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The impact of climate change on the development of marine aquaculture: a case study on Japanese scallop aquaculture in Funka Bay, Hokkaido, Japan

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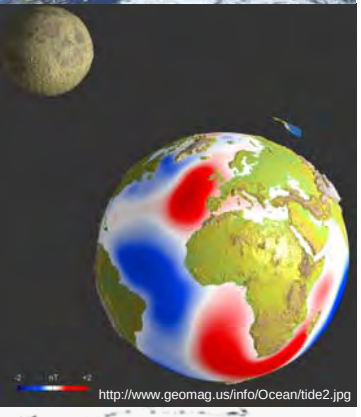

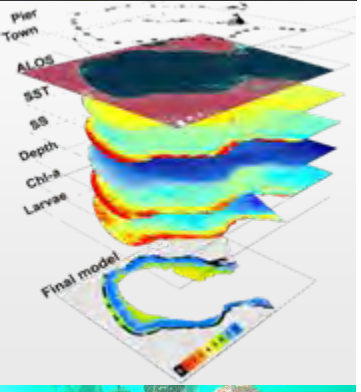

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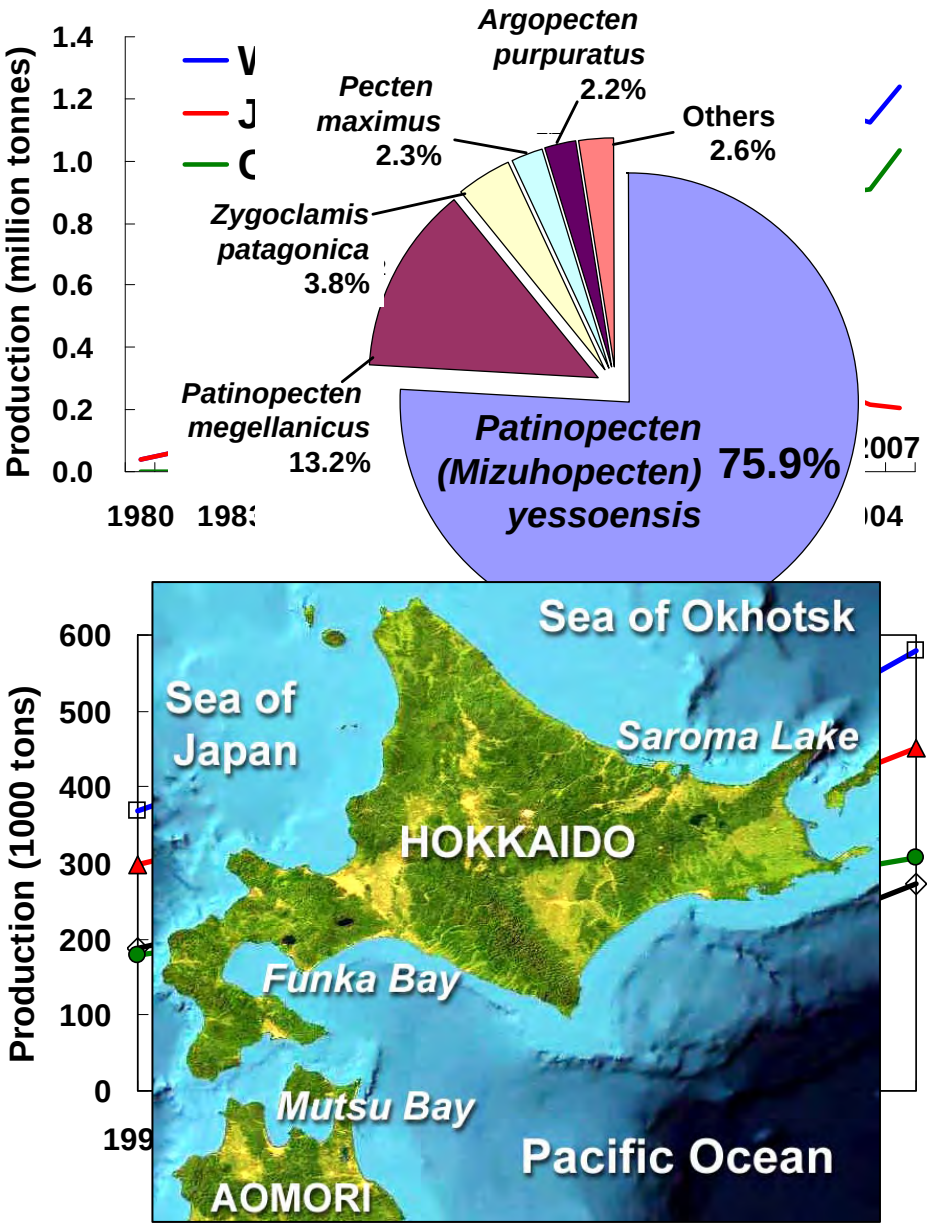
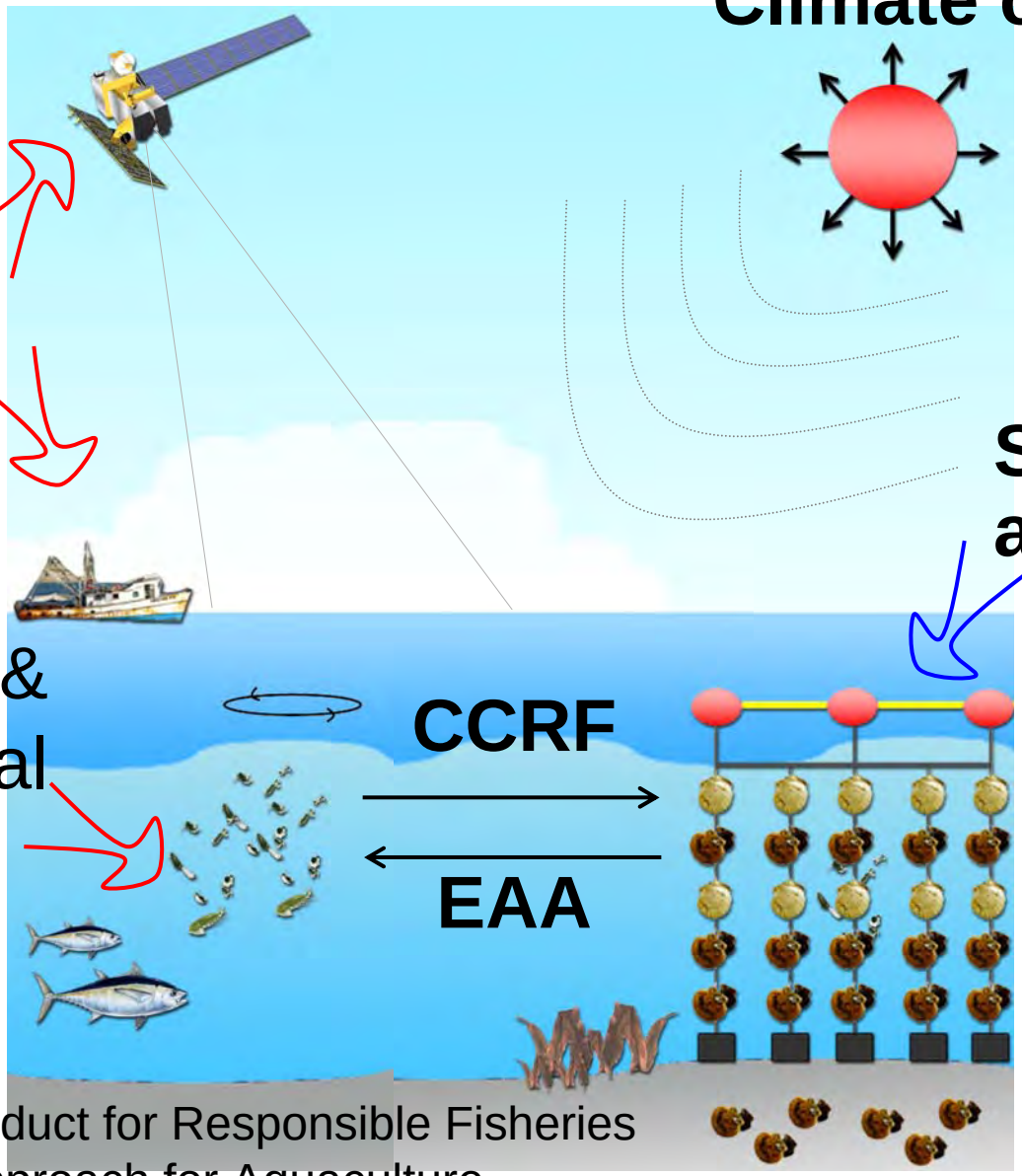
Japanese scallop culture

- **30 species of scallop harvested in the world and 20 species are cultured** (Bourne, 2000)
- **Japanese scallop is the dominant species**
- **Japan 2nd world producers**
- **Scallop cultivated : in the north part of Japan.**
- **Aquaculture: 40% scallop productions** (MAFF, 2005; FAO, 2007)

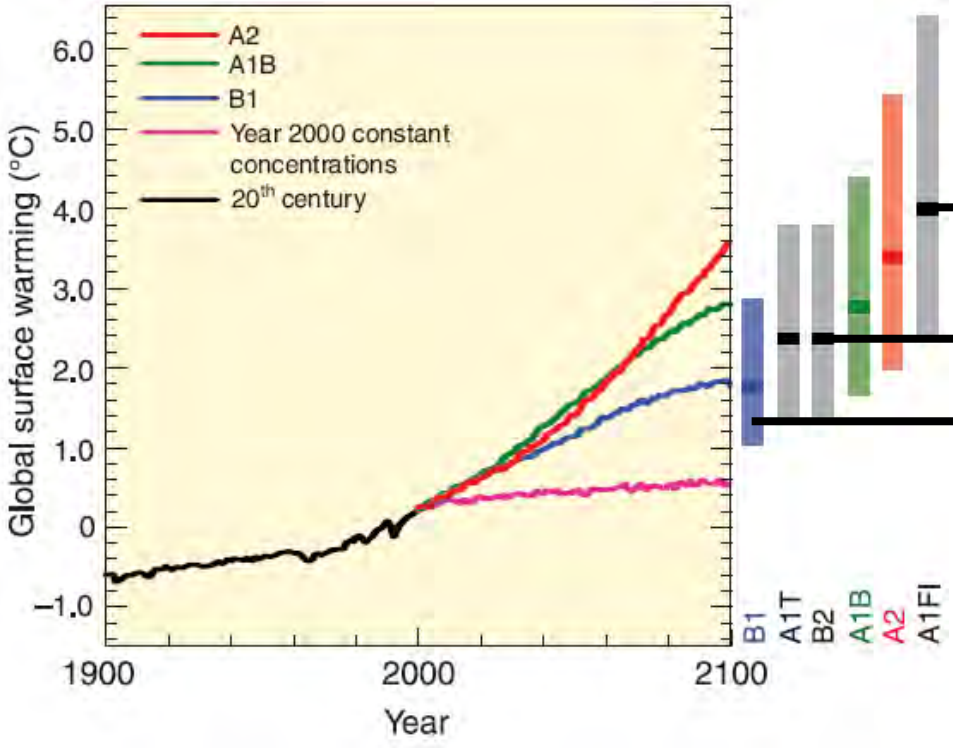


Sustainable scallop culture



CCRF: Code of Conduct for Responsible Fisheries
EAA: Ecosystem Approach for Aquaculture

Climate change



Temperature change

4.0 °C (A1FI)

2.4 °C (B2)

1.8 °C (B1)

(IPCC, 2007)

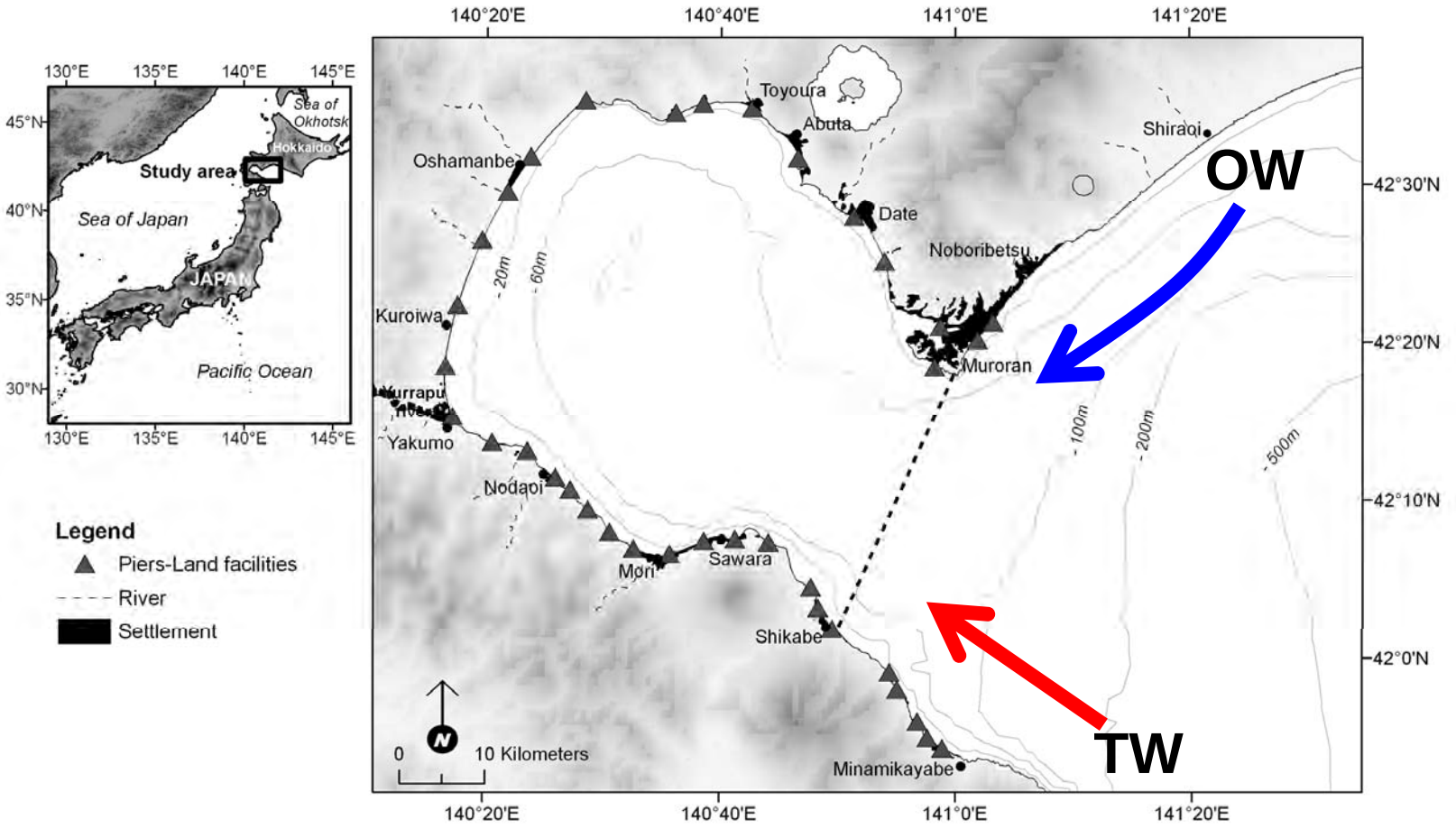
- **Future changes in surface temperature for the end of the 21st century**
- **Possible impacts on the productivity across the coastal and marine systems** (Beukema and Dekker, 2005; Harley et al., 2006; Baba et al., 2009)

Objective

To examine the potential impact of climate change on the development of scallop aquaculture

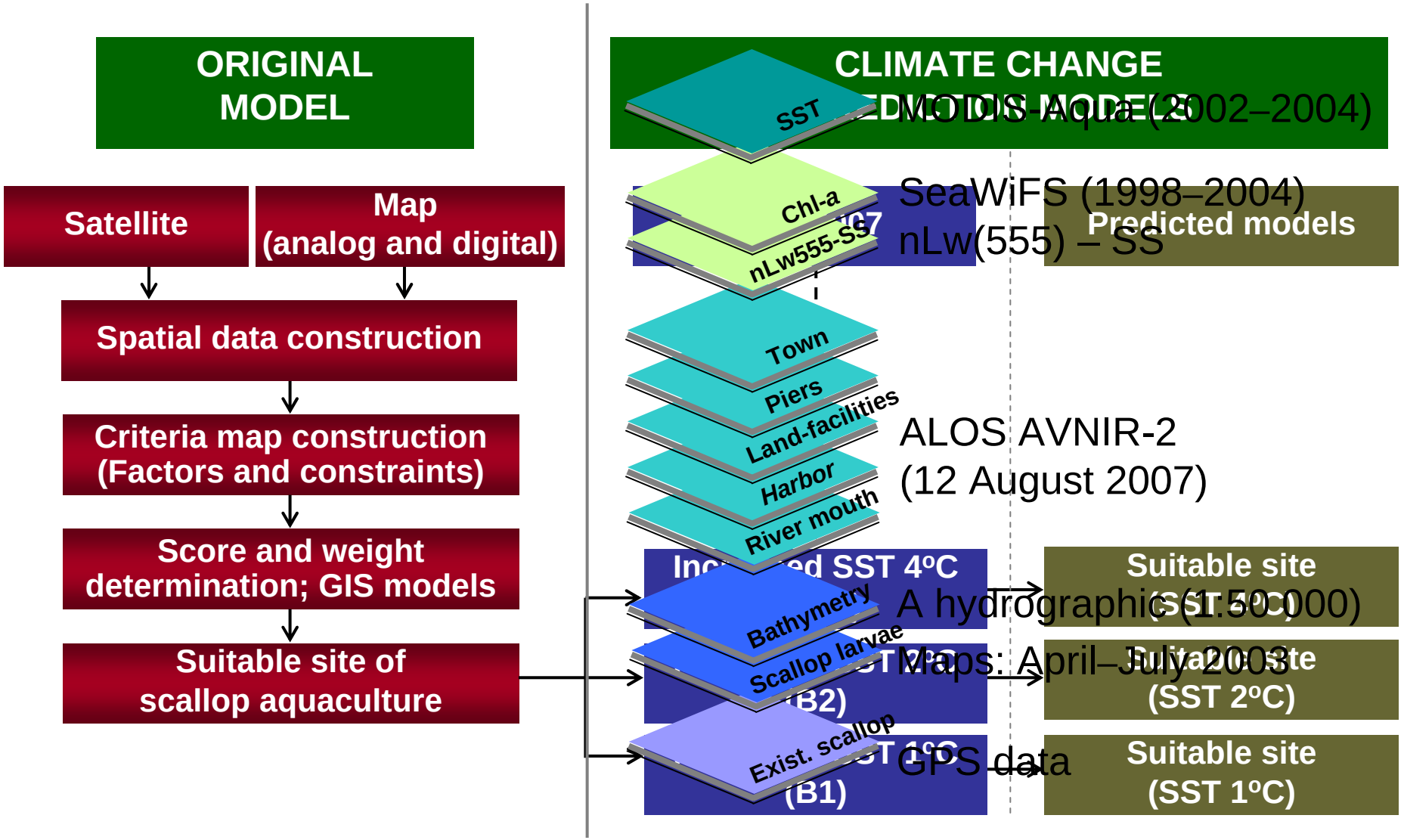
Investigate the indirect impact of CC on **suitable sites** of scallop aquaculture

Characteristic of the study area



- Depth, maximum 107 m and mean 38 m
- 2315 km^2 surface area, and a 195 km coastline
- Water replace 2 time a year : OW & TW

Methodology

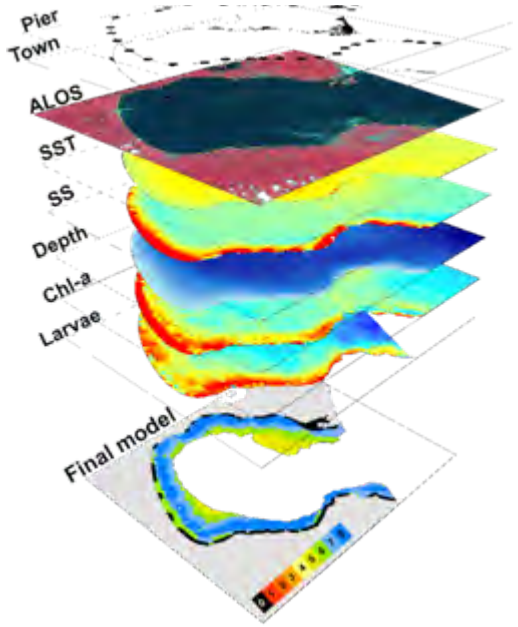


Original model construction

- Built on hierarchical structure
- Scoring: 1 (least suitable) - 8 (most suitable) (Radiarta et al., 2008)

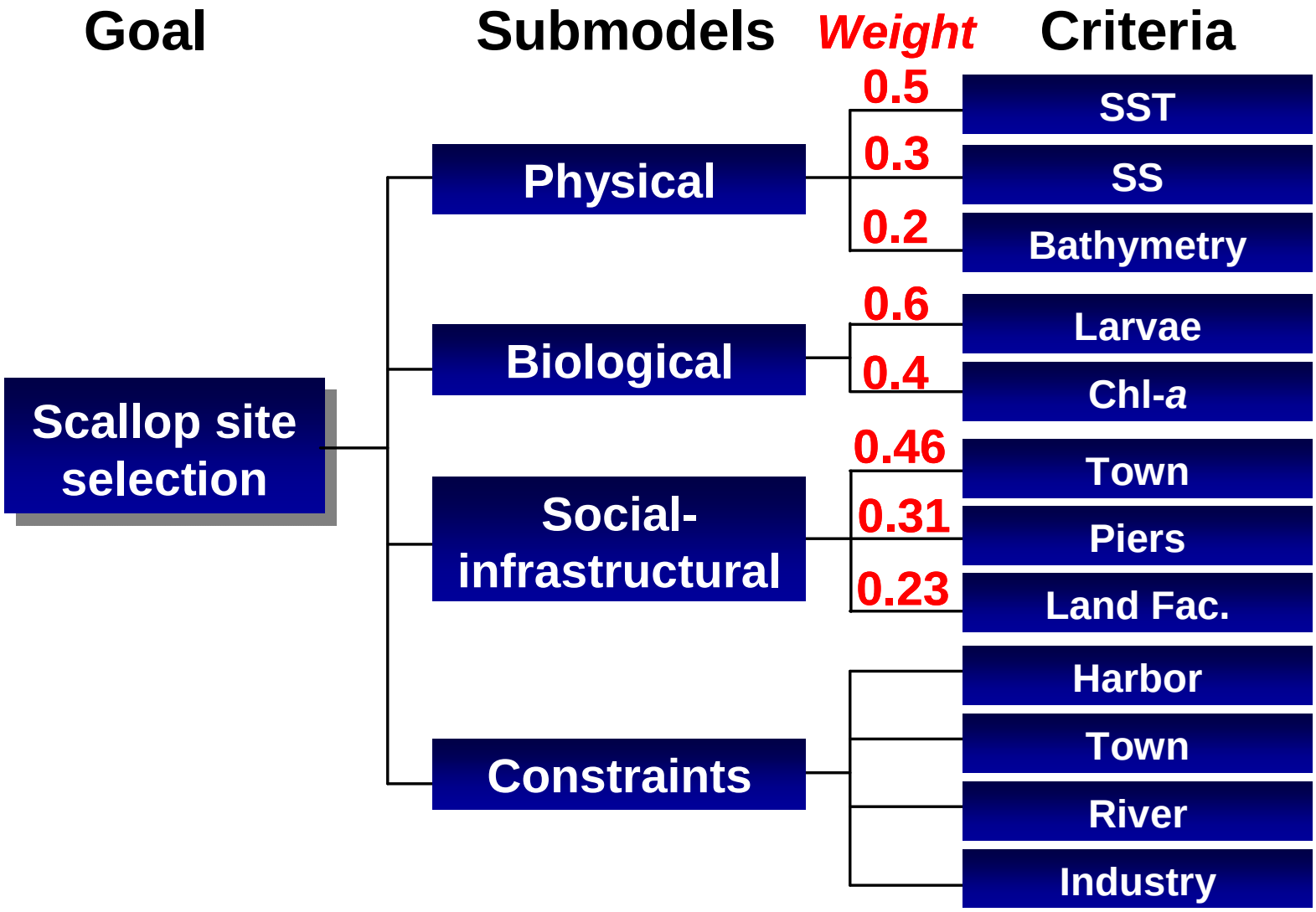
Parameters	Suitability score							
	8	7	6	5	4	3	2	1
Bathymetry (m)	> 20.0	17.5-20.0	15.0-17.5	12.5-15.0	10.0-12.5	7.5-10.0	5.0-7.5	<5.0
Larvae level (No./ton)	>1000	850-1000	700-850	550-700	400-550	250-400	100-250	<100
Distance to town (km)	<3	3-4	4-5	5-6	6-7	7-8	8-9	>9

$$V(x_i) = \sum_j w_j r_{ij}$$



w_j = weight, $\Sigma w_j = 1$,
r_{ij} = the attribute transformed into score (1-8)
The most preferred alternative is the maximum $V(xi)$ value

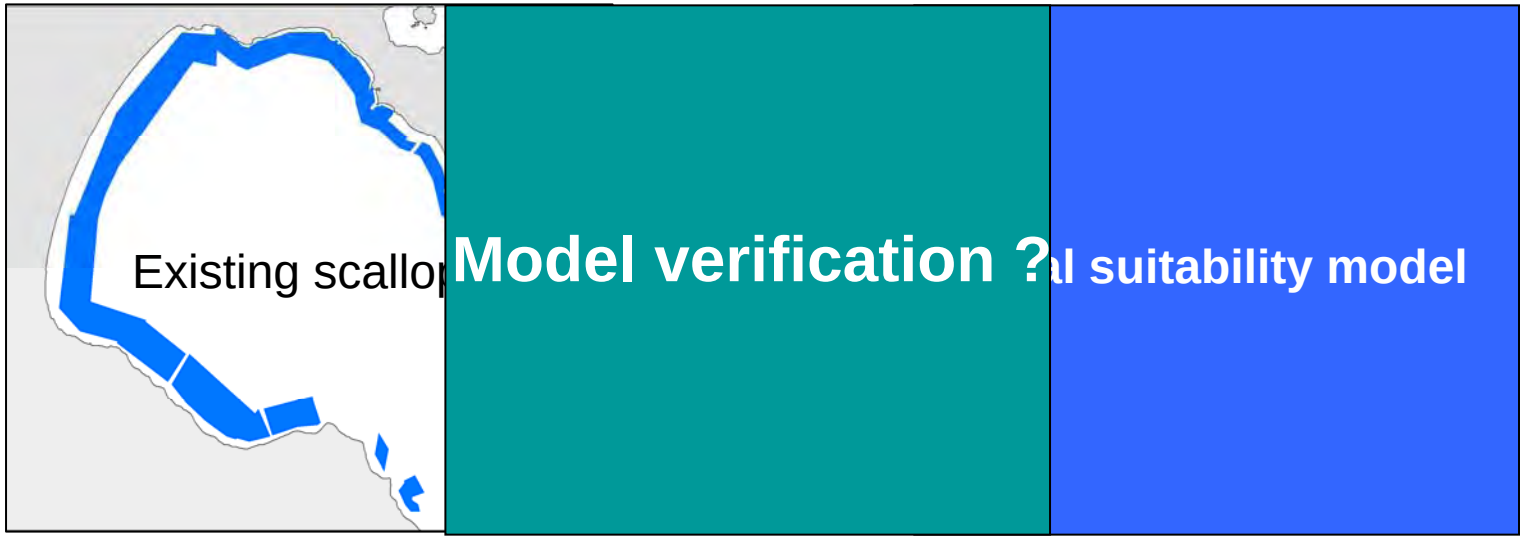
Original model construction



Original model verification

Model verification

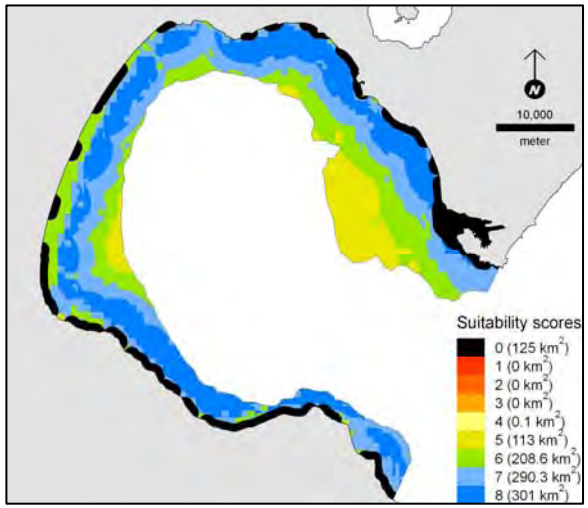
- To determine how much the existing scallop culture matched with the suitability sites model
- By making comparisons between the suitable-sites models and existing scallop aquaculture operations



CC model construction

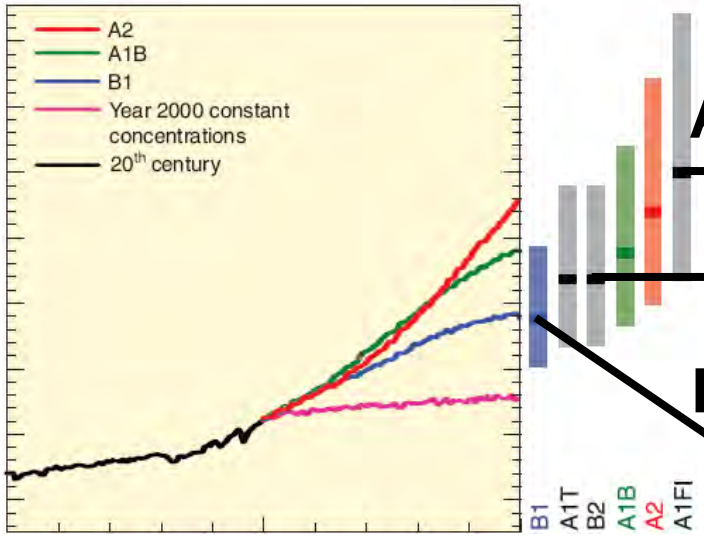
- Consider only change of SST values
- Assume other variables constant

Original model



Suitable sites

Reanalyzed



(IPCC, 2007)

Predicted models

A1FI → **SST Increased 4 °C**

B2 → **SST Increased 2 °C**

B1 → **SST Increased 1 °C**

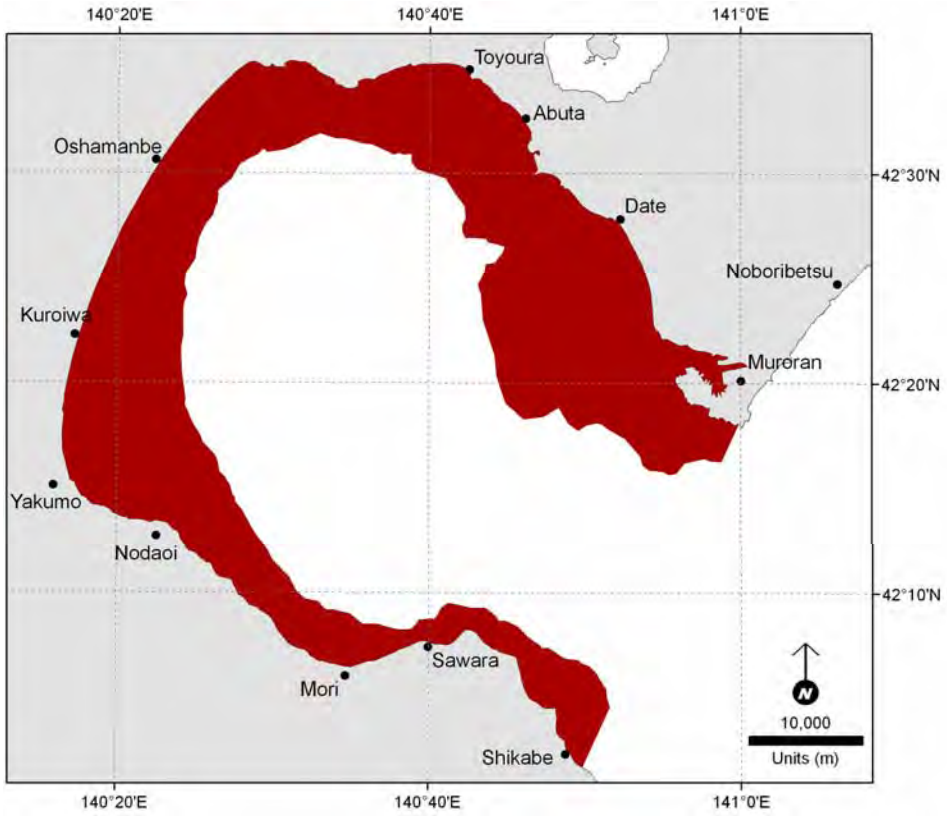
Results and discussion

Area of interest

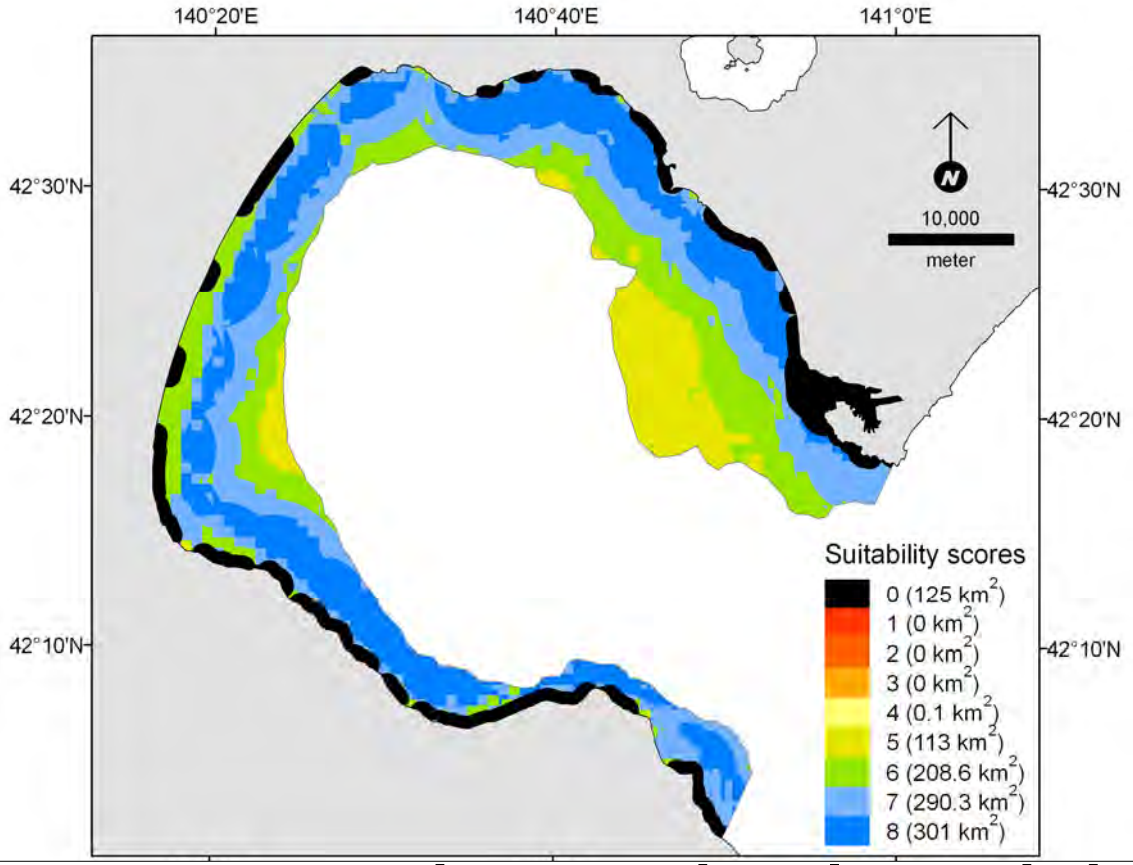
- **Suitable area based on 60 m depth**

  → to minimize operation costs and difficulty in mooring systems

- **Potential area about 1038 km^2 (45%)**



Final original model

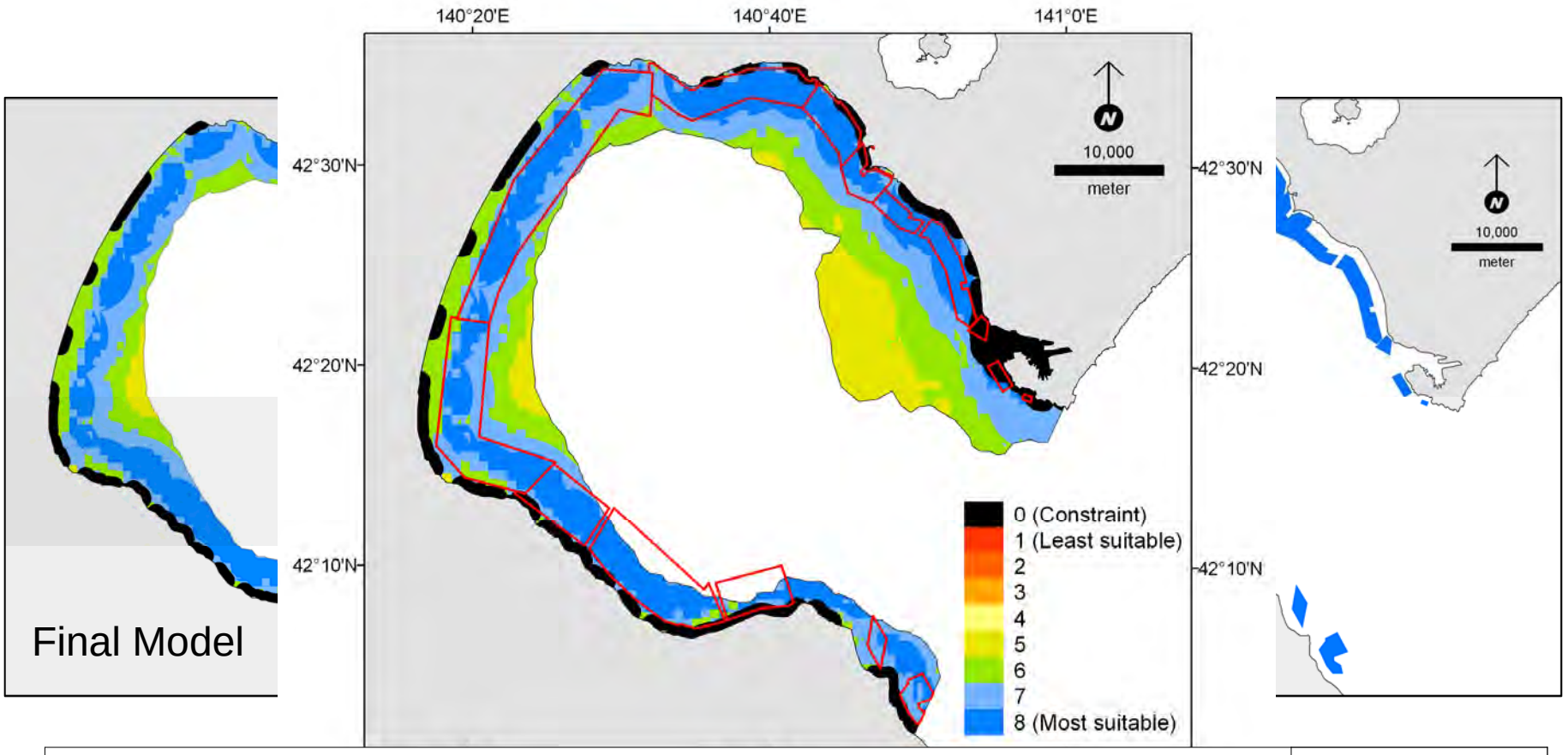


Scores and proportional area (%)

0	1	2	3	4	5	6	7	8
12	0.0	0.0	0.0	0.01	10.89	20.1	28	29

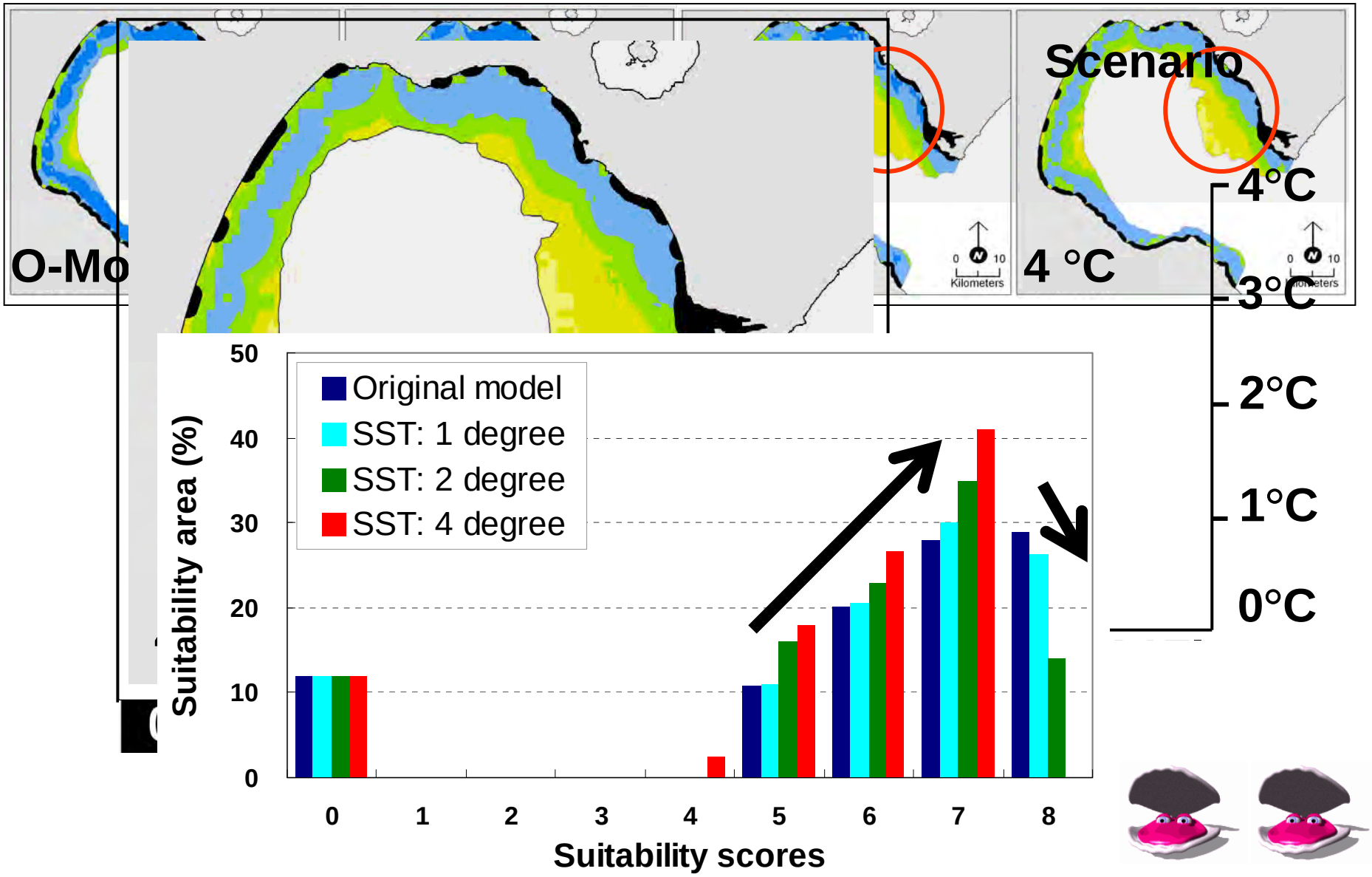
Constraint Low High

Original model verification

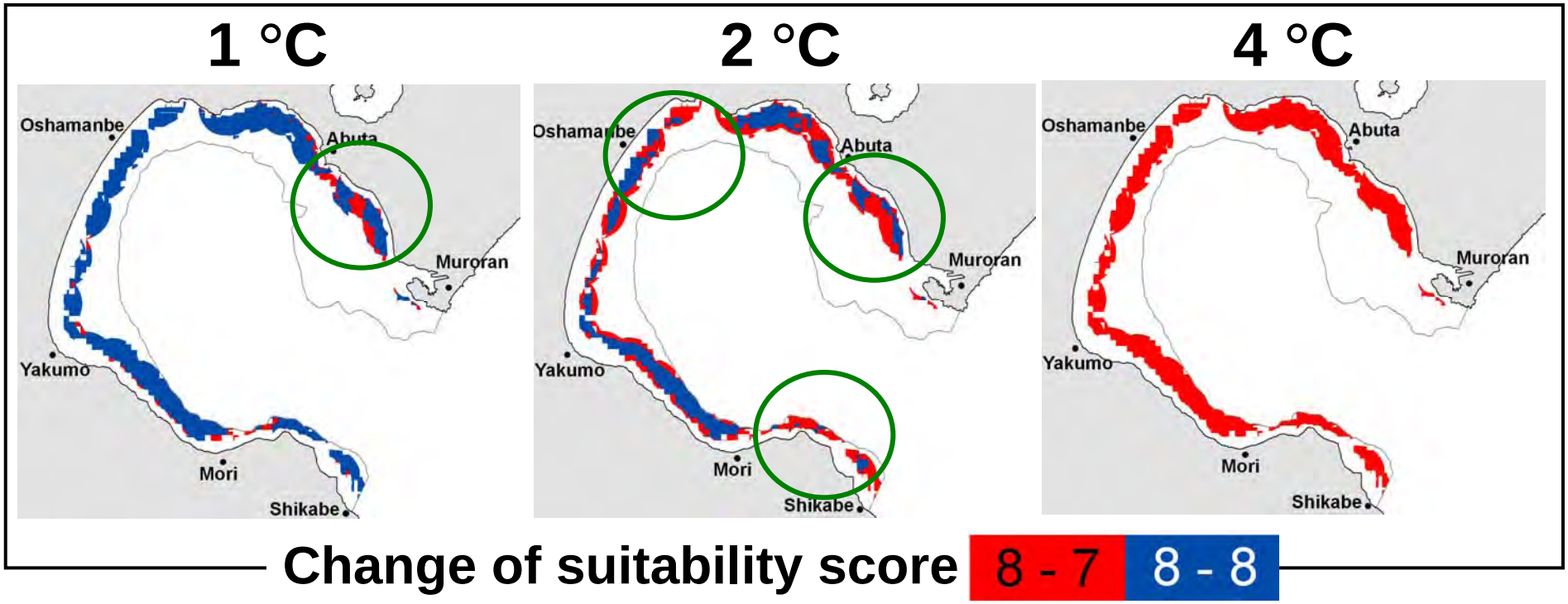


Scores and proportional area (%)									Outside > 60m
0	1	2	3	4	5	6	7	8	
4.0	0.0	0.0	0.0	0.0	0.2	3.0	24.8	60.0	8.0

CC – Prediction model



CC – Prediction model



- Prediction models showed CC impact on development of scallop culture
- Continues study on the impact of climate change on the scallop aquaculture development are challenging and need further research

Conclusions

- Funka Bay has a potential area for scallop aquaculture development, indicated by high suitable area (≈ 30%, score 8).
- Change of surface temperature (climate change) significantly affected the suitable areas.
- Climate change impact needs to be considered for future development of marine aquaculture.

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Thank you

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