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

**Taiki Fuji**, Yasuhiro Kamimura, Sho Furuichi, Hiroomi Miyamoto, Midori Hashimoto, Shin-ichiro Nakayama, Kazuhiro Oshima and Satoshi Suyama

1National Research Institute of Far Seas Fisheries, Japan
2National Research Institute of Fisheries Science, Japan
3Tohoku National Research Institute, Japan
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)
• They have similar feeding habits (zooplankton feeder)

Introduction

They are potential competitors!

Temperature

9.1~12.9 °C

10.3~16.9 °C

11.9~16.4 °C

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

**Introduction**

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/km²) 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
Geographical distribution of species

Results & Discussion
• 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
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

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

- “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

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

• Encounter probability of PS decreased under higher SD density condition
Distribution of PS (age-1) was potentially skewed by the presence of SD which expanded to cooler water in WA recently.