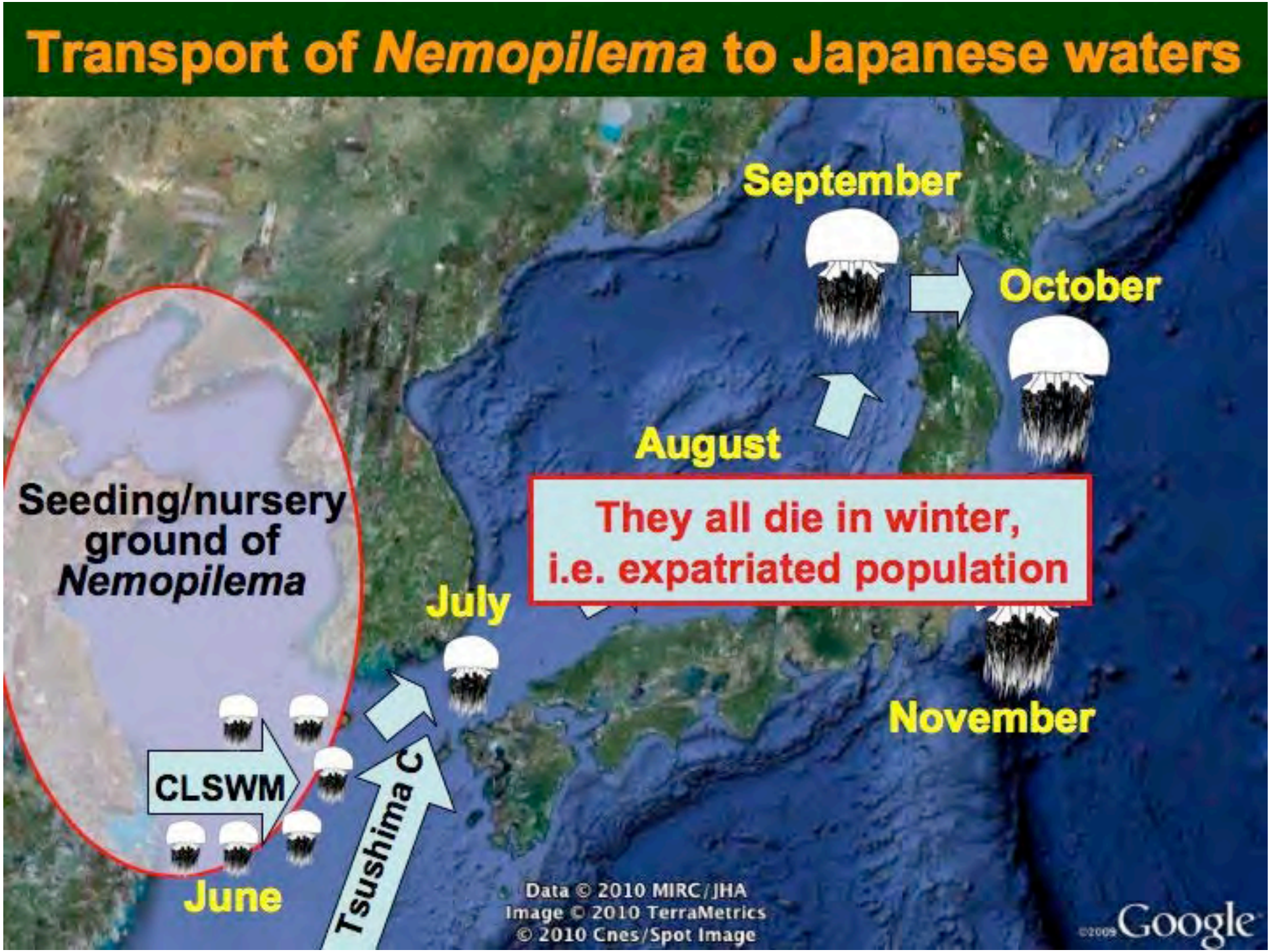
5th International Zooplankton Production Symposium

The giant jellyfish (*Nemopilema nomurai*) bloom in East Asian seas: causes, consequences and countermeasures

Shin-ichi Uye (Hiroshima University, Japan)


Transport of *Nemopilema* to Japanese waters
September
October
August
Seeding/nursery ground of *Nemopilema*
They all die in winter, i.e. expatriated population
July
November
CLSWM
Tsushima C
June
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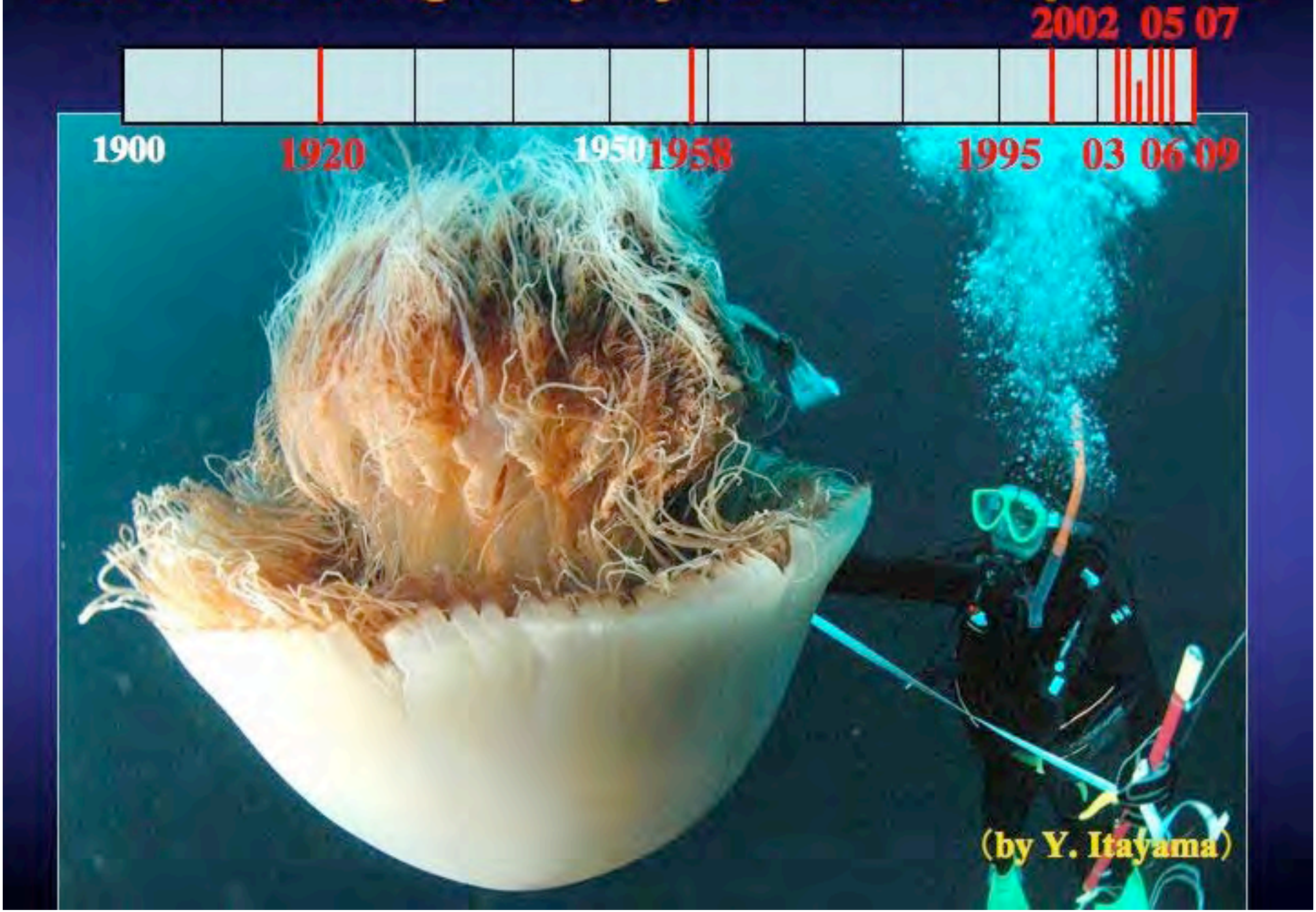
Bloom of the giant jellyfish in the Japan Sea



Consequences of *Nemopilema* plague

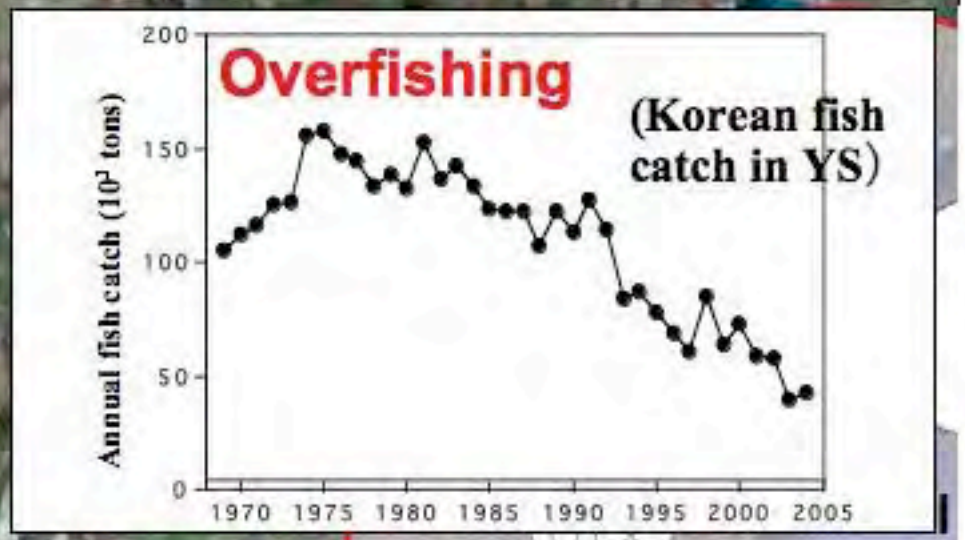
Nuisance to fisheries, in particular to net fisheries

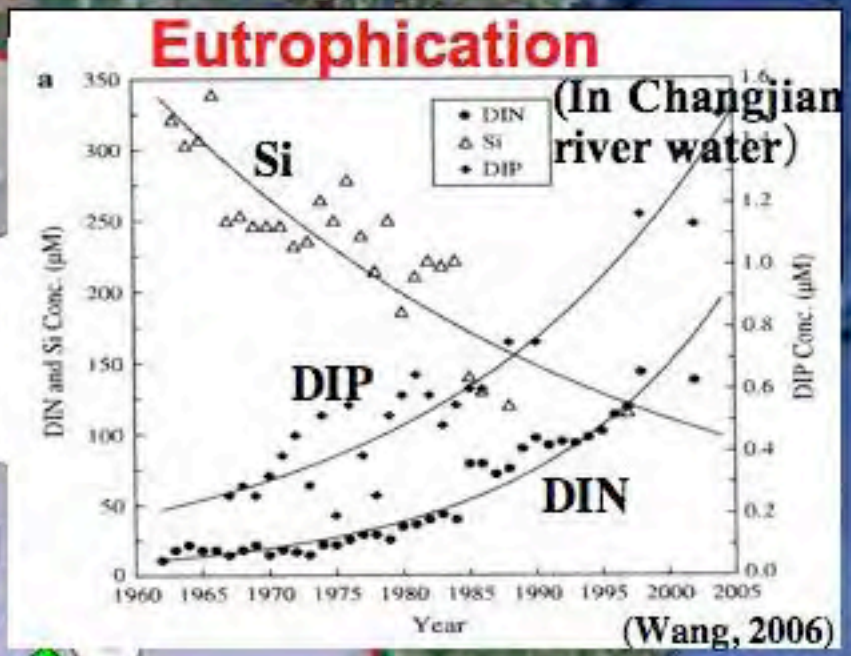
- Clogging and bursting fishing nets
- Decrease of fish catch
- Killing and spoiling fish
- Stinging fishermen
- Increase of time and labor to remove medusae from the nets
- Increase of capsizing of trawl boats

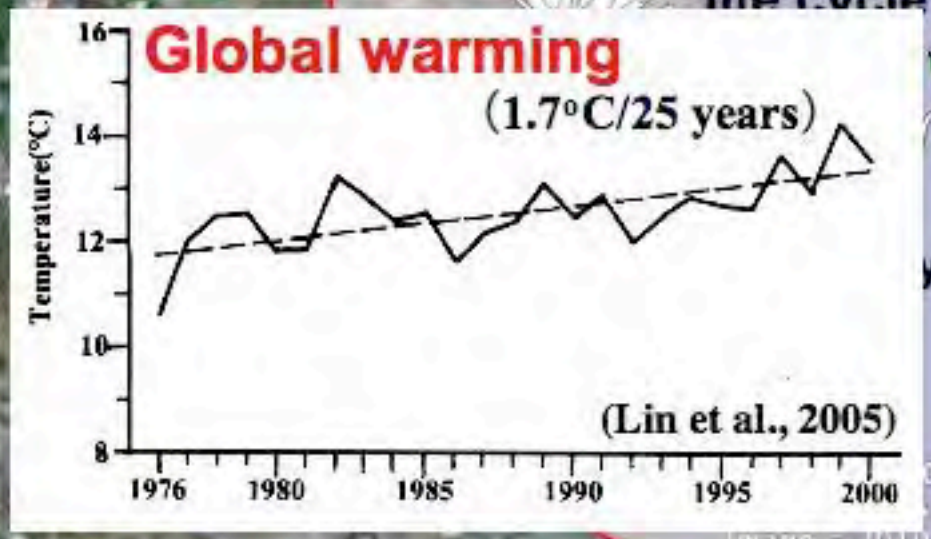
In 2005, >100,000 complains and reports on damage in fishery

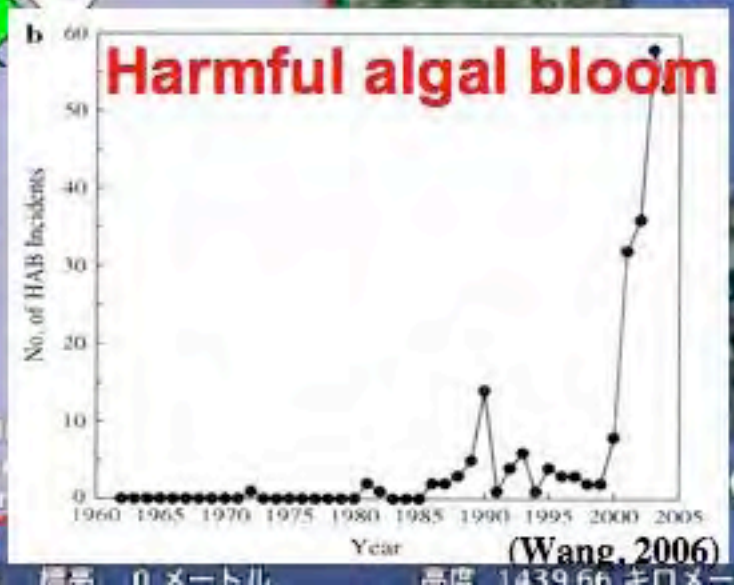
Estimated monetary loss:
ca. 30 billion Japanese yen
(ca. 300 million US$)

Causes: Environmental and ecosystem changes in Chinese coastal waters









Jellyfish spiral

Human forcing

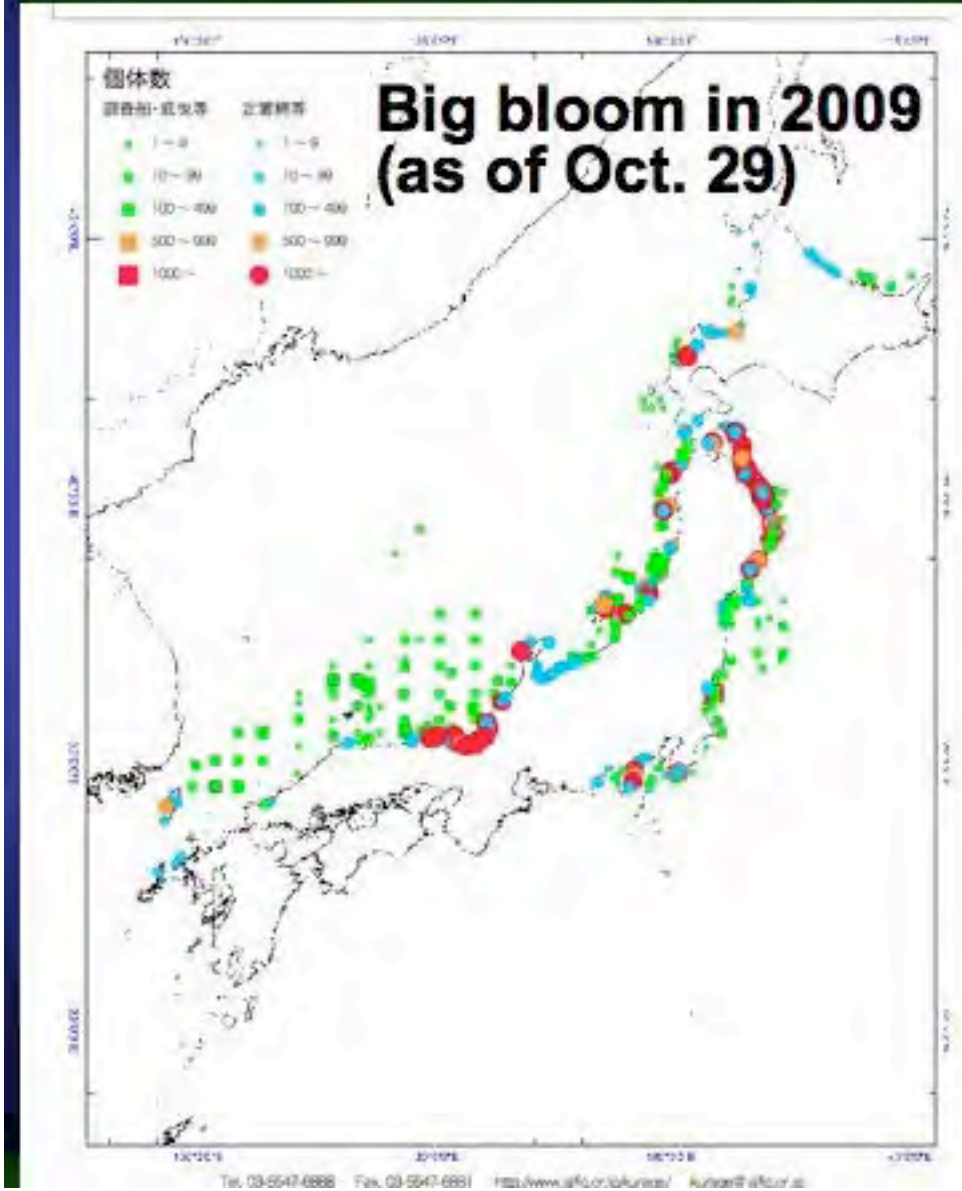
1) global warming
2) eutrophication
3) overfishing
4) marine construction
5) others

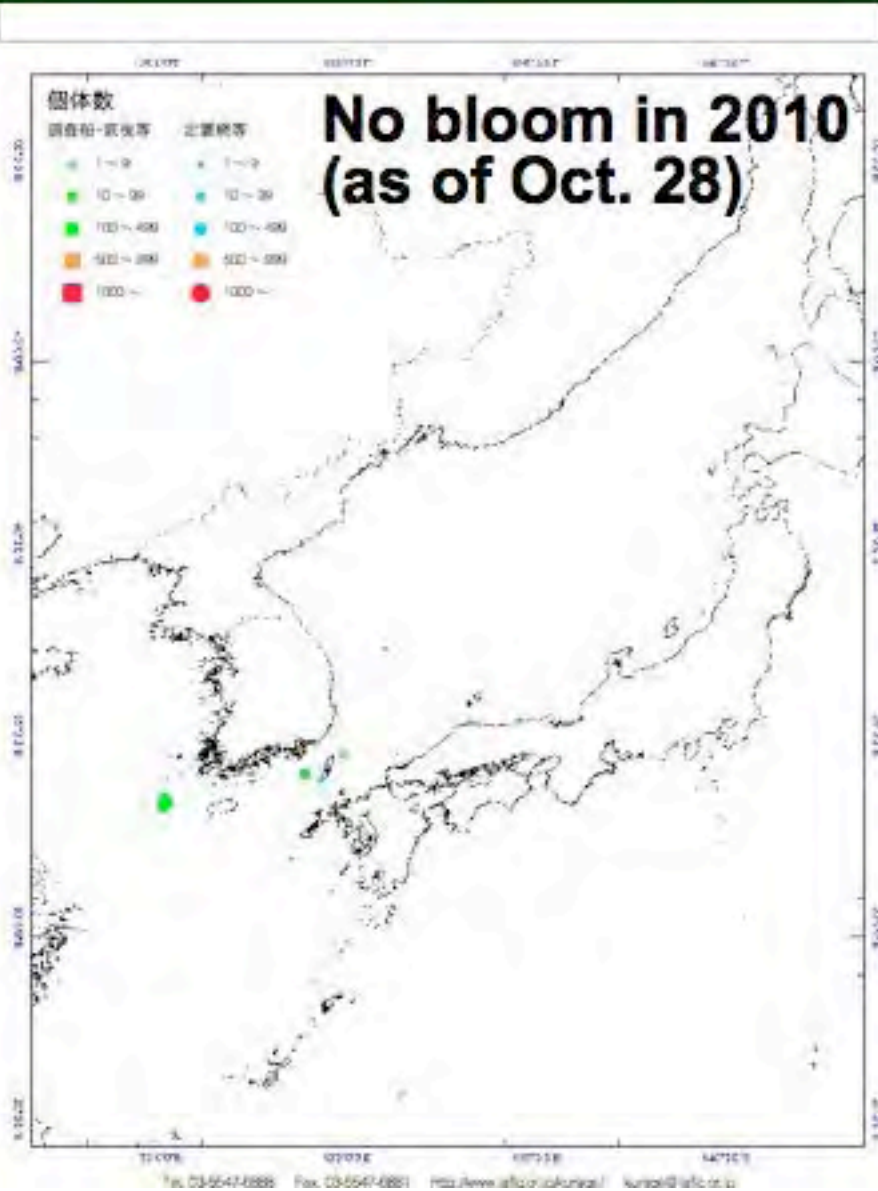
Jellyfish dominated ecosystem

Fish dominated ecosystem

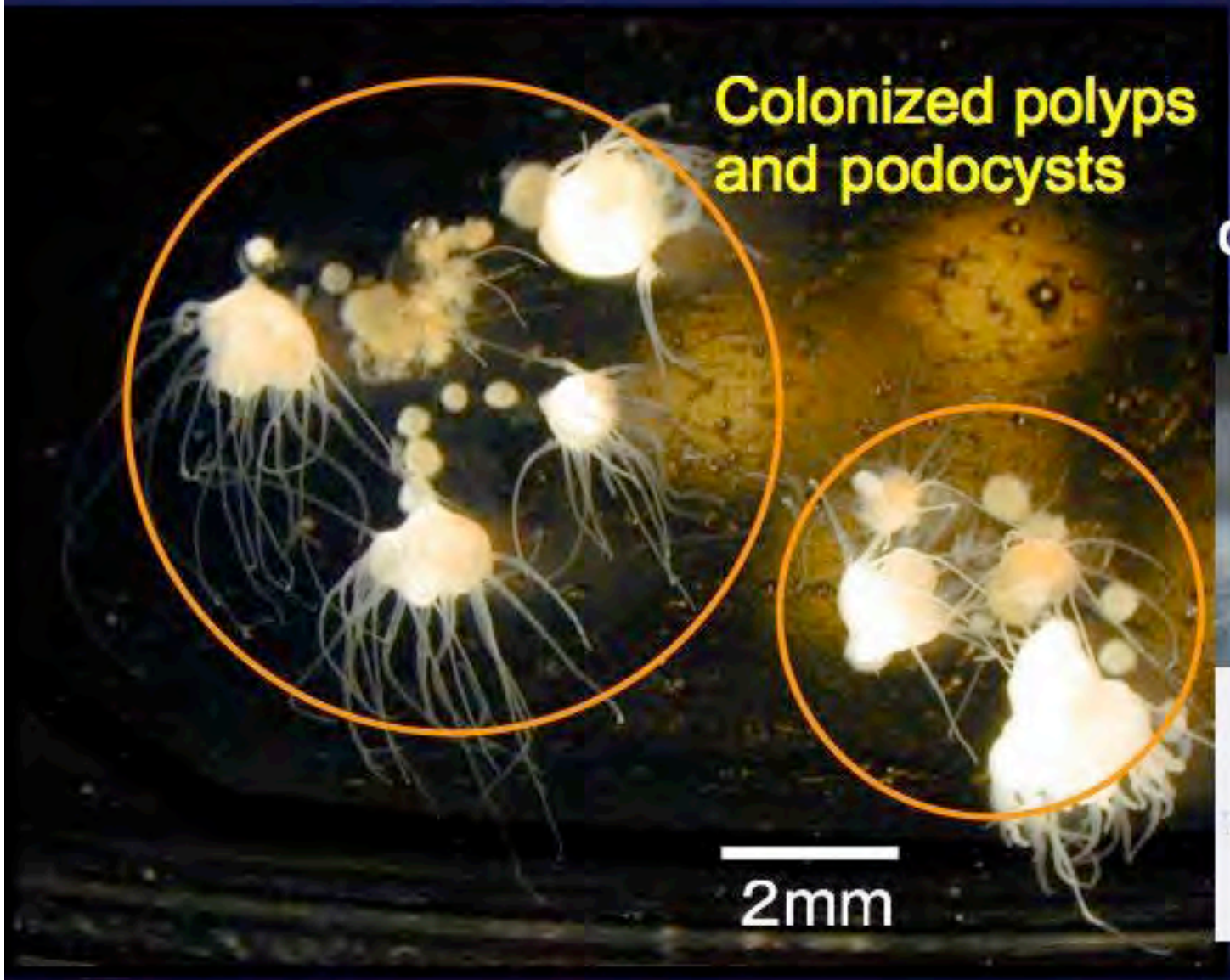
The more jellyfish prevail, the more fish would be eradicated

Environmental factors cannot explain a year-to-year difference in the occurrence of *Nemopilema*

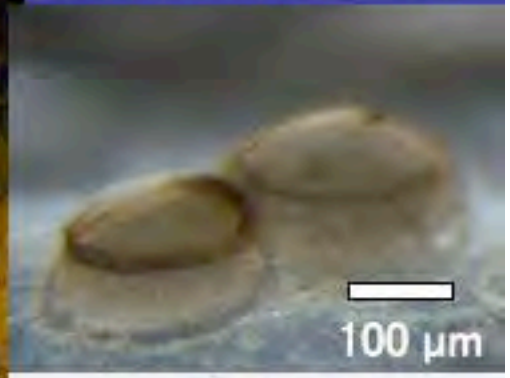


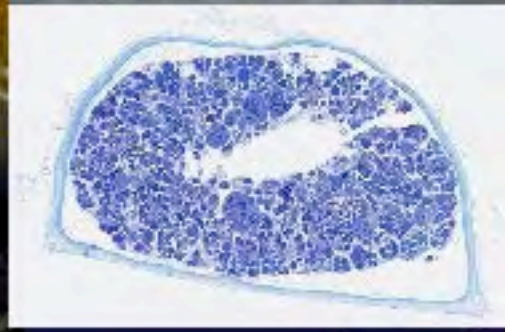


Biological factors: resting/excystment of podocysts



Podocysts can rest for at least 5 years



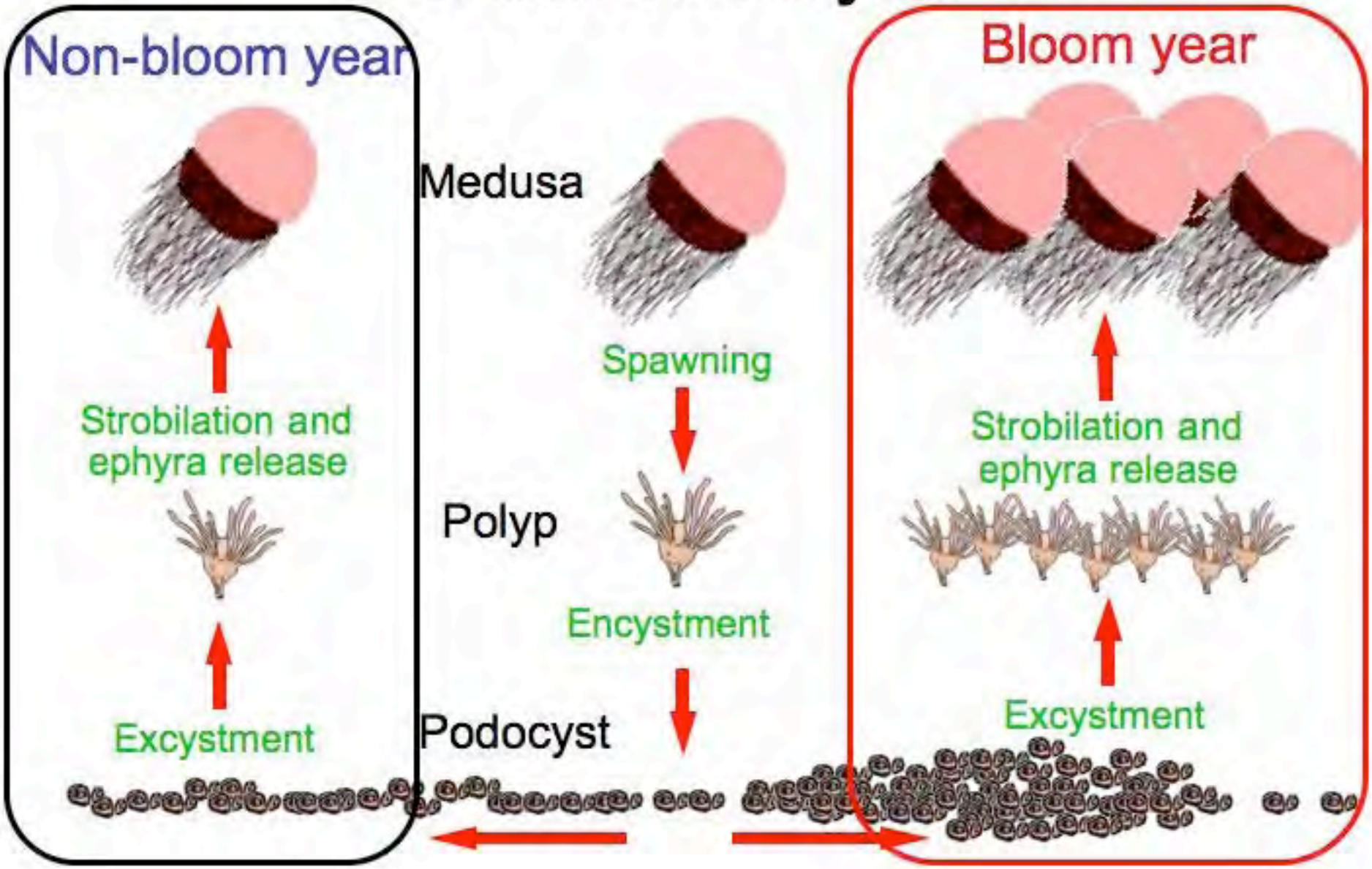


100 µm

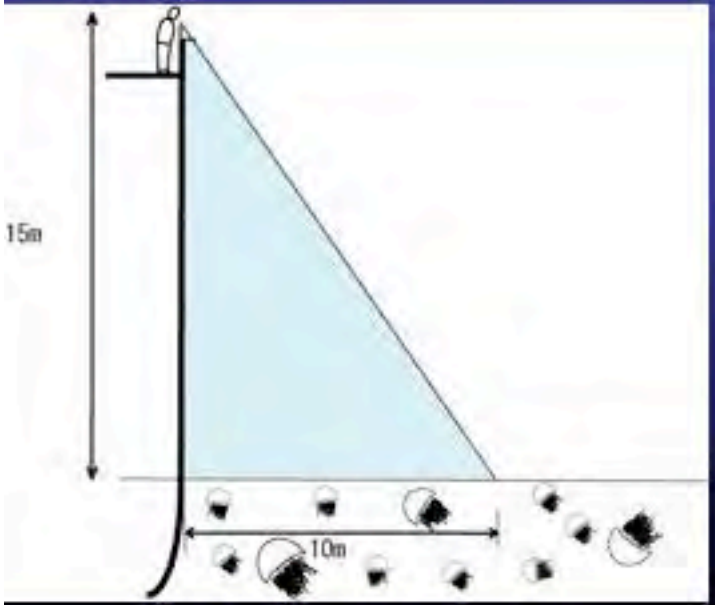
Induction of podocyst excystment

Temperature (°C)	Salinity	Excystment (%) for 80 days	
31	33	39	Extremely high temp.
27	33	55	
23	33	4	
19 (control)	33	1	
15-5	33	0	
19	24	7	
19	16	20	Extremely low sal.
19	8	19	
19 (in mud)	33	44	Deoxygenation

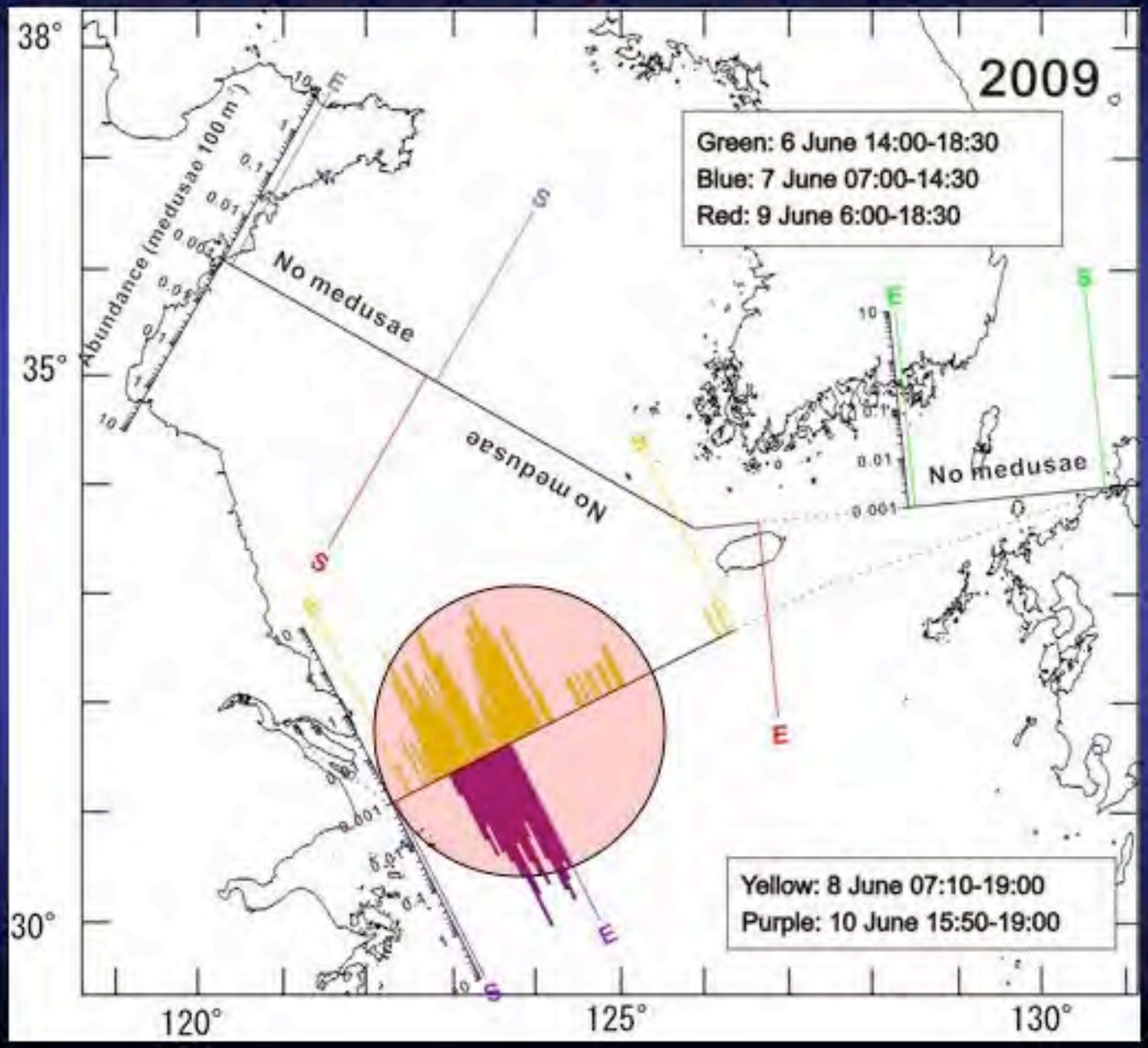
Hypothetic scheme to cause a bloom year or non-bloom year



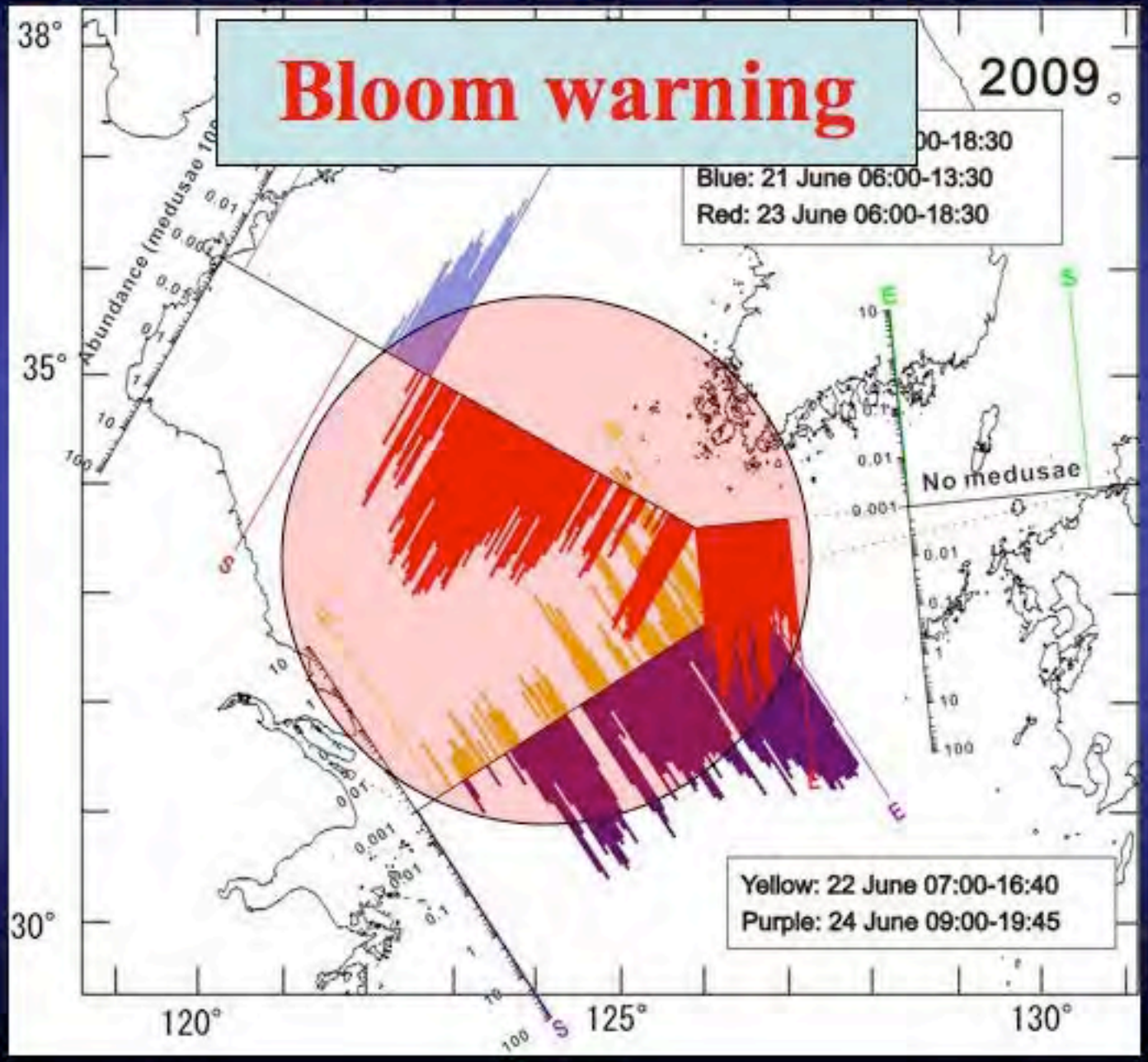
Forecast of *Nemopilema* bloom intensity by ferry-on-deck sighting survey



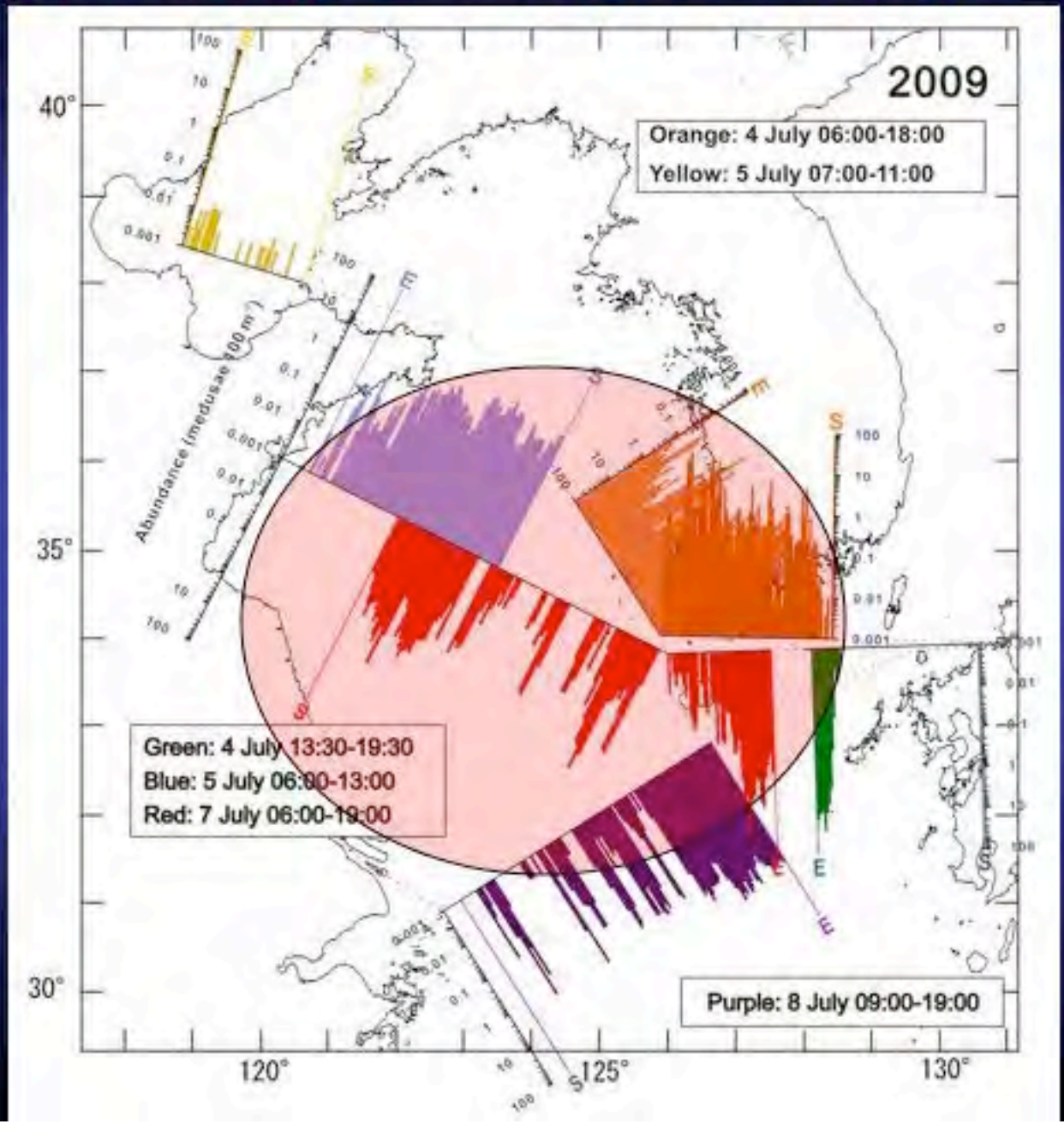
Ferry survey during 6-10 June, 2009



Ferry survey during 20-24 June, 2009

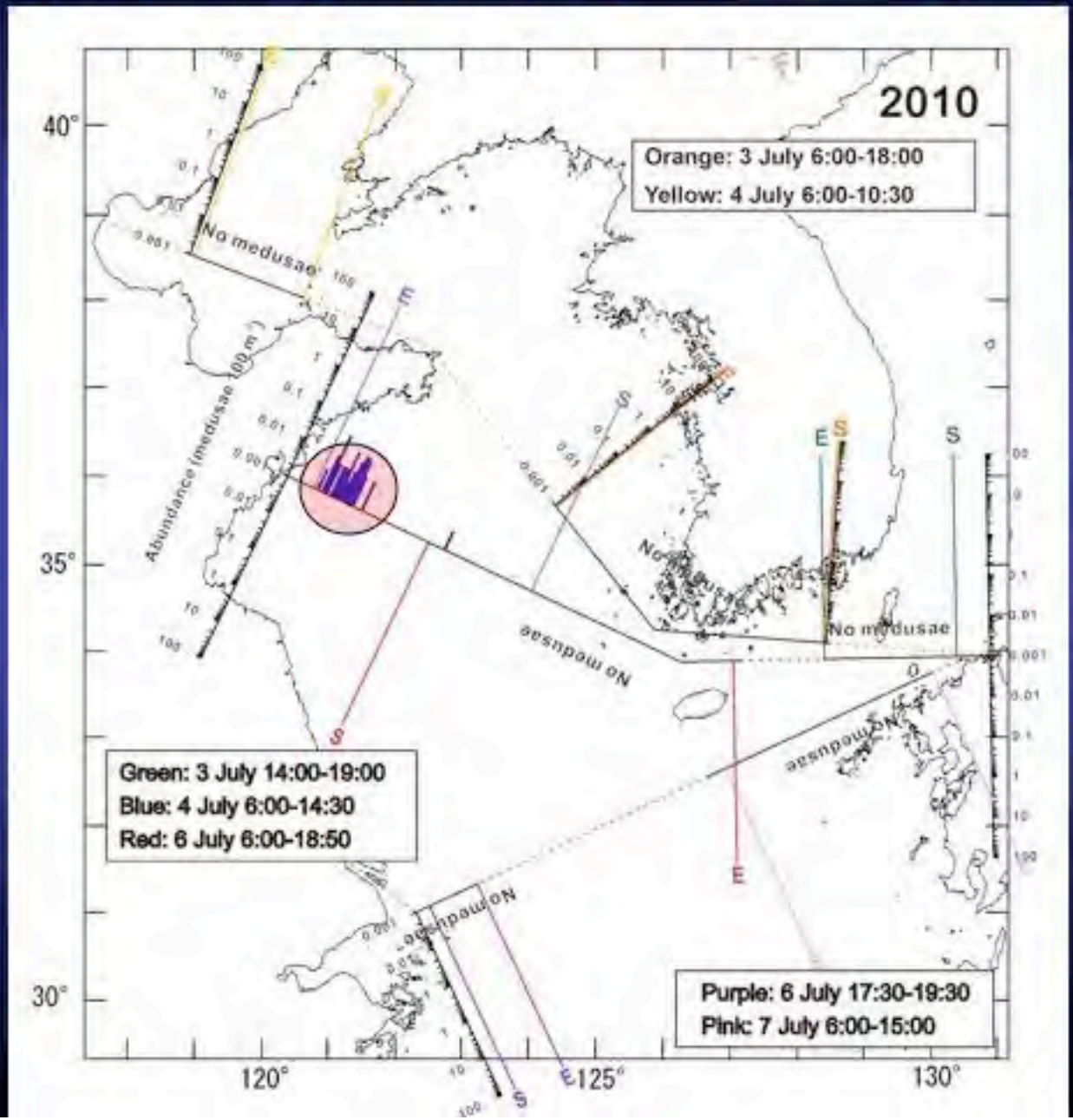


Ferry survey during 4-8 July, 2009

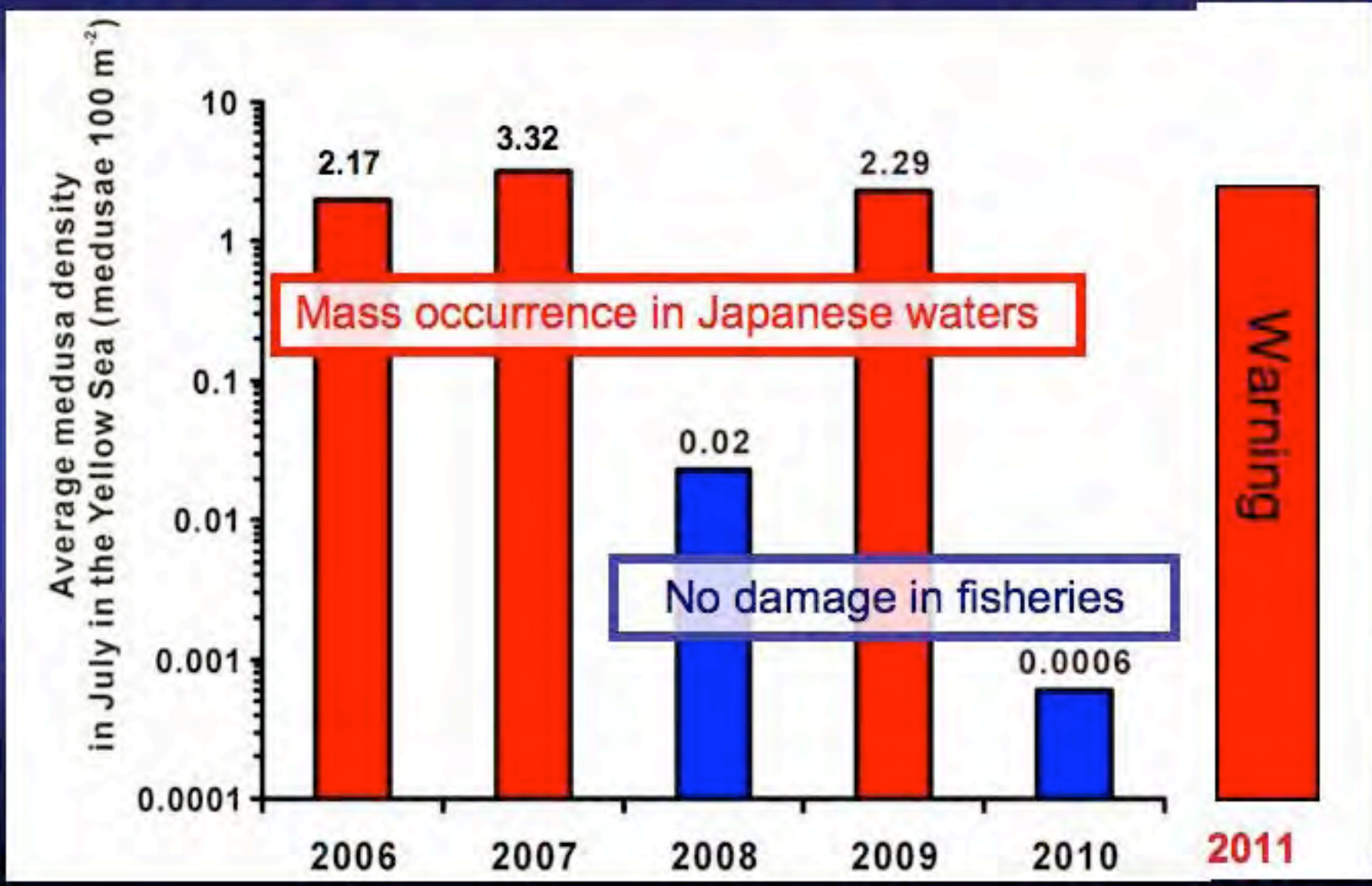


Seasonal change in average density of *Nemopilema* in the Yellow Sea in 2009

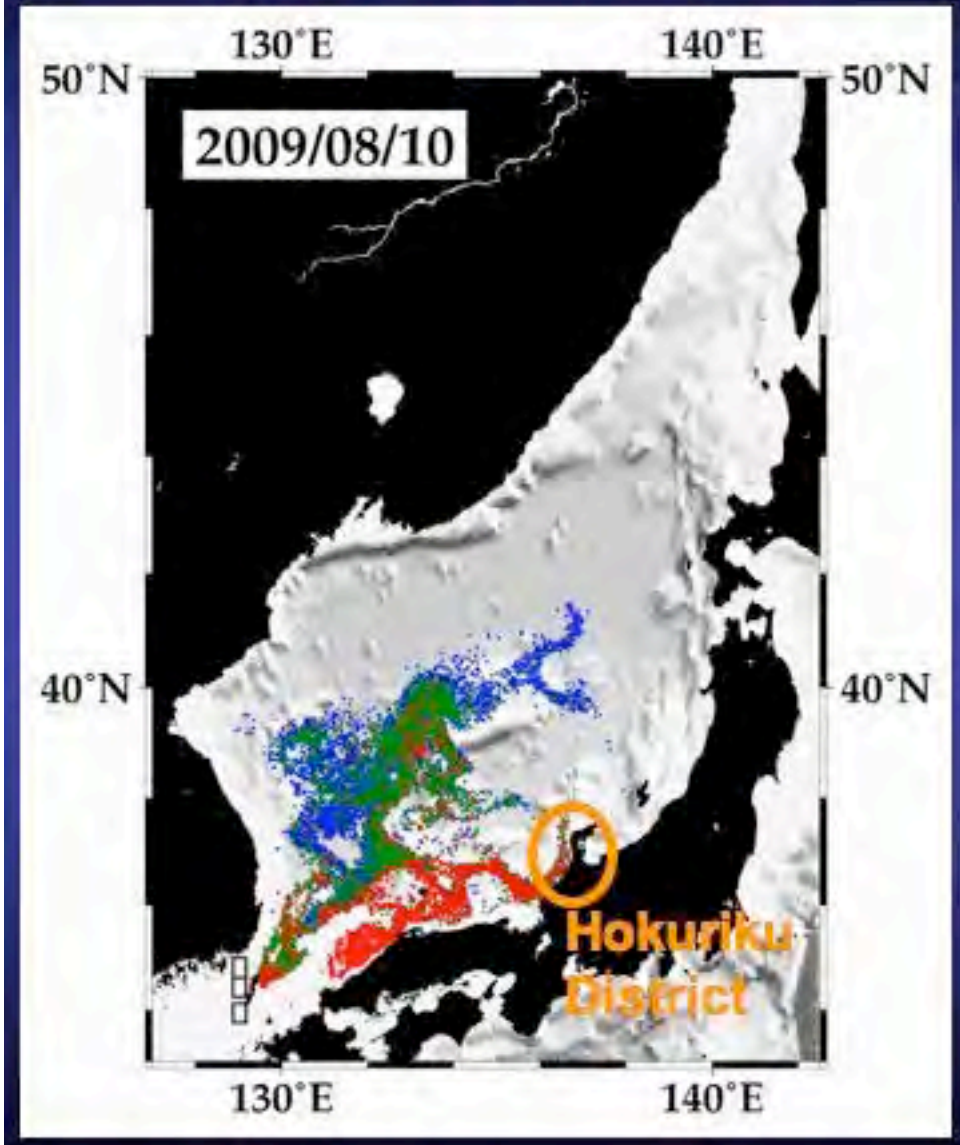
Ferry survey during 3-7 July, 2010



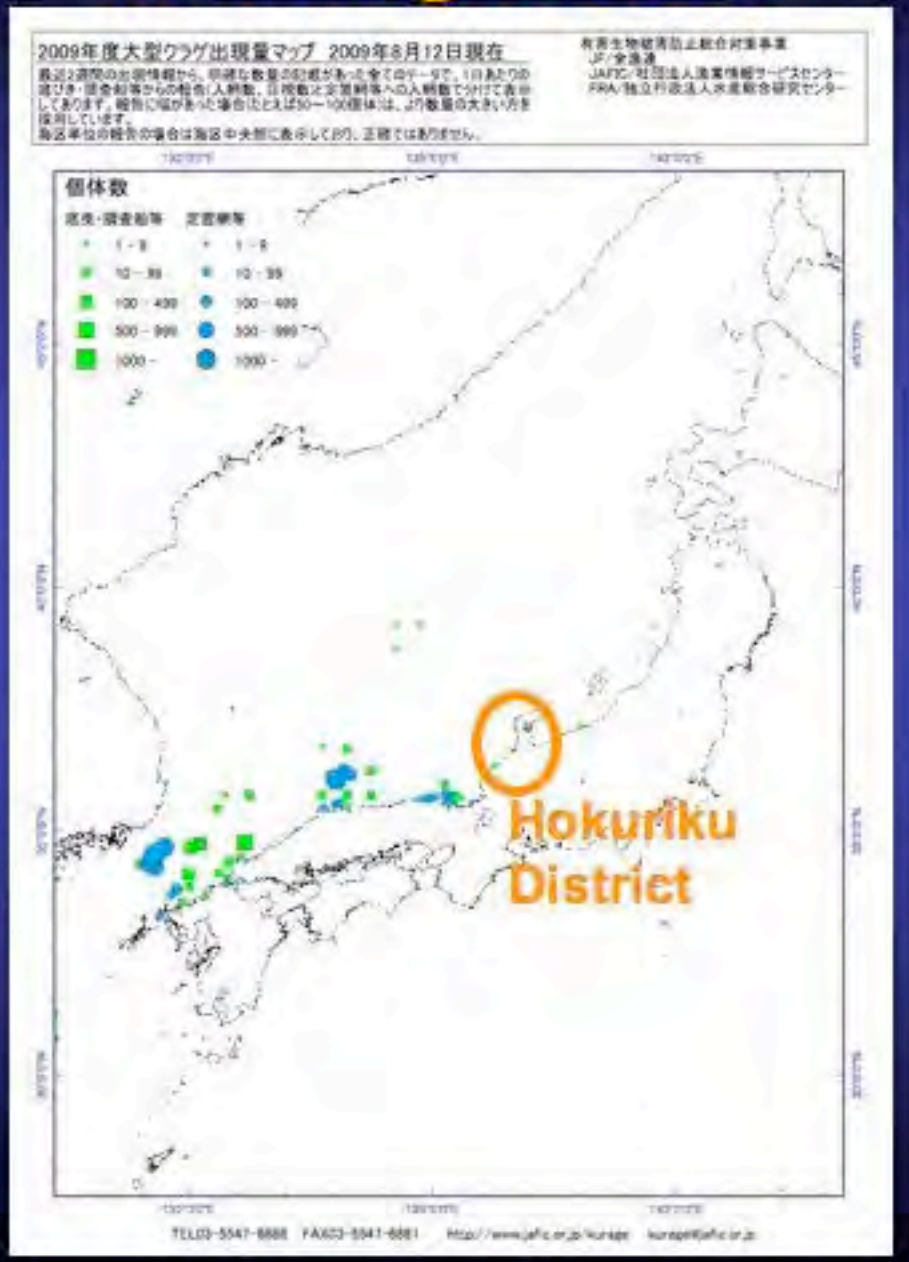
Year-to-year difference of the average density of *Nemopilema* in the Yellow Sea in July



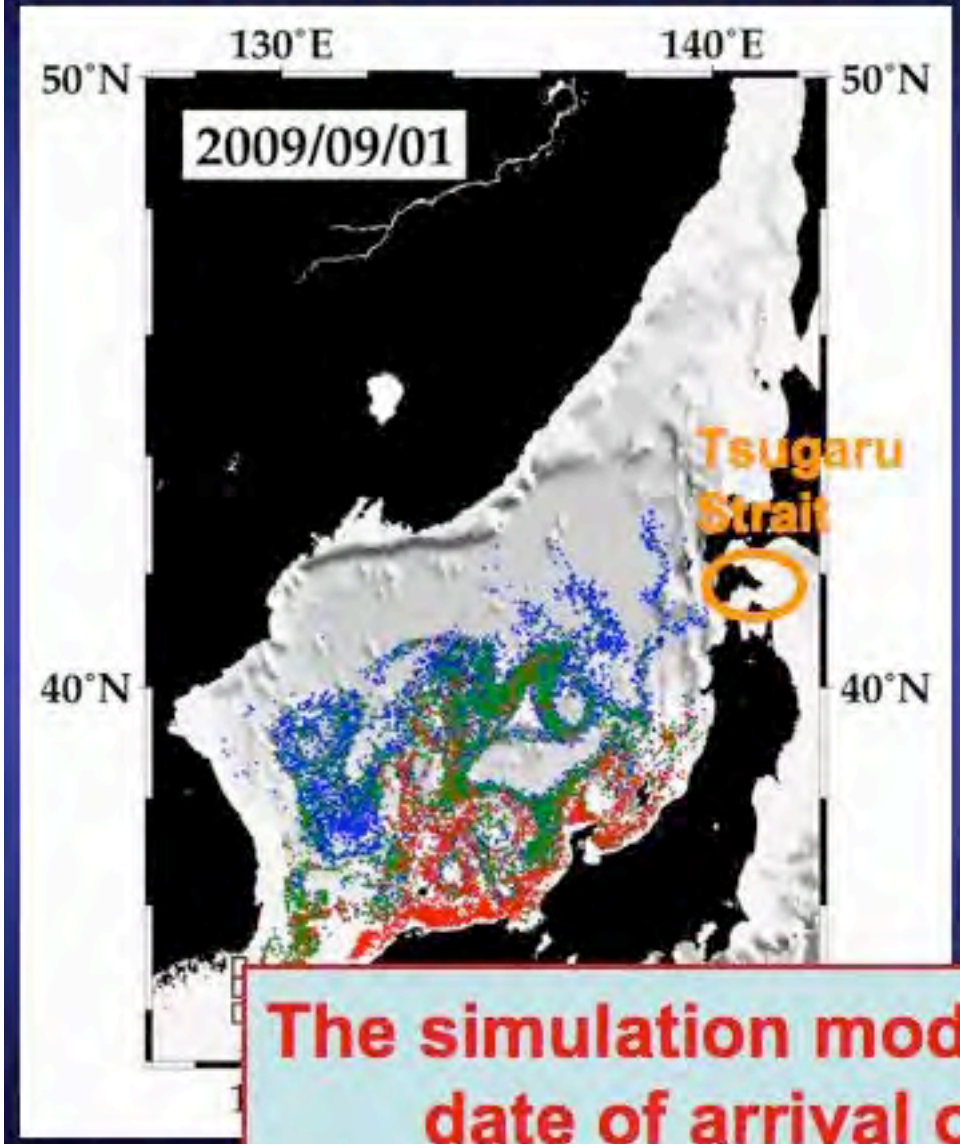
Simulated transportation on 10 August 2009



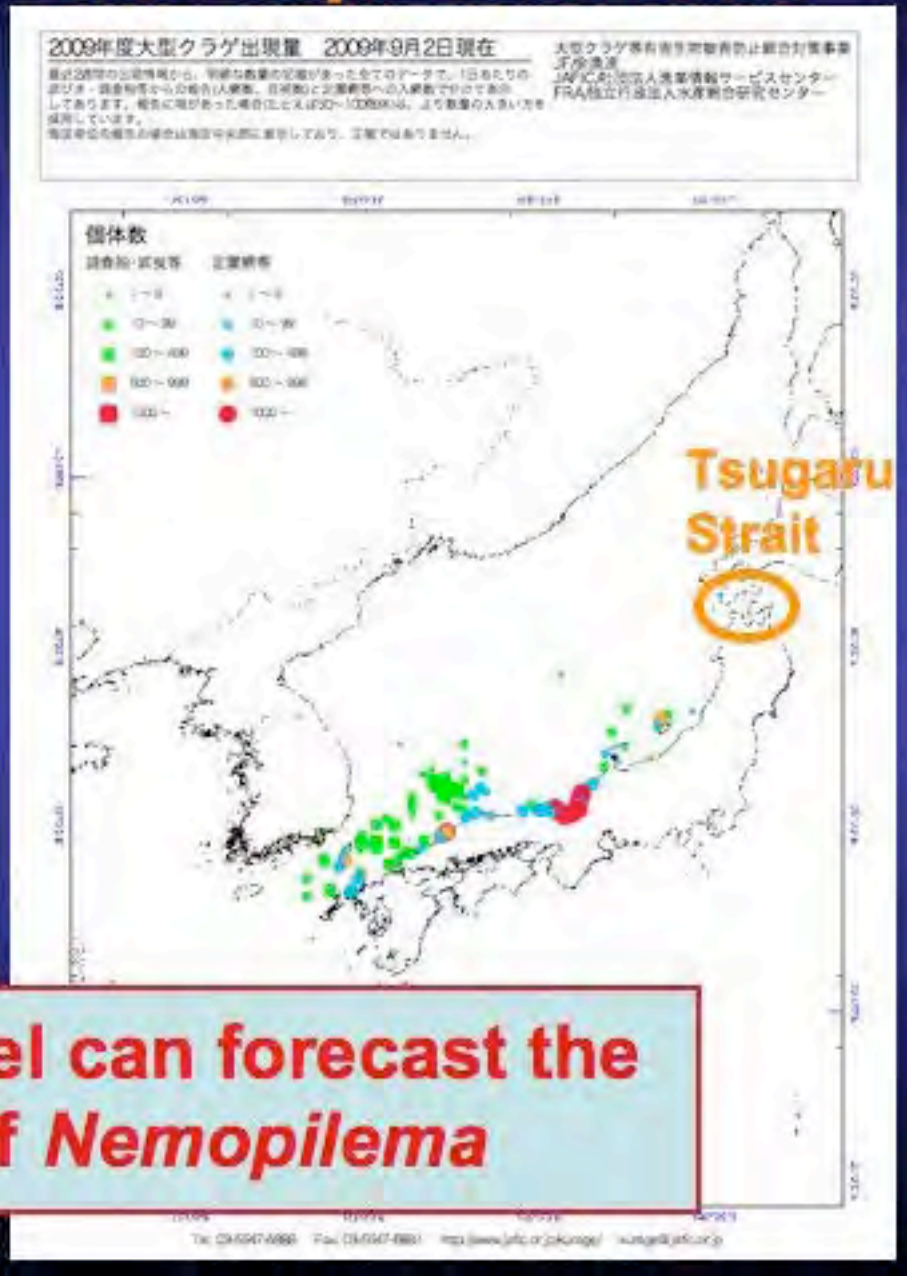
Actual occurrence on 12 August 2009



Simulated transportation on 1 September 2009

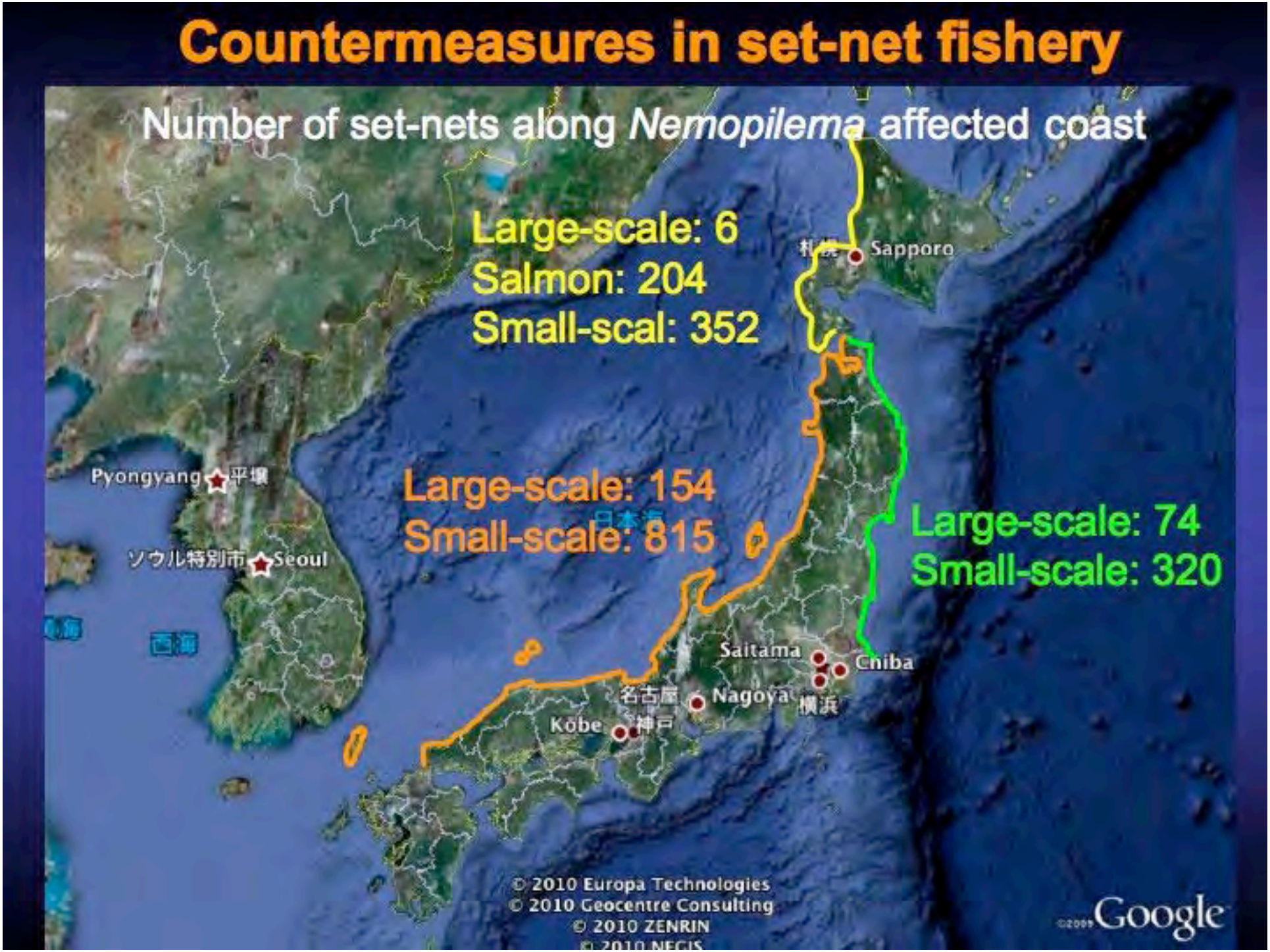


Actual occurrence on 2 September 2009

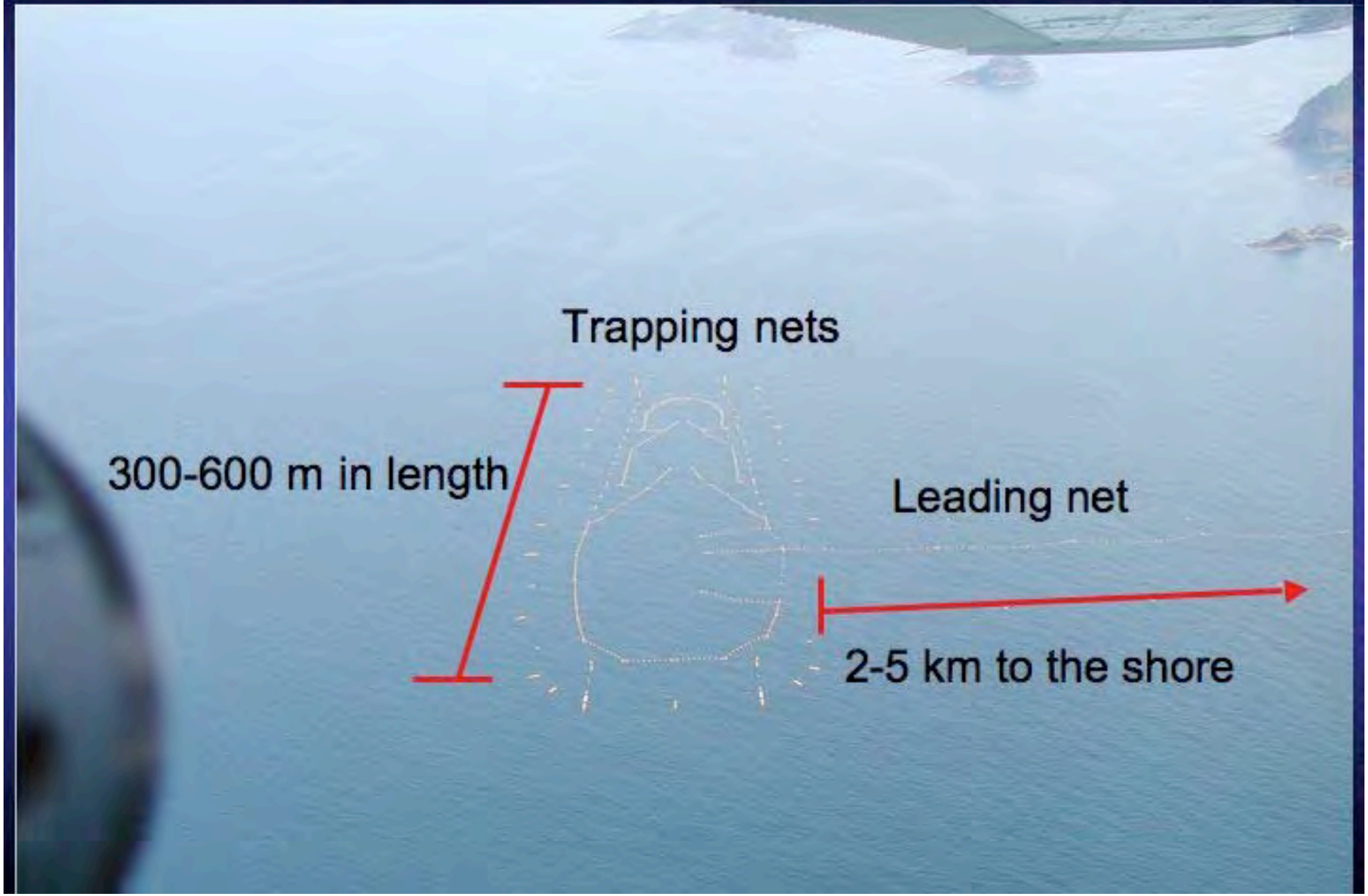


The simulation model can forecast the date of arrival of *Nemopilema*

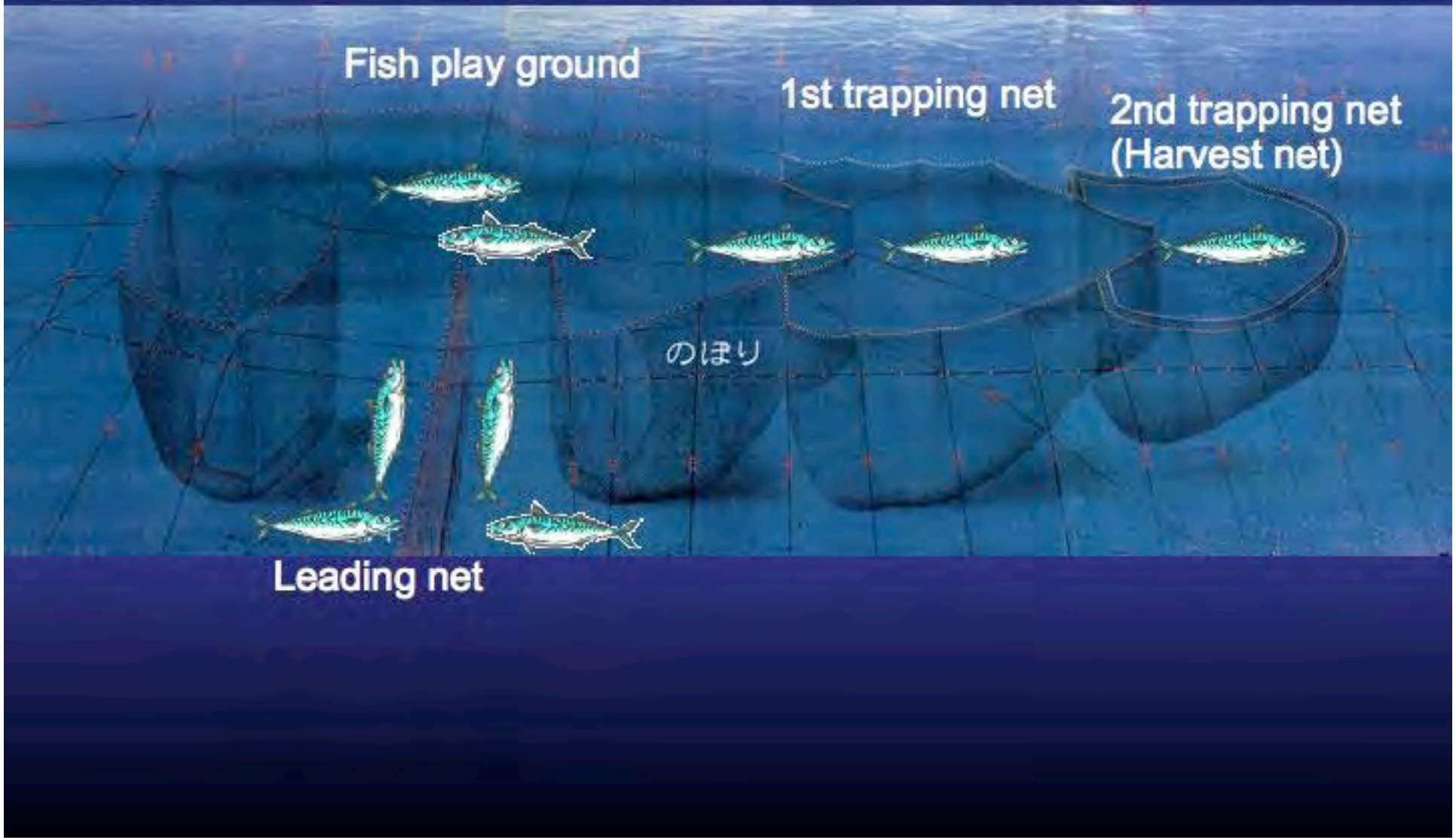
Countermeasures in set-net fishery



Structure of a large-scale set-net



Structure of a large-scale set-net




(by Matsuhira)

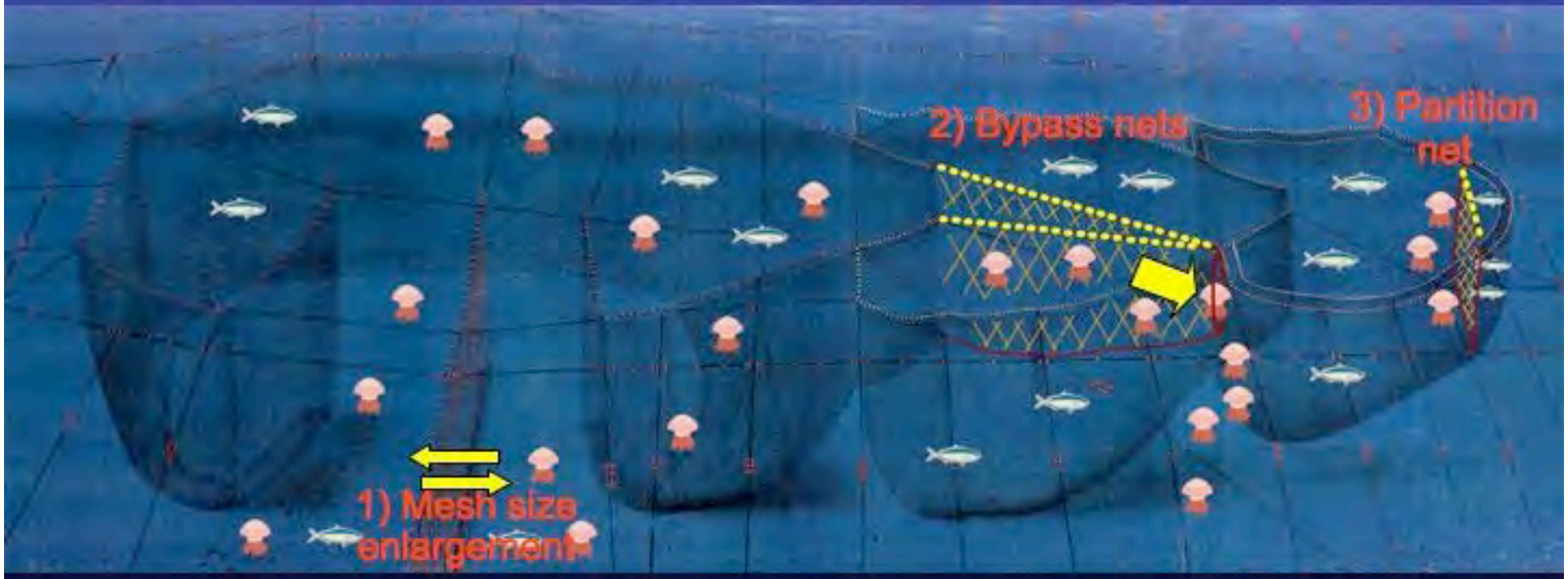

C8Z-80147
(by Matsuhira)

Modification of set-net to reduce the damage

1) **Enlargement of the mesh size of the leading net** → Medusae pass through the leading net

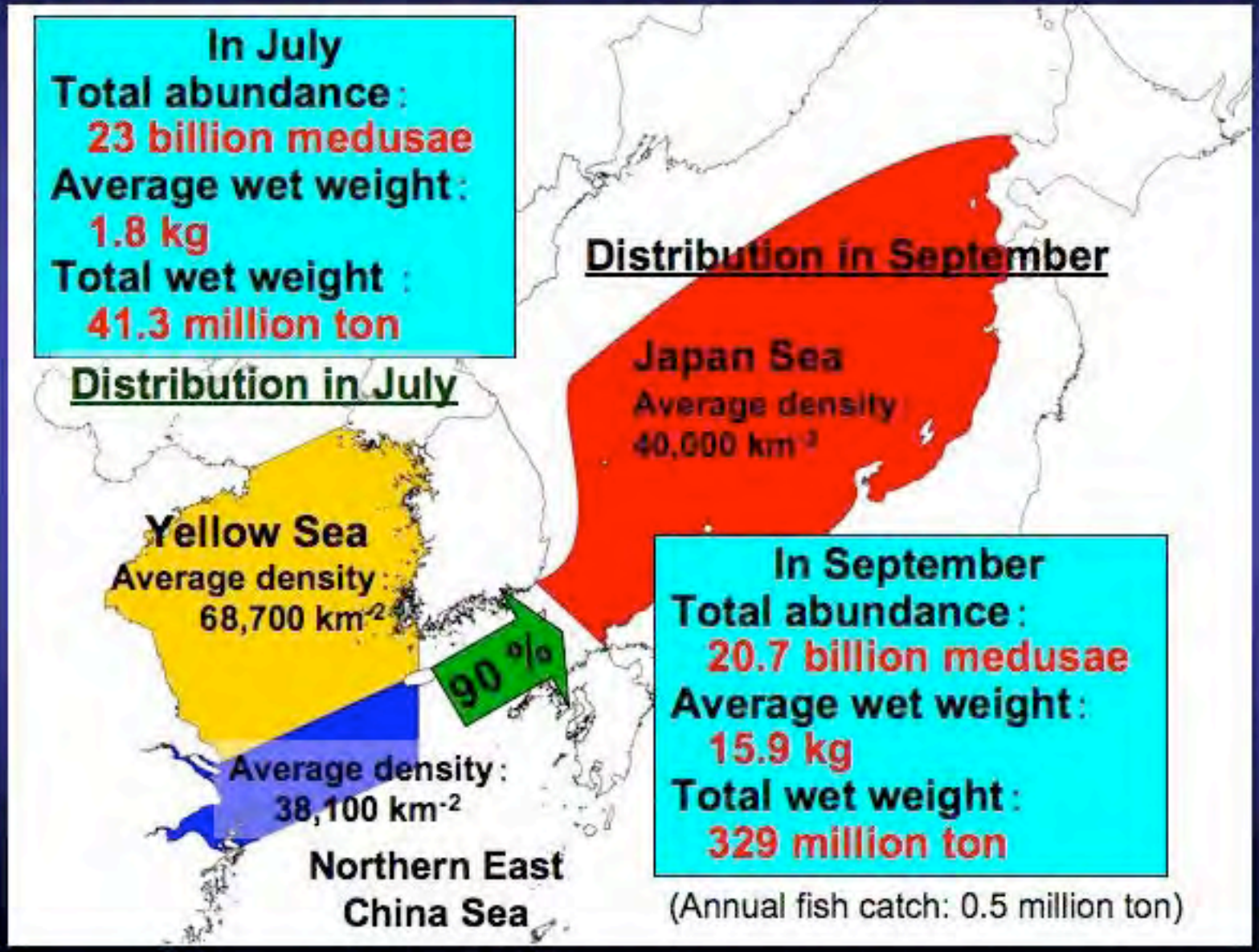
2) **Installment of bypass nets** → Entrapped medusae are removed outside the net

3) **Installment of a partition net** → Entrapped medusae are separated from fish and removed outside the net



Total investment: 5-10 million JPY (ca. 50-100 thousand USD)

Ecological impact of *Nemopilema* bloom: population biomass in July and September, 2009



Conclusion

Causes of the bloom

Human-induced environmental/ecosystem changes in Chinese coastal waters are primary responsible, but some biological factors (e.g. podocyst dormancy) may also be important.

Forecast of the bloom

Year-to-year bloom intensity can be forecasted by ferry sighting survey in early summer.

Dispersal pathways and approximate arrival date of medusae to each location can be predicted by numerical models.

These forecasts enable fishermen to prepare well in advance for possible jellyfish attacks.

Countermeasures of the bloom

Modification of set-nets is effective to alleviate the damage by entrapped medusae.

Such a modification is essential to keep operating set-net fisheries under currently recurrent bloom conditions