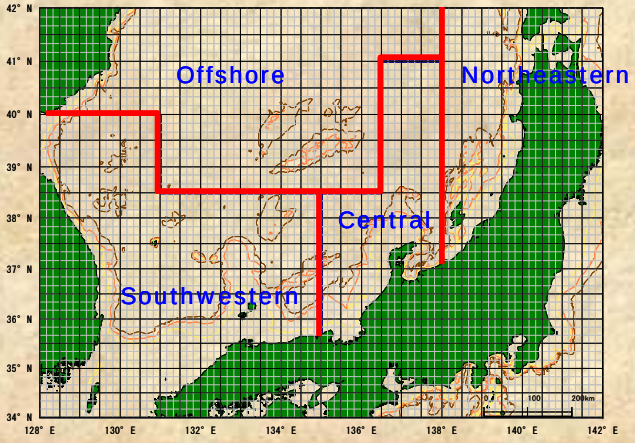
Nishimura (1969）

Single-trawler : Catch, effort and CPUE

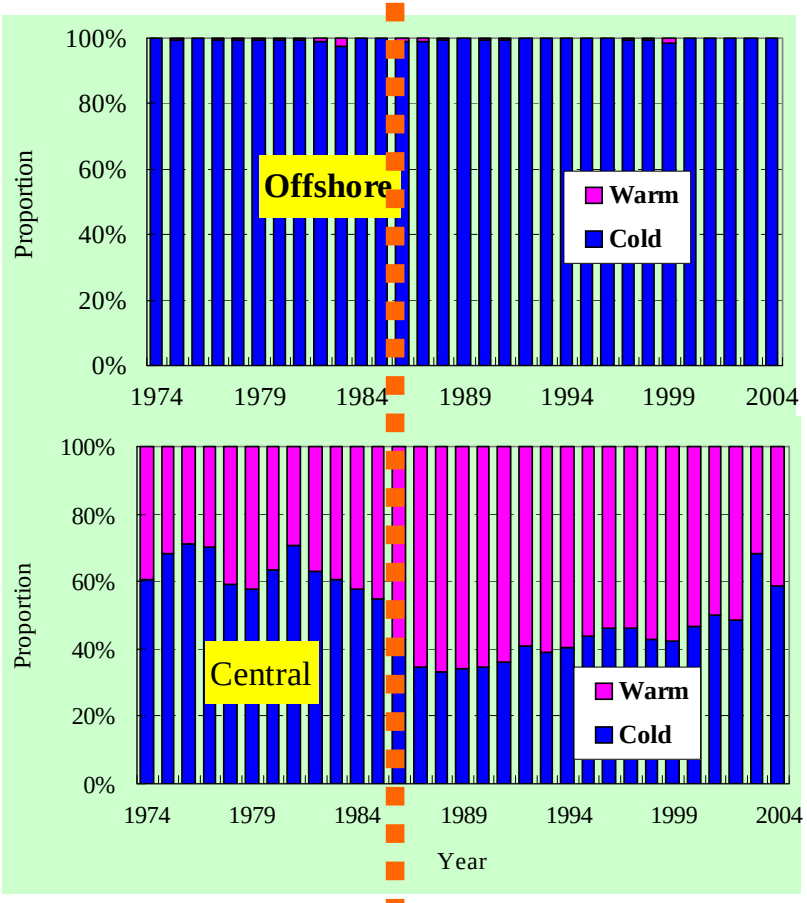


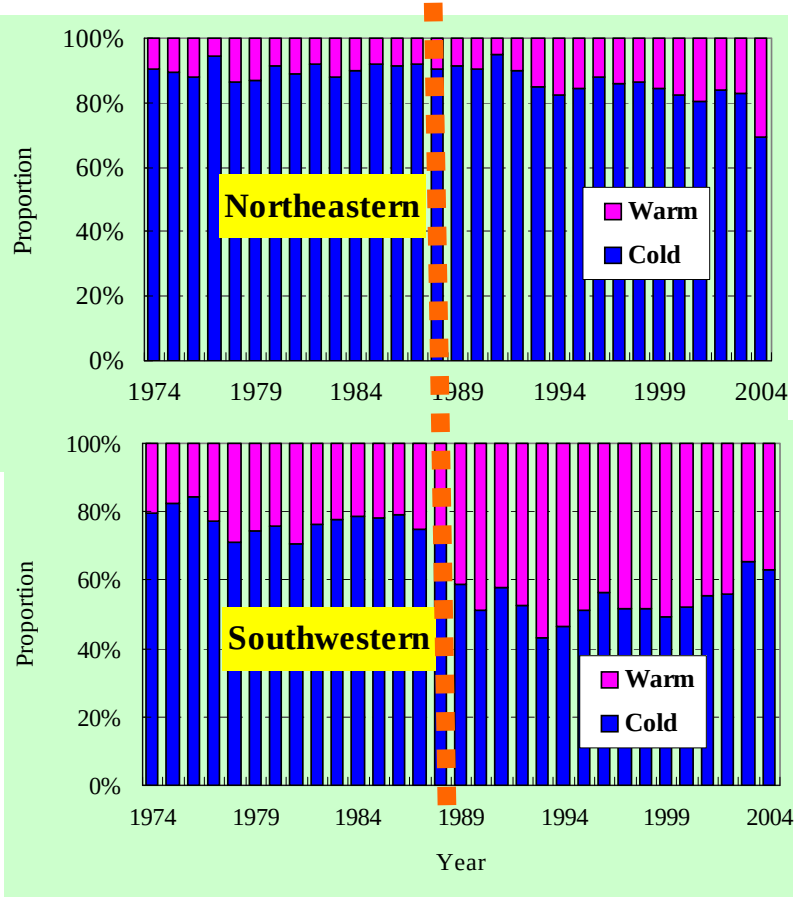


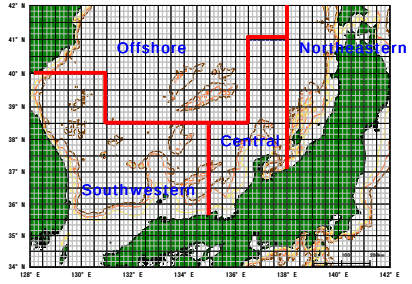


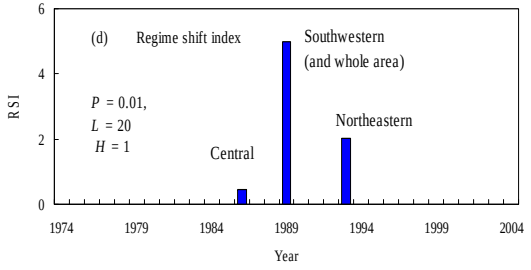


Single trawler:
Changes in compositions

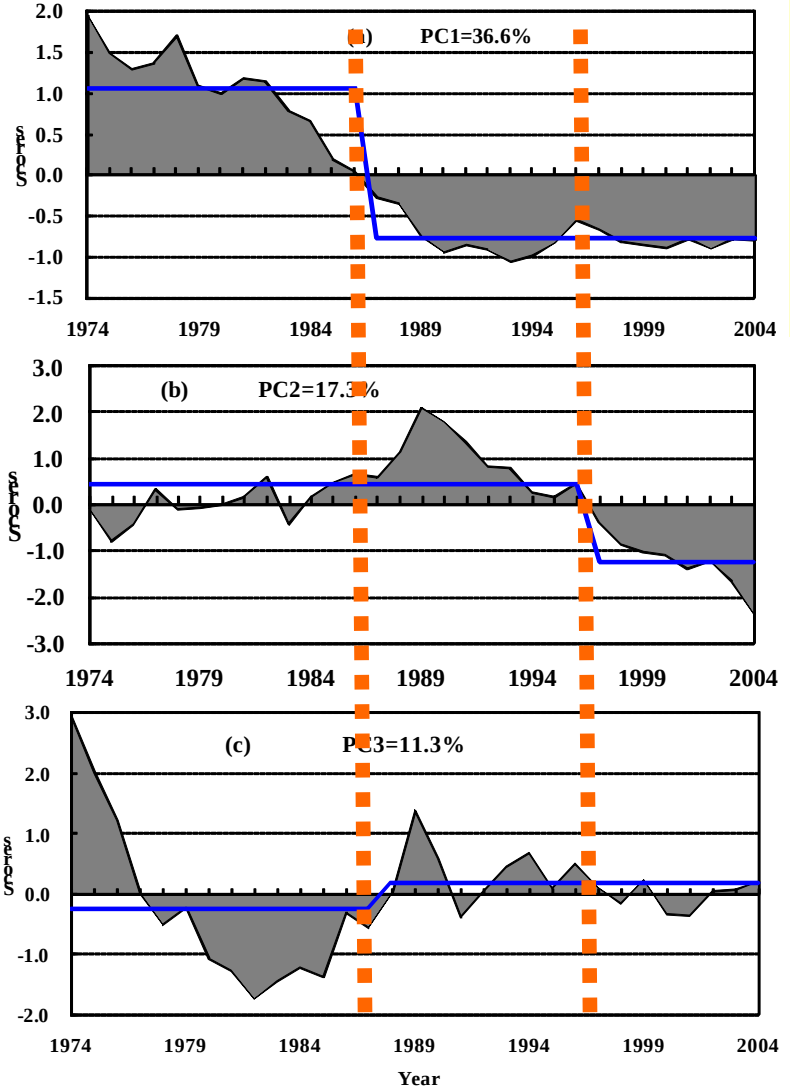








PCAs for target species of single-trawler: 1974-2004

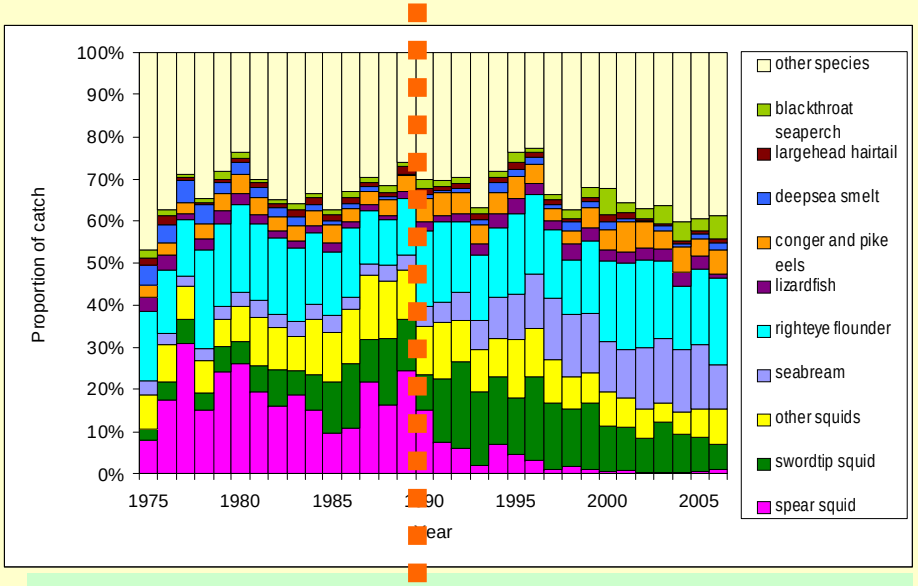


PC1-3: 65% of total variance

Step changes occurred in PC1 around late 1980s, and in PC2 in mid-1990s.

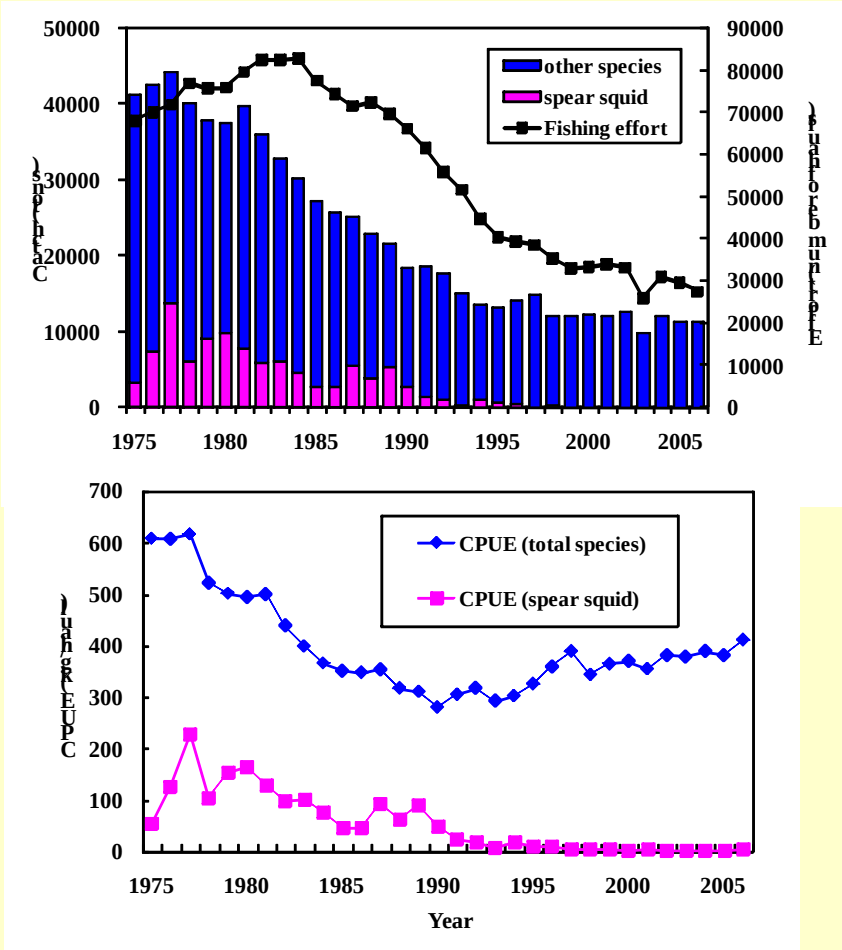
PC1 and PC2 corresponded well to winter and summer WT, respectively

Pair-trawler: Target species, catch, effort and CPUE during 1975-2006

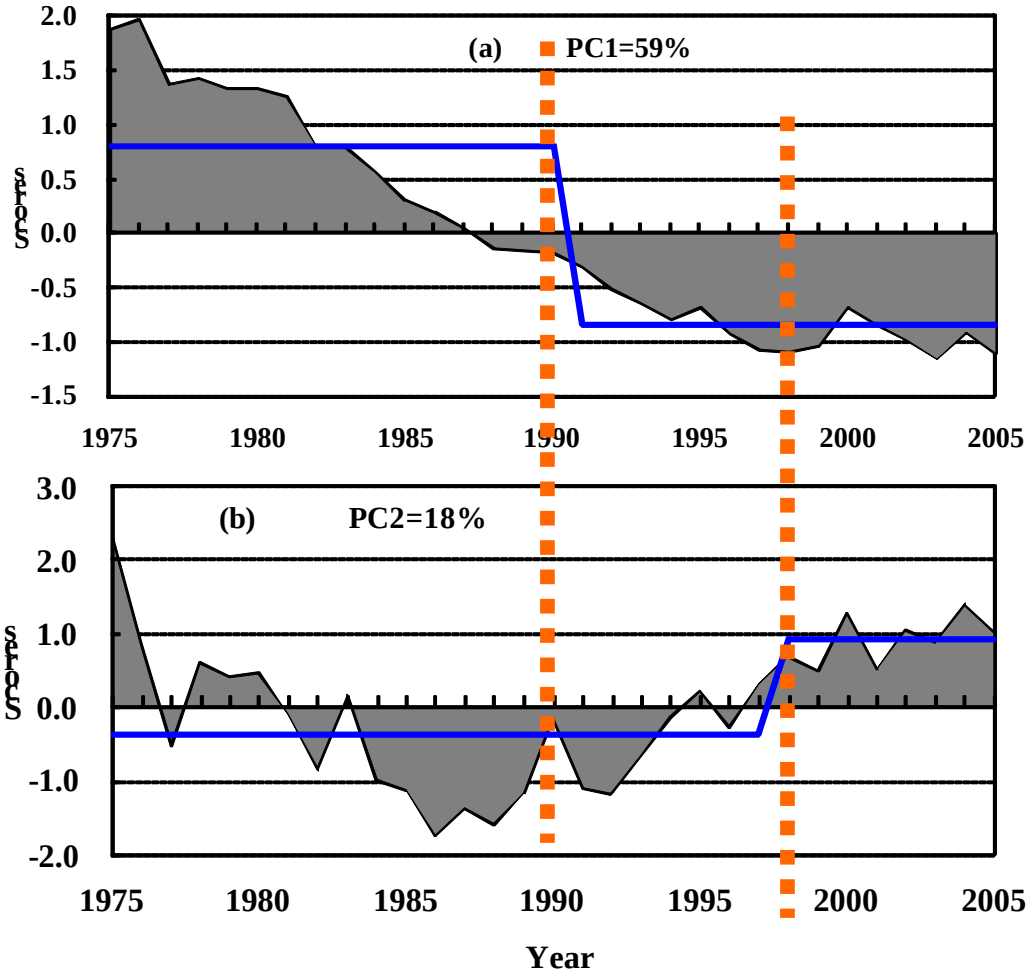


11 Target Species (Taxa)

Loligo squid, Seabream, flounders, largehead hairtail, etc



PCAs for target species of pair-trawler: 1975-2005



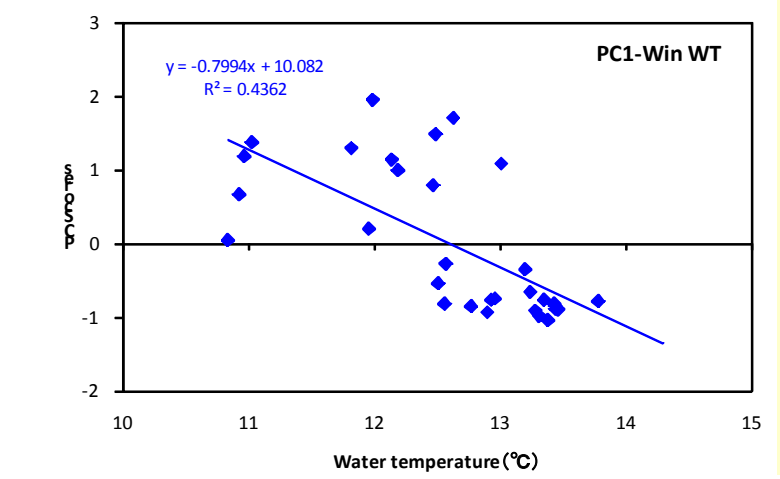
PC1-2: 67% of total variance

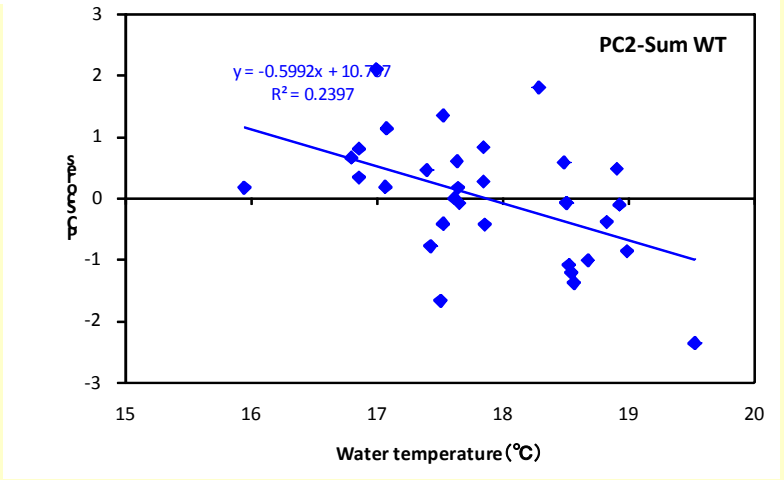
PC1 (PC2): changed around late 1980s (mid-1990s)

PC1 and PC2 corresponded well to winter and summer WT, respectively

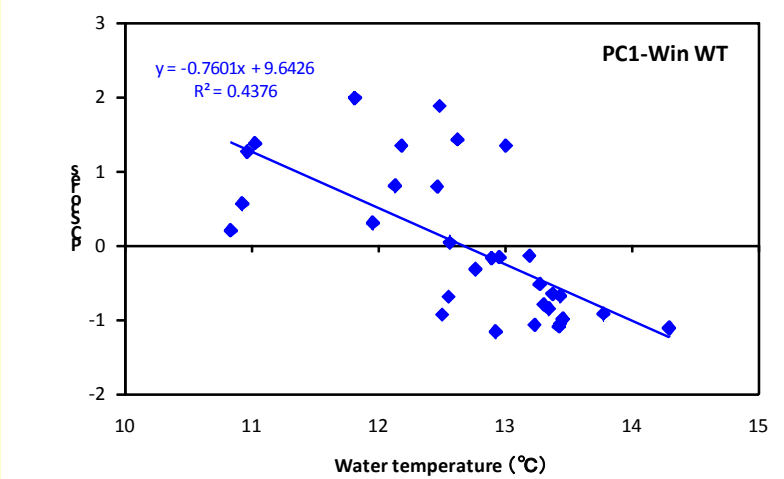
Response of PCs to Water temperature

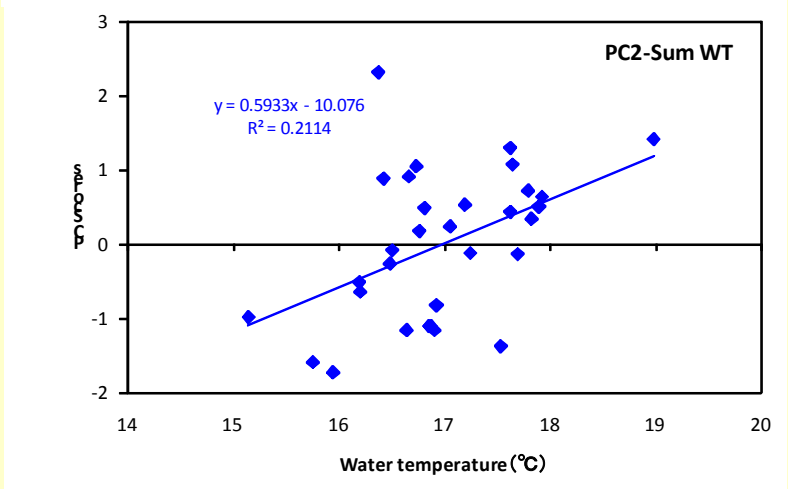
Single Trawler





Pair Trawler



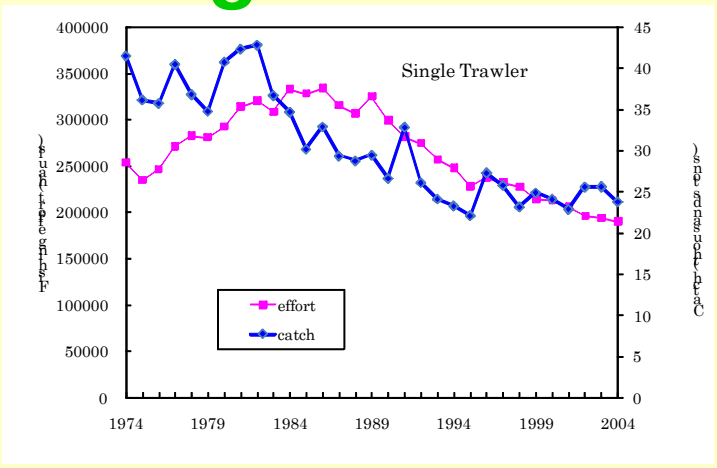


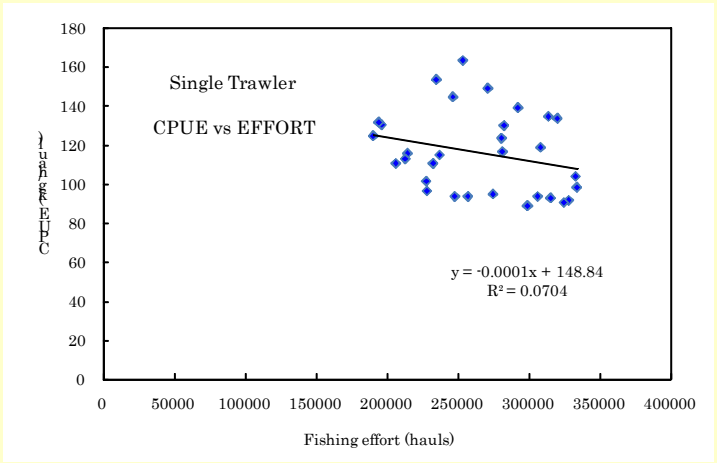
PC1- Winter WT

PC2- Summer WT

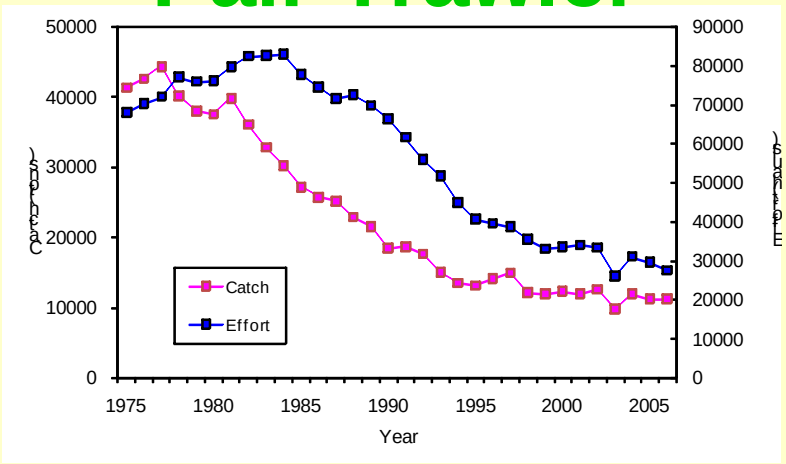
Impacts of fishing ?

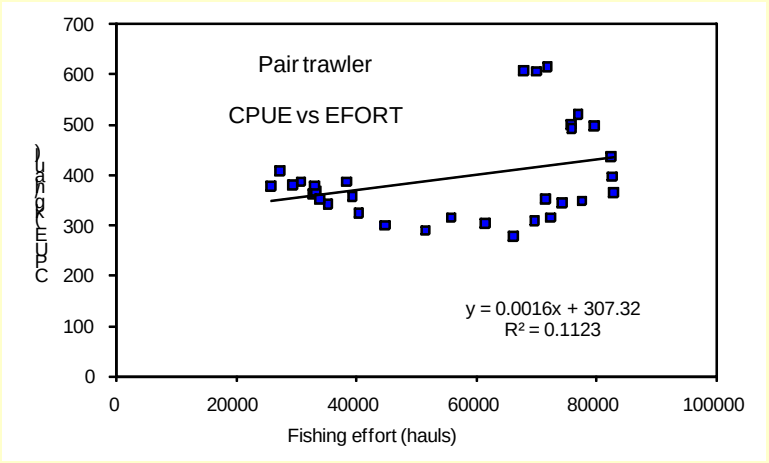
Single Trawler





Pair Trawler

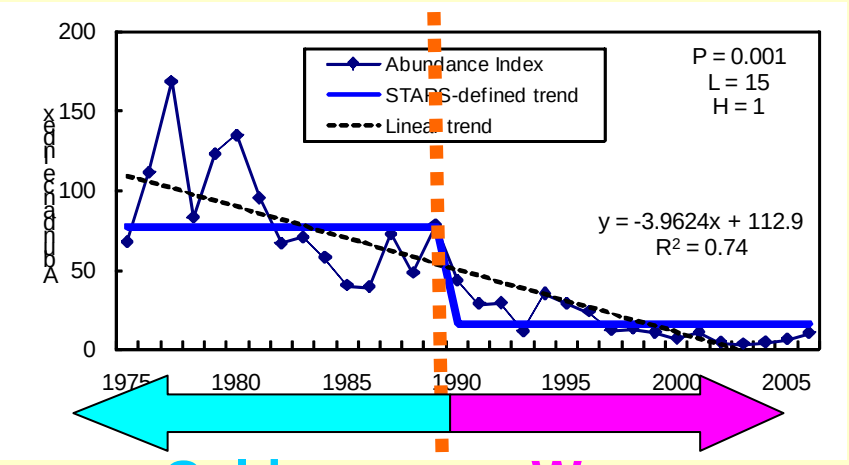




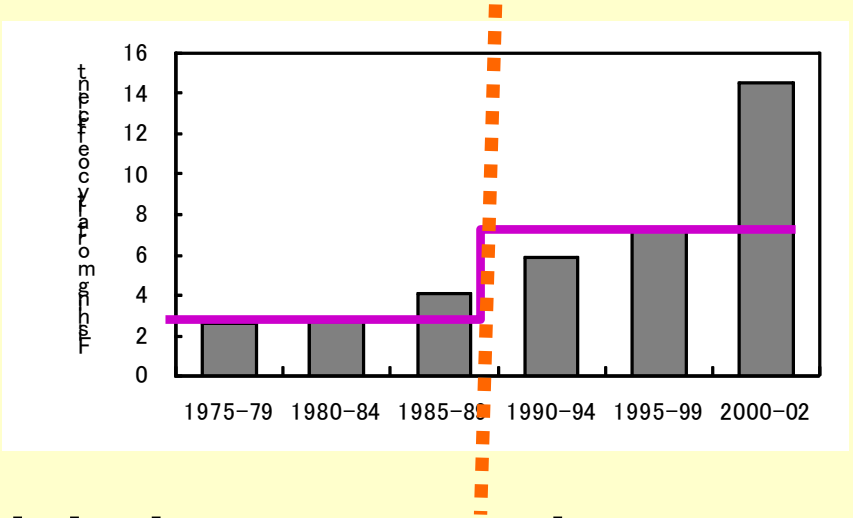
Impacts of fishing for whole target species seemed not obvious, but...

Impacts of fishing:
spear squid: a main target of pair-trawler

Abundance index (same trend as catch and CPUE) changed around 1990.



Estimated Fishing Mortality by DeLury Model



Fishing mortality increased during warm-regime, accelerated the collapse of spear squid stock.

Tian (2009): Fish. Res.,100,78-85

Single Trawler: two main target species

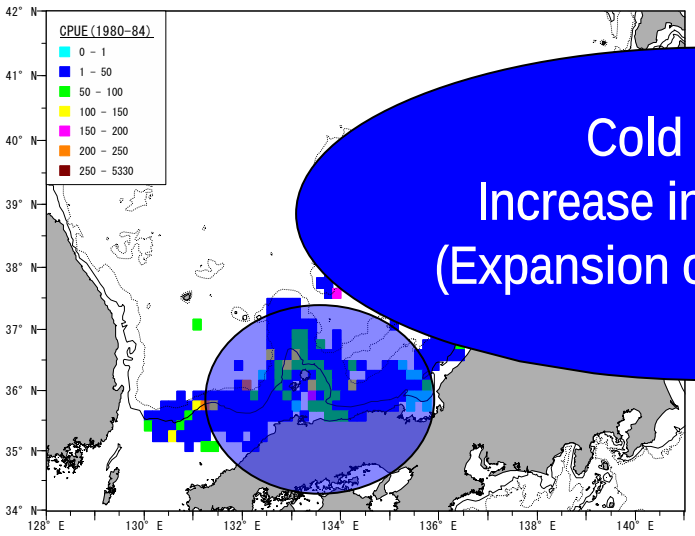
Walleye pollock

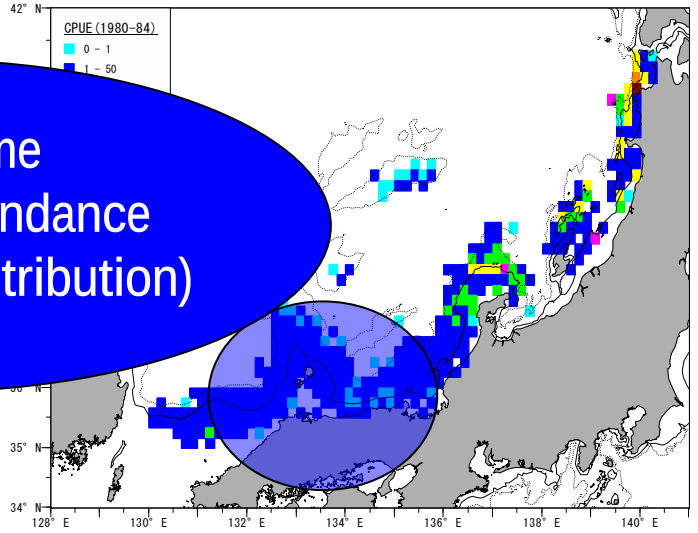
Cold water species

Pacific cod

1980s

cold

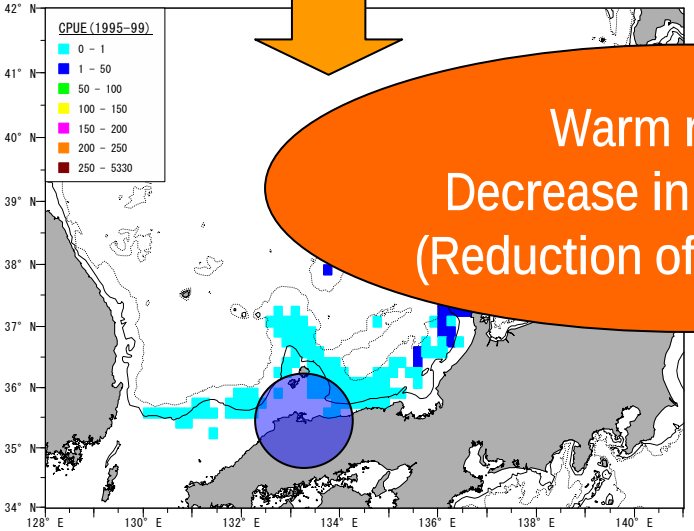


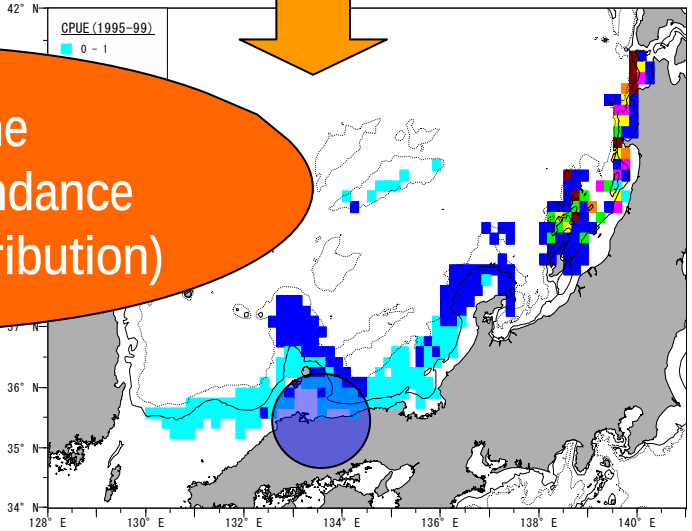


Cold regime
Increase in abundance
(Expansion of distribution)

1990s

warm



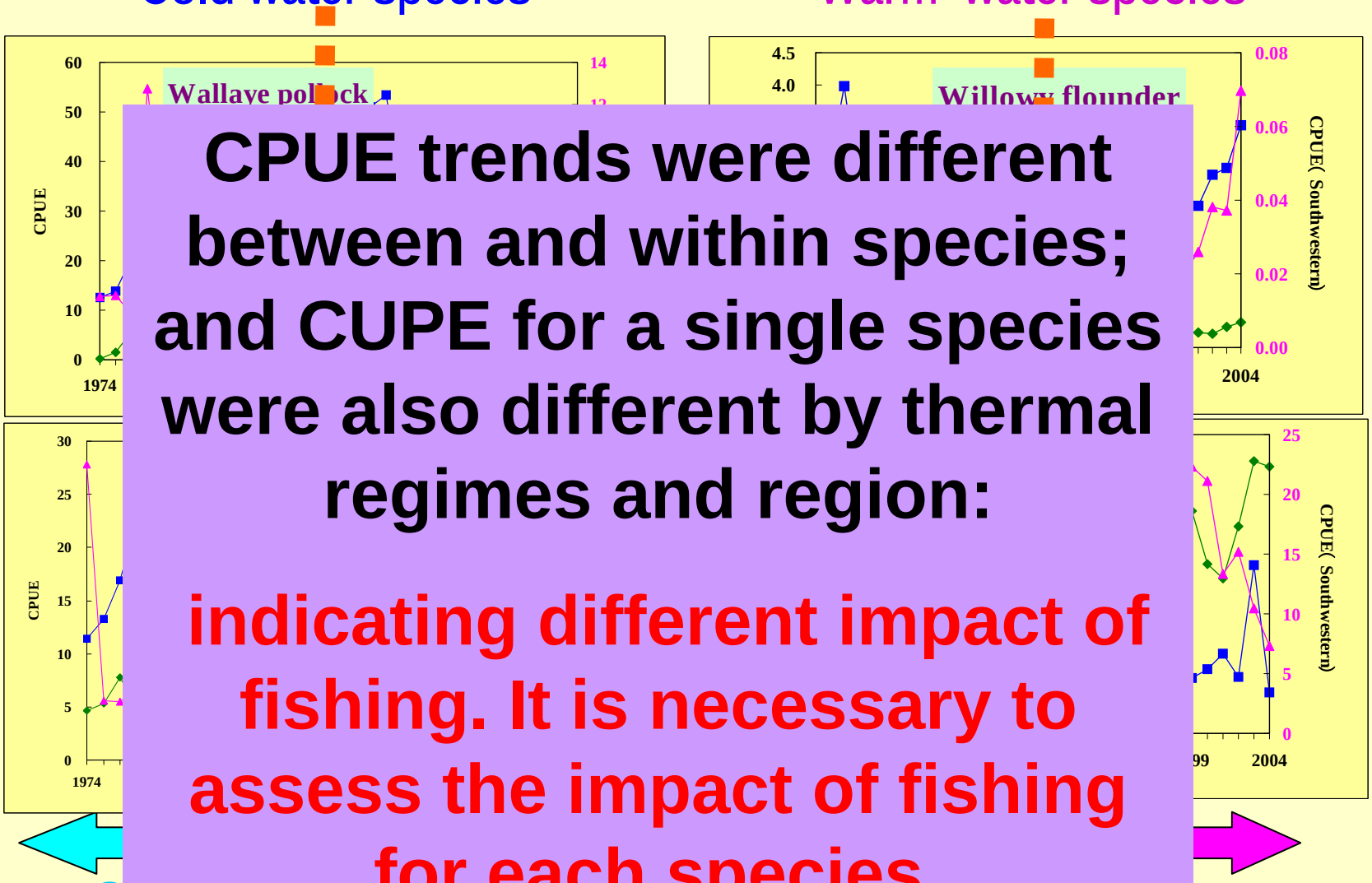


Warm regime
Decrease in abundance
(Reduction of distribution)

Single Trawler: CPUE for 4 indicator species

Cold water species

Warm water species



CPUE trends were different between and within species; and CUPE for a single species were also different by thermal regimes and region:

indicating different impact of fishing. It is necessary to assess the impact of fishing for each species.

CONCLUSIONS (1)

- Similar variation patterns were identified in the single- and pair-trawler target species from PCA, indicating decadal variability in the demersal fish community.
- Step change occurred in the late 1980s resulted from the oceanic regime shift.
- PC1-2 are well corresponded to winter and summer WT in interannul-decadal scales, suggesting that variations in demesal fish community are largely forced by WT in TWC.

CONCLUSIONS (2)

- Composition of target species of trawl fisheries changed; Response patterns are different between cold- and warm-water species to climatic regime shift.
- The impact of fishing was largely different by thermal regime, region and species: necessary to assess impact of fishing for each species.
- Fisheries assessment should take into account the impacts of regime shift and fishing, addition to changes in compositions of target species and different response pattern to regime shift.