Exploratory analysis of Japanese longline CPUE and body size trends for bigeye and yellowfin tuna in the Eastern Pacific Ocean

Takaaki Hasegawa

Fisheries Research and Education Agency, Fisheries Resources Institute, Yokohama, Japan

Summary

Recent years (2024–2025) have seen a marked increase in the CPUE of bigeye tuna (BET) and yellowfin tuna (YFT) in the Japanese longline fishery operating in the Eastern Pacific Ocean (EPO). This document presents an exploratory analysis to examine the potential drivers of this increase in CPUE, focusing on whether the trend reflects changes in stock abundance or operational changes by the fleet. Our vessel-level analysis showed that 94% of vessels recorded higher CPUE for both species in the recent period (2024–2025) compared to the baseline (2013–2023), suggesting that changes in operational strategy by some specific vessels are unlikely to explain the observed increase. Average body weight of fish declined by approximately 8–9 kg for both species, indicating an increase in the proportion of smaller fish in the catch. These results could suggest that the recent CPUE increase reflects an increase in abundance, particularly of relatively small fish. Potential factors to explain this pattern could involve in reduction of fishing mortality on juvenile BET resulting from the Individual Vessel Threshold (IVT) program, and enhanced recruitment associated with recent strong El Niño event. Because these factors cannot yet be disentangled, continued monitoring is required to understand this patterns.

1. Introduction

Nominal CPUE of BET and YFT in the Japanese longline fishery in the EPO has increased markedly since 2024. Standardized CPUE series for these species are reported in the indicator paper (SAC-17-02) and show trends consistent with the nominal CPUE. Understanding whether this increase reflects genuine changes in stock abundance or changes in fleet behavior is important for stock assessment and fisheries management. This document presents an exploratory analysis using Japanese longline logbook data to examine recent changes in fishing effort and spatial coverage, to assess whether the CPUE increase is consistent across individual vessels or attributable to a subset of vessels that may have altered their fishing strategy, and to evaluate whether changes in the size composition of the catch are consistent with an increase in the abundance of smaller fish.

2. Materials and Methods

2.1 Logbook data

Japanese longline logbook data covering the period 1979–2025 were used. The dataset includes information on fishing location (1° × 1° grid), hooks per set, number of fish caught by species, and weight in catch per set. This time series corresponds to the period used in the benchmark stock assessments for BET (SAC-15-02) and YFT (SAC-16-03).

Size composition data collected by at-sea observers were available through 2019 and for 2023–2024. Due to limited observer coverage during 2020–2022 as a result of COVID-19-related restrictions, observer-based length frequency data for those years were not available. For the analysis of catch size trends, we therefore used the average body weight per individual, calculated as the ratio of total weight in catch per set to number of fish in catch per set from the logbook records.

2.2 Data analysis

Analyses were conducted for two periods: a baseline period (2013–2023) and a recent period (2024–2025). Annual number of vessels and total hooks deployed were tabulated, and the spatial distribution of fishing effort was compared between the two periods using 1° × 1° cell-level hook counts. Annual nominal CPUE (number of fish per 1,000 hooks) was calculated quarterly for BET and YFT, and spatial patterns of CPUE were mapped for each period.

To assess whether changes in CPUE were consistent across the fleet or driven by specific vessels, annual CPUE was computed for each vessel with a minimum of 30 sets per year. Vessels were classified into three groups based on their mean CPUE during the recent period: the top 3, bottom 3, and remaining vessels, and the proportion of vessels showing higher CPUE in the recent period relative to the baseline was calculated.

Mean body weight per individual was computed quarterly for BET and YFT from logbook records. Spatial anomalies in body weight, defined as the deviation from the 2013–2025 cell-level mean, were mapped by year to identify whether size changes were spatially localized or broadly distributed across the fishing grounds.

3. Results

Annual fishing effort has declined substantially since 2013, with total hooks deployed reaching historically low levels in recent years (Figure 1). The number of active vessels has similarly declined, though a slight increase was observed in 2024–2025 relative to the lowest years. Spatial analysis shows that fishing grounds have contracted toward the equatorial zone (approximately 5°S–15°S), with a marked reduction in spatial coverage compared to the baseline period (Figure 2). Mean CPUE in the baseline period was 4.39 fish/1,000 hooks for BET and 1.29 fish/1,000 hooks for YFT, based on a total of approximately 281 million hooks set by up to 130 vessels.

Nominal CPUE for both BET and YFT increased sharply in 2024–2025 (Figure 3). Mean CPUE in the recent period was 7.57 fish/1,000 hooks for BET (+72% relative to baseline) and 4.49 fish/1,000 hooks for YFT (+248% relative to baseline). Standardized CPUE indices by the spatio-temporal models show a similar increasing trend (SAC-17-03). Based on the spatial analysis, the CPUE increase for BET was broadly distributed across the fishing grounds, while the YFT increase was concentrated near 5°S (Figure 4).

Vessel-level analysis showed that the CPUE increase in 2024–2025 was consistent across the fleet. Of 16 vessels for which both baseline and recent data were available, 15 (93.8%) showed higher mean CPUE for BET and all 16 (100%) showed higher mean CPUE for YFT in the recent period compared to the baseline (Figure 5). This pattern was evident across all vessel groups (top 3, bottom 3, and others in terms of recent-period CPUE), indicating that changes in the fishing strategy of specific vessels are unlikely to account for the observed increase.

Average body weight per fish declined in recent years for both species (Figure 6). For BET, mean body weight decreased from approximately 54 kg during the baseline period to approximately 45 kg in 2024–2025, a decline of approximately 9 kg. A similar decline of approximately 9 kg was observed for YFT (from approximately 39 kg to 30 kg). Using the weight–length relationships (SAC-15-02, SAC-16-03), these changes correspond to decreases in mean fork length of approximately 7 cm for BET (from 133 cm to 126 cm) and 10 cm for YFT (from 119 cm to 109 cm). This corresponds to a difference of approximately 1–2 quarters in mean age from 13–14 quarters to 12–13 quarters for BET, and from 9–10 quarters to 7–8 quarters for YFT. Spatial analysis of body weight anomalies shows that these declines are distributed broadly across the fishing grounds rather than being confined to specific areas (Figure 7), suggesting a fleet-wide shift toward smaller individuals rather than a spatially localized phenomenon.

4. Discussion

Our vessel-level analysis can provide possible explanation against the hypothesis that the recent CPUE increase could be driven by changes in the operational strategy of some specific vessels. The broad consistency of the increase across all vessel groups suggests a fleet-wide abundance signal rather than a behavioral artifact. Although the weight decline was substantial (9 kg for both species), the corresponding shift in mean age of approximately 1–2 quarters indicates that the catch composition has not shifted dramatically toward juvenile fish. Rather, the results suggest that fish from specific recent cohorts, those born approximately in 2022 for BET and 2023 for YFT, was dominant in the longline catch in 2024–2025.

Potential factors to explain this pattern could involve in reduction of fishing mortality on juvenile BET resulting from the Individual Vessel Threshold (IVT) program, and enhanced recruitment associated with recent El Niño events in 2023. Resolution C-21-04 (IATTC, 2021) introduced the IVT program for purse-seine BET catches in 2022. Under this program, vessels exceeding annual BET catch thresholds are subject to additional fishing closure days. Analyses by IATTC staff estimated that the IVT reduced BET catches by purse-seine highliner vessels by approximately 8,000–8,500 metric tons per year in 2022–2024, equivalent to a 22–23% reduction relative to expected catches in the absence of the IVT (Ovando et al., 2024, 2025).

A reduction in fishing mortality on juvenile BET by the purse-seine fishery could increase the number of fish surviving to recruit into the longline fishery. Consistent with this pattern, the assessment results for BET showed that fishing mortality on fish aged less than 9 quarters declined significantly after 2020 (SAC-15-02). The 2022 cohort now dominating the BET catch in longline fishery (12–13 quarters in 2024–2025) is the first cohort to have experienced reduced purse-seine fishing mortality throughout its juvenile period under the IVT effect. However, the IVT specifically targets BET and would not directly explain the concurrent increase in YFT CPUE (Ovando et al., 2024).

It is well known that ENSO events influence the recruitment for tropical tunas in the EPO (Domokos, 2023; Lin et al., 2023). For YFT, ENSO events have been associated with fluctuations in abundance in the purse-seine fishery (Crear et al., 2024; Crear, 2025), and the high YFT CPUE observed in the longline fishery in 2024–2025 may reflect recruitment enhancement associated with the strong 2023 El Niño event. For BET, the assessment model suggested elevated recruitment in 2023 (SAC-15-02), coinciding with the onset of a strong El Niño event. Studies using longline CPUE data from the equatorial Pacific have demonstrated lagged positive relationships between ENSO indices and BET and YFT CPUE, interpreted as recruitment signals (Domokos, 2023; Lin et al., 2023). The fact that both BET and YFT show simultaneous CPUE increases and body weight declines suggests that ENSO-driven recruitment enhancement may be a common driver contributing to the observed trends for both species. However, the assessment model for YFT does not show a strong recruitment signal in 2023, instead, it estimates higher recruitment in 2021 (SAC-16-03). Fish from the 2021 cohort would be approximately 13–16 quarters old in 2024–2025, older than the 7–8 quarter fish dominating the recent longline catch. This discrepancy remains unresolved and warrants further investigation.

At present, it is challenging to quantitatively separate the contributions of the IVT effect and ENSO-driven recruitment to the observed CPUE increase. The two mechanisms are not mutually exclusive and may have acted synergistically. Continued monitoring of CPUE trends, size composition, and recruitment indices in the coming years will be essential to distinguish between these hypotheses as ENSO conditions evolve and additional cohort information accumulates.

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Figures

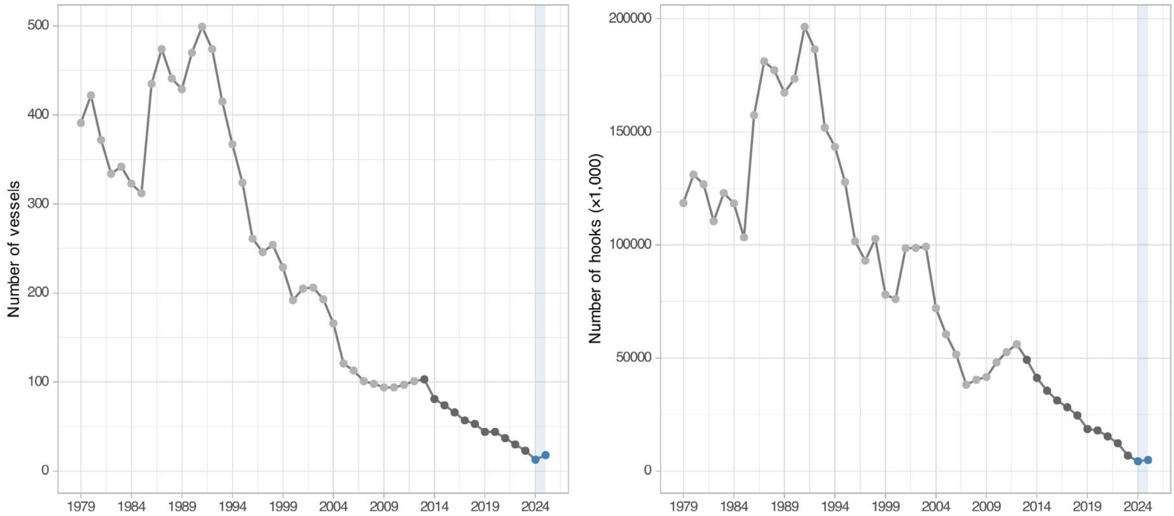

Figure 1. Annual trends in fishing effort by Japanese longline vessels in the EPO. Left: number of active vessels. Right: total number of hooks deployed (×1,000). Shaded area indicates the recent period (2024–2025). Gray points: baseline period (2013–2023); colored points: recent period.

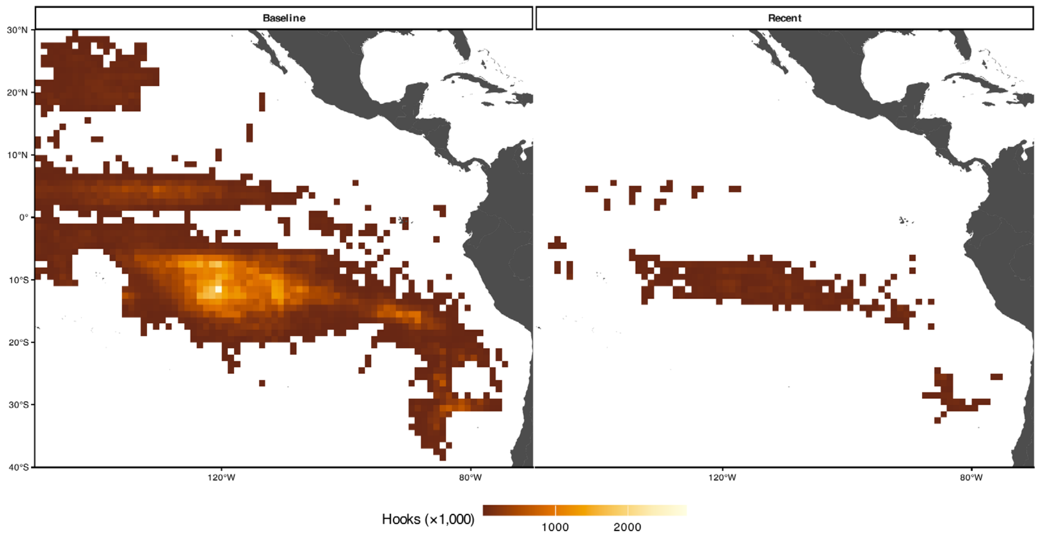

Figure 2. Spatial distribution of fishing effort (hooks × 1,000 per 1° × 1° cell) by Japanese longline vessels during the baseline period (2013–2023; left) and recent period (2024–2025; right).

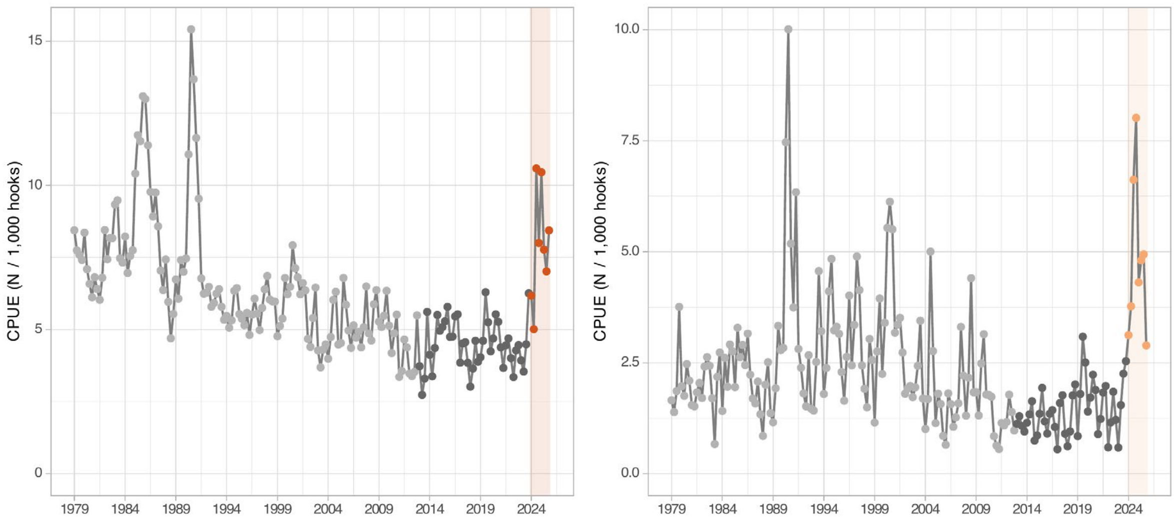

Figure 3. Quarterly nominal CPUE (fish per 1,000 hooks) for BET (left) and YFT (right) by Japanese longline vessels in the EPO, 1979–2025. Shaded area indicates the recent period (2024–2025).

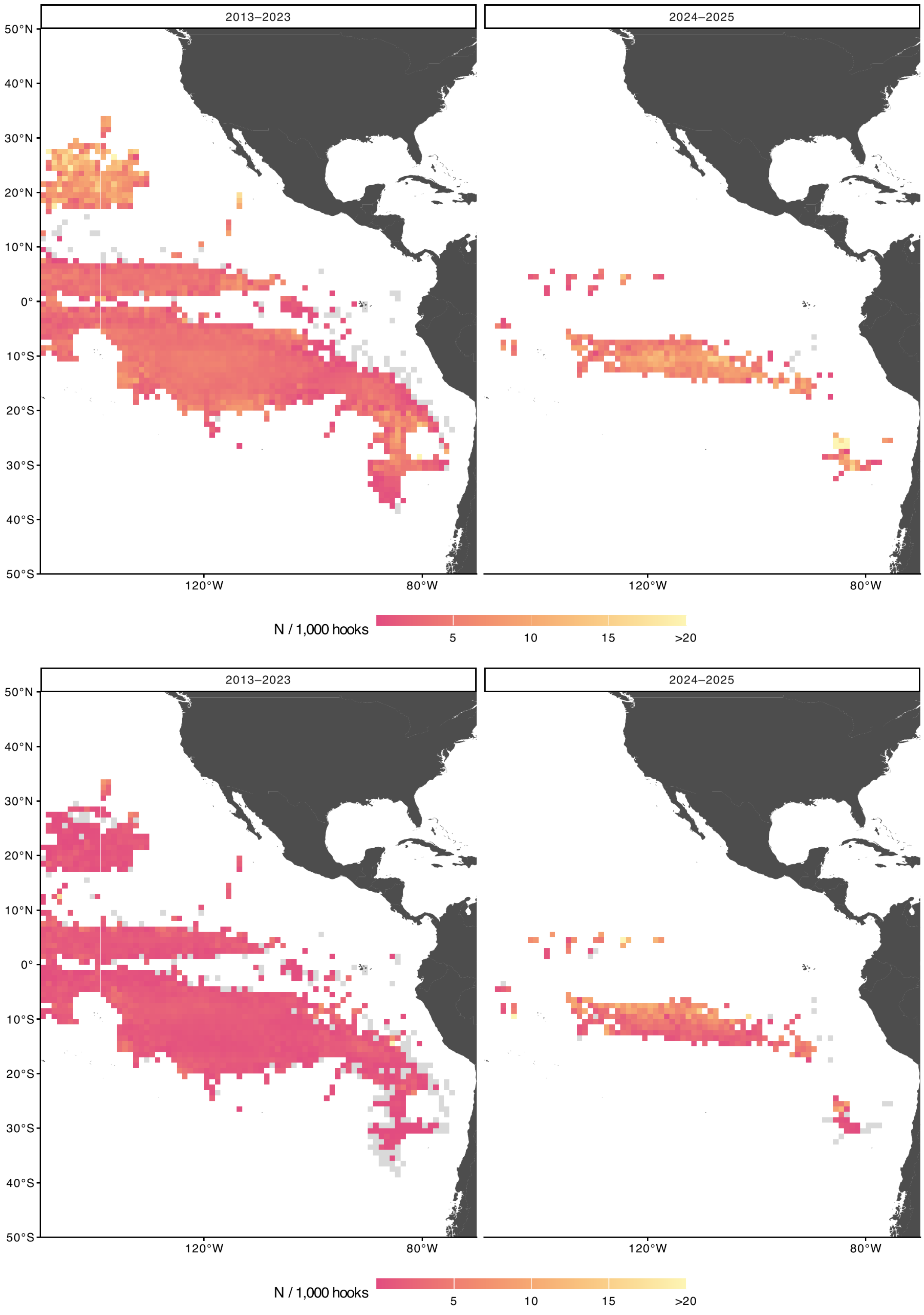

Figure 4. Spatial distribution of nominal CPUE (fish per 1,000 hooks per 1° × 1° cell) for BET (upper panels) and YFT (lower panels) during the baseline period (2013–2023; left) and recent period (2024–2025; right). Values capped at 20 for visualization.

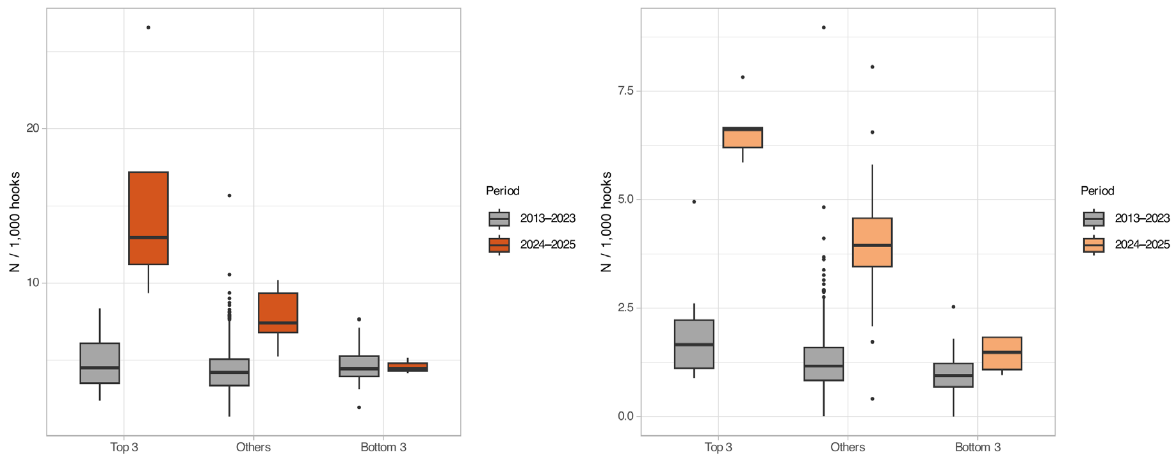

Figure 5. Vessel-level CPUE analysis for BET (left) and YFT (right), showing boxplots of CPUE distributions for each vessel group (Top 3, Others, Bottom 3) during the baseline (2013-2023; gray) and recent (2023-2025; colored) periods.

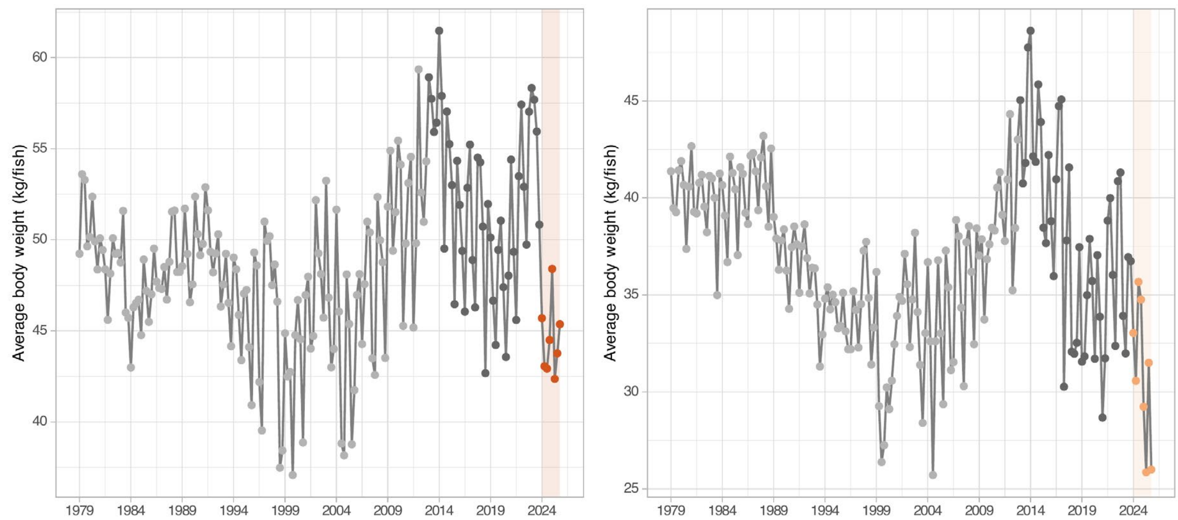

Figure 6. Quarterly average body weight (kg/fish) for BET (left) and YFT (right) derived from Japanese longline logbook records, 1979–2025. Shaded area indicates the recent period (2024–2025).

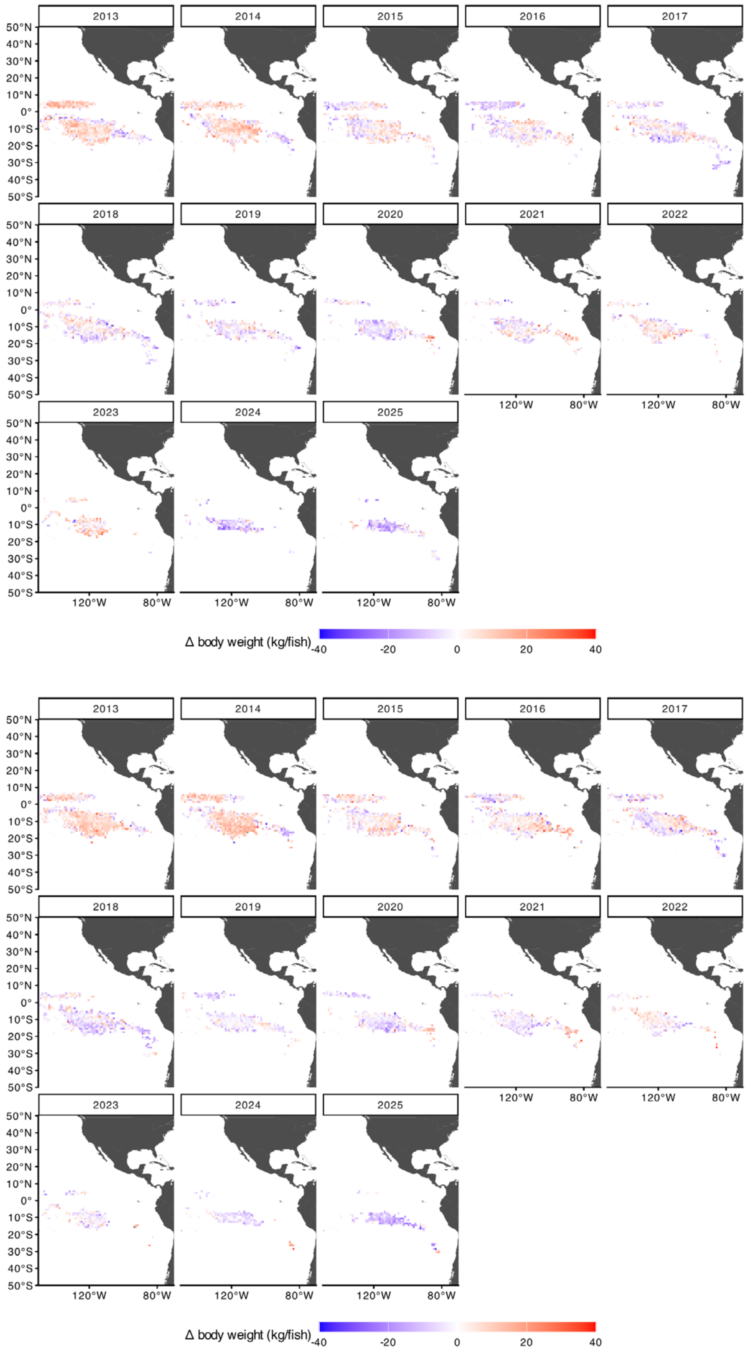

Figure 7. Spatial anomaly in BET (top) and YFT (bottom) average body weight (deviation from the 2013–2025 cell-level mean, kg/fish) by year. Positive values (red) indicate years with larger-than-average individuals; negative values (blue) indicate years with smaller-than-average individuals.