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Effects of climate change on fisheries in the western Pacific including Korean waters

presented by
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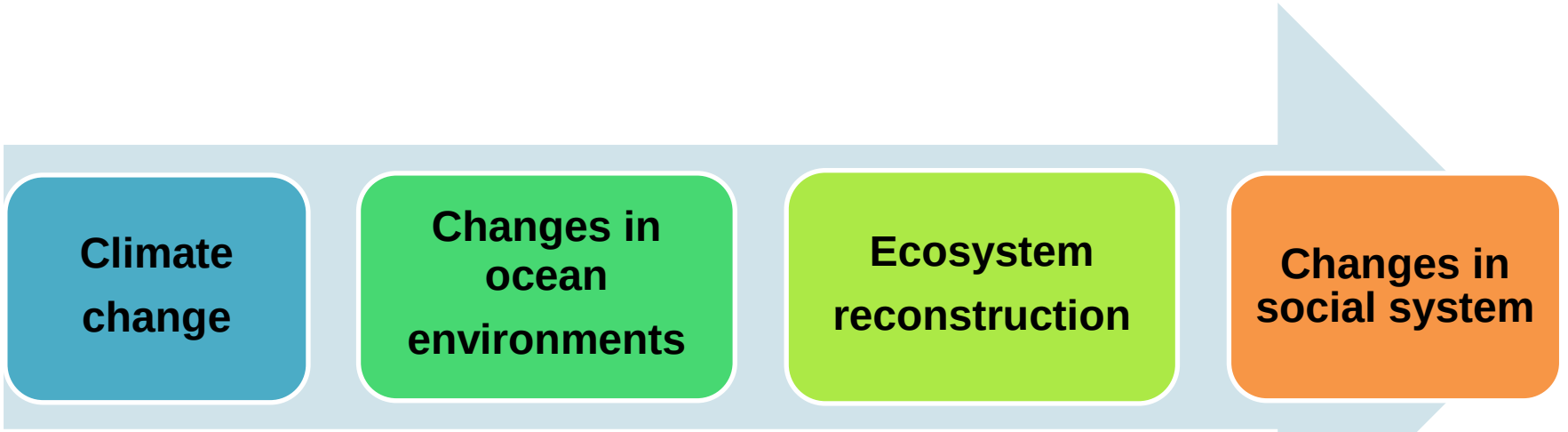
Climate-Ocean-Ecosystem-Society



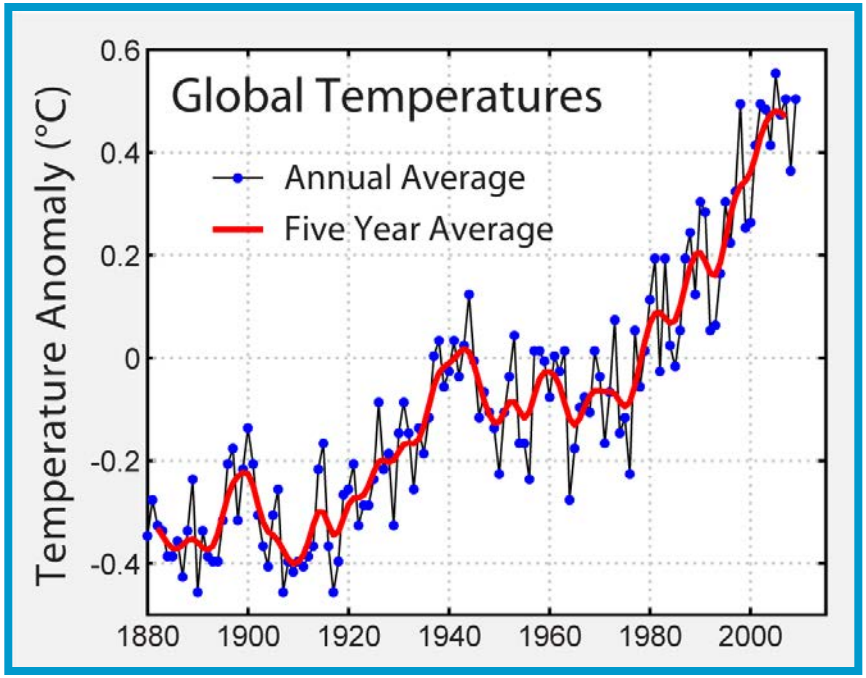
- increase in GHG
- global warming

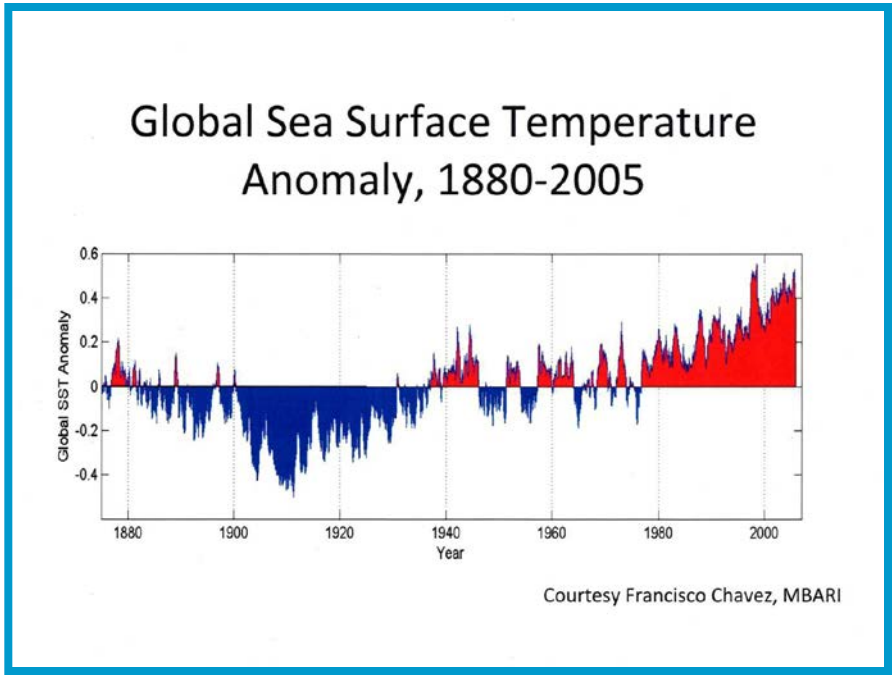
- increase in SST
- ocean acidification
- deoxygenation
- sea-level rise (changes in coastal area)
- current pattern change

- productivity change
- distribution and physiology changes
- fluctuation of fish stocks
- shift in phenology

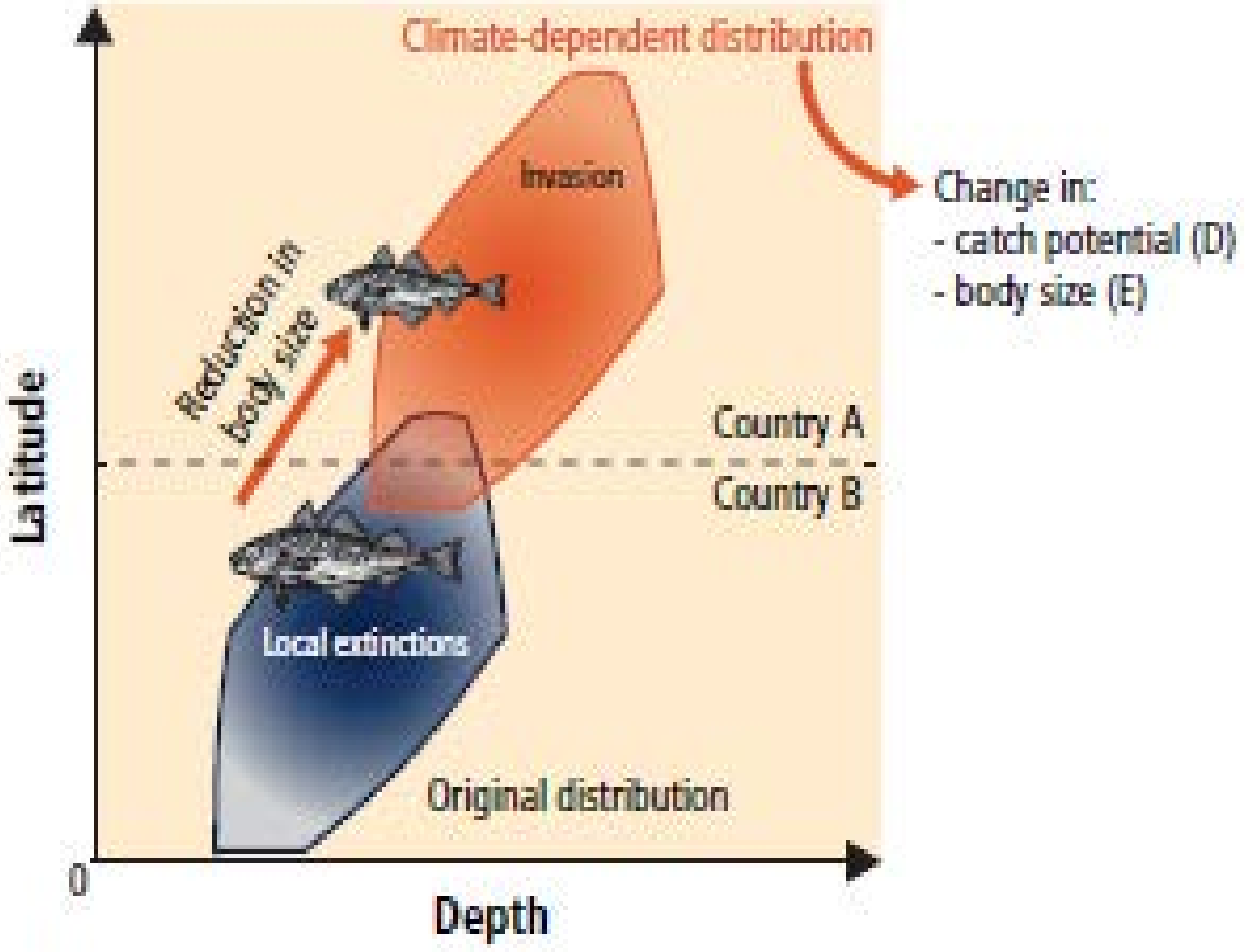
- population and household in fishery sector
- employee in fishery industry
- fishery policy

Environment is changing rapidly



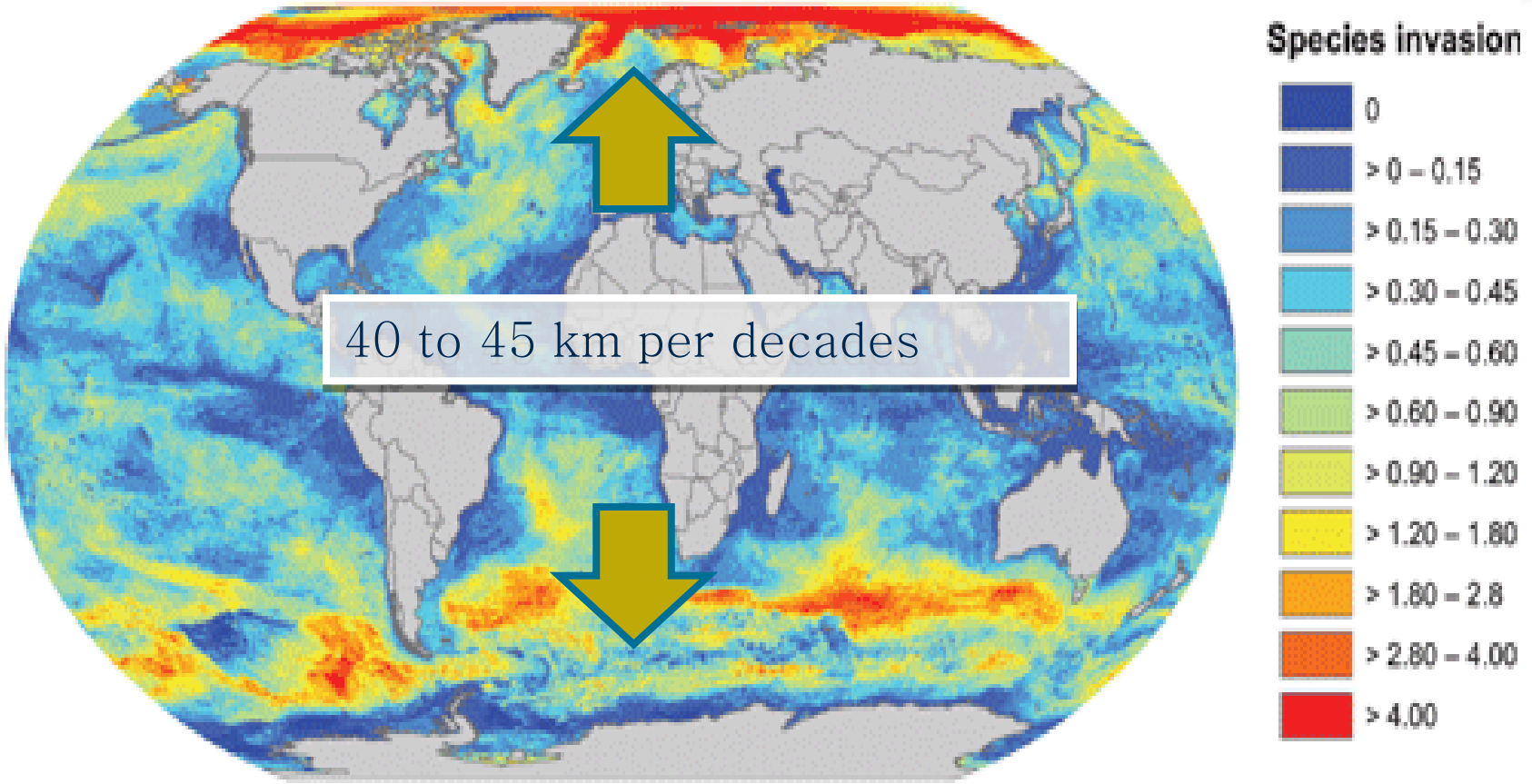


IPCC (2013) anticipated that atmospheric CO_2 would be 936 ppm by 2100, and global mean air temperature and sea level during 2081-2100 could be increased by 3.7 ^oC and 63 cm, respectively, compare to 1986-2005 period.



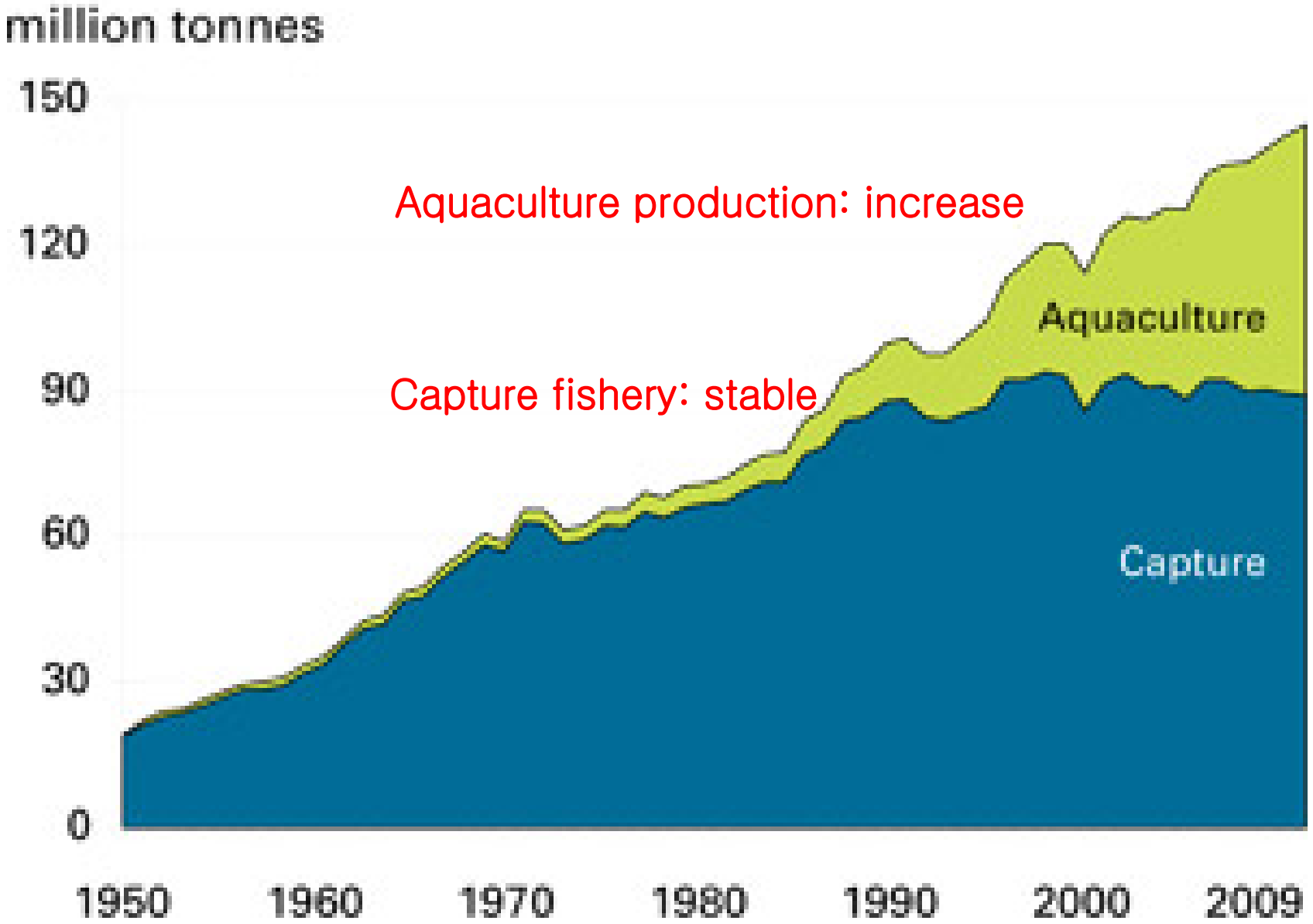
Shifts in distribution range and reduction in body size of exploited fish driven by projected warming, oxygen depletion and sea-ice retreat **(IPCC, 2013).**

Fish migrating to cooler waters (IPCC SRES A1B scenario)



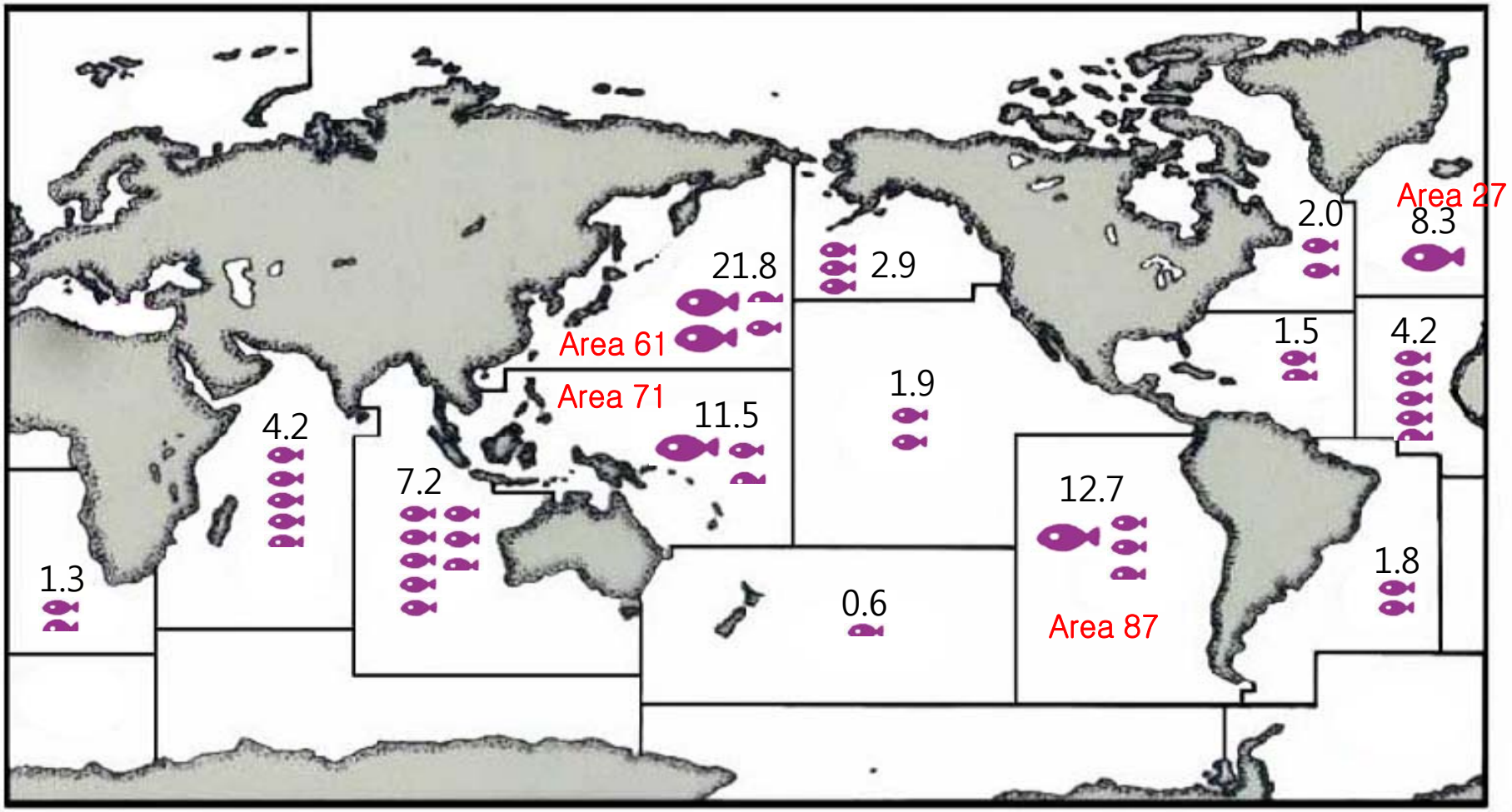
By 2050, large numbers of marine species (1,066 spp.) will migrate towards cooler waters – specifically the Arctic and Southern Ocean – at an average rate of 40 to 45 km per decades (Cheung *et al*. 2009).

World fishery production



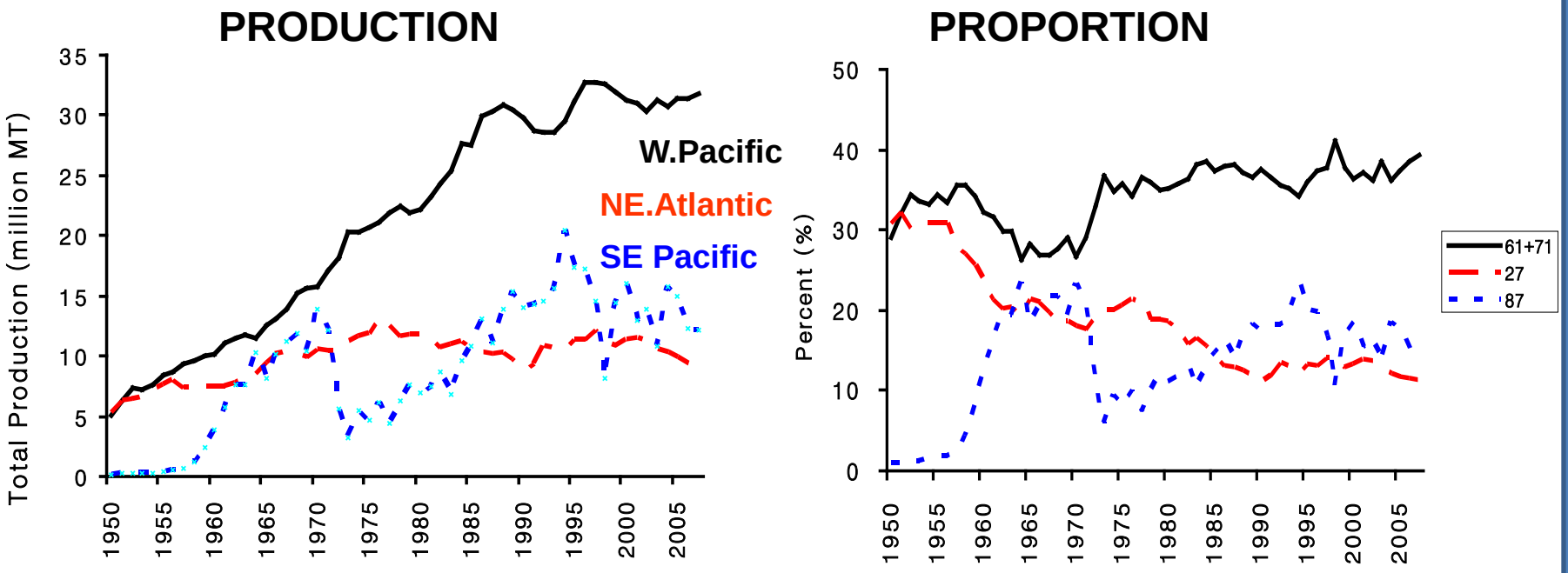
Catch by FAO marine fishing area

Total catch (in 2011) = 83.5 million tons



'Area 61' is Northwestern Pacific including Russia, Japan, Korea, China, and Vietnam.

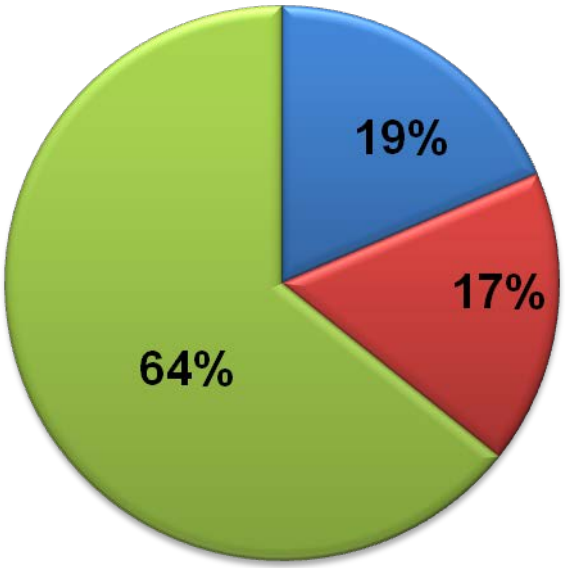
Fishery Production (MT) and Proportion (%) in world capture fishery



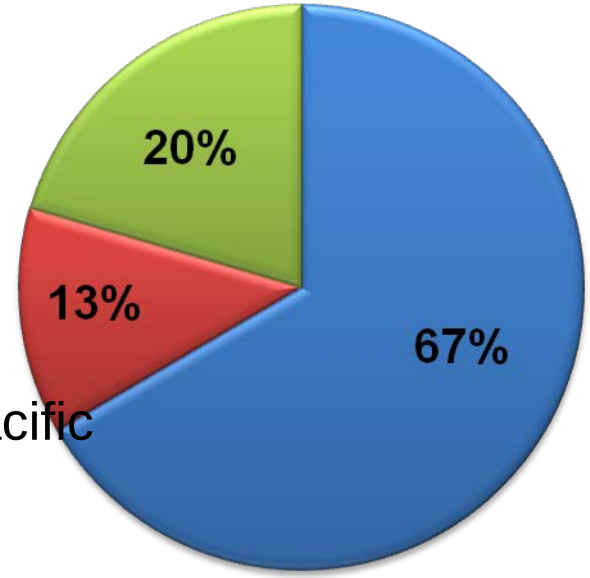
Solid black Line = Western Pacific Ocean (FAO Areas 61+71)
Dashed Red Line = NE Atlantic (FAO Area 27)
Dotted Blue Line = SE Pacific (FAO Area 87)

Western Pacific: Food Basket of the World

Capture Fisheries



Aquaculture



China
Rest of W. Pacific
Rest of World

In 2006, Western Pacific accounted for 36% of Capture Fisheries and 80% of Aquaculture Production

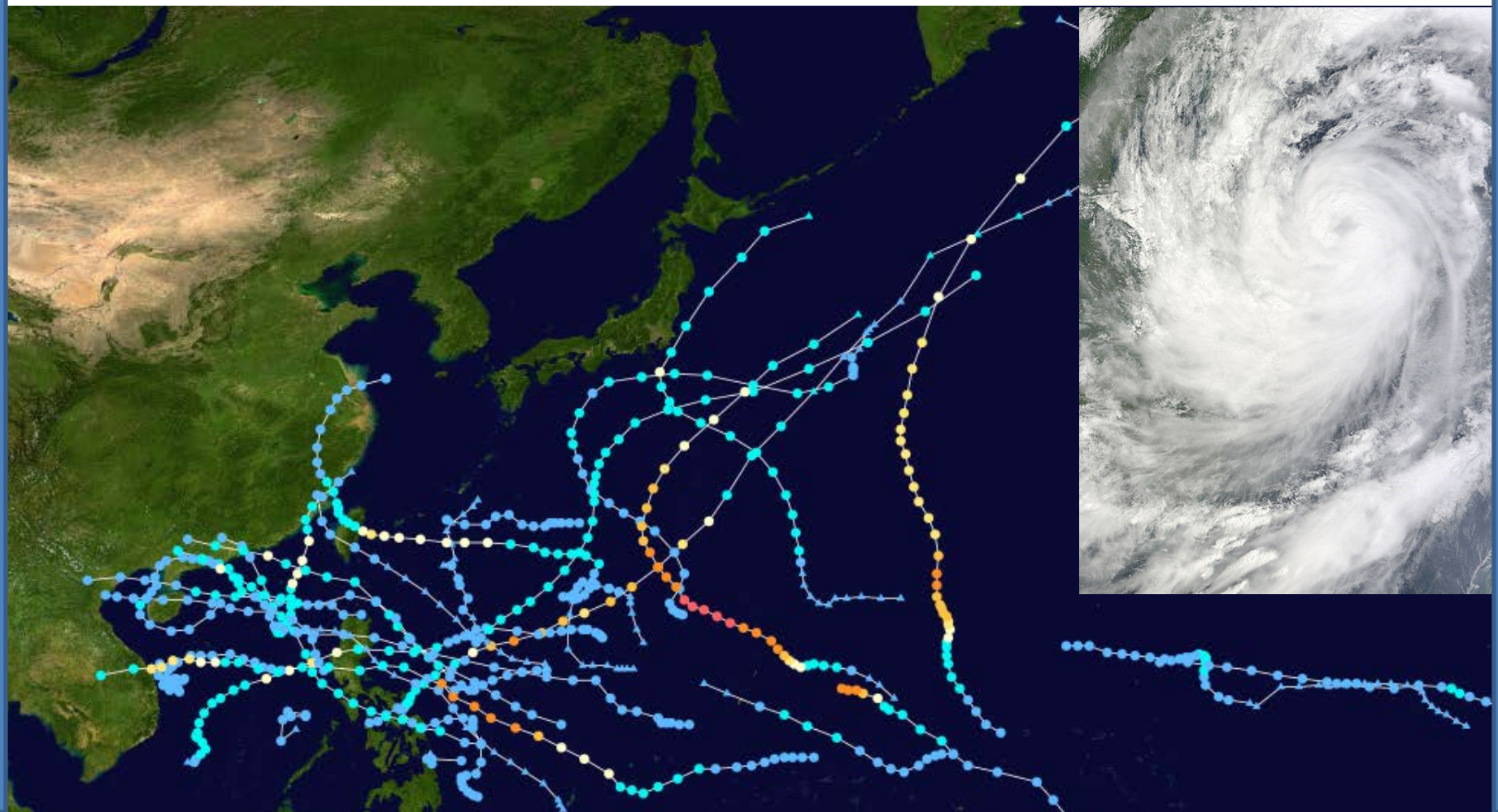
Compiled from FAO Statistical Yearbook 2006

Major Impacts of Climate Change to the Marine Environments in Western Pacific

- **Sea Surface Temperature and Ocean acidification**
  - **Warming rate is high**
  - **Risk from ocean acidification in coral reef ecosystem**
- **Sea Surface Level**
  - **Rise 1-3 mm/yr, higher than global average**
- **Storms and Storm surges**
  - **More intense and more frequent tropical storms, typhoons, and super typhoons**

Storm Events (2009 Typhoon Season)

For example in 2009, 20 storms in Philippine Area of Responsibility: 10 Typhoons, 3 super typhoons. >1,591 total fatalities, 5.6 billion USD damage (severe under-estimate)

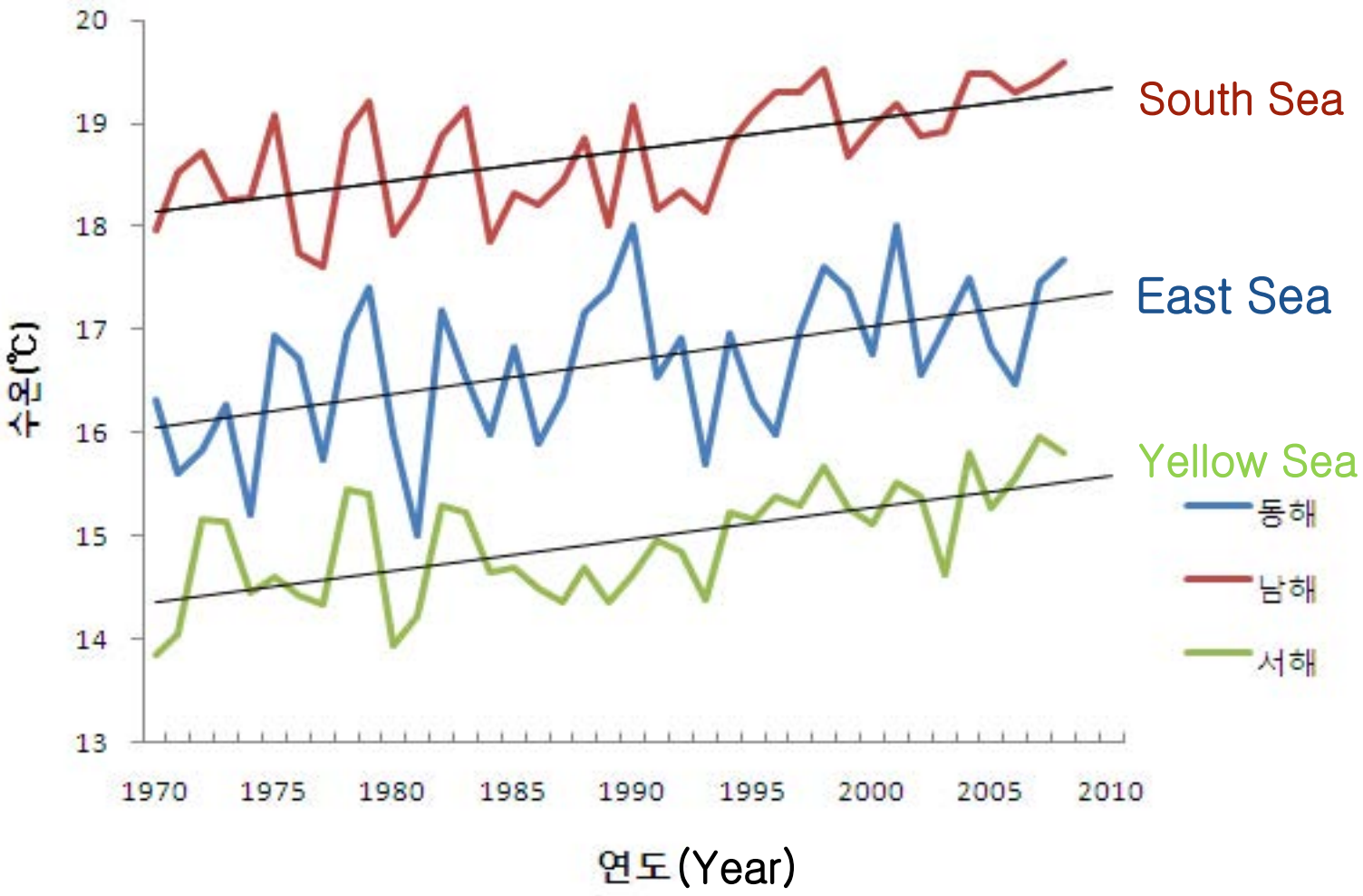


Storm Events Bring

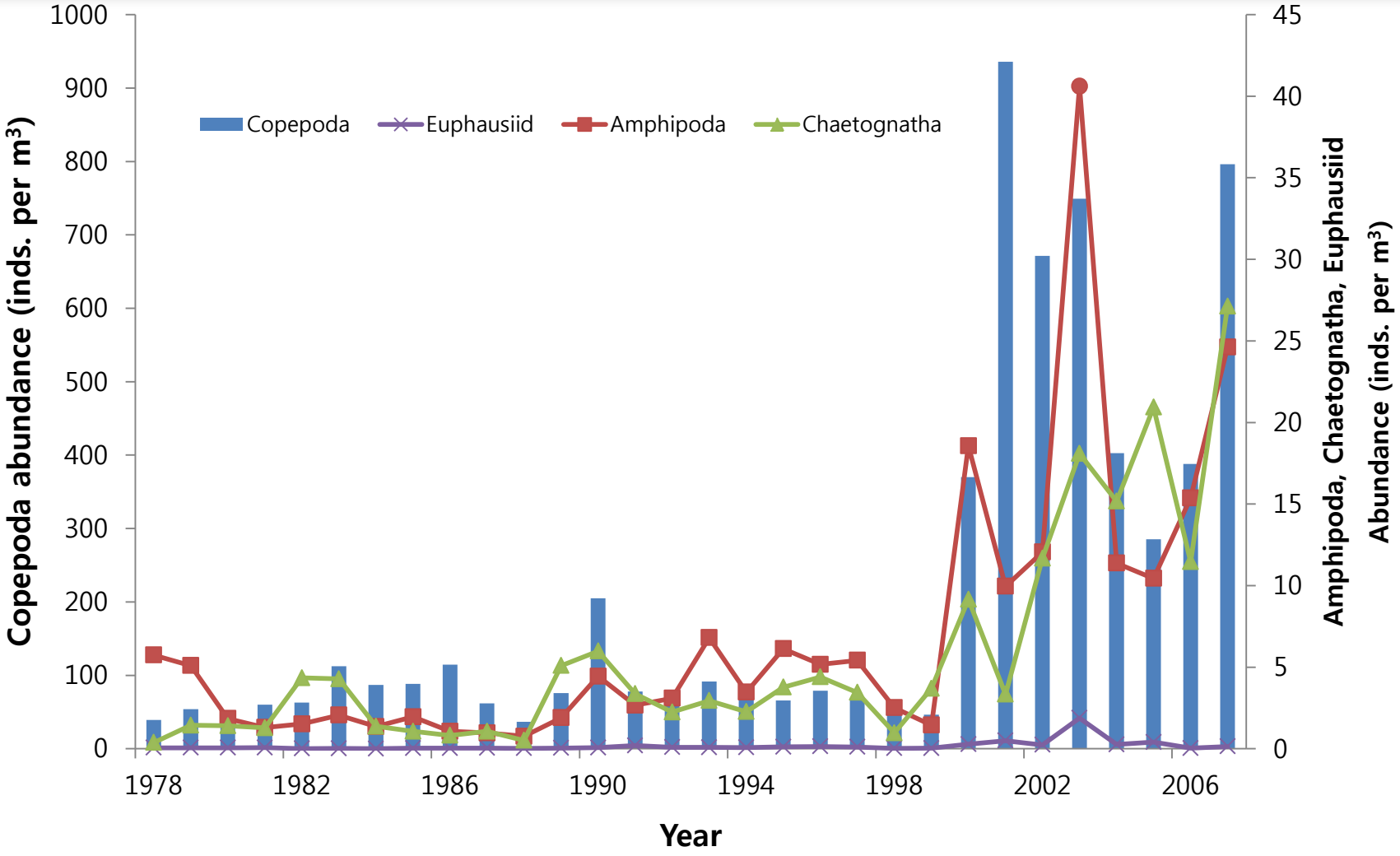
--Sudden & Drastic Impacts --

- Typhoons bring great destruction to coastal areas – wind, rain and flood
- Disrupts fishing patterns and seasons
- Physical harm to fishing vessels & aquaculture facilities
- Disrupts formation of fish schools and primary-secondary production
- Has unknown effects on fish productivity

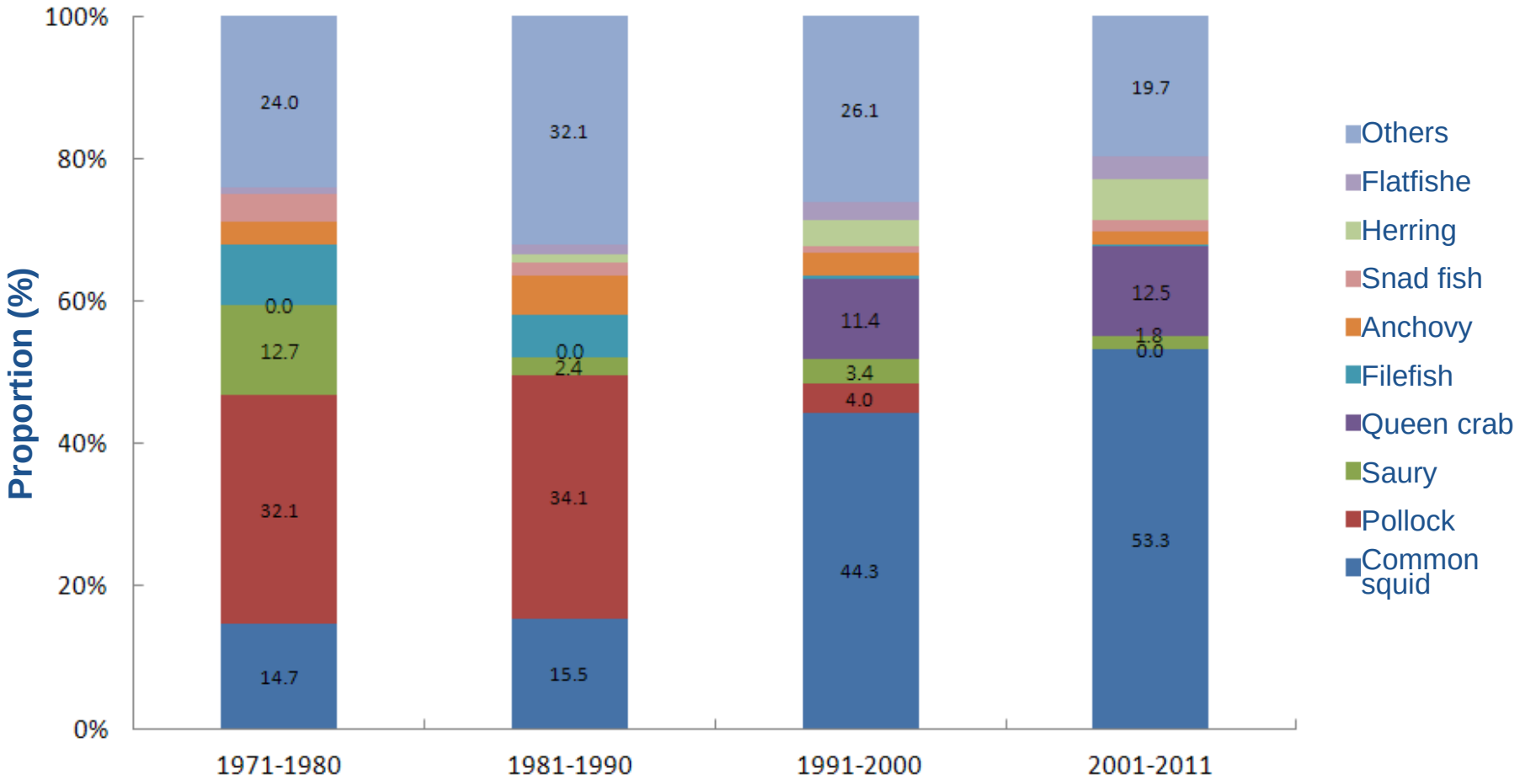
SST changes in Korean waters



Abundance of major zooplankton groups in the southwestern East Sea



Species composition change of the East Sea fisheries, ROK

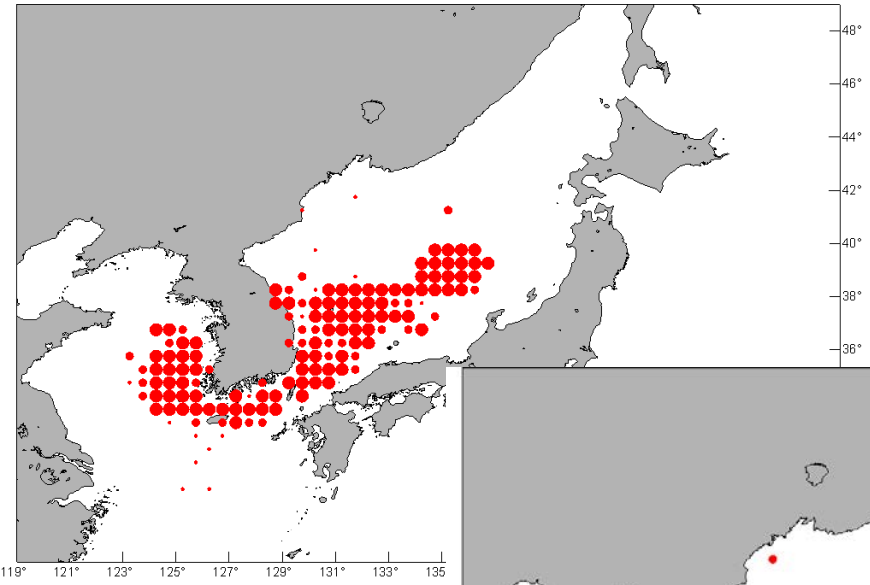


Some examples of climate change impacts on marine fishes in Korean waters:

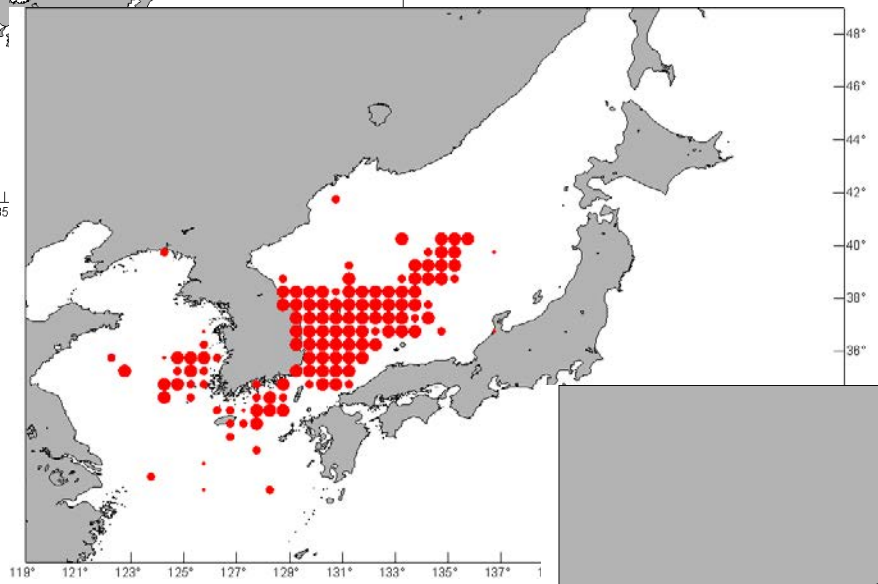
- **common squid**
- **walleye pollock**
- **chub mackerel**
- **Invasive species**

Catch locations from squid Jigging fishery

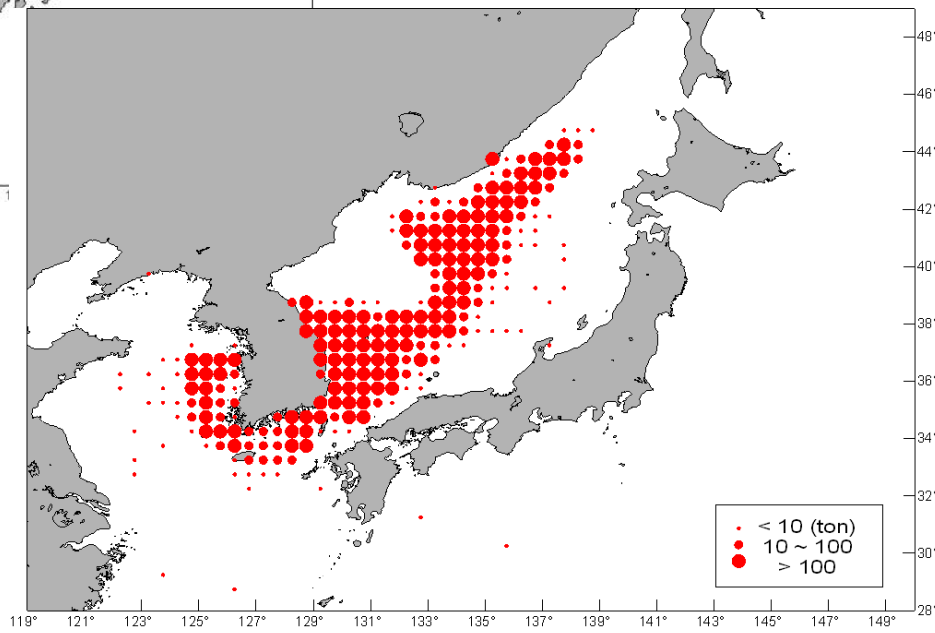
1980s



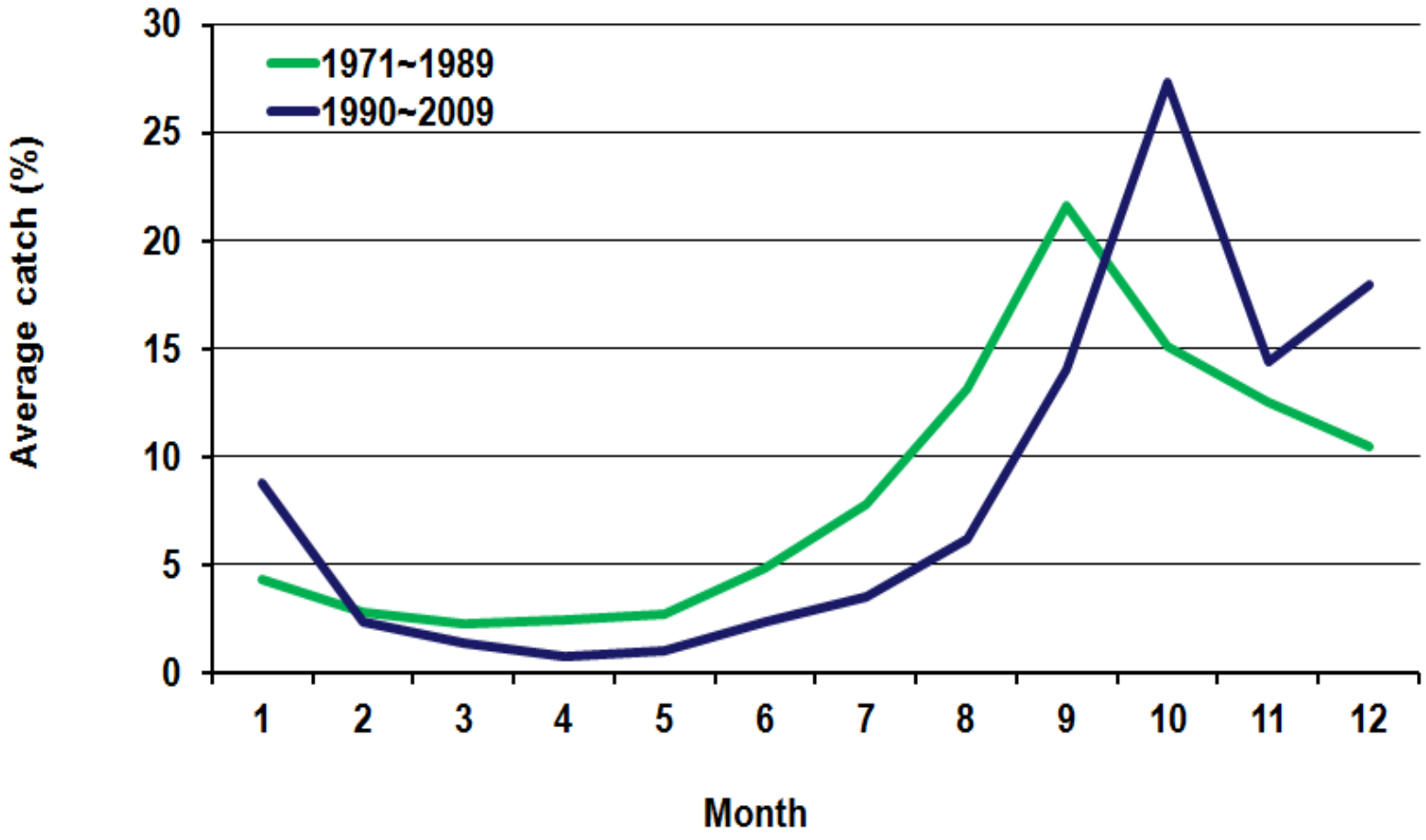
1990s



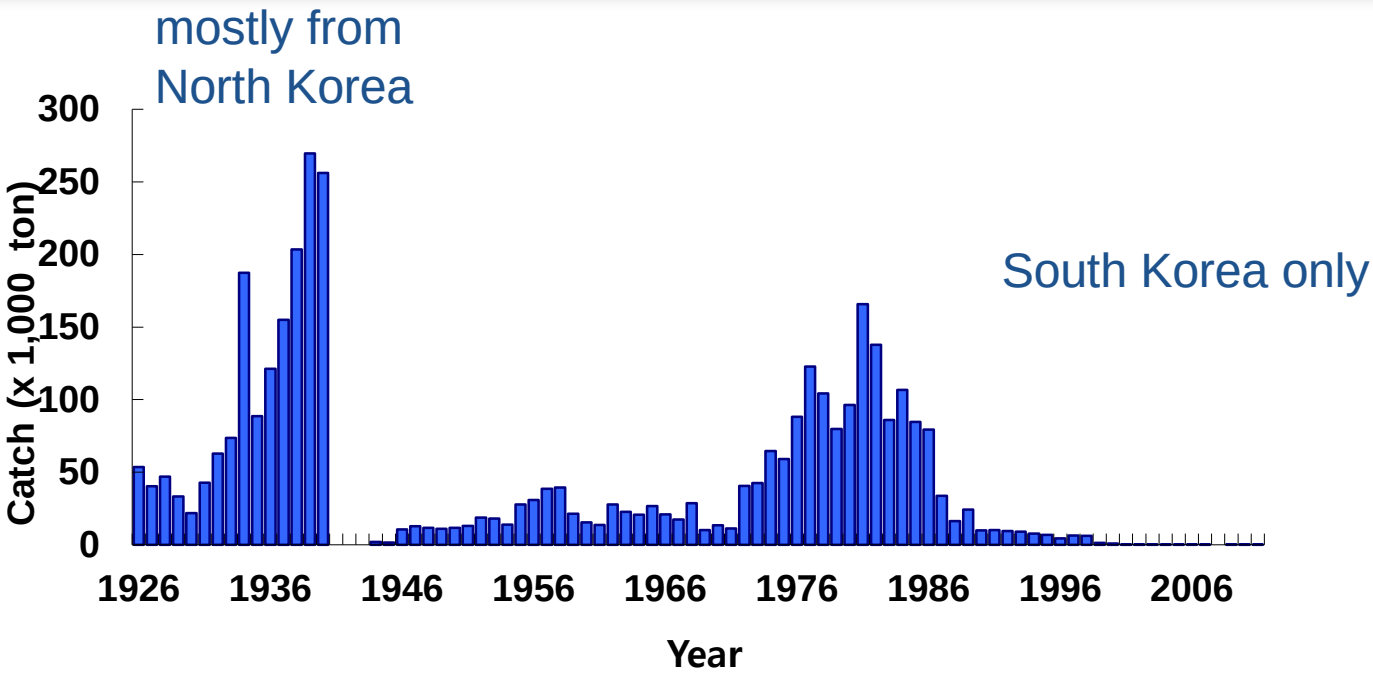
2000s



Monthly proportion of squid catch

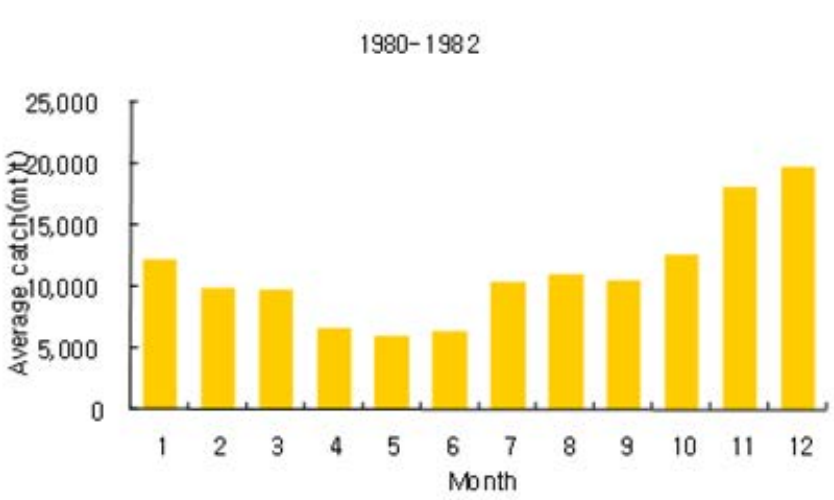


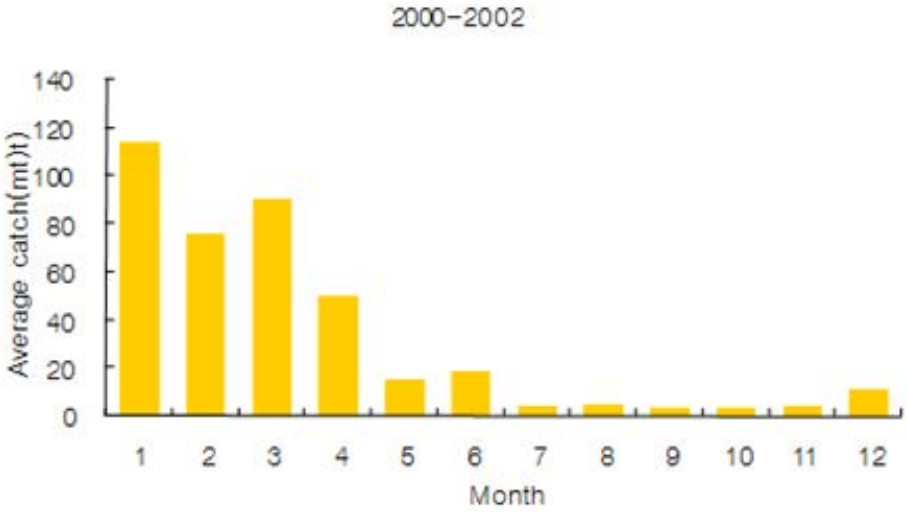
walleye pollock fishery (1926-2011)



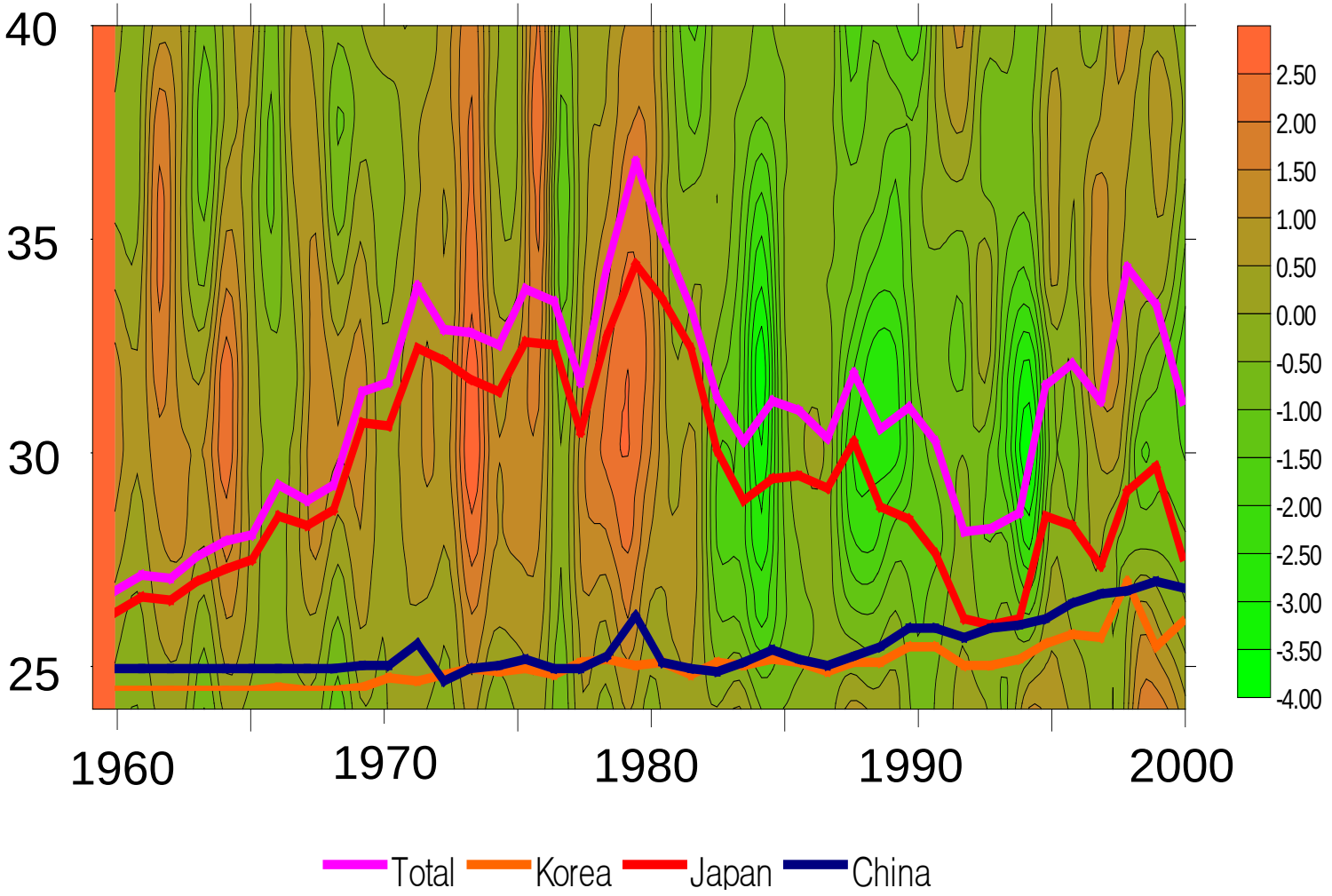
- **The catch of walleye pollock has shown a tremendous decline in the Korean EEZ of the East Sea since the late 1980s .**
- **In particular, since 2000 the pollock stocks were completely collapsed. (Annual catches were less than 1 ton nowadays.)**

Changes in fishing season





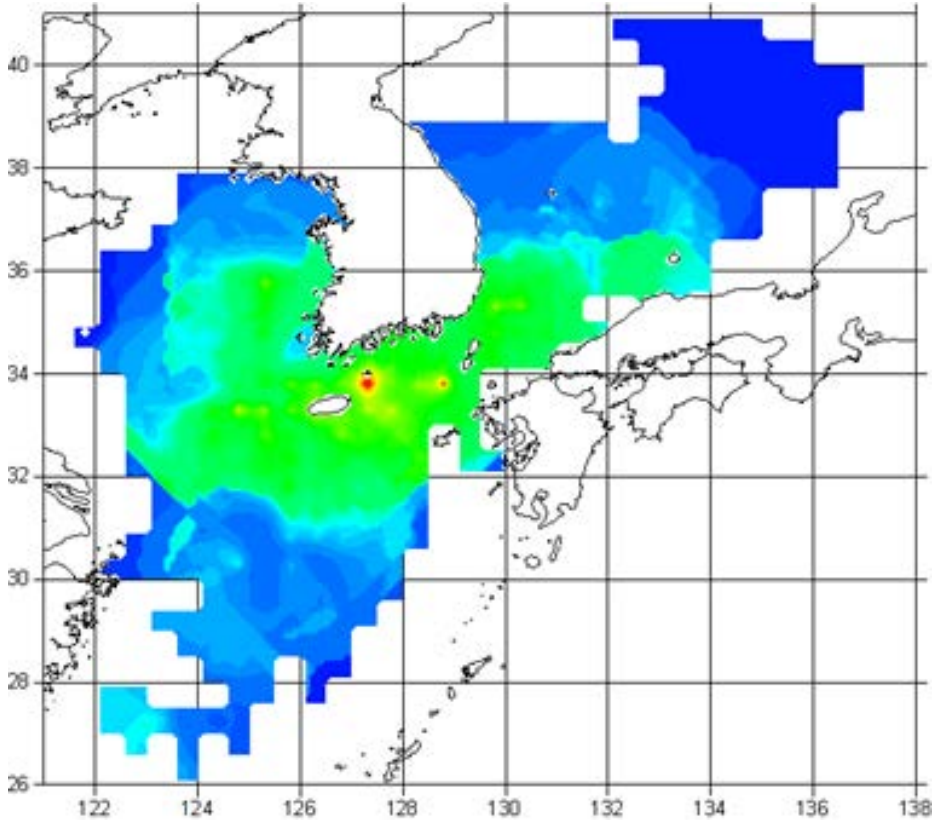
SST vs chub mackerel catch



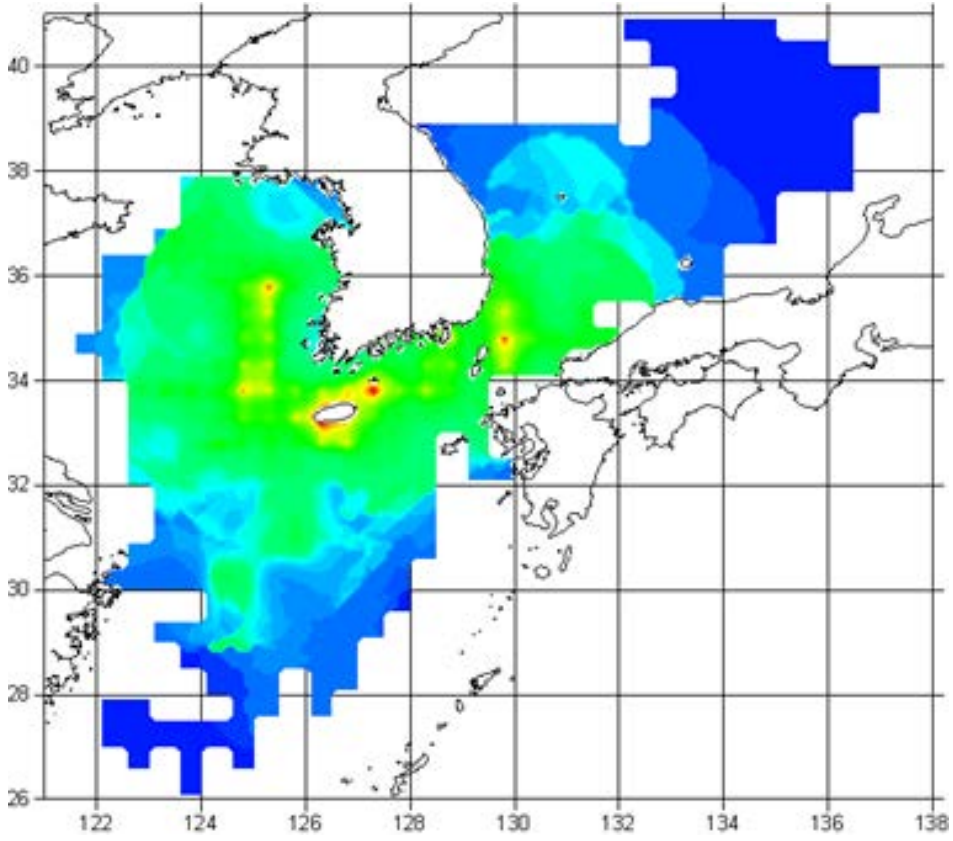
(along 123ºE)

Changes in chub mackerel catch distribution

(a) 1984–1988



(b) 1989–1997



Invasive species from subtropical waters

Hammerhead shark

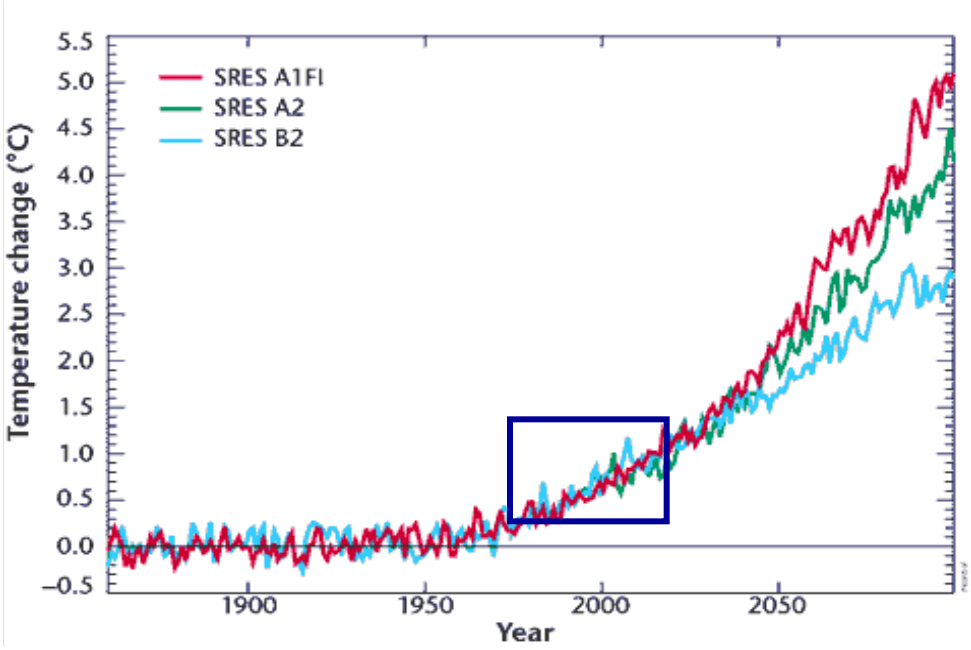
Common paper nautilus

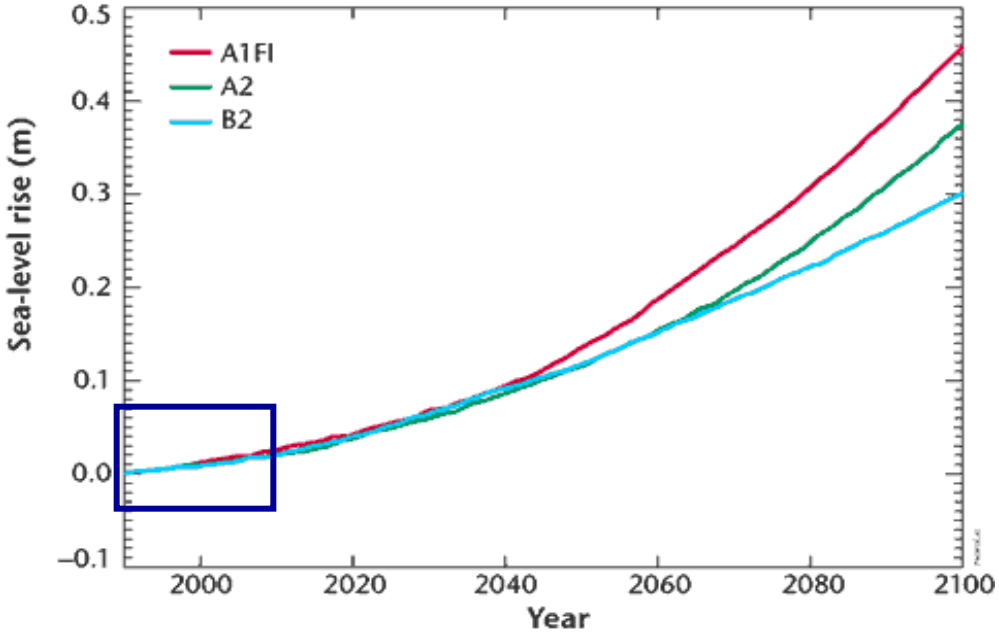
Bluefin tuna

Giant jellyfish

Summary

- About one third of the human population resides in the western Pacific region where accounts for about 36% of capture fisheries and 80% of aquaculture production in 2006: Food basket of the world and important place for the international trade of fishery products.
- Northwestern Pacific appeared one of the steepest warming region in the world during the last 3 decades, and ongoing local and regional environmental changes are anticipated to have strong impacts on fisheries.
- In Korean waters, we have observed changes in marine ecosystems as well as fishery species. Management plan in fishery should be considered in conjunction with changes in climate and social systems.
- The formation of a new international convention is suggested for proper management of marine resources in the region.





We are at the starting point in rapid environmental changes

How will the western Pacific ecosystem including fish resources be changed?
What vulnerability?
Adapation?