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Summary of fisheries structures for the 2019 assessment of skipjack tuna in the western and central Pacific Ocean

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Contents

Executive Summary

This report defines the fisheries used in the stock assessment in the western and central Pacific Ocean (WCPO) that was conducted using the statistical software MULTIFAN-CL. A "fishery" is a basic fishing component of the model used to assess the stocks of tuna in the WCPO. It is important that the rationale behind the fisheries definitions used within the stock assessment are documented for future assessments. This allows for the reproducibility of results and could inform future analysts of potential pitfalls. This report details the fisheries structures used in the 2019 skipjack tuna assessment in the WCPO for two different spatial structures (8 and 5 region) and changes made to the data from the 2016 stock assessment.

A brief summary of the changes to the fisheries are as follows:

- catch from the Japanese troll fishery was added to the pole-and-line fishery in Region 1;
- catch from the Japanese coastal pole-and-line fishery was added to the pole-and-line fishery in Region 3;
- the pole-and-line fishery in Region 5 used only length frequency data from Indonesia because the catch from the Japanese fleet was discovered to be a minor component;
- the Indonesia domestic fishery now includes the Indonesia troll fishery;
- the assumption of shared selectivities and number of nodes in the cubic spline for various fisheries was changed relative to the 2016 assessment;
- three pole-and-line fisheries were added to the new northern regions (Regions 2, 3, and 4);
- three longline fisheries were add to the three new northern regions (Regions 2, 3, and 4);
- two purse seine fisheries were added to the north-western regions (Regions 2 and 3).

The consequences of these changes to the fisheries are described in Vincent et al. (2019).

1 Introduction

This paper describes the fisheries used in the 2019 skipjack tuna *Katsuwonus pelamis* stock assessment. Two spatial structures were considered in the current stock assessment, and the fisheries for both of these are described separately. Additionally, changes to the catch and other modeling assumptions since the 2016 stock assessment are described. This assessment was fit to available data using the statistical software MULTIFAN-CL[2] (MFCL; Fournier et al., 1998; Hampton and Fournier, 2001; Kleiber et al., 2019). The assessment models are spatially explicit and consist of several discrete geographic regions containing sub-populations linked by model parameters such as movement and

[2]http://www.multifan-cl.org

spatially explicit recruitment. The basic unit of the fishing component of these models is a “fishery”. Fisheries are defined as a set of fishing activity extending over a region (or subregion) with similar characteristics such as catch per unit effort (CPUE) and size composition of the catch.

Fisheries structures often change between subsequent assessments of the same species. These changes may result from the discovery of different aspects of the data, availability of new data, or changes to the model structure itself. Additionally, changes can occur to some of the modeling assumptions regarding the fisheries, e.g. selectivity and catchability. Changes in these modeling assumptions can occur as a result of new analyses that suggest changes are warranted, or as a consequence of poor fit to data components occurring in the previous assessment. It is important to document the changes in these assumptions and the reasoning to support these changes, so that scientists conducting future assessments are aware of their justification.

The diagnostic model for the 2019 WCPO skipjack tuna stock assessment is substantially changed from the 2016 reference case model. These changes primarily resulted from the use of a new spatial structure with 8 regions (Figure 1). The rationale behind the 8 region model is presented in detail by Kiyofuji et al. (2019a) and will not be discussed here.

This report contains descriptions of the following aspects of the assessment model structure that were changed:

- Changes to the input data of various fisheries to reflect currently available information. Fishery-specific summaries for the catch, effort, and length frequency data utilized within the assessment are presented.
- Changes to the assumptions regarding selectivity sharing of various fisheries.
- Changes made to the regional structure of the assessment. Compared to the 2016 stock assessment, three additional regions were added to the regional structure to account for seasonal movement and differences in size in the northern distribution of the species.
- Changes to the fisheries definitions as a consequence of changes to the regional structure.

The 2019 skipjack tuna stock assessment was conducted using two spatial structures with different numberings for regions and fisheries, but many of the same modeling decisions applied to both spatial structures. Throughout this report we shall refer to the Region or fishery number(s) for the 8 region model and then subsequently list the number(s) for the 5 region model in parentheses. For example, the pole-and-line fishery in region 6 (5) would describe the exact same fishery in the region that includes the Bismark Sea because this region did not change between the two spatial structures (Figure 1).

2 Fisheries definitions

2.1 General notes on fisheries structure

Numerous changes to the fisheries used in the 2019 skipjack assessment were implemented as a result of additional and revised data. Despite the changes, the number of fisheries and general structure of the fisheries in the 5 region model used in the 2019 assessment were consistent with the 2016 assessment. While there were no changes to the overall fisheries structure from the 2016 assessment, minor changes were implemented regarding the selectivity of numerous fisheries and are as follows:

- The pole-and-line fisheries in Regions 1, 2, 3, 4, 7, and 8 (1, 2, 3) were assumed to share a common selectivity (cubic spline with four nodes). These fisheries were assumed to share selectivity because the size composition and catch was primarily from the Japanese (JP) fleets, which were assumed to operate similarly across the different regions.
- The pole-and-line fishery in Region 5 (4) assumed a unique selectivity cubic spline of 4 nodes, which was chosen to prevent an unreasonable increase in selectivity at the very oldest ages.
- The pole-and-line fishery in Region 6 (5) assumed a unique selectivity cubic spline of 6 nodes, which was chosen in an attempt to better fit the data for this fishery.
- The longline fisheries were given logistic function selectivity curves; this was chosen by Akaike Information Criteria (AIC) as giving the best fit with the least number of parameters.
- The longline fisheries in Regions 5, 6, and 7 (2, 4, 5) were assumed to share a common selectivity because data in Region 5 were sparse but similar to the other two regions.
- The longline fisheries in Region 1, 2, 3, and, 4 (1) were shared because it was deemed there would be insufficient length frequency samples in these regions to adequately estimate independent parameters.
- The miscellaneous fisheries in Indonesia (ID), Philippines (PH), and Vietnam (VN) were given separate selectivity functions with 5, 6, and 5 nodes respectively as chosen by AIC (see Section 2.2.3).
- The purse seine fisheries (associated and unassociated) were given separate selectivity splines with 4 nodes that were shared among regions to prevent estimates of unreasonably high selectivities at the oldest ages.

These changes were all improvements to the model in order to better fit the data and provide more reasonable parameter estimates compared to assuming all selectivity functions had 5 nodes.

2.2 Data Improvements

2.2.1 Catch data revisions

In preparing the catch data for the assessment, it was noted that catch with the gear code "XJ" was included in the extracted data. These data were discovered to be a JP catch and standardized effort time series that had been provided to SPC around 2004 for the spatial structure at the time, and were included in three fisheries in the 2016 skipjack tuna stock assessment (Figures 2 to 4). The inclusion of these data had the result of double counting the catch in these fisheries and were removed (see Figures 12, 24 and 29 for the data used in the 2019 assessment).

The catch data for the ID miscellaneous gear fishery was discovered to be missing catch records starting in 2013. It was discovered that a portion of the miscellaneous catches had be reclassified as troll gear. The troll gear for the ID fishery was previously not included in the fishery definition (Figure 5). For the 2019 skipjack tuna assessment, the fishery definition for ID was expanded to include all gears, including troll gear, to incorporate all sources of catch in this region (Figure 24).

2.2.2 Investigation of pole and line data in western equatorial region

Based on the revised catch history for the pole-and-line fishery in Region 5 (4), we discovered that the JP pole-and-line fishery in this region contributed only a minor amount of catch compared to the ID fishery. However, the length composition available early in the time series is from the JP pole-and-line fishery (Figure 6). The distribution of the length composition data from the JP pole-and-line fishery differs from the ID pole-and-line fishery (Figure 7). Therefore, the Pre-Assessment Workshop (PAW; (Pilling and Brouwer, 2019)) decided the most appropriate use of the data would be to exclude the JP data from this fishery and use only the available ID length composition data.

2.2.3 Investigation of Indonesia, Philippines, and Vietnam length compositions

In the 2016 stock assessment, the ID, PH, and VN miscellaneous fisheries were assumed to share a common selectivity function. This resulted in the model predicting large and small fish to be captured by the ID and VN fisheries which were not seen the length composition data. A comparison of the distributions of measured length frequencies for the fisheries showed that the PH generally caught smaller and larger skipjack tuna than the other fisheries (Figure 8). As a result of this difference, and the additional years of available length frequency data from the ID and VN sampling programs, the 2019 skipjack tuna stock assessment modeled these fisheries with independent selectivity functions (Figure 9 and Table 2).

2.2.4 Updates to Japanese data

Two major changes occurred to skipjack tuna-related data available to SPC from Japanese fisheries. First, catch data from the Japanese troll and coastal pole-and-line fleets became available for the assessment period (Fujioka and Kiyofiju, 2019). Only catch data were available for these fleets (i.e., no effort or size composition). Therefore, there was insufficient information to estimate the parameters required to make a separate fishery, and this catch data was incorporated into the pole-and-line fishery in Region 1 (1).

The length composition data for the JP pole-and-line fishery used in the 2016 skipjack tuna stock assessment showed an increase in the median length of the measured samples in the mid-1990s (Figure 10). The length frequency composition from Japanese pole-and-line fisheries was thus revised by Kiyofuji et al. (2019b) and incorporated into the 2019 skipjack tuna stock assessment.

The available raw data, which were used in the 5 region models in the 2019 skipjack tuna stock assessment, are presented in Figures 11 to 33.

3 Fisheries definitions for the 8 region spatial structure

To accommodate the increased number of regions used in the diagnostic case model compared to the 2016 reference case model the number of fisheries was increased. The fisheries defined were generally consistent with the fisheries that were used within the 5 region mode (Table 1). The fisheries described in Section 2.2 were identical for the equatorial fisheries but additional fisheries were created to accommodate the separation of the northern area of the 5 region model into 4 smaller regions (Figure 1a). Each of these 4 regions contained a pole-and-line fishery, a longline fishery, and a purse-seine fishery (except for Region 4). Common logistic selectivity parameters for the longline fisheries in Regions 1–4 were shared as were cubic spline parameters for the purse seine fisheries in Regions 1–3. The selectivity parameters for the pole-and-line fisheries in Regions 1, 2, 3, 4, 7, and 8 were shared because catch from the fisheries in these regions were primarily from Japanese vessels. Description of the assumed catchabilities, selectivities and reporting rates are presented in Table 2. Figures of the raw data used within the 2019 skipjack tuna stock assessment are presented in Figures 34 to 64.

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4 Tables

Table 1: Definition of fisheries for the MULTIFAN-CL skipjack analysis for the diagnostic case (8 region) model (see 2016 assessment for the 5 region). Gears: P = pole and line; S = purse seine unspecified set type; SA = purse seine associated set type; SU = purse seine unassociated set type; LL = longline; Dom = the range of artisanal gear types operating in the domestic fisheries of Philippines, Indonesia, and Vietnam. Flag/fleets: PH = Philippines; ID = Indonesia; VN = Vietnam; DW = distant water; ALL = all nationalities.

Fishery	Nationality	Gear	Region
F1 P-ALL-1	ALL	PL	1
F2 S-ALL-1	ALL	PS	1
F3 L-ALL-1	ALL	LL	1
F4 P-ALL-2	ALL	PL	2
F5 S-ALL-2	ALL	PS	2
F6 L-ALL-2	ALL	LL	2
F7 P-ALL-3	ALL	PL	3
F8 S-ALL-3	ALL	PS	3
F9 L-ALL-3	ALL	LL	3
F10 Z-PH-5	PH	Dom	5
F11 Z-ID-5	ID	Dom	5
F12 S-ID.PH-5	ID.PH	PS	5
F13 P-ALL-5	ALL	PL	5
F14 SA-DW-5	DW	PS	5
F15 SU-DW-5	DW	PS	5
F16 Z-VN-5	VN	Dom	5
F17 L-ALL-5	ALL	LL	5
F18 P-ALL-6	ALL	PL	6
F19 SA-ALL-6	ALL	PS	6
F20 SU-ALL-6	ALL	PS	6
F21 L-ALL-6	ALL	LL	6
F22 P-ALL-4	ALL	PL	4
F23 L-ALL-4	ALL	LL	4
F24 P-ALL-7	ALL	PL	7
F25 SA-ALL-7	ALL	PS	7
F26 SU-ALL-7	ALL	PS	7
F27 L-ALL-7	ALL	LL	7
F28 P-ALL-8	ALL	PL	8
F29 SA-ALL-8	ALL	PS	8
F30 SU-ALL-8	ALL	PS	8
F31 L-ALL-8	ALL	LL	8

Table 2: Summary of the groupings of fisheries within the 5 region assessment model for estimation of selectivity, catchability , tag recaptures, and tag reporting rates. In the table Sel is selectivity, Nodes is the number of nodes in the selectivity spline, SeasCat is seasonal catchability, TimVarCat is time varying catchability, TimVarCatCV is the CV on the time varying catchability random walk, EffPen is the effort deviation penalties grouping, EffPenCV is the CV on the effort deviations, Recaptures are the grouping of fisheries for tag recaptures, and Reporting is the sharing of the reporting rate parameters among fisheries within a tagging program . Note that effort is missing for all L and Z fisheries and so effort deviation penalties only apply to the last four quarters. See Table 1 for further details on each fishery.

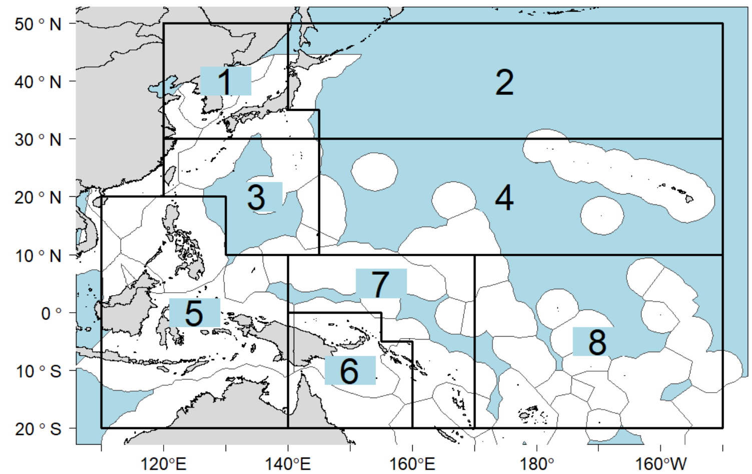
Fishery	Region	Sel Group	Sel Type	SeasCat	TimVarCat	TimVarCatCV	EffPen	EffPenCV	Recaptures	Reporting
F1 P-JPN-1	1	1	Nodes 4	Y	N	NA	time-variant	0.20	1	1
F2 S-ALL-1	1	2	Nodes 4	Y	Y	0.1	constant	0.71	2	1
F3 L-ALL-1	1	3	Logistic	N	N	NA	constant	0.22	3	1
F4 P-ALL-2	2	1	Nodes 4	Y	N	NA	time-variant	0.20	4	1
F5 SA-ALL-2	2	4	Nodes 4	Y	Y	0.1	constant	0.71	5	2
F6 SU-ALL-2	2	5	Nodes 4	Y	Y	0.1	constant	0.71	5	2
F7 L-ALL-2	2	6	Logistic	N	N	NA	constant	0.22	6	1
F8 P-ALL-5	5	7	Nodes 4	Y	Y	0.1	constant	0.71	7	1
F9 SA-ALL-5	5	4	Nodes 4	Y	N	NA	time-variant	0.20	8	3
F10 SU-ALL-5	5	5	Nodes 4	Y	Y	0.1	constant	0.71	8	3
F11 L-ALL-5	5	6	Logistic	N	N	NA	constant	0.22	9	1
F12 P-ALL-3	3	1	Nodes 4	Y	N	NA	time-variant	0.20	10	1
F13 SA-ALL-3	3	4	Nodes 4	Y	Y	0.1	constant	0.71	11	4
F14 SU-ALL-3	3	5	Nodes 4	Y	Y	0.1	constant	0.71	11	4
F15 L-ALL-3	3	8	Logistic	N	N	NA	constant	0.22	12	1
F16 Z-PH-4	4	9	Nodes 6	N	N	NA	constant	0.22	13	5
F17 Z-ID-4	4	10	Nodes 5	N	N	NA	constant	0.22	14	6
F18 S-ID.PH-4	4	11	Nodes 5	N	N	NA	time-variant	0.20	15	7
F19 P-ALL-4	4	12	Nodes 6	Y	Y	0.1	constant	0.71	16	1
F20 SA-DW-4	4	4	Nodes 4	Y	Y	0.1	constant	0.71	17	8

Table2– Continued from previous page

Fishery	Region	Sel Group	Sel Type	SeasCat	TimVarCat	TimVarCatCV	EffPen	EffPenCV	Recaptures	Reporting
F21 SU-DW-4	4	5	Nodes 4	Y	Y	0.1	constant	0.71	17	8
F22 Z-VN-4	4	13	Nodes 5	N	N	NA	constant	0.22	18	9
F23 L-ALL-4	4	6	Logistic	N	N	NA	constant	0.22	19	1

5 Figures

(a) 8 Region



(b) 5 Region

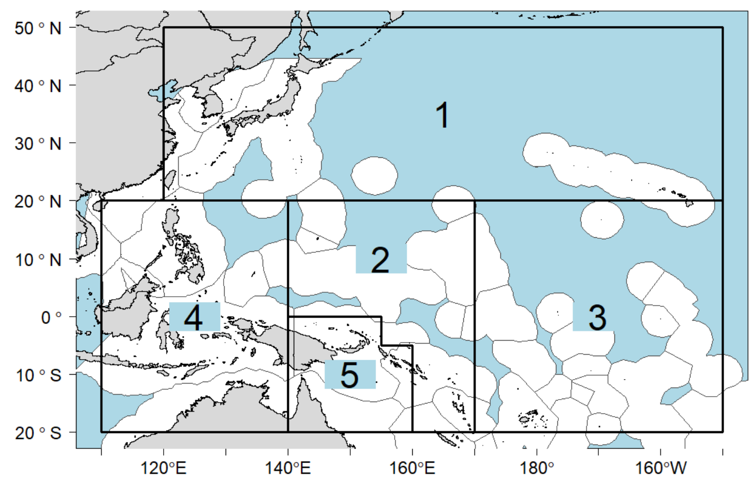


Figure 1: The geographical area covered by the stock assessment and the boundaries for the 8 region (top) and 5 region (bottom) assessment models.

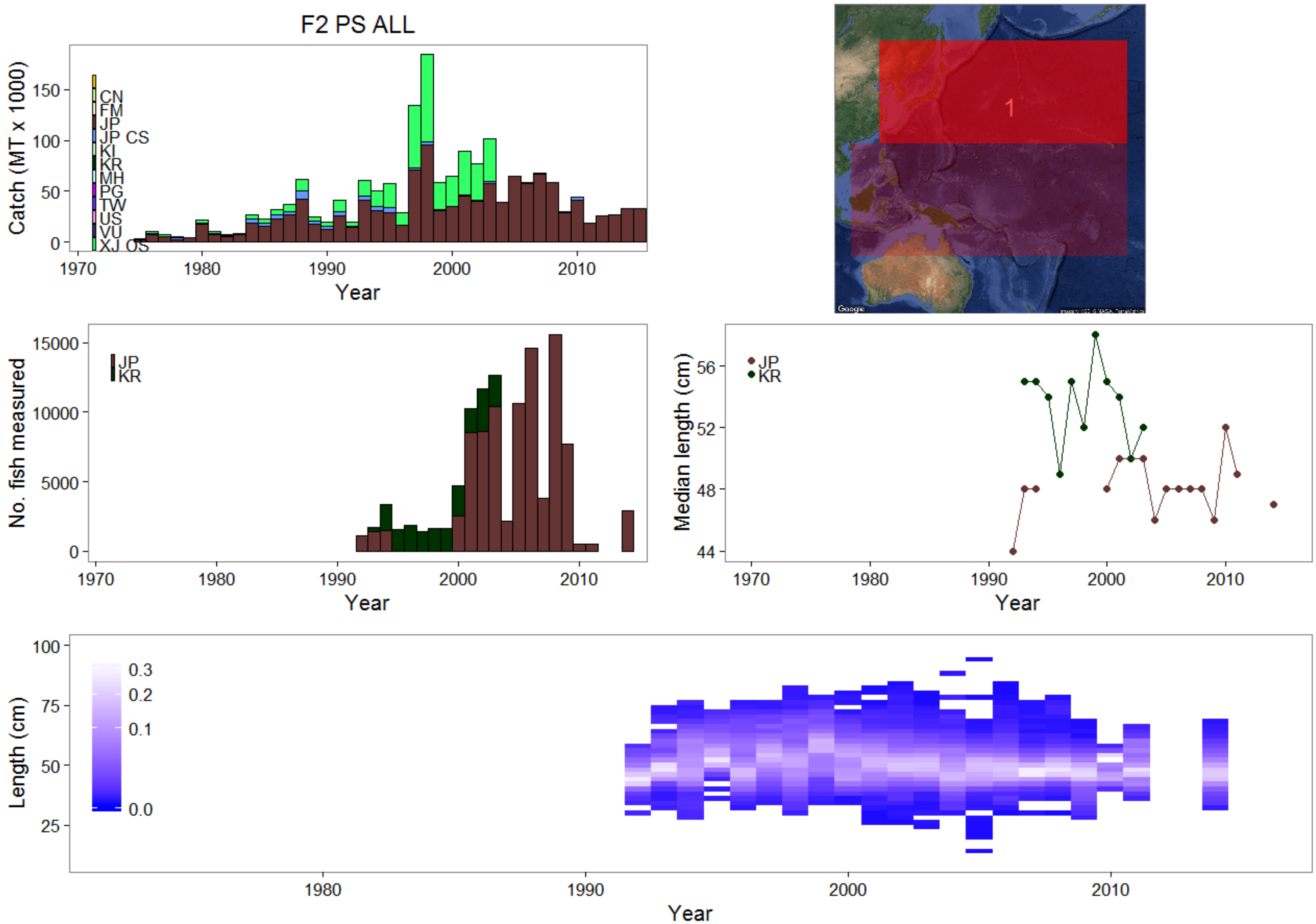


Figure 2: Summary of raw data available for fishery 2 used in the 2016 skipjack stock assessment. The panels display; annual catch (top left), region of occurrence (top right), the annual number of fish with measured length (middle left), median length of available length composition data (middle right) and a tile plot of the annual length distribution of fish (bottom).

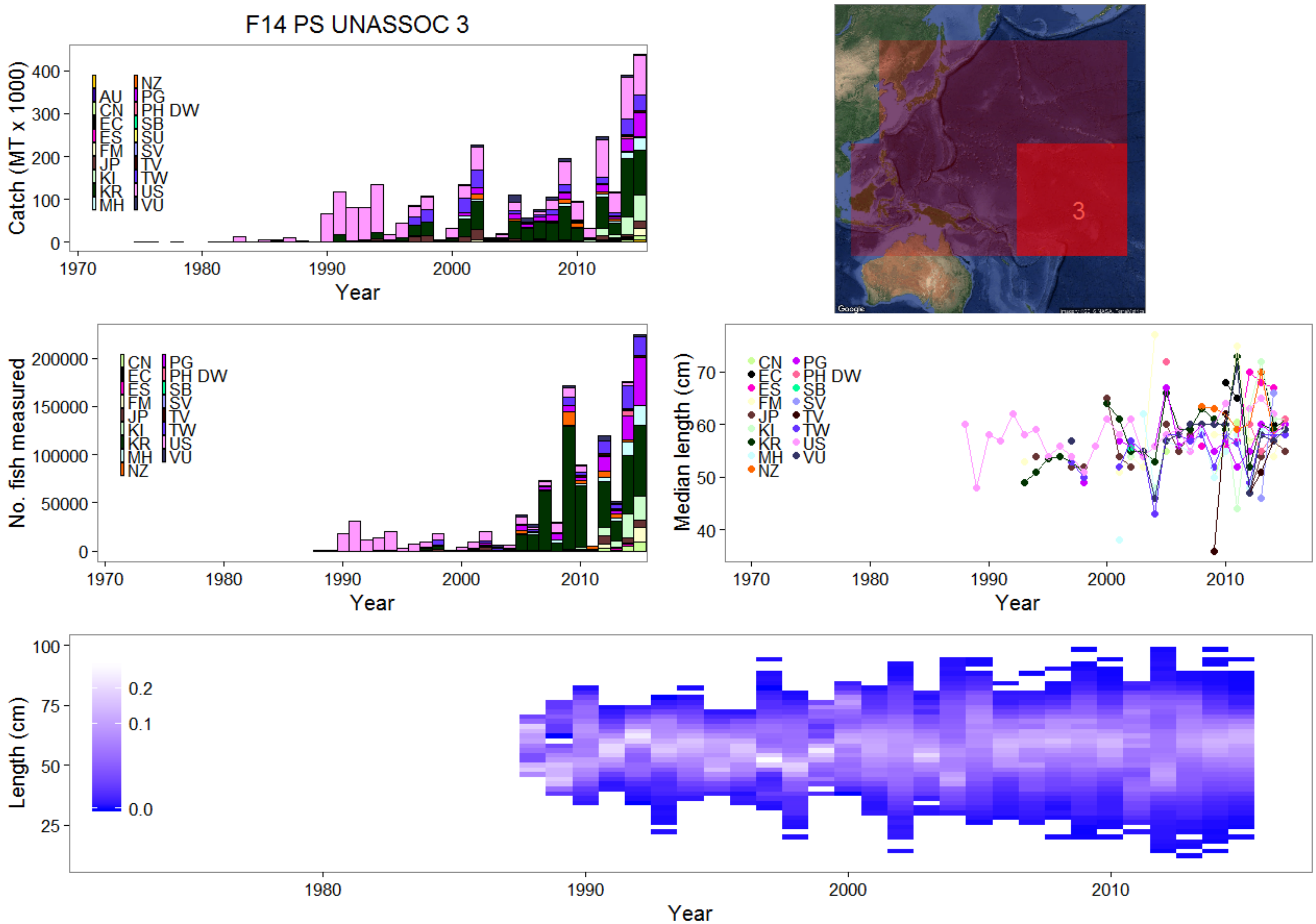


Figure 3: Summary of raw data available for fishery 14 used in the 2016 skipjack stock assessment. See Figure 2 for description of figure panels.

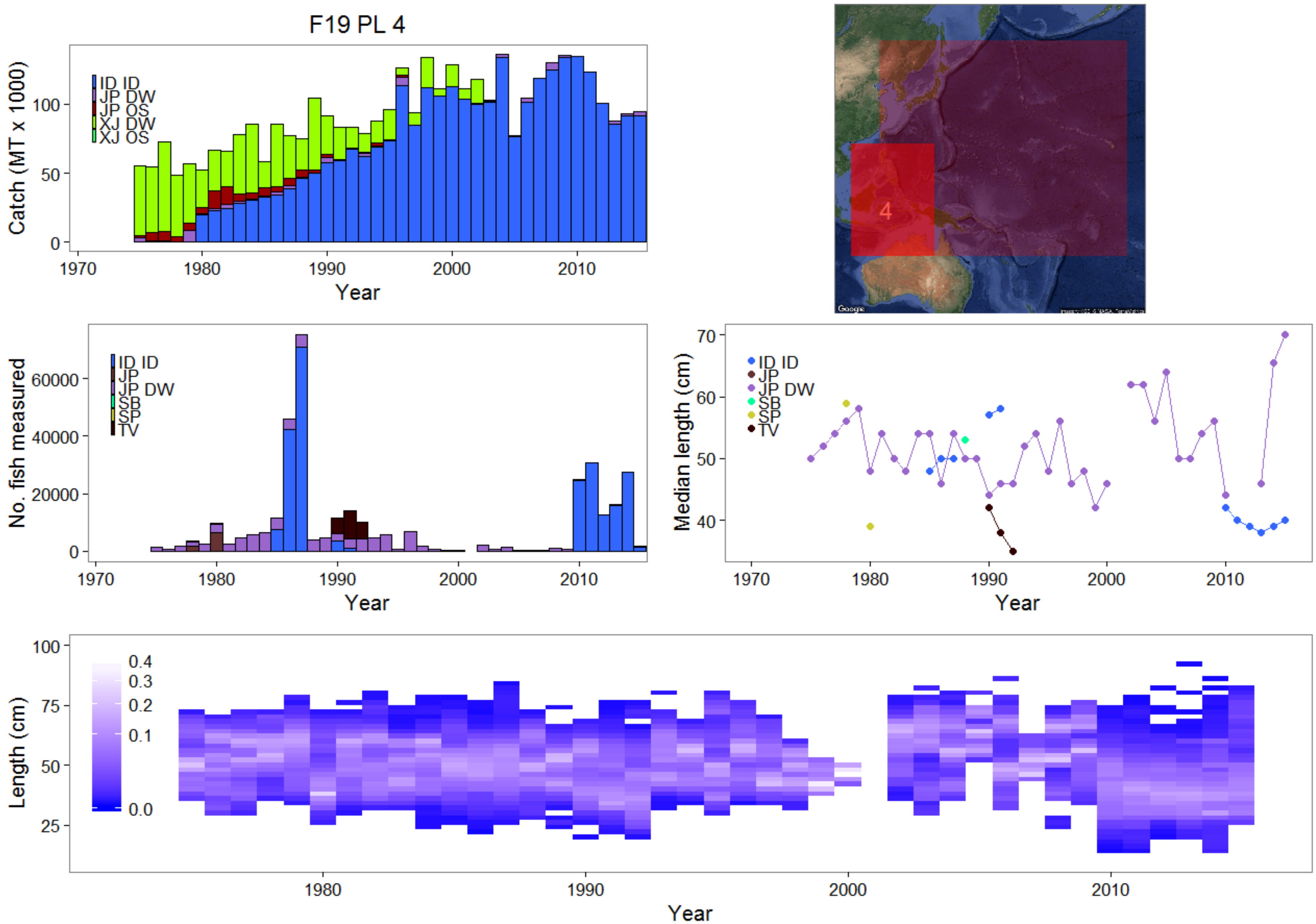


Figure 4: Summary of raw data available for fishery 19 used in the 2016 skipjack stock assessment. See Figure 2 for description of figure panels.

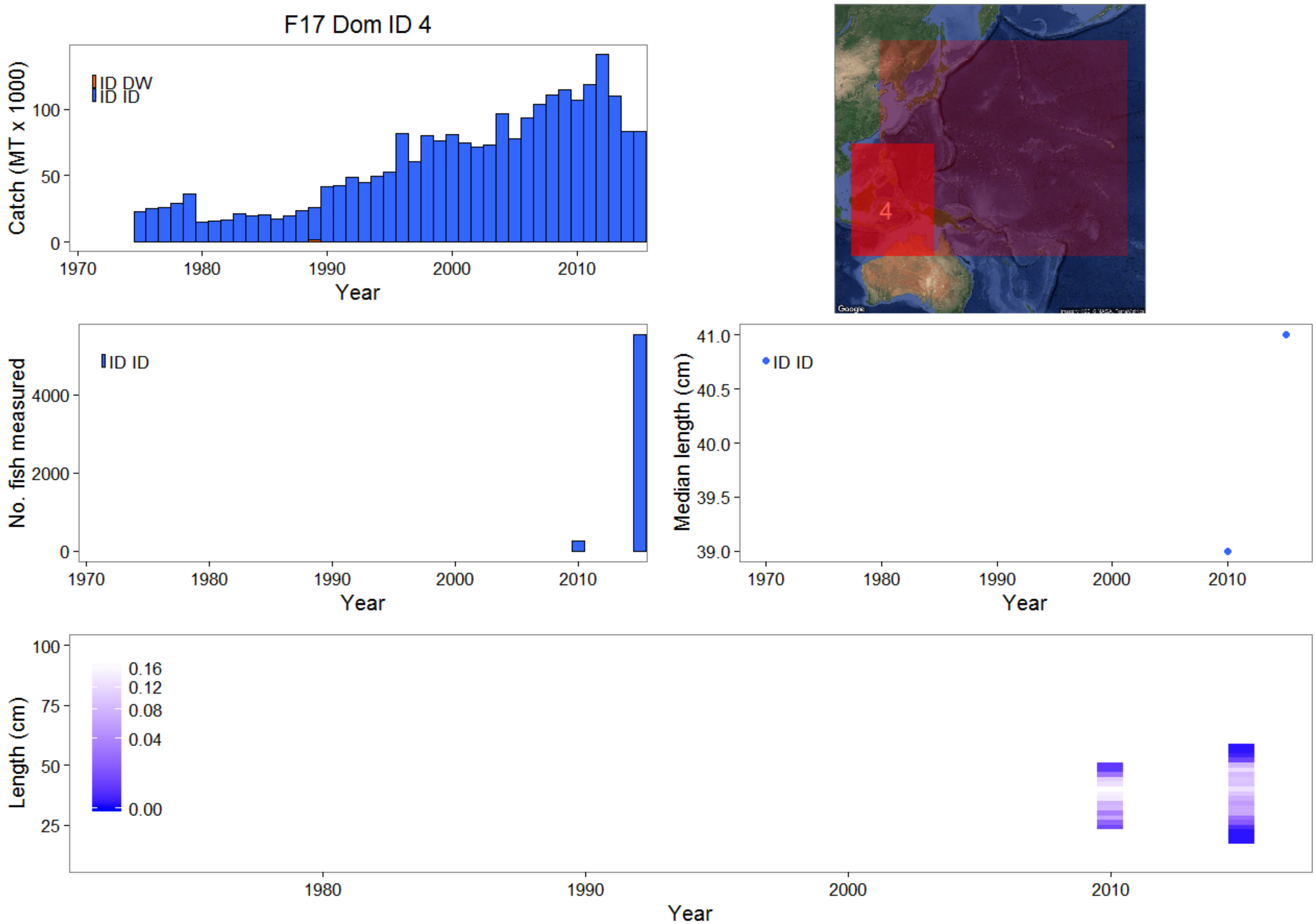


Figure 5: Summary of raw data available for fishery 17 used in the 2016 skipjack stock assessment. See Figure 2 for description of figure panels.

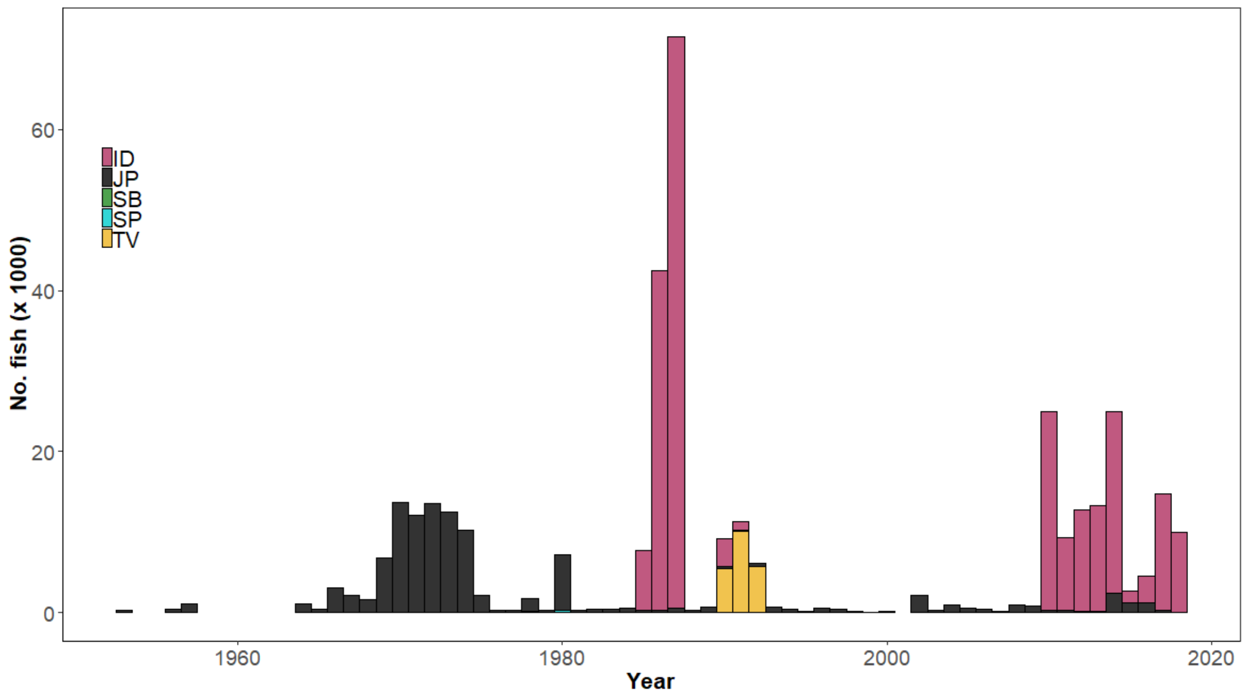


Figure 6: Time series of available number of length measurements from the pole-and-line fishery in Region 5 (4) by flag.

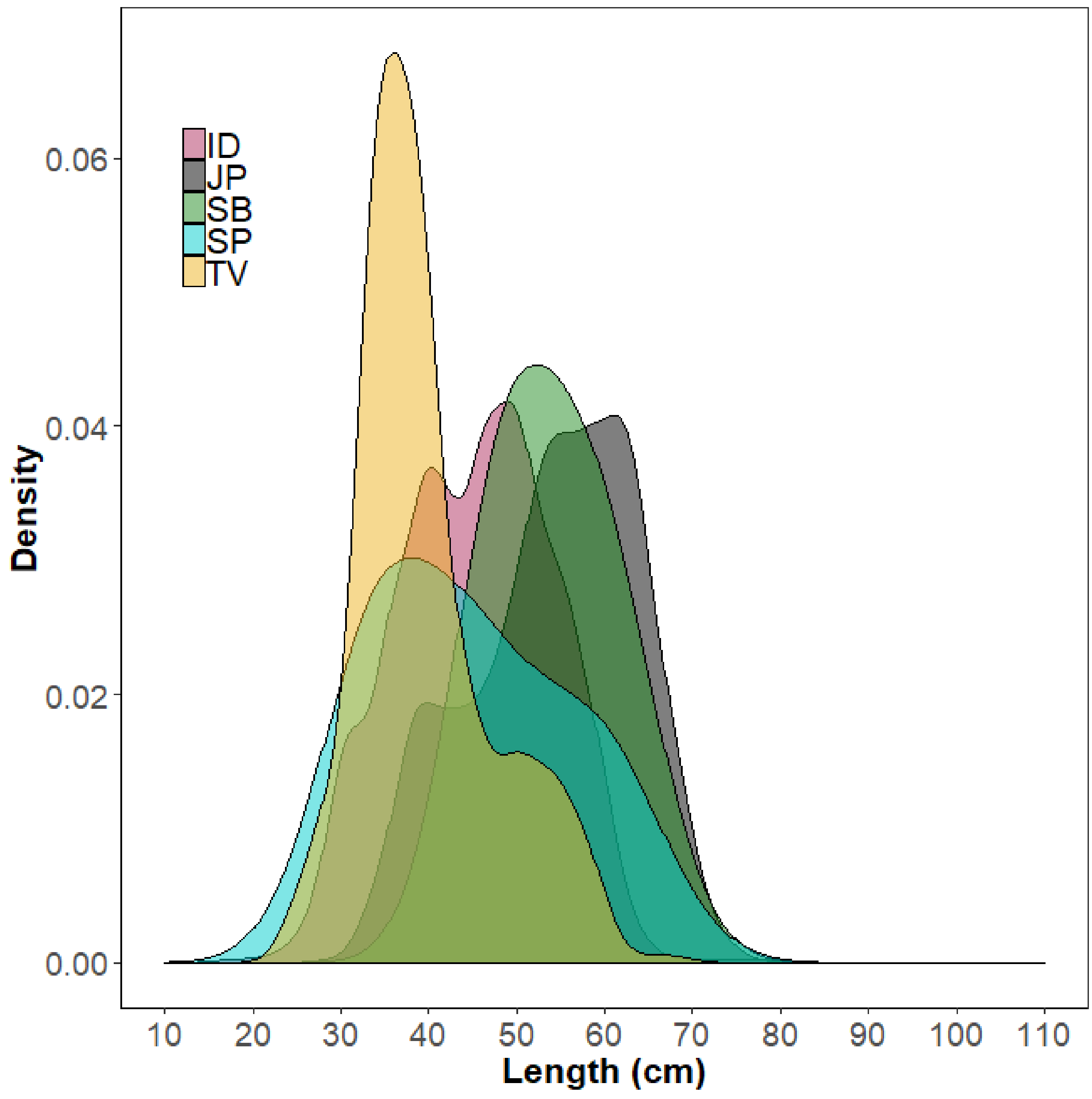


Figure 7: Density of measured length composition data from the pole-and-line fishery in Region 5 (4) by flag.

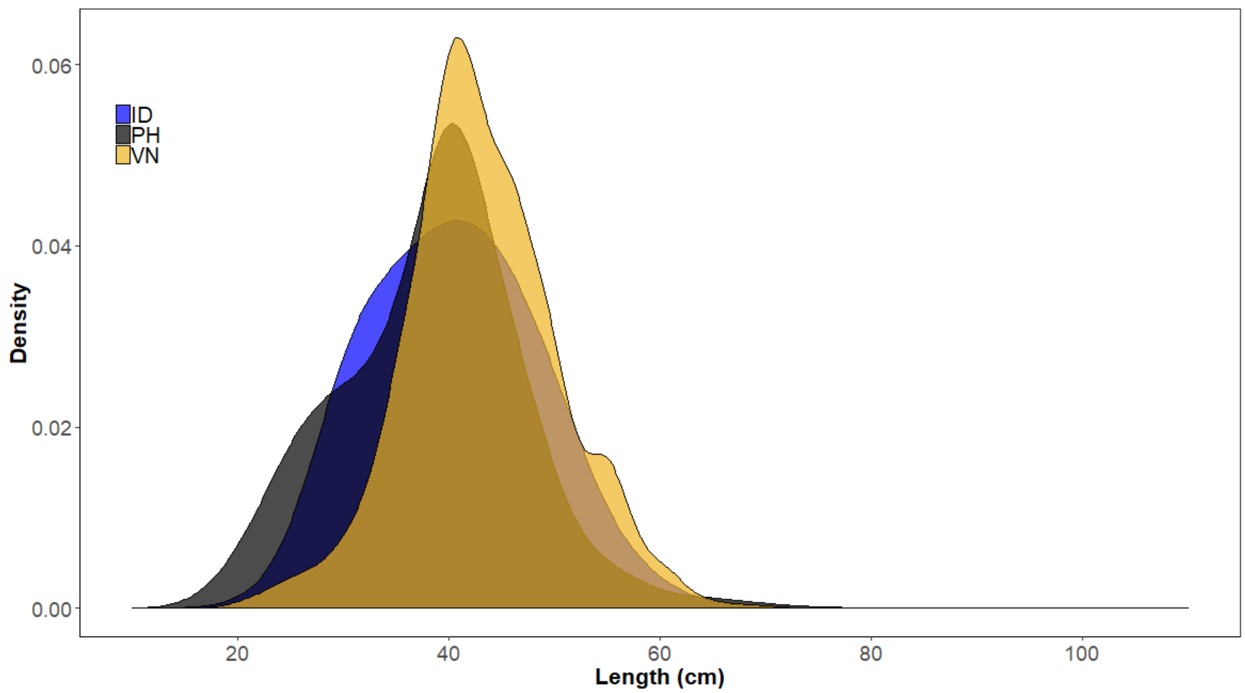


Figure 8: Density of measured length composition data from the miscellaneous fisheries in Region 5 (4) by flag.

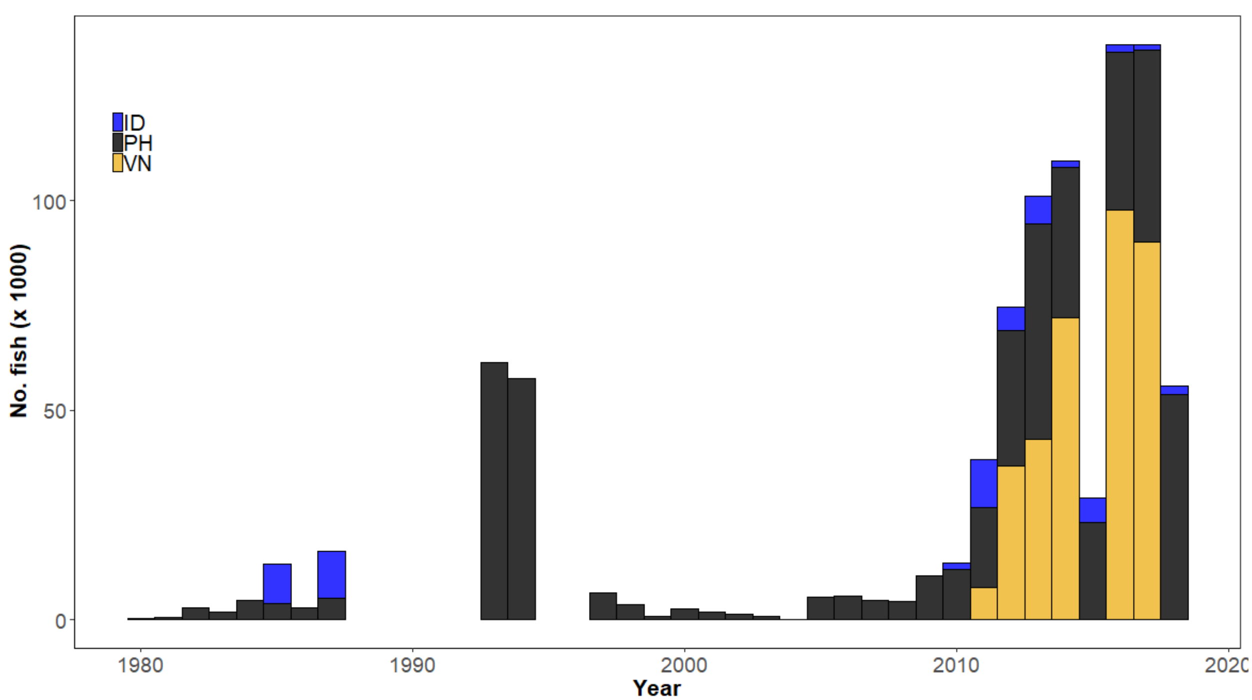


Figure 9: Time series of available length measurements from the miscellaneous fisheries in Region 5 (4) by flag.

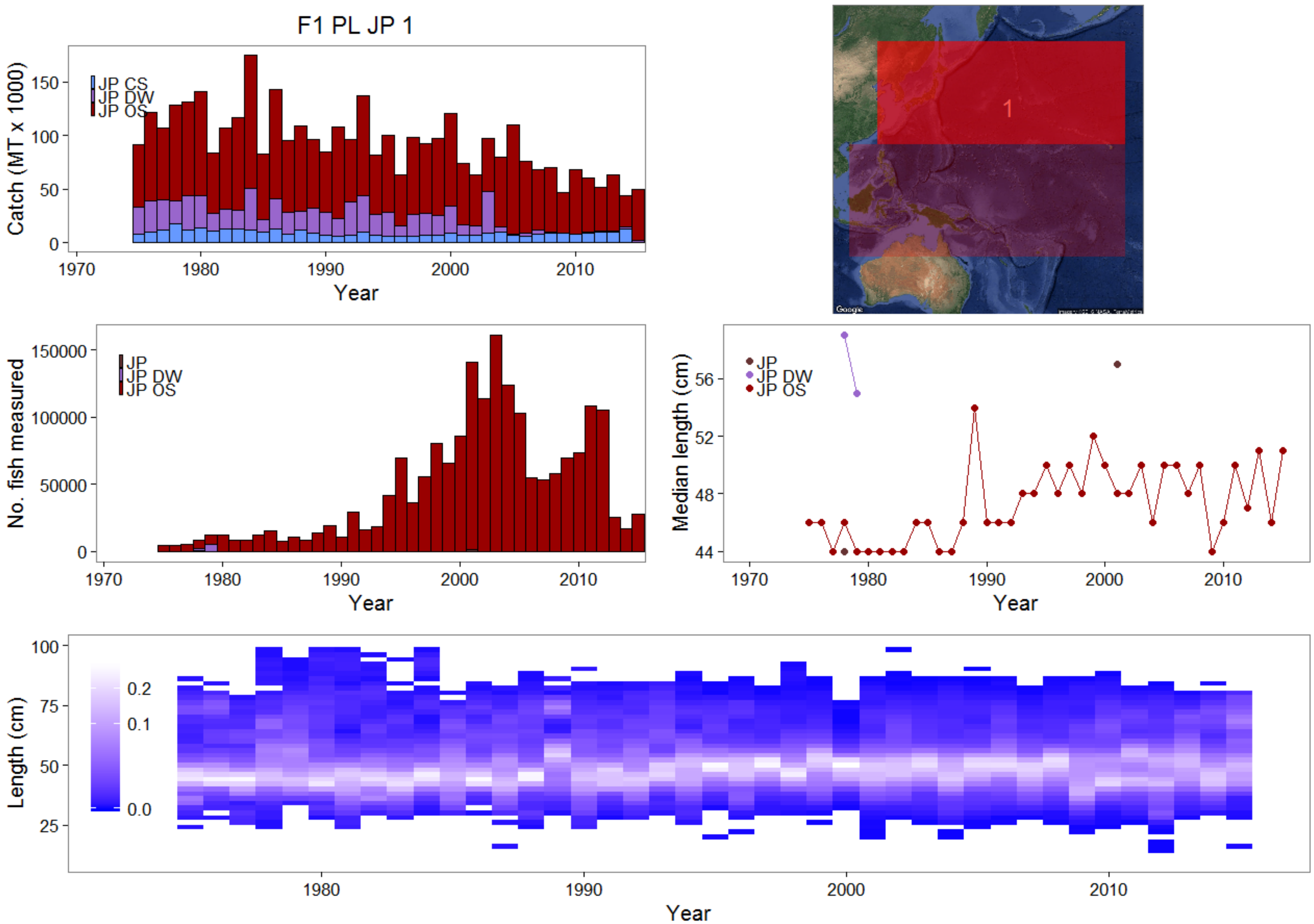


Figure 10: Summary of raw data available for fishery 1 used in the 2016 skipjack stock assessment. See Figure 2 for description of figure panels.

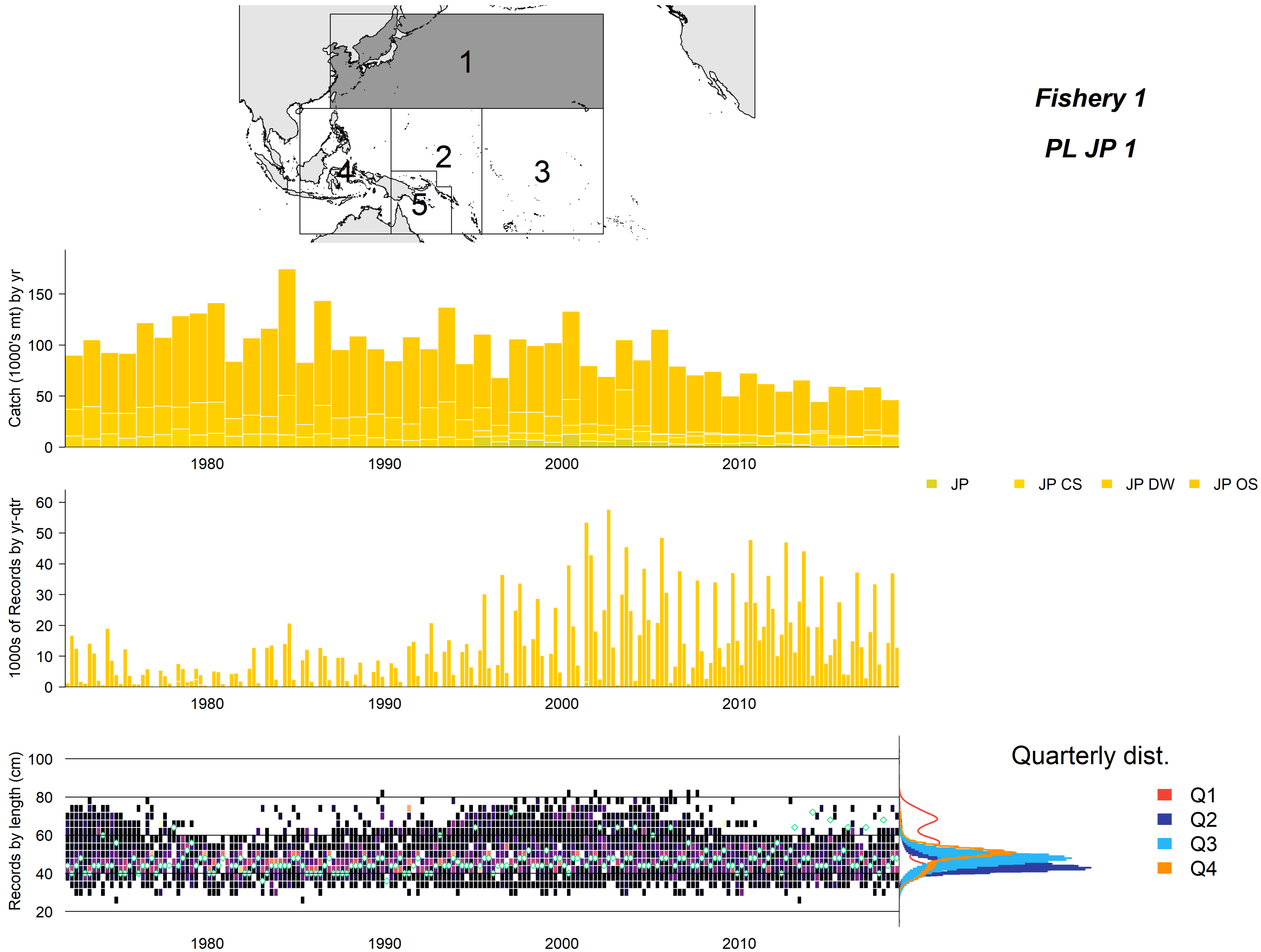


Figure 11: Summary of raw data available for fishery 1 in the 5 region structure. The top right panel displays the fishery number and name, while the top left panel highlights the region of occurrence. The middle two plots show the annual catch in thousands of metric tons per year (middle top) and the number of measured fish lengths in thousands of fish per year quarter (middle bottom) with the legend associated with both plots to the right. The bottom left panel displays a tile plot of the proportion of measured fish in each 2 cm length bin by year quarter, where the lighter colors indicate higher proportions and the median is indicated by the white diamond with a green border. The bottom right panel displays the density of length samples within each bin for each quarter.

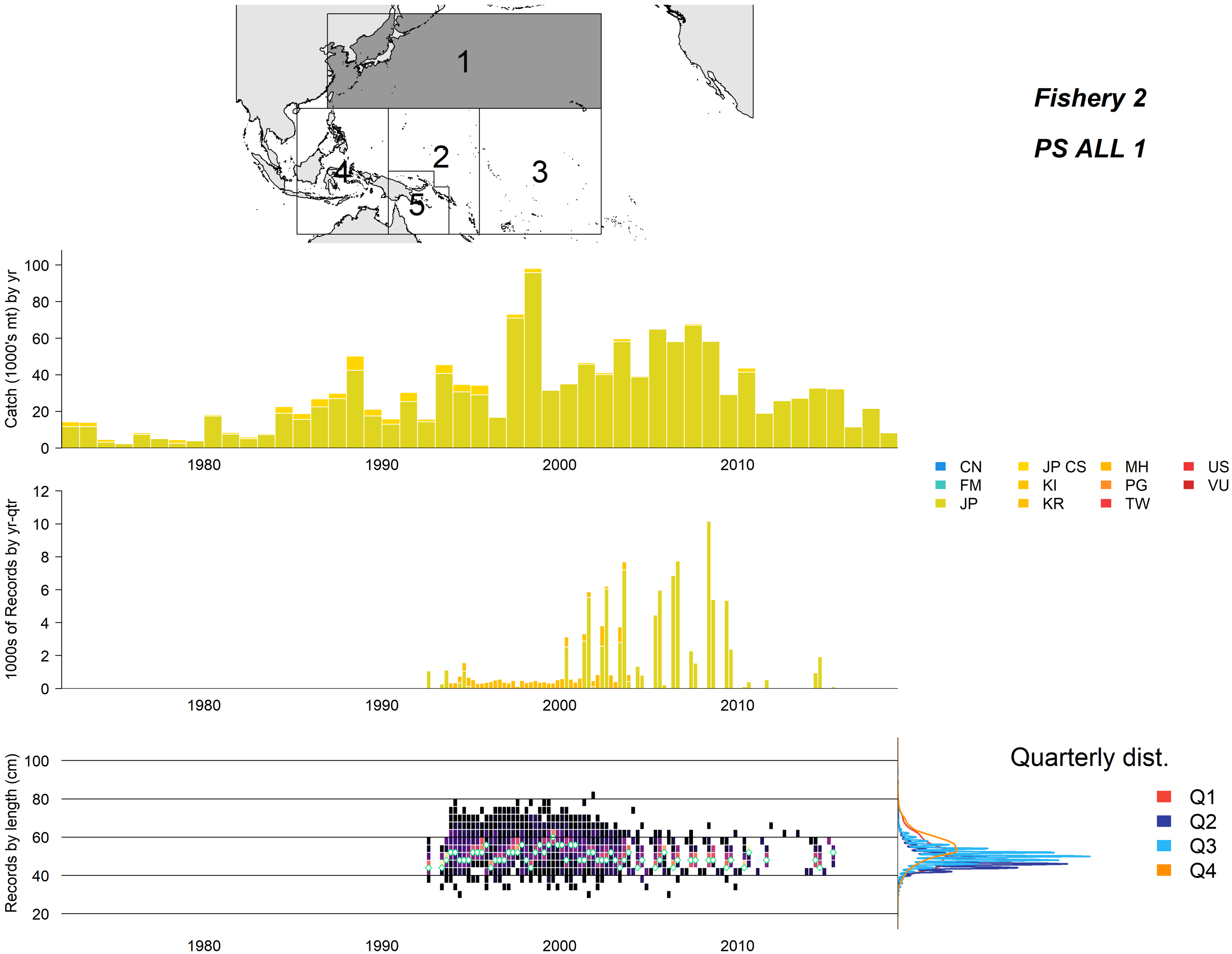


Figure 12: Same as Figure 11, except for fishery 2 of the 5 region spatial structure.

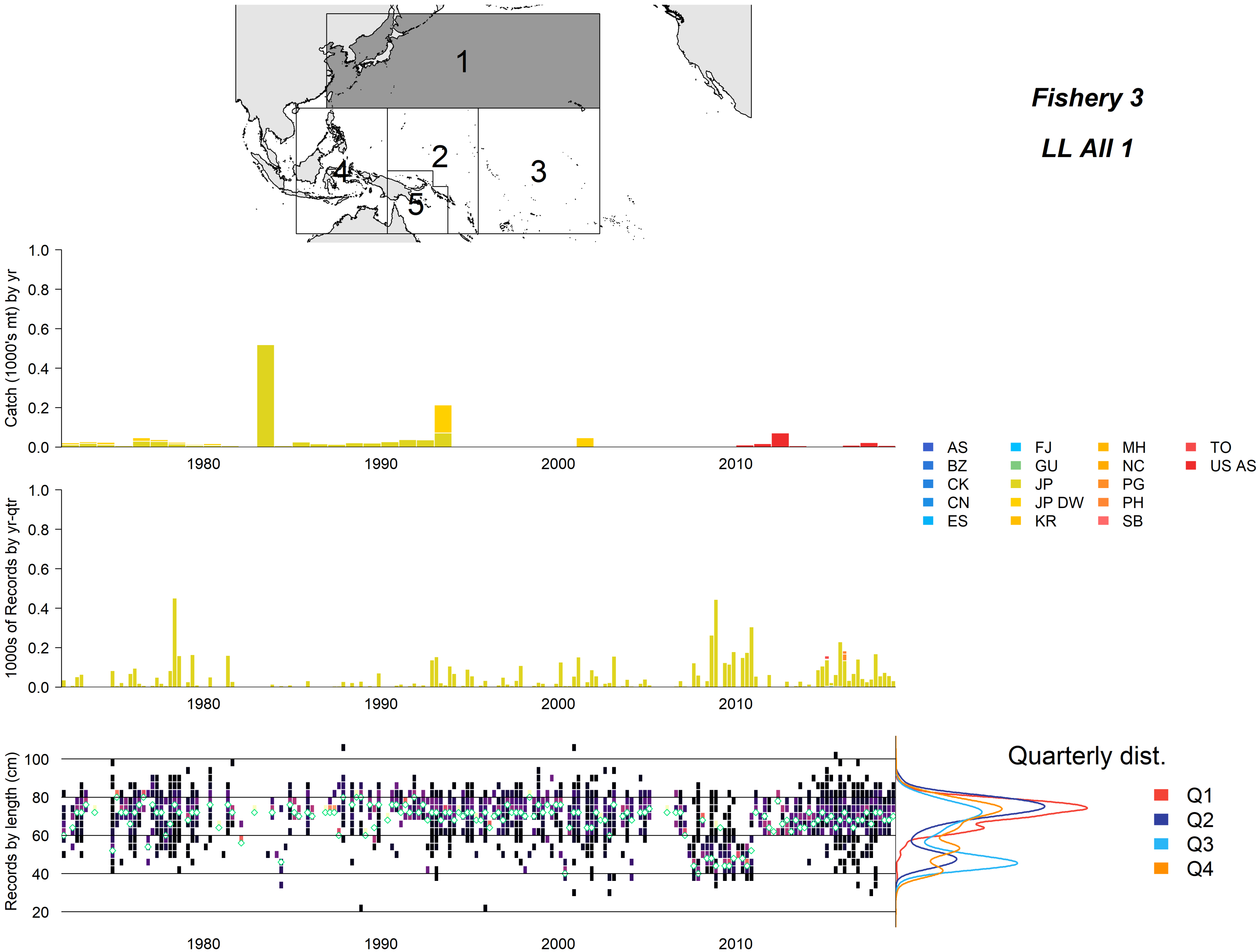


Figure 13: Same as Figure 11, except for fishery 3 of the 5 region spatial structure.

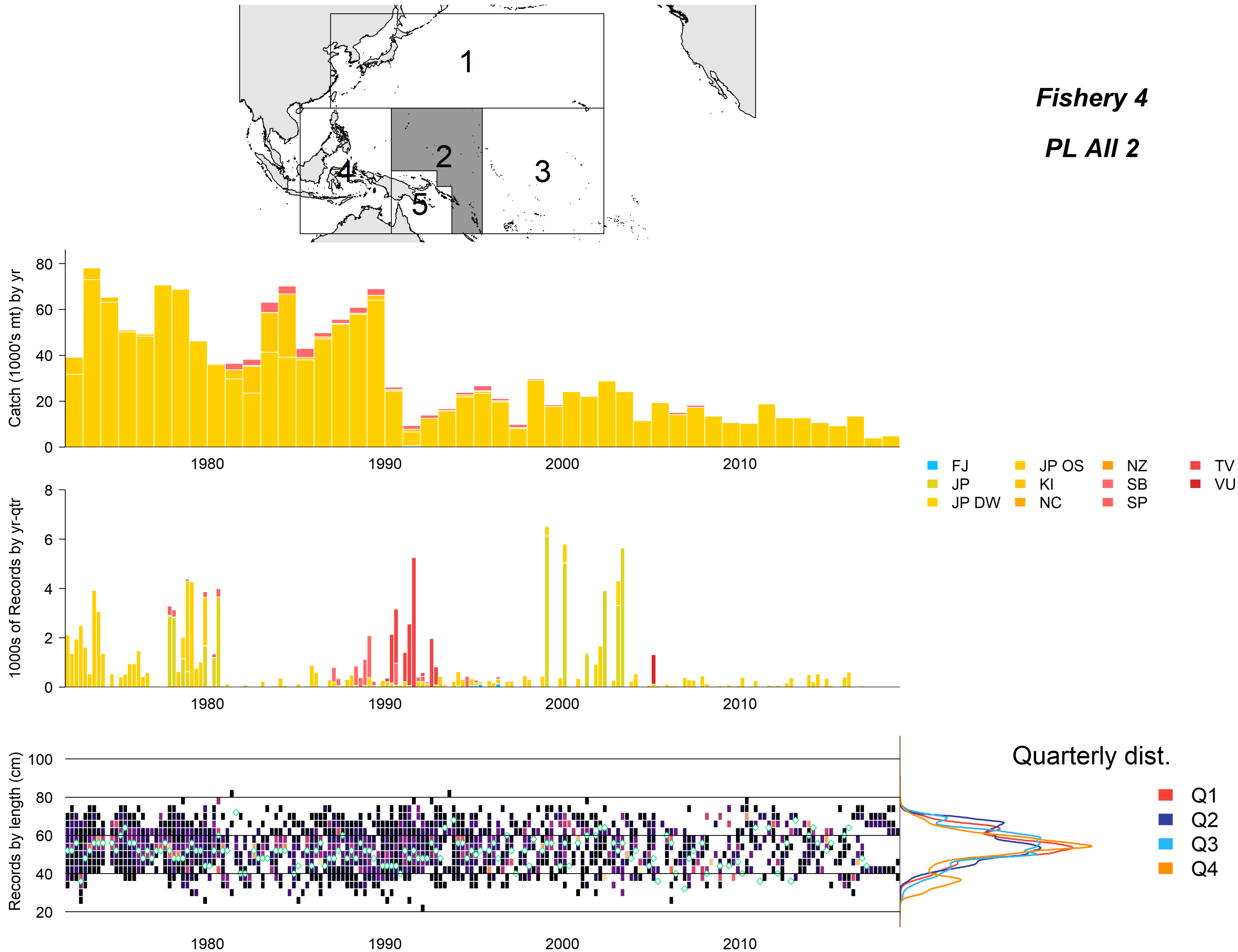


Figure 14: Same as Figure 11, except for fishery 4 of the 5 region spatial structure.

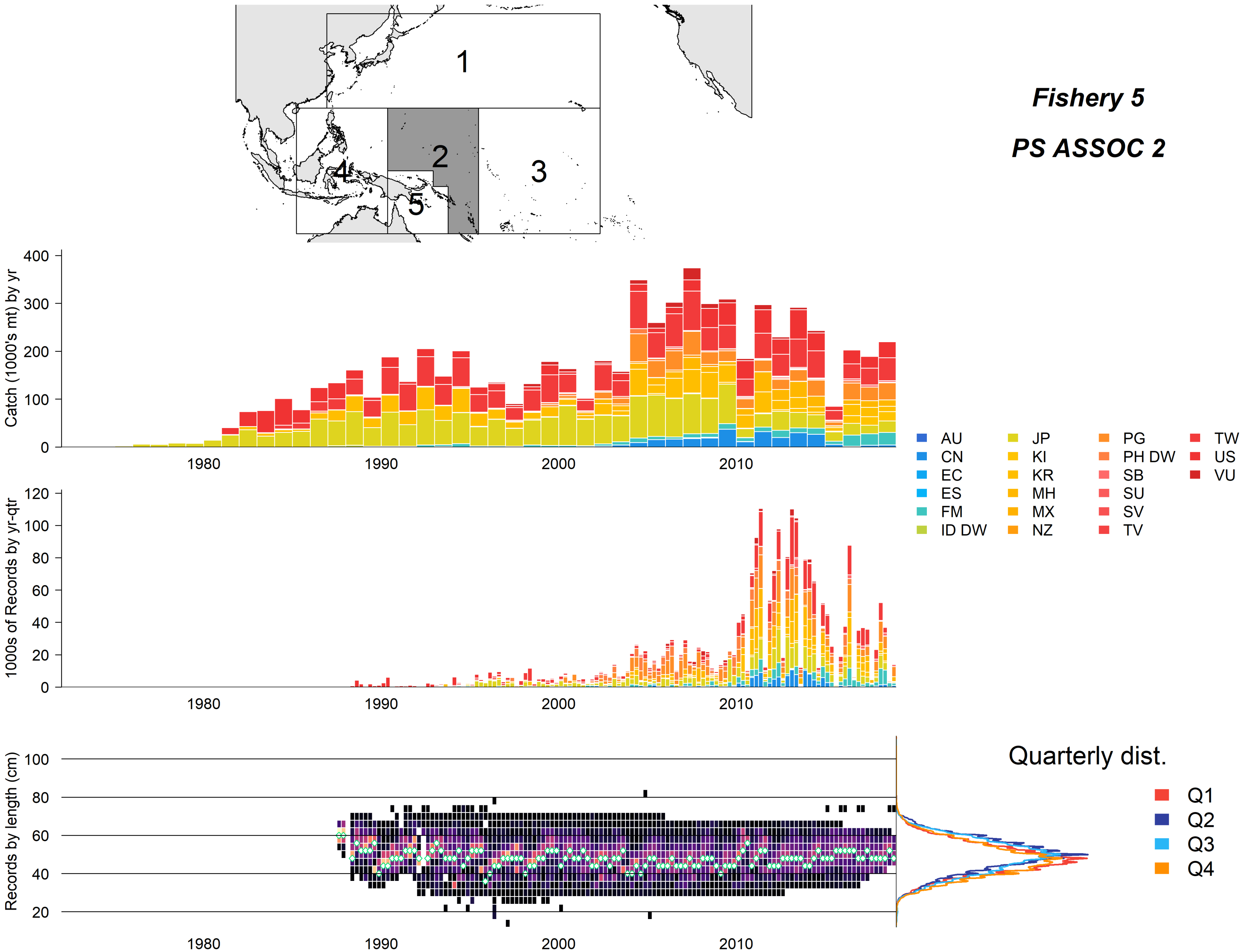


Figure 15: Same as Figure 11, except for fishery 5 of the 5 region spatial structure.

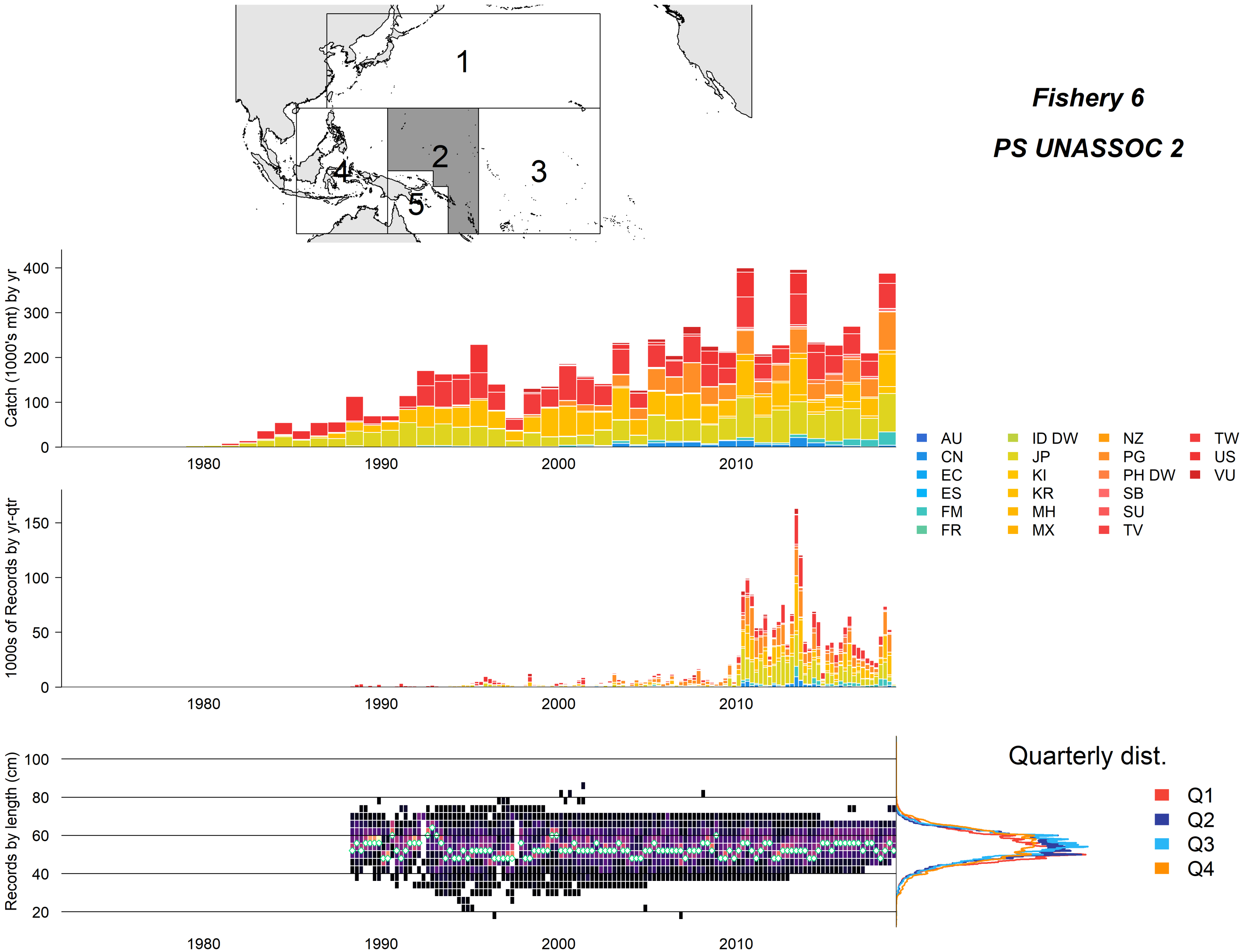


Figure 16: Same as Figure 11, except for fishery 6 of the 5 region spatial structure.

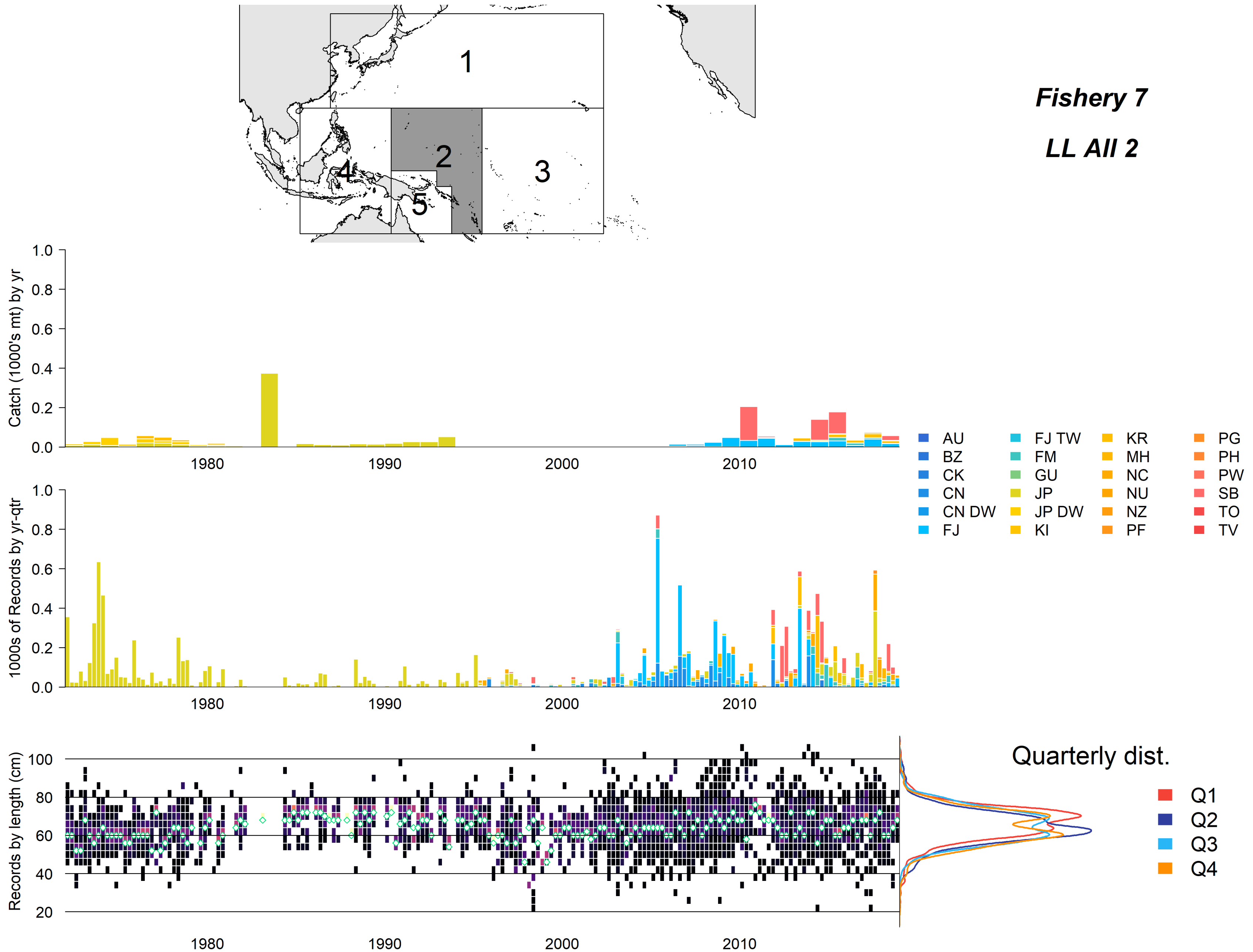


Figure 17: Same as Figure 11, except for fishery 7 of the 5 region spatial structure.

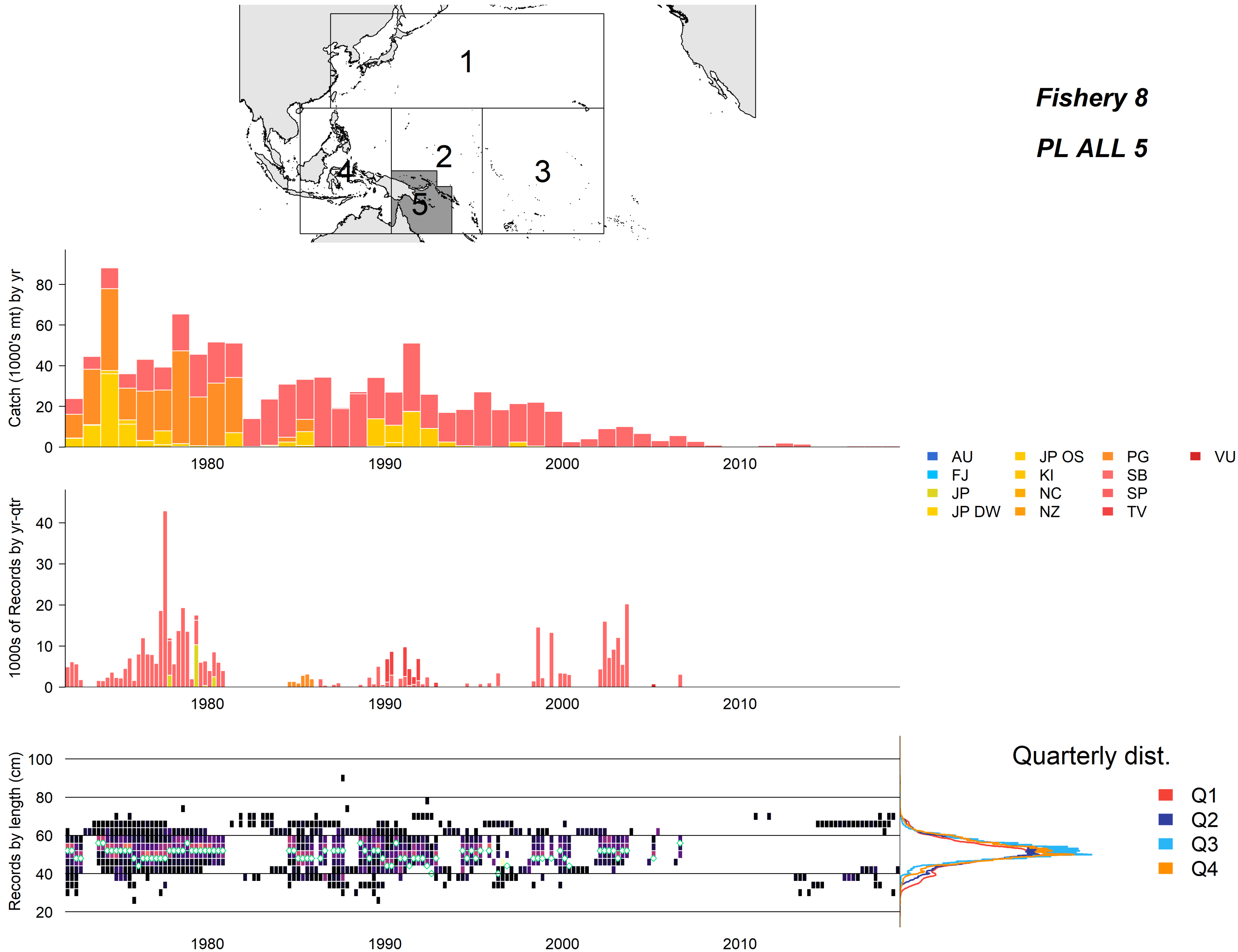


Figure 18: Same as Figure 11, except for fishery 8 of the 5 region spatial structure.

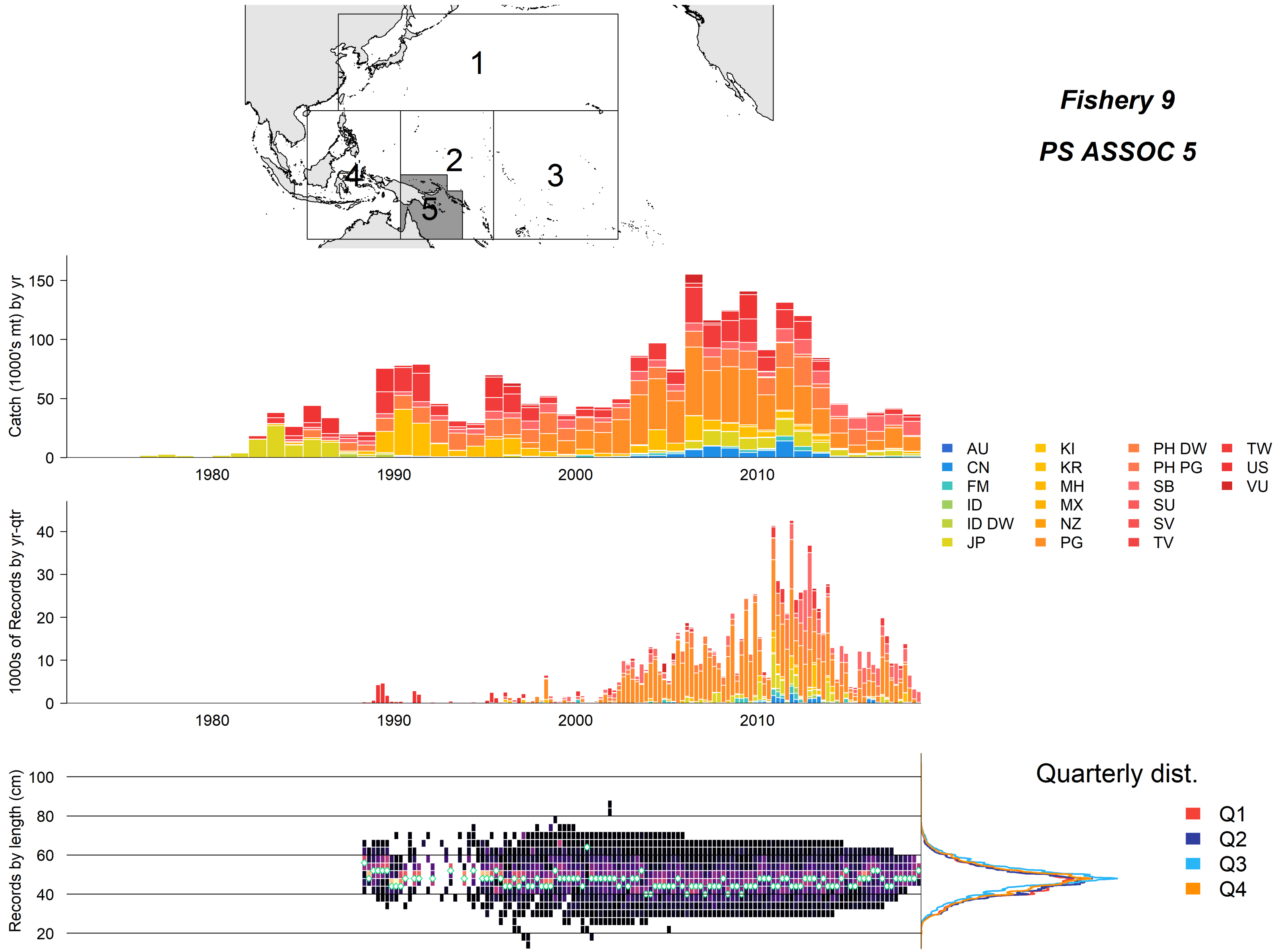


Figure 19: Same as Figure 11, except for fishery 9 of the 5 region spatial structure.

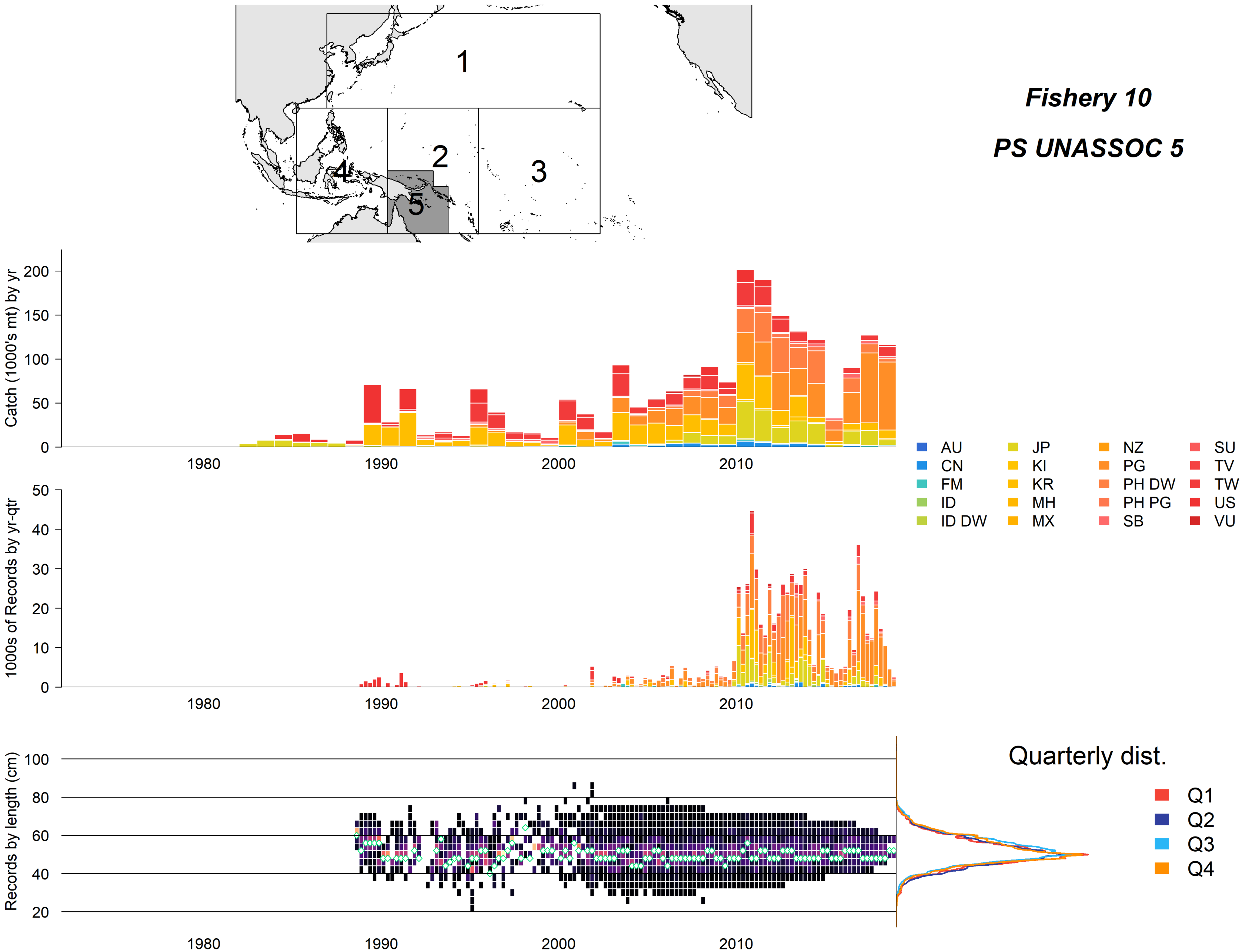


Figure 20: Same as Figure 11, except for fishery 10 of the 5 region spatial structure.

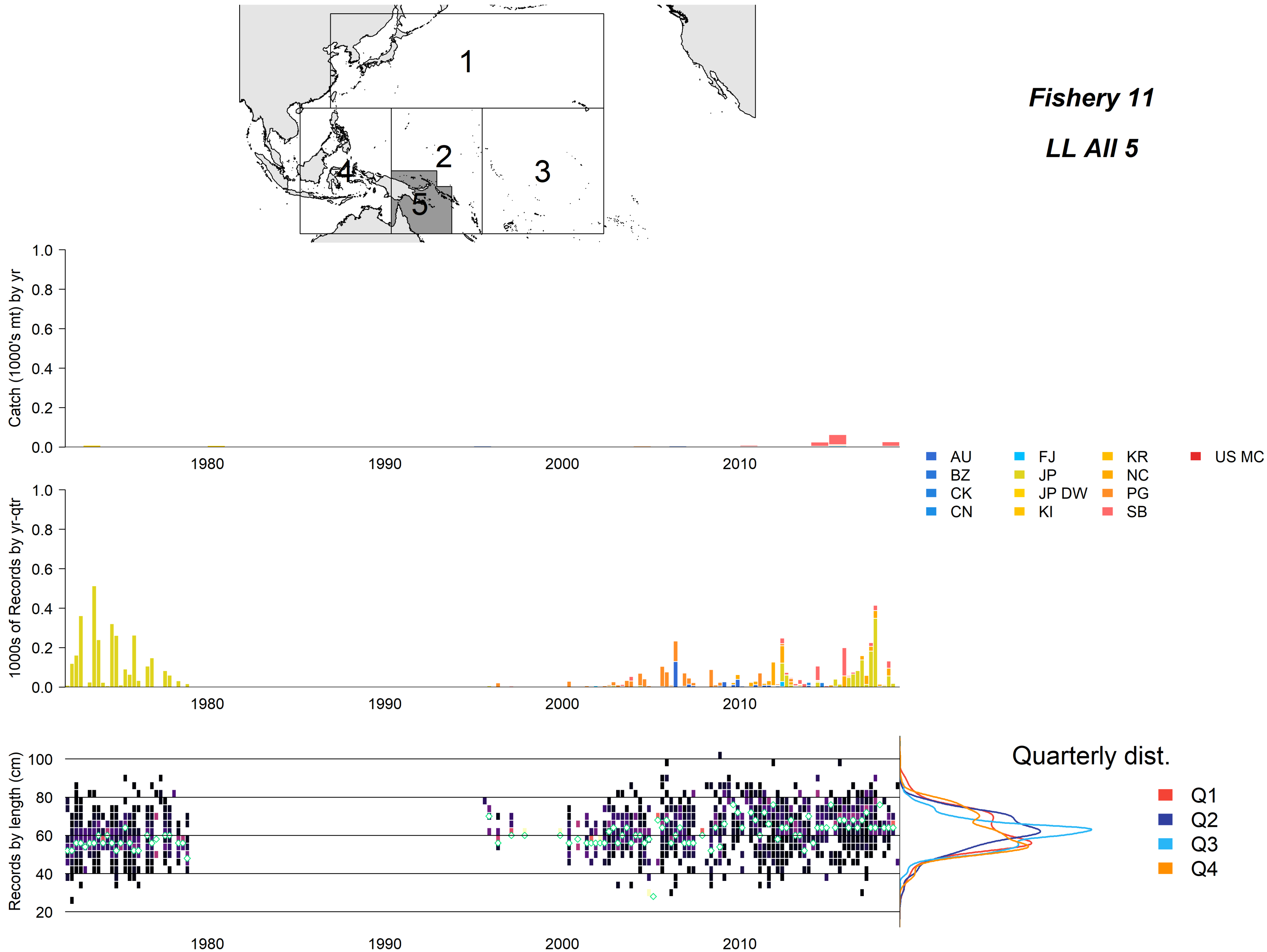


Figure 21: Same as Figure 11, except for fishery 11 of the 5 region spatial structure.

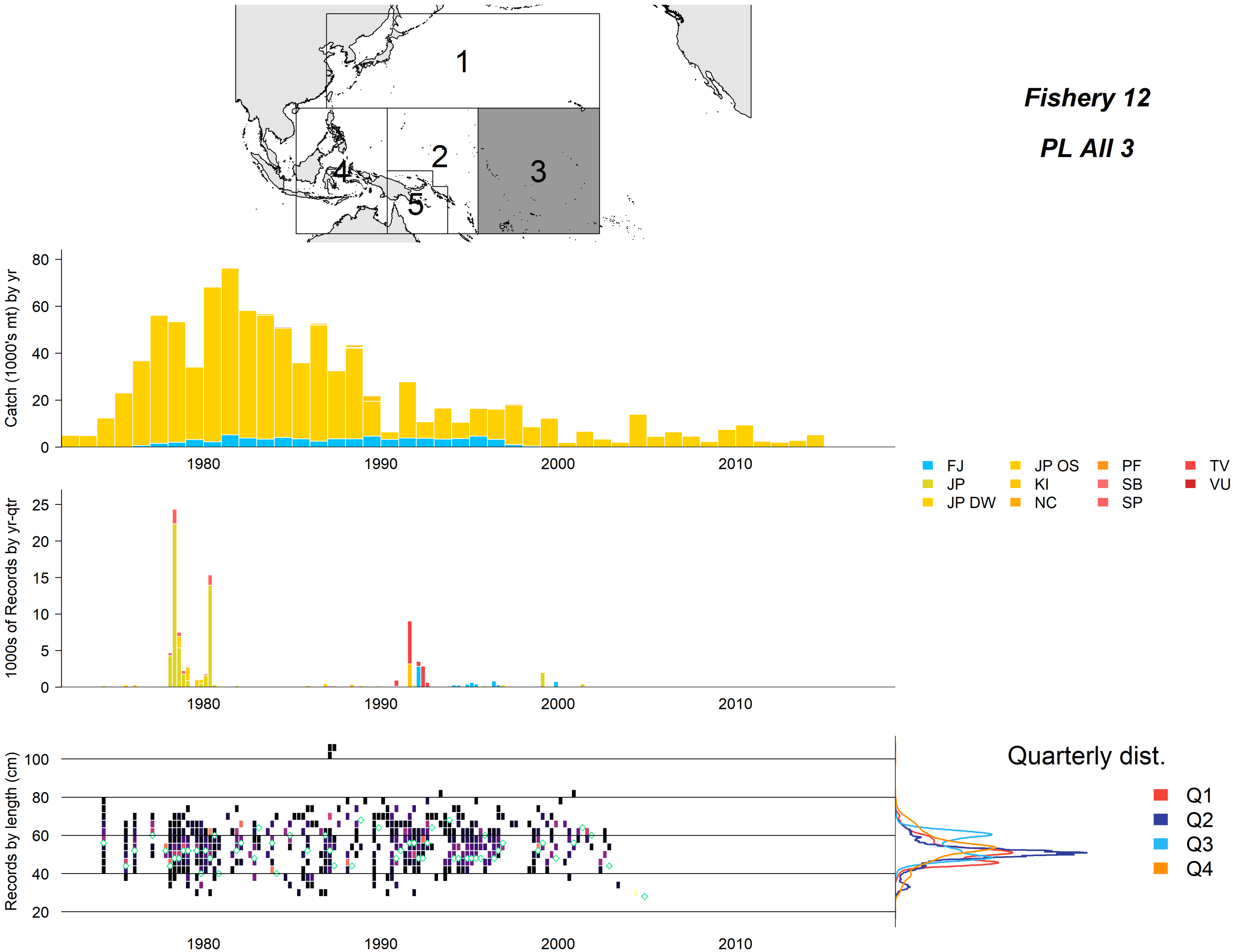


Figure 22: Same as Figure 11, except for fishery 12 of the 5 region spatial structure.

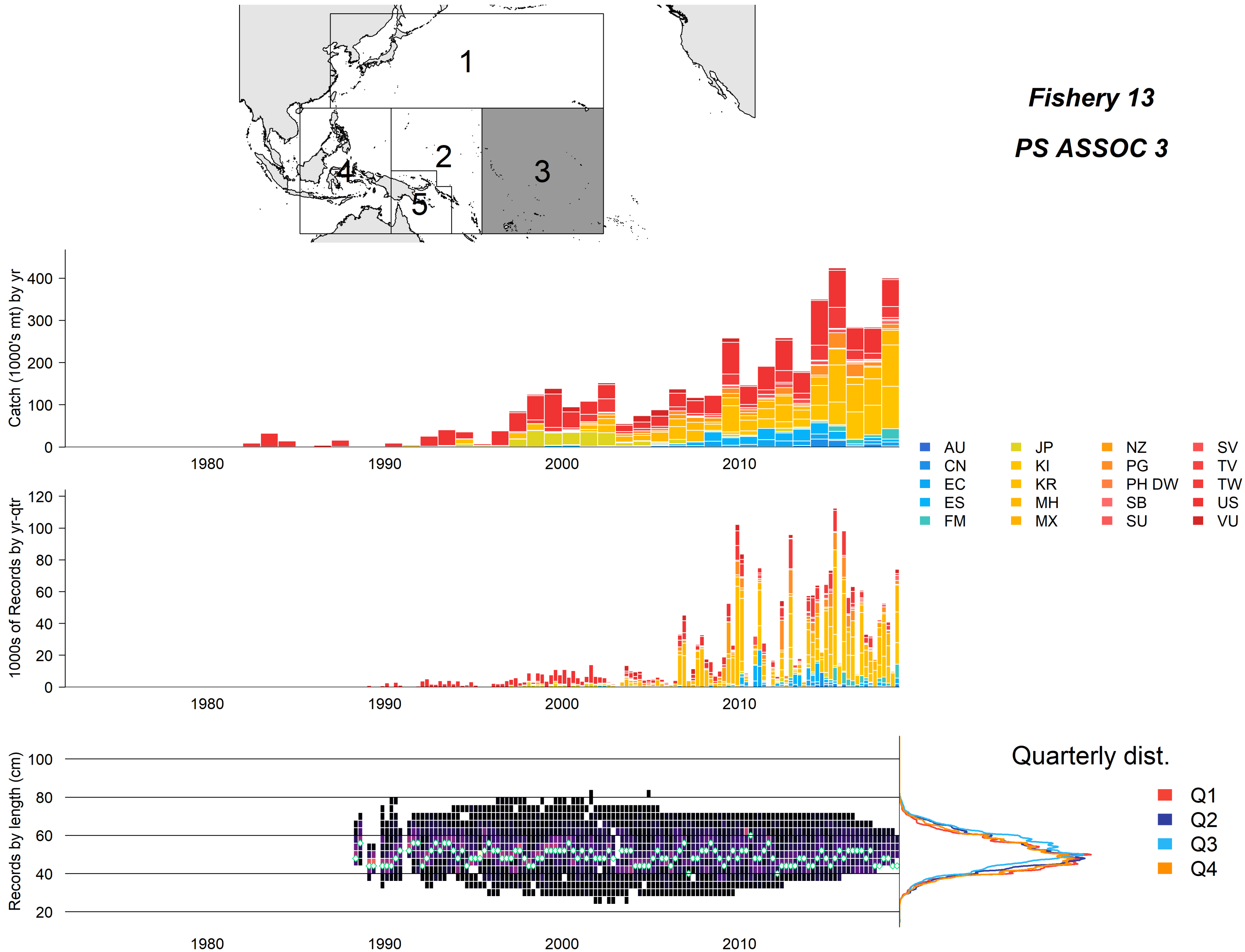


Figure 23: Same as Figure 11, except for fishery 13 of the 5 region spatial structure.

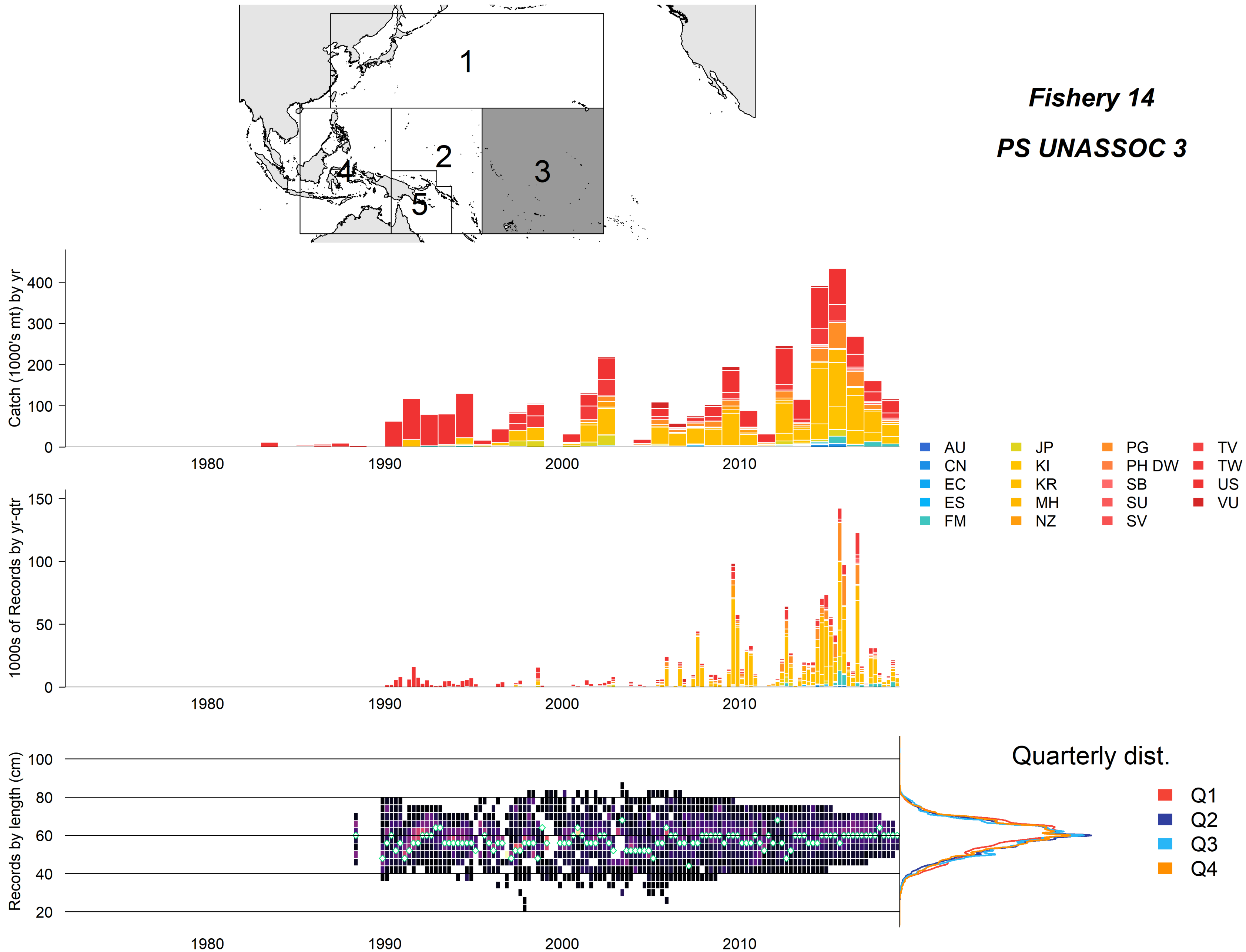


Figure 24: Same as Figure 11, except for fishery 14 of the 5 region spatial structure.

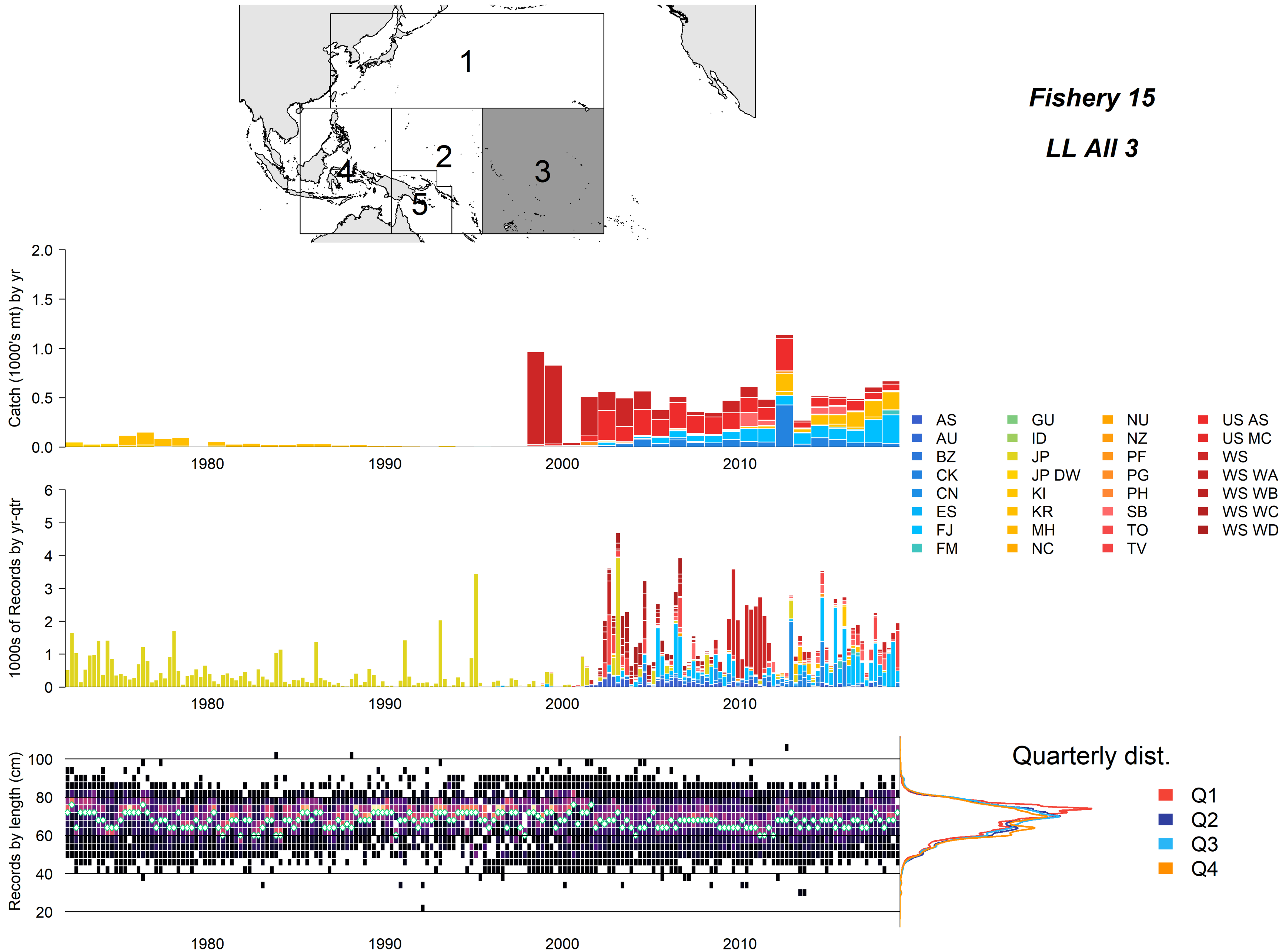


Figure 25: Same as Figure 11, except for fishery 15 of the 5 region spatial structure.

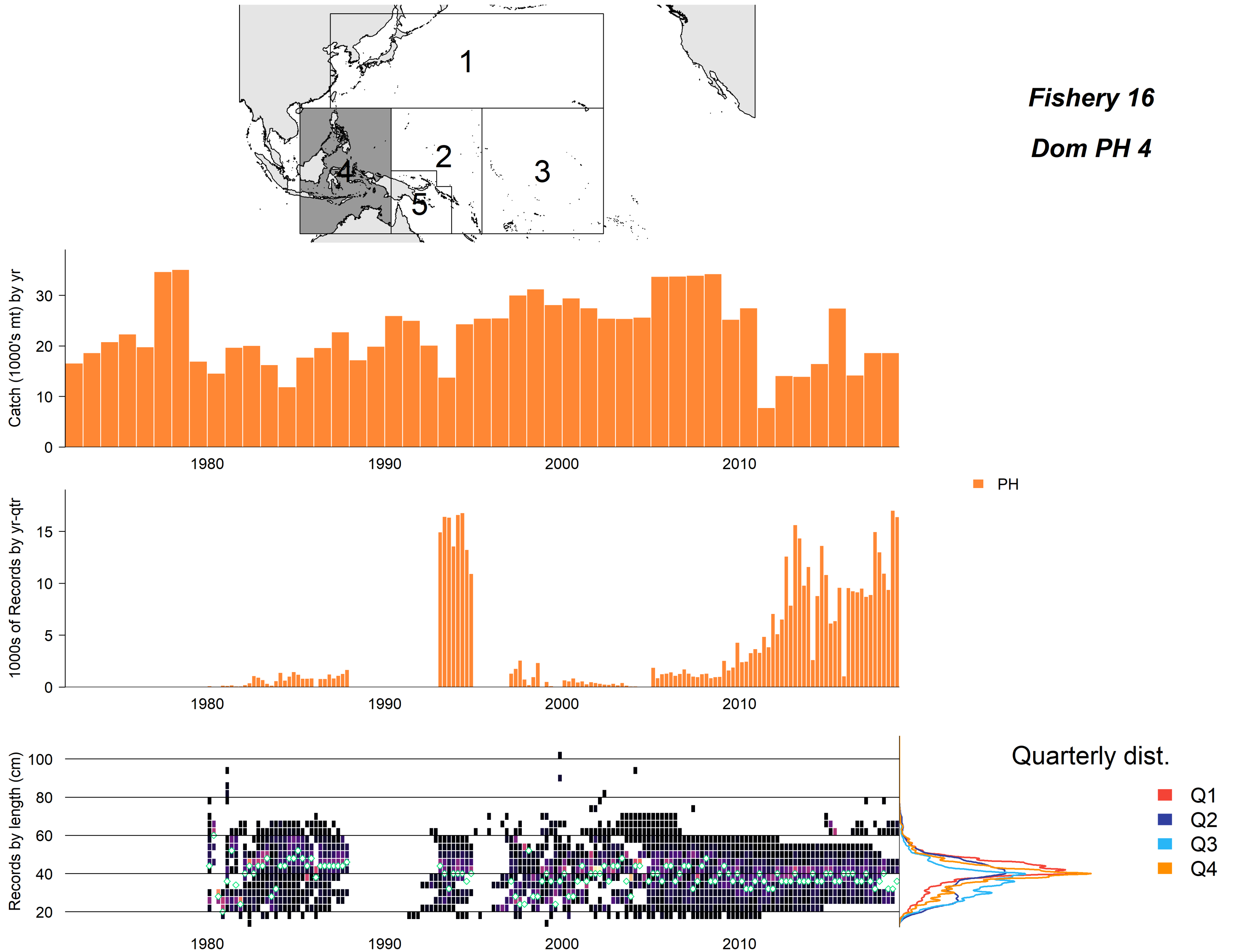


Figure 26: Same as Figure 11, except for fishery 16 of the 5 region spatial structure.

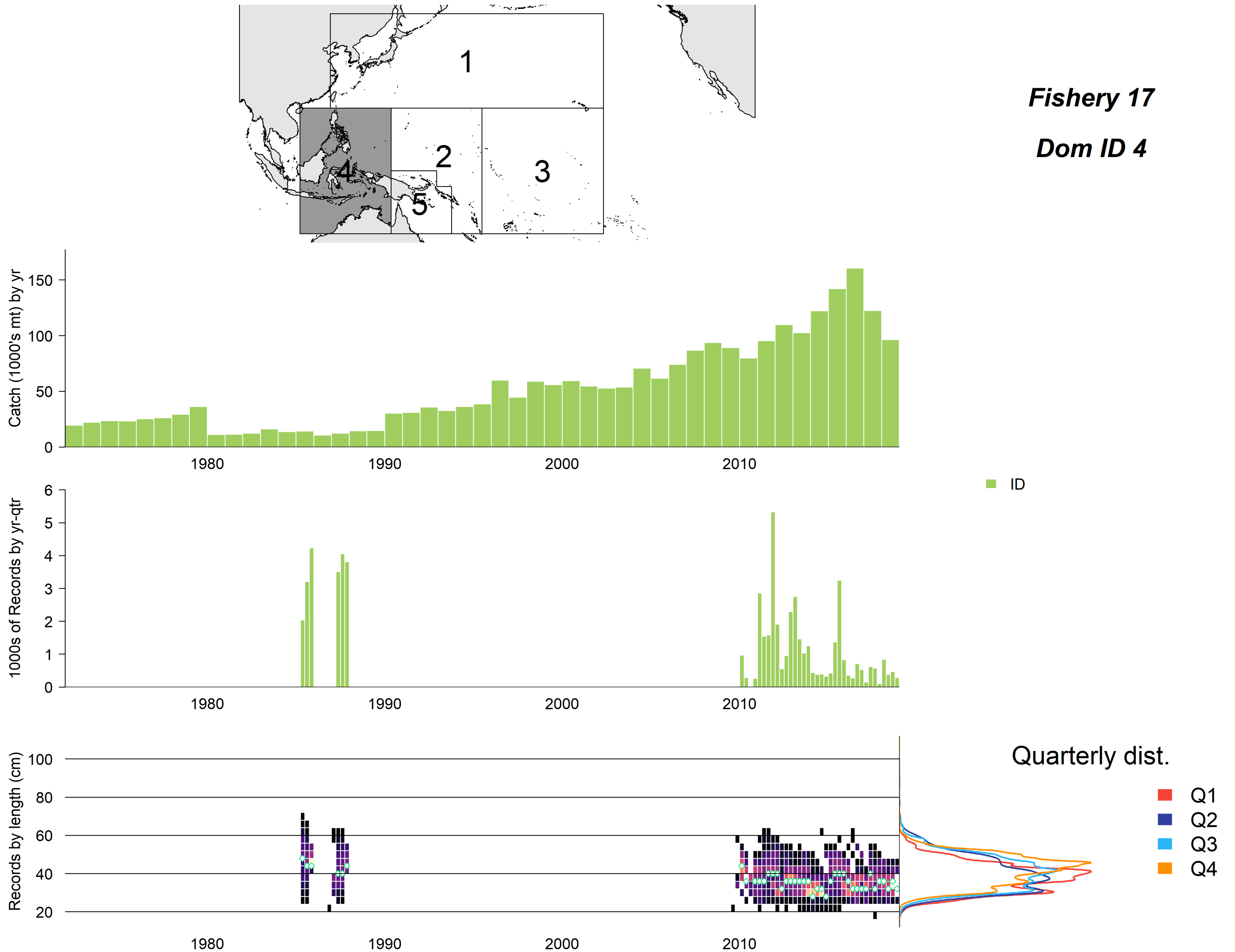


Figure 27: Same as Figure 11, except for fishery 17 of the 5 region spatial structure.

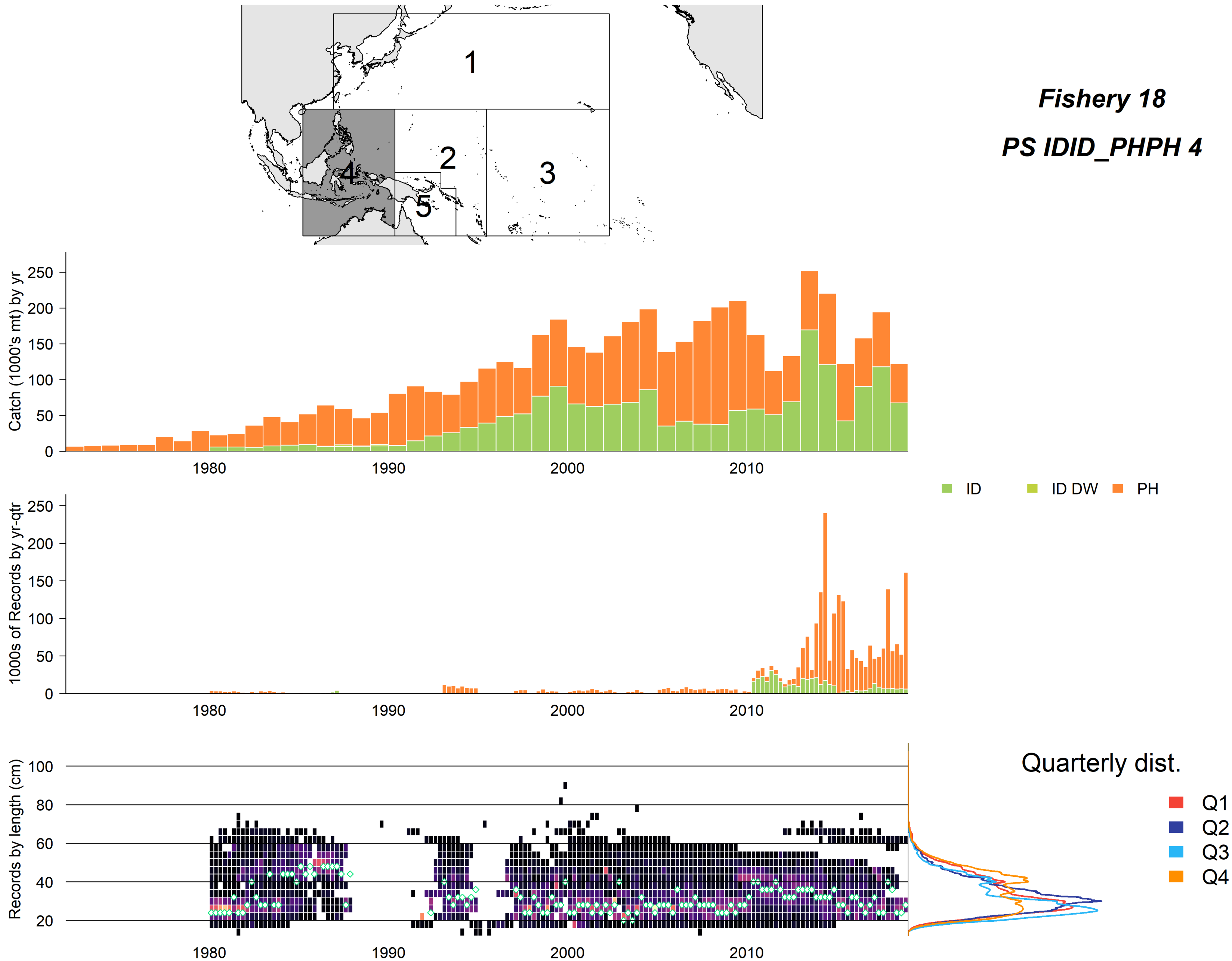


Figure 28: Same as Figure 11, except for fishery 18 of the 5 region spatial structure.

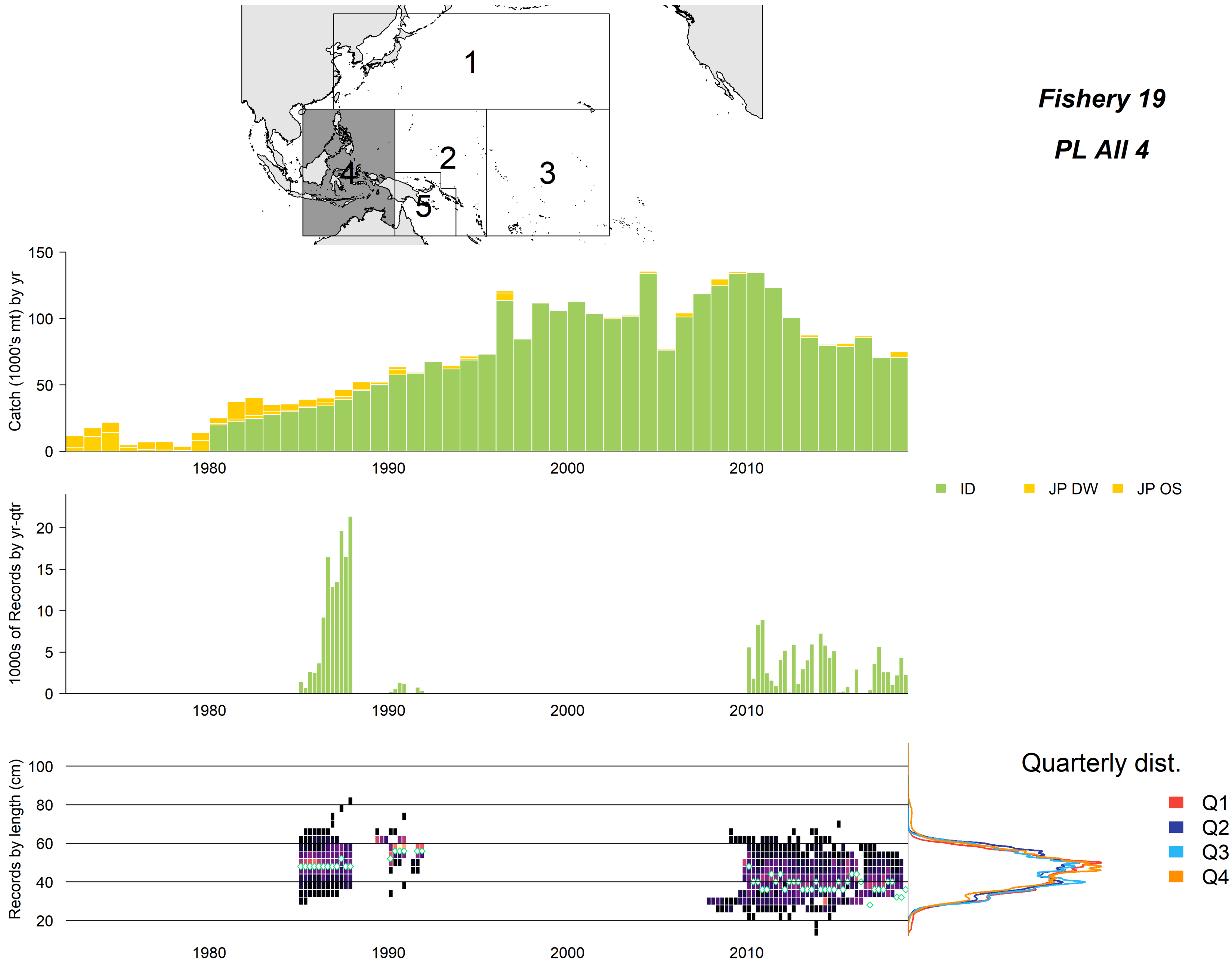


Figure 29: Same as Figure 11, except for fishery 19 of the 5 region spatial structure.

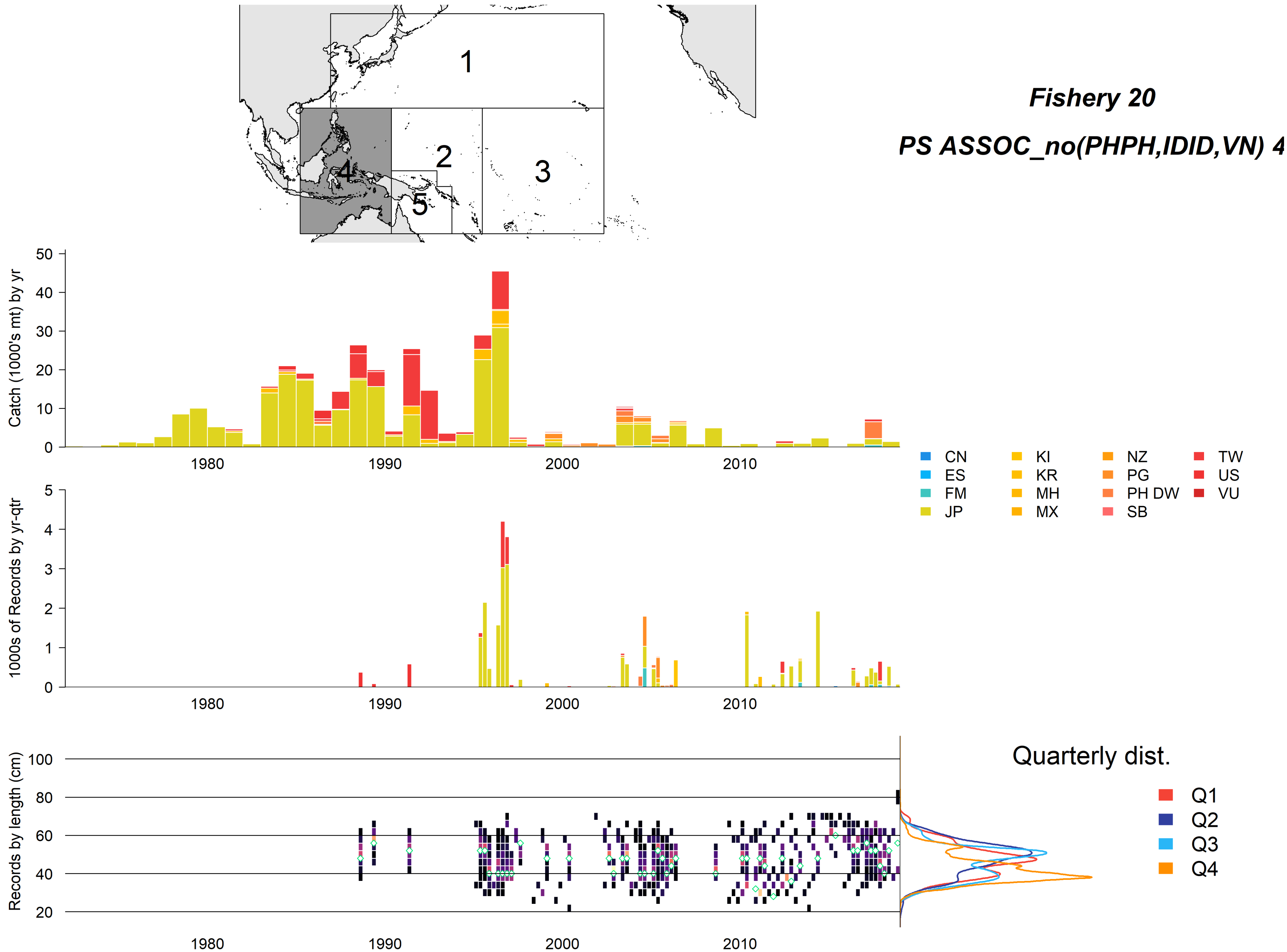


Figure 30: Same as Figure 11, except for fishery 20 of the 5 region spatial structure.

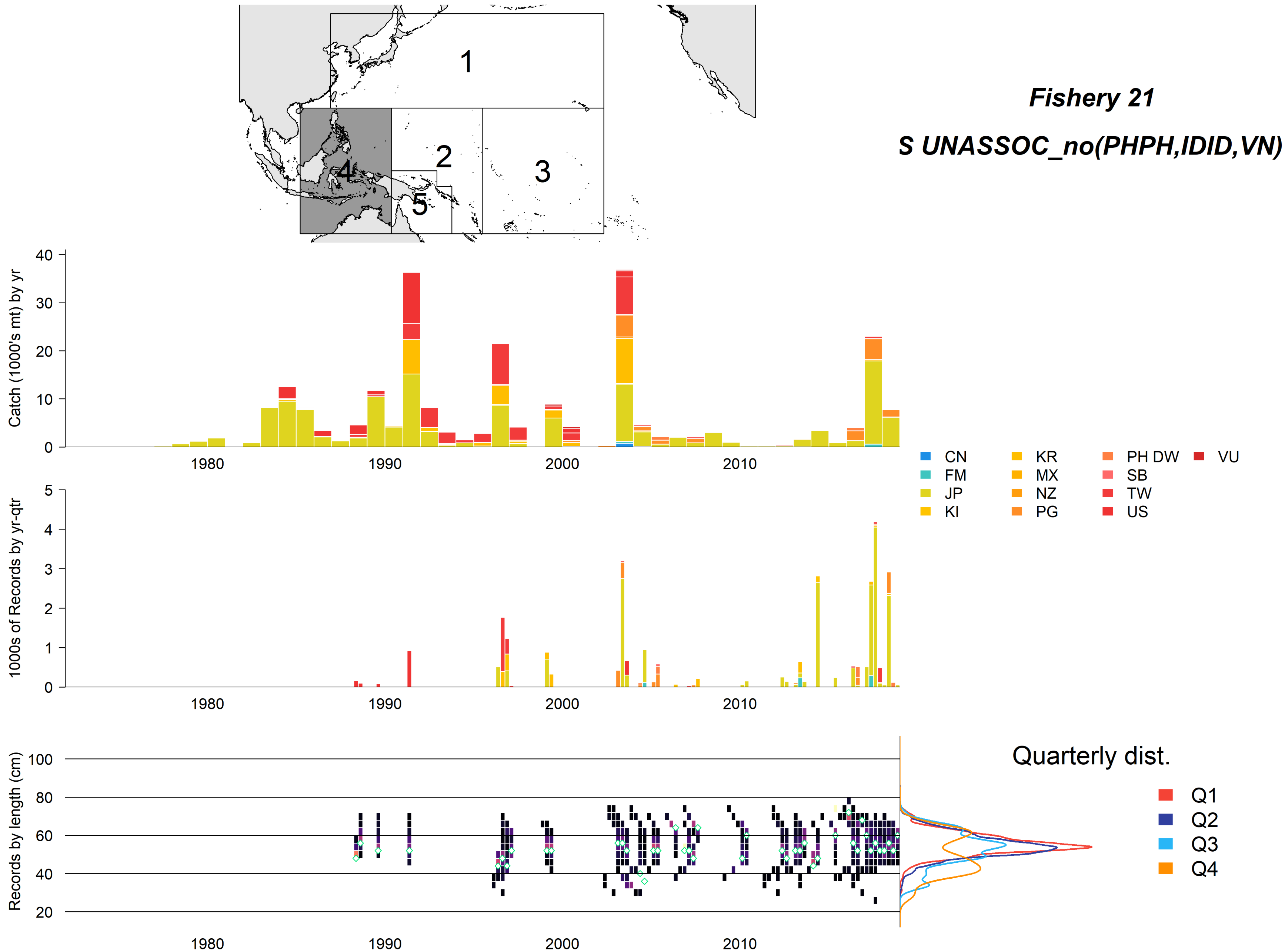


Figure 31: Same as Figure 11, except for fishery 21 of the 5 region spatial structure.

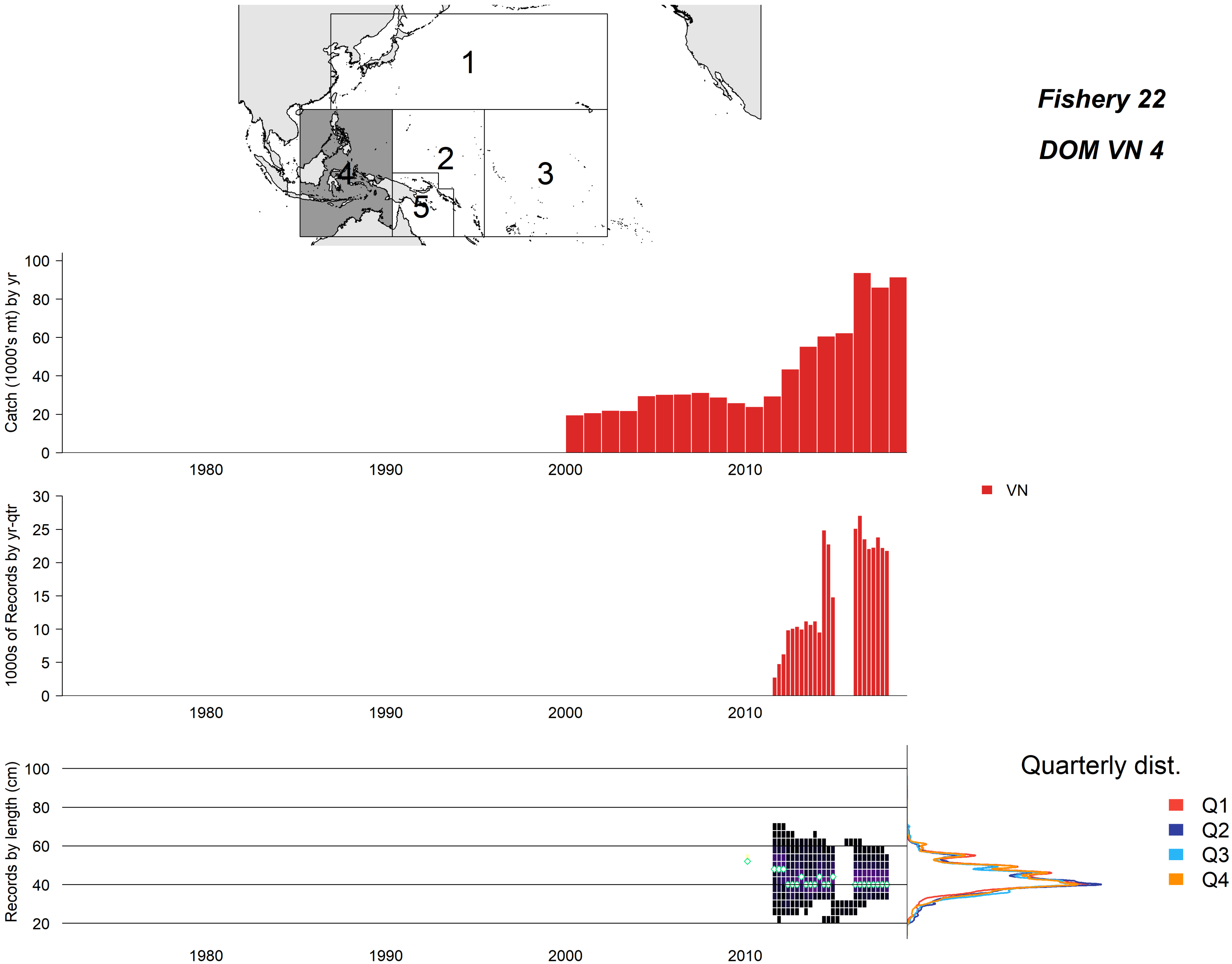


Figure 32: Same as Figure 11, except for fishery 22 of the 5 region spatial structure.

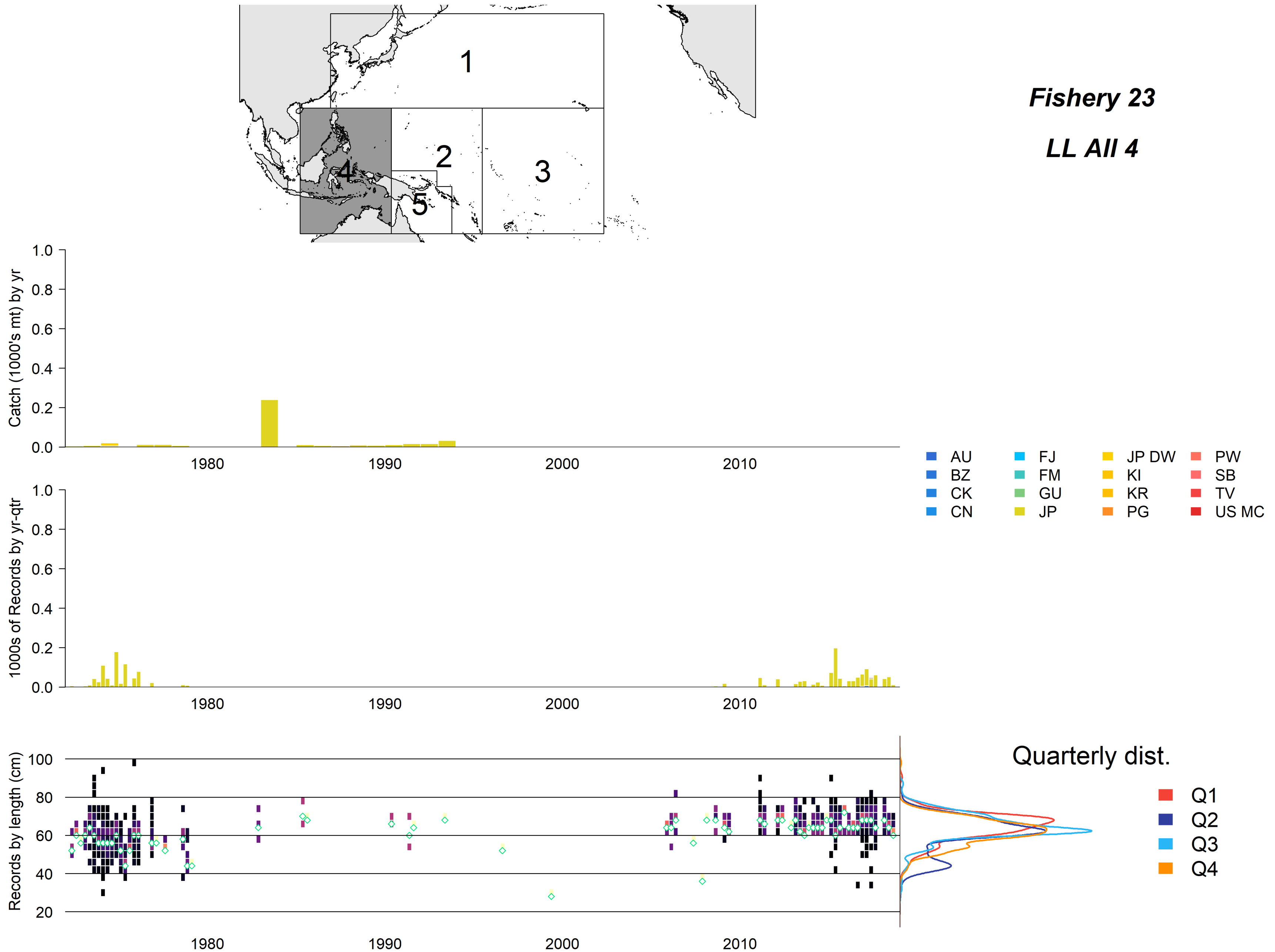


Figure 33: Same as Figure 11, except for fishery 23 of the 5 region spatial structure.

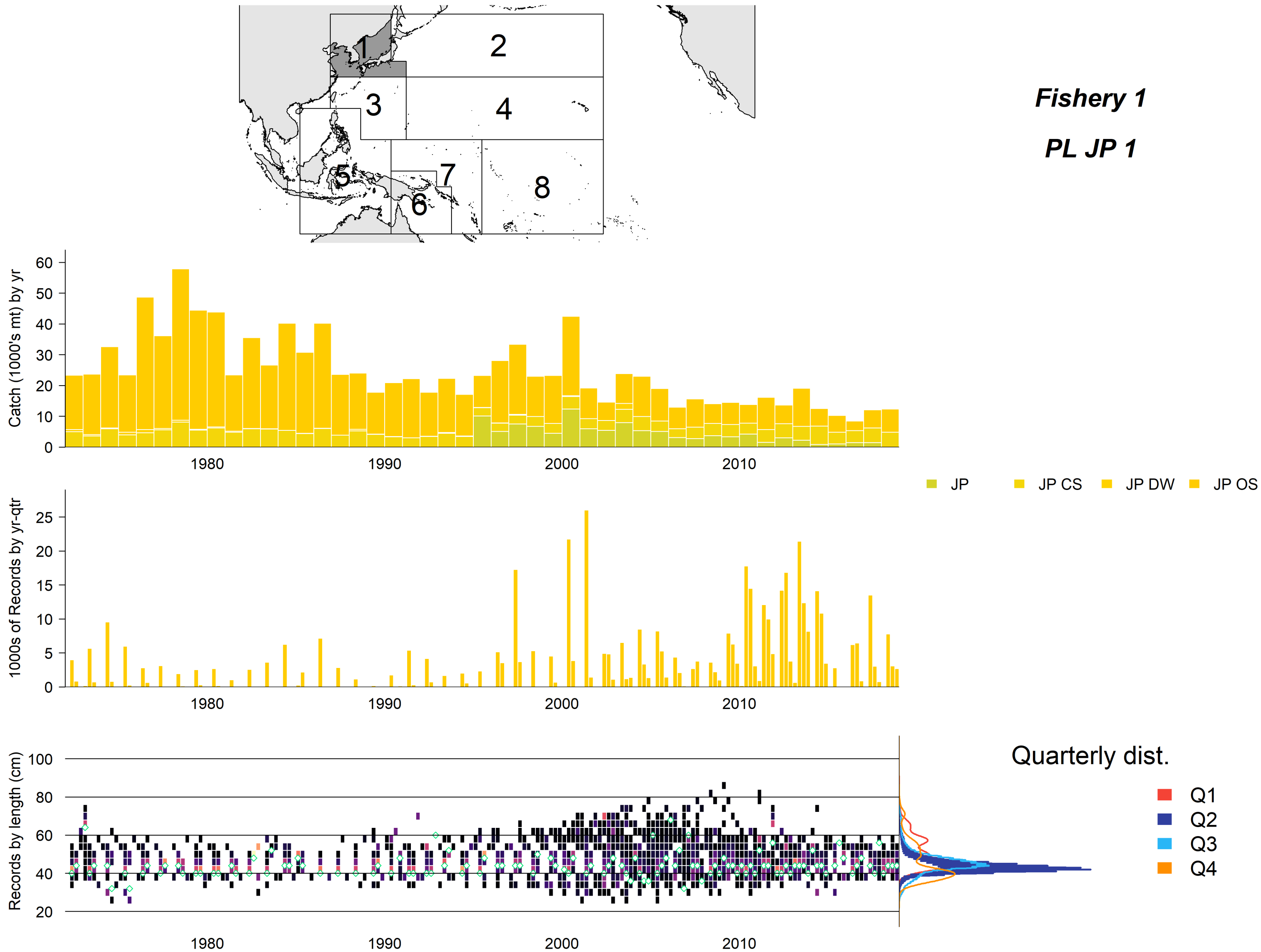


Figure 34: Summary of raw data available for fishery 1 in the 8 region structure. The top right panel displays the fishery number and name, while the top left panel highlights the region of occurrence. The middle two plots show the annual catch in thousands of metric tons per year (middle top) and the number of measured fish lengths in thousands of fish per year quarter (middle bottom) with the legend associated with both plots to the right. The bottom left panel displays a tile plot of the proportion of measured fish in each 2 cm length bin by year quarter, where the lighter colors indicate higher proportions and the median is indicated by the white diamond with a green border. The bottom right panel displays the density of length samples within each bin for each quarter.

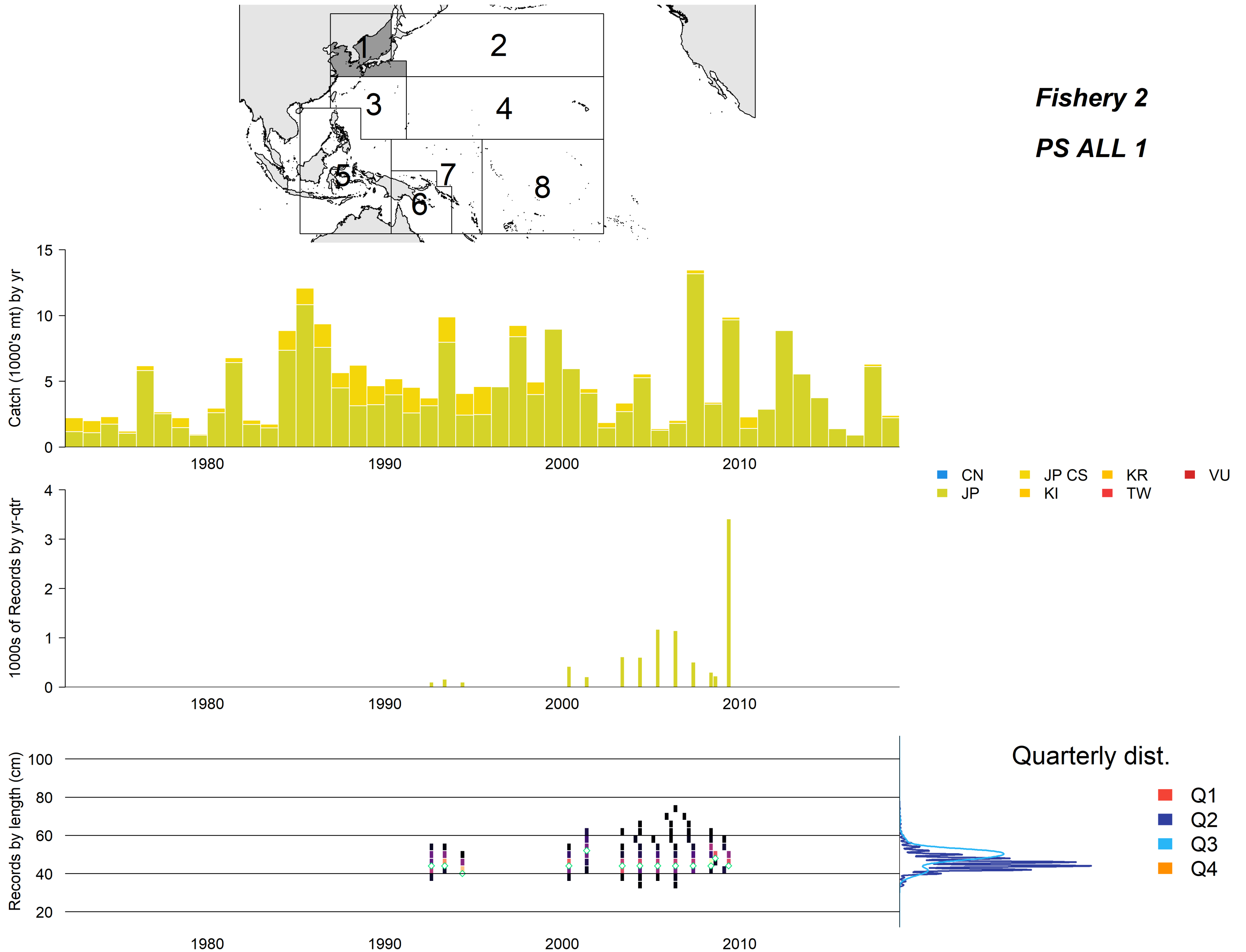


Figure 35: Same as Figure 34, except for fishery 2 of the 8 region spatial structure.

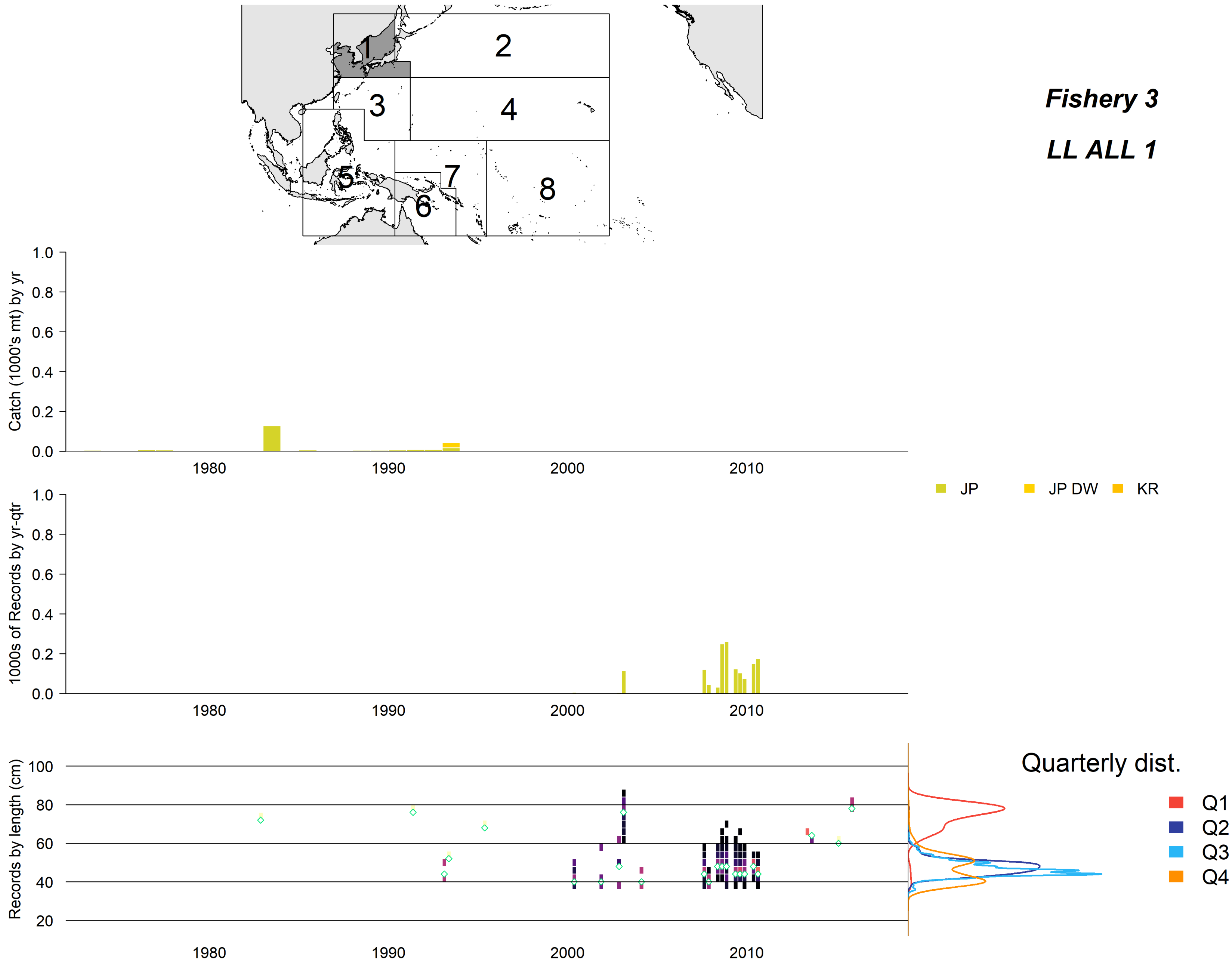


Figure 36: Same as Figure 34, except for fishery 3 of the 8 region spatial structure.

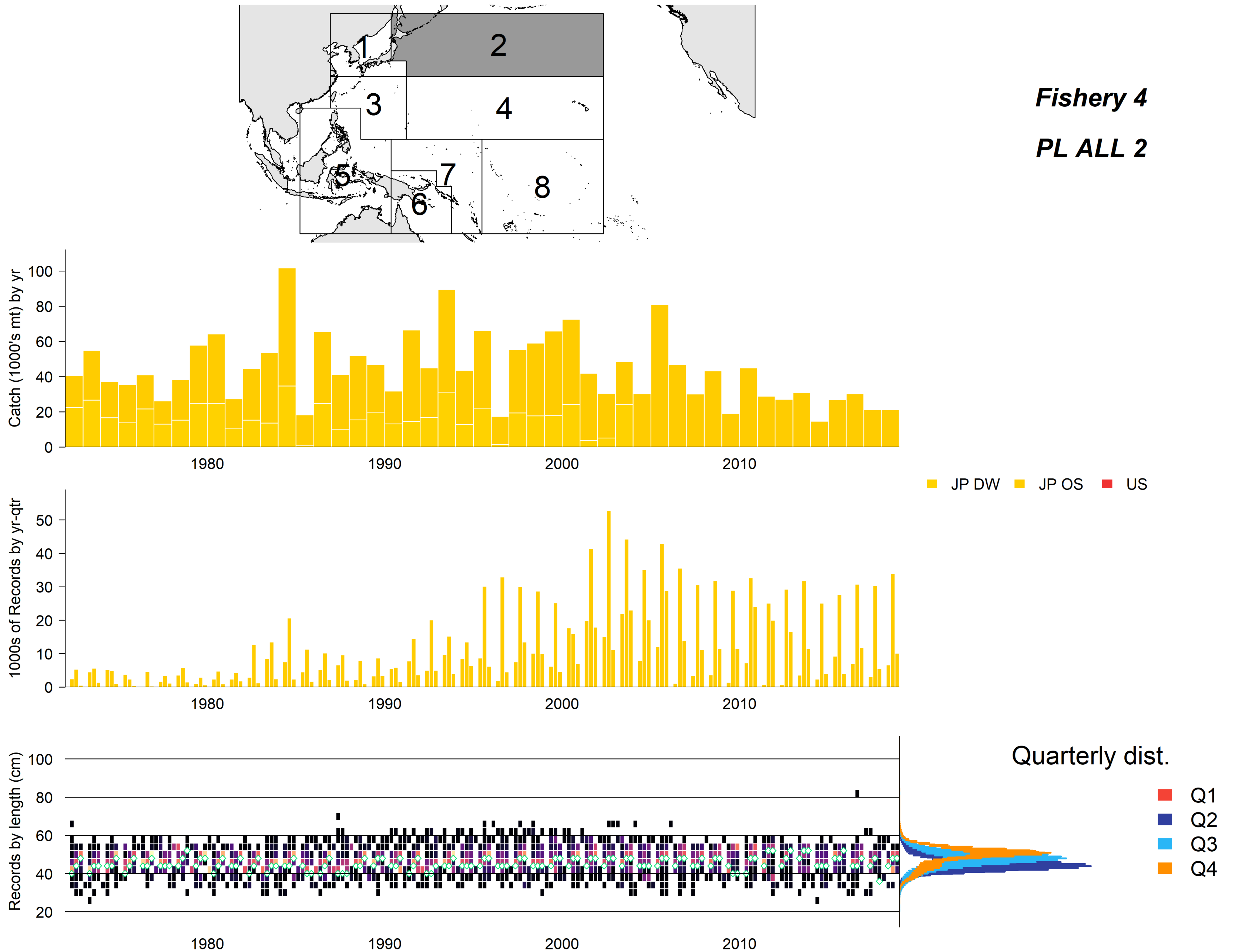


Figure 37: Same as Figure 34, except for fishery 4 of the 8 region spatial structure.

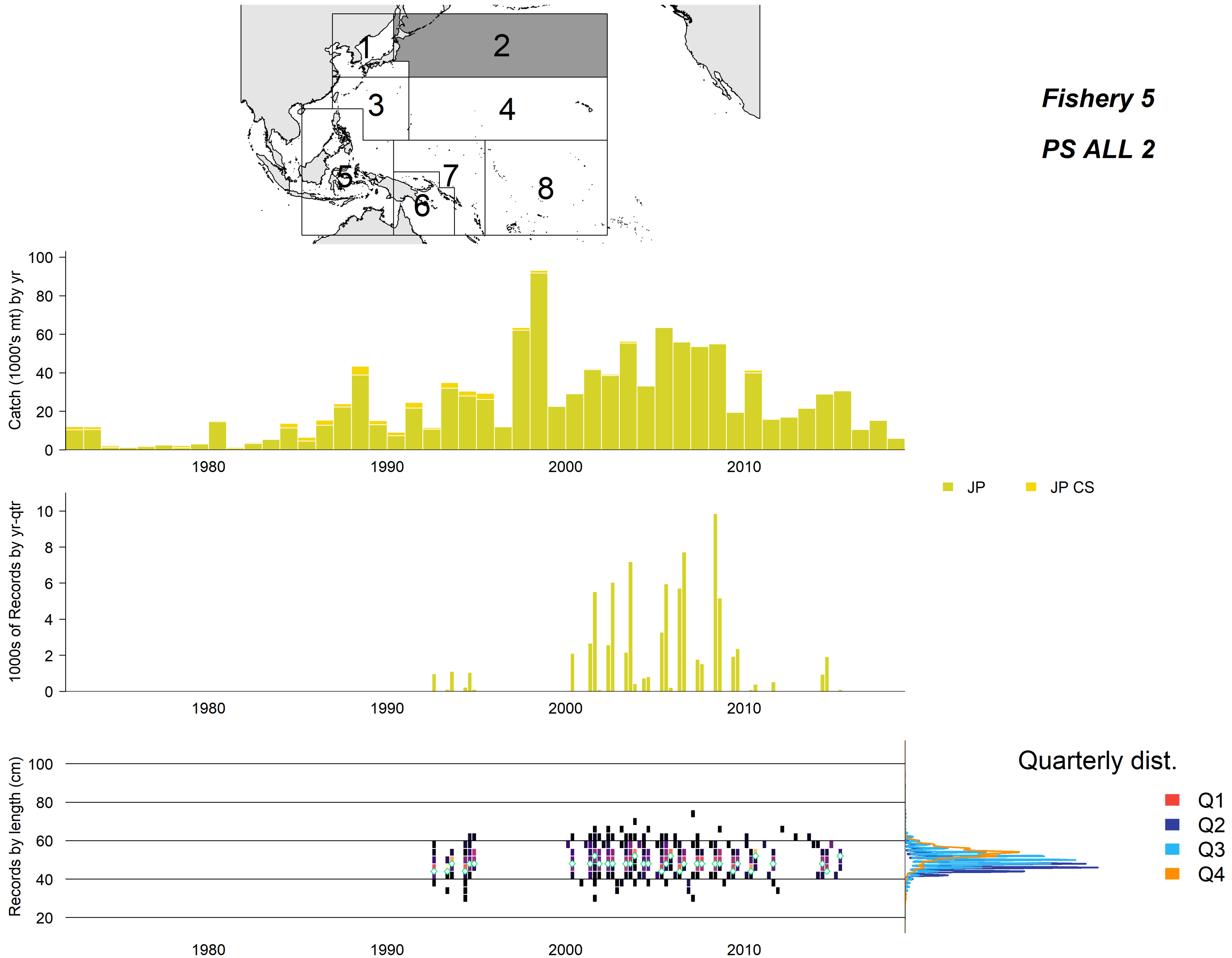


Figure 38: Same as Figure 34, except for fishery 5 of the 8 region spatial structure.

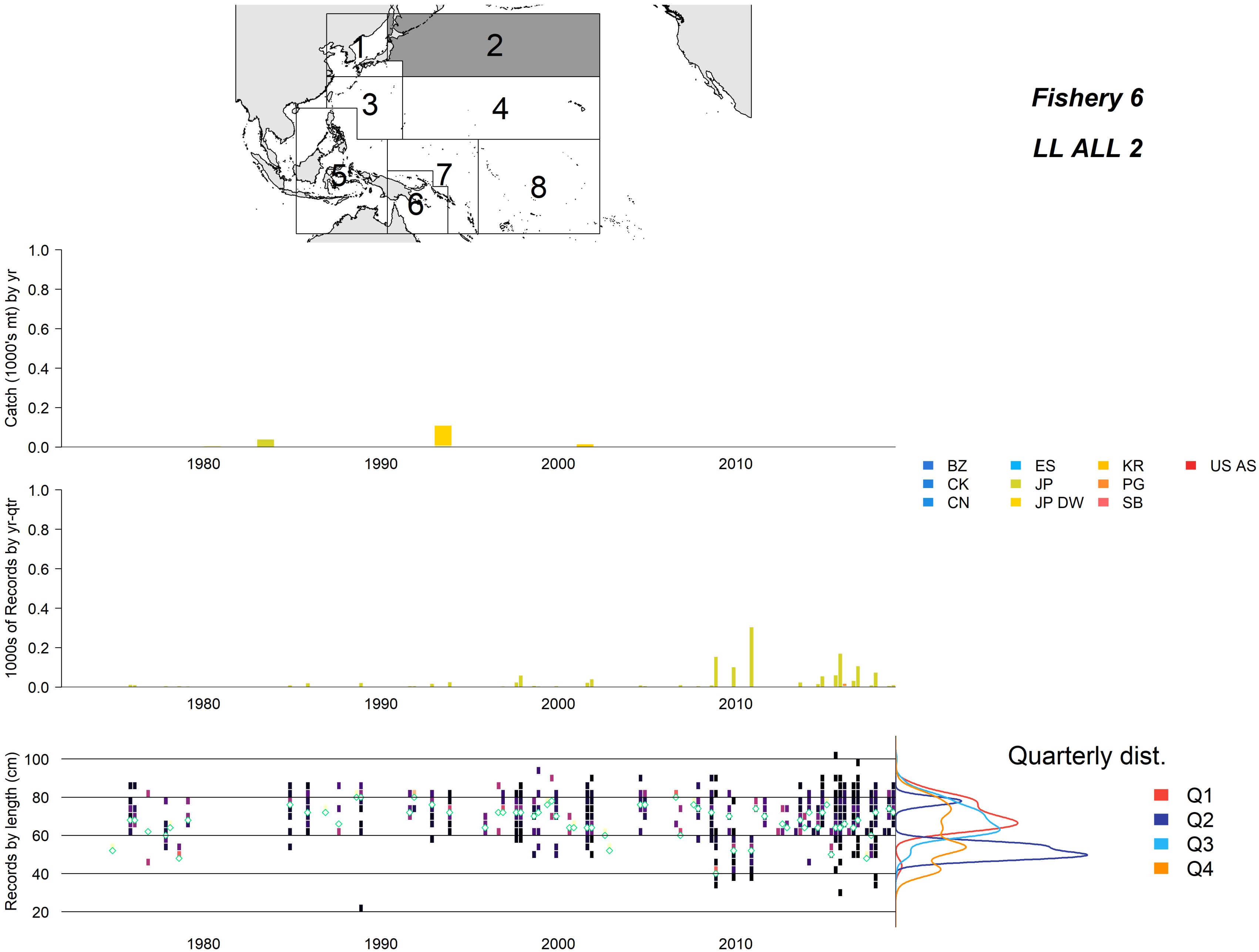


Figure 39: Same as Figure 34, except for fishery 6 of the 8 region spatial structure.

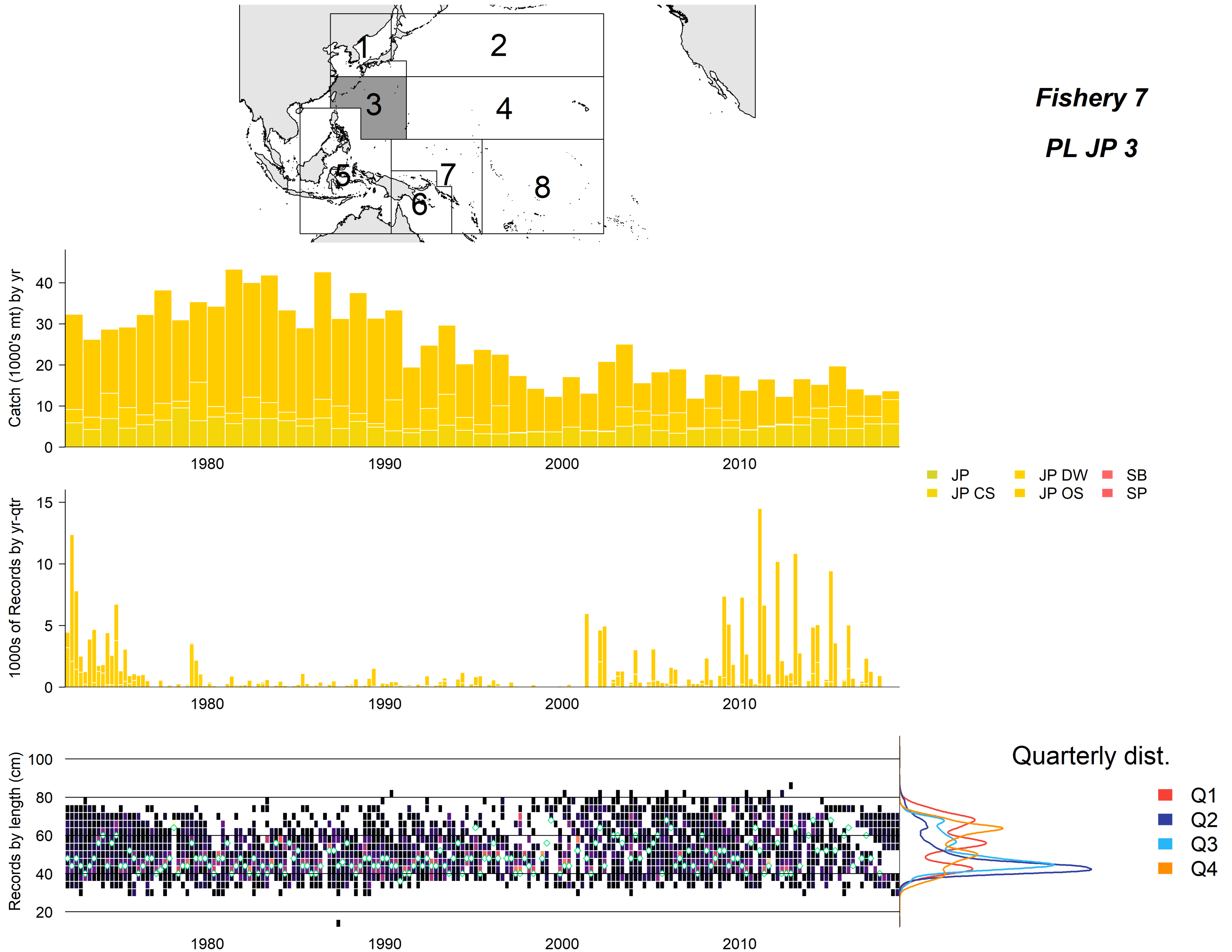


Figure 40: Same as Figure 34, except for fishery 7 of the 8 region spatial structure.

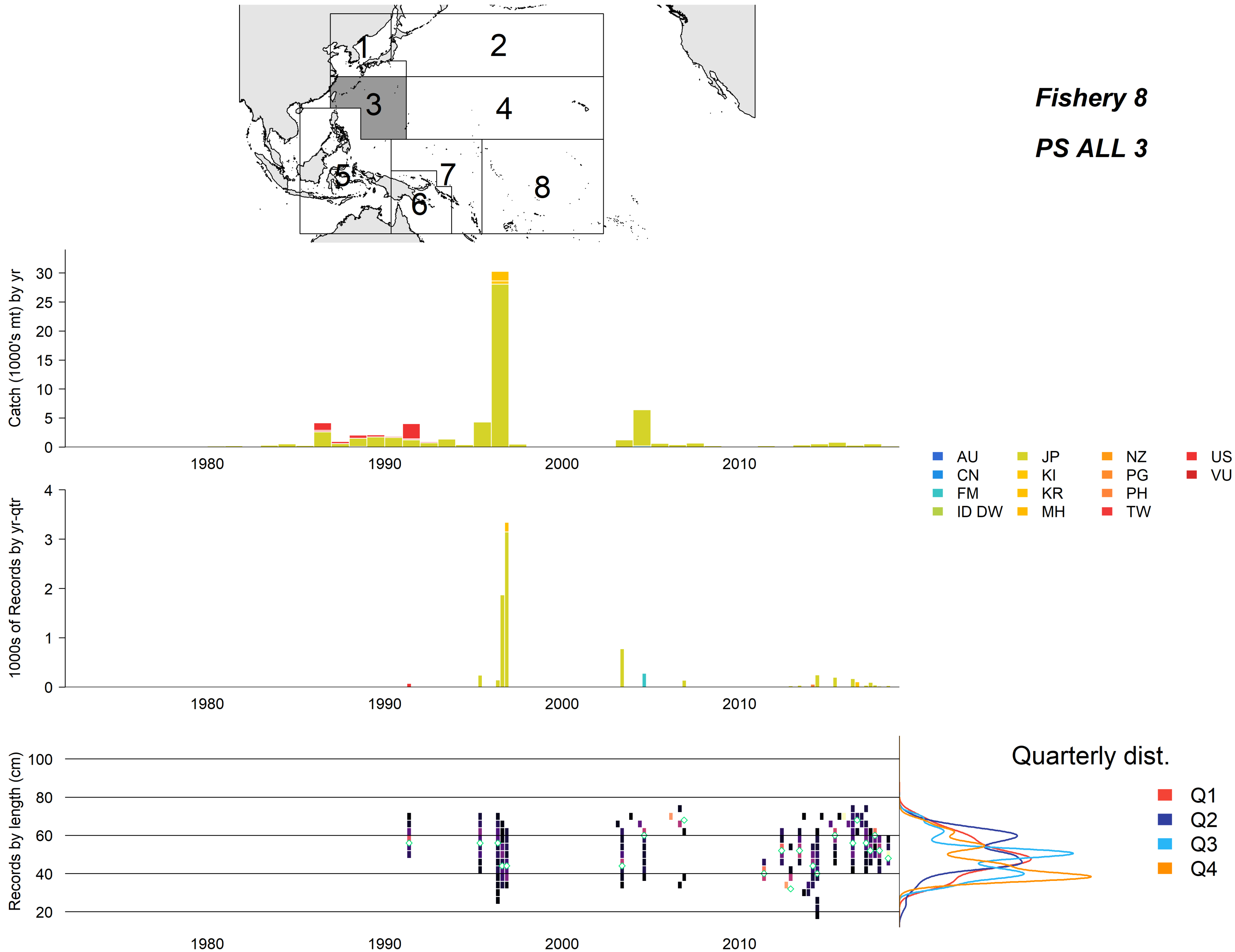


Figure 41: Same as Figure 34, except for fishery 8 of the 8 region spatial structure.

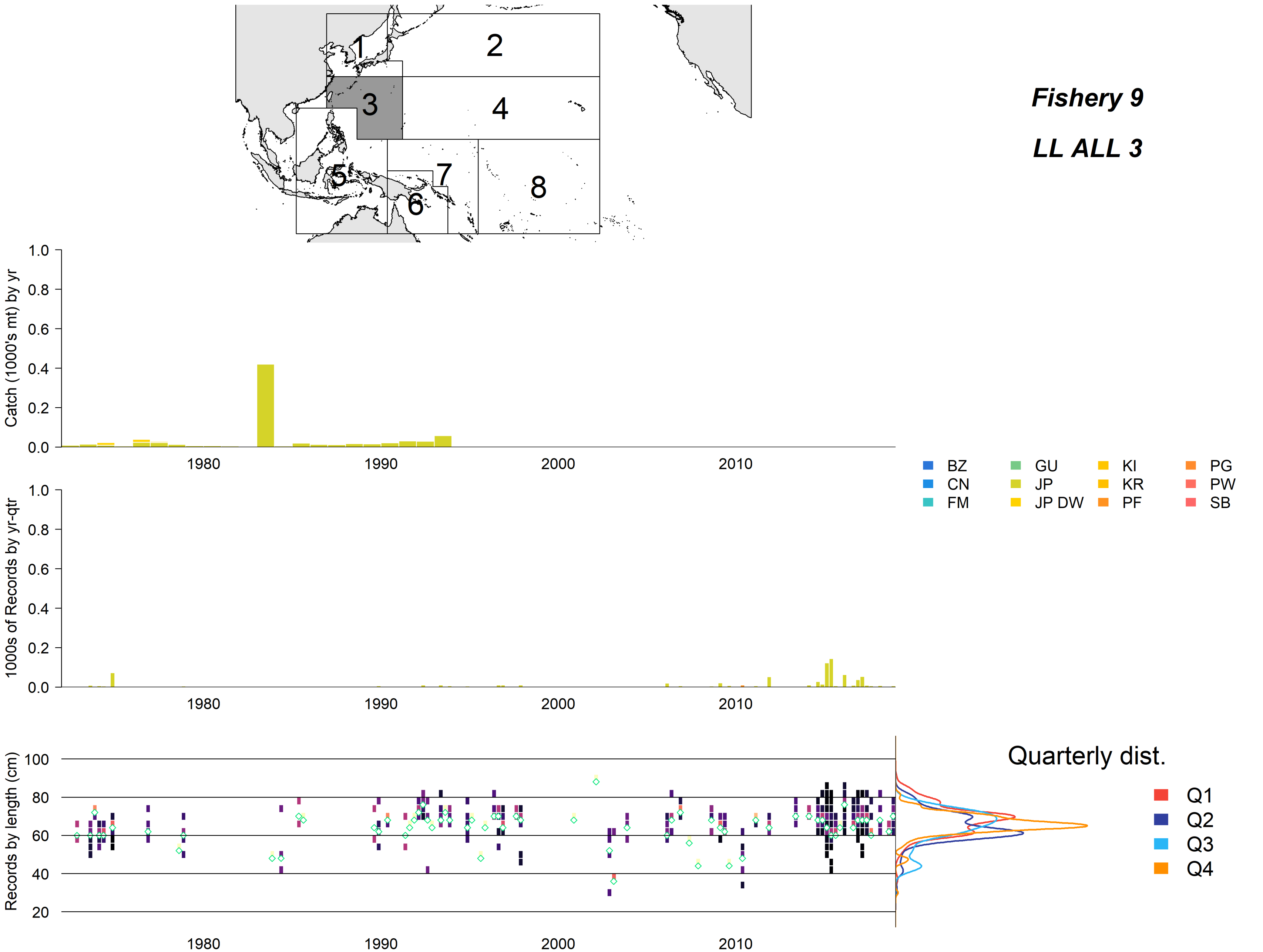


Figure 42: Same as Figure 34, except for fishery 9 of the 8 region spatial structure.

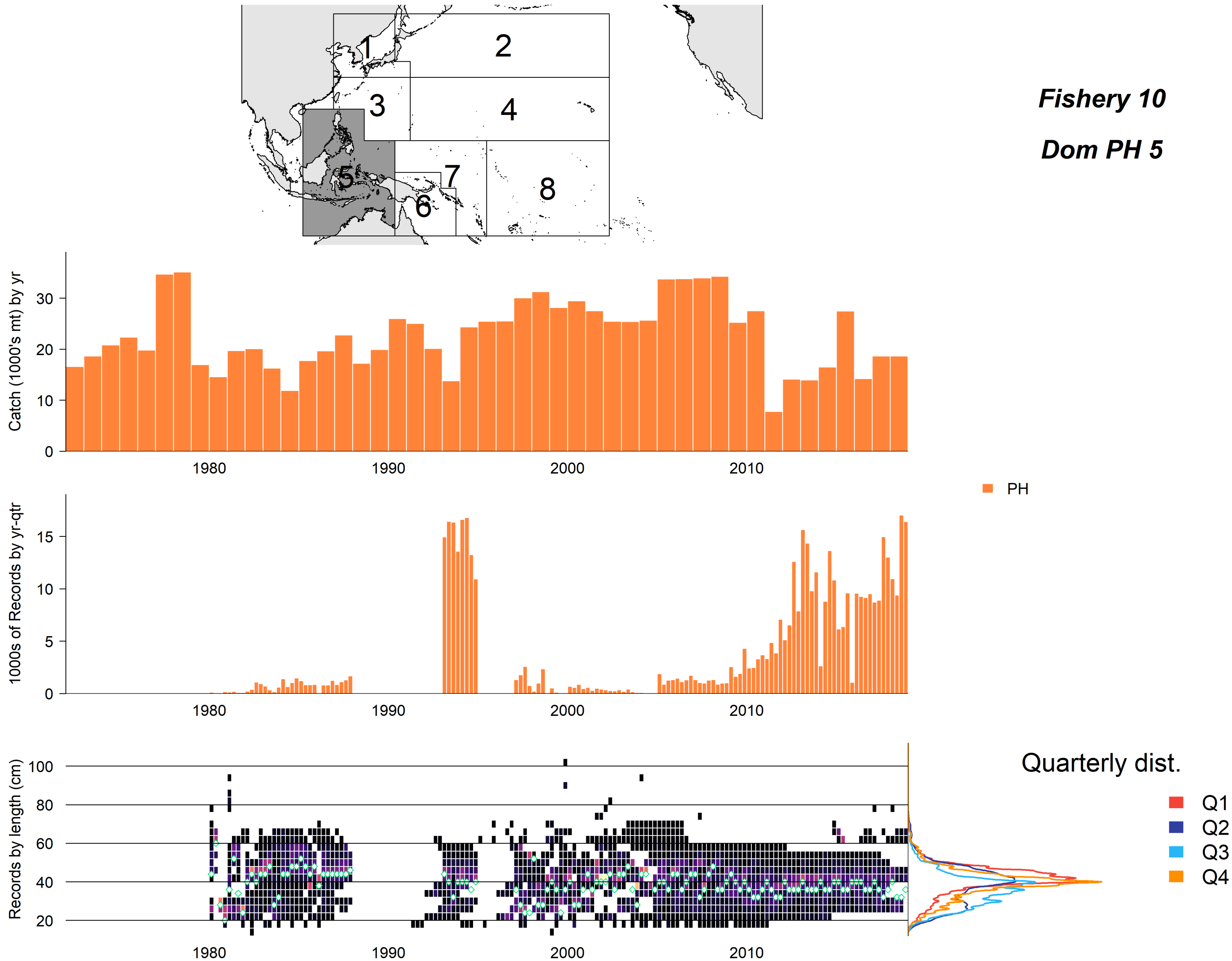


Figure 43: Same as Figure 34, except for fishery 10 of the 8 region spatial structure.

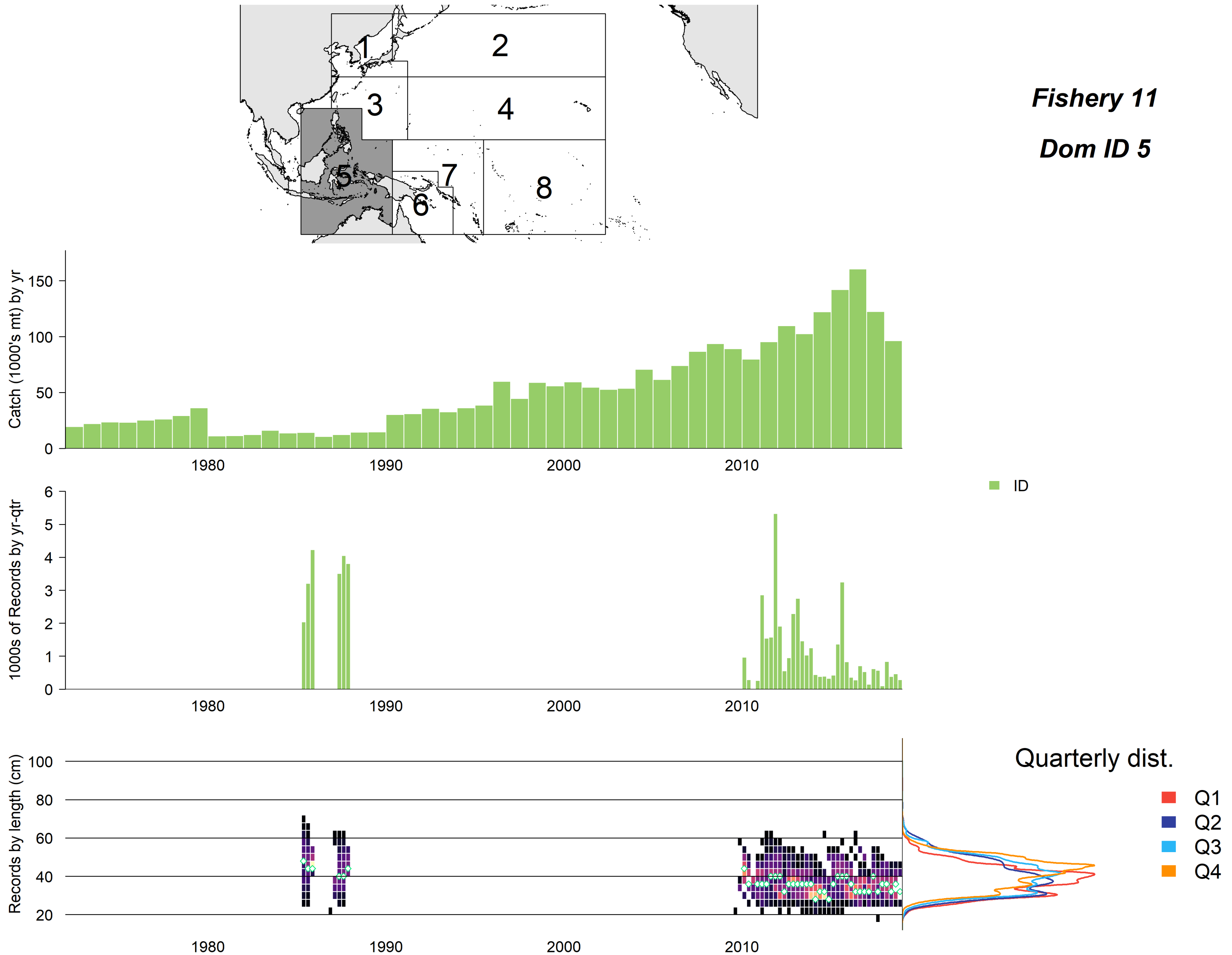


Figure 44: Same as Figure 34, except for fishery 11 of the 8 region spatial structure.

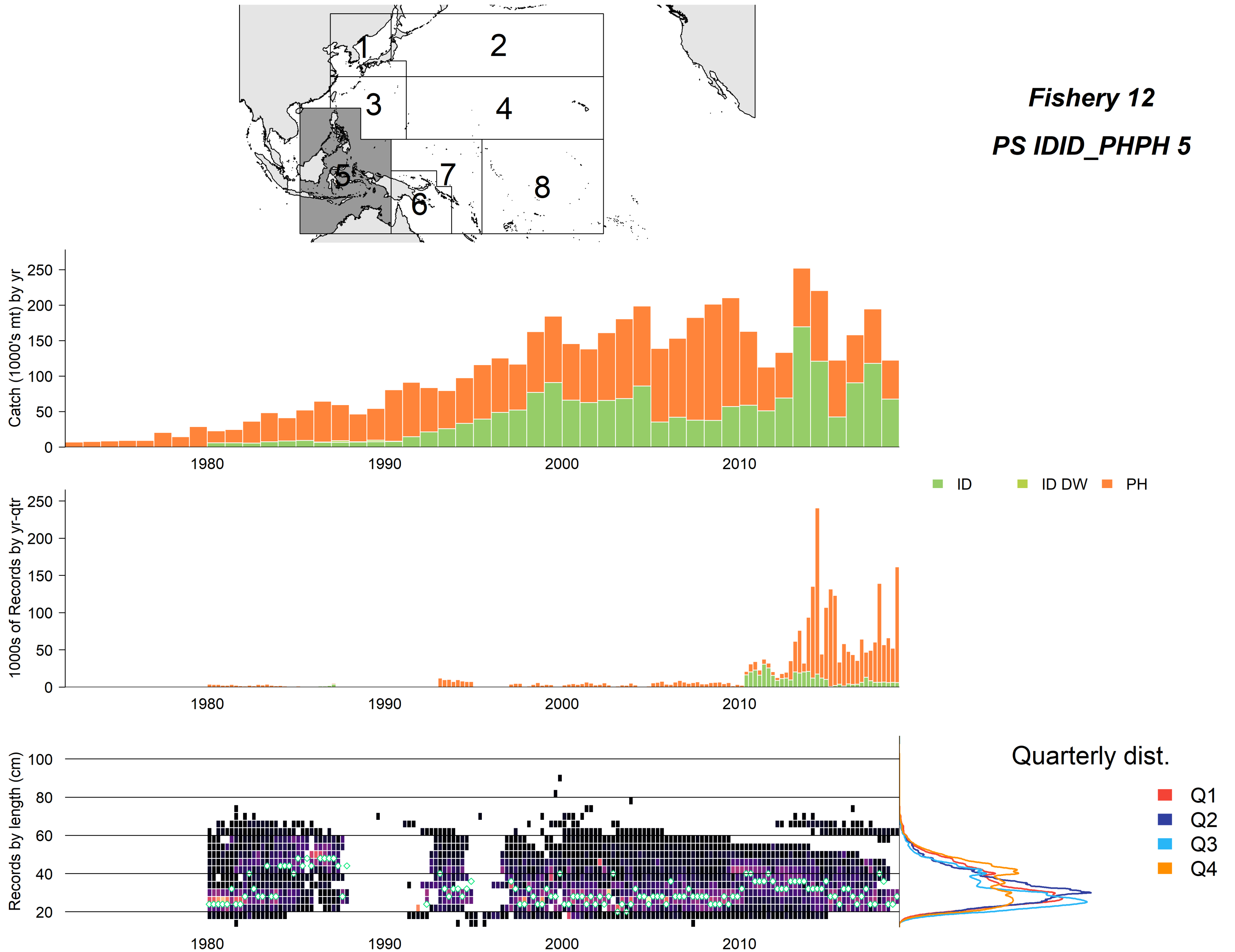


Figure 45: Same as Figure 34, except for fishery 12 of the 8 region spatial structure.

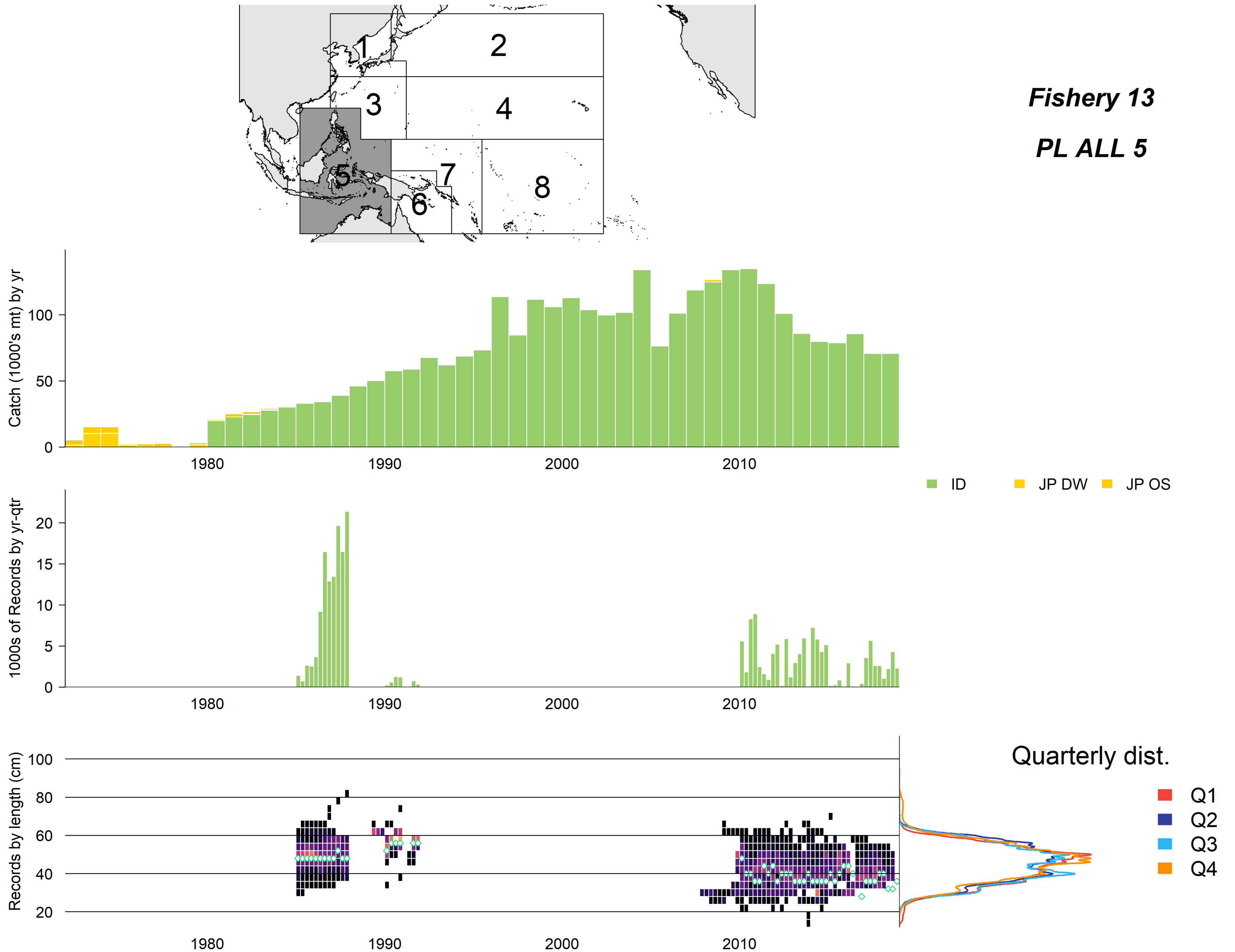


Figure 46: Same as Figure 34, except for fishery 13 of the 8 region spatial structure.

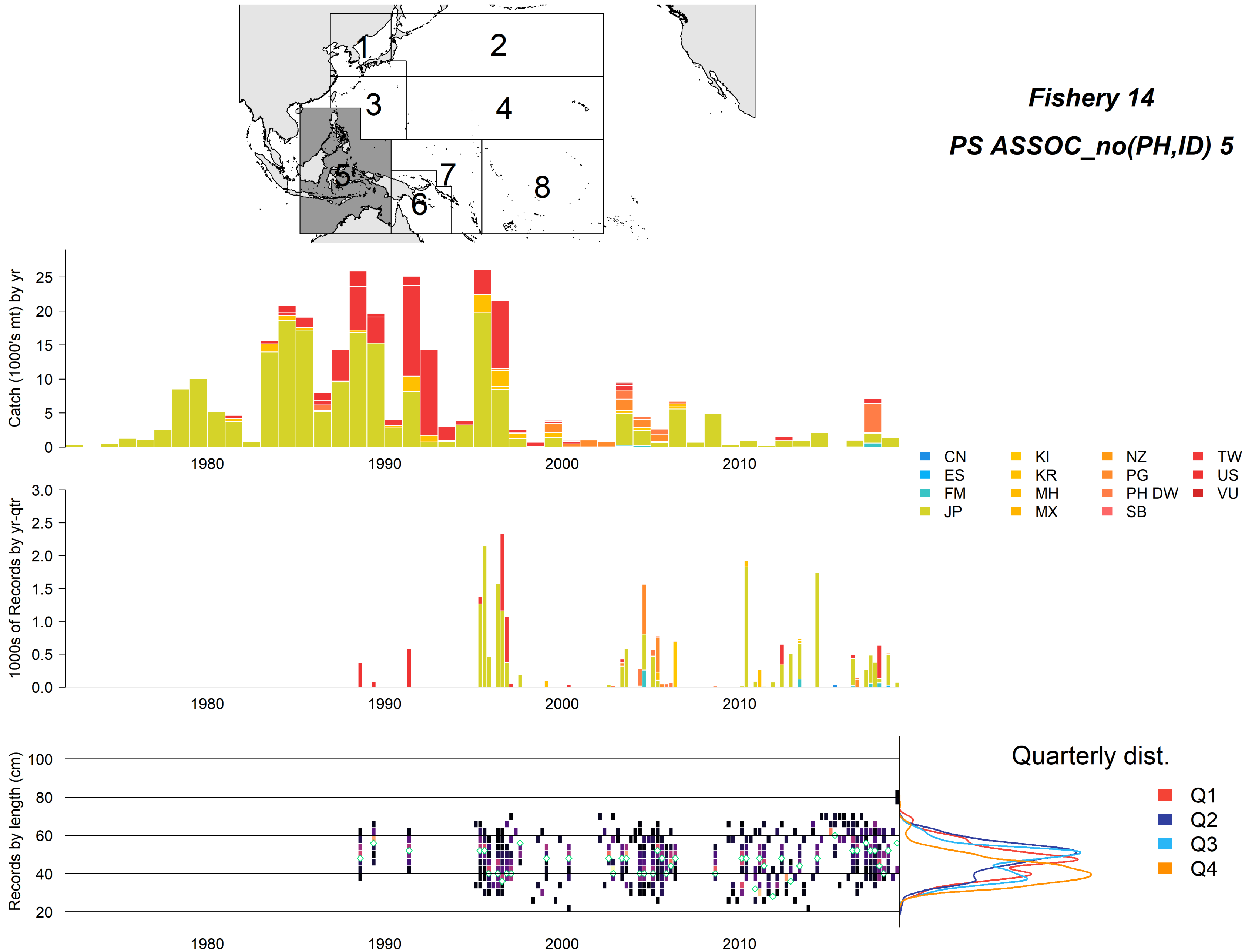


Figure 47: Same as Figure 34, except for fishery 14 of the 8 region spatial structure.

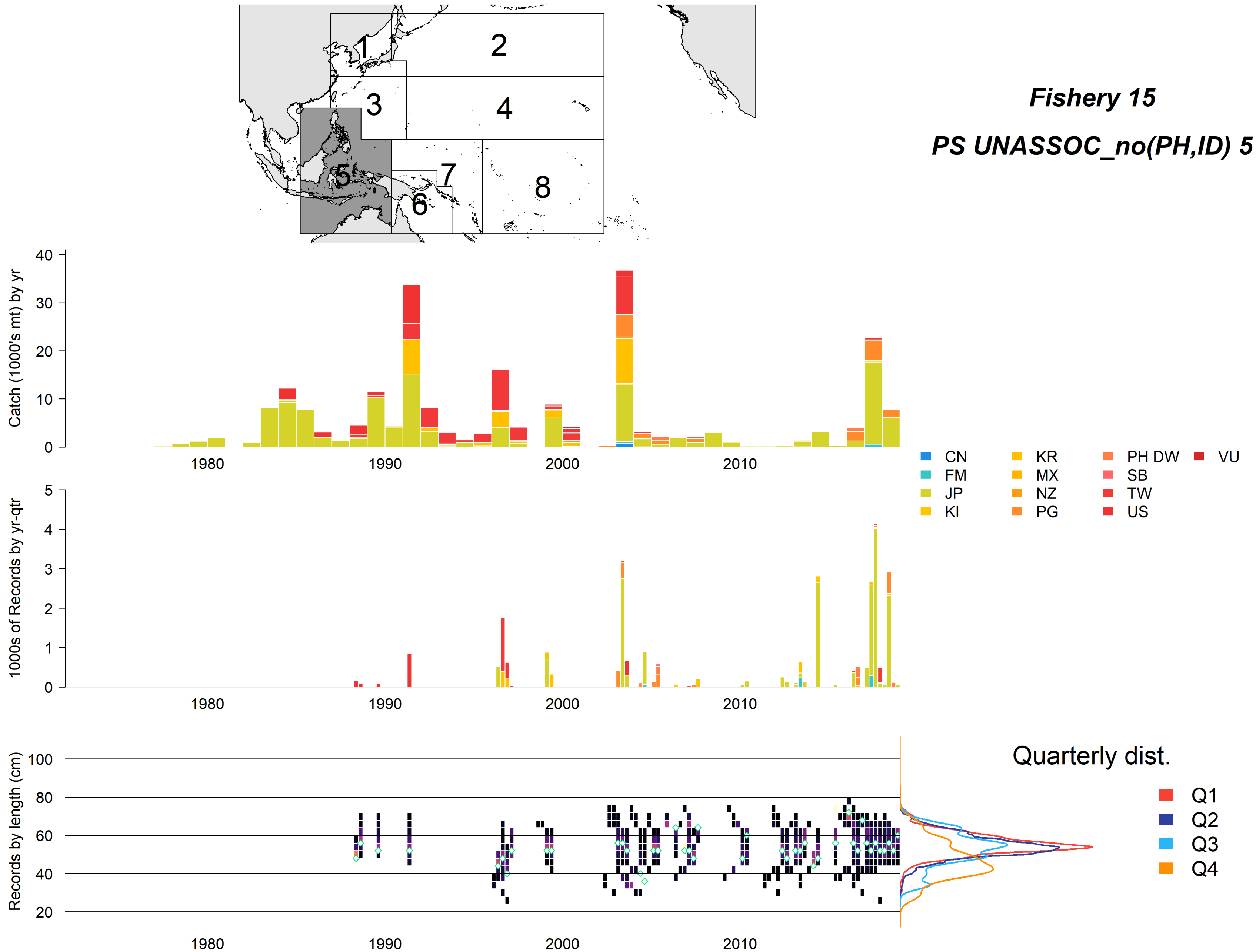


Figure 48: Same as Figure 34, except for fishery 15 of the 8 region spatial structure.

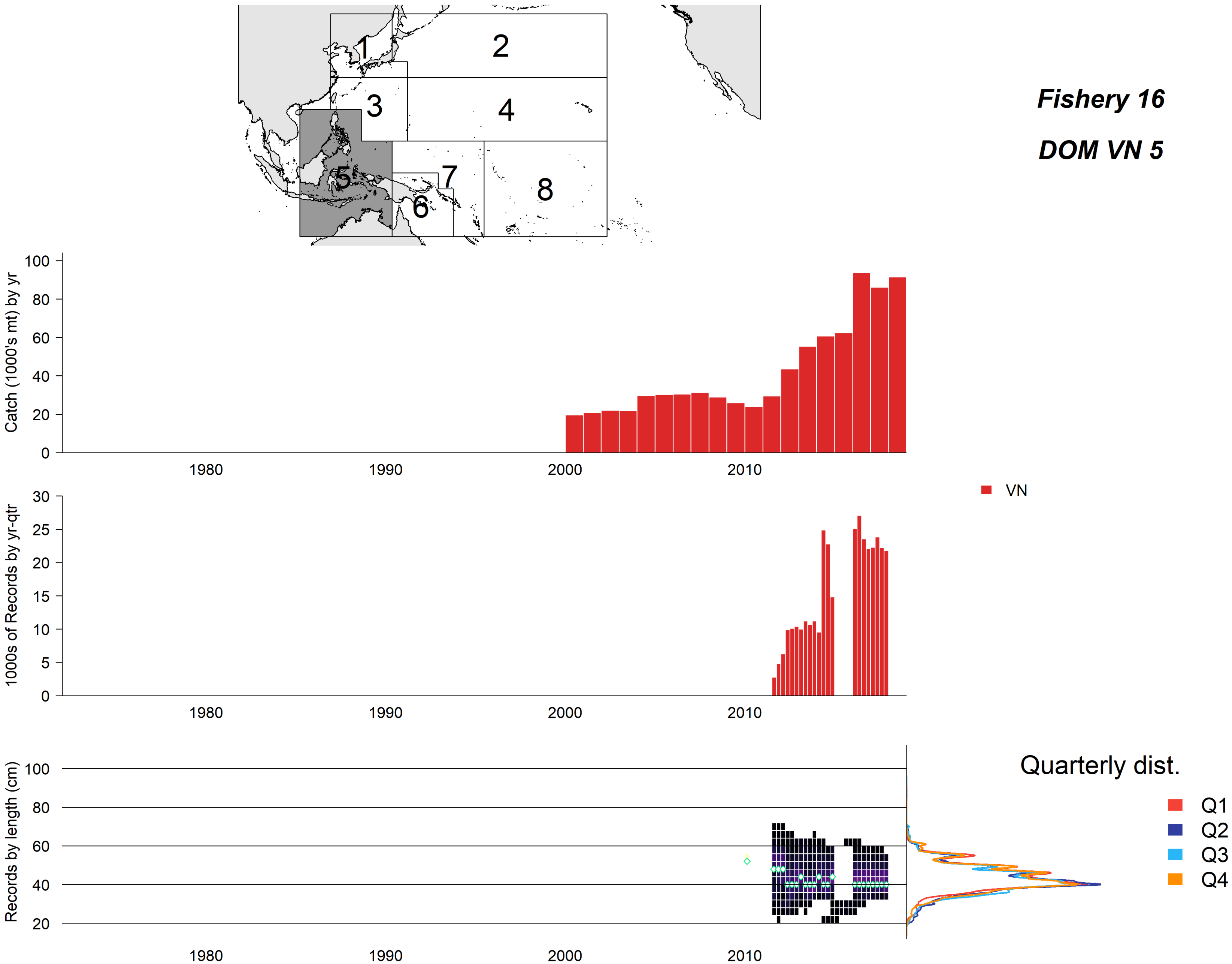


Figure 49: Same as Figure 34, except for fishery 16 of the 8 region spatial structure.

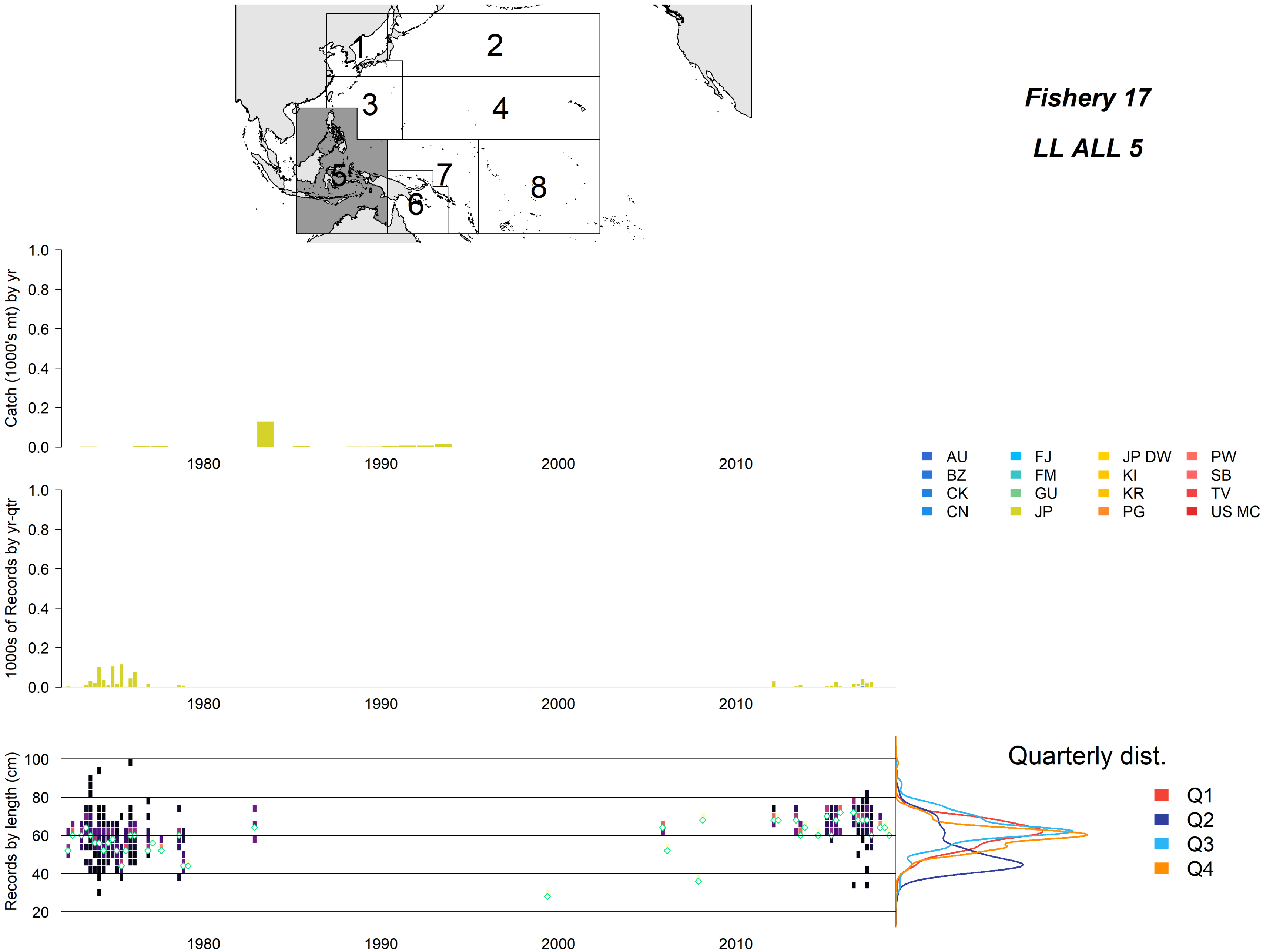


Figure 50: Same as Figure 34, except for fishery 17 of the 8 region spatial structure.

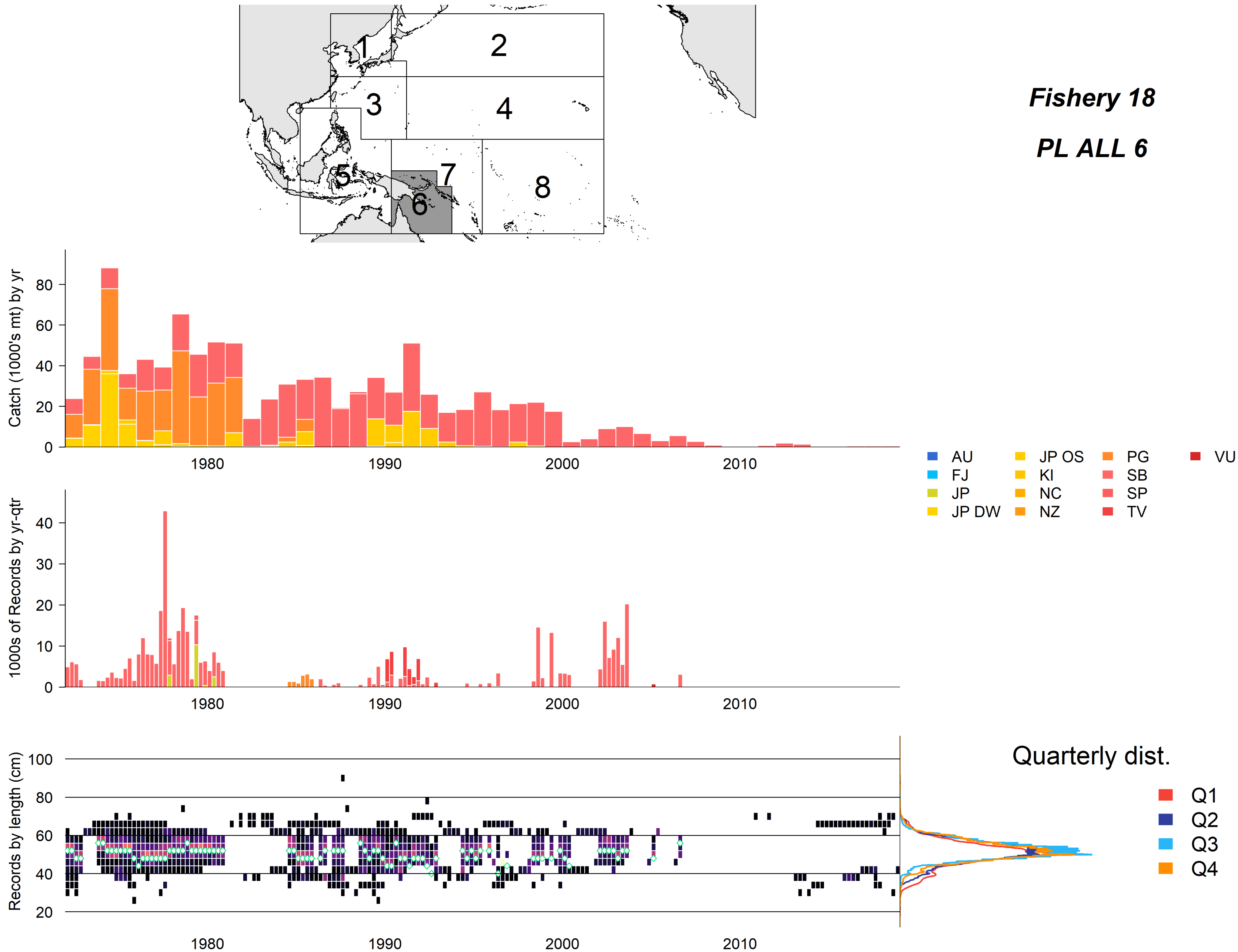


Figure 51: Same as Figure 34, except for fishery 18 of the 8 region spatial structure.

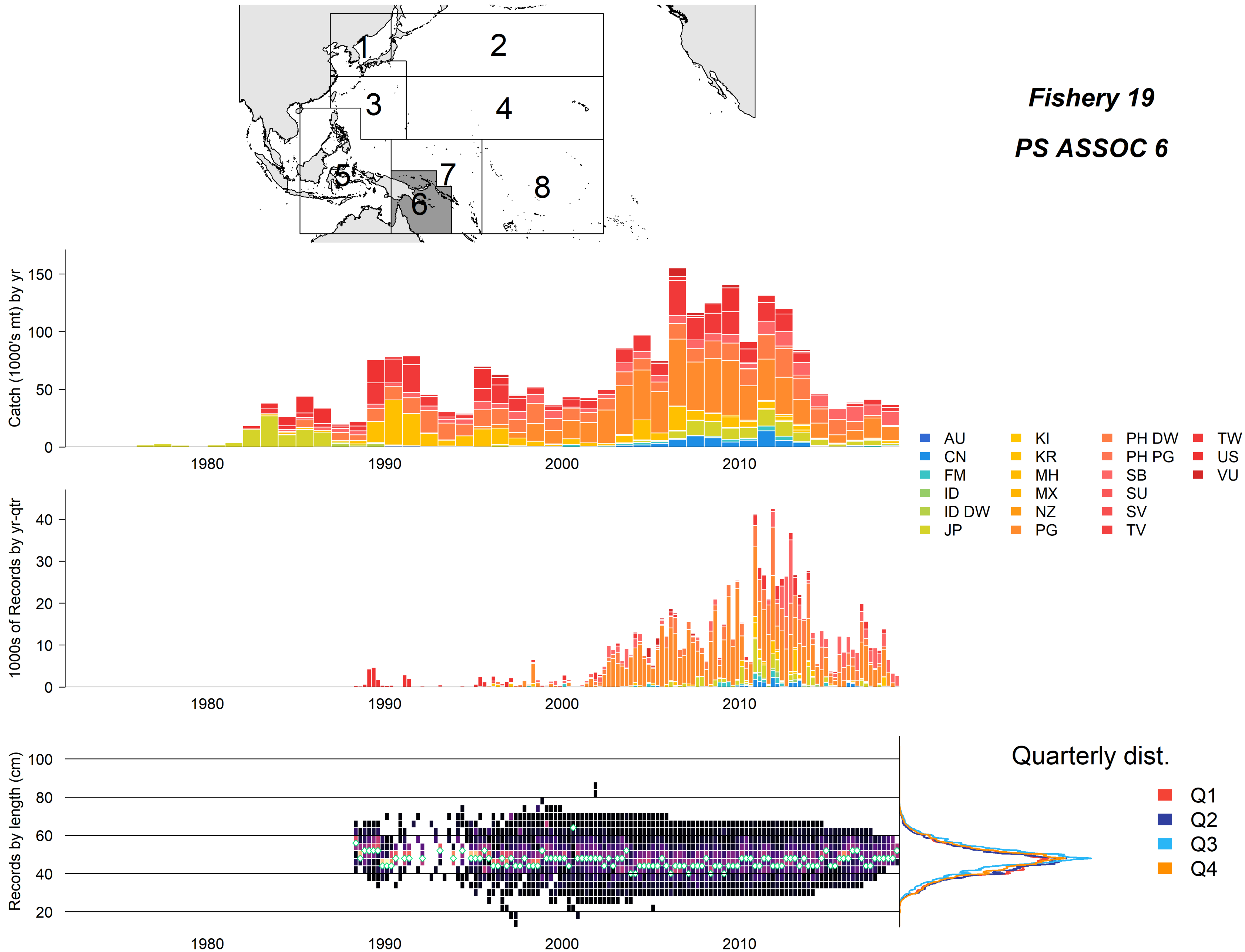


Figure 52: Same as Figure 34, except for fishery 19 of the 8 region spatial structure.

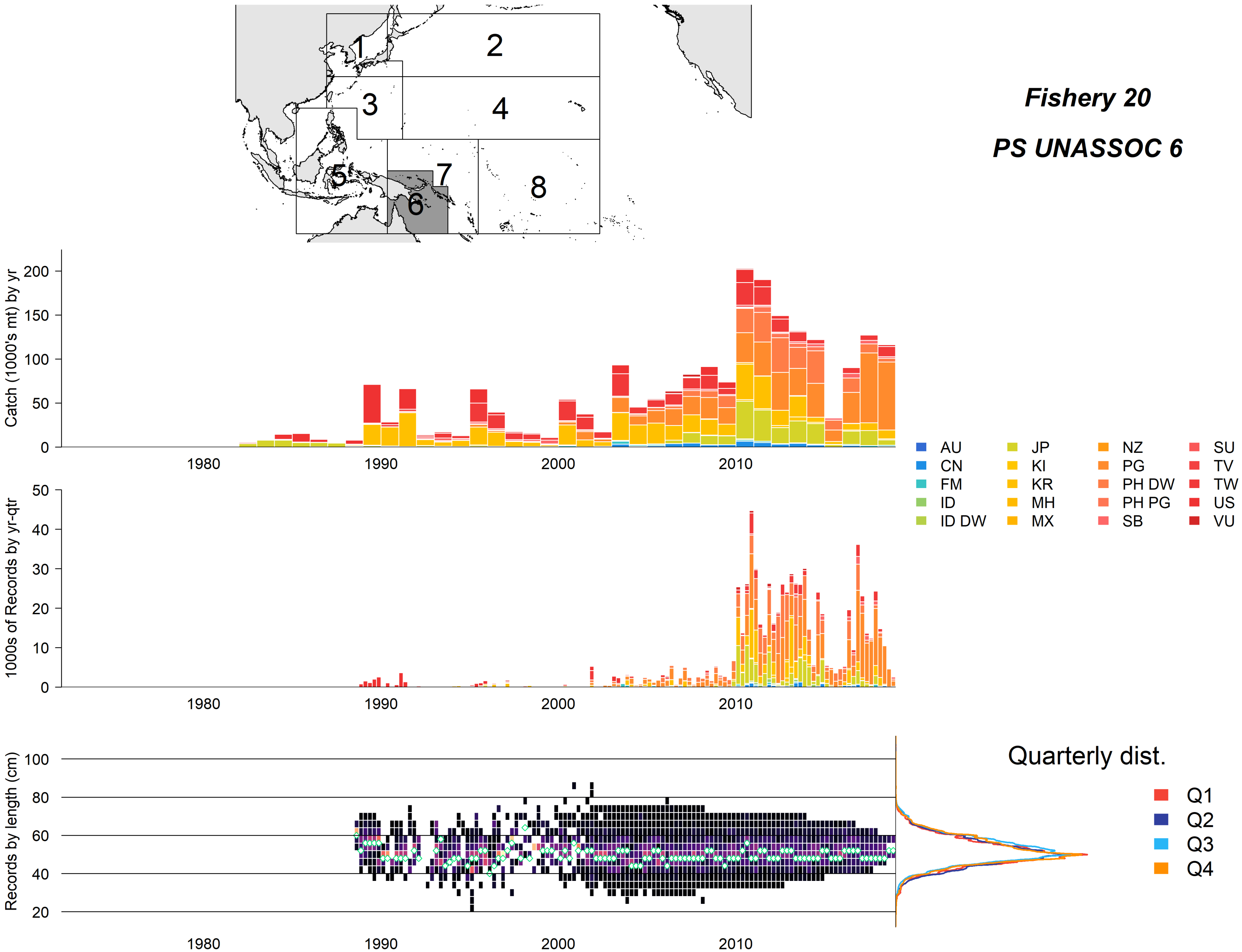


Figure 53: Same as Figure 34, except for fishery 20 of the 8 region spatial structure.

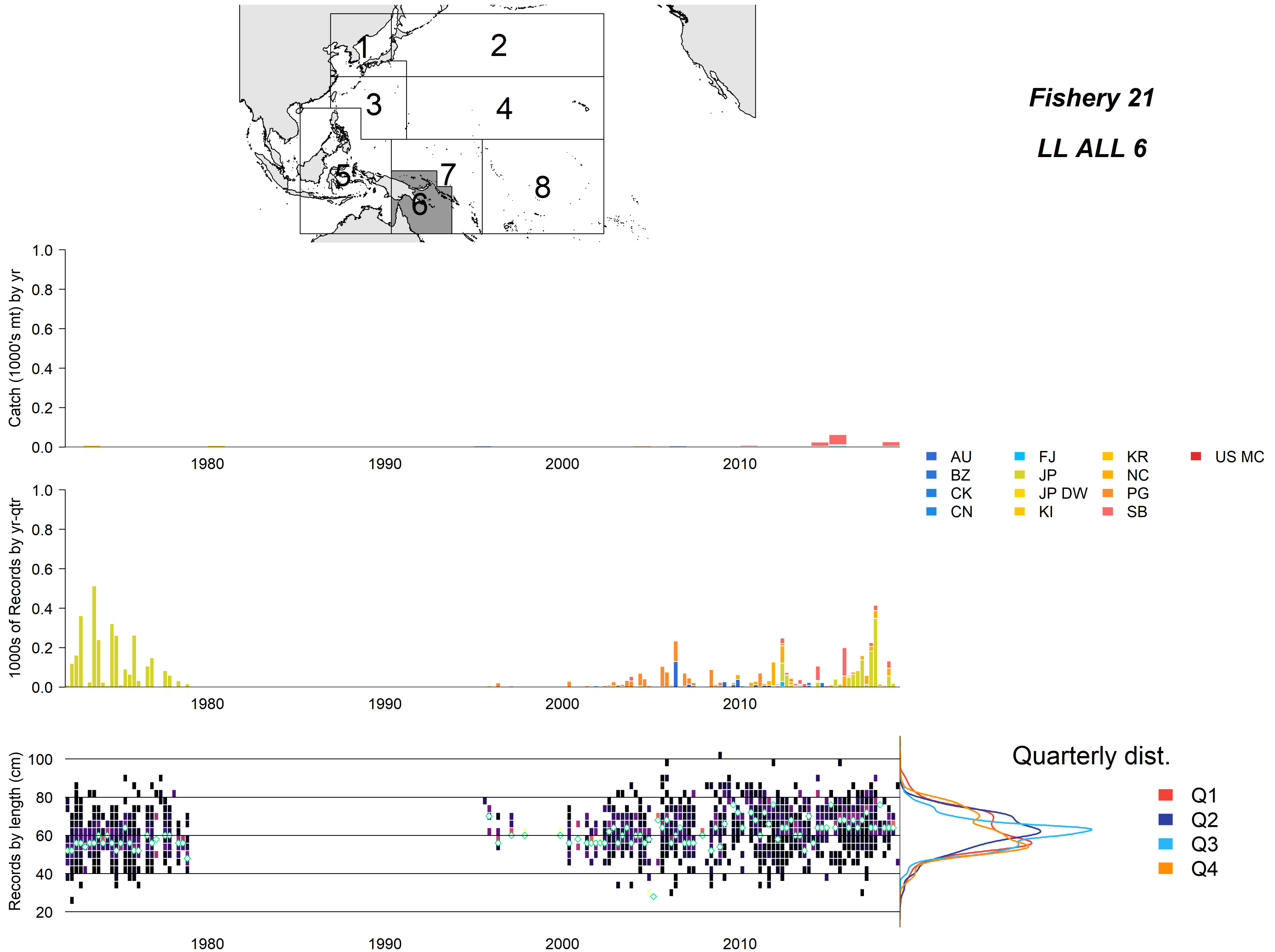


Figure 54: Same as Figure 34, except for fishery 21 of the 8 region spatial structure.

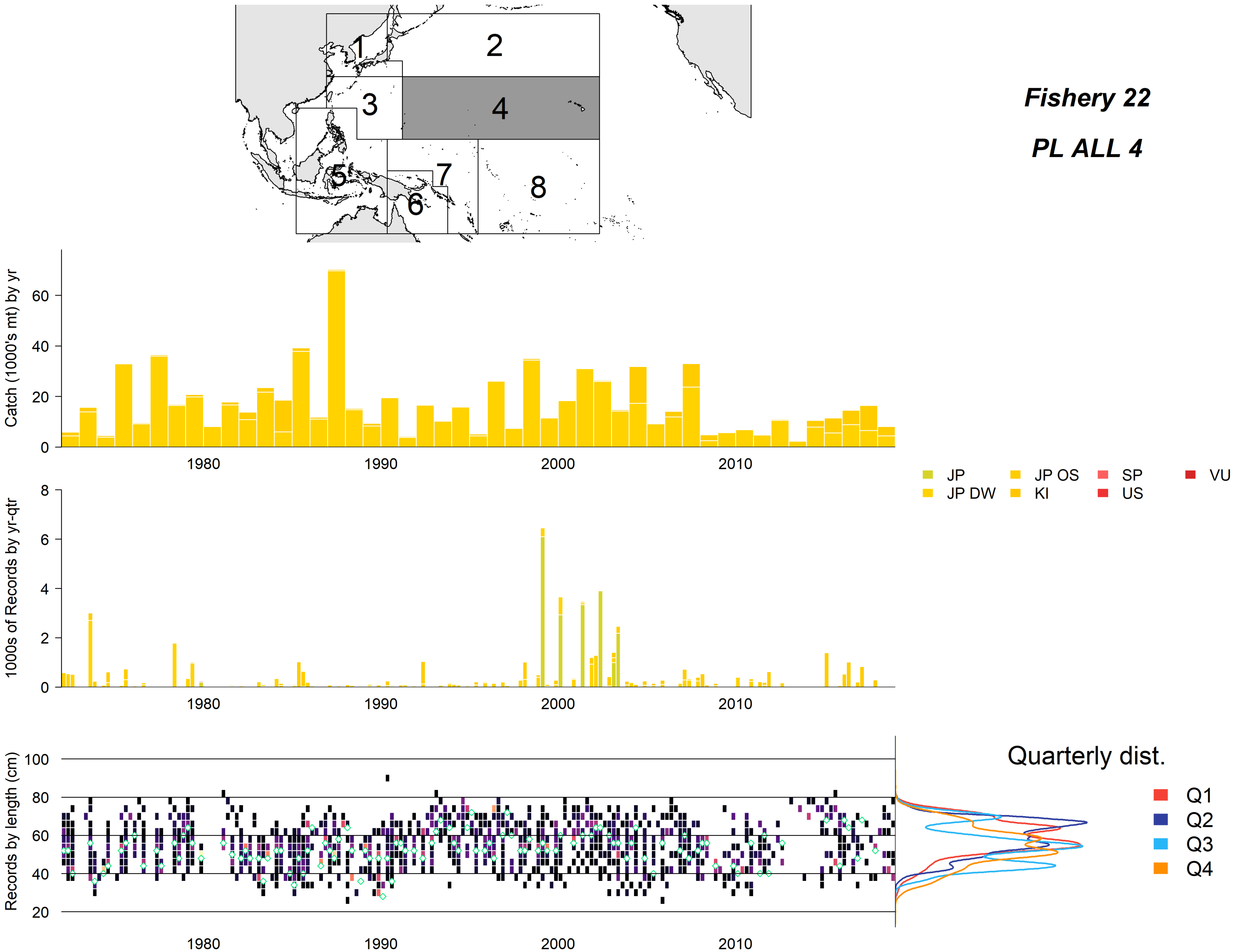


Figure 55: Same as Figure 34, except for fishery 22 of the 8 region spatial structure.

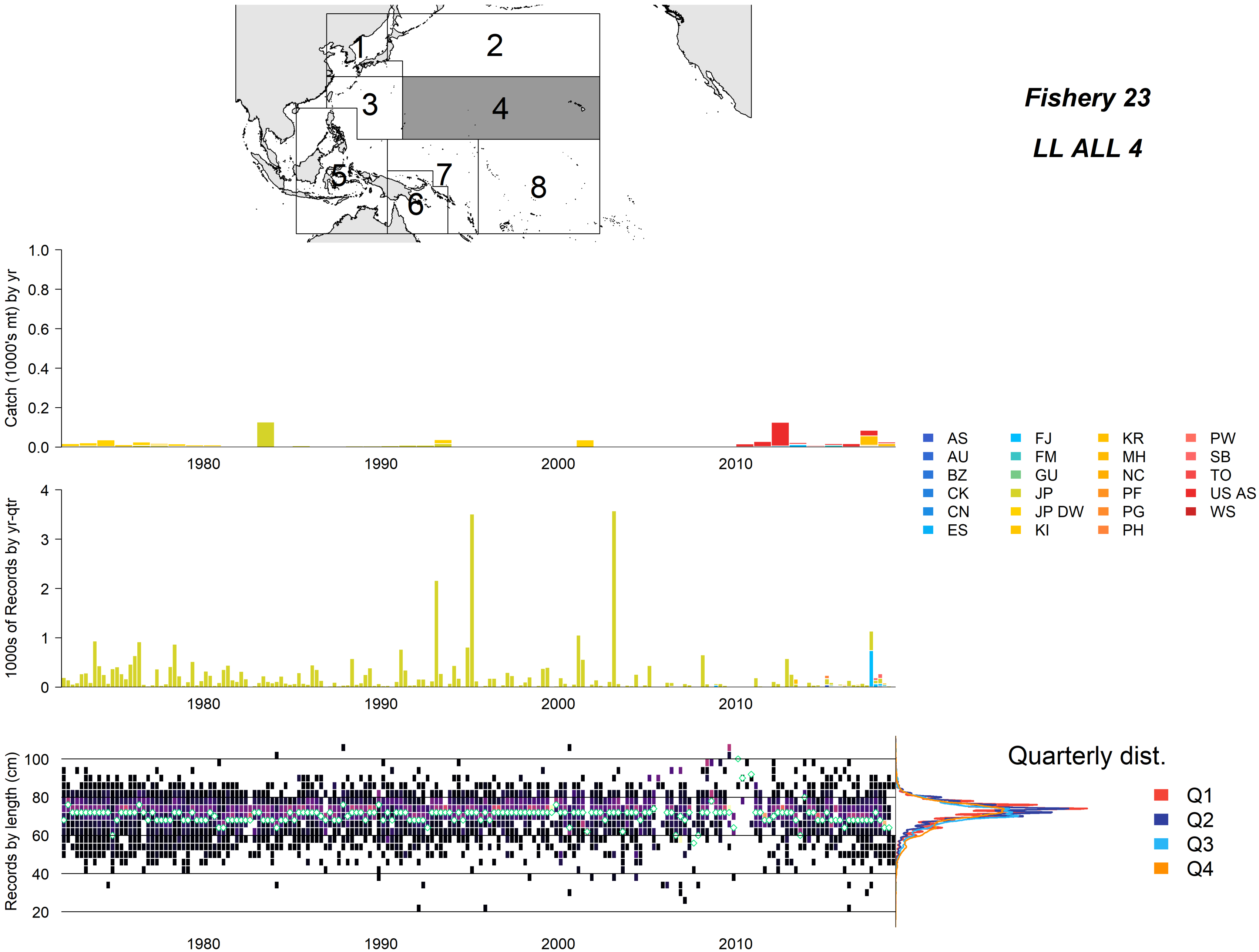


Figure 56: Same as Figure 34, except for fishery 23 of the 8 region spatial structure.

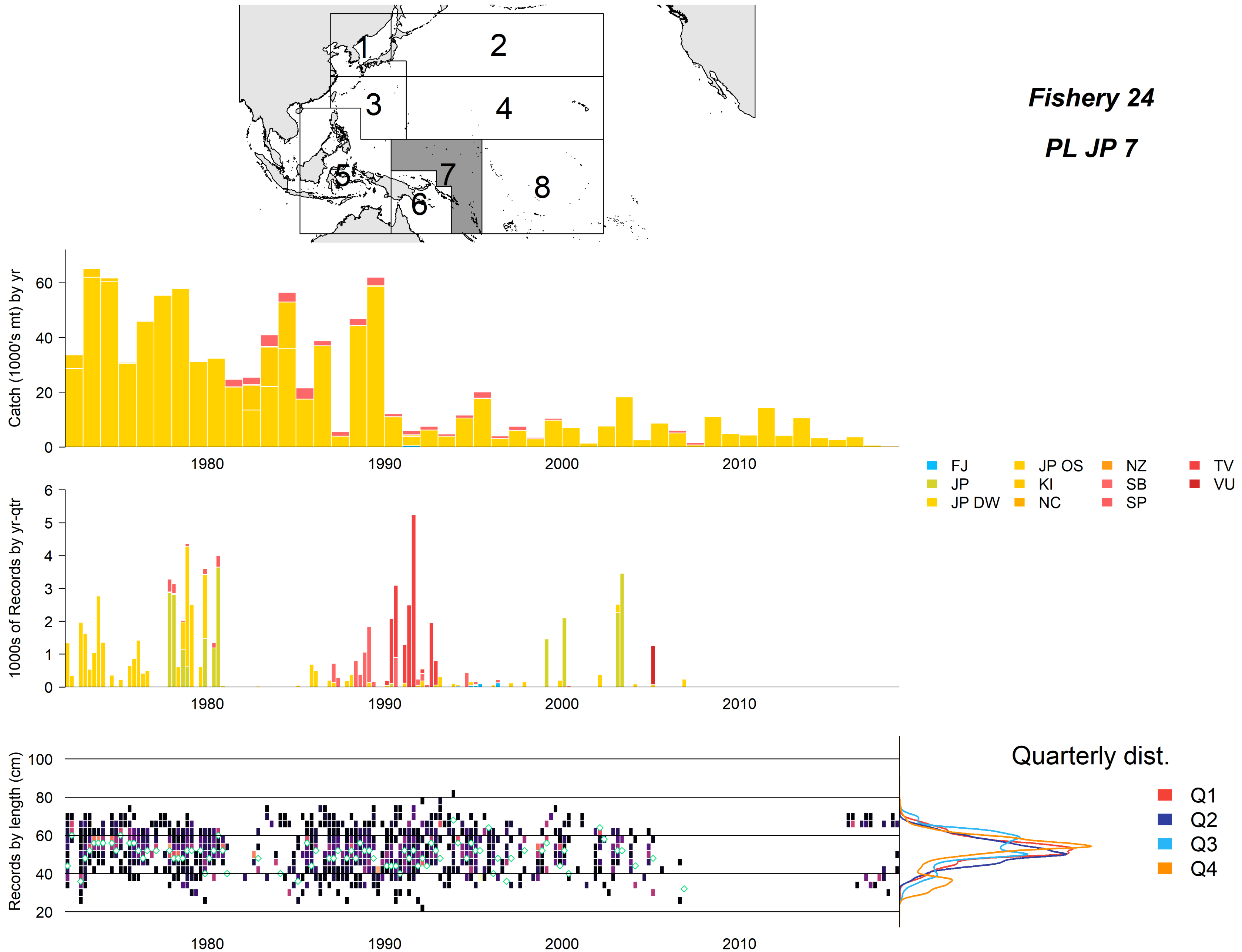


Figure 57: Same as Figure 34, except for fishery 24 of the 8 region spatial structure.

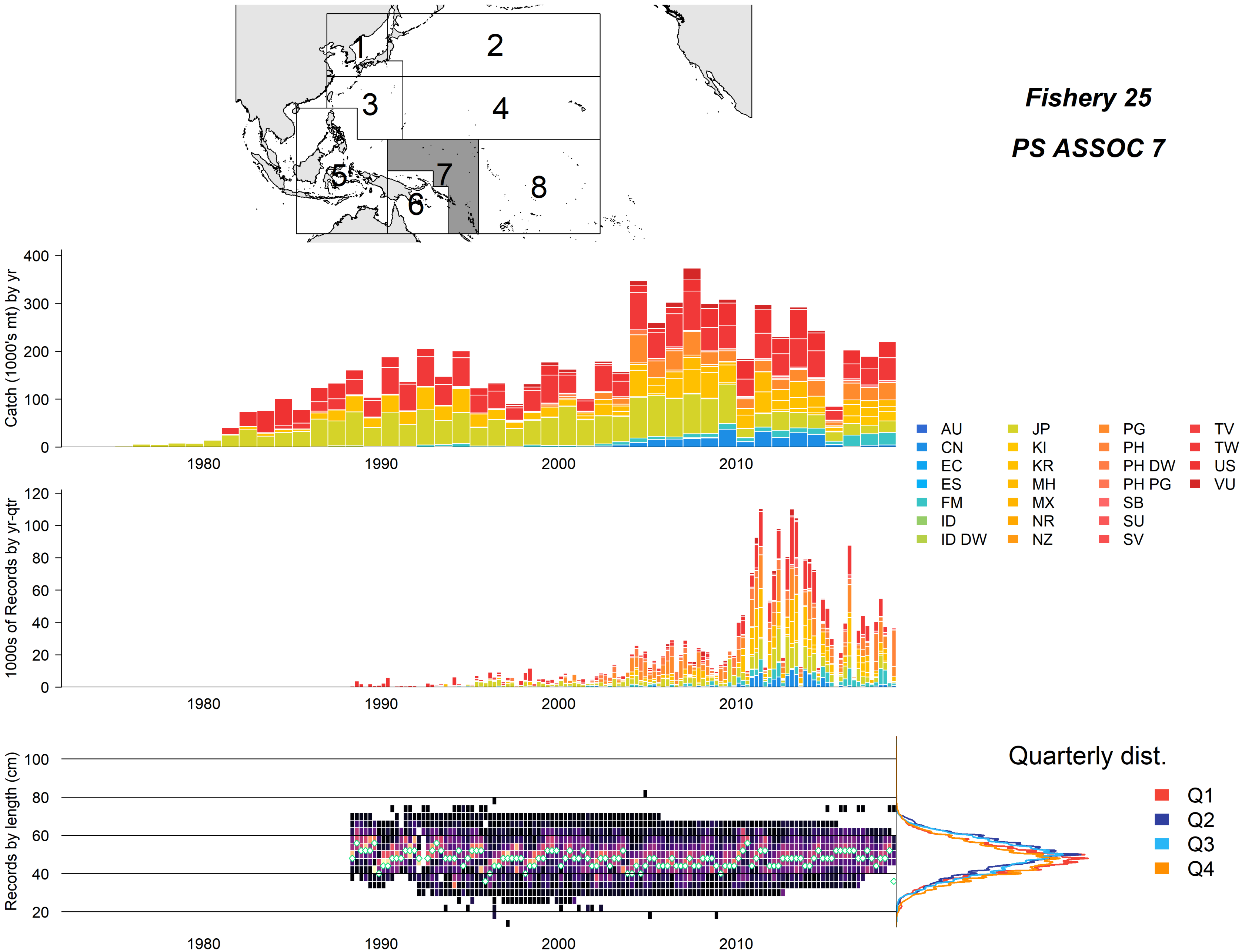


Figure 58: Same as Figure 34, except for fishery 25 of the 8 region spatial structure.

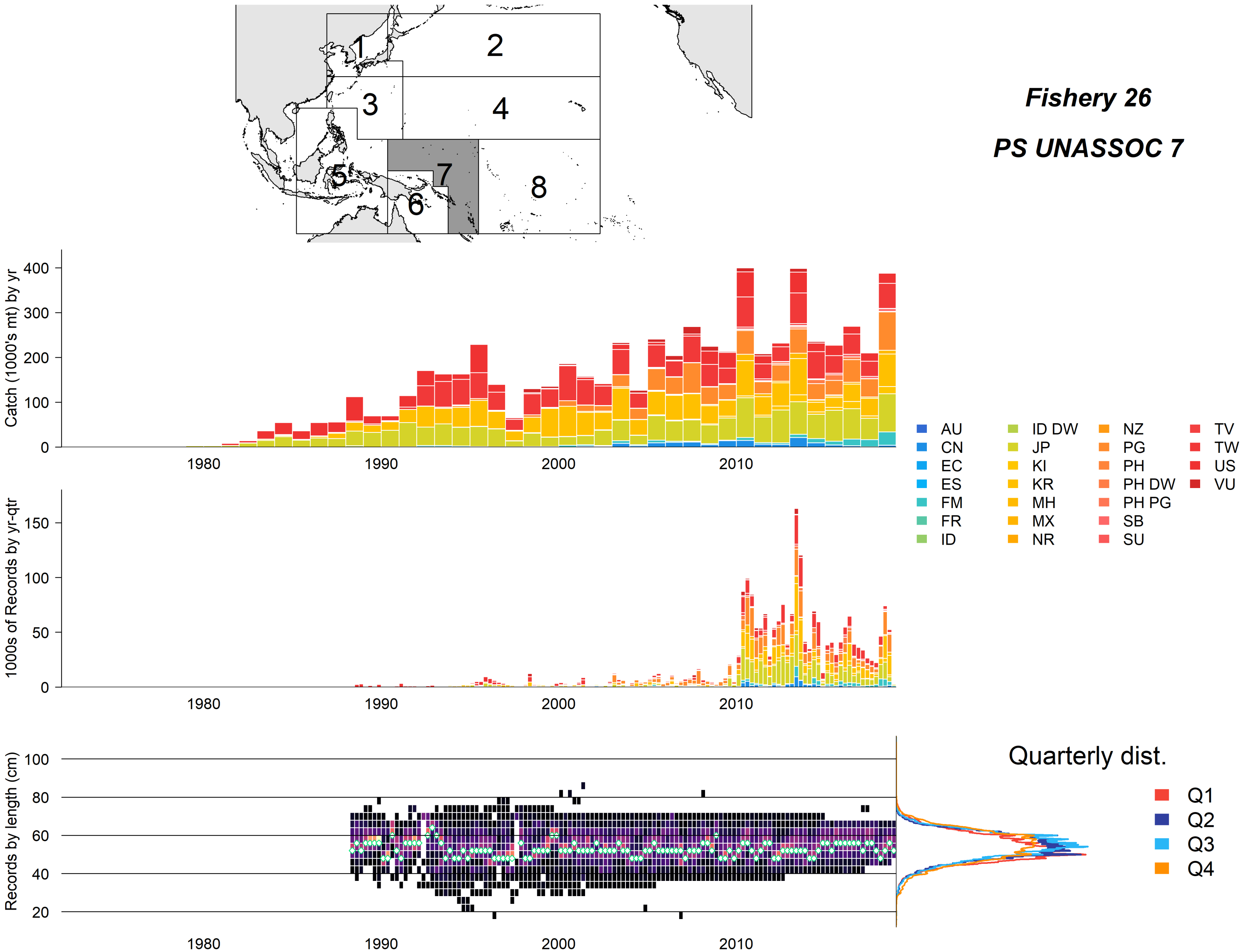


Figure 59: Same as Figure 34, except for fishery 26 of the 8 region spatial structure.

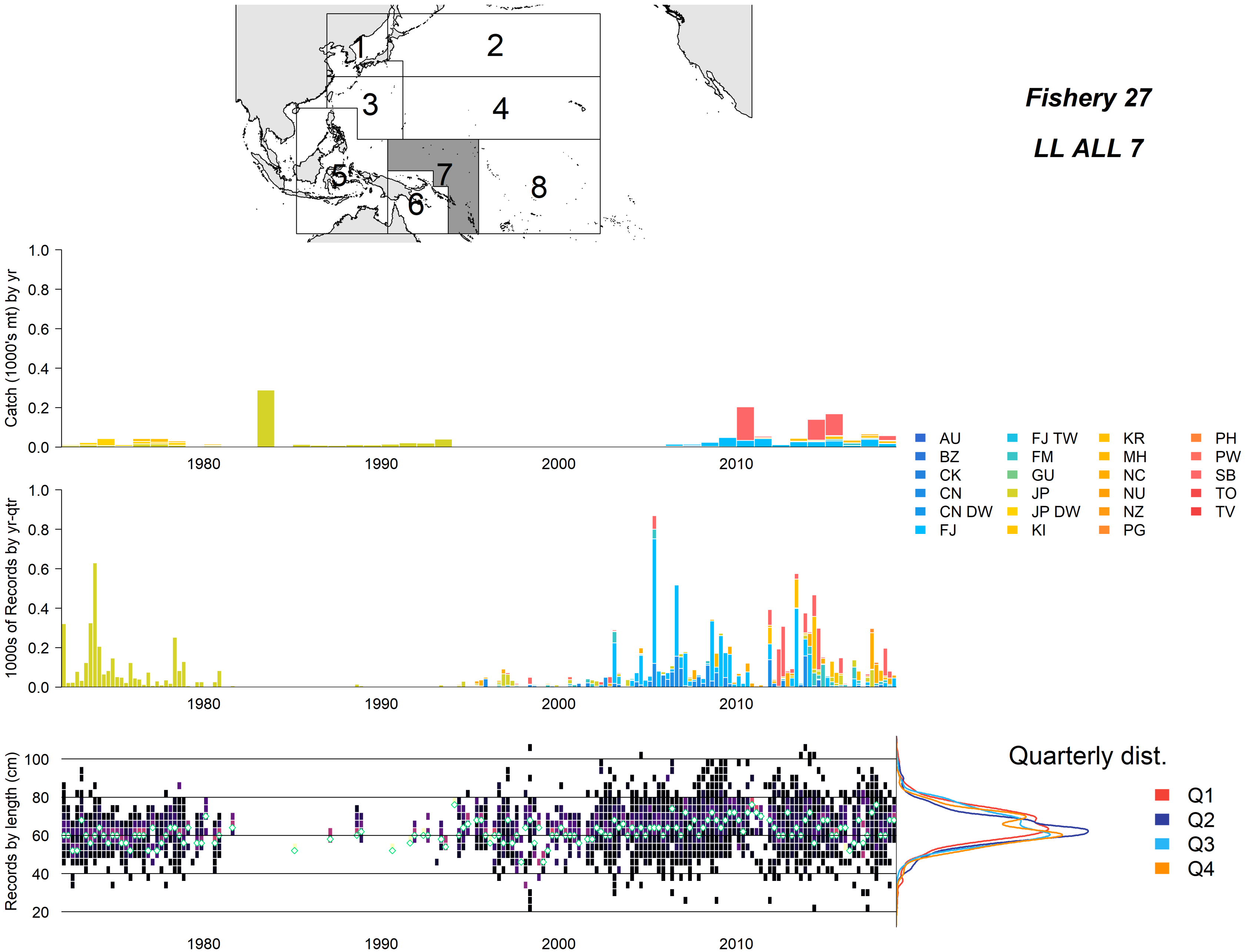


Figure 60: Same as Figure 34, except for fishery 27 of the 8 region spatial structure.

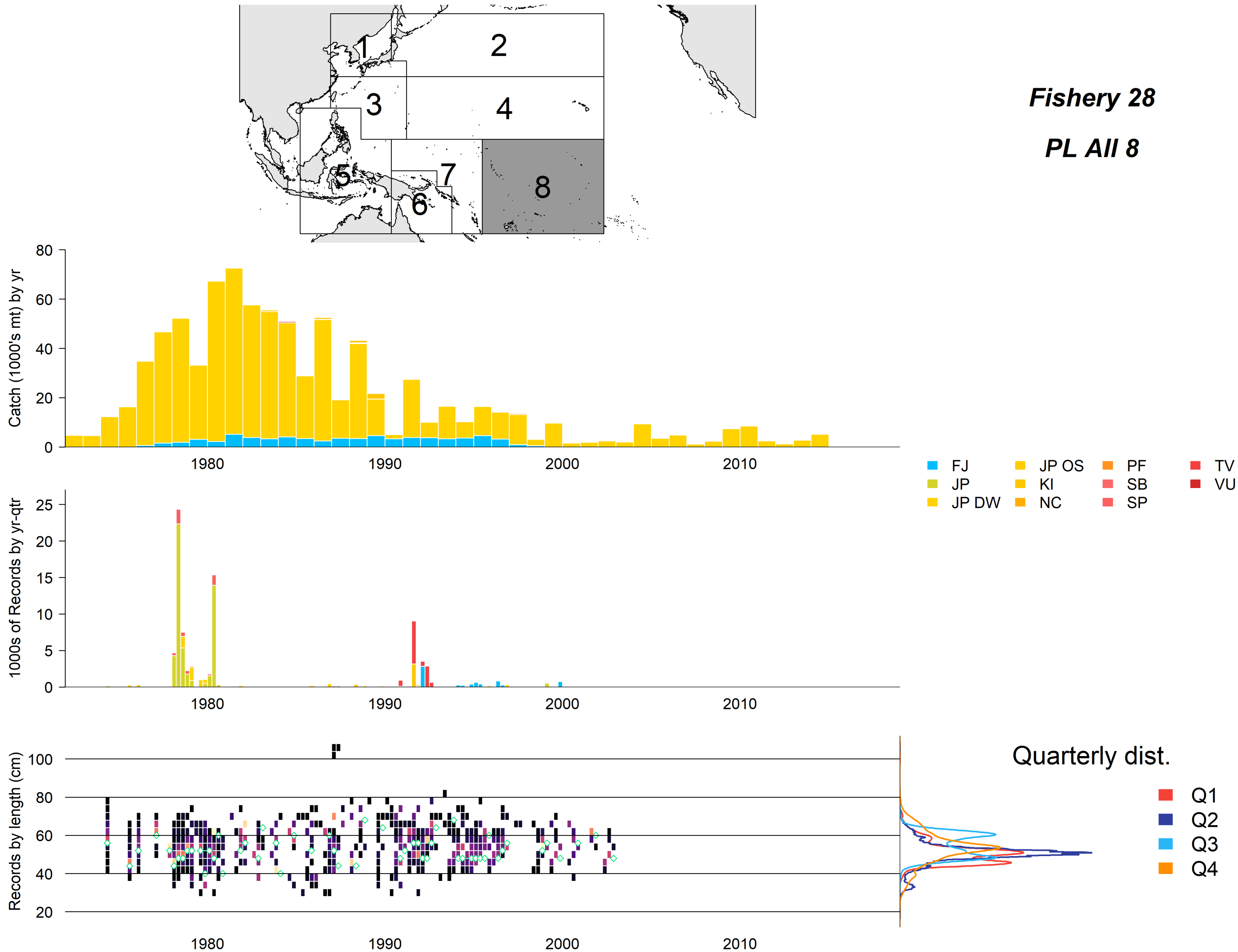


Figure 61: Same as Figure 34, except for fishery 28 of the 8 region spatial structure.

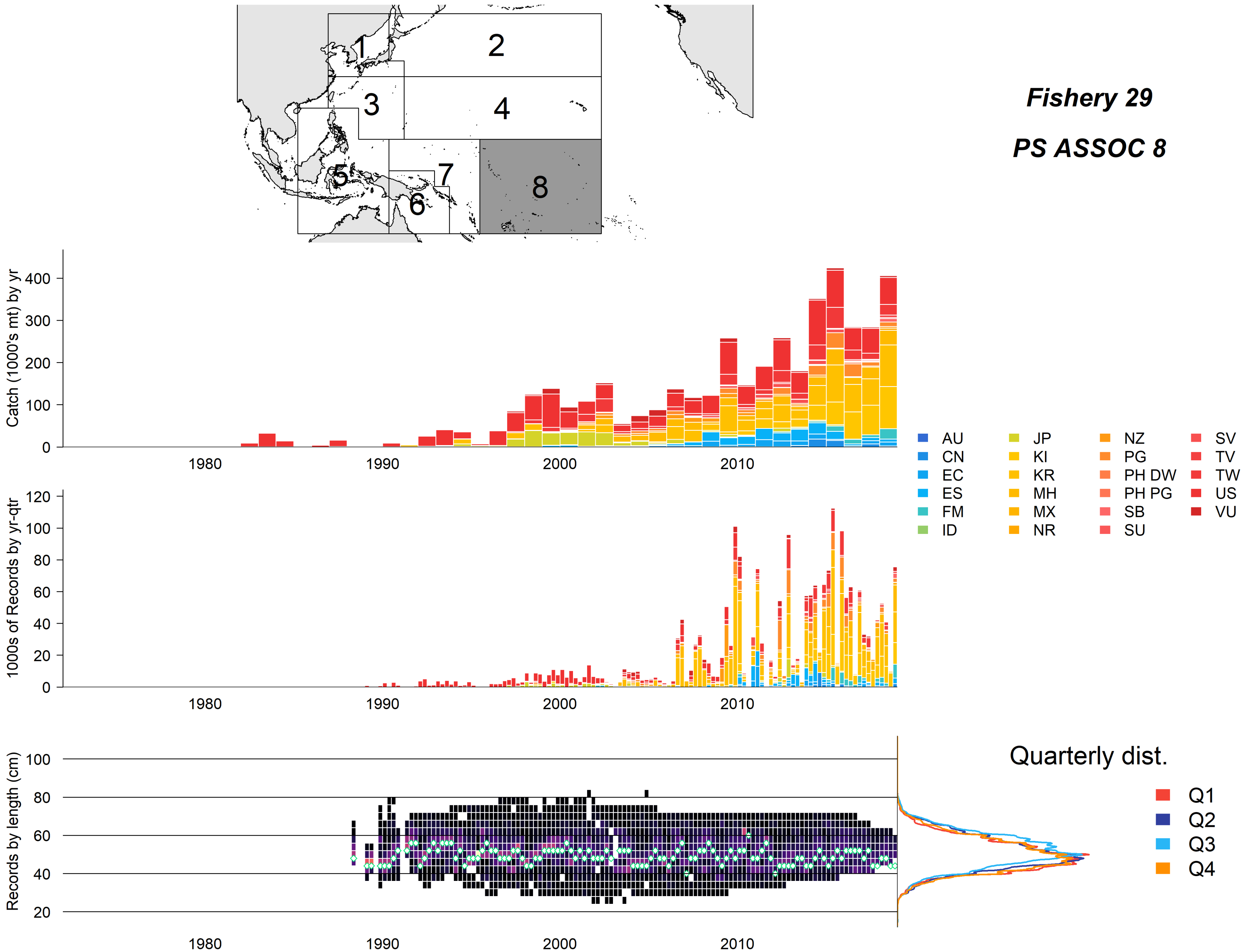


Figure 62: Same as Figure 34, except for fishery 29 of the 8 region spatial structure.

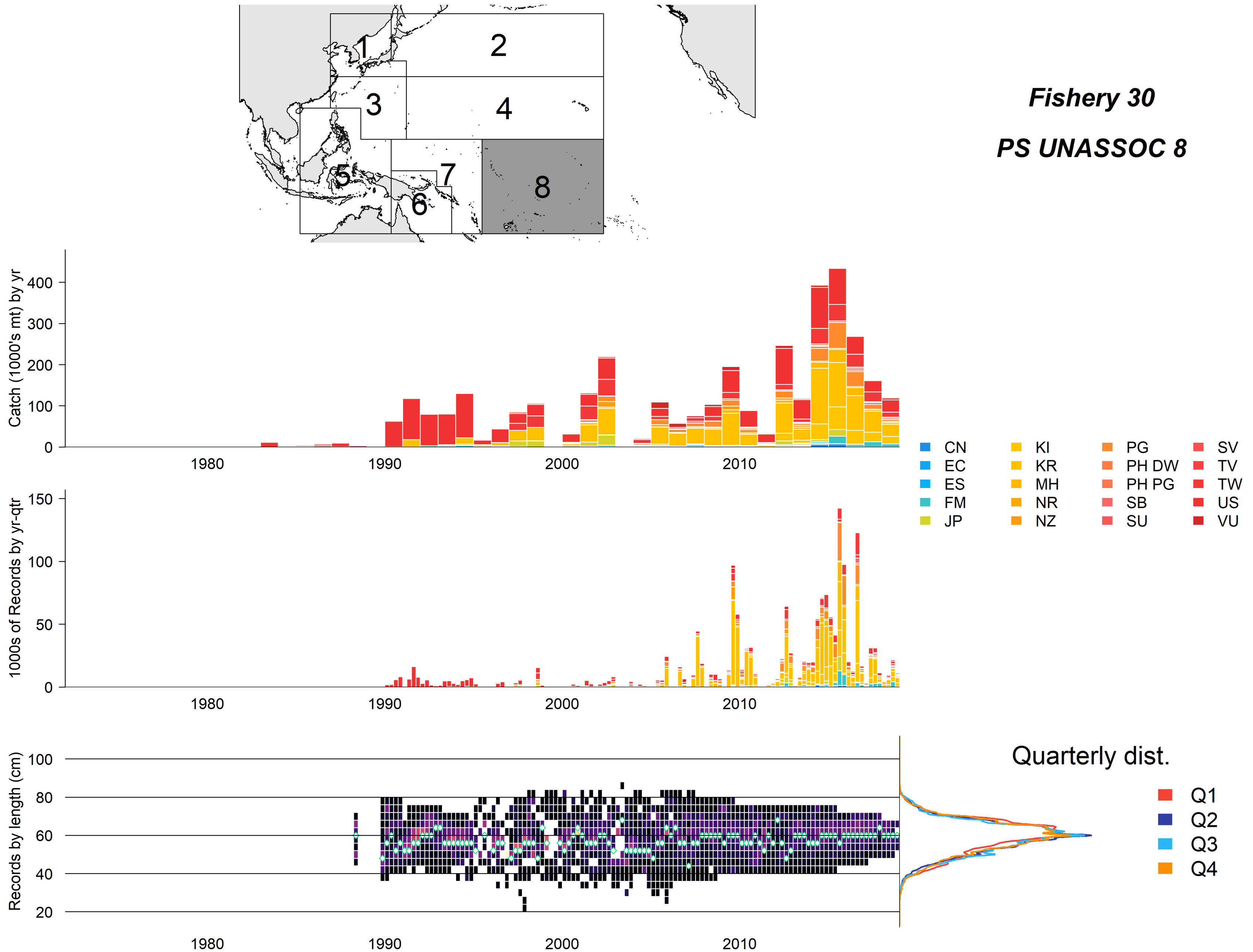


Figure 63: Same as Figure 34, except for fishery 30 of the 8 region spatial structure.

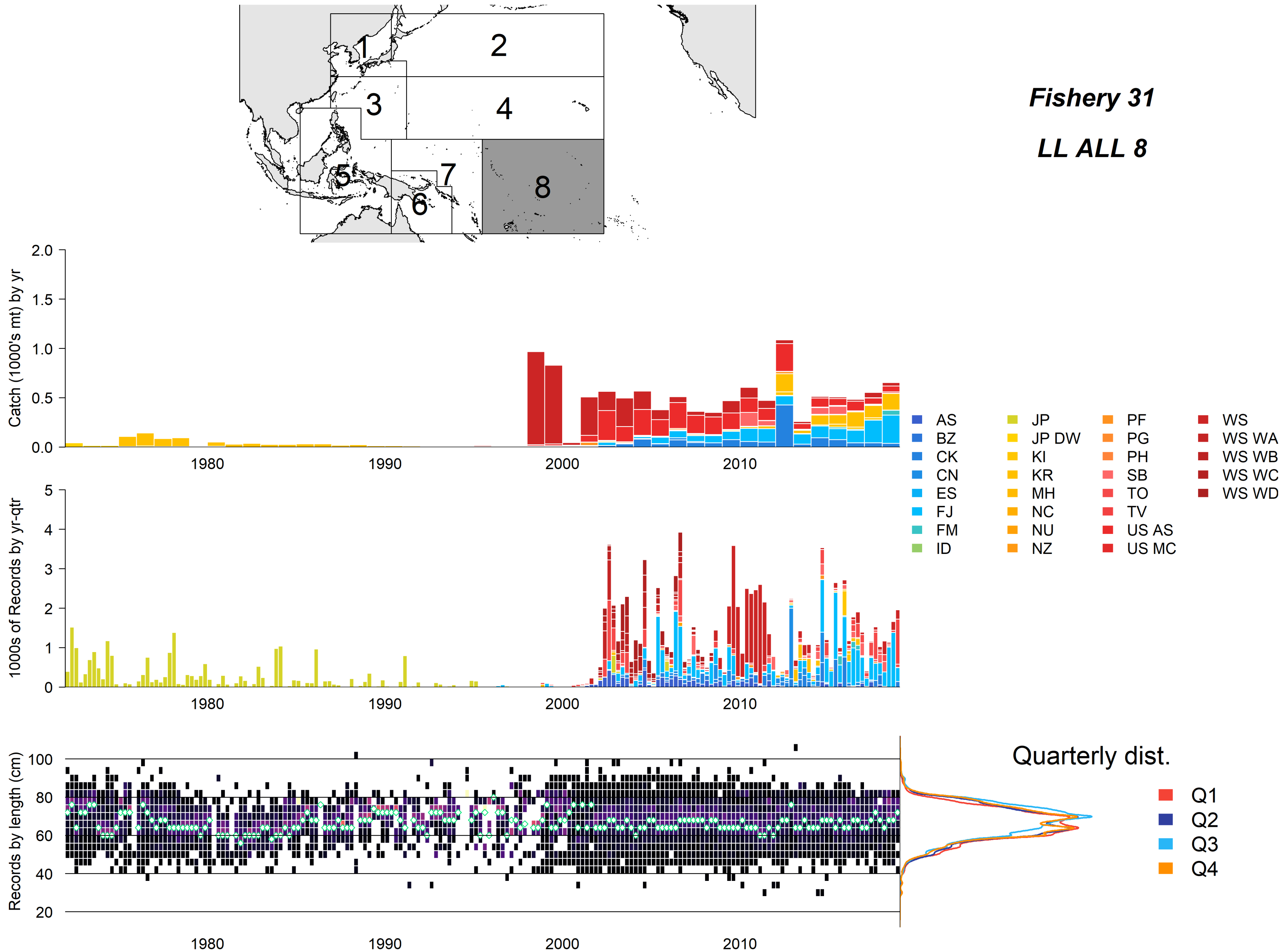


Figure 64: Same as Figure 34, except for fishery 31 of the 8 region spatial structure.