Estimation of the future change of anchovy recruitment in response to global warming off western coast of Kyushu, Japan

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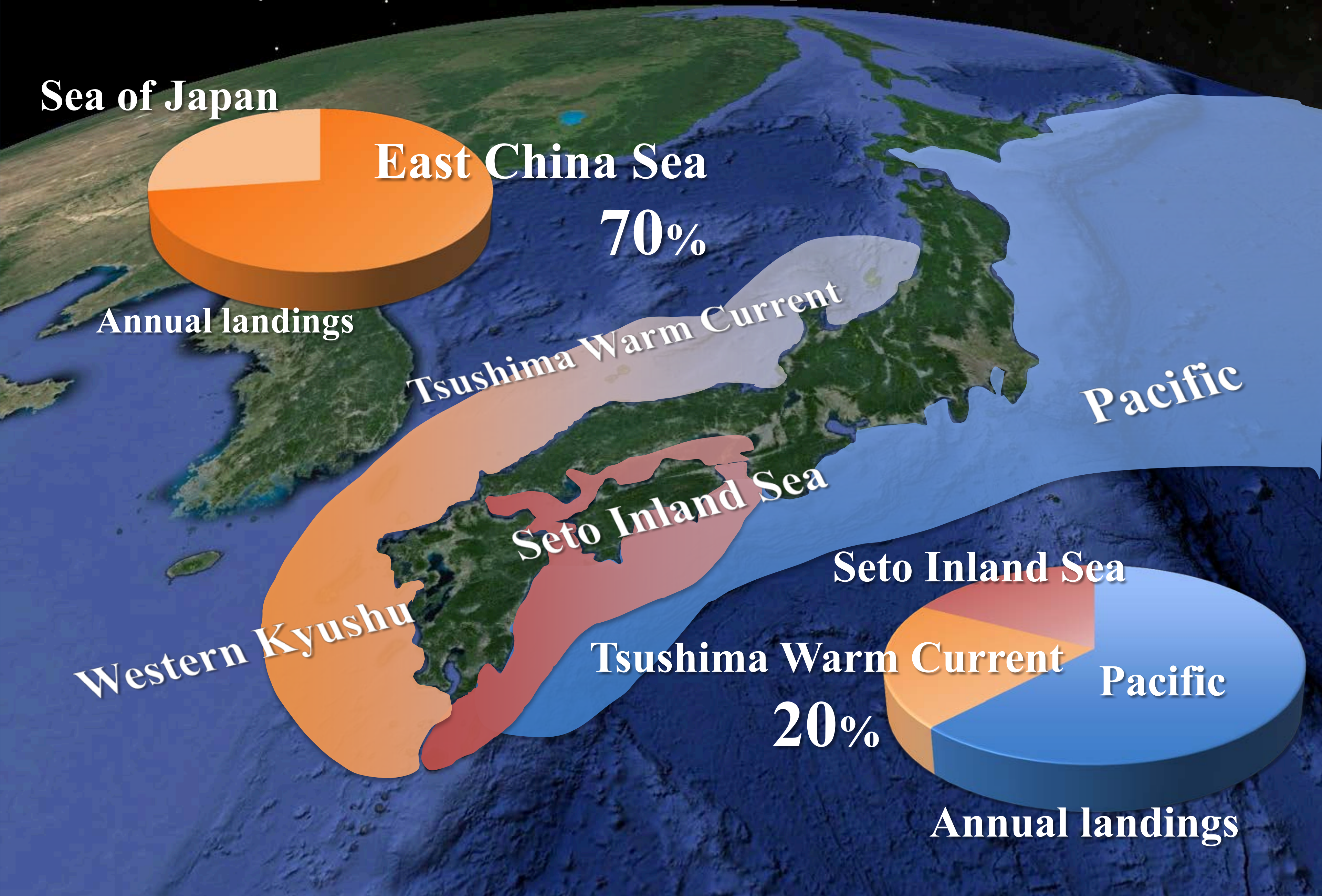
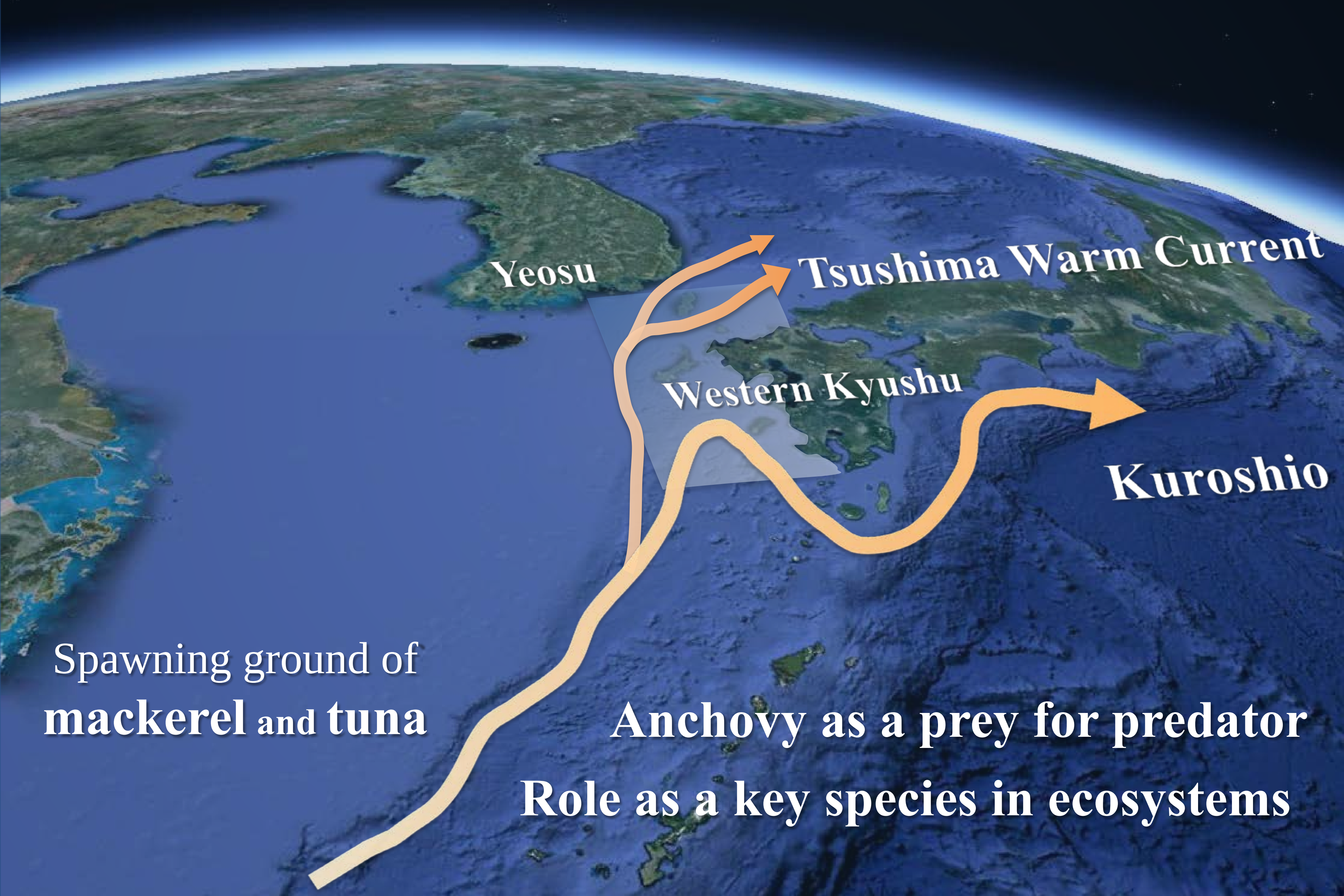
The University of Tokyo

Anchovy stocks around Japanese waters



The western Kyushu

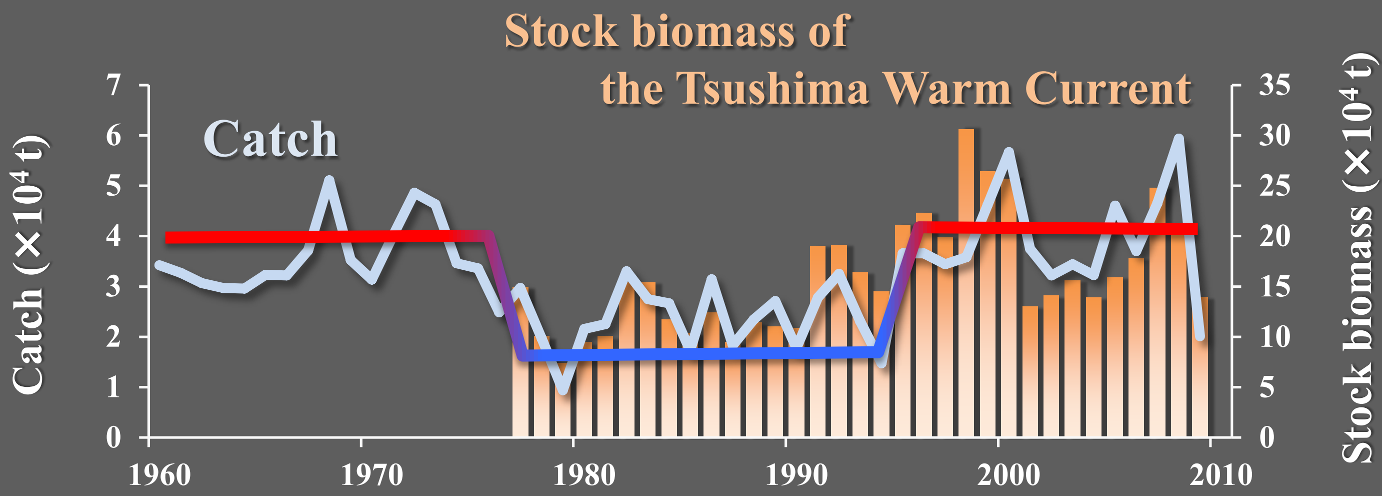


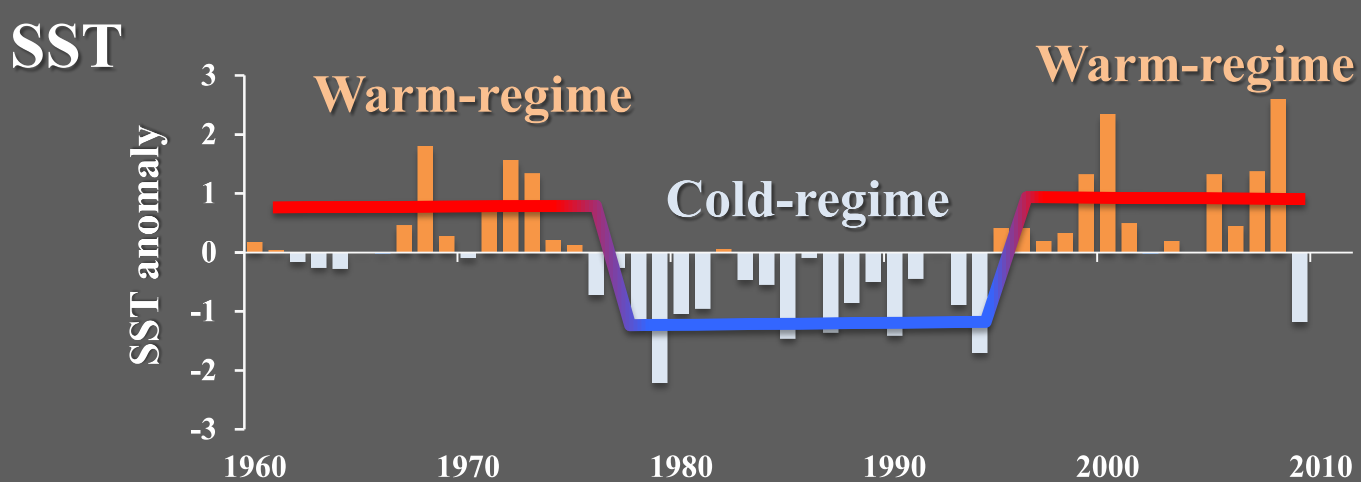
Spawning ground of **mackerel** and **tuna**

Anchovy as a prey for predator

Role as a key species in ecosystems

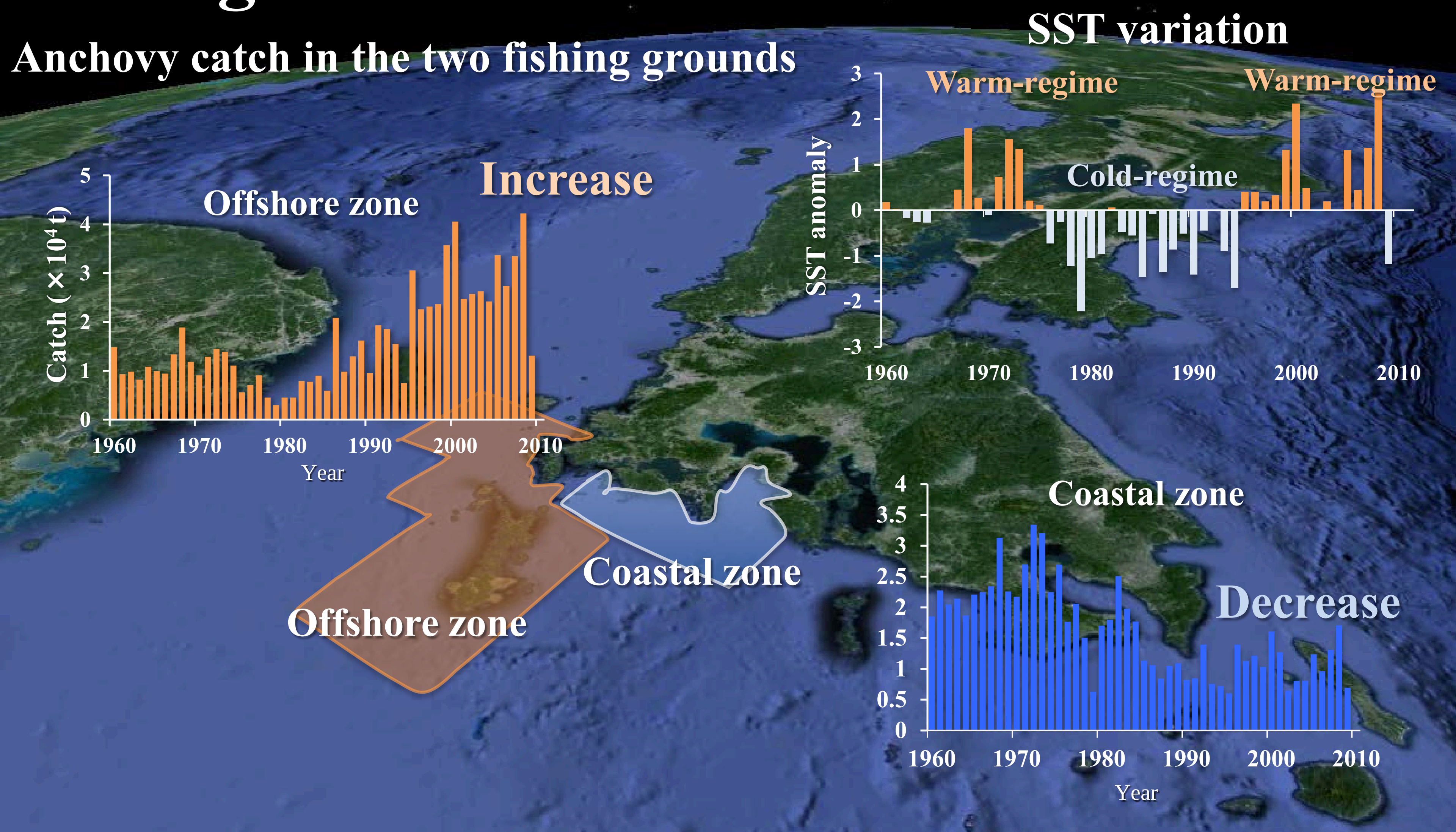
Climate change and anchovy





Decadal fluctuations relating with the SST

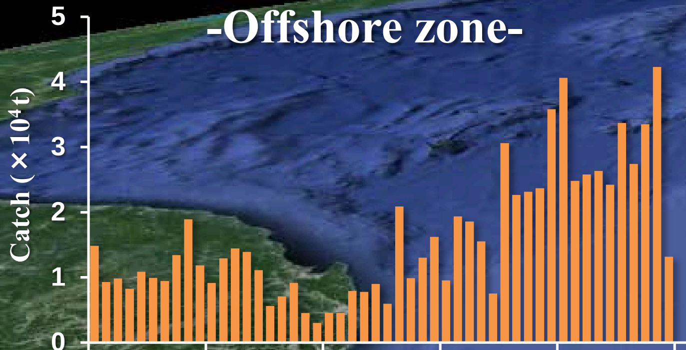
Background

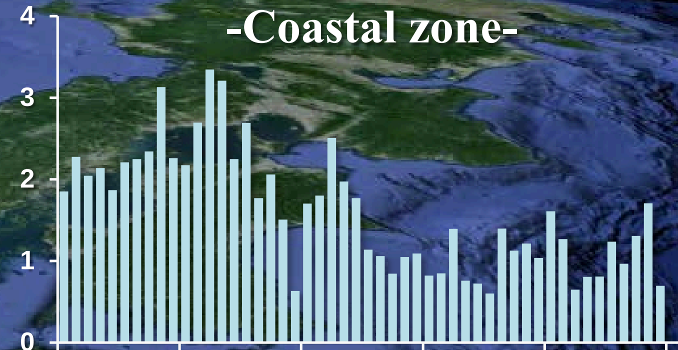


Temperature change induced by regime shift is not enough to explain the local catch fluctuation

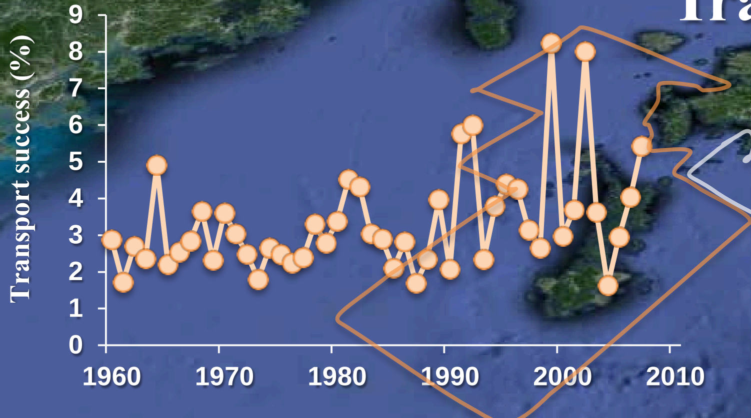
Background

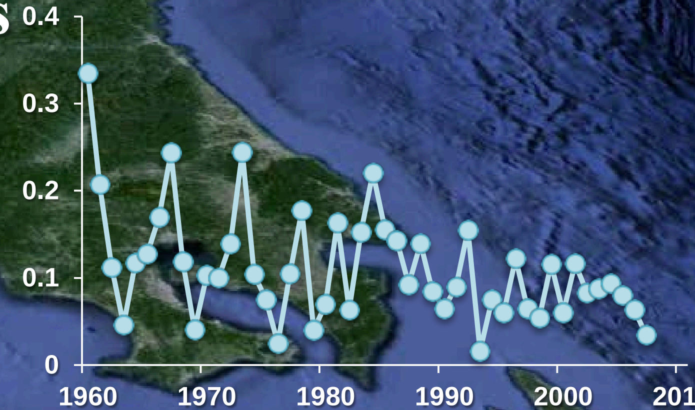
Catch





Transport success





Factors

Shift of the spawning ground
Weakened Tsushima Warm Current

Shift of the spawning ground
Weakened coastward current

Changes in the larval transport success leads decadal fluctuation in the catch

Hypothesis and Objective

Spawning ground

Connectivity

Nursery and fishing ground

Important for
the recruitment and stable fishery

Global warming

Hydrodynamic and biological conditions

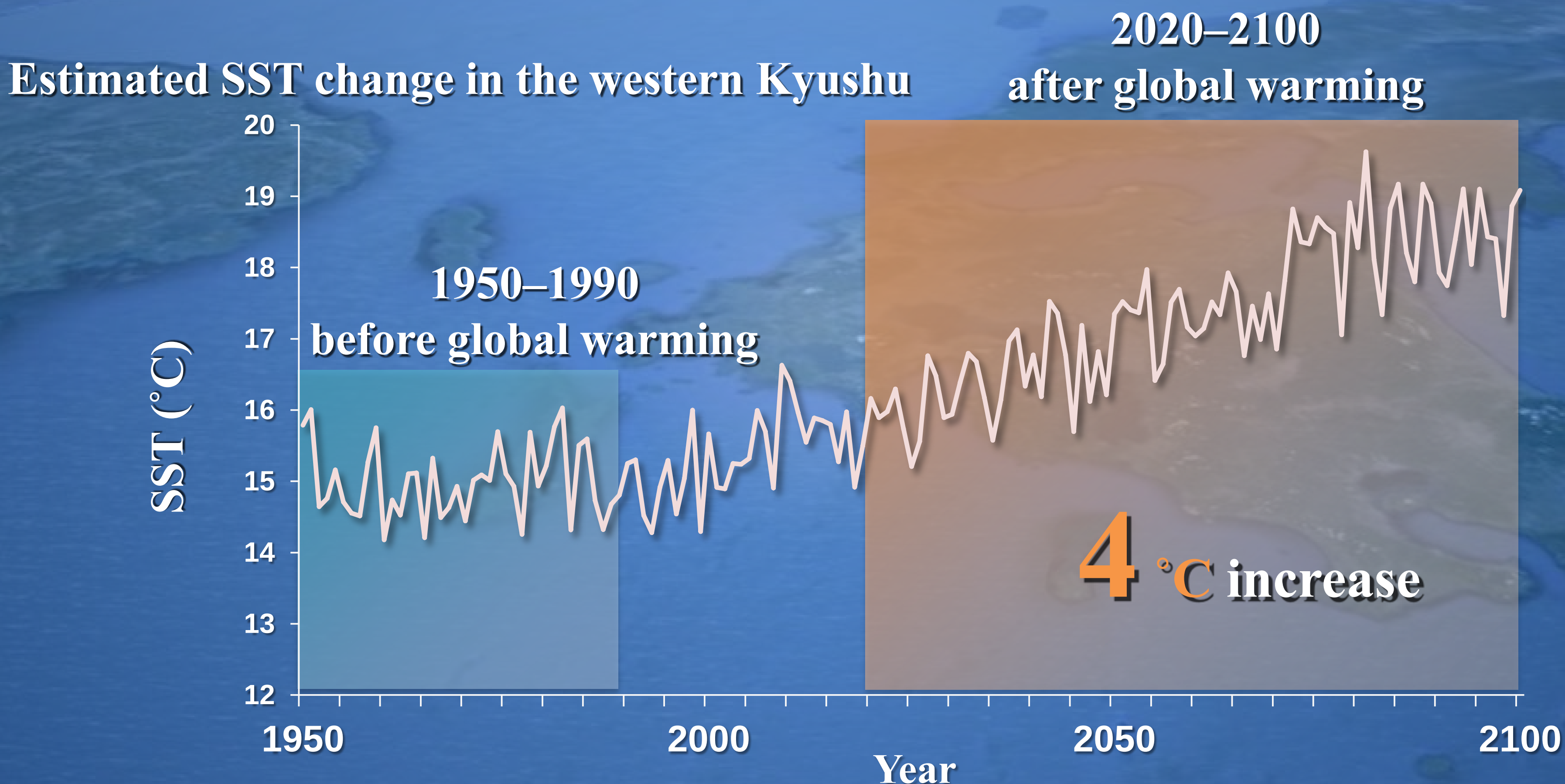
Recruitment and fishery

Estimating the effect of global warming on the larval transport and survival

Global warming scenario

・MIROC (Model for Interdisciplinary Research on Climate).

・IPCC A2 scenario



Compare the transport success and growth

between **before/after** global warming

Particle tracking simulation

Hydrodynamic model (Delft 3D-FLOW)

Resolution ：2 km，5σ-layers

Initial condition ：MIROC

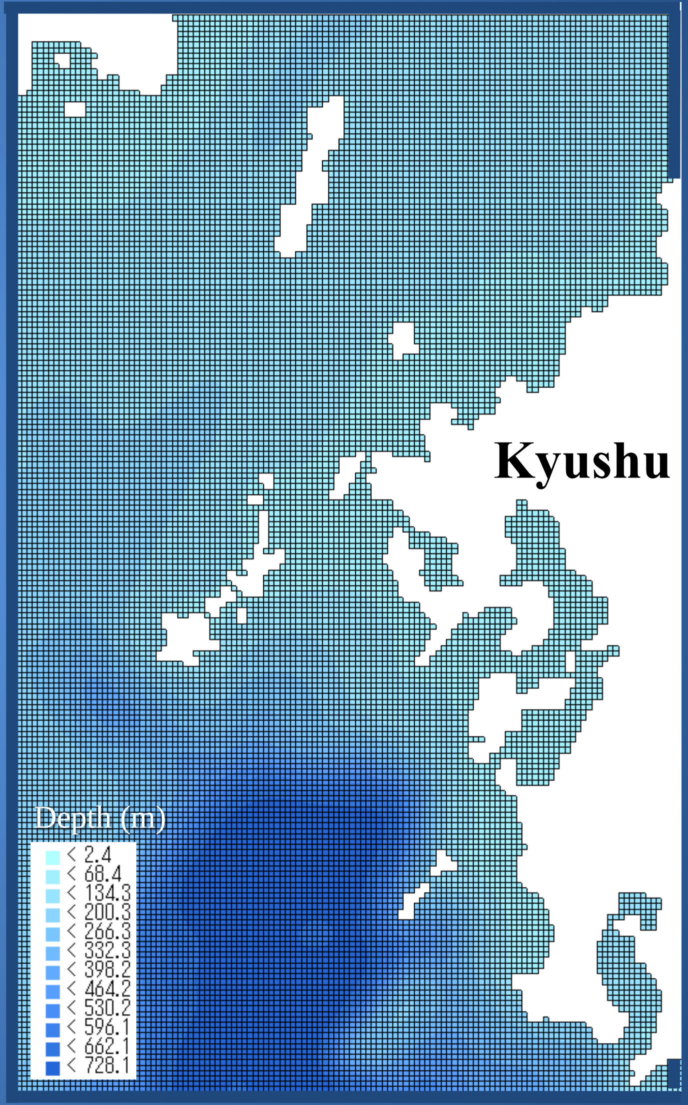
Lateral boundary ：MIROC (west/south)
：Water level (east/north)

Surface boundary ：Wind-stress，heat flux

Period ：1950–2100，Jan. – May

The model validation was tested by our previous study (please visit poster session)

-Model domain-

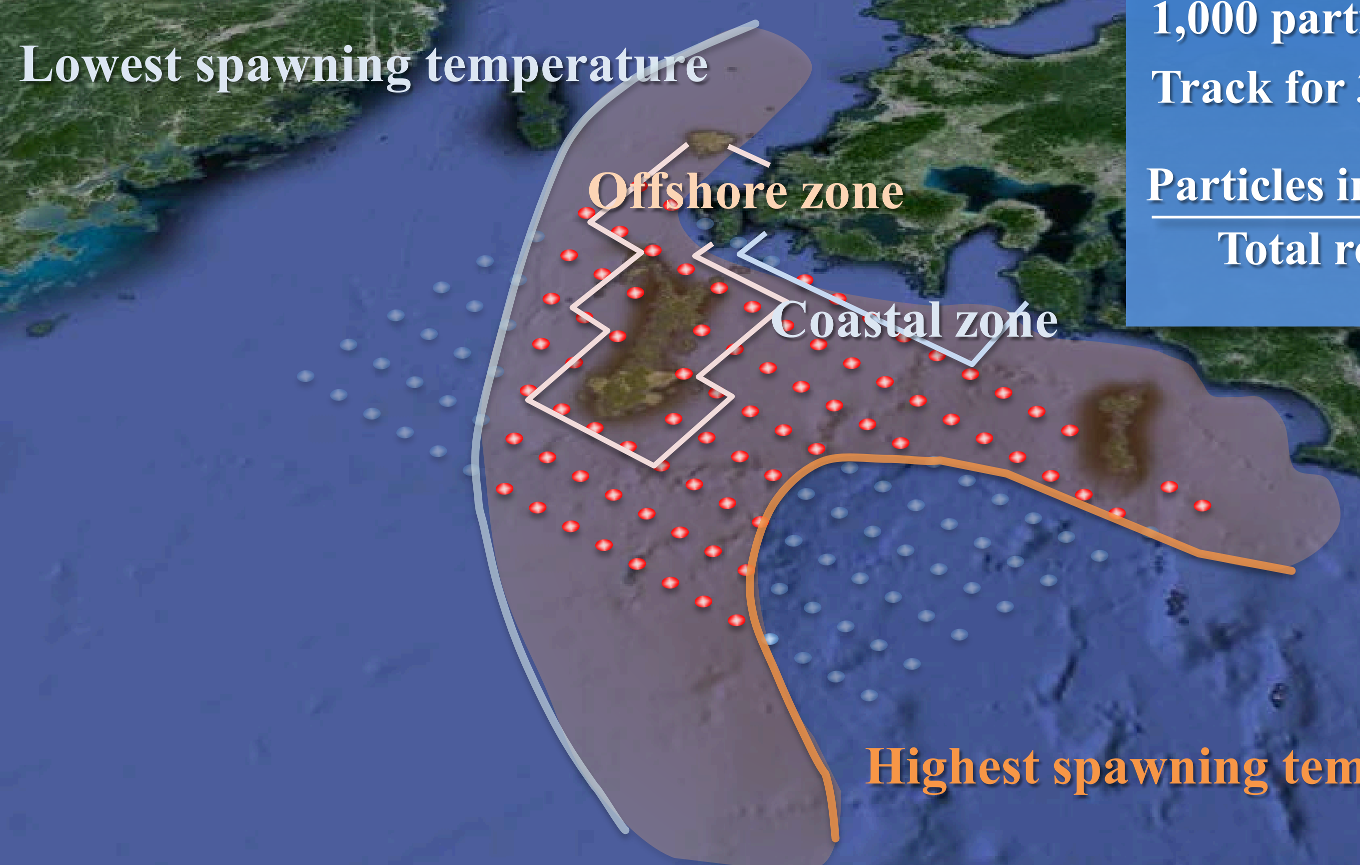


Particle release location

Based on the spawning temperature and the modeled SST in each year.

Spawning temperature range

April: 13.7–19.6°C, May: 15.7–20.1°C



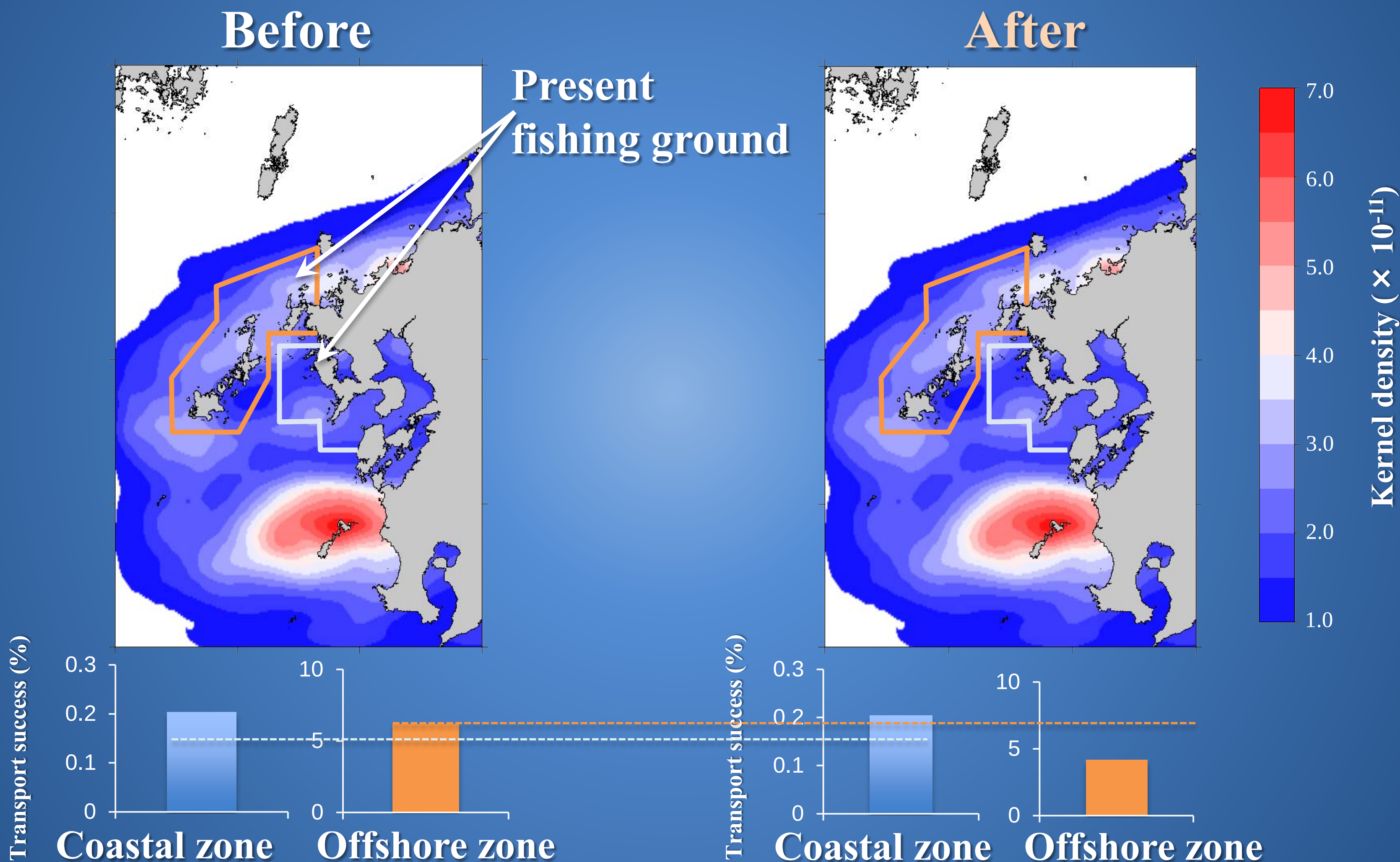
- **Transport success (%)**

1,000 particles × release points

Track for 30 days

$$\frac{\text{Particles in the fishing ground}}{\text{Total released particle}} \times 100$$

Result : larval distribution



Why the distribution shifted northward?

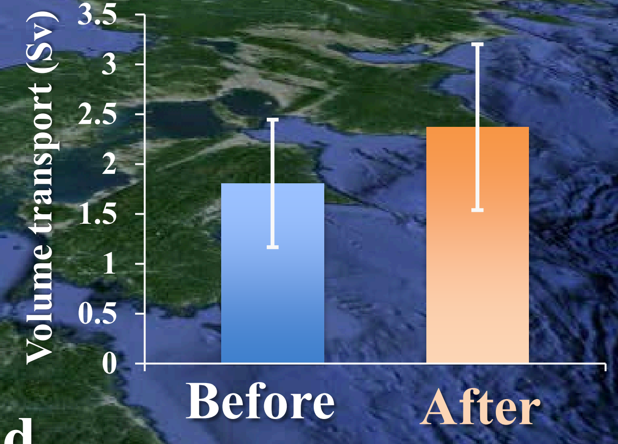
Environmental change affecting the transport

Strong Tsushima Warm Current
→transports particle to the Sea of Japan

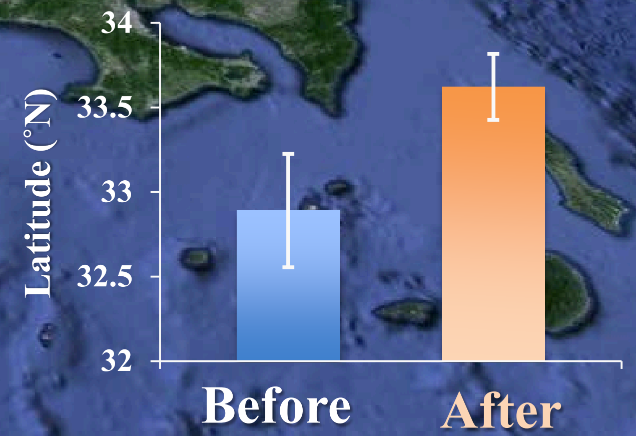
Northward shift of the spawning ground
→unfavorable place to reach the fishing ground

Spawning ground

Tsushima Warm Current



Location of the spawning ground



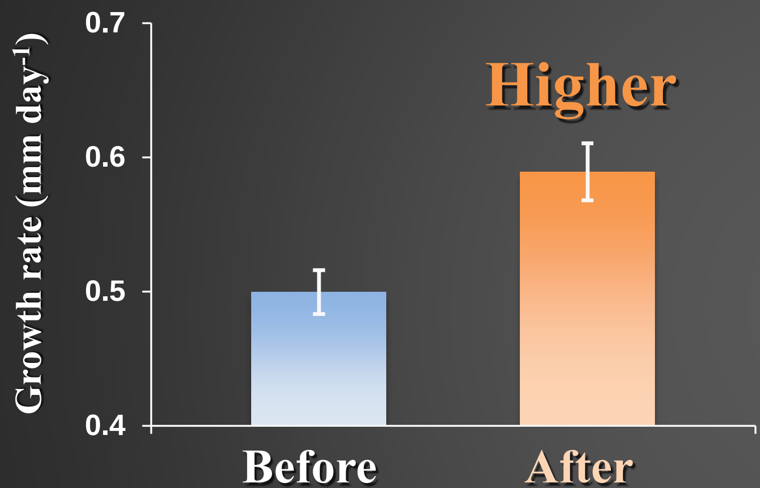
How will the growth and survival change after global warming?

Estimation of the growth rate and food environment

Growth rate

Calculated from the SST

Yasue and Takasuka (2009)

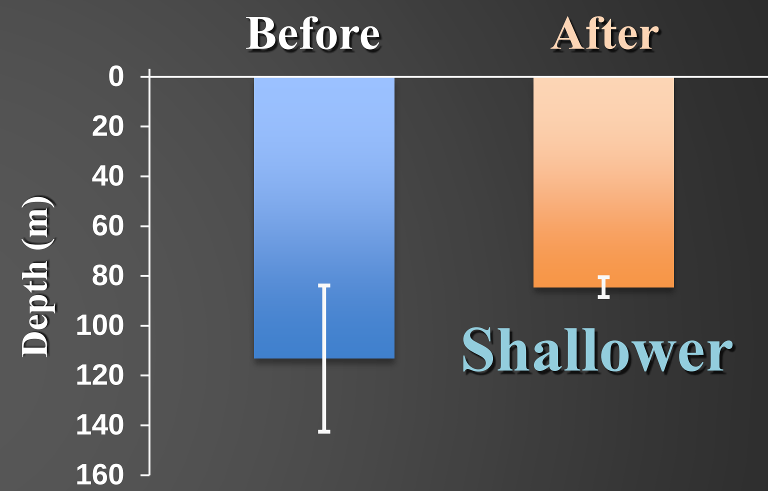


Higher survival rate

during the transport period

Food environment

Mixing layer depth as a proxy



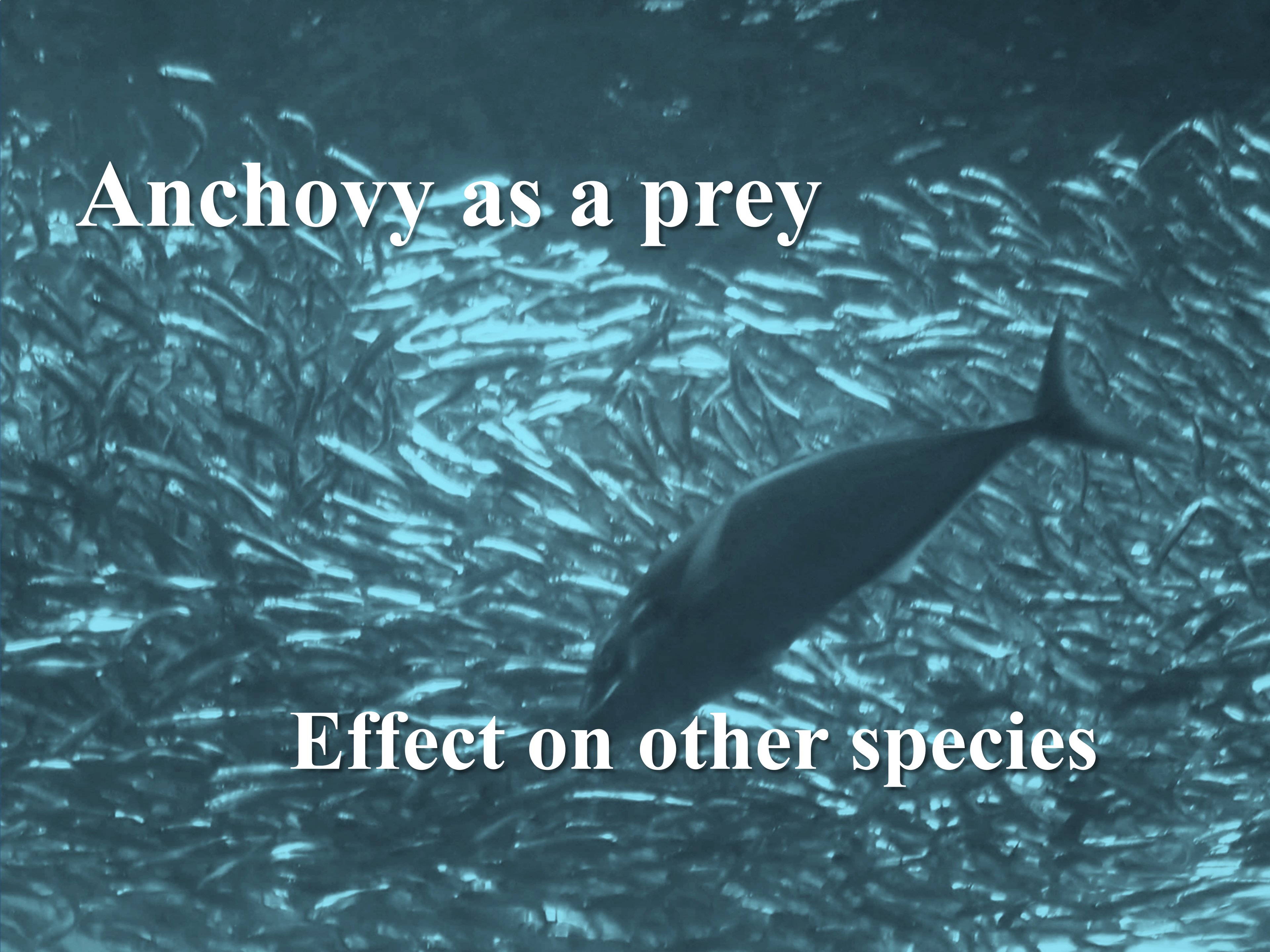
Less nutrient, low primary production

Low food availability

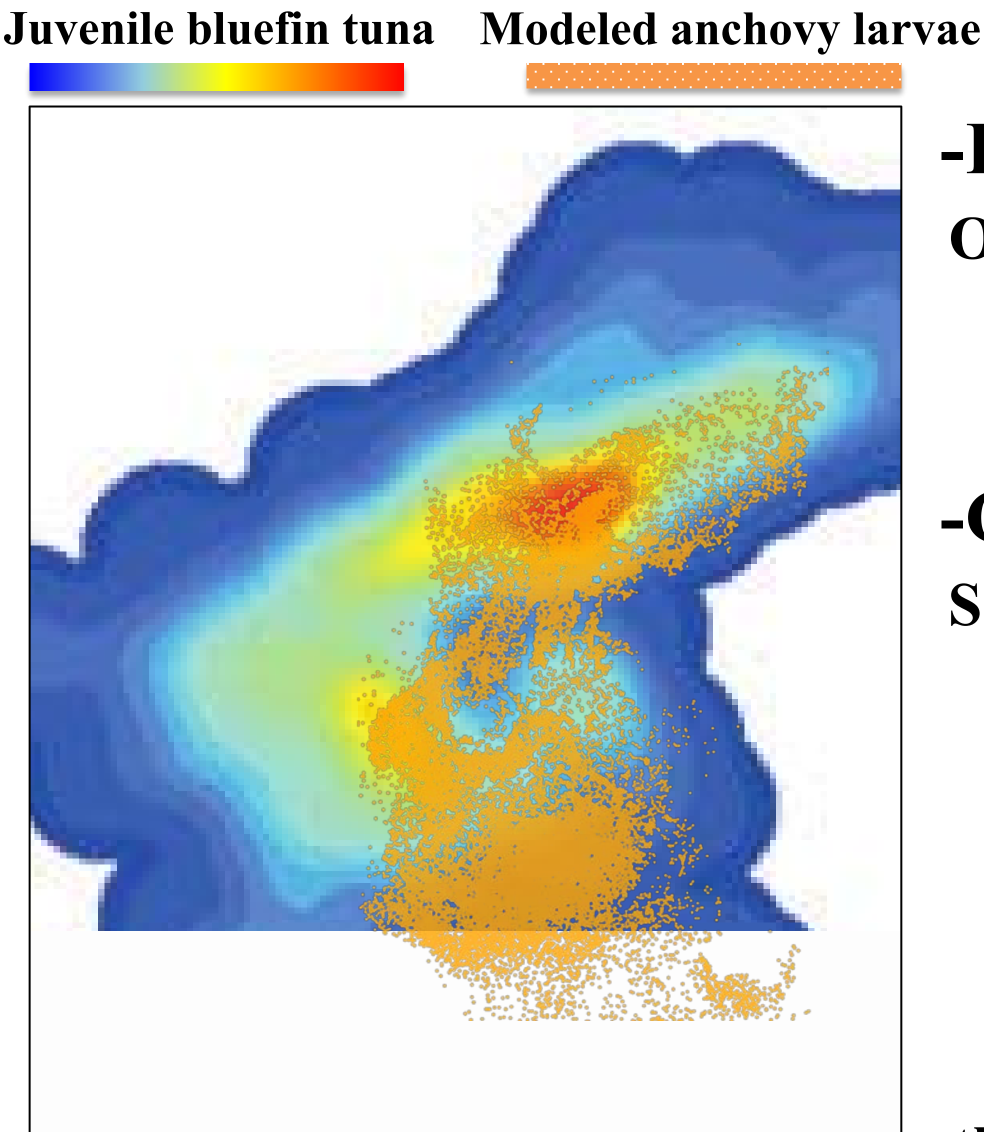
Food availability limit the growth rate

under a higher temperature (> 19˚C, Takahashi and Watanabe 2004)

Limit the growth and survival


Anchovy as a prey
Effect on other species

Effect of shift of anchovy distribution on the bluefin tuna



Kitagawa et al. (2006)

-Present-

Overlap in the distribution of

bluefin tuna and anchovy

-Global warming-

Shift of the anchovy distribution

and

Low survival of anchovy

↓

Possibly effect on

the recruit of the predatory fish

Conclusion

Global warming in the western Kyushu

Physical change

Intensified Tsushima Warm Current

Northward shift of the spawning ground

Weakened water mixing

Effect on anchovy

Change the connectivity between the spawning and nursery ground

Low survival due to the limited food availability

Ecosystem modeling will improve the future state of anchovy recruitment and ecosystems

Thank you for your attention