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Synchrony in the abundance trends of spear squid *Loligo bleekeri* in the Japan Sea and Pacific Ocean with special reference to the latitudinal differences in response to the climate regime shift

Yongjun Tian[1], Kazuya Nashida and Hideo Sakaji

JSFRI, Fisheries Research Agency

独立行政法人 水産総合研究センター
日本海区水産研究所
JSNFRI:Japan Sea National Fisheries Research Institute,Fisheries Research Agency

Outline

- Background : spear squid
- Abundance trends in the north and south stocks both in Pacific and the Japan Sea and, their responses to the climate regime shift
- Impact of fishing
- Conclusions

Life History of Spear Squid with Oceanographic Features

Fisheries are different in the south and north areas.

Fishing grounds in the south and north are affected by warm and cold currents, respectively.

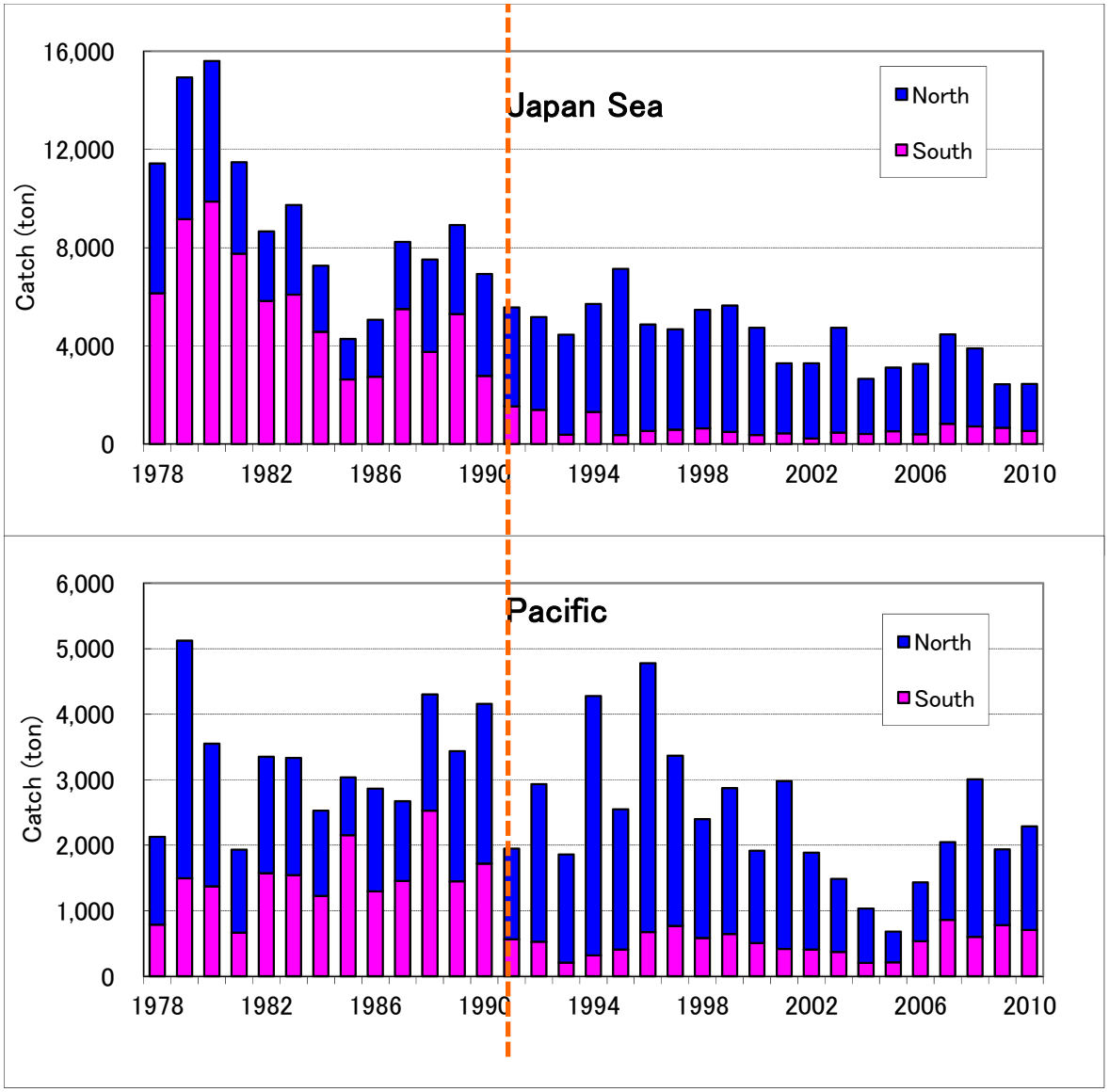
Growth and Age Male: 30cm in one year; Female: 20cm in one year

Life Span **1 year old**

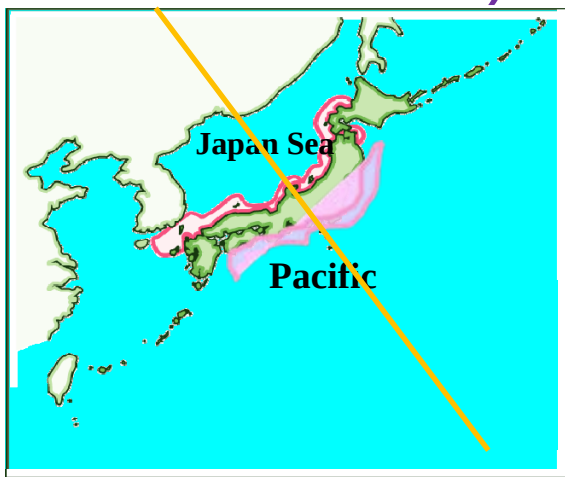
Spawning Season **Winter-Spring**

Distribution **Coastal waters**

Catch trend of spear squid in Japan



Catch from the south area declined largely since 1990s, suggested impact of the late 1980s regime shift? (Tian et al., 2008, 2009).



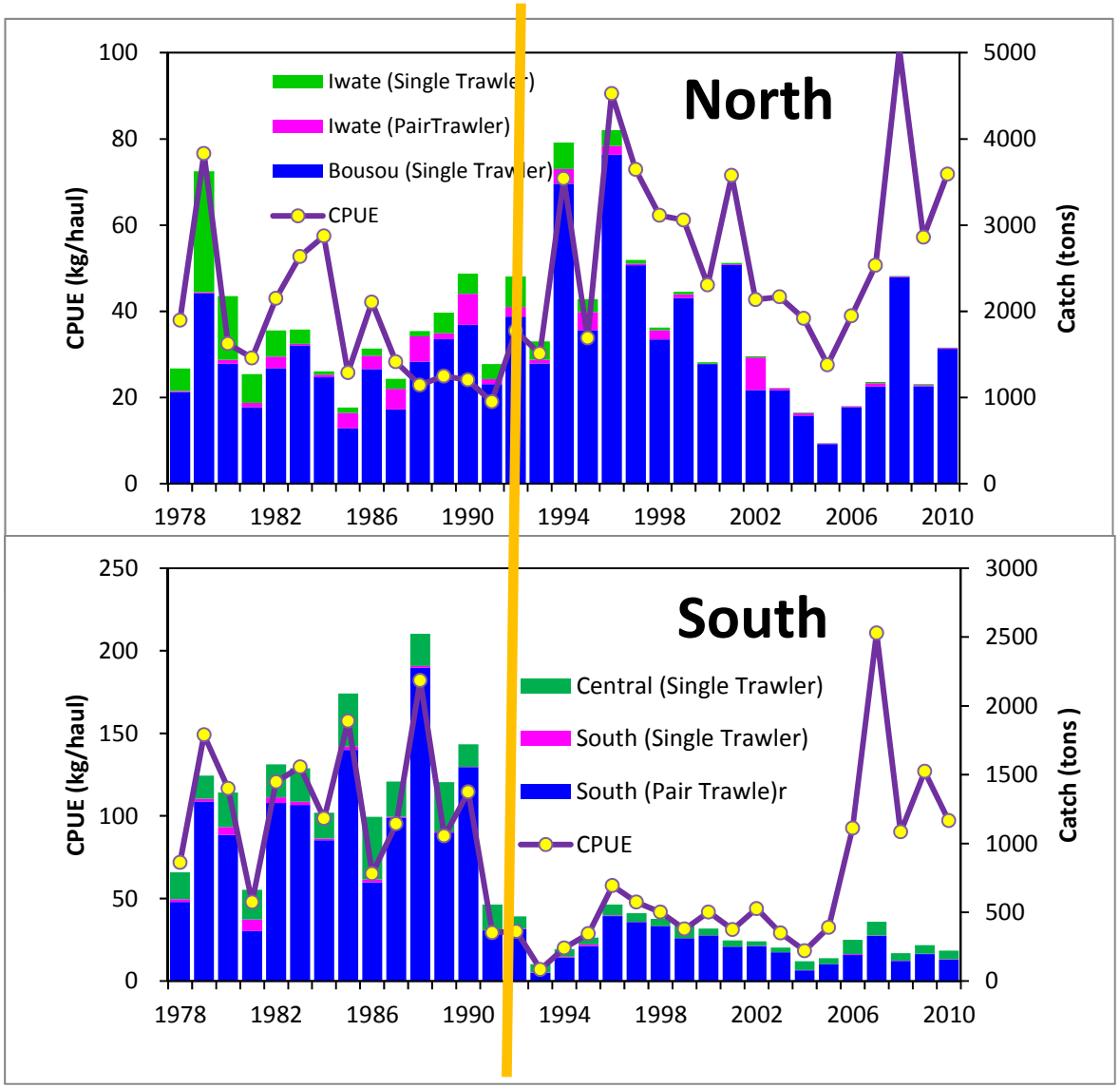
Objectives

- **To identify the variability in the abundance both in Pacific and the Japan Sea and the impact of the late 1980s regime shift.**
- **To identify and compare the variation patterns in the north and south stocks (latitudinal difference)**
- **To unravel the mechanism causing the latitudinal differences in different stocks.**

Data Source and Analysis

- Fisheries data: Catch data for trawl and set net.
- Abundance Index: CPUEs were estimated by areas and fisheries.
- Water Temperature (WT) in the Japan Sea: winter 50m WT used as indicator of TWC
- WT in Pacific: 100m WT (spring, averaged for 37-41° N) in the north and 150 m WT in the south (spring, costal Obs. St.3, in Kochi Pref.)

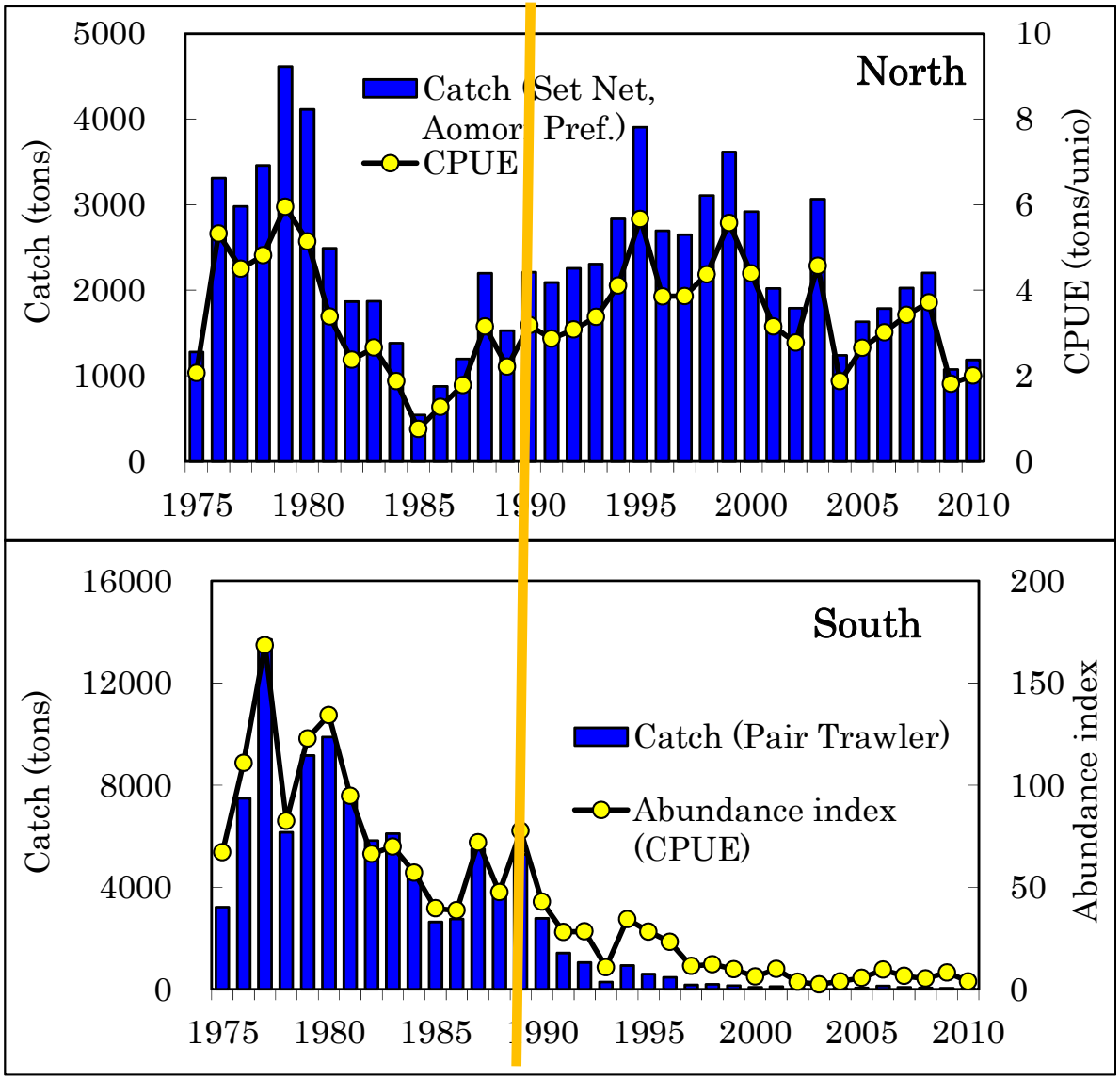
Catch and CPUE: Pacific



- **Abrupt change around in 1990**
- **Increase in the North but decline in the south since 1990**
- **Different trend between north and south**

Latitudinal difference

Catch and CPUE: Japan Sea



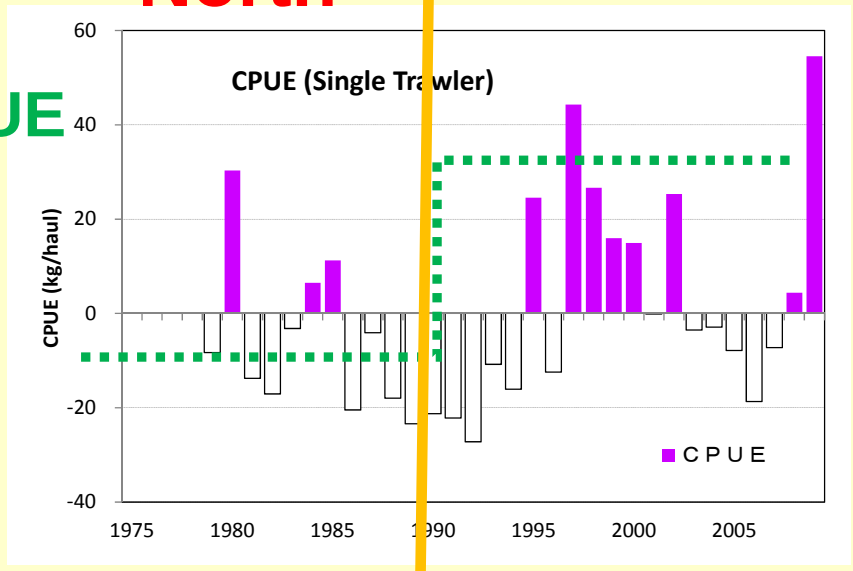
- **Similar pattern with Pacific**
- **Higher in the North but lower in the South since 1990s**
- **Different trend between north and south**

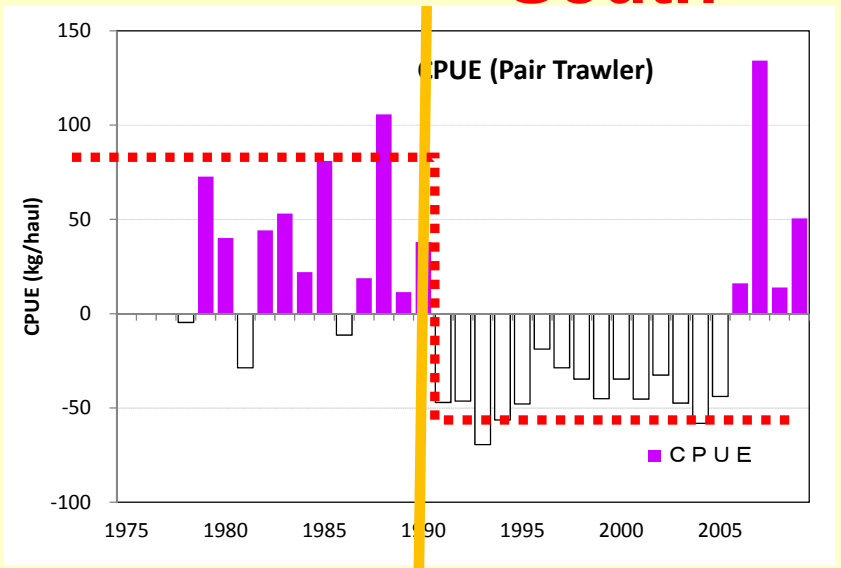
CPUE vs. WT : Pacific

North

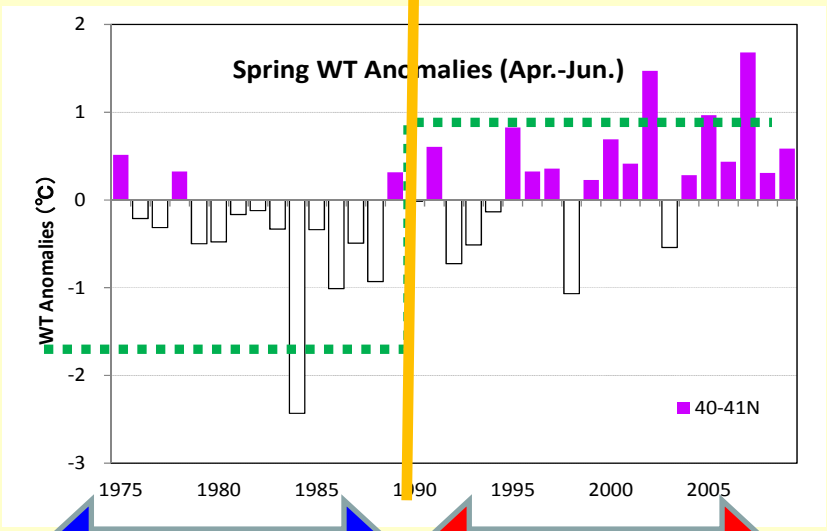
South

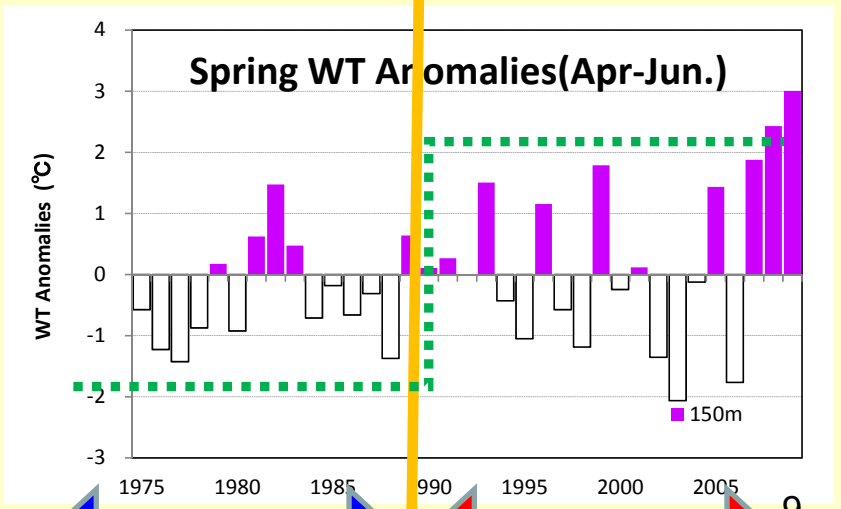
CPUE





WT





Cold Warm

Cold Warm

CPUE vs. WT : Japan Sea

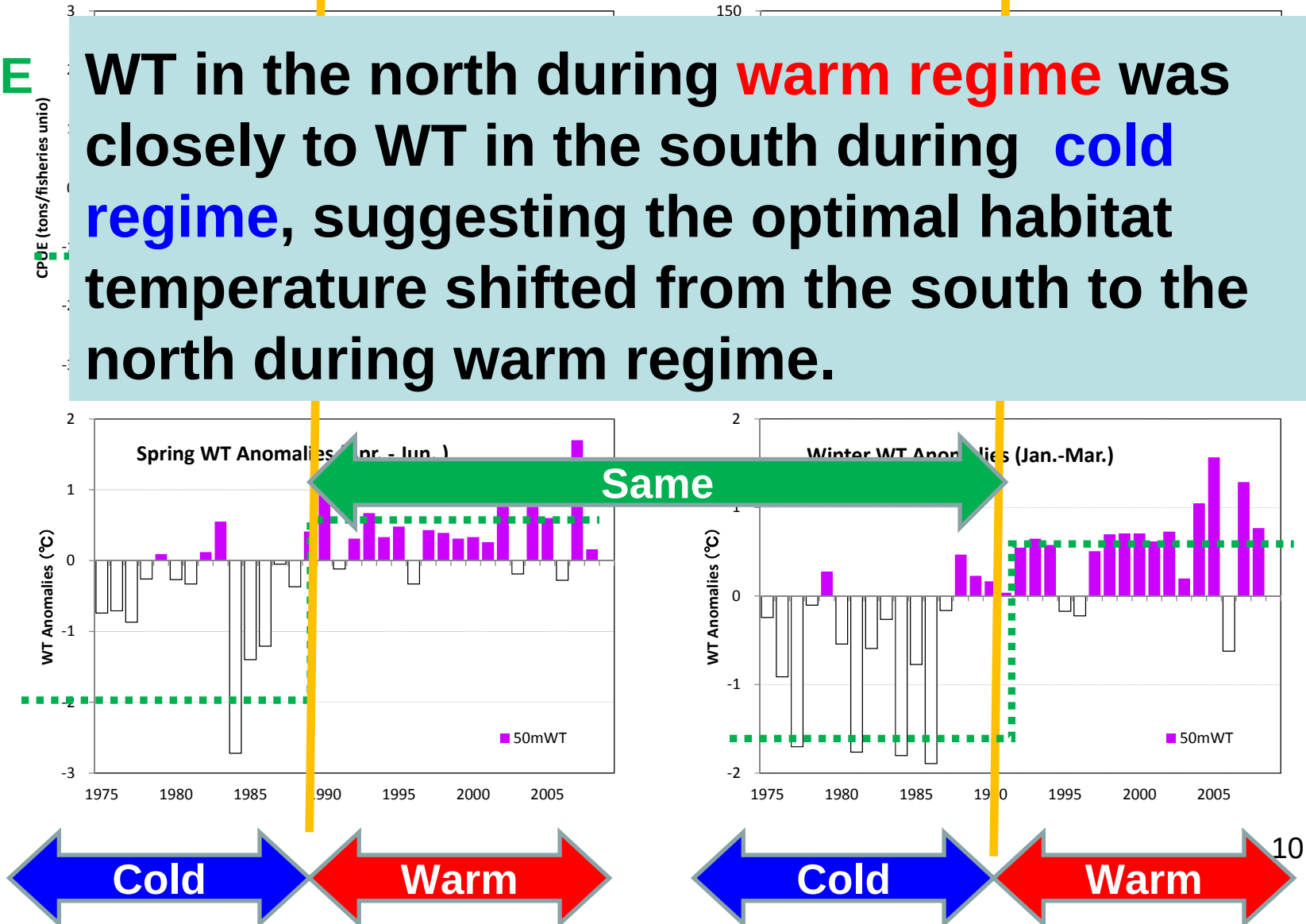
North

South

CPUE

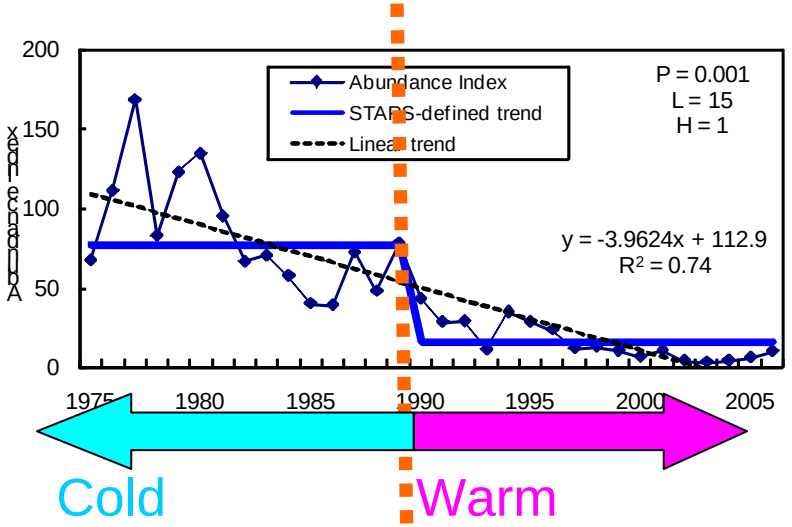
WT

WT in the north during warm regime was closely to WT in the south during cold regime, suggesting the optimal habitat temperature shifted from the south to the north during warm regime.

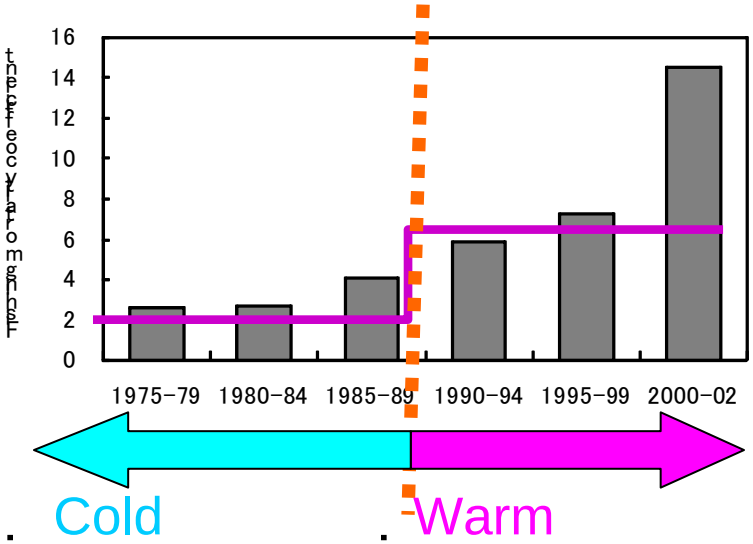


Fishing impact：a case study for the south stock in the Japan Sea

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



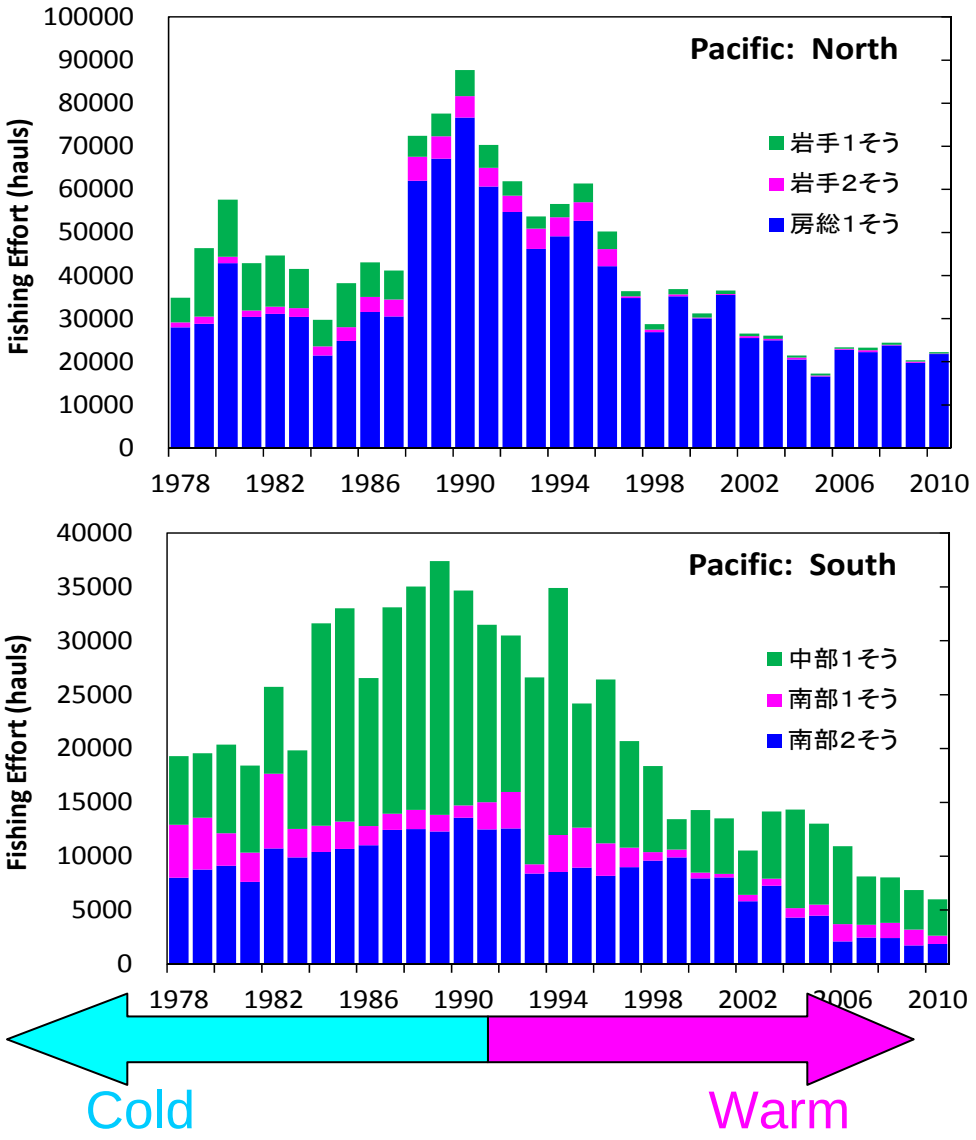
Estimated Fishing Mortality by DeLury Model



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

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

Fishing impacts: effort in Pacific



Fishing effort declined during 1990s both in the south and north of Pacific, indicating that the long-term catch trends were not depended on fishing effort.

Summary

- Decadal variability with large interannual variations in the abundance (abrupt change around 1990).
- Synchrony in the Japan Sea and Pacific Ocean strongly suggests environmental impacts (rather than fishing).
- Variability in the abundance corresponded well to WT, indicating the impact of the late 1980s regime shift.
- Opposite variation patterns between north and south stocks indicate the latitudinal difference in response to the climate regime shift: the optimum habitat shifted from the south to north during warm regime.
- Under an un-favorable thermal regime, fishing mortality can increase even with declining fishing effort, and accelerates the collapse of the stock.