Habitat of Pacific saury *Cololabis saira* is affected by the distributional change of other small pelagic fishes in the North Pacific

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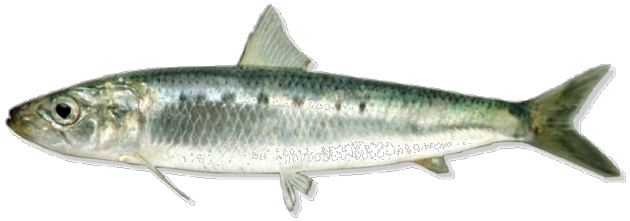
Introduction

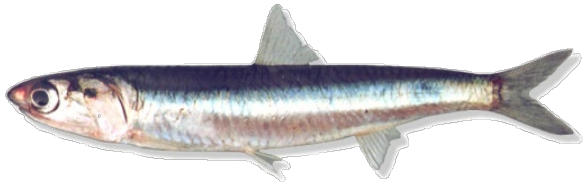
- Several pelagic fishes as well as Pacific saury are distributed in the western North Pacific

Pacific saury (PS)



Japanese sardine (SD)

Chub mackerel (CM)

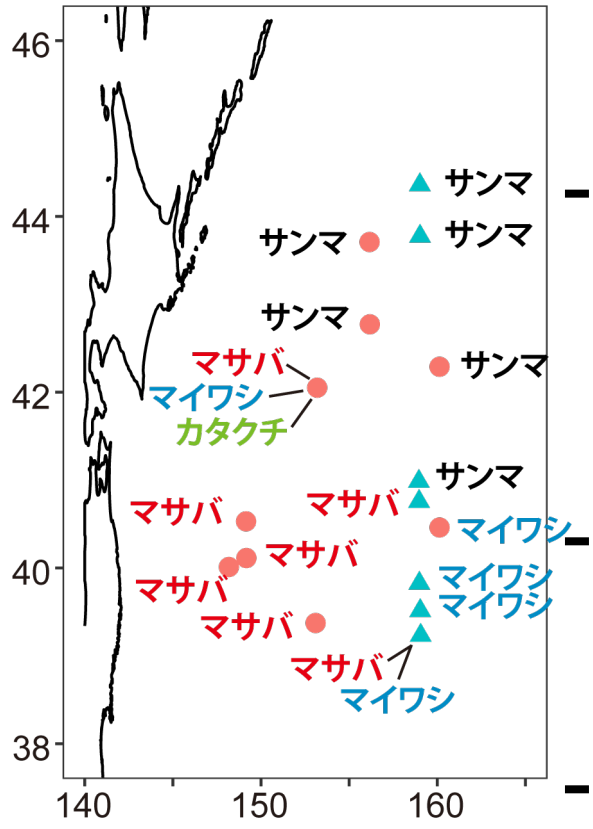


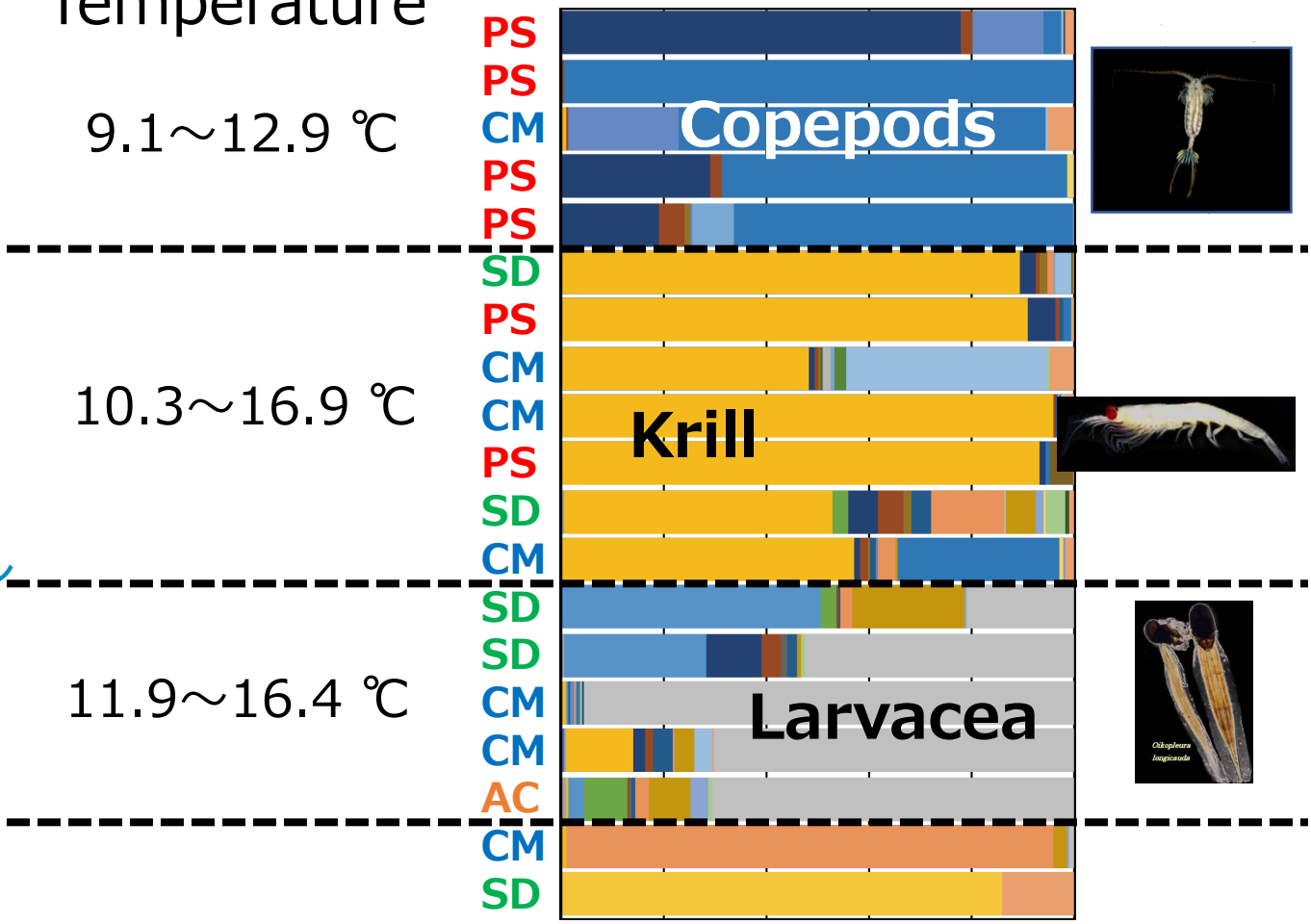
Japanese anchovy (AC)

Introduction

- They have similar feeding habits (zooplankton feeder)

Miyamoto, personal communication

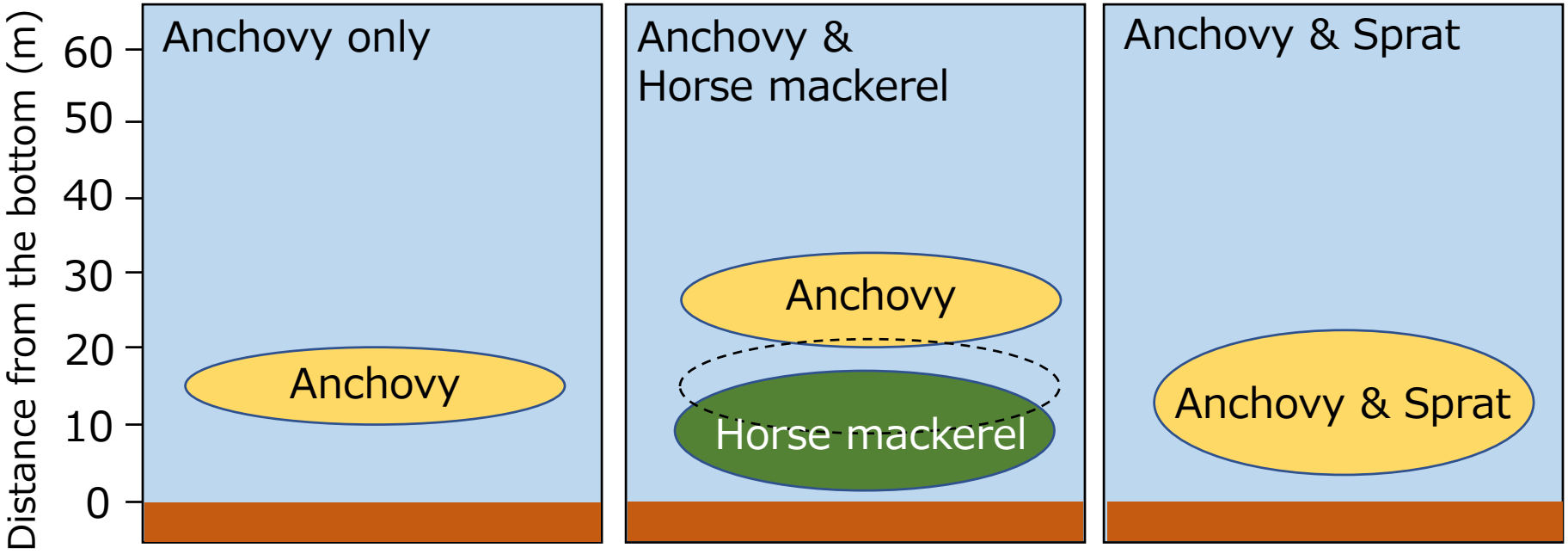




They are potential competitors!

Introduction

- In general, when several species with similar niche coexist, their habitat pattern shifts as a result of interactions such as competition



Massé et al. (1996)

PS distribution also might be affected by presence of the other species

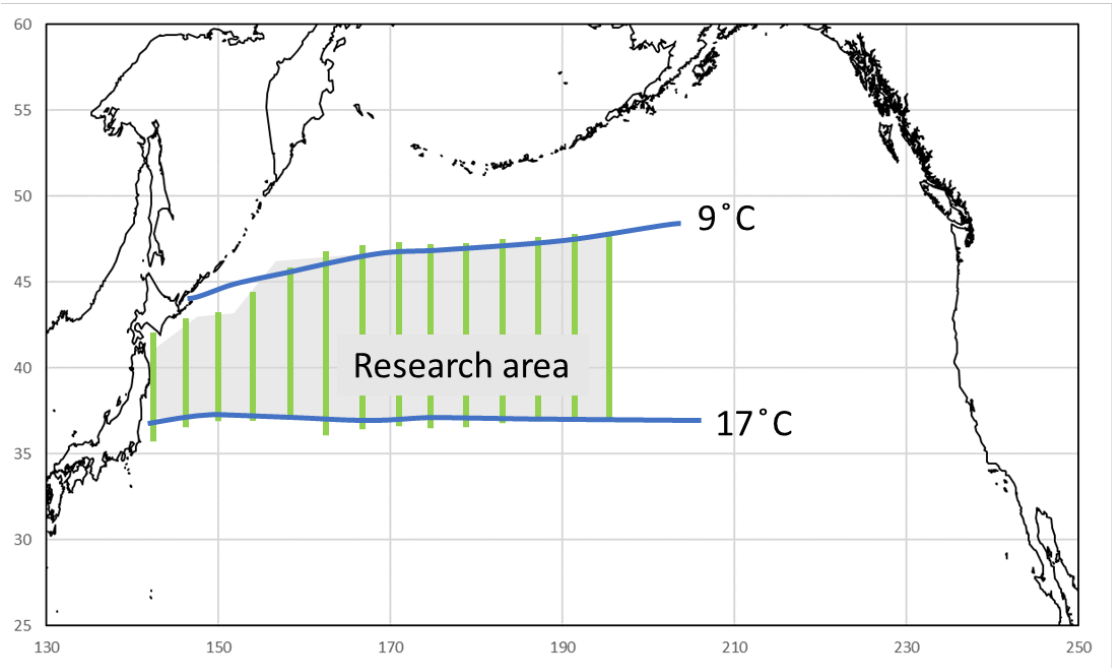
Objective

- To examine the relationship between the distributions of PS and the other species in the west North Pacific

What we did in this study

1. We overviewed the characteristics of distribution of these species
2. We focused on the annual change of PS distribution and its habitat characteristics
3. We applied a statistical model to describe the PS distribution and potential factors

Materials and methods



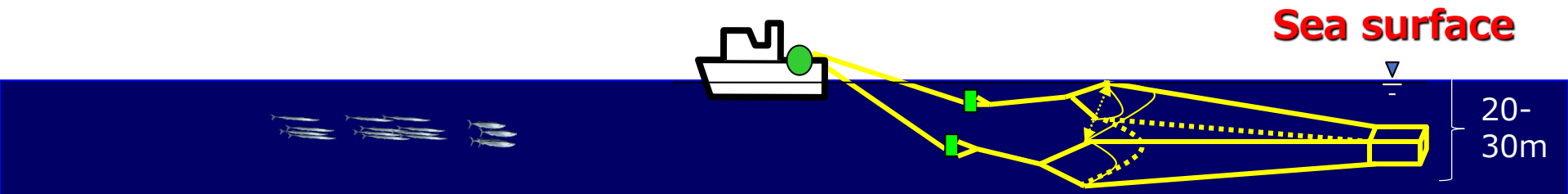
Season: June and July

Period: 2003-2018

Gear: Sea surface trawl net

Materials and methods

Sea surface trawl net



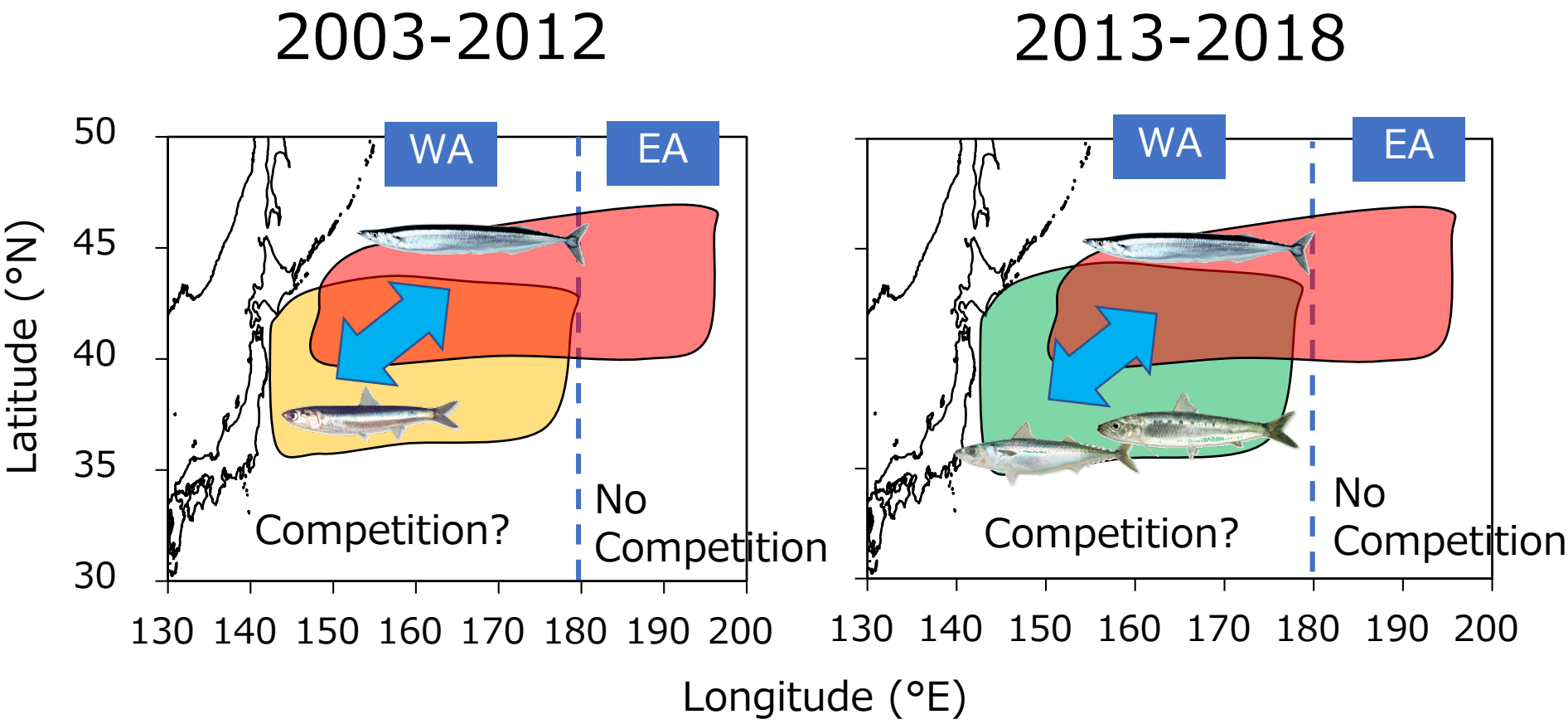
- Density (N/km^2) of four small pelagic species (PS, SD, CM, AC) at each station
- We mainly focused on PS of age1 (> 27 cm in length) for detailed analysis

Results & Discussion

Geographical distribution of species

Results & Discussion

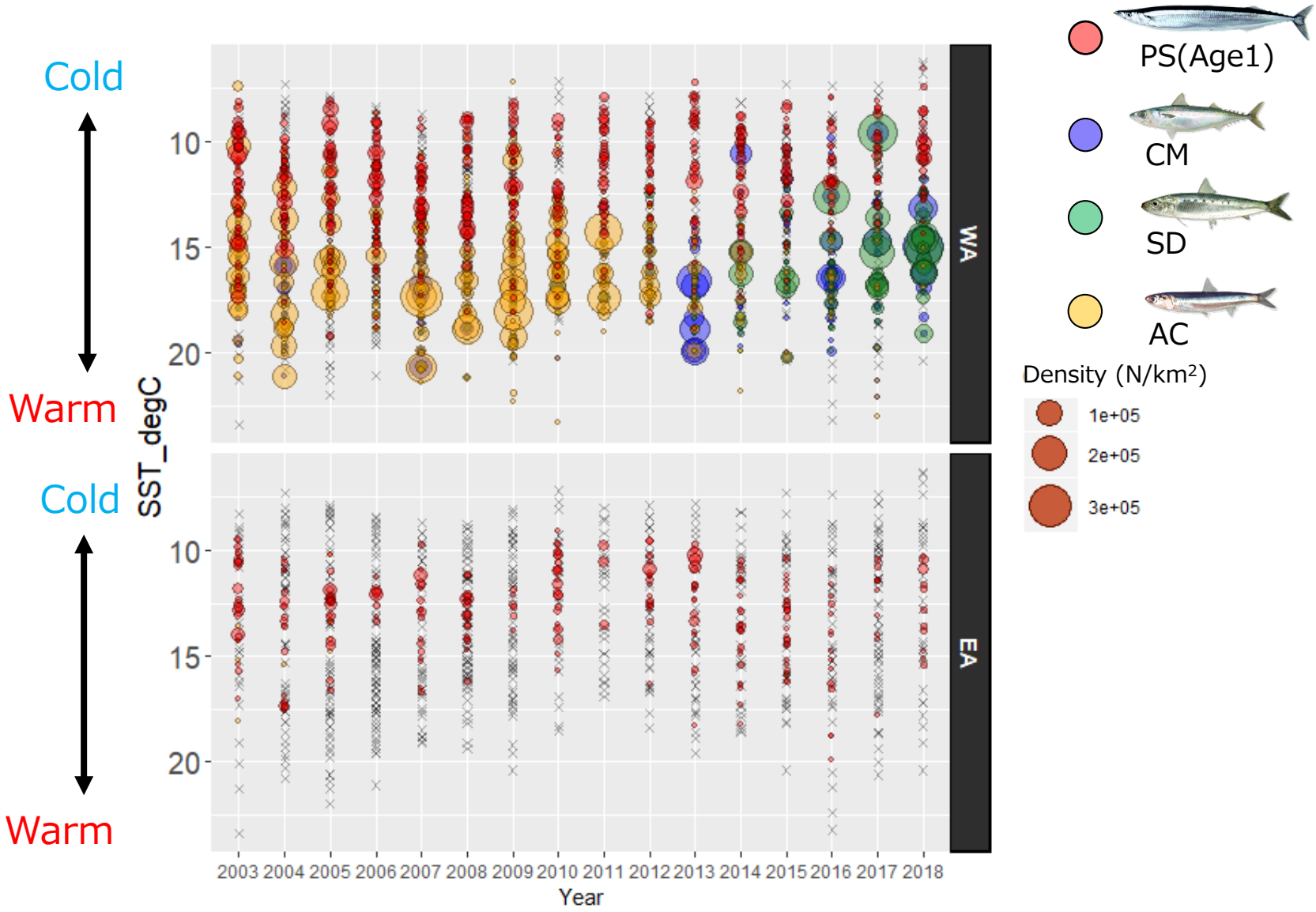
Geographical distribution of species



- **Two areas (WA and EA) were defined for further analysis**
- **It is possible to compare the habitat feature of PS between these two areas to find the effects of competitions**

Results & Discussion

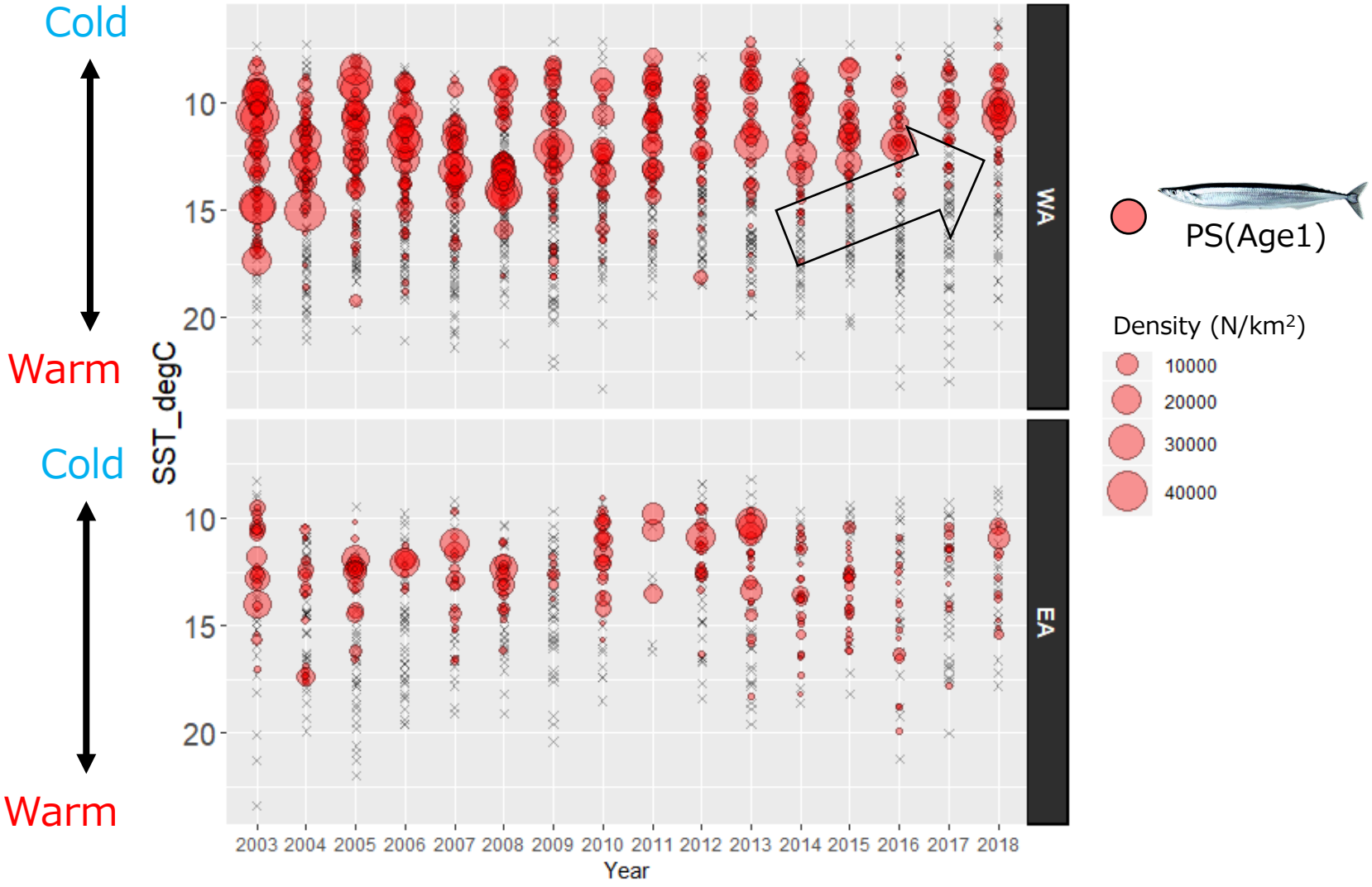
Distributional temperature of species



- PS: cooler water, other species: warmer water
- After 2013, SD and CM expanded to cooler water in WA

Results & Discussion

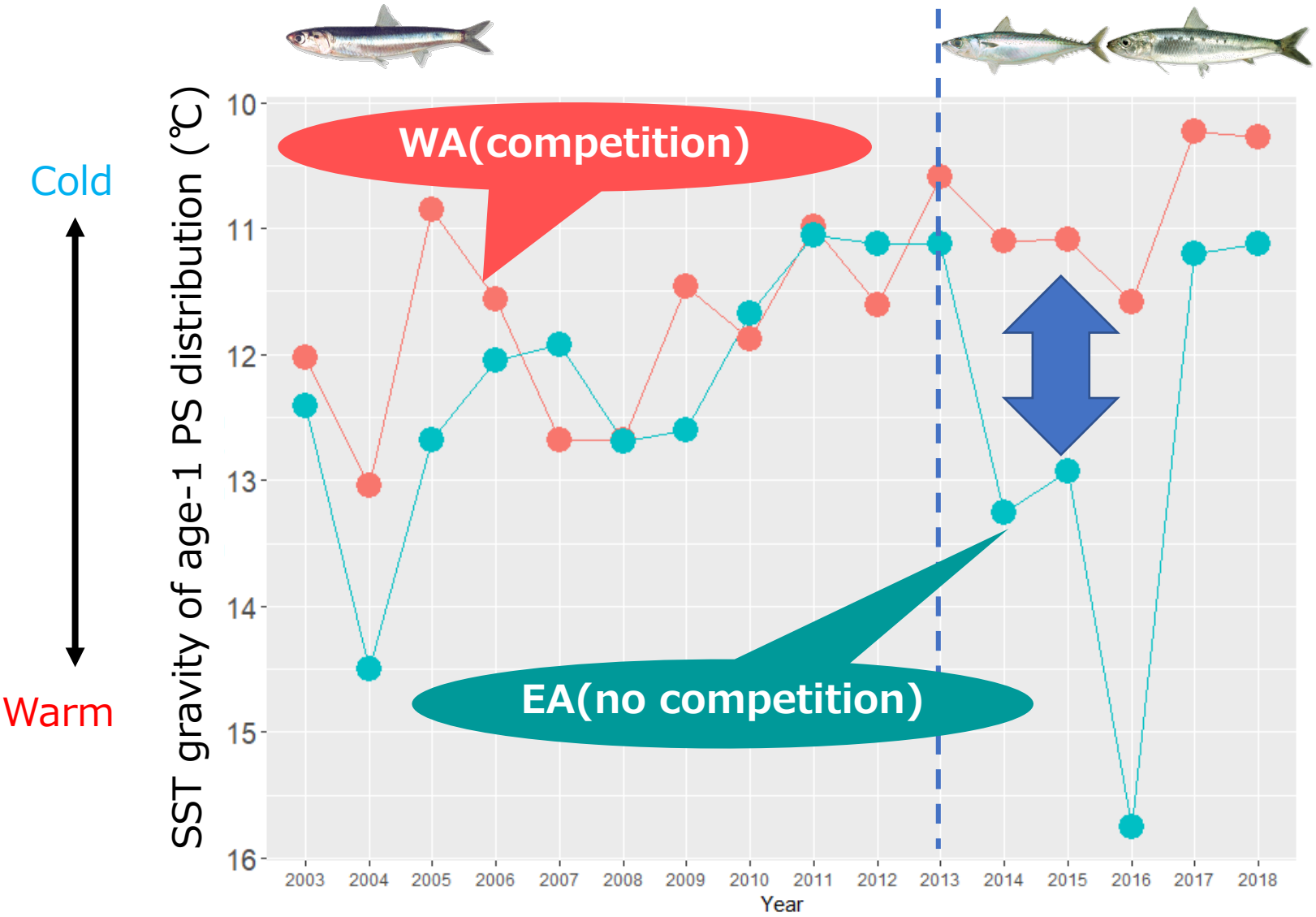
Distributional temperature of species



- PS distribution shrank into cooler water (< 12 degree C) recently
- The tendency was apparent only in WA

Results & Discussion

SST gravity of PS distribution



- Discrepancy in SST gravity between areas could be caused by expansion of CM/SD habitat

Modelling of encounter probability of age-1 PS

- Generalized additive model (GAM) with a binomial error distribution that had a logit-link function was applied.

Full model

$$\text{logit}(y) \sim s(SST) + s(Longitude) + s(SST{:}Year) + s(Longitude{:}Year) + s(D_{SD}) + s(D_{AC}) + s(D_{CM}) + Year + IC$$

y:encounter probability ($0 \leq y \leq 1$)
D_i: log(density of species i + 1)

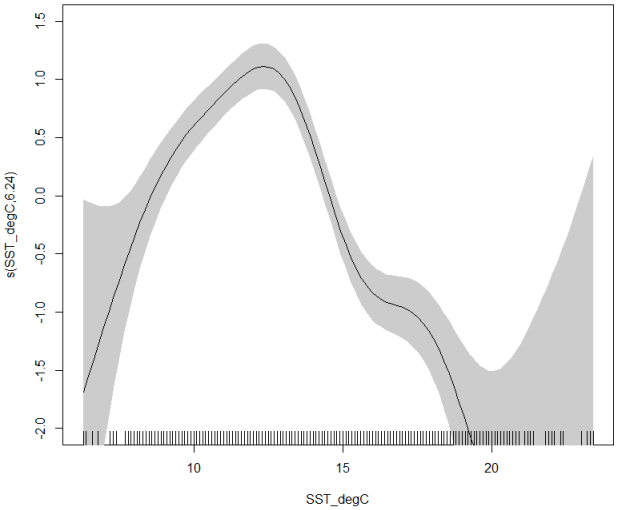
- "dredge" function of package "MuMIn" in R was used to determine whether a variable should be removed based on BIC.

Modelling of encounter probability of age-1 PS

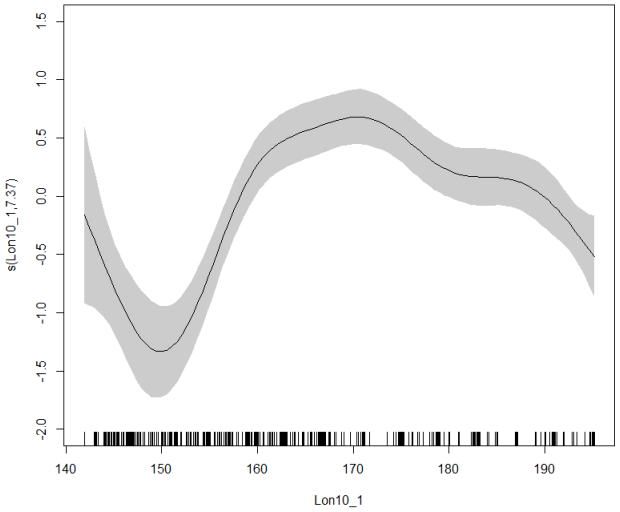
Selected model

$$\text{logit}(y) \sim s(SST) + s(Longitude) + s(D_{SD}) + IC$$

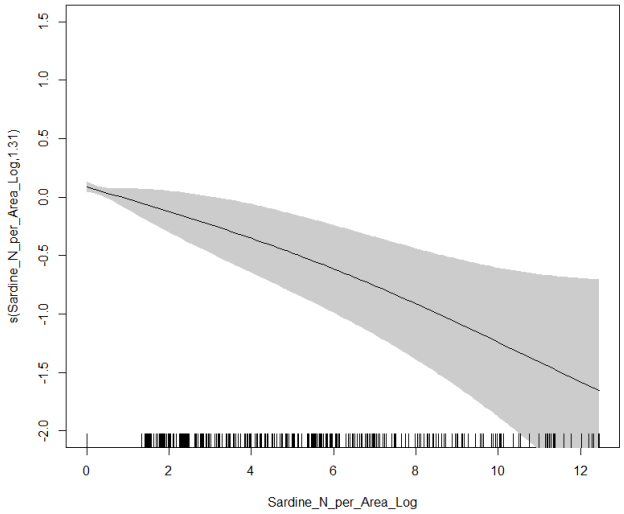
SST



Longitude

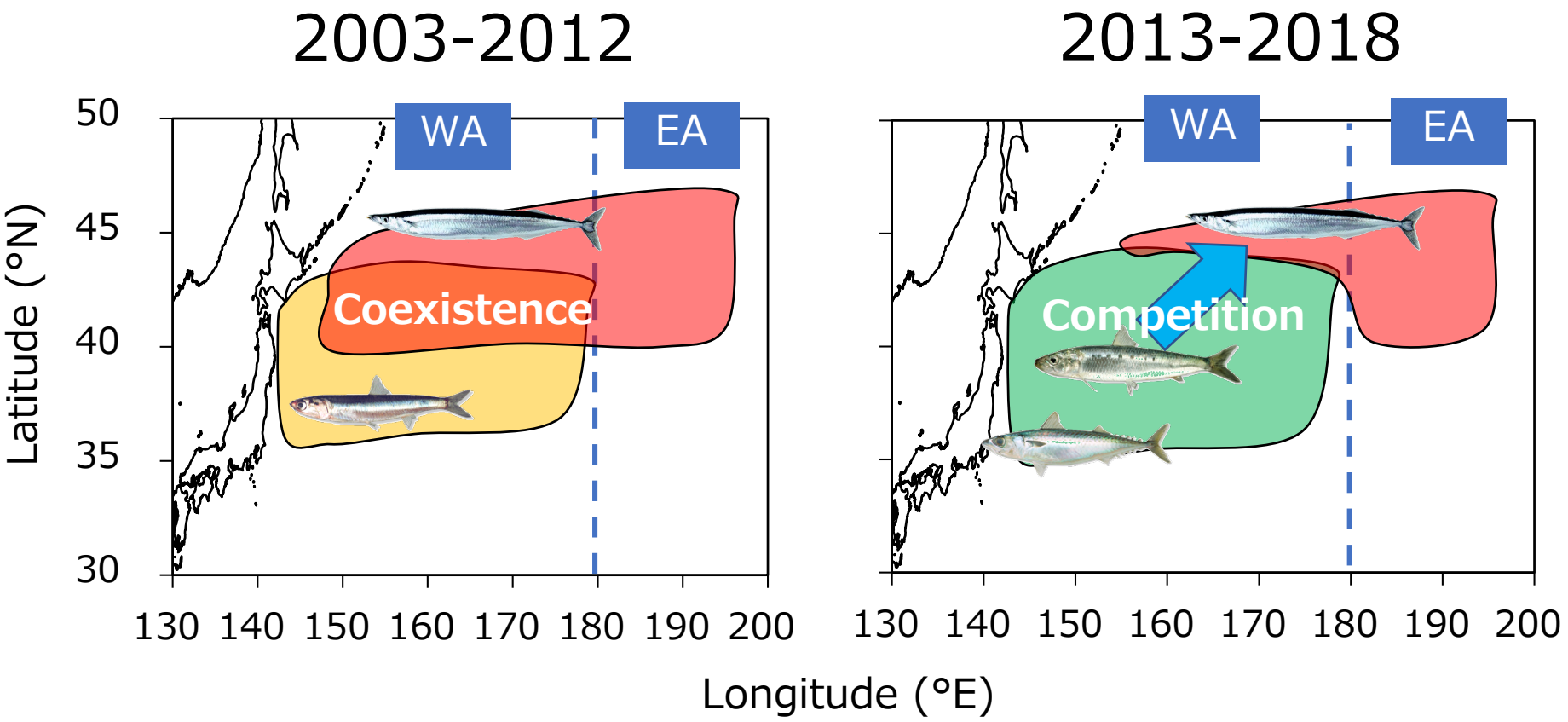


D_{SD}



- Encounter probability of PS decreased under higher SD density condition

Conclusion



Distribution of PS (age-1) was potentially skewed by the presence of SD which expanded to cooler water in WA recently.