PICES-2012 Keynote Lecture
October 15th, 2012, Hiroshima

Resilience and sustainability of the human-ocean coupled system – beyond the Great East Japan Earthquake

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Today's Topics

1. *Sato-yama* and *Sato-umi* in Japan

・As a concept of Human-Natural coupled system
for maintaining biodiversity and
for sustainable use of ecosystem services

2. Effects of the Great East Japan Earthquake on marine ecosystems and their recoveries

・Damage to fisheries and marine ecosystems,
・Radioactive contamination,

From CCCC to FUTURE

How respond the North Pacific ecosystems to climate changes?

CCCC Climate Change and Carrying Capacity (1995-2009)

Sardine, Walleye pollock, Pacific salmon
Offshore/Basin scale study

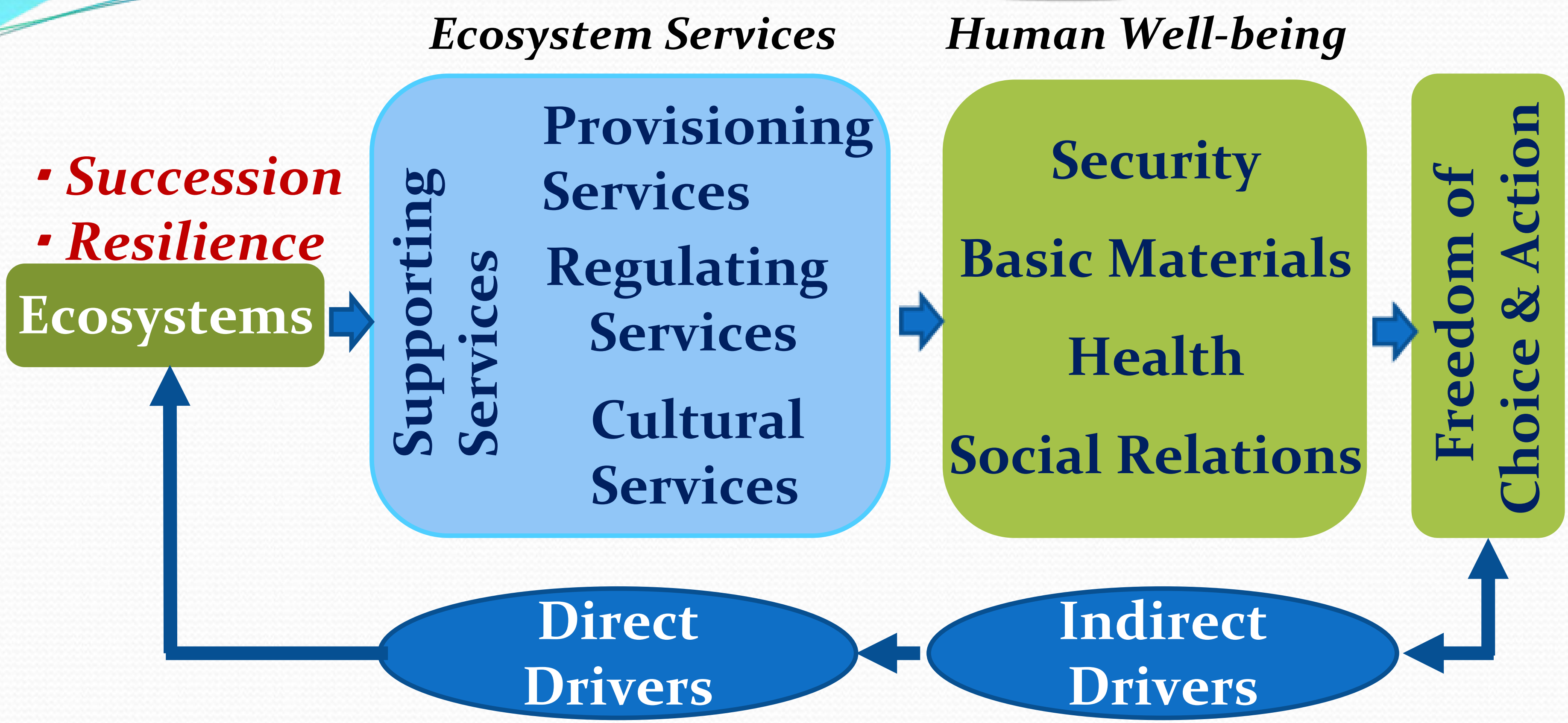
CBD, CoML,IPCC-AR4

How to achieve the sustainable use of the services from the North Pacific ecosystems ?

Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems (2009-) **FUTURE**

Exotic species, HABs, Biodiversity, Human dimension
Coastal/Regional scale study

Human Well-being and Ecosystem Services



Ecological Perturbation & Disturbance

Human activities :

- **Must be limited to the range of the resilience of ecosystems.**
- **Means of the regulation of ecological succession (= maintaining a mosaic of diverse habitats) through the moderate ecological perturbation and disturbance.**

Sato-yama- A Traditional Human-Natural Coupled System in Japan

Sato-yama: A secondary forest (***yama***) nearby a village (***Sato***) in an original sense.

Photo: Tateshina Town

Photo: Fukuoka Prefecture

Sato-yama has been managed as a commons of the village for the collection of firewood, fertilizer, and foods, such as nuts and mushrooms.

Sato-yama-Its Structure & Functions

Sato-yama: A plural ecosystem including various habitats

Illustration: Shiga Prefecture

- **Human activities *Agriculture/Forestry* prevent the ecological succession.**

- **Preservation of each habitat**

- **Maintain Biodiversity and Ecosystem Services of *Sato-yama***

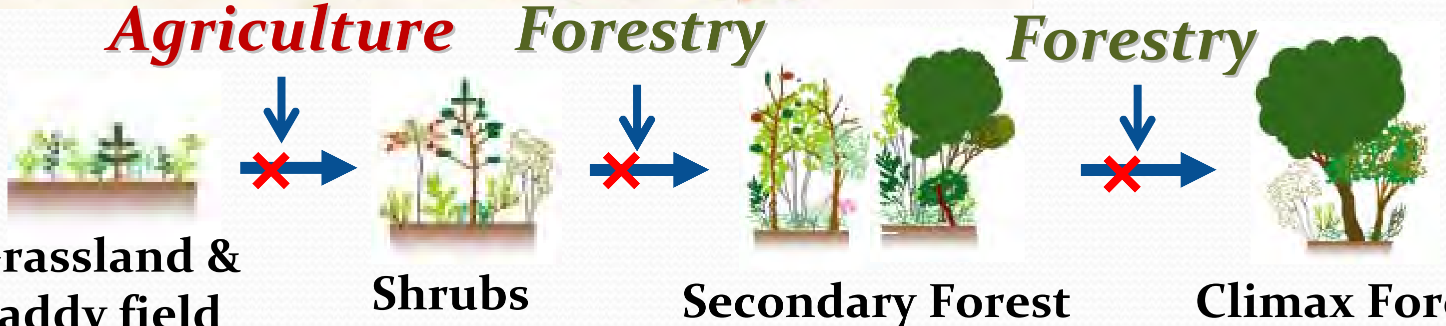


Illustration: http://www.cgr.mlit.go.jp/ootagawa/sand/west/plants/forest/3b/index.htm

Sato-umi – A Concept of Human-Ocean Coupled System

Sato-umi: A coastal area where biological productivity and biodiversity has increased through human interaction

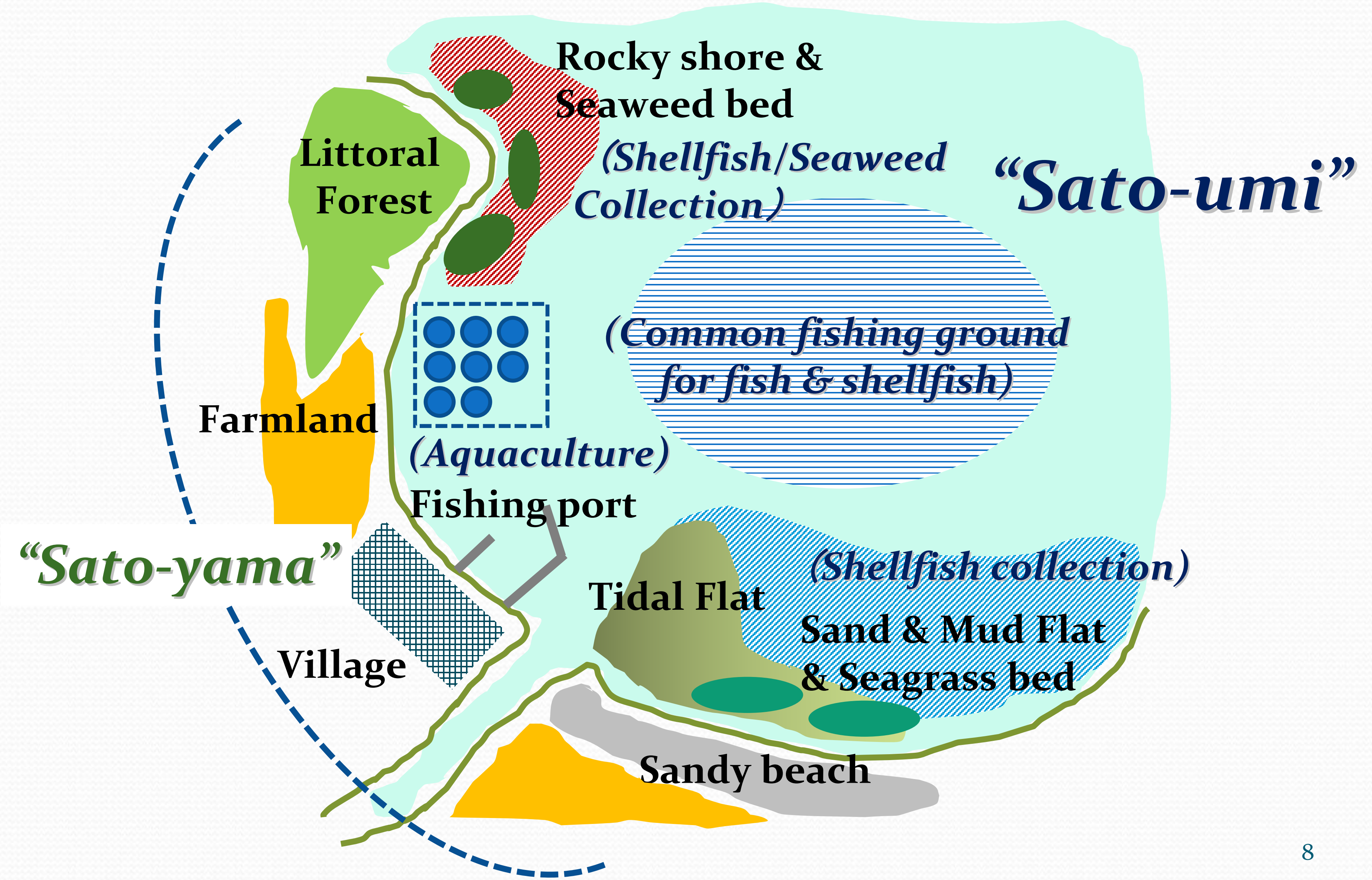
(Ministry of the Environment)

***"Umi"* = sea**

Photo: Kyoto Prefecture/ National Federation of Fisheries Co-operative Associations

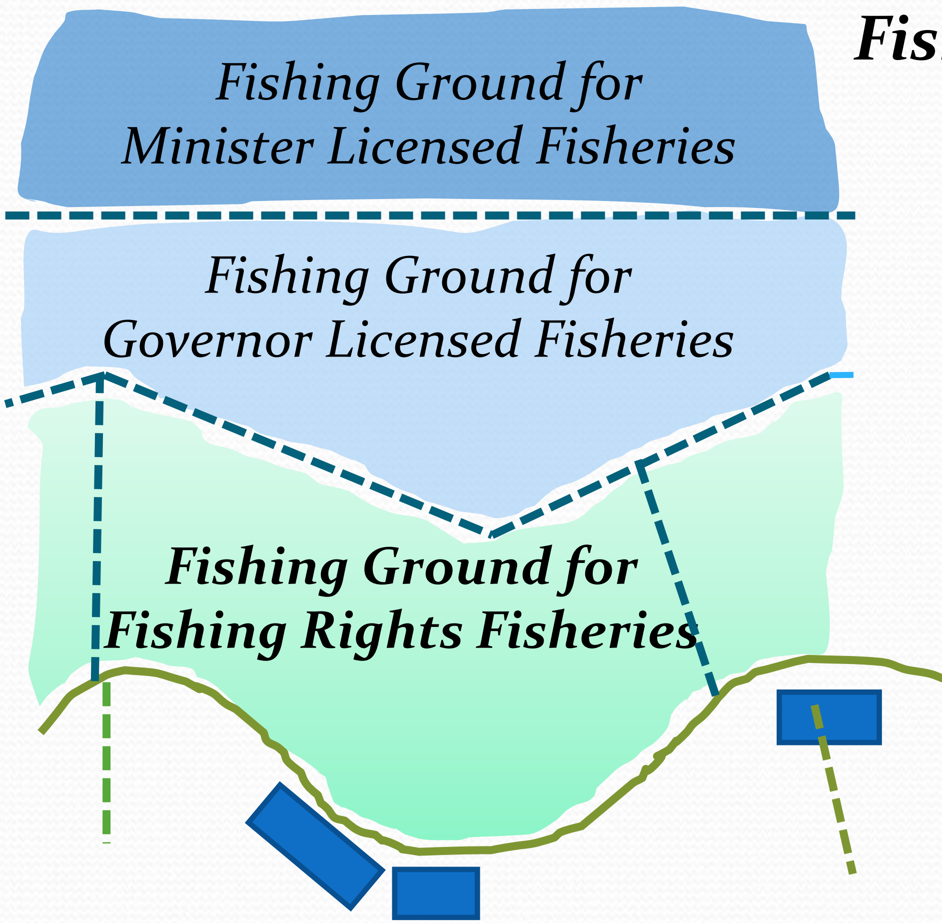
Sato-umi-Its Structure

An Image of the Structure of *Sato-umi*



Institutional Base of *Sato-umi*

Coastal Fisheries Management by Fishing Rights



Fishing village
(Fisheries Co-operative Association)

Fishing Rights:

- **Exclusive rights granted by the Government to engage in specific fisheries in public waters.**
- **Fishing ground of this fisheries is a commons for fishers who live in the village near the fishing ground.**

↓

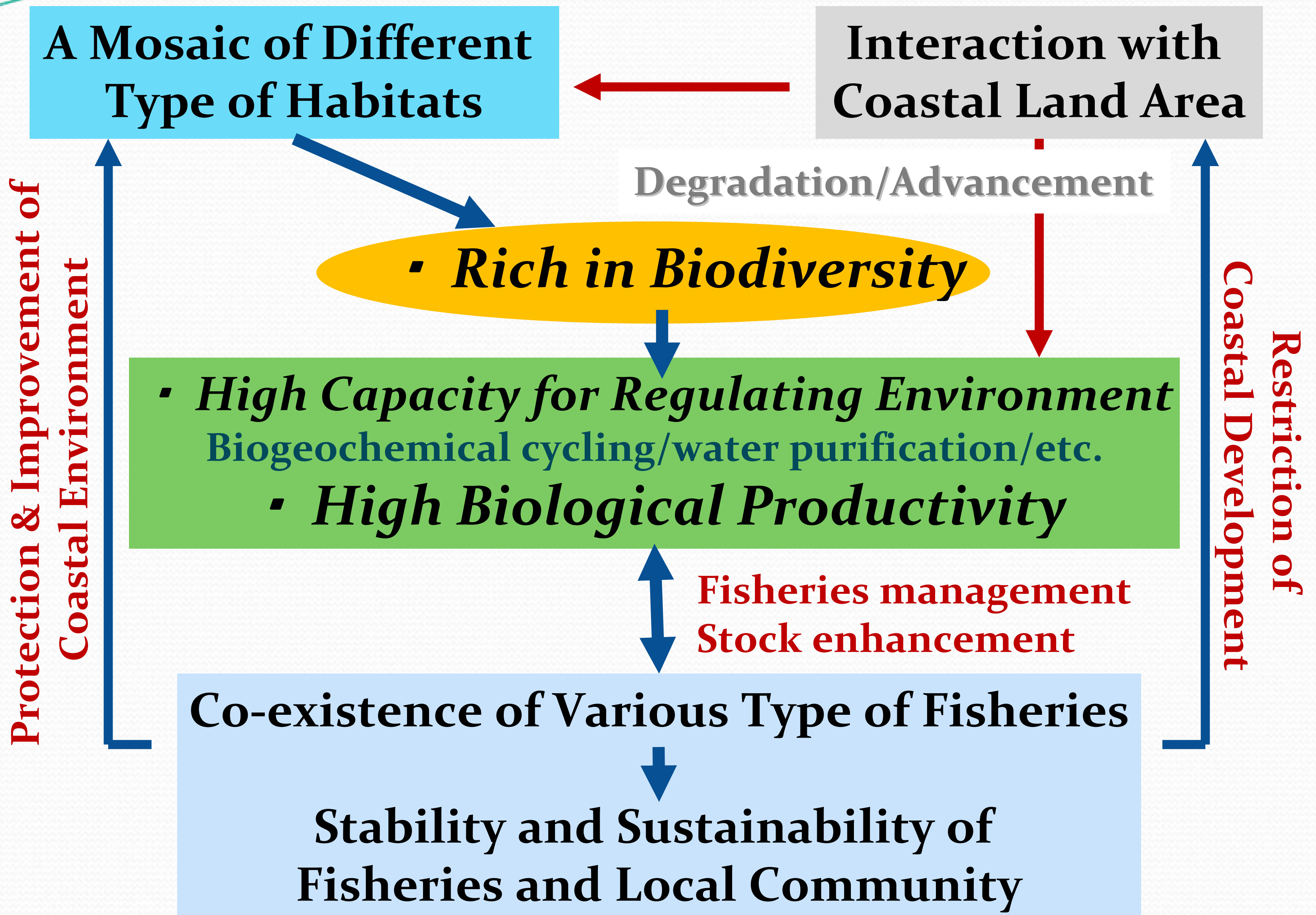
Control of the excessive entry to fisheries
Restraint to overexploitation in coastal areas

Characteristics of Japanese-style Coastal Fisheries Management

- Voluntary efforts of fishers based on their agreement
  Area & Time Closure/Catch & Effort Control/
  Size & Sex Limitation

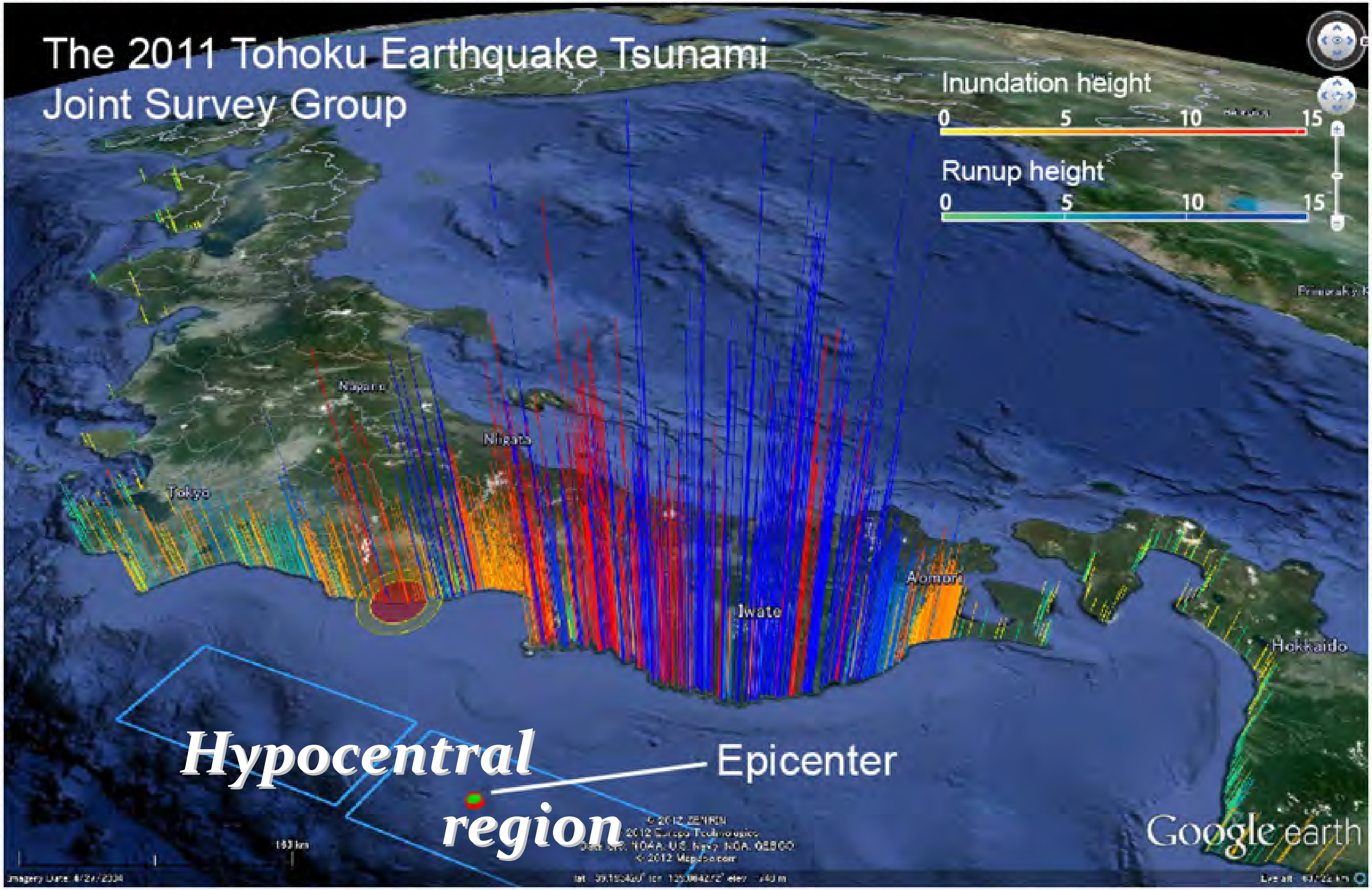
- Integrated implementation with Stock Enhancement and Improvement of Fishing Ground

Sato-umi-Its Functions



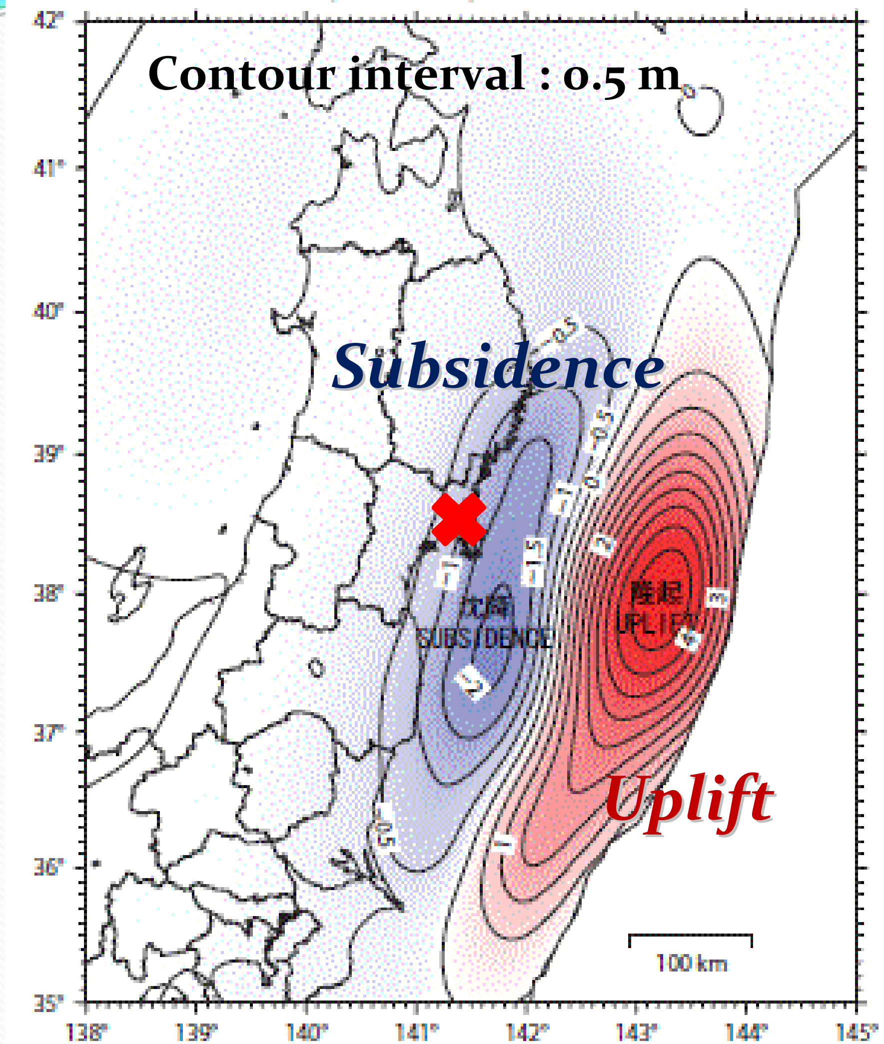
The Great East Japan Earthquake

1. Date and time : 14:46, March 11, 2011
2. Hypocenter : 38°6.2' N, 142°51.6'E
3. Depth : 24km,   4. Magnitude : M9.0

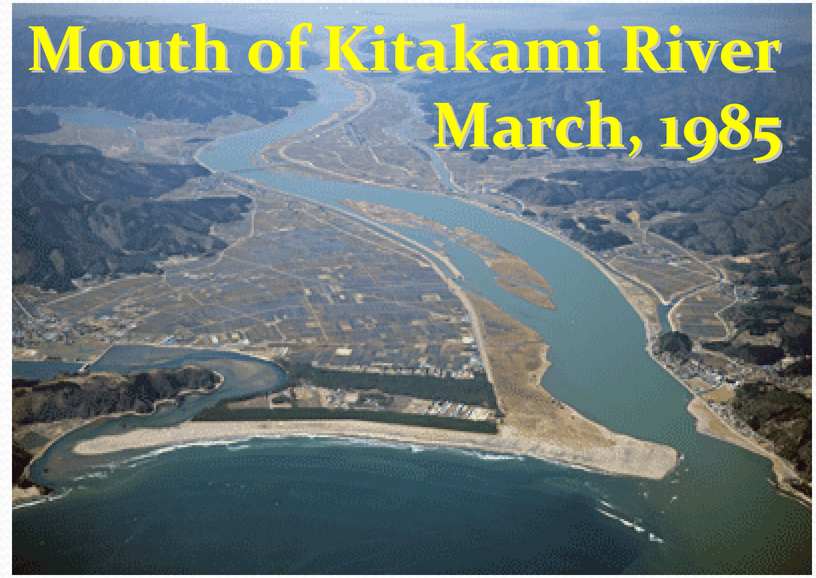


Data: The Coastal Engineering Committee of the Japan Society of Civil Engineers

Changes in Topography with the Earthquake



Vertical deformation calculated from slip distribution model

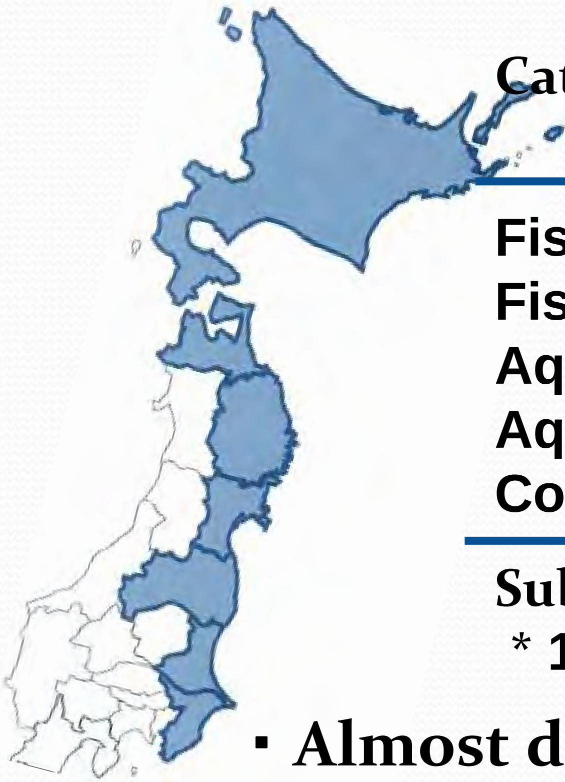


Ｄａｔａ：Geospatial Information Authority of Japan

Photo: Miyagi Prefecture

Damage to Fisheries

Damage from the Great East Japan Earthquake to the fisheries in Japan (as of July 5, 2012)



Category	Number of Damage	Amount of Damage*
Fishing vessels	28,612	1,822
Fishery harbor facilities	319	8,230
Aquaculture facilities	-	738
Aquaculture products	-	597
Common use facilities	1,725	1,249
Subtotal*		12,637

* 100 million \

- Almost damages were occurred in 7 prefectures from Hokkaido to Chiba. (12,544 x 100 million \)
- Seafood processing facilities in 7 prefectures were also damaged. (1,639 x 100 million \)

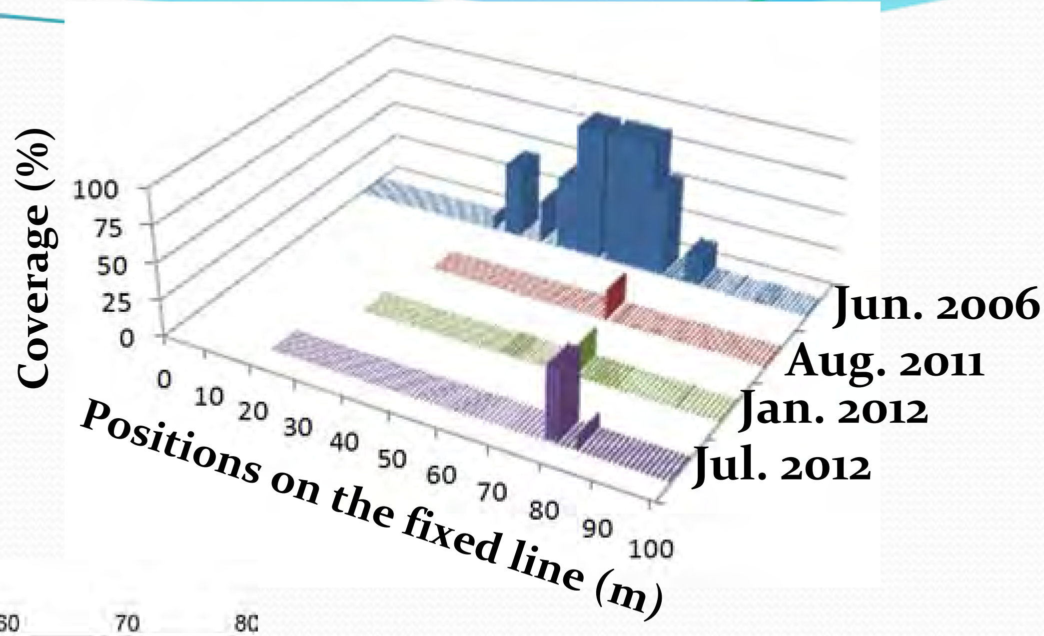
Data: Ministry of the Agriculture, Forestry and Fisheries

Effects to Sea grass bed and Tidal flat

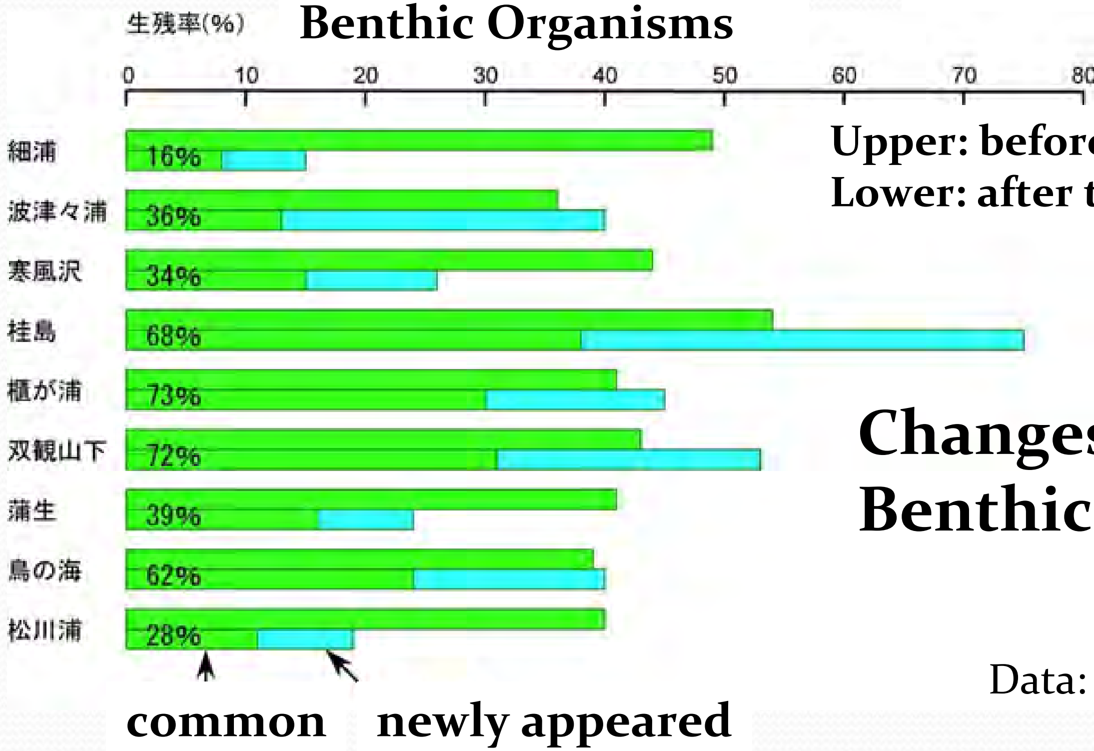
Changes in sea grass bed

(Same-no-ura/Ishinomaki City)

Data: Dr. Daisuke Muraoka/FRA



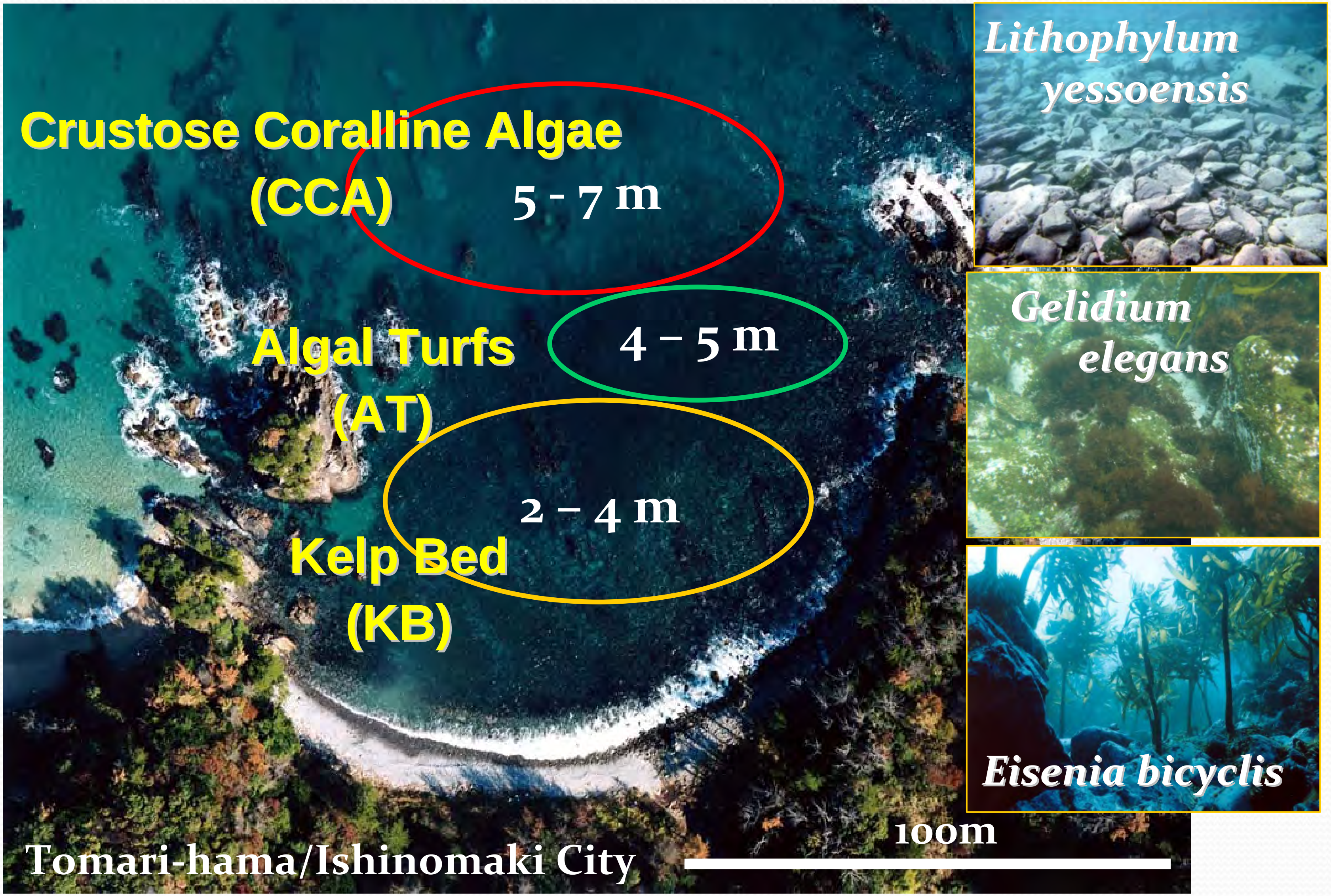
Number of Species of Benthic Organisms



Changes in number of Species of Benthic organisms in taidal flats

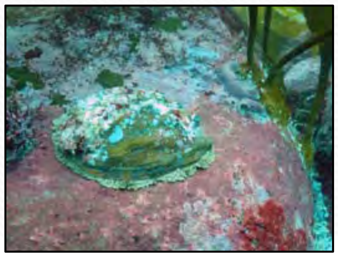
Data: Dr. Takao Suzuki, Univ. Tohoku/
Ministry of the Environment

Effects to Seaweed Bed

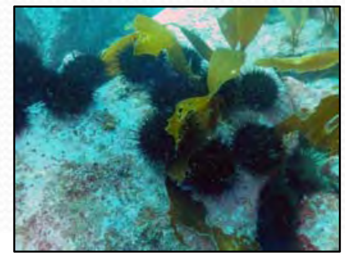


Data & Photo: Dr. Hideki Takami/FRA

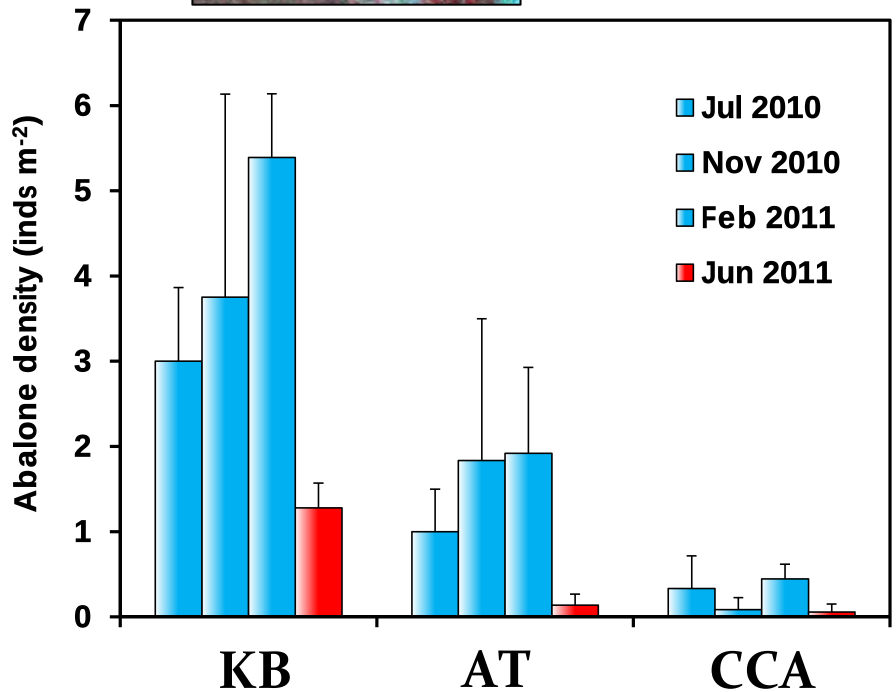
Changes in the densities of abalone and sea urchin between before and after the tsunami

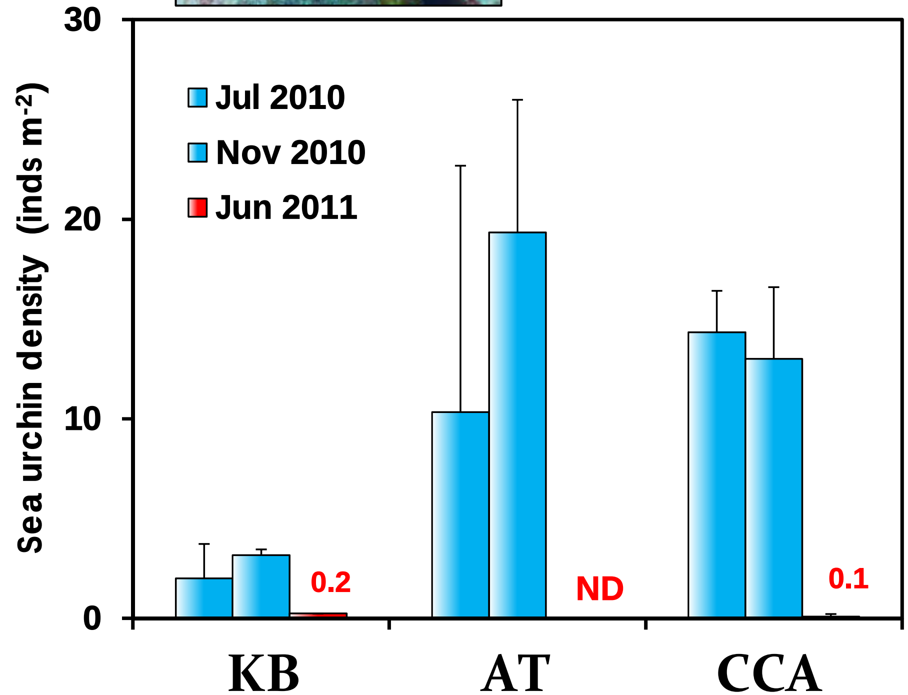


Abalone



Sea urchin

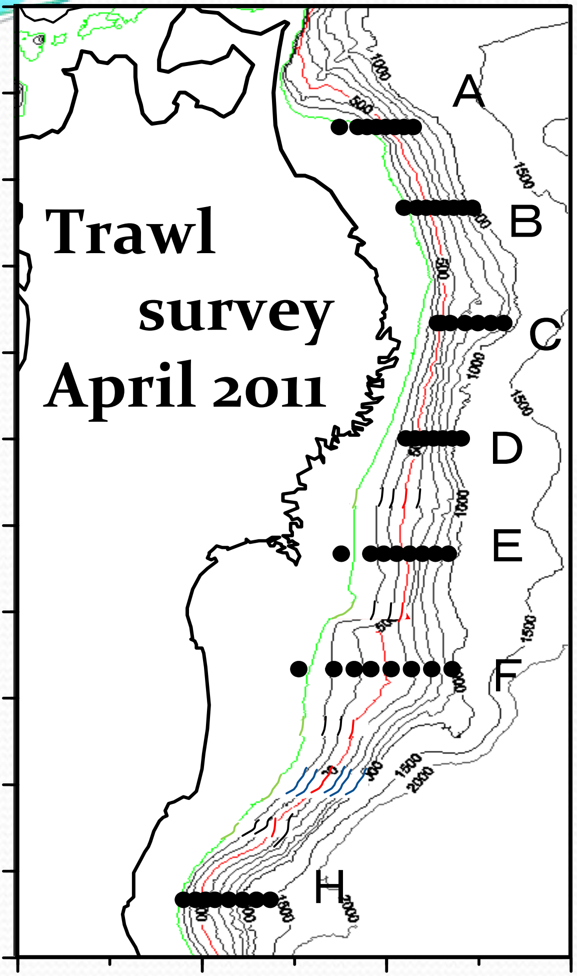




Type of Seaweed Bed

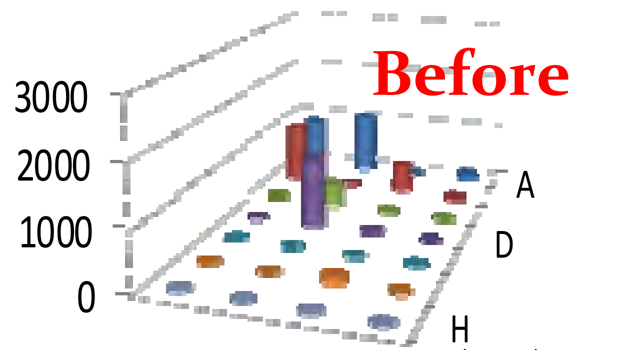
KB : Kelp Bed/AT : Algal Turfs/CCA : Crustose Coralline Algae

Effects to Offshore & Migratory Species

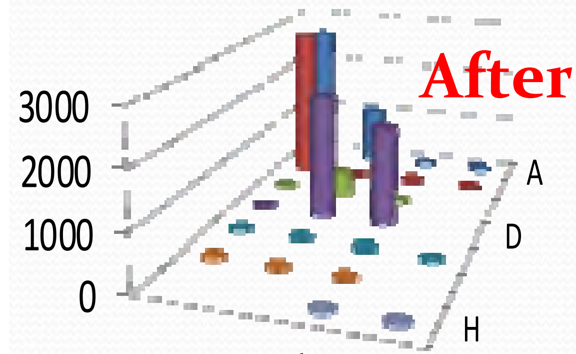


Trawl survey April 2011

Distribution of walleye pollock

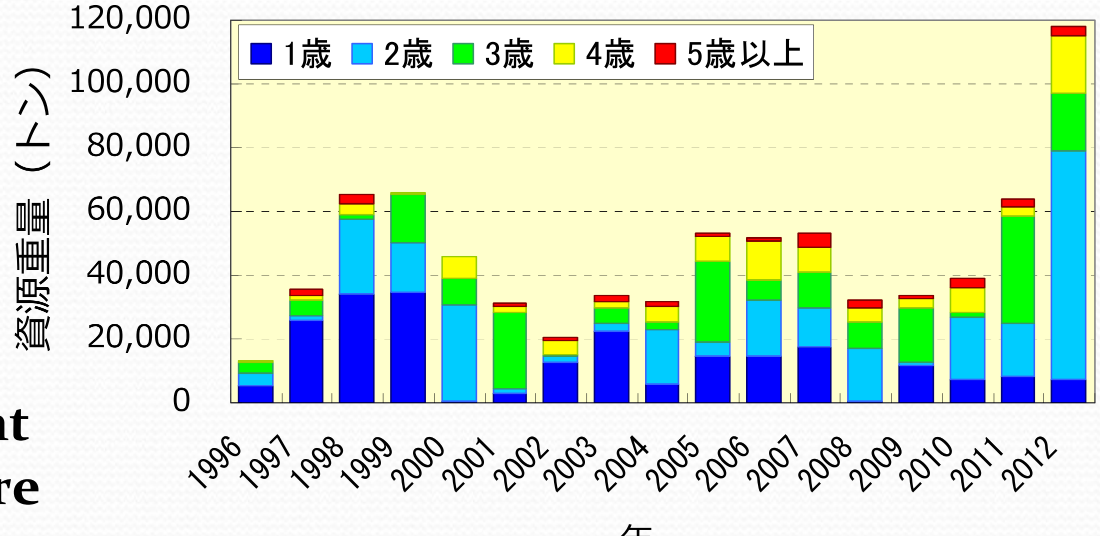


Apr. 2006-2010(Av)



Apr. 2011

Stock in weight of Pacific cod by age



- There was no significant deference between before and after the earthquake.

Data: Y. Narimatsu et.al./FRA (unpublished)

Radioactive Contamination

Estimated Amount of Radioactive Materials into the Ocean

(as of May 2012, Data: TEPCO)

Institution	Period of Assessment	Released amount in PBq I-131	Cs-134	Cs-137
TEPCO	Mar. 26 - Sept. 30	11	3.5	3.6
JAEA	Mar. 21 - Apr. 30	11.4	-	3.6
IRSN	Mar. 21 - Mid-Jul.	-	-	27

Half-life: I-131=8 days, Cs-134=2 years, Cs-137= 30 years PBq=10^{15}Bq

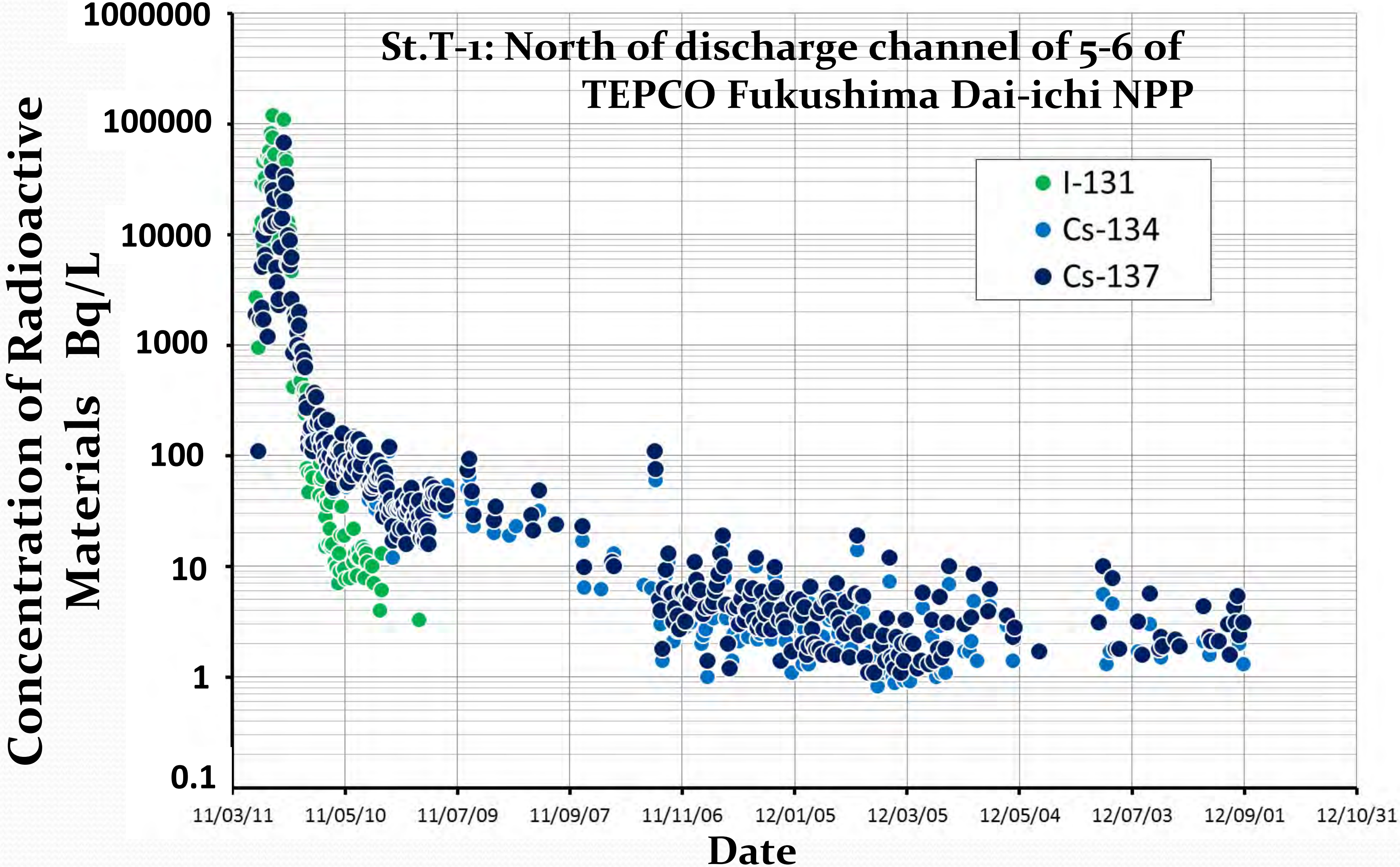
Method:

TEPCO/JAEA: Calculate the amount of radioactive materials using a diffusion model so as to reproduce the concentration in seawater near the discharge canals of the power plant.

IRSN: Draw a contour map of the Cs-137 concentration in the North Pacific Ocean off Fukushima Prefecture, and then calculate the total amount of Cs-137.

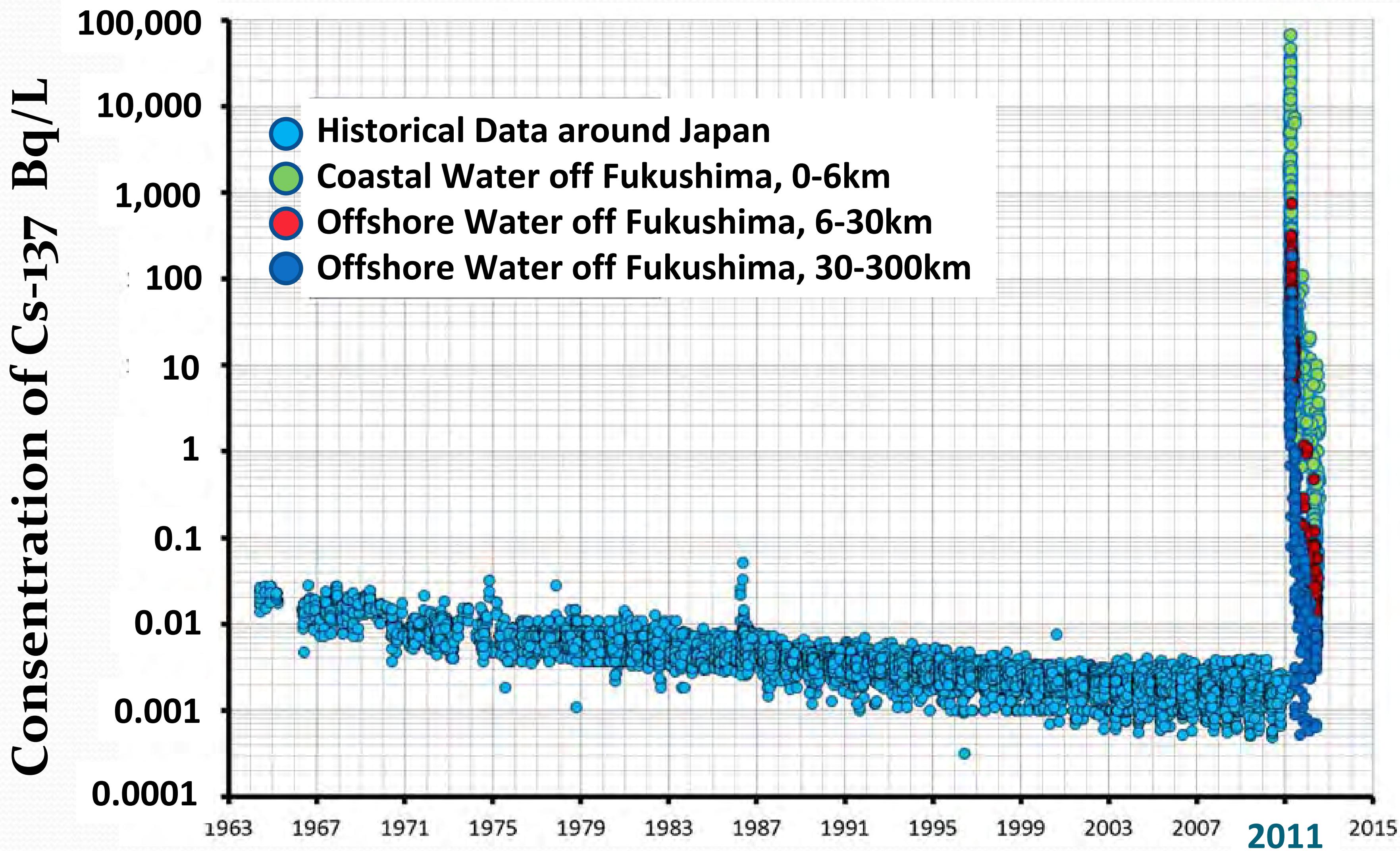
TEPCO: Tokyo Electric Power Company /JAEA: Japan Atomic Energy Agency
IRSN: Institute de Radioprotection et de Sûreté Nucléaire

Concentration of Radioactive Materials in the Seawater near the Fukushima Dai-ichi NPP



Data: MEXT

Cs-137 concentration of sea water around Japan for 1964-2010 and off Fukushima for 2011-2012

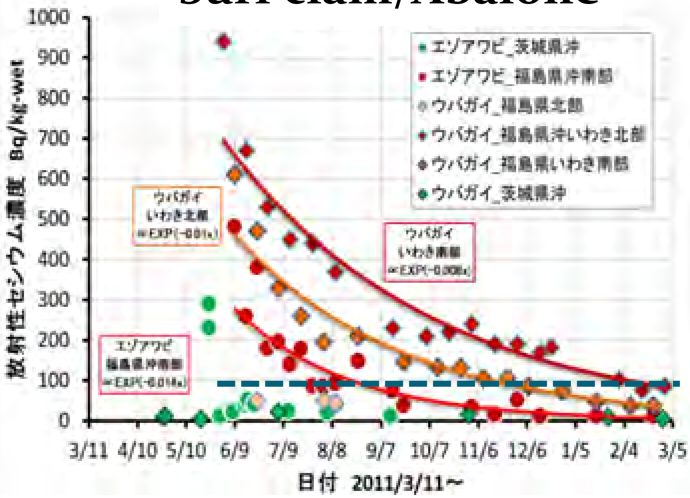


Data: MEXT/Meteorological Res. Inst.(Dr. Aoyama)

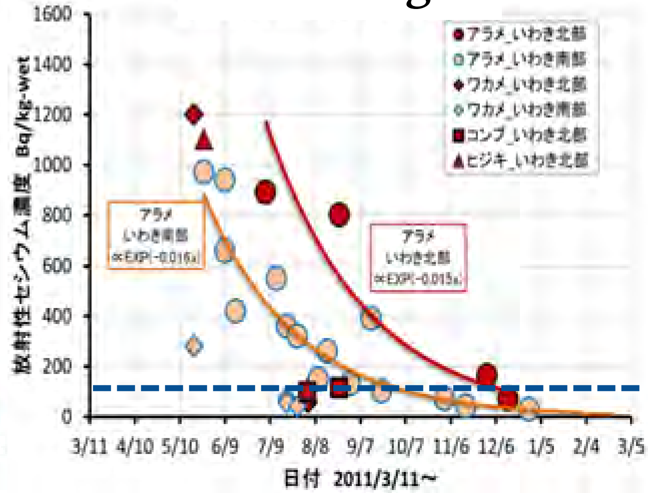
Concentration of Radioactive Cesiums (Cs-134 +Cs137) in Marine Organisms-1

Bq/kg-wet

Surf clam/Abalone



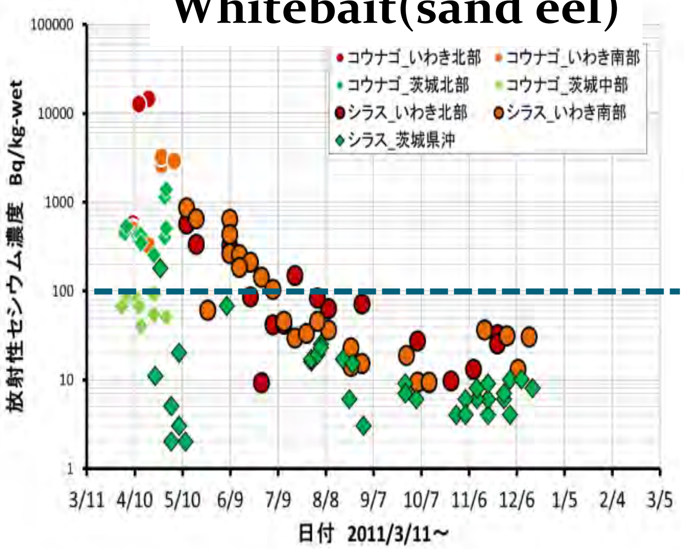
Brown Algae



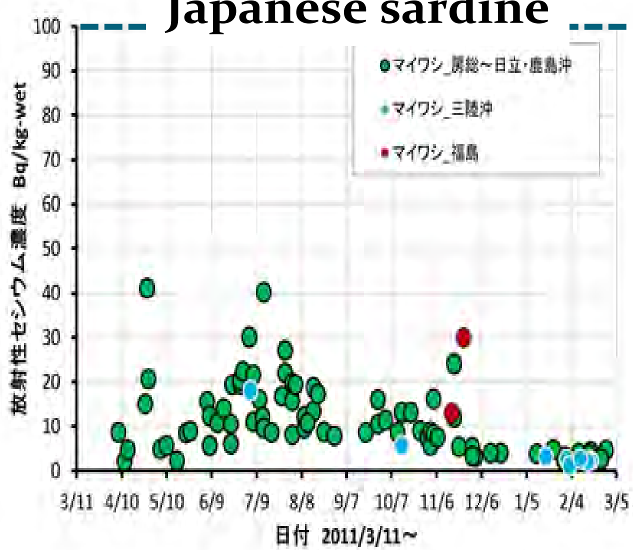
- **Biological half-life = 50 – 140 days**

Pelagic fishes & larvae,
Shellfishes,
Sea urchins,
Brown algae, etc.

Whitebait(sand eel)



Japanese sardine



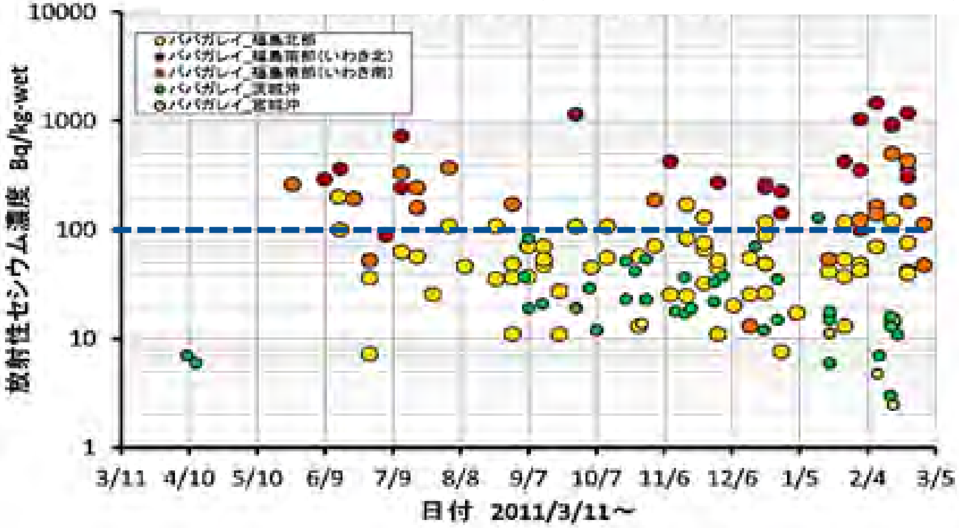
- **Decrease Cs conc. in Sea water**

- **Decreased to low or undetectable levels**

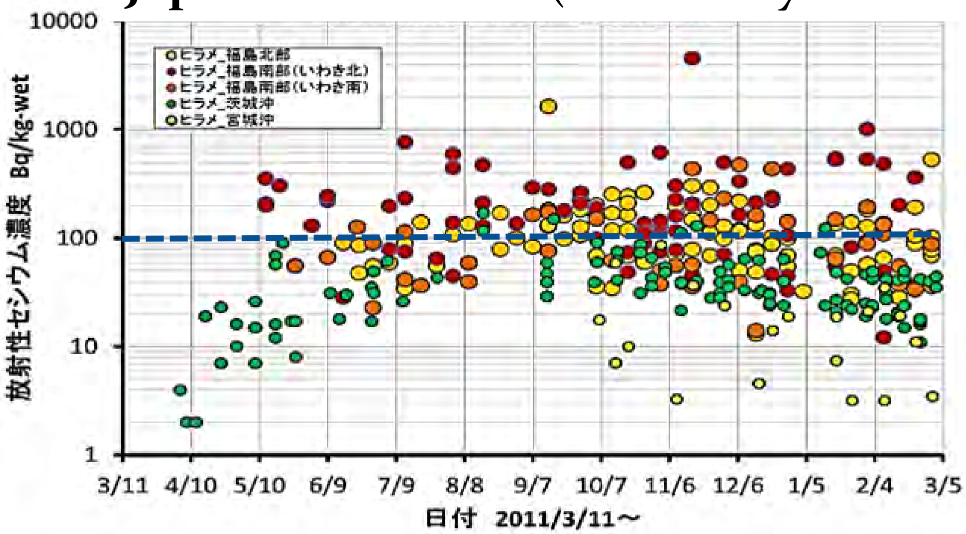
Data: The Fisheries Agency

Concentration of Radioactive Cesiums (Cs-134 +Cs137) in Marine Organisms-2

Slime flounder (*Microstomus achne*)



Japanese flounder (*Paralichthys olivaceus*)



- **Some benthic fishes and other organisms in some areas remain relatively high levels**

- ***food habits:***
  carnivorous
  cod, flounder
  ominivorous
  greenling,
  black sea bream
- ***Osmoregulatory ability:***
  euryhaline
  perch, black sea bream

Tsunami Debris – Type and Abundance

- About 5 million tons of debris from Iwate, Miyagi and Fukushima Prefectures washed out by the tsunami.
- Its 70 % (3.5 million tons) deposited on seabed along the coast of Japan, and the remaining 30 % (1.5 million tons) became floating debris.

(Unit: thousand tons)

Type	Floating Debris	Debris on Seabed	Sum
Houses	1,336	2,783	4,119
Cars	-	313	313
Driftwoods	199	-	199
Ships	1	101	102
Aquaculture facilities	-	16	16
Fixed fishing nets	-	18	18
Cargo containers	-	35	35
Total	1,536	3,266	4,802

Data: Ministry of the Environment

Influences of Floating Debris

1． Ecological Influences:

・Effects to Highly Migratory Species
= accidental ingestion/
tangle to organisms/ghost fishing

・Pollution of Coastal Environment

・Transport & Diffusion of Exotic Species

2． Influences to Ship Navigation and Fishing Operation:

・Collision with ships/Tangle to Ships' propellers and fishing gears

3． Other Influences:

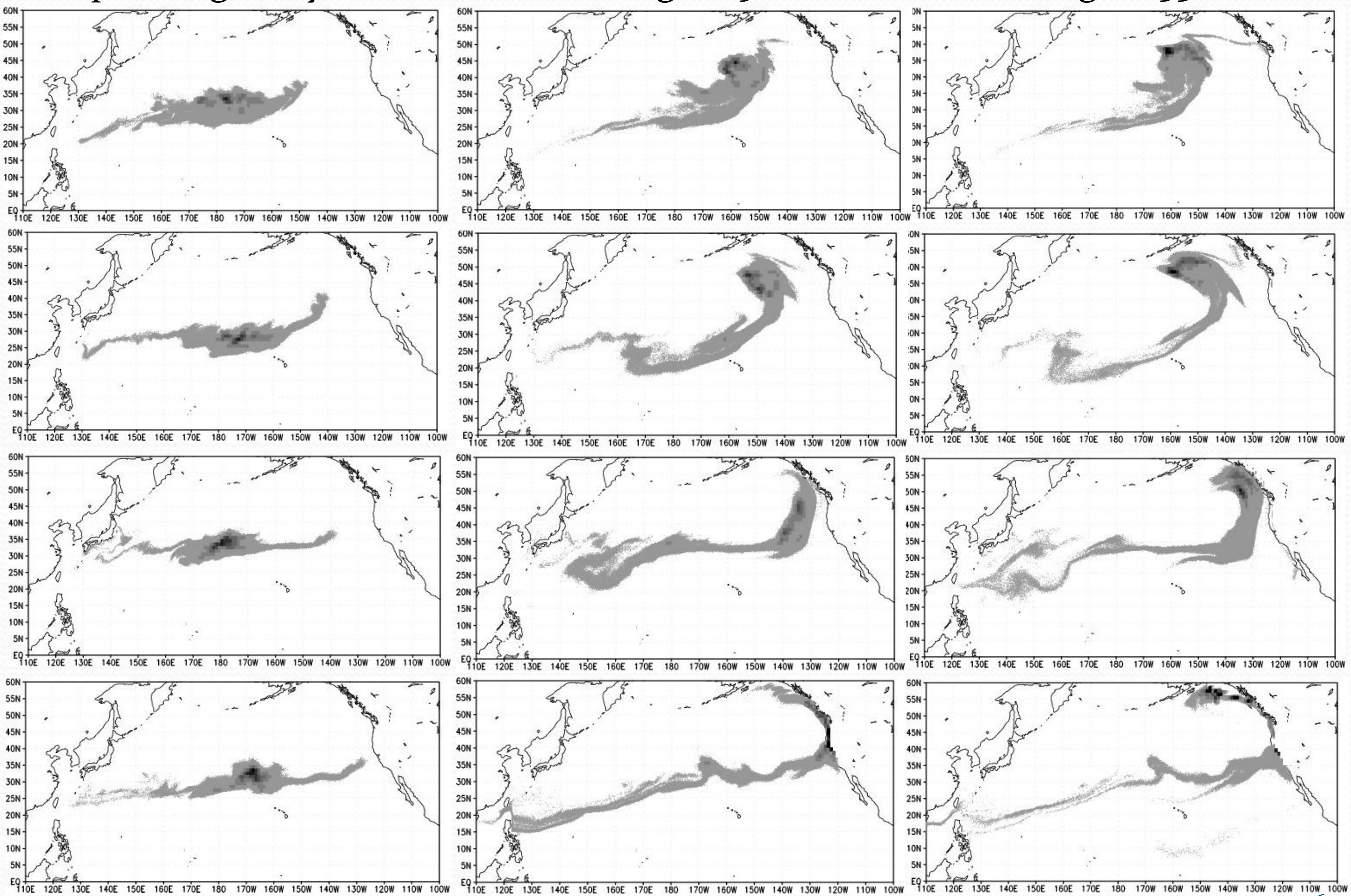
・Damage to coastal landscape by debris

Photo: U.S. Navy/AFLO/ZUMA Press

Photo: The Aquatic Nuisance Species (ANS) Task Force

Debris Drift Prediction

	Subsurface type Specific gravity=1.0	**Lumber type** S.g.=0.5	**Float type** S.g.=0.33
Feb. 2012			
Jun. 2012			
Oct. 2012			
Feb. 2013			



Data: Ministry of the Environment

Remaining Subjects and Necessity of International Cooperation-1

1. Ecological Impacts:

- Offshore region/Migratory species - Small or Negligible.
- Coastal ecosystems – Large. Take a long time to recover.
  Long-term monitoring and attention to ecological succession are required.

2. Radioactive contamination:

- Radioactivity in seawater has been decreased. But, still relatively high in sediments and benthic organisms in some waters.
- Continuation of monitoring and studies on the dynamics of radioactive materials in the ecosystem are required.

Remaining Subjects and Necessity of International Cooperation-2

3. Floating Debris:

- Lots of debris will drift widely in the North Pacific Ocean for several years, and arrived to the coast of the North Pacific rim.
- Monitoring and studies on impacts on coastal/oceanic ecosystems, mitigation ways of impacts, and treatment of debris are required.

- These subjects are common to the North Pacific Ocean.
- International cooperation is essential for enhance the research activities and continuation of the monitoring.
- PICES is expected to take a leading role in the planning and implementation of the international cooperation.

Acknowledgement-1

I would like to express our sincere thanks for the warm sympathy and strong aid from the PICES member countries and from all over the world in response to the terrible disasters of the Great East Japan Earthquake.

PICES and ICES kindly donated CD$55,100 to aid the marine science in the disaster area.

This donation was distributed to 11 research projects through the Japanese Society of Fisheries Oceanography and strongly support the ecological studies in the area.

The results of the projects will be summarized and presented in this Annual Meeting (S11) with our sincere thanks.

The title is

"General report of the projects aided by PICES/ICES/JSFO fund for fisheries and oceanographic research on the recovery from the Great East Japan Earthquake"

Acknowledgement-2

This presentation is based on the studies conducted by many institutes, universities, and scientific societies, including the Fisheries Research Agency (FRA).
I would like to express my sincere thanks and respects for their earnest activities.

I would like to express my deepest thanks to
Drs. Kaoru Nakata, Hiroaki Saito, Shin-ichi Ito,
Mitsutaku Makino, Toyomitsu Horii, Daisuke Muraoka,
Hideki Takami, Takami Morita, Hideki Kaeriyama,
Tomowo Watanabe, and Hiroya Sugisaki
for their kind support during the preparation of
this presentation.

Tank you very much for your kind attention.