A scenic view of a lake with mountains in the background and buildings along the shore. The water is calm, reflecting the sky and the surrounding landscape. In the foreground, there are several boats docked at a pier. The background features a range of mountains under a clear blue sky. The overall atmosphere is peaceful and natural.

**Underwater visual census as a tool
to monitor coastal ecosystem:
seasonal and interannual fluctuations, effect
of thermal discharge from power stations, and
recovery from the tsunami disaster**

Reiji Masuda

Maizuru Fisheries Research Station

Kyoto Univ.

Jacques- Yves Cousteau (1910-1997)

Invented Aqualung in
1944

Purchased Calypso in
1950

Photo from <http://www2.divers.ne.jp/vintage/sub8.htm>



Artificial reef (-6m)



Artificial reef (-10m)

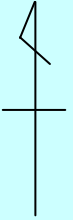
Maizuru Fish. Res. Stn.



-10m

**Bimonthly
Visual census
Since Jan 2002**

**200m x 2m x 3 lines
(400m²)**



カワハギ

Threadsail filefish *Stephanolepis cirrhifer*
(Mar 2008)

Calibrating my visual estimation of BL



Black Rockfish *Sebastes inermis*
(Dec. 2006)

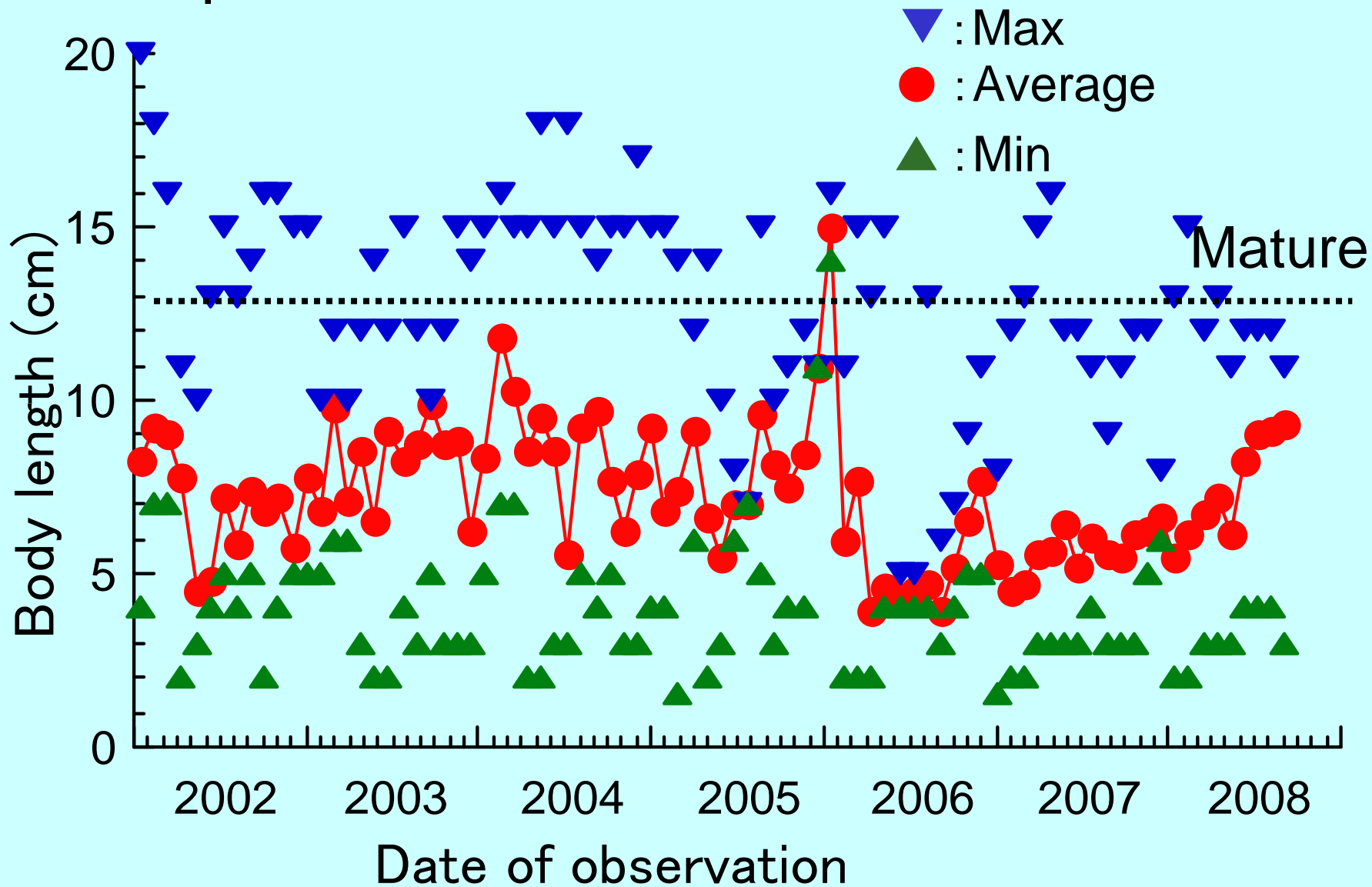
メバル

Black rockfish *Sebastes inermis*
(Jan 2005, Nagahama, Maizuru)

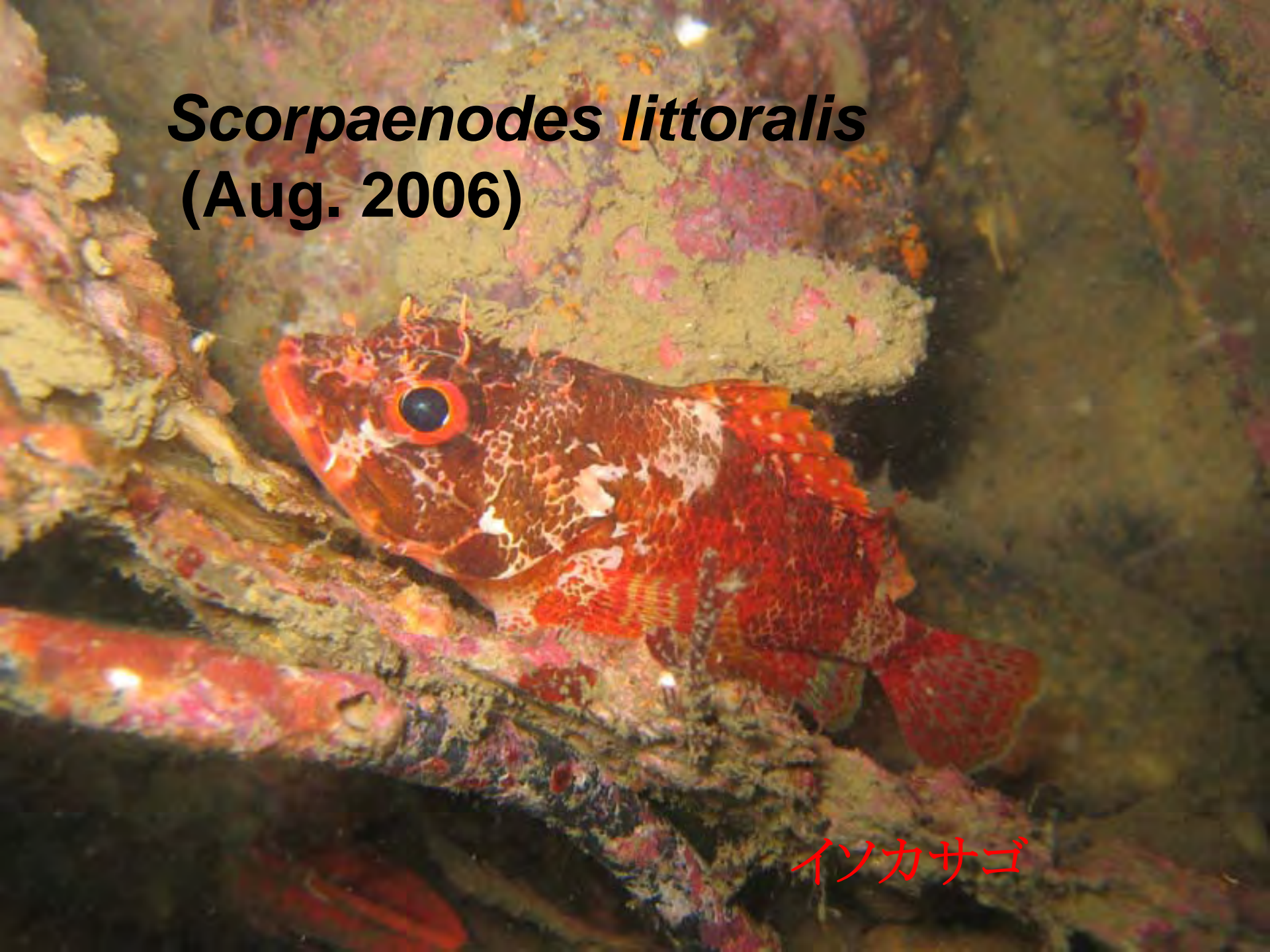


Black rockfish

Reproduces in a coastal reef habitat.



Scorpaenodes littoralis
(Aug. 2006)



イソカサゴ

Snapper *Lutjanus russellii*
(Sep. 2005)



クロホシフエダイ

Brownbanded butterflyfish
Chaetodon modestus
(Sep. 2012)



ゲンロクダイ

タツノオトシゴ

Seahorse *Hippocampus coronatus*
(Nov. 2002, Nagahama)



ヨウジウオ

Pipefish *Syngnathus schlegeli*
(May, 2004, Nagahama)

アカオビシマハゼ



**Goby *Tridentiger trigenocephalus*
capturing anchovy
(Nov. 2002, Nagahama)**

Who did this?



Bitten anchovy (Dec 2007)

Spanish mackerel

Scomberomorus niphonius

サワラ



(May 2008)



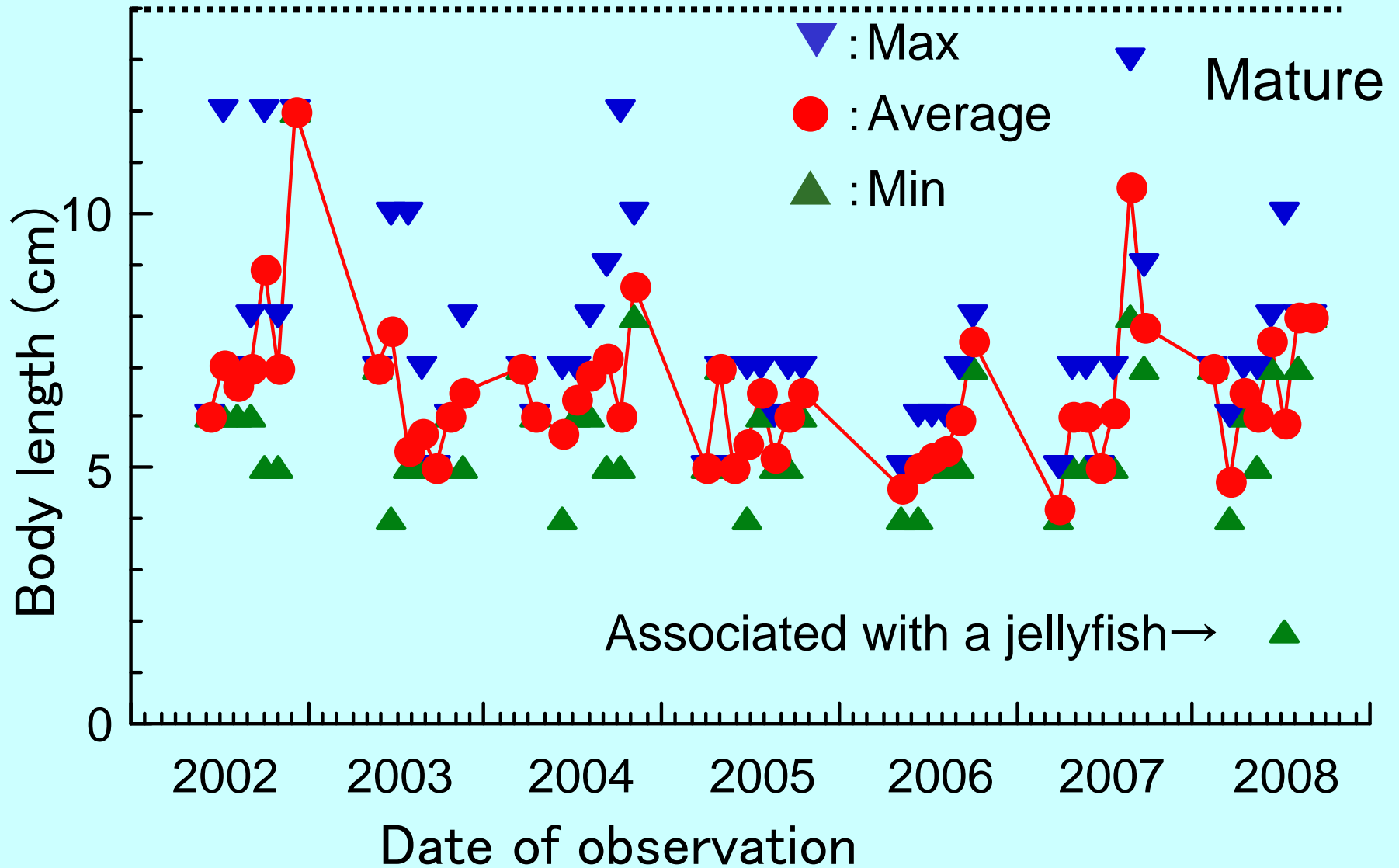
Jack mackerel *Trachurus japonicus*
is the most common fish.

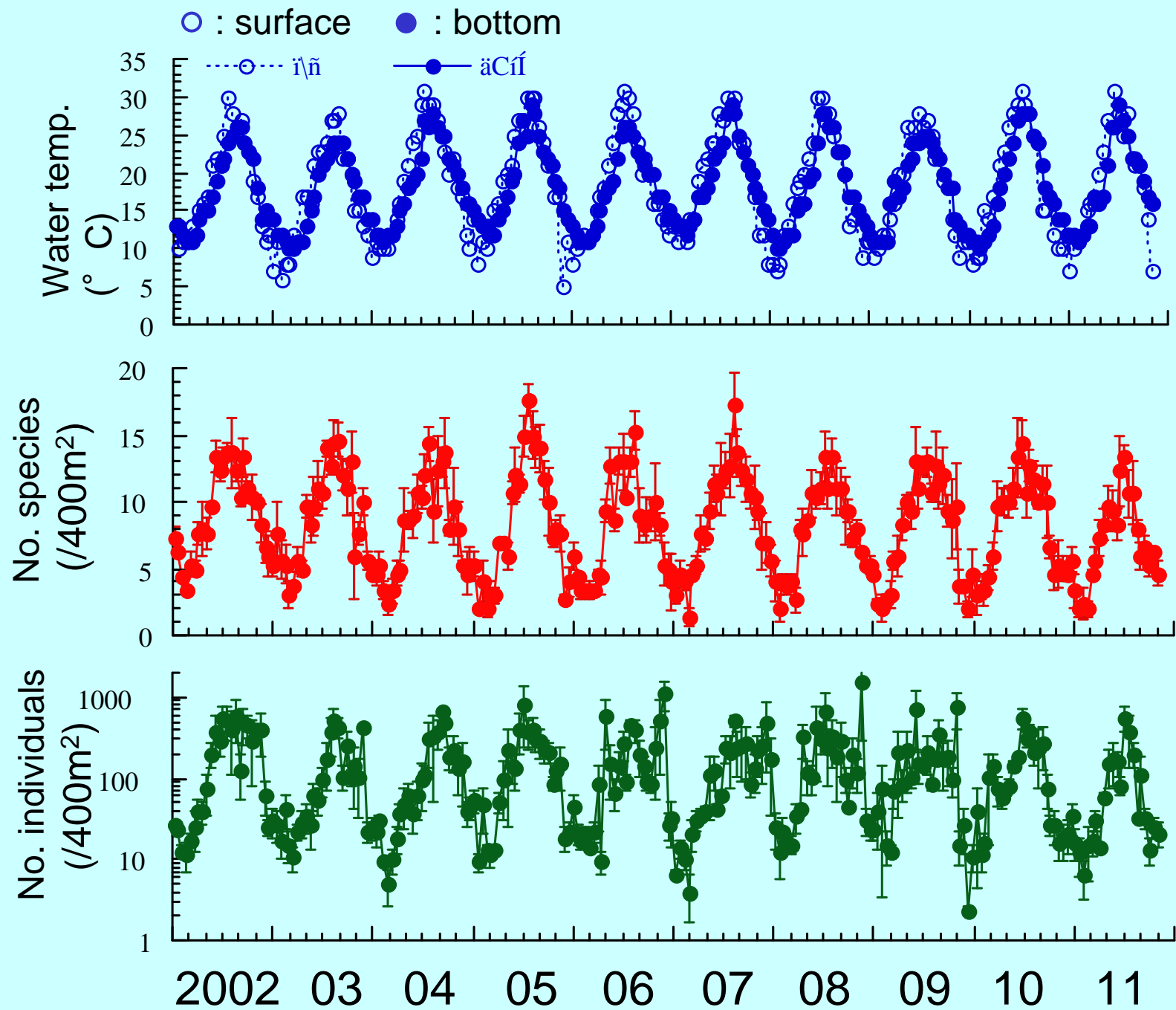
マアジ

(Sep. 2005, Nagahama)

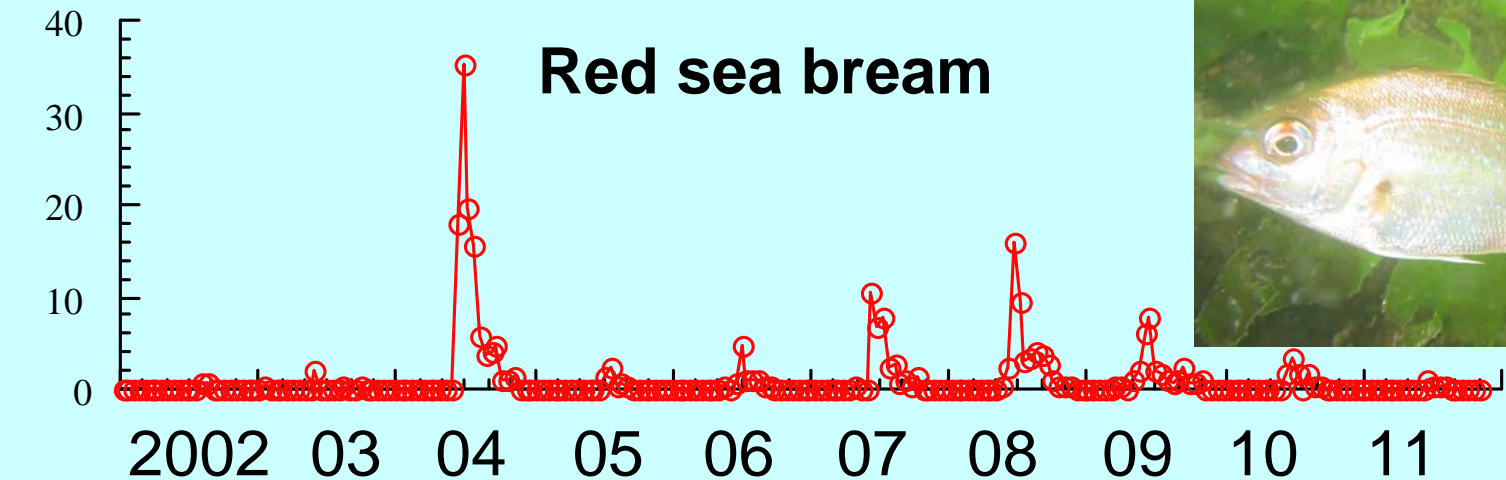
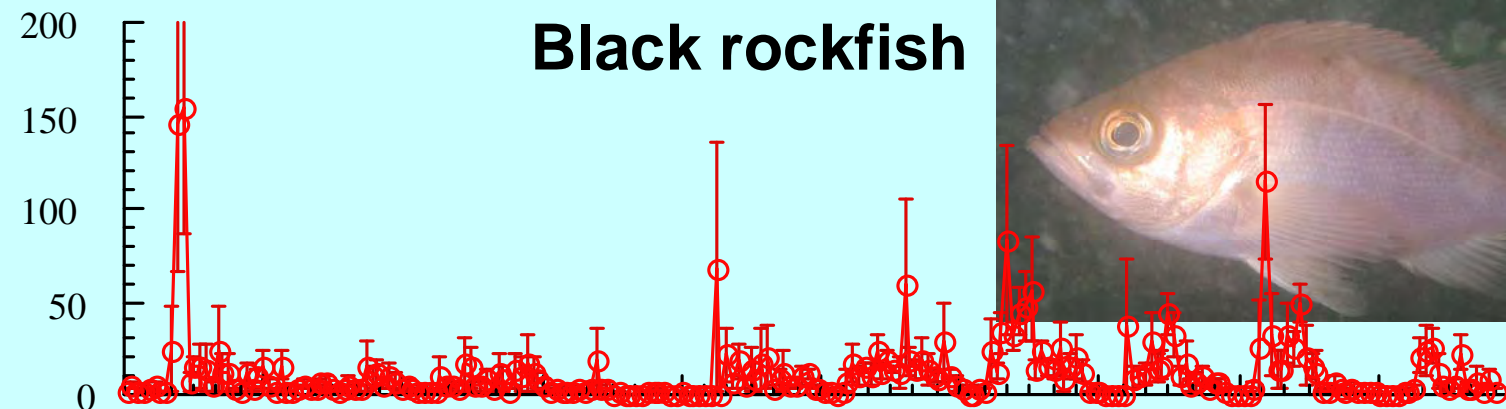
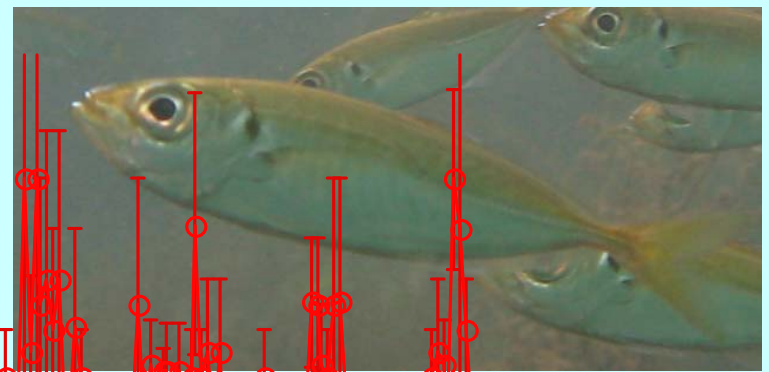
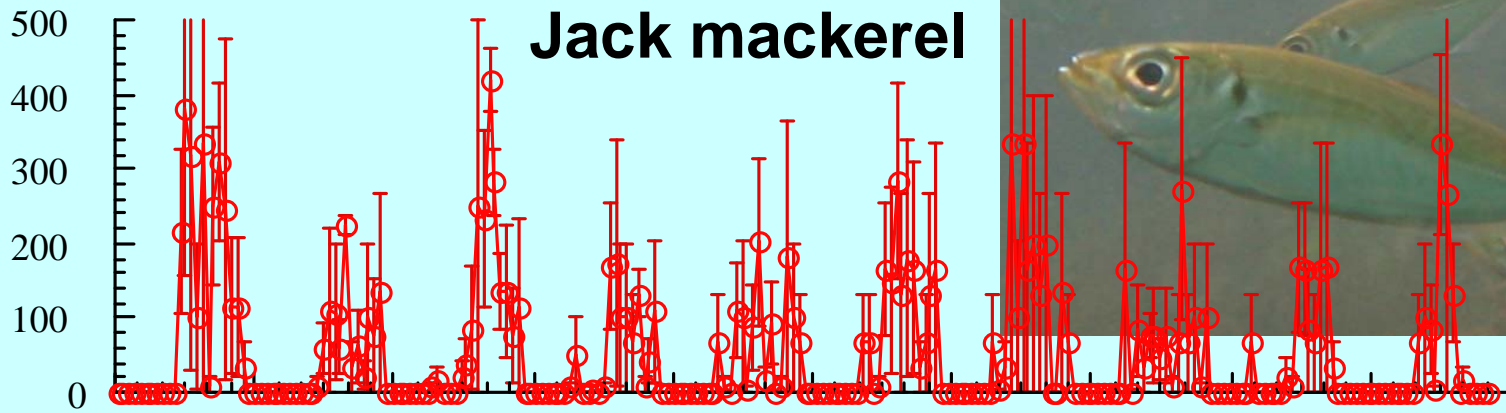
Jack mackerel

Utilizes coastal reef as a nursery habitat.





No. of individuals (/400m²)



Comparison with 1970-72 survey (Nishida et al. 1977) reporting 89 fish species

▪ **Sardine (*Sardinops melanostictus*) and yellowtail (*Seriola quinqueradiata*) have gone.**

▪ **New faces from Tropics**



Center of distribution in northern hemisphere

Distribution data based on Nakabo (2000) and FishBase



Seriola quinqueradiata

Southern limit: 30

Northern limit: 45

Center of distribution: 37.5

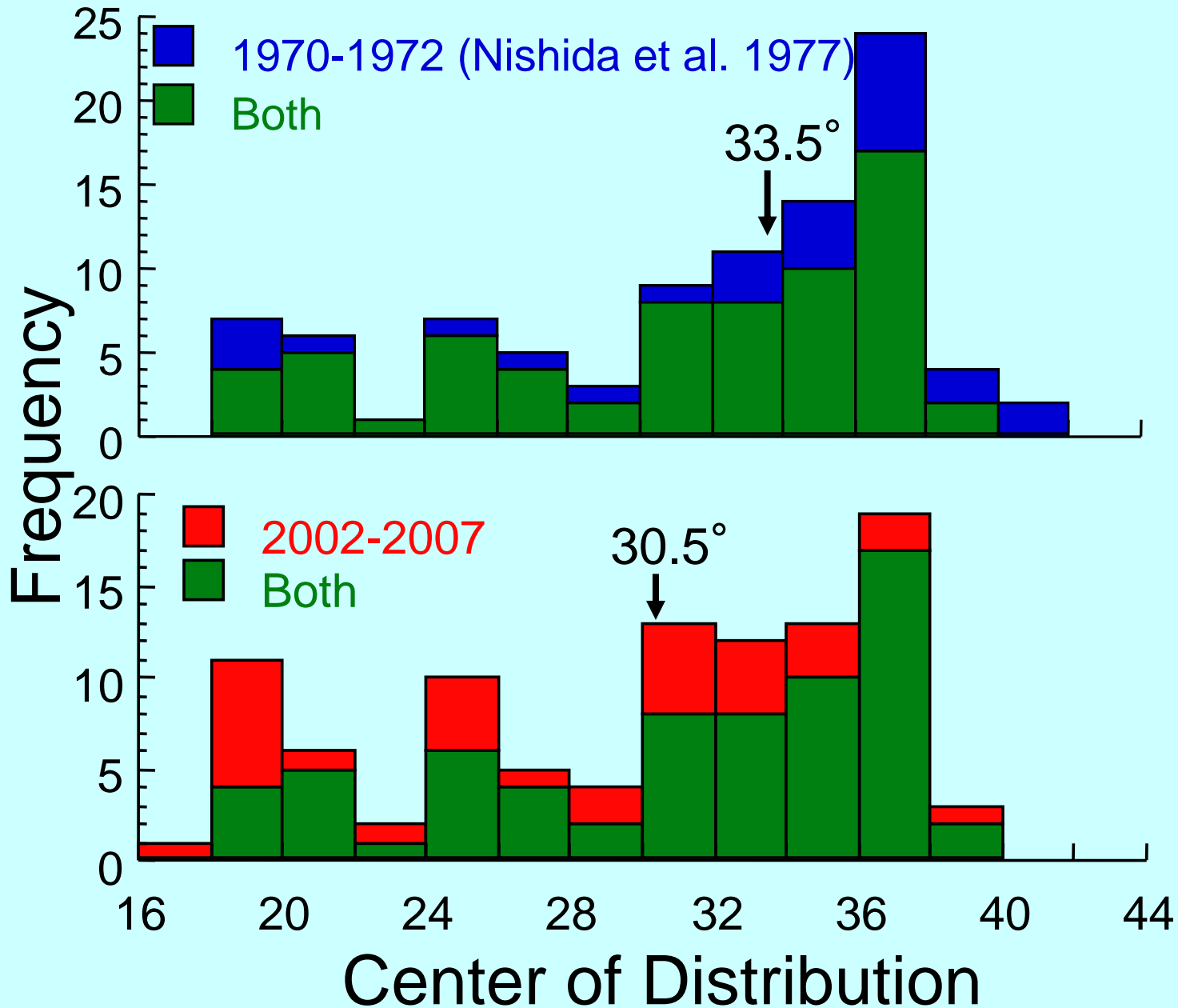


Lutjanus russelli

Southern limit: 0

Northern limit: 38

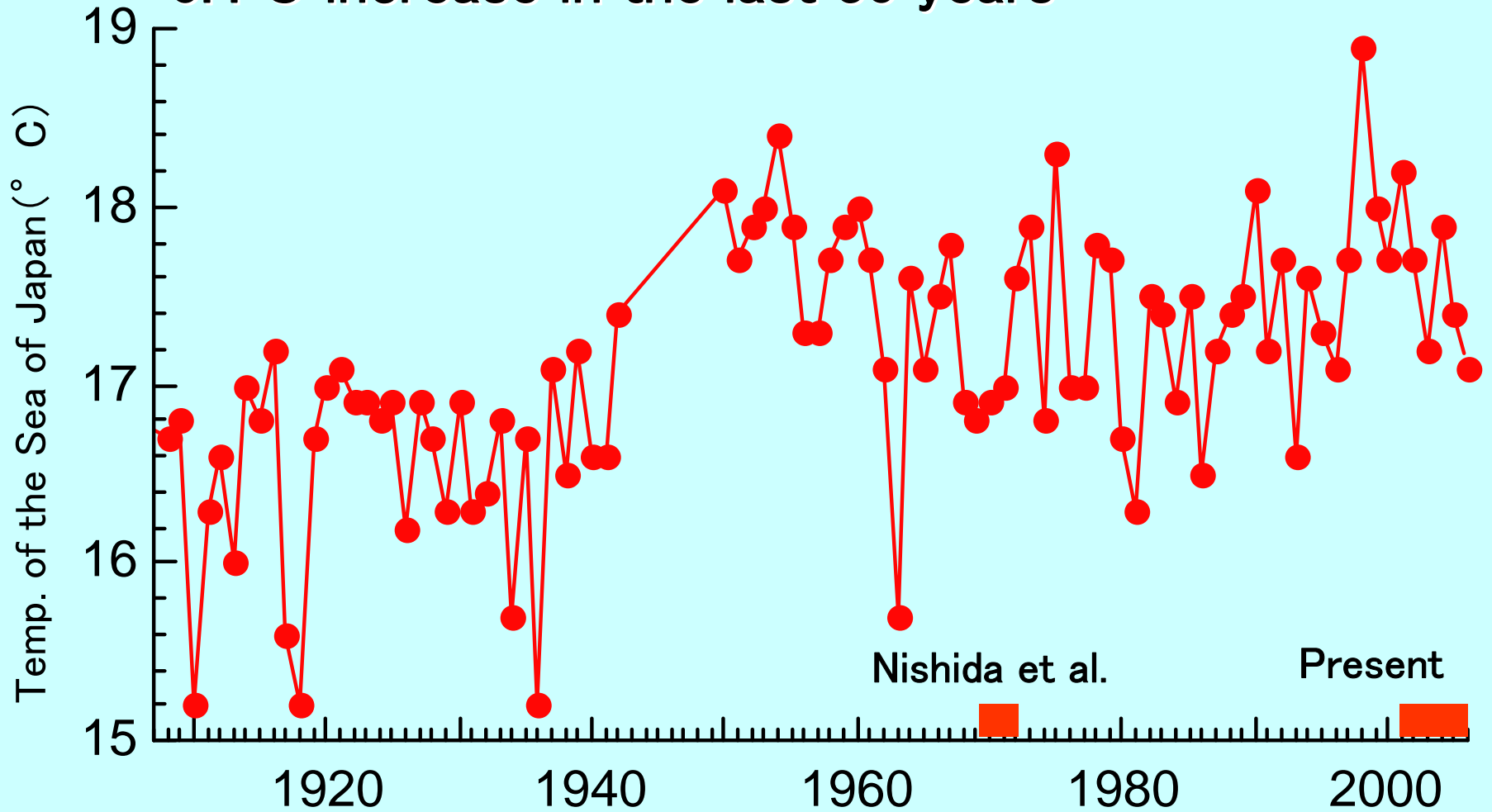
Center of distribution: 19



Masuda 2008 Env Biol Fish 82: 387-399.

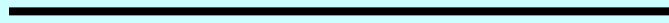
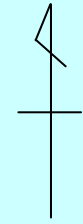
1.0°C increase in the last 100 years

0.4°C increase in the last 30 years



(From the HP of Japan Meteorology Agency)

Diving along thermal discharge from power stations



10km

Sezaki

Otomi

**River flow:
42 m³/s**



**Coal-fired
Power Station
73 m³/s**



**Nuclear
Power Station**



**Yura
River**



Nagahama

**FRS, Kyoto
Univ.**

**Thermal
discharge:
230 m³/s**

**Four times of uw visual census from Jan to Mar
since 2004**

Sezaki (Feb. 2008)





Greenling *Vellitor centropomus*
(Mar. 2004, Sezaki)

スイ



Rockfish *Sebastes pachycephalus*
(Mar. 2004, Sezaki)

ムラソイ

**Porcupinefish *Diodon holocanthus*
(Feb. 2007, Sezaki)**



ハリセンボン

**Pinecornfish *Monocentris japonica*
(Feb. 2008, Sezaki)**



マツカサウオ

Otomi where a nuclear power station had been running since 1974 (Jan 2004, Otomi)



ソラスズメダイ



Damselfish *Pomacentrus coelestis*
(Feb. 2004, Otomi, Fukui)



***Pomacentrus coelestis* with
Diadema (Feb. 2005, Otomi)**

Brocade perch
Ostichthys japonicus
(Mar. 2005, Otomi)

エビスダイ



Blue-speckled rubble goby
Asterropteryx semipunctata
(Jan. 2005, Otomi)

ホシハゼ

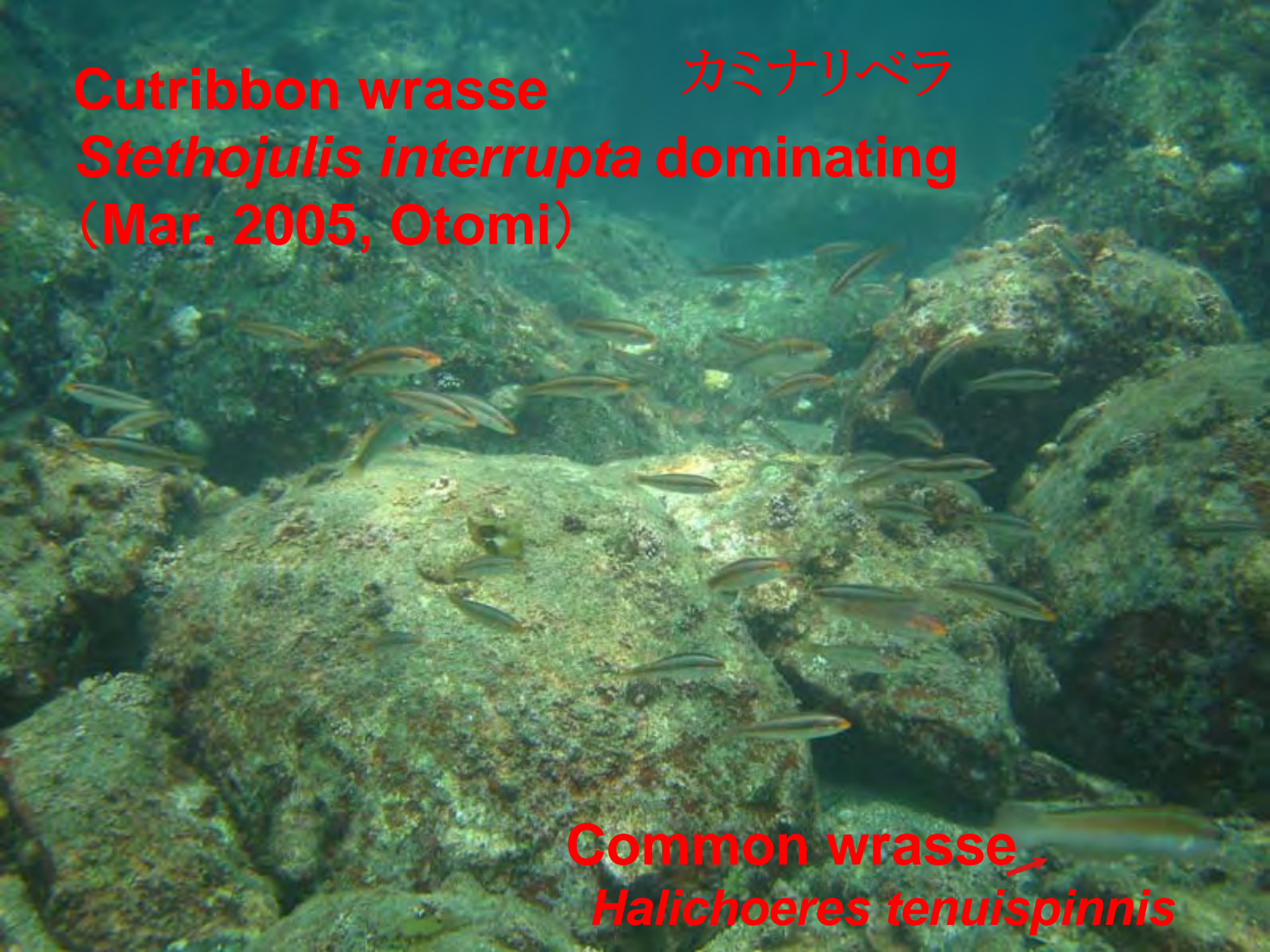


Cutribbon wrasse

カミナリベラ

***Stethojulis interrupta* dominating**
(Mar. 2005, Otomi)

Common wrasse →
Halichoeres tenuispinnis



The nuclear power station was
suspended from Feb 20, 2012



And silversides
Hypoatherina tsurugae died off
(Feb 22, 2012)

ギンイソイワシ

There were still too many *Diadema*
(Feb 22, 2012)



Diadema started to die
(Mar 7, 2012)



Dead flatfish

タマガンゾウビラメ

Pseudorhombus pentophthalmus

(Mar 7, 2012)



Other dead fish (Mar 7, 2012)



Spines of *Diadema*
(April 13, 2012)



Purple sea urchin recovering
(April 13, 2012)



Common wrasse returned
(June 5, 2012, Otomi)

ホンベラ

Juvenile St. Peter's fish
recruiting to *Sargassum* bed
(April 13, 2012)



マトウダイ

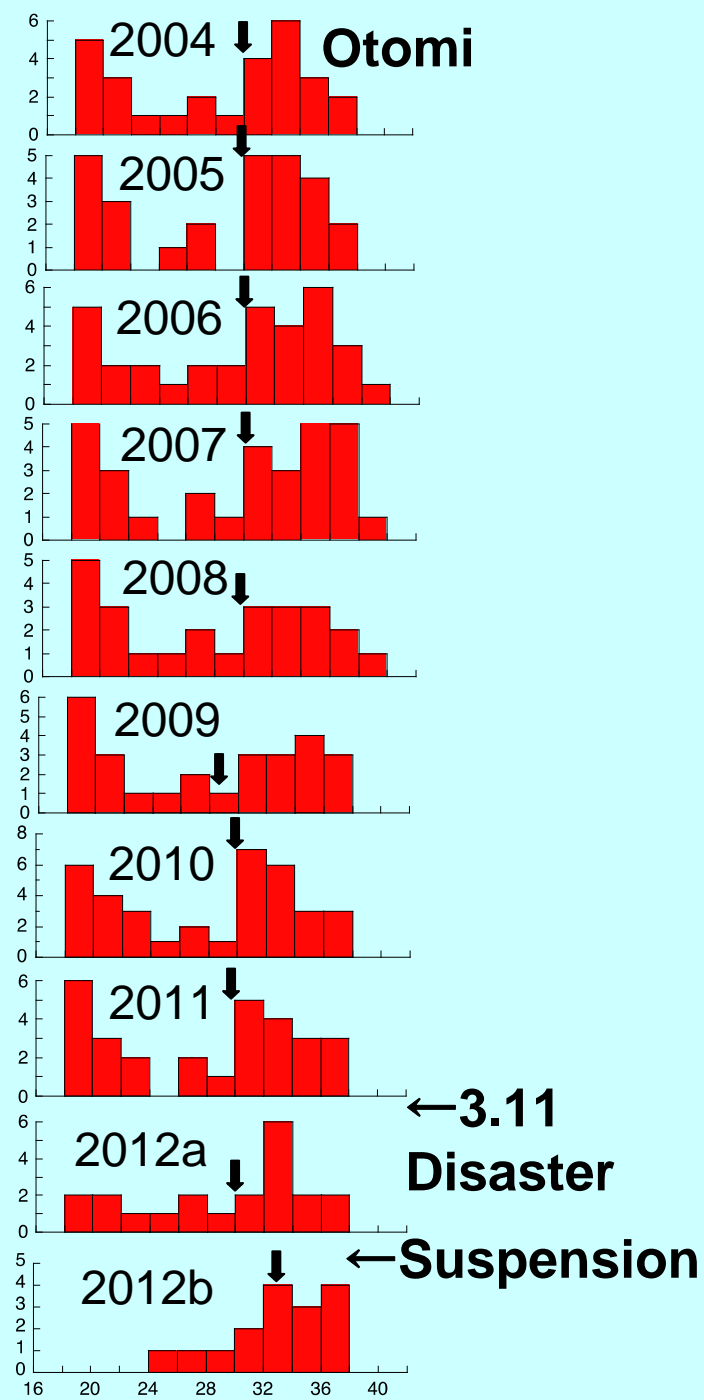
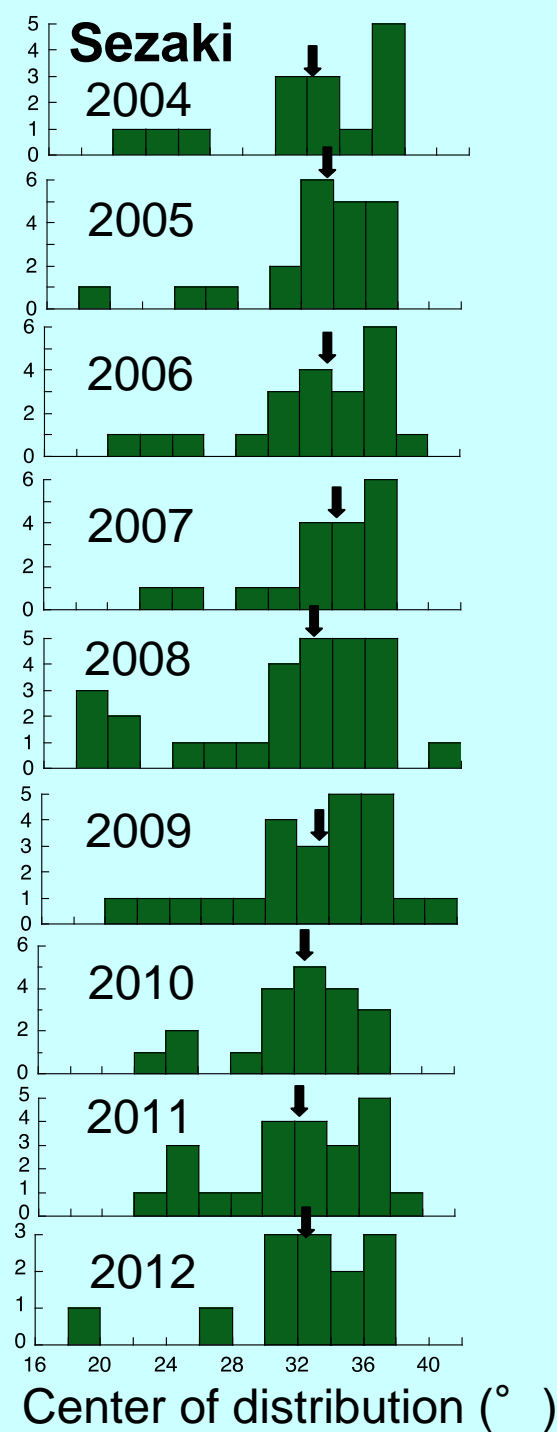
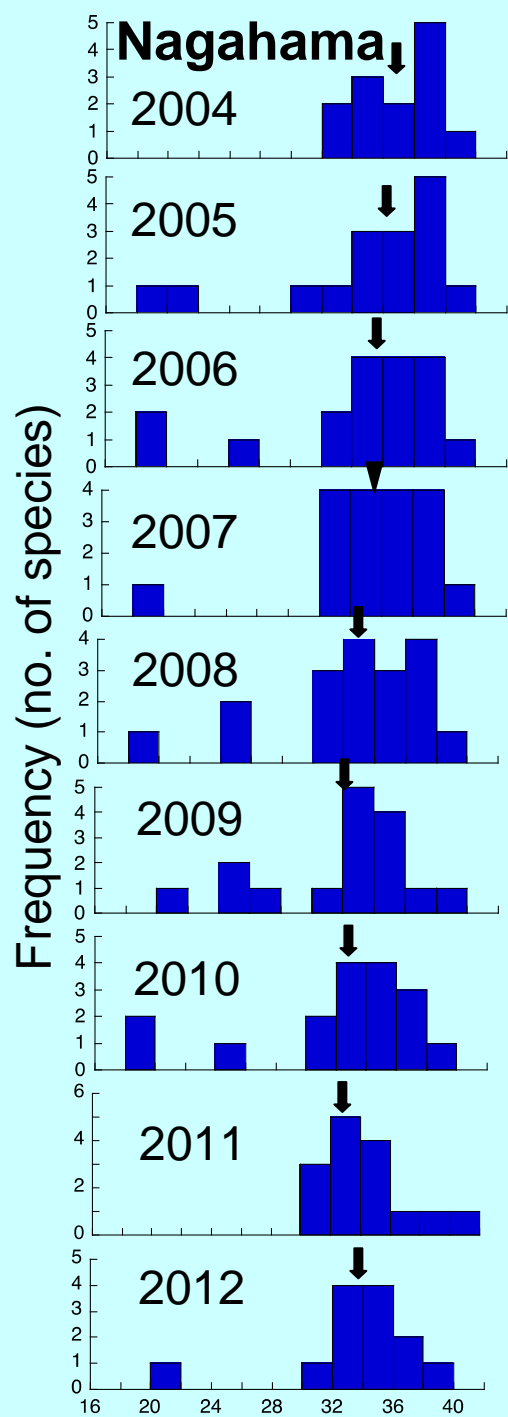
Center of latitudinal distribution in the northern hemisphere



Yellowtail
Seriola quinqueradiata
is distributed 30–45 ° N
Center of distribution: 37.5



Spotted snapper
Lutjanus russelli
is distributed 0–38 ° N
Center of distribution: 19



Risk of running a nuclear power station

Catastrophic risk of earthquake & tsunami

Radioactive waste

Thermal discharge

(7° C warmer than the ocean; 230 m³/s)

**Takahama Nuclear Power Station
(Otomi, Fukui; May. 2010)**

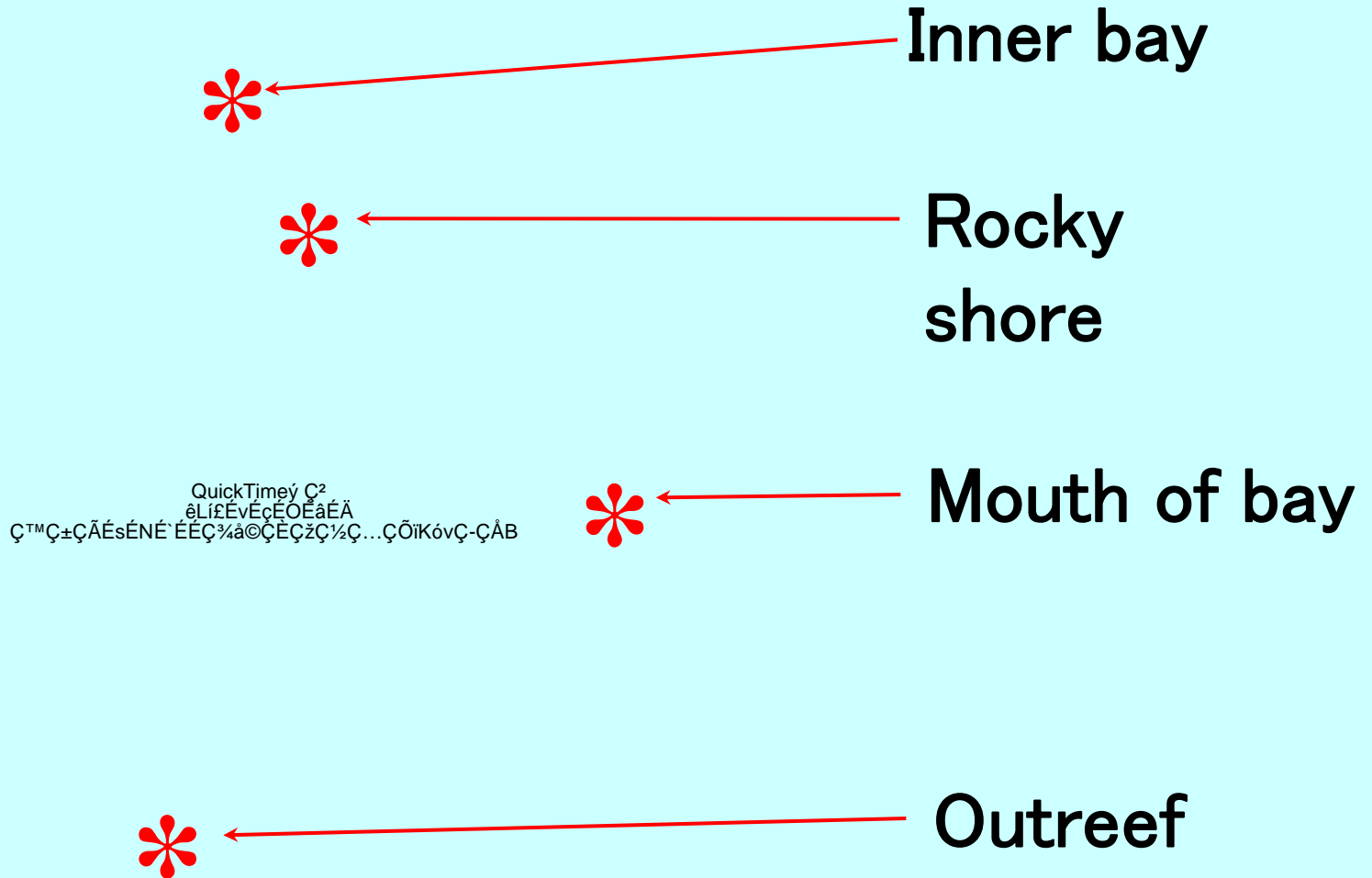


Diving in Tohoku After the *Tsunami* Disaster

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(May 2011, Kesennuma)

Every two-month visual survey



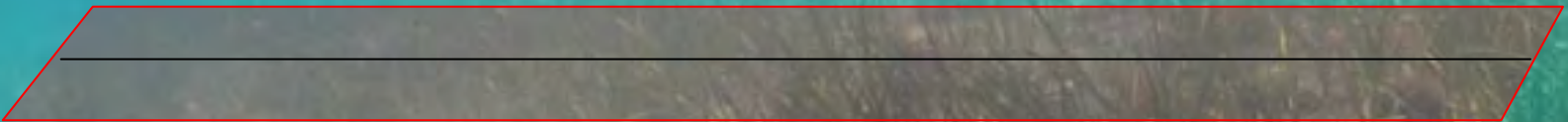
Redrawn from Google Map

Fin-kick transect



50 m

2 m



Line transect

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(May 2011)

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Wooden debris (May 2011)

Sunrize sculpin

***Pseudoblennius cottoides* (May 2011)**

アサヒアナハゼ

Prickleback

***Pholis crassispina* (May 2011)**



タケギンポ

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Sculpin *Alcichthys elongatus* (May 2011)

ニジカジカ

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***Goby Pterogobius elapoides* (July 2011)**

キヌバリ

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Greenling *Hexagrammos otakii* (July 2011)

アイナメ

Goby (Sep 2011)

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Goatfish *Upeneus japonicus* (Sep 2011)

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ヒメジ

Jack mackerel (Sep 2011)

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Mullet *Mugil cephalus* (Sep 2011)

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ボラ

Goby (Nov 2011)

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Greenling (Nov 2011)

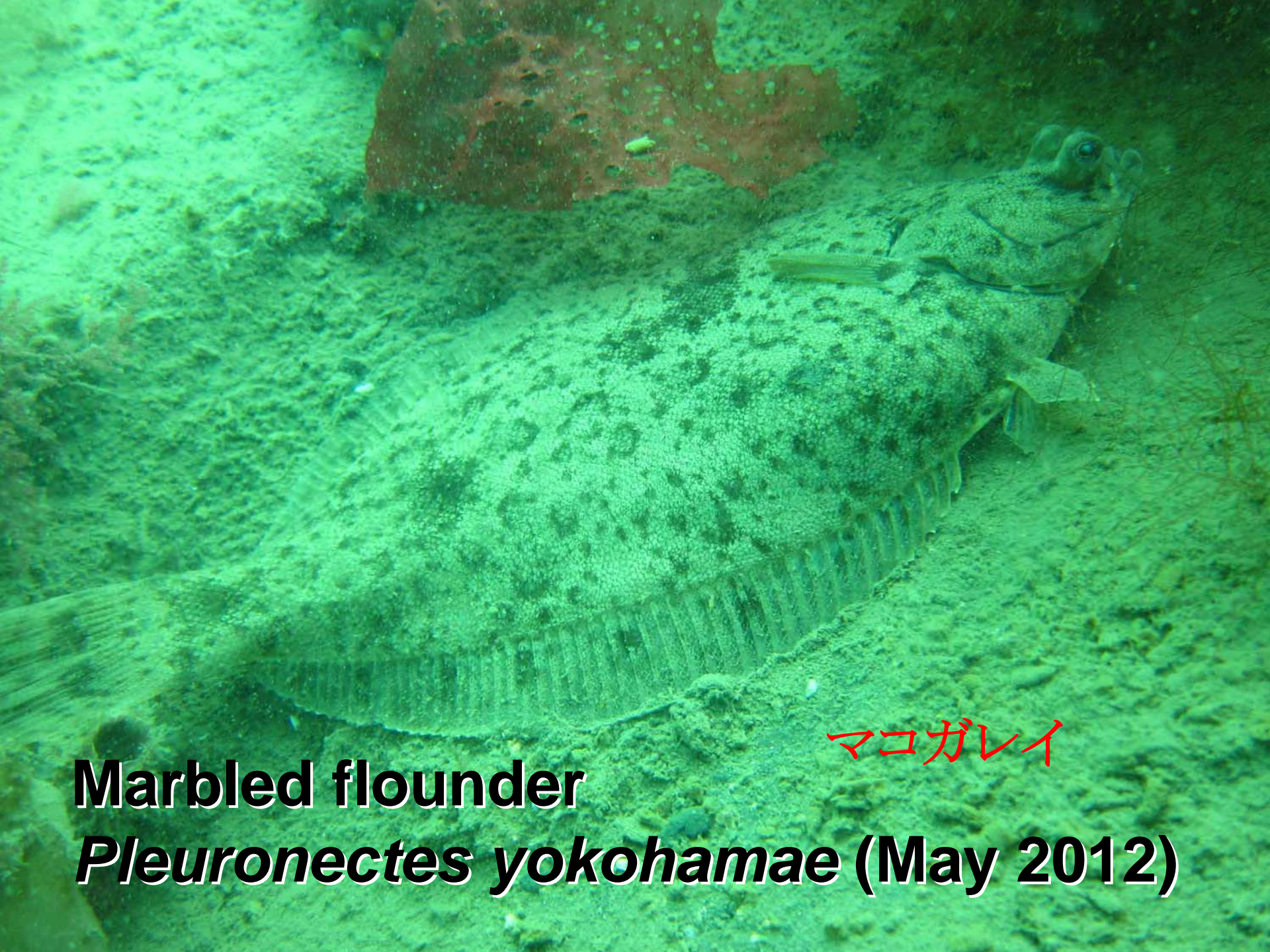
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Prickleback

***Opisthocentrus ocellatus* (May 2012)**

ガジ



マコガレイ

Marbled flounder

***Pleuronectes yokohamae* (May 2012)**

**Fox jacopever *Sebastes vulpes*
(Sep 2012)**

キツネメバル



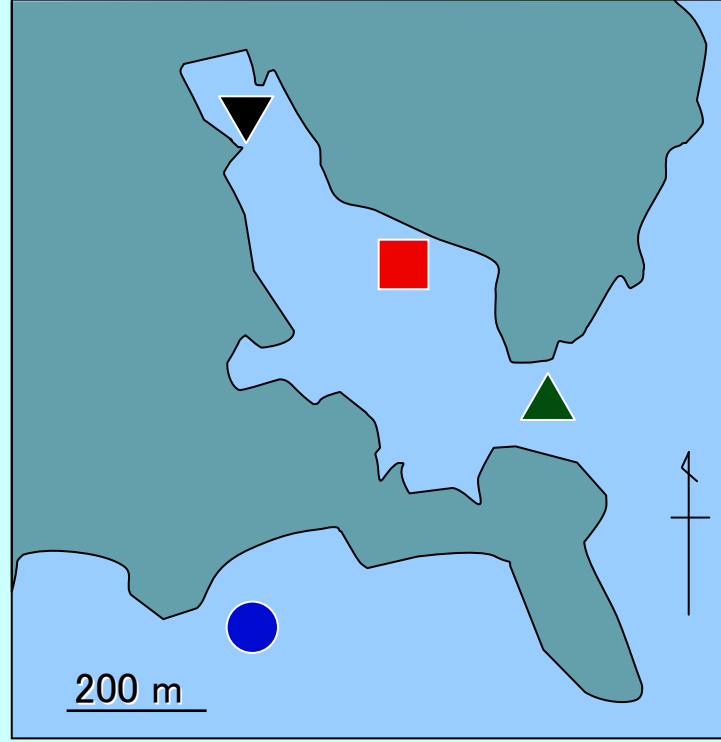
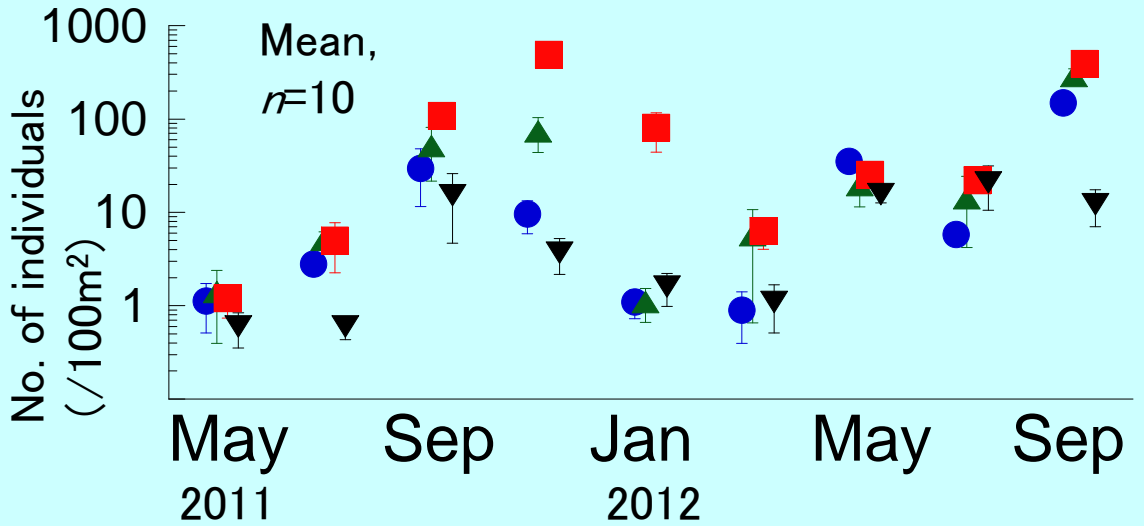
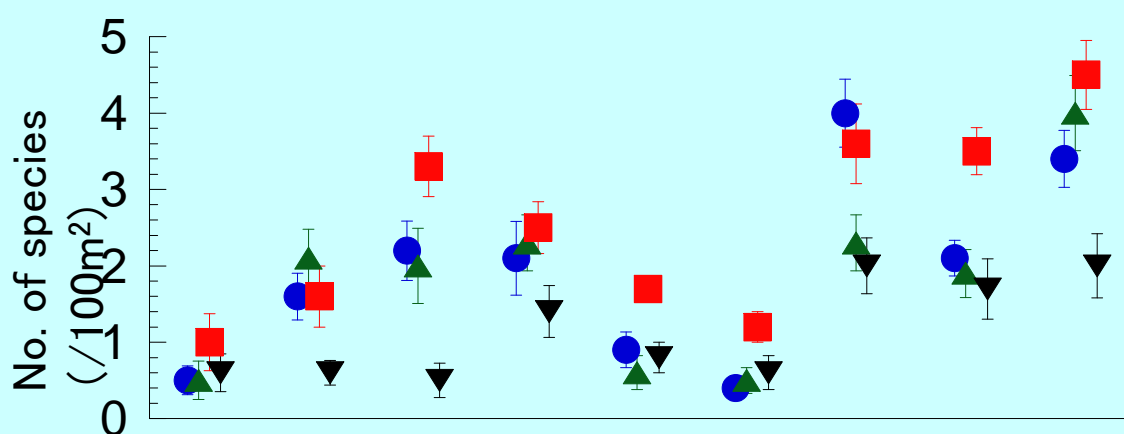
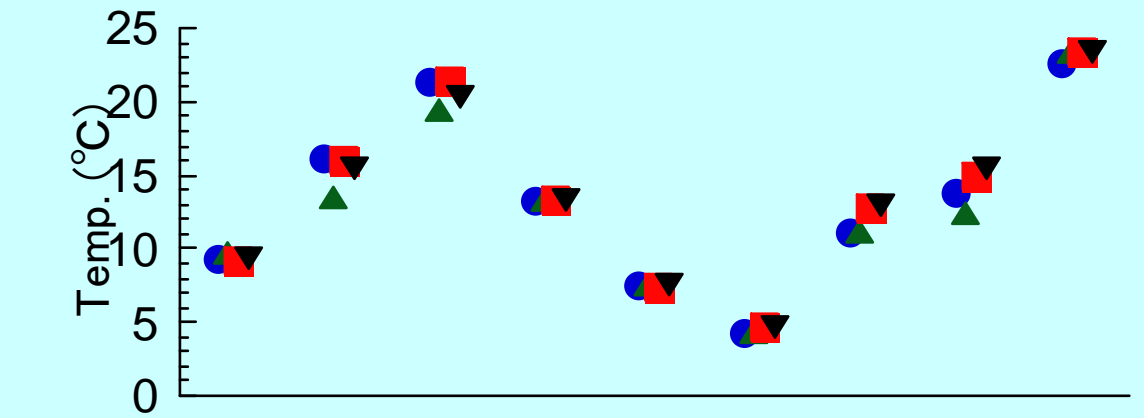
Surfperch *Ditrema temmincki* (Sep 2012)



ウミタナゴ

Sunrize sculpin mating (Sep 2012)





- ▼ : Inner bay
- : Rocky shore
- ▲ : Mouth of bay
- : Out reef

Fish are increasing
Rocky shore is quick in recovery

Natural rocky reef shore enabled rapid recovery of seaweed forest

(Sep 2012, Moune Bay)

U/W visual census

**Species richness, abundance,
BL, biomass**

**Comparing location,
time, treatment**

Insights

(Nov. 2003, Nagahama)

