

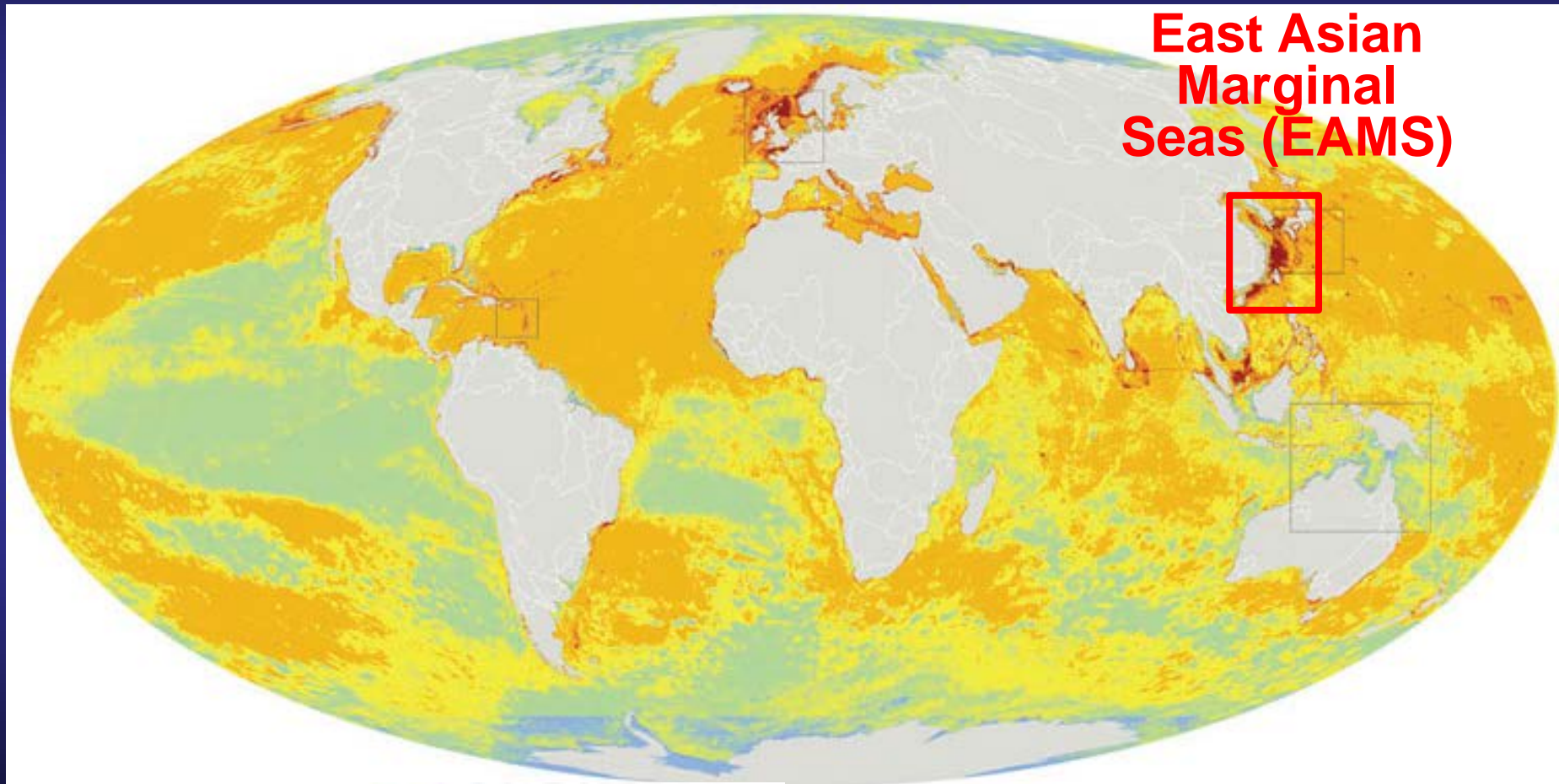
# Jellyfish blooms as a threat to the sustainability of the East Asian Marginal Seas: an overview of recent studies in China, Japan and Korea

**Shin-ichi Uye**, Hideki Ikeda (Hiroshima University, Japan)  
Sun Song, Fang Zhang (Institute of Oceanology, Chinese Academy of Science, China)  
Chang-Hoon Han, Won-Duk Yoon (National Fisheries Research and Development Institute, Korea)

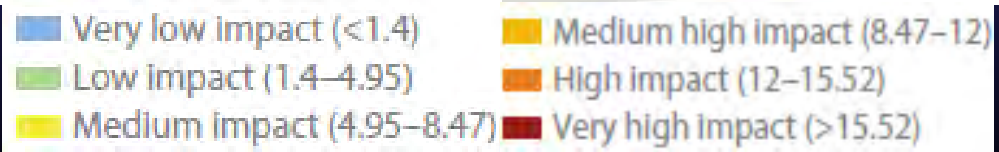
(by Y. Itayama)

# Global map of ecosystem deterioration

Based on various human impacts: (1) climate change, (2) fishery, (3) pollution, (4) shipping, etc. (Halpern et al., 2008)



**East Asian  
Marginal  
Seas (EAMS)**



# Global map of jellyfish population trends by LME (Brotz et al. 2012)

Jellyfish populations are increasing in 28 LMEs out of 45

Brooms of *Aurelia aurita* s.l.  
in the Inland Sea of Japan  
(Uye et al., 2004)



Blooms of *Nemopilema  
nomurai* in the Sea of Japan  
(Kawahara et al., 2006)



# National/international jellyfish research projects

## China: Two projects

- 1) “Operation-based demonstration and application to marine jellyfish disaster monitoring and early warning technology” conducted by National Bureau of Oceanography (2010~2014)
- 2) “The key processes, mechanisms and ecological consequences of jellyfish blooms in Chinese coastal waters” conducted by the Ministry of Science and Technology (2011~2015)

## Japan: One project

“Studies on prediction and control of jellyfish outbreaks: STOPJELLY” sponsored by the Ministry of Agriculture, Forestry and Fisheries (2007~2012)

## Korea: Two monitoring programs conducted by NFRDI

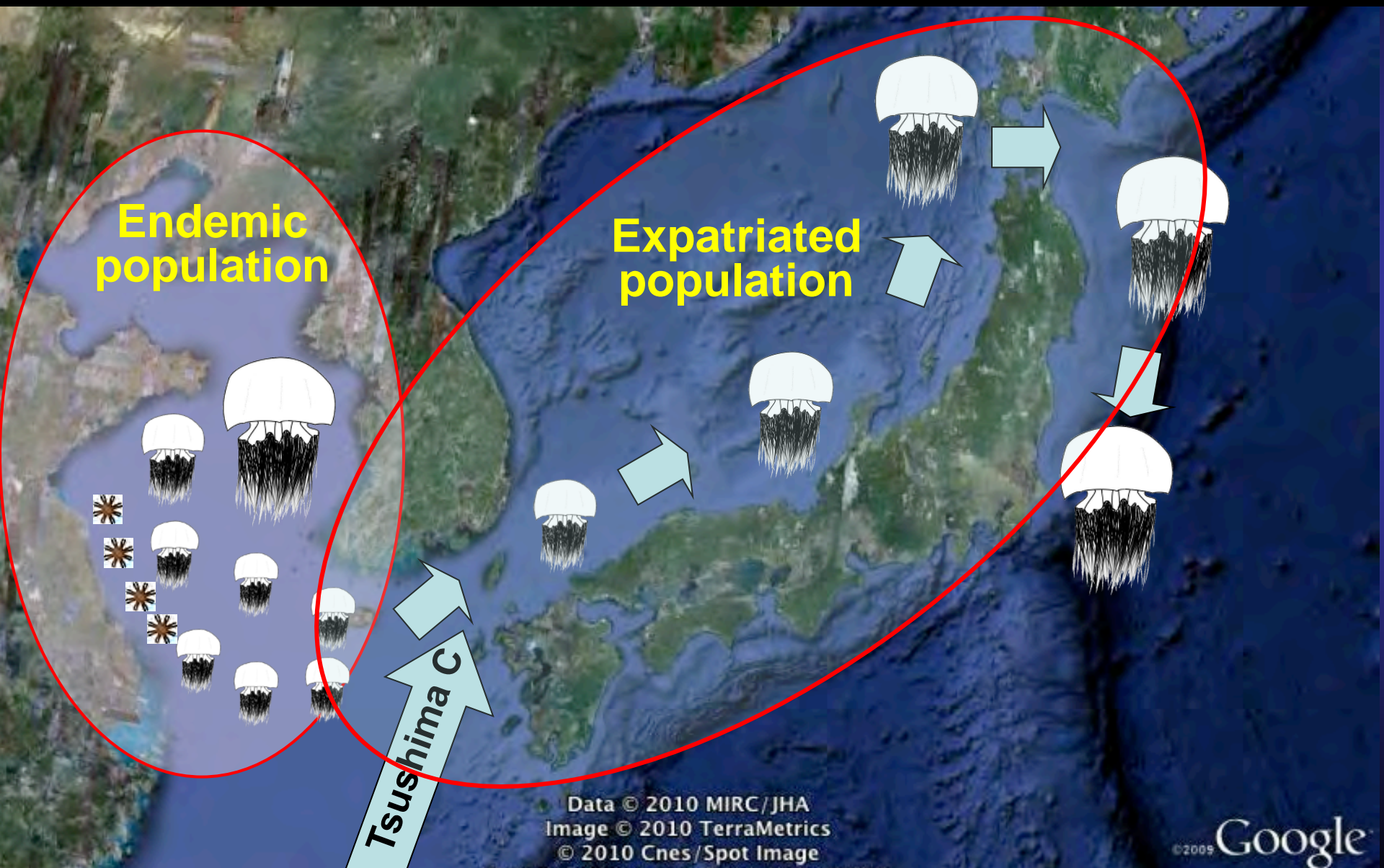
- 1) Korean Jellyfish Monitoring Network (2008~)
- 2) Korean Series of Oceanographic Monitoring Program (2005~)

## International: Annual workshop

The China-Japan-Korea international jellyfish workshop (2004~)

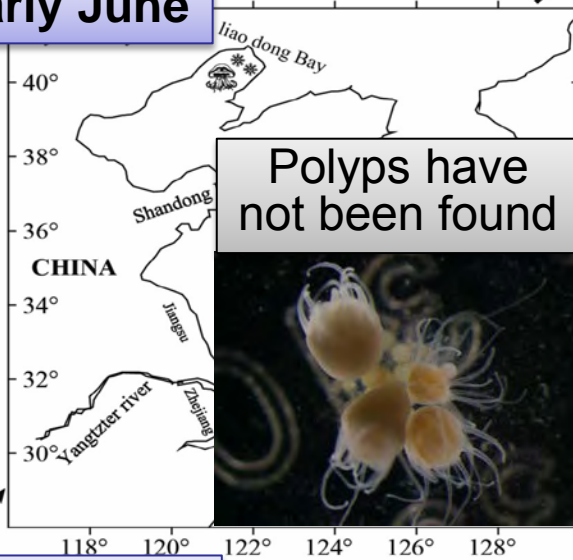
# *Nemopilema nomurai* in the EAMS

## Endemic and expatriated populations

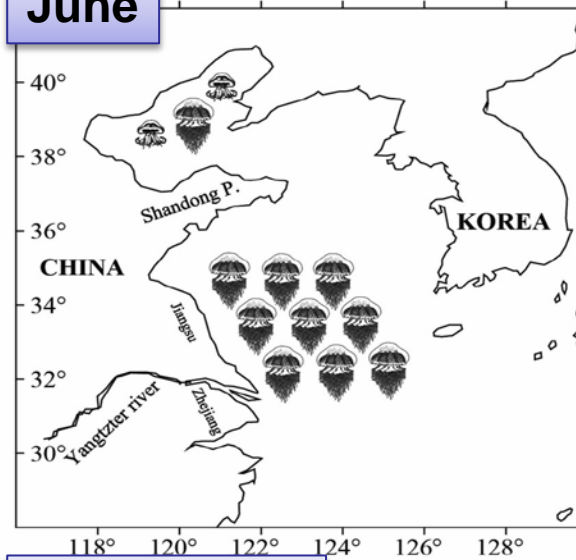


# Seasonal occurrence of *Nemopilama* in the Bohai, Yellow and East China Seas

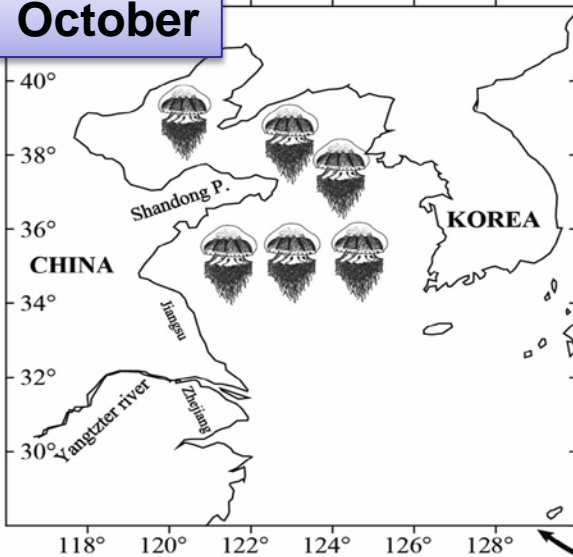
May-early June



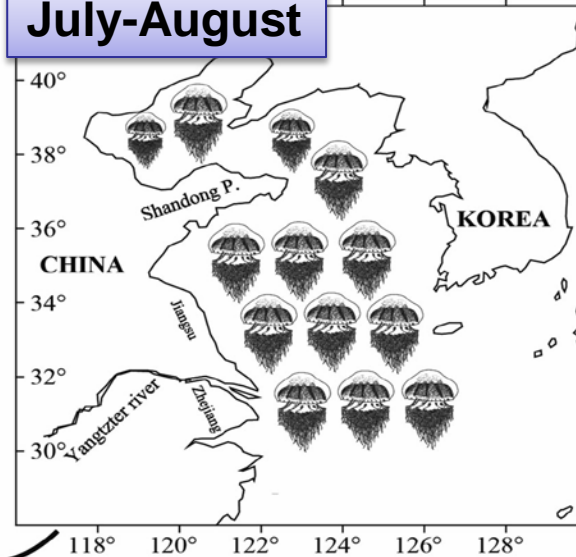
June



October



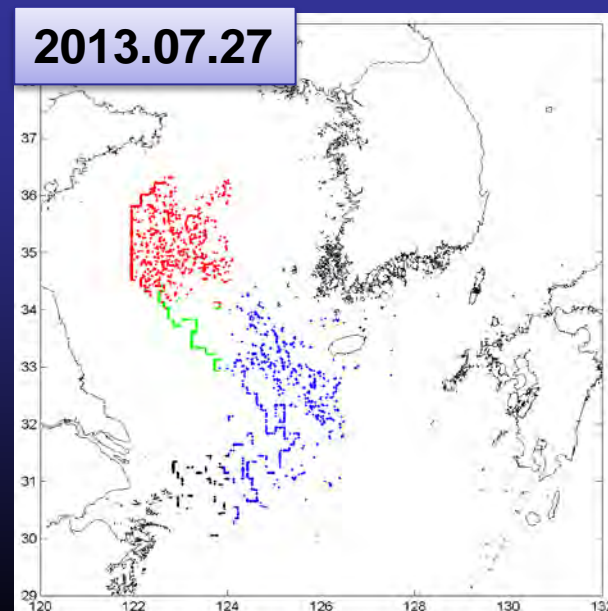
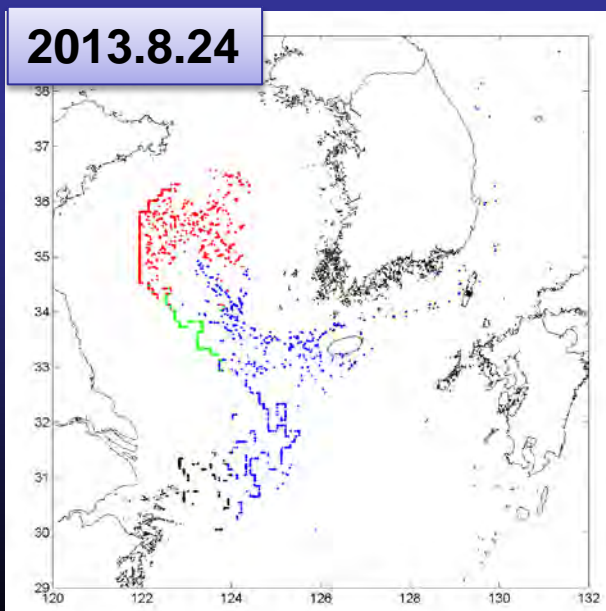
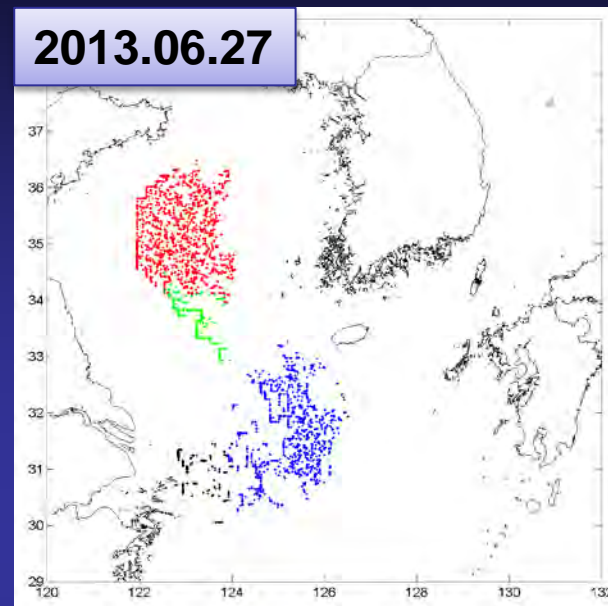
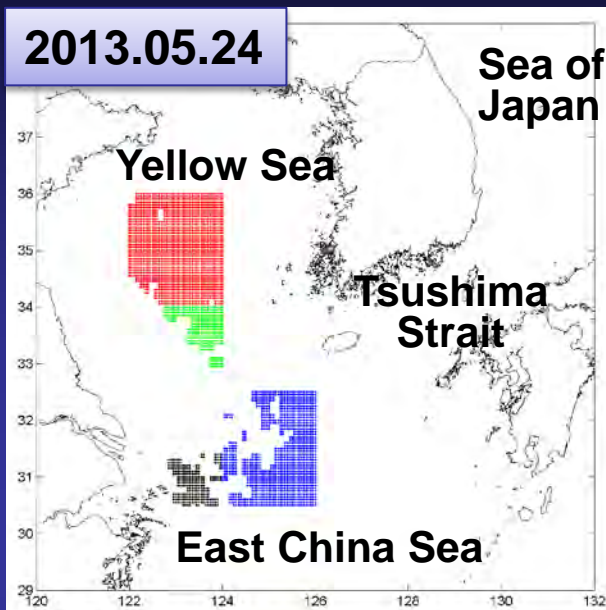
July-August



legend: \* Ephyra and metephyra    Juvenile medusa    large medusa

(Sun et al, 2015)

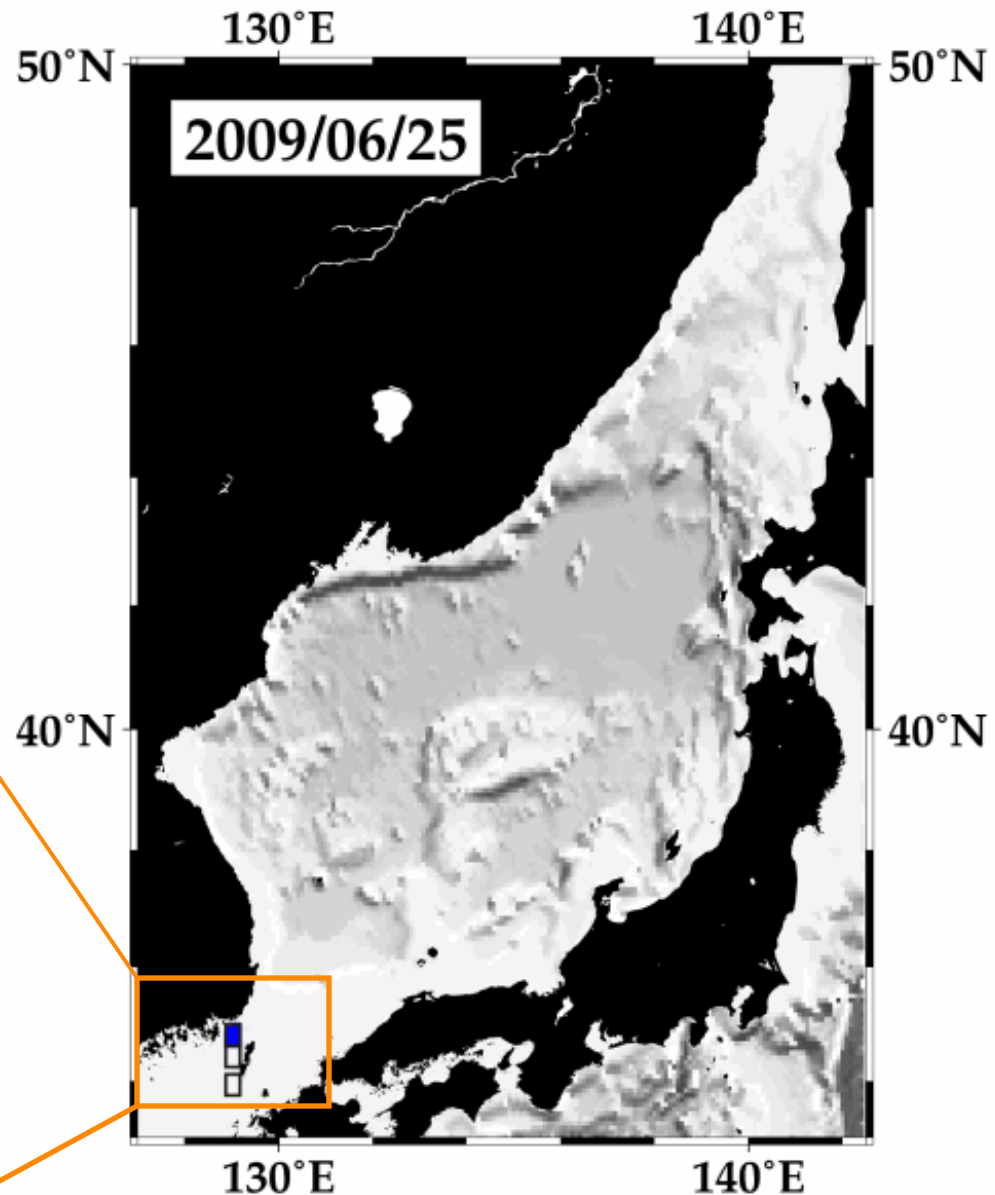
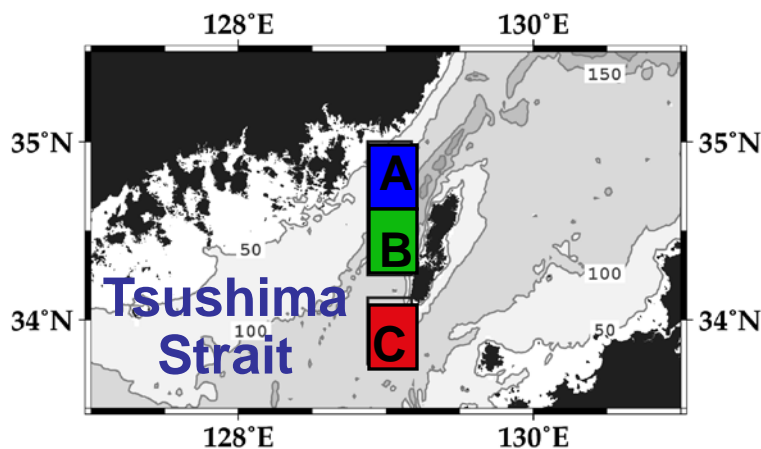
# Simulated transportation of *Nemopilema* by the Korean Jellyfish Tracking Model



# Simulated transportation of *Nemopilema* in the Sea of Japan

## Assumptions and conditions for the model

- 1) Initial position: Three (A, B and C) zones in the Tsushima Strait
- 2) Start of particle release: 25 June in A (blue), 30 June in B (green), 7 July in C (red)
- 3) Stop of particle release: 13 July
- 4) Calculation period: from 25 June to 15 September
- 5) Vertical movement: diel vertical migration





# Annual changes in bloom intensity of *Nemopilema*

## China

Based on various sources of information

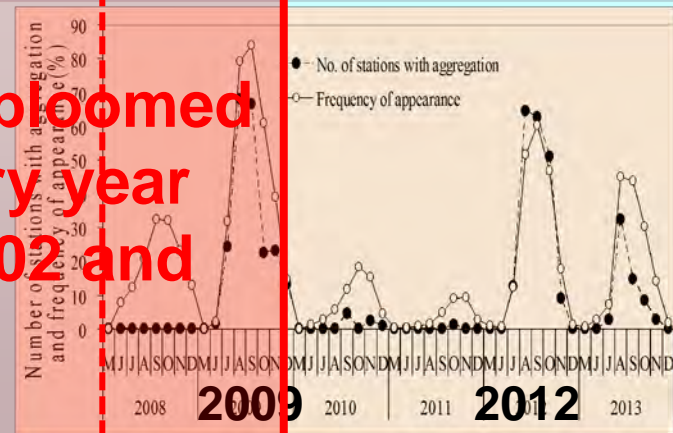


## Korea

Based on monitoring surveys

Bloom years:  
2002, 2003, 2005, 2007

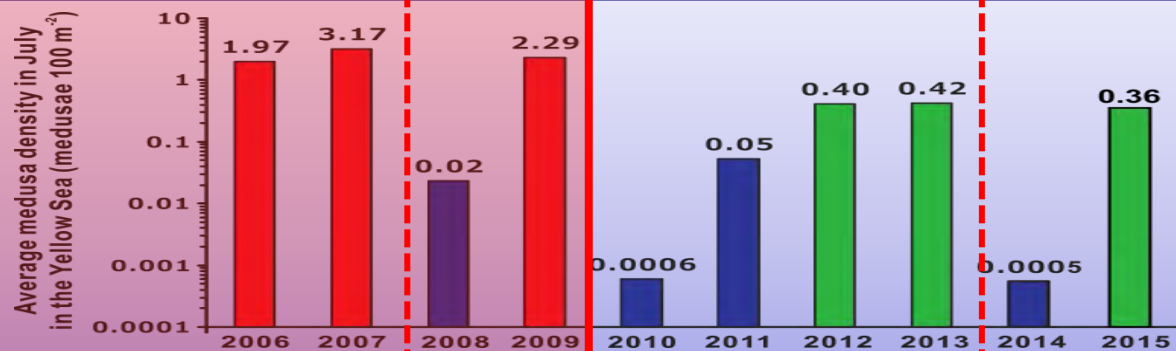
***Nemopilema* bloomed almost every year between 2002 and 2009,**



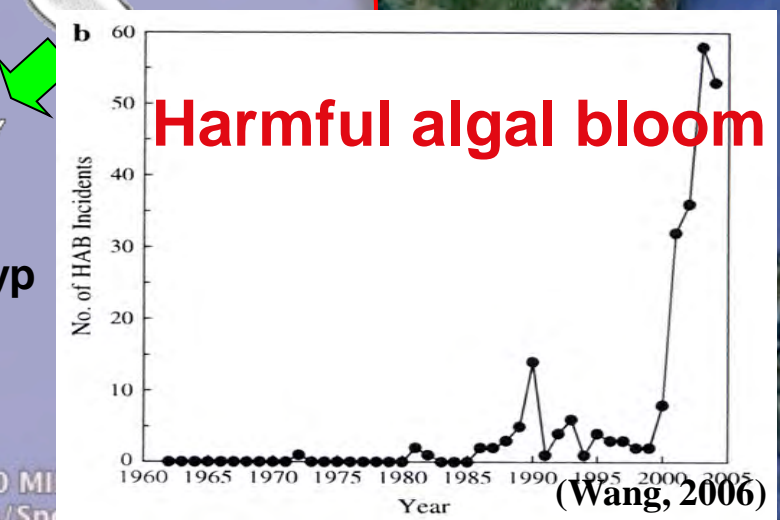
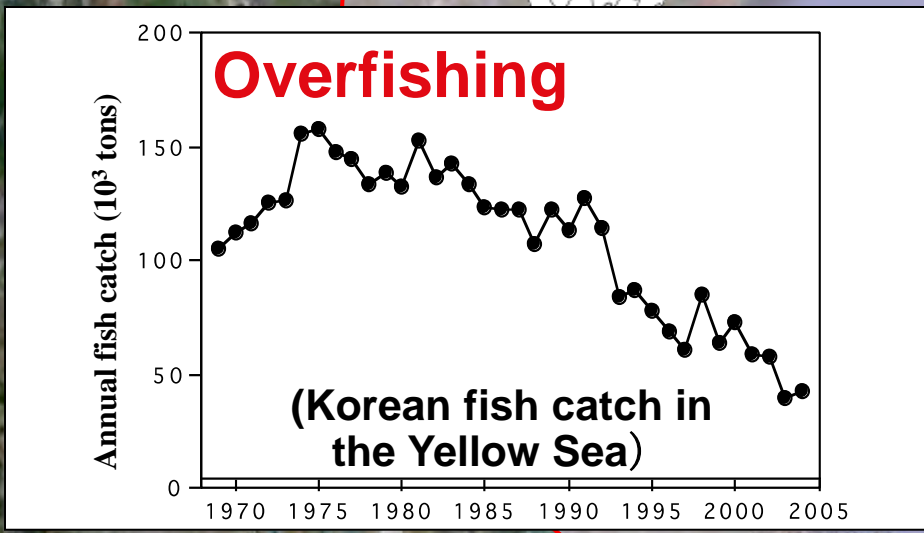
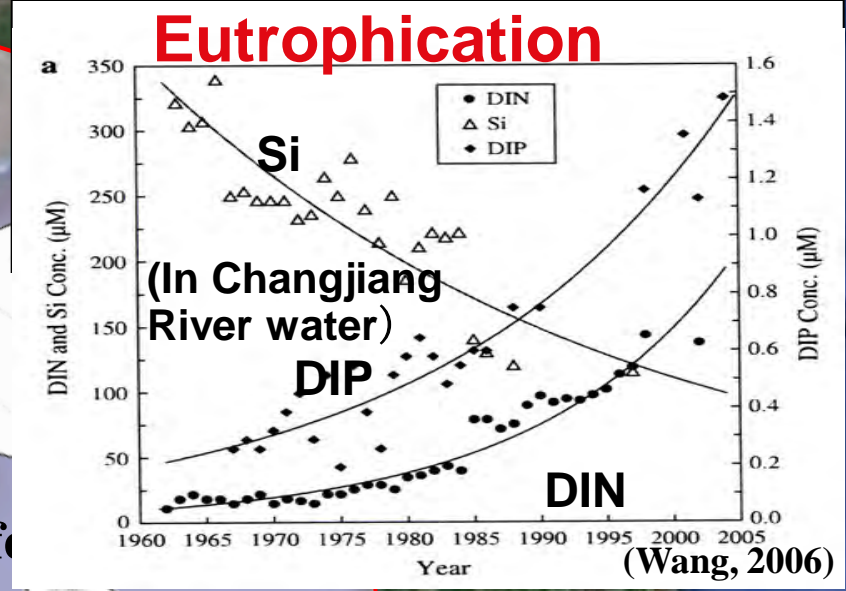
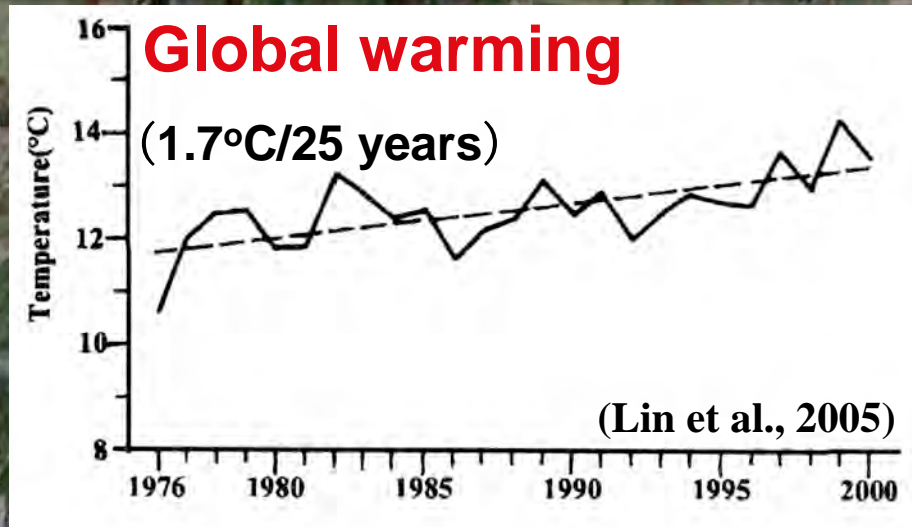
## Japan

Based on ferry surveys

Bloom years:  
2002, 2003, 2004, 2005



# Why? May be various anthropogenic impacts on Chinese coastal waters



Artificial polyp substrates

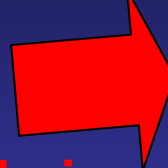
Deoxygenation

# Changes in fish catch and ecosystem of EAMS

Fish-dominated ecosystem



Warming  
Eutrophication  
N/P/Si ratio change



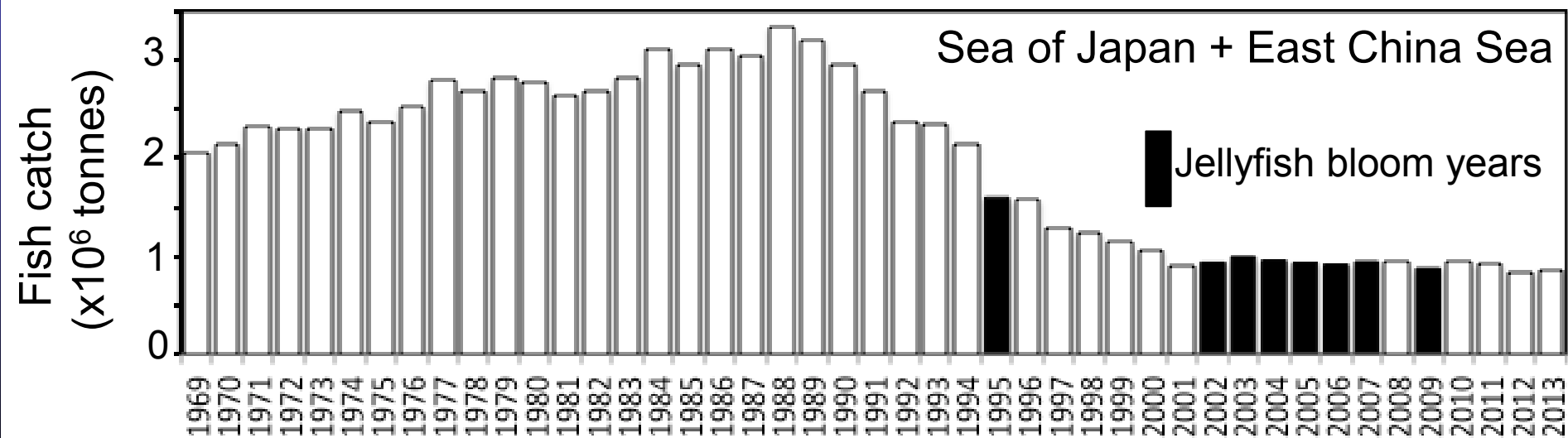
Marine construction  
Plastic garbage  
Overfishing

Jellyfish-dominated ecosystem



Fish-dominated

Jellyfish-dominated

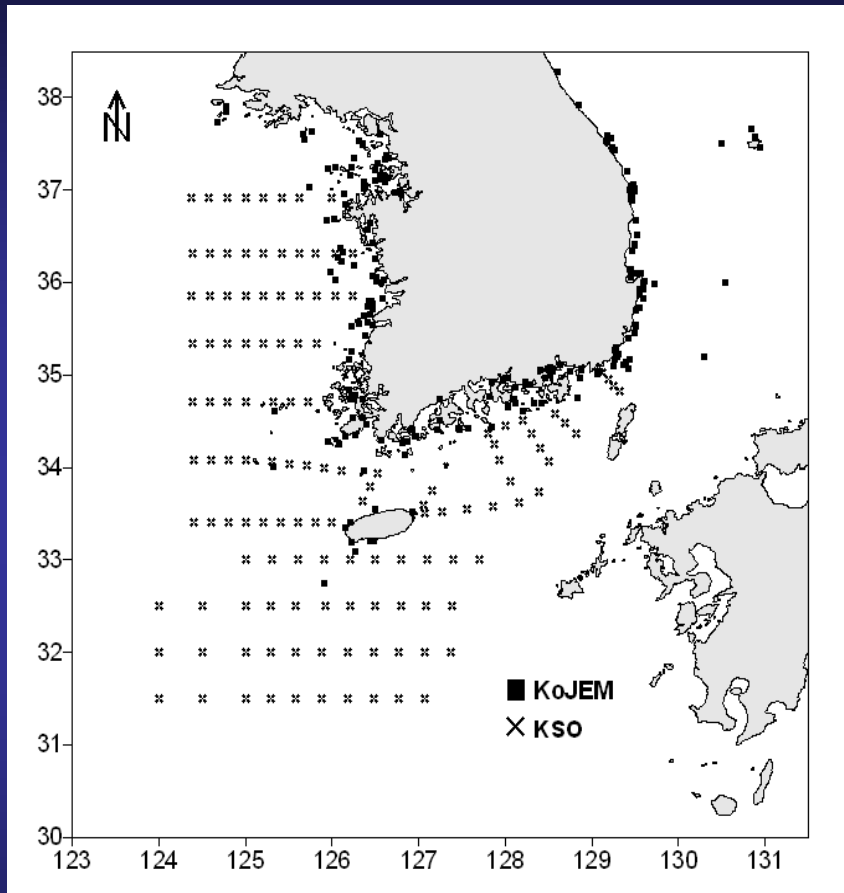


In the face of increasing jellyfish populations and decreasing fish stock size, the fisheries have to develop adaptive and management strategies, such as

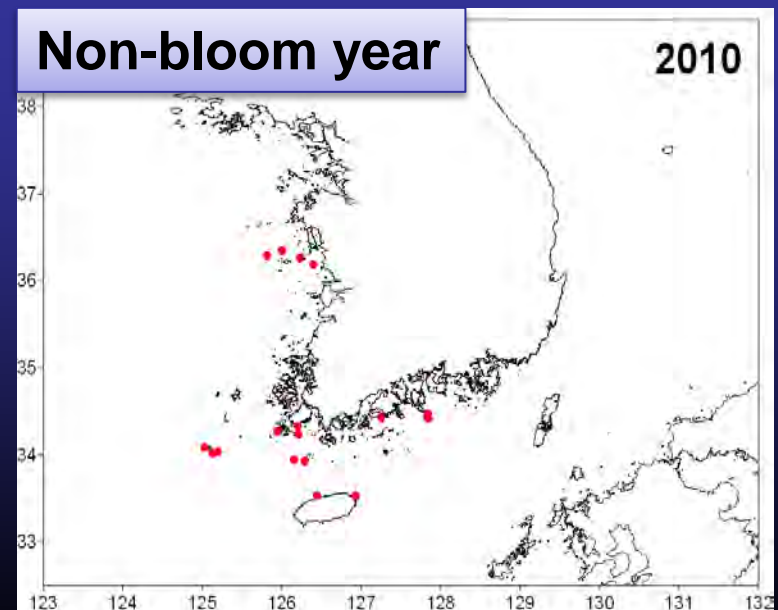
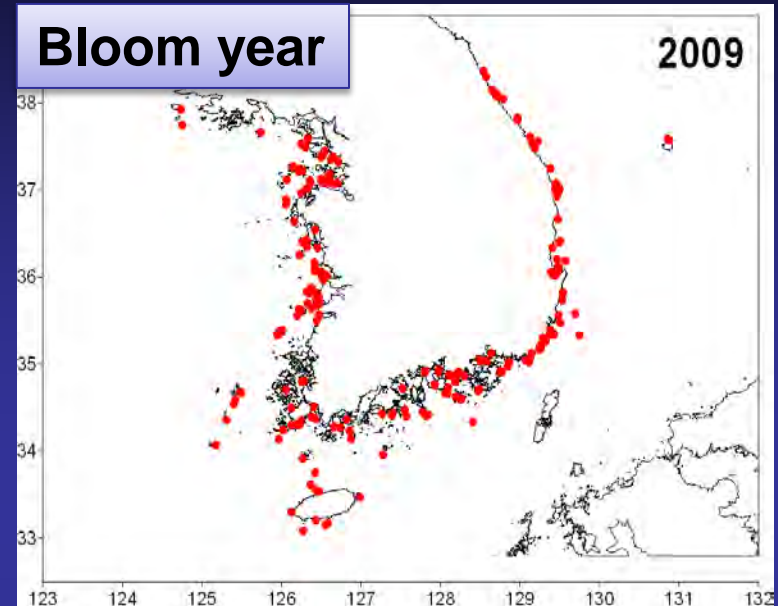
- (1) Identifying causes of the jellyfish blooms,
- (2) Forecasting their outbreaks, and
- (3) Developing countermeasures to alleviate their damage.

How to forecast the *Nemopilema* blooms and take proper countermeasures for them?

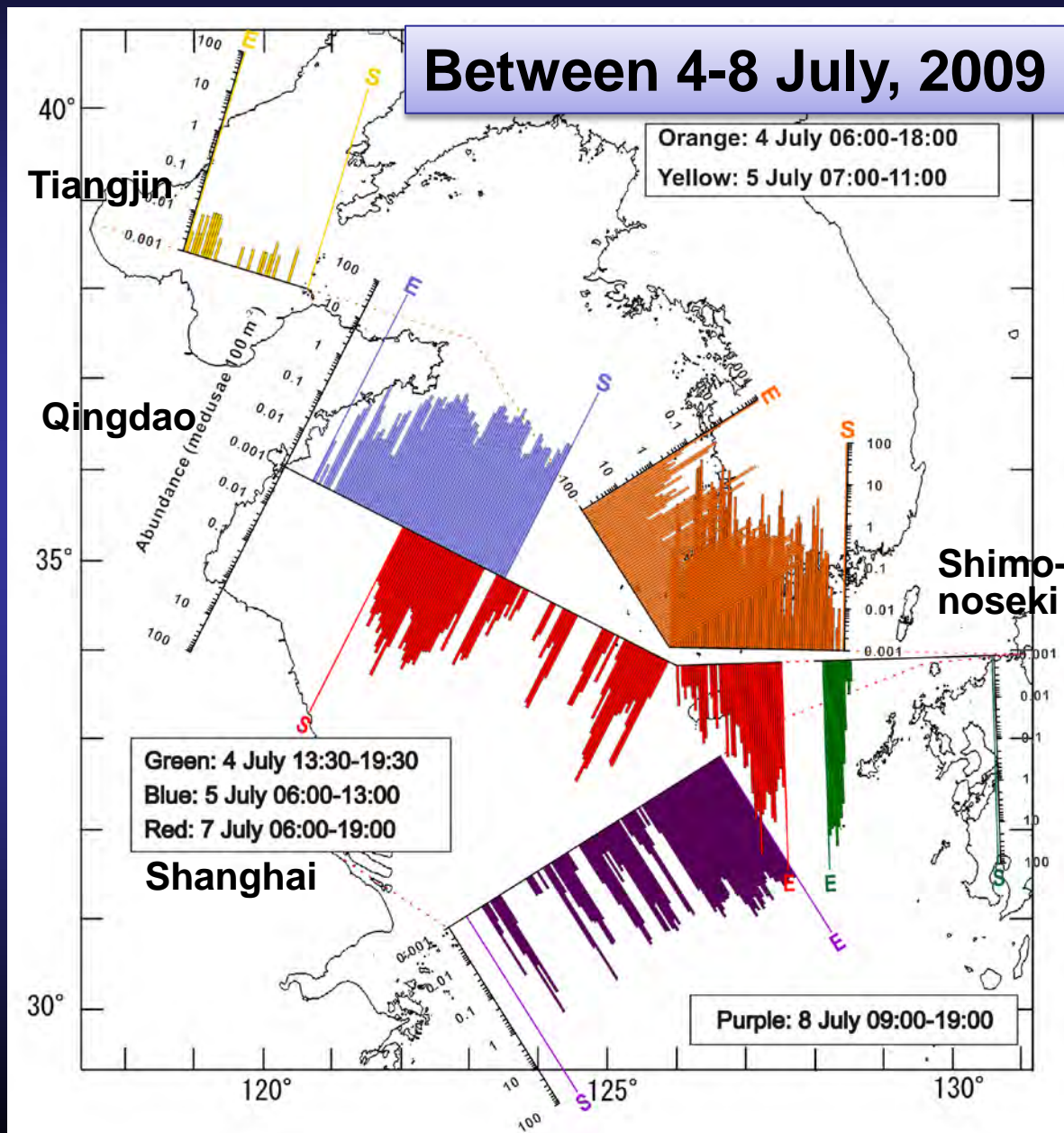
# Forecast of *Nemopilema* bloom intensity by Korean monitoring programs



**KoJEM: weekly report from 294 fishermen from May**  
**KSO: bimonthly survey at 207 stations by NFRDI R/V**



# Forecast of *Nemopilama* bloom intensity by sighting survey using ships of opportunity

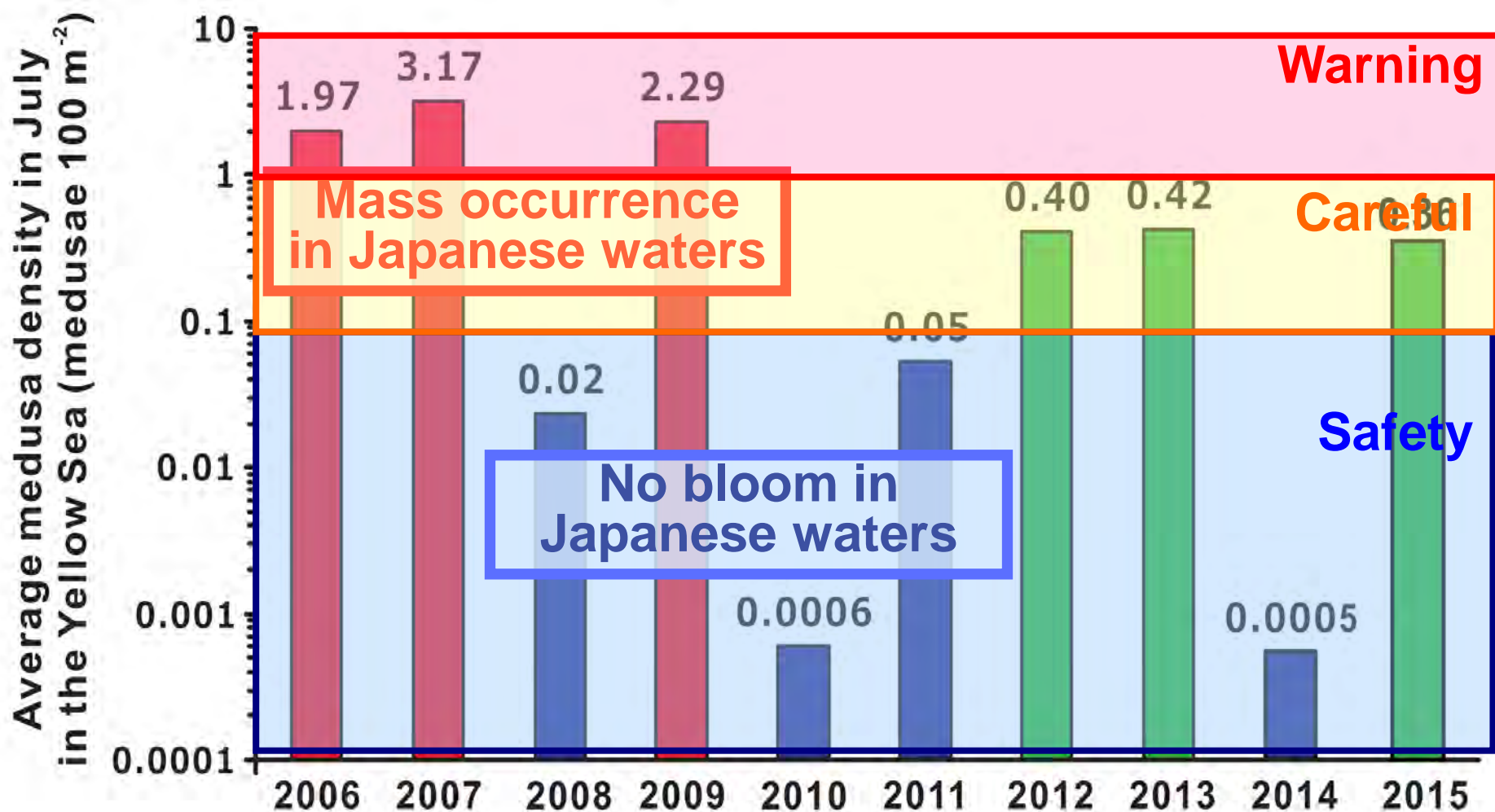


- Early warning from the ferry monitoring
- Forecast of jellyfish arrival time by the simulation model
- Nation-wide information network system



**Fishermen can prepare for jellyfish encounters well in advance**

# Average density of *Nemopilama* in the Yellow Sea in July in relation to bloom intensity in Japanese waters in 2006-2015



# To attain fishery sustainability in the EAMS

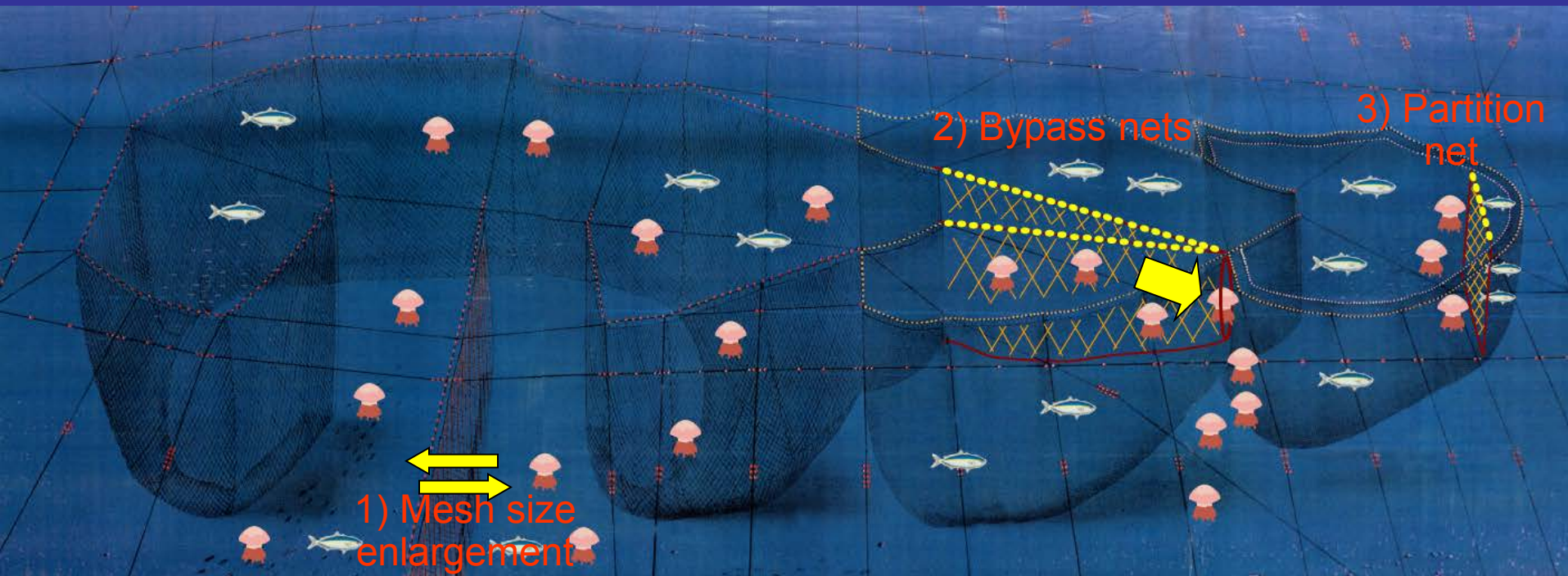


**Strengthen regional understanding  
and cooperation in coastal  
environmental and fisheries  
management**



# Modification of set-net to reduce the damage

- 1) **Enlargement of the mesh size of the leading net** → Medusae pass through the leading net
- 2) **Installment of bypass nets** → Entrapped medusae are removed outside the net
- 3) **Installment of a partition net** → Entrapped medusae are separated from fish and removed outside the net



# Removal of *N. nomurai* by a partition net



By R. Matsuhira