

# From biodiversity prediction to ecosystem service evaluation : marine case studies in Japan

Takehisa Yamakita

Japan Agency for Marine-Earth Science and Technology

## Acknowledgements:

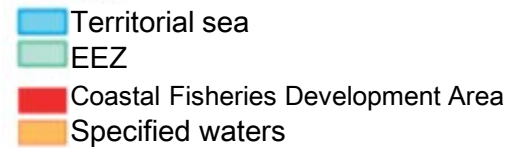
The Environment Research and Technology  
Development Fund (ERTDF), S9 and S15,  
Ministry of the Environment



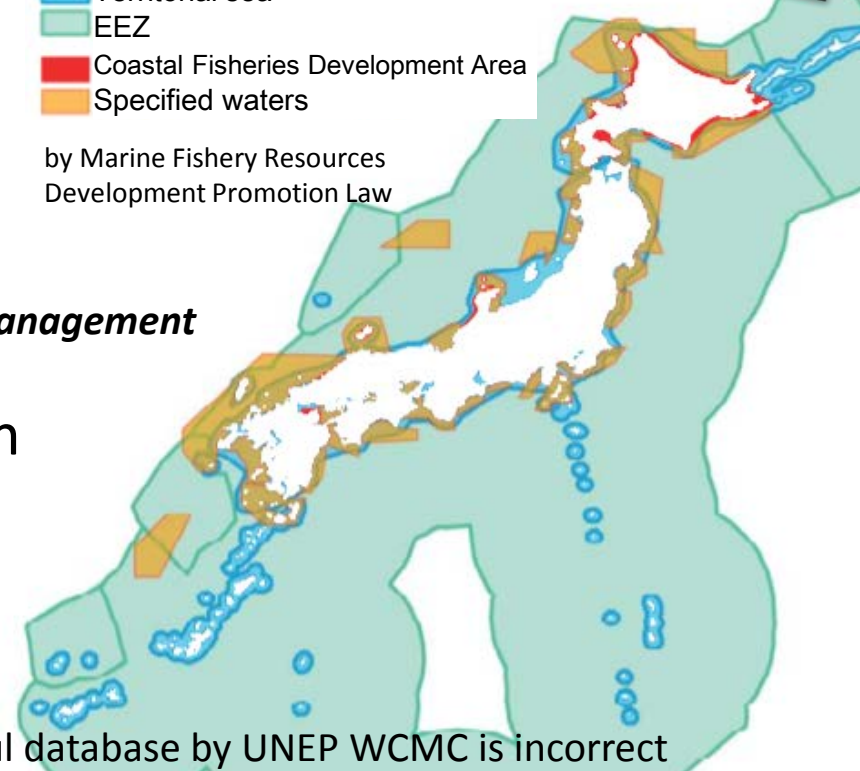


# Importance of marine spatial planning (MSP)

- Aichi Target (CBD strategic plan -2020)
  - Sustainable use of ecosystem
  - 10% MPA etc.... → Needs of spatial evaluation
- Status in Japan
  - 8.3% in EEZ & territorial sea ***incl. fishing right area*** (Cabinet Office 2011 )
  - 0.11% in Territorial sea **3.75% upper 10m deep** (WWF Japan 2009) ***without fishery management***
- MoE started to increase PA
- Fishery started BD consideration



by Marine Fishery Resources Development Promotion Law



Be careful database by UNEP WCMC is incorrect

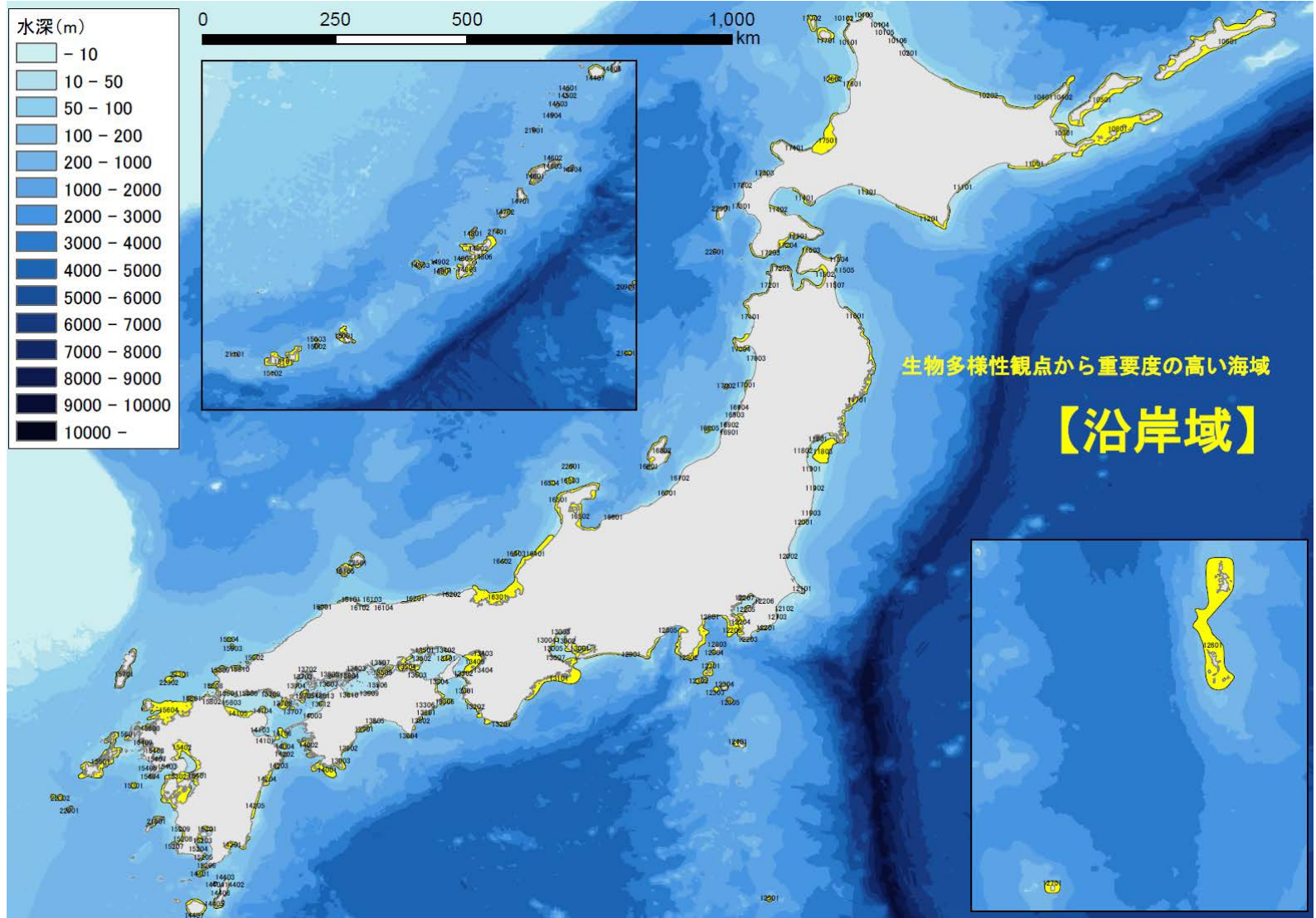


# Seven criteria for EBSA identification (CBD COP 9, annex I, decision IX/20)

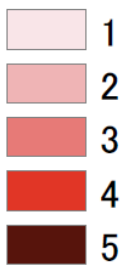
1. Uniqueness or rarity	Area contains either unique (the only one of its kind), rare (occurs only in few locations) or endemic species, populations or communities, and/or unique, rare or distinct, habitats or ecosystems; and/or unique or unusual geomorphological or oceanographic features
2. Special importance for life history of species	Areas that are required for a population to survive and thrive
3. Importance for threatened, endangered or declining species and/or habitats	Area containing habitat for the survival and recovery of endangered, threatened, declining species or area with significant assemblages of such species
4. Vulnerability, fragility, sensitivity, slow recovery	Areas that contain a relatively high proportion of sensitive habitats, biotopes or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery
5. Biological diversity	Area containing species, populations or communities with comparatively higher natural biological productivity
6. Biological productivity	Area contains comparatively higher diversity of ecosystems, habitats, communities, or species, or has higher genetic diversity
7. Naturalness	Area with a comparatively higher degree of naturalness as a result of the lack of or low level of human-induced disturbance or degradation

# EBSA identified by Japan (coastal version)

From the website of MOE

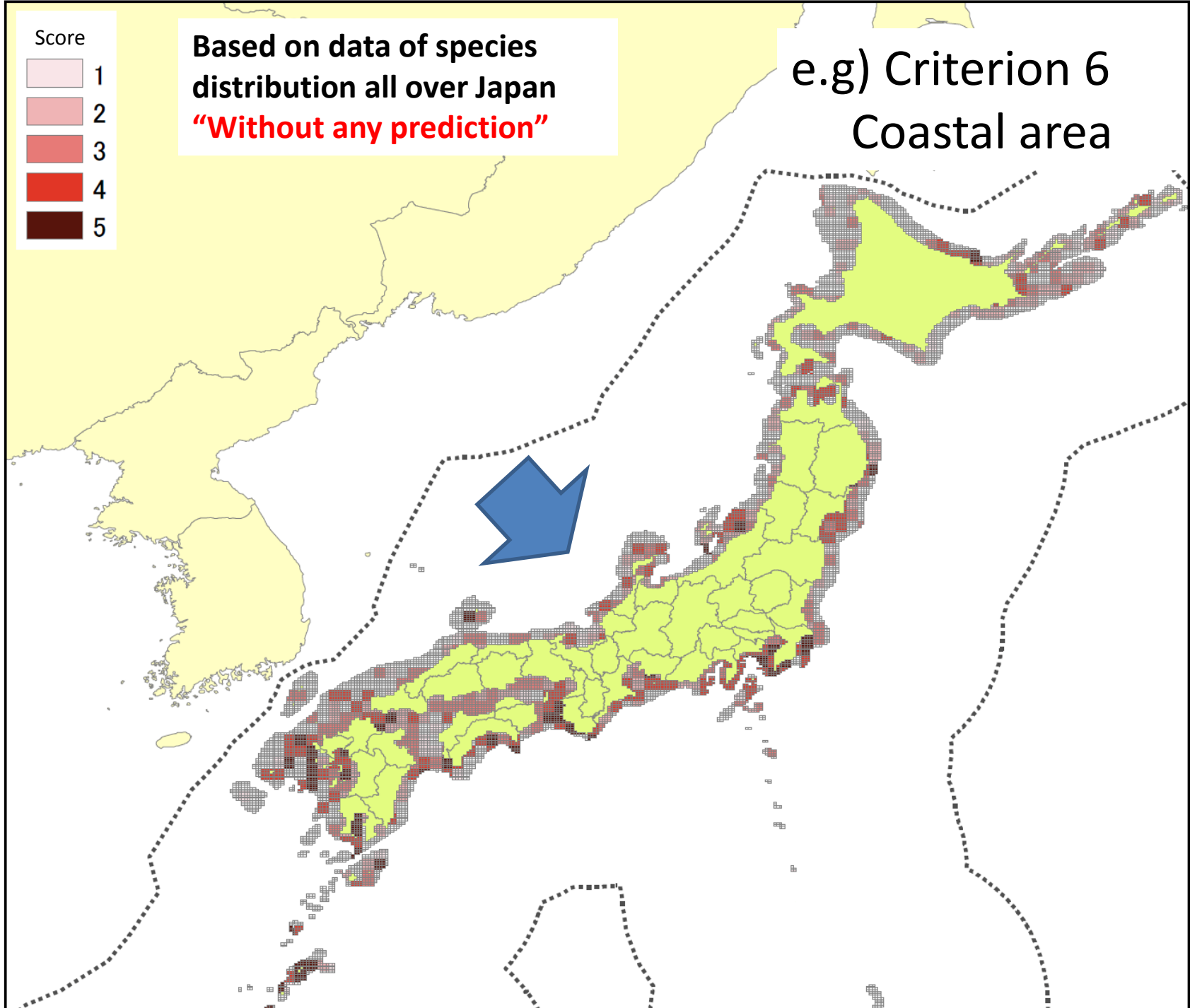


Score



Based on data of species  
distribution all over Japan  
**“Without any prediction”**

e.g) Criterion 6  
Coastal area





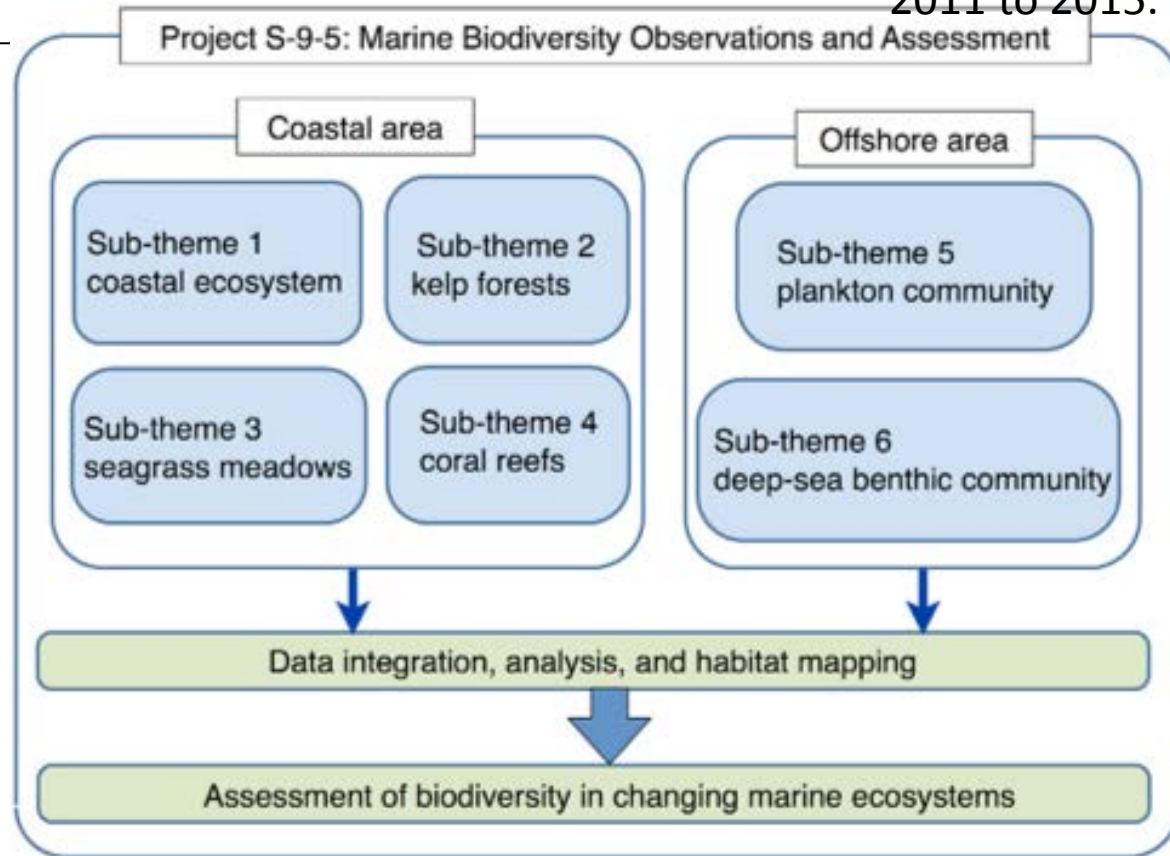
# Integrative observation and assessments of marine biodiversity in Asia-Pacific region by the strategic project S-9-5 of Japan

2011 to 2015.

This project, Integrative Observation and Assessments of Marine Biodiversity in Asia region (S-9-5) consists of six research teams;

- 1) regional biodiversity in Asia,
- 2) kelp forest and seaweed beds,
- 3) seagrass beds,
- 4) coral reefs,
- 5) plankton communities in pelagic water, and
- 6) deep-sea chemosynthetic communities.

Since 2011, the project collected over **2,213,148 records**, and studied to establish the protocol to select ecologically and biologically significant area (EBSA). These results are **adopted as expert opinion** and could contribute to achieve the Aichi Target, and as the baseline data of discussion on the International Science–Policy Platform on Biodiversity and Ecosystem Services (IPBES).

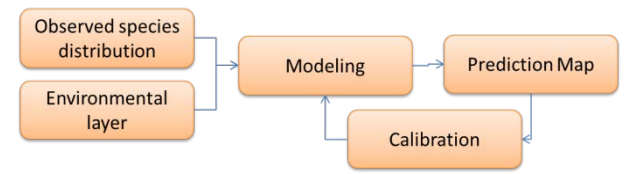


Project members:

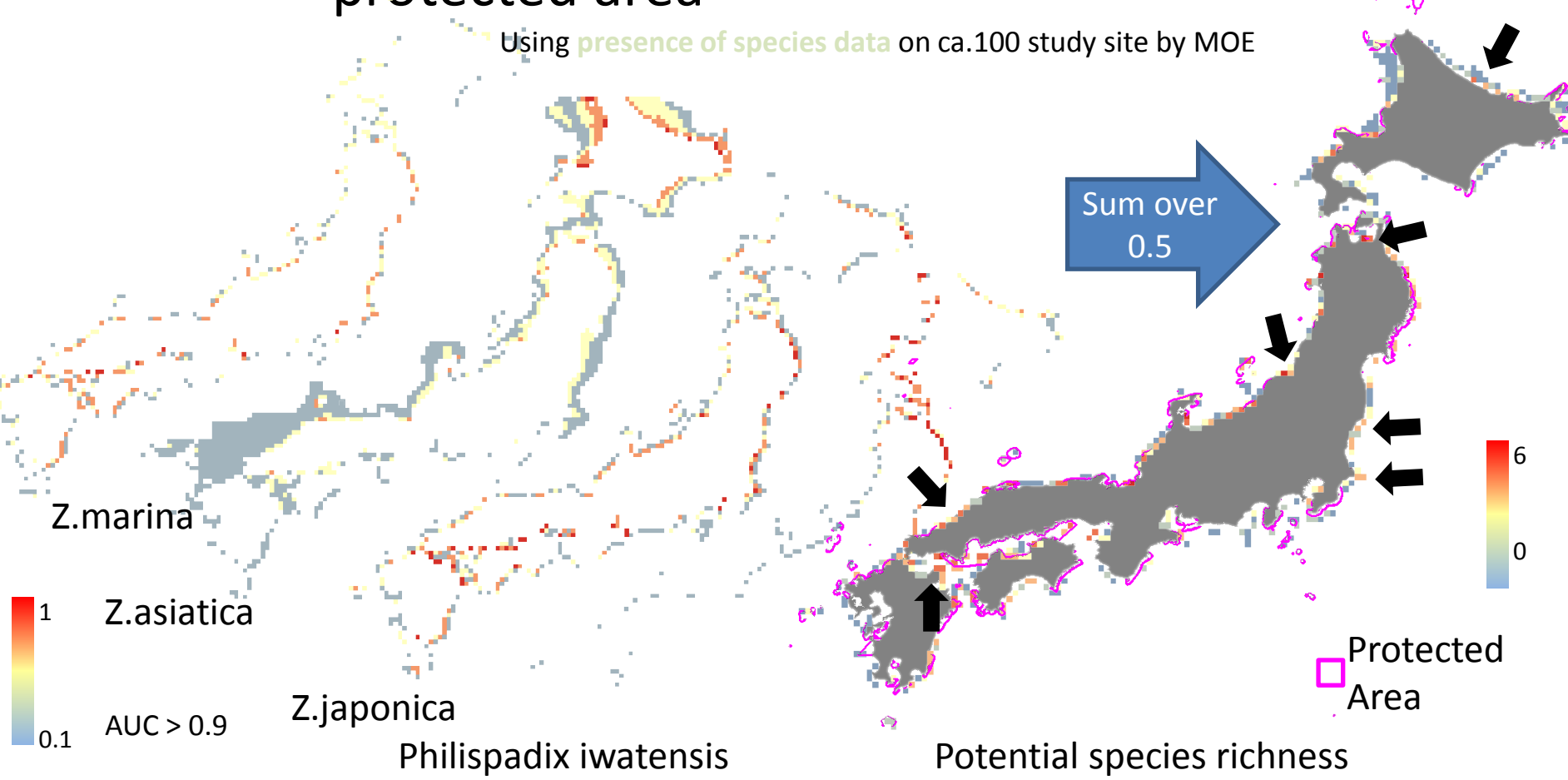
- + Japan Agency for Marine-Earth Science and Technology
  - + National Institute for Environmental Studies
  - + Fisheries Research Agency
  - + Hokkaido University
  - + Atmosphere and Ocean Research Institute, University of Tokyo
- Funding : Ministry of the Environment, Japan



# Predicted distribution of species and biodiversity to plan the protected area



Using presence of species data on ca.100 study site by MOE



# Prediction of future distribution of algae (number of species)

Increase:

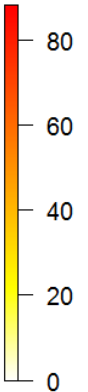
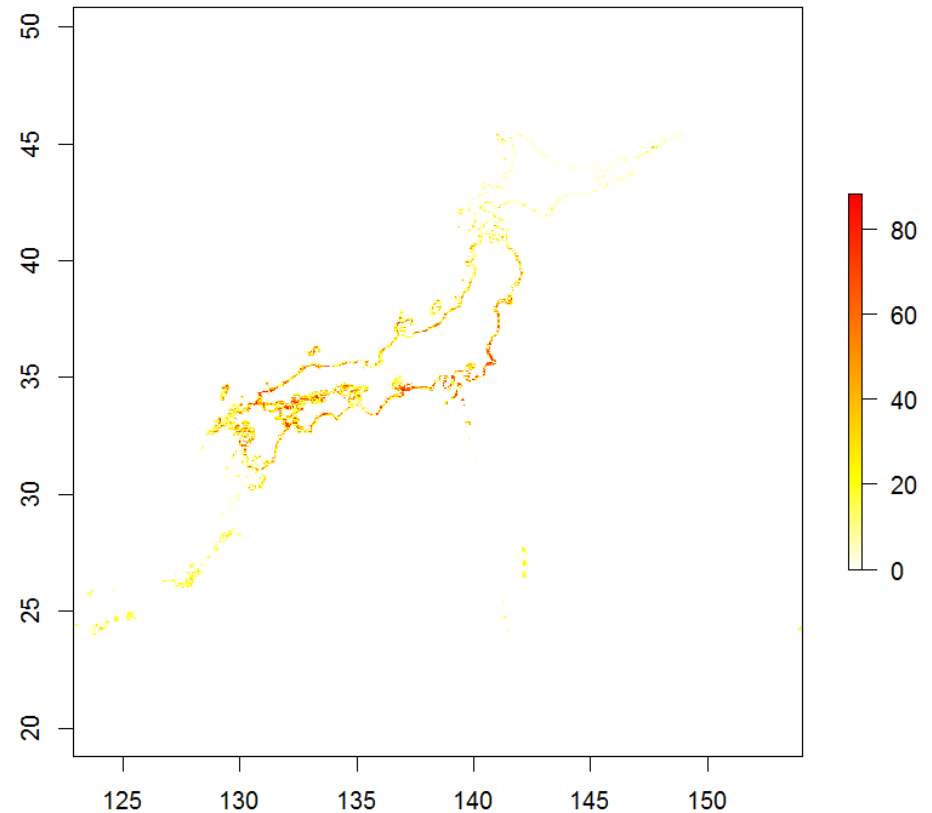
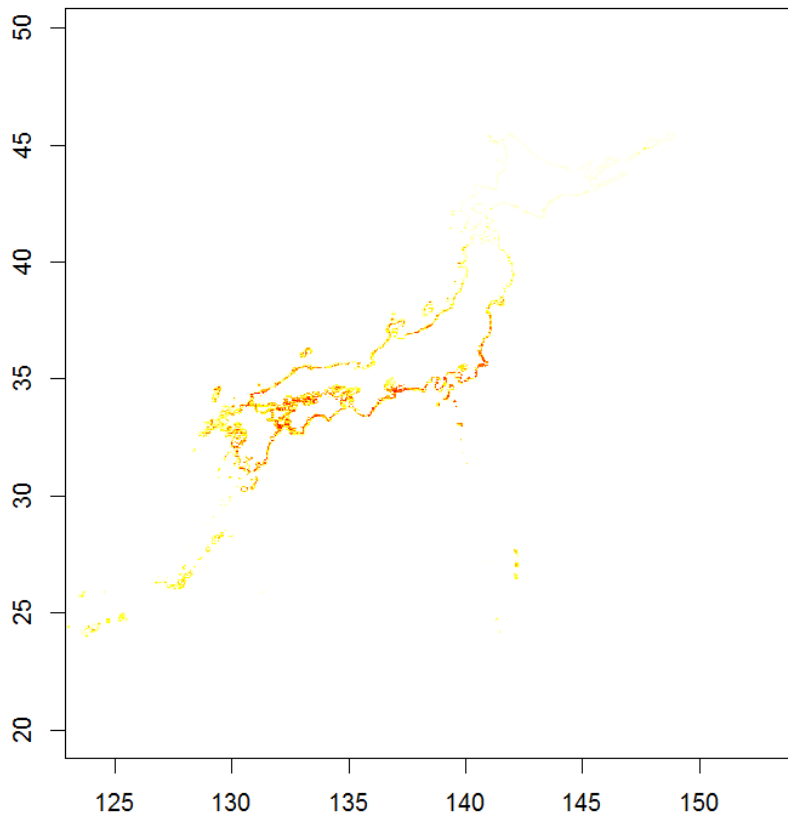
ホソジュズモ、ハイミル、ミル、キッコウグサ、  
クロガシラ属、イバラノリ

Decrease:

ウミウチワ、ヒジキ、ツルアラメ、ヒメカニノテ、  
ピリヒバ、オバクサ、フクロフノリ

2010

2050 RCP8.5





# ● Possibility of the evaluation of 7 EBSA criteria

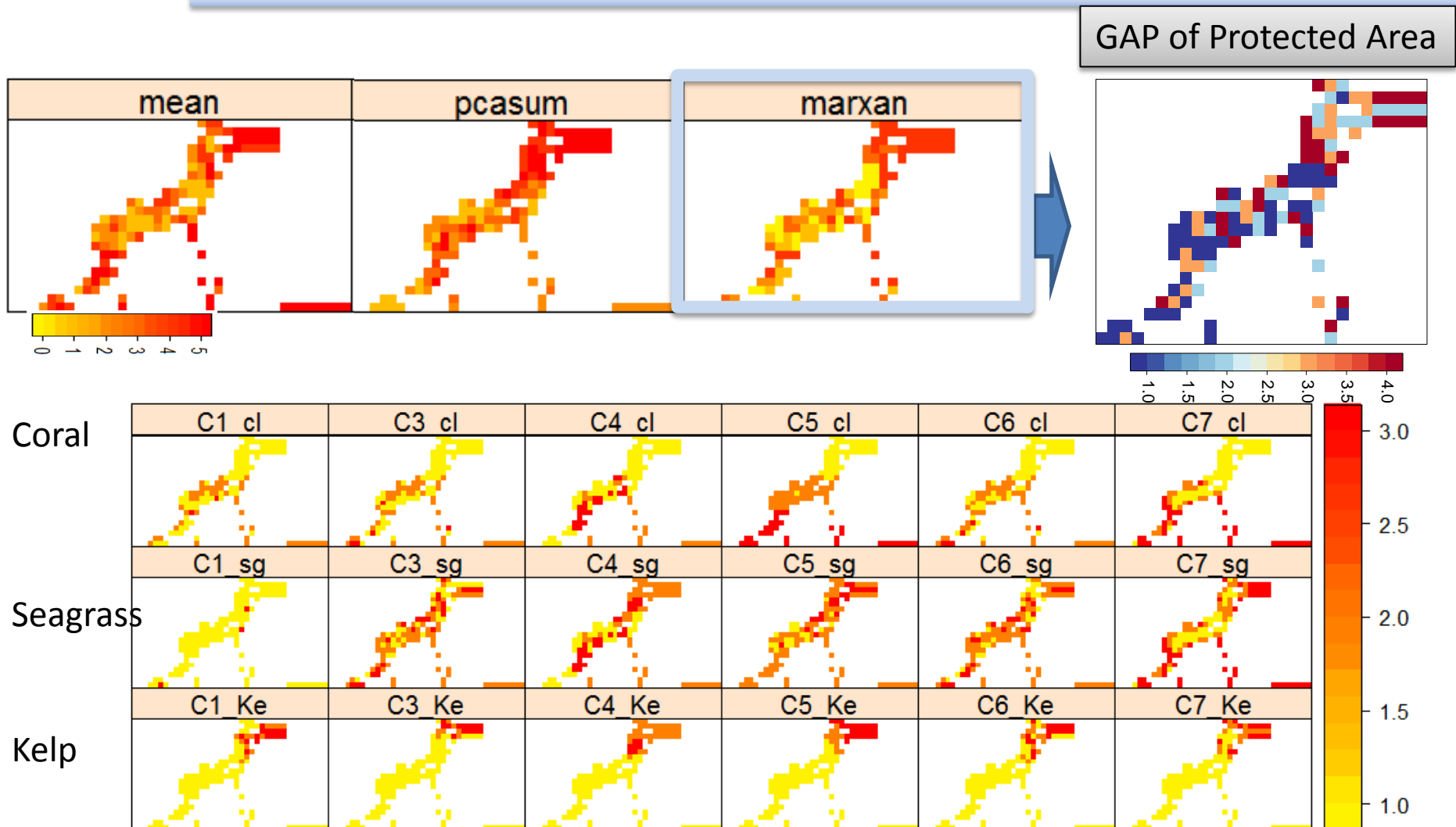
Cr.1 , Cr.2 , Cr.3 , Cr.4 , Cr.5 , Cr.6 , Cr.7  
 Naturalness, Diversity, Productivity, vulnerability ,endangered, Life history ,uniqueness

Candidate quantitative indices for each criterion	Data availability				
	Kelp bed	Seagrass bed	Coral reefs	Plankton	Deep sea
Distribution of endemic species	-	△	△	-	△
Unique species assemblage structure	○	△	-	-	○
Unique genetic structure of key species	-	△	-	-	-
Data on habitat use by important species	-	-	-	-	-
Fisheries statistics of important species	○	-	-	-	-
Animal tracking data	-	-	-	-	-
Genetic data as source and sink populations	-	-	-	-	-
Ocean current as source and sink populations	-	-	○	-	-
Occurrence in endangered species red lists	○	○	○	-	-
Data on long-term changes in habitat area	○	△	○	△	△
Indicator species information	-	-	△	-	-
Data on primary productivity	△	○	△	-	-
Area or coverage as a proxy of productivity	○	○	○	-	○
Secondary or higher trophic level productivity	△	△	○	○	○
Satellite images (e.g., ocean color)	△	△	△	○	-
Species richness and other diversity indices	○	○	○	○	○
Human population data	○	○	○	-	-
Data on coastal development	○	○	○	-	-
Level of protection as natural reserves	○	○	○	-	-
Fisheries data	△	-	△	○	-
Industrial use (e.g., marine mining)	△	△	△	-	○

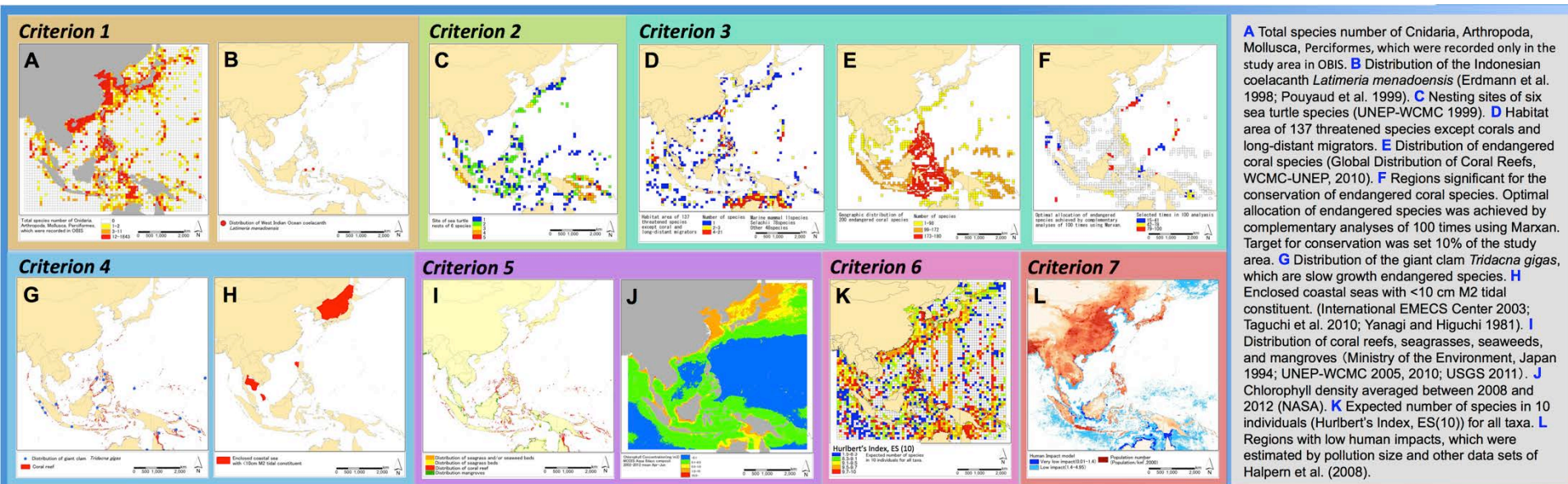
**Possible** to use multiple criteria for these 5 ecosystems

**Insufficient in ...**  
 Criterion 2  
 "Data on mobile fauna"  
 Criterion 4  
 "Data on the temporal dynamics of ecosystems"

# ● Integrated result in 1 degree

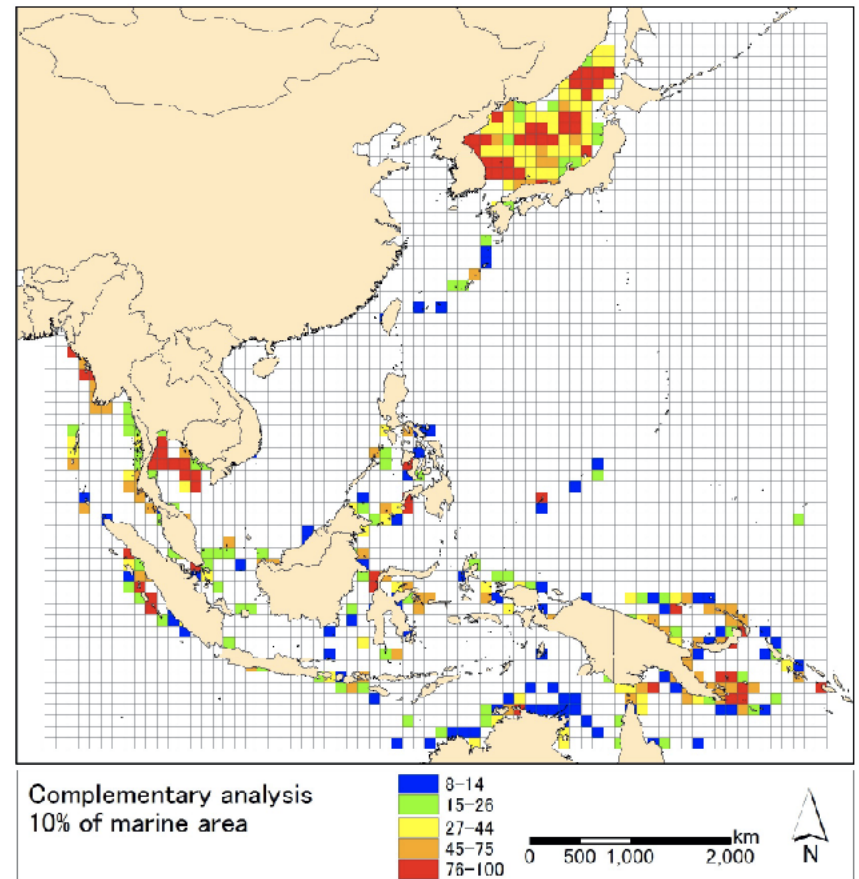
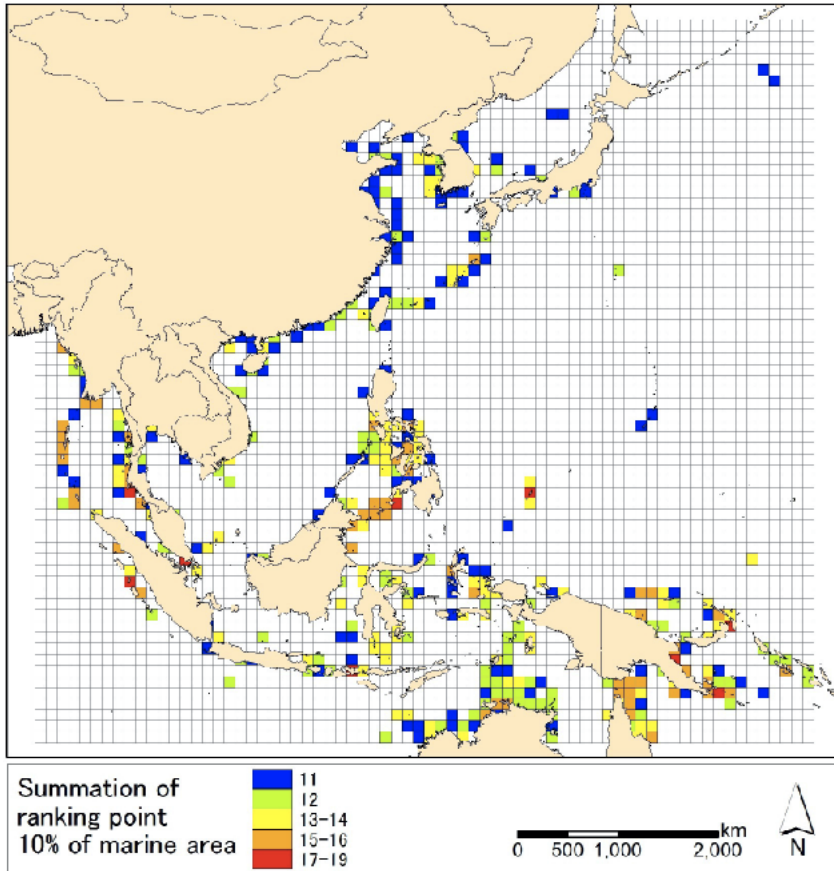


# EBSA identification trials for Asia region



Source of records for species occurrence		Years	Records collected
Database	OBIS	1748~2013	1,120,974
	GBIF	1700~2013	842,569
	NaGISA	2002~2010	2,928
	COPEPOD	1974~1981	1,475
	PANGAEA	2005	19,100
Cruise reports	H.M.S. Challenger Expedition	1874~1875	2,375
	Hakuho-Maruru Cruise	1972~2006	15,668
	Snellius-II Expedition	1984~1985	3,319
	Rumphius Biohistorical Expedition	1990	1,989
	Anambas Expedition	2002	2,127
Published papers		1939~2012	23,792
Total count of records			2,036,316

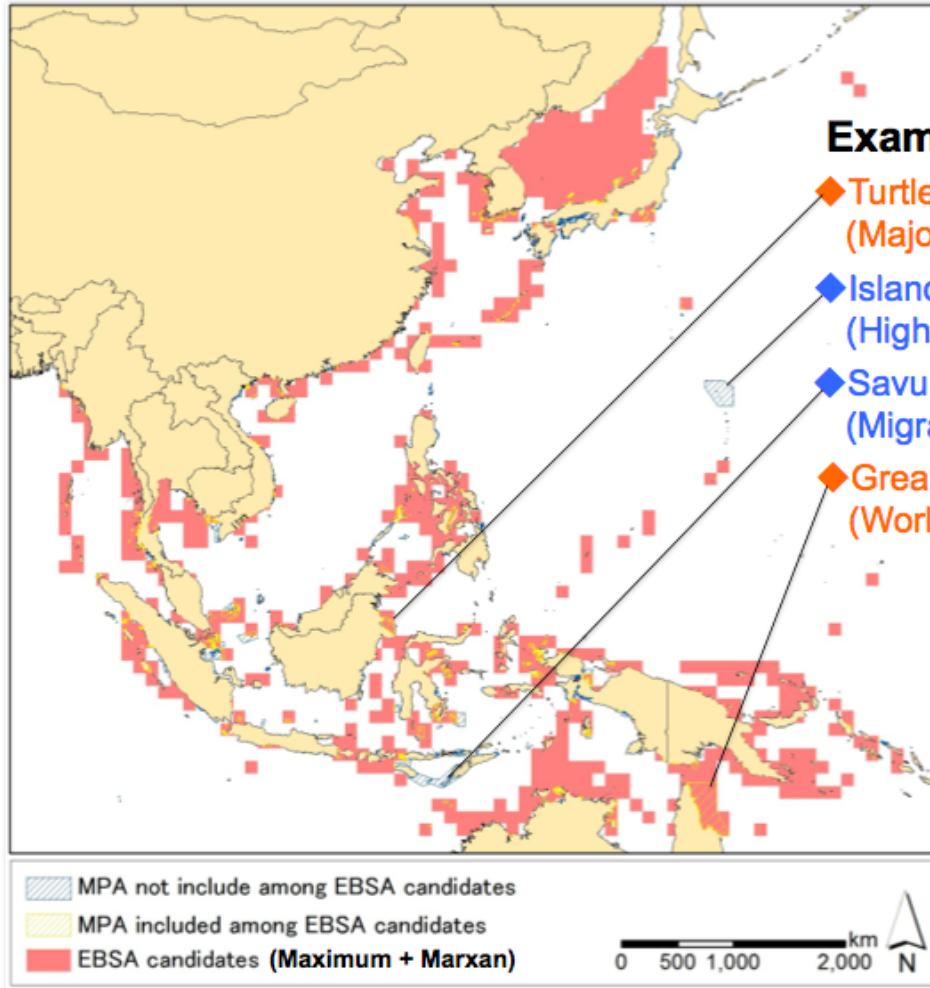
# Sum and Marxan





# Comparative study on issues of Marine Protected Area

Contribution to marine science and policy making on sustainable use



Sea area within Asia-Pacific region	Rate (%)
Marine Protected Area (MPA)	1.1
MPA included among EBSA candidates	0.5
MPA not included among EBSA candidates	0.6
EBSA candidate not overlap with MPA	13.9

Total area of EBSAs became 14.4% of the study area.  
Only 45% of MPAs overlapped with EBSA candidates.

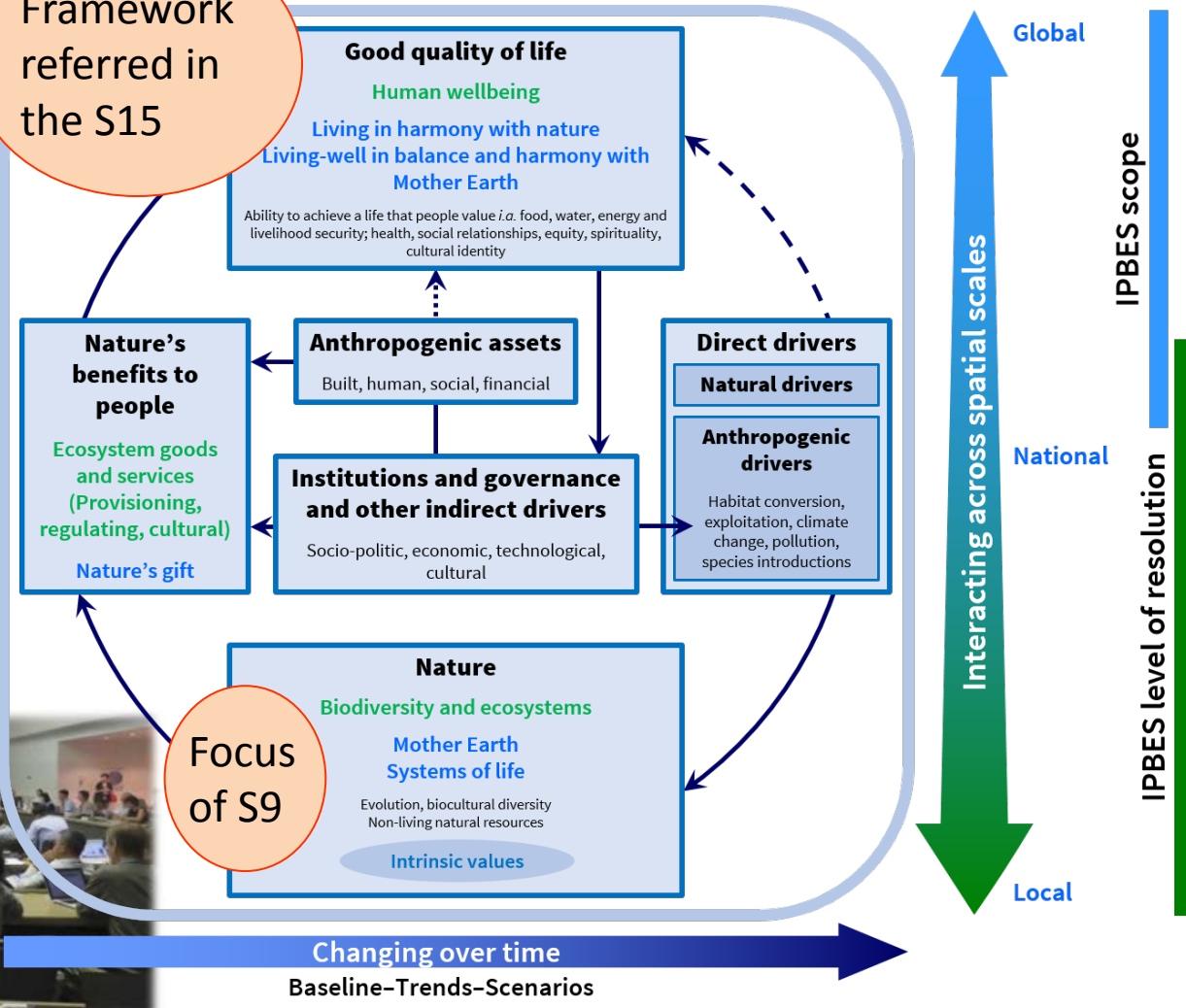
# Shifting effort to the IPBES and Ecosystem services



**P**REDICTING &  
**A**SSESSING  
**N**ATURAL  
**C**APITAL &  
**E**COSYSTEM  
**S**ERVICES

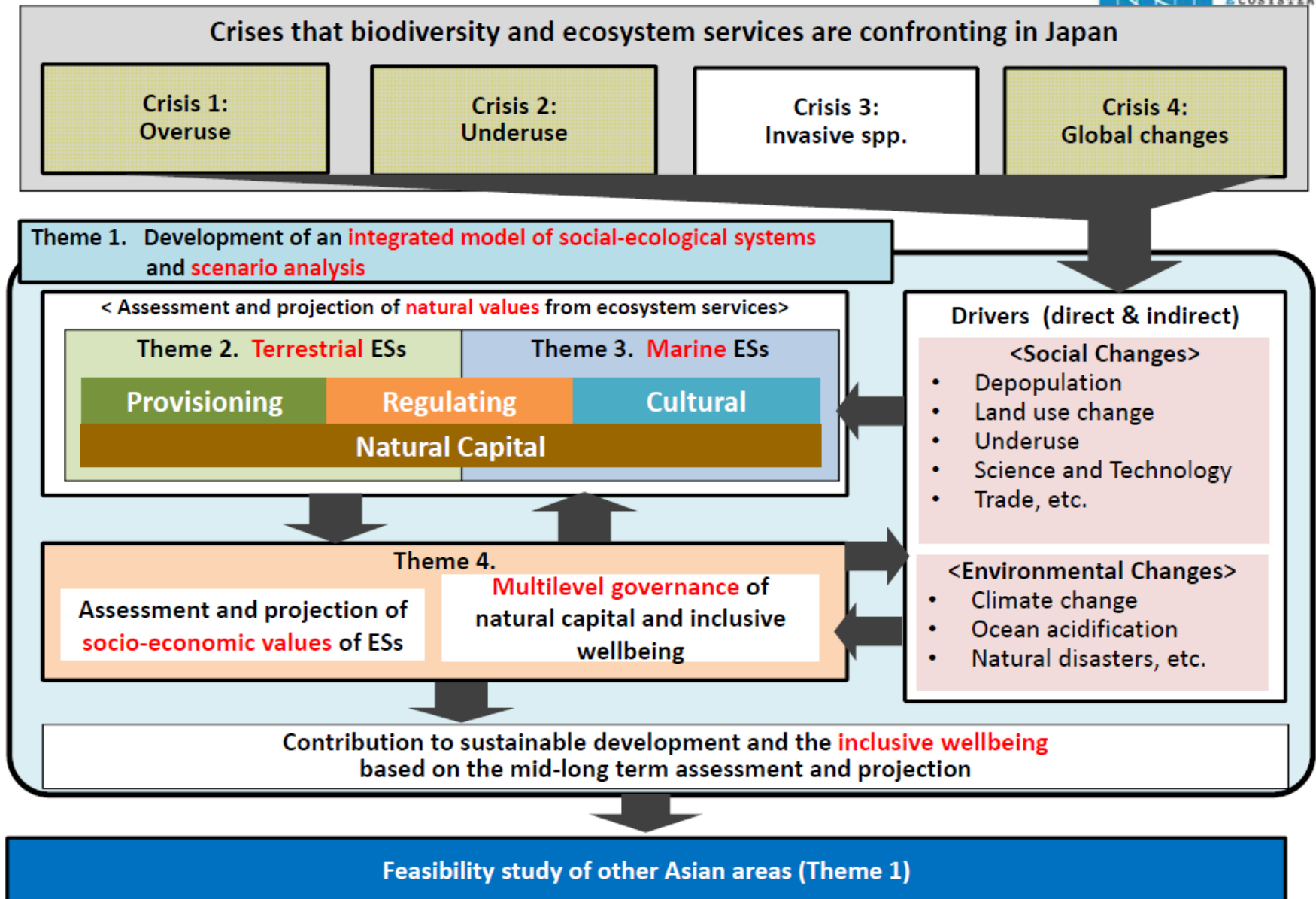
Framework referred in the S15

The Environment Research and Technology Development Fund (ERTDF) S15, by Ministry of the Environment (FY2016-2020)



1<sup>st</sup> Authors' meeting for IPBES Asia Pacific regional assessment (17-21 Aug. 2015)

# Framework of the PANCES Project



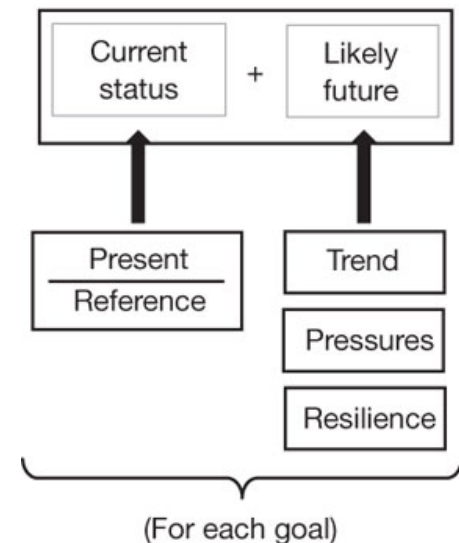
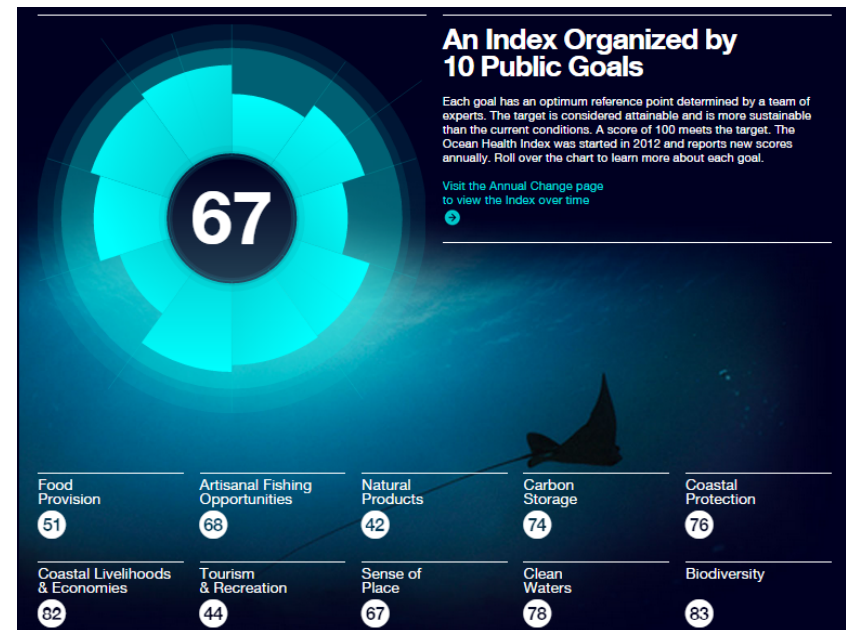
**Feasibility study of other Asian areas (Theme 1)**

# Integration of evaluation and connection with scenario

## Status:

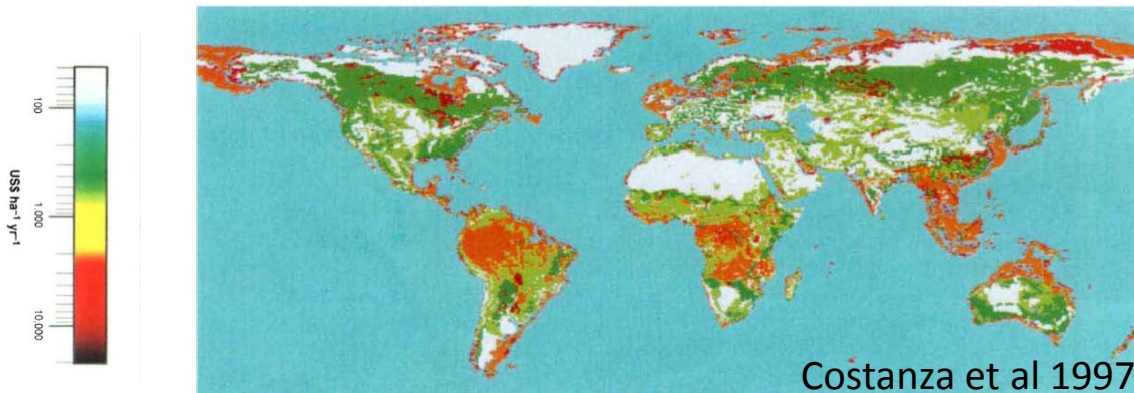
- Candidate list was discussed
- Present indicators were listed (OHI, Costanza, Invest etc)

OHI Goal	S9 EBSA	MoE Coral	MoE Wetland
Food Provision			
Fisheries	▲	●	
Mariculture			▲
Artisanal Fishing Opportunity			
Natural Products			
Coastal Protection		●	
Carbon Storage	▲		▲
Livelihoods and Economies			
Tourism and Recreation		●	▲
Sense of Place			▲
Clean Waters			▲
Biodiversity			
Habitats	●	▲	▲
Species	●	▲	





# Example of global or national evaluation of values on ecosystem services



Unit values of annual ecosystem services [US\$/ha/yr] (Costanza et al., 2014)

Coral reef	<b>Total:</b>	<b>352,257</b>
Seaweed bed	<b>Total:</b>	<b>28,916</b>
Tidal flat	<b>Total:</b>	<b>193,843</b>
	<b>cf. Tropical forest:</b>	<b>5,382</b>

## Coral reef value assets in Japan

- Tourism and recreation  
240 billion yen/year
- Fishing  
(commercial seafood) 11 billion yen/year
- Coastal protection function  
7.5-84 billion yen/year

## Evaluation of economic value of wetland 2014 (Committee of the Ministry of the environment)

Ecosystem Services		Price / yr (billion ¥)	Unit Price /ha/yr (million ¥)
Provisioning	Food	90.7	1.85
Regulating	Water qualification	296.3	6.03
Habitat (Supporting )	Habitat offering	218.8	4.45
Cultural	Recreation, Environment education	4.5	0.091

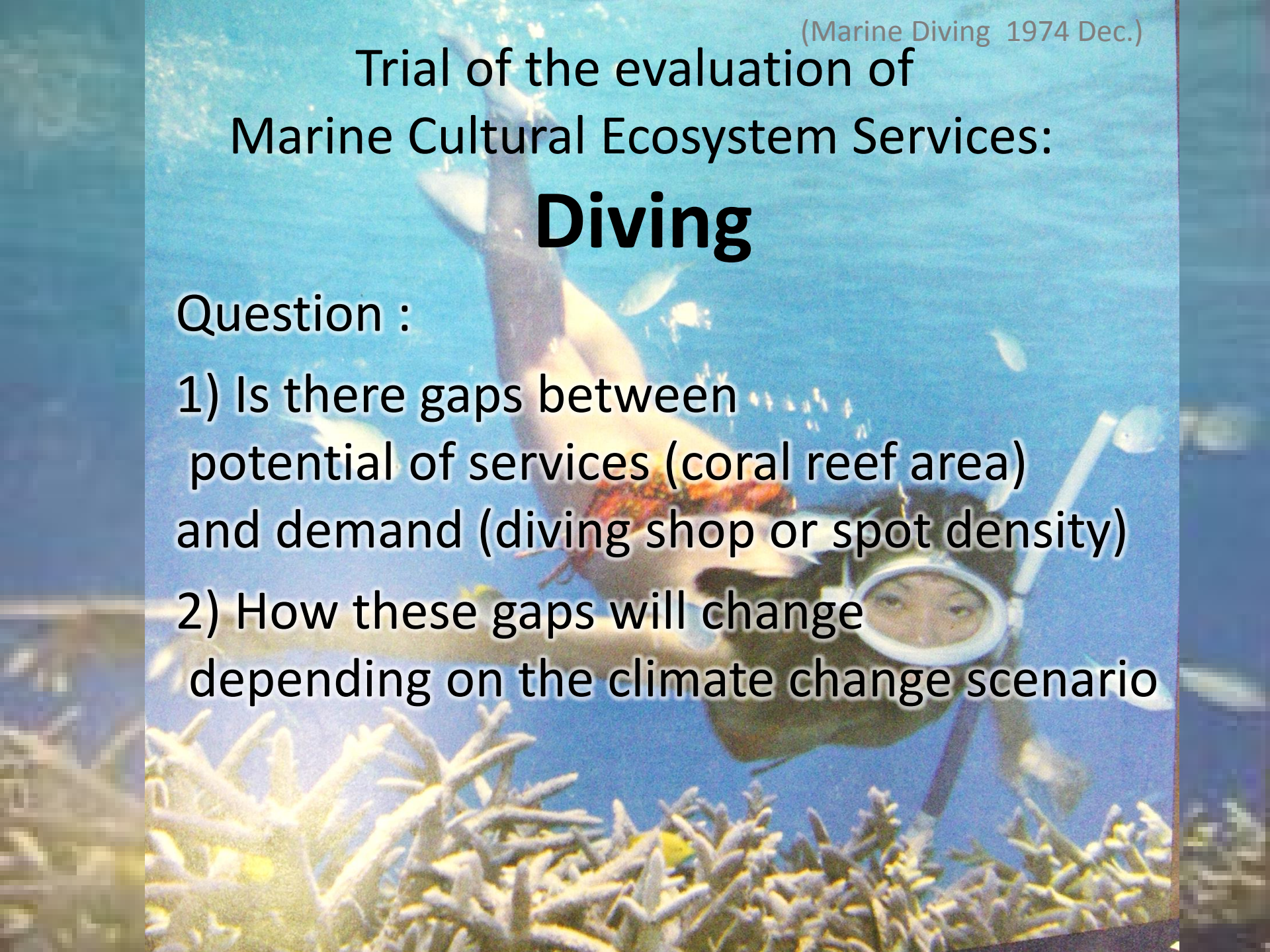
Clamming was only one evaluated ↑

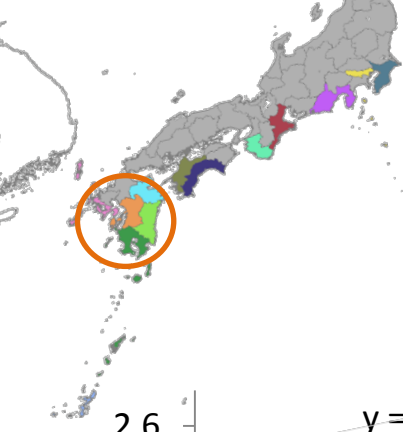


# Trial of the evaluation of Marine Cultural Ecosystem Services: **Diving**

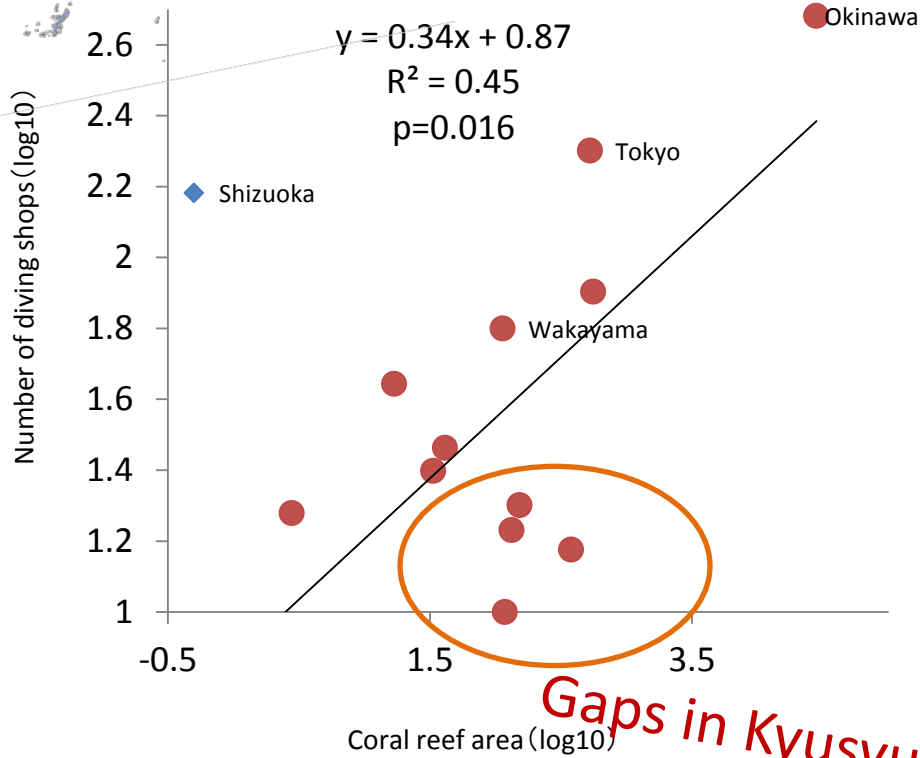
Question :

- 1) Is there gaps between potential of services (coral reef area) and demand (diving shop or spot density)
- 2) How these gaps will change depending on the climate change scenario

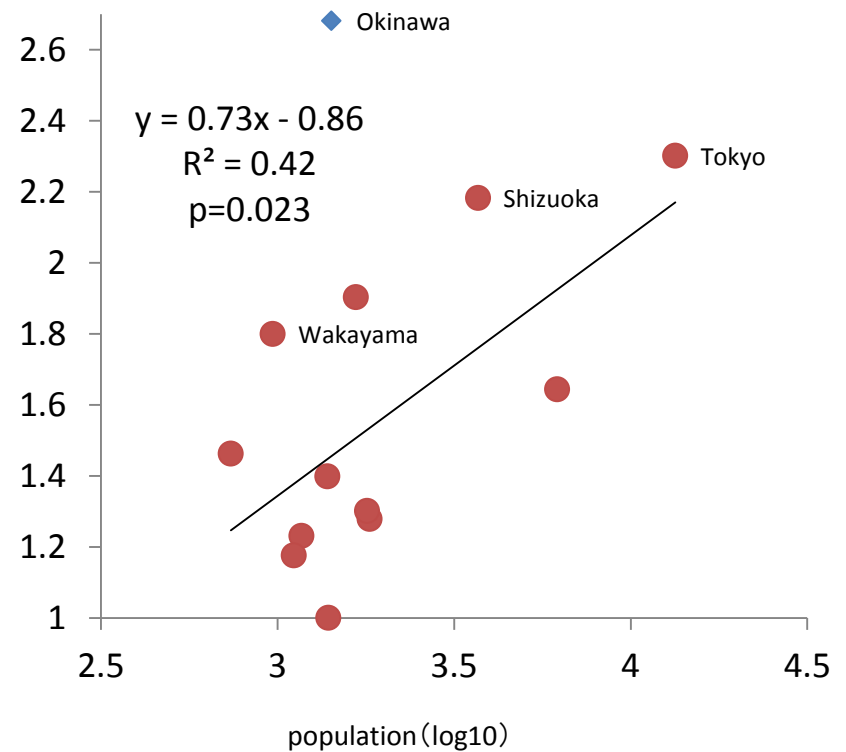


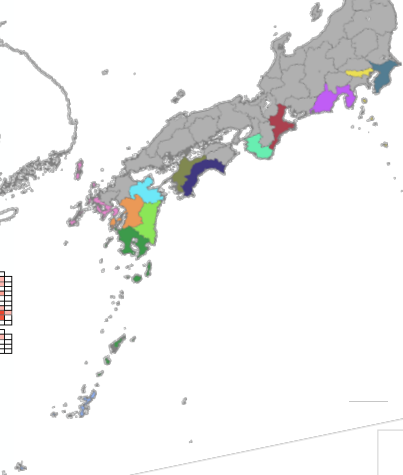


# Distribution of Diving shops vs coral reef area and population : prefecture level resolution



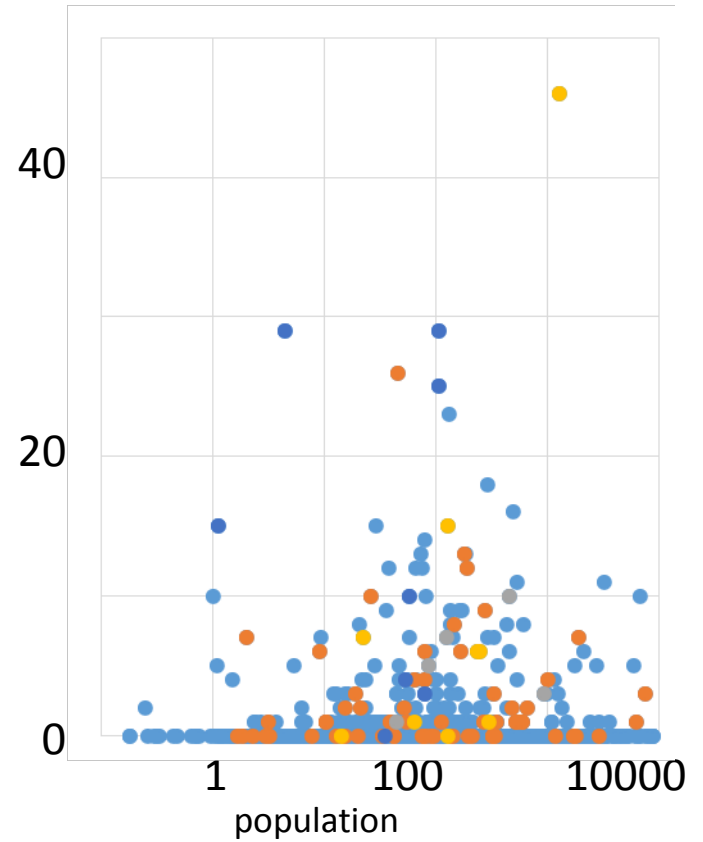
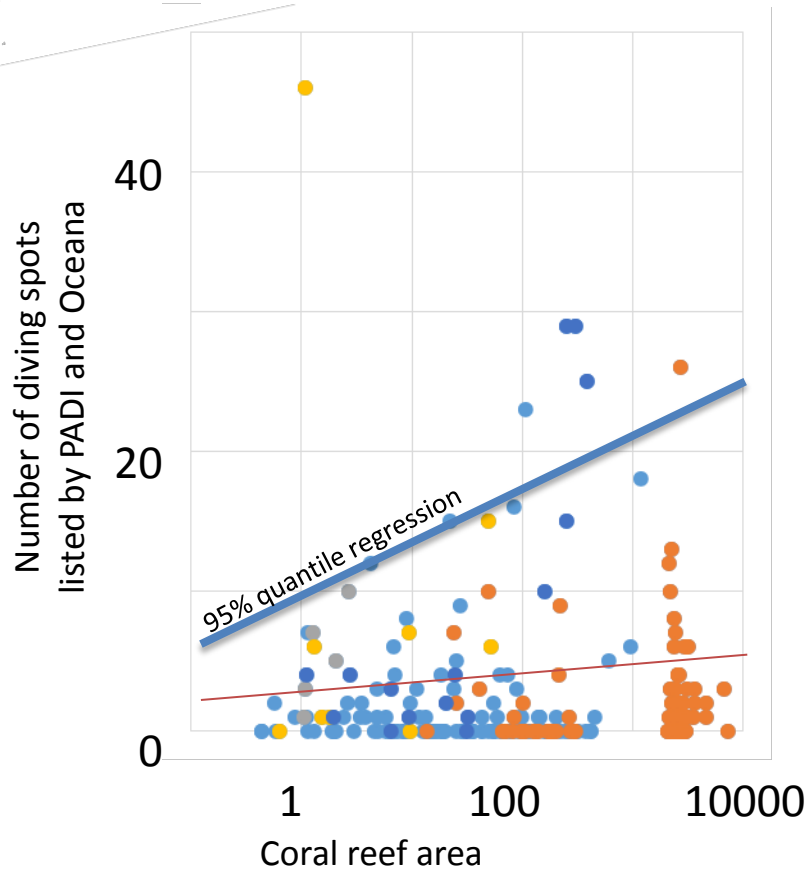
*Gaps in Kyusyu area*





# Distribution of **Diving spots** vs coral reef area /population : **10km grid level resolution**

● All data    ● Okinawa    ● Shizuoka    ● Wakayama    ● Tokyo

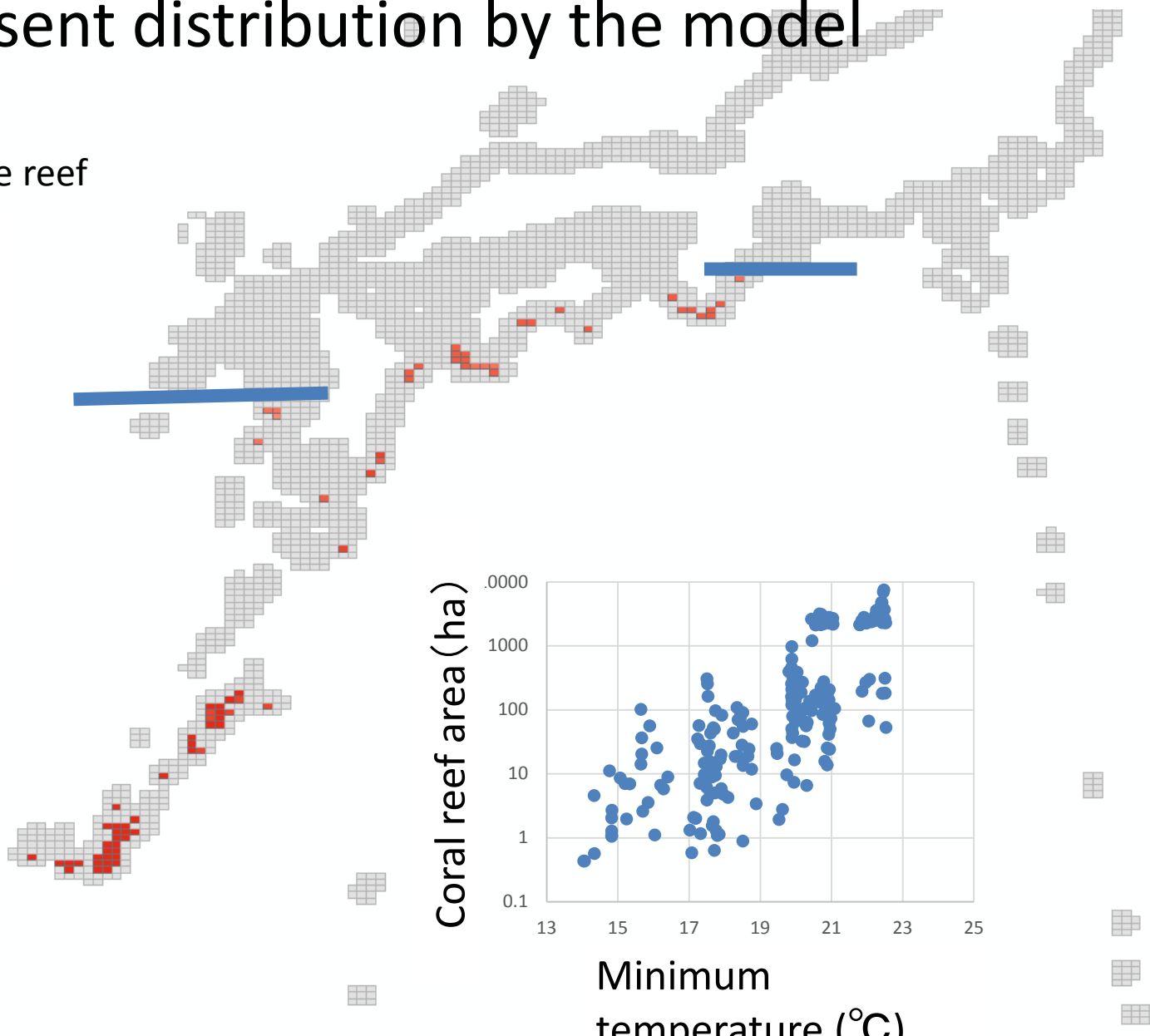
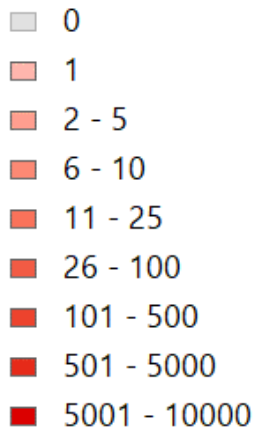


Maximum potential will be limited by natural capital (coral reef area)



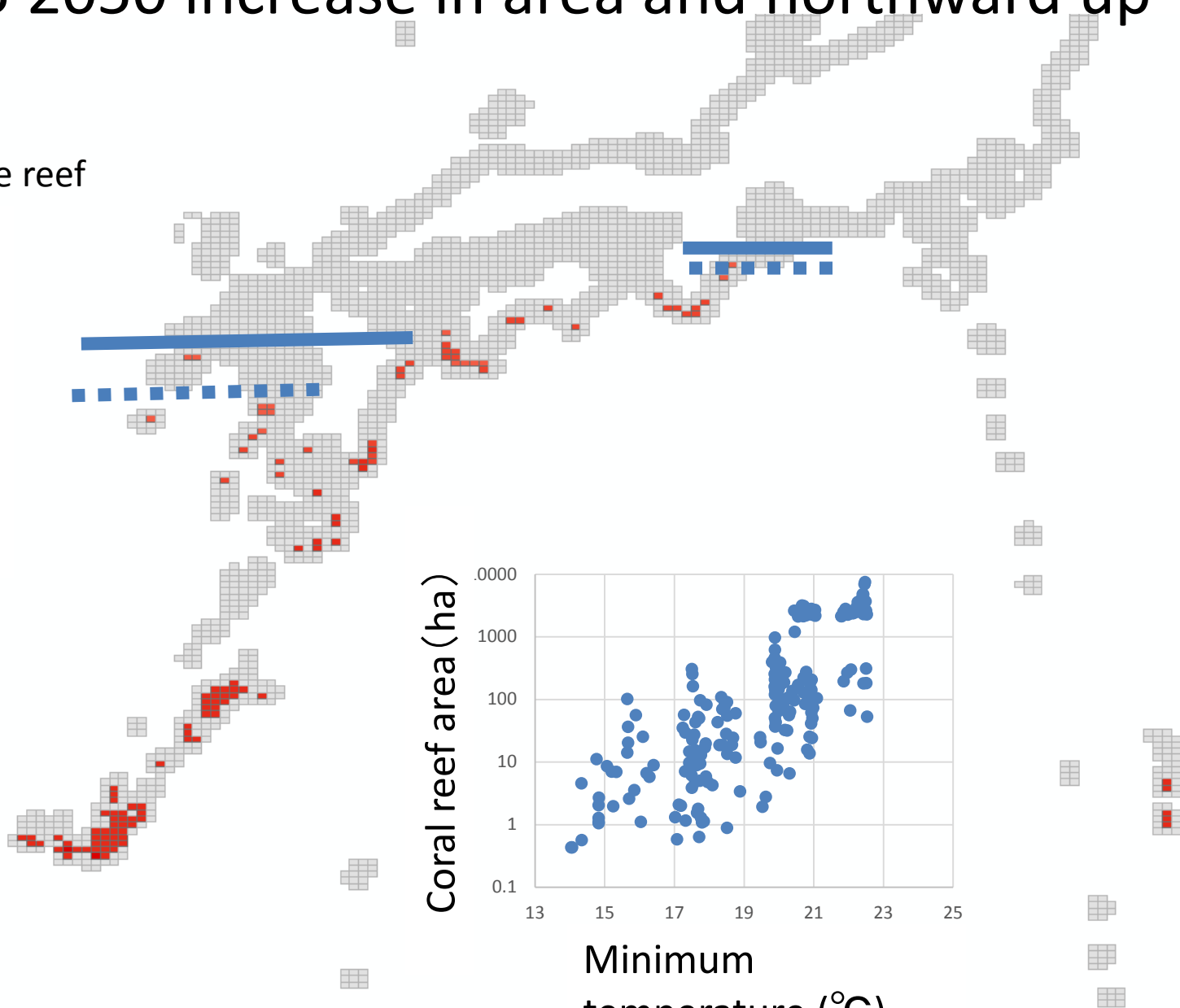
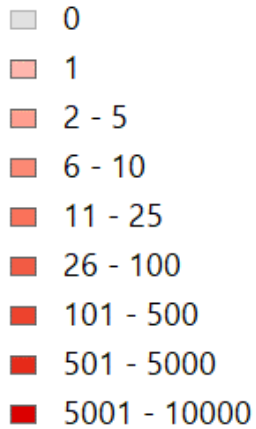
# Present distribution by the model

Area (ha) of the reef

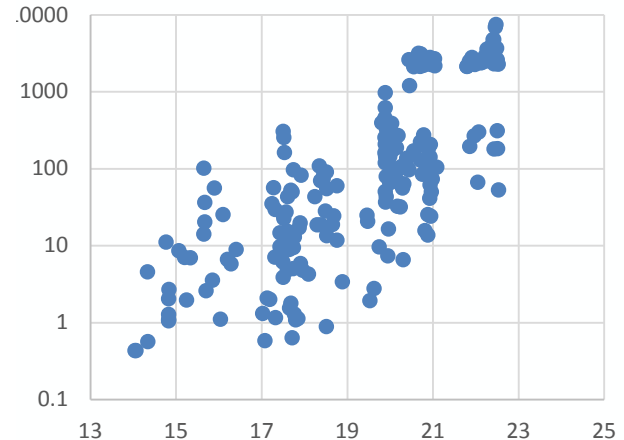


# RCP8.5 2050 increase in area and northward up

Area (ha) of the reef

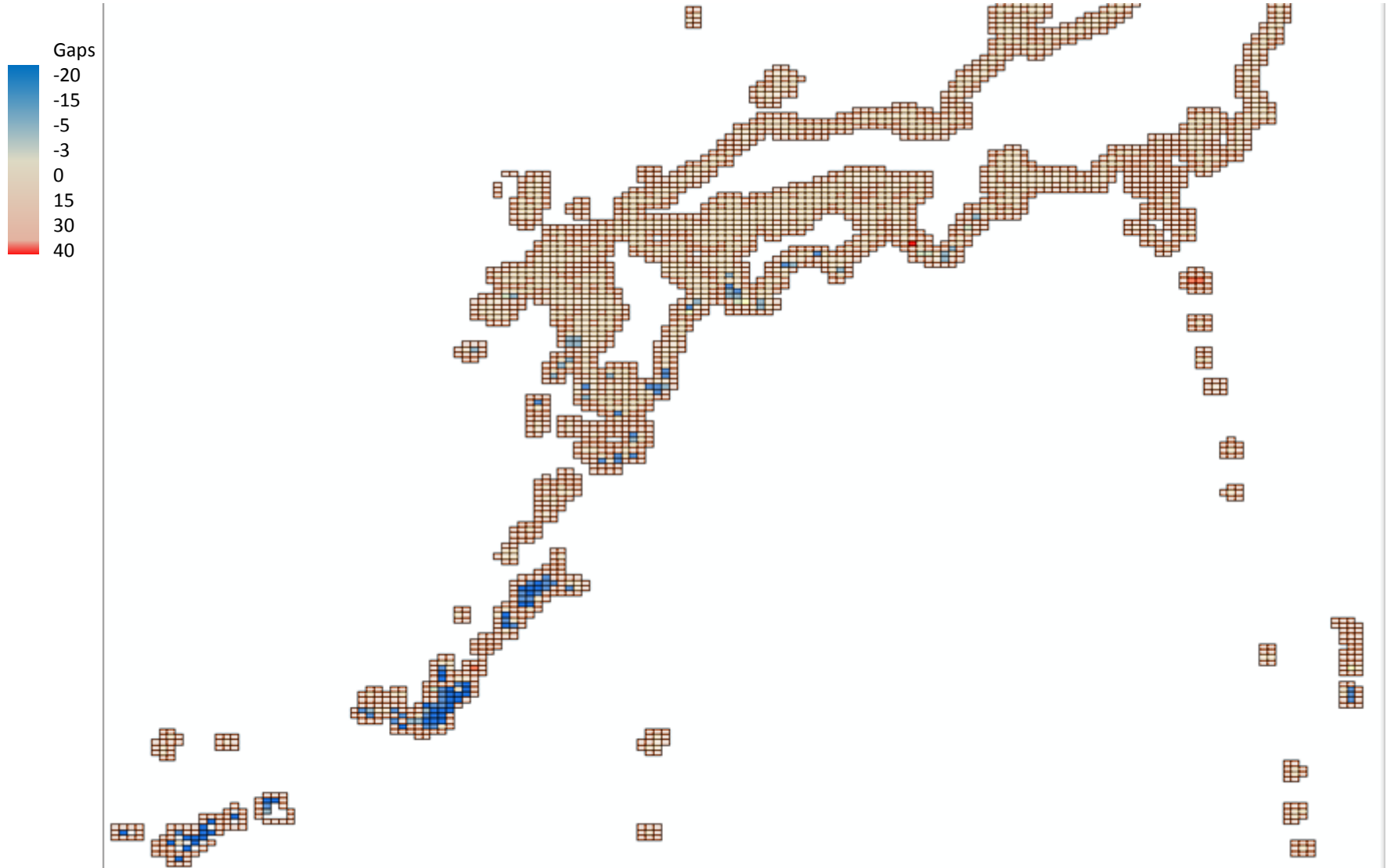


Coral reef area (ha)



Minimum temperature (°C)

# Future gaps in the diving use



# Target ecosystems

*in discussion*

discussed in marine theme of S15

- (Mangrove)
- Coral reef
- (Salt marsh)
- Seagrass beds
- Tidal flat
- Rocky shore (seaweed beds)
- Offshore (until the continental shelf)
- Aquaculture
- Sandy beach





# Final Target of our theme

**Making present and future maps based on assessment and projection of marine natural capital and ecosystem services of Japan coastal zone**

**3-1**  
Constructing a database/environmental variables  
of natural capital and ecosystem services (ES)

**3-2**  
Assessment of  
interaction  
between  
natural capital  
and drivers  
• terrestrial-marine  
assessment model with  
Theme 2

**3-3**  
Scenario  
analyses under  
future  
environment  
change

**3-4**  
Predicting and  
assessing ES  
under marine  
management  
options

**3-1**  
Integrating  
assessment of  
natural capital and  
ecosystem services

↓  
Projecting and  
Mapping at  
nationwide scale

↑  
Assessment of  
impacts on  
economy under  
scenarios

# Members

## **3-1)Japan Agency for Marine-Earth Science and Technology (JAMSTEC)**

Yoshihisa Shirayama , Takehisa Yamakita , Yoichi Ishikawa , Hiromichi Igarashi , Hashioka Taketo , Yoshikazu Sasai , Yushi Morioka , Yasumasa Miyazawa , Hideaki Saito , Takashi Hosono , Yusuke Tanaka , Misako Matsuba , Sachiko Oguma, Emily Skeehan

## **3-2)Hokkaido Univ.**

Masahiro Nakaoka , Norishige Yotsukura , Masahiko Fujii , Junjiro Negishi , Takashi Denboh , Jun Shoji (Hiroshima Univ. ), Ryuta Terada (Kagoshima Univ. )

## **3-3)National Institute for Environmental Studies (NIES)**

Hiroya Yamano , Tohru Yabe , Takahiro Kubo , Koichi Arita , Takahiro Tsuge (Konan Univ. )

## **3-4) Japan Fisheries Research and Education Agency (FRA)**

Mitsutaku Makino, Nanami Atsushi, Takaomi Kaneko, Masakazu Hori, Juri Hori , Masaaki Sato



# AP-BON and Marine data archive/curation

- Database of S15 PANCES



- BISMAL, OBIS  
(local node by JAMSTEC)



- Several marine env.  
data such as DIAS



- Plan of M-BON

