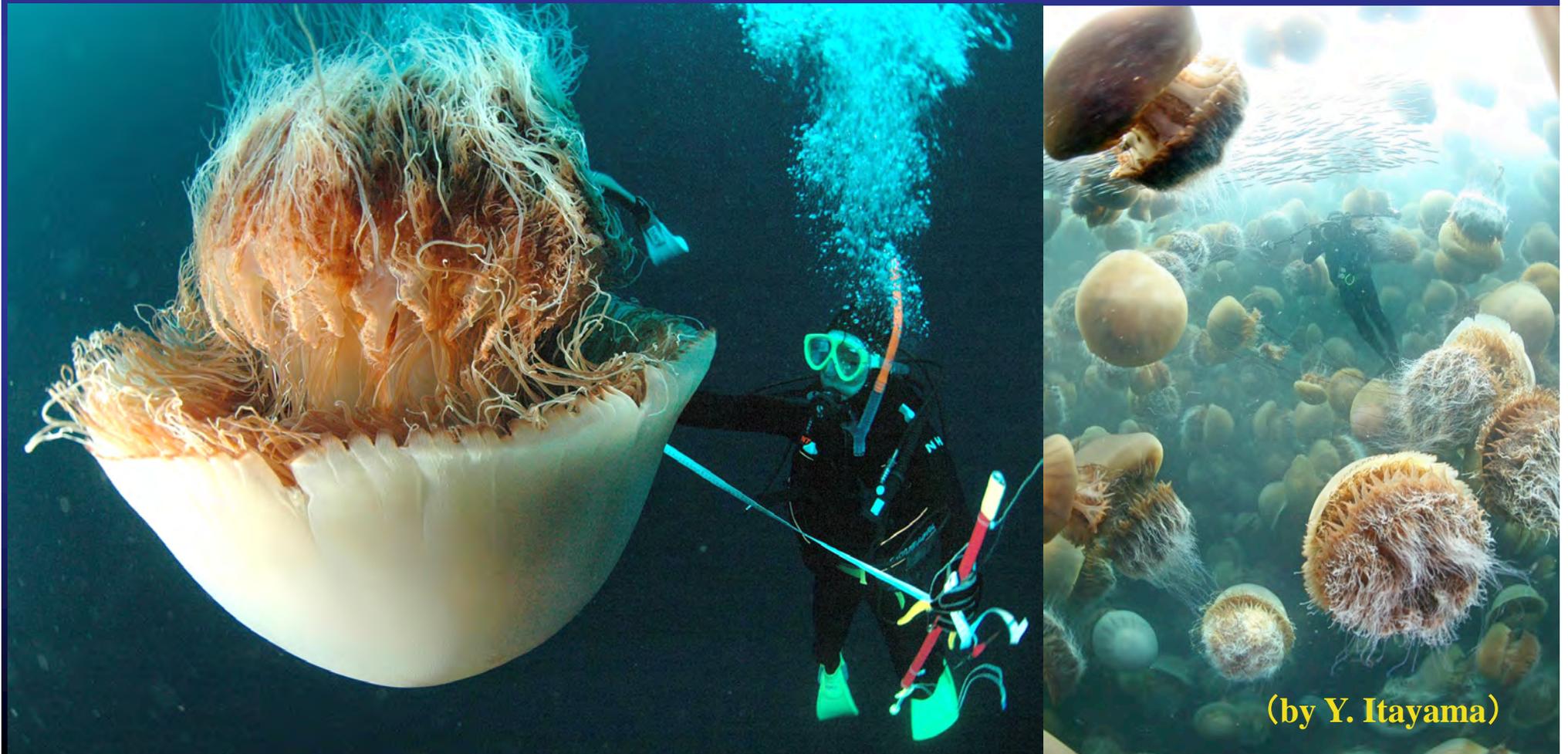
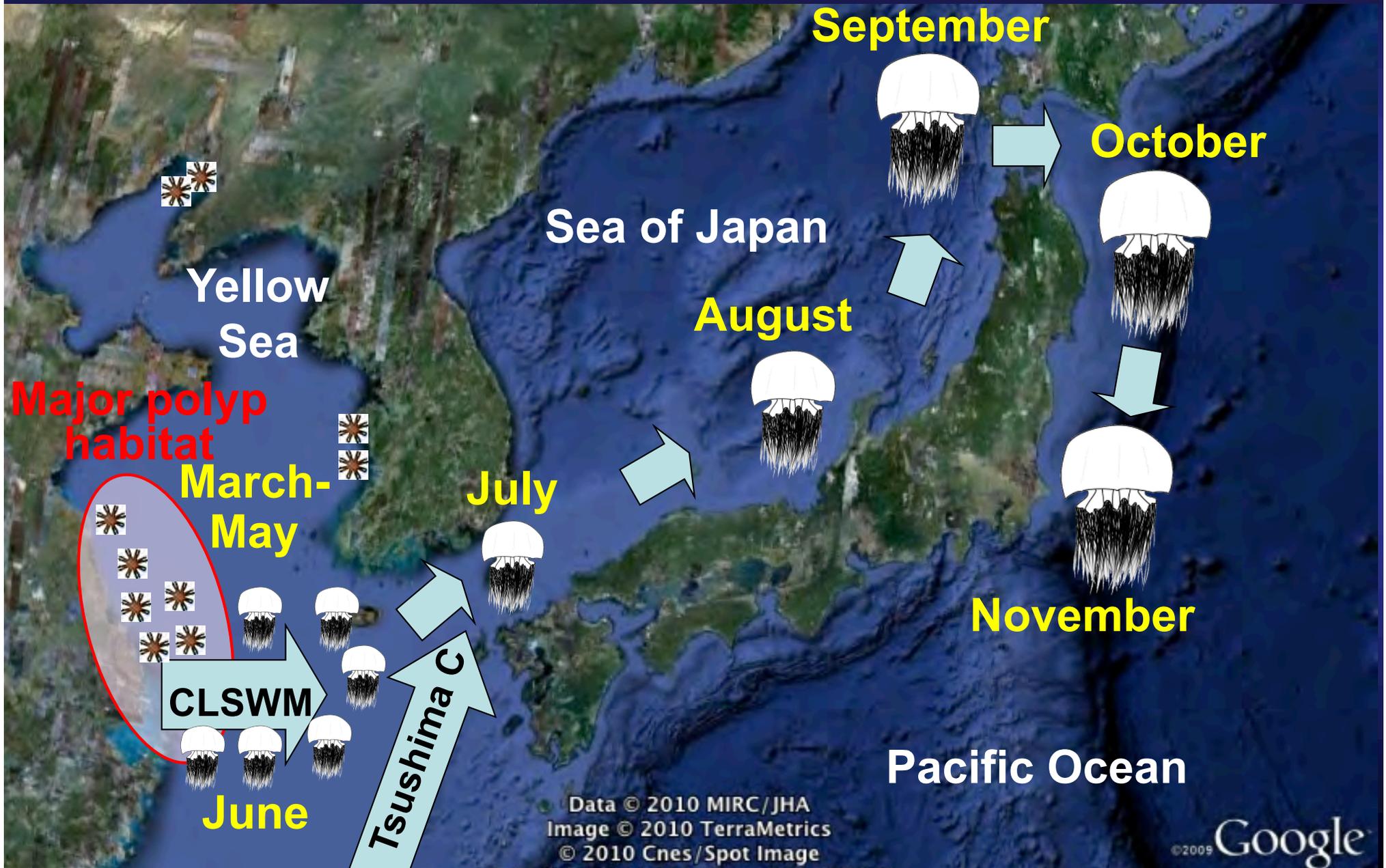


Blooms and non-blooms of the giant jellyfish *Nemopilema nomurai* in the East Asian Marginal Seas: 12-year monitoring using ships of opportunity

Shin-ichi Uye¹, Hideki Ikeda¹, Mariko Takao¹, Hiroko Okawachi¹, Miwa Hayashi¹, Manabu Shimizu², Takashi Setou² (¹ Hiroshima University, ² National Research Institute of Fisheries Science, Japan)



Extensive horizontal transportation of *Nemopilema* to Japanese waters



***Nemopilema* outbreaks cause serious damage in net-fisheries**

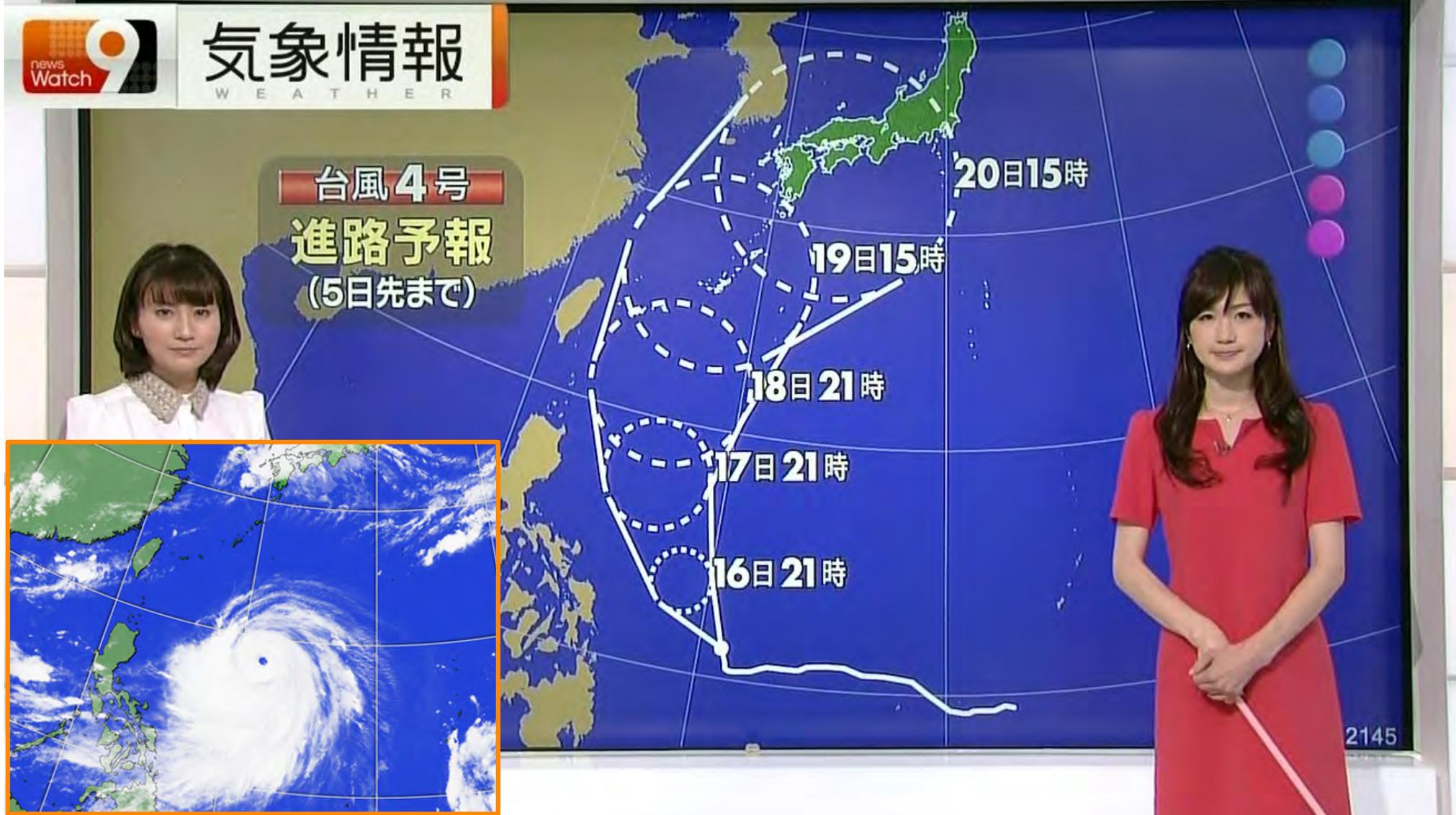


© Asahi Shimbun

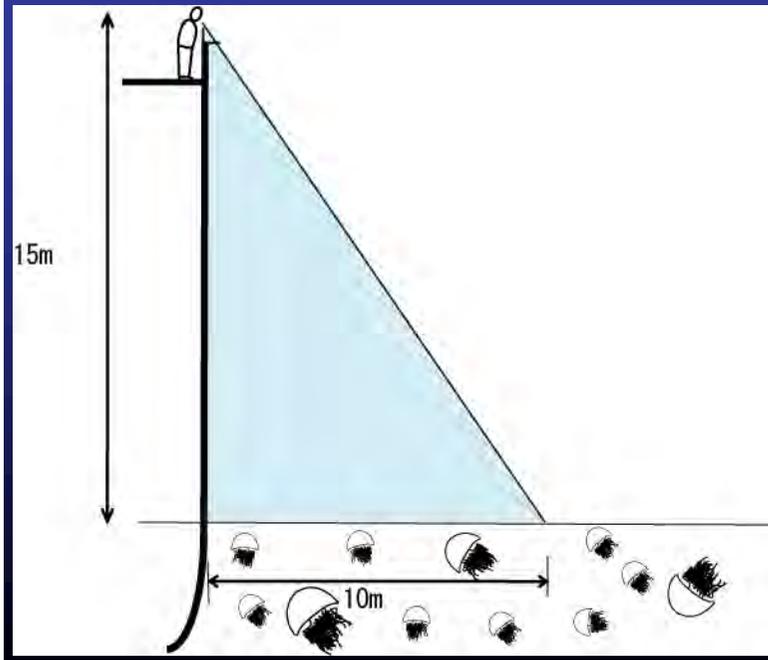
- **Clogging and bursting fishing nets**
- **Decrease of fish catch**
- **Killing and spoiling fish**
- **Stinging fishermen**
- **Increase of time & labor to remove medusae from the nets**
- **Increase of capsizing of trawl boats**

Monetary loss in 2005: ca. 30 billion JPY (270 million USD)

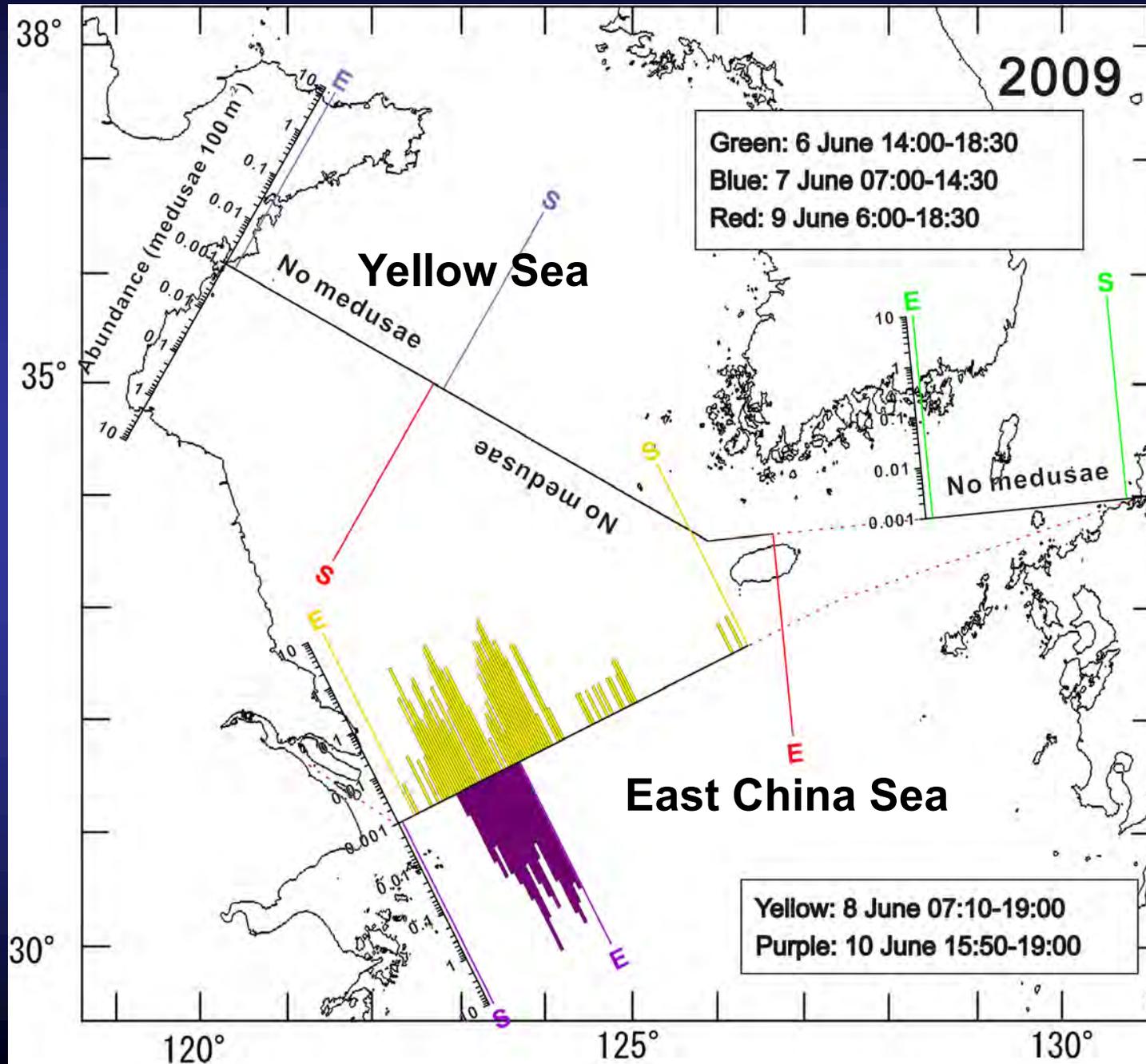
Forecast of *Nemopilema* outbreak like typhoon forecast



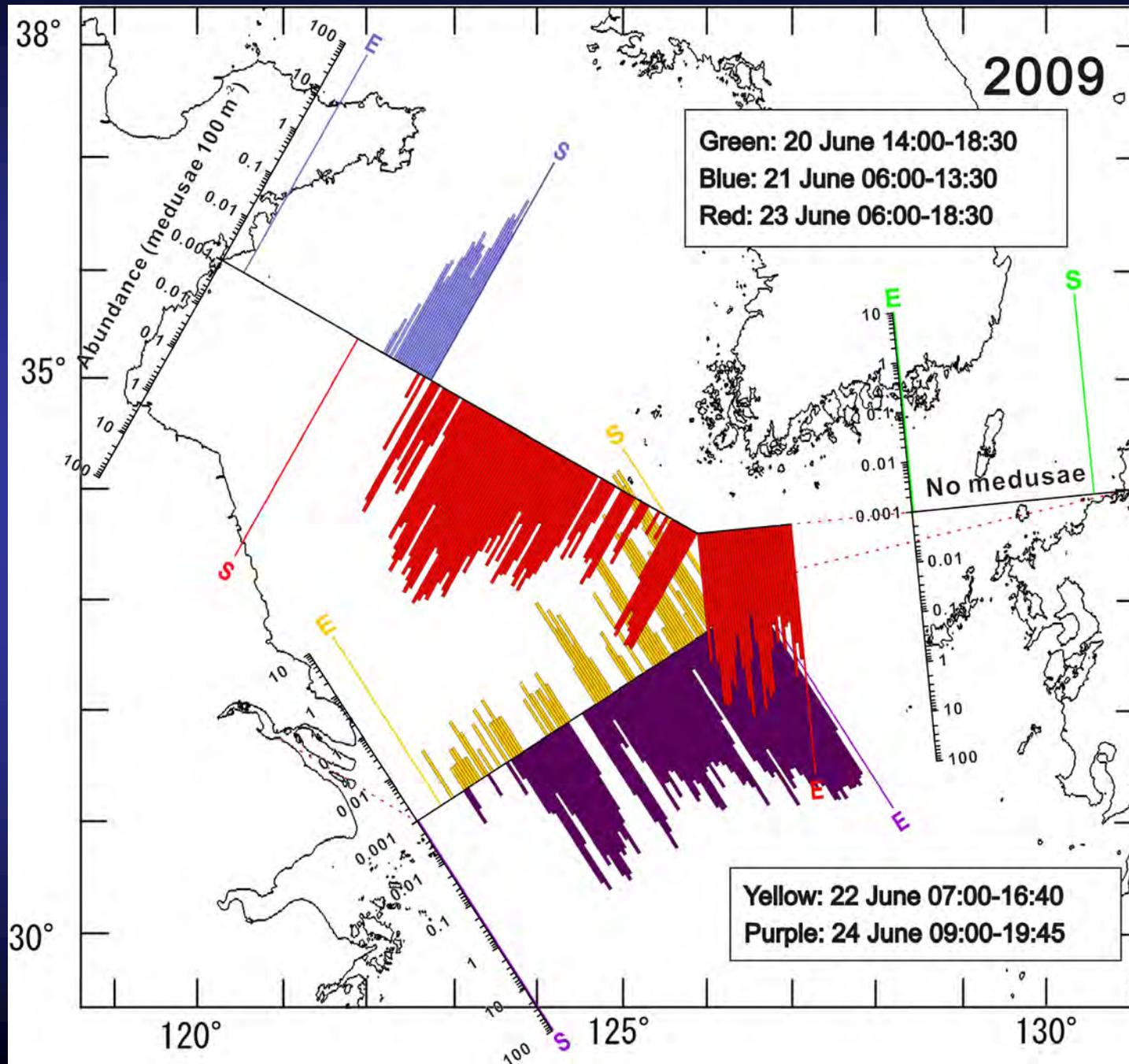
Forecast of *Nemopilema* bloom intensity using ships of opportunity



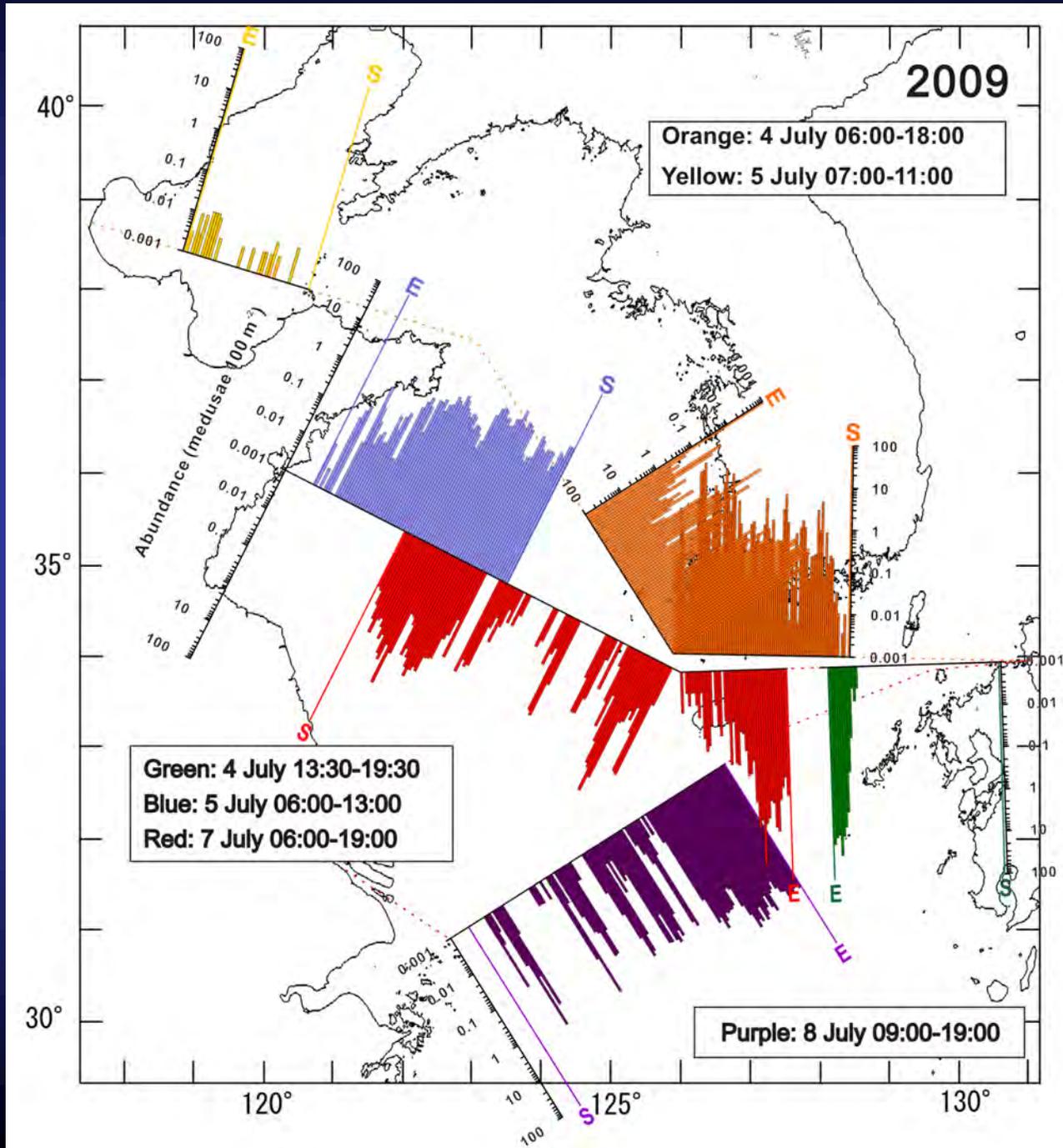
Nemopilema occurrence: 6-10 June, 2009



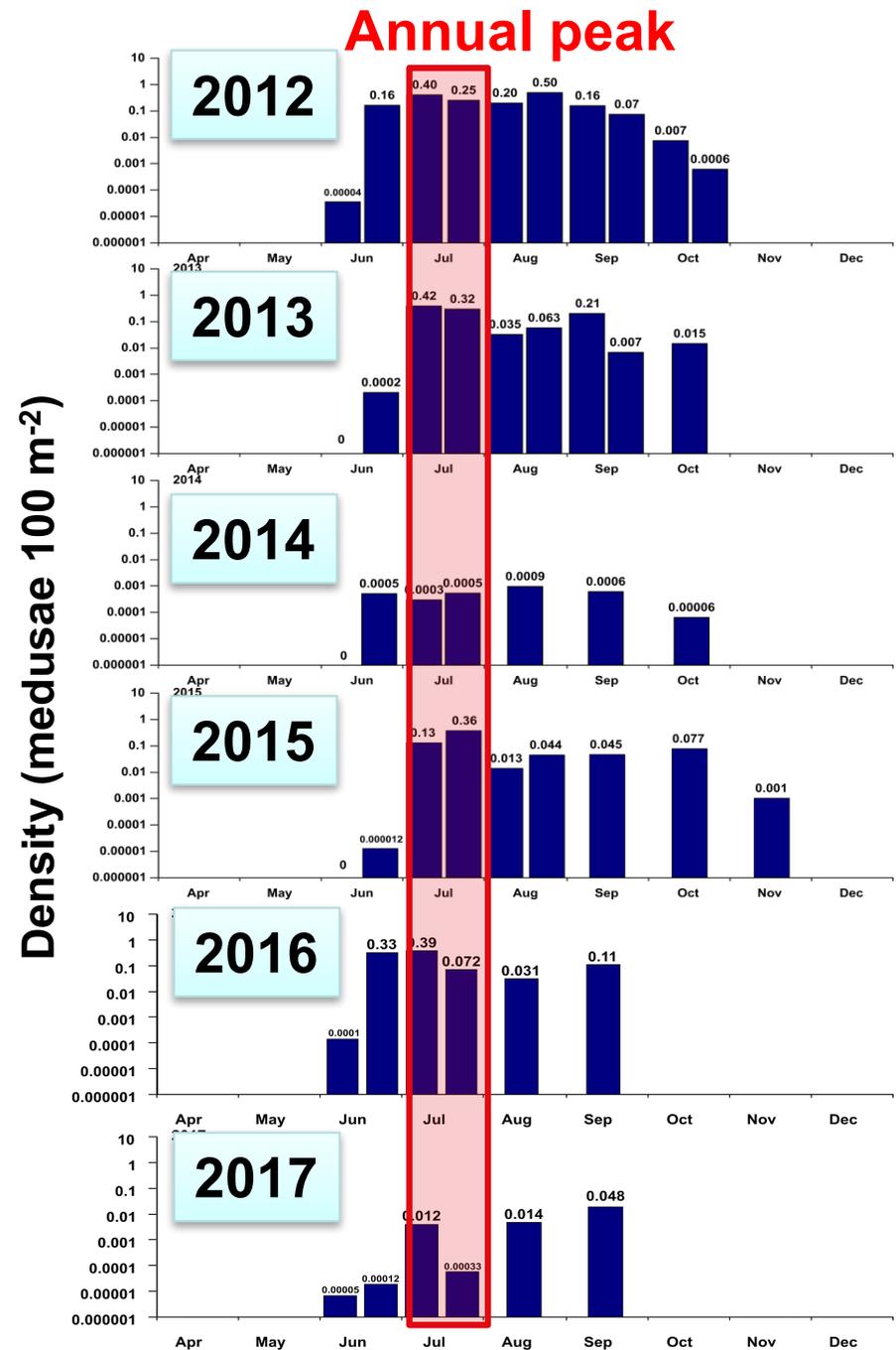
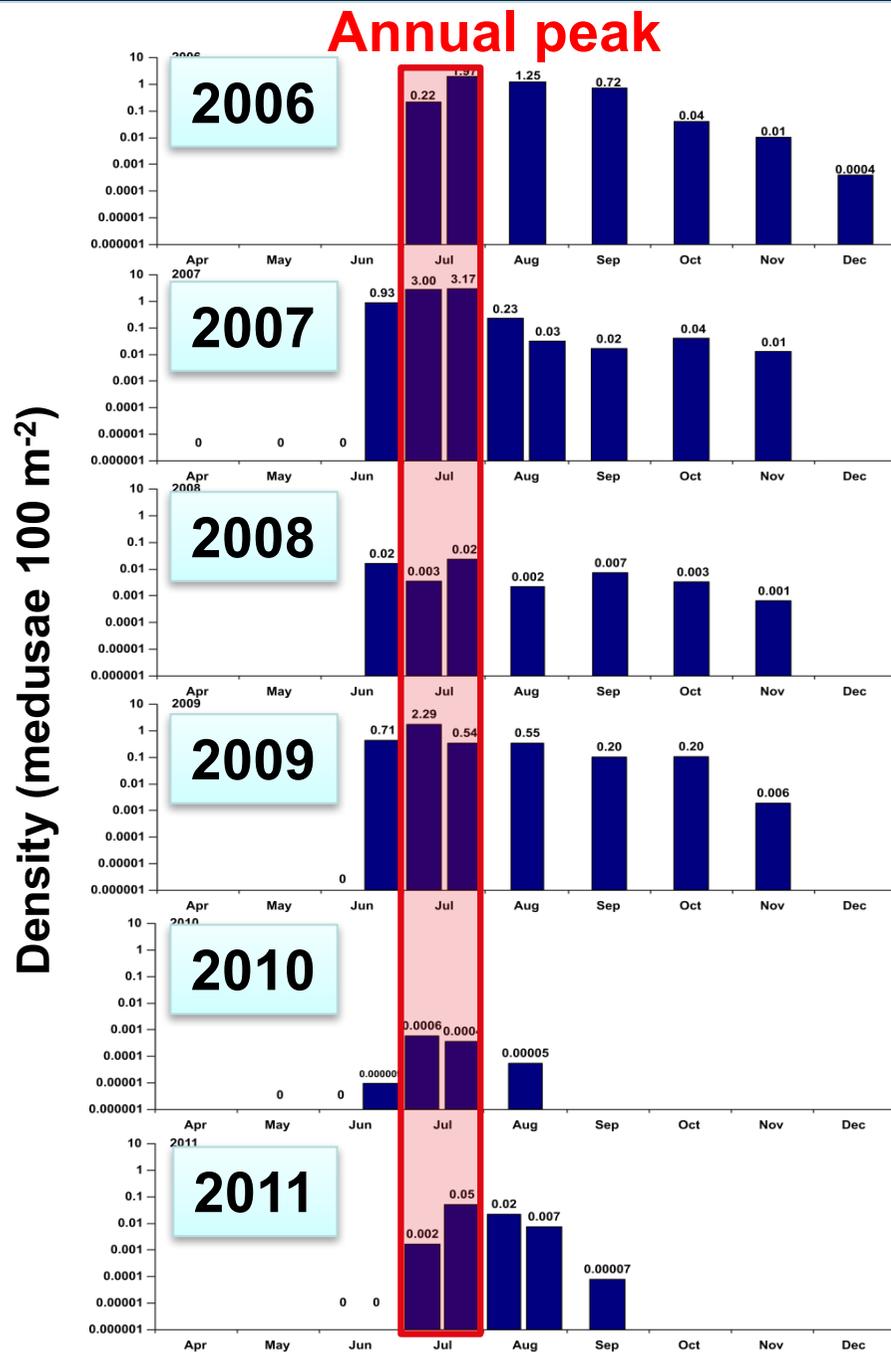
Nemopilema occurrence: 20-24 June, 2009



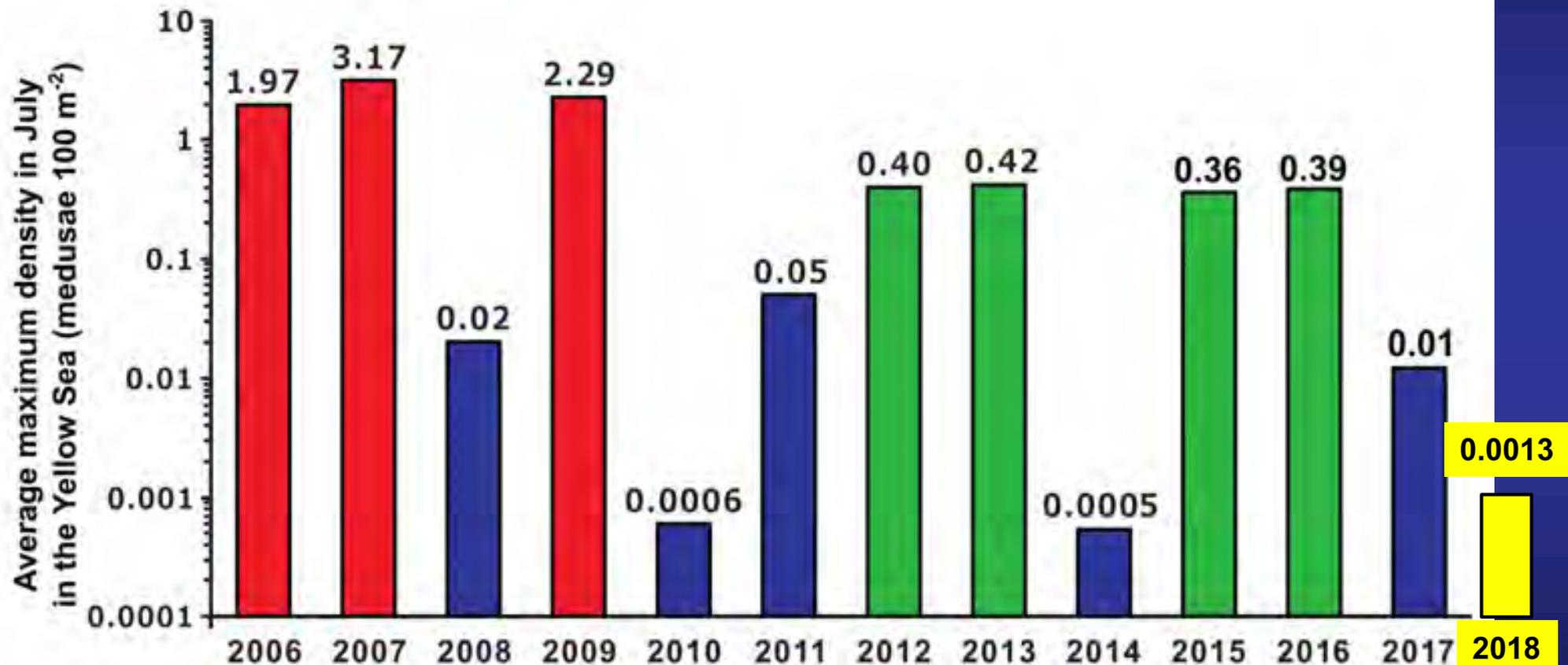
Nemopilema occurrence: 4-8 July, 2009



Seasonal change in *Nemopilema* density in the Yellow Sea

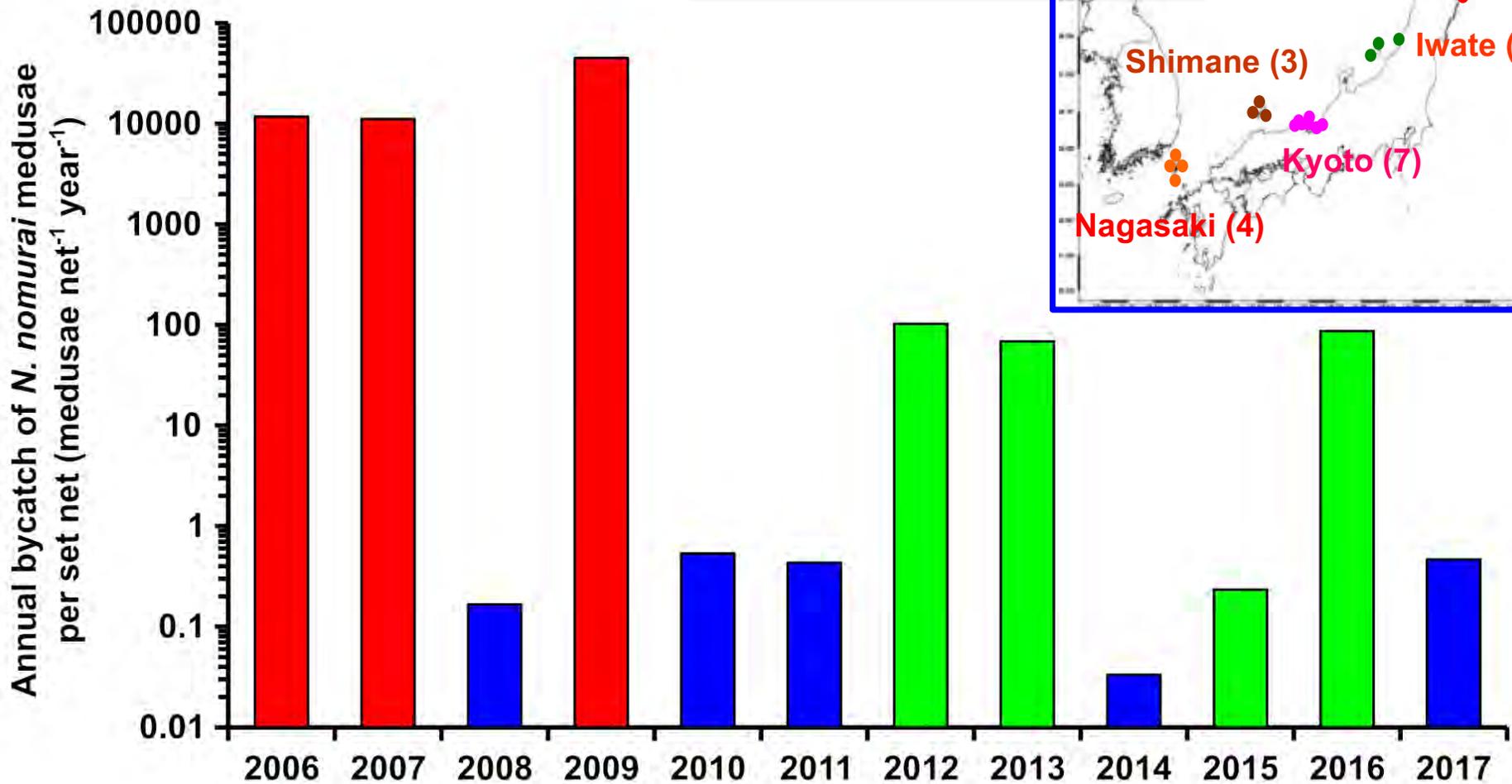
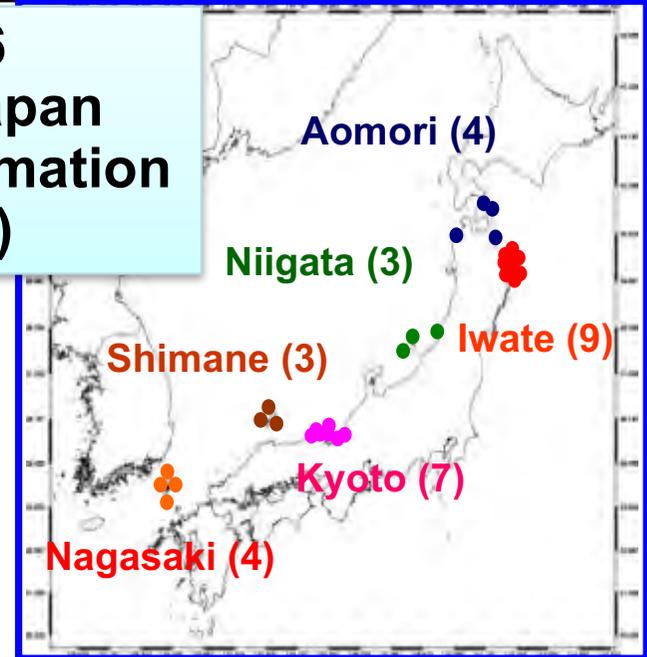


Average density of *Nemopilema* in the Yellow Sea in July from 2006 to 2017

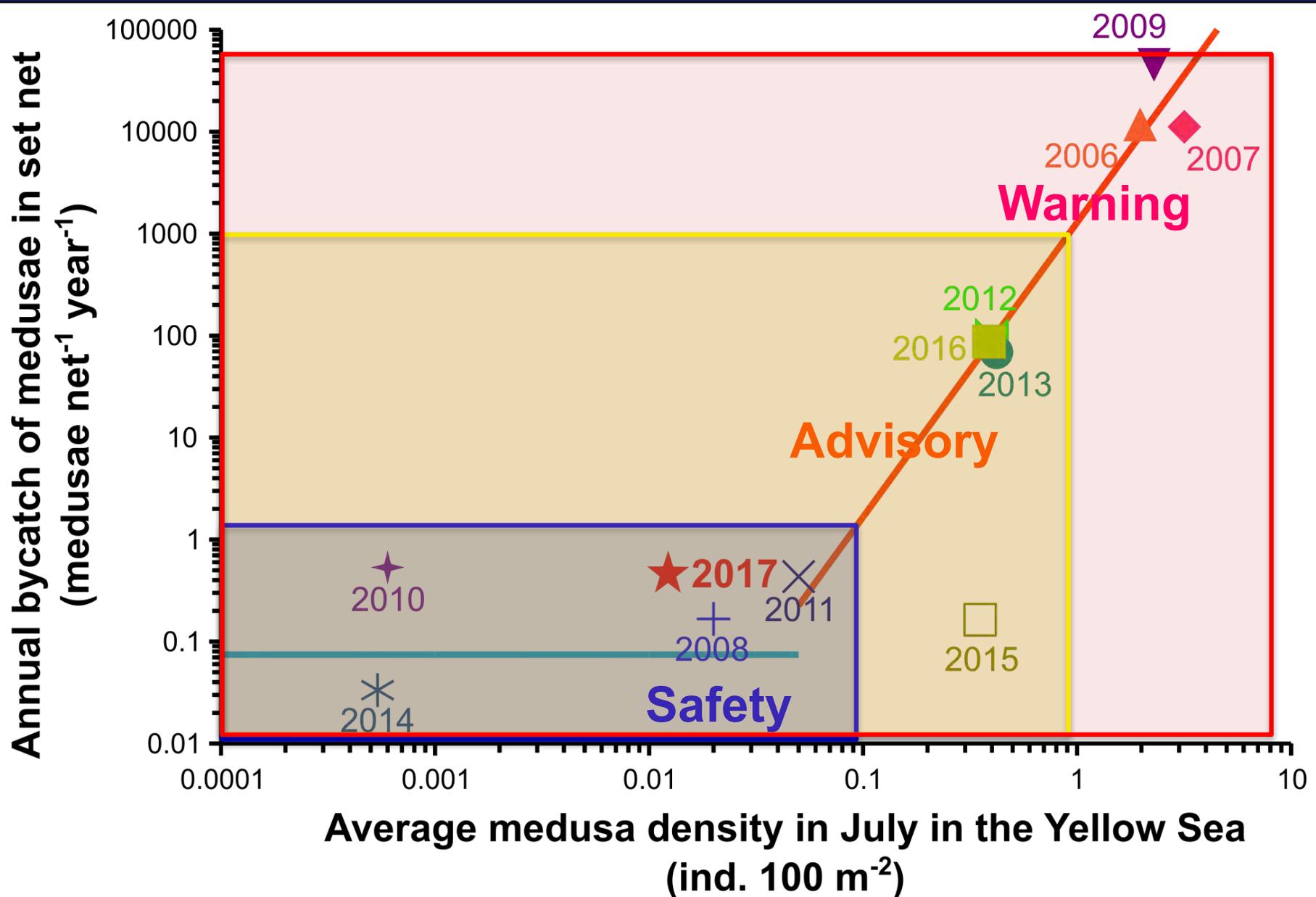


Average annual by-catch of *Nemopilema* in set-nets along Japan

30 set-nets in 6 prefectures (Japan Fisheries Information Service Center)

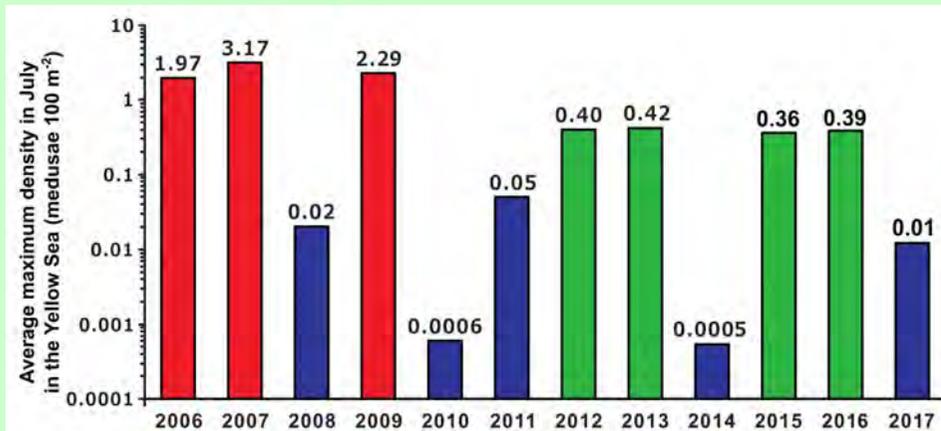


A relationship between the ferry survey data and the bloom intensity in Japanese waters



Which physical variables can explain *Nemopilema* density in the Yellow Sea in July?: Correlation analysis

Objective variables



Explanatory variables:

SST,
U-wind (west-wind),
V-wind (south-wind),
Precipitation,
Shortwave radiation
(Japan Meteorol. Agency)

Correlation maps between SST and *Nemopilema* density

Jan.

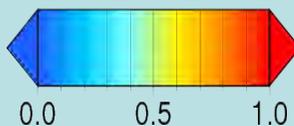
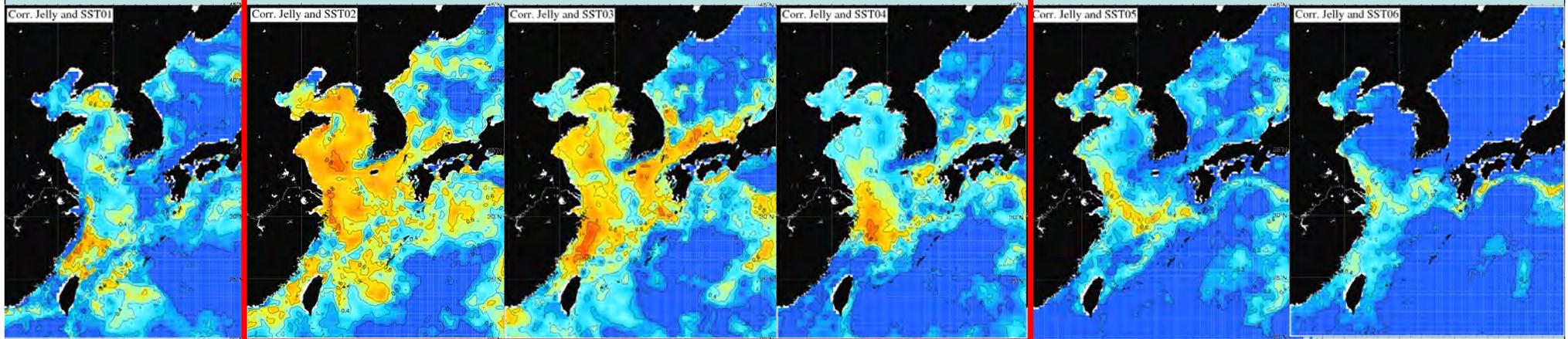
Feb.

Mar.

Apr.

May

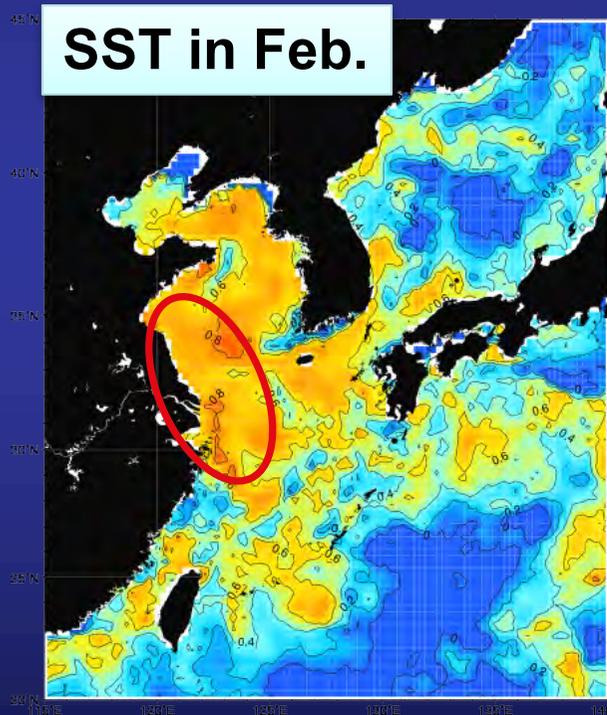
June



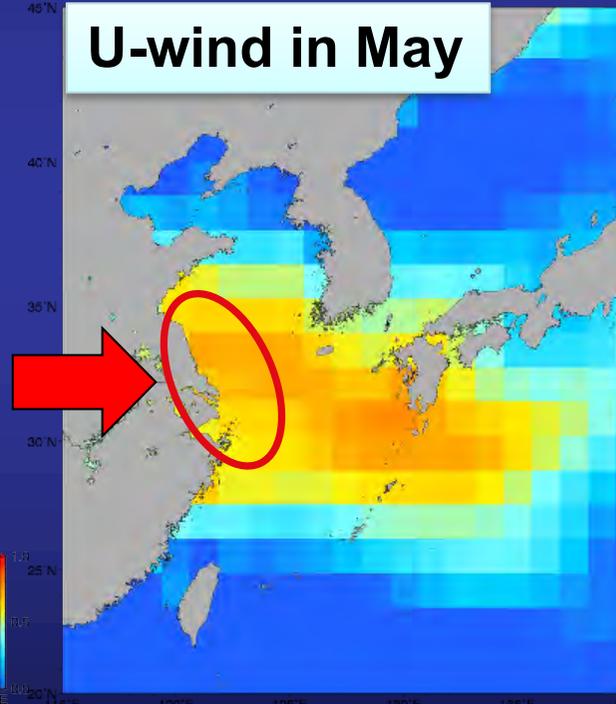
Higher SST in early spring → Higher density in July

Multiple regression model

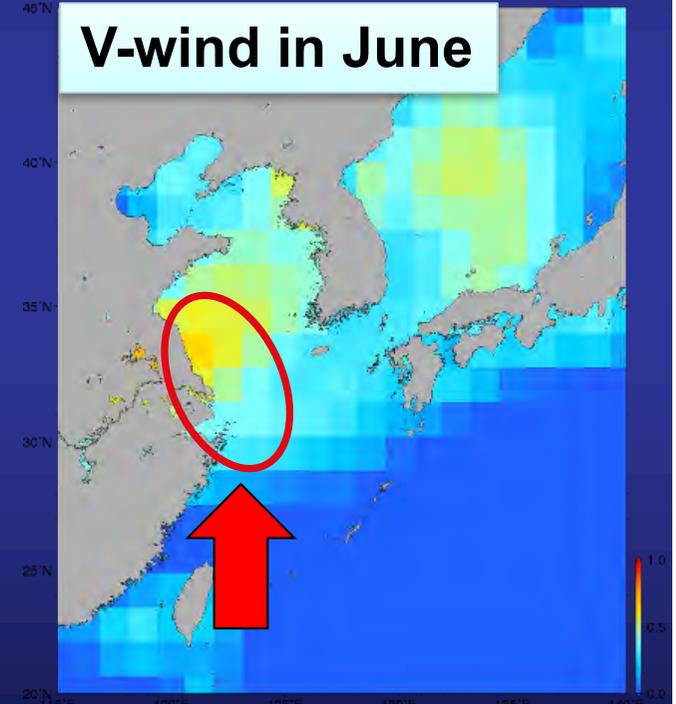
$$(\text{Nemopilema density in July}) = 0.56 \cdot (\text{SST in Feb.}) + 0.37 \cdot (\text{U-wind in May}) + 0.20 \cdot (\text{V-wind in June}) - 2.59 \quad (R^2=0.81)$$



Higher strobilation,
Higher survival of
ephyrae



Offshore transport
of young medusae
from inshore area



Offshore transport
of young medusae

***Nemopilema* bloom forecast: transmitted nation-widely from scientists to fishermen**

Monitoring of

- (1) SST in February**
- (2) U-wind in May**
- (3) V-wind in June**
- (4) Jellyfish density by sighting in May-July**



Forecast of bloom intensity (e.g. safety, advisory, warning) by July



Nation-wide transmission of information through Fisheries Agency network



Fishermen can prepare well in advance (i.e. 1-3 months prior to jellyfish arrival) for countermeasures



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

