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Background analyses and data Inputs for the 2025 skipjack tuna stock assessment in the Western and Central Pacific Ocean

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1 Executive Summary

This information paper provides details on the key supporting analyses and data sets used to inform the 2025 assessment model for the western and central Pacific Ocean (WCPO) skipjack stock. These include:

- The standardisation procedure used for the catch per unit effort (CPUE) time-series for the purse seine in regions 5, 6, 7, and 8 to provide relative abundance indices for the index fisheries in those regions.
- The preparation of tagging data to construct the tag input file.
- The development of mixing period assumptions.
- The adjustment of fishery length compositions.
- The reweighting approach of the length-composition data for extraction and index fisheries.

The CPUE time-series for the purse seine fisheries in regions 6–8 (Figure 1; PS.6–8) was standardised to provide indices of relative abundance for three of the 10 index fisheries. Similar to previous work on the standardisation of purse seine CPUE data for skipjack (Teears et al., 2022), free-school indices were developed using a spatiotemporal modelling approach with effort defined as the cumulative daytime path length between sets and vessels termed 'FAD specialists' removed. However, in contrast to the 2022 index where failed sets were defined as sets with <5 metric tons of total tuna, in the 2025 analysis we defined, failed sets as sets with <5 metric tons of skipjack. This has the effect of removing yellowfin dominated sets which are not indicative of skipjack. This change also has the effect of removing all zero catch skipjack sets resulting in indices with less severe declining trends.

Monthly catch and effort for the Philippines purse seine fishery (i.e., region 5, Figure 1; PS.5) were estimated from port sampling data and the CPUE time-series was then standardised to provide an index of relative abundance for the region 5 index fishery. Methodology for the standardisation of the Philippines purse seine CPUE followed those applied in the 2019 and 2022 skipjack stock assessments (Vincent et al., 2019b; Teears et al., 2022; Bigelow et al., 2019) by applying generalized linear models (GLMs). However, in previous assessments, the data from the high seas pocket (HSP#1) in region 5 were included with the data from the Philippines exclusive economic zone (EEZ). In the 2025 stock assessment, the data from this relatively small area straddling the eastern edge of region 5 was not considered representative of the region more broadly and was not included in the analysis. Removing the HSP#1 data had minor impact on the index.

The Japanese pole-and-line (JPPL) fishery CPUE time-series was standardised by colleagues from the Japan Fisheries Research and Education Agency (FRA), supported by SPC), to provide indices of relative abundance for six of the 10 index fisheries. For more information on the JPPL indices standardisation, see Nishimoto et al. (2025).

Since the 2022 skipjack stock assessment, improvements have been made to the tagging database as well as increased filtering (as recommended at the 2025 pre-assessment workshop, Hamer (2025)) of tagging data to increase the quality of the resulting tagging data inputs and subsequent stock assessment results. The final tagging input file has 14 fewer release groups, 44,068 fewer effective releases, and 1,247 fewer usable recaptures.

As was done in the previous skipjack stock assessment (Castillo Jordán et al., 2022), simulations using an individual-based model of tagged release groups were performed to estimate release event-specific mixing periods (Scutt Phillips et al., 2022).

The size composition data were reweighted prior to integration into the assessment model to remove potential bias due to uneven sampling of skipjack over space and time within model strata. This approach applies two reweighting schemes; one for extraction fisheries that uses catch as the weighting factor to promote length composition data that are representative of removals, and one for survey fisheries that uses CPUE as the weighting factor to promote length composition data that are representative. The reweighting of size compositions was performed using the methods applied in previous assessments of albacore, bigeye, and yellowfin tuna (Peatman et al., 2020a; Vidal et al., 2021; Teears et al., 2022; Peatman et al., 2023a; Teears et al., 2024b) and are described in detail in Section 14.

2 Introduction

Stock assessments for tuna in the Western and Central Pacific Ocean (WCPO) conducted by the Pacific Community (SPC) generally utilize the statistical software MULTIFAN-CL (MFCL, Fournier et al. (1998); Hampton and Fournier (2001); Kleiber et al. (2019)). These models have extensive data requirements and specific formats for input files. This paper describes the data and its pre-processing that were used in the 2025 stock assessment of skipjack tuna *Katsuwonus pelamis* in the WCPO where stand-alone manuscripts were not considered warranted in each case. This report should not be viewed as the only inputs used in the 2025 skipjack assessment. Instead, readers should also refer to Nishimoto et al. (2025).

3 Standardised catch per unit effort (CPUE)

Catch per unit effort (CPUE) data plays a vital role in the stock assessment of skipjack as it provides a measure of relative abundance to the assessment model. Variables affecting catchability and population density are accounted for in a spatiotemporal modelling approach (Thorson et al., 2015; Anderson et al., 2022). The standardisation of these data was performed using a spatiotemporal generalized linear mixed model (GLMM) when possible (i.e., PS.6–8) or generalized linear models (GLMs), otherwise (i.e., PS.5). Data from the purse seine fishery in the WCPO were used to develop indices of relative abundance. Data from the Japanese pole-and-line fishery is also used to develop abundance indices for region 1–4, and earlier periods not covered by the purse seine indices for regions 7 and 8; that analysis is reported in Nishimoto et al. (2025).

The current approach builds upon the previous analyses, employing similar data filtering criteria, model structure, and spatial domain (Teears et al., 2022). However, geostatistical modelling was performed using the sdmTMB package in R (Anderson et al., 2022) as opposed to the VAST package (Thorson et al., 2015) that was used in 2022. The conversion from VAST to sdmTMB was a recommendation of the 2022 peer review of the WCPFC yellowfin tuna assessment (Punt et al., 2023) and was implemented for the standardisation of longline data for albacore, bigeye, and yellowfin tuna (Teears et al., 2024b, 2023) as inputs to the most recent assessments of these species (Teears et al., 2024a; Day et al., 2023; Magnusson et al., 2023). The sdmTMB geostatistical software was selected as it has been developed to be computationally efficient, flexible, and user-friendly with online community support (Anderson et al., 2022) and thus, represents a reasonable alternative for improving reproducibility and efficiency of CPUE analyses.

Coding scripts for standardisation of purse seine CPUE are available at SPC GitHub repository ofp-sam-skj-2025-cpue (login required). All analyses performed in 'R' (Team, 2023).

3.1 Regions 6–8 purse seine

Indices of relative abundance were derived from CPUE data of skipjack caught by purse seine fishing vessels (focused on free school sets) in regions 6, 7, and 8 following the eight-region spatial structure (Figure 1). This spatial structure is consistent with the structure used in the previous two stock assessments (Castillo Jordán et al., 2022; Vincent et al., 2019a) with the exception of region 5 where the lower boundary was changed from 20°S to 10°S to ensure data from the Indian Ocean would not inadvertently be included in the assessment. This change has no material effects, but is more accurate with respect to the original intended spatial boundaries of region 5.

Operational (set-level) purse seine fishing catch and effort data were obtained for the tuna purse seine fleets within the WCPO regions 6, 7, and 8. As of 2010, 100% of tuna purse seine trips in the region were required to carry a fisheries observer (although in practice observer coverage is less than 100%), and therefore, the time series used for this analysis extended from 2010 through 2024. The skipjack stock assessment region extends roughly from 50°N to 20°S and from 110°E to 150°W; however, the tropical purse seine sector of the skipjack fishery primarily operates within the 2025 stock assessment Regions 6, 7, and 8 (Figure 2). Therefore, those were the focal regions for this analysis.

3.1.1 Fisheries data

Different fishing strategies are employed within the purse seine fleet, with the most notable difference distinguishing between associated and unassociated sets. Associated sets are those made in association with floating objects, either natural (e.g., logs, debris, whale sharks), or man-made (i.e., fish aggregating devices; FADs) whereas unassociated sets are those made on free-schooling tuna unassociated with floating objects. Advancements in FAD technology can impact the catchability of skipjack over time for fishers that frequently perform sets on FADs. This can be particularly influential on the catch and effort relationship, with the adoption of satellite tracked and sonar-equipped FADs that allow fishers to target more productive FADs with relatively higher biomass of tuna. Furthermore, fishers who fish primarily on FADs during quarters when FAD fishing is allowed (i.e., 'FAD specialists') are less likely to be proficient in free-school fishing during the FAD closure period, resulting in lower catch rates than those less reliant on FAD fishing (Figure 3). This could lead to artificially lower overall catch rates for the purse seine fishery during closure periods.

To remove the influence of these effects from FAD fishing, data was filtered to only include unassociated sets and vessels with $\geq$ 70% of sets on FADs over the time-series were removed from the analysis. The threshold of 70% was chosen to remove the influence from FAD specialists while preserving as much data as possible. This was a slight deviation from the 2022 analysis (Teears et al., 2022) where FAD specialists were identified and removed for each year whereas, in the current analysis, the identification and removal was implemented over the whole time-series. Therefore, the derived indices were essentially free-school only without long-term FAD specialists. Of the 286 vessels in the final dataset, 18 vessels were identified as FAD specialists and were removed. A sensitivity of the chosen threshold was performed to evaluate the robustness of the model to this assumption.

In the previous analysis (Teears et al., 2022), effort was defined as the cumulative daytime path length between unassociated sets which, represents the searching effort to find and catch skipjack schools. Purse seiners perform sets only after they have positively identified a substantial school of tuna. Thus, to appropriately quantify searching effort, we used the Vessel Monitoring System (VMS) data and calculated the sum of the hourly distances travelled (recorded by VMS) between sets during daytime hours with a buffer of 30 minutes prior to sunrise and after sunset. The effort for the first set of a trip was assigned the trip-specific median value.

In the current analysis, several aspects of the data preparation process have changed from the previous analysis which impact the effort metric calculation. In the 2022 analysis, effort leading up to a 'failed' set (i.e., low catch of all tuna, typically caused by equipment failure or entanglement) was included as part of the effort metric calculation for the next successful set. However, in the current analysis, we assume that a failed set likely occurred after the positive detection of a school of tuna, but the quantity caught was not reflective of the amount of skipjack present. Therefore, including the effort and/or catch associated with a failed set to compute a CPUE observation would be biased downwards, and it is therefore reasonable to remove both the effort and catch for that biased observation. Consequently, the effort calculation starts anew after a failed set until the next successful set is undertaken.

Additionally, the definition of a failed set was redefined as a set with skipjack catch $<$5 metric tons as opposed to the 2022 analysis where a failed set was defined as a set with total tuna $<$5 metric tons. This change in definition resulted in the removal of yellowfin dominated sets where little or no skipjack catch was present in the catch. The removal of these zero skipjack catches is important for standardising the CPUE data as this impacts vessel effects and can bias estimates of relative abundance. It should be noted that any effort occurring prior to yellowfin dominated sets would be included in the next preceding set if it is a successful skipjack set. This assumes that while searching for either yellowfin and/or skipjack, if a skipjack school is encountered, a set will be made on that school. This assumption has been questioned, and we sought advice from industry members on this. In particular the ability to identify and target yellowfin schools, and whether skipjack schools might be bypassed in search of yellowfin schools. The general response was that purse seiners don't typically discriminate; if they find a suitable tuna school, they set on it irrespective of species. Market doesn't really come into this and they can separate the species in the vessel holds. There are some areas closer to archipelagic waters (PNG/Solomon Islands) where they can encounter more yellowfin schools and they can increase their yellowfin catches in these areas but, they typically still wouldn't avoid setting on a good skipjack school.

A suggestion at the pre-assessment workshop (Hamer, 2025) was made in response to the removal of yellowfin dominated sets from the analysis that 'yellowfin specialists' (similar to FAD specialists) should be identified and removed from the analysis. Yellowfin tuna make up a large proportion of tuna catches (12.8–35.5% from 2010–2024, Figure 4) in the purse fishery. Identifying yellowfin specialists (vessels that predominately target yellowfin) can be difficult as the proportion of yellowfin dominated sets (sets where yellowfin make up >70% of the catch composition) for each vessel was less than 45% in the fishery. In other words, more than half of all sets for each vessel in the fishery are not predominately yellowfin as defined above. Thus, yellowfin specialists were not identified and removed from the analysis.

The inclusion of tuna prices such as Japanese longline (bigeye and yellowfin; fresh and frozen), purse seine (yellowfin, albacore, and skipjack), United States fresh sashimi (yellowfin, bigeye, and albacore), and the Japanese–United States exchange rate, as a proxy for targeting was explored. These explorations indicated confounding between significant variables and CPUE as the significant variables (i.e., interaction between the price of skipjack from the purse seine and the Japanese–United States exchange rate) correlated to CPUE due to the overall monotonic trend in the time-series however, advice from the industry provided inadequate evidence to support a causal relationship between tuna prices and catch rates of skipjack. Discussion with the industry suggested that the primary (and possibly the only) mechanism for targeting yellowfin was a spatiotemporal component. Given the difficulties with finding a metric that approximates species targeting in the purse seine coupled with the fact that the spatiotemporal nature of targeting would be accounted for by the geostatistical modelling framework, targeting was not included in the model configuration.

The full data set (n=366,865 sets) was also filtered to only include vessels between 50-80m in length which were active in the fishery for approximately 20% of the time-series of interest (observed fishing activity in at least 10 quarters between 2010 and 2024). To avoid a full exclusion of the vessels that had only recently entered the fishery, we included vessels that entered the fishery in 2021 or later if they had been active for at least seven quarters (∼44% of the most recent four years of the time series). The vessel length criteria was imposed (as previously implemented by Vidal et al. (2020); Teears et al. (2022)) to align with the Vessel Day Scheme (Dunn et al., 2006) that resulted in a fleet with predominately 50-80m vessels. In addition, extreme outlier catches (total tuna catch ≥99th quantile) were also removed. Lastly, records were removed if any data values were missing. The resulting filtered data set (n=105,328) was used for the CPUE standardisation.

Potential density (i.e., environmental factors) and catchability covariates were selected by comparing predictive performance (Geisser and Eddy, 1979; Sivula et al., 2020) of candidate models using k-fold cross-validation and the expected log pointwise predictive density (ELPD; Gelman et al. (2014)) as a metric. Cross-validation was implemented by splitting the data into five, approximately equal data sets that were spatially blocked (Figure 5) using the blockCV package (Valavi et al., 2019). One fold was withheld (for testing predictive performance) while the other folds were used to train the model. The trained model then predicts the testing data set and provides an estimate of predictive performance as ELPD. This process is repeated for each fold until all folds have been tested and the ELPD values are summed for comparison. The candidate model with the best predictive performance is then adopted as the best model. Covariates were added in a forward stepwise process until predictive performance no longer improved. This process was performed using three different random seeds and resulting ELPD values were summed over the random seeds in case the results were conflicting to ensure a robust analysis.

The potential density covariates included sea-surface temperature (sst), chlorophyll-a concentration, El Niño-Southern Oscillation (ENSO) data, and month (as a factor) as these were considered representative of important thermal and productivity metrics. An interaction between sst and chlorophyll-a was also included.

There are many potential catchability covariates such as vessel length, gross registered tonnage, well capacity, skiff horsepower, net length, net depth, etc., however; many of them are highly correlated (see Vidal et al. (2020) for further details). Therefore, vessel length was chosen as that was considered representative of these vessel characteristics. The other potential catchability covariates included vessel identification, flag, and detection method (i.e, information from anchored FADs, bird radar, information from other vessels, marked with beacon, seen from helicopter, seen from vessel, sonar/depth sounder).

Covariate selection results (Table 1) indicated the covariates that improved predictive performance of the CPUE standardisation model included vessel identification, detection method, month, the interaction between sst and chlorophyll, and ENSO.

3.1.2 Model configuration

For PS.6–8, we fit a spatiotemporal lognormal generalized linear mixed model using the sdmTMB package in R (Anderson et al., 2022). Spatiotemporal models implicitly account for spatial and spatiotemporal autocorrelation in catch rates using Gaussian Markov random fields assuming geometric anisotropy, which allows for spatial autocorrelation to vary in magnitude based on the direction of neighbouring knot locations. This provides a means of predicting the density relative to the aggregated environmental, biological, and vessel characteristic factors that influence both the distribution and catchability (Thorson, 2019; Anderson et al., 2022). The basic equation applied was as follows:

$$c_i \sim as.factor(YearQtr_i) + \omega(x_i) + \phi(x_i, t_i) + (1|vessel) + as.factor(detect.code) +$$
$$as.factore(month) + sst * chlor + ENSO + \varepsilon$$

where c is the CPUE (mt/km travelled), i is the record number, $YearQtr$ is the year-quarter effect, ω is the spatial random effect at location x, ϕ is the spatiotemporal random effect at location x and time t, *vessel* is the vessel-specific random effects, and *detect.code* is the fixed effect of detection method, *month* is the fixed effect of month, $sst * chlor$ is the interactive fixed effects of sst and chlorophyll, and $ENSO$ is the fixed effect of the El Niño-Southern Oscillation. The spatial variation term $\omega(x_i)$ is characterised by a Gaussian random field assuming a Matern covariance function to account for spatial autocorrelation with ω drawn from a multivariate normal distribution with a covariance matrix Σ_ω.

$$\omega \sim MVNormal(0, \Sigma)$$

The spatio-temporal random effects $\phi(x, t)$ account for the interaction between time and the model spatial structure. The model has an observation level random effect ε, assumed to come from a Gaussian distribution with a mean of 0.

The spatial knot configuration (i.e., mesh parameterisation) was structured to include 242 knots Figure 6. The extrapolation grid was at a 5°x5° spatial resolution across the spatial domain.

Predicted CPUE (density; $d(c, t)$) for each cell (c) within the extrapolation grid in each time period (t) was estimated by obtaining the product of the back-transformed linear predictors with catchability covariates (i.e., vessel identification and detection method) held constant to remove their effects on estimates of relative abundance. Area-weighted, bias-corrected, region-specific indices were calculated as:

$$E_{r,t} = \sum_{c=1}^{N_r} a_c d_{c,t}$$

where E is the estimated relative abundance in region r at time t and a is the area associated with cell c for cells 1 to N_r cells in region r. Standard errors associated with the indices are calculated internally in Template Model Builder (TMB) using the inverse Hessian and the delta method (Anderson et al., 2022).

Residual analysis was performed using probability-integrated-transform (PIT) residuals (Warton et al., 2017), evaluated using the DHARMa R package (Hartig and Lohse, 2017).

3.1.3 Relative abundance indices

The PIT residuals, aggregated across the time series, exhibited a normal distribution centered around 0.5 (Figure 7) with no clear spatial patterning of residuals, indicating an overall reasonable fit to the data. The resulting indices developed from the standardisation of CPUE data for PS.6–8 (Figure 8) suggested a slight declining overall trend from 2010 through 2024. The area-weighted standardised CPUE indices indicated progressively increasing total regional abundance moving westward from region 6 to region 8.

The regions were modelled jointly to maintain regional scaling differences to inform estimates of regional biomass in the integrated stock assessment model. However, during some periods of the time-series, low sample sizes were inadequate to inform relative abundance; particularly, in region 8 in 2011 (n=104), 2021 (n=68), and 2022 (n=40). This demonstrates both the strengths and weaknesses of the spatiotemporal modelling framework. In areas during periods where there is little or no information, relative abundance is estimated by utilising information from neighbouring observations (via the spatiotemporal correlation), by density covariates such as sst, chlorophyll, and ENSO, and by the overall (over the spatial extent) year-quarter expected value. Therefore, observations in region 6 and 7 impact the estimation of uncertainty in region 8 by keeping the standard error lower than expected given the lack of information over a region of approximately 15 million km^2. Consequently, additional model runs were performed where regions were modelled separately (termed 'regional' models hereafter) to provide estimates of uncertainty that are more reflective of the low sample sizes.

The trends in relative abundance from the 'global' model (i.e., regions modelled jointly) were similar to the trends from the regional models (Figure 9). However, estimates of coefficient of variation (CV) were overall higher in scale for region 6. Regions 7 and 8 showed much higher CVs during periods of low sample size (2021–2022 and 2011 in region 8).

The covariate influence plots (Figure 10) revealed that the influence of detection method declined until 2021 when it began to increase. The influence of month indicated a cyclic trend and was typically high during quarters 2 and 3 and lowest during quarter 4. The influence of vessel identification suggested a similar trend to detection method and these two catchability covariates were likely less influential due to the low number of vessels operating during this time-period when their influence was very low. The density covariates chlorophyll and ENSO indicated stable trends with temporal variability however, sst showed a declining trend over the time-series.

The aggregated spatial random effects plots (Figure 11) indicated lower random effects between the equator and 10°S and between 150°E and 170°W. The aggregated spatial fixed effects indicated more homogeneity over the spatial extent with a hot spot north of Papau New Guinea and relatively few hot spots interspersed throughout. Spatial uncertainty plots by year (Figure 12) indicated lower uncertainty between the equator and 10°S with relatively higher uncertainty in the north-eastern area of the spatial extent.

The effects of the covariates indicated variability among detection methods with sonar/sounder indicating the highest predicted density (Figure 13) and this is consistent with pole-and-line – which is also a free school fishing method. The month covariate indicated higher predicted density from April through July. The effect of ENSO indicated a slightly positive relationship between scaled ENSO and predicted density (Figure 14). The covariate effect of the interaction between sst and chloropyhll on predicted density showed a positive relationship.

The sensitivity analysis to evaluate the 70% FAD specialists threshold (Figure 15) suggested that the results were robust to this threshold however, there was a slight trend; when more FAD specialists were included, the index was slightly flatter. These results suggest that a threshold of 70% is appropriate to remove the influence of FAD specialists on the free-school only PS.6–8 indices while maximising the number of observations.

3.2 Philippines purse seine

The relative abundance index for the Philippines purse seine fishery located in region 5 (PS.5; Figure 1) was developed following the methods applied in the 2019 and 2022 skipjack stock assessments and for detailed methods we refer the reader to Bigelow et al. (2019). In the previous assessment, port sampling data were used to estimate effort, catch, and standardised CPUE from the purse seine fishery operating in the southern Philippines exclusive economic zone (EEZ) and High Seas Pocket #1 from 2005 to 2024. However, in the 2025 stock assessment, fisheries data from the high seas pocket were considered to not be representative of the wider region 5 (see Section 6). Therefore, the PS.5 index was developed using only data from the Philippines EEZ.

A relative abundance index was produced as a year-quarterly standardised CPUE index from 2005 to 2024 for use in the 2025 WCPFC skipjack tuna assessment. Effort, catch, and standardised CPUE was estimated using generalised linear models (GLMs) and model selection was performed using Akaike Information Criteria (AIC). Potential covariates for the CPUE standardisation included year-quarter, area, and vessel identification (as a random effect).

Results from the estimation of effort (Figure 16) indicated an overall stable trend from 2005 to 2012 and then an increasing trend until 2018 when the effort becomes more stable but highly variable. Results from the estimation of catch (Figure 16) demonstrated an overall declining trend from 2005 to 2012 and then an increasing overall trend thereafter with high temporal variability. There were 22 area designations in the database however, area was not a significant covariate but, vessel identification was a significant covariate. (Table 2).

Results from the CPUE standardisation indicated an overall declining trend from 2005 to 2012 when estimated CPUE increased sharply and then a subsequent declining trend throughout the remainder of the time-series with high temporal variability (Figure 17). These results are consistent with analyses from 2019 and 2022 stock assessments (Figure 18).

4 Construction of tagging data files

Mark-recapture tagging data can provide valuable information to an assessment if it is representative of the entire population. These data can influence the estimation of fishing mortality, natural mortality, regional biomass scaling, and movement among regions within an integrated assessment model. The creation of the tag files used in MFCL for the 2025 assessment of skipjack follow the general methods previously outlined in Berger et al. (2014); McKechnie et al. (2016, 2017); Vincent et al. (2019b); Teears et al. (2022). Preparation of input files coding scripts are available at SPC GitHub repository ofp-sam-skj-2025-data-prep (login required). All analyses performed in 'R' (Team, 2023).

4.1 Tag file preparation overview

Many of the tags are unusable in the assessment due to inadequate information such as missing data (e.g., time, location, or fishery of recapture), outside of spatial extent, or they cannot be attributed to a fishery because they are captured by a gear that is not included in the assessment. The ratio of releases to recaptures can impact estimates of mortality in the assessment model and, to preserve this ratio, the number of releases need to be corrected based on the number of recaptures that can be used in the model. Additionally, tagging induced mortality and tag shedding (Vincent et al., 2019b) can impact overall survival that is not related to either natural or fishing mortality as well as the differential effects of individual taggers on tagging-induced mortality (i.e., tagger effects; Berger et al. (2014); Peatman et al. (2022); Scutt Phillips et al. (2020); Vincent et al. (2019b).

Tag seeding studies provide some information on the magnitude of tag reporting rates for some of the purse seine fisheries in the assessment (see Peatman et al. (2020b) for further details). These factors need to be accounted for to ensure parameters of interest in MFCL are accurately estimated. The observed proportion of tag returns were corrected to reflect the actual recapture rate and this process was conducted using the same methods as the previous two skipjack stock assessments (Vincent et al., 2019b; Teears et al., 2022). The formulae and methods used are presented in detail in McKechnie et al. (2016) and we refer the readers to that report. A summary is provided below.

The creation of the tagging data files for use in MFCL were:

1. Extraction and filtering of release/recapture data from the database.

2. Correction of releases for base tagging-induced mortality (7% assumed) and mortality from tagger effects (Peatman, 2020; Scutt Phillips et al., 2020).
3. Correction for tag shedding (6.97%; Vincent et al. (2019b)).
4. Correction of usability ratio calculated as the ratio of usable to total recaptures at the scale of the release event.
5. Consideration of grouping of fisheries/tagging programs for tag recaptures and reporting rates.
6. Construction of tag reporting rate priors from tag seeding experiments (Peatman et al., 2020b).

To reduce computational time for MFCL and improve model stability, all release events with less than 30 effective tag releases were excluded. All release events that occurred after the end of 2022 were excluded from the assessment to prevent biases from not including re-captured fish that were not reported or entered into the database at the time of the assessment (there is often a substantial lag between recapture and reporting). Tagger effects and reporting rates were updated with additional data as available. An important improvement to the estimation of tagger effects is the incorporation of a new multi-species approach and are described in detail in Peatman (2025b,a).

4.2 Tagging data development

Tagging data for the skipjack assessment were acquired from multiple tagging programs implemented by SPC (Figure 19 and Figure 20) and these include the Regional Tuna Tagging Program (RTTP; 1989–1992) and the Pacific Tuna Tagging Program PTTP (2006–ongoing). Data from the Skipjack Survey and Assessment Program (SSAP; 1977–1982) were used in previous assessments but, based on suggestions from the pre-assessment workshop (Hamer, 2025), this tagging data was not included in the 2025 stock assessment due to concerns with representativeness and appropriate mixing periods. Additional data are available from the ongoing Japanese tagging program (JPTP; Figure 19 and Figure 20), but these data are not held by SPC and updated data sets are provided just prior to each stock assessment. Due to numerous differences between these data and those from programs held by SPC, they are processed separately, and the methods used for the JPTP are presented in Aoki and et al. (2025). The data obtained through the JPTP are particularly valuable for skipjack tuna stock assessments in the WCPO due to wide temporal and spatial coverage and numerous recaptured tags reported (Figure 21). Additional mortality caused by tagger effects were not estimated for the JPTP tagging data due to the lack of available data to inform these estimates thus, the mean correction factor for all release groups in the PTTP was assumed for the JPTP data.

Since the previous stock assessment, the tagging data has been updated and improved in multiple ways. Firstly, additional work was done to increase the percentage of validated skipjack tag recaptures from 77.4% to 83.4%. Validation of recaptures is challenging as many tags are difficult to assign to a specific location, date, and/or flag due to the nature of the shipping and processing of skipjack tuna catches. This information is vital for mapping recaptures to an extraction fishery and can sometimes be gleaned using auxiliary information.

Another important improvement to the tagging data was the restructuring of the tagging database allowing one recapture to be linked to multiple 'candidate' vessels that may have potentially recaptured the tagged skipjack in question (e.g., vessels that transshipped skipjack to the same vessel). Although this further complicates the processing of tagging data, the advantage is that a group of potential recapture locations and dates can be aggregated to provide a window of possible locations and dates subsequently, providing the ability to reasonably approximate the recapture fishery. Therefore, in the current assessment, a higher percentage of the recaptures were assigned to fisheries, resulting in higher quality tagging information being input into the MFCL assessment model.

Additional work was done to improve the tagging data in response to recommendations from the pre-assessment workshop (Hamer, 2025) as there were concerns regarding reporting rates hitting bounds and the lack of mixing of some recaptures from specific release groups. Furthermore, there were three release groups with unrealistically high recapture rates (0.6, 0.99, and 0.99) after applying correction factors. The improvements listed below were done specifically to improve how well the tagging data represented the population. Note that by assigning 'NA' as the fishery for a recapture allows it to be included in the usability correction applied to the release numbers (preserving the recapture rate) while removing it from the recaptures in the final tag input file.

- Recaptures that have not been validated were assigned 'NA' recapture fishery.
- Release groups from the PTTP in regions 1–4 were removed from the dataset as these releases were beyond the scope of the program.
- Release groups with recapture rates ≥ 0.6 (i.e., JPTP in 3rd quarter of 2021 in region 2, PTTP in 3rd quarter of 2022 in region 6, and PTTP in 3rd quarter of 2022 in region 6) were removed from the dataset.
- Tags recaptured from the pole-and-line fisheries in region 7 and 8 were assigned 'NA' for recapture fishery.
- All recaptures from longline fisheries were assigned 'NA' recapture fishery.
- Recaptures from the PTTP and RTTP in regions 1–4 were assigned 'NA' for recapture fishery.
- Recaptures from the PTTP and RTTP caught by the pole-and-line fishery in region 4 were assigned 'NA' for recapture fishery.
- Recaptures from the PTTP, RTTP, and JPTP caught by the pole-and-line fishery in region 6 were assigned 'NA' for recapture fishery.

– Recaptures caught by the research vessel that released them were assigned 'NA' recapture fishery.

After filtering as above, updating the tagger effects, and applying the various correction factors to the raw data, the resulting tagging data for the 2025 skipjack stock assessment were similar to the tagging data from the 2022 skipjack stock assessment as shown in Figure 22. However, for the PTTP, there were fewer effective releases and higher numbers of usable recaptures resulting in higher historical recapture rates. These apparent differences were primarily due to the improvements to the database. For the RTTP and JPTP, the differences were very slight and were primarily due to updated tagger effects and filtering of recaptures noted above.

5 Mixing periods

The assumption of representativeness of tagged fish to the underlying population is critical for their integration into stock assessment. An implicit 'mixing period' is included in MFCL to account for the period of time required for tagged fish to distribute themselves such that their estimated demographic and other parameters can be considered representative of the population. The failure to account for this lack of mixing can result in significant bias in parameter estimation (Abadi et al., 2013; Guillemain et al., 2014), particularly in the case of fishing mortality when fish are tagged in areas of relatively high fishing effort compared to the entire population (Scutt Phillips et al., 2024).

5.1 Tag mixing analysis overview

In previous skipjack stock assessments (Castillo Jordán et al., 2022; Vincent et al., 2019a), assumptions of mixing period duration were influential to stock status. Prior to 2022, all release group mixing periods were fixed at a certain number of quarters, with alternative, generally longer, periods explored in sensitivity runs. Tags reported during this mixing period are removed prior to integration into the likelihood calculation. In the 2022 skipjack stock assessment, a new approach was taken using a mixing period which varies by tag release group (Scutt Phillips et al., 2022), that is, a quarterly time-step and assessment region aggregation of historical tag releases. The length of this mixing period depends on the dissimilarity of recapture probability between the tag release group and the untagged population in the assessment region of release, as simulated in a separate, individual-based model. This measure of dissimilarity is used to indicate the degree of mixing between these two groups of fish, not in terms of spatial distribution, but rather in terms of the key spatially varying demographic parameter that is influenced by tagging data in the stock assessment model: fishing pressure.

Four scenarios of differing mixing periods are simulated, in which tagged fish are allowed to disperse from their release location for a period, before the dissimilarity in recapture probability distributions between the tagging and untagged groups is calculated. These scenarios were zero mixing (recapture probabilities compared immediately post-release), and one, two and three quarters of mixing. Dissimilarity (based on Kolmogorov dissimilarity K metric, referred in the 2022 assessment as the D statistic, but herein now referred to as K) was calculated for each release group, under each mixing scenario, and those that fell below particular cut-off values were chosen for the MFCL mixing period for that group. A full description of these simulation experiments is given in Scutt Phillips et al. (2022).

Simulations were undertaken using the Ikamoana individual-based simulation model (Scutt Phillips et al., 2018) and using an ocean habitat-driven movement model estimated on fisheries, environmental and conventional tagging data for skipjack tuna, SEAPODYM Senina et al. (2020). Ikamoana permits the tracking of attributes from many individuals whose spatial distribution evolves over time as described by an advection-diffusion equation. In this case, the attributes that are tracked are survival and recapture probability, as a function of natural mortality and movement through spatiotemporally varying fields of fishing mortality. A full description of the equations which govern the movement, survival and recapture probabilities of these individuals is given in Scutt Phillips et al. (2018, 2024).

For the 2025 WCPO Skipjack tuna assessment, two major improvements over the 2022 tag mixing analysis were implemented. First, the parameters and environmental forcing were updated to match the most recent SEAPODYM reference model solution for Pacific skipjack tuna (Senina et al., 2025). This reference model was estimated at 1° and 30 days resolutions, uses environmental forcing from JRA55-NEMO-PISCES-LMTL model outputs, and integrates geo-referenced fisheries data, conventional tagging data, and early life data including; larval distributions from historic Japanese surveys (Buenafe et al., 2022) and recent studies on temperature effects on skipjack egg hatching success and time (Fujioka et al., 2024).

Second, an alternative treatment of effort data to more appropriately calculate the spatiotemporally varying effort which drives recapture probability was used. The catchability parameters of several defined fisheries in SEAPODYM are not defined for purse-seine fisheries, for which either the fishing effort is considered unreliable, or the fleet catchability changes unknown. In the Eulerian model SEAPODYM, the fishing mortality from such fisheries is handled by 'catch-removal' or in other words 'biomass-removal' method, that is simply removing the biomass that is equal to the observed catch for a given month and 1 degree cell. In the Lagrangian model Ikamoana, where biomass is not removed in response to fishing, but rather probabilities of recapture are recorded over multiple individuals and tracked over time, such an approach is not possible. Instead, an instantaneous fishing mortality is required to calculate survival and recapture probabilities. In the case of purse-seine fisheries, to obtain the most accurate effort derived fishing mortality, the spatial fishing effort fields are computed from the model predicted catches, which are by definition equal to the observed catch. This provides model-corrected effort fields given the assumed constant catchabilities. Fishing mortality is then calculated from these effort fields, and the cumulative, probability of capture as function of instantaneous and natural mortality over time, can be recorded for each individual particle as they move through the model spatial domain.

Simulations of 100,000 particles, released at the time and location of all aggregated tag release events from the PTTP and JPTP, were undertaken. In parallel, simulations of 3 million particles spread throughout the Pacific Ocean at the same time as the tagging event were run, with which to compare the cumulative recapture probabilities. To reduce the number of simulations, all historic tagging events from the PTTP were aggregated to the mid-point date of their quarter of release, the one-degree cell of their release location, and their monthly age class. Age class was determined by assigning the observed length of release to the mean length at age assuming the monthly age structure defined in SEAPODYM. All aggregated release events with at least 30 tag releases at this quarter-location-age class aggregation were simulated using 100,000 individual particles distributed evenly throughout the degree cell of release. In parallel, Pacific-wide simulations of three million individuals of the matching age class, with initial spatial distribution as predicted by SEAPODYM, were run to provide the untagged population group to which tagged fish were compared. The same analysis was undertaken for all JPTP tag releases from 1998 to 2022.

The resulting recapture probability distributions from each group at each time step, and under the different mixing period scenarios, were then once again aggregated to the assessment release group level, that is, at quarter and region of release. The Kolmogorov dissimilarity K metric was calculated between the distribution of recapture probability for all tagging release simulations in the release group, and that of the untagged population in the same region. For the 2025 WCPO skipjack tuna assessment, the median K over time was used to determine dissimilarity, rather than the final value at the end of the simulation as was done for the 2022 assessment. For a more complete description of the simulation experiments, see Scutt Phillips et al. (2022).

The updated version of Ikamoana was compared for its prediction of spatial tuna density over time. While some discrepancies will always exist, particularly as the effects of numerical diffusion do not exist in the Lagrangian model, the spatial correlation between the two models never fell below 0.9. We also compared the observed total recapture rate from each quarter-degree tag release group with the corresponding distribution of simulated recapture probabilities generated by the SEAPODYM model. This approach carries several caveats, notably, the aggregation of real tagging events to a single mid-quarter date, and the lack of resolution of fine-scale processes in SEAPODYM, such as localised fish aggregation around FADs immediately after release, which may elevate early recapture rates. Additionally, the simulations assume 100% reporting of recaptures, whereas actual reporting rates likely vary across space, time, fleets, and other factors.

To evaluate consistency between observed and simulated outcomes, we calculated a two-sided, non-parametric p-value for each case by comparing the observed recapture rate to the empirical distribution of simulated values. Specifically, the p-value was computed as $2 * min(F(x), 1 - F(x))$, where $F(x)$ is the empirical cumulative distribution function of simulated recapture rates evaluated at the observed value. We found that 66% of observed recapture rates fell within the central 95% interval of their respective simulated distributions, suggesting broad, though not universal, agreement between the simulated tagging groups and observed recapture patterns. The 20 PTTP tag simulations representing the highest number of true, historical tag releases is summarised in table Table 3, with the final distribution of cumulative recapture probability shown for each alongside the single, observed recapture rate for all historical tags represented by this group. Examining the dissimilarity K metric by assessment region, the patterns are consistent with the results of the analysis for the 2022 stock assessment. The distribution of K is shown for both PTTP and JPTP tag release groups combined and separated by region and mixing scenario (Figure 23). Regions where the distribution of the population and fishing effort overlap show the fastest decrease in K over time (regions 1 and 2), whereas regions where fishing effort is heterogeneous compared to the population distribution exhibited slower and more variable mixing metrics (regions 6 and 7).

Median values of K were used to determine the earliest possible mixing period to be assigned to each release group in MFCL, using cut-off values of $K = 0.1$, 0.2, and 0.3 as alternatives for the uncertainty characterisation. The K of 0.1 results in generally requiring a longer mixing period than 0.2, which assumes a longer mixing period than 0.3. Hence the lower the K the more conservative the mixing period assumption. Based on these criteria, the mixing period assigned to each release group for each K value are provided in Section 12 (Table 8). A more conservative K statistic of 0.1 also results in only 8.3% of the total recaptures to be considered mixed and subsequently, included in the MFCL likelihood function (Figure 24). Whereas a much less conservative K statistic of 0.3 results in 53.2% of the total recaptures to be considered mixed. An intermediate K statistic of 0.2 would result in 31.0% of the total recaptures to be considered mixed and thus, permitted to inform the MFCL model parameters.

The simulations were computationally demanding and, as such, not all release groups could be simulated from the four tagging program data sets. Thus, various release groups from the PTTP and the JPTP were selected to be simulated to maximize the spatial coverage and the number of releases simulated. However, release groups varied considerably by number of effective releases. As shown in Figure 25, more release groups were simulated for the JPTP, yet the number of effective releases simulated was much higher for the PTTP as these release groups typically have a much higher number of effective releases per release group (Figure 20) than the JPTP. Release groups with higher numbers of releases were preferred over release groups with few releases if adequate spatial coverage could be maintained among the selection of release groups simulated. The resulting proportion of total recaptures by region considered mixed and not mixed for each K statistic are shown in Figure 26. RTTP release groups (n=29) were not simulated and were assigned the region-specific median estimates from the PTTP. There were 9 (of 49) PTTP release groups that were not simulated and were assigned the PTTP region-specific median estimates and there were 130 (of 236) JPTP release groups that were not simulated and were assigned the JPTP region-specific median mixing period calculated from simulated release groups.

6 Adjustment to length compositions and fishery definitions

In the three previous skipjack stock assessments (i.e., 2016, 2019, and 2022), the length compositions in the longline fishery from the Japanese fleet from 2007-2010 in regions 1-4 were removed from the length compositions due to anomalies in the size distributions (McKechnie, 2016). Specifically, there was evidence of a prominent bimodal distribution during this period and a notable reduction in median length. The specific reason for these differences (i.e., changes in fishing practices) has not been determined nevertheless, for the 2025 skipjack stock assessment, these anomalous longline length compositions from the Japanese fleet in regions 1–4 from 2007-2010 were removed.

Longline length compositions were an important point of discussion in the pre-assessment workshop (Hamer, 2025). Longline catches of skipjack are relatively low by comparison and are primarily included in the assessment with logistic selectivity in order to allow other fisheries to have dome-shaped selectivity. Therefore, it was recommended to aggregate these compositions into one time-step to allow them to characterize selectivity while not influencing population scaling and dynamics. This suggestion was adopted and applied in the 2025 stock assessment.

In the previous assessment, length compositions from the purse seine and ring net gears in region 5 from vessels flagged as Philippines or Indonesia operating in their respective EEZs were combined into a common fishery. However, there were significant differences in length composition patterns between the Philippines and Indonesia, therefore, the Indonesia flagged data was separated into an additional fishery (see Table 4, Figure 38, and Figure 39).

Additionally, in the previous assessment, the selectivity associated with the PS.5 index fishery mirrored the selectivity with the formerly termed fishery 12. This index was developed using data from the Philippines EEZ and data from international waters in the high seas pocket #1 that extends across the eastern most border where region 5 adjoins region 7. In the 2025 assessment, length data from the high seas pocket was evaluated and determined to be progressively more variable over time and was not considered representative of the wider region 5. Thus, the length data corresponding to the index fishery PS.5 came exclusively from data from the Philippines EEZ which was considered to be more representative of region 5.

Extraction fishery catch and length composition data summaries are provided (Section 12; Figure 27 – Figure 58) as well as length composition data for index fisheries (Figure 59 – Figure 67). These summaries provide raw length (for extraction fisheries) and processed length data (for both extraction and index fisheries; as input into MFCL) for comparison.

7 Reweighting of size compositions

This section describes the reweighting of size composition data prior to integration into the assessment model. Statistical correction of size composition data is required as length samples are often collected unevenly in space and time. As such, the samples require reweighting using either catch, to be representative of the size of fish being removed from the population in the case of extraction fisheries, or estimates of relative abundance, to be representative of the size of fish in the population in the case of index fisheries. The reweighting procedure was applied to size compositions of purse seine and pole and line fisheries.

7.1 Methods

The procedure used to reweight size compositions for purse seine fisheries was based on the approach used for the 2023 bigeye and yellowfin assessments for extraction fisheries (Peatman et al., 2023a), and the 2022 skipjack assessment for index fisheries (Teears et al., 2022). The procedure for pole and line extraction and index fisheries was based on the approach used to prepare longline size compositions for the 2023 bigeye and yellowfin assessments (Peatman et al., 2023a), which was developed from the approach of McKechnie (2014) and Tremblay–Boyer et al. (2018) for regular and index fisheries respectively. Fifty 2cm length classes were used, covering 10–12cm through to 108–110cm.

7.1.1 Region structures and fisheries

Reweighted size compositions were generated for the eight region structure considered for the 2025 assessment (Figure 1), and a subset of the purse seine and pole and line fisheries included in the 2025 assessment (Tables 5 and 6). For extraction fisheries, size compositions were not reweighted for fisheries with insufficient data to support the reweighting procedure, (e.g., longline fisheries).

7.1.2 Purse seine data preparation

Length samples from the US Multilateral Treaty Port Sampling (i.e. origin ID = 'TTPS') and Japanese Purse Seine Port Sampling (origin ID = 'JPPS') datasets were extracted from SPC's LF MASTER database. Data from 2010 onwards were excluded due to the high observer coverage during this period. Samples that could not be attributed to assessment fisheries were excluded, e.g., samples with unknown school association in regions where fisheries are specific to set-type. Samples provided at a 10 (latitude) x 20° (longitude) or 5 x 10° spatial resolution were split to 5° cells, using the proportion of reported US (TTPS data) or Japanese catch (JPPS) in each 5° cell, for the year-quarter and set type in question (i.e. associated vs unassociated). We note that the majority of TTPS (85%) and JPPS (83%) samples were available at a 5° resolution.

Observer grab and spill samples were extracted from SPC's master observer database, along with the association type and total catch of each set recorded by observers. Data from an observer's first purse seine trip were excluded. Spill samples were used where available, including both paired grab / spill trips and observer data from the Philippines observer programme, otherwise grab samples were used. Grab samples were corrected for grab sample bias using correction factors (Peatman et al., 2019).

The resolution of strata used in the reweighting process was year-quarter, 5° cell, and fishery. Fisheries were specific to set type, i.e., free-school vs associated. First, we implemented a set-level lower limit for observer sampling intensity, i.e., total samples per tonne of catch. This ensures that high volume sets with low levels of sampling do not have excessive influence on reweighted length compositions in years with relatively limited sampling coverage. The lower limit was set at approximately 20% of the target grab sampling rate, i.e. 0.33 grab samples per tonne .

Observer length samples of all tropical tunas were raised from set-level to strata-level by first converting set-level numbers by species and length class to proportions by species and length class. These proportions were then raised to estimated numbers caught by species and length class, so that the estimated set catch across all species summed to the observer's estimate of catch weight for the set. Length weight parameters used in this process are provided in Table 7. We then aggregated from set-level to strata-level by summing estimated numbers caught by species and length class across sets, and then rescaling the strata-level numbers so that the total frequency in each strata was equal to the original sample size. We then filtered the length frequencies for skipjack.

Separately, US Multilateral Treaty Port Sampling data and Japanese Port Sampling data were raised to a strata-level by summing the numbers of samples in each length class across records. These samples were then combined with the strata-level observer samples, giving skipjack length frequencies per strata (i.e., a resolution of year-quarter, 5° cell, and fishery).

7.1.3 Reweighting of purse seine extraction fishery compositions

The strata-level purse-seine length frequencies (Section 7.1.2) were raised to an MFCL fishery resolution, i.e. year-quarter and fishery, as follows:

1. The size samples were filtered for strata with a minimum of samples, to attempt to reduce noise in size compositions due to low sample sizes. The total remaining samples per fishery and year-quarter are referred to as the 'original sample size' (OSS).

2. Strata-level numbers by size class were converted to catch weight proportions by size class, using the length-weight parameters in Table 7.

3. Strata-level catch weight proportions by size class were then converted to total species-specific catch weights by size class by multiplying by strata-level species-specific catch taken from S BEST data.

4. Strata-level catch weights by size class were then aggregated across strata to obtain MFCL fishery resolution catch weights by size class (i.e., year-quarter, fishery and length class).

5. Catch weights by size class were then converted to numbers caught by size class, by calculating the average weight of each size class using the length-weight relationships in Table 7.

6. Numbers caught by size class were then converted to proportions by size class, and then rescaled so that the total frequency in each year-quarter for a given fishery was equal to the

'original sample size' (from step 1) multiplied by the proportion of catch from strata with length samples.

7. The MFCL fishery resolution length compositions were then filtered for year-quarters where sampled strata accounted for a minimum proportion of the species-specific total catch of the fishery, i.e., filtering for year-quarters where the sum of strata weights from sampled cells exceeded a specified threshold. This limit is referred to as the 'minimum sampled weighting'.
8. Finally, the MFCL fishery resolution length compositions were filtered for year-quarters with a minimum 'original sample size'.

This approach scales the reweighted frequencies at a year-quarter and fishery resolution by the proportion of skipjack catch from 5° cells with size samples. For example, if sampled 5° cells accounted for 75% of the total skipjack catch for an (extraction) fishery and year-quarter, then the sum of the reweighted frequencies for that fishery and year-quarter would be equal to 75% of the original sample size.

7.1.4 Reweighting of purse seine index fishery compositions

Purse seine CPUE indices were generated for regions 6 to 8 using data from free-school sets. Reweighted size compositions were generated for the purse seine index fisheries in these regions, using size samples from free-school sets for consistency with the data used to generate the CPUE indices.

'Strata weights' were defined as the proportion of estimated relative abundance in a region over a time-window of $2k + 1$ quarters accounted for by each strata, i.e.

$$W_{i,t} = \frac{\sum_{\tau=t-k}^{t+k} v_{i,\tau}}{\sum_i \sum_{\tau=t-k}^{t+k} v_{i,\tau}}$$

where $W_{i,t}$ and $v_{i,t}$ are the strata weight and estimated relative abundance (respectively) for 5° cell i and year-quarter t. A time window of 1 quarter was used to calculate the strata weights, i.e. $k = 0$.

The strata-level length frequencies (Section 7.1.2) were raised to MFCL fishery resolution, i.e. year, quarter and fishery, by:

1. Converting from strata-level numbers by size-class to proportions by size class.
2. The strata-level proportions by size class were then multiplied by the strata weight, $W_{i,t}$, and summed across strata to obtain MFCL fishery resolution proportions by size class.
3. The MFCL fishery-resolution proportions by size class were then raised to numbers by size class, by multiplying with the original sample size for the fishery and year-quarter.
4. The MFCL fishery resolution length compositions were then filtered using the 'minimum

sampled weighting', i.e., filtering for year-quarters where sampled strata accounted for a minimum proportion of the total estimated relative abundance in the MFCL region.

5. Finally, the MFCL fishery resolution length compositions were then filtered for year-quarters with a minimum 'original sample size'.

This approach implicitly scales the reweighted frequencies at a year-quarter and fishery resolution by the proportion of relative abundance from 5° cells with size samples. For example, if sampled cells accounted for 50% of the total relative abundance for an (index) fishery and year-quarter, then the sum of the reweighted frequencies for that fishery and year-quarter would be equal to 50% of the original sample size.

7.1.5 Purse seine compositions for the domestic Philippines fisheries in region 5

The domestic Philippines extraction fishery in region 5 ('PSRN.PHPH.5') consists of three distinct fleets: the purse seine high-seas pocket fishery; domestic ringnet vessels operating in the Philippines's EEZ; and, domestic purse seine vessels operating in the Philippines EEZ. In earlier assessments, these fleets were grouped with the domestic Indonesian purse seine fishery operating in region 5, and size compositions were not reweighted due to the lack of information on the spatial distribution of catches for the domestic fleets. In this assessment, extraction fishery compositions for the 'PSRN.PHPH.5' fishery were reweighted using the approach outlined in Section 7.1.3, but with strata defined on the basis of year-quarter, fleet, and (MFCL) fishery.

Similarly, reweighted index fishery compositions for the domestic Philippines index fishery in region 5 ('Index.PS.PHPH.5') were generated using length samples from the two purse seine fleets, with strata weights equal to the estimated standardised CPUE for each fleet, rather than the catch, i.e., assuming the area covered by each fleet was equal.

7.1.6 Pole and line data preparation

Available length samples from SPC's LF MASTER database were extracted. Length samples, and aggregate pole and line catch data, were aggregated to consistent flag-fleet groupings, using lookup tables held by SPC's Data Management team. We used a 10° x 20° spatial resolution to reweight the pole and line size compositions. The resolution of strata used in the reweighting process was year, quarter, 10° x 20° cell, and fishery. Available length samples were aggregated to a strata level, by summing frequencies by length class across records.

Following earlier assessments, only Indonesian size samples were used to generate size compositions for the pole and line fishery in region 5, given that the Indonesian fleet accounted for the majority of the reported catches from the fishery (Vincent et al., 2019a; Castillo Jordán et al., 2022). This excluded 70,000 samples, representing c. 20% of the total samples available for the fishery, which were mainly samples from Japanese vessels collected pre-1980 when reported catches from the region were relatively low.

7.1.7 Reweighting of pole and line extraction and index fishery compositions

The size compositions were then reweighted spatially by fishery in the assessment model, using the following approach:

1. For a given fishery, size samples and aggregate catches (numbers) were aggregated to a strata resolution (i.e., a stratification of year-quarter, 10° x 20° cell and fishery).
2. The size samples were filtered for strata with a minimum of samples, to attempt to reduce noise in size compositions due to low sample sizes. The total remaining samples per fishery and year-quarter are referred to as the 'original sample size' (OSS).
3. 'Strata weights' for regular fisheries were then calculated using the proportion of catch over a time-window of $2k + 1$ quarters accounted for by each 10° x 20° cell

$$W_{i,t} = \frac{\sum_{\tau=t-k}^{t+k} C_{i,\tau}}{\sum_i \sum_{\tau=t-k}^{t+k} C_{i,\tau}}$$

   where $W_{i,t}$ and $C_{i,t}$ are the strata weight and catch (respectively) for 10° x 20° cell i and year-quarter t. Strata weights for index fisheries were equivalent but weighted by estimated relative abundance from the CPUE standardisation model by 10° x 20° cell and year-quarter, rather than catch. Time windows of 11 ($k = 5$) and 1 ($k = 0$) quarters was used to calculate the strata weights for extraction and index fisheries, respectively.
4. Strata-level numbers by size class were then converted to proportions by size class.
5. Strata-level proportions by size class were then weighted by multiplying by the appropriate strata weight $W_{i,t}$.
6. The weighted proportions by size class were then summed across strata to obtain proportions by size class and year-quarter for the fishery.
7. The fishery-resolution proportions by size class were then raised to numbers by size class, by multiplying by the total number of length samples for the fishery and year-quarter.
8. The MFCL fishery resolution length compositions were then filtered for year-quarters where sampled strata accounted for a minimum proportion of the species-specific total catch (extraction fisheries) or relative abundance (index fisheries), i.e., filtering for year-quarters where the sum of strata weights from sampled 10° x 20° cells exceeded a specified threshold. This limit is referred to as the 'minimum sampled weighting'.
9. Finally, the MFCL fishery resolution length compositions were filtered for year-quarters with a minimum 'original sample size'.

This approach implicitly scales the reweighted frequencies at a year-quarter and fishery resolution by the proportion of catch (regular fisheries) or relative abundance (index fisheries) from 10° x 20°

cells with size samples.

7.1.8 Input sample sizes for the assessment models

As described above, the number of samples per fishery and year-quarter after the initial filtering (e.g., step 1 in Section 7.1.3) is referred to as the 'original sample size'. We refer to the unit of frequencies of the reweighted size compositions as 'input sample sizes'. The input sample sizes are equal to the original sample size multipled by the proportion of the total catch (extraction fisheries) or abundance (index fisheries) from strata with size samples. The input sample sizes were also further reduced by 50% for fisheries where samples were used for both extraction and index fisheries size compositions. We note that the input sample sizes may be further adjusted within MFCL as part of the model fitting procedure.

7.1.9 Data filtering strengths

Reweighted size compositions for purse seine extraction fisheries were generated with the following filters: a minimum of 100 samples per strata; a minimum sampled weighting of 0.3 (i.e., sampled strata must account for a minimum of 30% of the catch for a fishery and year-quarter); and, a minimum original sample size of 250 for a fishery and year-quarter. The filters for the domestic Philippines extraction fishery in region 5 ('PSRN.PHPH.5') were: a minimum of 1000 samples per strata (as the stratification was at a relatively coarse resolution); and, a minimum sampled weighting of 0.3. The minimum original sample size filter was not implemented.

Reweighted size compositions for purse seine index fisheries were generated with the following filters: a minimum of 100 samples per strata; a minimum sampled weighting of 0.1 (i.e., sampled strata must account for a minimum of 10% of the estimate relative abundance for the index fishery and year-quarter); and, a minimum original sample size of 250. The filters for the domestic Philippines index fishery in region 5 ('Index.PS.PHPH.5') were: a minimum of 1000 samples per strata (as the stratification was at a relatively coarse resolution). The minimum sampled weighting and original sample size filters were not implemented.

Reweighted size compositions for pole and line extraction fisheries were generated with the following filters: a minimum of 30 samples per strata; a minimum sampled weighting of 0.3; and, a minimum original sample size of 100 for a fishery and year-quarter. Reweighted size compositions for pole and line extraction fisheries were generated with the following filters: a minimum of 30 samples per strata; a minimum sampled weighting of 0.1; and, a minimum original sample size of 100 for a fishery and year-quarter.

7.2 Results and Discussion

Reweighted size compositions and their associated input sample sizes are provided in Appendices specific to each gear and fishery type (i.e., extraction and index fisheries):

- Purse seine extraction fisheries: Appendix 14.1, Figures 1 to 12.
- Purse seine index fisheries: Appendix 14.2, Figures 1 to 4.
- Domestic Philippines purse seine extraction and index fisheries: Appendix 14.3, Figures 1 & 2.
- Pole and line extraction fisheries: Appendix 14.4, Figures 1 to 9.
- Pole and line index fisheries: Appendix 14.5, Figures 1 to 7.

The number of available size samples varies between fisheries, with the most samples available for purse seine fisheries in regions 6 to 8 from 2010 to 2019 when observer coverage rates were comparatively high (Figure 1). Observer coverage rates decreased in the second half of 2020 and 2021 due to Covid-19, leading to lower numbers of samples for purse seine fisheries, particularly for fisheries in regions 7 and 8. There was also a corresponding reduction in the spatial coverage of samples for the purse seine fisheries in regions 7 and 8. This could lead to bias in size compositions for these fisheries in the impacted year-quarters, if available samples are not representative of the fishery as a whole. The number of samples largely recovered to pre-2020 levels by 2023.

The downweighting of input sample sizes was relatively weak in purse seine extraction fisheries (Figure 1), particularly post-2010, and more pronounced for purse seine index fisheries (Figure 1) and both extraction (Figure 1) and index (Figure 1) pole and line fisheries. This reflects the comprehensive coverage of available length samples for the purse seine fisheries, at least in relation to their catch, through observers. The stronger downweighting of index fishery compositions is typical of recent assessments of tuna stocks in the WCPFC Convention Area, reflecting estimated abundance in areas with no length samples, and potentially no catch, for a given year-quarter.

The reweighting process did reduce, but did not completely remove, apparent noise in size compositions. Remaining apparent noise was commonly associated with year-quarters with relatively low sample sizes, e.g. purse seine fishery compositions pre-2000 (e.g., Figure 8). There was apparent cohort progression in reweighted size compositions for a number of fisheries, most clearly seen in the pole and line extraction fishery in region 2 (Figure 3), as well as purse seine extraction fisheries in regions 6 to 8 (Figure 7 to 12). Reweighted size compositions for the pole and line extraction fishery in region 3 demonstrated strong temporal variation, particularly in the 1970s and 2000s (Figure 4). The observed variation in sizes in this region has been suggested to reflect the periodic occurrence of large spawning fish and smaller recruits (Hamer, 2022).

The choice of minimum sampled weighting is a compromise between attempting to remove temporal variation in size compositions as a result of unrepresentative sampling, whilst avoiding excessive filtering (McKechnie, 2014). We recommend that a minimum sampled weighting of 0.3 be used for both purse seine and pole and line extraction fisheries. This requires sampled strata in a given year-quarter to account for a minimum of 30% of the catch from the fishery, otherwise the reweighted size compositions for that year-quarter are excluded. Additionally, we recommend that a minimum sampled weighting of 0.1 be used for both purse seine and pole and line index fisheries. These minimum sampled weightings are broadly consistent with those used recommended for recent assessments of tropical tunas (Peatman et al., 2023b).

The reweighting procedure includes a new data filtering step, where the fishery-level length compositions are filtered for year-quarters with a minimum 'original sample size'. This filter is intended to remove compositions with insufficient samples to inform a robust estimate of the size compositions, and so mitigate against the propogation of noise through to assessment model inputs. This filter is not particularly influential for skipjack with the current reweighting methodology given the large sample sizes and often representative coverage. However, the large original and input sample sizes are likely illusionary, in the sense that they over-estimate the precision of the estimated size composition. As discussed at the 2025 Pre-Assessment Workshop, it would be better to estimate the input sample sizes in a way that better reflects the precision of the compositional data (e.g., Stewart and Hamel, 2014). However, this would require samples to be available at a trip, and ideally an event, resolution. This information is not comprehensively available for all of SPC's size data holdings, particularly historic aggregated size data submissions.

The existing procedures used to reweight size compositions provide a means of accounting for imbalanced sampling across fleets and regions. However, the reweighting procedure can not infer size compositions for strata with no available samples. This can result in temporal variation in index and extraction fishery compositions which likely reflects changes in sampling availability and intensity between fleets, rather than changes in the composition of catches or the underlying population. Spatial-temporal modelling approaches provide a means of inferring size compositions for strata missing samples (Maunder et al., 2020).

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9 References

Abadi, F., Botha, A., and Altwegg, R. (2013). Revisiting the effect of capture heterogeneity on survival estimates in capture-mark-recapture studies: does it matter? *PloS one*, 8(4):e62636. Publisher: Public Library of Science San Francisco, USA.

Anderson, S. C., Ward, E. J., English, P. A., and Barnett, L. A. (2022). sdmTMB: an R package for fast, flexible, and user-friendly generalized linear mixed effects models with spatial and spatiotemporal random fields. *BioRxiv*, pages 2022–03. Publisher: Cold Spring Harbor Laboratory.

Aoki, Y. and et al. (2025). Japanese data update: tagging, size and biological infromation. Technical Report WCPFC-SC21-SA-IP04.

Berger, A. M., McKechnie, S., Abascal, F., Kumasi, B., Usu, T., and Nichol, S. J. (2014). Analysis of tagging data for the 2014 tropical tuna assessments: data quality rules, tagger effects, and reporting rates. Technical Report WCPFC-SC10-2014/SA-IP-06, Majuro, Republic of the Marshall Islands, 6–14 August 2014.

Bigelow, K., Garvilles, E., Bayate, D. E., and Cecilio, A. (2019). Relative abundance of skipjack tuna for the purse seine fishery operating in the Philippines Moro Gulf (Region 12) and High Seas Pocket# 1. Technical Report WCPFC-SC15-2019/SA-IP-08.

Buenafe, K. C. V., Everett, J. D., Dunn, D. C., Mercer, J., Suthers, I. M., Schilling, H. T., Hinchliffe, C., Dabalà, A., and Richardson, A. J. (2022). A global, historical database of tuna, billfish, and saury larval distributions. *Scientific Data*, 9(1):423. Publisher: Nature Publishing Group UK London.

Castillo Jordán, C., Teears, T., Hampton, J., Davies, N., Scutt Phillips, J., McKechnie, S., Peatman, T., MacDonald, J., Day, J., Magnusson, A., Scott, R., Scott, F., Pilling, G., and Hamer, P. (2022). Stock assessment of skipjack tuna in the western and central Pacific Ocean: 2022. *18th Regular Session of the WCPFC Scientific Committee*, WCPFC-SC18-2022/SA-WP-01.

Day, J., Magnusson, A., Teears, T., Hampton, J., Davies, N., Castillo Jordan, C., Peatman, T., Scott, R., Scutt Phillips, J., McKechnie, S., Scott, F., Yao, N., Pilling, G., Williams, P., and Hamer, P. (2023). Stock assessment of bigeye tuna in the western and central Pacific Ocean: 2023. Technical Report WCPFC-SC19-2023/SA-WP-05.

Dunn, S., Rodwell, L., and Joseph, G. (2006). The Palau arrangement for the management of the western Pacific purse seine fishery-management scheme (Vessel Day Scheme). In *Sharing the Fish Conference, Perth.*

Fournier, D., Hampton, J., and Sibert, J. (1998). MULTIFAN-CL: a length-based, age-structured model for fisheries stock assessment, with application to South Pacific albacore, *Thunnus alalunga*. *Canadian Journal of Fisheries and Aquatic Sciences*, 55:2105–2116.

Fujioka, K., Aoki, Y., Tsuda, Y., Okamoto, K., Tsuchida, H., Sasaki, A., and Kiyofuji, H. (2024). Influence of temperature on hatching success of skipjack tuna (*Katsuwonus pelamis*): Implications for spawning availability of warm habitats. *Journal of Fish Biology*, 105(1):372–377. Publisher: Wiley Online Library.

Geisser, S. and Eddy, W. F. (1979). A predictive approach to model selection. *Journal of the American Statistical Association*, 74(365):153–160. Publisher: Taylor & Francis.

Gelman, A., Hwang, J., and Vehtari, A. (2014). Understanding predictive information criteria for Bayesian models. *Statistics and computing*, 24:997–1016. Publisher: Springer.

Guillemain, M., Pradel, R., Devineau, O., Simon, G., and Gauthier-Clerc, M. (2014). Demographic heterogeneity among individuals can explain the discrepancy between capture–mark–recapture and waterfowl count results. *The Condor: Ornithological Applications*, 116(3):293–302. Publisher: Oxford University Press.

Hamer, P. (2022). Report from the SPC pre-assessment workshop – March 2022. *18th Regular Session of the WCPFC Scientific Committee*, WCPFC-SC18-2022/SA-IP-02.

Hamer, P. (2025). Summary report from the SPC Pre-assessment Workshop – April 2025. Technical Report WCPFC-SC21-2025/SA-IP-01, Pacific Community.

Hampton, J. and Fournier, D. (2001). A spatially-disaggregated, length-based, age-structured population model of yellowfin tuna (*Thunnus albacares*) in the western and central Pacific Ocean. *Marine and Freshwater Research*, 52:937–963.

Hartig, F. and Lohse, L. (2017). Residual diagnostics for hierarchical (multi-level/mixed) regression models. *R package version 0.1*, 5:1–21.

Kleiber, P., Fournier, D., Hampton, J., Davies, N., Bouye, F., and Hoyle, S. (2019). MULTIFAN-CL User's Guide. Technical report.

Macdonald, J. (2023). Project 90 update: Better data on fish weights and lengths for scientific analyses. *19th Regular Session of the WCPFC Scientific Committee*, WCPFC-SC19-2023/ST-IP-04.

Magnusson, A., Day, J., Teears, T., Hampton, J., Davies, N., Castillo Jordan, C., Peatman, T., Scott, R., Scutt Phillips, J., McKechnie, S., Scott, F., Yao, N., Pilling, G., Williams, P., and Hamer, P. (2023). Stock assessment of yellowfin tuna in the western and central Pacific Ocean: 2023. Technical Report WCPFC-SC19-2023/SA-WP-04.

Maunder, M. N., Thorson, J. T., Xu, H., Oliveros-Ramos, R., Hoyle, S. D., Tremblay-Boyer, L., Lee, H. H., Kai, M., Chang, S.-K., Kitakado, T., and others (2020). The need for spatio-temporal modeling to determine catch-per-unit effort based indices of abundance and associated composition data for inclusion in stock assessment models. *Fisheries Research*, 229:105594. Publisher: Elsevier.

McKechnie, S. (2014). Analysis of longline size frequency data for bigeye and yellowfin tunas in the WCPO. *10th Regular Session of the WCPFC Scientific Committee*, WCPFC-SC10-2014/SA-IP-04.

McKechnie, S. (2016). Summary of fisheries structures for the 2016 stock assessment of skipjack tuna in the western and central Pacific Ocean. Technical Report WCPFC-SC12-2016/SA-IP-06, Bali, Indonesia, 3–11 August 2016.

McKechnie, S., Ochi, D., Kiyofuji, H., Peatman, T., and Caillot, S. (2016). Construction of tagging data input files for the 2016 skipjack tuna stock assessment in the western and central Pacific Ocean. Technical Report WCPFC-SC12-2016/SA-IP-05, Bali, Indonesia, 3–11 August 2016.

McKechnie, S., Tremblay-Boyer, L., and Pilling, G. (2017). Background analyses for the 2017 stock assessments of bigeye and yellowfin tuna in the western and central Pacific Ocean. Technical Report WCPFC-SC13-2017/SA-IP-06, Rarotonga, Cook Islands.

Nishimoto, M., Yoshinori, A., Matsubara, N., Tsuda, Y., Kiyofuji, H., Teears, T., Yao, N., and Hamer, P. (2025). CPUE standardization using sdmTMB for skipjack tuna stock assessment. Technical Report WCPFC-SC21-SA-IP-05.

Peatman, T. (2020). Analysis of tag seeding data and reporting rates. Technical Report SC16-SA-IP-04.

Peatman, T. (2025a). Analysis of tag seeding data for the 2025 skipjack assessment: reporting rates for purse seine fleets. Technical Report WCPFC-SC21-SA-IP-07.

Peatman, T. (2025b). Analysis of tagging data for the 2025 skipjack assessment: corrections to tag release for tagging conditions. Technical Report WCPFC-SC21-SA-IP-06.

Peatman, T., Day, J., Magnusson, A., Teears, T., Williams, P., Hampton, J., and Hamer, P. (2023a). Analysis of purse-seine and longline size frequency data for the 2023 bigeye and yellowfin tuna assessments. *19th Regular Session of the WCPFC Scientific Committee*, WCPFC-SC19-2023/SA-IP-03.

Peatman, T., Day, J., Magnusson, A., Teears, T., Williams, P., Hampton, J., and Hamer, P. (2023b). Analysis of purse–seine and longline size frequency data for the 2023 bigeye and yellowfin tuna assessments. *19th Regular Session of the WCPFC Scientific Committee*, WCPFC-SC19-2023/SA-IP-03.

Peatman, T., Ducharme-Barth, N., and Vincent, M. (2020a). Analysis of purse-seine and longline size frequency data for bigeye and yellowfin tuna in the WCPO. Technical Report SC16-SA-IP-18.

Peatman, T., Ducharme Barth, N., and Vincent, M. (2020b). Analysis of purse-seine and longline size frequency data for bigeye and yellowfin tuna in the WCPO. *16th Regular Session of the WCPFC Scientific Committee*, WCPFC-SC16-2020/SC16-SA-IP-18.

Peatman, T., Fukofuka, S., Park, T., Williams, P., Hampton, J., and Smith, N. (2019). Better purse seine catch composition estimates: progress on the Project 60 work plan. Technical Report.

Peatman, T., Scutt Phillips, J., Potts, J., and Nicol, S. (2022). ANALYSIS OF TAGGING DATA FOR THE 2022 SKIPJACK TUNA ASSESSMENT: CORRECTIONS FOR TAGGING CONDITIONS. (SC18-SA-IP-20).

Punt, A. E., Maunder, M. N., and Ianelli, J. N. (2023). Independent review of recent WCPO yellowfin tuna assessment. *19th Regular Session of the WCPFC Scientific Committee*, WCPFC-SC19-2023/SA-WP-01.

Scutt Phillips, J., Lehodey, J., Hampton, J., Hamer, P., Senina, I., and Nicol, S. (2022). Quantifying Rates of Mixing in Tagged, WCPO Skipjack Tuna. Technical Report WCPFC-SC18-2022/SA-WP-04.

Scutt Phillips, J., Lehodey, J., Senina, I., Barker, R., Peatman, T., Schofield, M., Sen Gupta, A., Van Sebille, E., and Nicol, S. (2024). Optimising the design and analysis of capture-mark-recapture experiments using individual-based models. *Frontiers in Marine Science*, 11:1497812. Publisher: Frontiers Media SA.

Scutt Phillips, J., Peatman, T., Vincent, M., and Nicol, S. (2020). Analysis of tagging data for the 2020 tropical tuna assessments: tagger and condition effects. Technical Report SC16-SA-IP-05.

Scutt Phillips, J., Sen Gupta, A., Senina, I., Sebille, E., Lange, M., Lehodey, P., J, H., and Nichol, S. (2018). An individual-based model of skipjack tuna (*Katsuwonus pelamis*) movement in the tropical Pacific Ocean. *Progress in Oceanography*, 164:63–74.

Senina, I., Bonnin, L., Lengaigne, M., Kiyofuji, H., Buenafe, K., Fuller, D., and Nicol, S. (2025). Reference model of skipjack tuna using SEAPODYM with catch, length, conventional tagging and early-life history stages data. Technical Report WCPFC-SC21-SA-IP20.

Senina, I., Lehodey, P., Sibert, J., and Hampton, J. (2020). Integrating tagging and fisheries data into a spatial population dynamics model to improve its predictive skills. *Canadian Journal of Fisheries and Aquatic Sciences*, 77(3):576–593. Publisher: NRC Research Press.

Sivula, T., Magnusson, M., Matamoros, A. A., and Vehtari, A. (2020). Uncertainty in Bayesian leave-one-out cross-validation based model comparison. *arXiv preprint arXiv:2008.10296*.

Stewart, I. J. and Hamel, O. S. (2014). Bootstrapping of sample sizes for length–or age–composition data used in stock assessments. *Canadian Journal of Fisheries and Aquatic Sciences*, 71(4):581–588. Publisher: NRC Research Press.

Teears, T., Aoki, Y., Matsubura, N., Tsuda, Y., Castillo Jordan, C., Hampton, J., Schneiter, E., Scutt Phillips, J., Peatman, T., Bigelow, K., and Hamer, P. (2022). Background analyses and data inputs for the 2022 skipjack stock assessment in the Western and Central Pacific Ocean. *18th Regular Session of the WCPFC Scientific Committee*, WCPFC-SC18-2022/SA-IP-05.

Teears, T., Castillo-Jordan, C., Davies, N., Day, J., Hampton, J., Magnusson, A., Peatman, T., Pilling, G., Xu, H., Vidal, T., Williams, P., and Hamer, P. (2024a). Stock Assessment of South Pacific Albacore: 2024. Technical Report WCPFC-SC20-2024/SA-WP-01, Manilla, Phillippines, 14–21 August 2024.

Teears, T., Day, J., Hampton, J., Magnusson, A., McKechnie, S., Peatman, T., Scutt Phillips, J., Williams, P., and Hamer, P. (2023). CPUE analysis and data inputs for the 2023 bigeye and yellowfin tuna assessments in the WCPO. Technical Report SC19-SA-WP-03.

Teears, T., Hampton, J., Peatman, T., Vidal, T., Williams, P., Xu, H., and Hamer, P. (2024b). Background Analyses and Data Inputs for the 2024 South Pacific Albacore Tuna Stock Assessment. Technical Report SC20-SA-IP-05.

Thorson, J. T. (2019). Guidance for decisions using the Vector Autoregressive Spatio-Temporal (VAST) package in stock, ecosystem, habitat and climate assessments. *Fisheries Research*, 210:143–161.

Thorson, J. T., Shelton, A. O., Ward, E. J., and Skaug, H. J. (2015). Geostatistical delta-generalized linear mixed models improve precision for estimated abundance indices for West Coast groundfishes. *Ices Journal of Marine Science*, 72(5):1297–1310.

Tremblay–Boyer, L., McKechnie, S., and Pilling, G. (2018). Background analysis for the 2018 stock assessment of South Pacific albacore tuna. *14th Regular Session of the WCPFC Scientific Committee*, WCPFC-SC14-2018/SA-IP-07.

Valavi, R., Elith, J., Lahoz-Monfort, J. J., and Guillera-Arroita, G. (2019). blockCV: An r package for generating spatially or environmentally separated folds for k-fold cross-validation of species distribution models. *Methods in Ecology and Evolution*, pages 225–232.

Vidal, T., Castillo-Jordán, C., Peatman, T., Ducharme-Barth, N., Xu, H., Williams, P., and Hamer, P. (2021). Background analyses and data inputs for the 2021 South Pacific albacore tuna stock assessment. *17th Regular Session of the WCPFC Scientific Committee*, WCPFC-SC17-2021/SA-IP-03.

Vidal, T., Hamer, P., Escalle, L., and Pilling, G. (2020). Assessing trends in skipjack tuna abundance from purse seine catch and effort data in the WCPO. Technical Report WCPFC-SC16-SA-IP-09 Rev 1.

Vincent, M., Pilling, G. M., and Hampton, J. (2019a). Stock assessment of skipjack tuna in the western and central Pacific Ocean. *19th Regular Session of the WCPFC Scientific Committee*, WCPFC-SC15-2019/SA-WP-05.

Vincent, M. T., Aoki, Y., Kiyofuji, H., Hampton, J., and Pilling, G. M. (2019b). Background analyses for the 2019 stock assessment of skipjack tuna. Technical Report WCPFC-SC15-2019/SA-IP-04, Pohnpei, Federated States of Micronesia.

Warton, D. I., Thibaut, L., and Wang, Y. A. (2017). The PIT-trap—A "model-free" bootstrap procedure for inference about regression models with discrete, multivariate responses. *PloS one*, 12(7):e0181790. Publisher: Public Library of Science San Francisco, CA USA.

10 Tables

Table 1: Results from the covariate selection for the purse seine CPUE in regions 6, 7, and 8 using forward stepwise selection based on predictive performance (expected log pointwise predictive density – ELPD). The potential density covariates included sea-surface temperature (sst), chlorophyll-a concentration (chlor), El Niño-Southern Oscillation (ENSO) data, and month. The potential catchability covariates included vessel identification (vessel), flag, vessel length (vess.len), and detection method (detect.code).

Model configuration	ELPD
cpue ∼ yrqtr + vessel + detect.code + month + sst * chlor + ENSO	**1,877,702**
cpue ∼ yrqtr + vessel + detect.code + month + sst * chlor	1,878,617
cpue ∼ yrqtr + vessel + detect.code + month + sst * chlor + ENSO + vess.len	1,879,460
cpue ∼ yrqtr + vessel + detect.code + month	1,885,420
cpue ∼ yrqtr + vessel + detect.code	1,936,009
cpue ∼ yrqtr + vessel	2,301,437
cpue ∼ yrqtr	4,422,541

Table 2: Results from the covariate selection for the Phillipines purse seine standardised CPUE model in region 5 using Akaike Information Criterion (AIC). The potential covariates included vessel identification (vessel) and area.

Model configuration	AIC
cpue ∼ yrqtr + vessel	**84,280.42**
cpue ∼ yrqtr + vessel + area	84,291.26
cpue ∼ yrqtr + area	84,679.62
cpue ∼ yrqtr	84,704.51

Table 3: Aggregated tag release events representing the 20 largest tag releases from the PTTP, comparing observed total recapture rate (yellow bar) and probability distribution of simulated total recapture probability (Prob. dist.) from tag mixing simulations (gray line distribution).

Date	Cohort	Lon	Lat	N	Recapture %	Region	Prob. Dist.
15/05/2009	45.27	173	2	4820	0.14	8	
15/08/2019	51.19	134	8	2308	0.12	5	
15/08/2019	53.86	134	8	2154	0.11	5	
15/11/2008	38.49	132	-4	2129	0.07	5	
15/05/2013	38.49	147	0	1950	0.12	7	
15/11/2008	38.49	126	-3	1836	0.28	5	
15/05/2013	38.49	150	-7	1797	0.1	6	
15/08/2009	51.19	151	-3	1766	0.19	6	
15/08/2017	38.49	151	-3	1578	0.08	6	
15/11/2008	38.49	131	0	1564	0.25	5	
15/05/2009	41.99	173	2	1482	0.14	8	
15/05/2007	38.49	149	-4	1380	0.06	6	
15/05/2009	38.49	159	-8	1366	0.2	6	
15/02/2009	34.73	153	-11	1362	0.02	4	
15/08/2011	53.86	155	-5	1361	0.15	7	
15/02/2012	41.99	148	-4	1335	0.49	6	
15/11/2017	51.19	158	-8	1266	0.36	6	
15/11/2017	48.33	158	-8	1255	0.36	6	
15/08/2011	51.19	155	-5	1252	0.15	7	
15/05/2009	48.33	173	2	1240	0.15	8	

Table 4: Definition of fisheries for the 2025 MFCL skipjack tuna stock assessment, refer to Figure 1.

Fishery Number	Gear	Model Code-Fleets	Flags	Model Region
1	PL	1.PL.ALL.1	ALL	1
2	PS	2.PS.ALL.1	ALL	1
3	LL	3.LL.ALL.1	ALL	1
4	PL	4.PL.ALL.2	ALL	2
5	PS	5.PS.ALL.2	ALL	2
6	LL	6.LL.ALL.2	ALL	2
7	PL	7.PL.ALL.3	ALL	3
8	PS	8.PS.ALL.3	ALL	3
9	LL	9.LL.ALL.3	ALL	3
10	Dom	10.Z.PH.5	PH	5
11	Dom	11.Z.ID.5	ID	5
12	PS	12.S.PH.5	PH	5
13	PS	13.S.ID.5	ID	5
14	PL	14.PL.ALL.5	ALL	5
15	PS.ASSOC	15.SA.DW.5	DW	5
16	PS.UNASSOC	16.SU.DW.5	DW	5
17	Dom	17.Z.VN.5	VN	5
18	LL	18.LL.ALL.5	ALL	5
19	PL	19.PL.ALL.6	ALL	6
20	PS.ASSOC	20.SA.ALL.6	ALL	6
21	PS.UNASSOC	21.SU.ALL.6	ALL	6
22	LL	22.LL.ALL.6	ALL	6
23	PL	23.PL.ALL.4	ALL	4
24	LL	24.LL.ALL.4	ALL	4
25	PL	25.PL.ALL.7	ALL	7
26	PS.ASSOC	26.SA.ALL.7	ALL	7
27	PS.UNASSOC	27.SU.ALL.7	ALL	7
28	LL	28.LL.ALL.7	ALL	7
29	PL	29.PL.ALL.8	ALL	8
30	PS.ASSOC	30.SA.ALL.8	ALL	8
31	PS.UNASSOC	31.SU.ALL.8	ALL	8
32	LL	32.LL.ALL.8	ALL	8
33	PL	33.PL.INDEX.JP.1	JP	1
34	PL	34.PL.INDEX.JP.2	JP	2
35	PL	35.PL.INDEX.JP.3	JP	3
36	PL	36.PL.INDEX.JP.4	JP	4
37	PS	37.PS.INDEX.PH.PH.5	PH	5
38	PL	38.PL.INDEX.JP.7	JP	7
39	PL	39.PL.INDEX.JP.8	JP	8
40	PS.UNASSOC	40.PS.UNASSOC.INDEX.ALL.6	ALL	6
41	PS.UNASSOC	41.PS.UNASSOC.INDEX.ALL.7	ALL	7
42	PS.UNASSOC	42.PS.UNASSOC.INDEX.ALL.8	ALL	8

Table 5: Extraction fisheries in the 2025 skipjack assessment with reweighted size compositions. PL = pole and line; PS = purse seine unspecified; RN = ringnet; ASSOC = associated; UNASSOC = unassociated. Nationalities: ALL = all flags; DW = distant water (large-scale) fleets; IDID = Indonesia (domestic fleet); JP = Japan; PHPH = Philippines (domestic fleet).

Fishery ID	Nationality	Gear	Region
PL.JP.1	JP	PL	1
PL.ALL.2	ALL	PL	2
PL.JP.3	JP	PL	3
PL.ALL.4	ALL	PL	4
PL.ALL.5	ALL	PL	5
PL.ALL.6	ALL	PL	6
PL.JP.7	JP	PL	7
PL.ALL.8	ALL	PL	8
PS.ALL.1	ALL	PS	1
PS.ALL.2	ALL	PS	2
PS.ALL.3	ALL	PS	3
PSRN.PHPH.5	PHPH	PS	5
PS.ASSOC.DW.5	ALL	PS	5
PS.UNASSOC.DW.5	ALL	PS	5
PS.ASSOC.ALL.6	ALL	PS	6
PS.UNASSOC.ALL.6	ALL	PS	6
PS.ASSOC.ALL.7	ALL	PS	7
PS.UNASSOC.ALL.7	ALL	PS	7
PS.ASSOC.ALL.8	ALL	PS	8
PS.UNASSOC.ALL.8	ALL	PS	8

Table 6: Index fisheries in the 2025 skipjack assessment with reweighted size compositions. PL = pole and line; PS = purse seine unspecified; UNASSOC = unassociated. PHPH refers to domestic fisheries of the Philippines.

Fishery ID	Nationality	Gear	Region
Index.PL.1	Index	PL	1
Index.PL.2	Index	PL	2
Index.PL.3	Index	PL	3
Index.PL.4	Index	PL	4
Index.PL.7	Index	PL	7
Index.PL.8	Index	PL	8
Index.PS.PHPH.5	Index	PS	5
Index.PS.UNASSOC.6	Index	PS	6
Index.PS.UNASSOC.7	Index	PS	7
Index.PS.UNASSOC.8	Index	PS	8

Table 7: Length-weight parameters used to reweight purse seine fishery compositions. Parameters for skipjack were taken from Teears et al. (2022). Parameters for bigeye and yellowfin were generated through WCPFC Project 90 (Macdonald, 2023).

Species code	a	b
SKJ	1.144e-05	3.148
YFT	1.987e-05	2.991
BET	3.063e-05	2.932

11 Figures

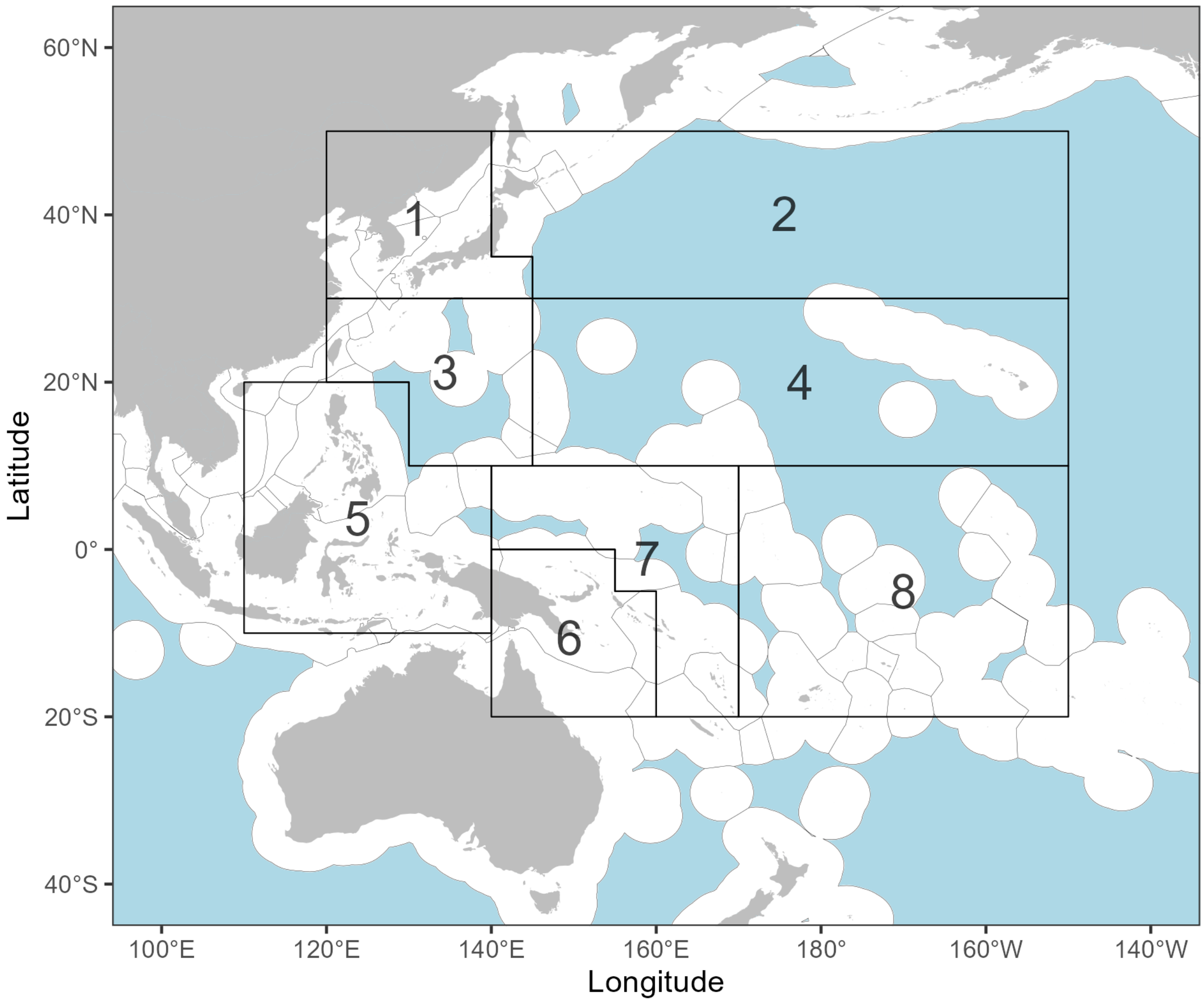


Figure 1: The geographical area covered by the stock assessment and the boundaries of the eight model regions used for the 2025 skipjack assessment.

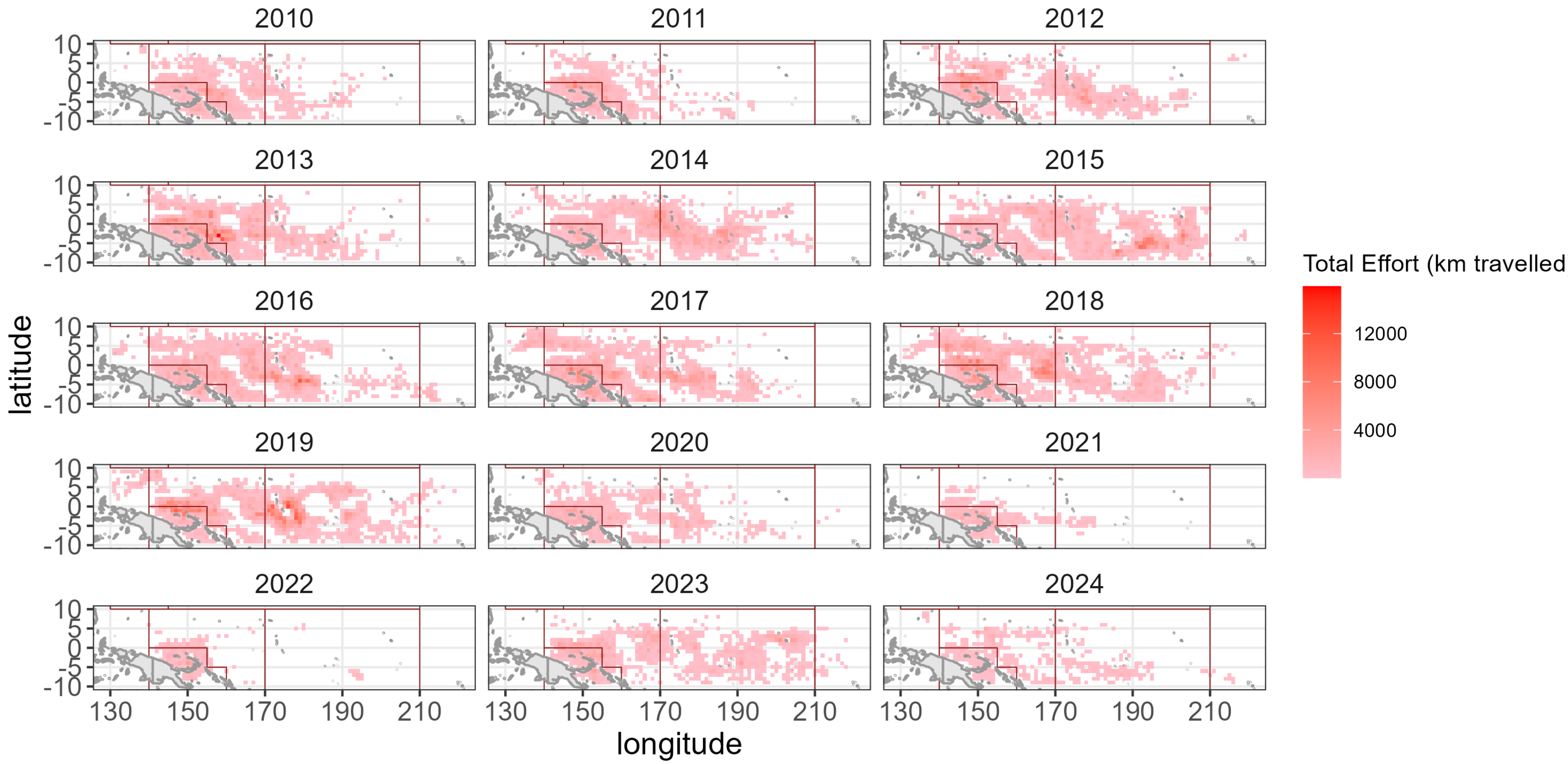


Figure 2: Observer unassociated purse seine effort (km travelled) in regions 6, 7, and 8 (regional boundary lines in red and in ascending order from left to right), from 2010-2024. Does not include unassociated effort from vessels defined as FAD specialists.

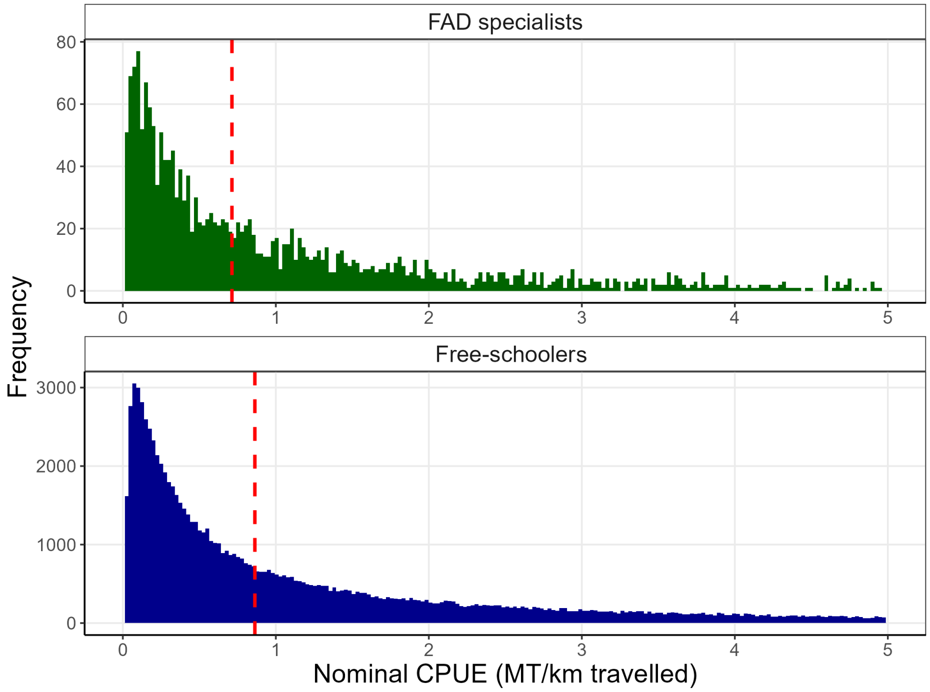


Figure 3: Histogram of unassociated nominal CPUE (MT/km travelled) for 'FAD' specialist vessels and non-FAD specialist vessels (free-schoolers). Red dashed lines represent the median of the distributions.

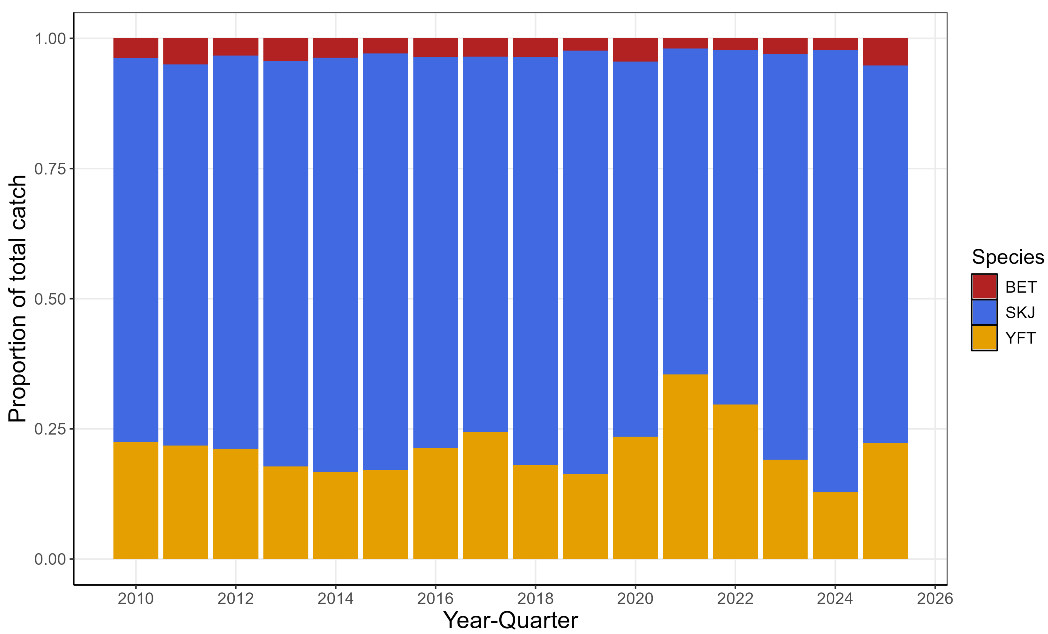


Figure 4: Proportion of skipjack (SKJ), yellowfin (YFT), and bigeye (BET) tuna in purse seine catches from 2010 through 2024 from the observer data.

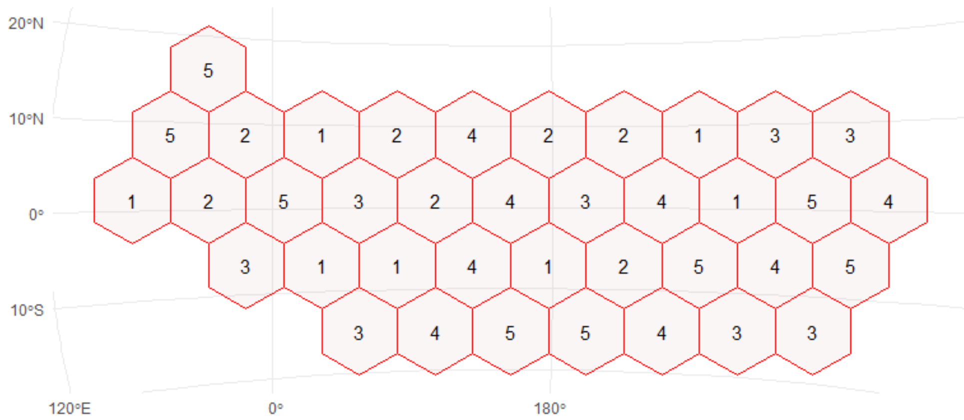


Figure 5: Example of spatial blocking of purse seine observer data for PS.6–8 for k-fold (k = 5) cross validation used in testing the predictive performance of candidate models with potential environmental and catchability covariates. The number in each block corresponds to the fold assignment (1-5).

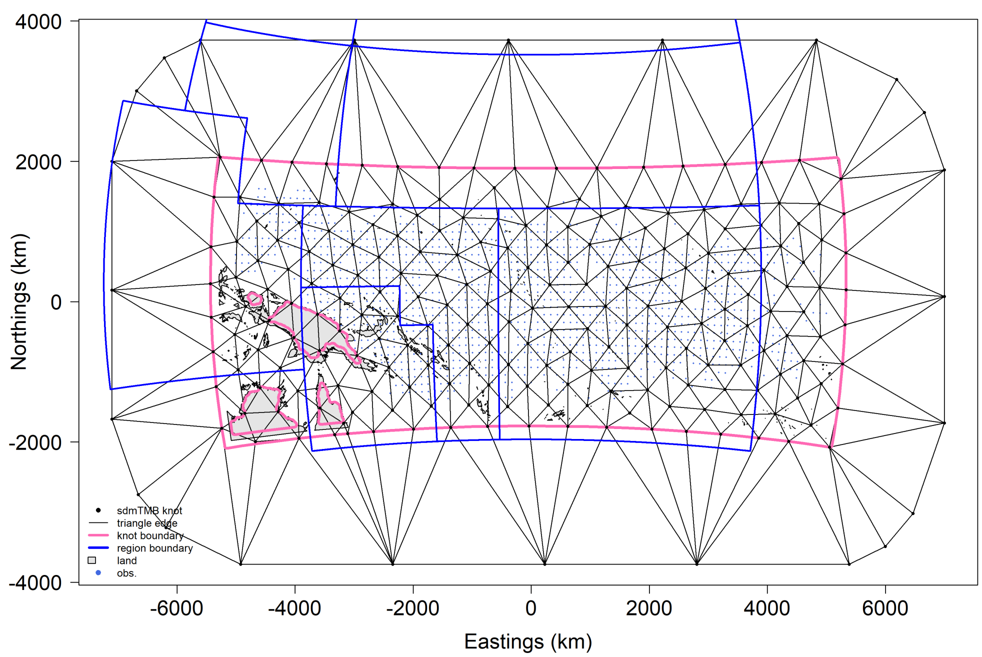
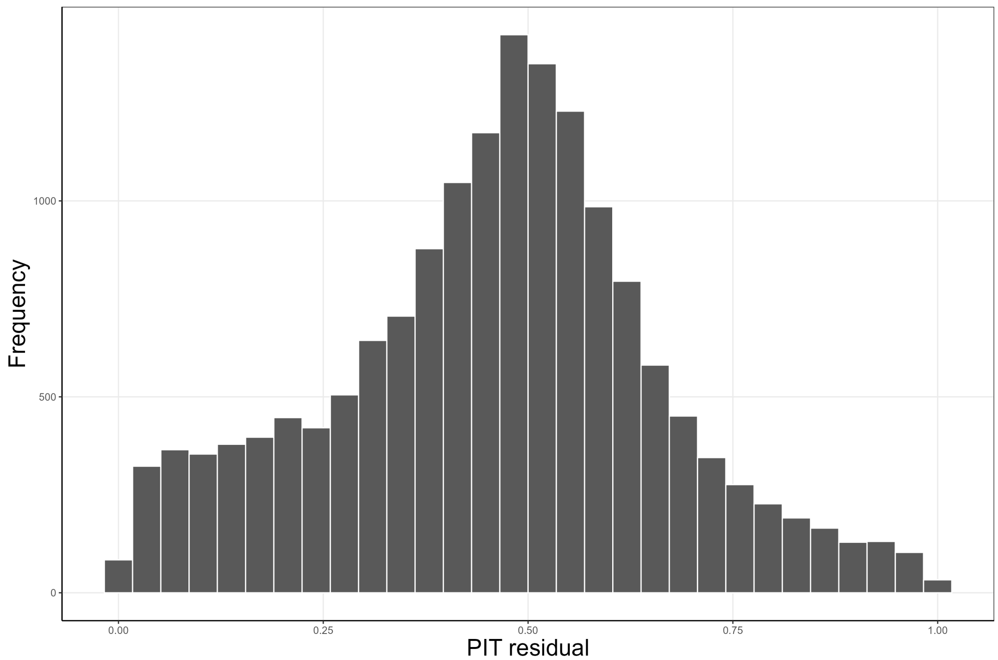


Figure 6: Equidistant projection showing the distribution of 242 spatial knots used to define the mesh for the spatiotemporal standardisation. The regional stock assessment spatial structure (blue lines), the mesh boundaries (pink line), and the observation locations (blue dots) are included.



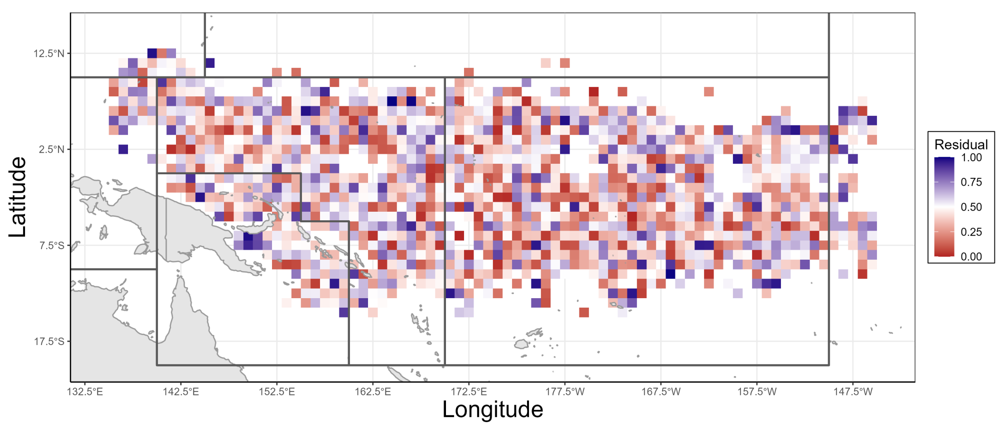
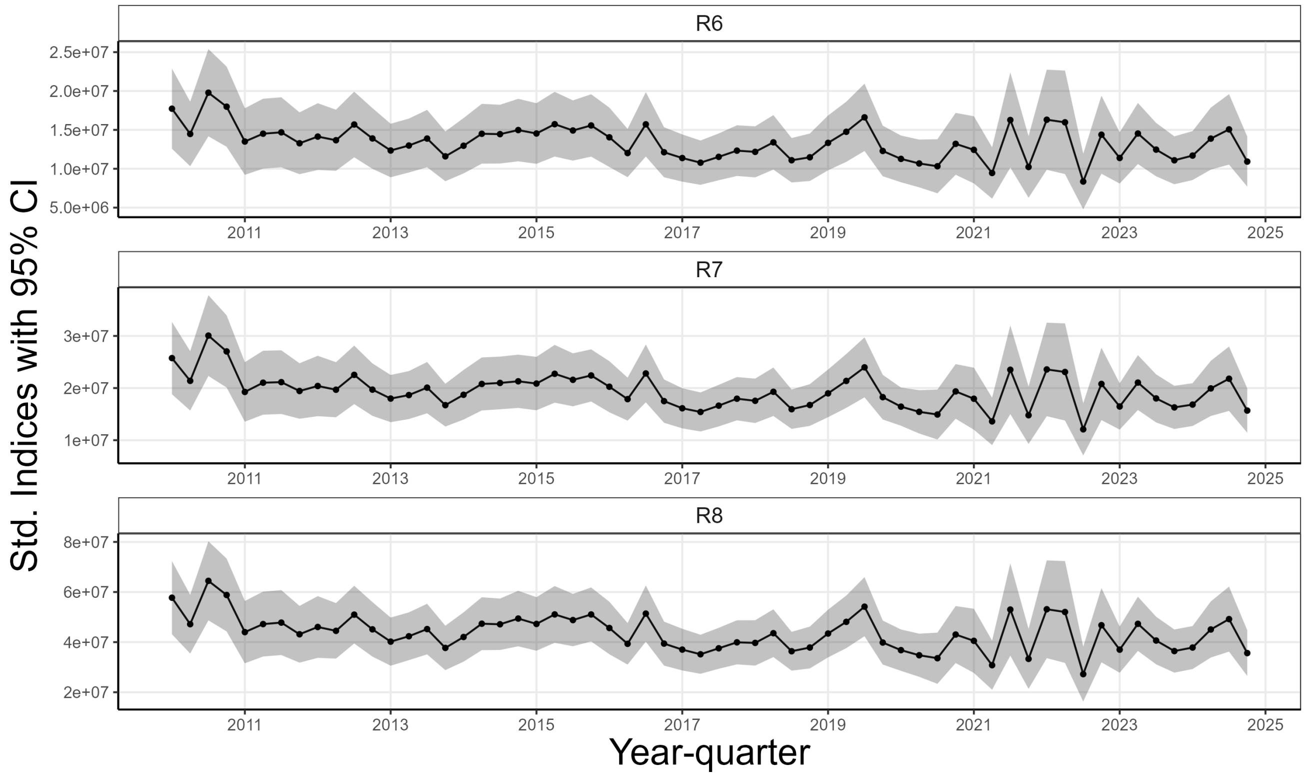


Figure 7: Probability-integrated-transform (PIT) residuals as histograms (top) and spatially by 5°x5° grid cells (bottom) of CPUE standardization of purse seine in regions 6–8.



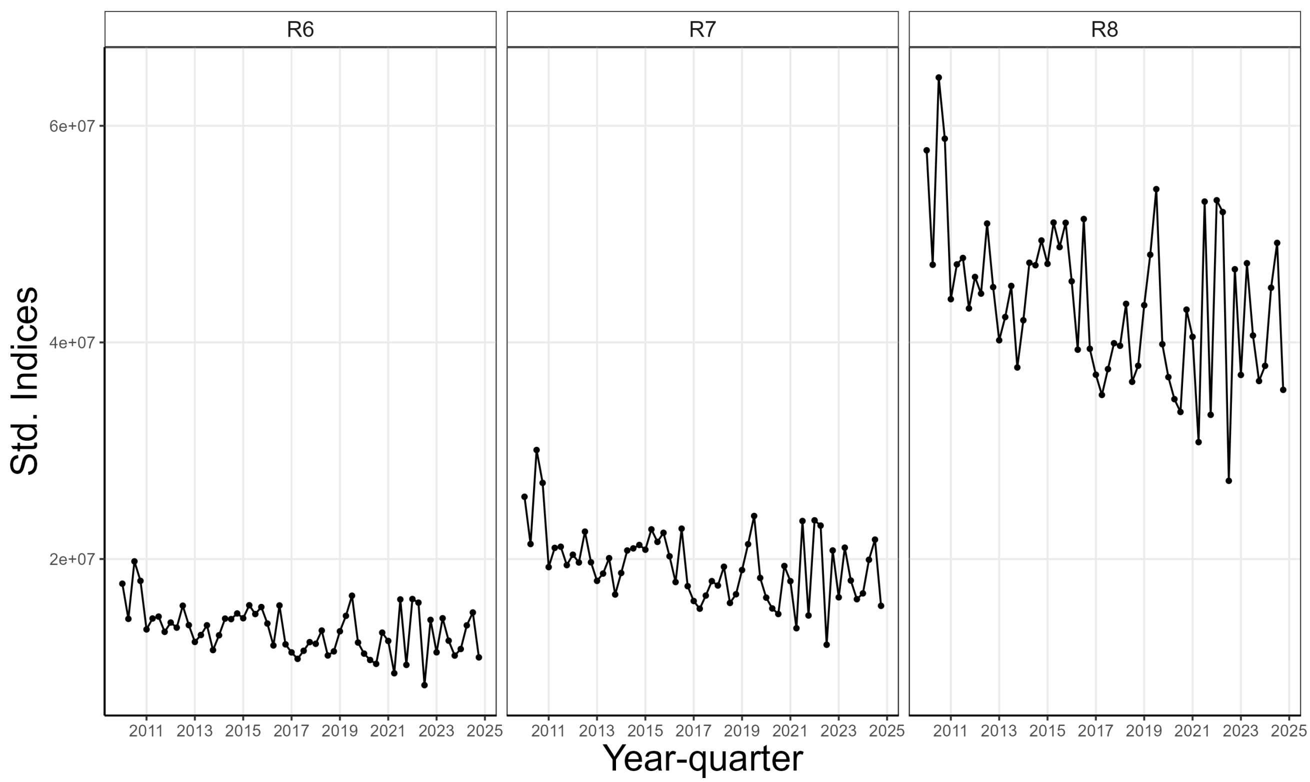


Figure 8: Area-weighted standardised relative abundance indices with (top) and without (bottom; scaling comparison) 95% confidence intervals for purse seine regions 6–8.

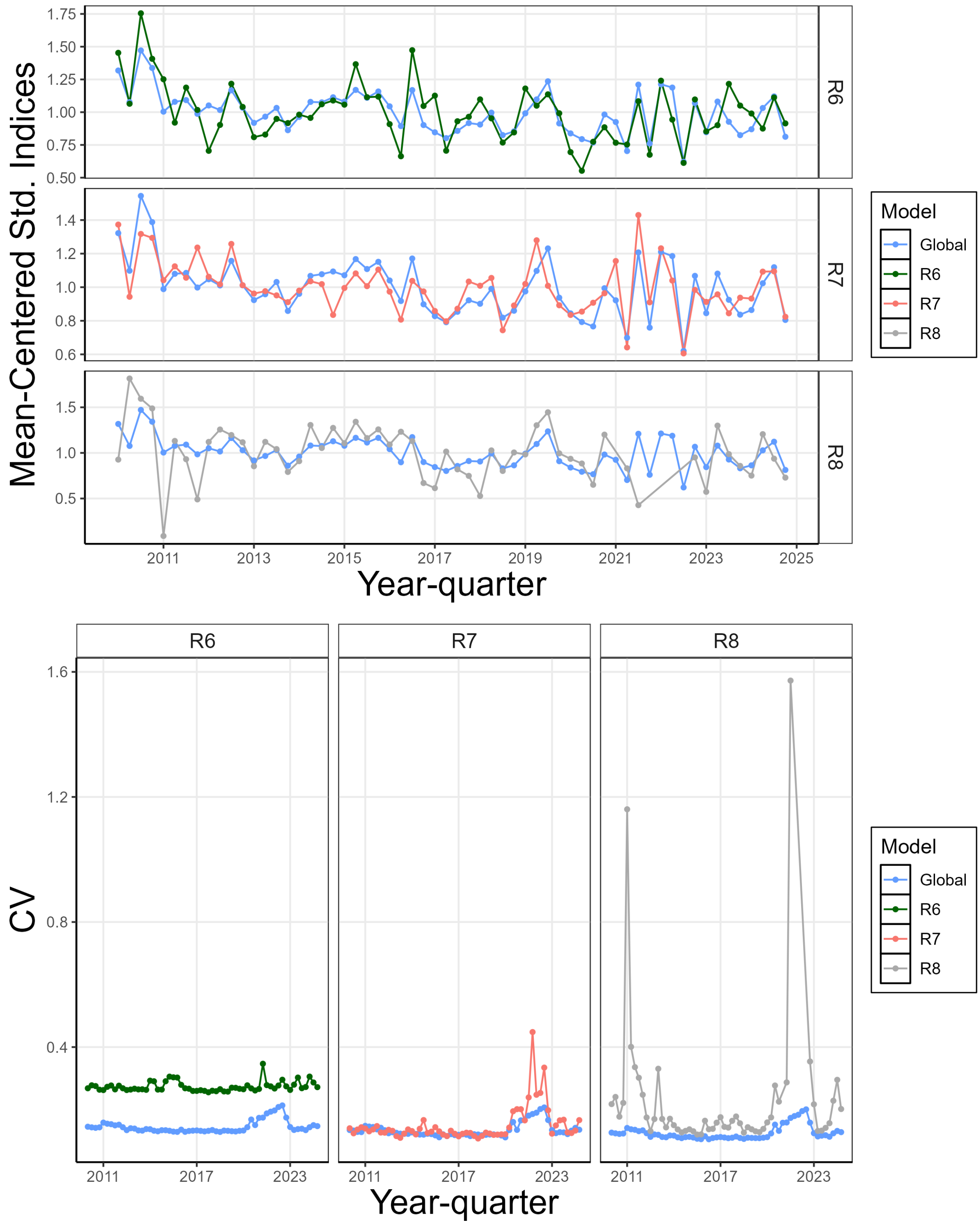


Figure 9: Comparison of global (regions modelled jointly) and regional (regions modelled independently) standardised mean-centered relative abundance indices (top) and region-specific coefficient of variation (CV) time-series for purse seine regions 6–8.

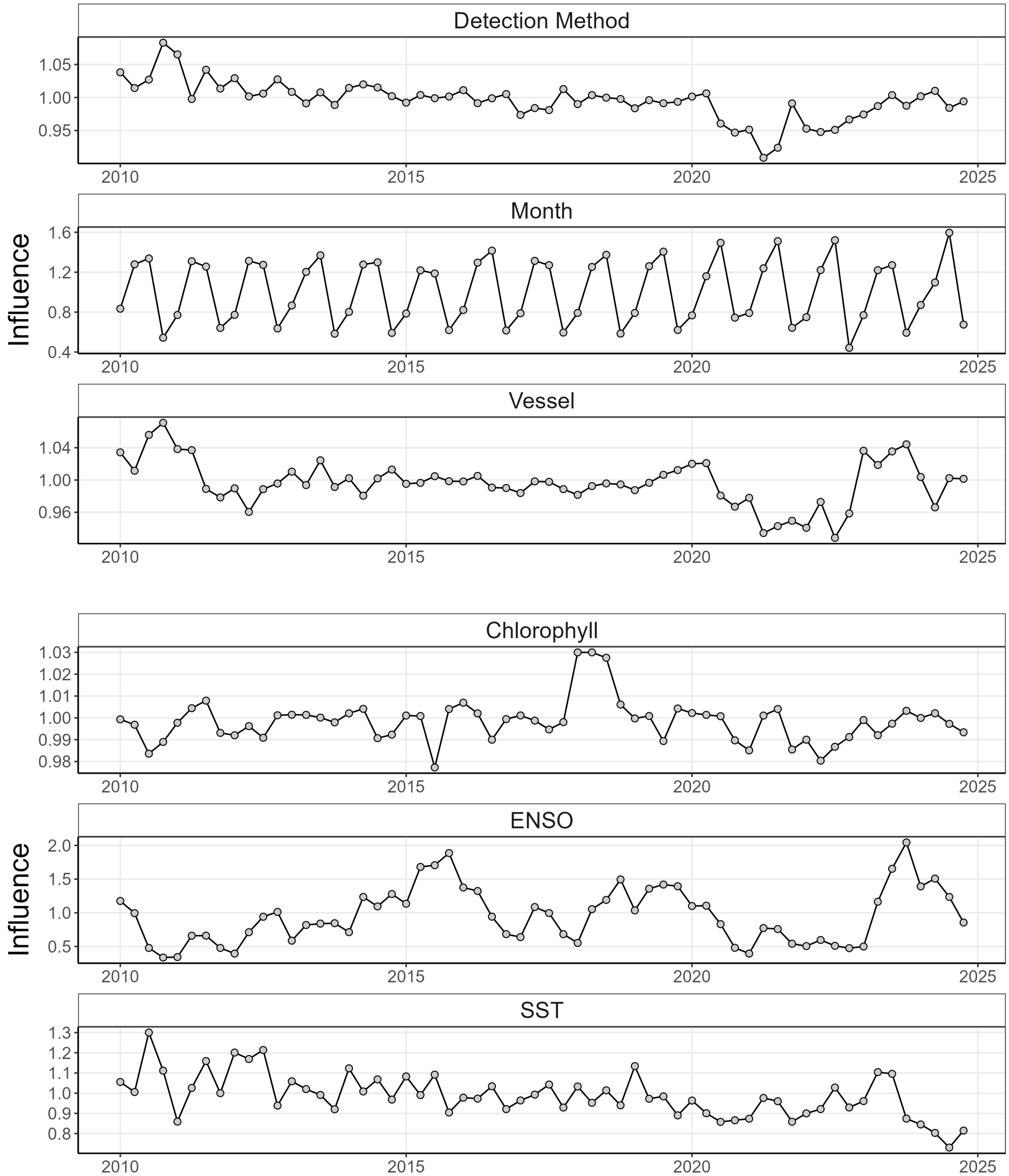


Figure 10: Influence plots for detection method, month, random effects for vessel identification (vessel), chlorophyll, El Niño-Southern Oscillation (ENSO), and sea-surface temperature (sst) from the standardisation model of purse seine regions 6–8.

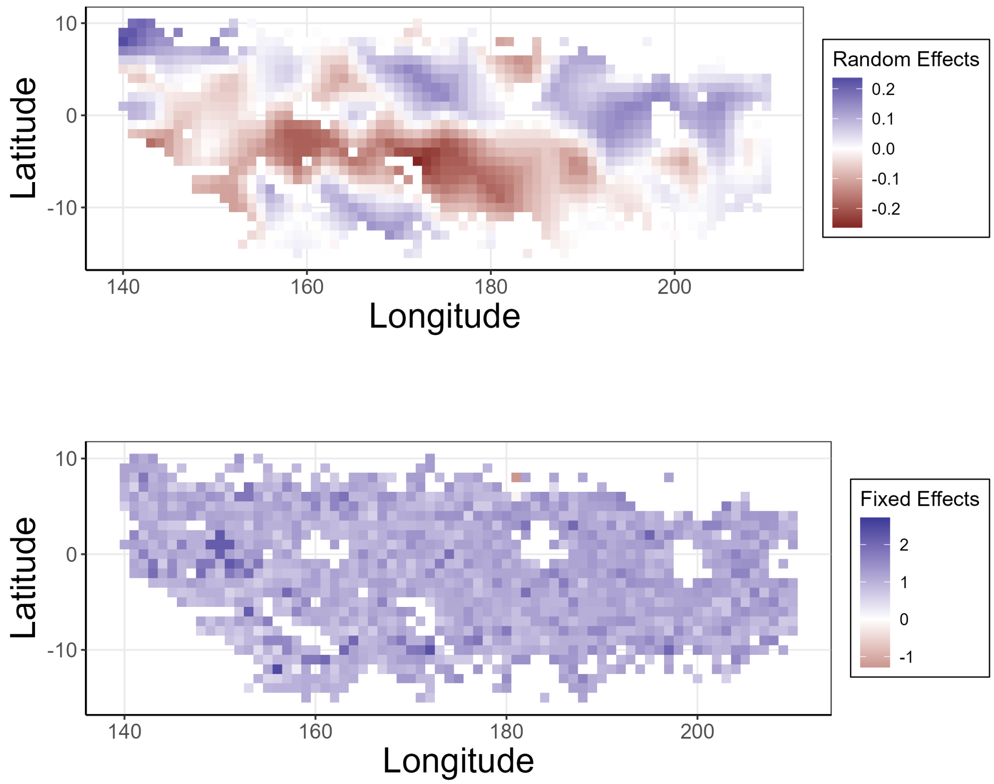


Figure 11: Aggregated spatial random effects (top) and aggregated spatial fixed effects (bottom) from the standardisation model of purse seine regions 6–8 at a 5°x5° grid cell resolution.

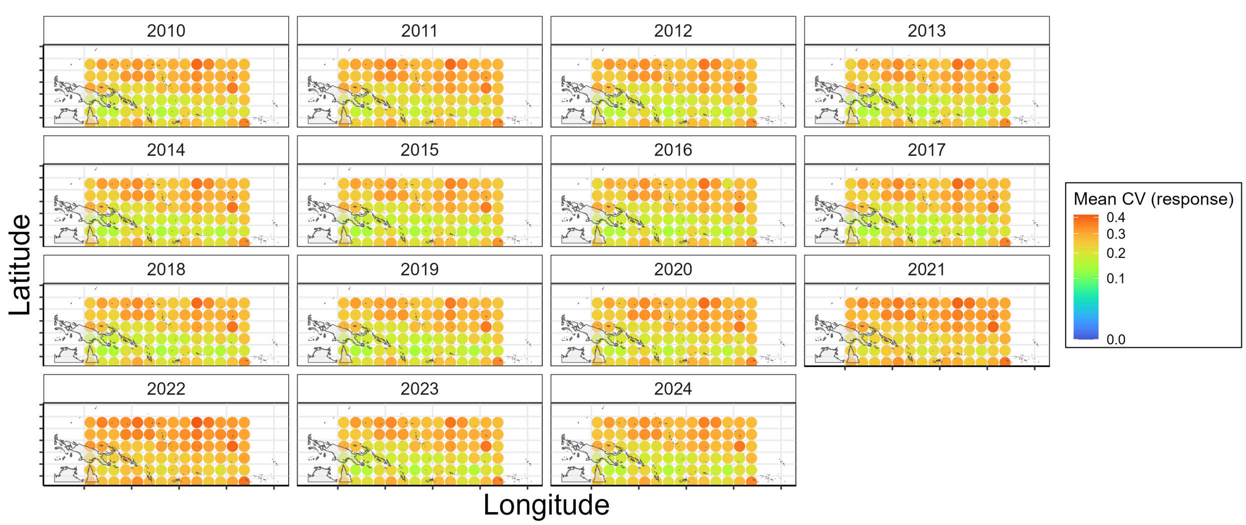


Figure 12: Estimates of uncertainty derived by bootstrapping from the joint precision matrix plotted at a 5°x5° grid cell resolution from the standardisation model of purse seine regions 6–8.

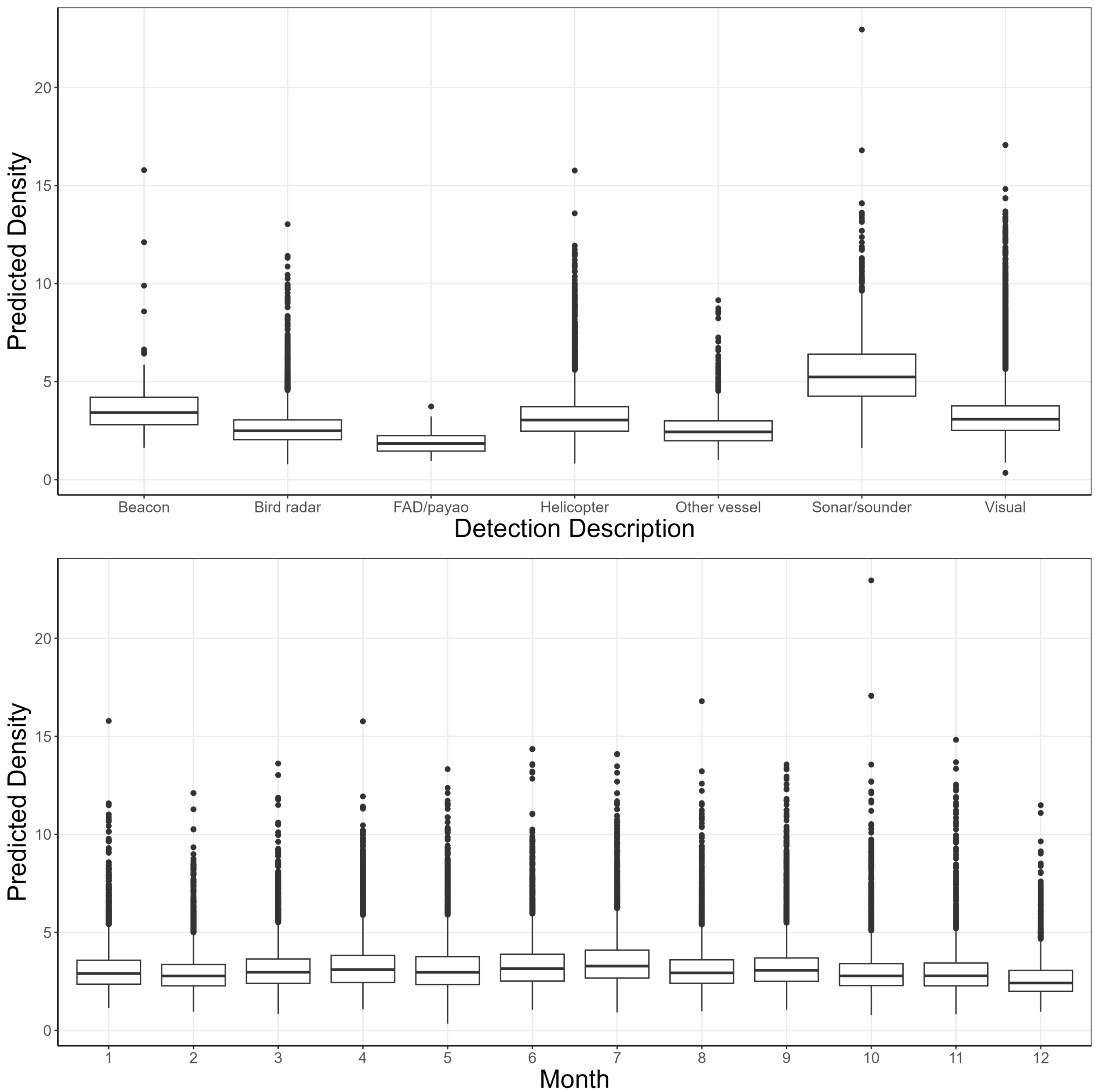


Figure 13: Predicted density for detection method (top) and month (bottom) covariates from the standardisation model for the purse seine regions 6–8.

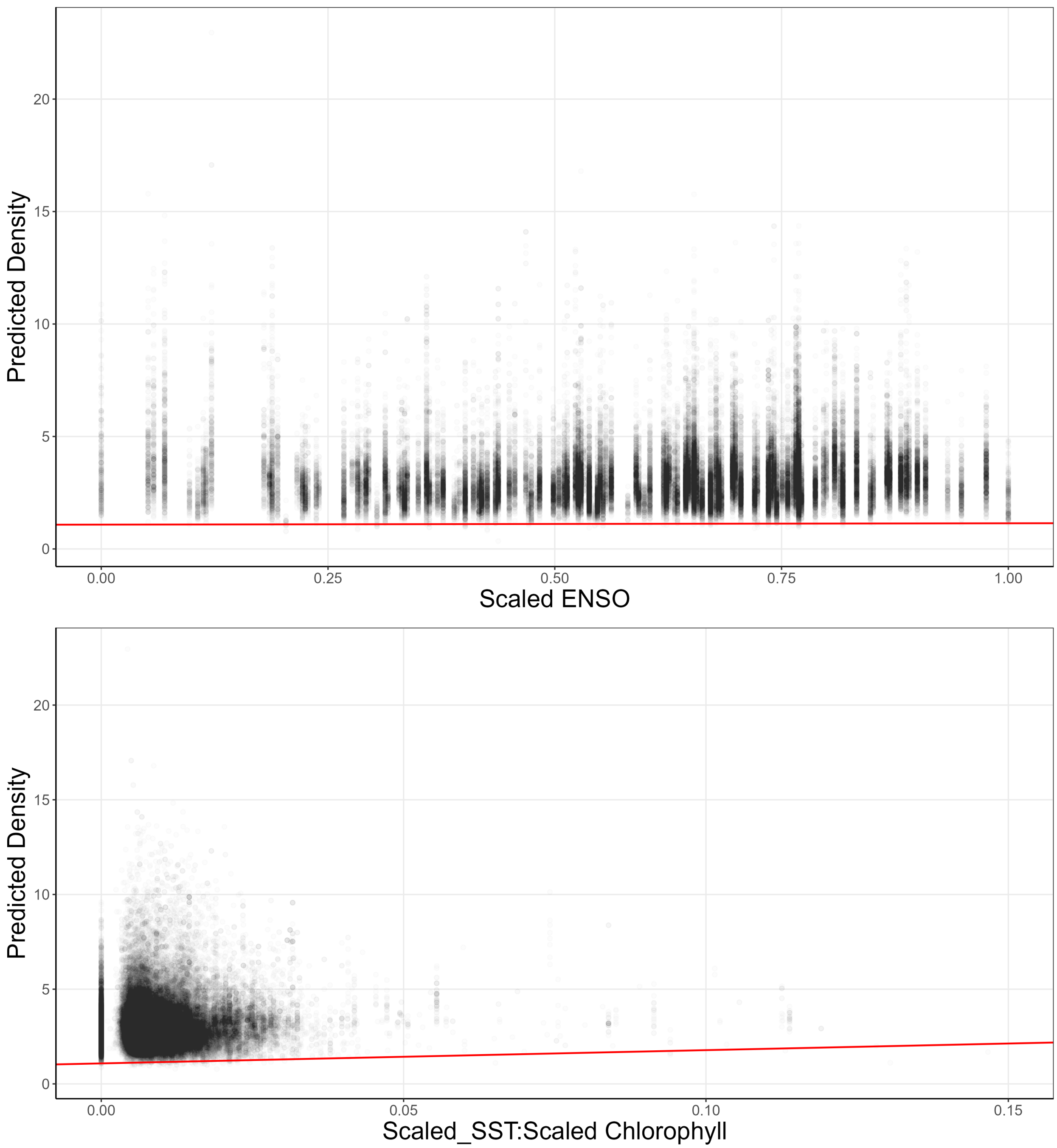


Figure 14: Predicted density for scaled El Niño-Southern Oscillation (scaled ENSO; top) and the interaction of scaled sea-surface temperature (sst) and scaled chlorophyll (bottom) covariates from the standardisation model for the purse seine regions 6–8. Red line represents the linear relationship between the covariate and the predicted density.

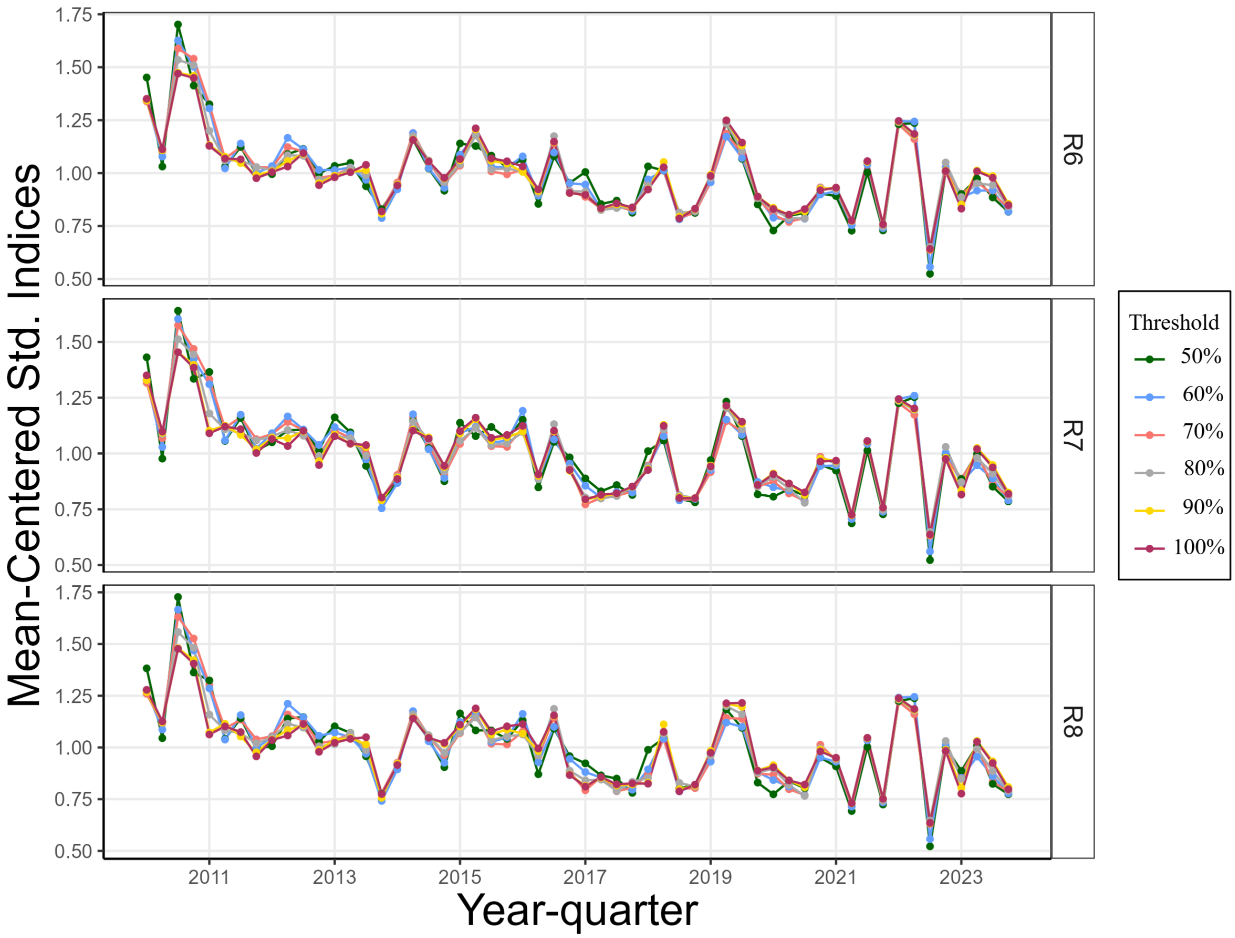


Figure 15: Sensitivity analysis results for the fish aggregating device (FAD) specialists threshold with vessels filtered from the data set where the proportion of total sets were on FADs of $\geq$ 50%, 60% 70%, 80%, 90%, and 100% over the time-series for the purse seine regions 6–8.

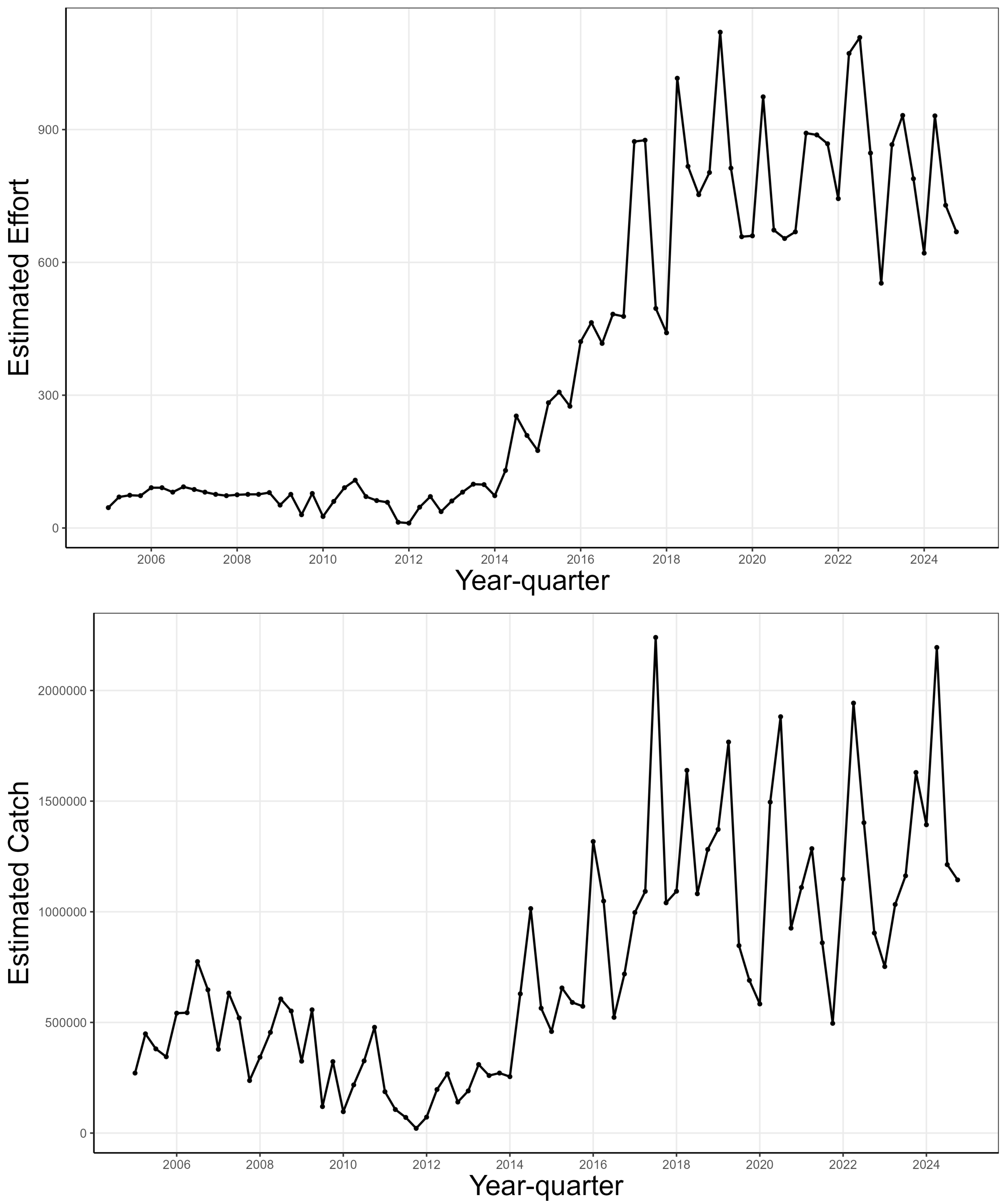


Figure 16: Estimated effort (top; in days) and catch (bottom; in metric tons) time-series for the Philippines purse seine fishery in region 5.

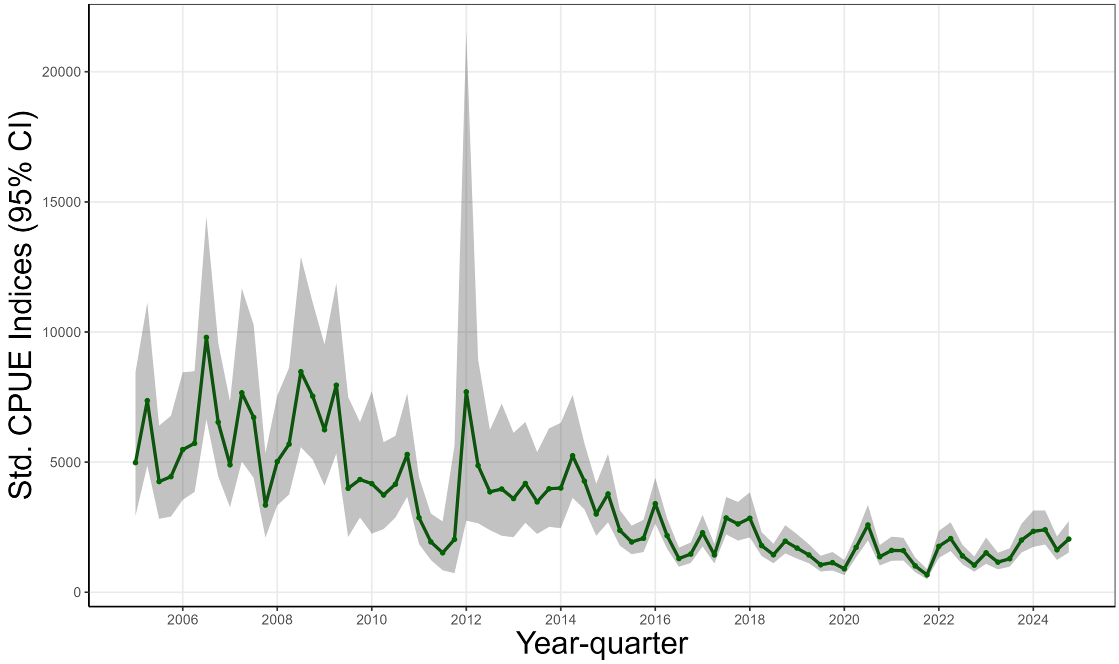


Figure 17: Resulting index and 95% confidence interval from the CPUE standardisation generalised linear model (GLM) for the Philippines purse seine fishery in region 5. The selected model included year-quarter and vessel identification as a random effect.

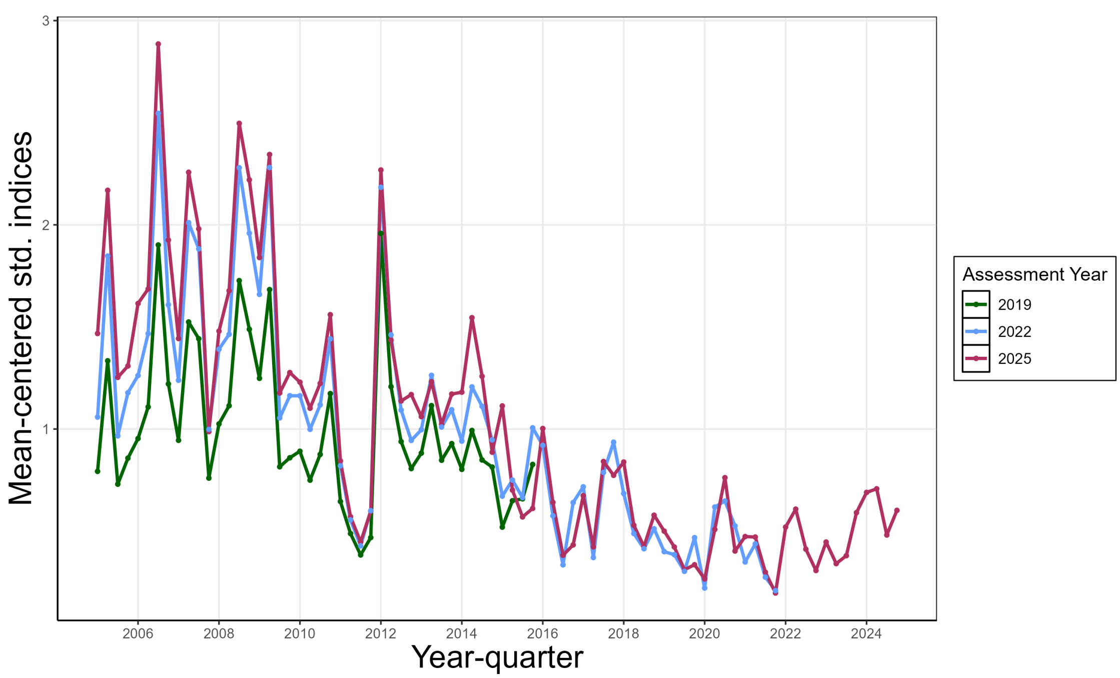


Figure 18: Mean-centered standardised indices from the 2019, 2022, and 2025 stock assessments for the Philippines purse seine fishery in region 5.

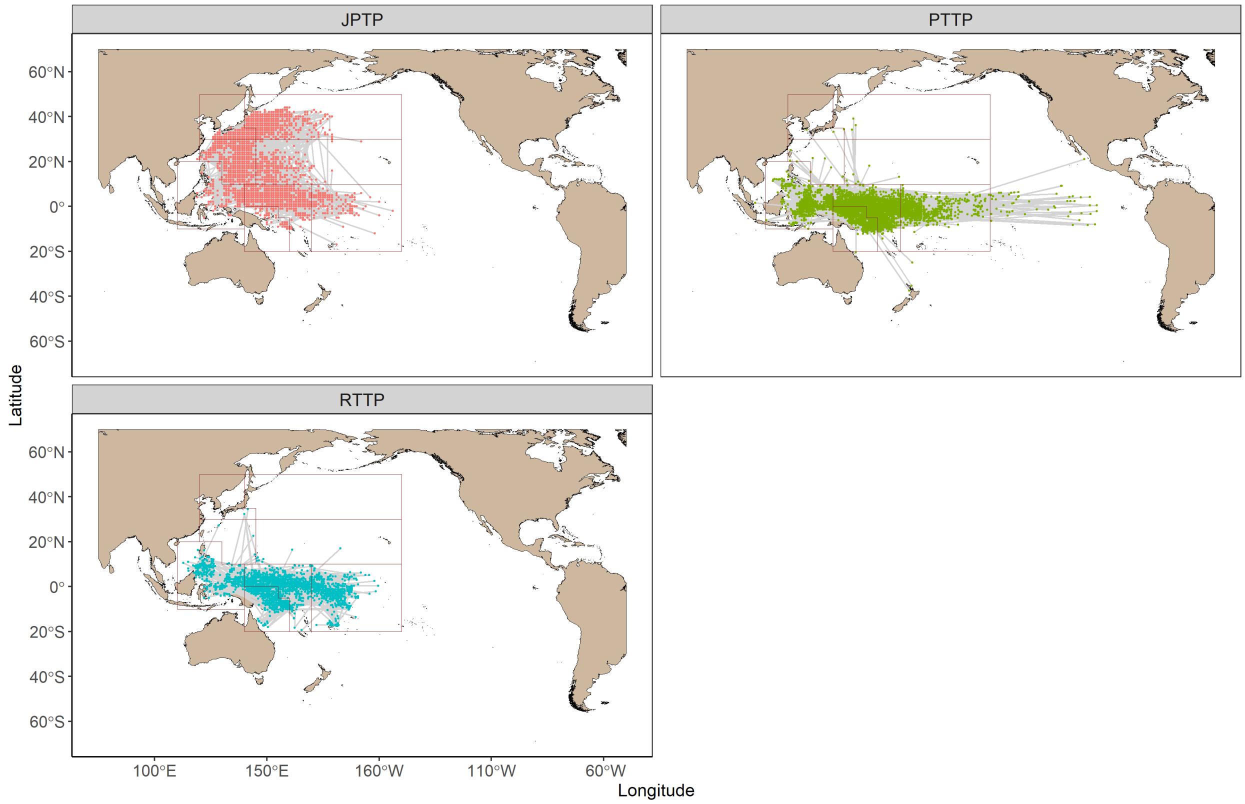


Figure 19: Mark-recapture tagging displacements for the Pacific Tuna Tagging Program (PTTP), the Regional Tuna Tagging Program (RTTP), and Japanese Tagging Program(JPTP).

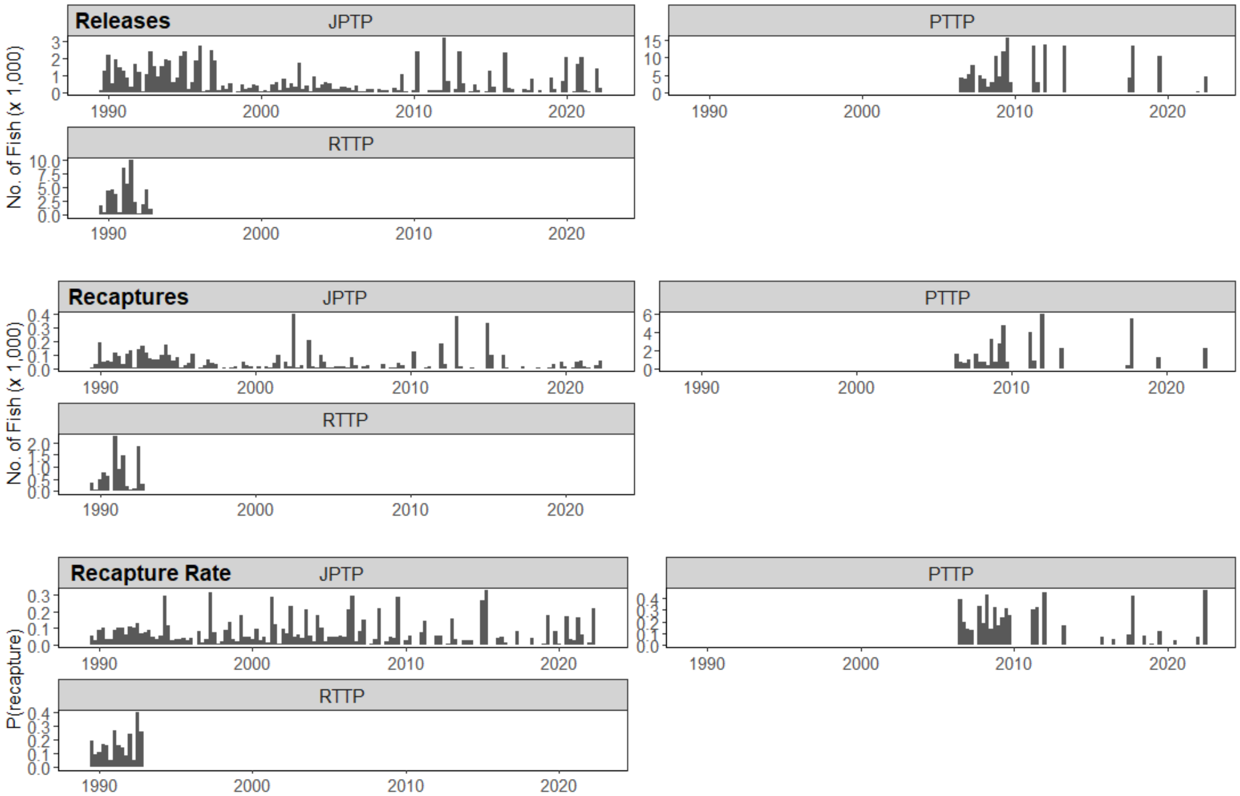


Figure 20: Number of effective releases, recaptures, and the probability of recapture by year for tagged skipjack from the Japanese Tagging Program (JPTP), Pacific Tuna Tagging Program (PTTP), and Regional Tuna Tagging Program (RTTP) included in the tagging input file.

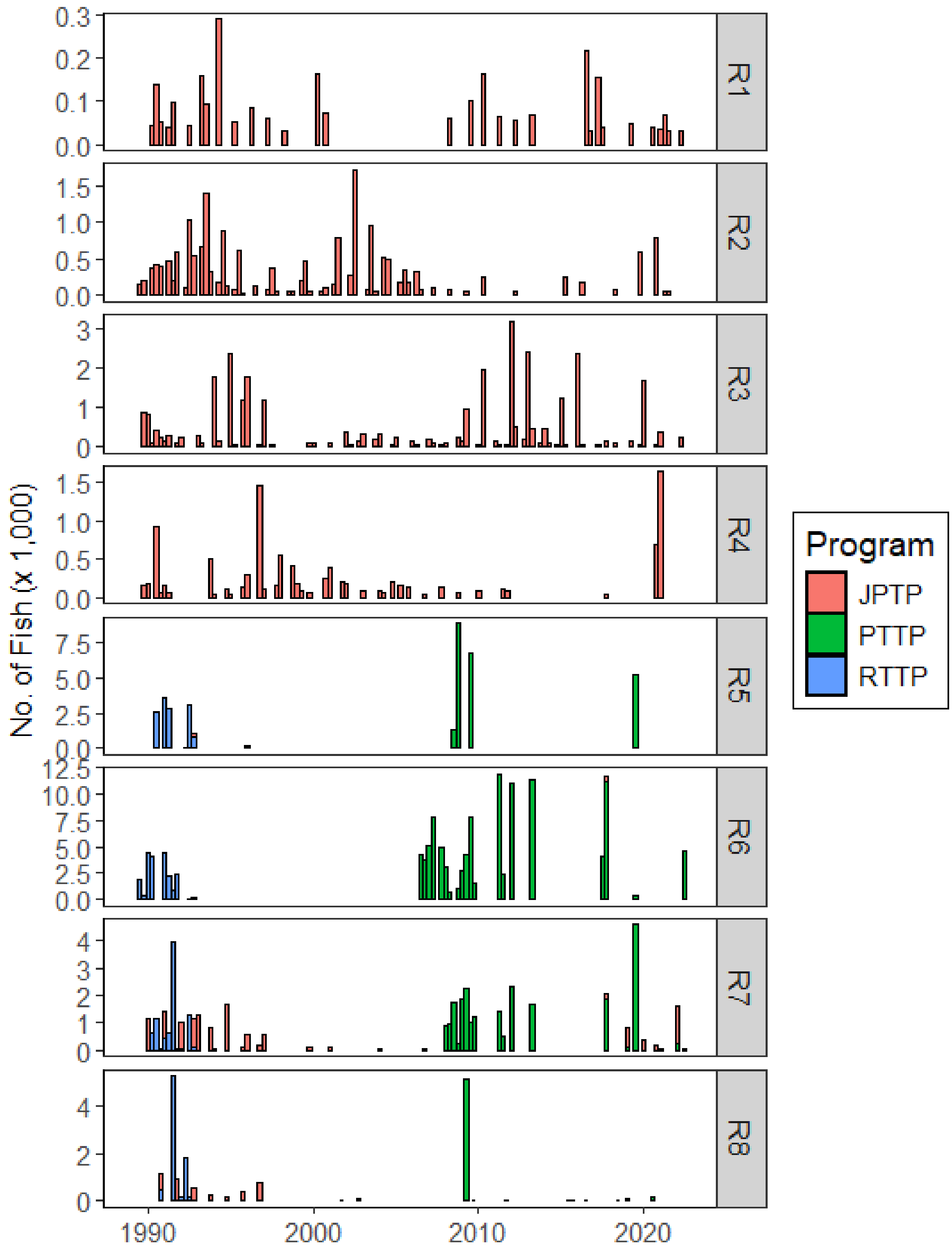


Figure 21: Number of releases by region and program for tagged skipjack from the Japanese Tagging Program (JPTP), Pacific Tuna Tagging Program (PTTP), and Regional Tuna Tagging Program (RTTP) included in the tagging input file.

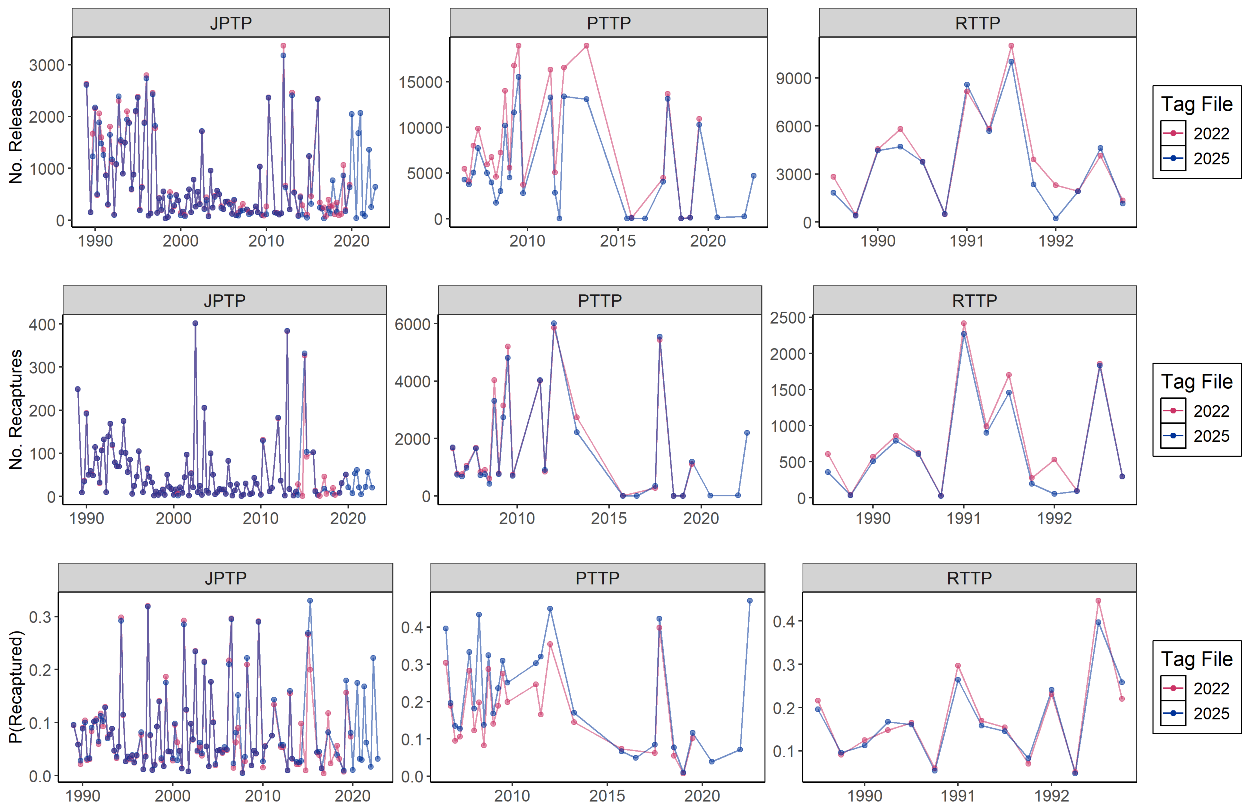


Figure 22: Number of effective releases, recaptures, and the probability of recapture by year for tagged skipjack from the Japanese Tagging Program (JPTP), Pacific Tuna Tagging Program (PTTP), and Regional Tuna Tagging Program (RTTP) from the 2022 and 2025 skipjack stock assessments.

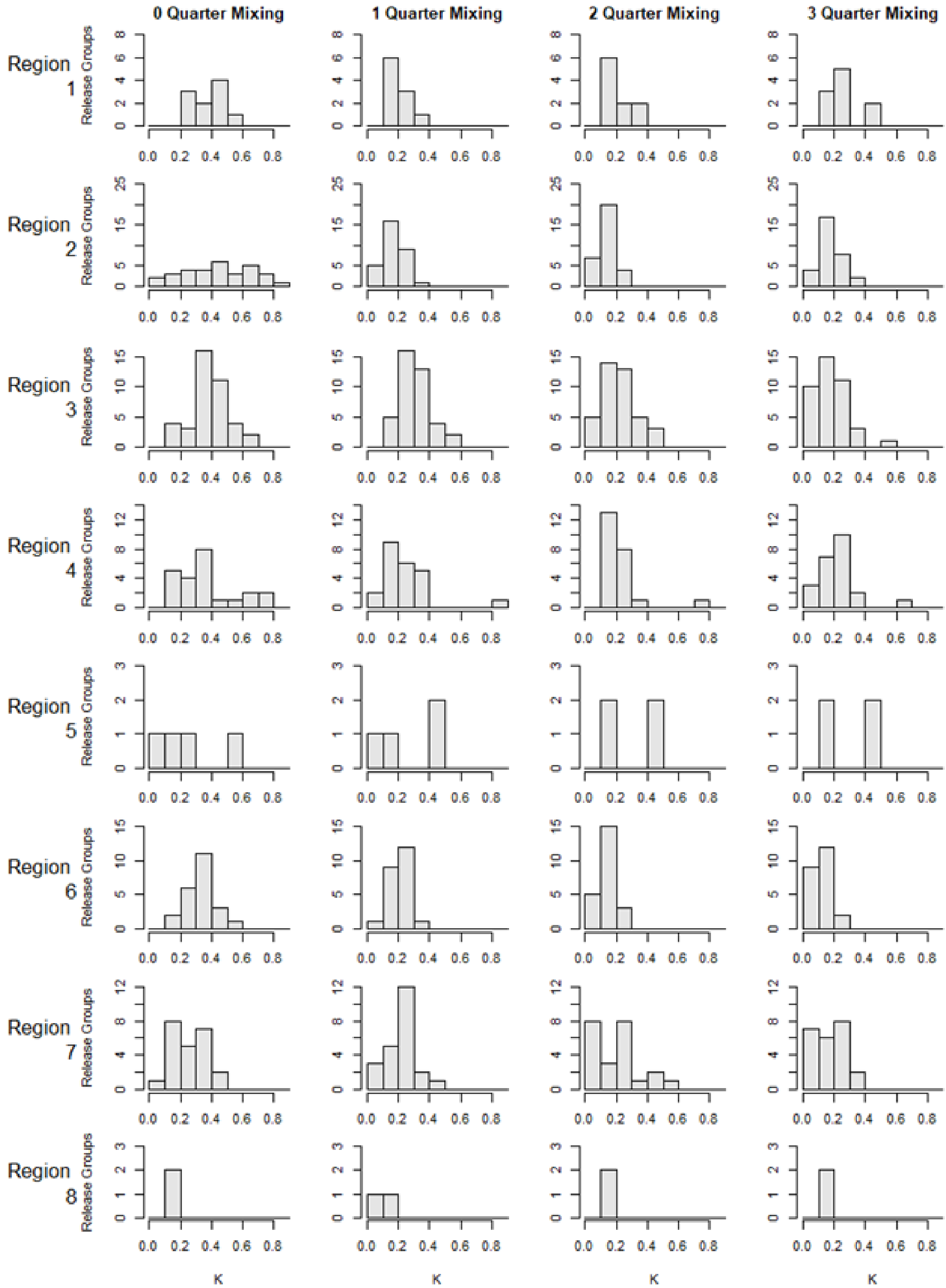


Figure 23: Histograms of K statistic separated by assessment region and mixing scenario, for combined PTTP and JPTP release groups. The lower the K statistic the more similar are the recapture probabilities for the tagged and untagged fish and the more likely the tagged fish are mixed with the untagged population. Requiring a lower K statistic generally equates to assuming a longer mixing period.

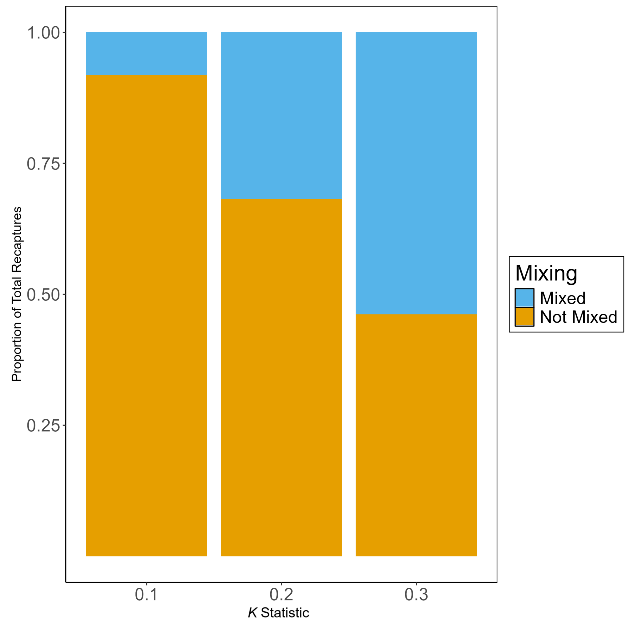


Figure 24: Proportion of recaptures by mixing assignment for dissimilarity statistic (K) at 0.1, 0.2, and 0.3 for skipjack tagging data. Total recaptures included in the tag input file were 57,809.

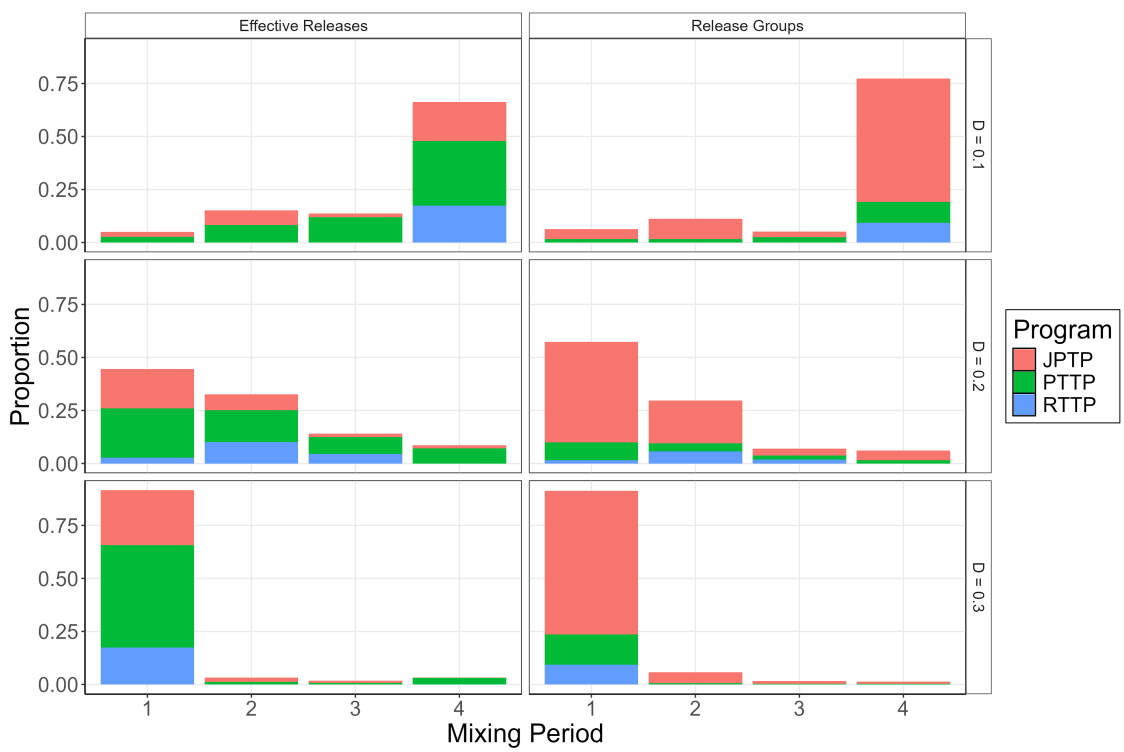


Figure 25: Proportion of total number of effective releases and total number of release groups by mixing period for dissimilarity statistic (K) at 0.1, 0.2, and 0.3 for the Pacific Tuna Tagging Program (PTTP), the Regional Tuna Tagging Program (RTTP), and Japanese Tagging Program (JPTP).

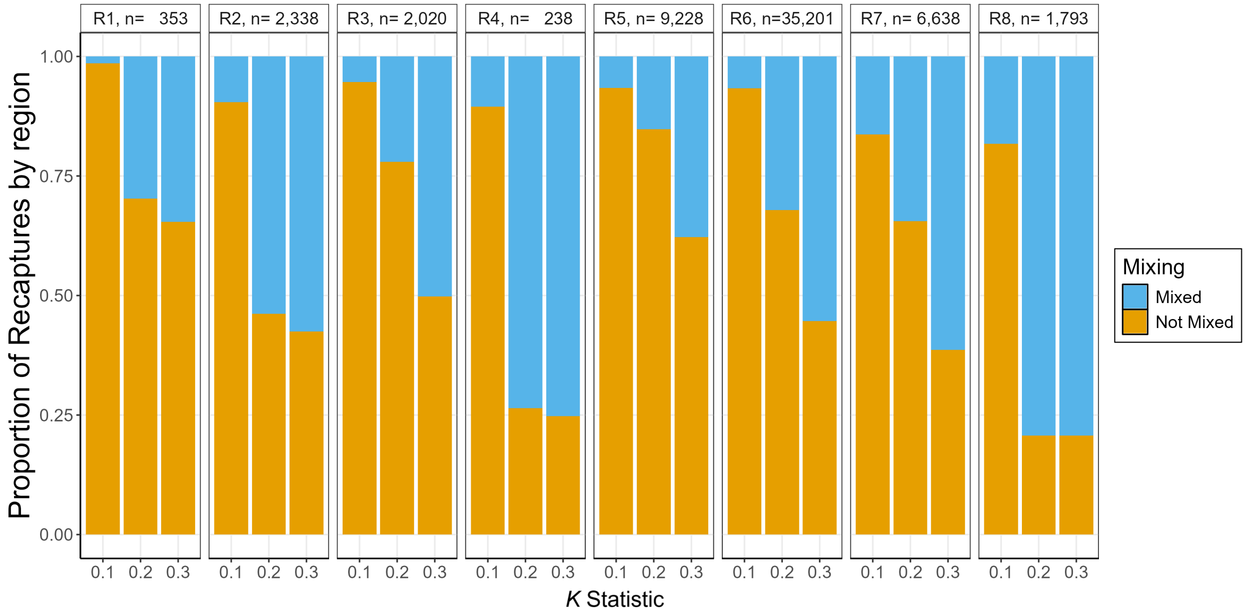


Figure 26: Proportion of recaptures by region and mixing assignment for dissimilarity statistic (K) at 0.1, 0.2, and 0.3 for skipjack tagging data in regions 1–8 from the Pacific Tuna Tagging Program (PTTP), Regional Tuna Tagging Program (RTTP), and the Japanese Tagging Program (JPTP). Total recaptures by region and program are indicated on each plot.

12 Appendix 1: Table of mixing periods by release group

Table 8: Effective releases (releases), recaptures (recaps), assigned mixing period at K statistic of 0.3 (K=0.3), assigned mixing period at K statistic of 0.2 (K=0.2), and assigned mixing period at K statistic of 0.1 (K=0.1) by release group, year, month, and program.

Group	Region	Year	Month	Program	Releases	Recaps	K=0.3	K=0.2	K=0.1
1	5	1990	8	RTTP	2,621	470	1	3	4
2	5	1991	2	RTTP	3,641	764	1	3	4
3	5	1991	5	RTTP	2,817	403	1	3	4
4	5	1992	5	RTTP	85	0	1	3	4
5	5	1992	8	RTTP	3,047	1,389	1	3	4
6	5	1992	11	RTTP	825	291	1	3	4
7	6	1989	8	RTTP	1,825	358	1	2	4
8	6	1989	11	RTTP	387	37	1	2	4
9	6	1990	2	RTTP	4,475	504	1	2	4
10	6	1990	5	RTTP	4,105	676	1	2	4
11	6	1991	2	RTTP	4,489	1,400	1	2	4
12	6	1991	5	RTTP	2,243	440	1	2	4
13	6	1991	8	RTTP	782	347	1	2	4
14	6	1991	11	RTTP	2,349	196	1	2	4
15	6	1992	8	RTTP	83	11	1	2	4
16	6	1992	11	RTTP	197	2	1	2	4
17	7	1990	5	RTTP	603	113	1	2	4
18	7	1990	8	RTTP	1,140	135	1	2	4
19	7	1991	2	RTTP	453	106	1	2	4
20	7	1991	5	RTTP	628	56	1	2	4
21	7	1991	8	RTTP	3,917	545	1	2	4
22	7	1992	2	RTTP	68	22	1	2	4
23	7	1992	8	RTTP	1,288	432	1	2	4
24	7	1992	11	RTTP	125	3	1	2	4
25	8	1990	11	RTTP	500	27	1	1	4
26	8	1991	8	RTTP	5,302	563	1	1	4
27	8	1992	2	RTTP	160	33	1	1	4
28	8	1992	5	RTTP	1,831	92	1	1	4
29	8	1992	8	RTTP	196	2	1	1	4
30	5	2008	8	PTTP	1,292	202	1	1	1
31	5	2008	11	PTTP	8,949	2,806	4	4	4
32	5	2009	8	PTTP	6,768	2,194	1	4	4

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Table 8 – continued from previous page

Group	Region	Year	Month	Program	Releases	Recaps	K=0.3	K=0.2	K=0.1
33	5	2019	8	PTTP	5,278	700	1	1	4
34	6	2006	8	PTTP	4,270	1,691	1	2	4
35	6	2006	11	PTTP	3,758	737	1	1	3
36	6	2007	2	PTTP	5,043	680	1	1	3
37	6	2007	5	PTTP	7,727	982	1	1	2
38	6	2007	11	PTTP	4,990	1,659	1	1	3
39	6	2008	2	PTTP	3,099	597	1	1	4
40	6	2008	5	PTTP	768	253	1	1	1
41	6	2008	11	PTTP	1,045	447	1	2	4
42	6	2009	2	PTTP	2,656	246	2	2	3
43	6	2009	5	PTTP	4,240	1,464	1	2	4
44	6	2009	8	PTTP	7,737	2,525	1	3	4
45	6	2009	11	PTTP	1,553	382	1	2	3
46	6	2011	5	PTTP	11,907	3,535	1	1	4
47	6	2011	8	PTTP	2,324	754	1	1	4
48	6	2012	2	PTTP	11,054	5,565	1	2	3
49	6	2013	5	PTTP	11,406	1,935	1	3	4
50	6	2017	8	PTTP	4,068	345	1	2	4
51	6	2017	11	PTTP	11,268	5,077	1	2	2
52	6	2019	8	PTTP	428	164	1	4	4
53	6	2022	8	PTTP	4,637	2,192	1	1	3
54	7	2008	2	PTTP	870	123	2	3	3
55	7	2008	5	PTTP	985	505	1	3	4
56	7	2008	8	PTTP	1,751	217	1	3	4
57	7	2008	11	PTTP	222	61	1	3	4
58	7	2009	2	PTTP	1,866	512	1	1	2
59	7	2009	5	PTTP	2,259	315	3	4	4
60	7	2009	8	PTTP	1,024	85	1	1	1
61	7	2009	11	PTTP	1,214	320	1	1	4
62	7	2011	5	PTTP	1,390	498	1	2	2
63	7	2011	8	PTTP	513	156	1	1	4
64	7	2012	2	PTTP	2,353	452	1	4	4
65	7	2013	5	PTTP	1,675	284	1	2	2
66	7	2017	11	PTTP	1,866	461	1	1	4
67	7	2019	2	PTTP	98	1	1	1	1
68	7	2019	8	PTTP	4,572	332	1	1	1

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Group	Region	Year	Month	Program	Releases	Recaps	K=0.3	K=0.2	K=0.1
69	7	2022	2	PTTP	239	17	1	2	4
70	7	2022	8	PTTP	42	9	1	2	4
71	8	2009	5	PTTP	5,134	962	1	1	4
72	8	2009	11	PTTP	35	0	1	1	4
73	8	2011	11	PTTP	32	0	1	1	4
74	8	2015	8	PTTP	32	0	1	1	4
75	8	2015	11	PTTP	60	4	1	1	4
76	8	2016	8	PTTP	41	2	1	1	4
77	8	2018	8	PTTP	39	3	1	1	4
78	8	2020	8	PTTP	154	6	1	1	4
79	1	1990	5	JPTP	42	13	1	1	4
80	1	1990	8	JPTP	139	6	1	1	4
81	1	1990	11	JPTP	51	3	1	1	4
82	1	1991	5	JPTP	41	14	1	1	4
83	1	1991	8	JPTP	95	7	1	1	4
84	1	1992	8	JPTP	42	6	1	1	4
85	1	1993	5	JPTP	160	11	1	1	4
86	1	1993	8	JPTP	92	9	1	1	4
87	1	1994	5	JPTP	289	70	1	1	4
88	1	1995	5	JPTP	52	0	1	1	4
89	1	1996	5	JPTP	83	0	1	1	4
90	1	1997	5	JPTP	58	5	1	1	4
91	1	1998	5	JPTP	33	3	1	1	4
92	1	2000	5	JPTP	163	16	1	1	4
93	1	2000	11	JPTP	72	11	4	4	4
94	1	2008	5	JPTP	59	8	1	4	4
95	1	2009	8	JPTP	100	29	1	4	4
96	1	2010	5	JPTP	165	14	1	1	4
97	1	2011	5	JPTP	65	15	1	1	4
98	1	2012	5	JPTP	56	10	2	2	4
99	1	2013	5	JPTP	68	15	1	1	4
100	1	2016	8	JPTP	217	3	1	1	4
101	1	2016	11	JPTP	33	0	1	1	4
102	1	2017	5	JPTP	154	15	1	1	4
103	1	2017	8	JPTP	39	0	1	1	4
104	1	2019	5	JPTP	48	27	1	1	4

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Group	Region	Year	Month	Program	Releases	Recaps	K=0.3	K=0.2	K=0.1
105	1	2020	8	JPTP	40	7	1	1	4
106	1	2021	2	JPTP	36	2	1	1	4
107	1	2021	5	JPTP	69	17	1	1	4
108	1	2021	8	JPTP	31	4	1	1	4
109	1	2022	5	JPTP	33	13	1	1	4
110	2	1989	8	JPTP	154	9	1	1	4
111	2	1989	11	JPTP	196	15	1	1	4
112	2	1990	5	JPTP	373	26	1	1	4
113	2	1990	8	JPTP	413	8	1	1	4
114	2	1990	11	JPTP	406	19	1	1	4
115	2	1991	5	JPTP	472	73	1	1	4
116	2	1991	8	JPTP	212	25	1	1	4
117	2	1991	11	JPTP	583	57	1	1	4
118	2	1992	5	JPTP	97	10	1	1	4
119	2	1992	8	JPTP	1,040	133	1	1	4
120	2	1992	11	JPTP	537	74	1	1	4
121	2	1993	5	JPTP	661	68	1	1	4
122	2	1993	8	JPTP	1,395	61	1	1	4
123	2	1993	11	JPTP	318	27	1	1	4
124	2	1994	5	JPTP	185	33	1	1	4
125	2	1994	8	JPTP	876	101	1	1	4
126	2	1994	11	JPTP	135	4	1	1	4
127	2	1995	5	JPTP	78	5	1	1	4
128	2	1995	8	JPTP	625	24	1	1	4
129	2	1995	11	JPTP	42	4	1	1	4
130	2	1996	8	JPTP	123	10	1	1	4
131	2	1997	5	JPTP	83	40	1	1	4
132	2	1997	8	JPTP	377	32	1	1	4
133	2	1997	11	JPTP	46	0	1	1	4
134	2	1998	8	JPTP	57	8	1	1	4
135	2	1998	11	JPTP	57	4	1	1	4
136	2	1999	5	JPTP	209	49	1	2	4
137	2	1999	8	JPTP	481	22	1	2	4
138	2	1999	11	JPTP	68	6	1	1	4
139	2	2000	8	JPTP	69	2	2	2	4
140	2	2000	11	JPTP	118	5	1	2	4

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Group	Region	Year	Month	Program	Releases	Recaps	K=0.3	K=0.2	K=0.1
141	2	2001	5	JPTP	154	44	1	1	4
142	2	2001	8	JPTP	780	97	1	1	4
143	2	2002	5	JPTP	270	19	1	1	4
144	2	2002	8	JPTP	1,716	402	1	1	2
145	2	2003	5	JPTP	72	3	1	1	1
146	2	2003	8	JPTP	958	205	1	1	1
147	2	2003	11	JPTP	67	7	1	2	4
148	2	2004	5	JPTP	512	99	1	1	4
149	2	2004	8	JPTP	499	50	1	1	4
150	2	2005	5	JPTP	190	16	1	1	4
151	2	2005	8	JPTP	357	16	1	1	4
152	2	2005	11	JPTP	170	13	1	1	4
153	2	2006	5	JPTP	324	82	1	1	4
154	2	2006	8	JPTP	91	27	1	1	4
155	2	2007	5	JPTP	105	16	1	1	2
156	2	2008	5	JPTP	76	22	1	1	4
157	2	2009	5	JPTP	56	3	1	1	4
158	2	2010	5	JPTP	245	26	1	2	4
159	2	2012	5	JPTP	63	12	1	2	4
160	2	2015	5	JPTP	244	100	1	1	2
161	2	2016	5	JPTP	177	9	1	2	4
162	2	2018	5	JPTP	82	4	1	2	4
163	2	2019	11	JPTP	596	48	1	1	4
164	2	2020	11	JPTP	781	39	1	1	1
165	2	2021	5	JPTP	56	4	1	1	4
166	2	2021	8	JPTP	49	1	1	1	4
167	2	2022	11	JPTP	640	20	1	1	4
168	3	1989	2	JPTP	1,134	61	1	2	4
169	3	1989	11	JPTP	881	17	1	2	4
170	3	1990	2	JPTP	825	50	1	2	4
171	3	1990	5	JPTP	83	11	1	2	4
172	3	1990	8	JPTP	420	13	1	2	4
173	3	1990	11	JPTP	217	4	1	2	4
174	3	1991	2	JPTP	129	9	1	2	4
175	3	1991	5	JPTP	279	1	1	2	4
176	3	1991	11	JPTP	70	2	1	2	4

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Table 8 – continued from previous page

Group	Region	Year	Month	Program	Releases	Recaps	K=0.3	K=0.2	K=0.1
177	3	1992	2	JPTP	209	8	1	2	4
178	3	1993	2	JPTP	283	15	1	2	4
179	3	1993	5	JPTP	74	0	1	2	4
180	3	1994	2	JPTP	1,778	100	1	2	4
181	3	1994	5	JPTP	126	72	1	2	4
182	3	1995	2	JPTP	2,330	84	1	2	4
183	3	1995	5	JPTP	57	1	1	2	4
184	3	1995	11	JPTP	1,172	39	1	2	4
185	3	1996	2	JPTP	1,759	70	1	2	4
186	3	1996	11	JPTP	43	0	1	2	4
187	3	1997	2	JPTP	1,176	37	1	2	4
188	3	1997	8	JPTP	41	0	1	2	4
189	3	1999	11	JPTP	103	9	1	1	4
190	3	2000	2	JPTP	94	3	1	1	4
191	3	2001	2	JPTP	103	1	1	1	4
192	3	2002	2	JPTP	353	23	1	2	2
193	3	2002	5	JPTP	36	2	1	2	4
194	3	2002	11	JPTP	139	9	2	3	3
195	3	2003	2	JPTP	303	23	2	2	3
196	3	2003	11	JPTP	170	6	3	4	4
197	3	2004	2	JPTP	301	8	1	1	4
198	3	2004	11	JPTP	36	0	1	2	4
199	3	2005	2	JPTP	213	10	2	2	3
200	3	2006	2	JPTP	121	6	1	2	2
201	3	2006	5	JPTP	67	0	1	2	4
202	3	2007	2	JPTP	172	14	2	3	4
203	3	2007	5	JPTP	79	12	1	1	4
204	3	2007	11	JPTP	68	1	1	2	4
205	3	2008	2	JPTP	113	4	2	4	4
206	3	2008	11	JPTP	205	5	2	4	4
207	3	2009	2	JPTP	149	7	1	2	4
208	3	2009	5	JPTP	972	40	1	2	4
209	3	2010	2	JPTP	32	2	1	2	4
210	3	2010	5	JPTP	1,948	89	1	1	2
211	3	2011	2	JPTP	147	11	1	2	4
212	3	2011	5	JPTP	68	4	1	2	4

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Table 8 – continued from previous page

Group	Region	Year	Month	Program	Releases	Recaps	K=0.3	K=0.2	K=0.1
213	3	2011	11	JPTP	49	0	1	2	4
214	3	2012	2	JPTP	3,175	183	1	1	4
215	3	2012	5	JPTP	509	14	1	2	4
216	3	2012	11	JPTP	203	2	3	4	4
217	3	2013	2	JPTP	2,408	384	3	4	4
218	3	2013	5	JPTP	459	2	1	2	2
219	3	2013	11	JPTP	79	2	2	3	3
220	3	2014	2	JPTP	440	11	1	3	4
221	3	2014	5	JPTP	108	3	1	2	4
222	3	2014	11	JPTP	43	0	1	2	4
223	3	2015	2	JPTP	1,234	332	1	3	4
224	3	2015	5	JPTP	68	3	1	1	4
225	3	2016	2	JPTP	2,332	102	2	3	3
226	3	2016	5	JPTP	65	2	1	2	4
227	3	2017	5	JPTP	65	3	1	2	4
228	3	2017	11	JPTP	126	0	1	2	4
229	3	2018	5	JPTP	73	2	1	4	4
230	3	2019	5	JPTP	125	4	1	2	4
231	3	2019	11	JPTP	37	3	3	3	4
232	3	2020	2	JPTP	1,687	16	2	2	2
233	3	2020	11	JPTP	57	1	1	2	4
234	3	2021	2	JPTP	354	25	4	4	4
235	3	2022	5	JPTP	219	43	1	2	3
236	4	1989	2	JPTP	52	3	1	1	4
237	4	1989	11	JPTP	152	3	1	1	4
238	4	1990	2	JPTP	177	13	1	1	4
239	4	1990	8	JPTP	915	32	1	1	4
240	4	1990	11	JPTP	58	2	1	1	4
241	4	1991	2	JPTP	167	10	1	1	4
242	4	1991	5	JPTP	68	0	1	1	4
243	4	1993	11	JPTP	504	8	1	1	4
244	4	1994	2	JPTP	33	0	1	1	4
245	4	1994	11	JPTP	102	2	1	1	4
246	4	1995	2	JPTP	34	1	1	1	4
247	4	1995	11	JPTP	144	2	1	1	4
248	4	1996	2	JPTP	291	17	1	1	4

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Table 8 – continued from previous page

Group	Region	Year	Month	Program	Releases	Recaps	K=0.3	K=0.2	K=0.1
249	4	1996	11	JPTP	1,453	15	1	1	4
250	4	1997	2	JPTP	105	5	1	1	4
251	4	1997	11	JPTP	149	2	1	1	4
252	4	1998	2	JPTP	553	11	1	1	4
253	4	1998	11	JPTP	402	11	1	1	4
254	4	1999	2	JPTP	169	3	2	2	4
255	4	1999	5	JPTP	76	1	1	2	4
256	4	1999	11	JPTP	62	1	1	1	4
257	4	2000	11	JPTP	262	5	1	1	4
258	4	2001	2	JPTP	398	7	1	1	4
259	4	2001	11	JPTP	213	2	1	4	4
260	4	2002	2	JPTP	191	30	2	4	4
261	4	2003	2	JPTP	81	1	4	4	4
262	4	2004	2	JPTP	90	0	1	1	4
263	4	2004	5	JPTP	54	1	1	3	4
264	4	2004	11	JPTP	193	5	1	1	4
265	4	2005	5	JPTP	160	1	1	1	4
266	4	2005	11	JPTP	127	3	1	3	4
267	4	2006	11	JPTP	41	1	1	1	4
268	4	2007	11	JPTP	136	0	2	2	4
269	4	2008	11	JPTP	58	0	1	4	4
270	4	2010	2	JPTP	78	1	2	3	3
271	4	2011	8	JPTP	106	0	1	1	4
272	4	2011	11	JPTP	85	0	1	1	4
273	4	2017	11	JPTP	45	0	1	1	4
274	4	2020	11	JPTP	688	6	1	1	1
275	4	2021	2	JPTP	1,641	33	1	1	3
276	5	1992	11	JPTP	269	9	1	1	4
277	5	1996	2	JPTP	143	0	1	1	4
278	6	2017	8	JPTP	84	0	2	2	4
279	6	2017	11	JPTP	384	0	1	2	2
280	7	1989	2	JPTP	1,420	185	1	1	2
281	7	1990	2	JPTP	1,169	129	1	1	2
282	7	1990	11	JPTP	71	3	1	1	2
283	7	1991	2	JPTP	962	95	1	1	2
284	7	1991	11	JPTP	44	1	1	1	2

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Table 8 – continued from previous page

Group	Region	Year	Month	Program	Releases	Recaps	K=0.3	K=0.2	K=0.1
285	7	1992	2	JPTP	960	124	1	1	2
286	7	1992	11	JPTP	1,018	68	1	1	2
287	7	1993	2	JPTP	1,265	105	1	1	2
288	7	1993	11	JPTP	849	29	1	1	2
289	7	1994	2	JPTP	58	2	1	1	2
290	7	1994	11	JPTP	1,649	47	1	1	2
291	7	1995	11	JPTP	107	1	1	1	2
292	7	1996	2	JPTP	542	18	1	1	2
293	7	1996	11	JPTP	164	5	1	1	2
294	7	1997	2	JPTP	538	22	1	1	2
295	7	1999	11	JPTP	146	1	1	1	2
296	7	2001	2	JPTP	95	0	1	1	1
297	7	2004	2	JPTP	54	0	1	1	2
298	7	2006	11	JPTP	46	1	1	2	2
299	7	2017	11	JPTP	211	0	1	1	4
300	7	2019	2	JPTP	728	7	1	1	4
301	7	2020	2	JPTP	361	5	1	2	2
302	7	2020	11	JPTP	150	7	1	1	4
303	7	2021	2	JPTP	35	1	1	1	2
304	7	2022	2	JPTP	1,356	22	1	1	2
305	8	1990	11	JPTP	671	17	1	1	1
306	8	1991	11	JPTP	947	46	1	1	1
307	8	1992	11	JPTP	564	17	1	1	1
308	8	1993	11	JPTP	266	5	1	1	1
309	8	1994	11	JPTP	218	3	1	1	1
310	8	1995	11	JPTP	407	0	1	1	1
311	8	1996	11	JPTP	766	9	1	1	1
312	8	2001	11	JPTP	44	0	1	1	1
313	8	2002	11	JPTP	74	1	1	1	1
314	8	2019	2	JPTP	133	1	1	1	1

13 Appendix 2: Catch and length frequency data summaries by fishery

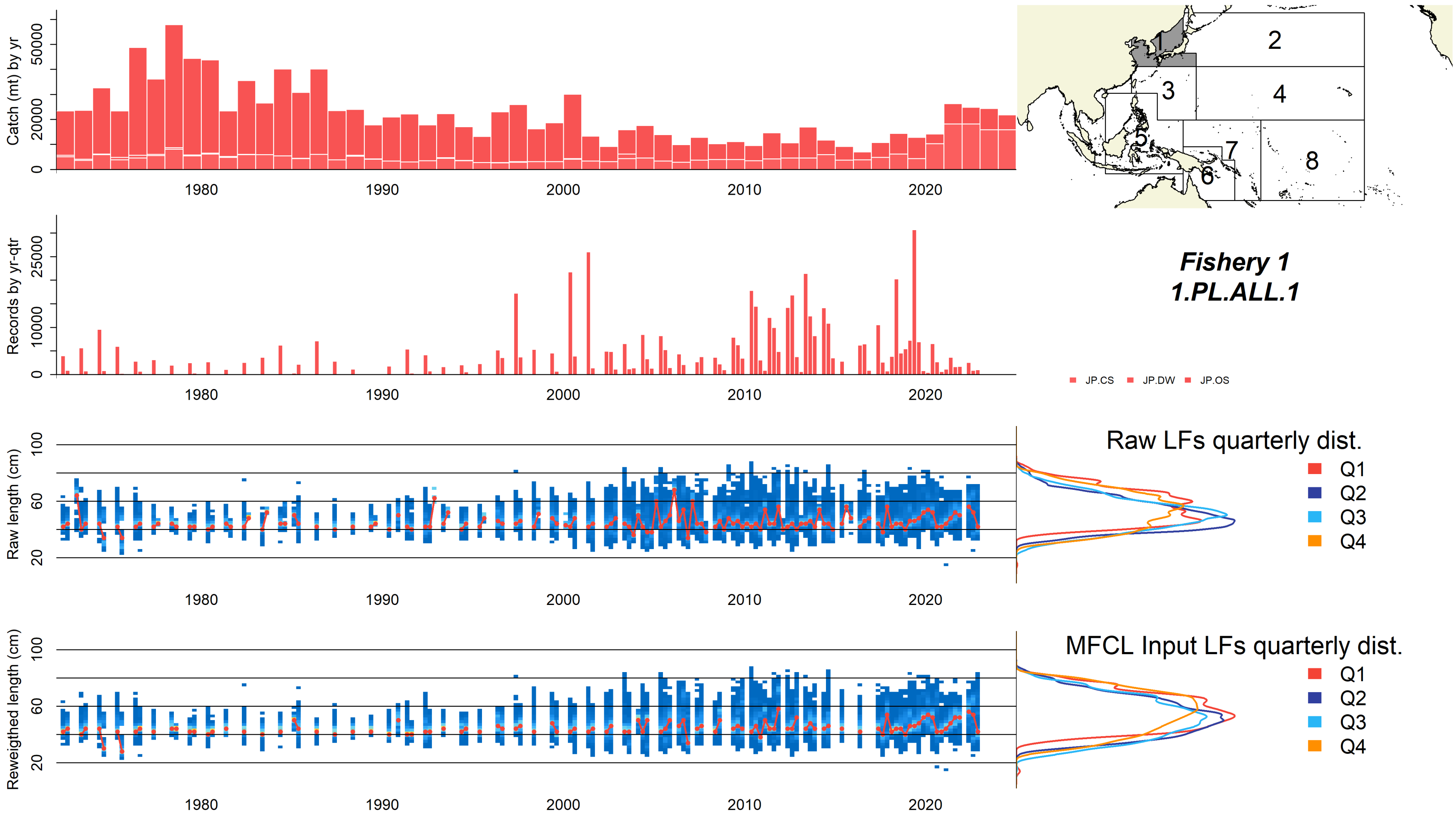


Figure 27: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 1 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

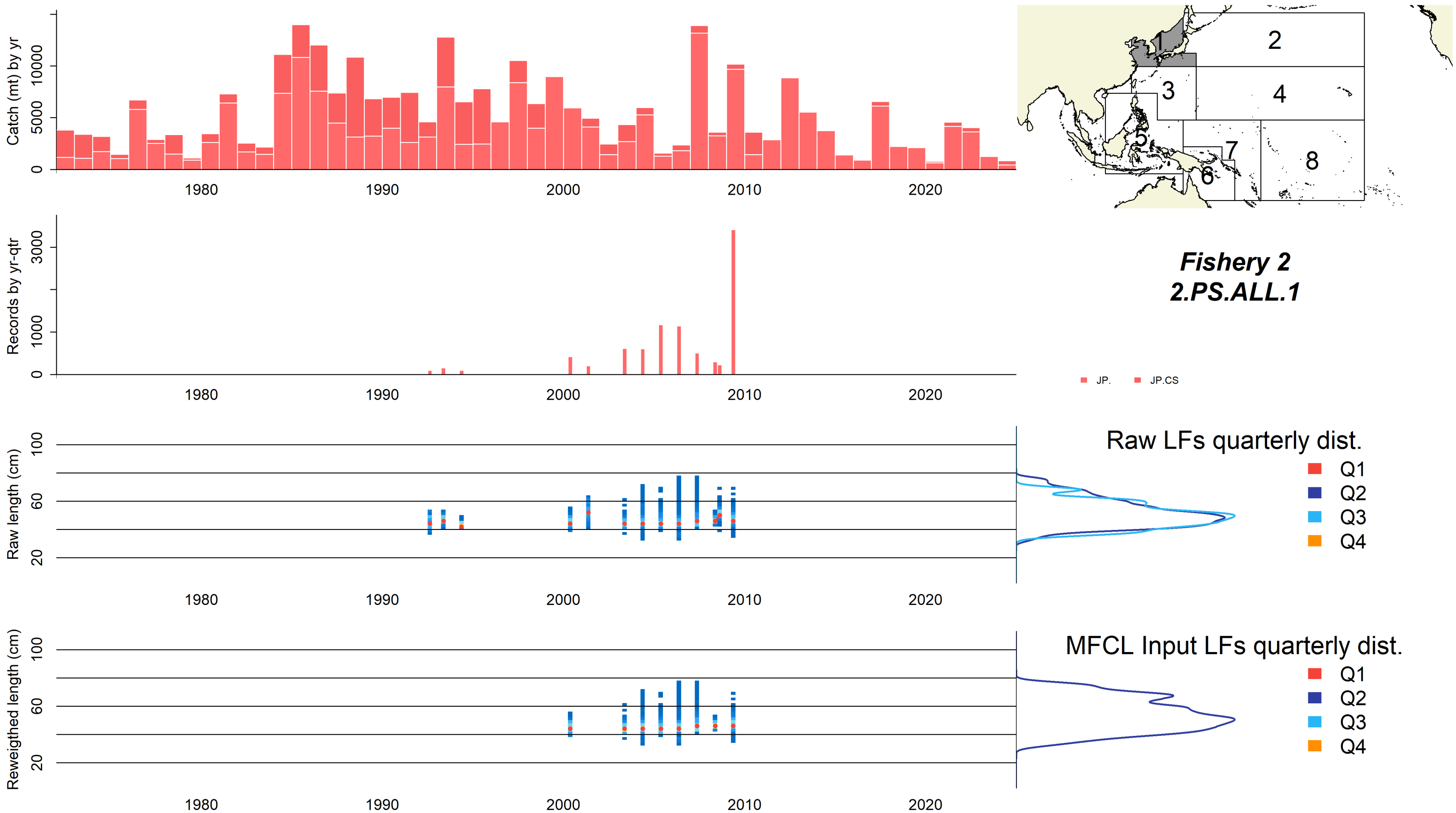


Figure 28: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 2 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

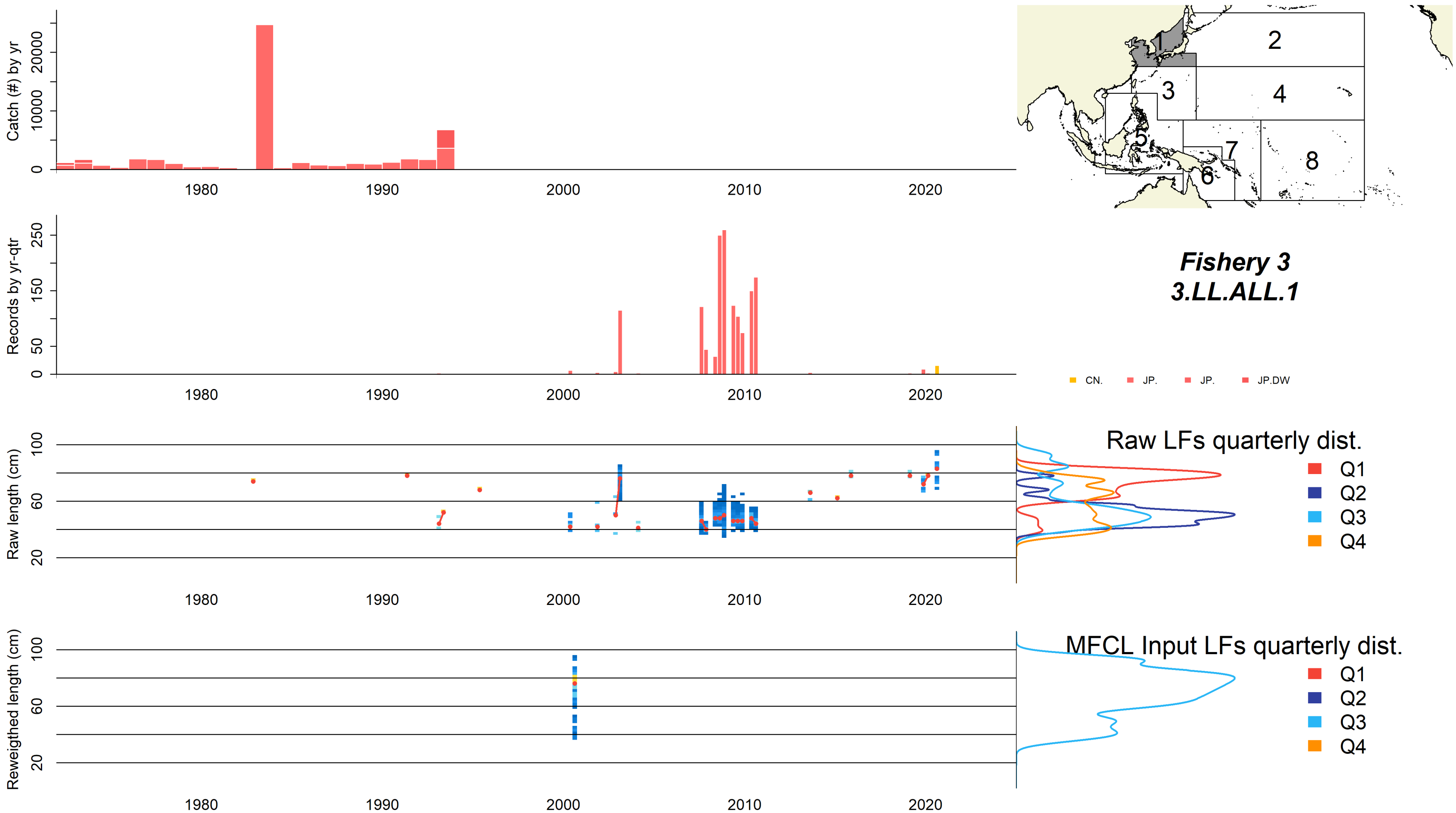


Figure 29: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 3 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

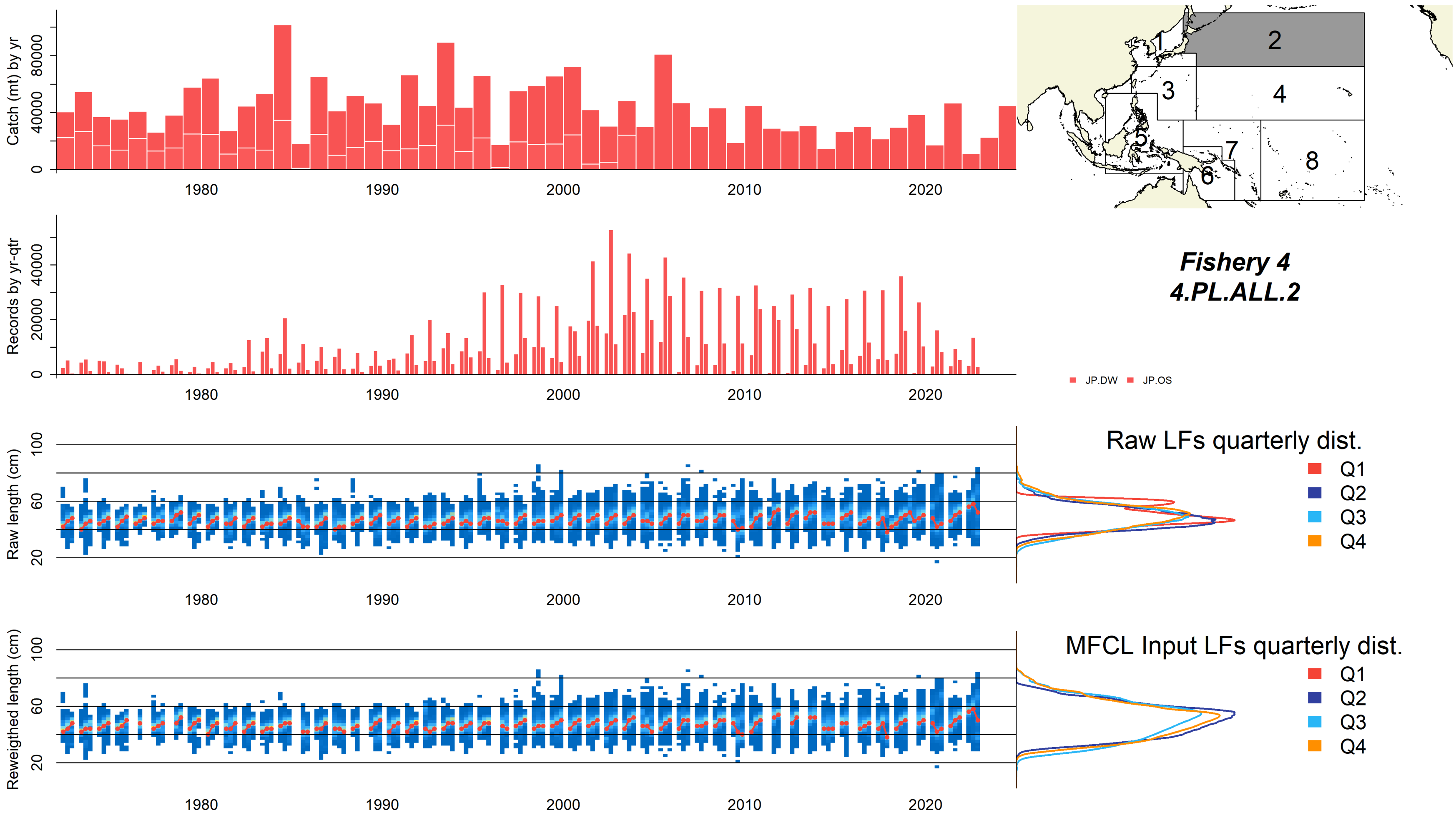


Figure 30: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 4 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

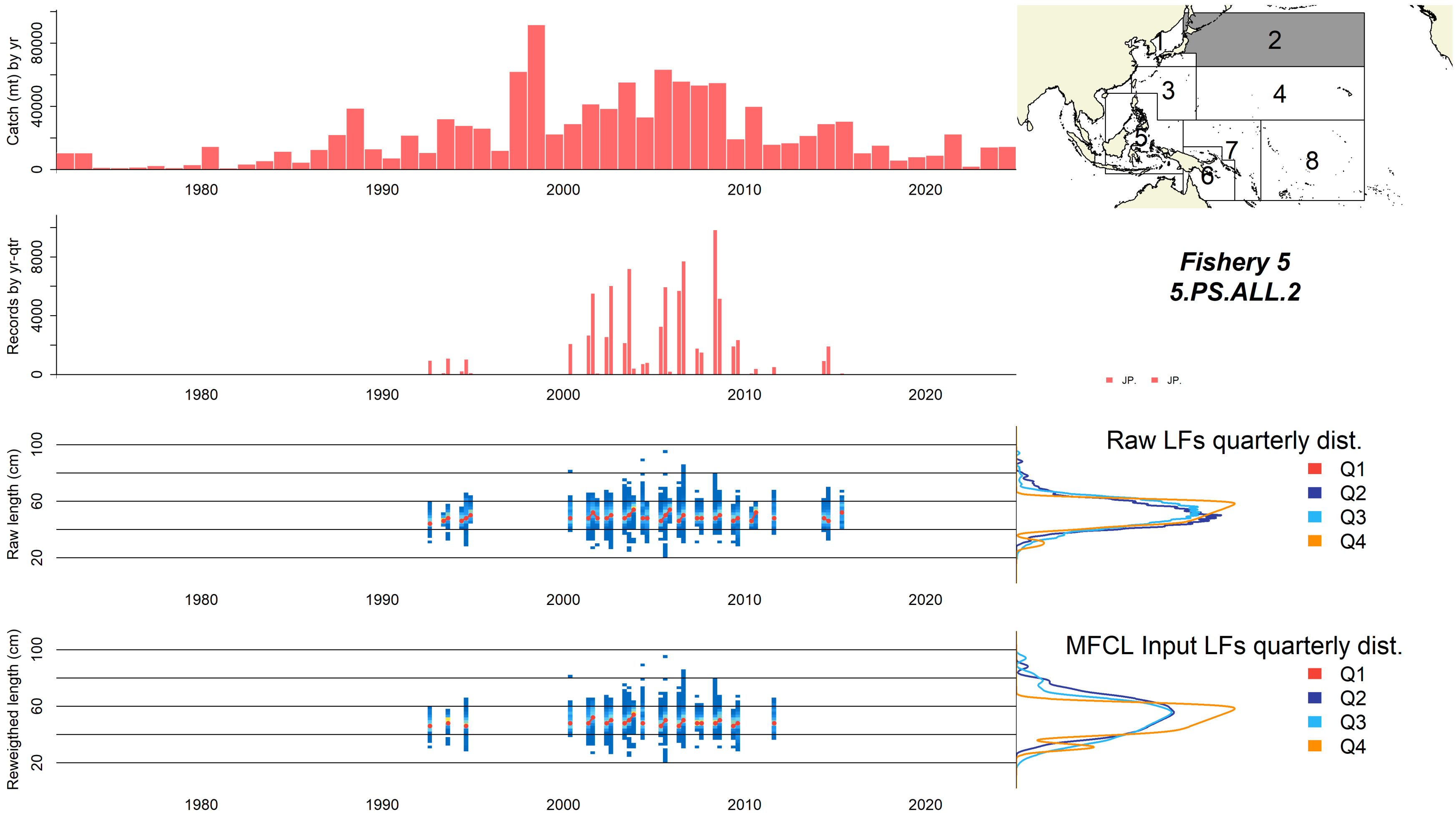


Figure 31: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 5 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

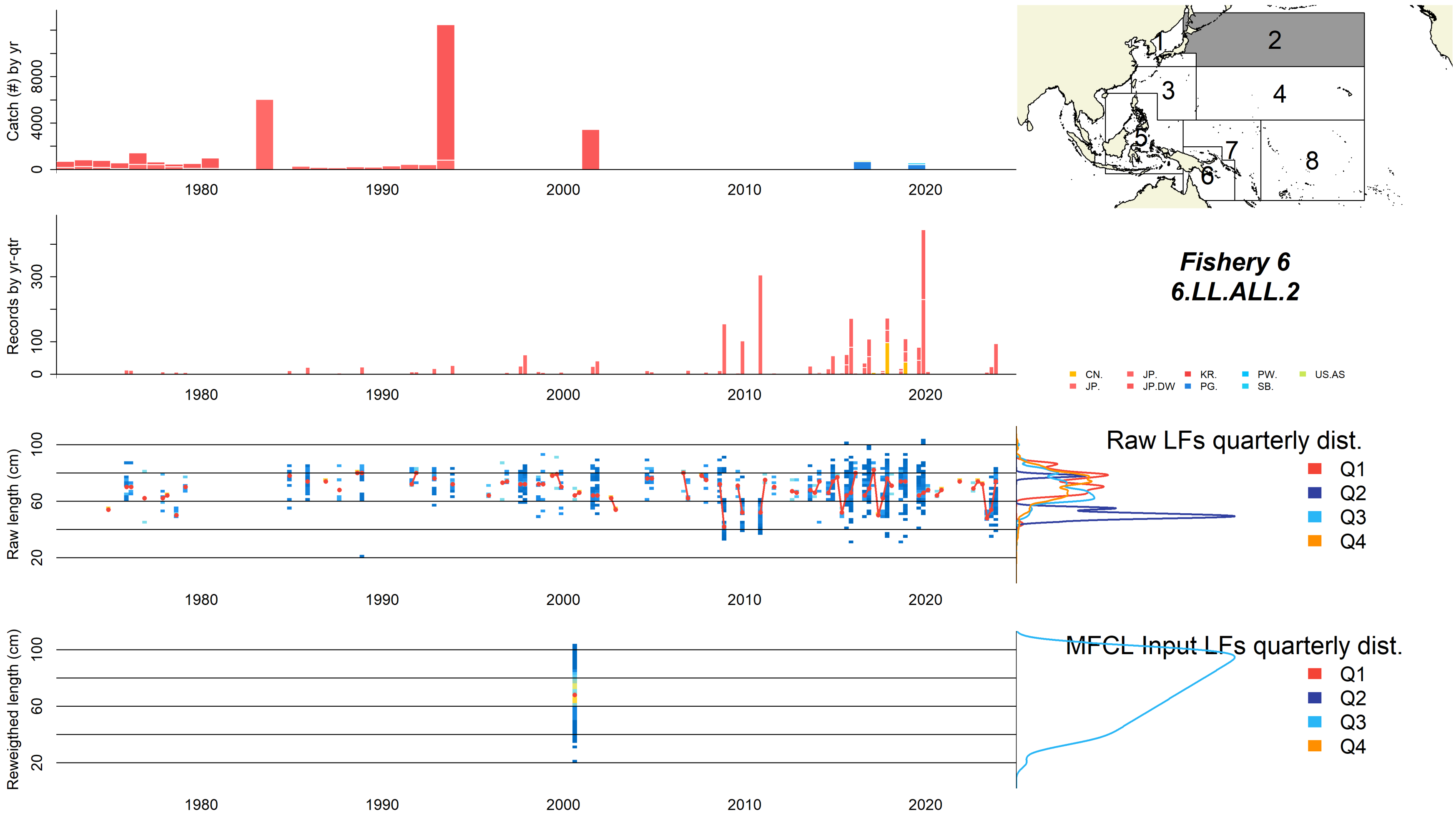


Figure 32: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 6 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

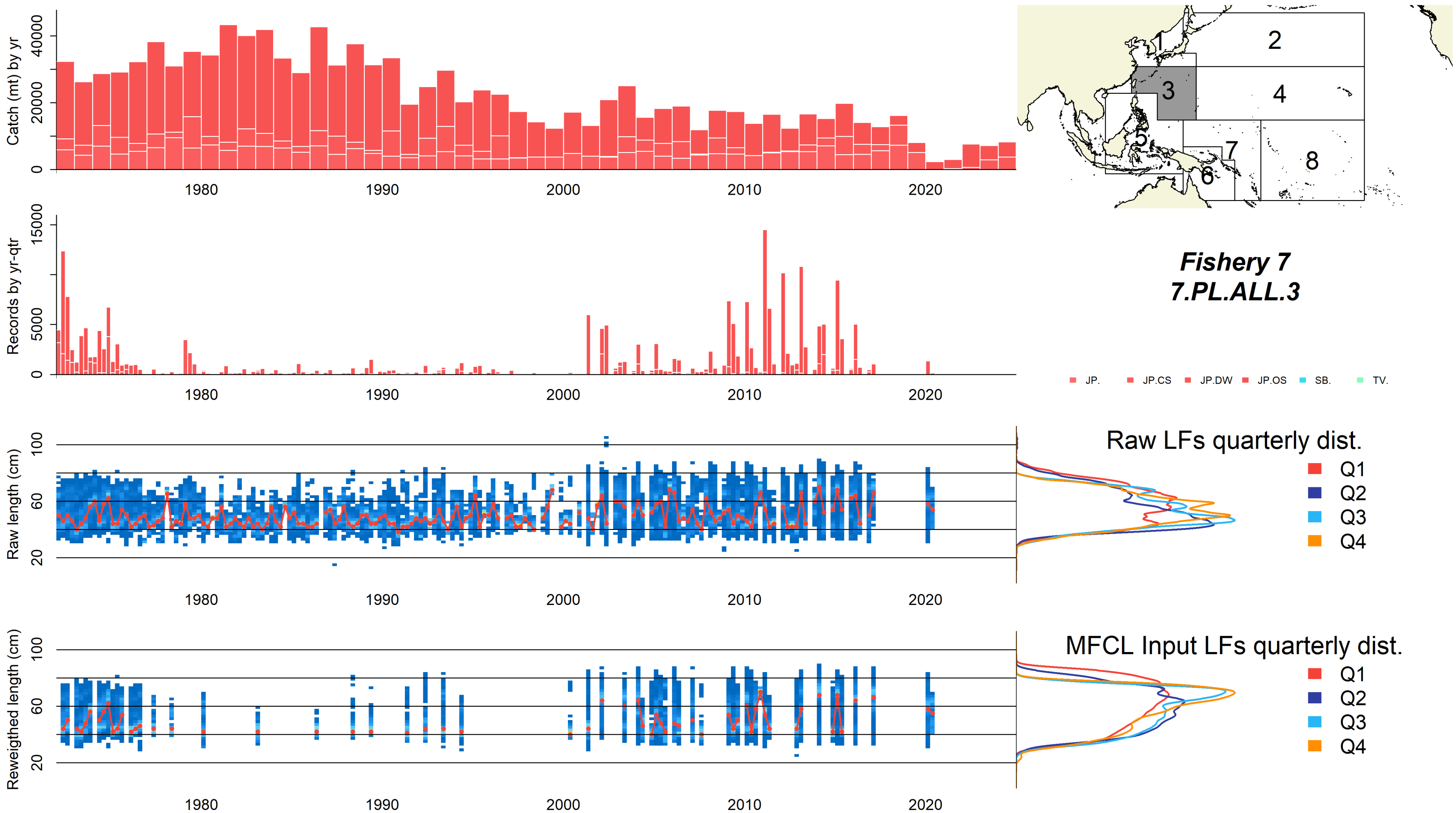


Figure 33: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 7 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

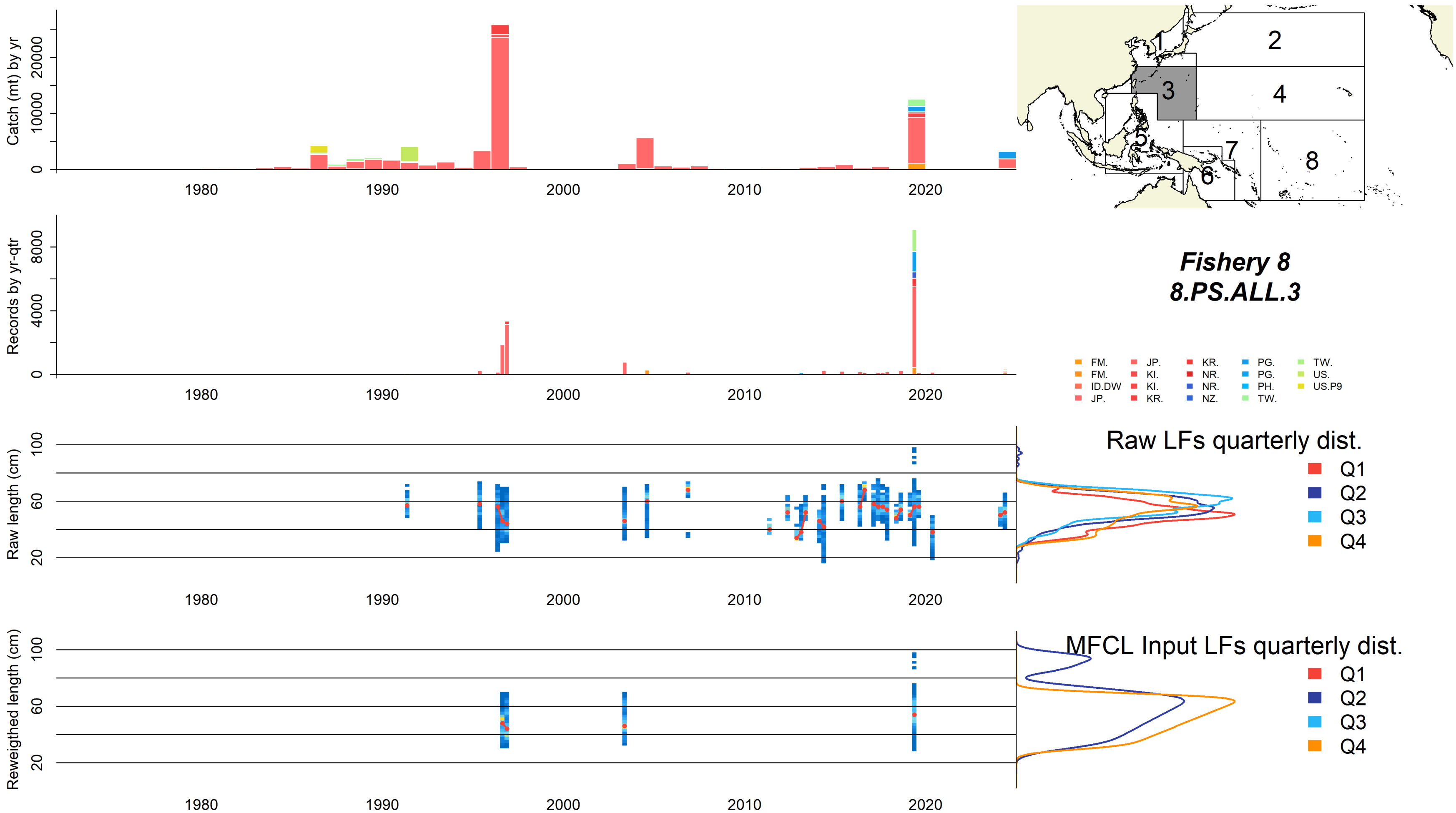


Figure 34: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 8 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

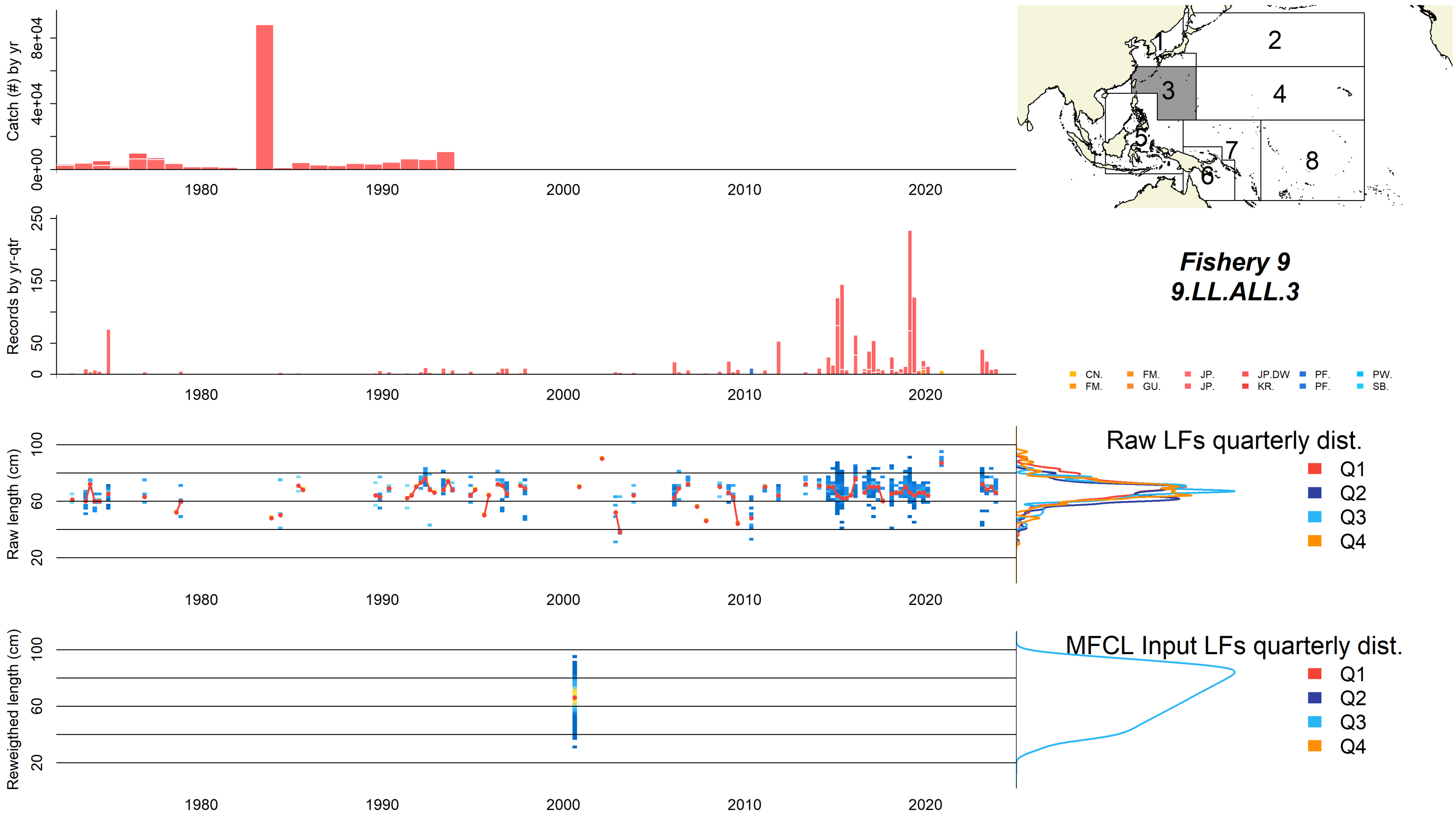


Figure 35: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 9 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

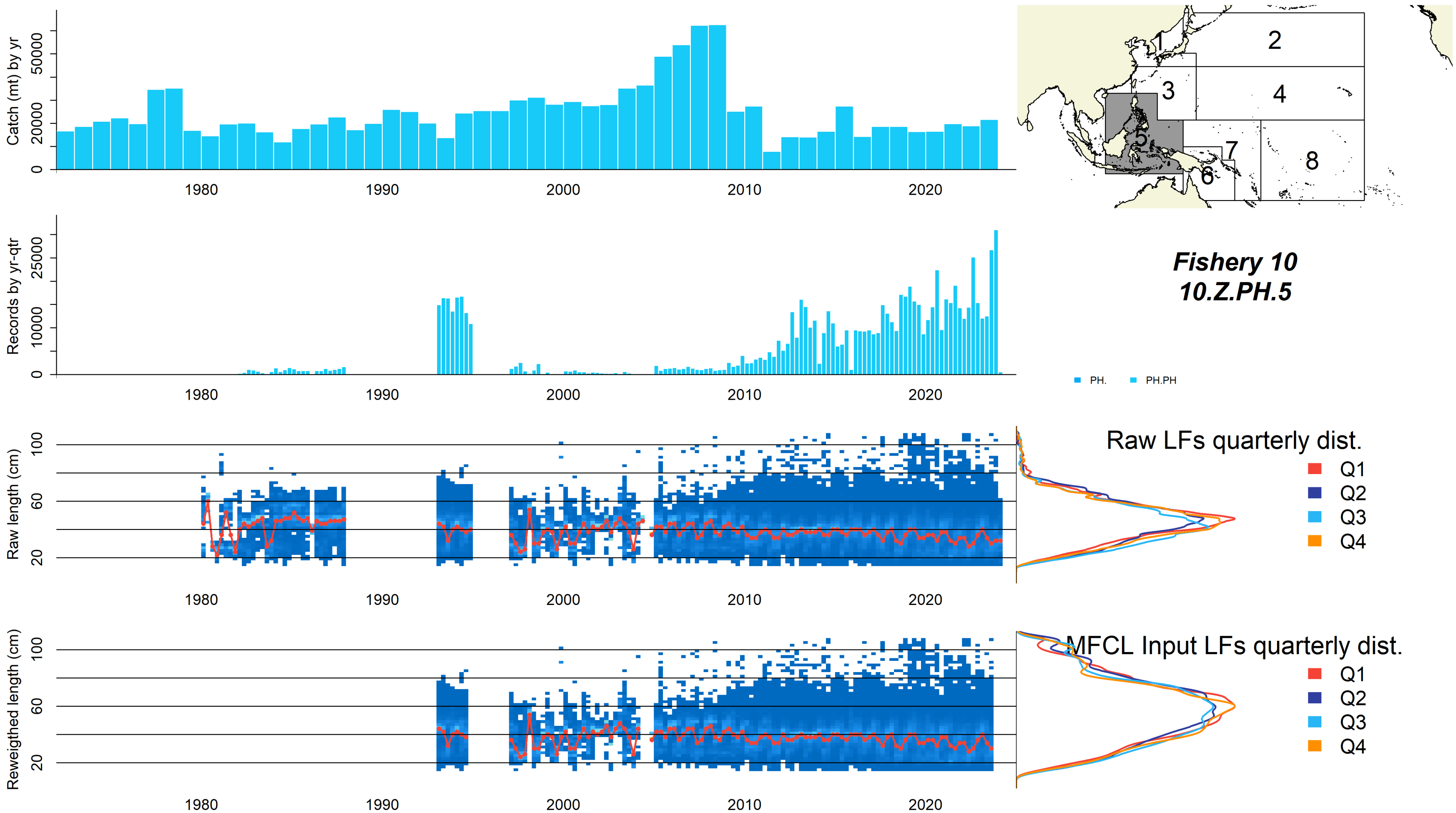


Figure 36: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 10 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

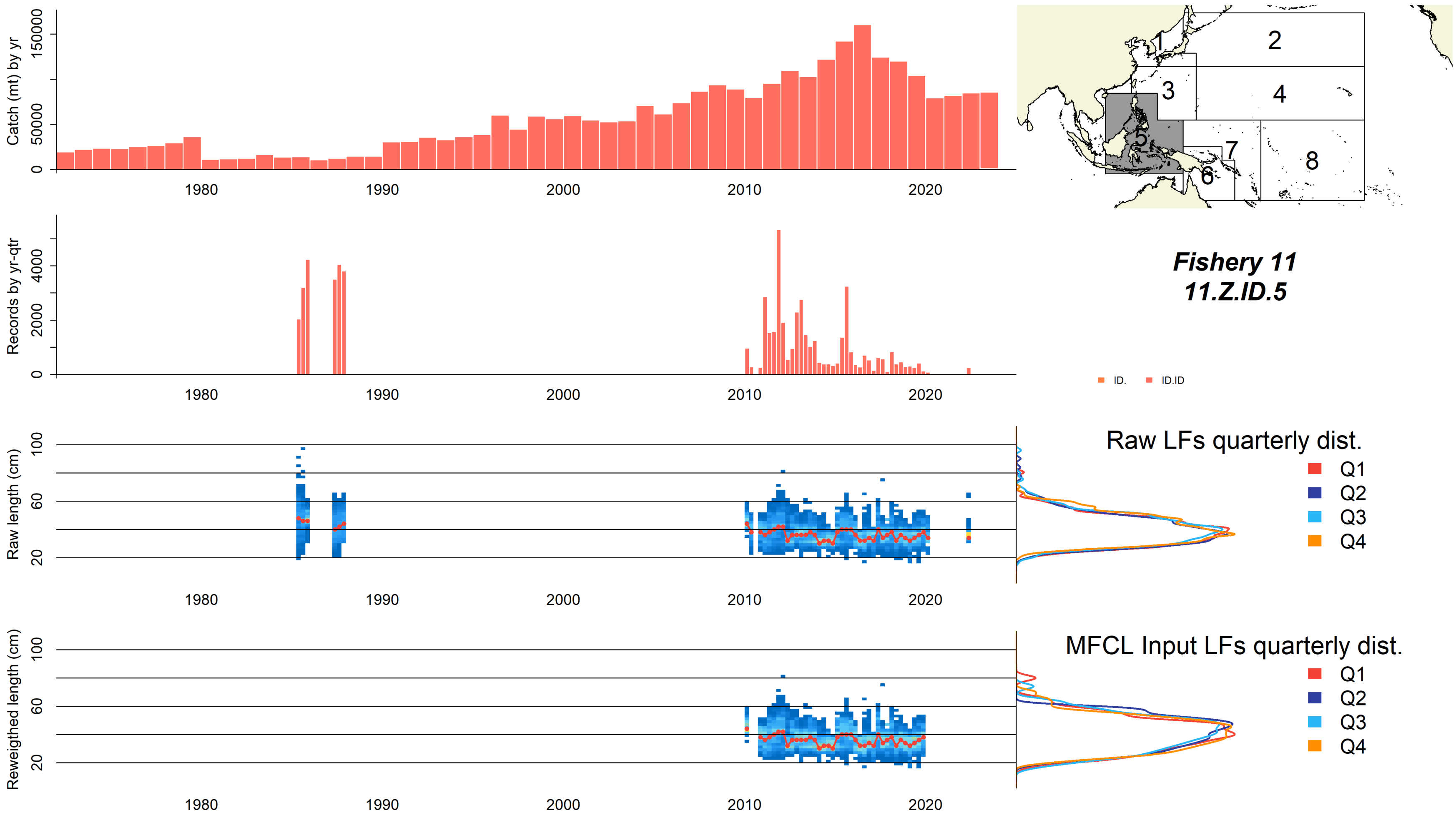


Figure 37: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 11 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

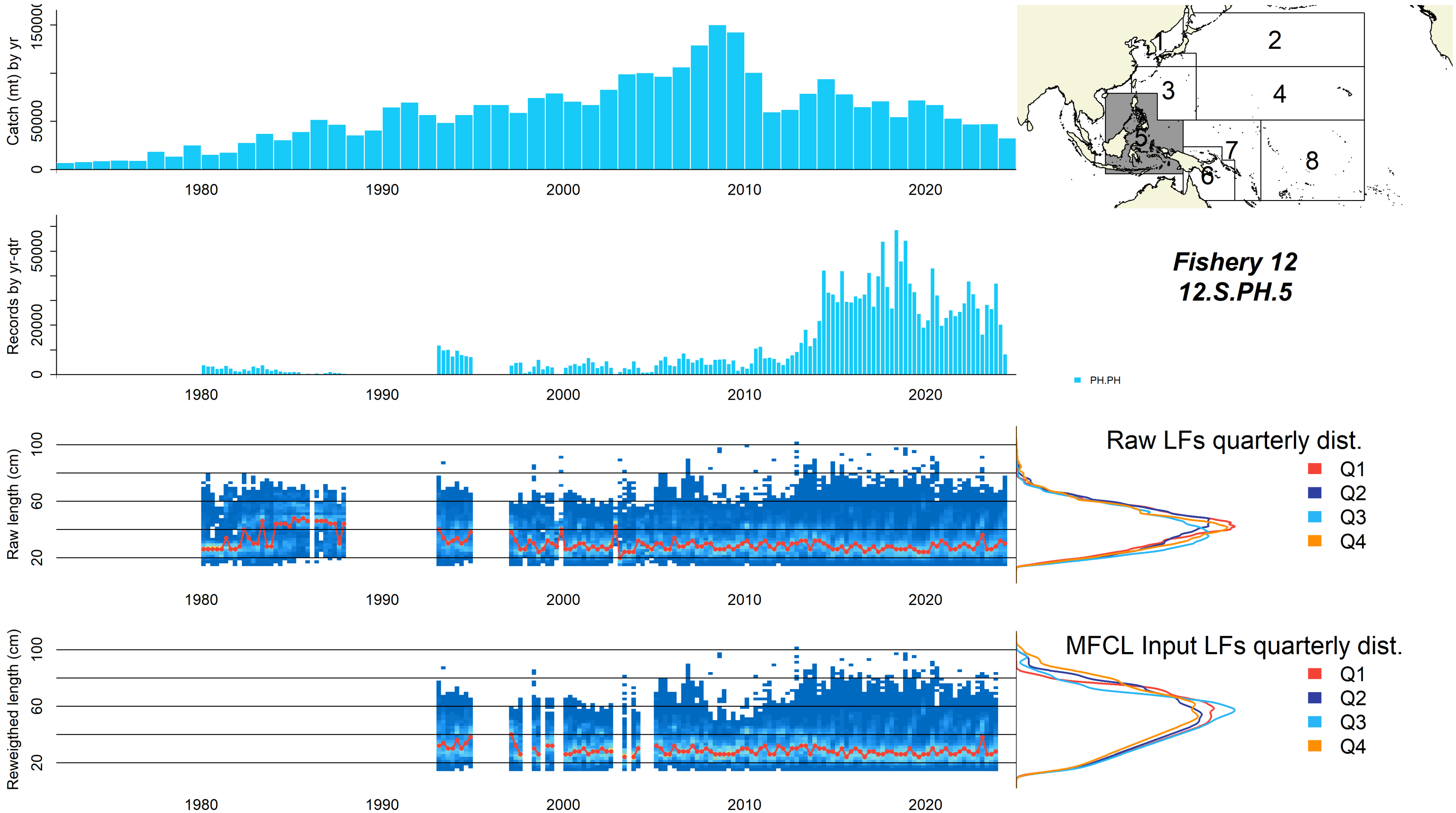


Figure 38: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 12 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

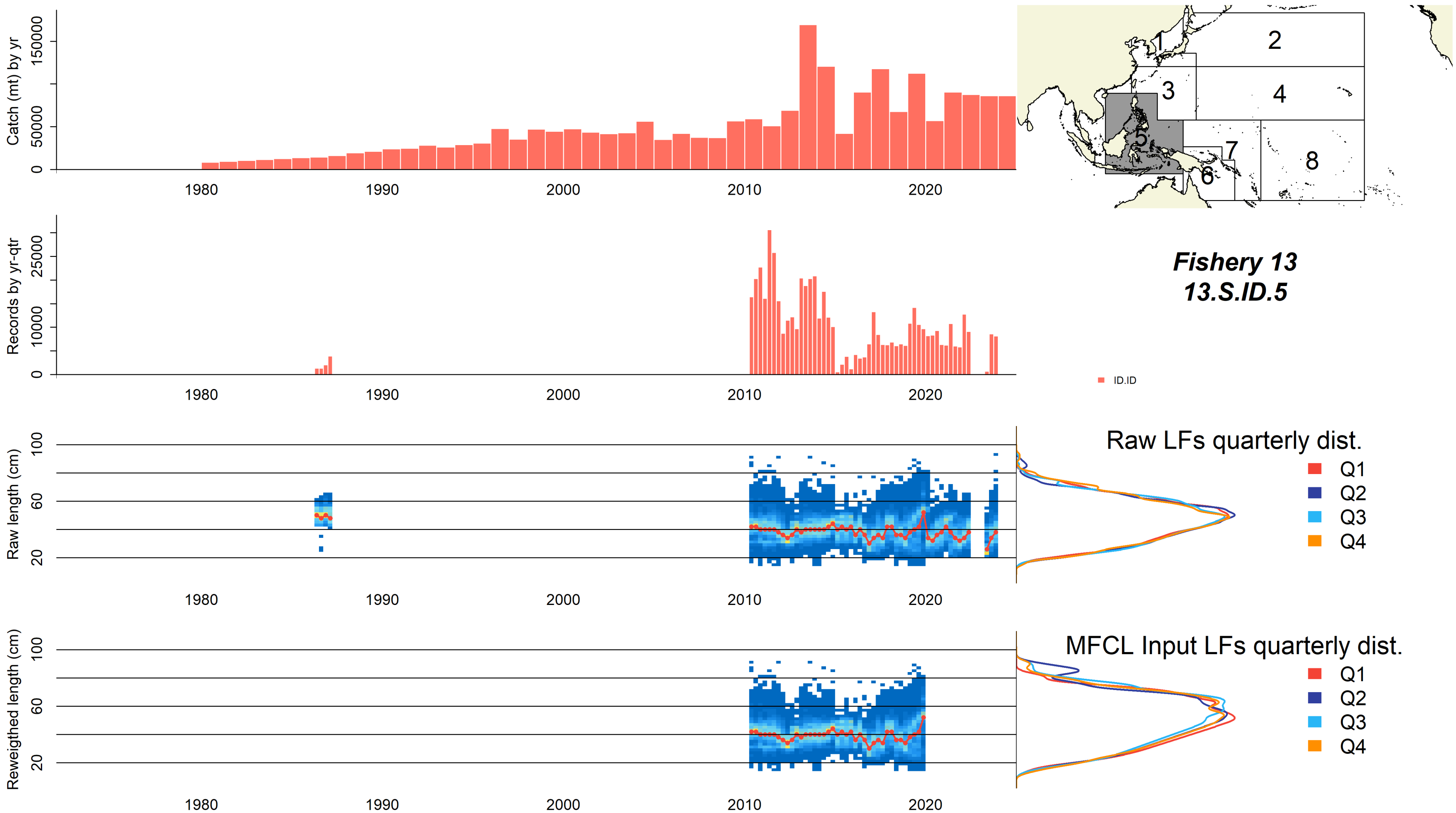


Figure 39: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 13 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

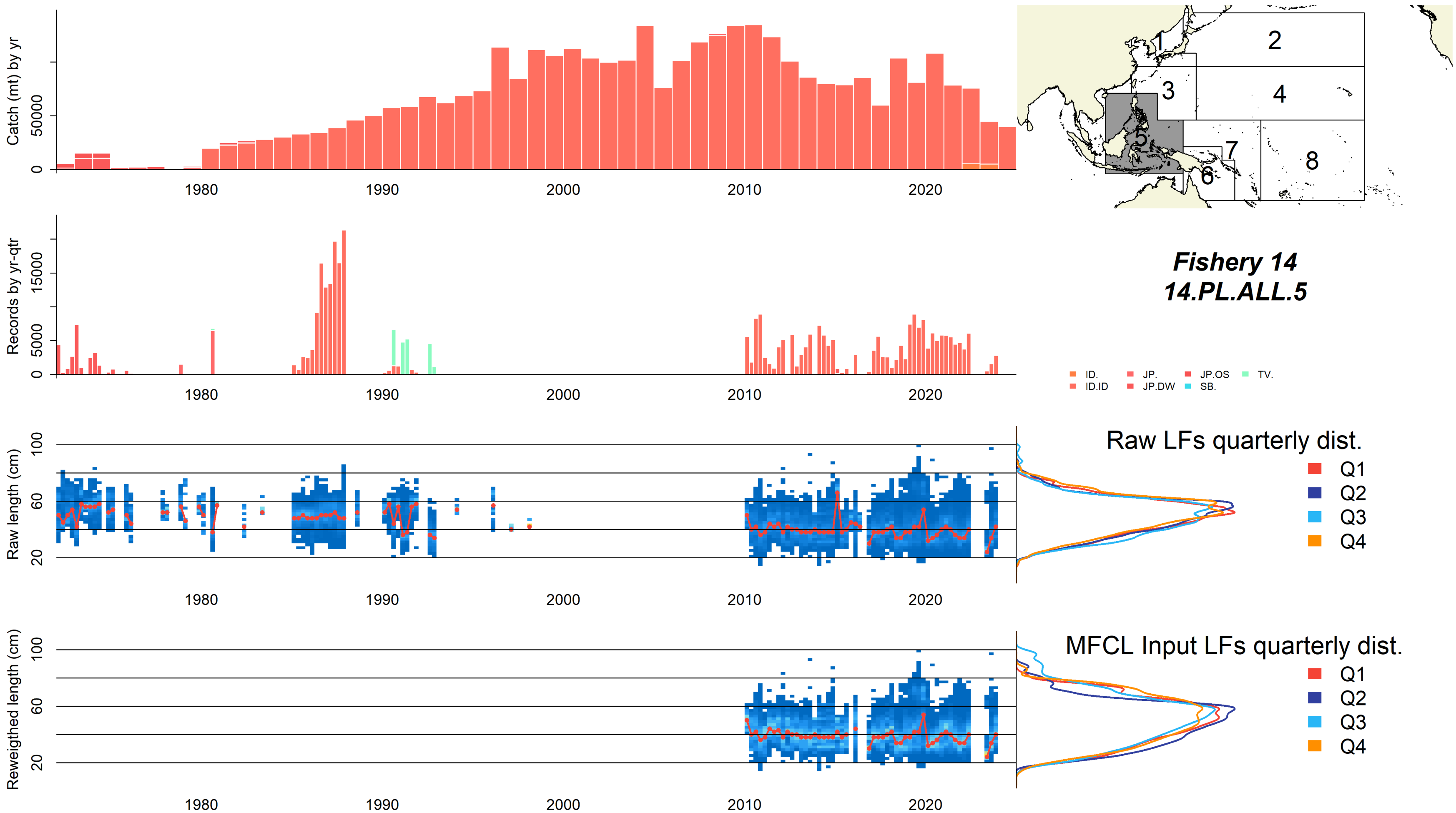


Figure 40: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 14 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

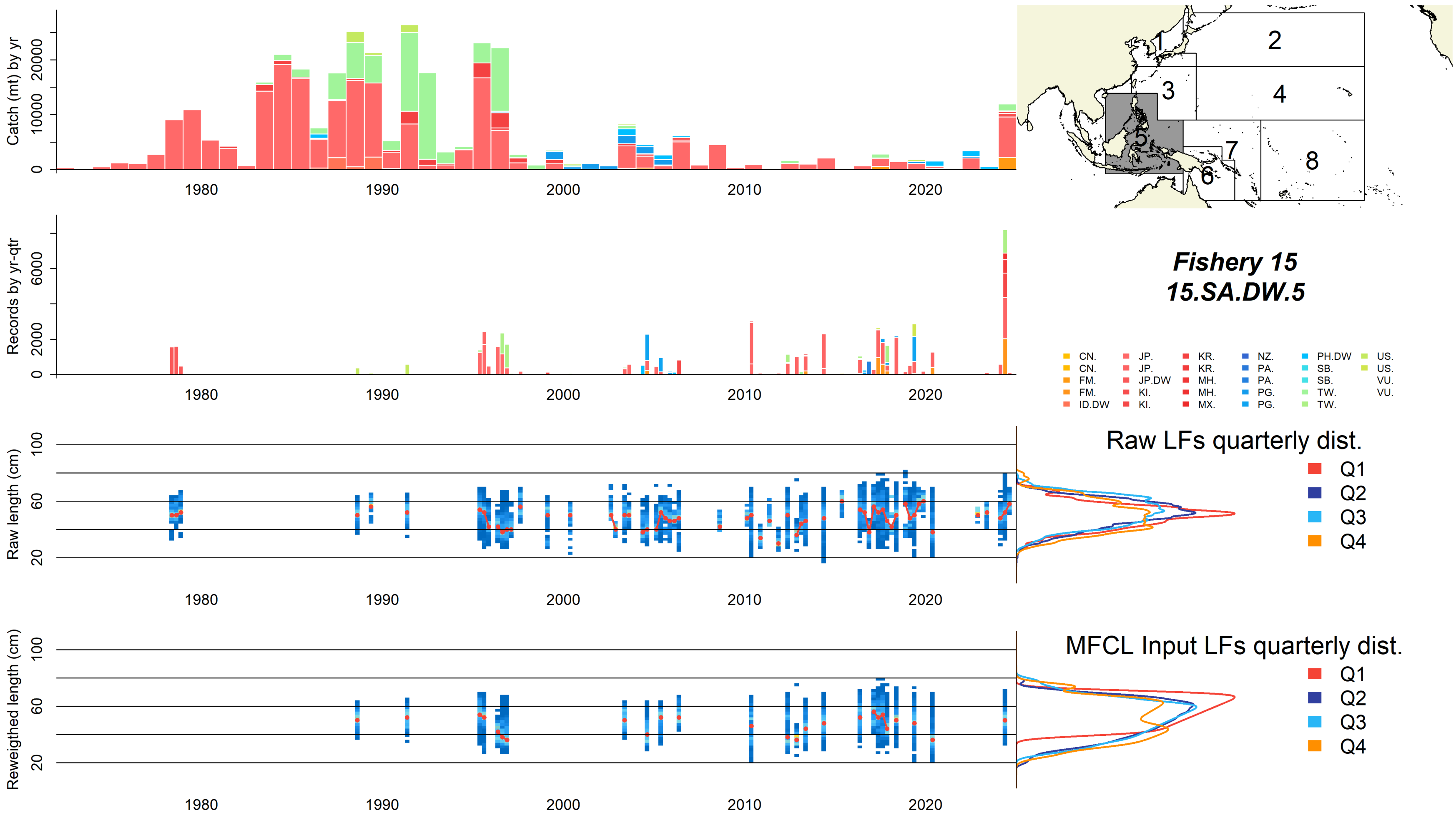


Figure 41: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 15 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

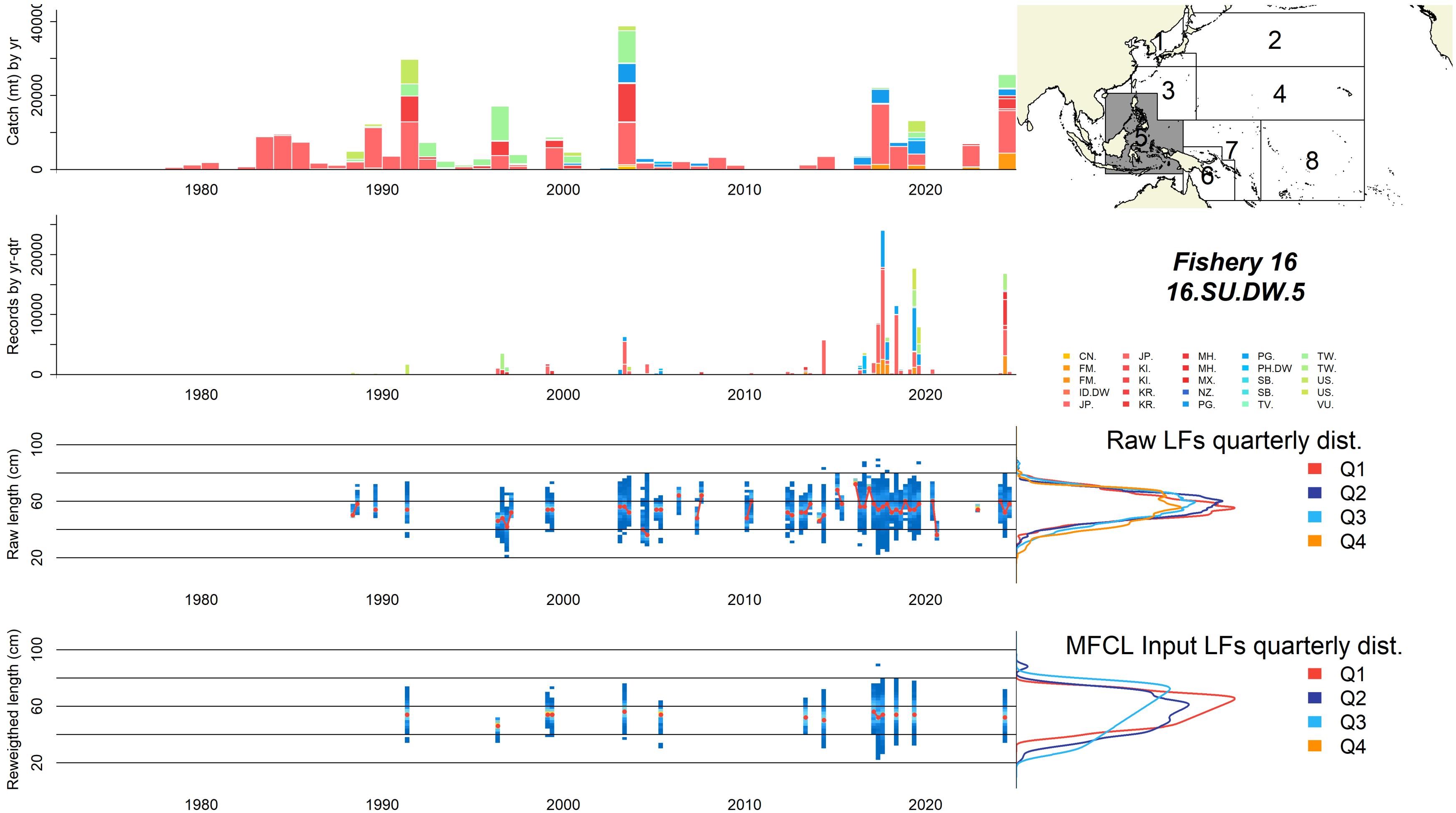


Figure 42: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 16 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

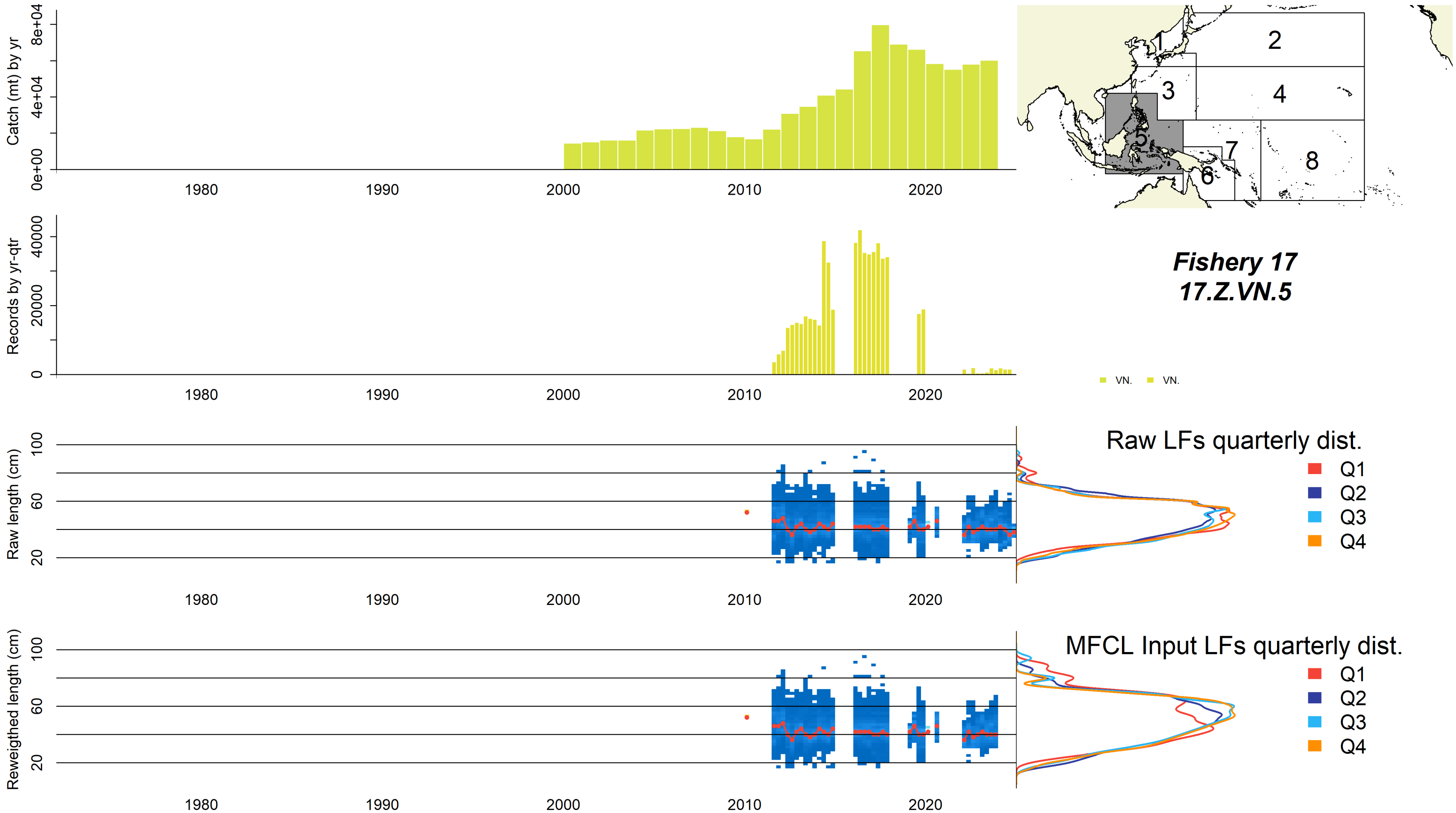


Figure 43: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 17 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

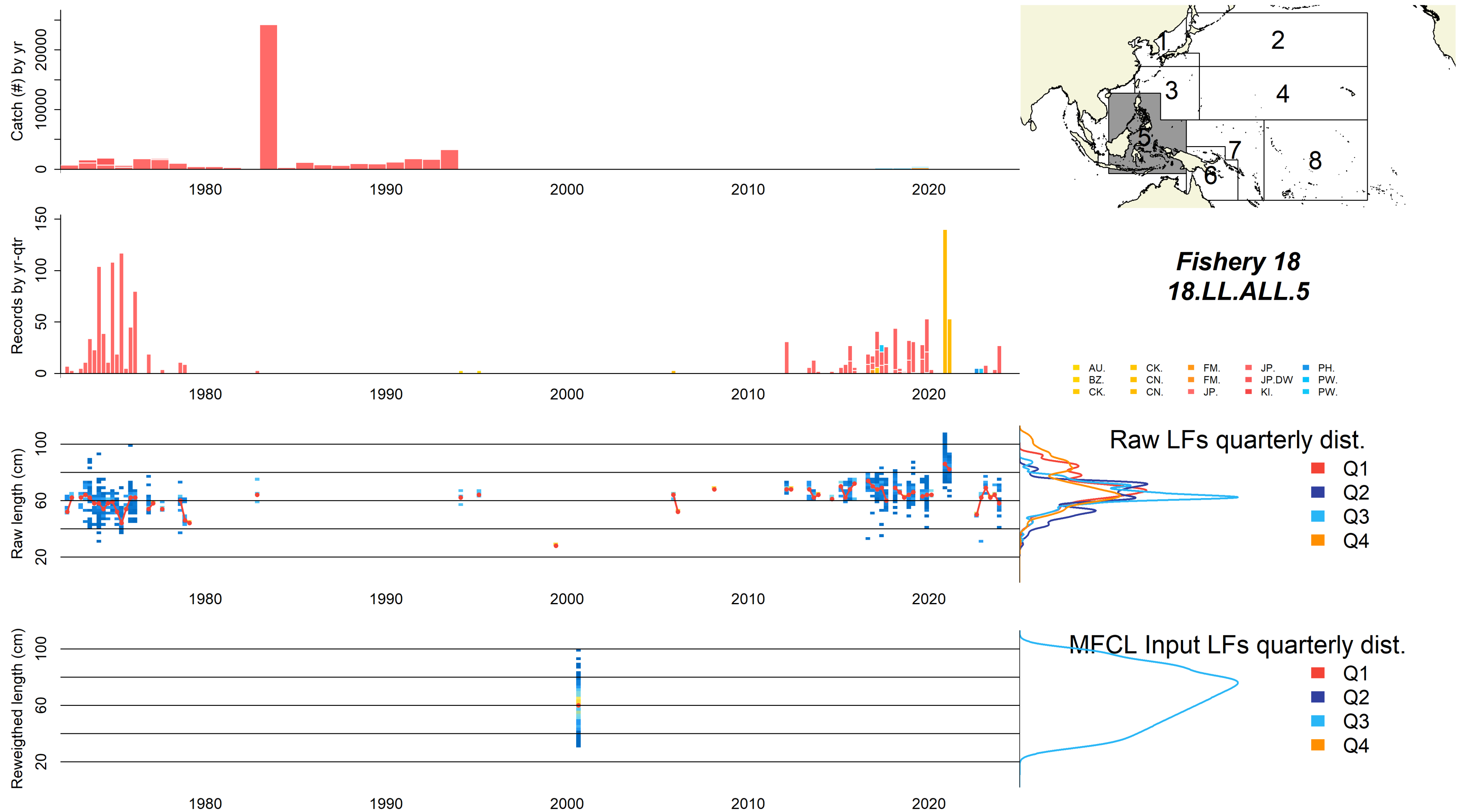


Figure 44: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 18 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

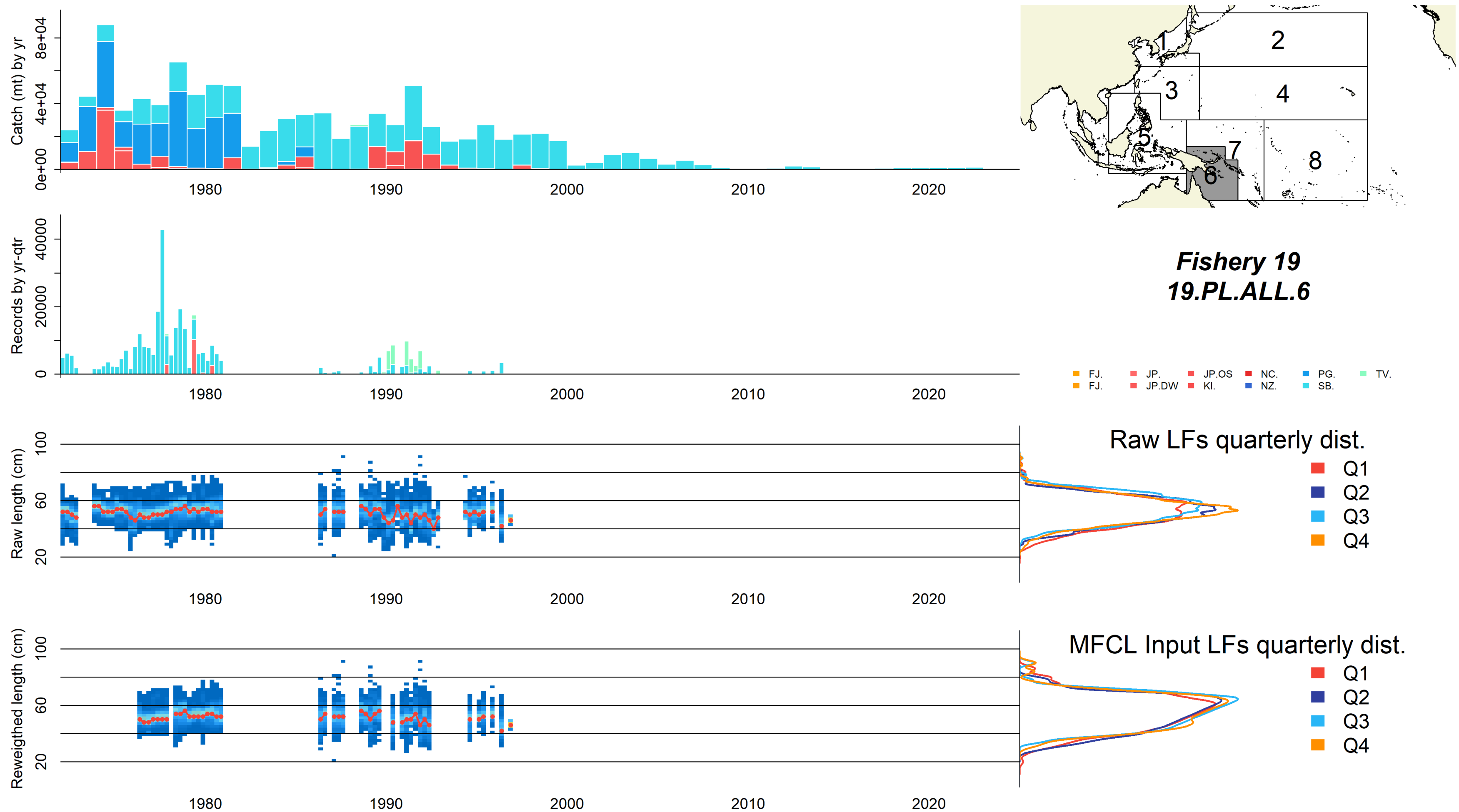


Figure 45: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 19 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery..

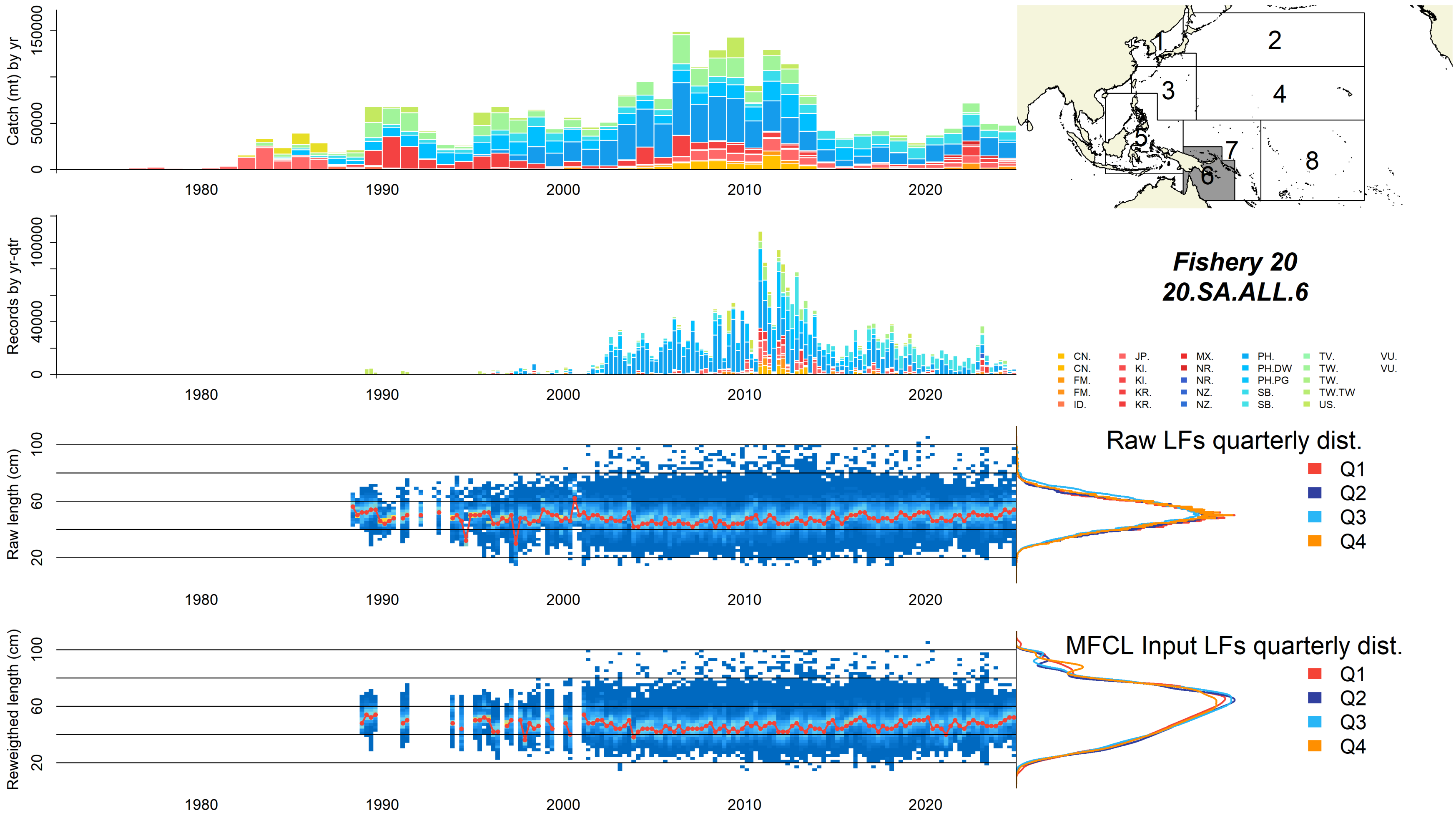


Figure 46: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 20 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

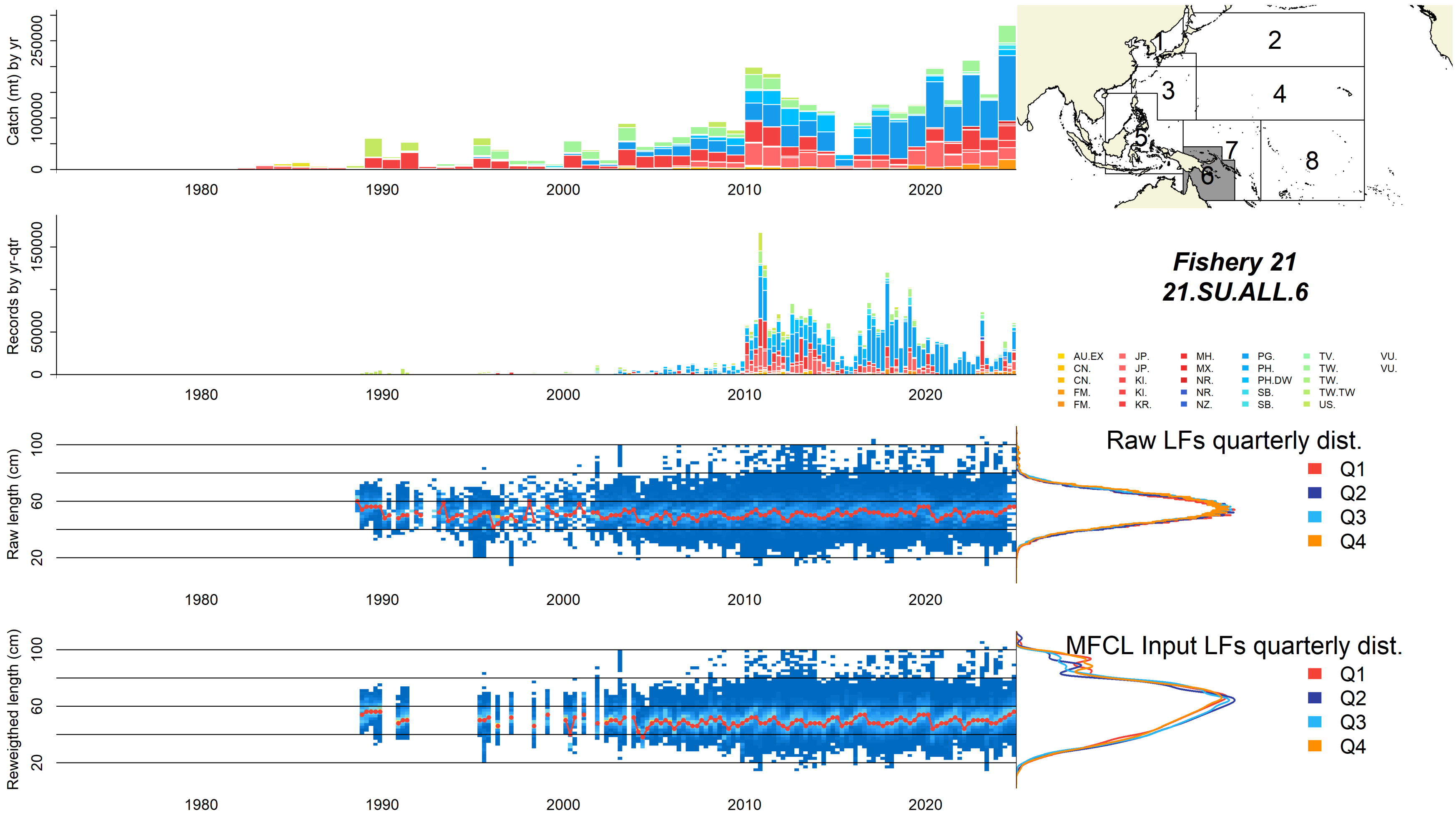


Figure 47: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 21 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

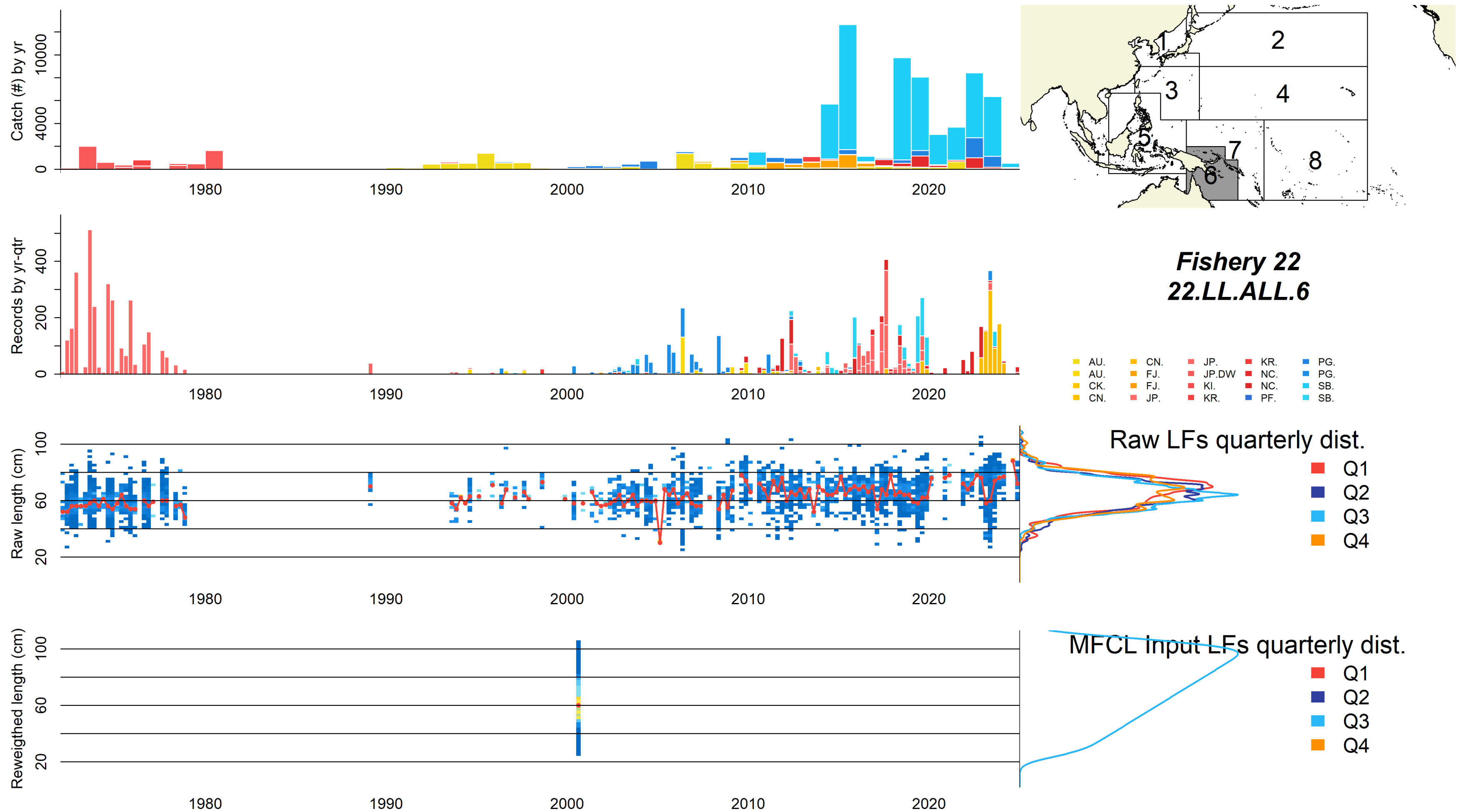


Figure 48: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 22 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

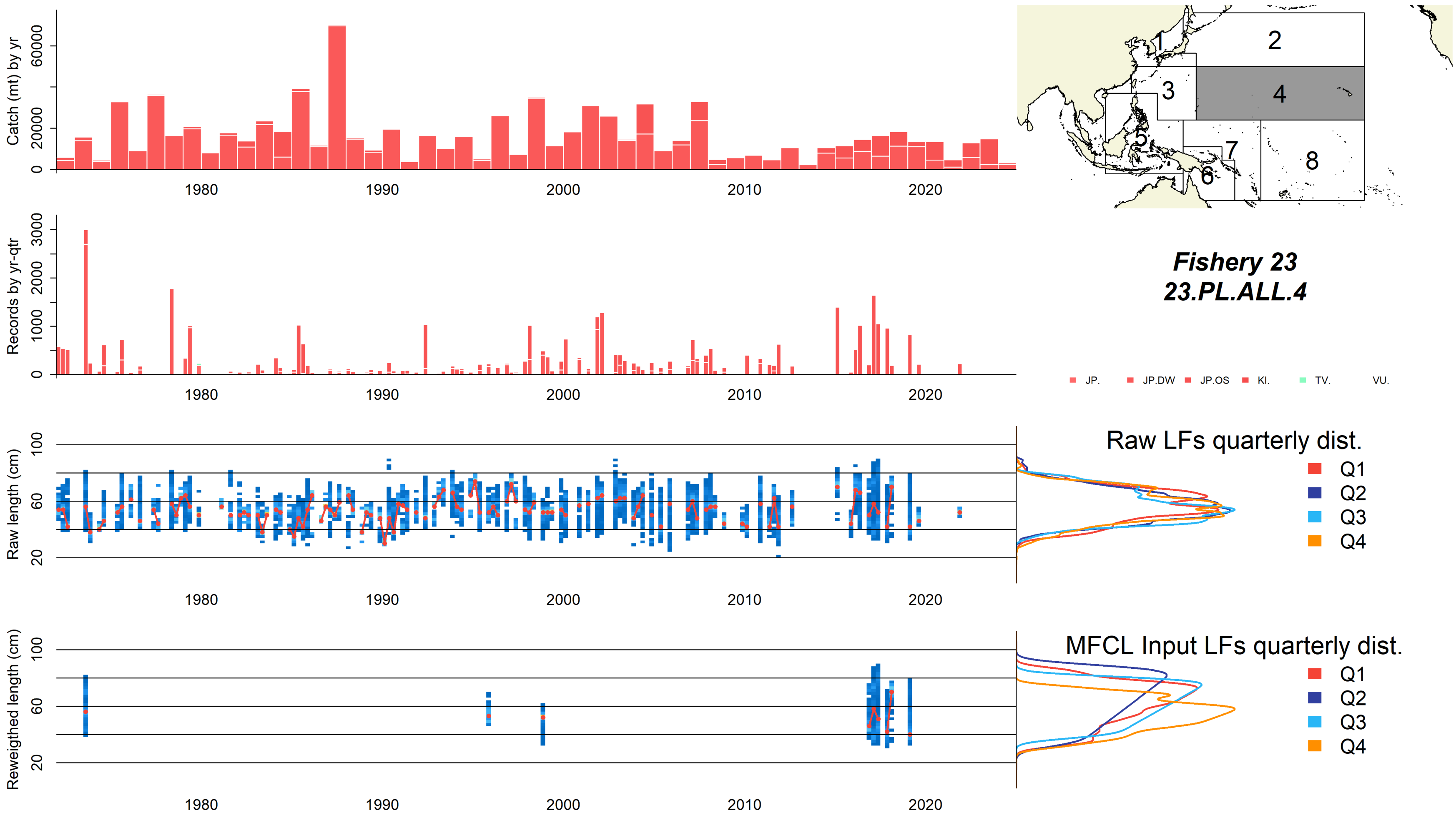


Figure 49: Summary of raw available data and processed length frequencies (MFCL input LFs) for fishery 23 of the 2025 skipjack stock assessment. The panels display: (1) the region and fishery area of occurrence (top right), (2) the annual catch by fleet within the fishery, in metric tons (top left), (3) the annual number of fish with measured length (second left), (4) trends in length composition data with the median highlighted in red (third left) along with the overall quarterly size distribution over the time span of the fishery, and (5) trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time span of the fishery.

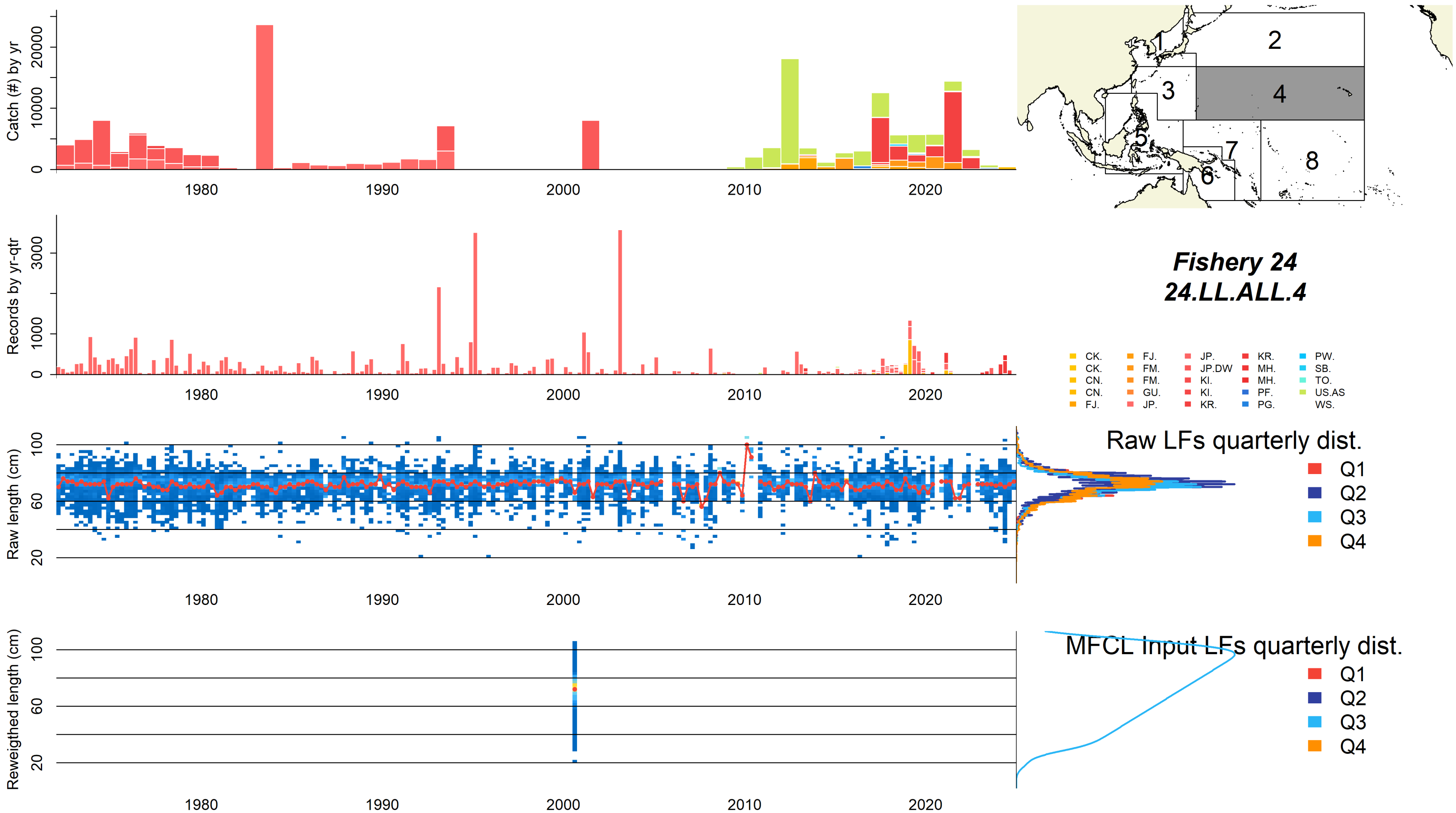


Figure 50: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 24 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

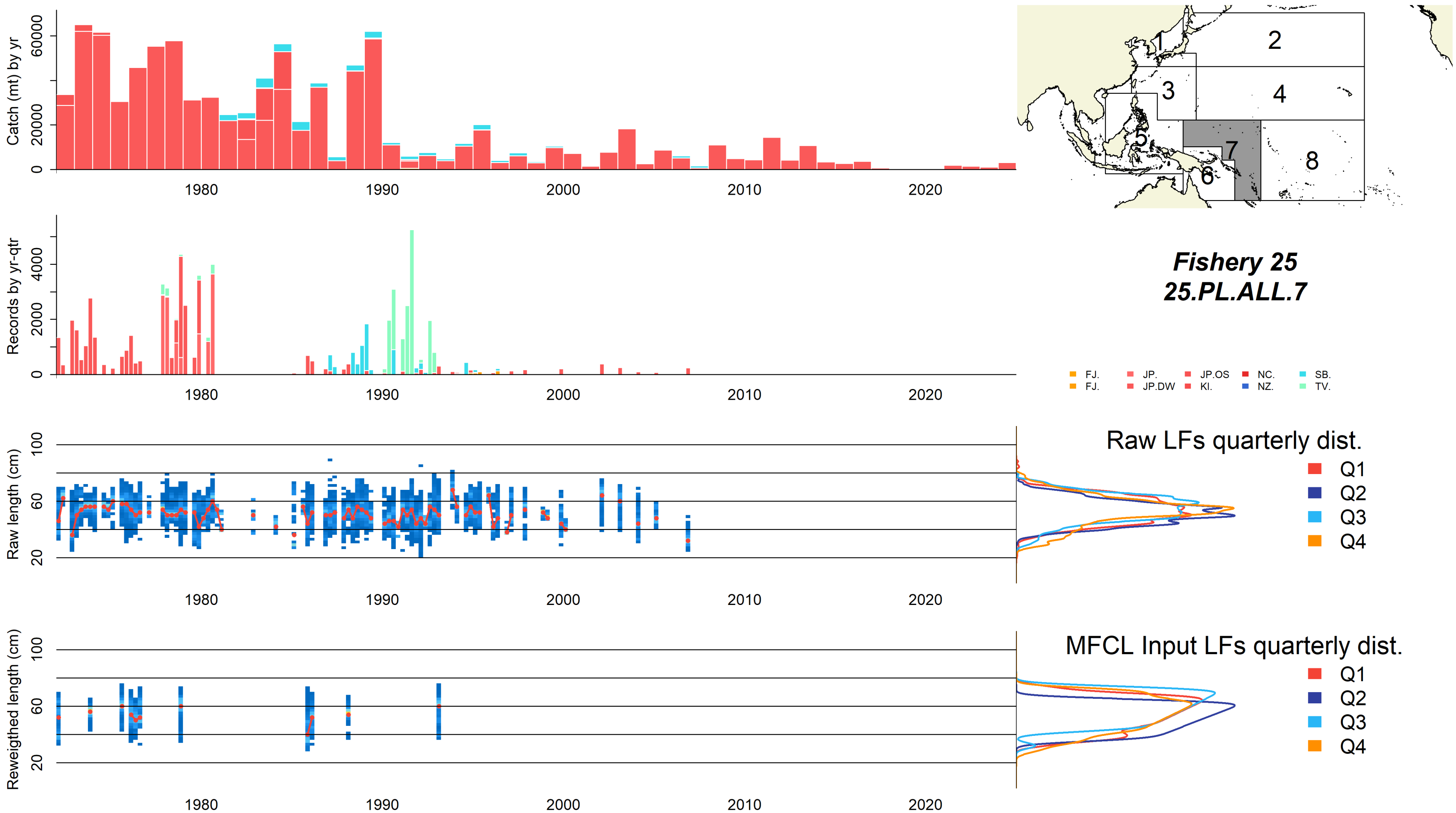


Figure 51: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 25 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

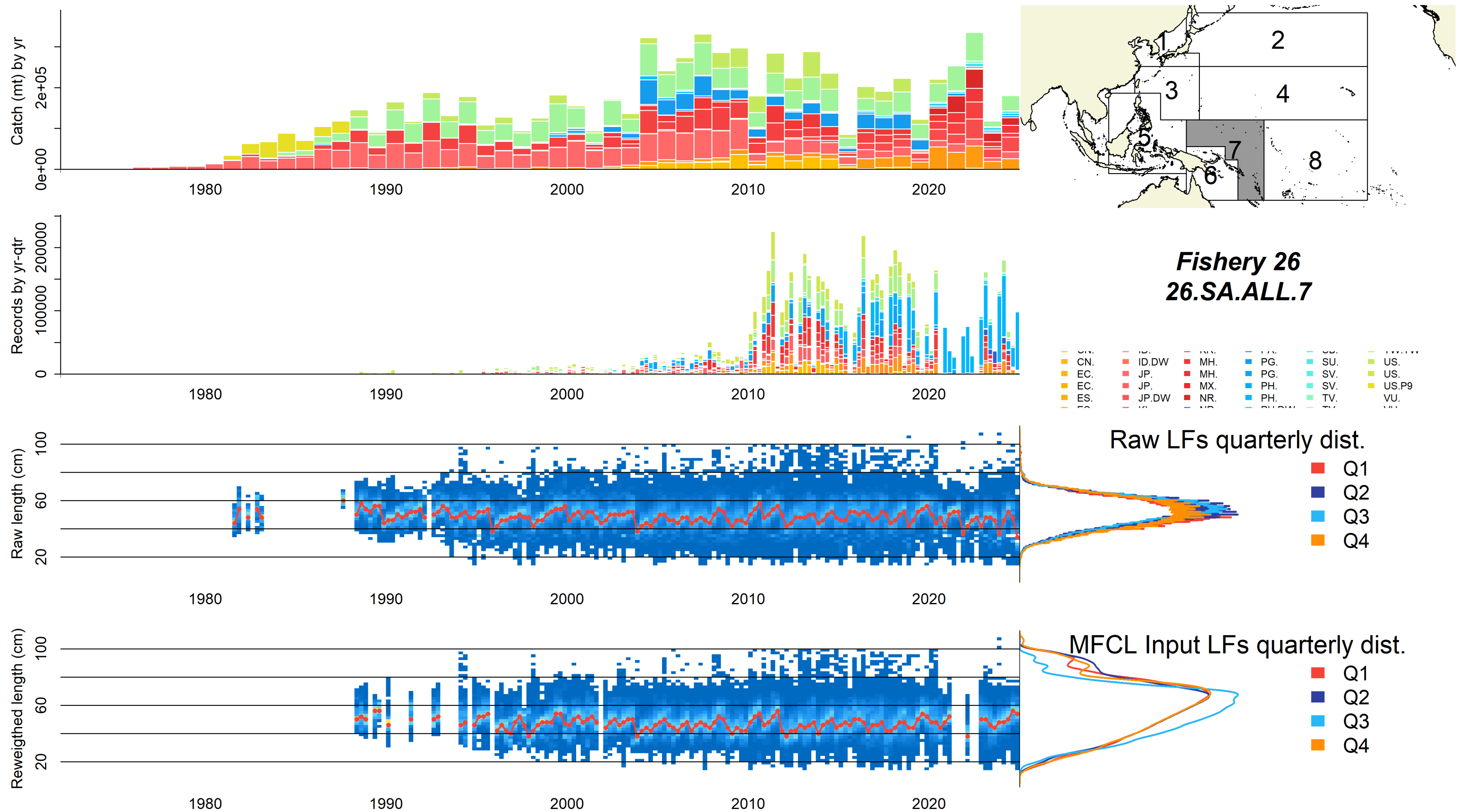


Figure 52: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 26 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

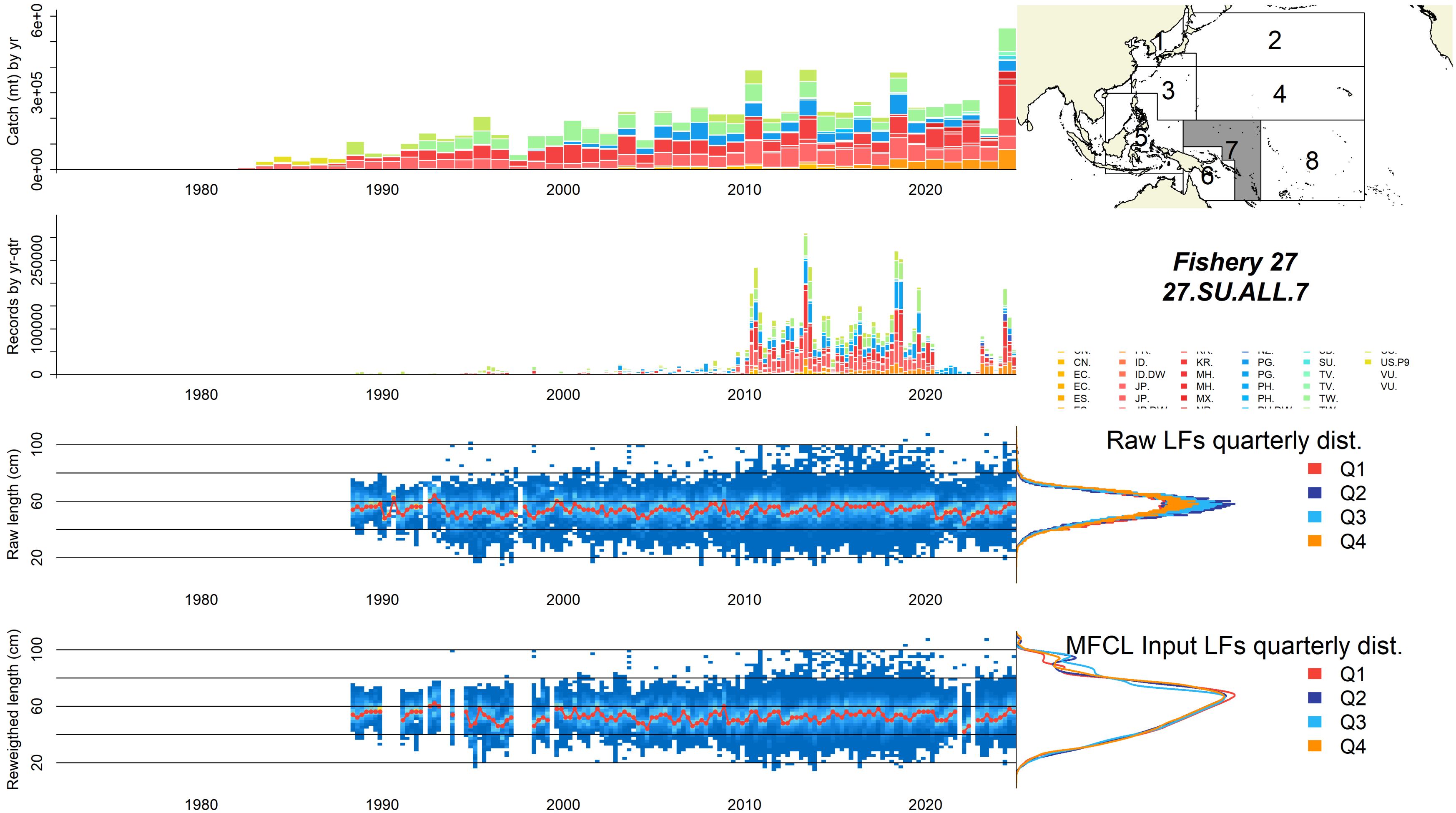


Figure 53: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 27 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

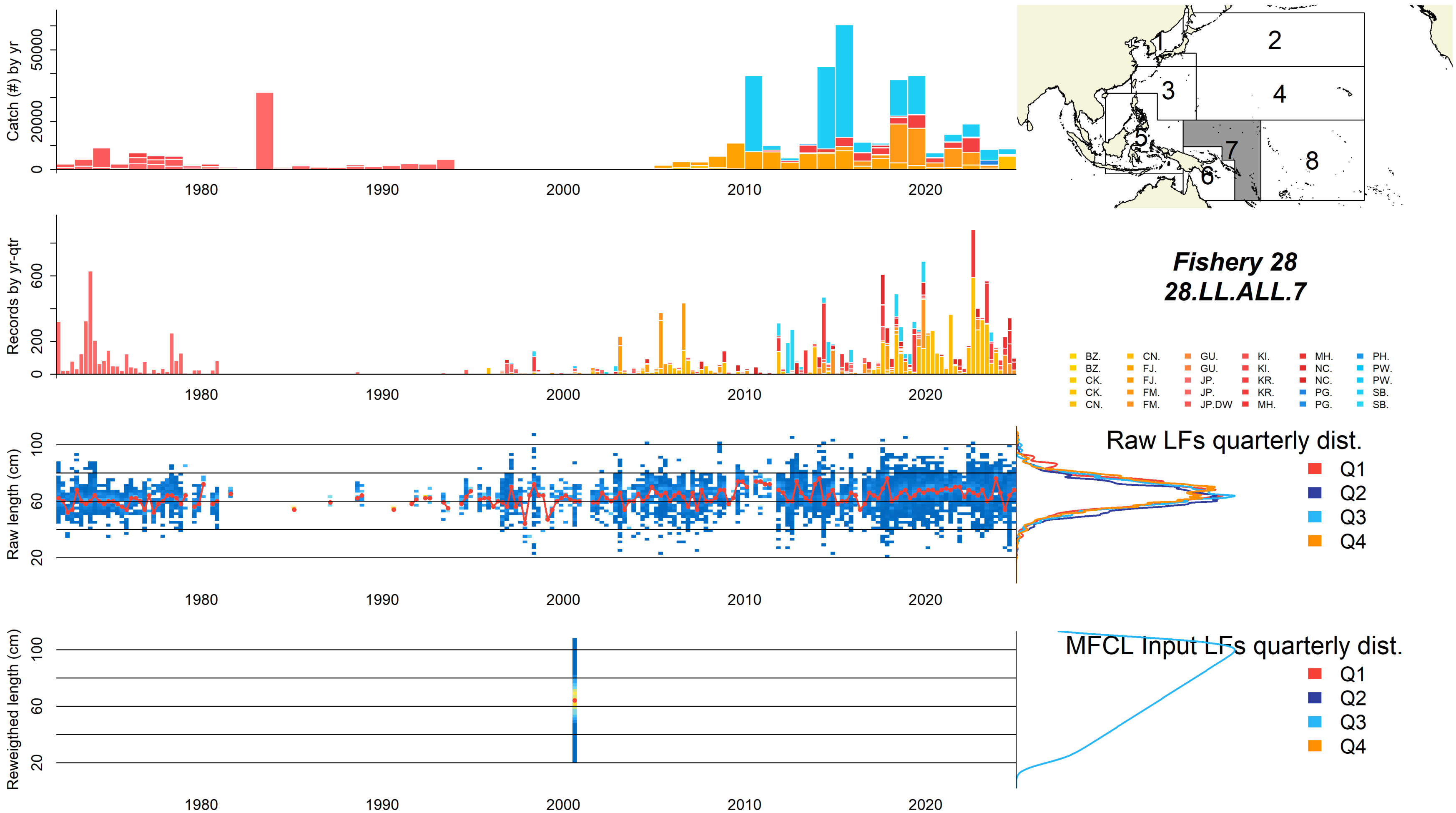


Figure 54: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 28 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

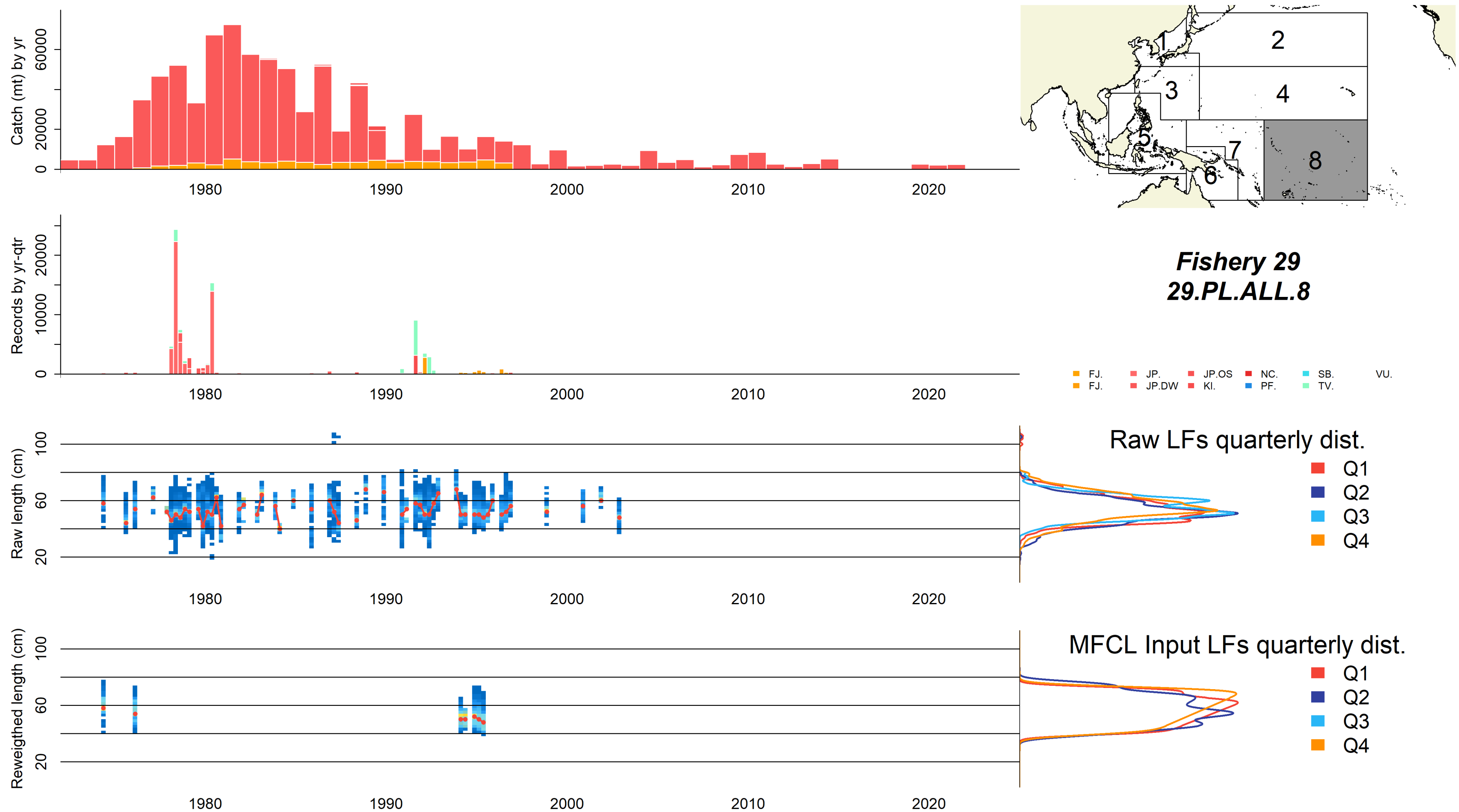


Figure 55: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 29 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

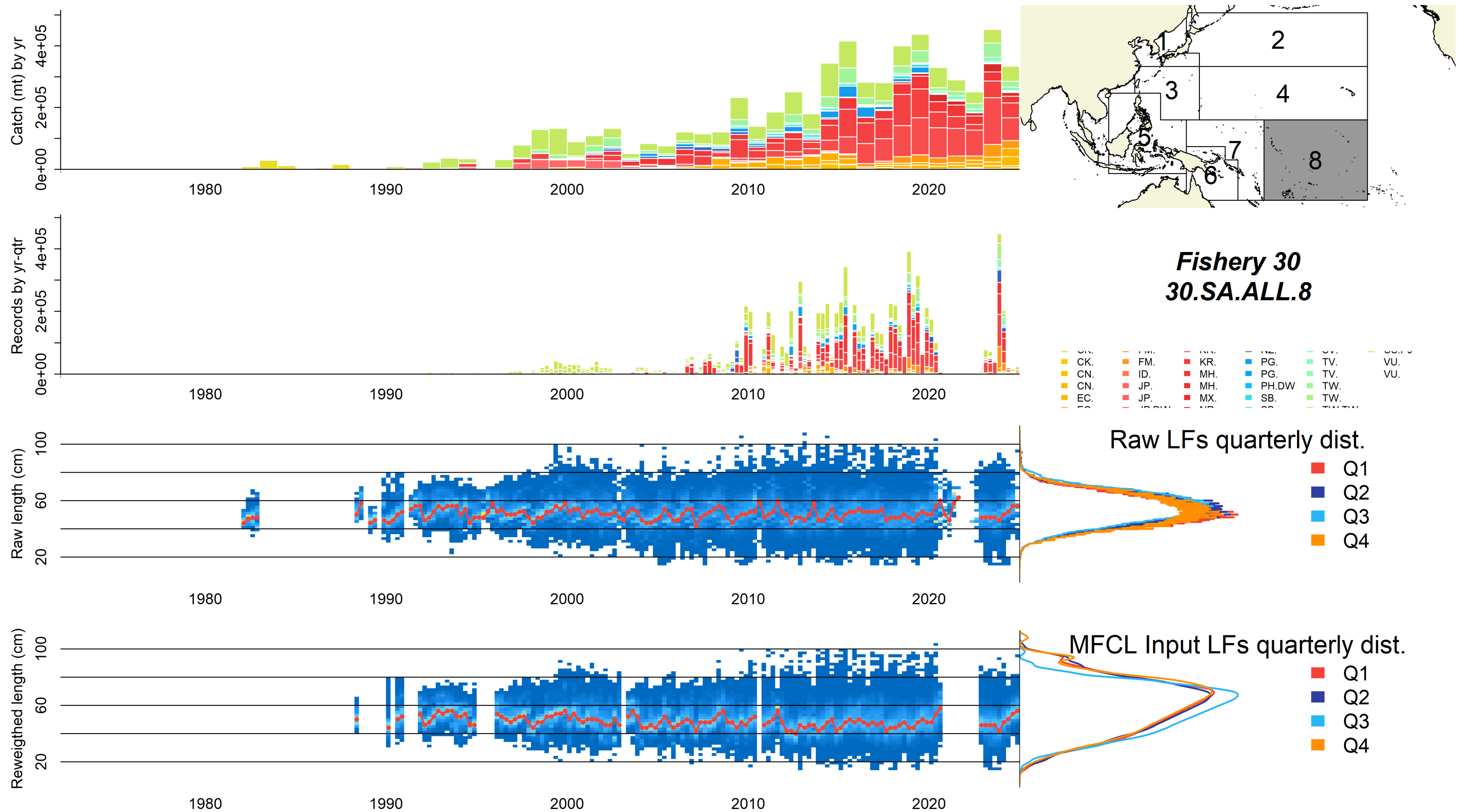


Figure 56: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 30 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

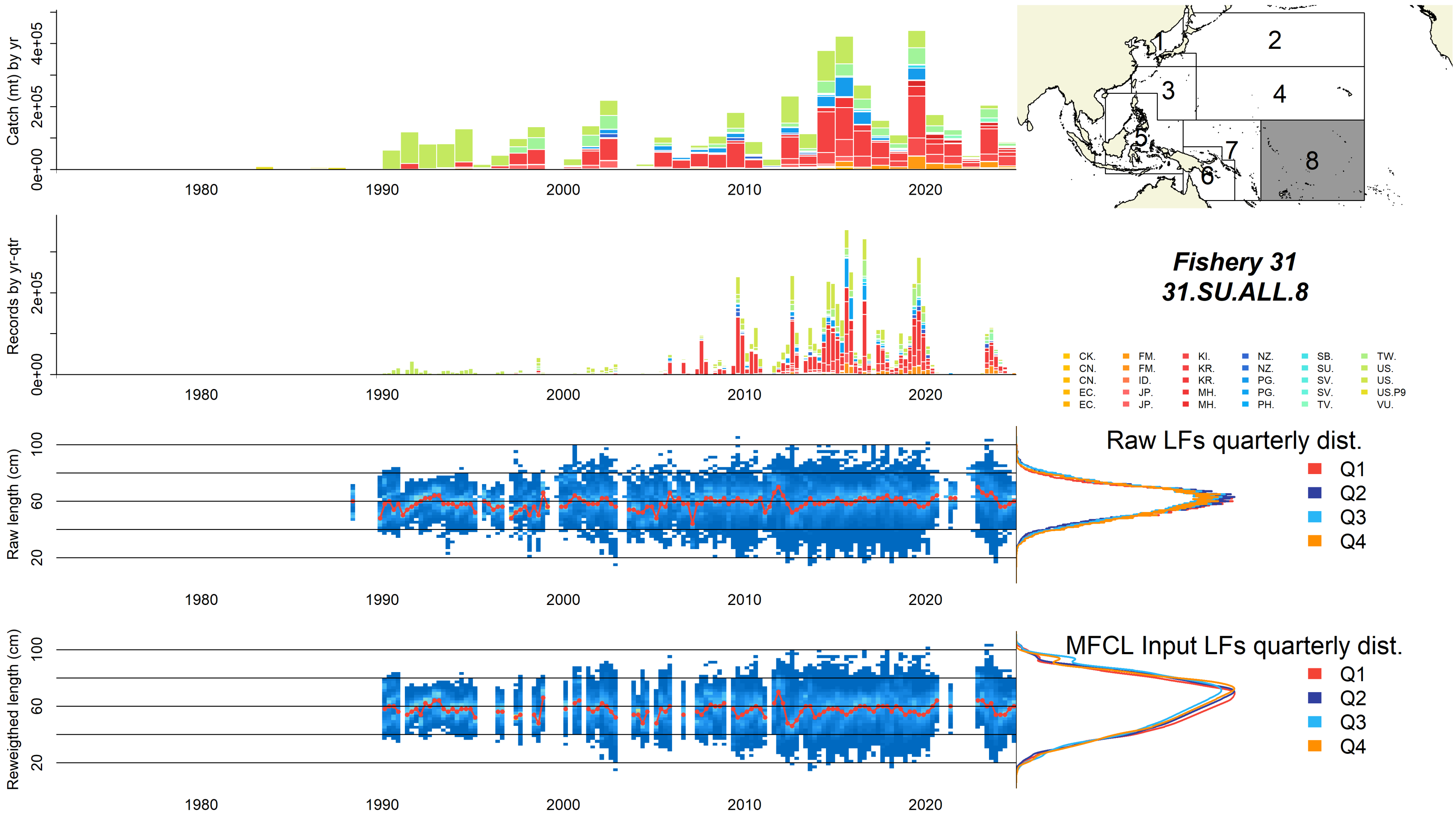


Figure 57: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 31 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

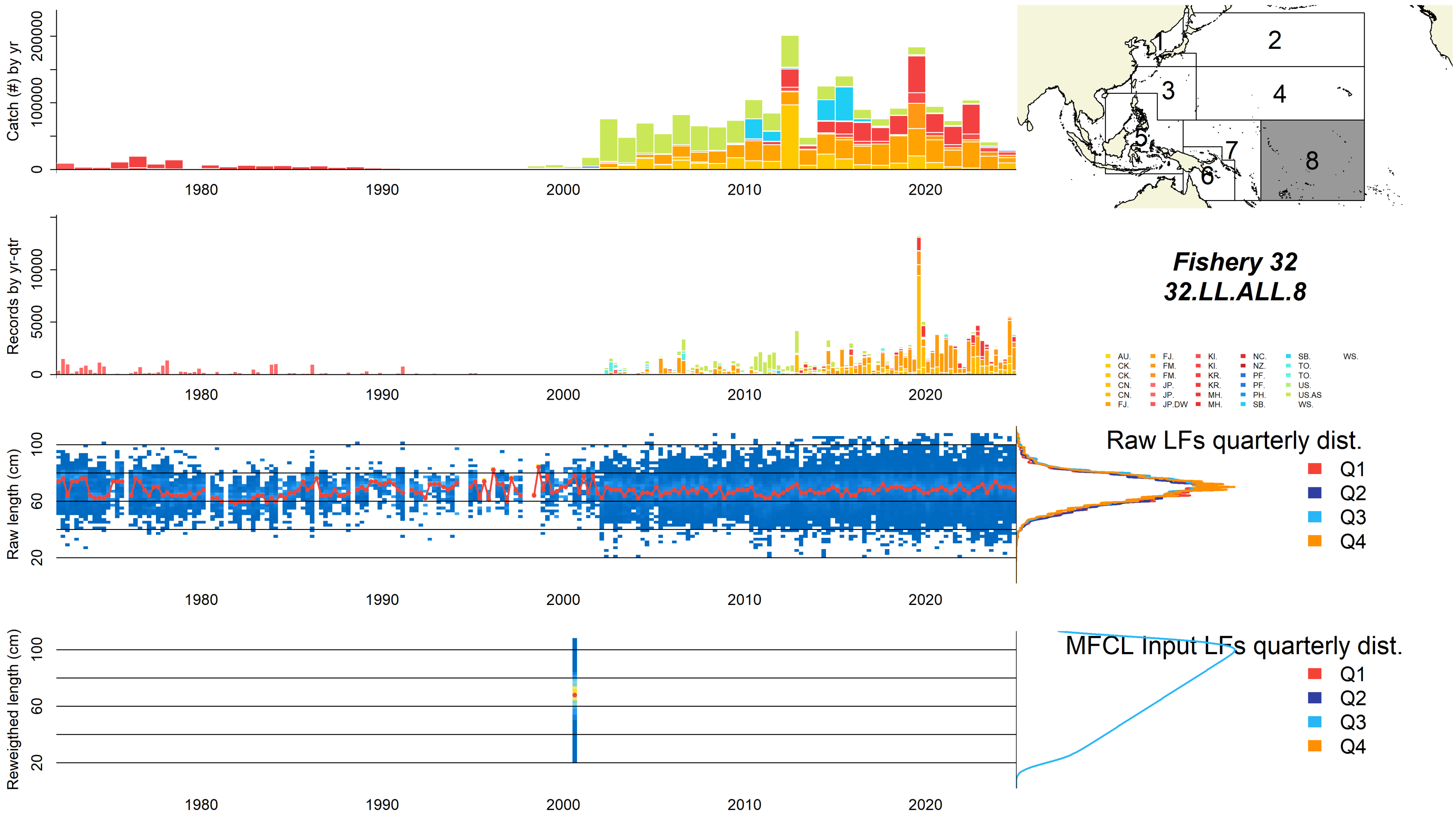


Figure 58: Summary of raw available data and processed length frequencies (MFCL Input LFs) for fishery 32 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top right), the annual catch by fleet within the fishery, in metric tons (top left), the annual number of fish with measured length (2nd left), trends in length composition data with the median highlighted in red (3rd left) with the overall quarterly size distribution over the time-span of the fishery, trends in processed length compositions with the median highlighted in red (bottom left) with the overall quarterly size distribution over the time-span of the fishery.

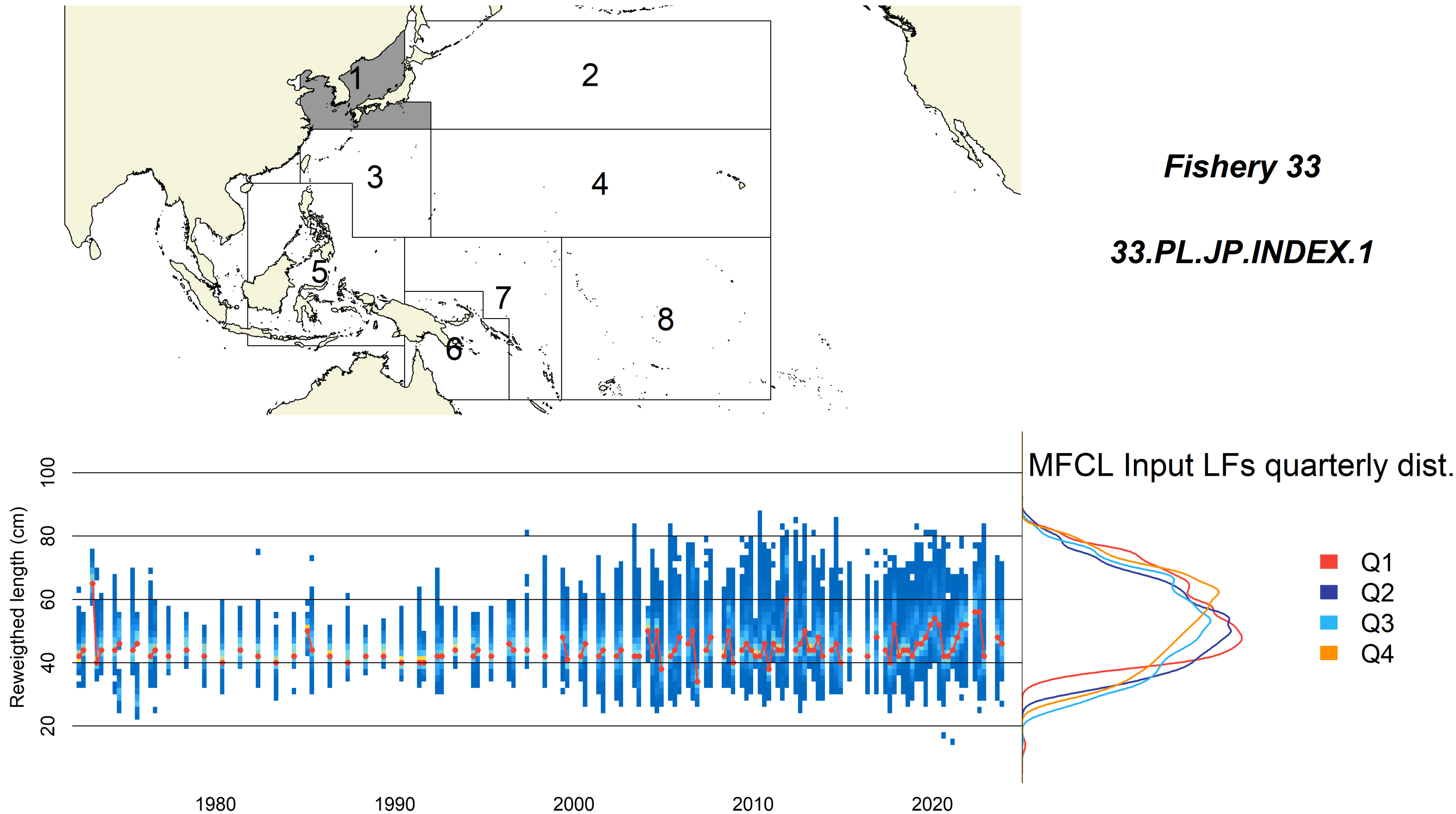


Figure 59: Summary of processed length compositions (MFCL Input) for index fishery 33 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top left) and trends in processed length compositions with the median highlighted in red (bottom) with the overall quarterly size distribution over the time-span of the fishery.

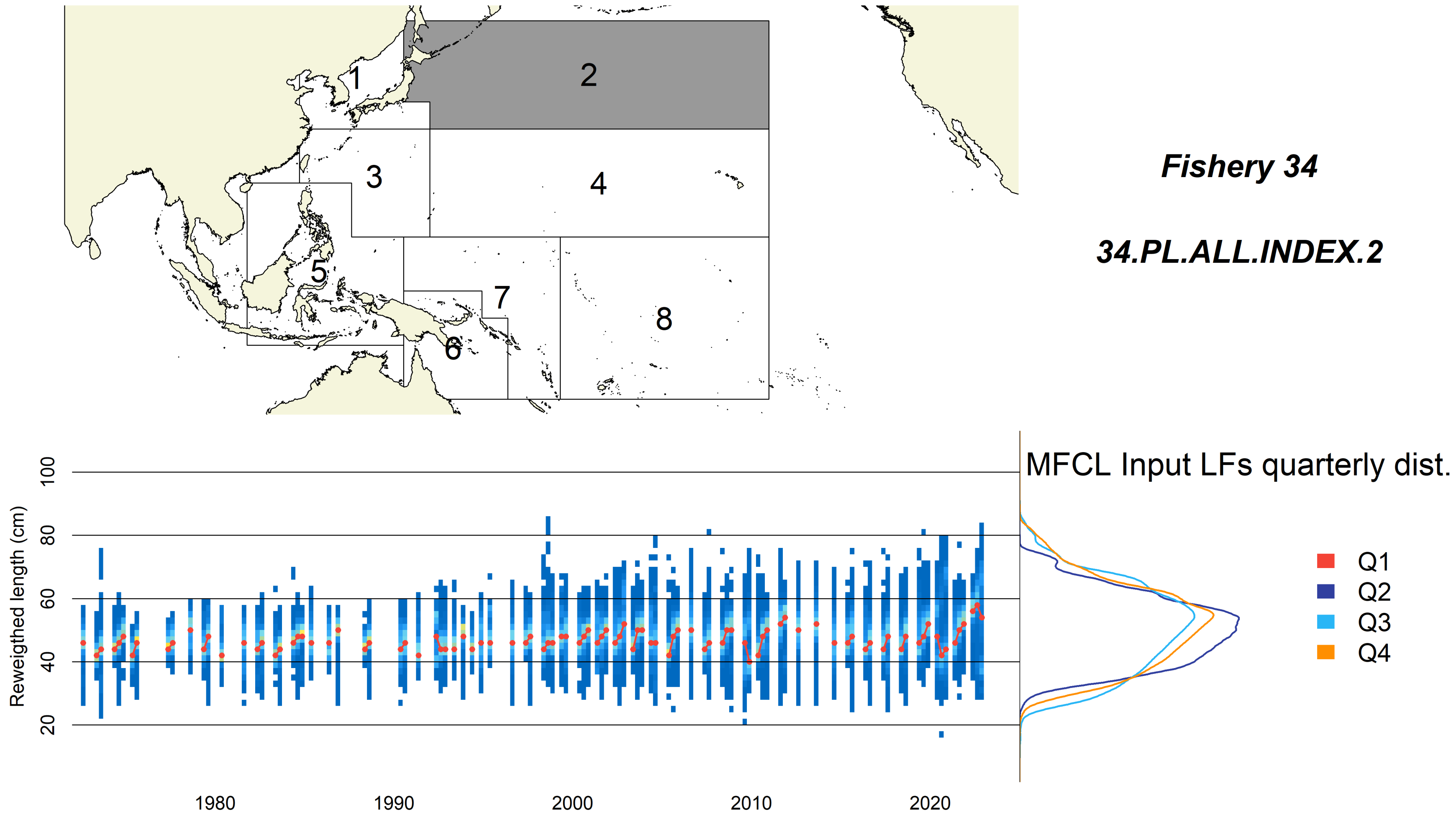


Figure 60: Summary of processed length compositions (MFCL Input) for index fishery 34 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top left) and trends in processed length compositions with the median highlighted in red (bottom) with the overall quarterly size distribution over the time-span of the fishery.

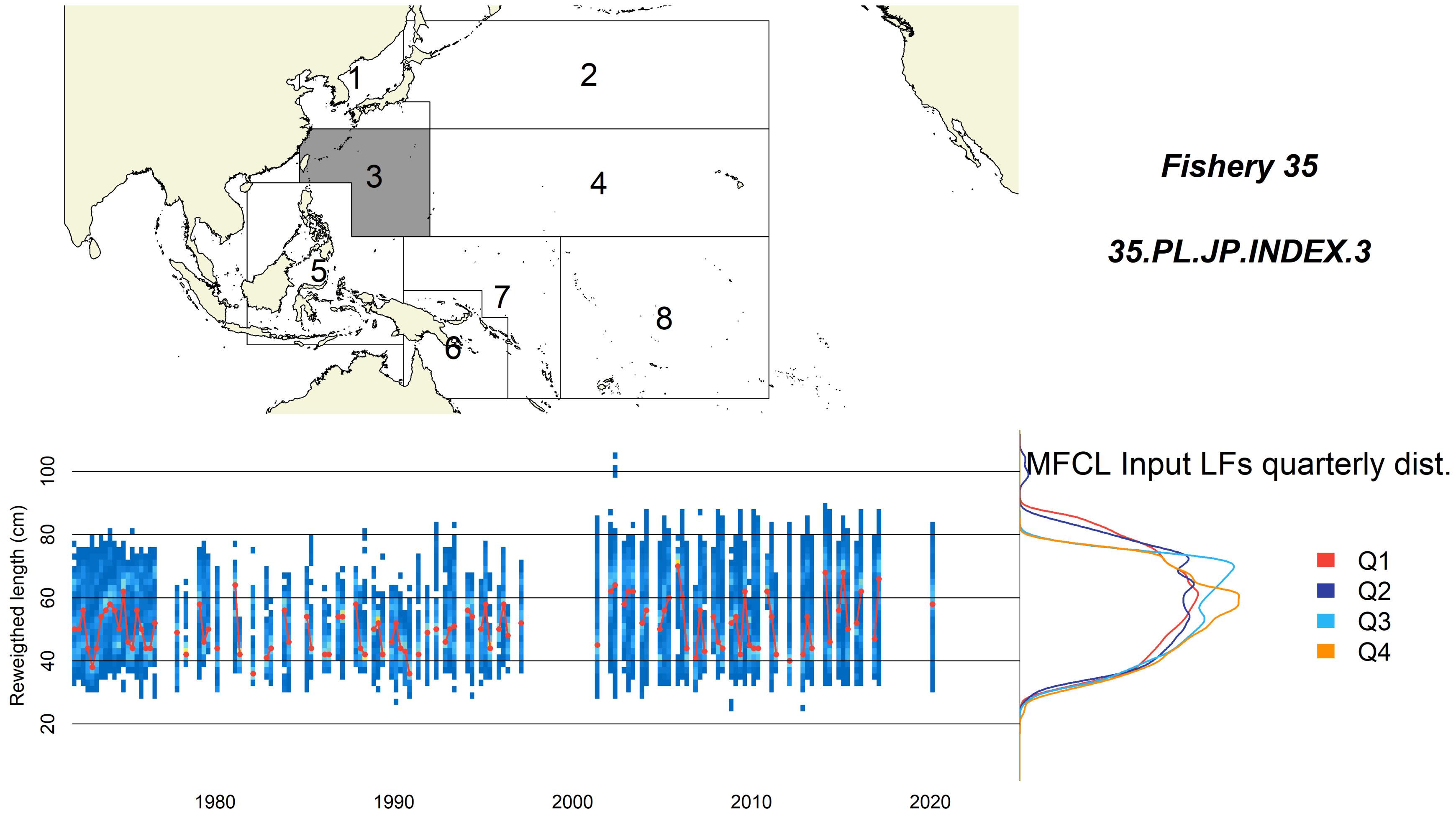


Figure 61: Summary of processed length compositions (MFCL Input) for index fishery 35 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top left) and trends in processed length compositions with the median highlighted in red (bottom) with the overall quarterly size distribution over the time-span of the fishery.

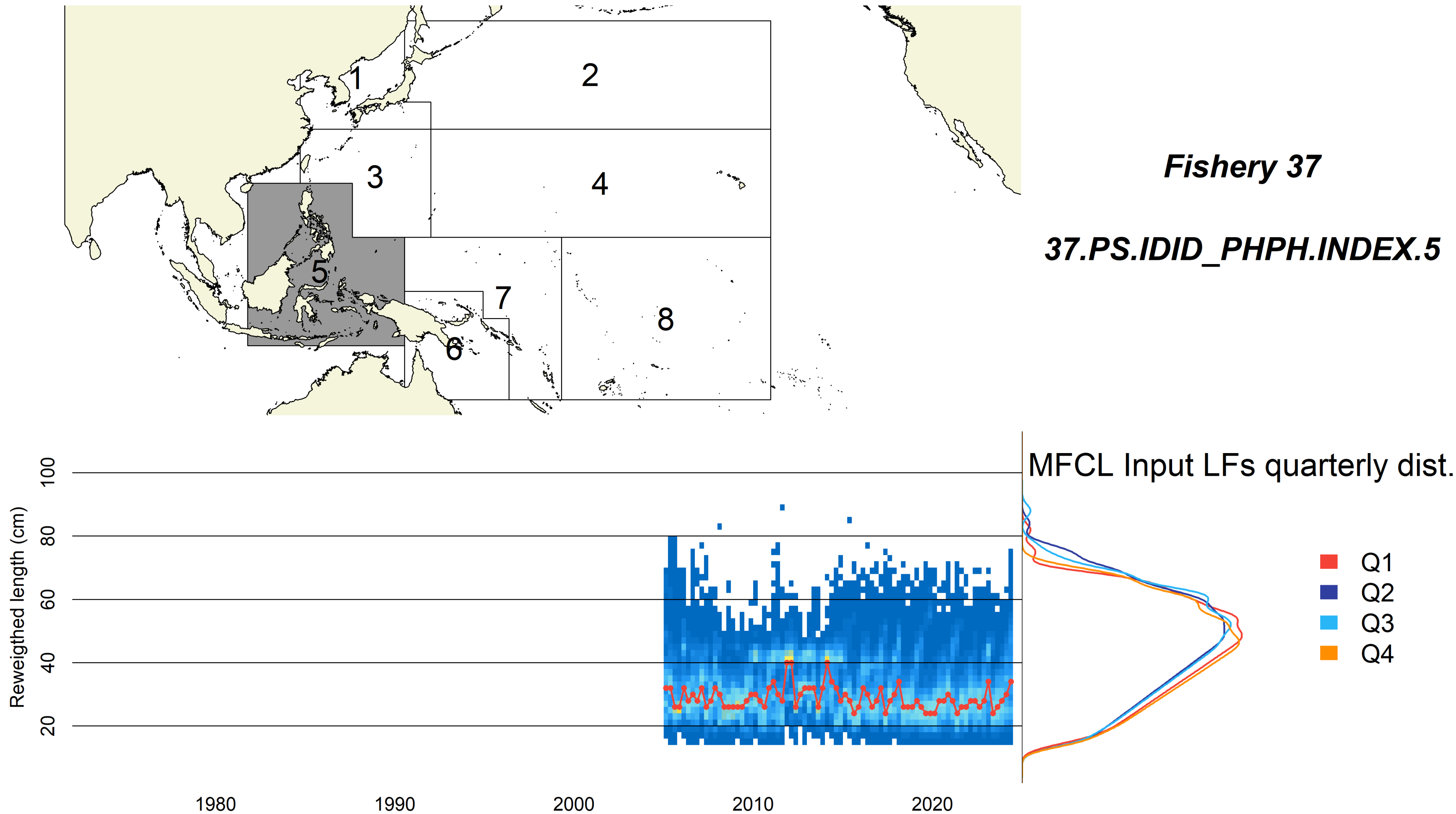


Figure 62: Summary of processed length compositions (MFCL Input) for index fishery 37 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top left) and trends in processed length compositions with the median highlighted in red (bottom) with the overall quarterly size distribution over the time-span of the fishery.

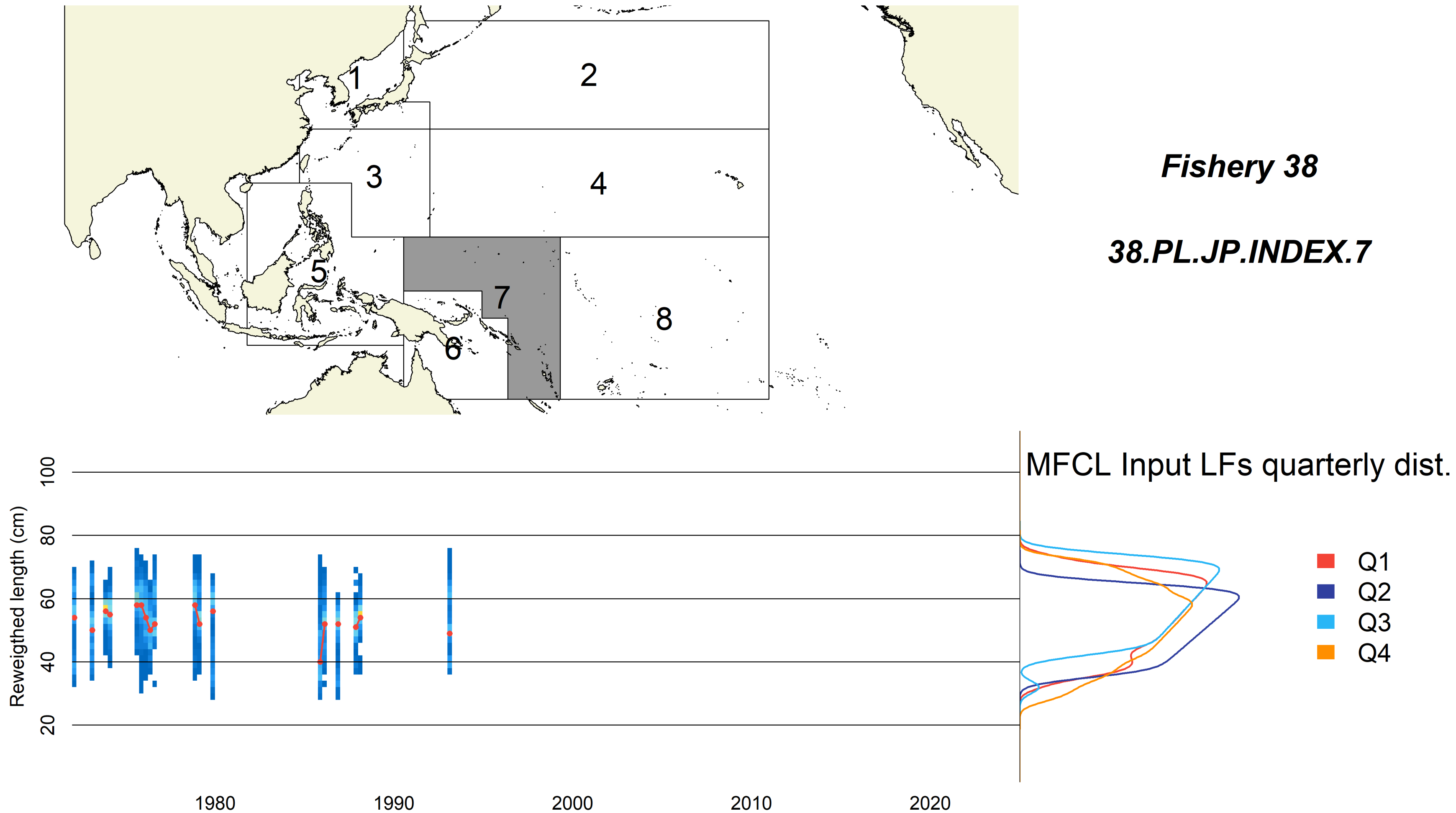


Figure 63: Summary of processed length compositions (MFCL Input) for index fishery 38 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top left) and trends in processed length compositions with the median highlighted in red (bottom) with the overall quarterly size distribution over the time-span of the fishery.

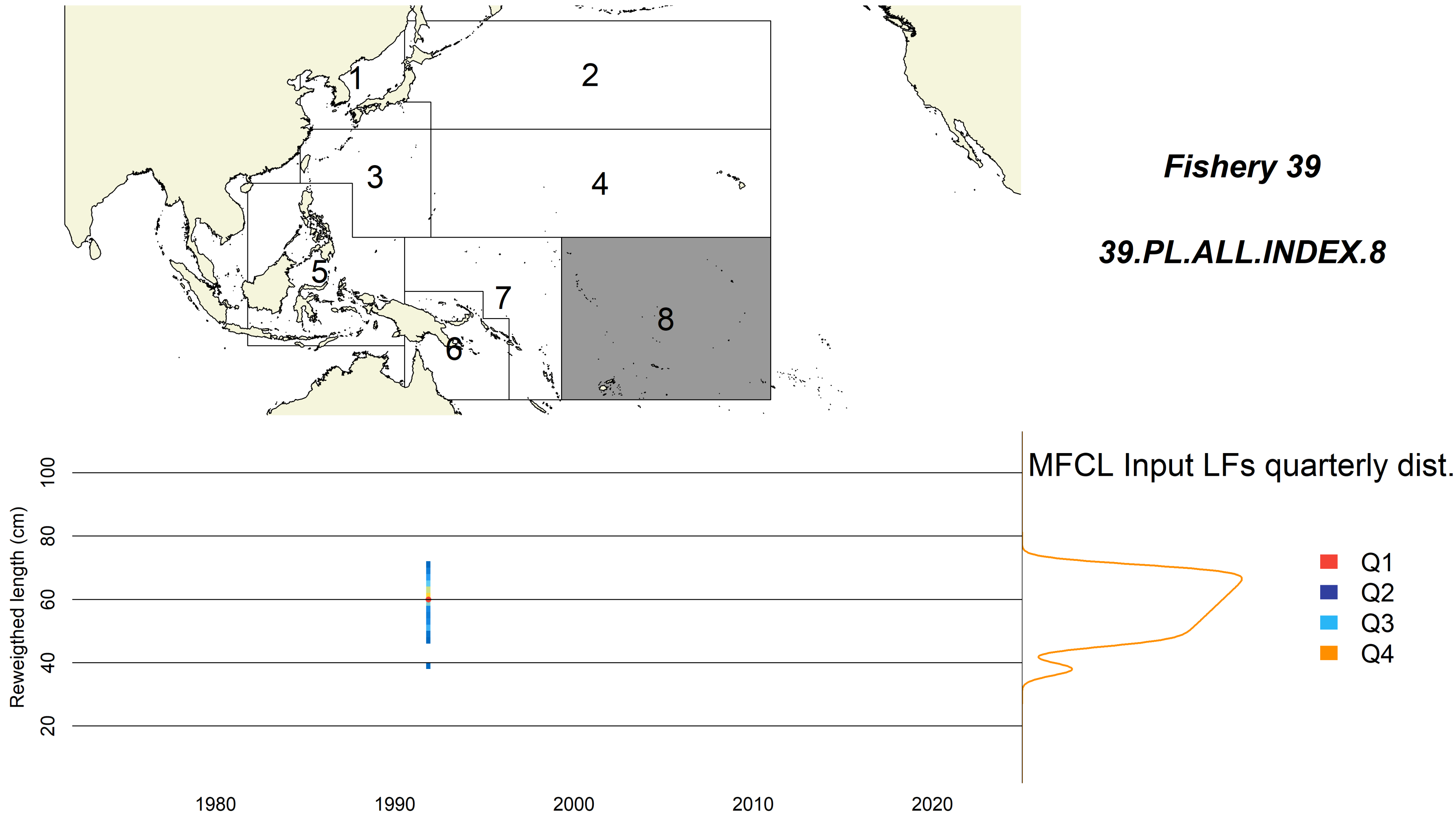


Figure 64: Summary of processed length compositions (MFCL Input) for index fishery 39 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top left) and trends in processed length compositions with the median highlighted in red (bottom) with the overall quarterly size distribution over the time-span of the fishery.

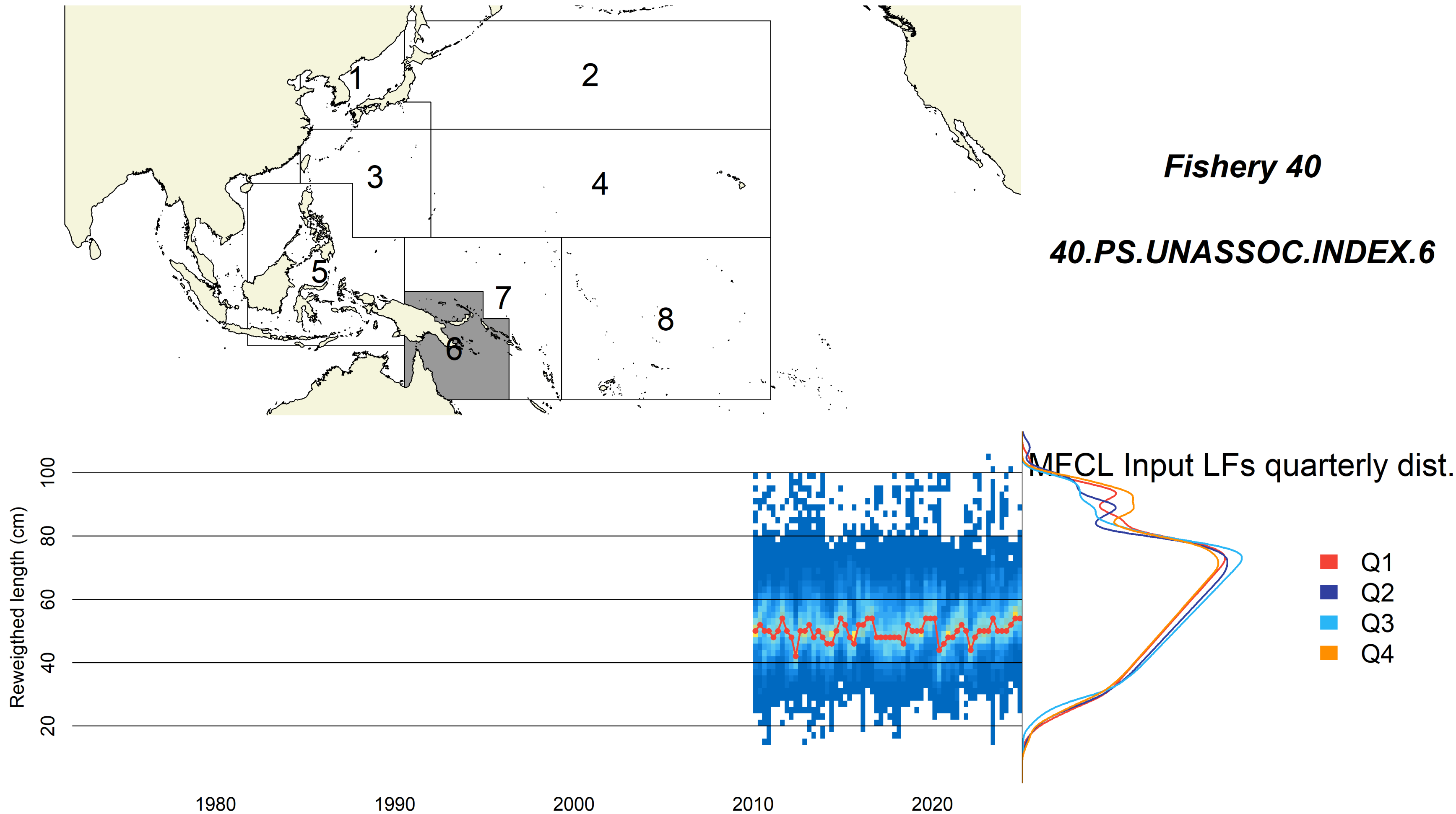


Figure 65: Summary of processed length compositions (MFCL Input) for index fishery 40 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top left) and trends in processed length compositions with the median highlighted in red (bottom) with the overall quarterly size distribution over the time-span of the fishery.

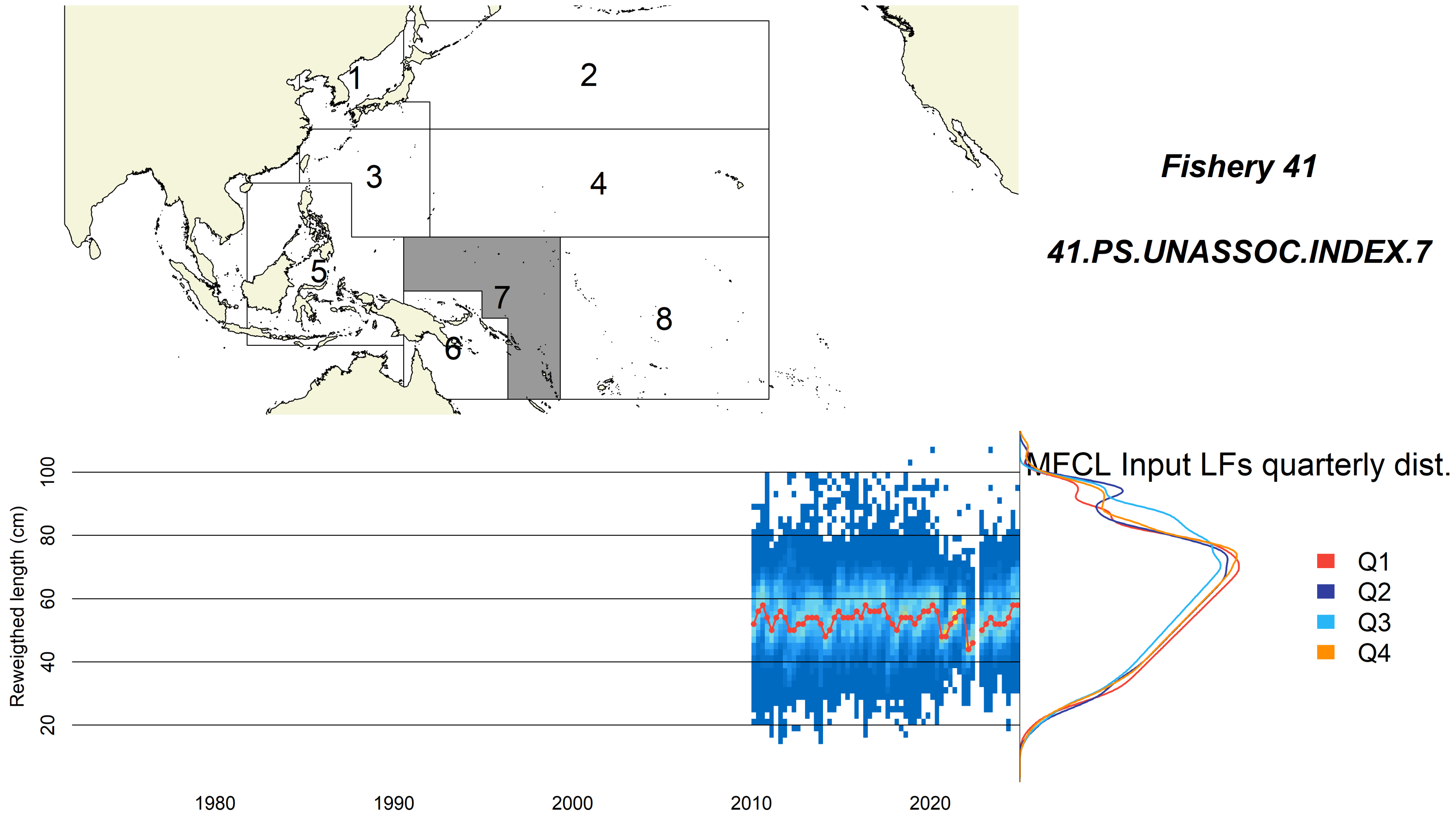


Figure 66: Summary of processed length compositions (MFCL Input) for index fishery 41 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top left) and trends in processed length compositions with the median highlighted in red (bottom) with the overall quarterly size distribution over the time-span of the fishery.

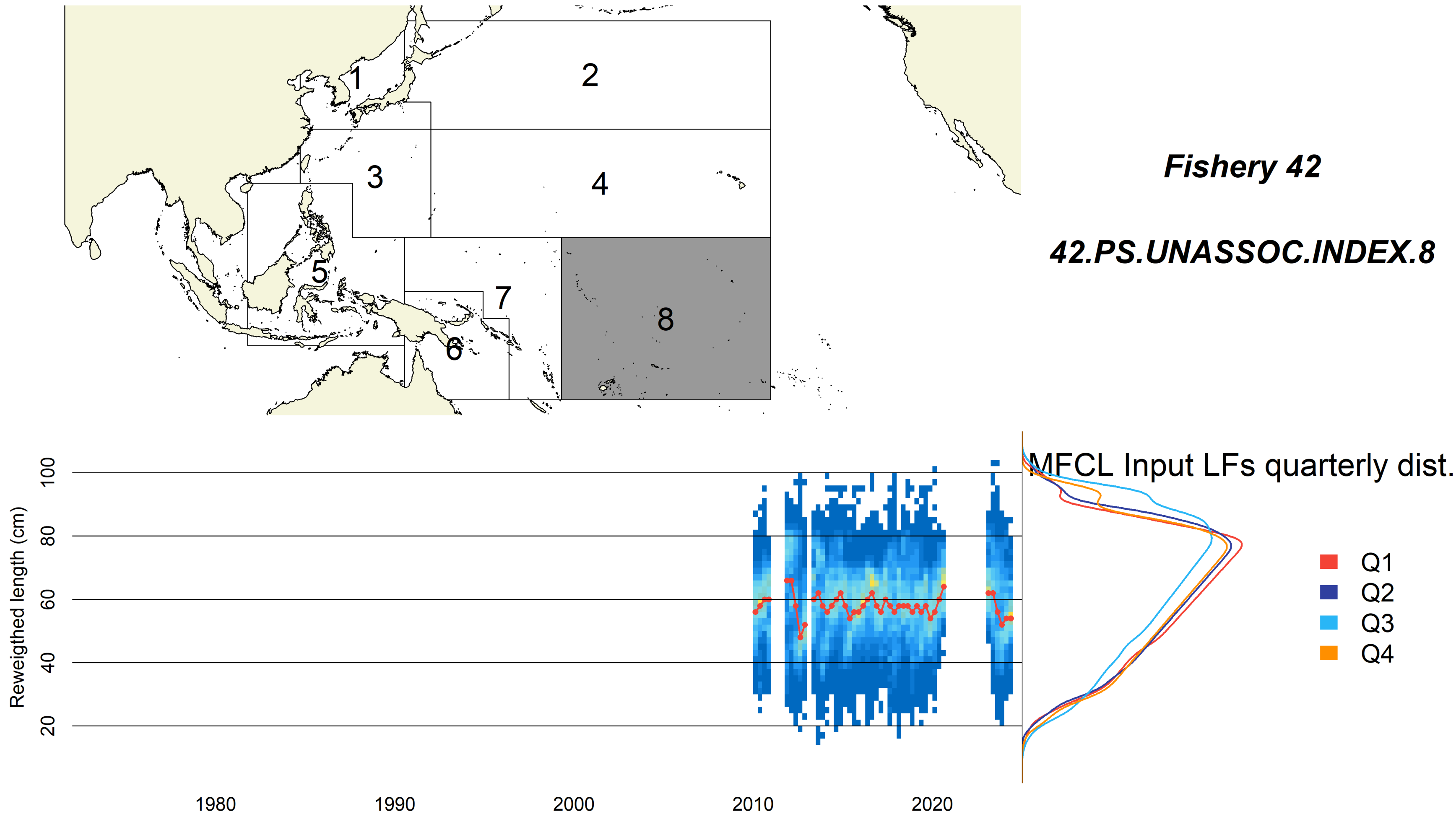


Figure 67: Summary of processed length compositions (MFCL Input) for index fishery 42 of the 2025 skipjack stock assessment. The panels display: the region and fishery area of occurrence (top left) and trends in processed length compositions with the median highlighted in red (bottom) with the overall quarterly size distribution over the time-span of the fishery.

14 Appendix 3: Reweighted size compositions

14.1 Purse seine extraction fishery compositions

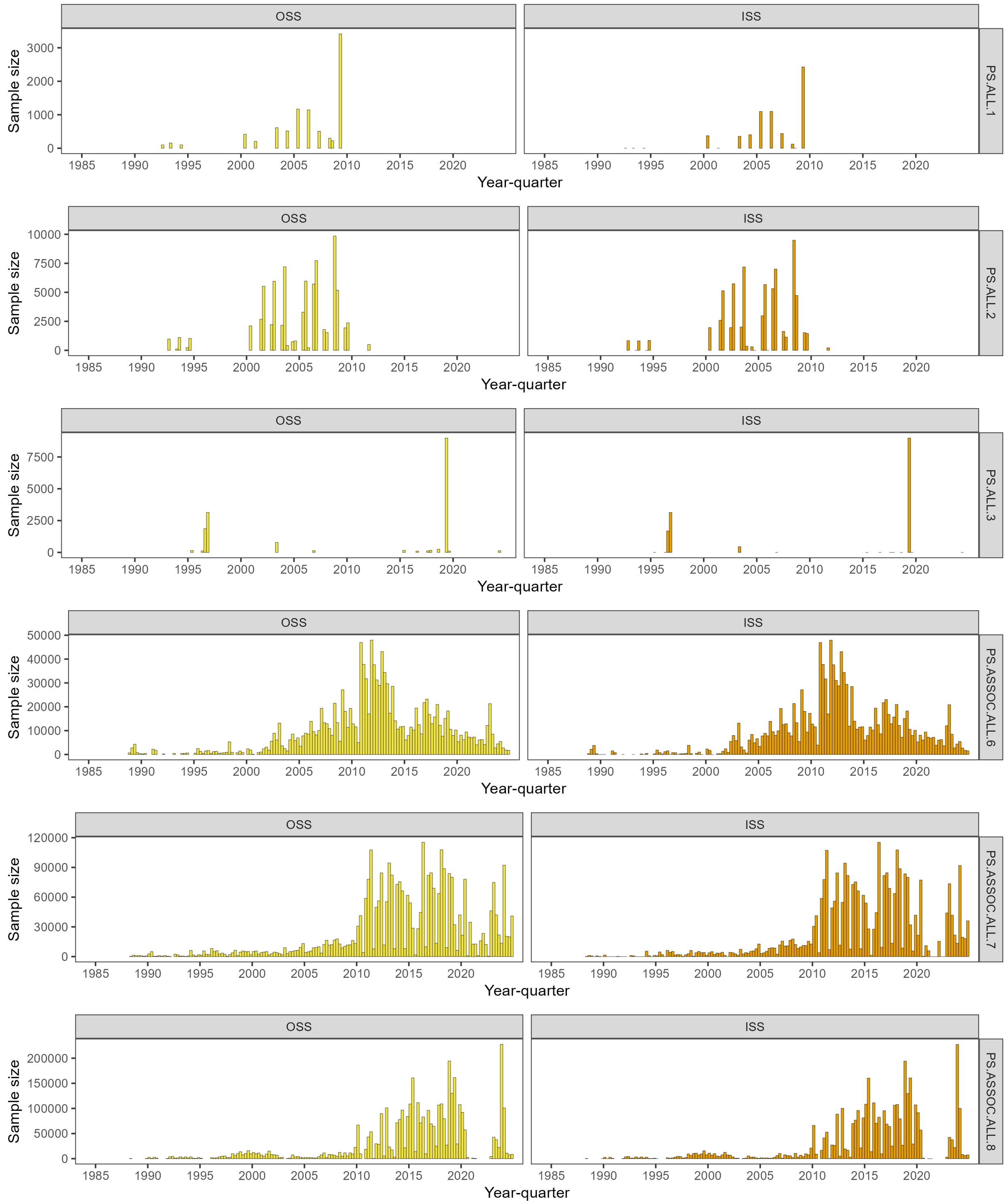


Figure 1: Original sample sizes (OSS) and input sample sizes (ISS) for purse seine extraction fisheries.

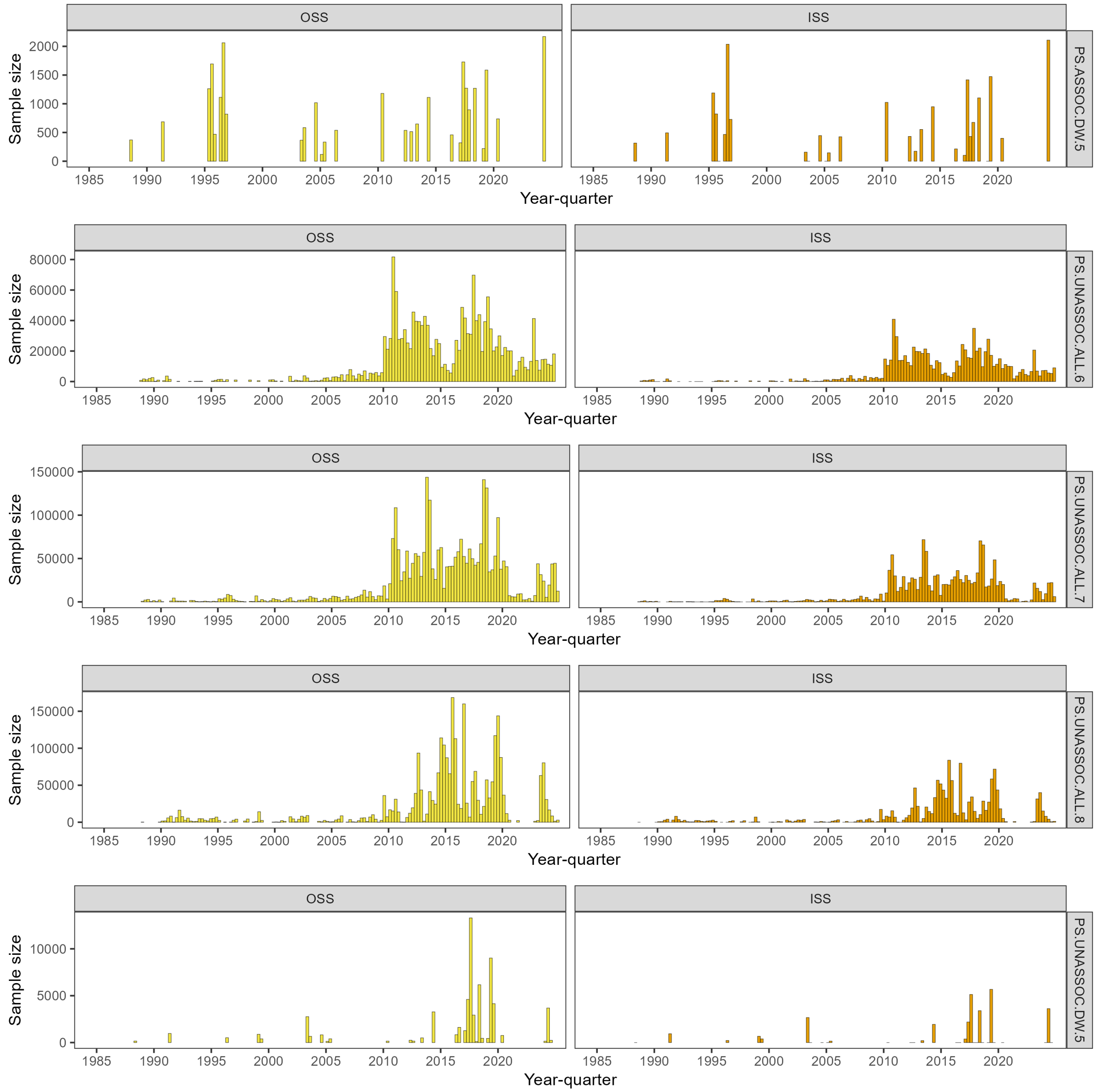


Figure 1: Original sample sizes (OSS) and input sample sizes (ISS) for purse seine extraction fisheries (cont.).

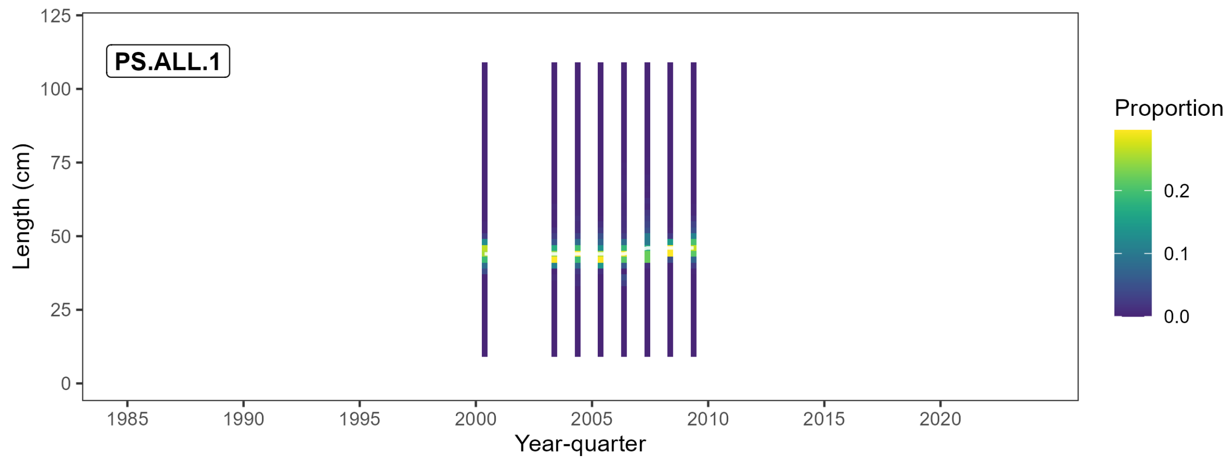


Figure 2: Reweighted size comps for fishery PS.ALL.1. The white line provides the median size class per year-quarter.

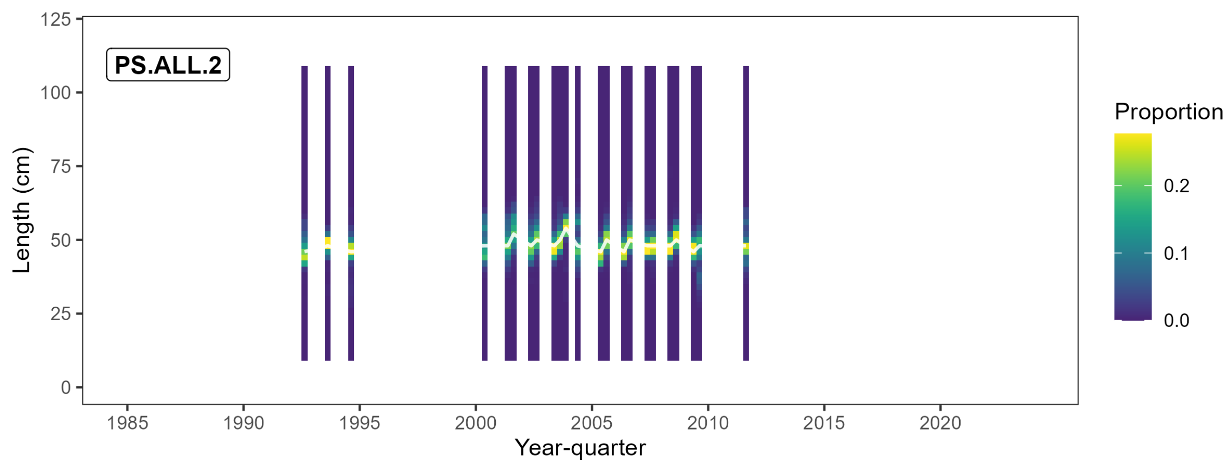


Figure 3: Reweighted size comps for fishery PS.ALL.2. The white line provides the median size class per year-quarter.

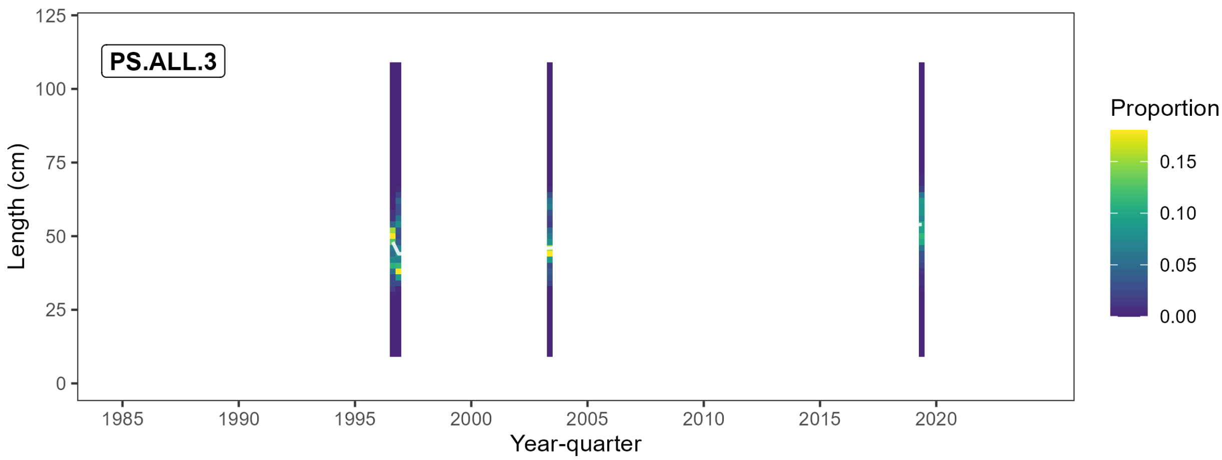


Figure 4: Reweighted size comps for fishery PS.ALL.3. The white line provides the median size class per year-quarter.

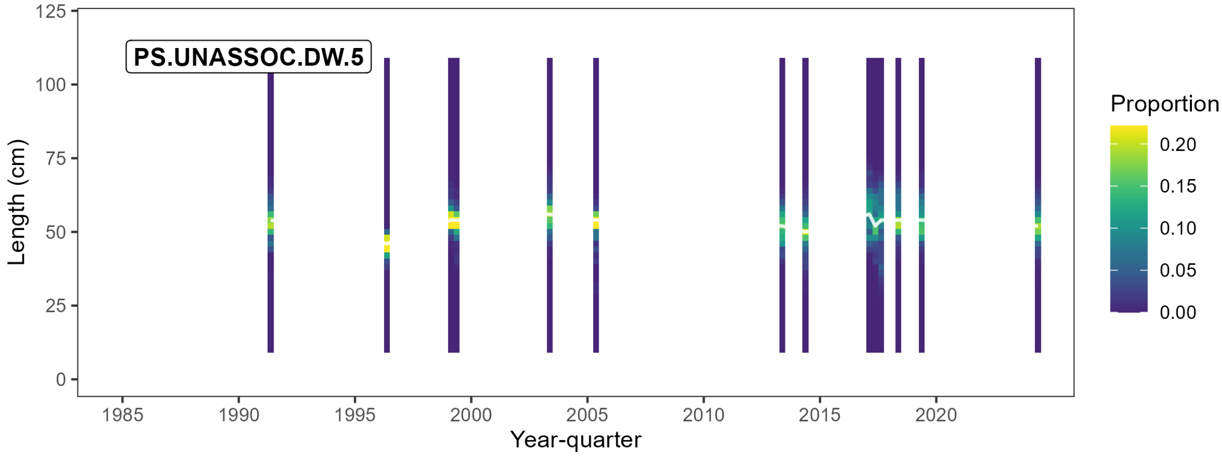


Figure 5: Reweighted size comps for fishery PS.UNASSOC.DW.5. The white line provides the median size class per year-quarter.

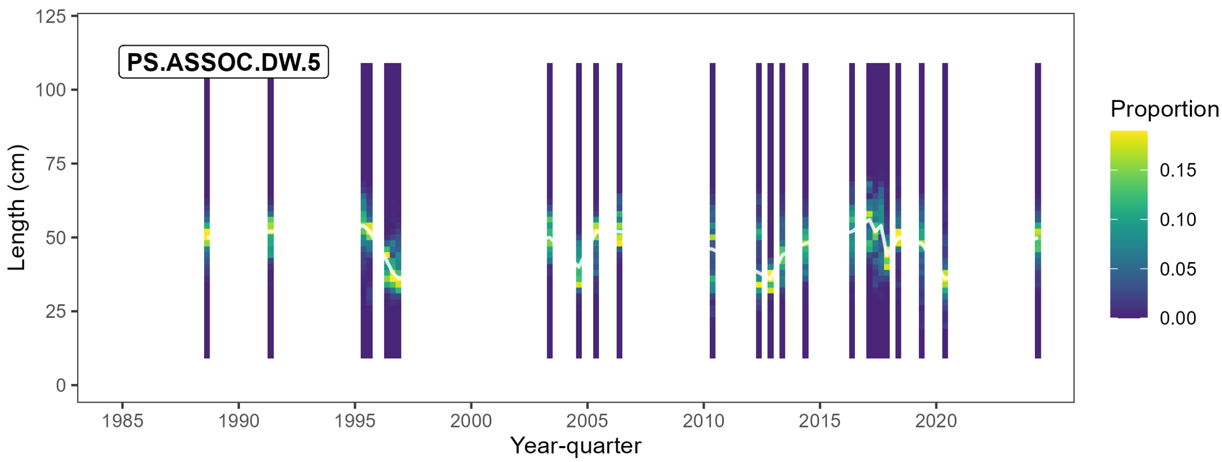


Figure 6: Reweighted size comps for fishery PS.ASSOC.DW.5. The white line provides the median size class per year-quarter.

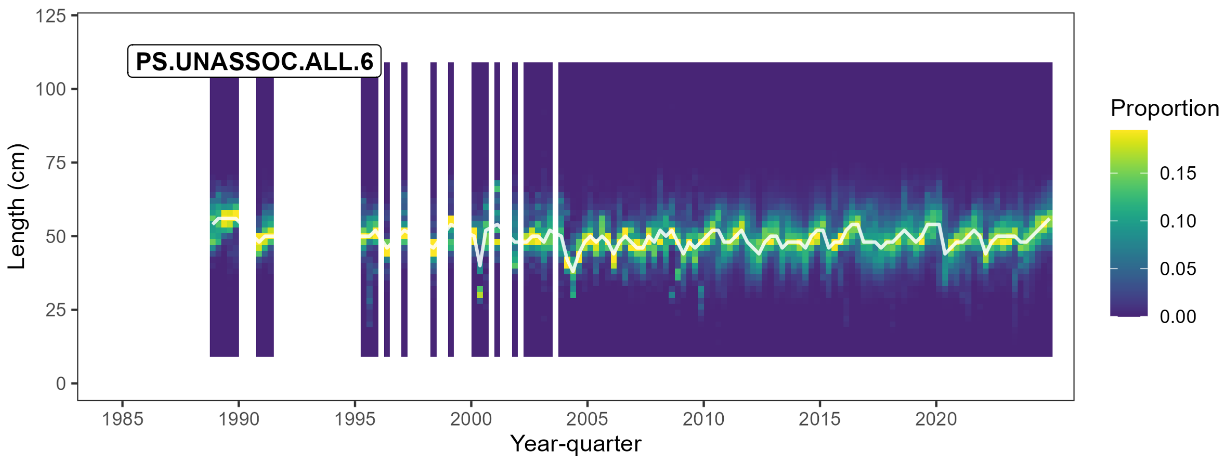


Figure 7: Reweighted size comps for fishery PS.UNASSOC.ALL.6. The white line provides the median size class per year-quarter.

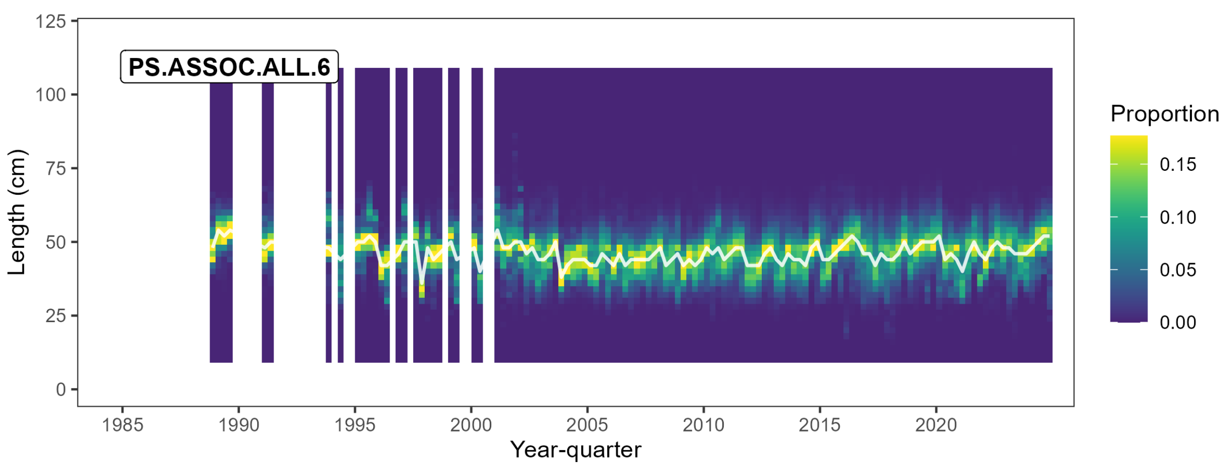


Figure 8: Reweighted size comps for fishery PS.ASSOC.ALL.6. The white line provides the median size class per year-quarter.

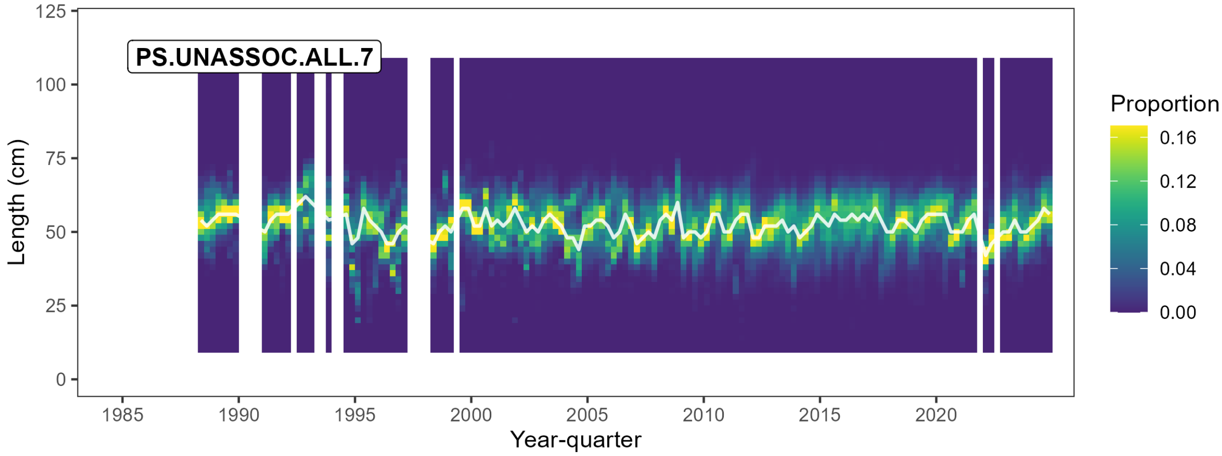


Figure 9: Reweighted size comps for fishery PS.UNASSOC.ALL.7. The white line provides the median size class per year-quarter.

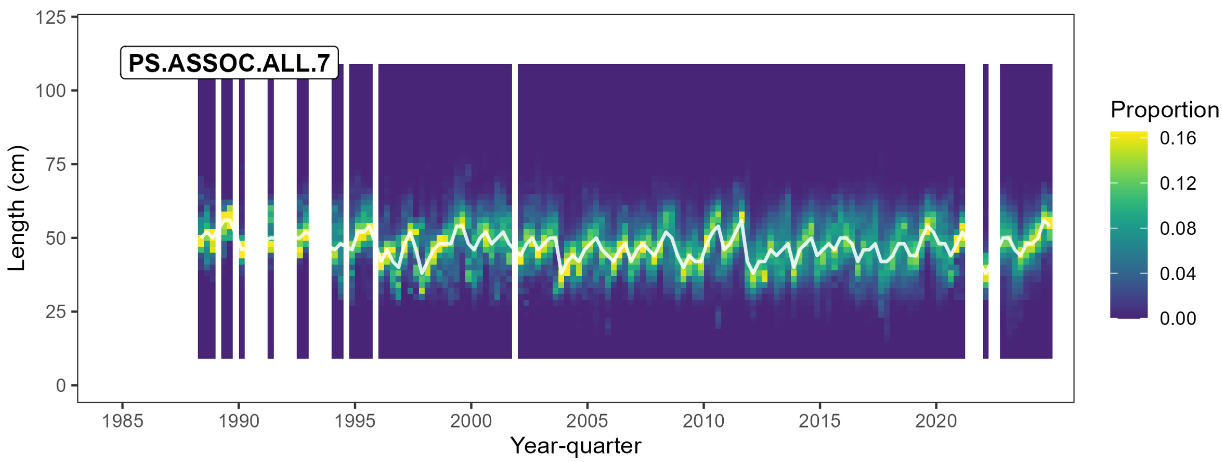


Figure 10: Reweighted size comps for fishery PS.ASSOC.ALL.7. The white line provides the median size class per year-quarter.

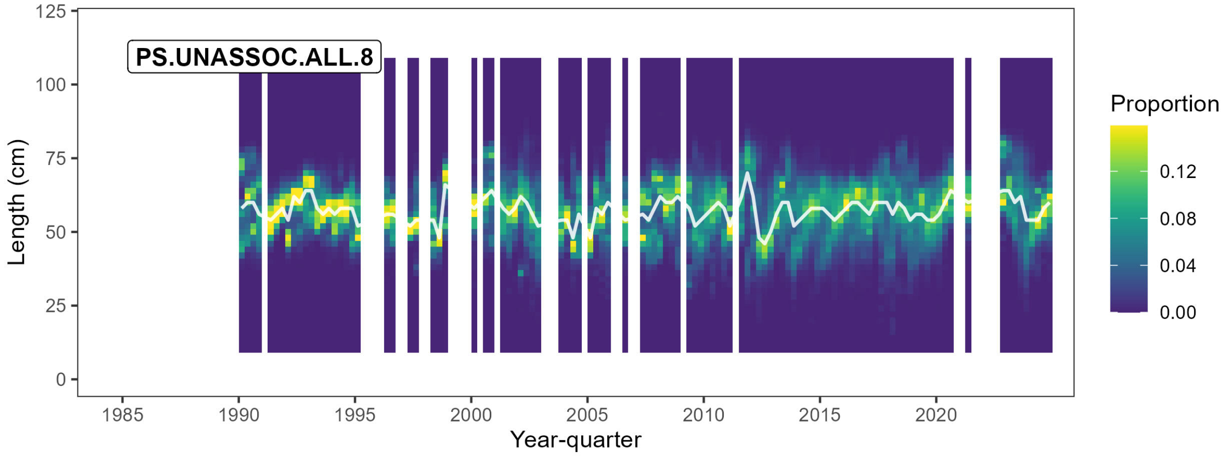


Figure 11: Reweighted size comps for fishery PS.UNASSOC.ALL.8. The white line provides the median size class per year-quarter.

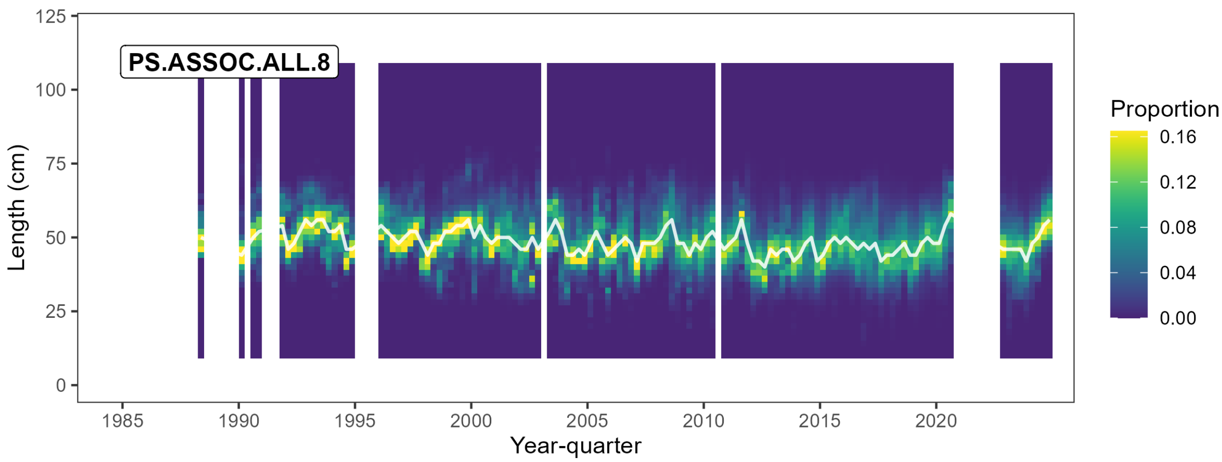


Figure 12: Reweighted size comps for fishery PS.ASSOC.ALL.8. The white line provides the median size class per year-quarter.

14.2 Purse seine index fishery compositions

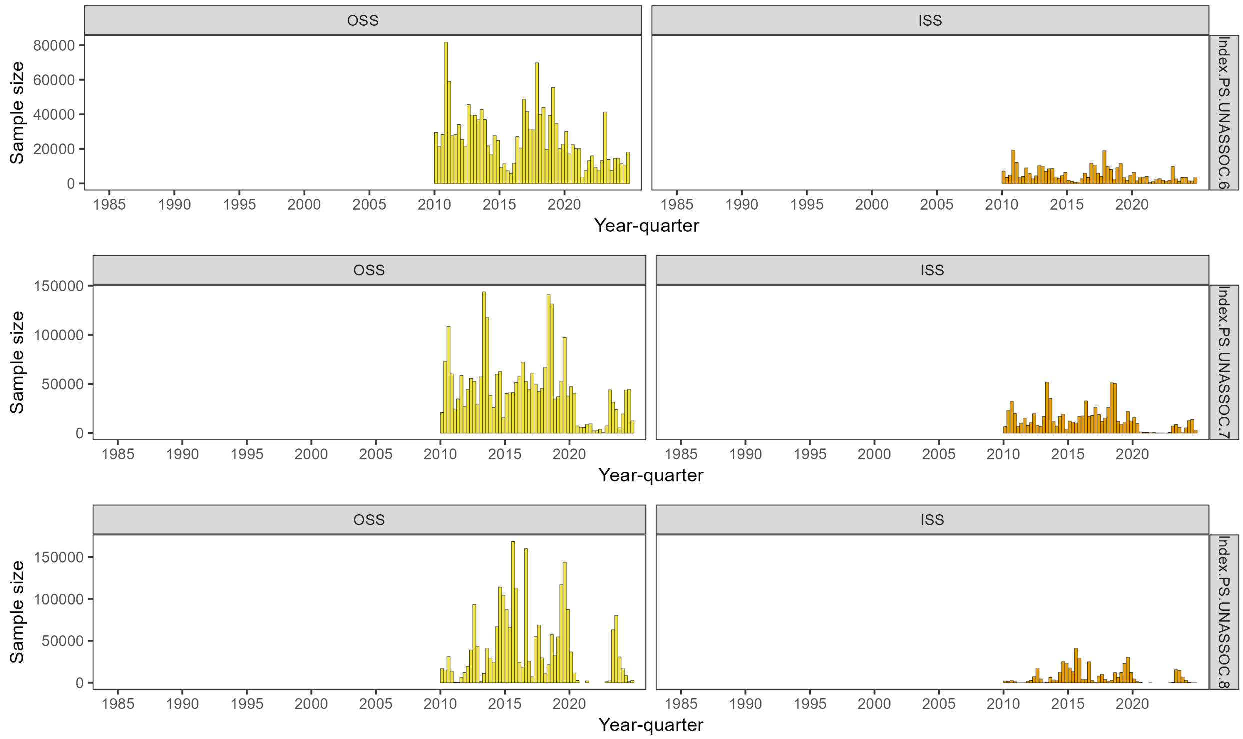


Figure 1: Original sample sizes (OSS) and input sample sizes (ISS) for purse seine index fisheries.

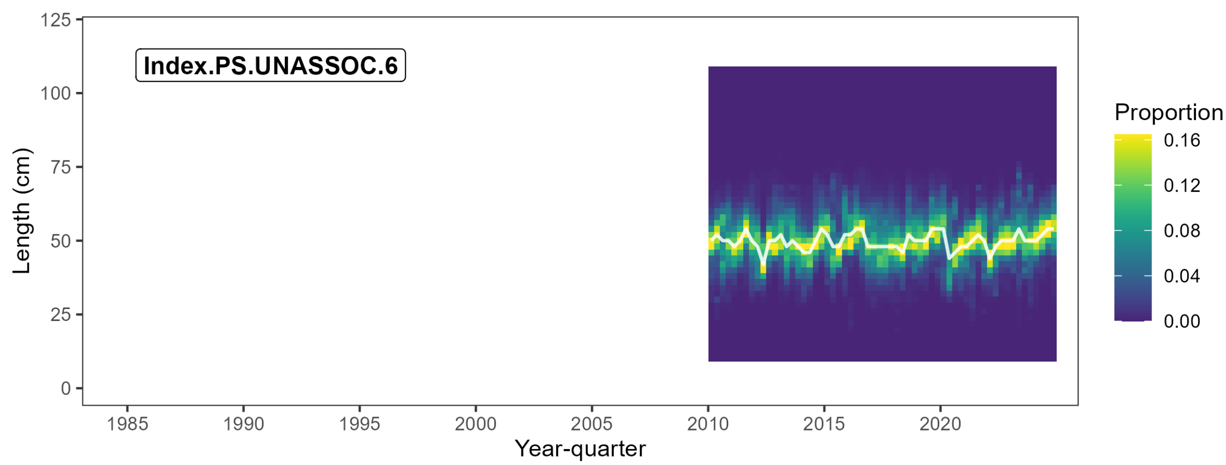


Figure 2: Reweighted size comps for fishery Index.PS.UNASSOC.6. The white line provides the median size class per year-quarter.

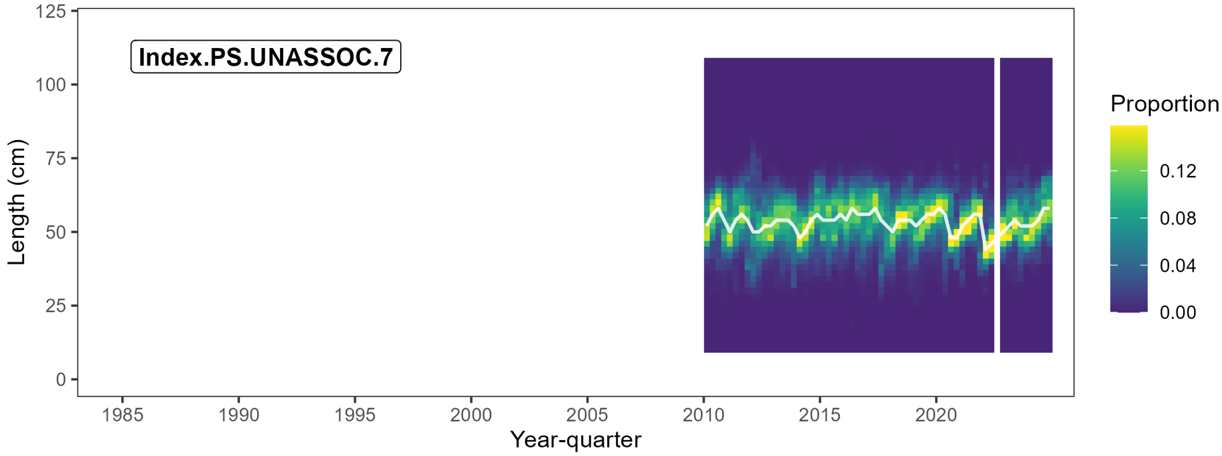


Figure 3: Reweighted size comps for fishery Index.PS.UNASSOC.7. The white line provides the median size class per year-quarter.

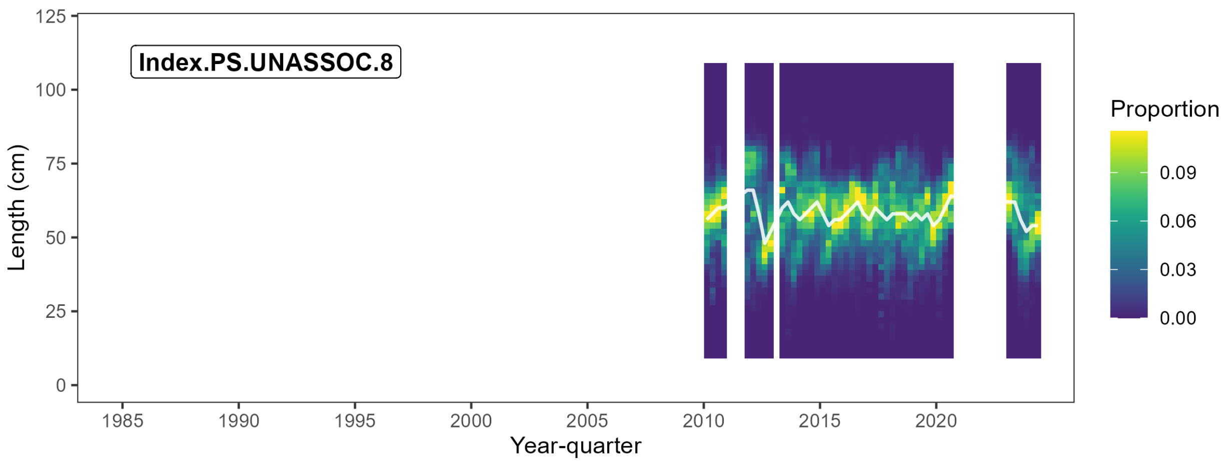
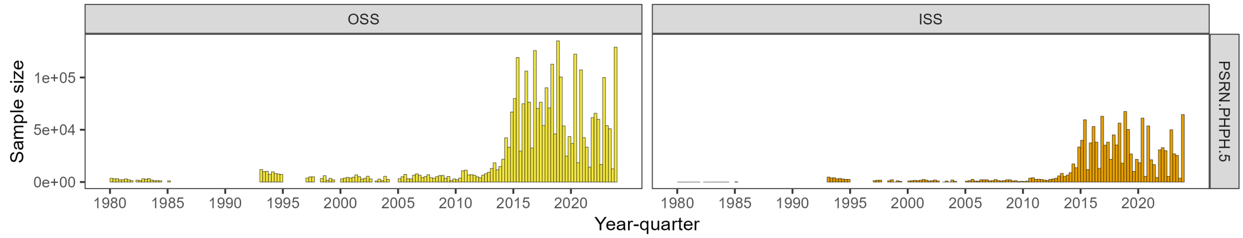
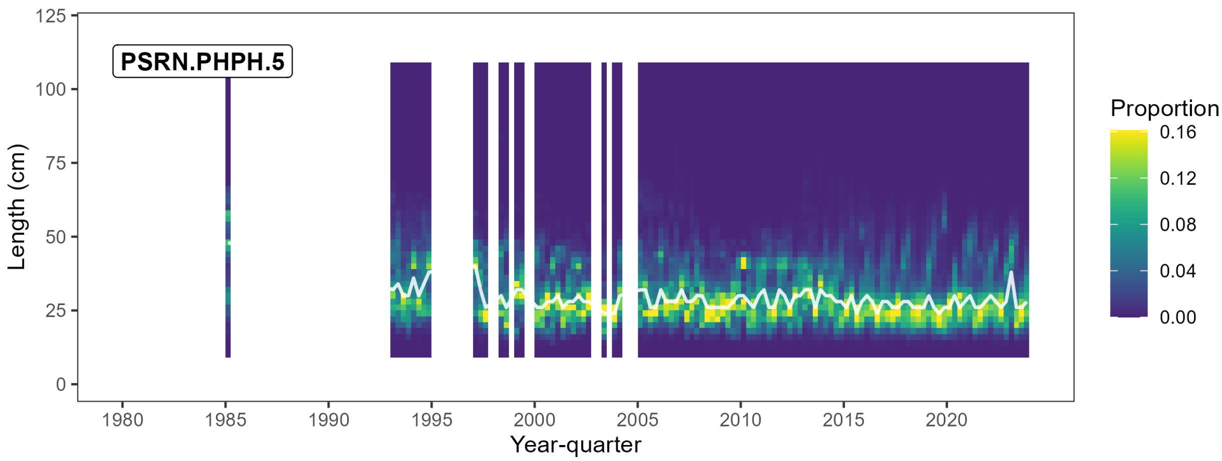


Figure 4: Reweighted size comps for fishery Index.PS.UNASSOC.8. The white line provides the median size class per year-quarter.

14.3 Domestic Philippines purse seine fishery compositions

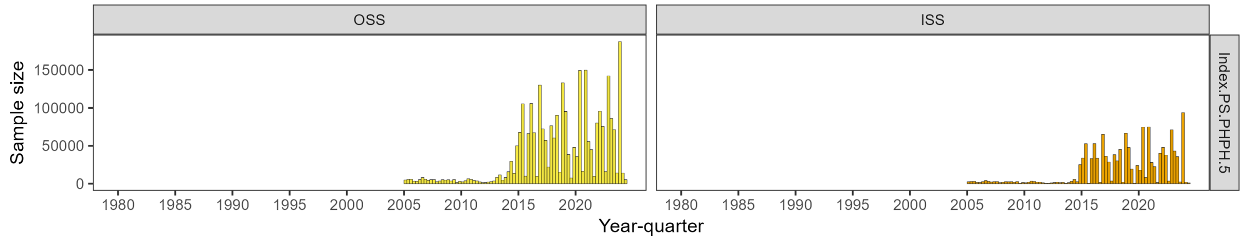


(a) Original and input sample sizes

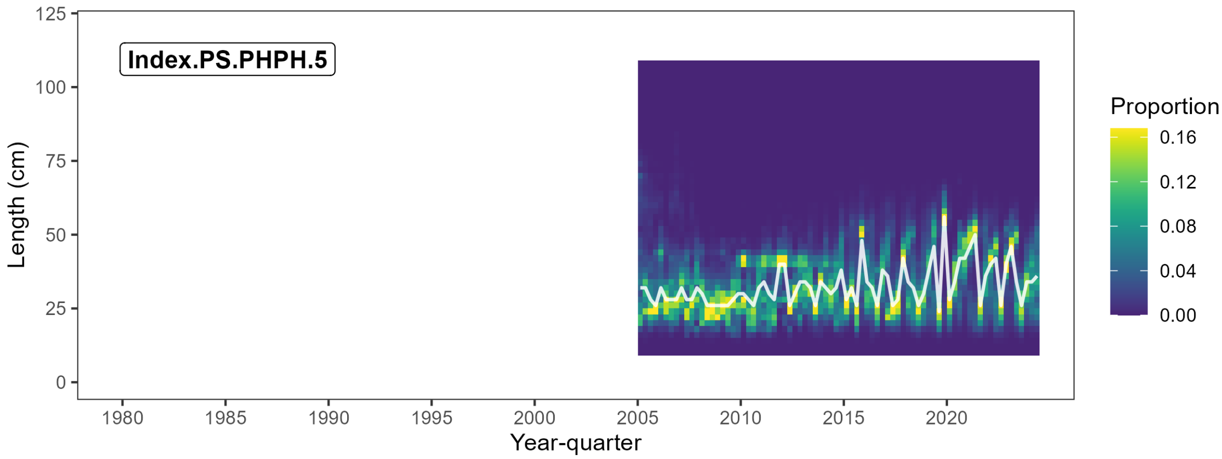


(b) Reweighted compositions

Figure 1: a) Original sample sizes (OSS) and input sample sizes (ISS), and b) reweighted size compositions, for the domestic Philippines purse seine and ring net extraction fishery. The white line provides the median size class per year-quarter.



(a) Original and input sample sizes



(b) Reweighted compositions

Figure 2: a) Original sample sizes (OSS) and input sample sizes (ISS), and b) reweighted size compositions, for the domestic Philippines purse seine index fishery. The white line provides the median size class per year-quarter.

14.4 Pole and line extraction fishery compositions

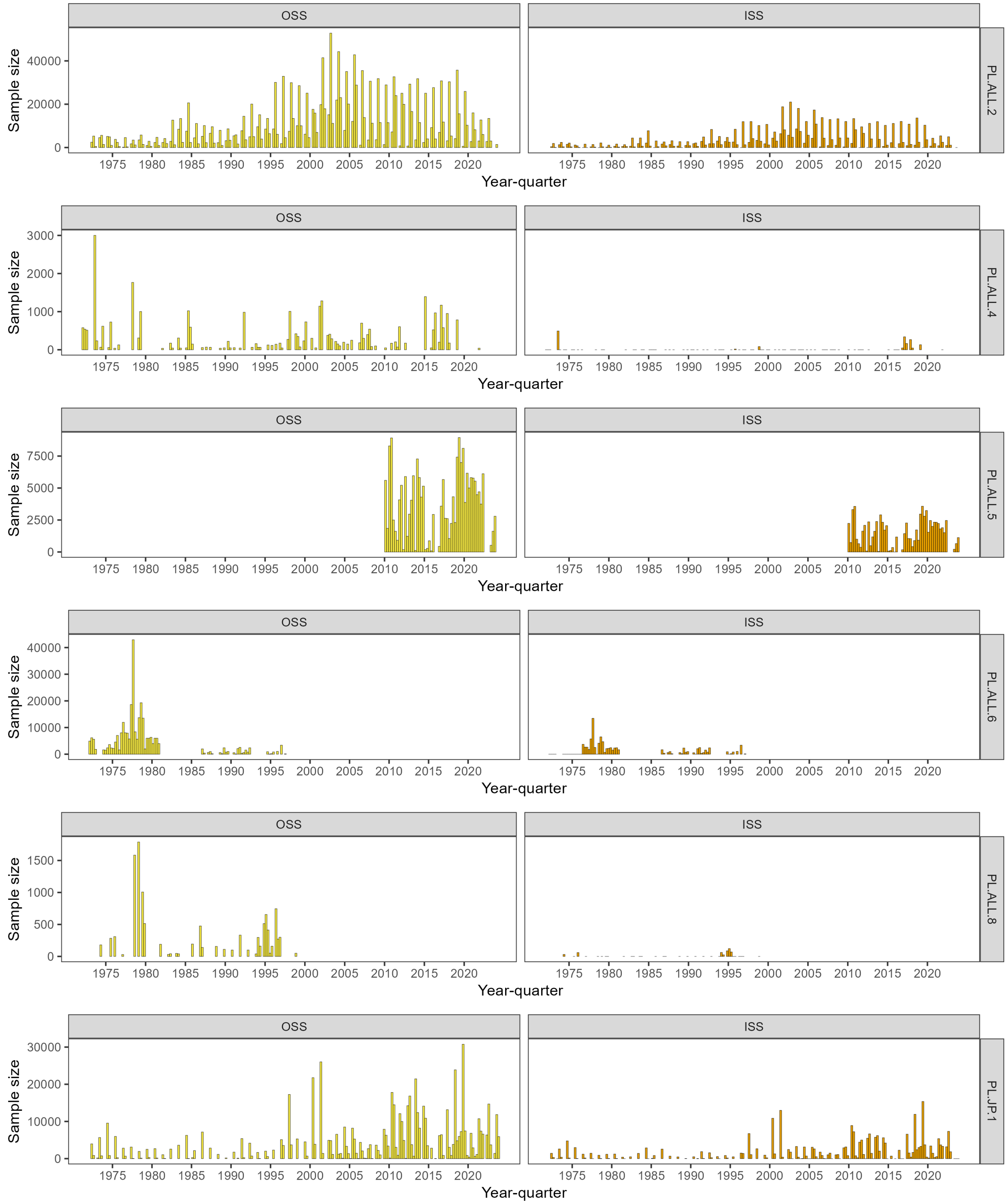


Figure 1: Original sample sizes (OSS) and input sample sizes (ISS) for pole and line extraction fisheries.

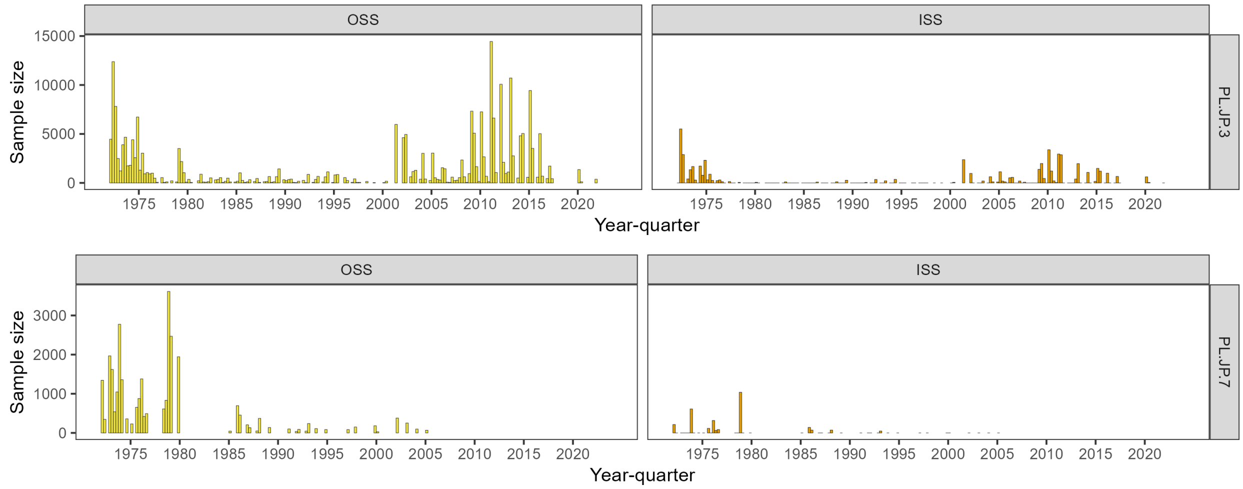


Figure 1: Original sample sizes (OSS) and input sample sizes (ISS) for pole and line extraction fisheries (cont.).

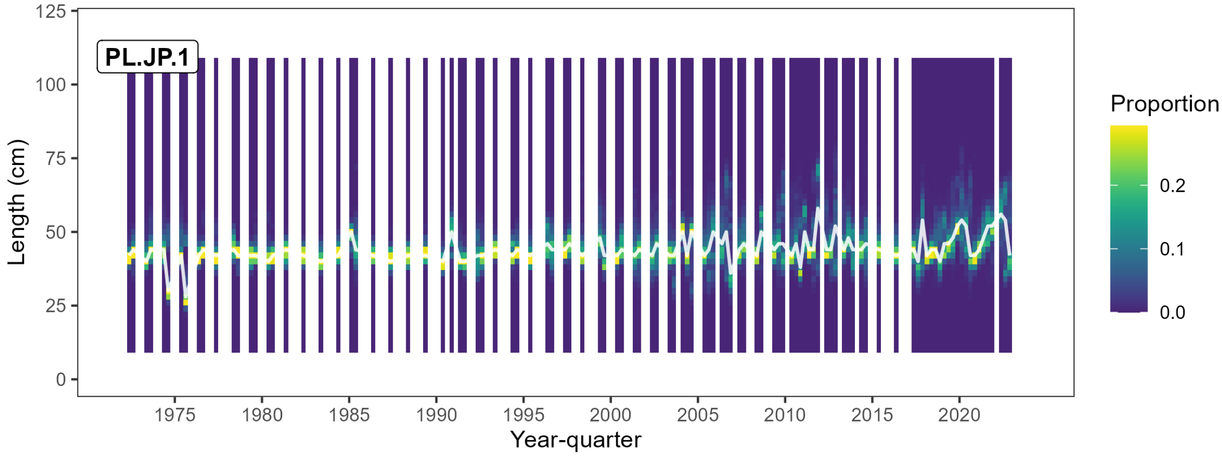


Figure 2: Reweighted size comps for fishery PL.JP.1. The white line provides the median size class per year-quarter.

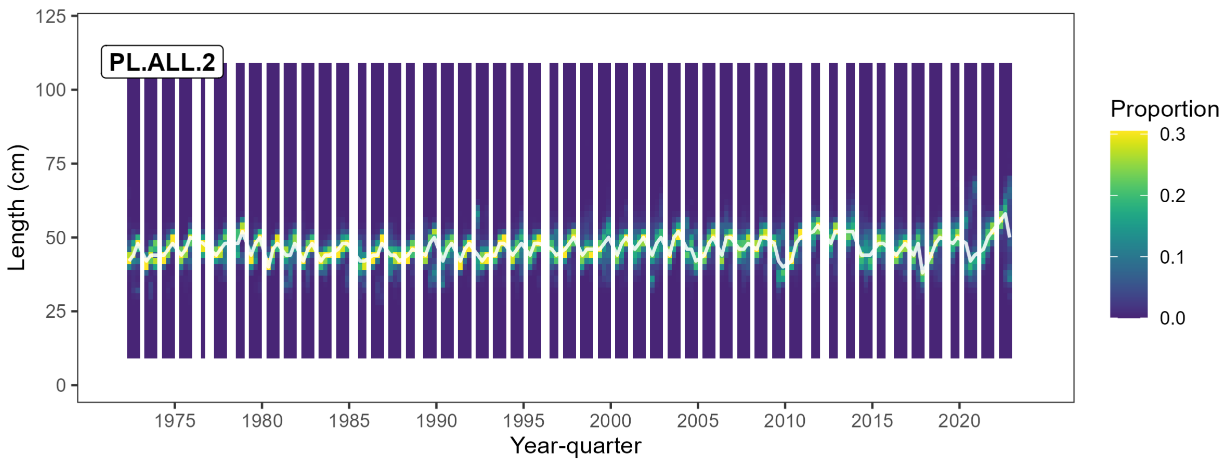


Figure 3: Reweighted size comps for fishery PL.ALL.2. The white line provides the median size class per year-quarter.

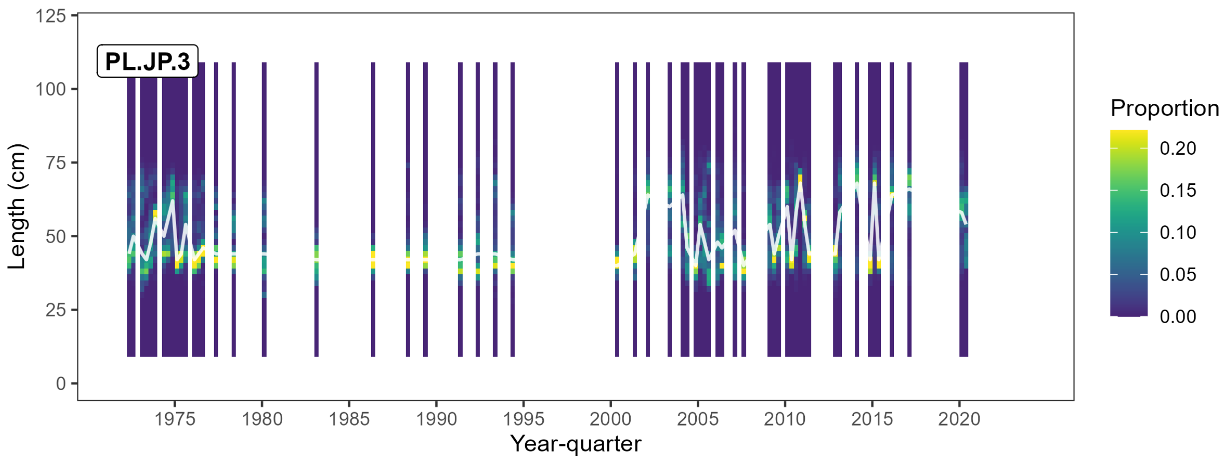


Figure 4: Reweighted size comps for fishery PL.JP.3. The white line provides the median size class per year-quarter.

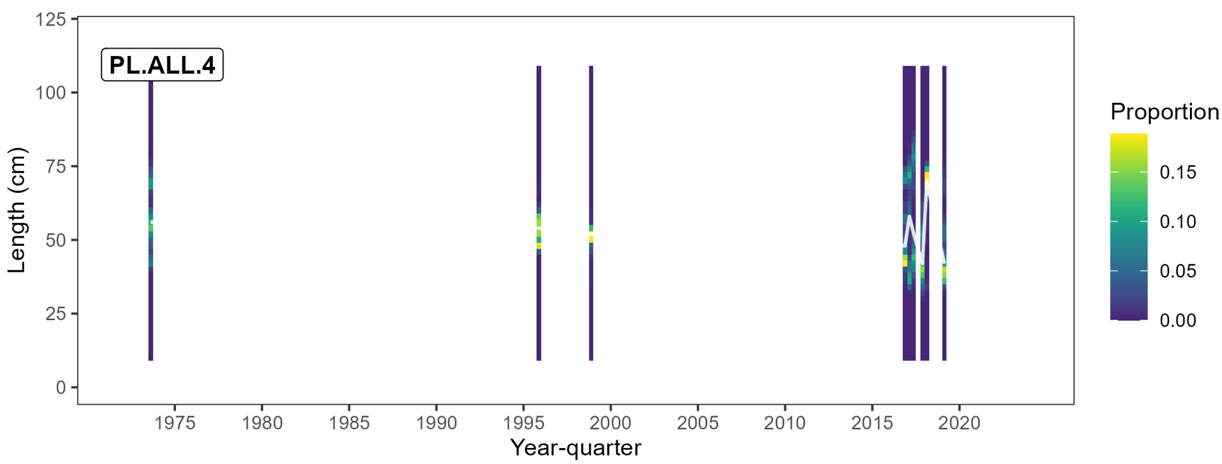


Figure 5: Reweighted size comps for fishery PL.ALL.4. The white line provides the median size class per year-quarter.

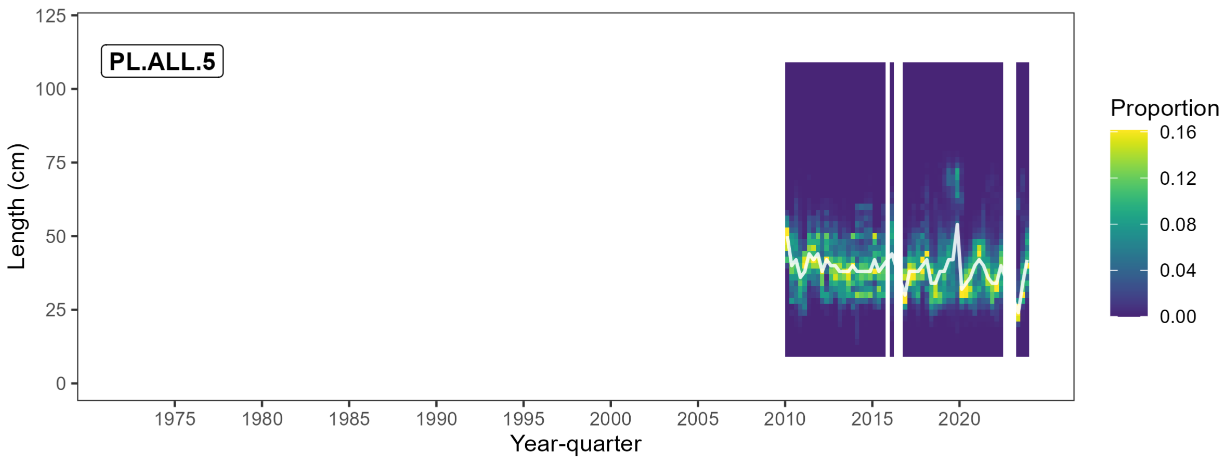


Figure 6: Reweighted size comps for fishery PL.ALL.5. The white line provides the median size class per year-quarter.

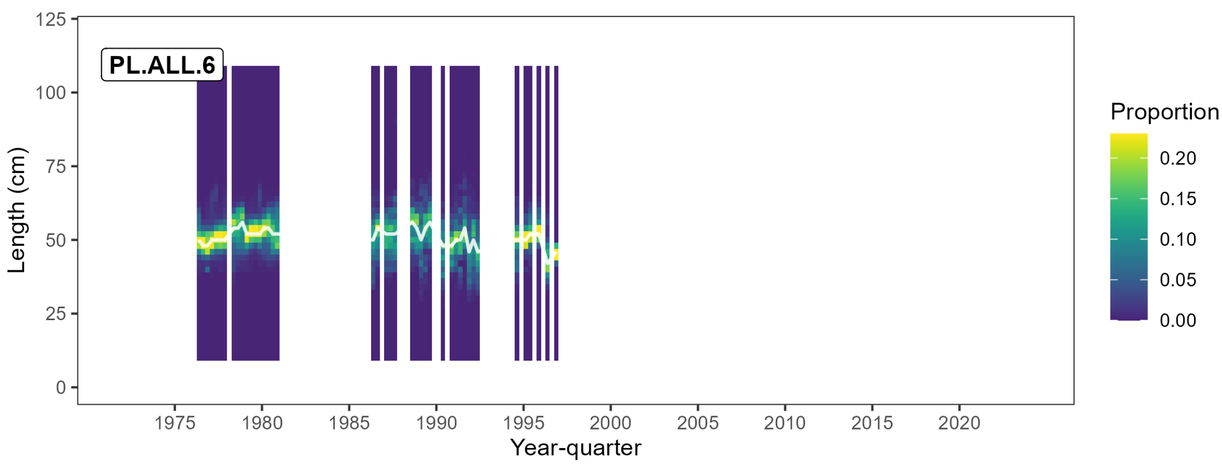


Figure 7: Reweighted size comps for fishery PL.ALL.6. The white line provides the median size class per year-quarter.

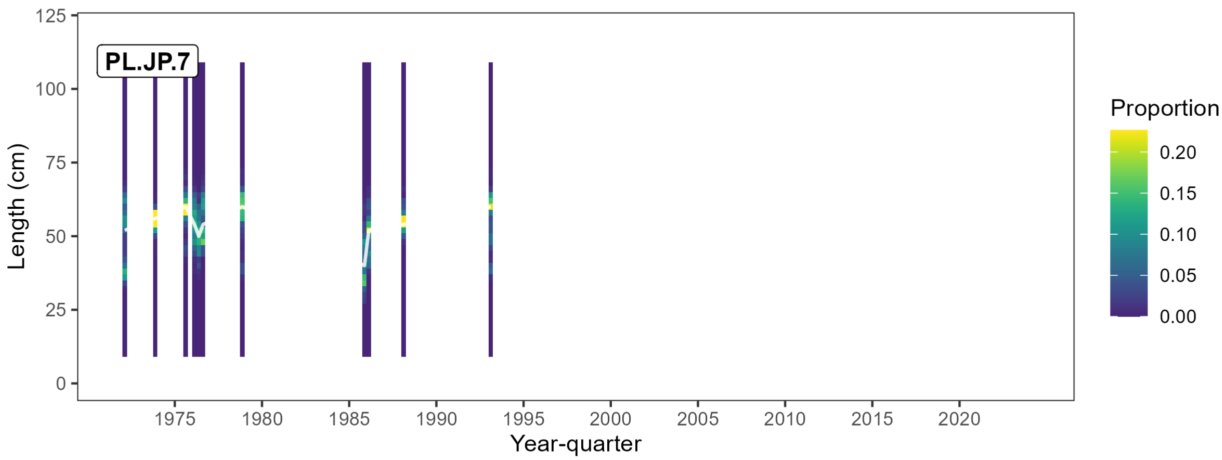


Figure 8: Reweighted size comps for fishery PL.JP.7. The white line provides the median size class per year-quarter.

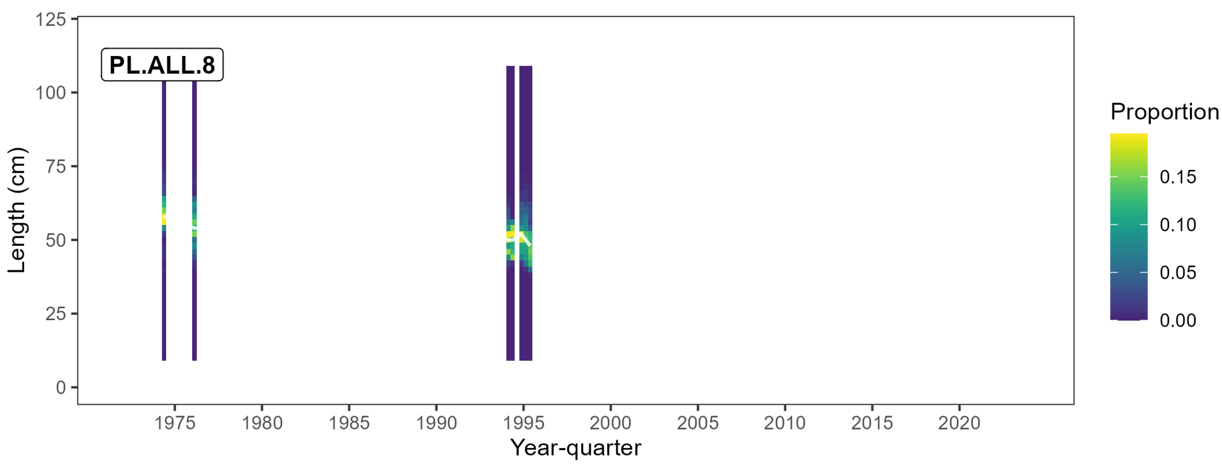


Figure 9: Reweighted size comps for fishery PL.ALL.8. The white line provides the median size class per year-quarter.

14.5 Pole and line index fishery compositions

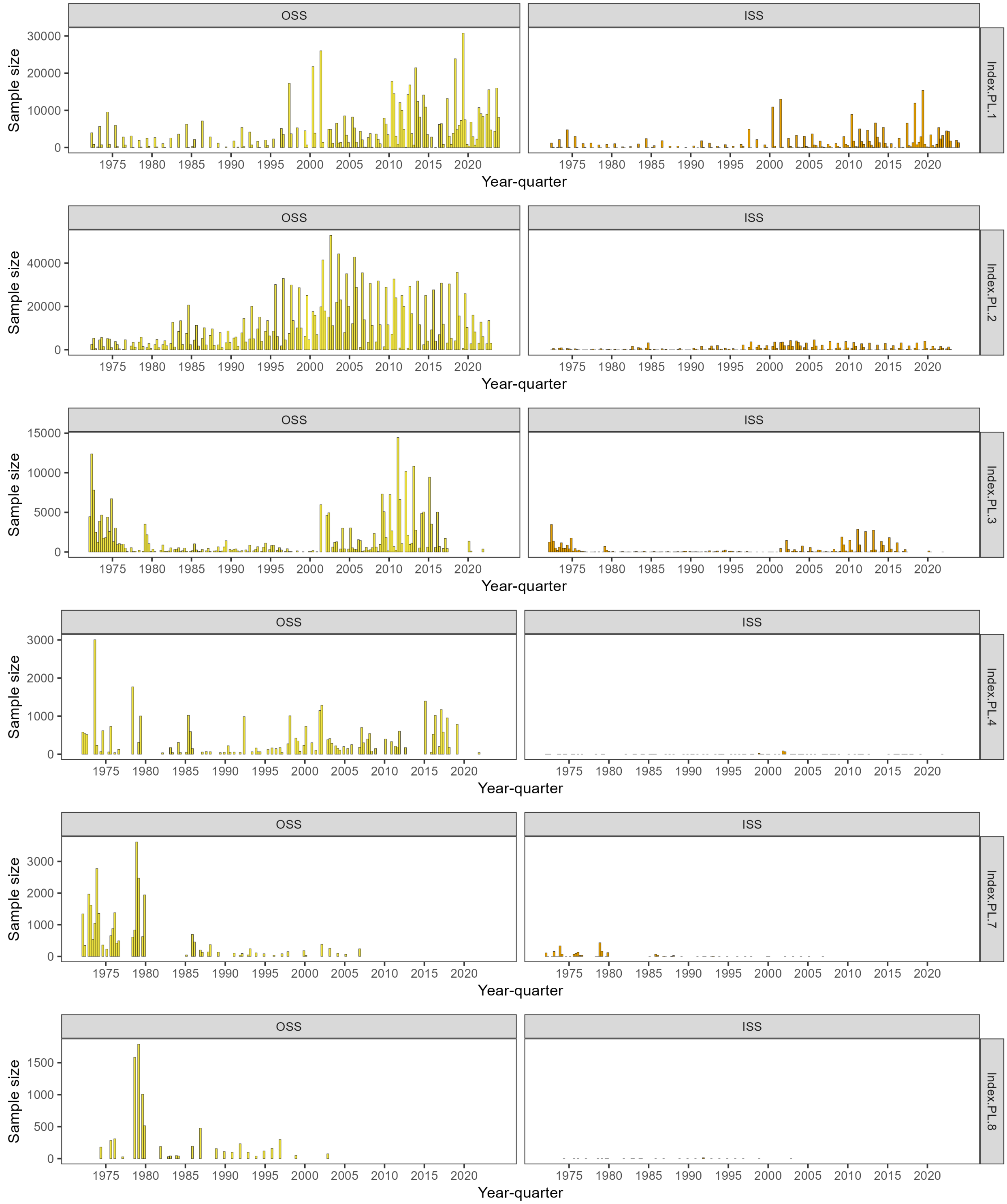


Figure 1: Original sample sizes (OSS) and input sample sizes (ISS) for pole and line index fisheries.

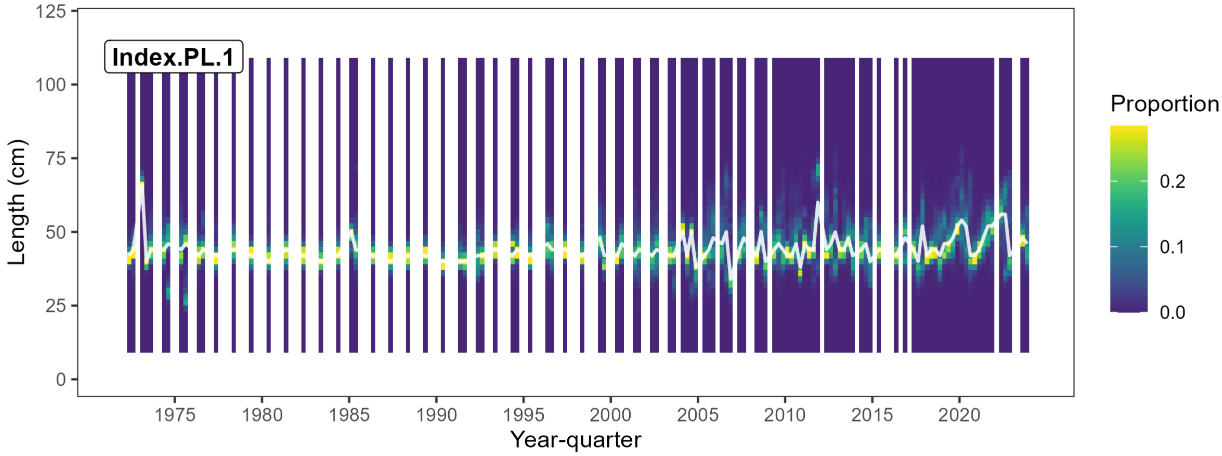


Figure 2: Reweighted size comps for fishery Index.PL.1. The white line provides the median size class per year-quarter.

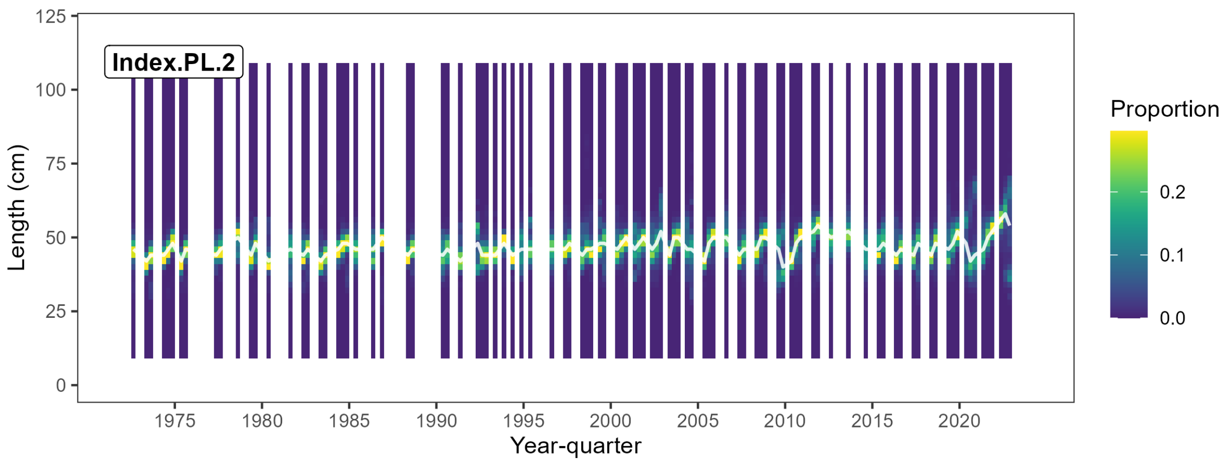


Figure 3: Reweighted size comps for fishery Index.PL.2. The white line provides the median size class per year-quarter.

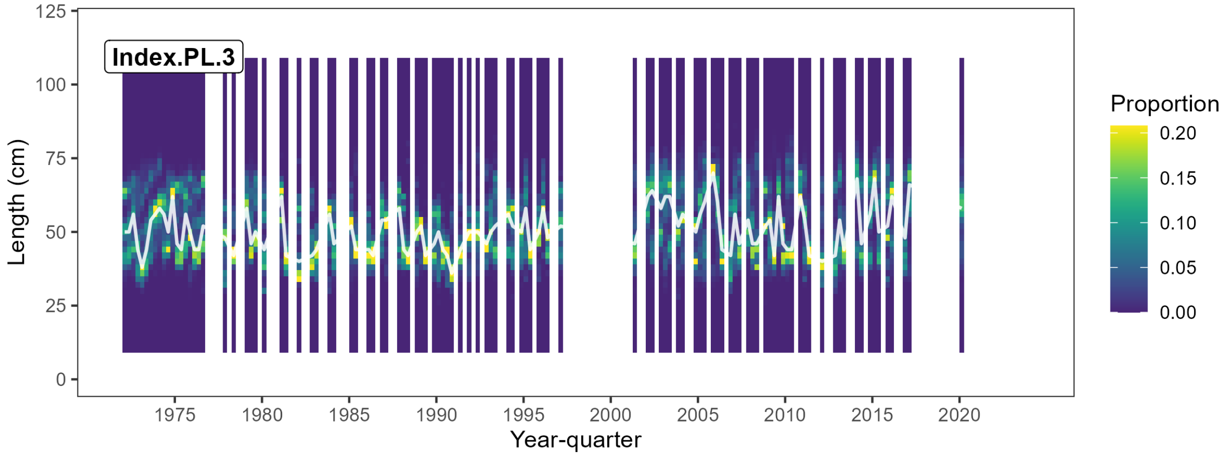


Figure 4: Reweighted size comps for fishery Index.PL.3. The white line provides the median size class per year-quarter.

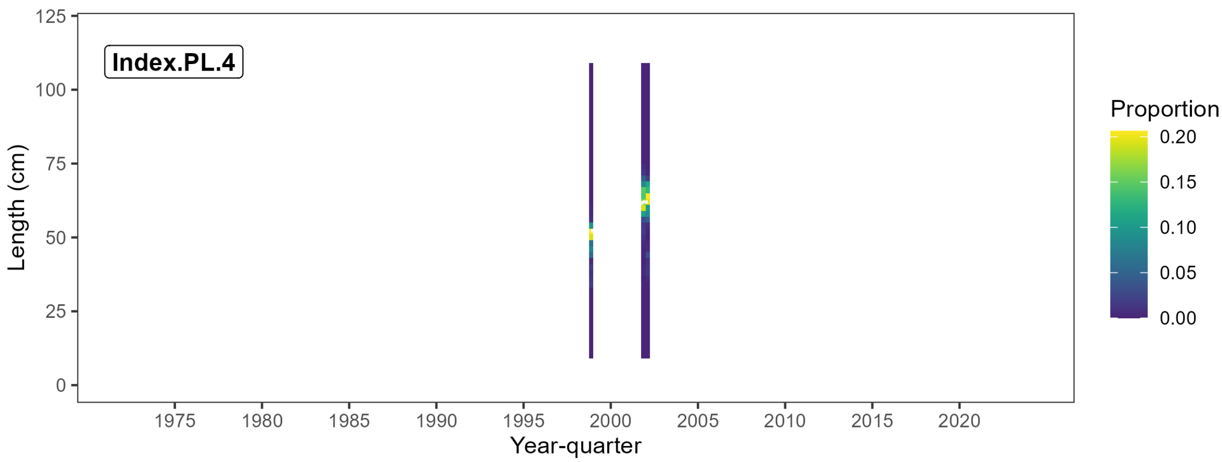


Figure 5: Reweighted size comps for fishery Index.PL.4. The white line provides the median size class per year-quarter.

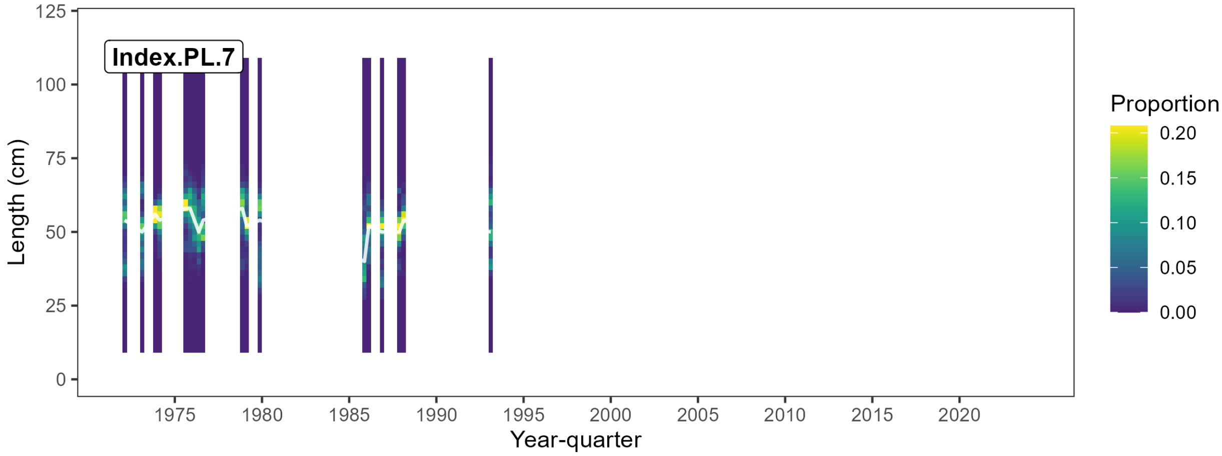


Figure 6: Reweighted size comps for fishery Index.PL.7. The white line provides the median size class per year-quarter.

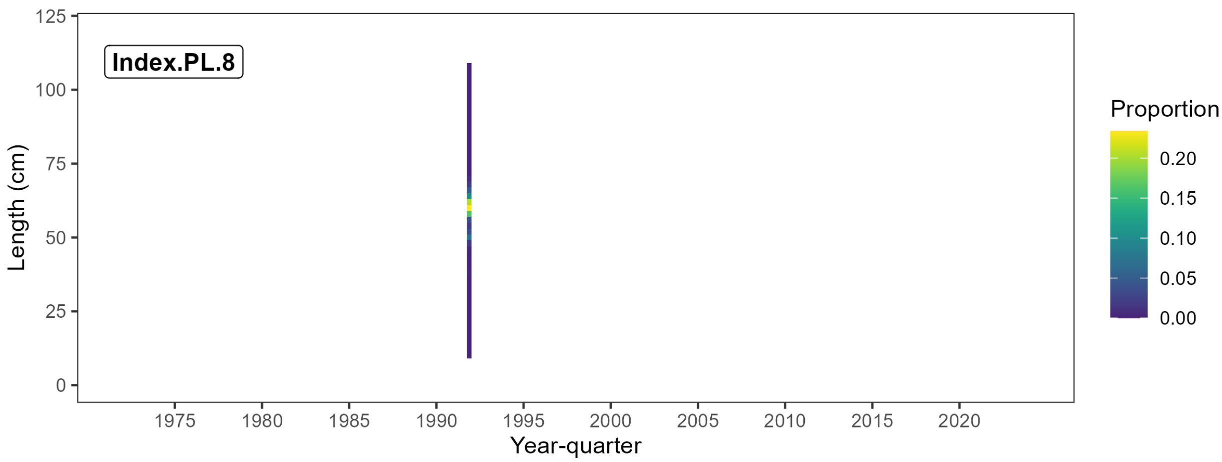


Figure 7: Reweighted size comps for fishery Index.PL.8. The white line provides the median size class per year-quarter.