New fisheries definition from Japanese longline North Pacific albacore size data[1]

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Abstract

In this study, fisheries definitions for the North Pacific albacore (*Thunnus alalunga*) caught by the Japanese longline (JPN LL) were reconsidered based on size data from JPN LL. Cluster analysis was applied to the size data to investigate spatial characteristics of fish size. As results of cluster analysis, three major groups were identified from different fish size caught by the JPN LL.

Introduction

In 2014 North Pacific albacore (NPALB) tuna stock assessment, ISC albacore working group (ALBWG) used integrated stock assessment model as Stock Synthesis 3 (SS3) (ISC 2014). SS3 is length-based stock assessment model that needs catch size data (Methot et al., 2013). These catch size data were summarized by fishery and put into the SS3. SS3 estimate the selectivity of each fishery using catch size data and catch at age by fishery is calculated by growth model, selectivity, and catch amount. Hence size information is important for the stock assessment. Especially, the hypothesis of selectivity has a large effect on the performance of model estimation (Maunder et al., 2014). Thus the configuration of the selectivity is one of the most issues to operate integrated stock assessment model.

Basically, SS3 assumed the same selectivity in the one fishery. However, catch size of Japanese longline fishery was changed by year, area, and season because NPALB shows seasonal migration and their vertical swimming behavior was changed by Oceanic condition (Kiyofuji et al., 2013). To reflect these phenomena to SS3, ALBWG divided longline fishery into 17 fisheries. The definition of the longline fishery was decided by the time-spatial plot of catch size data and ALBWG classified the area where large size fish was caught. In this area, SS3 assumed that maximum size albacore tuna was caught historically. In general, it is rare to catch maximum size fish. This result indicated that some fishery's selectivity might be overestimated. Thus, ALBWG needs a reconsideration to define the area 2 where large size albacore tuna was caught (Fig.1). Statistical analysis is also necessary because it was thought the possibility that an important factor was overlooked. Here we addressed cluster analysis using catch size data to redefine longline fishery definition.

Data and Methods

Following analysis is based on albacore size (folk length) data which was collected from Japanese pole-and-line and longline fisheries during 1993-2015 around the north Pacific Ocean. In order to illustrate characteristics of size composition, the size data was aggregated and averaged by year, quarter, area (5 x 5 degree) and gear type (pole and line + longline and only longline).

- Cluster analysis

Hierarchical cluster analysis had been carried out to divide the size data into specific size composition groups with using size data collected from longline fishery. For simplification, raw size data was categorized by five age groups (Age 1-2: 10-67cmFL ; Age 3-4: 68-84cmFL, Age 5-6: 85-94cmFL; Age 7-8: 94-99cmFL, 9+: over 100cmFL). Frequency of this five age class was aggregated

by quarter and area(10 x 10 degree) and composition of the age classes in each plot was used as minimum data case for cluster analysis. Distance of each data cases was calculated by furthest neighbor method with Euclidean distance. Groups for clustering was set as three.

Results

Quarterly geographical distribution of average size of albacore caught by longline plus pole-and-line and only longline was shown in Fig. 2. More than 100 cm FL albacores were caught around center of the north Pacific (0-30N, 165E-140W) on average. When data from pole-and-line was included into that from longline, albacore size was characterized by small fishes (50-70cm FL).

- Cluster analysis

Dendrogram produced from hierarchical clustering was shown in Fig 3a. Three groups were produced from the clustering but the size data was actually divided into two groups because group #3 had only one case. Clustered group #2 almost occupied by the largest fishes (>100cm FL) with high age while group #1 was composed of various age classes (Fig. 3b). Seasonal and geographical appearance of Group #2 was almost matched with those of appearance of larger fishes on average (Fig. 2)

Summary and recommendations

1) Around the center of north Pacific (0-30N, 165E-140W), large fishes over 100 cm FL were specifically caught.

2) Composition of albacore had weak seasonal trend, but cluster analysis showed geographical characteristics was not changed through all season. Therefore it seems not to consider seasonal effects on size of albacore.

3) From the result of the analyses, another area definition should be suggested as below;
   - Conventional area 2 and 4 was aggregated as new area 2.
   - Central north Pacific (165E-140W, 0-30N) where large fishes were specifically caught was defined as new area 4.

4) Eastern Pacific north of 30N could be summed up as the EPO area for JPN vessels but data reliability may be low because of small sample size.

References

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Maunder, M. N., et al. "Selectivity: theory, estimation, and application in fishery stock assessment models." Fisheries Research 158 (2014): 1-4.

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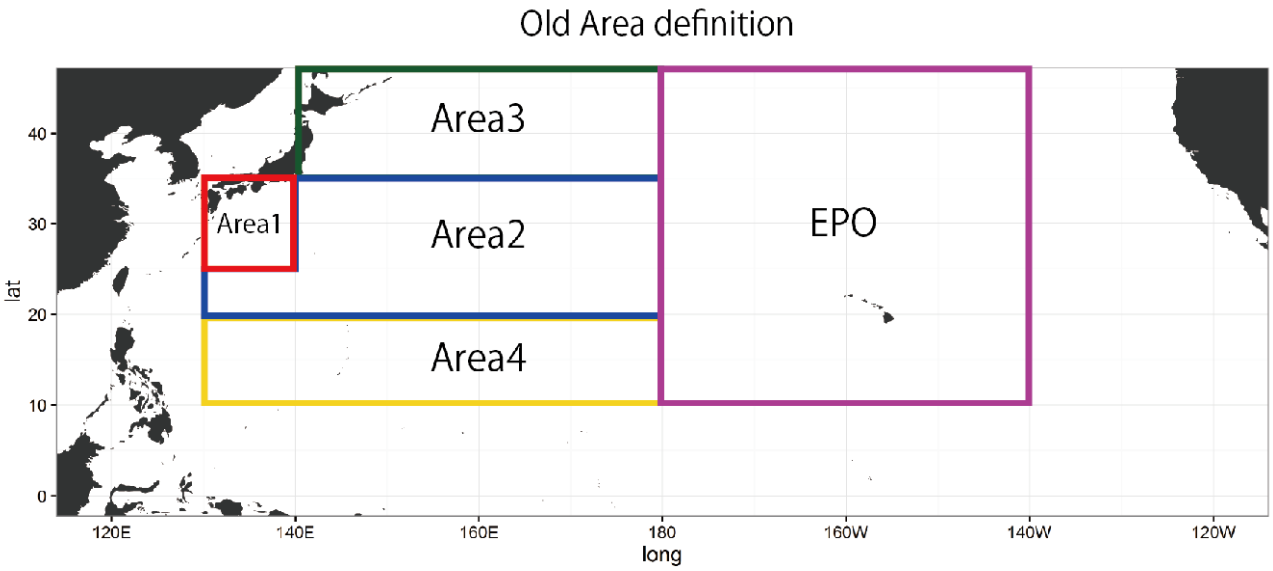


Figure 1. Conventional area definition of JPN longline fisheries which were used for the previous ALB stock assessment in 2014.

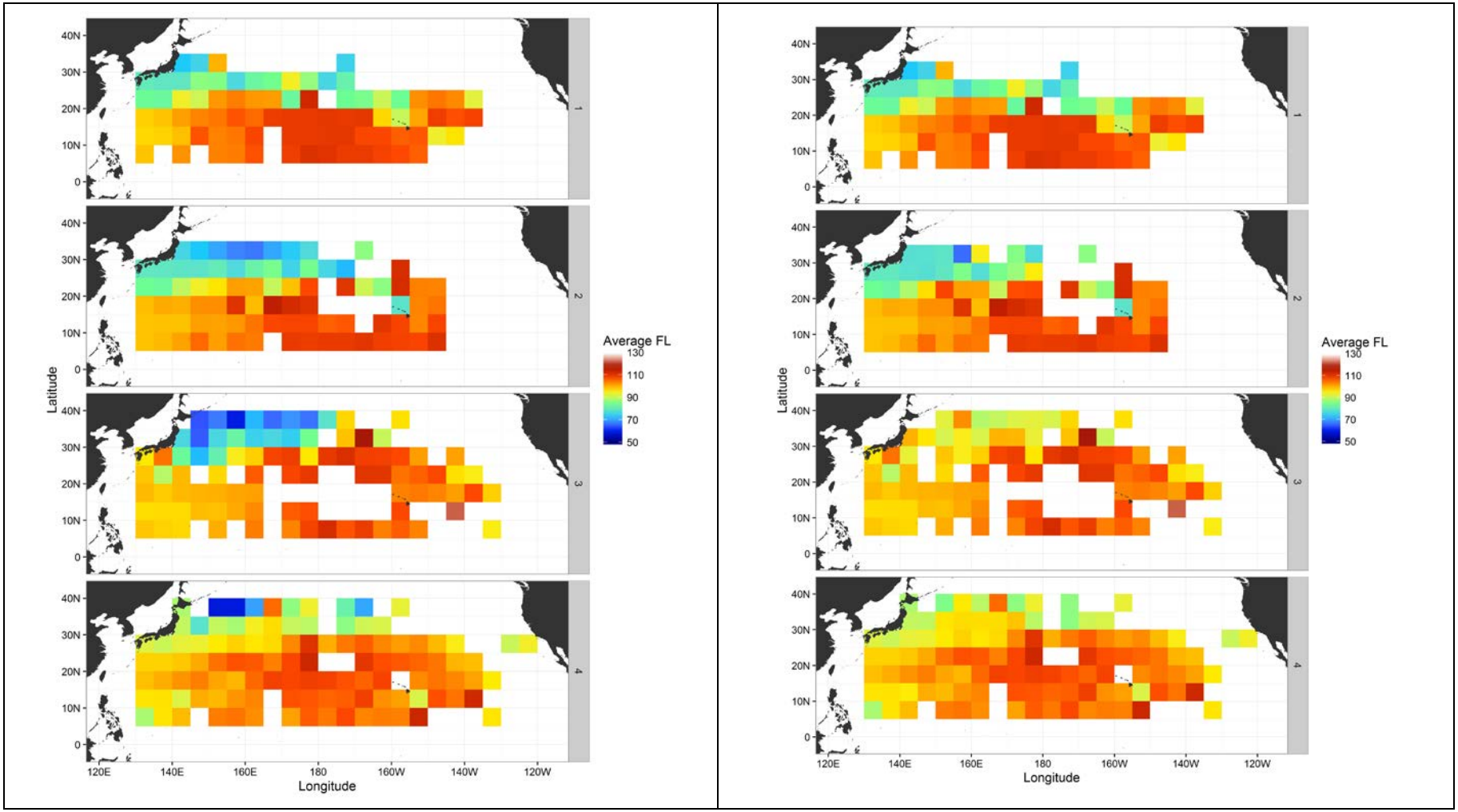
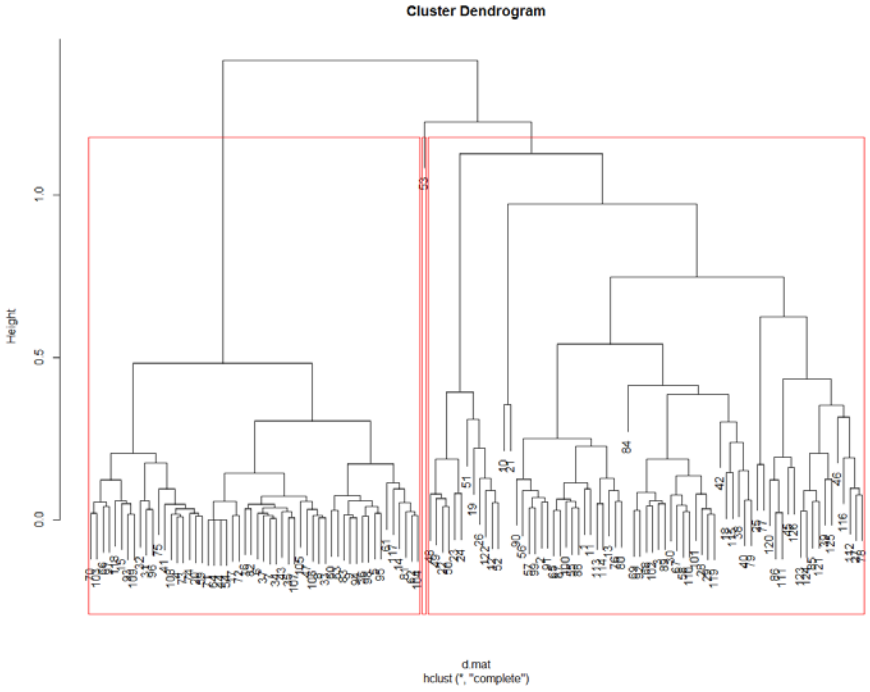


Figure 2. Geographical distributions of fork lengths of albacore caught by JPN PL and LL (Left) and LL (Right) fisheries between 1993-2015. FLs were aggregated by 5x5 degrees and averaged.

(a)



(b)

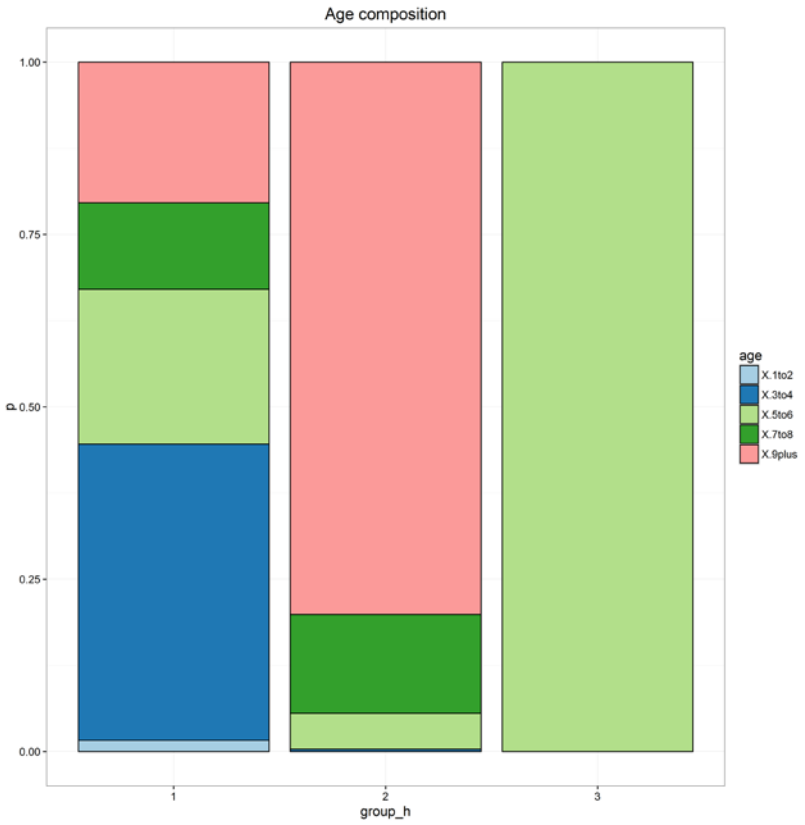


Figure 3. (a) Cluster dendrogram and (b) Age composition of each cluster.

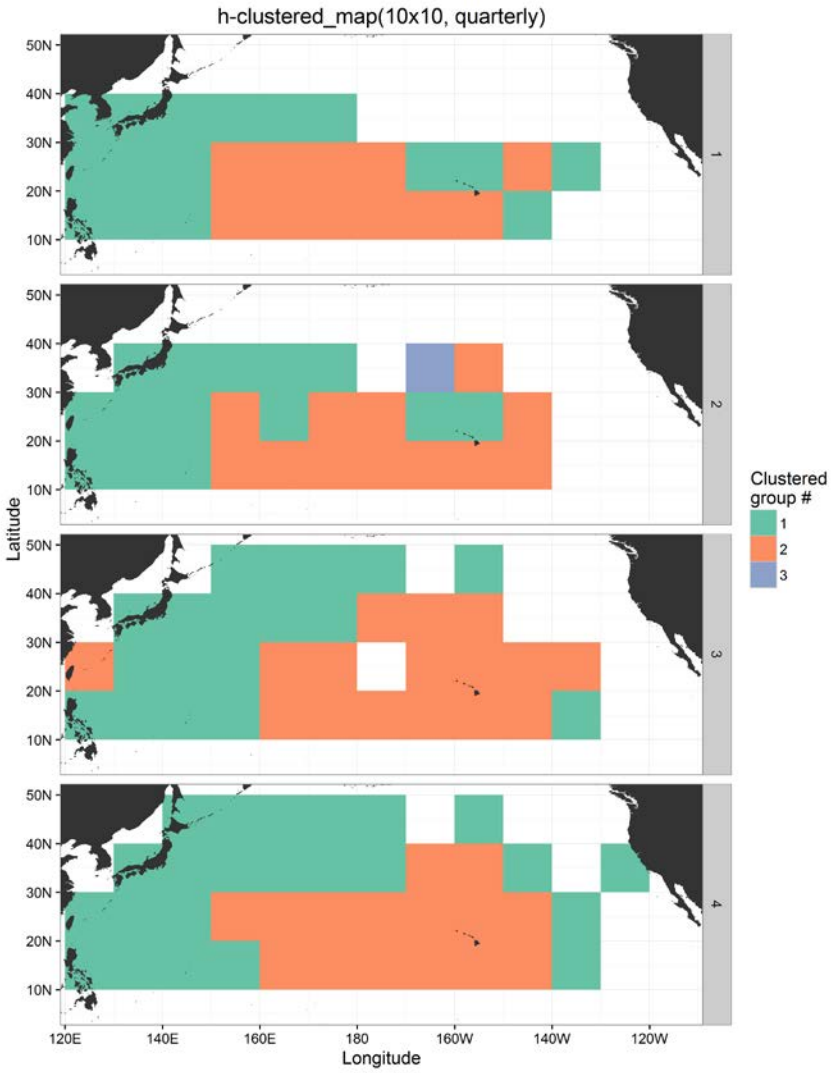


Figure 4. Spatial distributions (10x10 degrees) of each group classified by cluster analysis in each quarter.

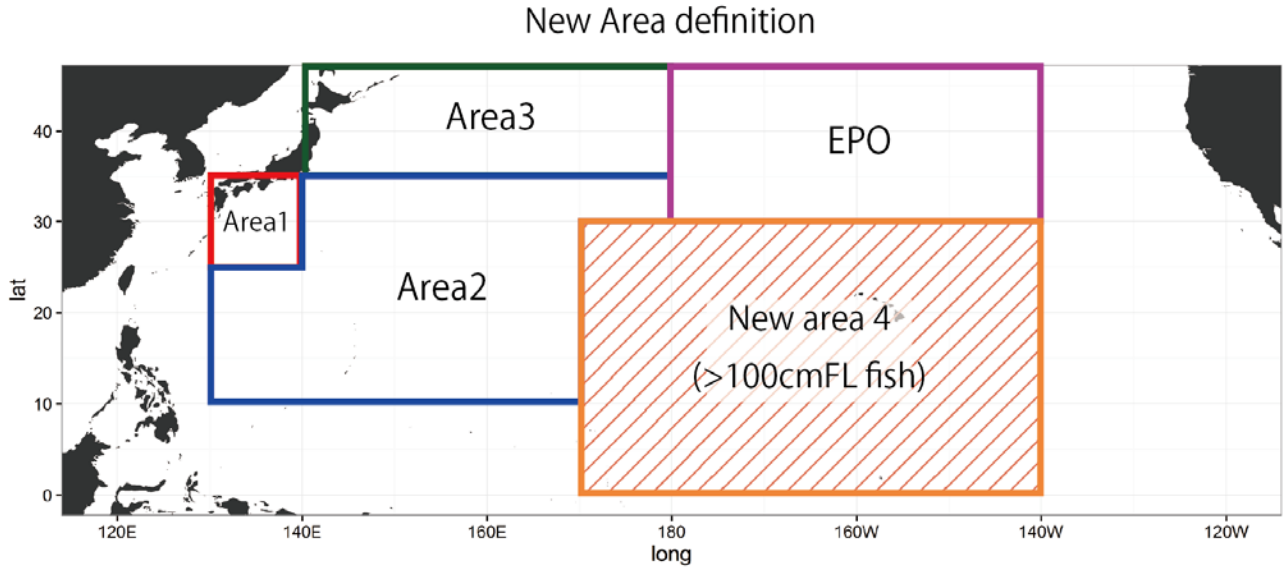
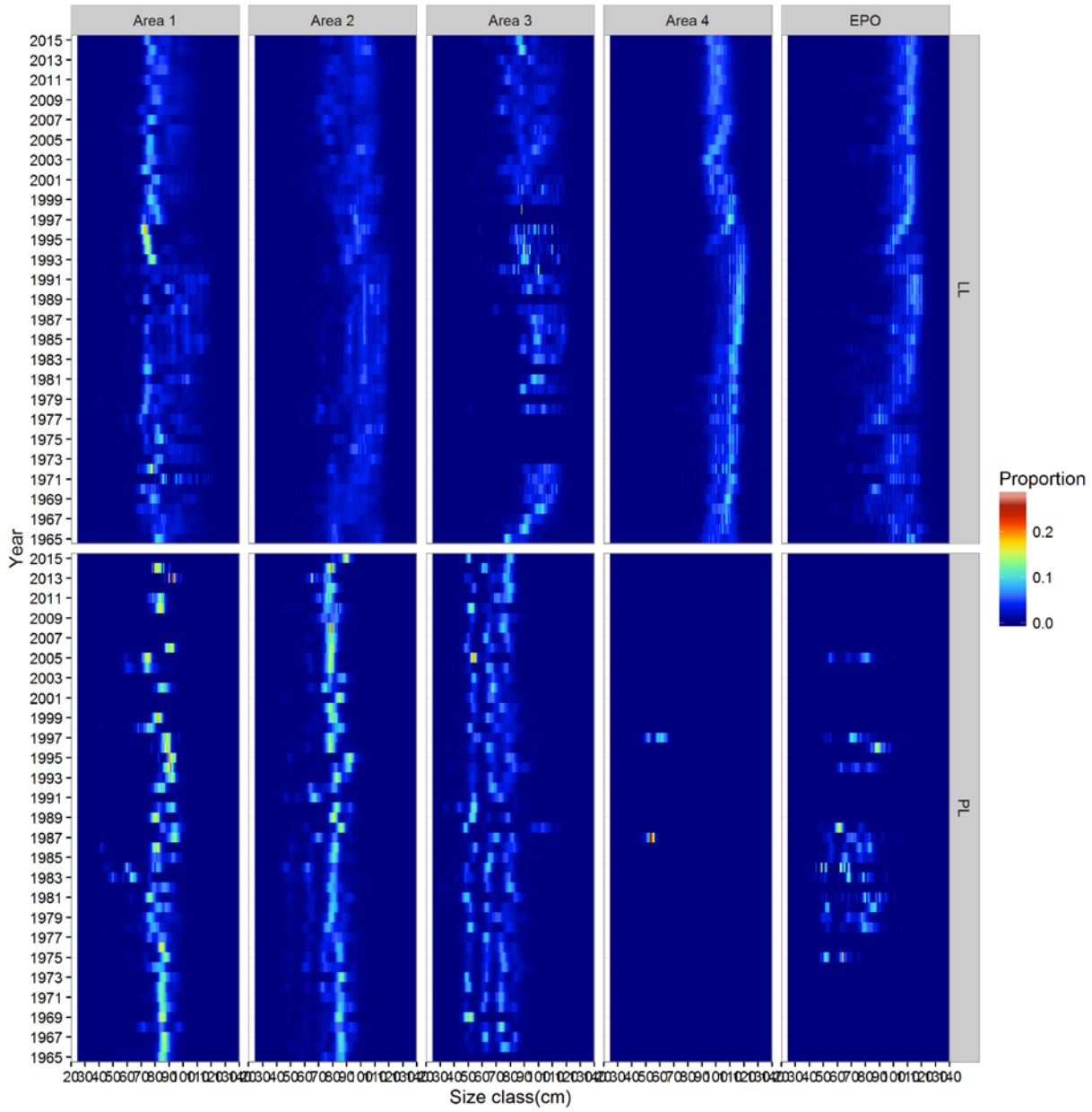


Figure 5. New area definition of JPN longline fisheries based on size data of caught albacore.

Appendix 1. Historical trends of ALB size caught by JPN Pole-and-Line and Longline fisheries in each area (Old area def.).



Appendix 2. Difference in trend of ALB size around southern area (< 20N) between west and east of 165E.