Studies on the secondary succession in coastal ecosystems after the enormous disturbance by the Great East Japan Earthquake on Sanriku Coast; importance of scientific guidelines for the future sustainable fisheries and ecosystem management

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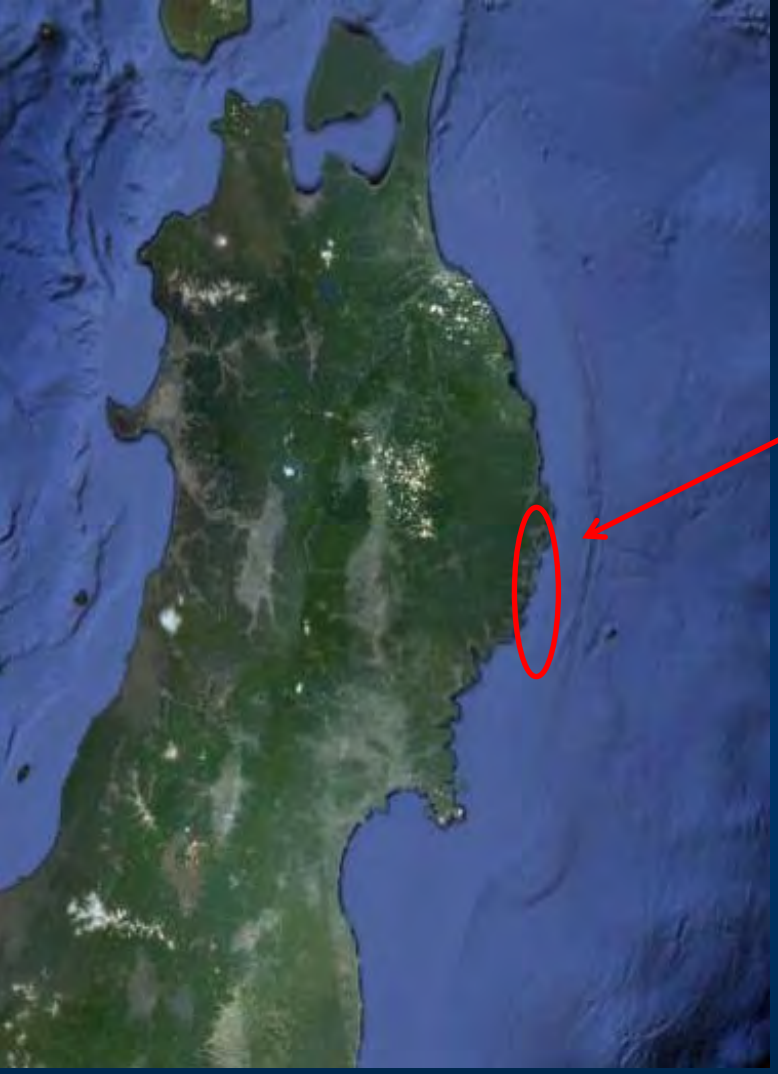


Otsuchi, Iwate

Coastal Ecosystem Restoration,

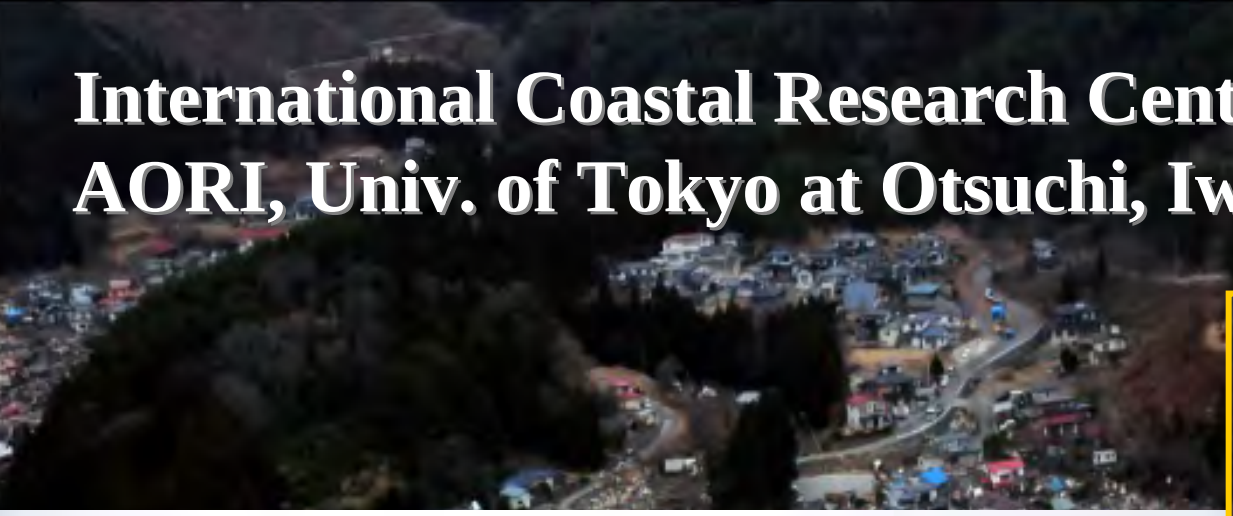
International Coastal Research Center, AORI, UT

established in April 2012

International Coastal Research Center
AORI, Univ. of Tokyo at Otsuchi, Iwate

The maximum tsunami height: 12.2 m

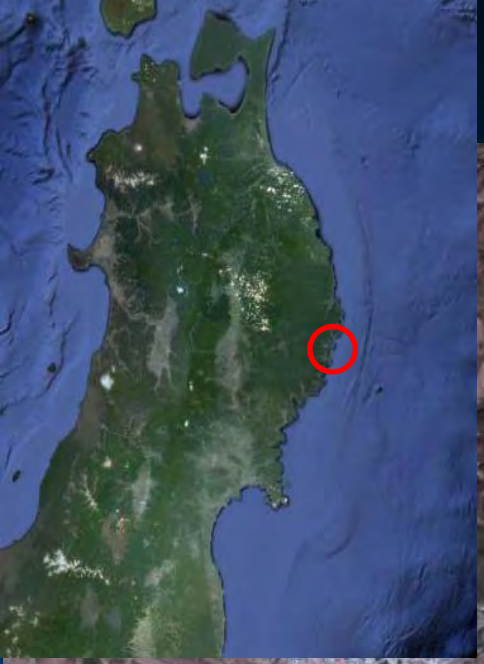
International Coastal Research Center
AORI, Univ. of Tokyo at Otsuchi, Iwate (after tsunami)



- ✓All of the staffs and students escaped unhurt.
- ✓Some of the local staffs lost their houses.
- ✓All buildings and facilities were completely destroyed or damaged.
- ✓1300 people were killed or still missing out of ~15000 in the town.

What happened in coastal ecosystems, and in the populations of fisheries resource organisms?

Otsuchi Bay



6 – 10 m
Kelp bed: *Saccharina religiosa*

> 10 m
CCA: *Lithophyllum yessoensis*

ICRC

No apparent effects of tsunami on macroalgal populations in both Kelp bed and CCA bed.

What happened in benthic animals?

Underwater quadrat samplings using SCUBA

2 × 2 m or 1 × 1 m by hand for large animals

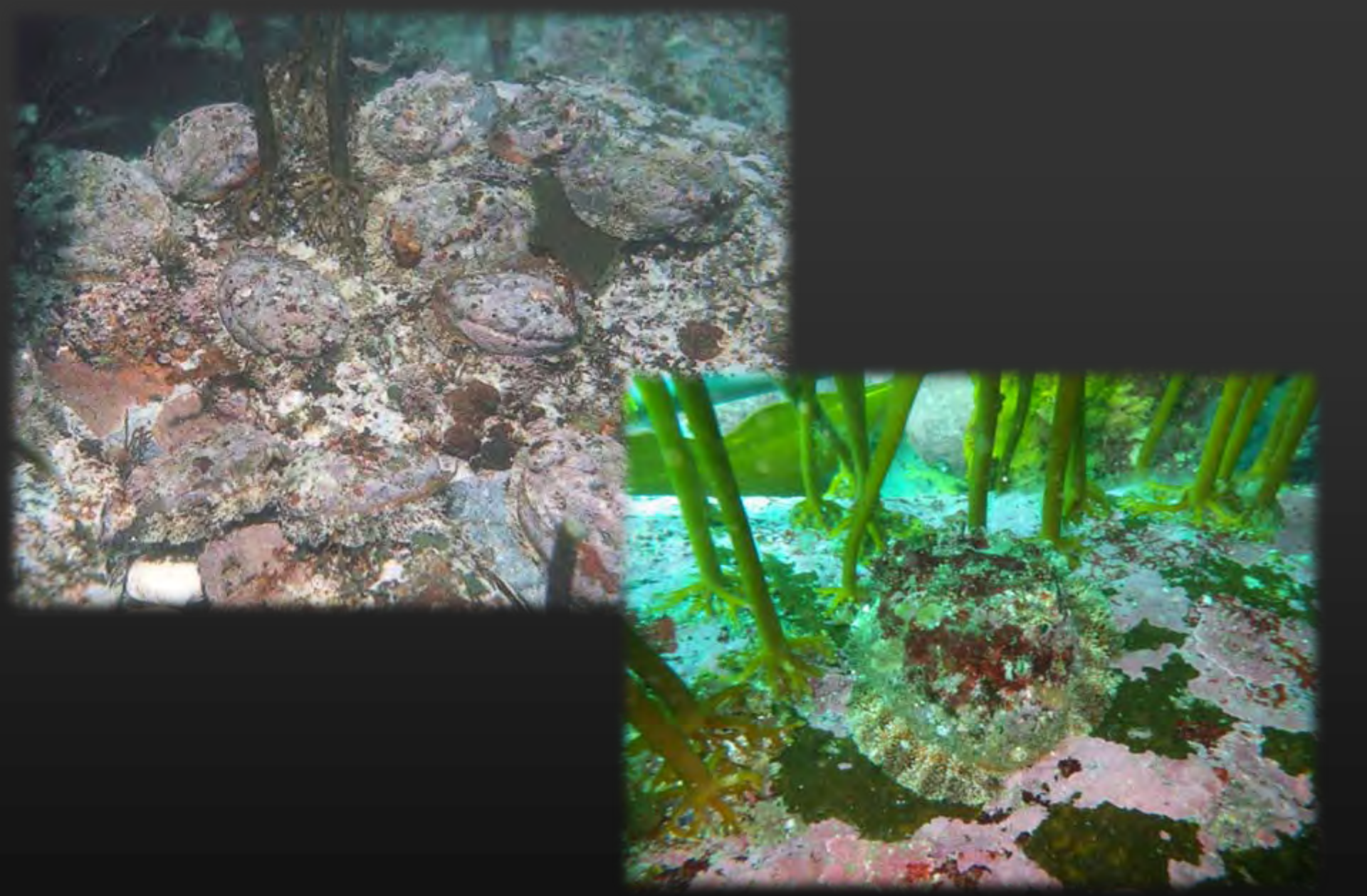
0.25 × 0.25 m by a air-lift sampler for smaller ones

CCA bed

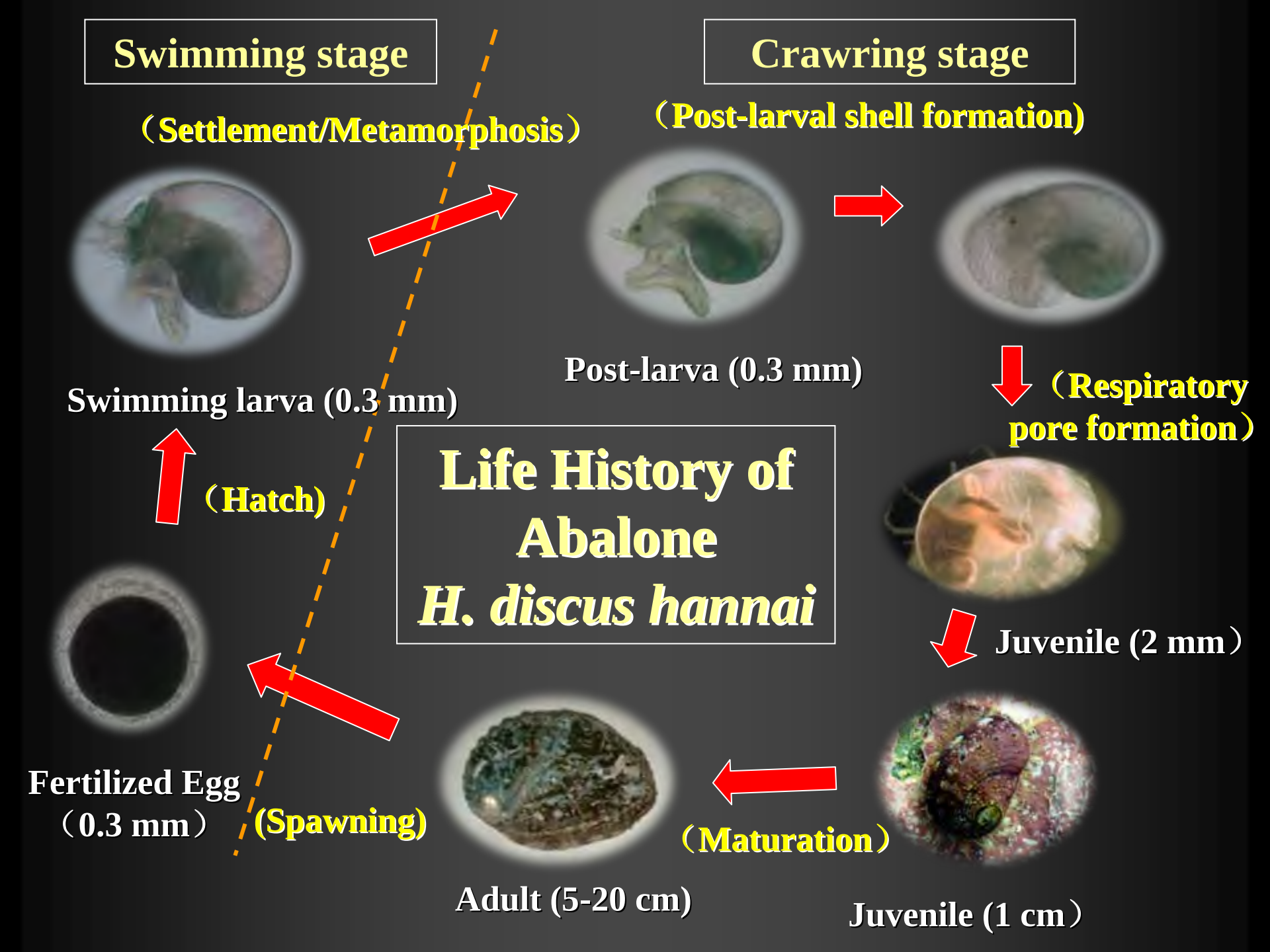
Kelp bed

Abalone
Haliotis discus hannai

Sea urchin
Strongylocentrotus nudus



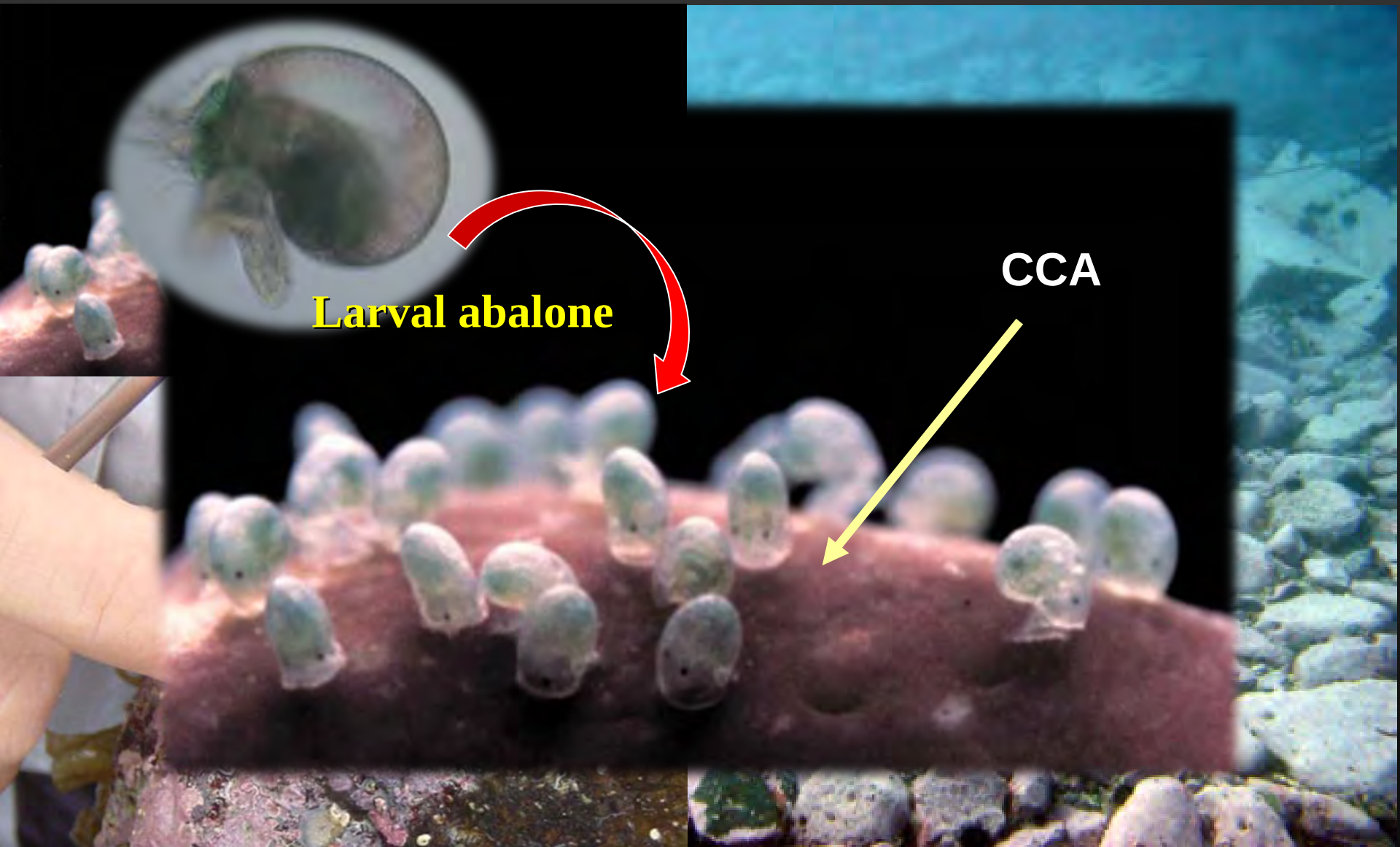
Adult abalone *Haliotis discus hannai* inhabits mainly in the kelp bed


Swimming stage
Crawring stage
（Settlement/Metamorphosis）
（Post-larval shell formation)
Post-larva (0.3 mm)
Swimming larva (0.3 mm)
（Respiratory pore formation）
（Hatch)
Life History of Abalone
H. discus hannai
Juvenile (2 mm）
Fertilized Egg （0.3 mm）
(Spawning)
（Maturation）
Adult (5-20 cm)
Juvenile (1 cm）

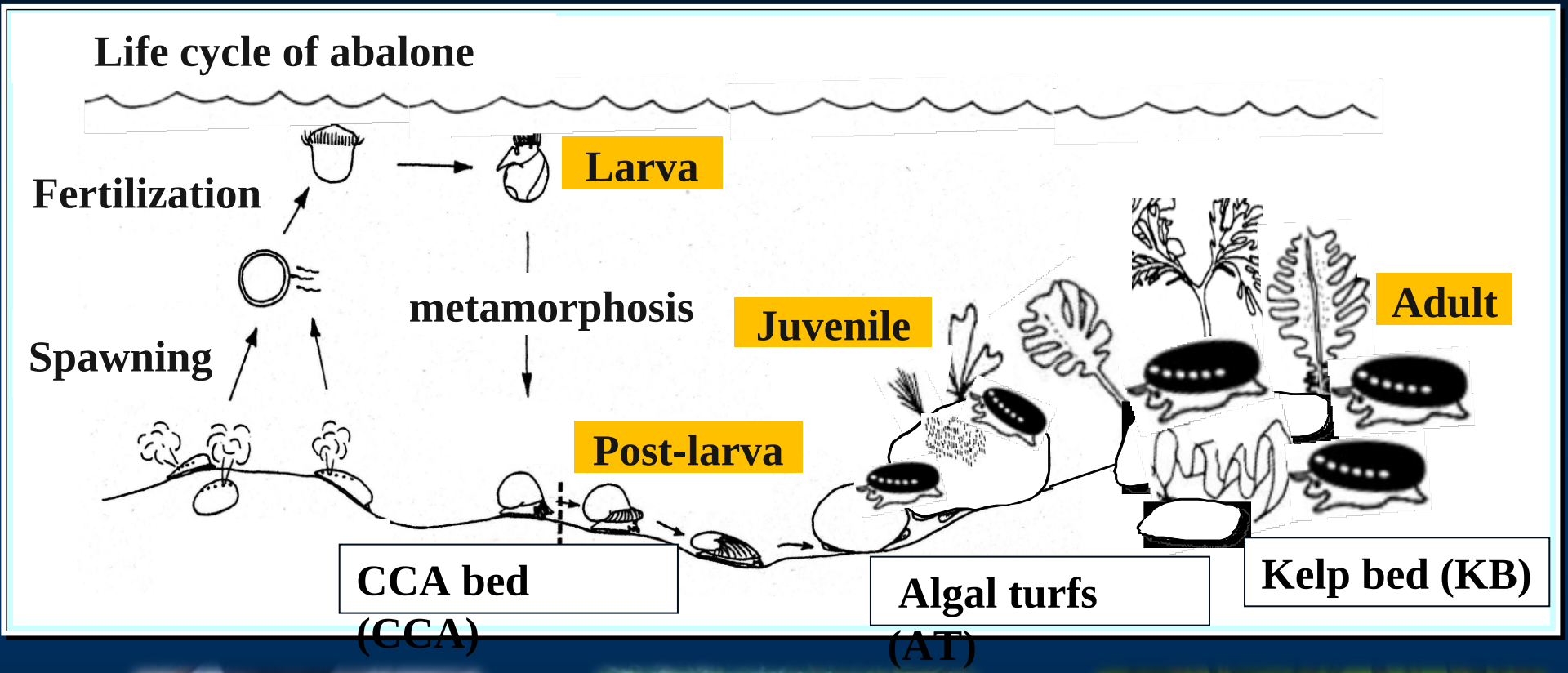
- **Larval abalone settle on crustose coralline algae (CCA) in the natural environment**

Larval abalone

➢Larval abalone settle on crustose coralline algae (CCA) in the natural environment



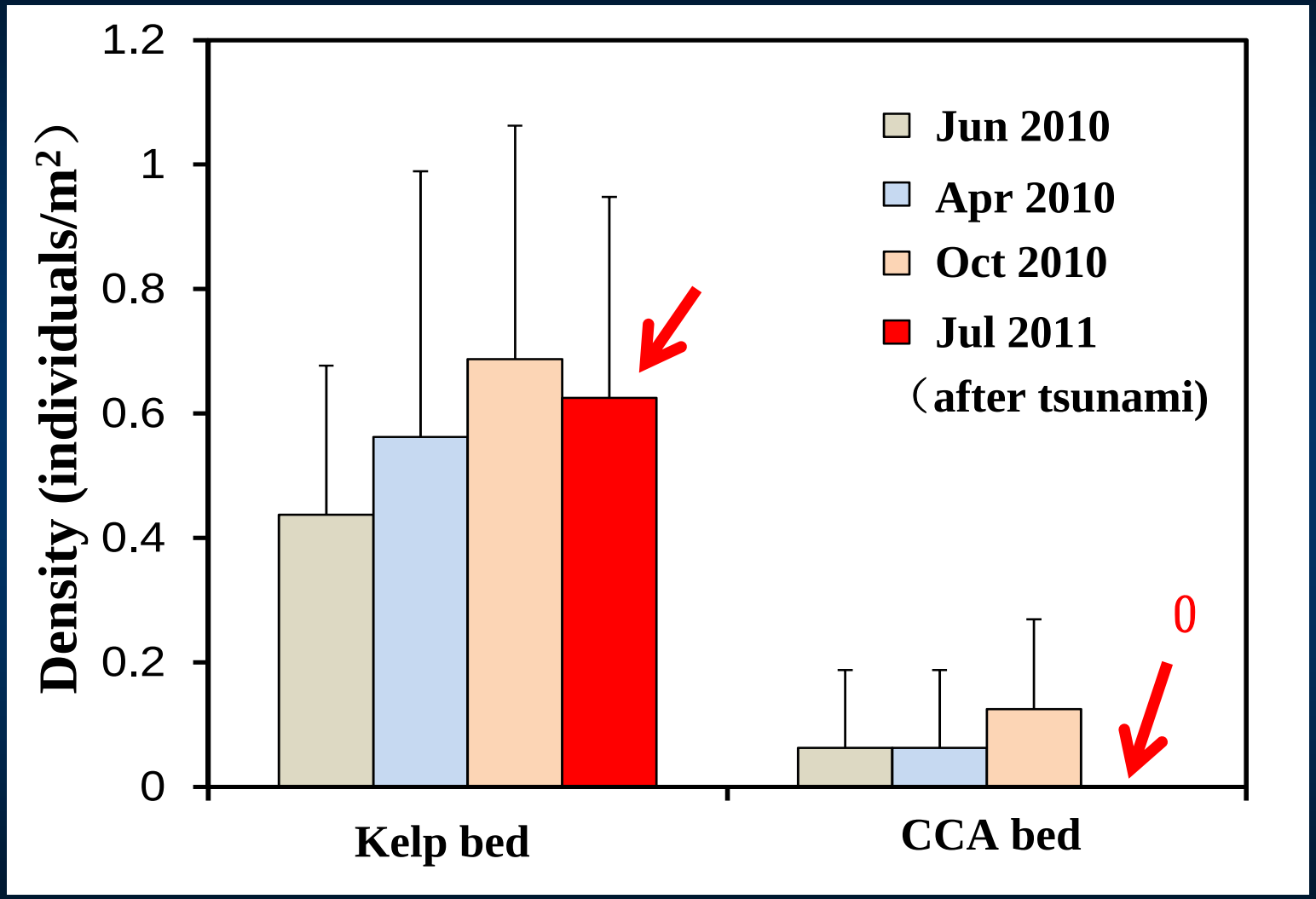
Ontogenetic habitat shifts in abalone *H. discus hannai*



Settlement - 2 cm SL Juveniles (2 - 3 cm SL) Adults (> 3 cm SL)

Abalone densities (Otsuchi Bay) (2×2 m quadrat)

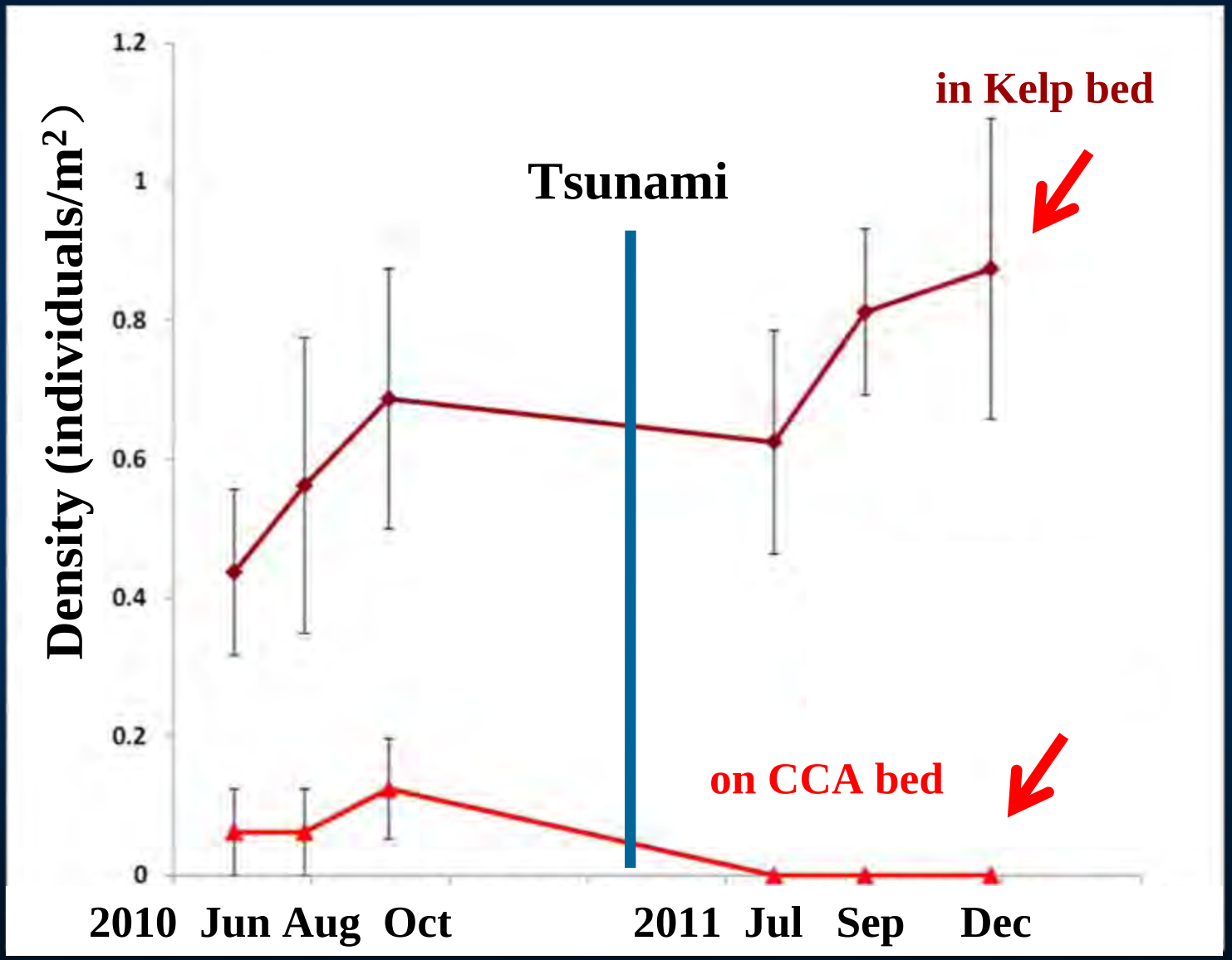
(Takami et al. in prep.)



No difference in abalone density in KB before and after tsunami , but no juveniles were found in CCA after tsunami.

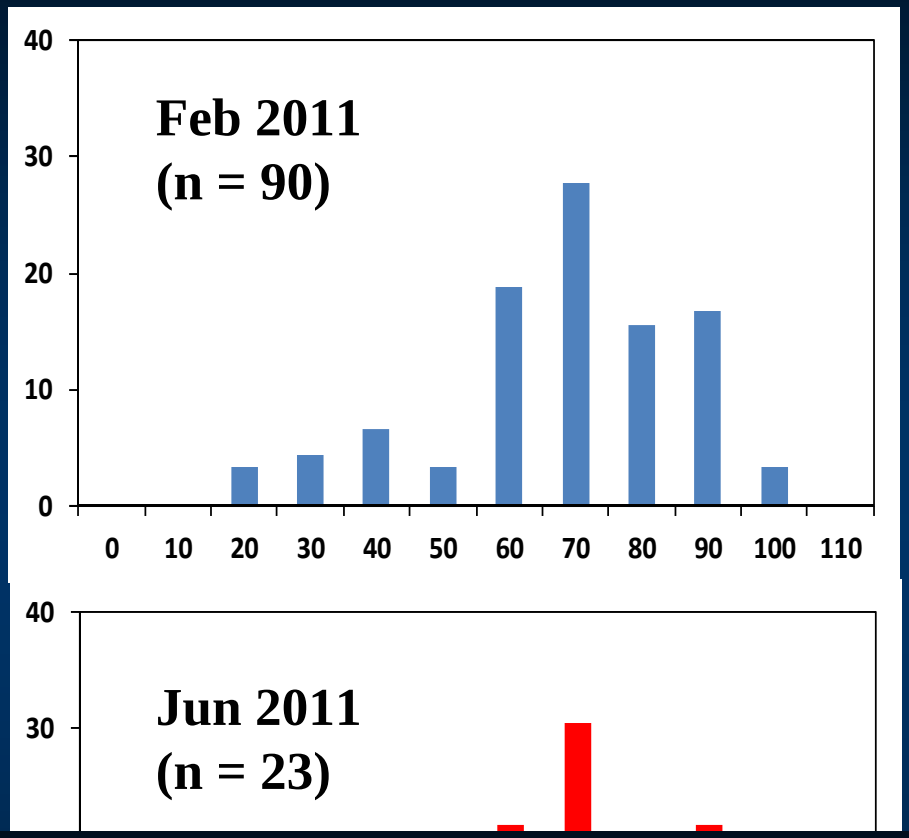
Abalone densities (Otsuchi Bay) (2×2 m quadrat)

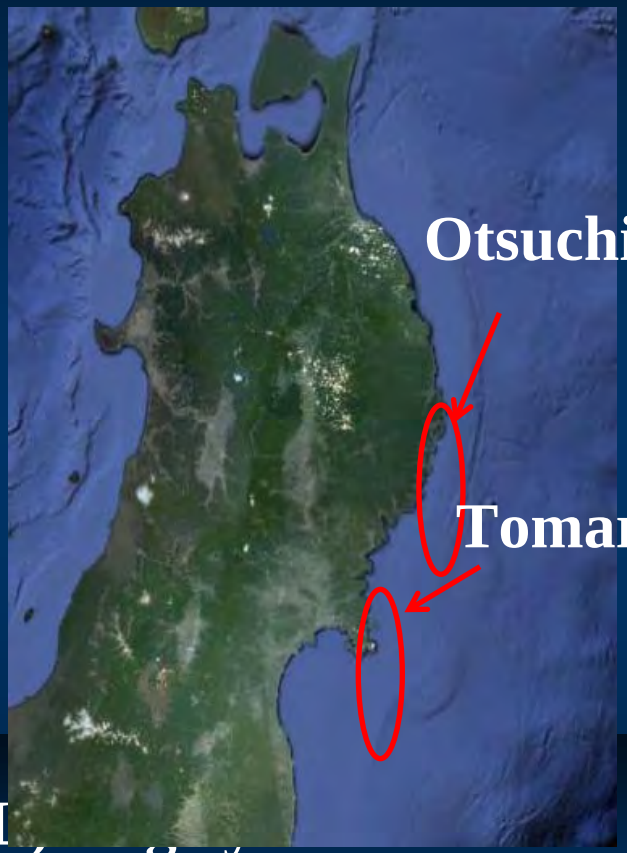
(Takami et al. in prep.)



Abalone size distribution (Tomarihama)

(Takami et al. in press)



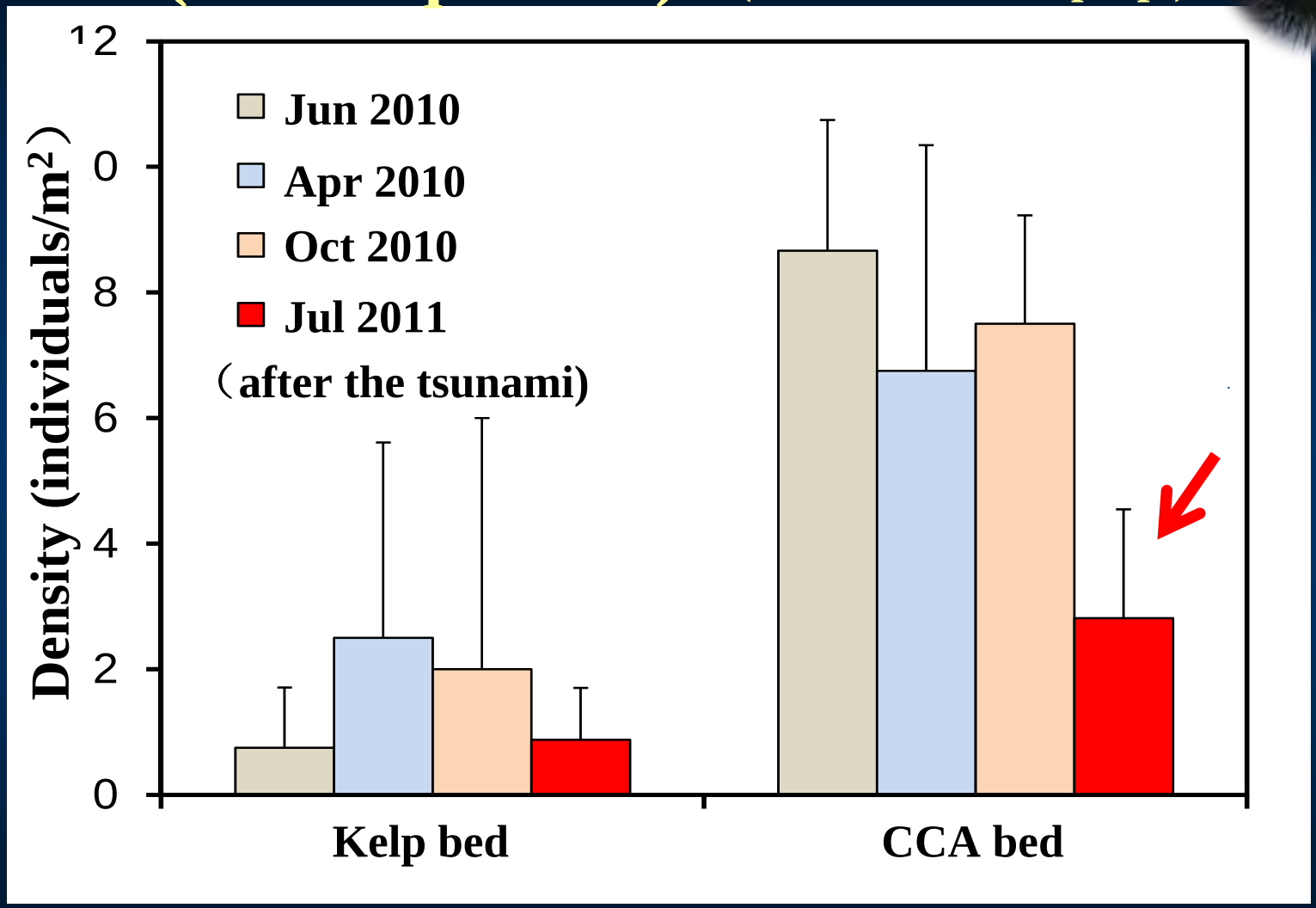


- Densities of juvenile abalone (< 4cm SI[illegible]

Recruits to the fishery resource will sharply decrease 2 - 3 years later for at least 3 - 4 years.

***Reseedings have stopped and may not be opened for several years.**

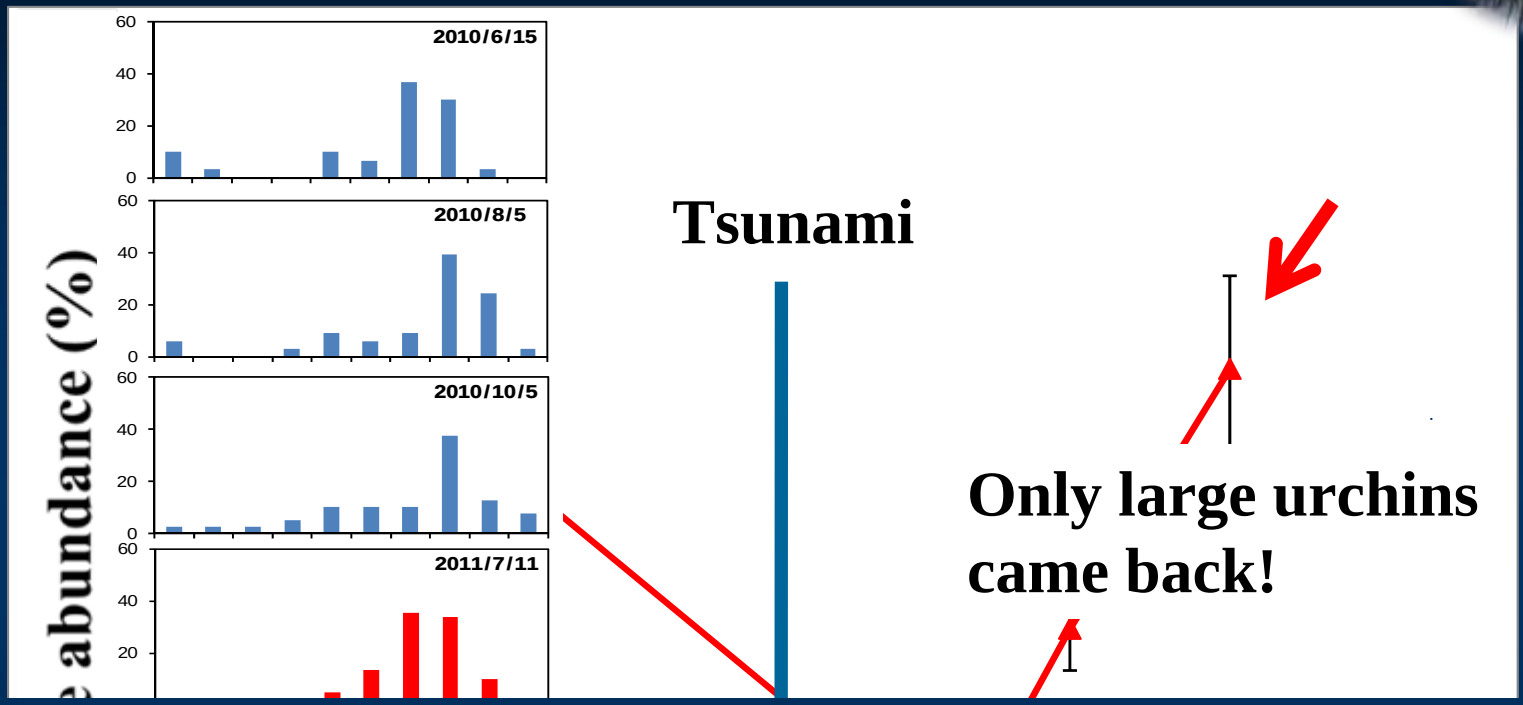
Sea urchin densities (Otsuchi Bay) (2×2 m quadrat) (Takami et al. in prep.)



Urchin density in CCA bed decreased by ~70% after tsunami.

Sea urchin densities (Otsuchi Bay) (2×2 m quadrat)

(Takami et al. in prep.)



- Different species/growth stages of organisms had different effects.
  - Organisms with weaker adhesive strength decreased more.
  - Organisms inhabiting CCA decreased more than those in KB.

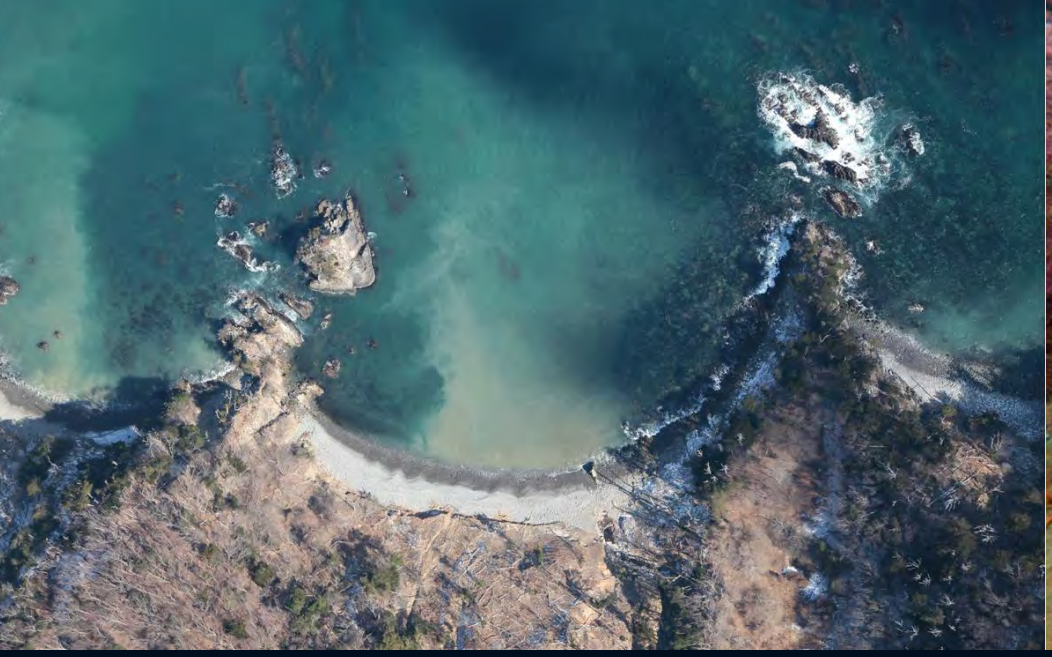
The changes in community structure and balance of organisms may affect ecosystems and organisms for a long time.

- Survival of juvenile macroalgae improved in CCA areas due to the decrease in grazing pressure.

  Macroalgal forests may expand offshore to CCA areas.

  →may improve the food environment for adults

  →may decrease settlement/nursery areas for larvae/juveniles



Long-time effects by the earthquake and tsunami

Land subsidence, Sea level rise

→ Continuous sedimentations

→ Negative effects on settlement of larvae and zoospores

Long-time effects by the earthquake and tsunami

Land subsidence, Sea level rise

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Destructions of seagrass bed, mud flat inner Otsuchi Bay

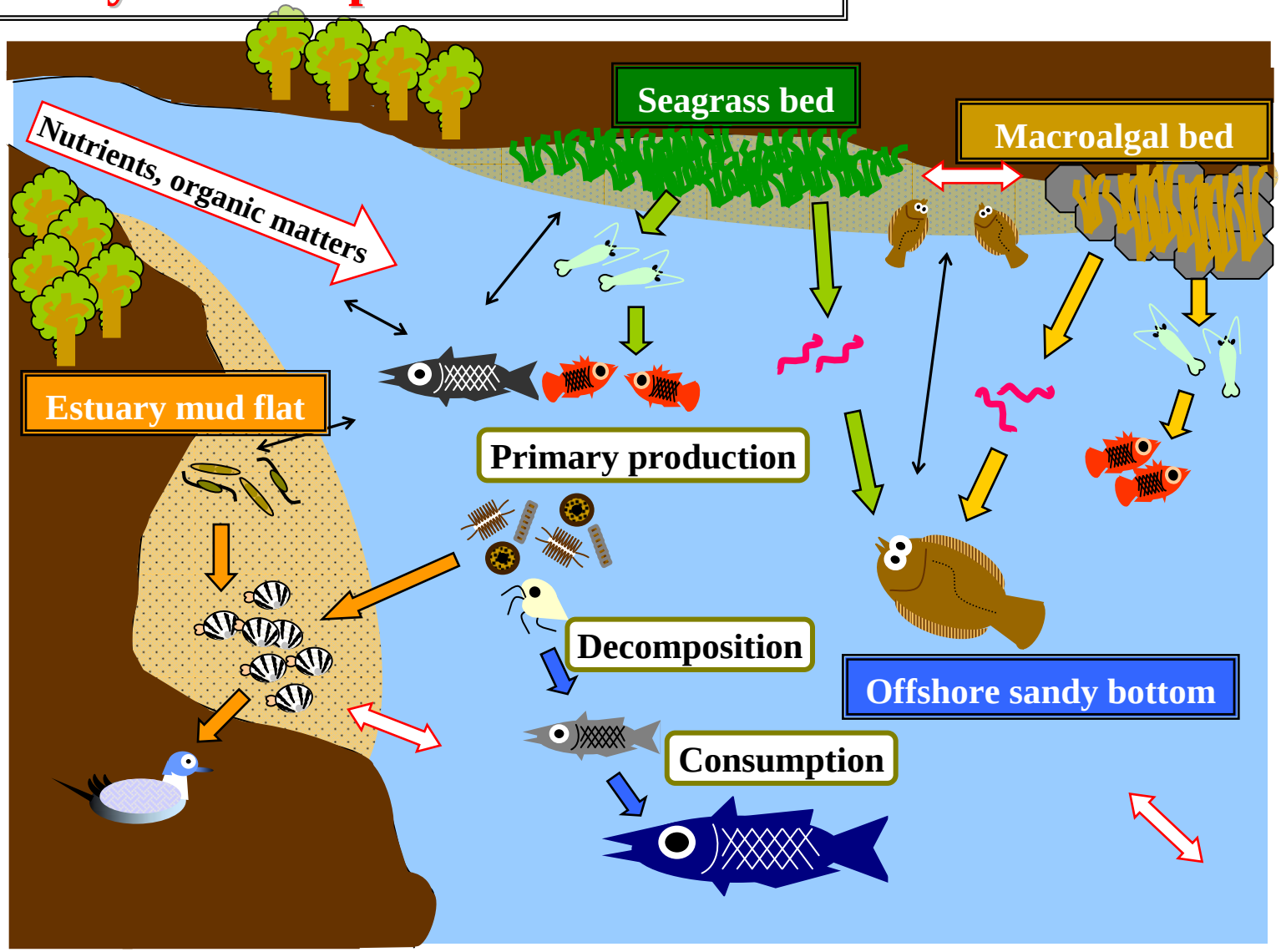
→ Changes in transparency and nutrient concentrations (?)

→ Effects on algal/seagrass growth/survival/species composition

Changes in species composition of animals

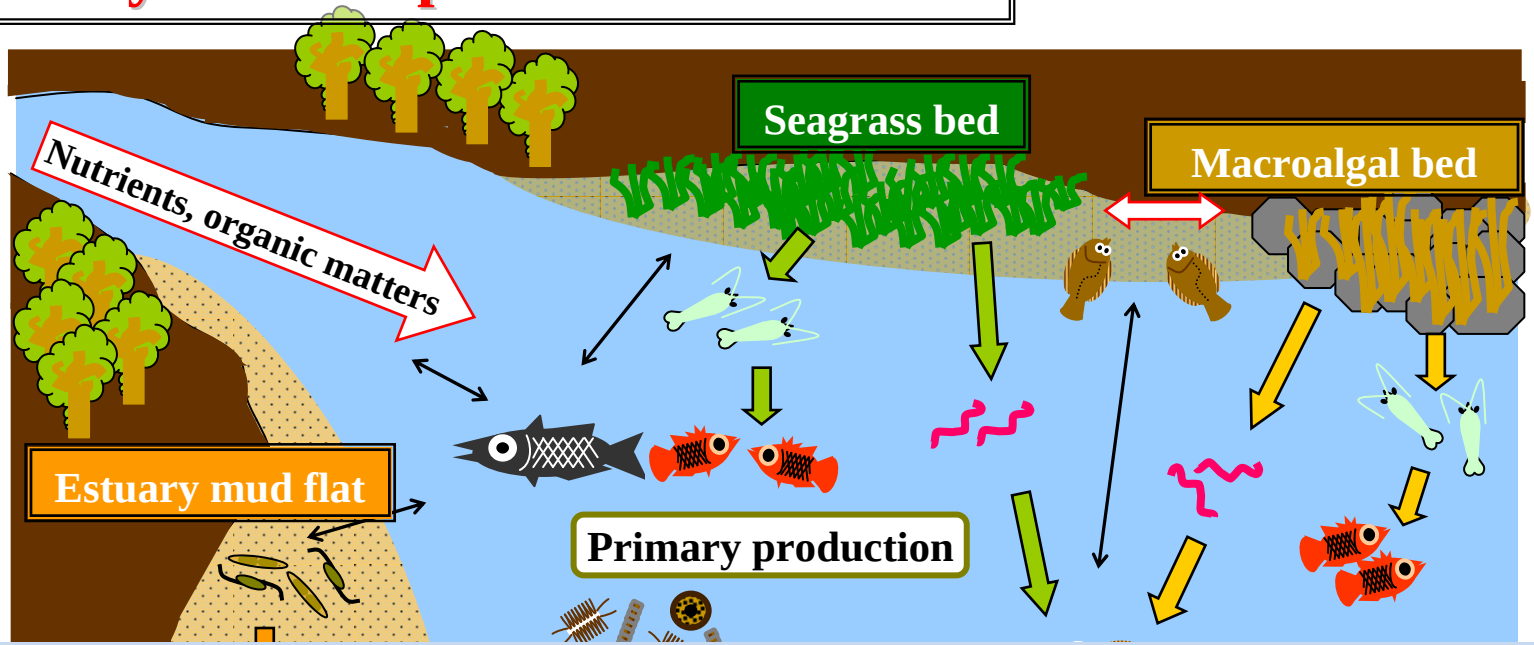
→ Changes in community and food-web structures (?)

Ecosystem complex in coastal areas



The effects of the earthquake and tsunami may affect on neighboring other ecosystems in the area.

Ecosystem complex in coastal areas



To understand effects of quake and tsunami on coastal ecosystems

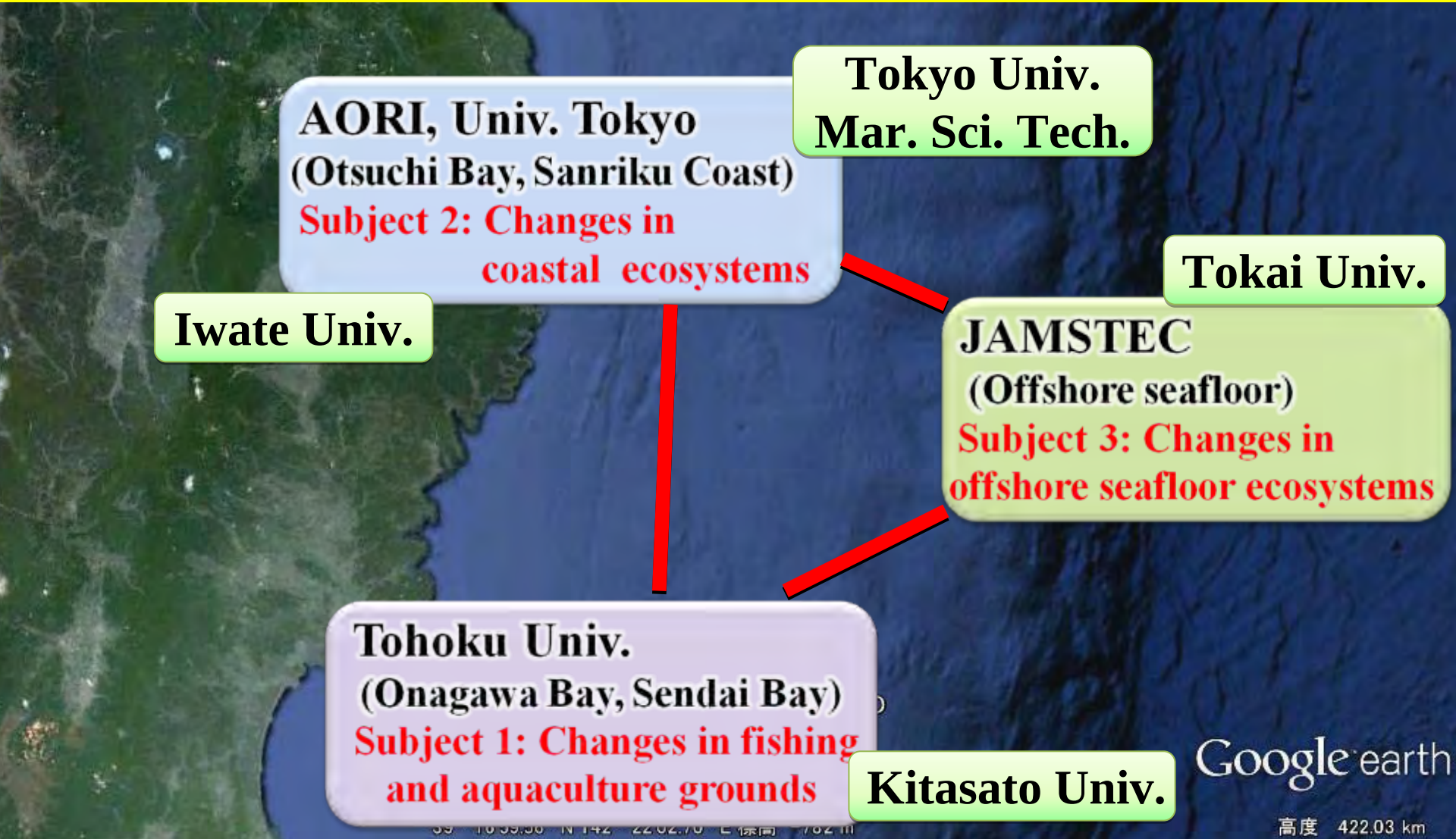
- **Long-time monitoring and analyses in the same places before and after the events are important.**
- **Interaction between different ecosystems in wide area should be considered.**

→ Collaboration of various scientists studying different ecosystems and organisms is necessary

Tohoku Ecosystem-Associated Marine Sciences (TEAMS)

funded by MEXT, Japan (2012-2021)

Analyze effects of the earthquake and tsunami on marine ecosystems and subsequent recovering processes, to restore and develop fisheries



Tohoku Ecosystem-Associated Marine Sciences (TEAMS)

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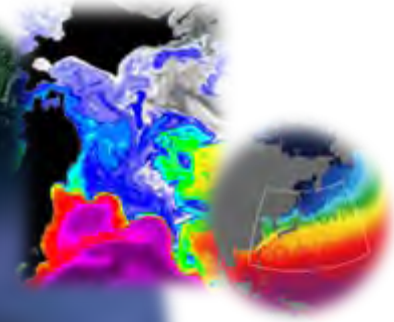
Analyze effects of the earthquake and tsunami on marine ecosystems and subsequent recovering processes, to restore and develop fisheries

Subject 2: Changes in coastal ecosystems (AORI, Univ Tokyo)

①Establish monitoring/analyses tools

⑦Ecosystem modeling for rebuilding fisheries



②Changes in communities and populations of organisms

③Changes in the material cycle

④Influx of environmental pollutant

⑤Effects of forests and rivers on coastal marine environments

⑥Physical environments in coastal ecosystems

Analyze and monitor ecosystems and

Tohoku Ecosystem-Associated Marine Sciences (TEAMS)

Subject 2: Changes in coastal ecosystems

② Changes in communities and populations of organisms (by over 100 scientists and students)

- **Studies on various coastal ecosystems**

Estuary mudflat

Intertidal rocky reef

Subtidal algal bed

Seagrass bed

Offshore seafloor

Salt marsh

➢**Studies on various communities and populations**

Ayu

Pacific Herring

Chum Salmon

Ezo Abalone

Sea urchins

Manila clam

Eel grasses

Streaked Shearwater

Finless Porpoise

Benthos community

Studies on changes in communities and populations of organisms in the disaster area after 3.11

What are important to utilize fisheries resources continuously and efficiently?

Studies on changes in communities and populations of organisms in the disaster area after 3.11

What are important to utilize fisheries resources continuously and efficiently?

- Exactly understand the effects of the earthquake and tsunami on marine ecosystems, monitor their secondary succession processes, and clear their mechanisms.
- Consider suitable styles of fisheries and utilizations of fishing grounds adapting the succession process of ecosystems, and establish new measures for fisheries and resource managements.
- Consider not to prevent the natural recovery, and switch to the adaptive fisheries and uses of sea areas.

＊Huge impacts of fishery activities on marine organisms!

＊Nature can be easily destroyed by humans,
but very difficult to be restored!!