North Pacific Fisheries Commission

NPFC-2020-SSC PS06-WP15 (Rev. 1)

Description of longitudinal distribution of Pacific saury juvenile in response to NPFC CMM 2019-08

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Summary

We described geographical distribution of age-0 Pacific saury in the early fishing season in this paper. Cumulative percentages of age-0 abundance from west to east were calculated for all years from 2003 to 2019. Two major patterns in annual longitudinal distributions were observed. Age-0 fish showed the multi-peak longitudinal distribution pattern in some years. On the contrary, most of age-0 fish was found only in the waters east of 180° in rest of those years. The present western boundary at 170°E is highly likely to fail to protect large part of age-0 under the situations of some years. In light of the precautionary approach, we propose to expand the area by setting the western boundary at 160°E to prevent not only east part but also west part of distributions of age-0 from exposure to fishing pressure.

1. Introduction

Paragraph 14 of the existing CMM for Pacific saury (NPFC CMM 2019-08) says: "*In order to protect juvenile fish, Members of the Commission are encouraged to take measures for fishing vessels flying their flags to refrain from fishing for Pacific saury in the areas east of 170E from June to July. The SC and its subsidiary Small Scientific Committee on Pacific Saury will submit to the Commission relevant scientific information on geographical distribution of juvenile fish in the Convention Area, and its migration patterns*".

Commission required a submission of the relevant scientific information on migration and geographical distribution of juvenile Pacific saury (NPFC CMM 2019-08). To address this requirement, the SSC PS05 agreed a good proxy of juvenile fish was age-0 fish (Small Scientific Committee on Pacific Saury 2019). Therefore, we treat age-0 Pacific saury as a proxy of juvenile fish in this document.

In the case of highly migratory species such as Pacific saury, migration patterns

are important factors in considering effective management measures (Gell and Roberts, 2002). Basically, age-0 Pacific saury are considered not to migrate widely. The center of distribution for age-0 during June - July is always located in the east of that for age-1 (Fuji et al. 2018). This implies that age-0 fish migrate westward slightly by next early summer. However, it is worth mentioning that the migratory distance of age-0 is considerably smaller than that of age-1 (Yasuda and Watanabe 1994). Low swimming ability of age-0 attributed to its small body size could be one possible reason of their small migration extent. This migration pattern of age-0 would support the efficacy of the geographical approach to preserve age-0 fish as stipulated in paragraph 14 of the existing CMM.

However, we have obtained no information how many age-0 fish could be preserved under the setting of the existing measure yet. Therefore, we describe geographical distribution of age-0 Pacific saury in the early fishing season. Finally, based on our results, we propose a longitude of the western boundary of the temporal area to preserve the age-0 Pacific saury relevant to the existing CMM.

2. Materials and methods

Sea surface trawl net survey has been conducted in June and July since 2003 in the North Pacific Ocean (details were described in Ueno et al. 2004, Ueno et al. 2017 and Hashimoto et al. 2020). Numbers at age in each sampling station were estimated by the numbers in each size bin and the annual age-length keys. Then annual numbers at age were estimated through a swept area method with post stratification employed in Hashimoto et al. (2020). Subsequently, annual longitudinal distributions based on the estimated numbers of age-0 fish at each stratum along with survey line (longitude) were calculated. Finally, cumulative percentages of age-0 abundance from west to east were calculated for all years. A hierarchical cluster analysis based on Euclidean distance and Ward's minimum variance method was performed for the annual cumulative percentages at each longitude in order to identify differences in longitudinal distribution patterns between years.

3. Results

Longitudinal distribution pattern of age-0 Pacific saury showed annual variation (Fig. 1). A cluster analysis revealed two major patterns in annual longitudinal distributions (Fig. 1a). The longitudinal distributions classified into group A, which corresponded to those in 2003-2007, 2012, 2016 and 2017, had two peaks in the west and east of 180°, respectively (Fig. 1b). Cumulative percentage exceeded 35 % west of 170°E

in these years (Fig. 1c). On the contrary, most of age-0 fish was found only in the waters east of 180° in rest of those years (group B) (Fig. 1b). Therefore, cumulative relative abundance showed lower values (less than 25 %) at the longitudes west of 170°E in these years (Fig. 1c).

4. Discussion

We found two typical distributional patterns of age-0 Pacific saury. Two types can be distinguished by the occurrence of fish in the area west of 180°. Age-0 fish showed the multi-peak longitudinal distribution pattern in some years (Fig. 1b). Such variation in age-0 distribution pattern might be caused by variation in larval transportation by Kuroshio current (e.g., Oozeki et al. 2015) and spawning migration pattern in autumn-winter season (Yasuda and Watanabe 1994, Huang et al. 2007).

Expected proportions of age-0 fish which were not subject to fishing pressure were calculated when a western boundary of the area to preserve age-0 fish was set at 160°E, 165°E, 170°E, 175°E and 180° (Fig. 2, Table 1). The mean proportion of age-0 fish without exposure to fishing pressure decreased as the western boundary moved to east. The standard deviations showed large values especially in the east of 170°E because of annual variations in geographical distribution as indicated in Fig. 1. Under the setting of the western boundary at 170°E, which was stipulated in the existing CMM, 73.2 % of age-0 could be expected to be preserved, on average with 19.0% as a standard deviation.

The distributional variation of age-0 fish is likely to cause large uncertainty of the proportion of those fish to be preserved. It is important to pay attention to the large uncertainty of the preservation proportion in recent unfavorable trend of fishing pressure and biomass of Pacific saury (Small Scientific Committee on Pacific saury 2019). The present western boundary at 170°E is highly likely to fail to protect large part of age-0 under the situations of group A years. In light of the precautionary approach, we propose to expand the area by setting the western boundary at 160°E to prevent not only east part but also west part of distributions of age-0 from exposure to fishing pressure.

5. Reference

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Table 1. Expected averaged proportions and standard deviations of age-0 fish which were not subject to fishing pressure for each longitudinal boundary position.

Boundary position	160°E	165°E	170°E	175°E	180°
Averaged proportion (%)	94.1	81.8	73.2	65.7	58.6
Standard deviation	8.5	17.3	19.0	22.2	24.6

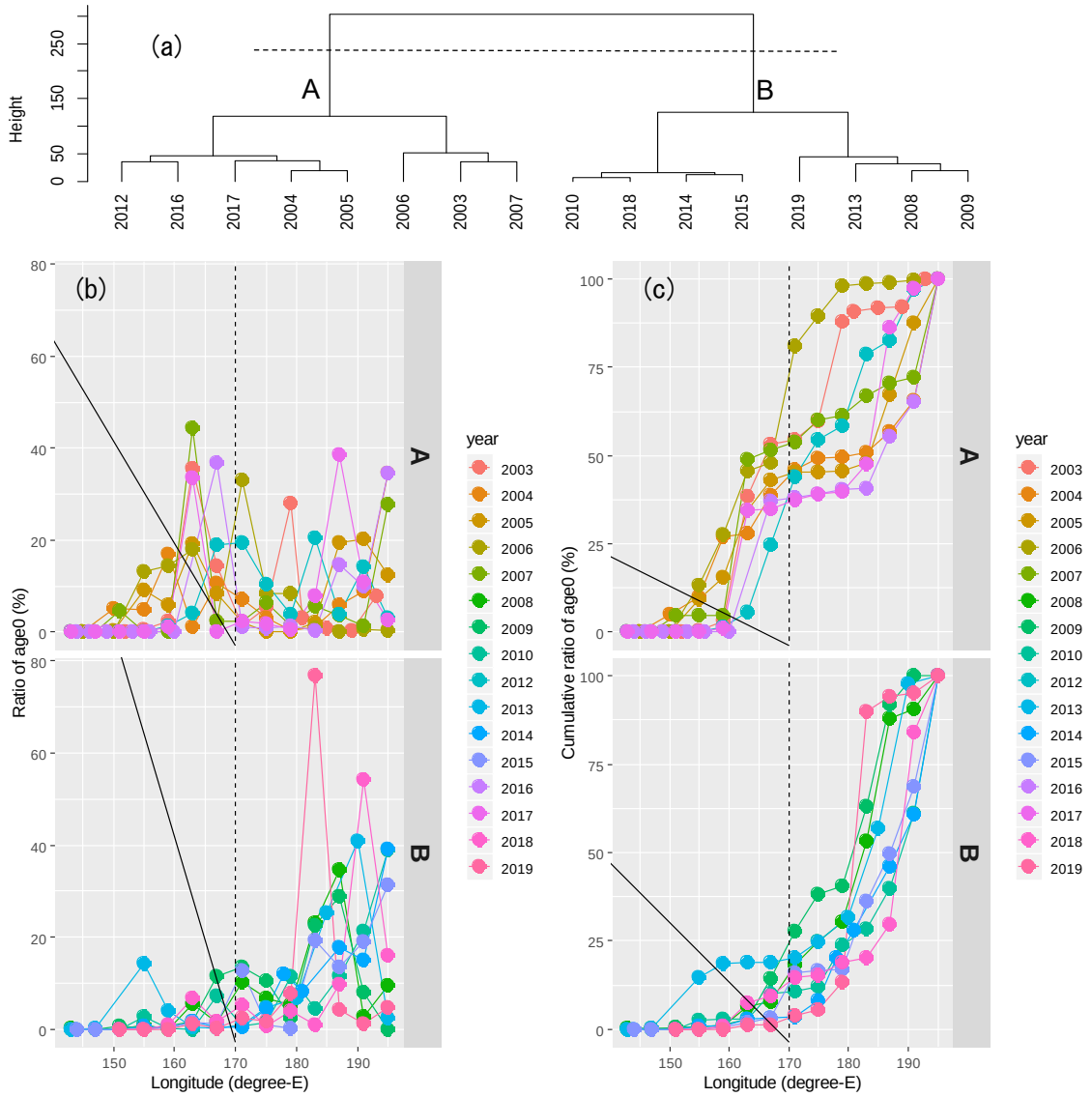

Figure 1. (a) Cluster dendrogram. Groups A and B were identified by the cutoff indicated by the horizontal dotted line. (b) Variation in ratio of age-0 abundance and (c) cumulative ratio of age-0 abundance with longitude for each group identified through the cluster analysis (A and B). Now fishing vessels are encouraged to refrain from fishing for Pacific saury in the areas east of 170°E (emphasized by vertical dotted lines in the figures (b) and (c)) from June to July for protecting age-0 fish (NPFC-2019-CM05-Final Report).

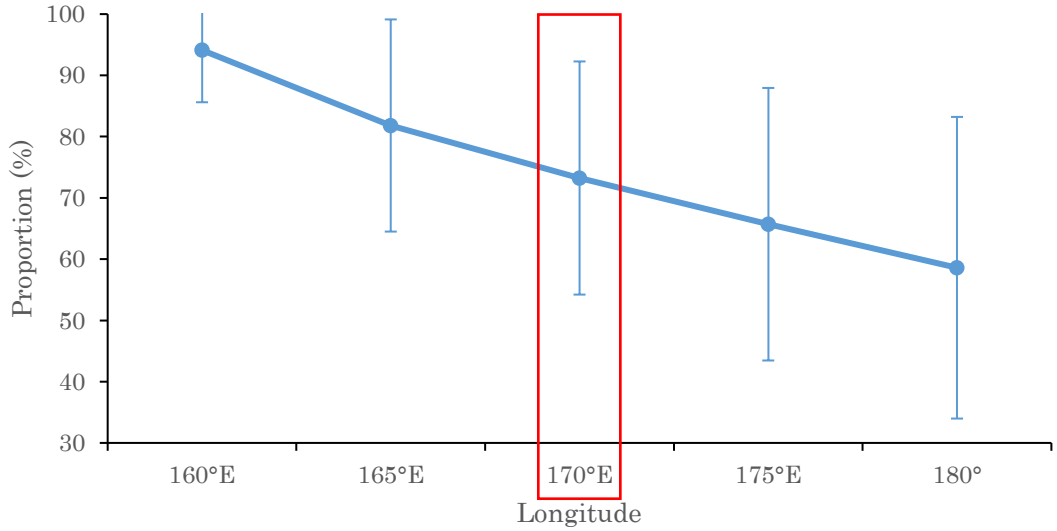

Figure 2. Expected averaged proportions of age-0 fish which were not subject to fishing pressure with various longitudinal boundaries. Error bars indicate the standard deviations. Now fishing vessels are encouraged to refrain from fishing for Pacific saury in the areas east of 170°E (emphasized by red rectangle in the figure) from June to July for protecting age-0 fish (NPFC-2019-CM05-Final Report).