Changes in occurrence of paralytic shellfish poisoning and the effects on bivalve aquaculture in Tohoku region of Japan after the Great East Japan Earthquake

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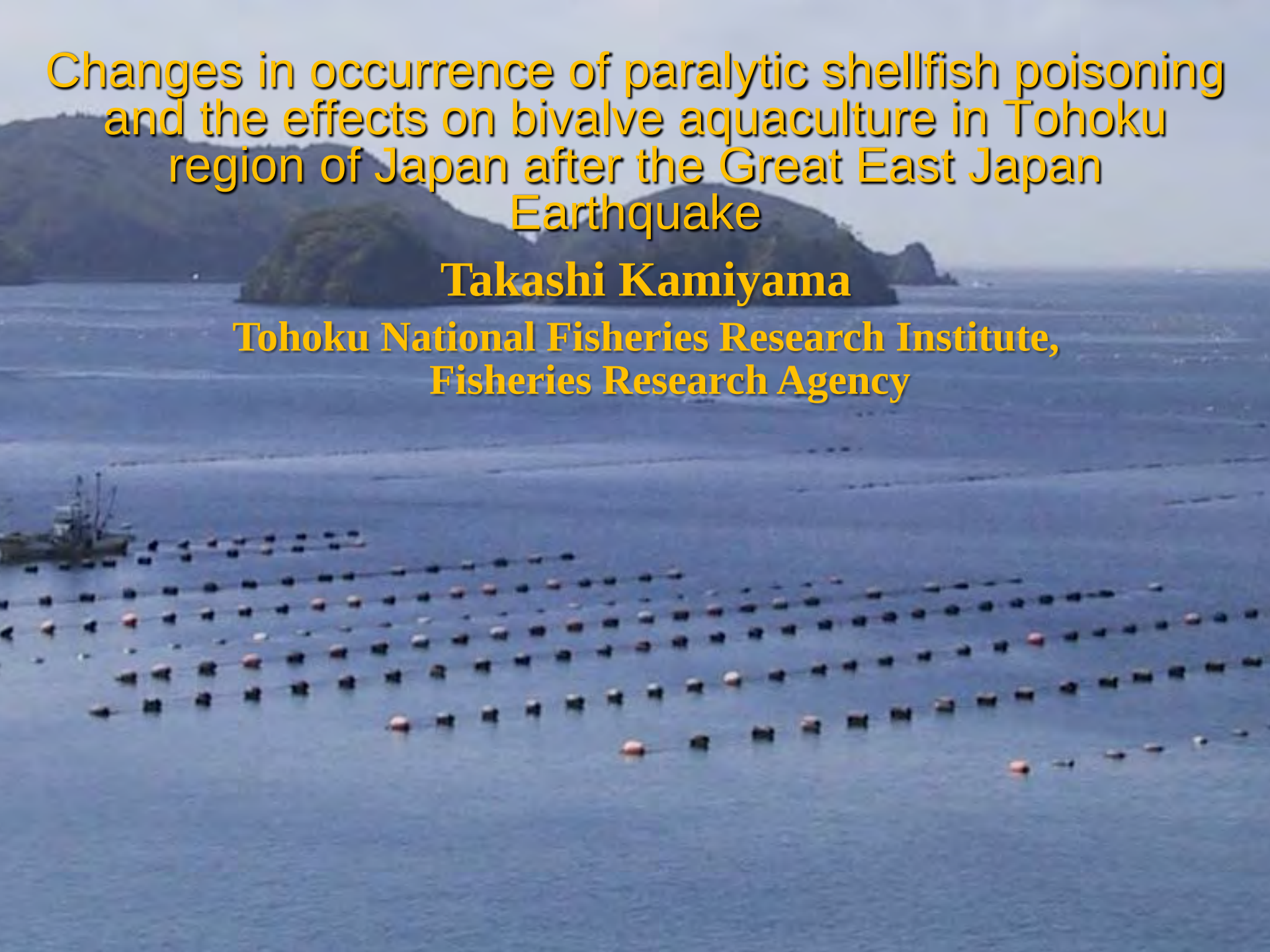

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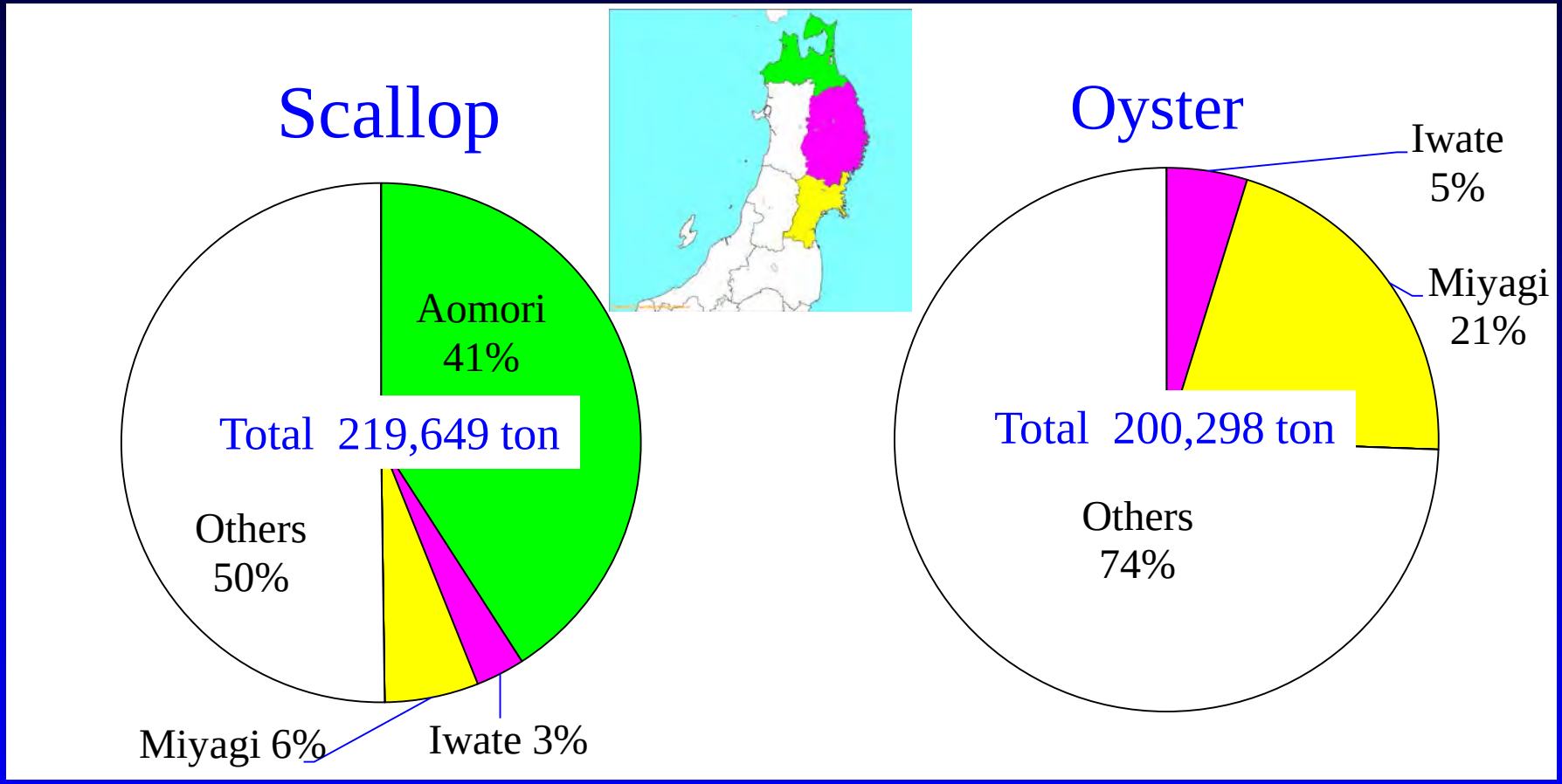
PSP: Paralytic Shellfish Poisoning

Bivalve aquacultures in the Pacific coast of Tohoku region, Japan

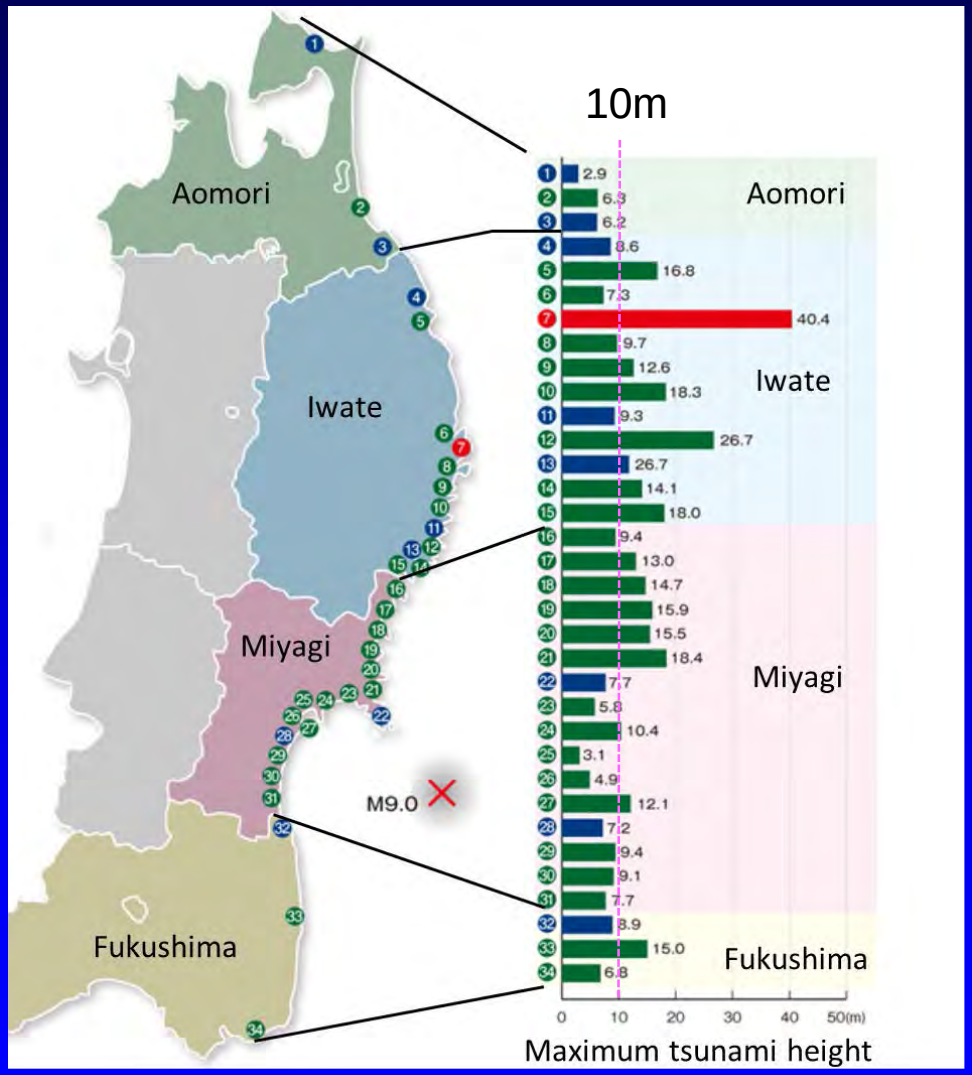
Scallop aquaculture Oyster acquaculture

Percentage in total production in Japan



Source : Annual Statistics of Fishery and Fish Culture 2010 by Statistics Department of Ministry of Agriculture, Forestry and Fisheries, Japan

Tsunami by the Great East Japan Earthquake on 3.11 in 2011



from Tohoku Gakuin Univ HP

Source: Miyako city (Iwate Prefecture, Japan) HP

Bivalve aquacultures: destruction and reconstruction

Destruction of almost all facilities

Recovering

A example in South Iwate

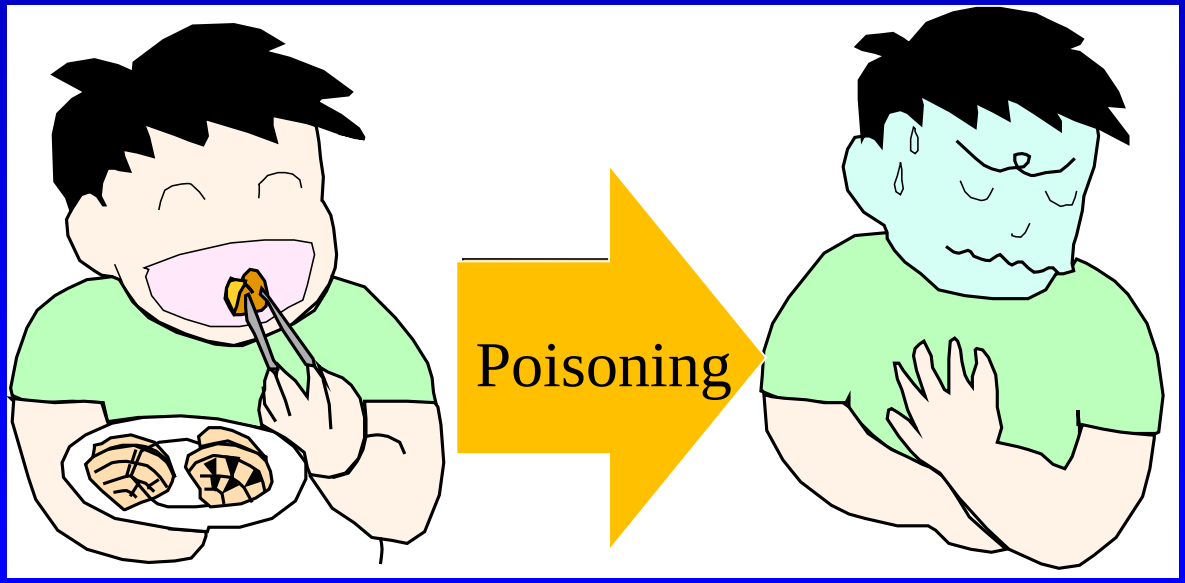
March 14, 2011

June 1, 2015

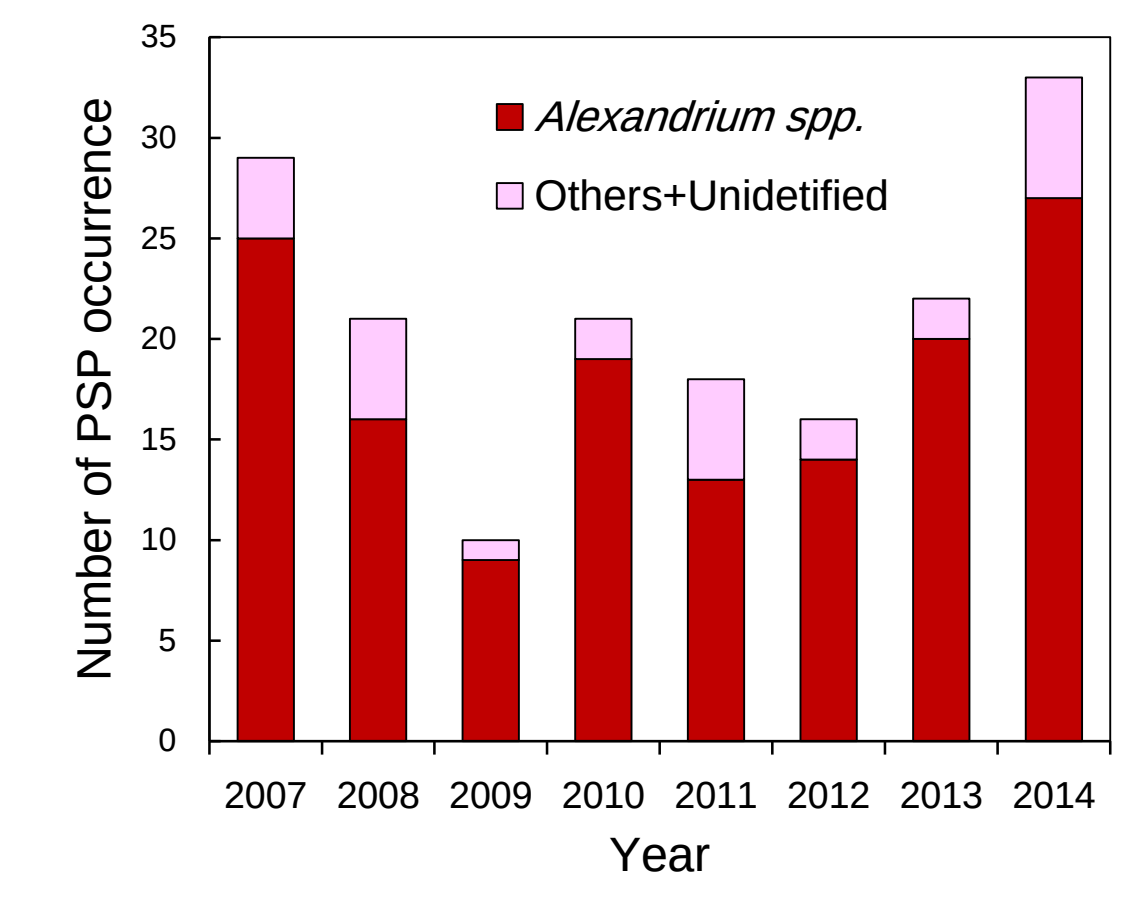
Shellfish poisoning

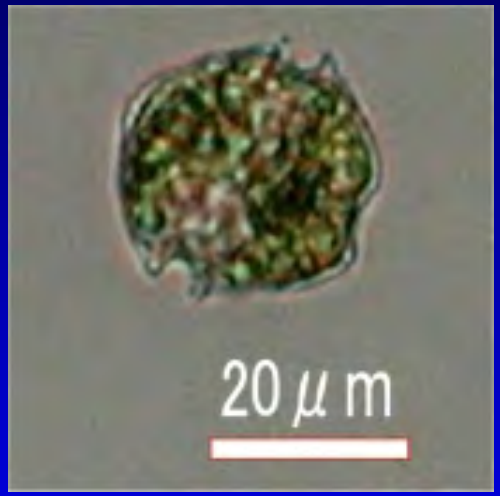
- Indicate poisoning that occurs when shellfish are eaten by humans (in a narrow sense)
- Indicate situation when shellfish have biotoxins exceeding the quarantine levels of toxicity (in a broad sense)

e.g. Paralitic shellfish poisoning 4 MU/g



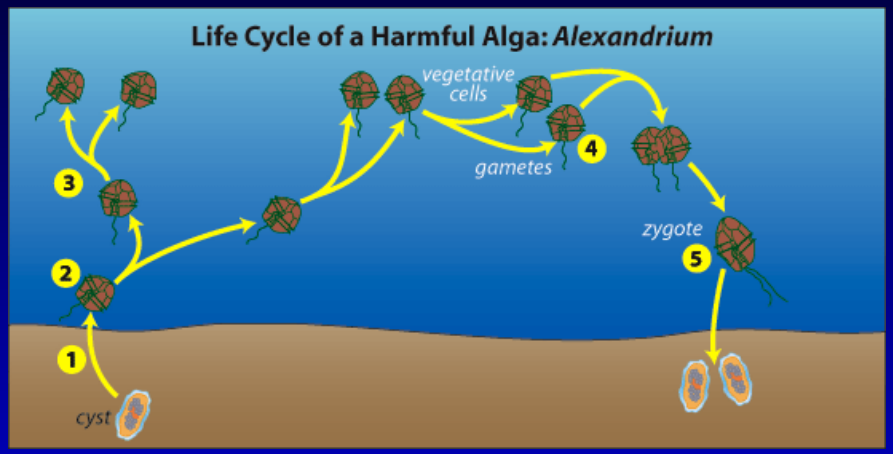
The number of PSP occurrence in Japan and the causative plankton



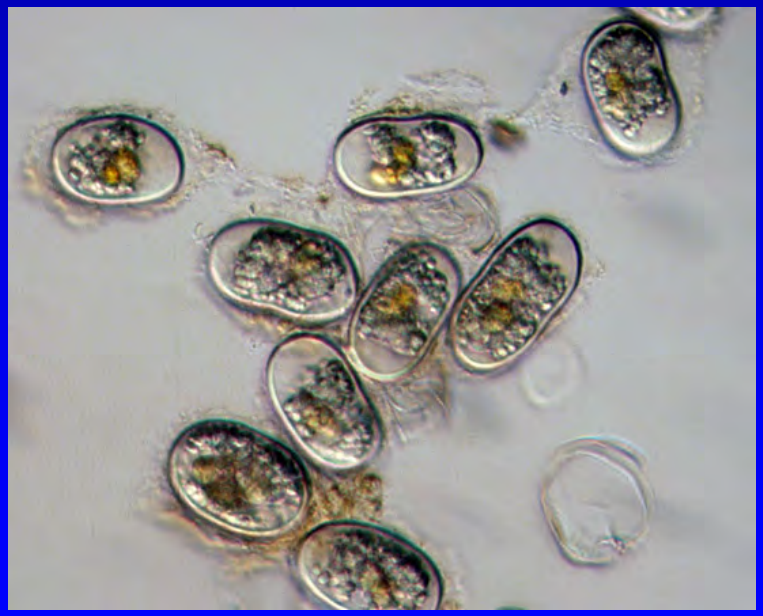


Source: Report of Research Meeting on Shellfish Poisoning in Tohoku Region, Japan

Life cycle of *Alexandrium tamarense*



Source: MicrobeWiki (By Jack Cook, Woods Hole Oceanographic Institution.)



Source: MicrobeWiki (Photo By D. Wall)

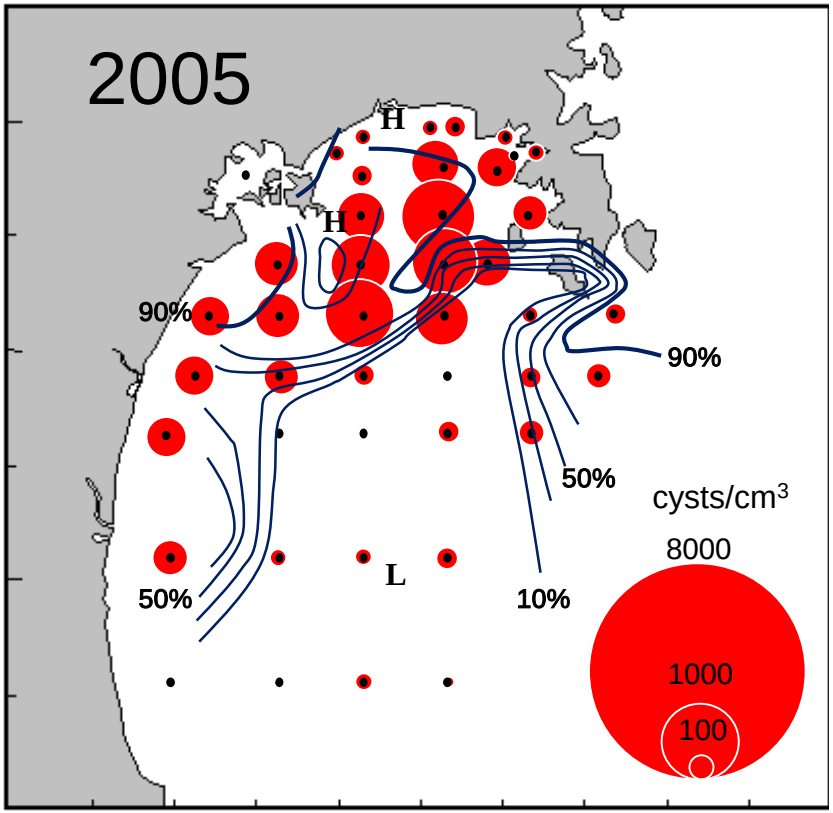
- Occurrence of the vegetative cells is germination of the cysts
- The blooms mostly occur in cold water season (in spring)
- At the end of the blooms the cyst was produced after sexual conjugation of vegetative cells

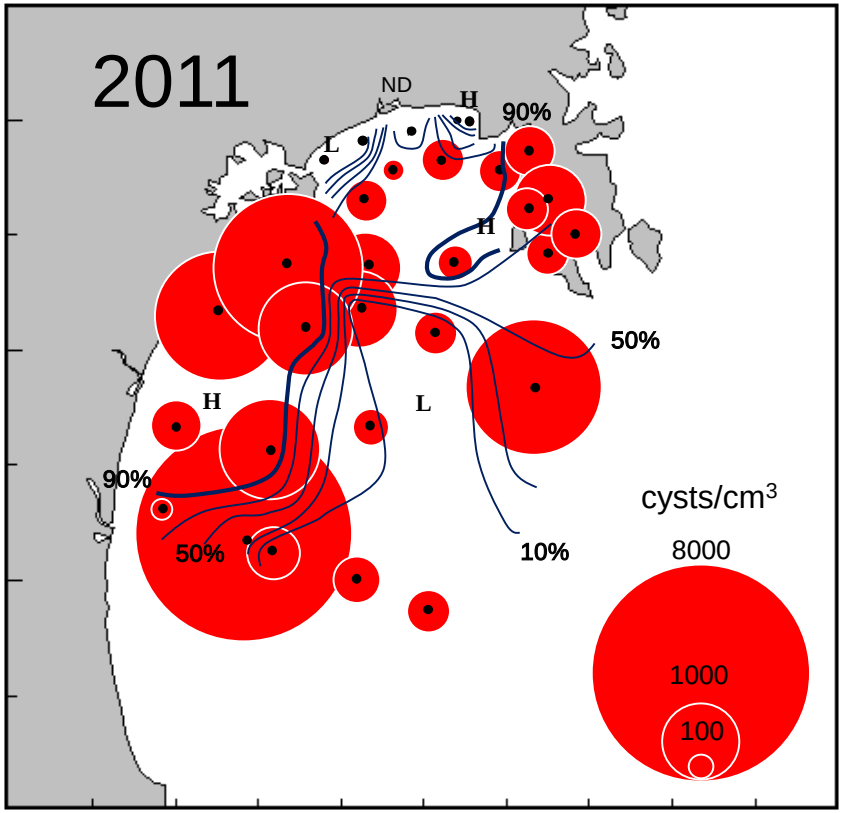
Distribution and abundance of *Alexandrium* cysts are important information to evaluate the risk of PSP occurrence

Distribution of mud contents（% of <63μm particles）and *Alexandrium* cyst density

Before the Earthquake

After the Earthquake



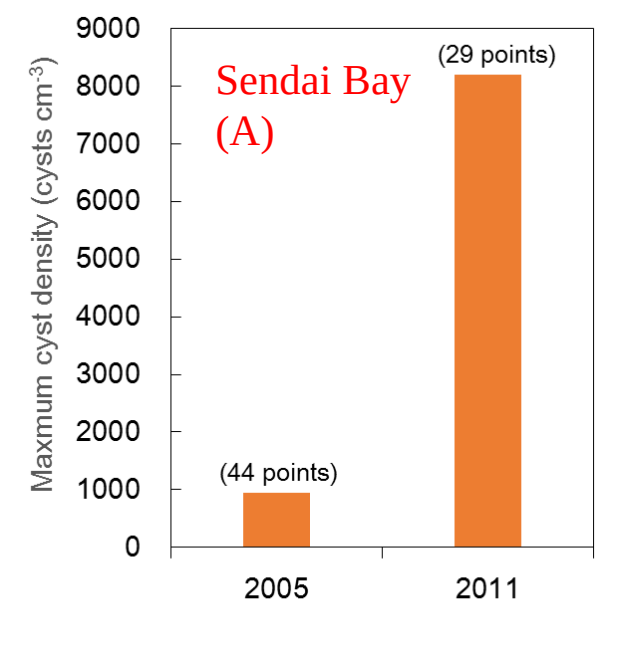


Max. 950 cysts cm^{-3}

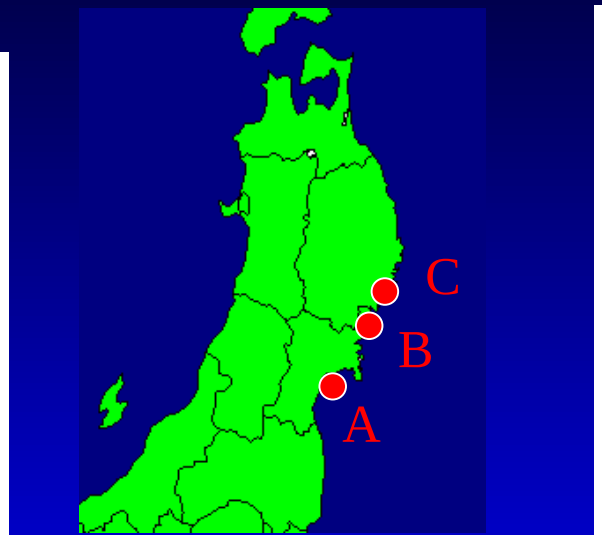
Max. 8,200 cysts cm^{-3}

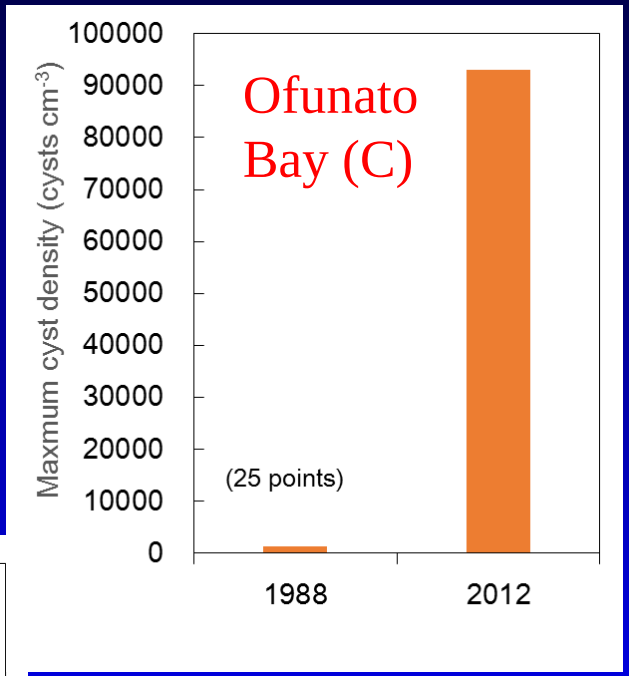
Kamiyama et al. (2014) J. Oceanogr.70:185-

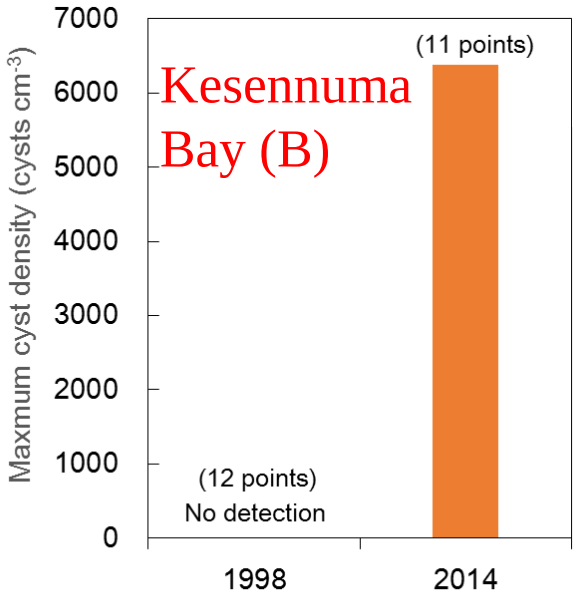
Changes in the maximum abundances of *Alexandrium* cysts in 3 bays



Kamiyama et al. (2014)
J. Oceanogr.70:185-



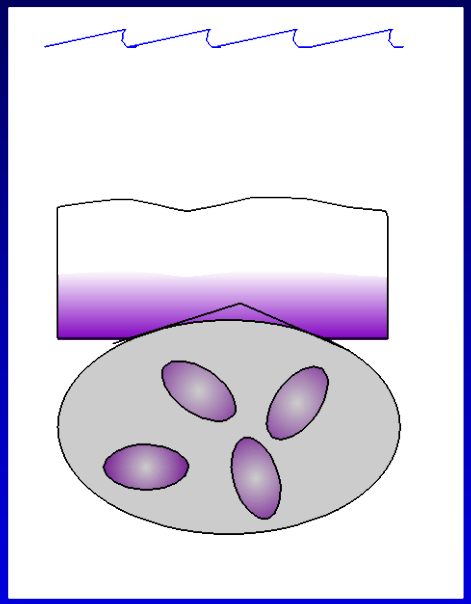




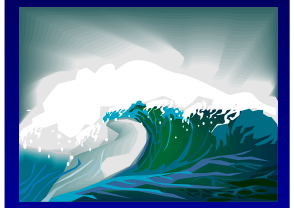
Ogata et al. (2014)

Ishikawa et al. (2014)
Nippon Suisan Gakkaishi 81 (2):256-

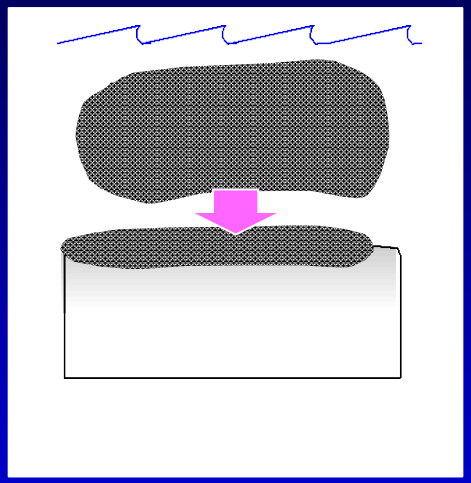
Why did abundance of cysts increased in surface sediments after the tsunami?



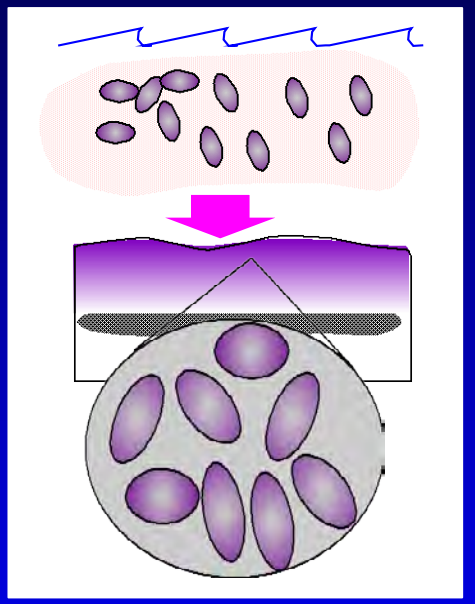
re-suspended diverse sediment particles into seawater



Huge tsunami



High specific gravity particles (minerals) were firstly settled

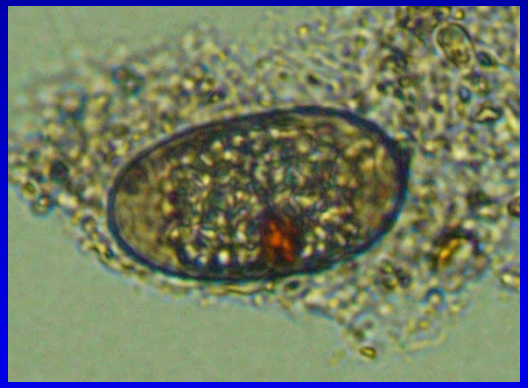


Biogenic particles (cysts) with low specific gravity were settled at the end

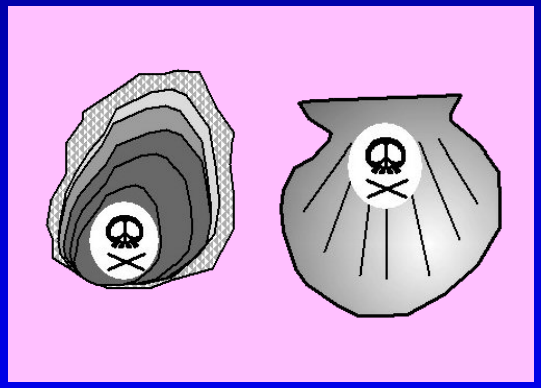
The cysts buried in sediments were accumulated in surface sediment by the tsunami

2. Changes in PSP occurrence after the tsunami

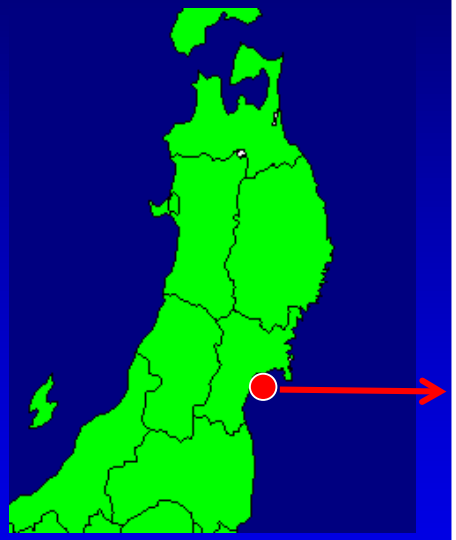
Increased cysts

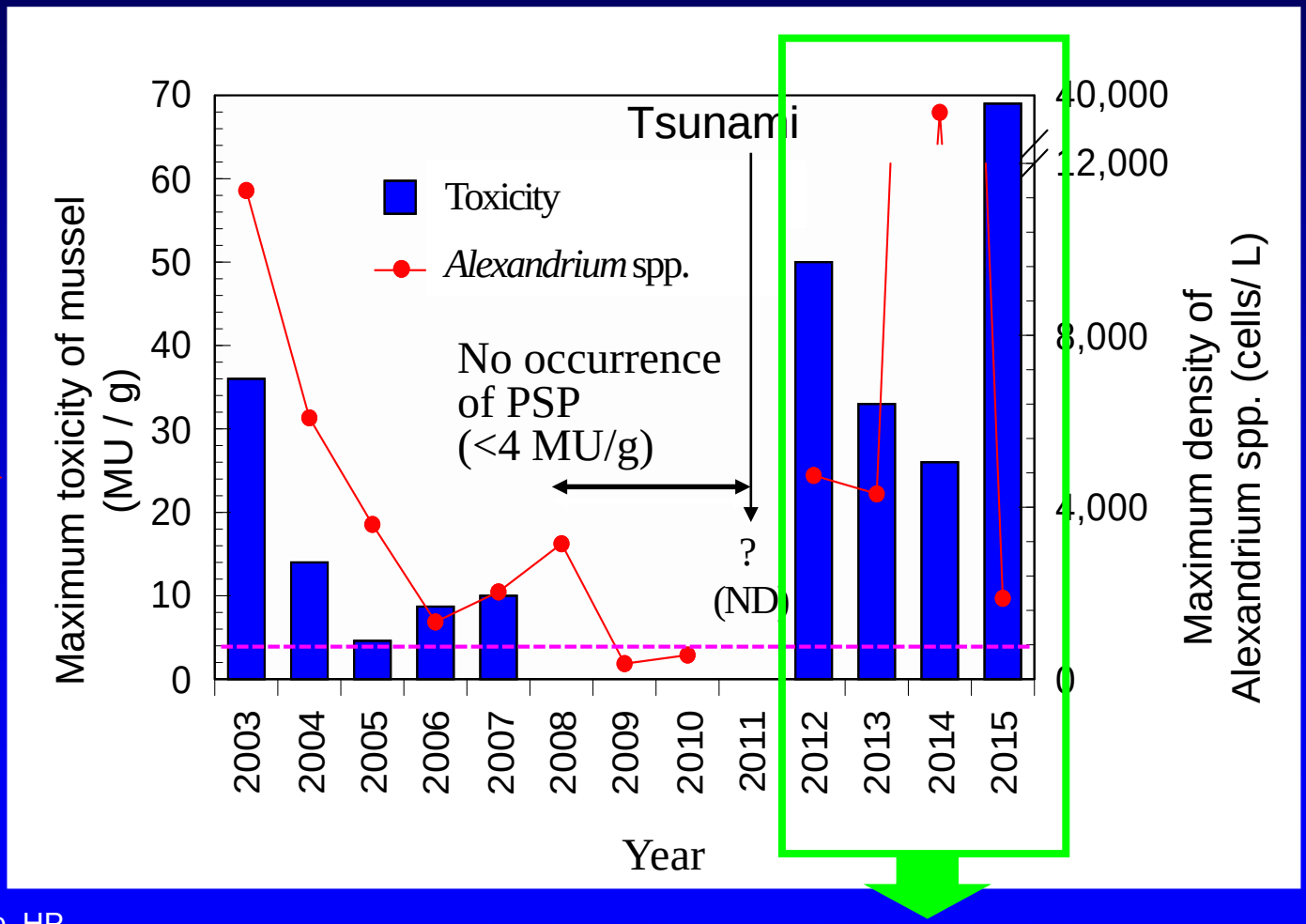


PSP occurrence



Annual changes in maximum PSP toxicity of mussel and maximum *Alexandrium* density in Sendai Bay

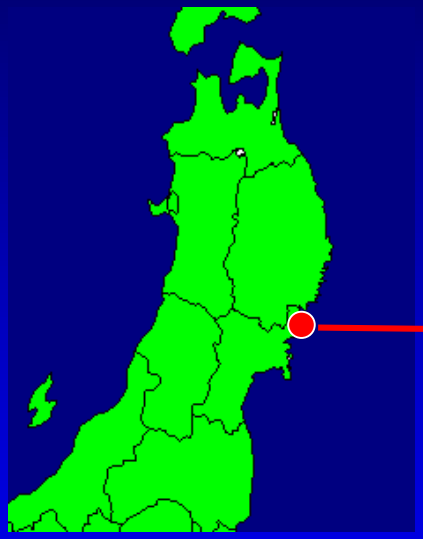


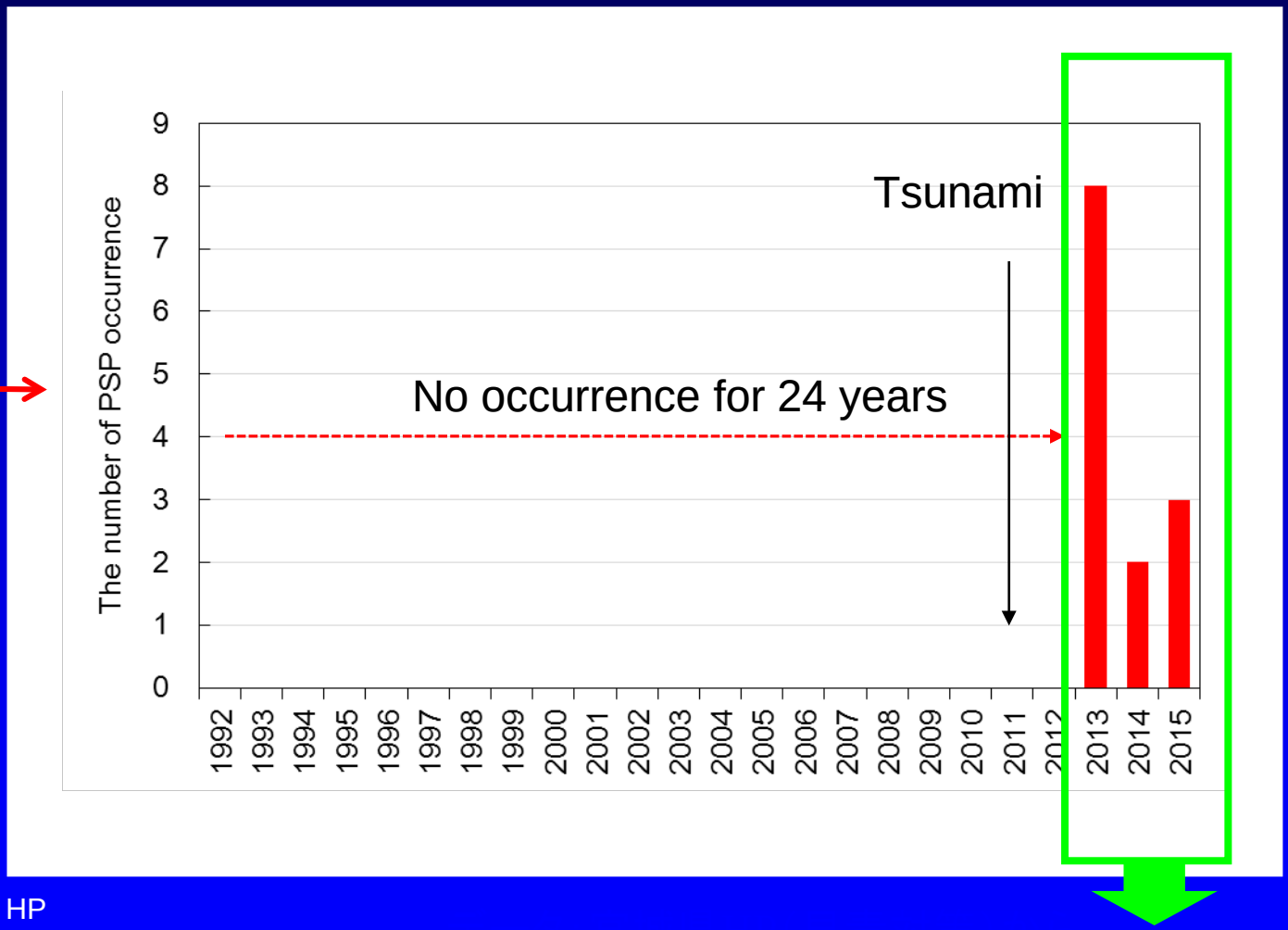


Source : Miyagi Prefecture, HP
http://www.pref.miyagi.jp/uploaded/attachment/272350.pdf
http://www.pref.miyagi.jp/soshiki/mtsc/kaidoku.html

Drastic change after the tsunami

Annual changes in the number of PSP occurrence in Kesennuma Bay



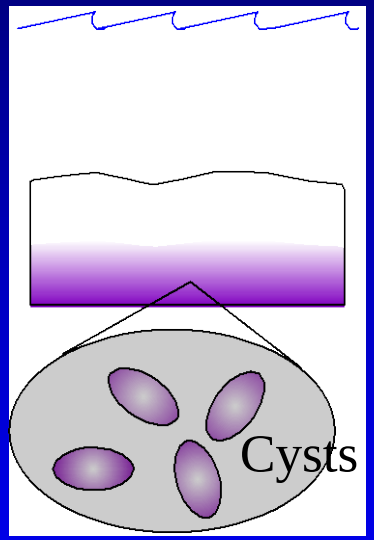


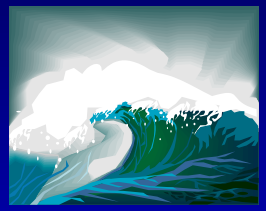
Source : Miyagi Prefecture, HP
http://www.pref.miyagi.jp/uploaded/attachment/272350.pdf

Drastic change after the tsunami

Scenario for increasing PSP occurrence after the tsunami

In the areas where PSP had occurred in the past

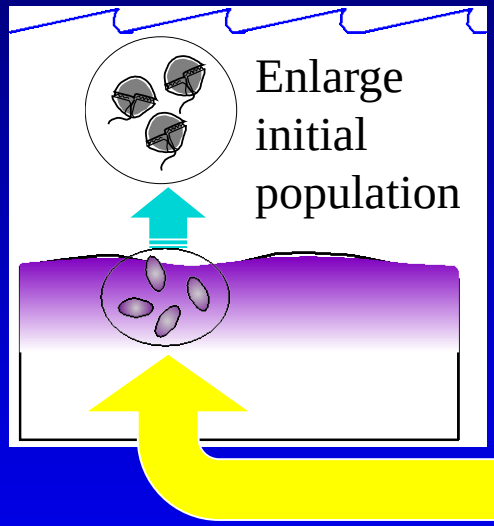




Huge tsunami

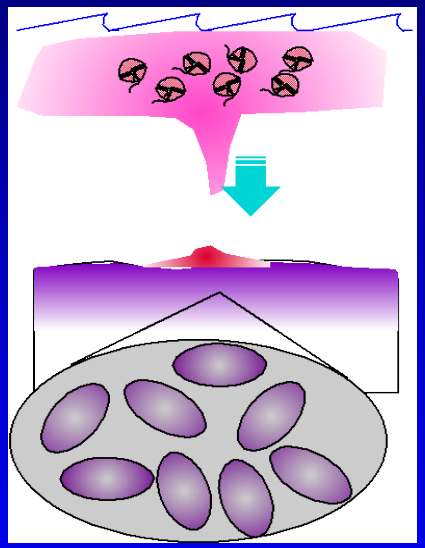
- Mixing the bottom sediments
- Accumulation of cysts near the surface layer

High density of planktonic cells in seawater



Supply the cyst on the sediments

Dense bloom
High PSP toxins in bivalves

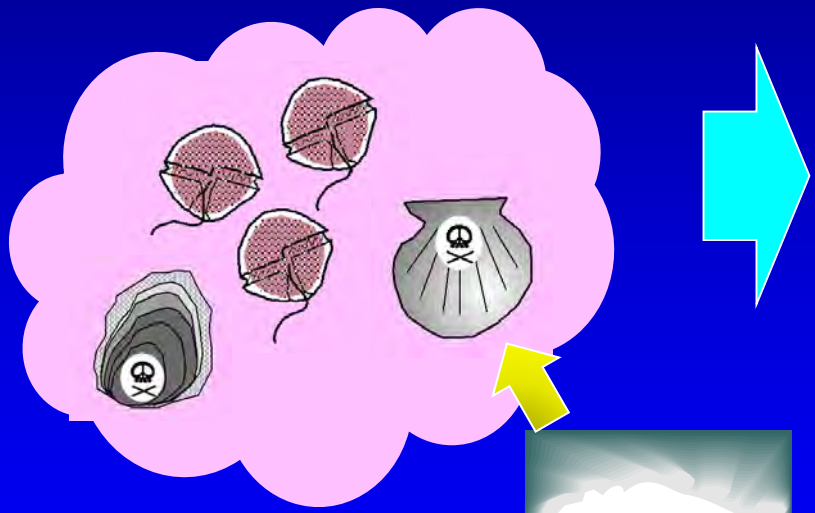


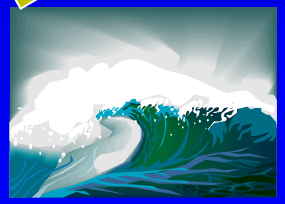
Produce new cysts

Cycle of development of *Alexandrium* bloom and PSP

3. Effects of PSP occurrence on bivalve aquaculture after the tsunami

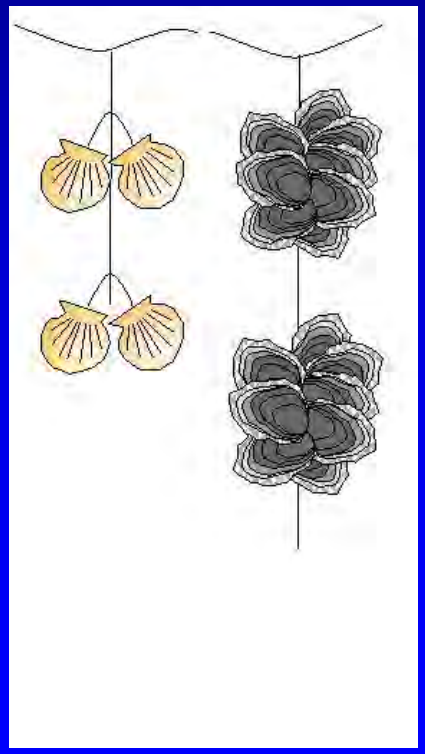
Occurrence of PSP



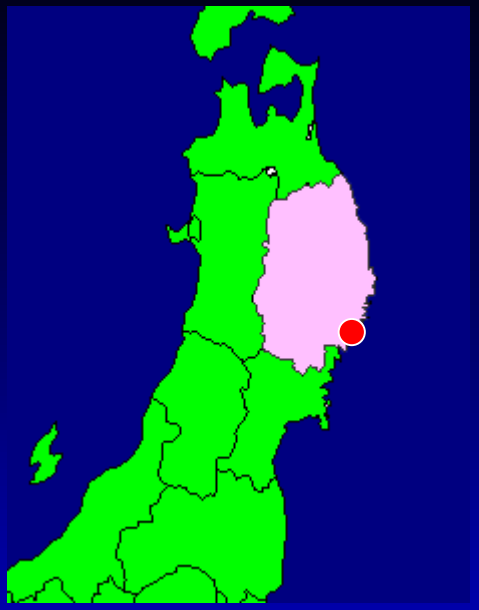


Huge tsunami

Bivalve aquaculture



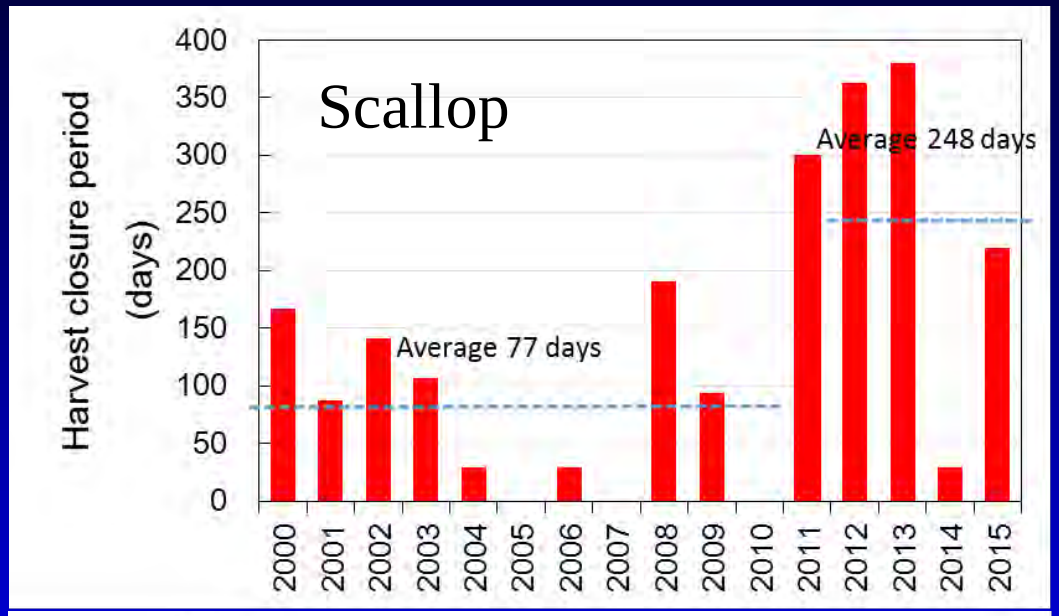
“Ofunato Bay“, Iwate prefecture

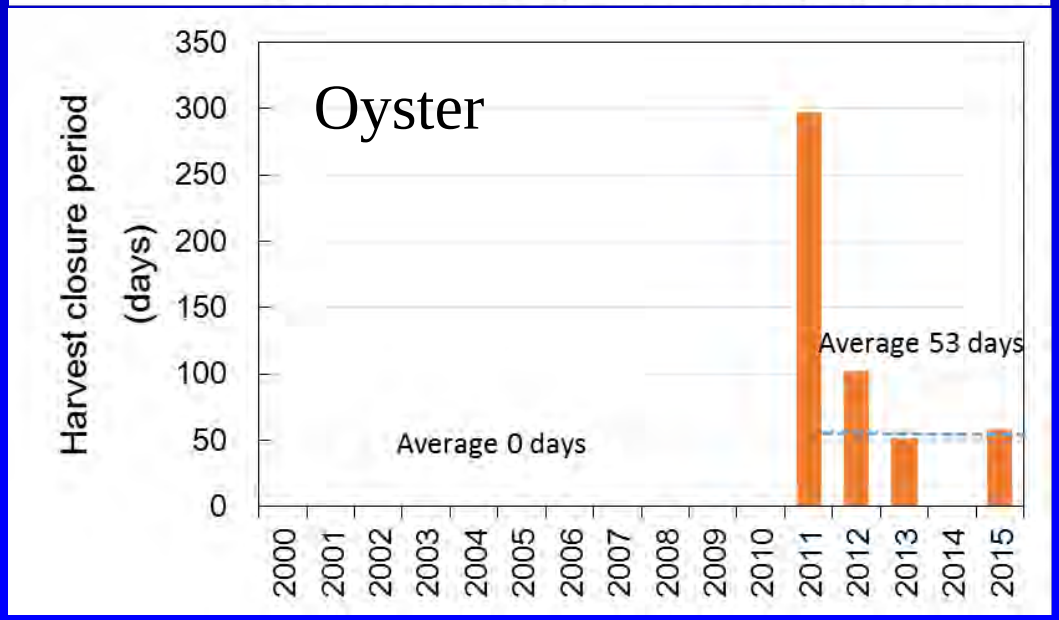


Backgrounds

- Main production area in Iwate Prefecture
  Scallop : 41%, Oyster: 31% in all area of Iwate Pref. (2010)
- Almost all aquaculture is family-run
  2 to 3 persons per a organization
- Almost all farmers simultaneously operate aquacultures for several target species in their culture area (scallop, oyster, sea squirt, seaweeds)
- PSP has often occurred

Harvest closure period for scallop and oyster by PSP in the southern part of Ofunato Bay



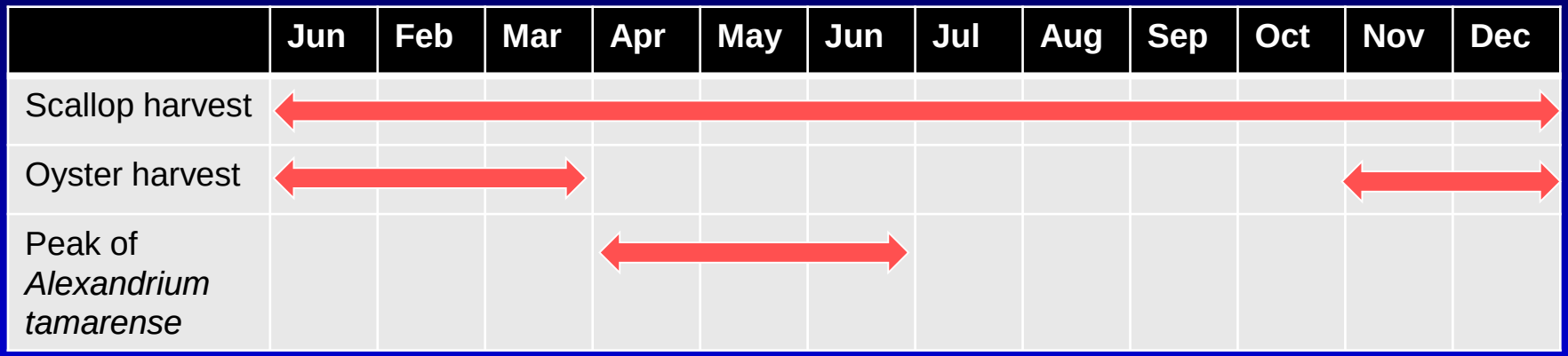


- The mean period after the tsunami become longer for both bivalves
- The period for oysters is generally shorter than that for scallop
- In particular, average 8 month period for scallop seriously influence the aquaculture management.

Data in southern part of Ofunato Bay

Source: Report of Research Meeting on Shellfish Poisoning in Tohoku Region, Japan

Main harvest period for scallop and oyster and abundance peak of *A. tamarense* in Ofunato Bay



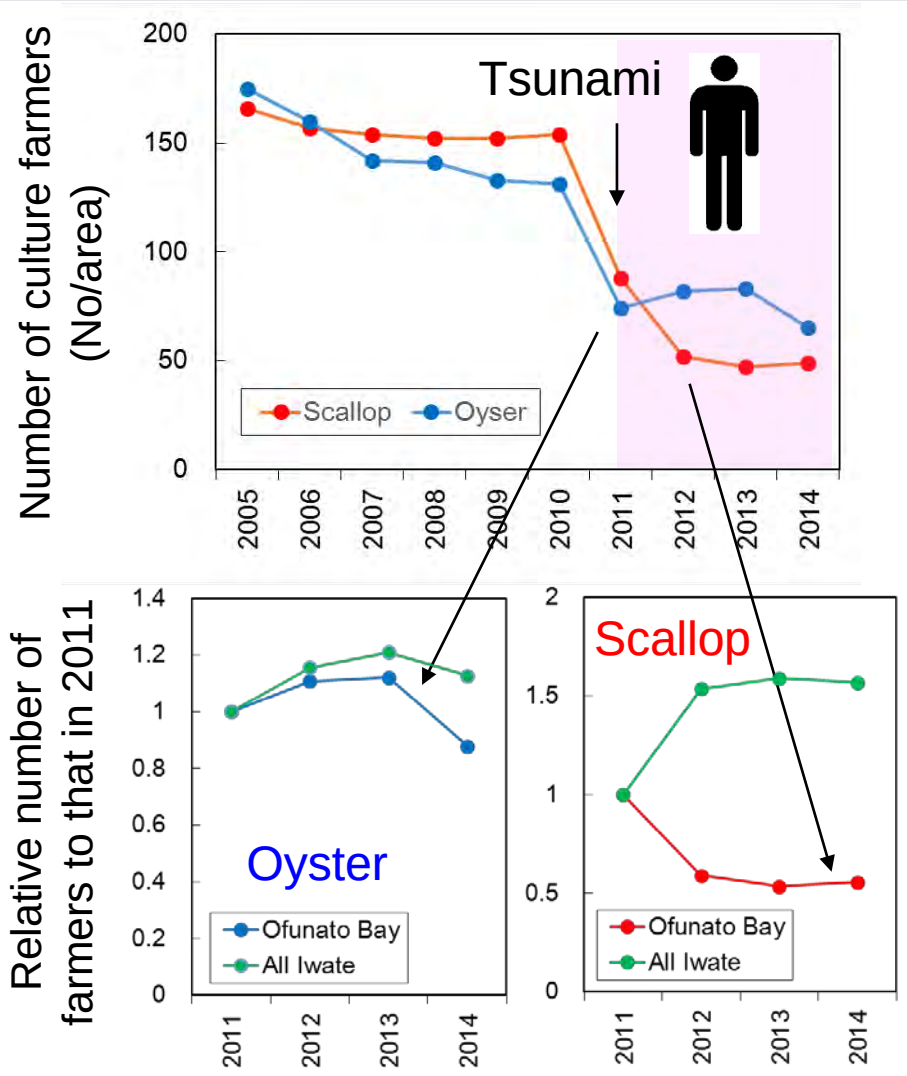
Main harvest period

for oyster ≠ abundance peak period of *A. tamarense*

for scallop ⊃ abundance peak period of *A. tamarense*

Economical damages due to toxification are fewer for oyster than the scallop

Number of farmer in Ofunato Bay after the tsunami

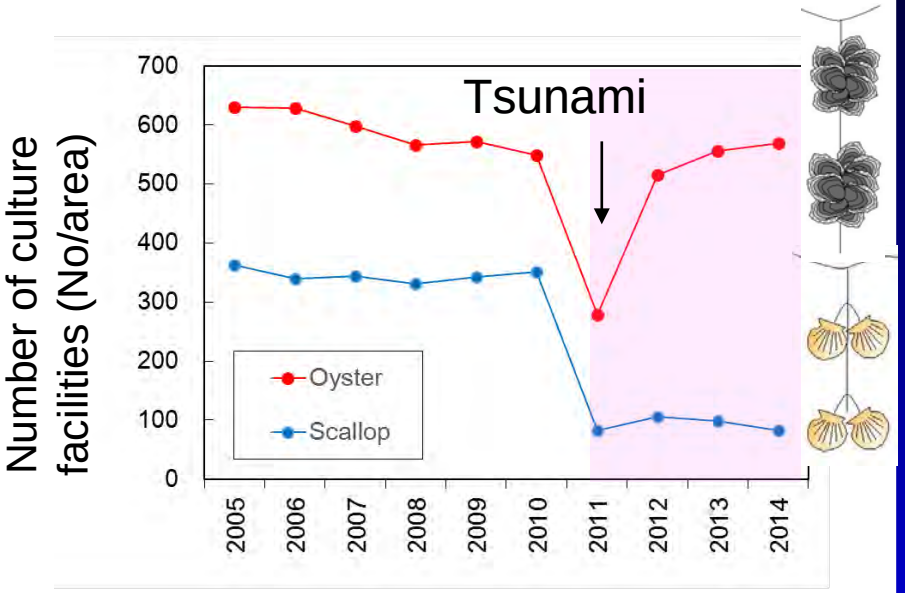


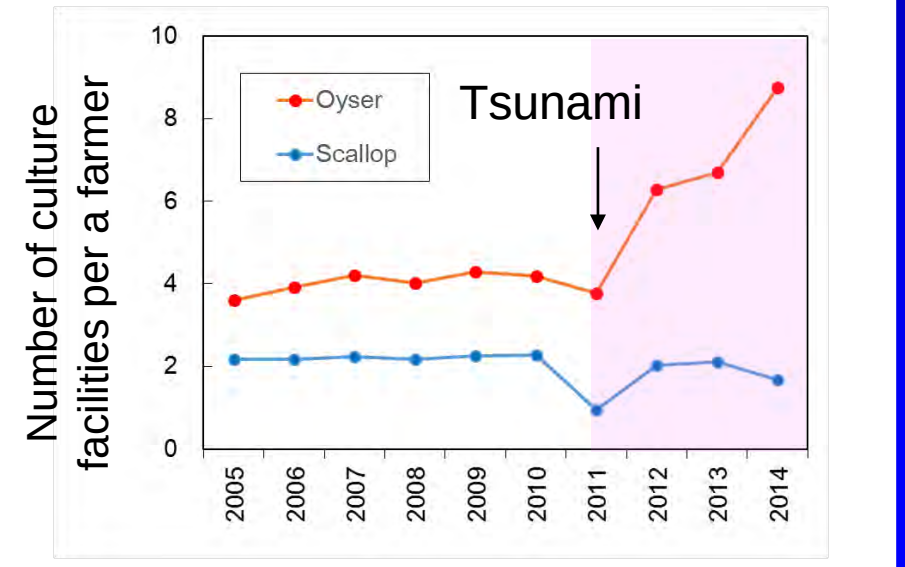
Source: Iwate prefectural report

- Decreased after the tsunami
- For oyster, generally changed similar to the number in all Iwate
- For scallop, decreased clearly, although all Iwate number increased

Decay of scallop aquaculture is specific in Ofunato Bay, caused by long harvest closure period for scallop

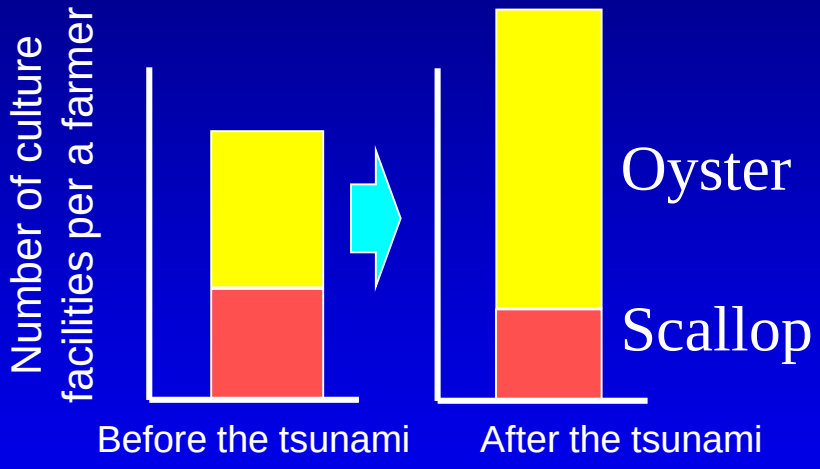
Number of facilities in Ofunato Bay after the tsunami





Source: Iwate prefectural report

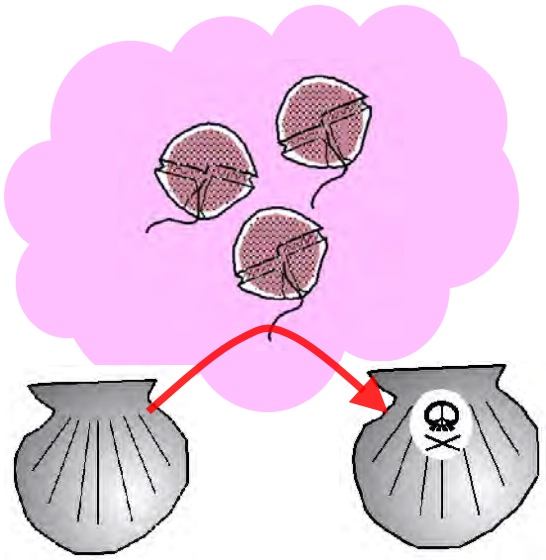
- Number of facilities
  Oyster: recovered
  Scallop: not recovered
- Number of facilities per a farmer
  Oyster: increased
  Scallop: still low level or decreased



The farmers are expanding each culture area, increasing the effort for oyster, decreasing the effort for scallop

Effects of increasing PSP occurrence after the tsunami on bivalve aquaculture (An example in Ofunato Bay)

Occurrence of PSP



Long period of harvest closure for scallop

Decrease farmer's income for scallop.

What should I do?

O The harvest closure period for oyster can be shorter

O Main harvest period is different from the occurrence period of the PSP causative plankton

Farmers are shifting target species from scallop to oyster