

A sunset scene with the sun low on the horizon, casting a warm orange glow over a range of dark mountains.

PICES Annual Meeting, Jeju, R. Korea
S5-MEQ Session, October 28, 2009

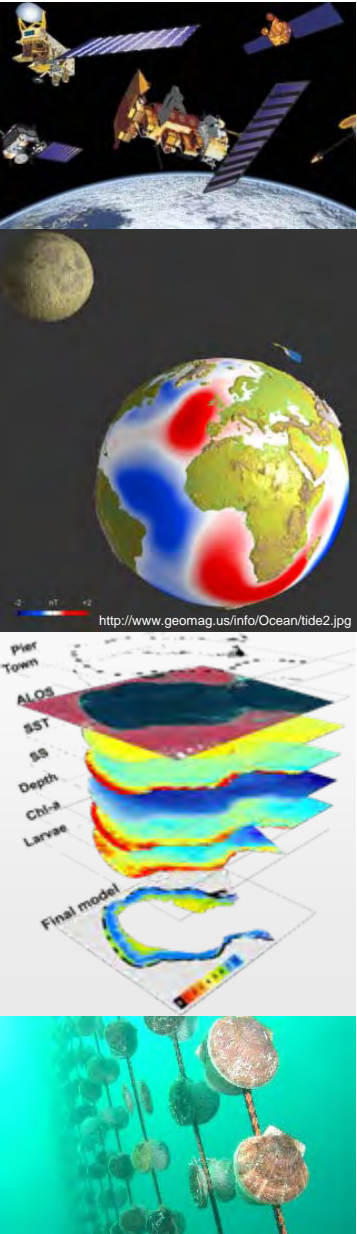
The impact of climate change on the development of marine aquaculture: a case study on Japanese scallop aquaculture in Funka Bay, Hokkaido, Japan

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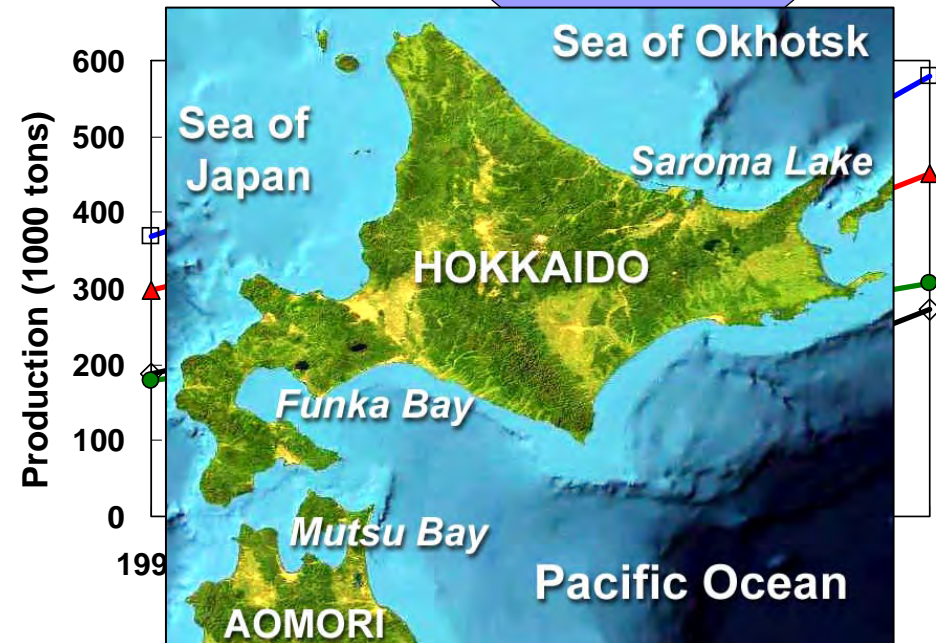
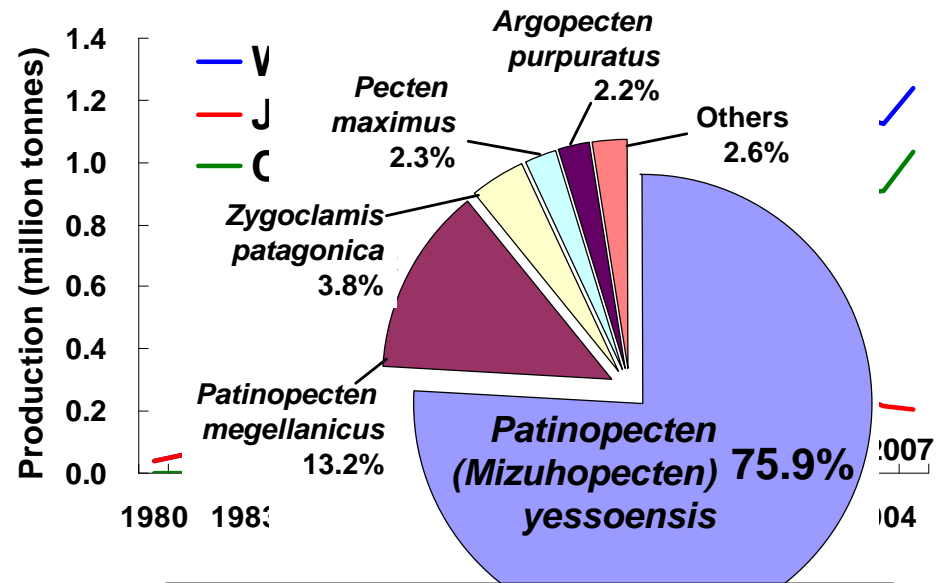
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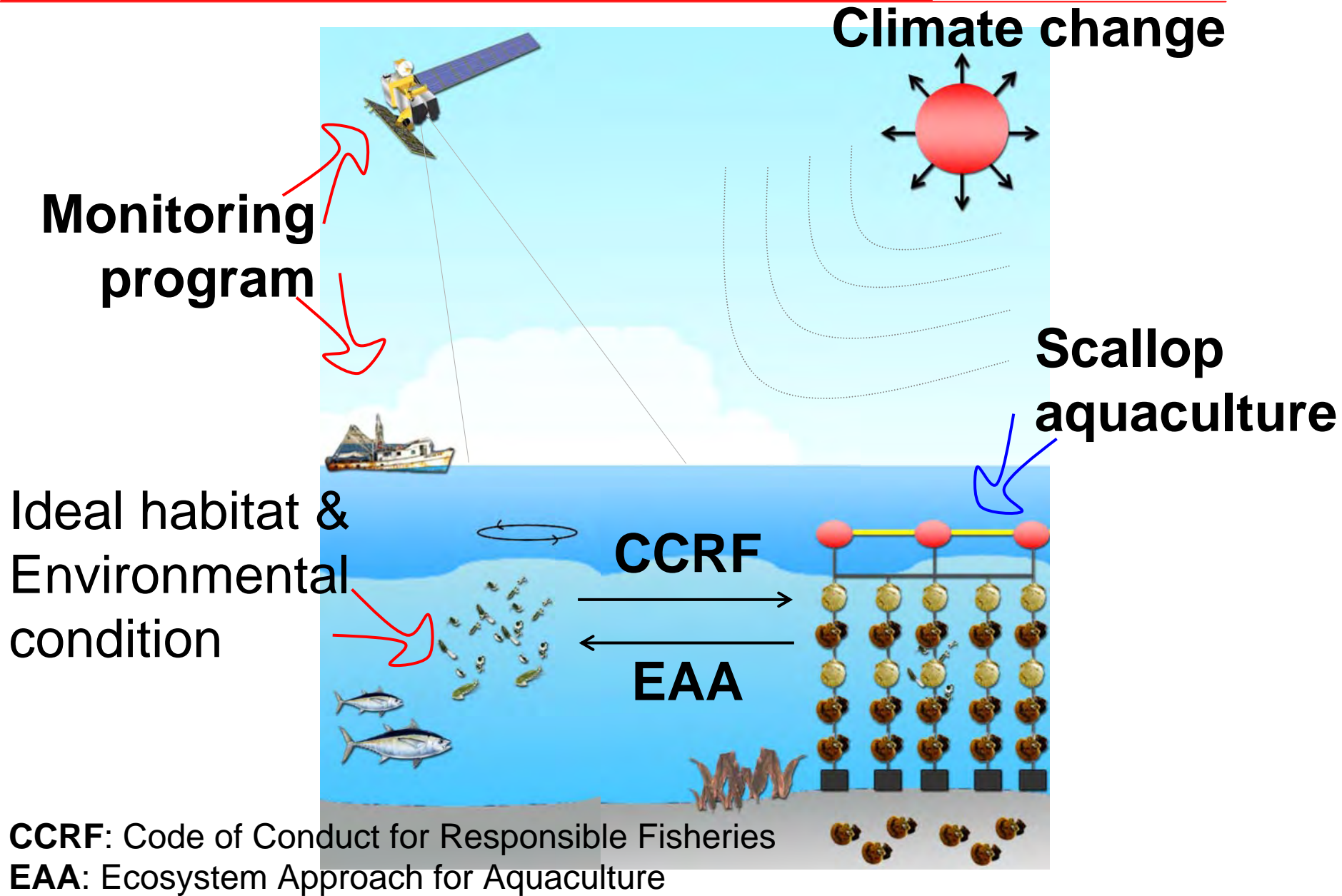
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Japanese scallop culture

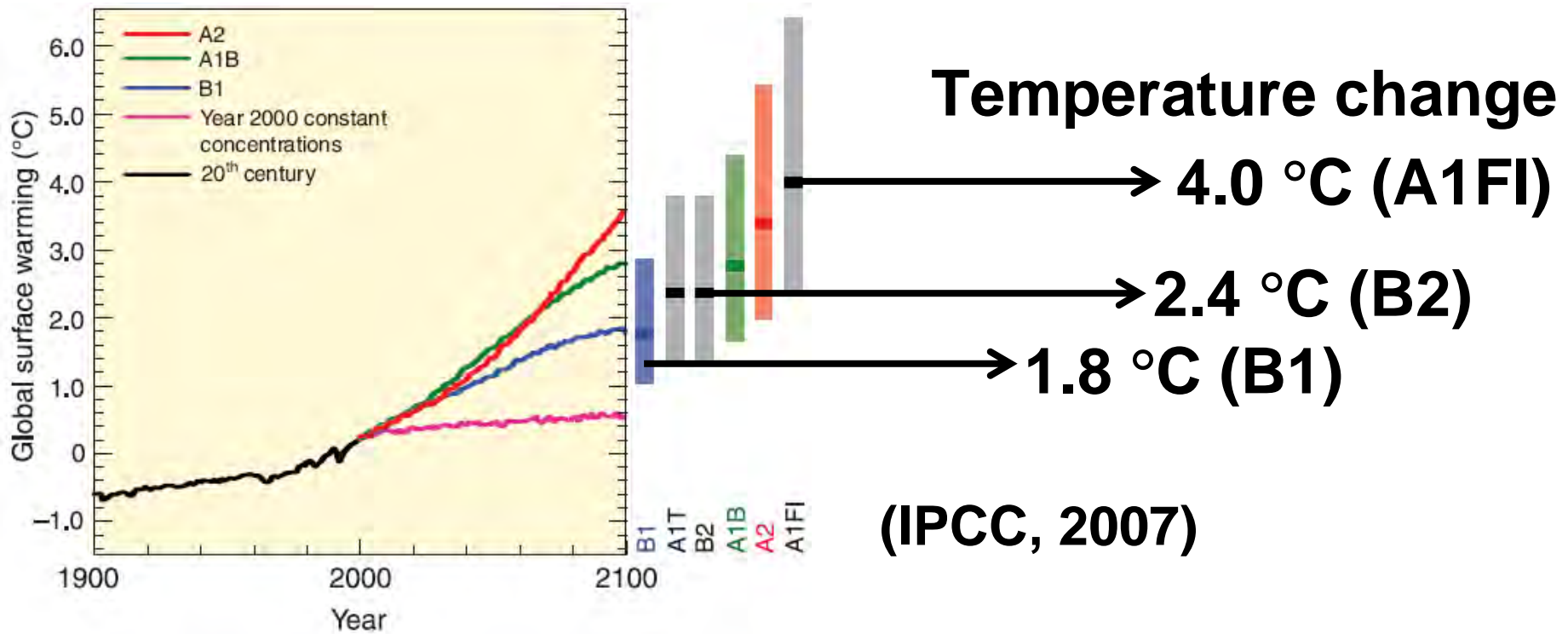
- 30 species of scallop harvested in the world and 20 species are cultured (Bourne, 2000)
- Japanese scallop is the dominant species
- Japan 2nd world producers
- Scallop cultivated : in the north part of Japan.
- Aquaculture: 40% scallop productions (MAFF, 2005; FAO, 2007)



Sustainable scallop culture



Climate change



- **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)

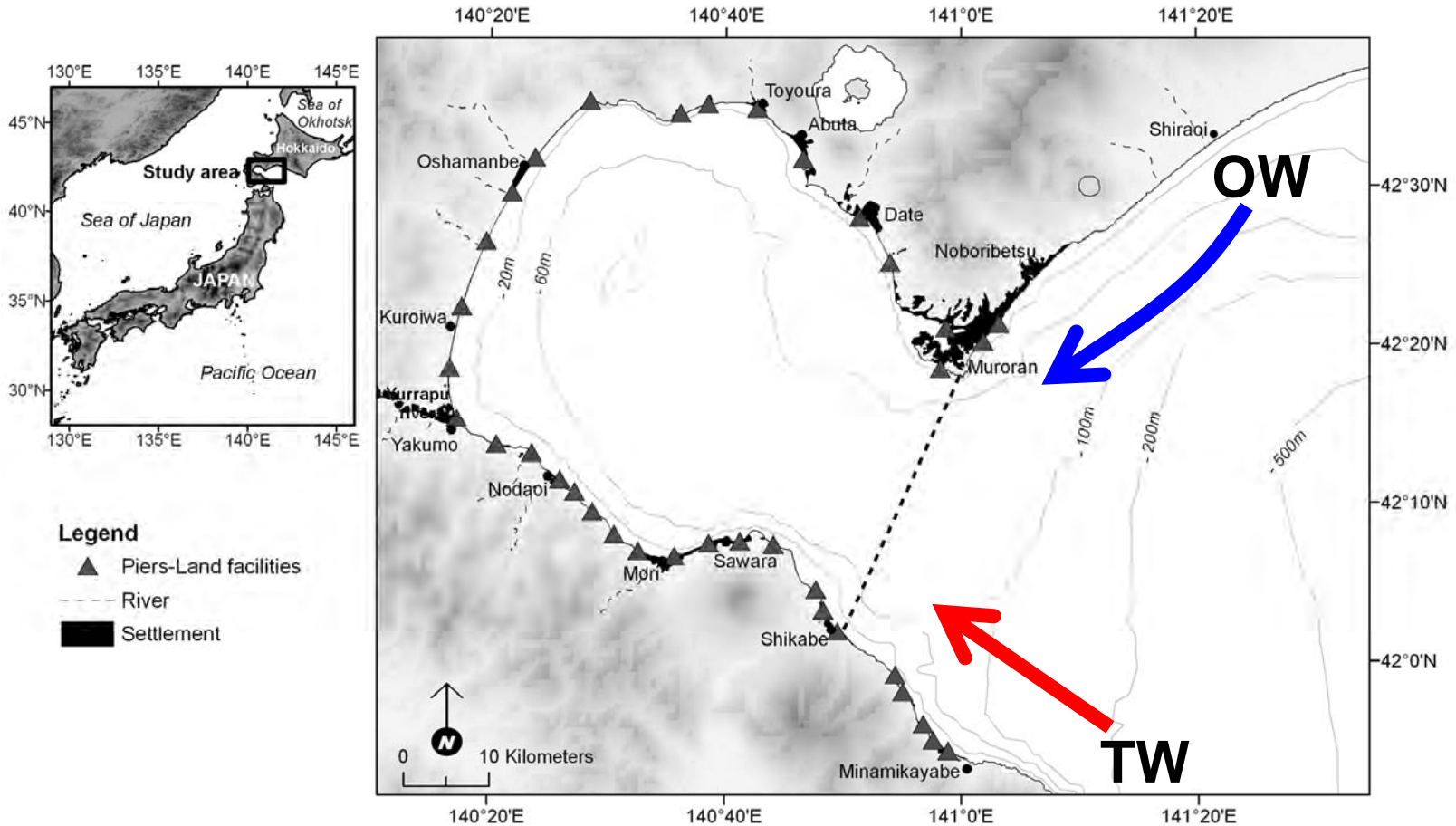
Objective

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

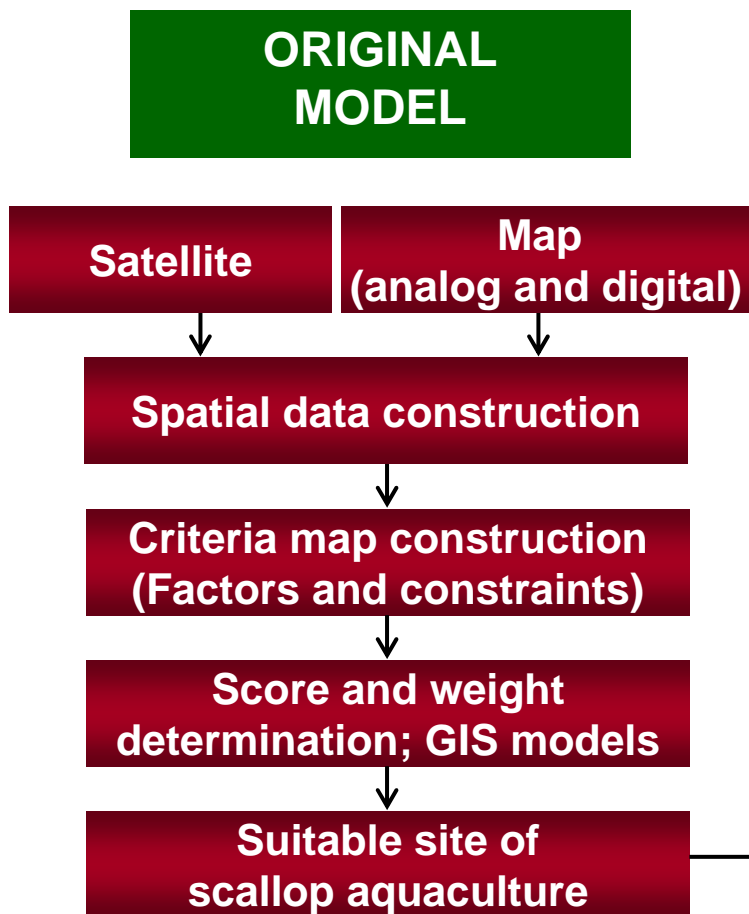
Characteristic of the study area



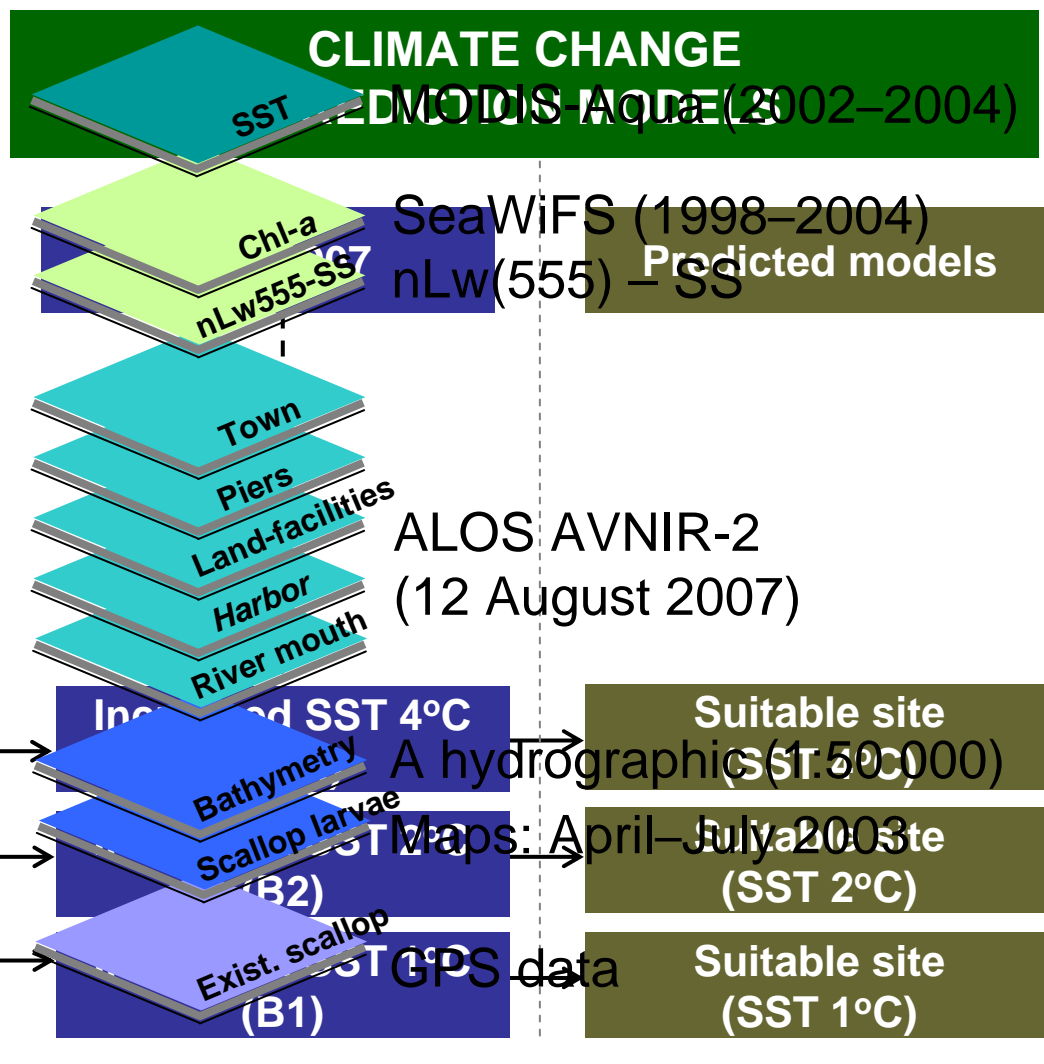
- Depth, maximum 107 m and mean 38 m
- 2315 km² surface area, and a 195 km coastline
- Water replace 2 time a year : OW & TW

Methodology

ORIGINAL MODEL



CLIMATE CHANGE



Original model construction

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

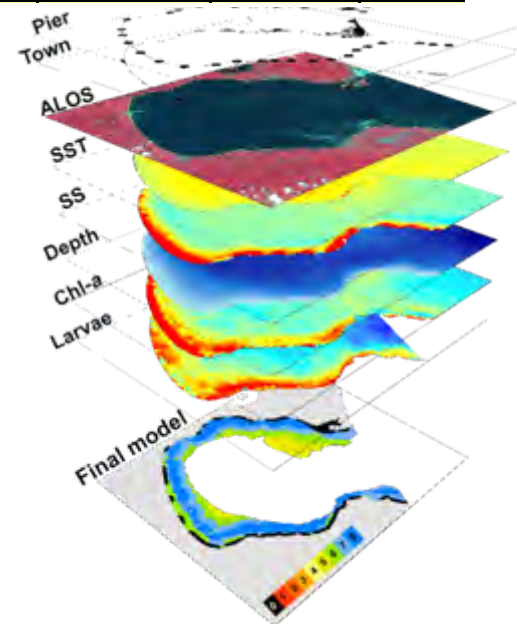
| Parameters | Suitability score | | | | | | | |
|------------------------|-------------------|-----------|-----------|-----------|-----------|----------|---------|------|
| | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Bathymetry (m) | > 20.0 | 17.5-20.0 | 15.0-17.5 | 12.5-15.0 | 10.0-12.5 | 7.5-10.0 | 5.0-7.5 | <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 |

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

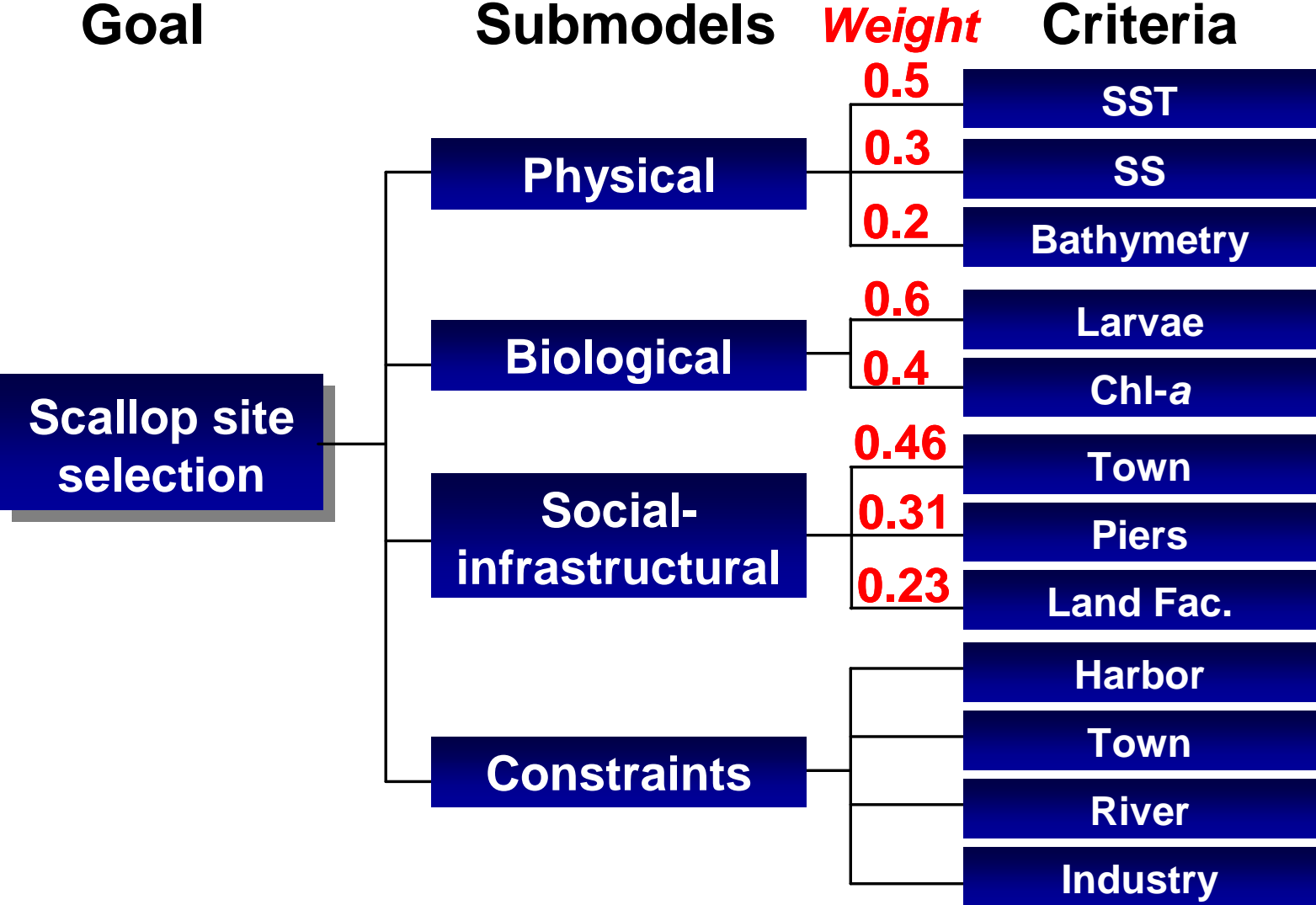
w_j = weight, $\sum w_j = 1$,

r_{ij} = the attribute transformed into score (1-8)

The most preferred alternative is the maximum $V(x_i)$ value



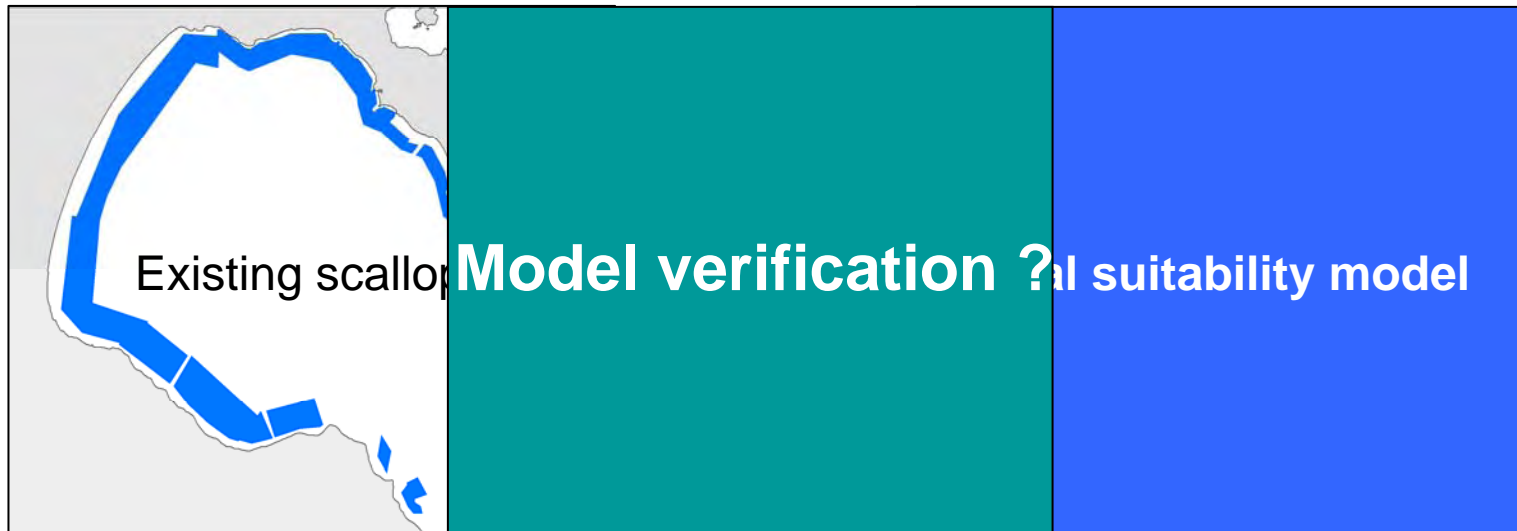
Original model construction



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

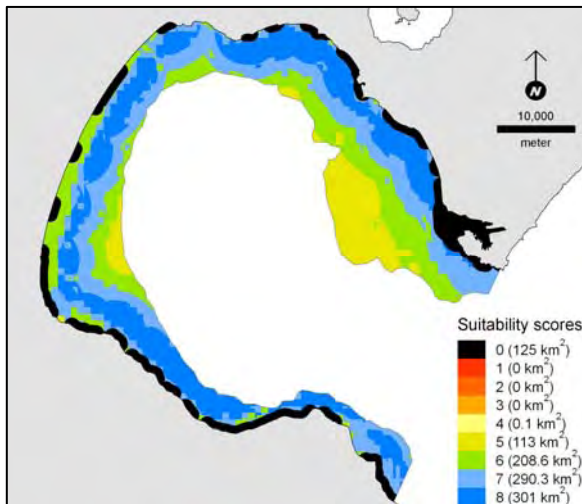
Predicted models

SST Increased 4 °C

SST Increased 2 °C

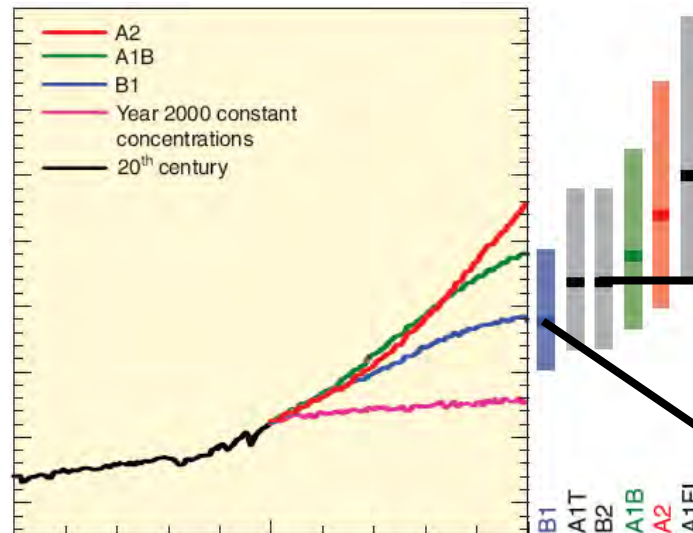
SST Increased 1 °C

Original model



Suitable sites

Reanalyzed



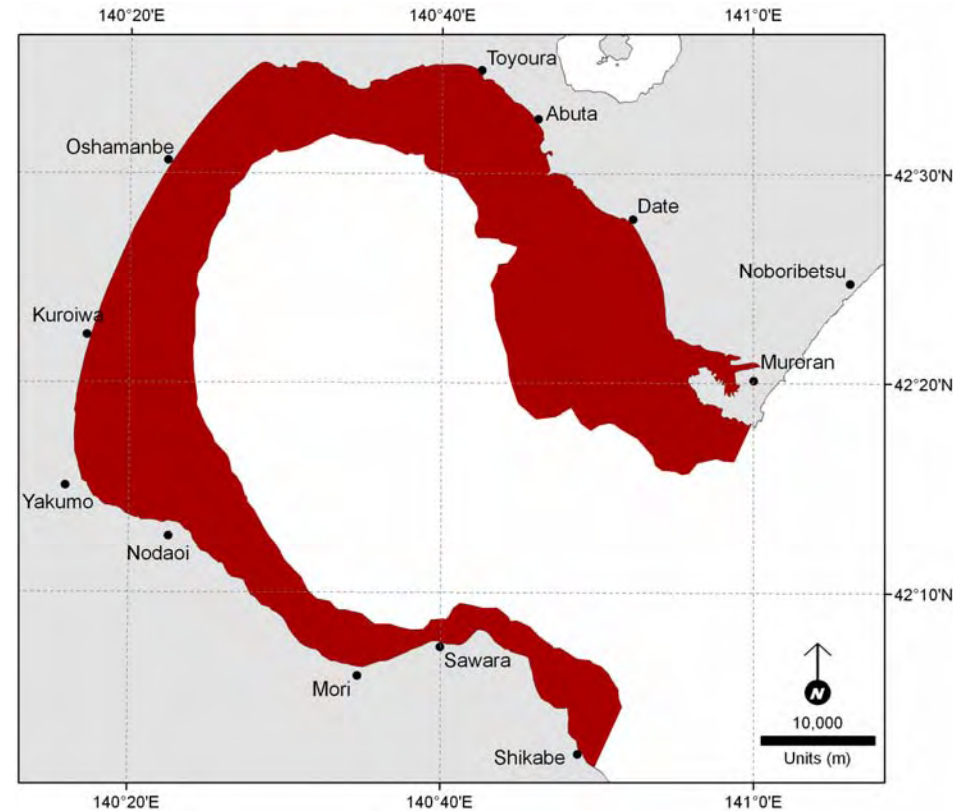
(IPCC, 2007)



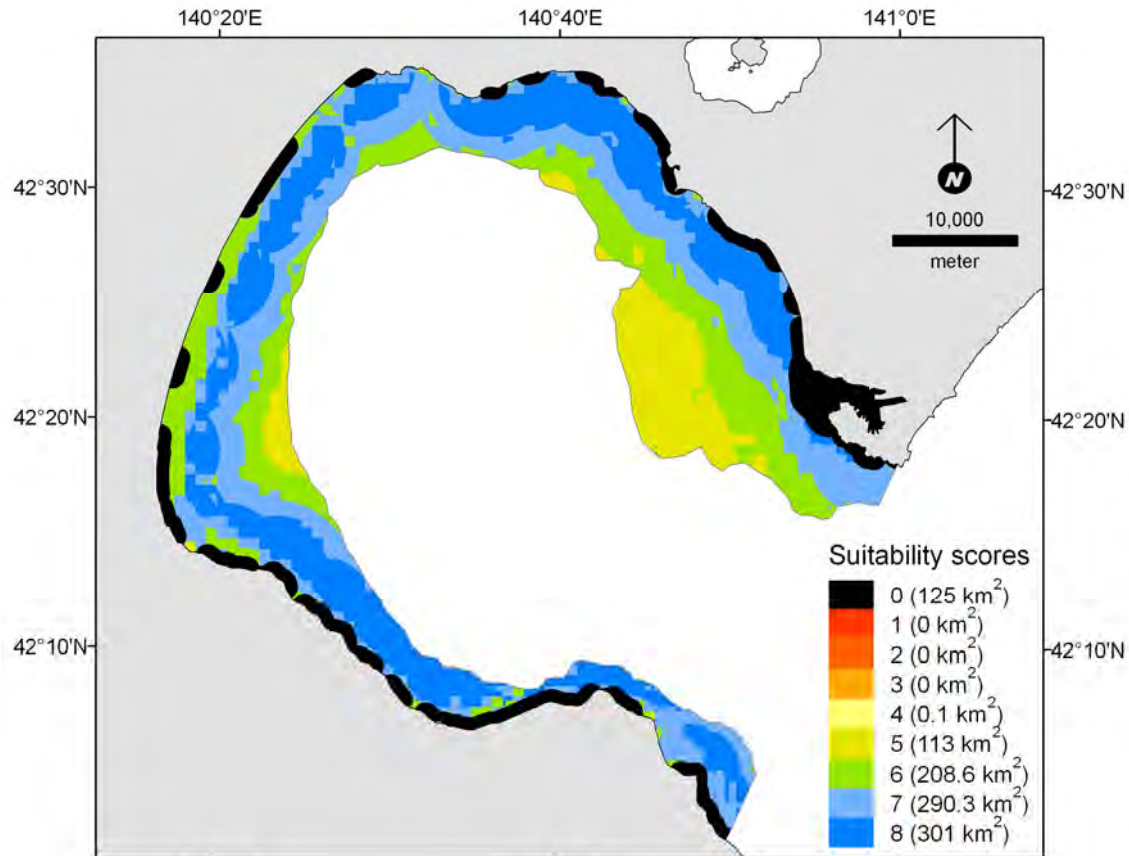
Results and discussion

Area of interest

- Suitable area based on 60 m depth
→ to minimize operation costs and difficulty in mooring systems
- Potential area about 1038 km² (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 |

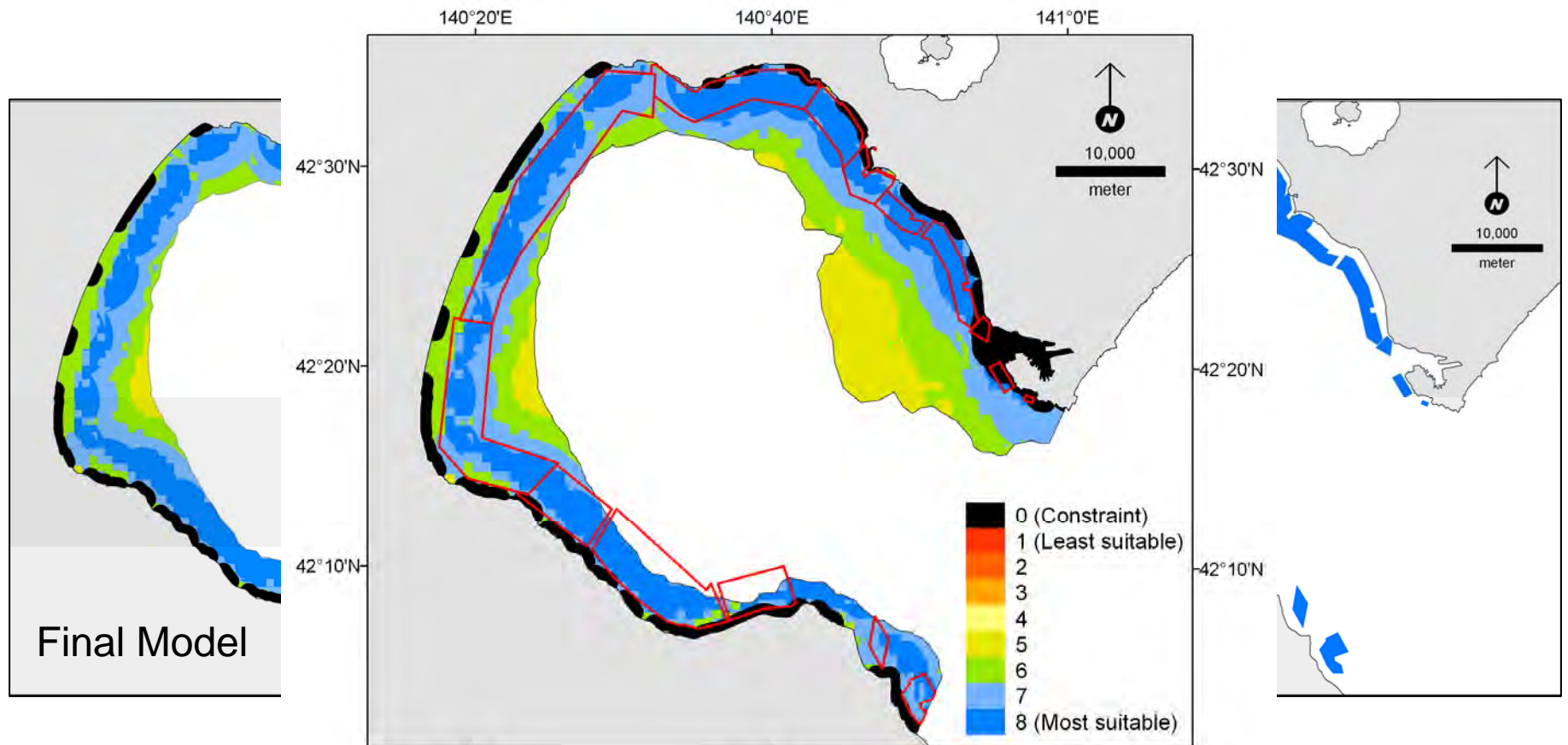


Constraint

Low

High

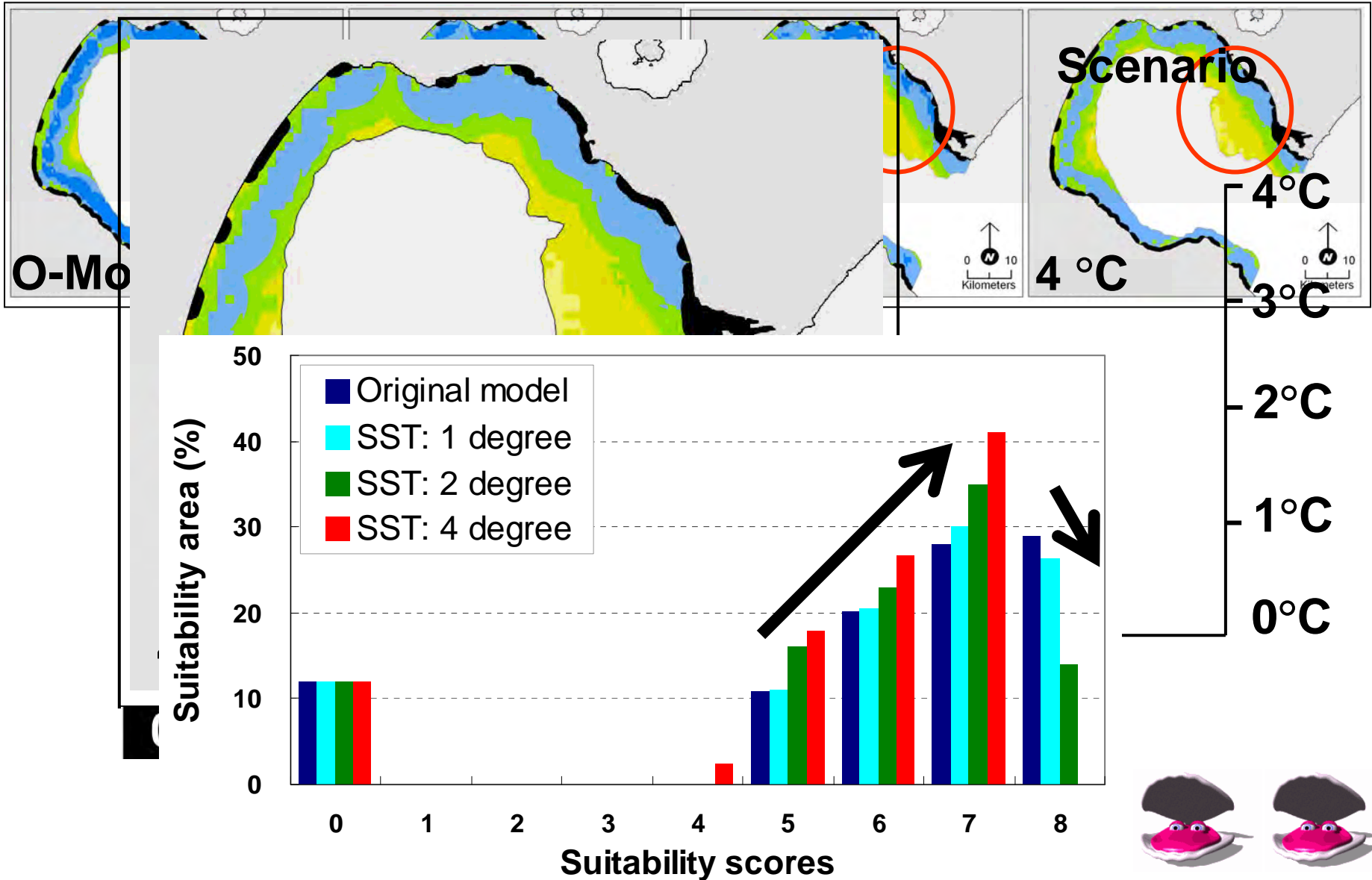
Original model verification



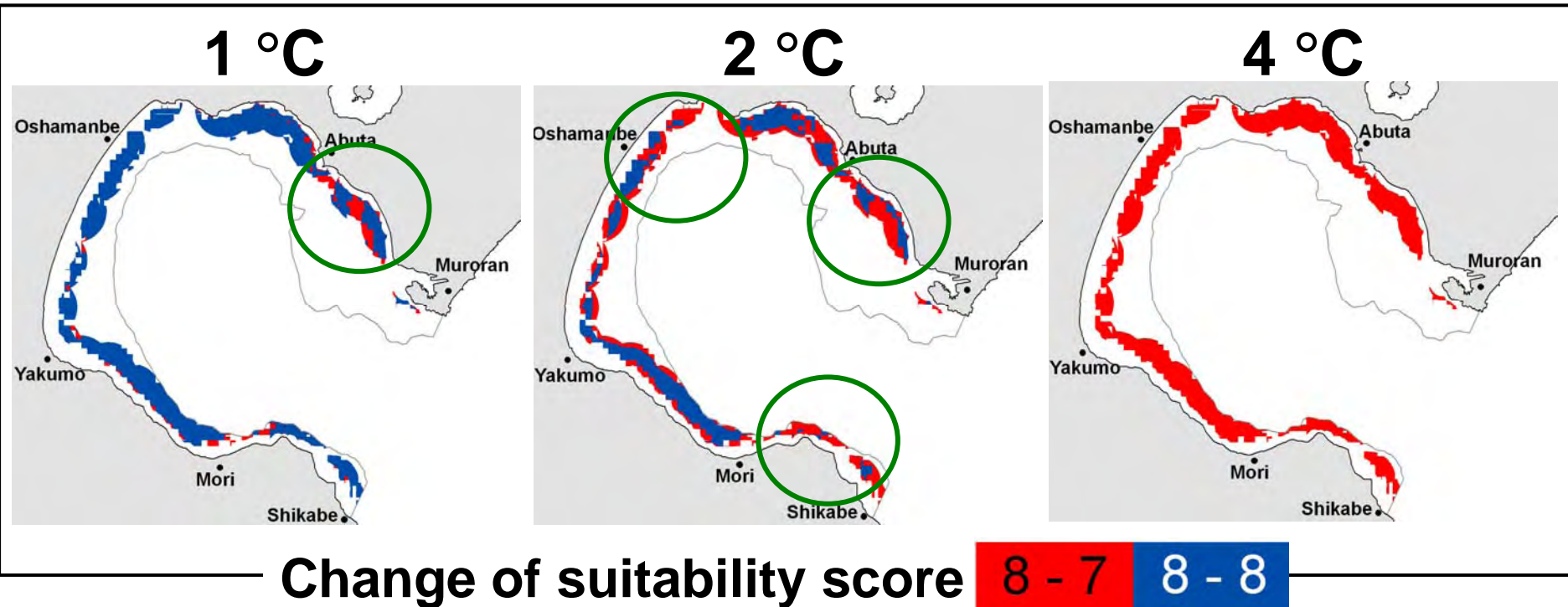
Scores and proportional area (%)

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Outside > 60m |
|-----|-----|-----|-----|-----|-----|-----|------|------|---------------|
| 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 ($\approx 30\%$, 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.

A photograph of a sunset over a mountain range. The sun is low on the horizon, casting a warm orange glow across the sky and the silhouettes of the mountains.

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Thank you

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