Changes in marine ecosystems attacked by the mega-earthquake and subsequent massive tsunami on Pacific coast of northeast Japan

Tomohiko Kawamura 河村知彦

Coastal Ecosystem Restoration, International Coastal Research Center,
Atmosphere and Ocean Research Institute (AORI), The University of Tokyo
東京大学大気海洋研究所・国際沿岸海洋研究センター・生物資源再生分野


Otsuchi, Iwate
岩手県大槌町
Otsuchi Bay
大槌湾
International Coastal Research Center,
AORI, The University of Tokyo
東京大学大気海洋研究所
国際沿岸海洋研究センター

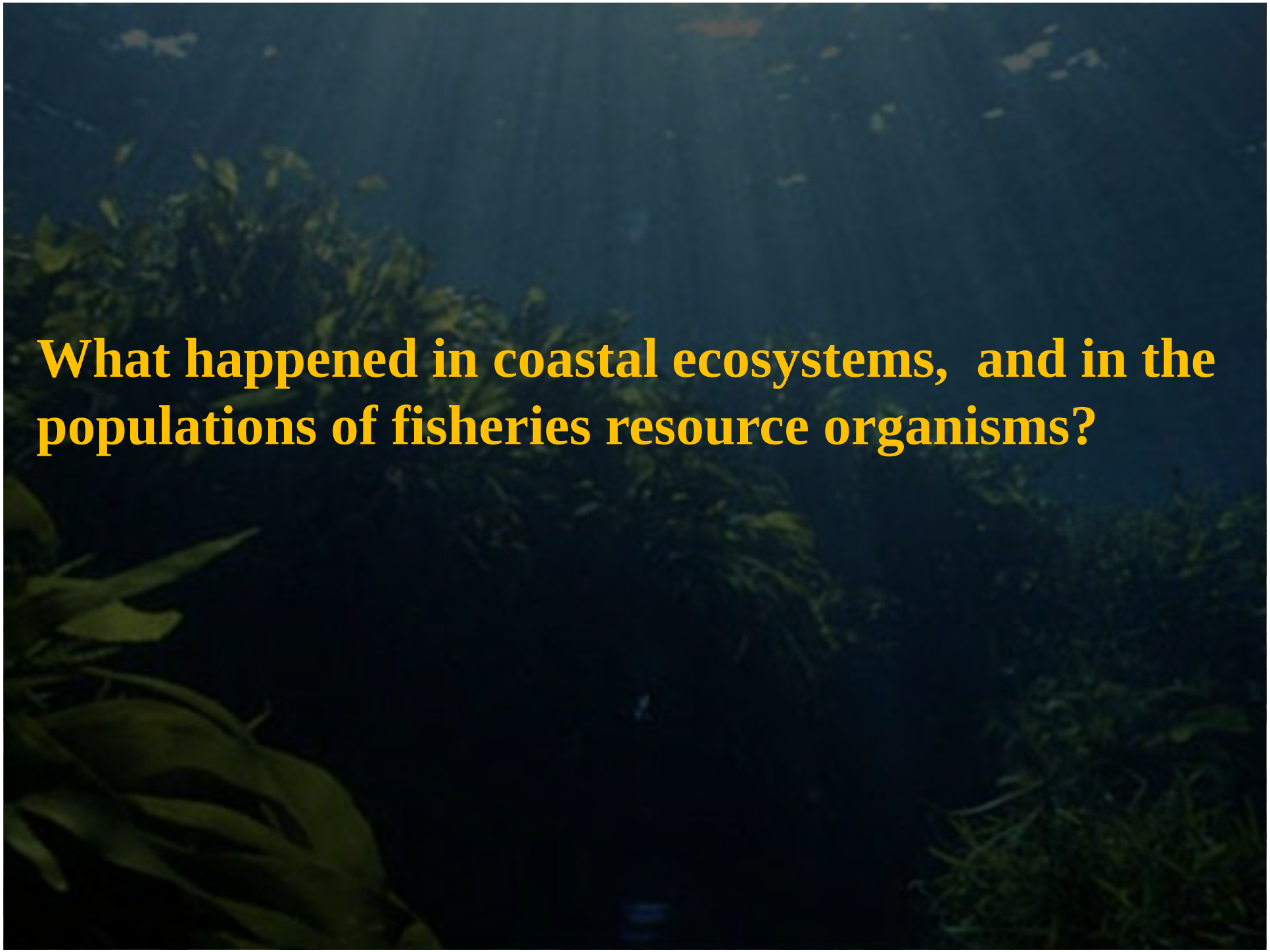
International Coastal Research Center
AORI, Univ. of Tokyo at Otsuchi, Iwate


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.**

International Coastal Research Center
AORI, Univ. of Tokyo at Otsuchi, Iwate (May, 2013)

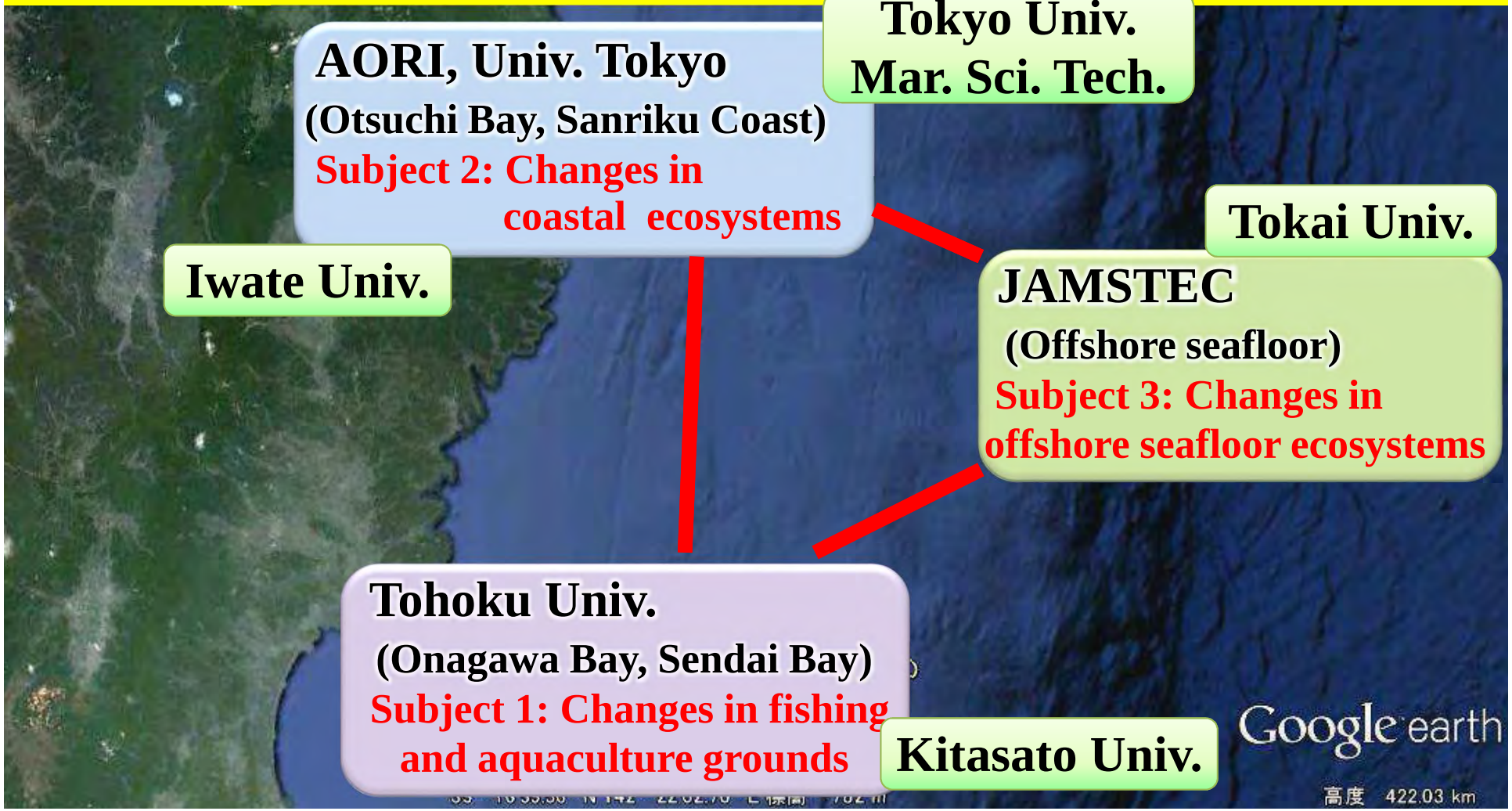

What happened in coastal ecosystems, and in the populations of fisheries resource organisms?

Tohoku Ecosystem-Associated Marine Sciences (TEAMS)

funded by MEXT, Japan (2012-2021)

文部科学省補助事業・東北マリンサイエンス拠点形成事業

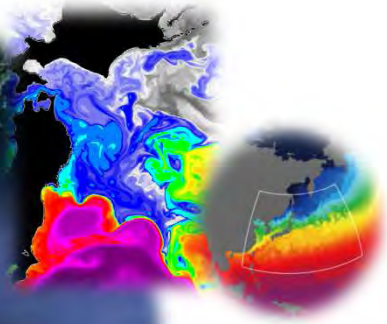
Analyze effects of the earthquake and tsunami on marine ecosystems and subsequent recovering processes, to restore and develop fisheries



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 environments

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

Macro-algae

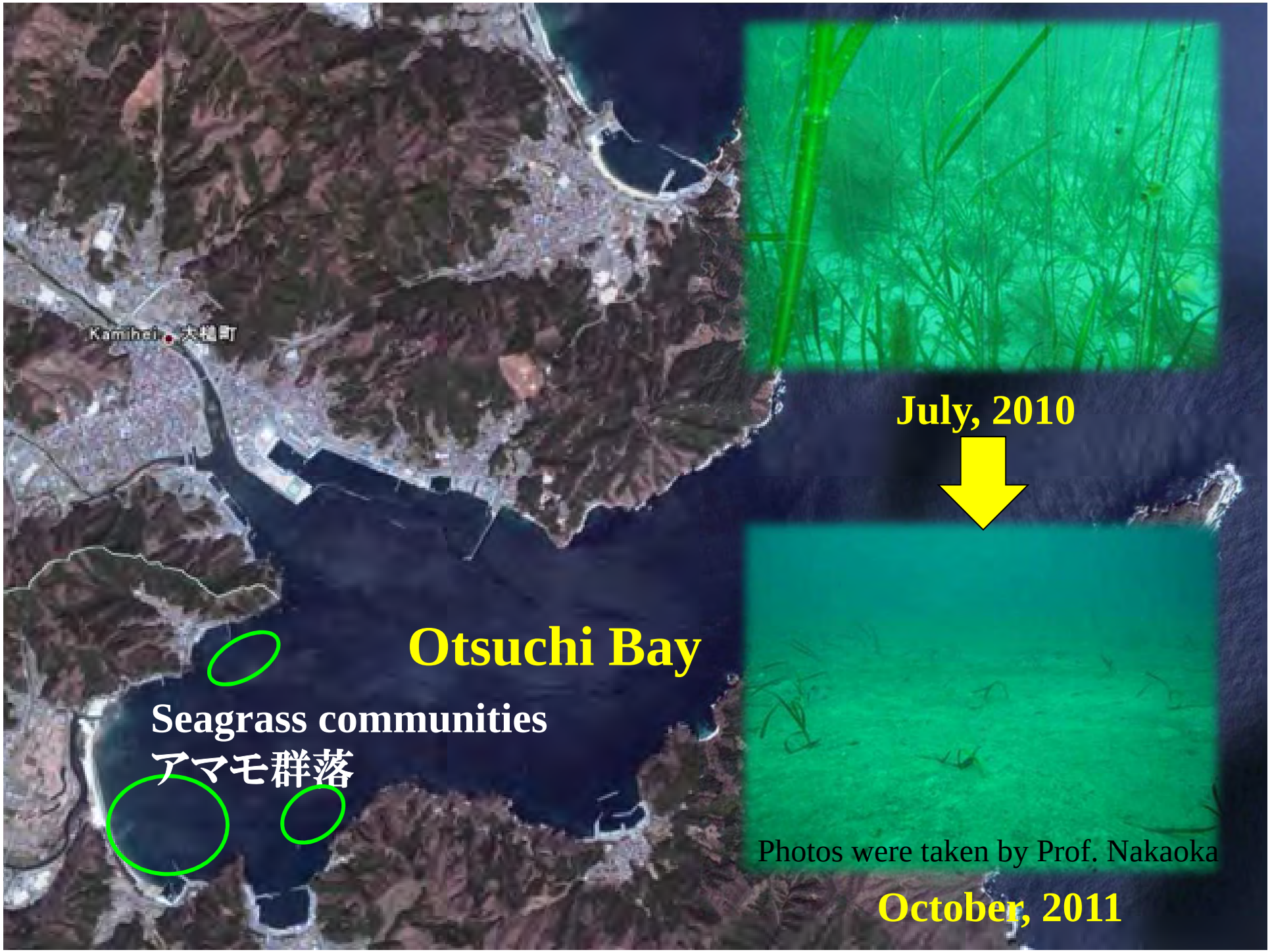
Ezo Abalone

Sea urchins

Manila clam

Seagrasses

Streaked Shearwater **Finless Porpoise** **Benthos community**


Kamihei 大槌町
Otsuchi Bay
Seagrass communities
アマモ群落
July, 2010
Photos were taken by Prof. Nakaoka
October, 2011

Changes in mega-benthos distribution in Fanakoshi Bay after the tsunami

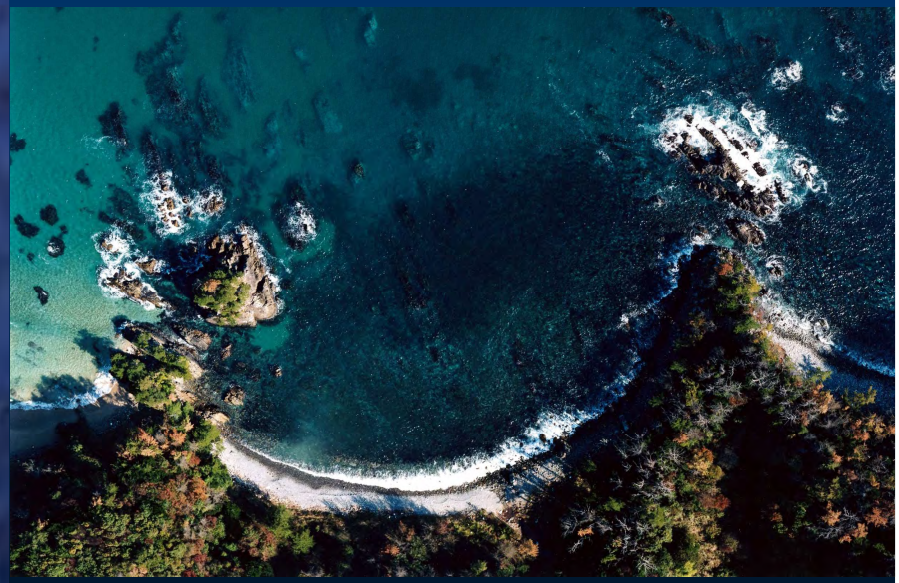
(Seike et al. 2013)

2010 2011 2012

- Sand dollars (~5 cm diam.), found in high density in 2010, almost completely disappeared after the tsunami in 2011.

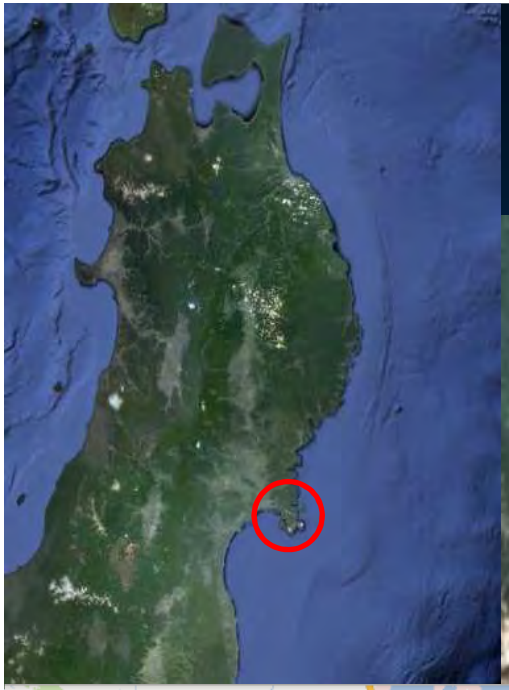
Organisms on shallow rocky reefs have been studied and monitored seasonally for over five years.

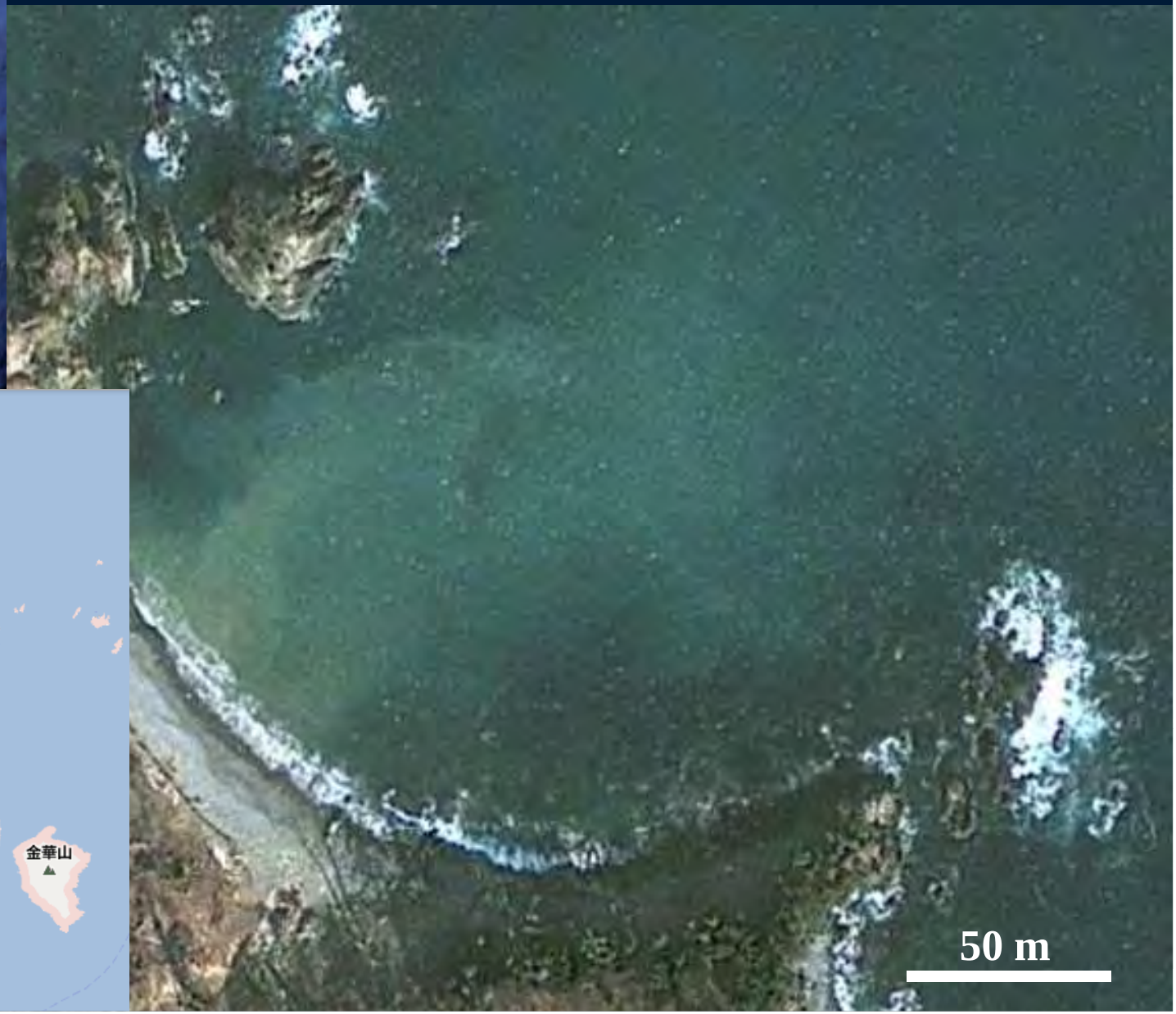
Otsuchi Bay 大槌湾



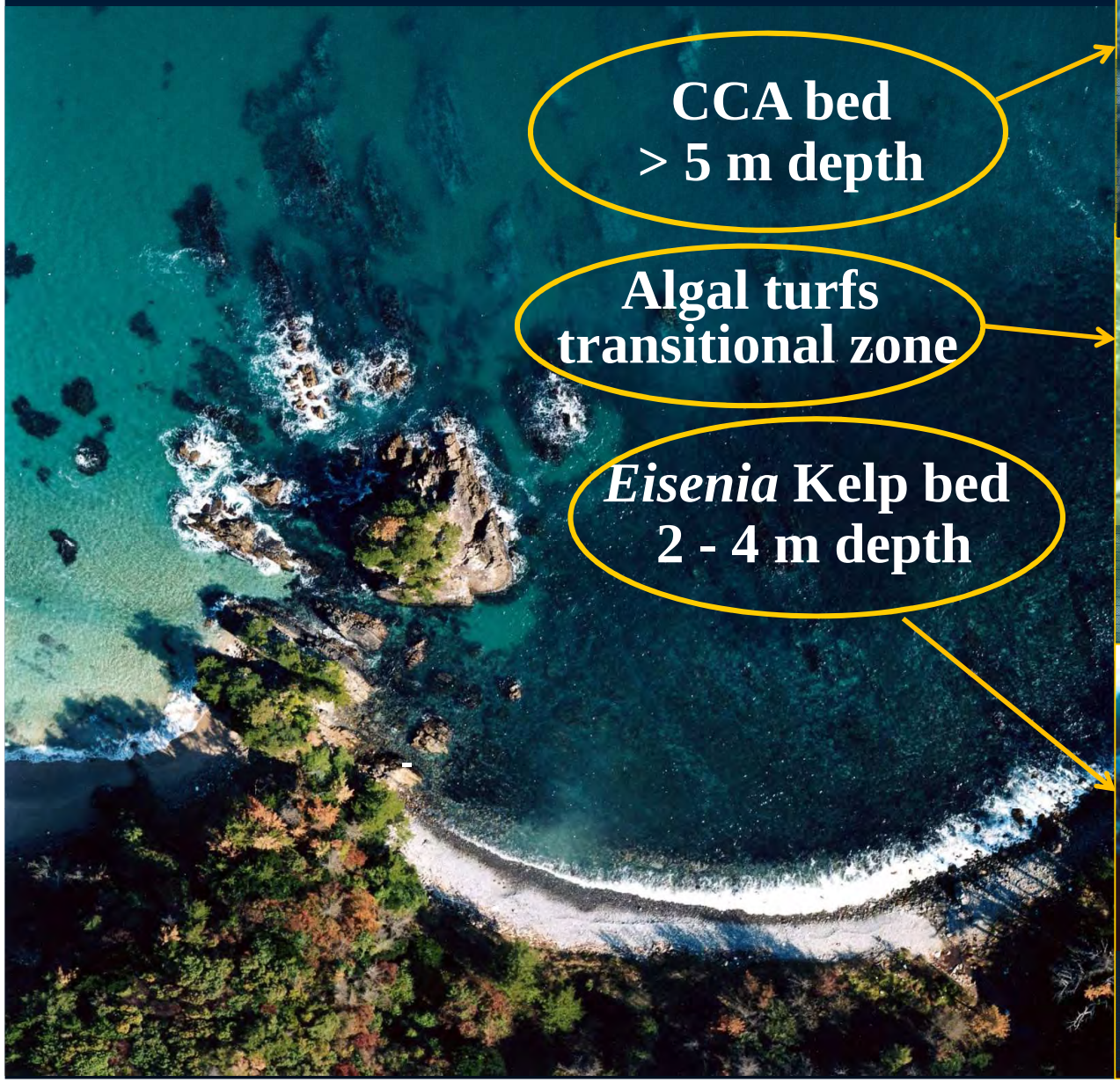
Tomarihama, Oshika Peninsula
牡鹿半島泊浜

Tomarihama, Oshika Peninsula





Macroalgal zonation 海藻帯状構造 (Tomarihama　泊浜)



CCA bed
> 5 m depth

Algal turfs
transitional zone

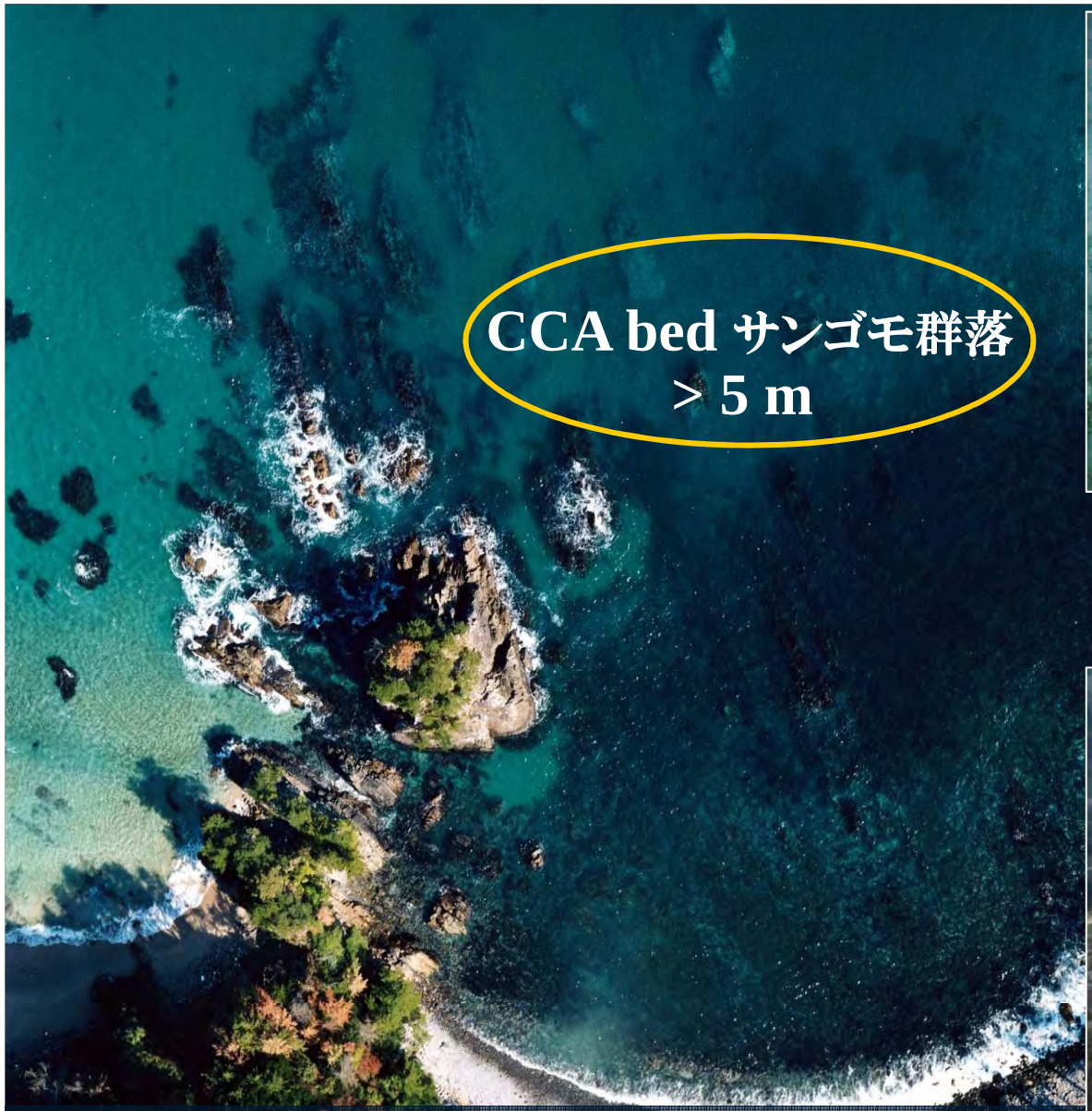
Eisenia Kelp bed
2 - 4 m depth

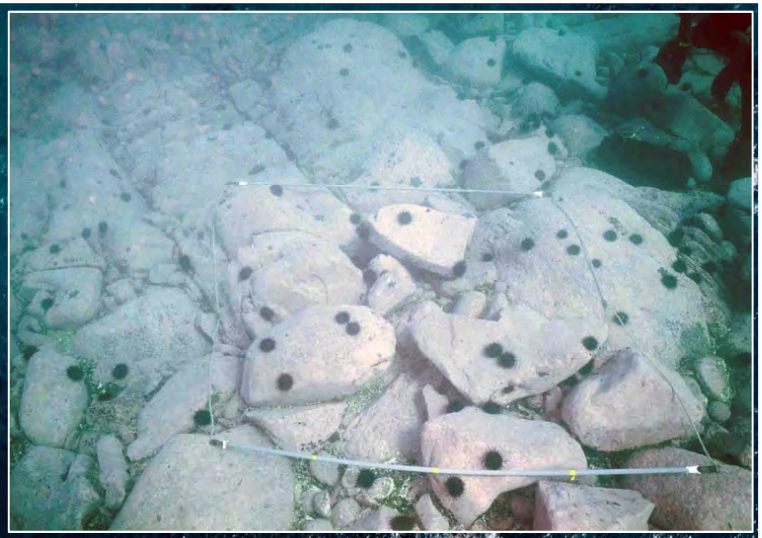
Crustose Coralline Algae:
Lithophyllum yessoensis
無節サンゴモ群落

Red algae: *Gelidium elegans*
小型紅藻群落

Brown alga: *Eisenia bicyclis*
アラメ群落


Kelp bed アラメ群落
2 - 4 m
November, 2010
June, 2011
Remaining *Eisenia* holdfasts that lost their fronds were observed in Kelp bed, but *Eisenia* biomass has not significantly decreased after tsunami.





November, 2010

June, 2011

In CCA bed, many large rocks were cracked and rotated, and bare rocks without any epibiota and CCA emerged.

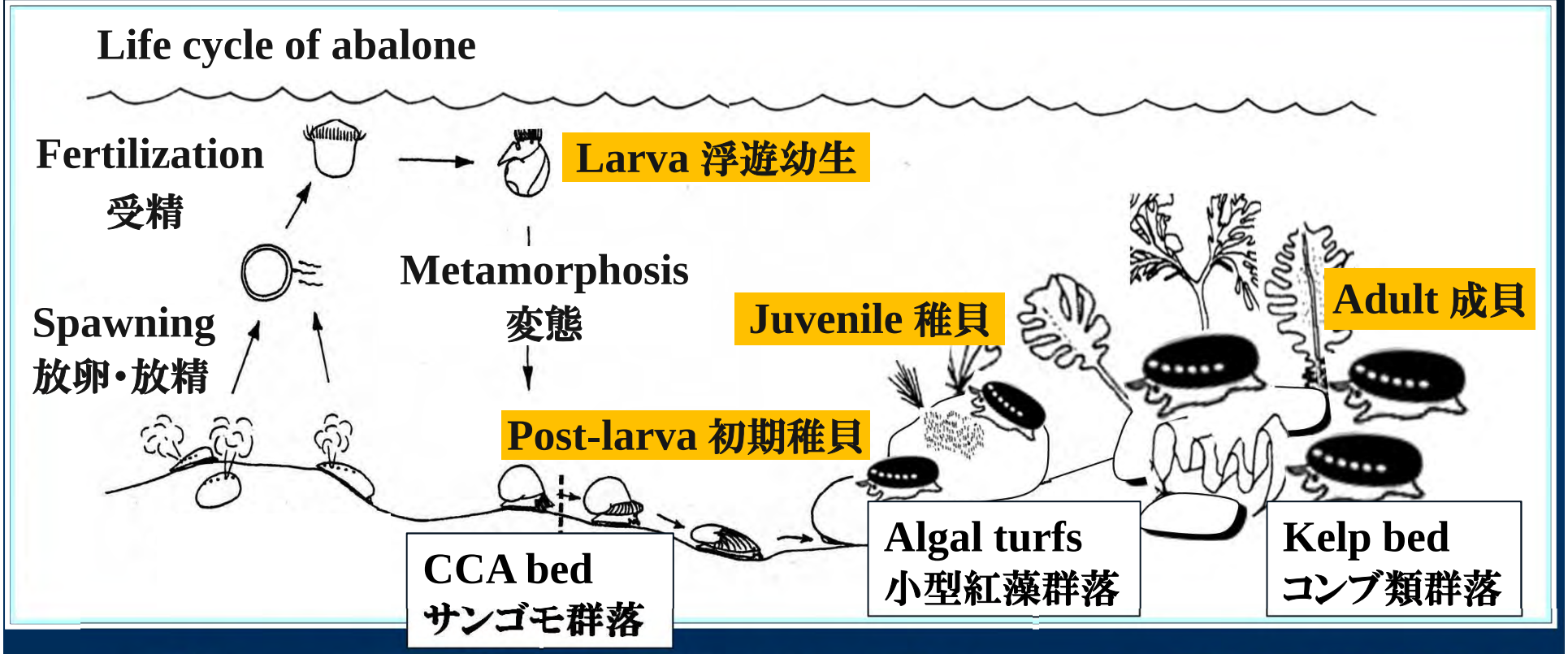
Abalone　エゾアワビ

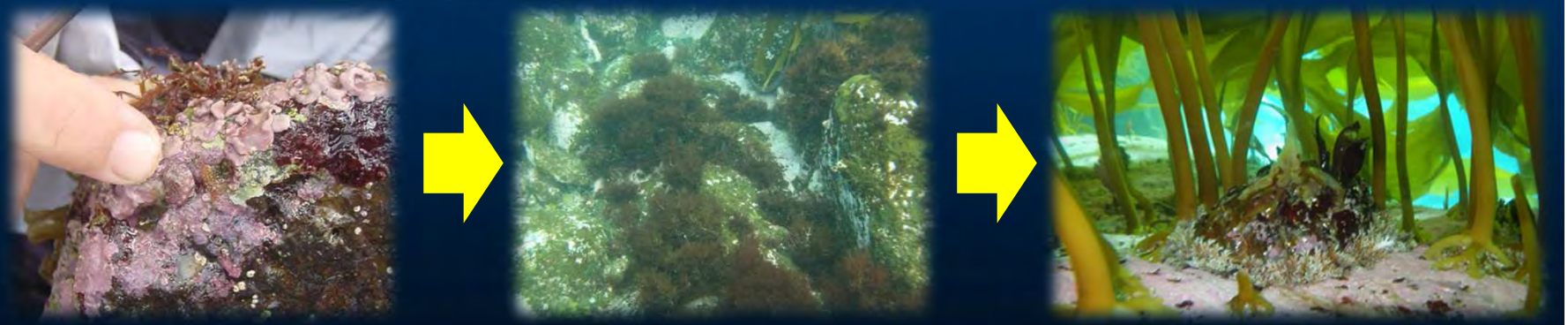
Haliotis discus hannai

Sea urchin　キタムラサキウニ

Strongylocentrotus nudus

Ontogenetic habitat shifts in abalone *H. discus hannai*

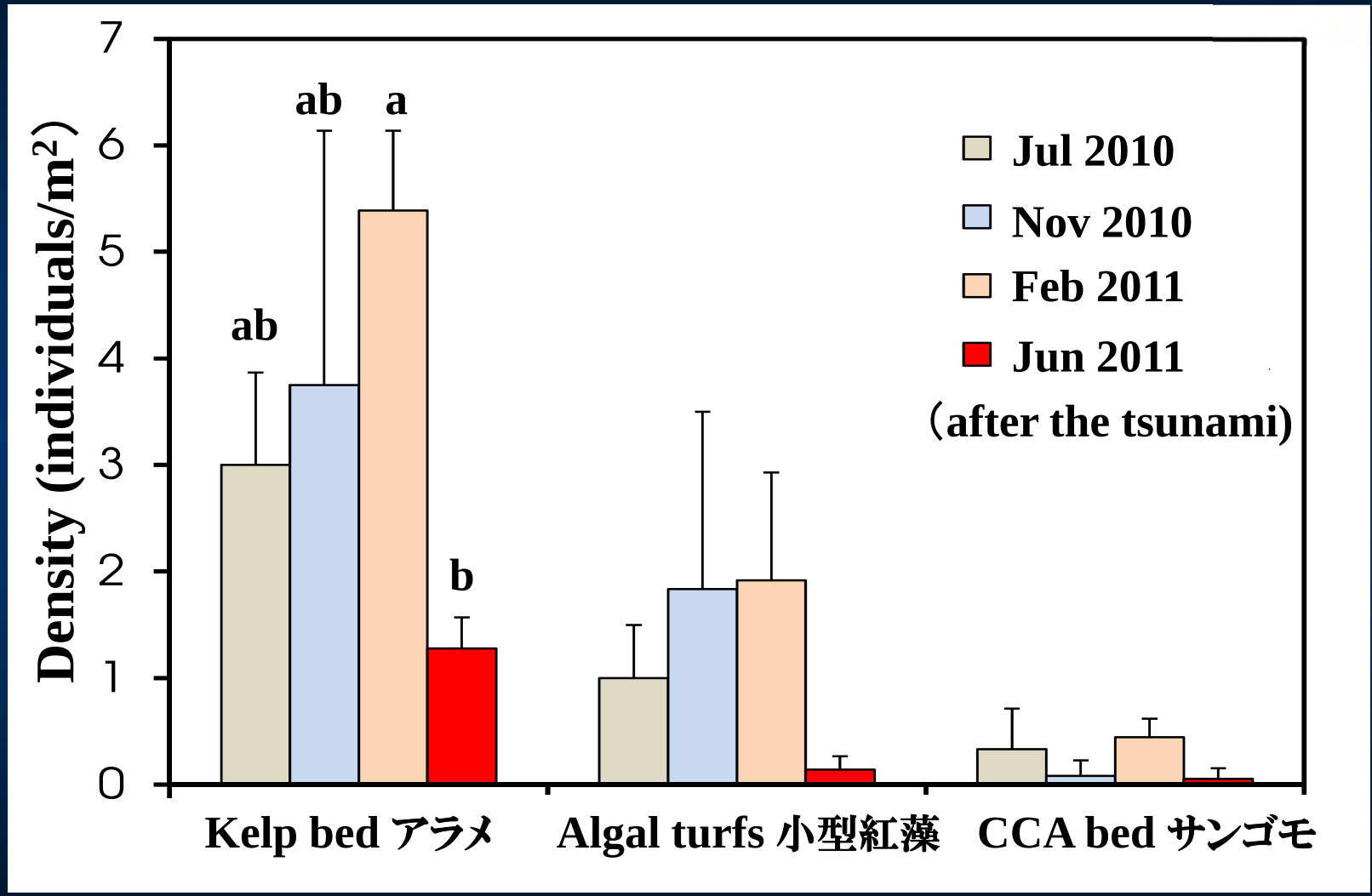




Settlement - 2 cm SL Juveniles (2 - 4 cm SL) Adults (> 4 cm SL)

Abalone densities (Oshika peninsula)
エゾアワビ個体数密度（牡鹿半島）

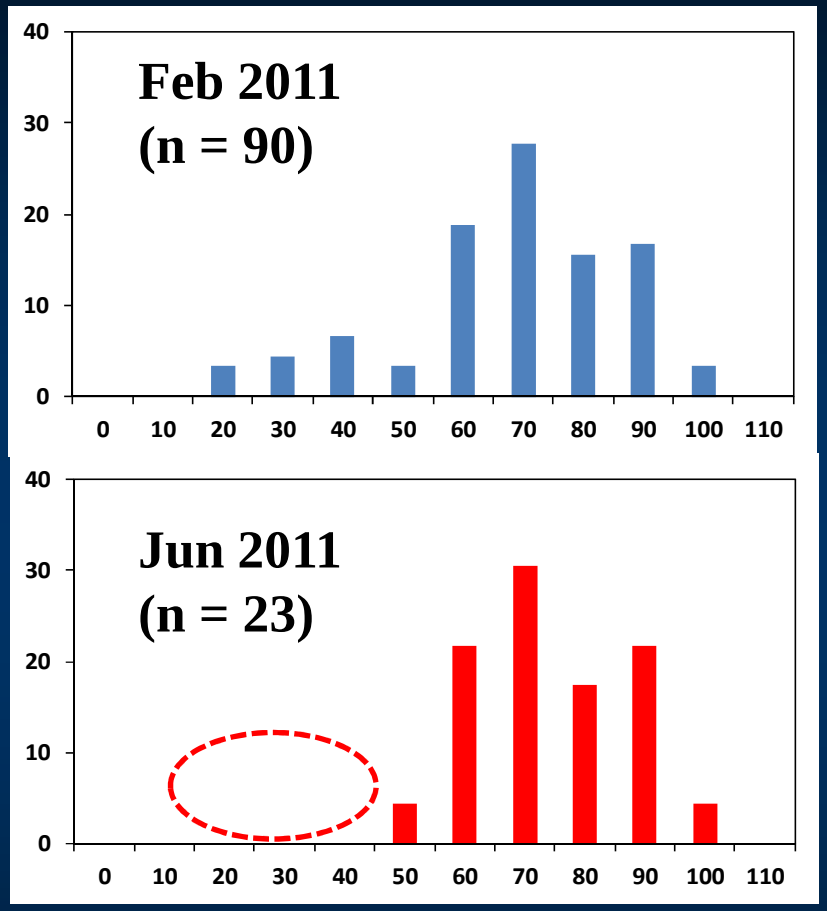
(Takami et al. 2013)



Adult abalone (> 5 cm) mainly in Kelp bed decreased by ~50%.
Juvenile abalone mainly in CCA bed decreased by ~90%.

Abalone size distribution (Oshika peninsula)
エゾアワビ殻長組成（牡鹿半島）

(Takami et al. 2013)



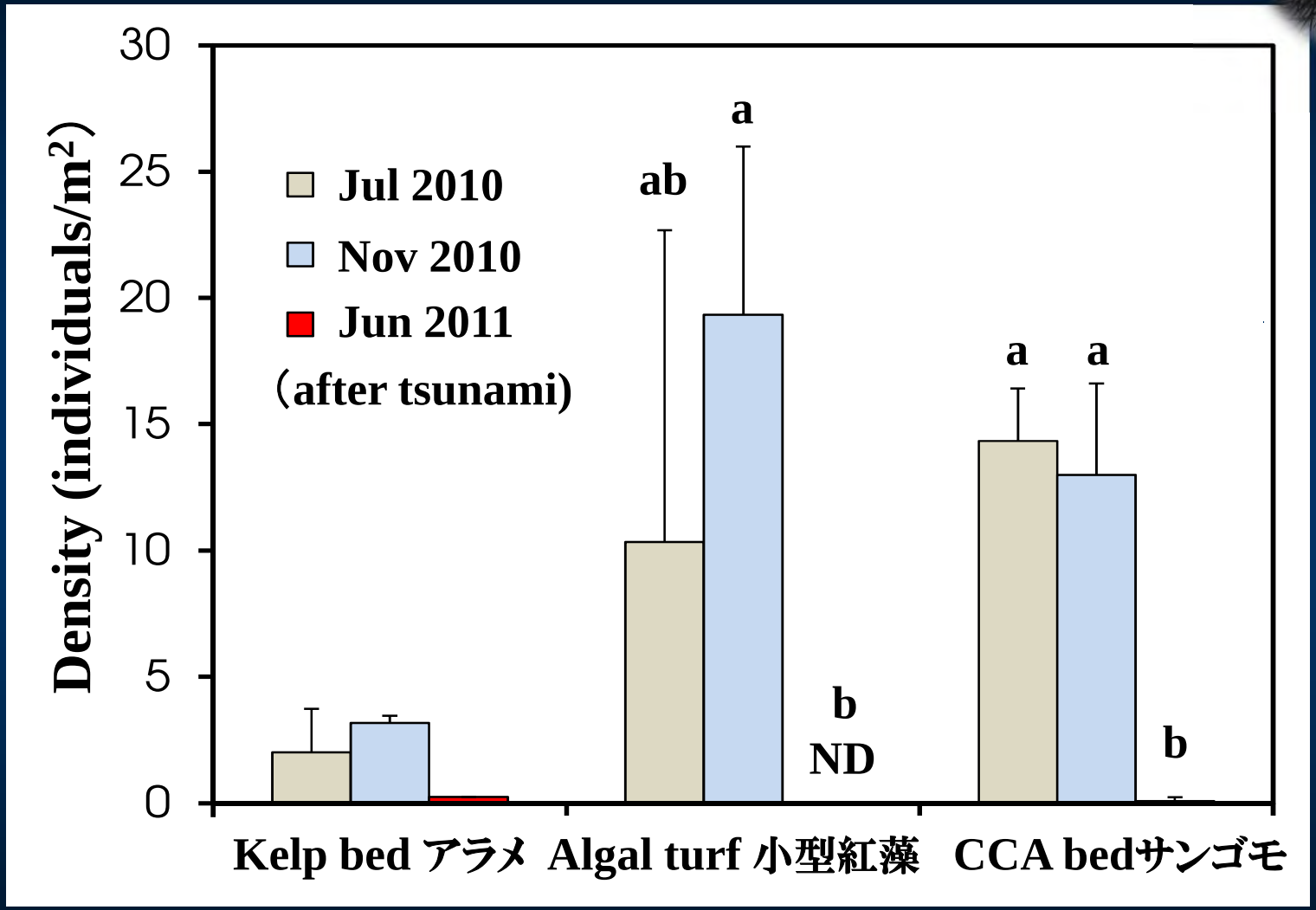
- **Densities of juvenile abalone (< 5 cm SL) largely decreased.**

Recruits to the fishery resource will largely decrease for 3 - 4 years.

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

Sea urchin densities (Oshika peninsula)
キタムラサキウニ個体数密度（牡鹿半島）

(Takami et al. 2013)

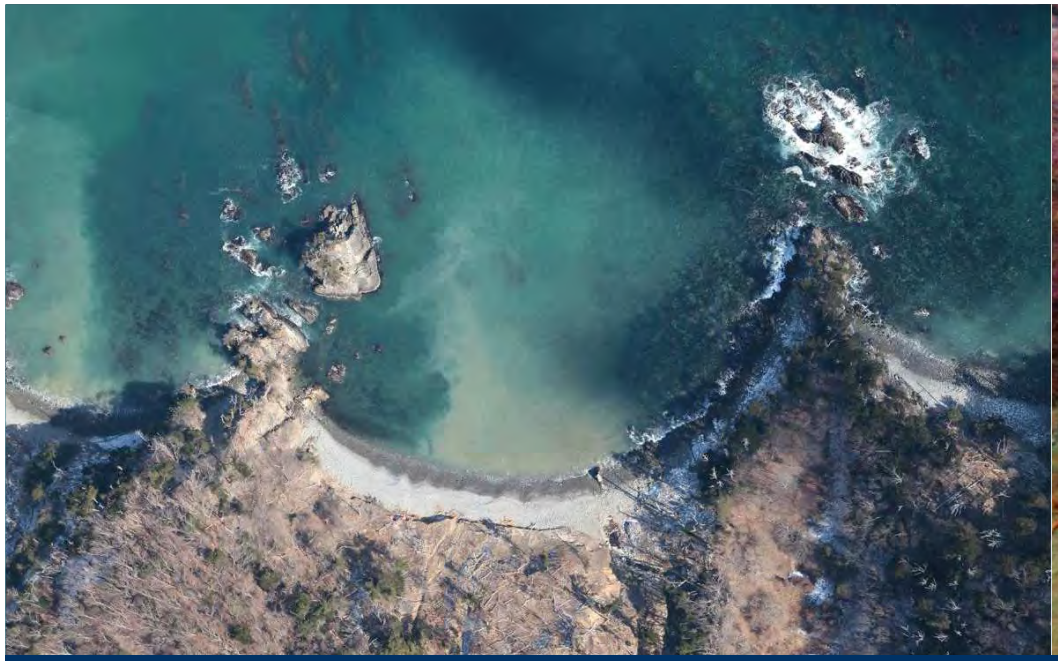


Sea urchin density in AT and CCA decreased by ~95%.

Short-time effects by the earthquake and tsunami

- 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 for a long time.



Long-time effects by the earthquake and tsunami

Land subsidence, Sea level rise 地盤沈下、海面上昇

→ Continuous sedimentations

→ Negative effects on settlement of larvae and zoospores

Destructions of seagrass bed and mud flat 海草群落・干潟の減少

→ Changes in transparency and nutrient concentrations (?)

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

Changes in species composition of animals 動物組成の変化

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

What are important to conserve marine ecosystems and utilize fisheries resources continuously and efficiently in the disaster area?

- 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.
- Any human activities should be conducted carefully based on the scientific guidelines to minimize further negative effects on the damaged ecosystems, and not to prevent the natural recovery.

  * Huge impacts of fishery activities on marine organisms!

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