ISC/25/ALBWG-02/07

Standardized CPUE for North Pacific Albacore by Japanese Longline

Naoto Matsubara[1], Haikun Xu[2], Makoto Nishimoto[1], Yoshinori Aoki[1], Hirotaka Ijima[1], and Yuichi[1] Tsuda[1]

[1] Highly Migratory Resources Division, Fisheries Resources Institute,
Japan Fisheries Research and Education Agency (FRA)
[2] Inter-American Tropical Tuna
Commission (IATTC)

[1] 2-12-4, Fukuura, Kanazawa-ku, Yokohama,
Kanagawa 236-8648, JAPAN
[2] 8901 La Jolla Shores Drive
La Jolla CA 92037, USA

Email: matsubara_naoto84@fra.go.jp

1. This working paper was submitted to the ISC Albacore Working Group Intercessional Workshop, October 27 – November 2, 2025, held at the National Research Institute of Fisheries Science, Yokohama, Japan.

This document (rev1) is a revised version prepared in response to the request from the working group, with some additional results included.

The added content is as follows:

- CV variation for All ISC area and data-rich area (Appendix. Fig. A5)
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Summary

This document reports on the development of a new Japanese longline CPUE for the ISC North Pacific albacore stock assessment. Following the discussions at the March 2025 working group meeting, the following tasks were undertaken:

- Change the R package from VAST to sdmTMB package for CPUE standardization
- Estimation of standardized CPUE using sdmTMB across the entire ISC area
- Development of an adult index for albacore based on standardized size composition and standardized CPUE

All models successfully converged. Whether the new adult index will be applied in the stock assessment will be discussed within ALBWG during the dataprep meeting.

Introduction

In the North Pacific albacore fisheries, the Japanese longline fishery is one of the major fleets for albacore catch. In the previous 2023 stock assessment, Japanese longline CPUE was used as an abundance index (ALBWG, 2023), and it is also expected to be used in the next assessment in 2026. In the previous ALBWG, albacore CPUE standardized using the VAST package was reported (Matsubara et al., 2025a), and the working group proposed several issues to be addressed before its application as input to the stock assessment model.

The first issue concerned the package for CPUE standardization. The R package used for the previous standardization was VAST (Matsubara et al., 2025a), which depends on INLA and other packages. Concerns were raised that the results may not be reproducible due to INLA or other packages version inconsistencies among dependent packages for INLA. The working group therefore recommended shifting from VAST to the sdmTMB package for CPUE standardization (ALBWG, 2025).

The second issue was related to the spatial extent of the data. Historically, Area 2 had been used as a representative area for adults (Ijima et al., 2017). However, CPUE was found to decline when the distribution shifted outside this area in 2020 (Matsubara et al., 2025a). ALBWG suggested that CPUE should be developed across the entire ISC area (excluding regions with limited fishing data) to better capture trends in albacore distribution (ALBWG, 2025).

The third issue concerned the construction of an adult index. Survey length composition can be estimated by weighting standardized size composition with standardized CPUE (**Figure 1**). By reformulating this relationship, it is theoretically possible to derive an adult index for albacore by weighting standardized CPUE with standardized size composition in adult size classes. Based on this, ALBWG proposed the calculation of an adult index (ALBWG, 2025).

Accordingly, this document reports the results of addressing the above three issues in order to provide standardized longline CPUE for use as input data in the 2026 stock assessment.

Data and methods

Logbook data

Standardized CPUE was calculated using logbook data from 1994–2024. The Japanese longline dataset includes year, month, day, fishing position (latitude and longitude at 1-minute resolution), vessel information, and details on hooks and HPB (hooks per basket). Following the aggregation methods used in previous CPUE estimations (Matsubayashi et al., 2023; Nishimoto et al., 2024), the logbook data were aggregated by year, quarter (only when calculating quarterly CPUE), latitude and longitude (1-degree resolution), vessel name, and HBF.

Transition to the sdmTMB package

In line with the discussion at the previous working group (ALBWG, 2025), the source code previously used with VAST was rewritten entirely using sdmTMB. To evaluate the impact of changing packages, standardized CPUE was recalculated with the same filtering (Area 2 and Quarter 1) and methods as in the previous study (Matsubara et al., 2025a). The equations used for CPUE standardization under both VAST and sdmTMB are:

$$p \sim s(HBF) + (1|Vessel) + w(s) + \phi(s,t) \tag{1}$$
$$c \sim s(HBF) + (1|Vessel) + w(s) + \phi(s,t) \tag{2}$$

where a delta-lognormal distribution was applied. Here, $p$is the encounter probability and c is the positive CPUE. $s(HBF)$ is a spline smoother (k = 3), Vessel is a random effect, $w(s)$is the spatial random effect at location s, and $\phi(s,t)$is the spatiotemporal random effect (iid). The results were compared with those from the VAST-based standardized CPUE (Matsubara et al., 2025a).

CPUE standardization

Using sdmTMB, standardized CPUE was estimated across the entire ISC area. Since effort decreased west of 180°E after the 2010s, leading to a contraction of fishing grounds (**Figure A1**), two types of standardized CPUE were calculated: (1) ISC all area (west of 220°E excluded) in Quarter 1, and (2) ISC data-rich area (west of 180°E) in Quarter 1 (**Figure 2**). Models with both iid and AR1 spatiotemporal random effects were considered, resulting in four model combinations (**Table 1**).

Adult index

To calculate the adult albacore index, length frequency (LF) standardization was first conducted. Size data were used for LF standardization (**Figure 1**), consistent with previous documentation (Matsubara et al., 2024). Following the earlier approach, size data from albacore caught between 1994 and 2024 were aggregated by year and 5-degree latitude-longitude, categorized into 5-cm bins from 75–120 cm (Matsubara et al., 2025a). Since sdmTMB fails when encounter probabilities are 0% or 100%, standardized LF was estimated using VAST.

The adult index was then calculated as:

$$Adult\ index(S)_{t,l} = \sum_{s}(a_s \times d_{s,t} \times lf_{s,t,l}) \quad (3)$$

This corresponds to the calculation of the survey length composition equation proposed by IATTC (2023), where $a_s$is the area of grid s, $d_{s,t}$is fish density in grid s at time t, and $lf_{s,t,l}$ is standardized LF at grid s, time t, and length l. Standardized CPUE was weighted by two types of standardized LF: one extracted for the assumed female albacore size range (80–100 cm), and the other weighted by a logistic function (Figure A1). The adult albacore index was calculated based on these weighted values of standardized LF.

Results and Discussion

Standardized CPUE by VAST vs sdmTMB

The sdmTMB model converged successfully. A comparison of standardized CPUE between VAST and sdmTMB showed nearly identical short- and long-term trends (**Figure 3**). Therefore, the effect of shifting from VAST to sdmTMB on CPUE estimation was deemed minimal, and subsequent analyses were based on sdmTMB.

CPUE standardization

All models (iid vs AR1, ISC all area vs ISC data-rich area) converged successfully. Model selection using AIC and BIC indicated that AR1 models performed better, regardless of spatial extent (**Table 1**), suggesting temporal autocorrelation in the data. Annual CPUE trends compared to the previous estimates are shown in **Figure 4**. The drop observed in 2020 in the previous CPUE did not appear in the new models, indicating that the expanded spatial domain better captures the albacore trend.

Adult index

All LF standardization models using VAST converged. Using Eq 3, adult indices were calculated by weighting standardized CPUE (All area or Data-rich area AR1 models) with standardized LF from 80 – 100 cm range or weighted by logistic curve. The comparison (**Figure 5**) showed that there was little difference between the two types of standardized LF in both the all-area and data-rich area models. By weighting the original standardized CPUE with standardized LF, the both all-area and data-rich area CPUE showed similar trends to the backup CPUE which was calculated using the same method as the previous stock assessment but with updated data. (Matsubara et al., 2025b).

Conclusion

This document provided information on a new Japanese longline CPUE for the ISC North

Pacific albacore stock assessment. The main findings are:

- Change from VAST to sdmTMB had minimal impact on standardized CPUE.
- Standardized CPUE was successfully estimated for both the all-area and data-rich area models. Compared to using only Area 2, the 2020 CPUE drop was no longer observed.
- An adult albacore index was successfully calculated. Trends were similar across all models, and in the all-area and data-rich area model. The both all-area and data-rich area CPUE also showed similar trends to the backup CPUE.

References

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Table 1 The sdmTMB model settings and the results of AIC and BIC for standardizing CPUE. CPUE.

Area	Covariate	Random effect	Spatiotemporal	AIC	BIC
ISC All Area	Year, HBF	Vessel Spatial and Spatiotemporal	iid	1286585.2	1286734.2
			AR1	1286275.0	1286443.9
Data Rich Area			iid	1154781.6	1154926.8
			AR1	1154534.9	1154699.5

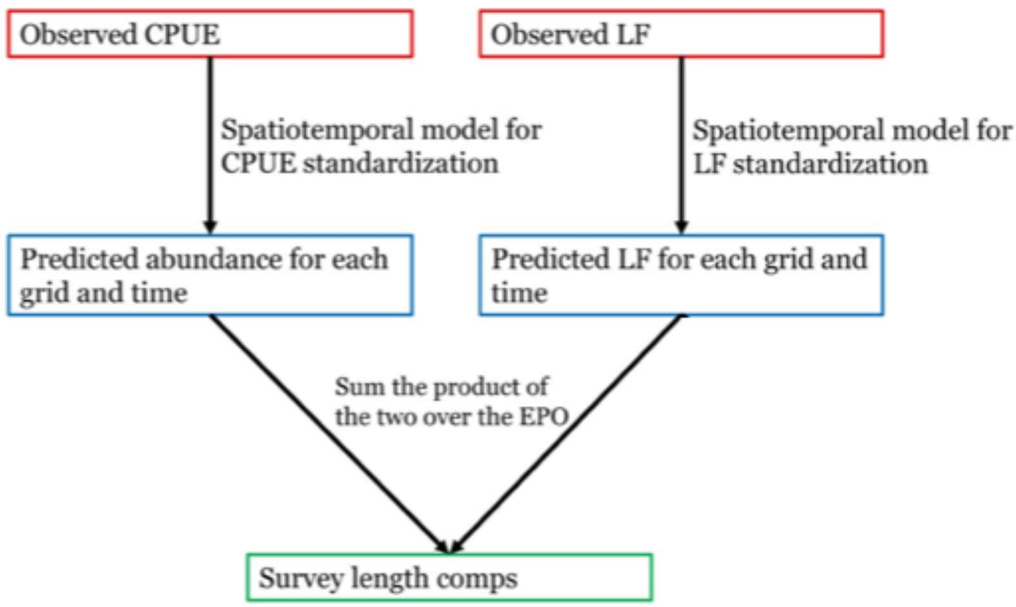


Figure 1 Summary of the IATTC's approaches to computing length compositions for longline fishery and survey fleets. Red, blue, and green boxes represent observed data, VAST predictions, and stock assessment inputs, respectively. (modified from IATTC, 2023)

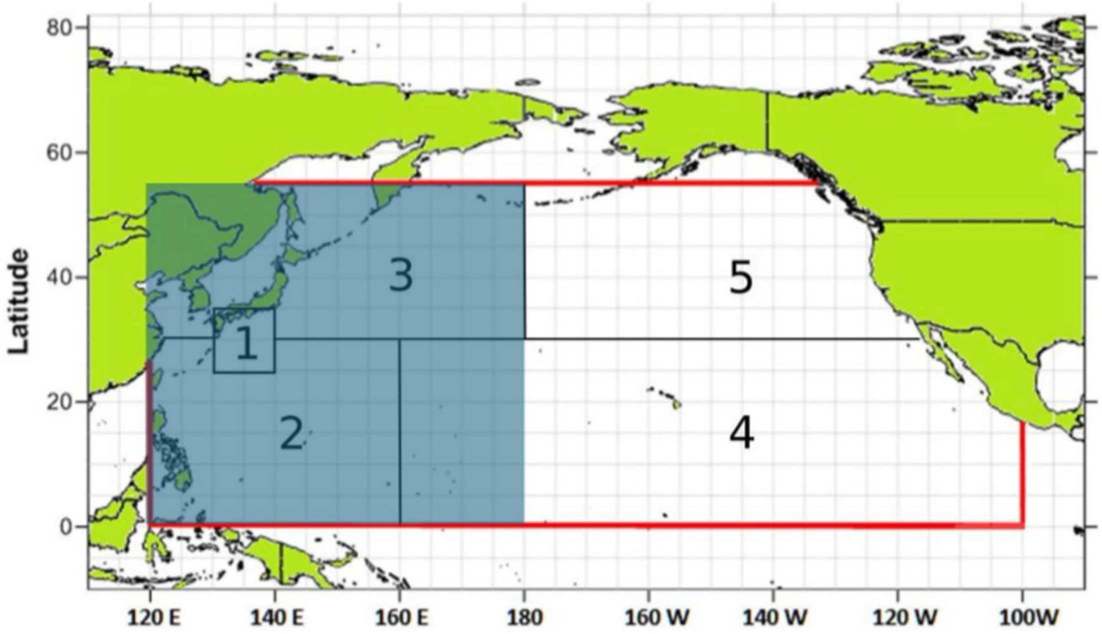


Figure 2 Area definition for new Japanese longline CPUE analysis (modified from ALBWG. 2023). The blue area represents the "Data-rich area," located east of 180°E, while " all area" refers to the entire ISC area (the sum of Areas 1 to 5).

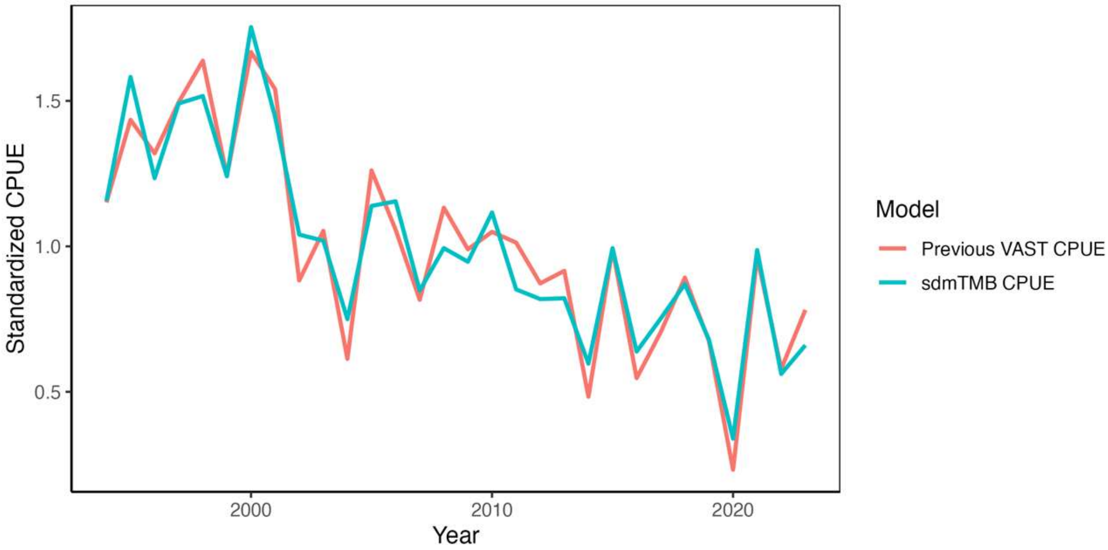


Figure 3 Standardized CPUE for Japanese longline in Area 2 at quarter 1 from 1994-2023 by VAST and sdmTMB model. The x-axis indicates year and y-axis mean the relative standardized CPUE.

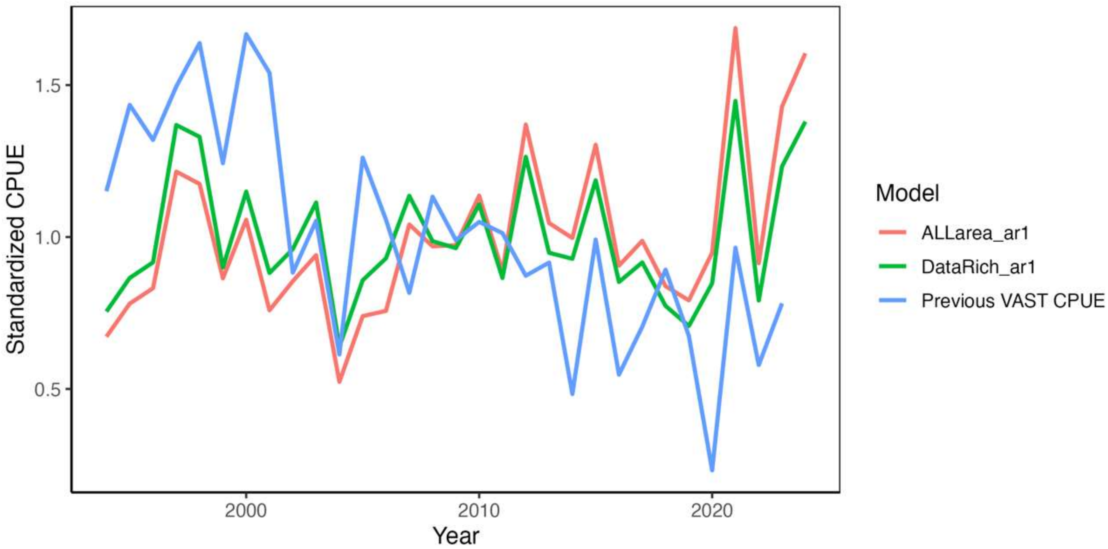


Figure 4 Standardized CPUE for Japanese longline in all area or data-rich area with AR1 for spatial temporal random effect from 1994-2024.

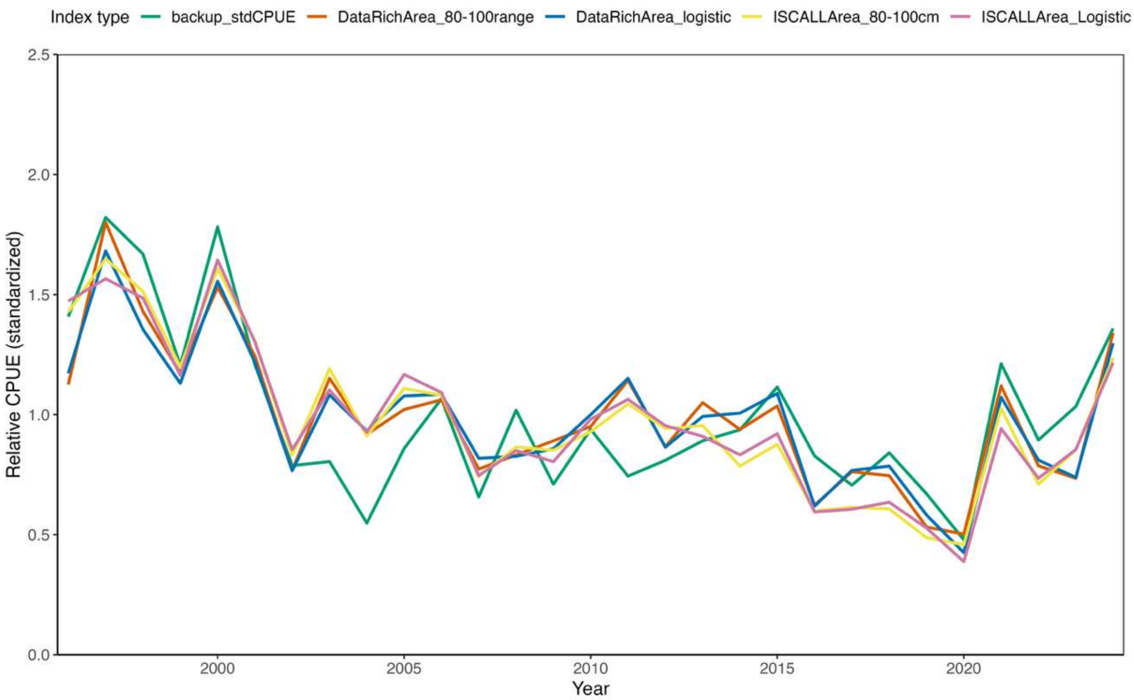


Figure 5 Comparison of Adult Indices between the all area and data-rich area, with two types of standardized LF (extract from 80 -100 cm and weighting with logistic curve).

Appendix

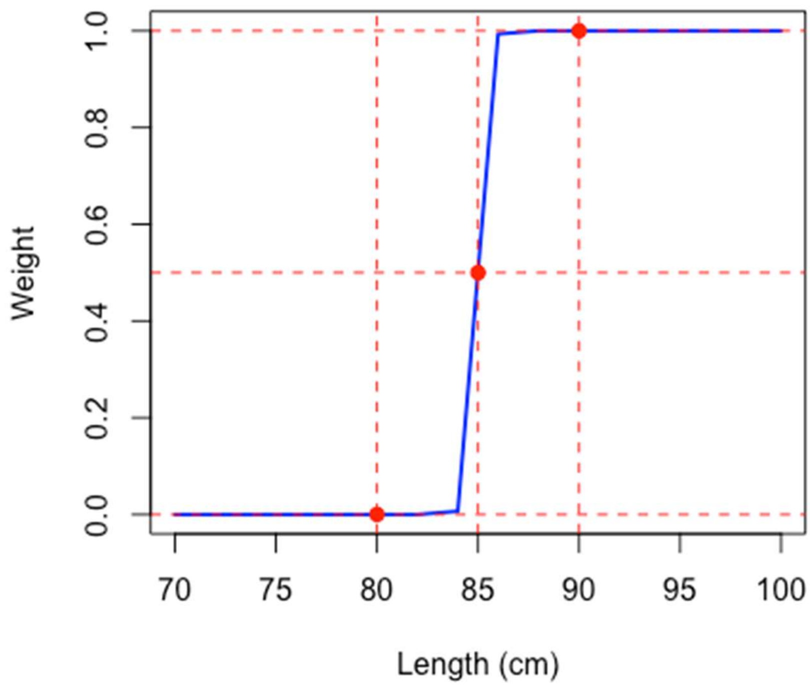


Figure A1 Logistic plot for calculating adult index. Based on the length-specific weights on the y-axis, we adjusted the standardized LF. Using the adjusted standardized LF, we weighted the standardized CPUE to calculate the Adult Index.

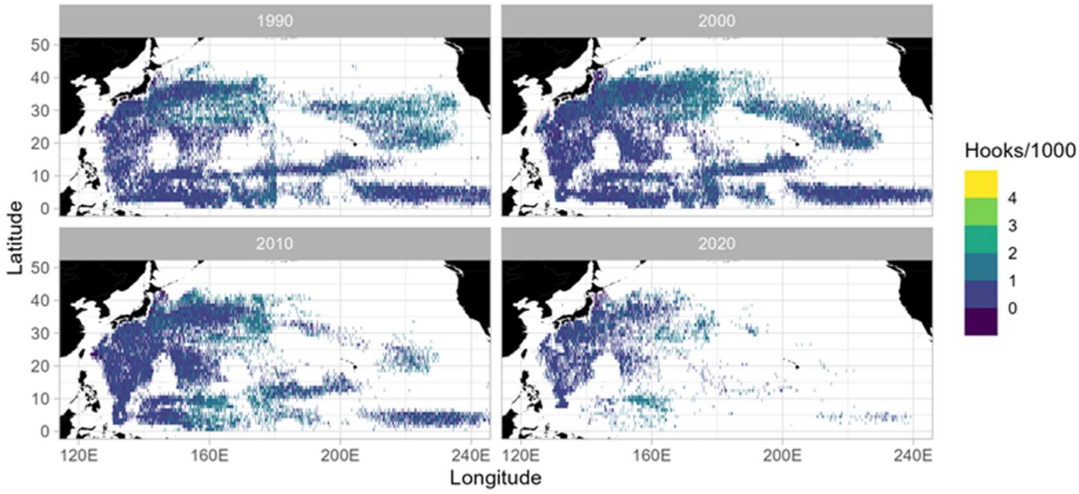


Figure A2 Decadal change of effort (Hooks/1000) distribution. Colors indicate the effort which is the mean for number of hooks/1000 by 1*1 grid.

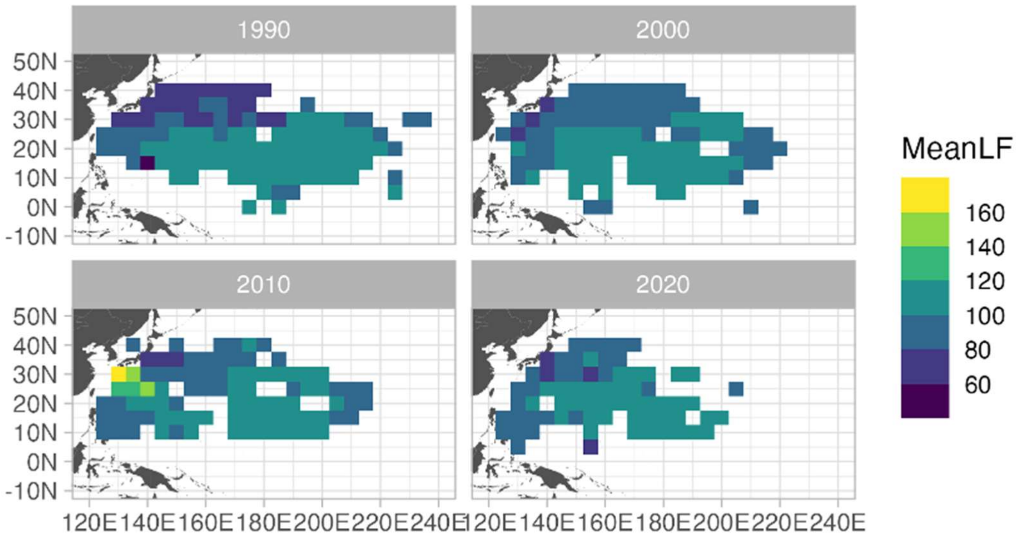
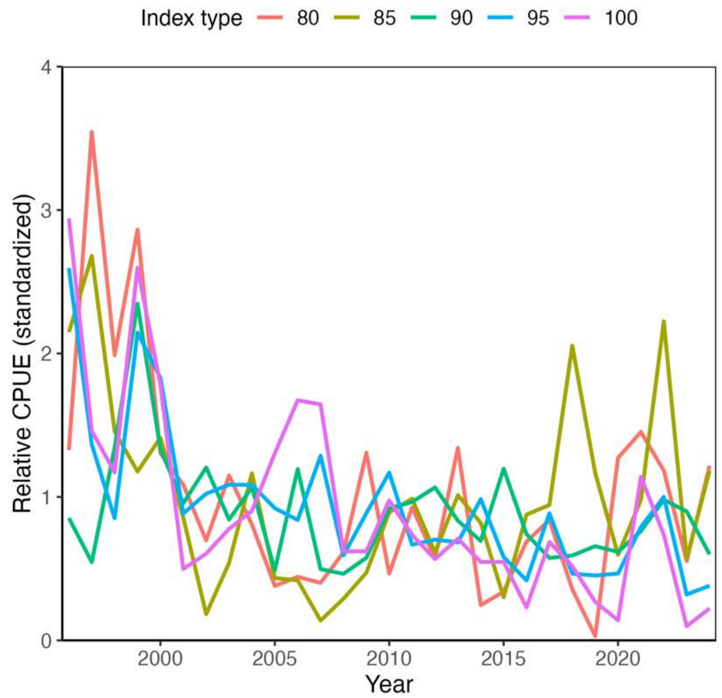


Figure A3 Decadal change of mean Fork length (cm). Colors indicate the mean fork length of ALB aggregated by 5*5 grid.



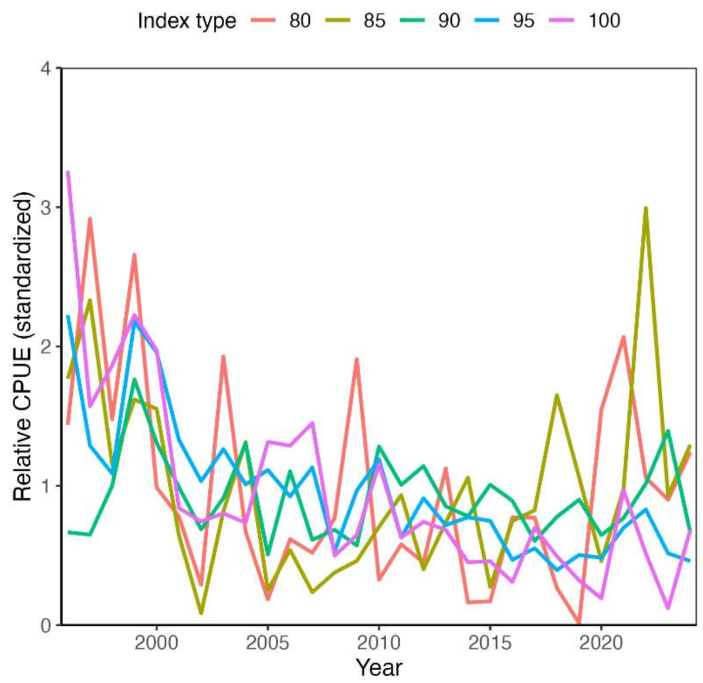


Figure A4 Adult index in each bin from 80-100 cm (upper) for ISC all area and data-rich area (lower).

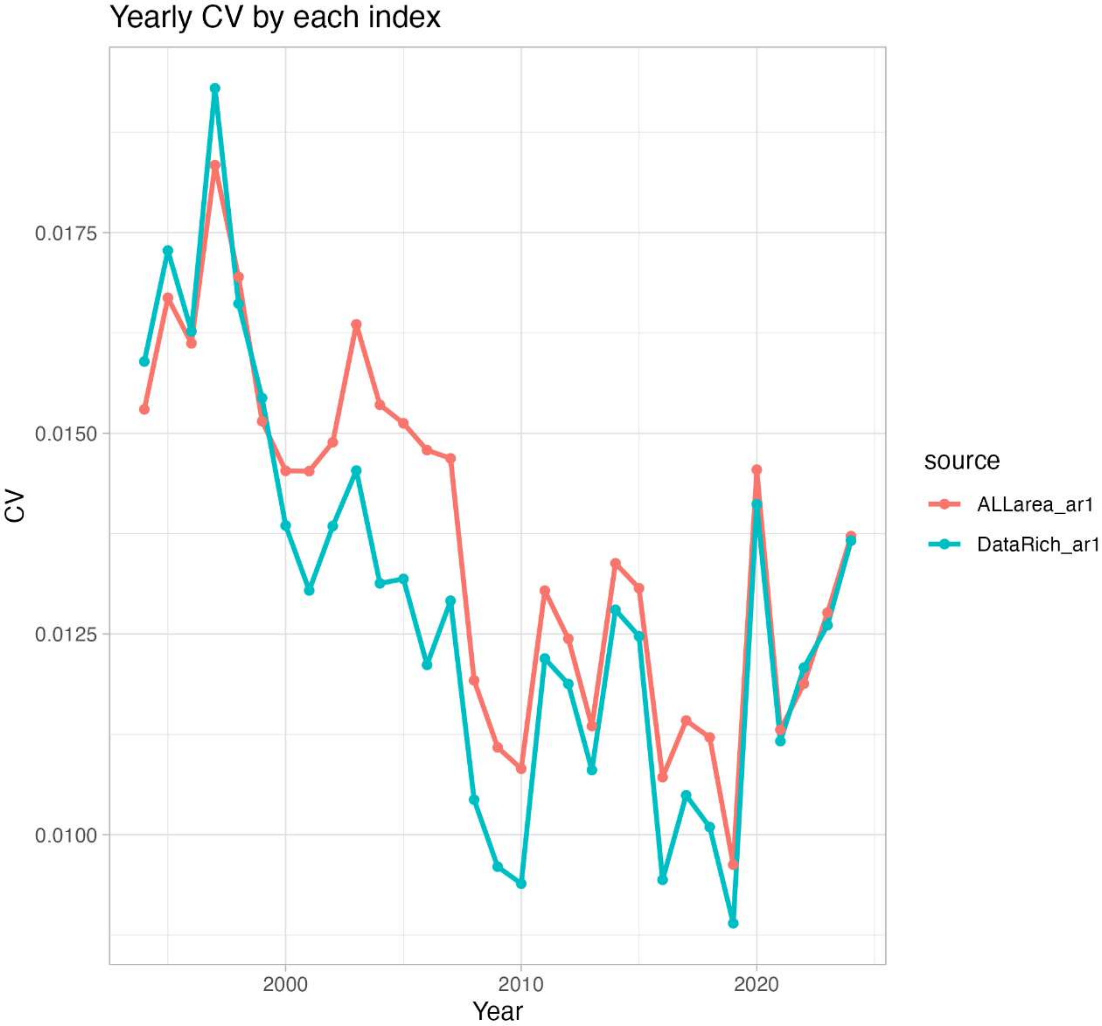


Figure A5 Comparison of CV for each index (All area and data-rich area).

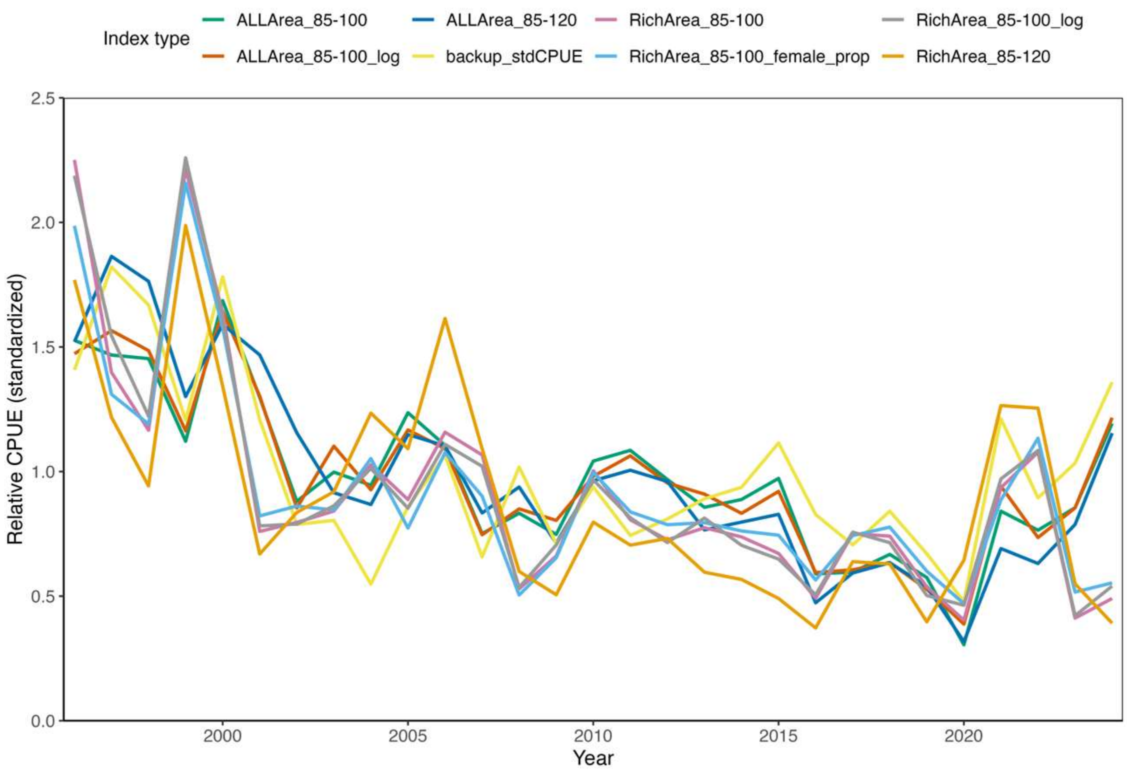


Figure A6 Comparison of Adult Indices between the all area and data-rich area with backup CPUE (Matsubara et al 2025b), with three types of standardized LF (extract from 85 -100 cm, 85-120 cm and weighting with logistic curve).