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CPUE STANDARDISATION FOR STRIPED MARLIN IN THE WESTERN AND CENTRAL PACIFIC OCEAN

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Executive summary

Indices of standardised catch per unit effort are presented for striped marlin in the WCPO from 1952 to 2011, based on separate analyses of aggregated Japanese and Taiwanese distant water longline data. This paper updates the CPUE standardisation analysis presented in Langley et al. (2006) with the addition of eight years of catch and effort data, and uses standardisation approaches similar to those of the recent WCPO tuna stock assessments.

GLMs were applied to the data for each fleet by stock assessment model Region. For the Japanese fleet data, year/quarter, hooks between floats, total hooks and latitude/longitude were included as covariates. As contrasting information on hooks between floats was absent from the Chinese Taipei data, this covariate was excluded.

The standardised indices showed a general pattern of a steep decline from the 1950s through 1960s, with a slower decline thereafter. During the 1970s and late 1990s, peaks in the Japanese indices are seen. Toward the end of the time series, a general decline in the 2000s in those series is also seen. The pattern in the most recent period (2000s) is less clear in the Chinese Taipei regional indices, with a conflict between Regions 2 and 4; the former showing an increase and then decrease in the 2000s, with the latter showing a general increase.

The highly variable and imprecise Japanese standardised indices for Region 4 are not recommended as a relative index of striped marlin abundance.

1. Introduction

The last stock assessment of striped marlin (*Tetrapturus audax*) in the southwest Pacific Ocean was performed in 2006 (Langley *et al*. 2006), using Multifan-CL (MFCL; Fournier *et al*. 1998). Within that assessment, the indices from the key fisheries were standardised using generalized linear modelling. Indices of standardized catch per unit effort (CPUE) are critical inputs into stock assessments carried out using integrated analysis methods (Fournier and Archibald 1982; Maunder 2003), including methods such as MULTIFAN-CL.

The Japanese longline fleet has the longest history of widespread fishing of any fleet operating in the Pacific Ocean (1952-present). The catch and effort series (Figure 1 to Figure 2) represent key indices of relative abundance for that part of the striped marlin biomass that is exploited by longline fisheries. These data are collected by the Japan Fisheries Agency and reported in an aggregated state, as described below. During the history of the fishery there have been systematic changes in the operation of the Japanese longline fleet that are likely to have influenced the catchability of species. These include changes in the geographic area fished (Figure 3); changed configuration of the longline gear, most notably increases in the number of hooks between floats (HBF); and changes in the principal target species. In recent years Japanese fishing effort has declined considerably, as has the area fished.

Chinese Taipei tuna fisheries also have a long history of fishing in the WCPO. Records of longline fisheries are available as far back as the 1960s (Chang et al. 2011). As the longline fisheries developed, some vessels began to fish in the waters of coastal states of the WCPO in accordance with fishing access agreements. These vessels were termed the ‘offshore longline fishery’ and the rest, which constituted the majority of the effort, was termed the ‘distant-water longline fishery’ (DWLL). The DWLL fleet provides about 45 years of fishing records since 1964, thereby offering another key index of relative abundance. As for the Japanese fleet, the species targeting by the Chinese Taipei fleet has changed over time, as well as spatially. Albacore, yellowfin and bigeye tunas have been the main species caught.

To account for temporal changes in species-specific catchability of the WCPO longline fishery, the time series data have been standardized using a variety of approaches; most recently using generalised linear modelling techniques (McCullagh and Nelder 1989; Langley 2003; Langley *et al*. 2005; Hoyle 2009). Examples of stock assessments using such indices are the MFCL assessments of yellowfin and bigeye in the WCPO (Langley et al. 2011; Davies et al. 2011).

Changes in fishing strategy can cause large changes in catch rates. However, the aggregated dataset available holds information only on grid square, month, hooks between floats (HBF), catch of the main tuna species, and number of hooks. Aggregated data provide limited opportunities to either observe or compensate for changes in fishing strategy (Hoyle *et al*. 2010). In addition, the lack of vessel information mean there is the potential for bias in the CPUE indices as it is not possible to account for some of the potential increases in efficiency over time such as the phasing out of old vessels and introduction of new ones.

This report documents the analyses undertaken to provide standardised CPUE indices for the 2012 stock assessment of striped marlin in the WCPO, based upon aggregated distant water fishing nation longline data.

2. Methods

The essentials of the method were as summarised in Langley *et al*. (2005), and updated in Hoyle (2010).

Catch and effort data for the Japanese longline fleet for the period 1952 to 2011 inclusive were available aggregated by year, month, and spatial cell. Prior to 1966, the data were available at a five degree spatial resolution, i.e., aggregated by spatial cells of dimensions 5° of latitude and longitude. From 1966, data were available at one degree spatial resolution. For years 1975 onwards, data were also stratified by the gear configuration of the longline (number of hooks between floats, HBF). In this analysis it was assumed that all longline sets before 1975 had similar gear configuration to that deployed during the early 1970s, i.e., shallow sets deploying five HBF. Catch was recorded as the number of fish caught and effort as the number of hooks set.

Catch and effort data for the Chinese Taipei longline fleet for the period 1967 to 2011 inclusive were available aggregated by year, month, and 5° spatial cell. Information on gear configuration of the longline was limited to total number of hooks deployed (hundreds of hooks).

Analyses were performed separately for the striped marlin catch rate data in each of the four geographic regions within the MFCL model, by fleet. The catch (in number) and effort (in hundreds of hooks) data were aggregated by year, quarter, five degree latitude and longitude cell, and HBF category (Japanese fleet only). Spatial cells with few records (five or less) were excluded from the data set.

GLM indices were calculated by quarter for the period within the data sets. The dependent variable in the GLMs was the natural logarithm of the 1 + catch (in numbers) .

The GLMs applied to the Japanese and Chinese Taipei data time series had similar model structures, including the categorical variables year/quarter, latitude/longitude, and the number of hooks as a continuous variable. In addition, the GLM applied to the Japanese data included the additional continuous variable hooks between floats (HBF). For both fleets in each geographic stratum, the CPUE data were offset by adding 1.

Therefore for the Japanese data, the offset natural logarithm of the catch (in numbers) per year-quarter (*t*), and stratum (*st*) defined by five degree latitude/longitude (LL) cell and HBF was predicted as follows:

$$\log(\mathrm{stm}_{t,st} + 1) = c + \alpha_t + \beta_{LL} + f(\mathrm{HBF}_{t,st}) + g\left(\log(\mathrm{hooks}_{t,st})\right) + \epsilon_{t,st}$$

The function $f(\mathrm{HBF}_{t,st})$ estimated the parameters γ_{HBF} of the ordered HBF values by fitting a cubic spline with 7 parameters. Similarly $g\left(\log(\mathrm{hooks}_{t,st})\right)$ fitted a cubic spline with 10 parameters to $\log(\mathrm{hooks}_{t,st})$. Error $\epsilon_{t,st}$ was assumed to be normally distributed.

For the Chinese Taipei data, the offset natural logarithm of the catch (in numbers) per year-quarter (*t*), and stratum (*st*) defined by five degree latitude/longitude (LL) cell was predicted as follows:

$$\log(\mathrm{stm}_{t,st} + 1) = c + \alpha_t + \beta_{LL} + g\left(\log(\mathrm{hooks}_{t,st})\right) + \epsilon_{t,st}$$

The resulting CPUE index was the exponentiated year/quarter coefficients (α) from the region-specific GLM. The relationships between predicted catch and the dependent variables included in the GLM were examined for each model. The R predict function was used to estimate time variant precision in each year/quarter time period for each geographic stratum.

3. Results

Standardised annual indices for each fleet and geographic stratum are presented in Figure 4 and the ratios of the nominal CPUE to the standardised estimates are presented in Figure 5 (see also Tables 1 and 2).

For the Japanese CPUE time series, standardising the time series in region 1 reduced the year/quarter variability seen in the nominal data. The recent trend since 2000 changed from one that declines to one that increased slightly. This is seen clearly in Figure 5 where the ratio between the nominal and standardised series declines to below 1 over that period.

In region 2, the variability in the early time series of the Japanese index appears greater in the standardised index, and the ratio between the two time series is generally below 1 until the early 1970s; the standardised index shows a rapid decline in this period. The decline in standardised CPUE appears to have occurred most notably in the fourth quarter of the year during this period (Figure 6). During the period between the mid-1970s to mid-1980s, the standardised time series appears lower than the nominal index values. This pattern reverses in the late 2000s, and a slightly steeper decline is apparent in the standardised index between the late 1990s and the end of the series. Quarterly variation has also reduced over this period. Over the whole time series the standardised index declined notably, from an average in the 1950s around 4, to a value of less than 1 in recent years. Peaks in catch rate are seen in the 1970s and the late 1990s.

The standardised Japanese time series in Region 3 is consistently higher than the nominal over the period 1970s to the late 1980s, where the ratios are less than 1, a pattern repeated in the last five years of the time series. The general trend from 1970 to the end of the series has been one of decline, with peaks in the late 1990s, as also seen in Region 2. High quarterly variation is seen (Figure 6) with high catch rates occurring in the first quarter of the year. Those quarters with high catch rates are associated with lower precision.

The paucity of observations from the Japanese time series in Region 4 results in highly variables indices with data gaps in many year/quarters after 1980. This makes interpretation of trends very difficult.

The Taiwanese time series in Regions 1 and 3 generally showed no clear overall trends. Highest catch rates in Region 1 occurred in the mid-2000s, and in the most recent year in Region 3. Both Regions 2 and 4 display an overall declining trend throughout the series, in particular during the 1970s. Catch rates were highly variable in Region 4, with peaks occurring in the late 1970s, mid 1990s and mid 2000s. In Region 4 there was an overall increasing trend since 2001, slightly more prominent in the standardised time series. Consistent with the quarterly pattern seen in the Japanese time series in Region 2, Chinese Taipei standardised catch rates in that region were higher in the final quarter of the year. In contrast, in Region 3 the Chinese Taipei catch rates tended to be higher in the third quarter of the year. There was no clear seasonal pattern in the standardised catch rates within Region 4.

The annualised indices are presented in Figure 7. For the Japanese standardised indices, the steep initial decline in region 2 was not reflected in the other three Regions. Following this initial decline, a steady decline in standardised catch rates was seen from the 1960s to the end of the time series. In Regions 1 and 3, an overall decline was seen from 1970 to 2011, with peaks seen in the 1970s and 1990s. Before the 1970s, trends were increasing and highly variable. The variable indices pre-1970 were also imprecise in Region 3 (Figure 6). As noted, the high variability and imprecision in catch rates in Region 4 prevents the clear identification of consistent trends.

Chinese Taipei annualised indices (Figure 7) show different trends among Regions, with some consistency between Regions 2 and 4. Both those Regions show a steep decline in the mid-1960s to early 1970s, and steady declines thereafter. Both also show a peak in the indices in the mid-2000s. The Region 4 index shows infrequent high indices with low precision.

The diagnostic plots for the GLM fits to the data are presented in Figure 8 for the Japanese and Figure 9 for the Chinese Taipei series. All model fits satisfy the assumptions for normality and closely follow the linear trend line.

The models were used to estimate striped marlin relative catch rates by 5° by 5° square using Japanese (Figure 10) and Chinese Taipei (Figure 11) data. Peaks in catch rate were found in both data sets at the latitude 20° to 25° S in Regions 2 and 4. In particular, high catch rates were estimated in Region 2 half way between Queensland (Australia) and New Caledonia, with another area of high catch rates at these latitudes in Region 4 visible based on the Chinese Taipei data.

4. Discussion

This paper updates the CPUE standardisation analysis presented in Langley et al. (2006) with the addition of eight years of catch and effort data, and uses approaches similar to those of the recent WCPO tuna stock assessments. The trends in the indices developed in the current paper for the Japanese fleet (all four Regions) and Chinese Taipei fleet (Region 4) are comparable to those presented in the 2006 southeastern Pacific striped marlin assessment (Langley et al. 2006; see Figure 6 of that paper).

The general patterns from the standardised indices are a steep decline from the 1950s through 1960s, with a slower decline thereafter. During the 1970s and late 1990s, peaks in the Japanese indices are seen. Toward the end of those time series, a general decline in the 2000s is also seen. The pattern in the most recent period is less clear in the Chinese Taipei regional indices, with a conflict between Regions 2 and 4; the former showing an increase and then decrease in the 2000s, with the latter showing a general increase.

These indices are not adjusted for changes in catchability associated with changes in fleet composition, as estimated in analyses of Japanese longline operational catch and effort data for bigeye tuna (Hoyle et al. 2010). Nor are they adjusted for changes in catchability that may have occurred within existing vessels.

This analysis also did not consider the impact of targeting practices, nor changes in those practices during the time series (Hoyle and Okamoto 2011). Using a targeting indicator based upon catch rates of associated species may explain some of the variability both within and among regions identified in the current study. For example, this may have been a factor in the visibly conflicting trends in Regions 1 and 3 for the Chinese Taipei standardised catch rate series. Since striped marlin is a bycatch of the tuna-target fishery for both Japanese and Chinese Taipei fleets, changes in the targeting practices through time should be identified as they will affect striped marlin catch rates. This should be a focus for future research.

Given the paucity of data, and consequently the highly variable and imprecise indices generated for Region 4, we do not recommend using the Japanese index for this region as a relative index of striped marlin abundance.

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6. Tables

Table 1: Estimated striped marlin CPUE and CV from JP LL data.

	cpue1	cv1	cpue2	cv2	cpue3	cv3	cpue4	cv4
1952.125	0.398	0.41	-	-	-	-	-	-
1952.375	0.353	0.27	-	-	-	-	-	-
1952.625	0.388	0.22	-	-	-	-	-	-
1952.875	0.39	0.21	12.8	0.88	1.44	1.1	-	-
1953.125	0.866	0.18	0.224	0.35	-	-	-	-
1953.375	0.781	0.18	-	-	-	-	-	-
1953.625	0.614	0.19	5.64	0.6	-	-	-	-
1953.875	0.933	0.19	12.4	0.43	-	-	-	-
1954.125	1.24	0.15	0.441	0.24	-	-	-	-
1954.375	1.93	0.14	0.476	0.35	-	-	-	-
1954.625	2.15	0.19	3.82	0.2	-	-	-	-
1954.875	2.11	0.15	8.22	0.18	-	-	0.796	0.48
1955.125	1.36	0.13	1.13	0.21	4.19	0.95	0.312	0.55
1955.375	1.2	0.13	1.21	0.3	-	-	0.669	0.67
1955.625	1.61	0.12	2.08	0.18	-	-	2.22	0.47
1955.875	1.97	0.12	5.4	0.2	-	-	1.46	0.26
1956.125	0.885	0.11	0.558	0.27	-	-	0.292	0.39
1956.375	0.965	0.12	0.684	0.25	-	-	-	-
1956.625	1.03	0.15	2	0.19	2.6	0.67	2.64	0.54
1956.875	1.53	0.13	4.47	0.18	1.48	0.48	1.62	0.33
1957.125	0.674	0.12	0.331	0.35	-	-	0.133	0.43
1957.375	0.509	0.13	0.958	0.49	-	-	-	-
1957.625	1.09	0.13	1.59	0.18	0.534	0.55	1.5	0.39
1957.875	1.14	0.11	3.33	0.19	0.207	0.34	0.953	0.3
1958.125	1.02	0.12	0.503	0.35	4.38	0.55	0.211	0.29
1958.375	0.674	0.12	0.0951	0.61	-	-	0.102	0.67
1958.625	1.54	0.12	1.25	0.18	0.785	0.32	1.24	0.28
1958.875	2.18	0.11	3.75	0.18	0.411	0.36	1.6	0.25
1959.125	0.662	0.11	0.265	0.3	-	-	0.61	0.28
1959.375	0.831	0.12	0.881	0.24	0.885	0.55	0.123	0.95
1959.625	1.44	0.11	1.66	0.18	0.355	0.36	0.326	0.3
1959.875	1.63	0.12	3.11	0.19	0.263	0.36	0.88	0.42
1960.125	0.656	0.11	0.529	0.27	-	-	0.289	0.42
1960.375	0.938	0.12	1.31	0.23	1.32	0.48	0.766	0.55
1960.625	1.41	0.11	2	0.19	0.214	0.39	0.633	0.27
1960.875	1.39	0.12	2.72	0.19	0.164	0.43	1.11	0.32
1961.125	0.485	0.11	0.288	0.33	-	-	0.553	0.67
1961.375	0.619	0.12	1.12	0.27	0.0556	0.55	0.0504	0.55
1961.625	1.13	0.11	2.48	0.18	0.18	0.26	0.574	0.55
1961.875	1.24	0.11	4.49	0.18	0.163	0.39	3.29	0.42
1962.125	1.07	0.11	0.564	0.24	-	-	0.229	0.54
1962.375	0.711	0.11	0.325	0.22	0.929	0.67	0.584	0.33
1962.625	1.31	0.11	1.08	0.18	0.208	0.48	0.86	0.24
1962.875	1.14	0.1	3.61	0.19	0.279	0.39	0.627	0.22
1963.125	0.819	0.11	0.263	0.29	-	-	0.207	0.29
1963.375	1.15	0.11	0.589	0.2	1.07	0.26	0.594	0.21
1963.625	1.74	0.11	0.608	0.19	0.811	0.24	0.684	0.19
1963.875	2.31	0.11	3.18	0.18	0.427	0.32	0.81	0.22
1964.125	0.995	0.1	0.463	0.21	0.681	0.43	0.469	0.25
1964.375	0.924	0.11	0.398	0.24	0.578	0.34	0.998	0.32
1964.625	0.889	0.11	0.726	0.18	1.04	0.28	0.979	0.24
1964.875	1.36	0.1	2.58	0.18	0.476	0.29	0.757	0.25
1965.125	3.21	0.11	1.15	0.23	1.97	0.48	0.286	0.3
1965.375	2.04	0.11	0.64	0.27	1.1	0.3	0.145	0.36
1965.625	1.72	0.1	0.735	0.18	0.216	0.27	0.785	0.21
1965.875	1.21	0.11	1.79	0.19	0.249	0.28	0.866	0.21
1966.125	1.37	0.1	0.641	0.2	2.03	0.43	0.212	0.25
1966.375	2.02	0.1	0.673	0.19	0.978	0.26	0.578	0.43

1966.625	1.13	0.11	0.944	0.18	0.401	0.25	0.732	0.22
1966.875	1.53	0.1	1.62	0.18	0.304	0.26	0.47	0.21
1967.125	1.26	0.11	0.375	0.2	2.73	0.55	0.243	0.24
1967.375	1.14	0.11	0.33	0.19	0.875	0.27	0.45	0.24
1967.625	1.31	0.11	0.528	0.18	0.487	0.25	0.789	0.2
1967.875	1.34	0.11	0.978	0.19	1.41	0.43	0.714	0.2
1968.125	1.59	0.11	0.593	0.23	1.31	0.39	0.211	0.21
1968.375	1.1	0.11	0.451	0.19	1.32	0.27	0.792	0.24
1968.625	1.24	0.13	0.573	0.18	0.41	0.28	0.917	0.27
1968.875	1.15	0.12	1.18	0.19	0.744	0.55	1.02	0.24
1969.125	1.36	0.12	0.71	0.29	2.54	0.26	0.822	0.34
1969.375	1.09	0.13	0.339	0.26	0.61	0.27	0.683	0.43
1969.625	0.796	0.13	0.56	0.2	0.265	0.27	0.716	0.3
1969.875	1.53	0.12	1.68	0.26	0.758	0.34	1.33	0.31
1970.125	1.77	0.13	1.08	0.3	5.14	0.26	0.478	0.26
1970.375	1.8	0.13	0.518	0.3	1.78	0.26	0.78	0.31
1970.625	1.2	0.13	1.39	0.2	0.635	0.29	0.919	0.21
1970.875	1.87	0.13	2.76	0.24	2.35	0.28	1.44	0.2
1971.125	1.89	0.11	0.549	0.23	7.04	0.27	0.508	0.43
1971.375	1.45	0.13	0.767	0.29	1.01	0.25	0.824	0.43
1971.625	1.3	0.13	1.34	0.23	0.49	0.29	0.567	0.36
1971.875	1.94	0.13	2.42	0.22	0.556	0.3	1.26	0.42
1972.125	1.62	0.13	1.14	0.22	3.85	0.26	-	-
1972.375	1.54	0.14	0.671	0.3	1.95	0.28	-	-
1972.625	1.47	0.13	1.24	0.19	0.287	0.28	2.76	0.47
1972.875	1.2	0.12	3.06	0.22	0.372	0.39	2	0.39
1973.125	1.15	0.13	1.05	0.27	5.66	0.27	-	-
1973.375	1.49	0.15	0.164	0.32	1.08	0.3	-	-
1973.625	1.52	0.13	0.414	0.26	0.457	0.29	1.22	0.55
1973.875	1.72	0.16	1.68	0.27	1.93	0.39	1.06	0.47
1974.125	1.15	0.14	0.972	0.27	5.69	0.27	-	-
1974.375	1.46	0.15	0.362	0.35	1.05	0.27	-	-
1974.625	1.51	0.13	0.792	0.26	0.608	0.32	1.19	0.27
1974.875	1.42	0.13	1.08	0.24	0.801	0.34	1.29	0.55
1975.125	0.816	0.09	1.03	0.27	2.99	0.19	0.227	0.94
1975.375	1.29	0.094	0.594	0.38	0.724	0.21	-	-
1975.625	1.22	0.065	0.662	0.25	0.265	0.28	0.398	0.55
1975.875	0.983	0.06	2.17	0.27	1.38	0.55	0.985	0.68
1976.125	0.818	0.065	0.946	0.21	3.1	0.17	0.486	0.4
1976.375	1.02	0.069	0.28	0.32	0.443	0.21	0.422	0.67
1976.625	1.18	0.062	0.562	0.25	0.357	0.24	1.9	0.56
1976.875	1.02	0.054	1.01	0.32	1.84	0.48	2.04	0.28
1977.125	0.708	0.065	1.27	0.35	2.02	0.23	0.221	0.98
1977.375	0.819	0.069	0.221	0.49	0.589	0.21	-	-
1977.625	0.933	0.06	0.422	0.43	0.152	0.34	0.925	0.49
1977.875	0.827	0.057	1.15	0.23	0.884	0.55	0.898	0.41
1978.125	0.756	0.066	0.955	0.22	1.91	0.21	-	-
1978.375	0.94	0.08	0.223	0.43	1.63	0.27	-	-
1978.625	1.1	0.063	0.786	0.26	0.43	0.34	0.98	0.4
1978.875	0.988	0.054	1.47	0.21	0.78	0.48	1.33	0.45
1979.125	0.731	0.066	1.18	0.26	1.66	0.32	-	-
1979.375	0.825	0.07	0.399	0.32	0.735	0.19	-	-
1979.625	0.844	0.06	0.915	0.2	0.238	0.16	-	-
1979.875	0.912	0.052	1.18	0.21	1.07	0.55	0.829	0.45
1980.125	0.848	0.053	0.855	0.25	3.03	0.27	0.184	0.94
1980.375	0.779	0.055	0.146	0.32	0.515	0.2	-	-
1980.625	0.91	0.048	0.518	0.19	0.206	0.19	-	-
1980.875	0.884	0.048	1.05	0.16	0.33	0.3	-	-
1981.125	0.796	0.05	0.682	0.21	2.56	0.2	1.22	0.49
1981.375	0.737	0.054	0.287	0.3	0.982	0.21	-	-
1981.625	0.745	0.057	0.806	0.17	0.329	0.18	-	-
1981.875	0.844	0.048	1.27	0.14	0.571	0.32	-	-
1982.125	0.547	0.054	0.408	0.15	2.25	0.19	-	-

1982.375	0.666	0.055	0.281	0.18	0.644	0.18	4.83	0.62
1982.625	0.736	0.051	0.69	0.16	0.312	0.17	-	-
1982.875	0.615	0.055	1.54	0.13	1.81	0.95	2.25	0.96
1983.125	0.652	0.059	0.586	0.17	2.57	0.19	-	-
1983.375	0.735	0.078	0.105	0.38	0.481	0.19	-	-
1983.625	0.647	0.069	0.631	0.15	0.26	0.17	-	-
1983.875	0.799	0.055	1.13	0.15	0.568	0.34	-	-
1984.125	0.747	0.057	0.743	0.24	2.64	0.22	-	-
1984.375	0.713	0.061	0.236	0.29	0.757	0.18	-	-
1984.625	0.727	0.069	0.737	0.15	0.296	0.16	-	-
1984.875	0.743	0.056	0.781	0.17	-	-	-	-
1985.125	0.52	0.061	0.568	0.17	1.73	0.29	-	-
1985.375	0.604	0.058	0.335	0.26	0.638	0.21	-	-
1985.625	0.685	0.062	0.571	0.16	0.322	0.19	-	-
1985.875	0.668	0.053	0.617	0.19	1.2	0.95	0.21	0.99
1986.125	0.594	0.055	0.306	0.17	1.58	0.22	-	-
1986.375	0.662	0.074	0.361	0.21	0.667	0.17	-	-
1986.625	0.605	0.067	0.453	0.19	0.299	0.17	-	-
1986.875	0.723	0.076	1.08	0.19	0.54	0.36	0.495	0.67
1987.125	0.573	0.088	0.279	0.2	1.52	0.18	-	-
1987.375	0.605	0.14	0.239	0.26	0.327	0.19	-	-
1987.625	0.76	0.072	0.5	0.17	0.368	0.18	-	-
1987.875	0.813	0.071	0.632	0.2	-	-	5.11	0.99
1988.125	0.975	0.075	0.24	0.16	1.27	0.28	-	-
1988.375	0.822	0.078	0.357	0.22	0.406	0.17	-	-
1988.625	0.869	0.067	0.52	0.16	0.357	0.17	1.45	0.65
1988.875	1.12	0.077	0.856	0.18	0.371	0.55	-	-
1989.125	0.845	0.076	0.178	0.21	2.46	0.55	-	-
1989.375	0.79	0.083	0.549	0.18	0.705	0.2	2.29	0.58
1989.625	0.895	0.071	0.76	0.18	0.316	0.18	0.65	0.48
1989.875	0.884	0.075	1.68	0.18	0.476	0.67	2.57	0.51
1990.125	0.507	0.081	0.393	0.16	0.91	0.43	-	-
1990.375	0.638	0.089	0.44	0.22	0.436	0.19	-	-
1990.625	0.72	0.069	0.514	0.13	0.263	0.15	-	-
1990.875	0.699	0.068	0.886	0.17	-	-	0.826	1
1991.125	0.584	0.072	0.359	0.2	0.375	0.32	-	-
1991.375	0.535	0.085	0.453	0.22	0.355	0.18	-	-
1991.625	0.621	0.079	0.483	0.18	0.209	0.19	-	-
1991.875	0.697	0.079	1.84	0.2	-	-	0.808	1
1992.125	0.612	0.1	0.211	0.19	0.678	0.3	-	-
1992.375	0.577	0.12	0.129	0.43	0.349	0.19	-	-
1992.625	0.741	0.07	0.445	0.16	0.174	0.15	0.615	0.44
1992.875	1.37	0.076	0.789	0.32	-	-	0.7	0.49
1993.125	0.956	0.085	0.255	0.23	1.65	0.25	-	-
1993.375	0.695	0.069	0.497	0.17	0.455	0.19	-	-
1993.625	0.876	0.061	0.651	0.15	0.306	0.2	-	-
1993.875	1.09	0.064	0.681	0.32	0.0817	0.67	0.337	0.98
1994.125	0.917	0.066	0.541	0.17	2.1	0.25	-	-
1994.375	0.911	0.063	0.593	0.14	0.702	0.18	-	-
1994.625	1.02	0.055	0.652	0.12	0.254	0.25	-	-
1994.875	0.977	0.057	1.75	0.22	0.53	0.95	-	-
1995.125	0.805	0.06	0.262	0.15	2.25	0.24	-	-
1995.375	0.797	0.066	0.385	0.12	1.04	0.18	-	-
1995.625	0.87	0.066	0.752	0.15	0.297	0.22	-	-
1995.875	0.956	0.068	0.84	0.18	1.78	0.95	-	-
1996.125	0.677	0.086	0.291	0.18	2.28	0.23	-	-
1996.375	0.742	0.07	0.29	0.17	0.457	0.15	-	-
1996.625	1.06	0.07	0.514	0.15	0.256	0.2	-	-
1996.875	1.29	0.099	1.71	0.49	-	-	-	-
1997.125	0.967	0.095	0.557	0.3	1.96	0.24	-	-
1997.375	0.936	0.1	0.337	0.24	0.418	0.17	-	-
1997.625	1.16	0.072	0.735	0.15	0.23	0.23	-	-
1997.875	1.21	0.096	0.583	0.85	0.863	0.67	-	-

1998.125	0.701	0.089	1.63	0.22	4.14	0.23	-	-
1998.375	0.966	0.092	0.686	0.29	1.07	0.18	-	-
1998.625	1.31	0.058	1.39	0.15	0.254	0.18	4.53	0.87
1998.875	0.903	0.076	0.902	0.35	0.861	0.67	-	-
1999.125	0.816	0.13	0.891	0.22	2.85	0.28	-	-
1999.375	0.951	0.085	0.356	0.2	0.711	0.22	1.59	0.7
1999.625	1.39	0.071	0.725	0.19	0.215	0.15	5.04	0.68
1999.875	1.56	0.099	1.03	0.6	-	-	1.28	0.83
2000.125	0.865	0.068	0.201	0.23	1.96	0.3	-	-
2000.375	0.835	0.074	0.098	0.2	0.283	0.2	-	-
2000.625	0.857	0.068	0.395	0.49	0.168	0.18	0.147	1.2
2000.875	0.9	0.083	1.87	0.6	1.05	0.67	1.26	1
2001.125	0.54	0.087	0.0726	0.49	1.83	0.55	0.428	0.84
2001.375	0.773	0.1	0.411	0.3	0.311	0.2	-	-
2001.625	0.718	0.073	0.342	0.22	0.283	0.18	0.687	1.1
2001.875	0.699	0.074	0.669	0.23	0.453	0.34	0.715	0.71
2002.125	0.603	0.074	0.46	0.29	0.685	0.24	-	-
2002.375	0.643	0.08	0.1	0.2	0.173	0.22	-	-
2002.625	0.745	0.067	0.184	0.18	0.125	0.18	-	-
2002.875	0.72	0.065	0.263	0.27	-	-	0.596	0.71
2003.125	0.674	0.071	0.519	0.25	1.31	0.3	-	-
2003.375	0.686	0.082	0.379	0.23	0.167	0.22	-	-
2003.625	0.763	0.076	0.563	0.18	0.204	0.19	0.416	0.51
2003.875	0.744	0.074	0.716	0.29	0.165	0.27	-	-
2004.125	0.722	0.079	0.374	0.25	1.16	0.39	-	-
2004.375	0.841	0.085	0.196	0.35	0.246	0.22	-	-
2004.625	0.874	0.073	0.276	0.25	0.203	0.17	0.573	1.2
2004.875	0.885	0.076	0.343	0.31	0.324	0.43	-	-
2005.125	0.628	0.084	0.245	0.27	0.527	0.36	-	-
2005.375	0.809	0.095	0.0884	0.33	0.182	0.22	-	-
2005.625	0.92	0.085	0.136	0.27	0.147	0.17	-	-
2005.875	1.14	0.12	0.365	0.35	0.268	0.55	-	-
2006.125	0.848	0.11	0.361	0.38	0.918	0.32	-	-
2006.375	0.712	0.093	0.23	0.22	0.214	0.2	-	-
2006.625	0.932	0.077	0.292	0.18	0.149	0.25	1.68	1.1
2006.875	0.817	0.092	0.394	0.39	0.131	0.39	1.69	1.1
2007.125	0.655	0.088	0.256	0.28	0.703	0.39	0.0714	0.96
2007.375	0.709	0.12	0.289	0.27	0.288	0.24	-	-
2007.625	1.03	0.088	0.195	0.23	0.178	0.23	0.921	1.1
2007.875	1.08	0.091	0.395	0.43	0.216	0.43	-	-
2008.125	0.769	0.15	0.435	0.6	2.15	0.55	-	-
2008.375	0.969	0.25	0.507	0.85	0.631	0.48	-	-
2008.625	1.24	0.18	0.558	0.6	0.133	0.67	-	-
2008.875	0.515	0.41	-	-	-	-	-	-
2009.125	0.523	0.083	0.238	0.43	0.927	0.32	-	-
2009.375	0.763	0.11	0.34	0.35	0.248	0.21	-	-
2009.625	0.743	0.087	0.33	0.25	0.186	0.25	-	-
2009.875	0.644	0.09	0.429	0.49	0.2	0.67	0.303	1.1
2010.125	0.51	0.089	0.172	0.49	1.99	0.27	-	-
2010.375	0.844	0.084	0.331	0.28	0.394	0.24	-	-
2010.625	0.754	0.078	0.197	0.26	0.215	0.39	-	-
2010.875	0.804	0.067	0.409	0.85	-	-	0.435	1.1
2011.125	0.695	0.079	0.555	0.5	1.71	0.32	0.655	1.2
2011.375	0.814	0.091	0.248	0.22	0.385	0.21	-	-
2011.625	0.851	0.084	0.147	0.23	0.269	0.25	-	-
2011.875	0.789	0.12	0.435	0.35	0.347	0.39	-	-

Table 2: Estimated striped marlin CPUE and CV from TW LL data

	cpue1	cv1	cpue2	cv2	cpue3	cv3	cpue4	cv4
1967.125	1.2	0.36	-	-	-	-	-	-
1967.375	0.456	0.34	7.5	1.1	-	-	7.62	0.53
1967.625	0.619	0.21	0.65	0.44	-	-	6.9	0.47
1967.875	1.01	0.21	0.865	0.76	-	-	8.1	0.48
1968.125	0.757	0.17	0.332	0.63	-	-	0.809	0.31
1968.375	0.412	0.19	1.44	0.36	1.51	0.93	1.83	0.28
1968.625	0.591	0.19	1.92	0.28	1.46	0.93	1.57	0.37
1968.875	1.2	0.17	1.67	0.41	-	-	0.912	0.33
1969.125	0.576	0.18	0.68	0.41	-	-	1.18	0.4
1969.375	0.4	0.21	0.923	0.48	-	-	4.63	0.74
1969.625	0.731	0.34	5.18	0.48	-	-	-	-
1969.875	0.989	0.21	0.664	0.63	-	-	2.15	0.74
1970.125	0.687	0.23	0.419	0.41	-	-	0.35	0.74
1970.375	1.38	0.19	0.633	0.44	1.72	0.93	1.92	1
1970.625	1.88	0.18	6.52	0.31	1.19	0.92	1.63	0.24
1970.875	2.13	0.16	6.26	0.3	-	-	0.406	0.47
1971.125	0.797	0.16	0.856	0.34	-	-	0.768	0.53
1971.375	0.526	0.17	1.19	0.27	1.09	0.47	1.17	0.23
1971.625	0.993	0.16	3.18	0.23	0.849	0.66	1.15	0.25
1971.875	1.43	0.16	3.31	0.31	-	-	2.08	0.37
1972.125	1.3	0.16	1.35	0.38	-	-	0.682	0.36
1972.375	1.15	0.16	1.07	0.3	2.05	0.54	2.6	0.35
1972.625	1.73	0.19	3.89	0.24	2.08	0.66	1.71	0.23
1972.875	2.33	0.17	6.01	0.3	3.58	0.95	1.85	0.26
1973.125	0.916	0.16	1.21	0.28	-	-	0.561	0.26
1973.375	0.649	0.19	0.95	0.31	0.49	0.38	1.84	0.29
1973.625	1.11	0.19	1.63	0.27	0.465	0.93	0.877	0.27
1973.875	0.965	0.18	1.22	0.38	-	-	0.449	0.4
1974.125	0.757	0.17	0.492	0.34	0.649	0.95	0.367	0.26
1974.375	0.504	0.28	0.632	0.31	0.423	0.29	0.747	0.22
1974.625	0.638	0.19	0.322	0.29	0.313	0.54	2.19	0.25
1974.875	1.15	0.2	1.53	0.34	-	-	1.2	0.43
1975.125	0.851	0.18	0.486	0.36	3.38	0.94	0.455	0.29
1975.375	0.657	0.19	0.683	0.27	1.49	0.31	0.61	0.23
1975.625	1.36	0.21	1.49	0.23	0.929	0.46	0.6	0.25
1975.875	1.8	0.22	1.11	0.34	-	-	0.791	0.47
1976.125	0.592	0.21	0.735	0.36	-	-	0.221	0.48
1976.375	0.601	0.22	1.29	0.36	1.88	0.47	0.513	0.3
1976.625	1.2	0.25	1.32	0.25	0.114	0.93	0.977	0.32
1976.875	0.721	0.19	0.72	0.34	0.148	0.95	8.42	0.47
1977.125	1.46	0.18	0.923	0.41	-	-	0.283	0.43
1977.375	0.879	0.22	0.31	0.33	1.46	0.39	0.984	0.25
1977.625	1.45	0.2	0.854	0.24	1.57	0.38	0.919	0.22
1977.875	0.989	0.17	1.54	0.38	-	-	1.87	0.31
1978.125	1.51	0.15	0.74	0.36	0.616	0.46	1.02	0.35
1978.375	1.37	0.17	0.756	0.31	1.6	0.35	0.67	0.22
1978.625	1.19	0.19	1.15	0.26	3.12	0.93	1.29	0.23
1978.875	1.46	0.18	3.39	0.41	-	-	1.04	0.31
1979.125	0.859	0.16	0.655	0.44	-	-	2.01	0.37
1979.375	1.03	0.2	0.848	0.3	1.63	0.31	0.765	0.25
1979.625	1.36	0.17	1.22	0.24	0.803	0.38	0.957	0.22
1979.875	2.35	0.16	1.37	0.31	-	-	1.98	0.52
1980.125	1.7	0.16	0.675	0.36	0.791	0.93	1.32	0.33
1980.375	1.28	0.17	0.962	0.27	1.11	0.28	0.807	0.23
1980.625	1.41	0.16	0.849	0.25	0.414	0.38	0.563	0.23
1980.875	1.22	0.16	1.97	0.33	-	-	0.484	0.47
1981.125	1.08	0.15	1.1	0.3	0.793	0.48	0.808	0.37
1981.375	0.761	0.17	0.748	0.25	1.39	0.28	0.894	0.21
1981.625	1.5	0.18	1.19	0.25	1.03	0.35	0.845	0.22
1981.875	1.59	0.17	2.78	0.36	-	-	0.996	0.32

1982.125	1.66	0.17	0.645	0.41	-	-	0.557	0.29
1982.375	1.54	0.22	1.12	0.34	0.721	0.46	0.468	0.22
1982.625	0.807	0.2	1.21	0.25	3.98	0.93	1.01	0.2
1982.875	0.823	0.19	0.858	0.31	-	-	0.609	0.61
1983.125	1.36	0.19	0.838	0.44	0.293	0.93	0.531	0.3
1983.375	0.769	0.29	0.656	0.34	0.48	0.37	0.421	0.24
1983.625	1.11	0.34	0.504	0.25	0.659	0.65	1	0.37
1983.875	1.03	0.23	0.638	0.33	-	-	0.829	0.53
1984.125	1.27	0.22	0.67	0.33	0.482	0.93	0.435	0.37
1984.375	0.636	0.36	1.22	0.31	0.885	0.3	0.627	0.24
1984.625	1.3	0.21	1.51	0.25	0.73	0.46	0.891	0.26
1984.875	1.19	0.24	1.03	0.41	-	-	0.409	0.37
1985.125	1.47	0.24	0.932	0.33	-	-	0.43	0.43
1985.375	0.613	0.43	0.748	0.34	0.915	0.37	0.356	0.3
1985.625	0.73	0.3	0.412	0.29	0.361	0.93	0.753	0.35
1985.875	0.76	0.26	1.17	0.41	-	-	1.46	0.61
1986.125	0.498	0.26	0.265	0.41	-	-	0.899	0.47
1986.375	0.608	0.3	0.496	0.33	0.933	0.46	0.147	0.37
1986.625	0.415	0.43	0.61	0.38	-	-	0.213	0.4
1986.875	0.547	0.3	0.939	0.48	-	-	0.246	1
1987.125	0.613	0.22	0.56	0.54	-	-	0.32	0.35
1987.375	0.529	0.48	0.277	0.62	-	-	0.176	0.26
1987.625	0.78	0.43	0.578	0.33	-	-	0.442	0.35
1987.875	0.928	0.26	0.494	0.33	-	-	-	-
1988.125	0.537	0.28	1.28	0.41	-	-	0.51	0.37
1988.375	0.175	0.67	0.215	0.76	-	-	0.124	0.26
1988.625	0.858	0.34	0.766	0.34	-	-	0.812	0.53
1988.875	0.536	0.29	0.55	0.38	-	-	1.28	1
1989.125	0.299	0.29	0.179	0.77	-	-	0.238	0.37
1989.375	0.609	0.39	1.23	0.31	0.604	0.35	0.148	0.29
1989.625	0.757	0.27	0.716	0.32	0.16	0.65	0.924	0.47
1989.875	0.456	0.3	0.87	0.77	-	-	0.532	0.74
1990.125	0.198	0.29	1.05	1.1	0.223	0.93	0.164	0.61
1990.375	0.0353	0.67	0.625	0.62	0.616	0.56	0.0845	1
1990.625	0.412	0.43	1.42	0.44	-	-	0.702	0.37
1990.875	0.196	0.24	0.784	0.54	-	-	0.0169	1
1991.125	0.307	0.2	0.204	0.62	-	-	0.109	0.74
1991.375	0.183	0.48	0.103	0.62	0.912	0.37	0.26	0.53
1991.625	0.596	0.26	0.32	0.34	0.324	0.66	1.58	0.43
1991.875	0.628	0.26	0.118	1.1	-	-	0.42	0.75
1992.125	0.0539	0.67	-	-	-	-	0.23	0.28
1992.375	-	-	-	-	-	-	0.203	0.27
1992.625	1.78	0.95	0.993	1.1	-	-	0.136	0.27
1992.875	0.0909	0.95	-	-	-	-	0.182	0.23
1993.125	0.396	0.34	0.605	0.44	1.22	0.92	0.487	0.21
1993.375	1.25	0.43	0.295	0.34	0.195	0.37	0.506	0.24
1993.625	0.664	0.43	0.318	0.29	-	-	0.463	0.24
1993.875	0.719	0.36	1.01	0.33	-	-	0.666	0.24
1994.125	2.1	0.23	2.29	0.48	-	-	2.14	0.21
1994.375	2.08	0.36	0.68	0.3	0.612	0.38	0.866	0.22
1994.625	1.64	0.25	1.01	0.31	-	-	0.98	0.24
1994.875	0.754	0.3	0.779	0.41	-	-	1.88	0.43
1995.125	0.778	0.34	0.391	0.48	-	-	0.964	0.61
1995.375	0.324	0.39	0.114	0.44	0.195	0.94	1.78	0.74
1995.625	0.213	0.36	0.805	0.31	-	-	0.223	0.74
1995.875	0.59	0.34	0.708	0.33	-	-	0.747	0.52
1996.125	0.456	0.34	0.364	0.41	0.477	0.66	1	0.33
1996.375	0.483	0.95	1.19	0.36	0.898	0.35	0.396	0.26
1996.625	1.4	0.67	0.848	0.31	-	-	0.736	0.37
1996.875	0.623	0.32	0.392	0.44	1.73	0.93	0.854	0.53
1997.125	0.429	0.39	0.104	0.76	1.62	0.54	0.312	0.35
1997.375	-	-	0.442	0.54	1.09	0.38	0.242	0.25
1997.625	1.41	0.48	0.657	0.29	-	-	1.25	0.43

1997.875	0.44	0.48	1.04	0.41	-	-	1.22	0.47
1998.125	0.206	0.3	0.223	0.54	-	-	0.32	0.52
1998.375	0.39	0.34	1.39	0.54	0.754	0.47	0.214	0.29
1998.625	0.295	0.95	0.0713	0.34	-	-	0.188	0.74
1998.875	-	-	0.518	0.77	-	-	0.144	0.61
1999.125	0.69	0.27	0.279	0.48	0.203	0.53	0.247	0.28
1999.375	0.439	0.39	0.342	0.36	0.457	0.41	0.662	0.25
1999.625	1.37	0.32	0.406	0.33	0.33	0.65	0.308	0.37
1999.875	0.936	0.32	1.41	0.54	-	-	0.205	0.61
2000.125	0.517	0.21	0.354	0.41	-	-	0.638	0.25
2000.375	0.772	0.21	0.168	0.41	0.338	0.34	0.619	0.25
2000.625	1.08	0.23	0.276	0.3	0.121	0.65	0.657	0.35
2000.875	1.06	0.21	0.402	0.49	-	-	0.126	0.61
2001.125	0.4	0.21	0.0833	0.5	-	-	0.049	0.74
2001.375	1.31	0.2	0.351	0.44	-	-	0.176	0.25
2001.625	0.945	0.23	0.651	0.41	-	-	0.19	0.32
2001.875	0.732	0.21	-	-	-	-	0.132	0.43
2002.125	0.771	0.26	0.0369	0.49	1.07	0.93	0.802	0.33
2002.375	0.825	0.24	0.677	0.34	1.17	0.38	0.931	0.28
2002.625	2.66	0.24	1.12	0.3	0.496	0.54	1.18	0.33
2002.875	1.57	0.25	1.29	0.48	-	-	2.12	1.1
2003.125	1.43	0.16	1.07	0.36	0.745	0.41	0.874	0.25
2003.375	2.07	0.15	0.914	0.34	1.14	0.32	1.36	0.21
2003.625	3.54	0.17	1.55	0.33	1.2	0.92	1.33	0.21
2003.875	2.32	0.2	0.328	0.62	-	-	1.2	0.33
2004.125	2.35	0.17	1.29	0.31	-	-	1.84	0.26
2004.375	2.01	0.17	0.919	0.41	0.566	0.33	1.06	0.21
2004.625	1.47	0.16	0.928	0.32	0.613	0.53	1.23	0.22
2004.875	2.71	0.16	1.06	0.38	-	-	0.691	0.47
2005.125	1.25	0.079	0.829	0.44	0.789	0.68	2.9	0.53
2005.375	1.15	0.089	0.836	0.29	0.701	0.2	0.669	0.12
2005.625	1.61	0.079	0.716	0.2	0.416	0.33	0.852	0.19
2005.875	1.52	0.084	0.969	0.41	-	-	1.27	0.38
2006.125	1.04	0.095	0.787	0.54	0.528	0.93	0.53	0.28
2006.375	1.13	0.11	0.57	0.34	0.552	0.24	0.582	0.13
2006.625	1.38	0.089	0.601	0.24	0.558	0.46	0.562	0.16
2006.875	1.26	0.11	0.642	0.39	-	-	0.586	0.3
2007.125	0.883	0.097	0.662	0.76	-	-	0.348	0.43
2007.375	0.873	0.11	0.855	0.33	0.425	0.33	0.683	0.17
2007.625	1.44	0.11	0.895	0.24	0.419	0.33	0.957	0.18
2007.875	1.63	0.11	0.464	0.45	-	-	1.01	0.31
2008.125	0.83	0.11	0.64	0.77	-	-	1.14	0.33
2008.375	0.937	0.12	0.587	0.63	0.192	0.65	0.733	0.19
2008.625	1.24	0.12	0.5	0.36	0.311	0.66	0.867	0.23
2008.875	0.842	0.12	1.13	0.48	0.989	0.56	0.574	0.29
2009.125	0.819	0.093	0.432	0.23	-	-	1.03	0.25
2009.375	0.694	0.088	0.552	0.23	0.516	0.35	0.573	0.17
2009.625	0.945	0.078	0.376	0.23	0.497	0.31	0.51	0.17
2009.875	1.1	0.087	0.554	0.28	0.915	0.54	0.835	0.32
2010.125	0.885	0.09	0.18	0.35	-	-	0.602	0.28
2010.375	0.725	0.089	0.419	0.29	0.382	0.33	0.817	0.2
2010.625	0.805	0.078	0.42	0.21	0.39	0.39	0.967	0.17
2010.875	0.93	0.078	0.425	0.3	-	-	0.582	0.26
2011.125	0.8	0.093	0.292	0.31	9.75	0.93	0.471	0.44
2011.375	0.611	0.098	0.303	0.24	0.551	0.47	0.563	0.15
2011.625	0.714	0.091	0.384	0.21	0.461	0.47	0.624	0.21
2011.875	0.456	0.18	0.619	0.41	-	-	2.79	1

7. Figures

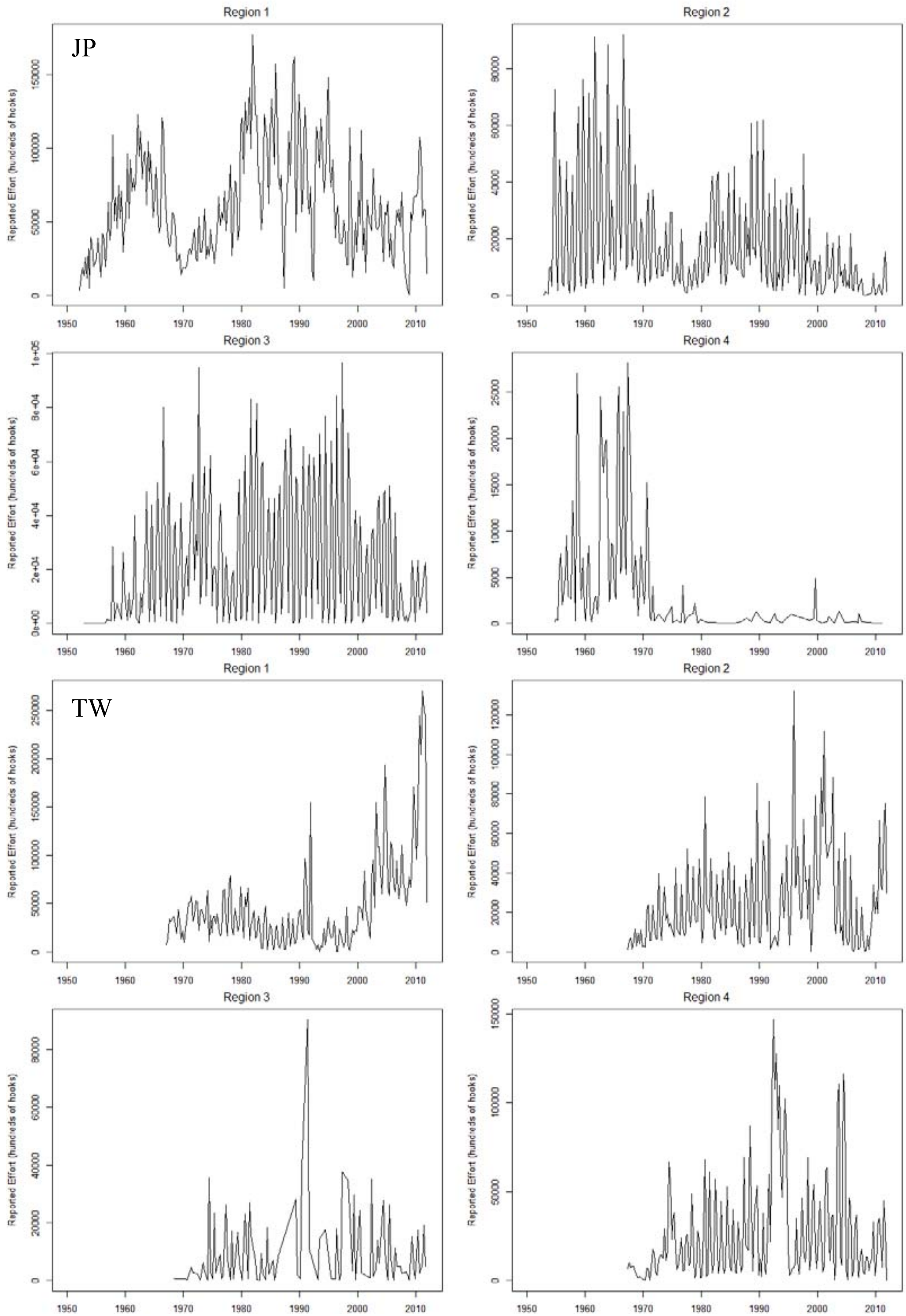

Figure 1: Effort by region and year-quarter by the Japanese (top) and Taiwanese (bottom) distant-water longline fleets, as recorded in the aggregated dataset.

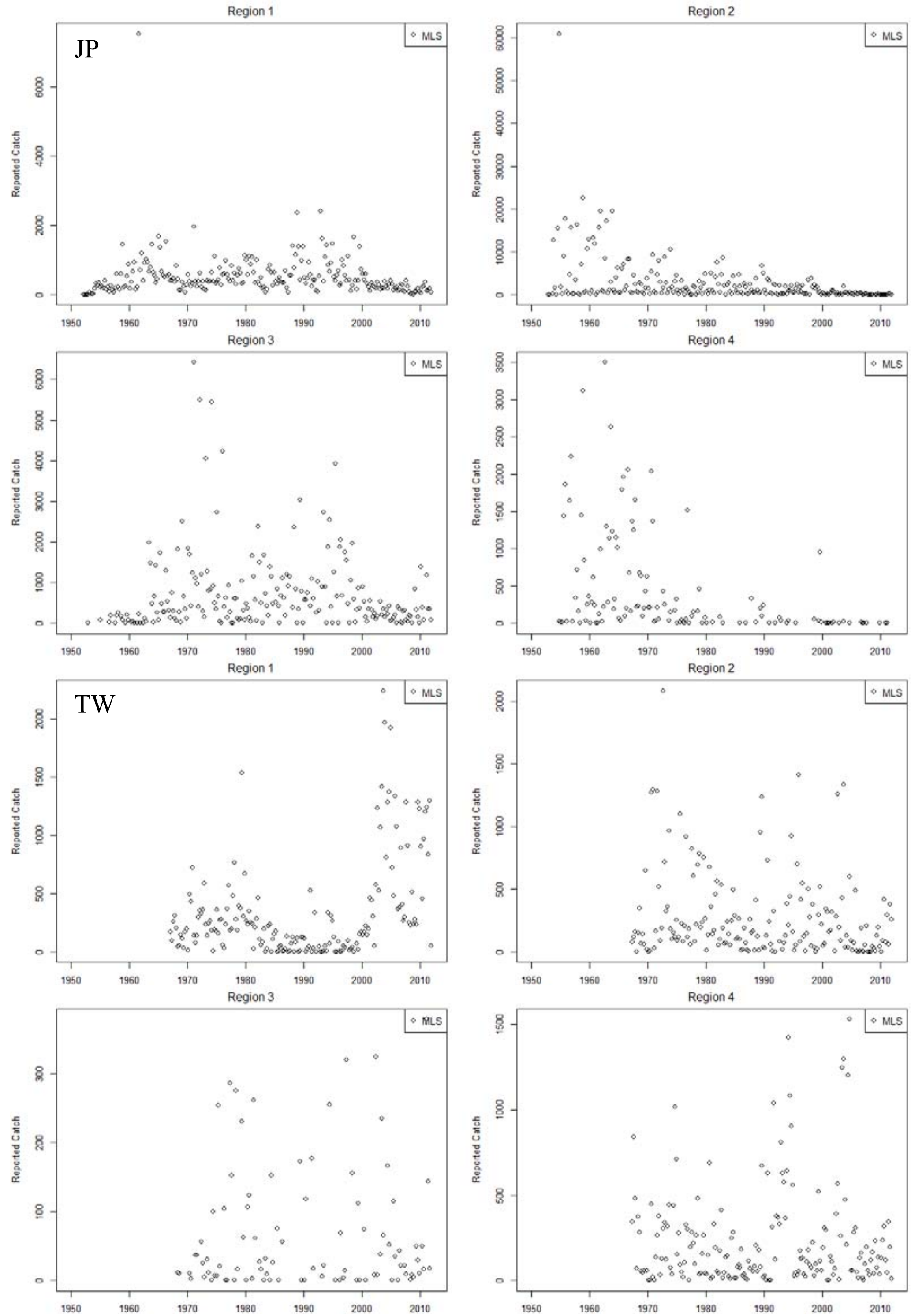

Figure 2: Catch of southwest Pacific striped marlin by region and year-quarter, by the Japanese (top) and Taiwanese (bottom) distant-water longline fleets, as recorded in the aggregated dataset.

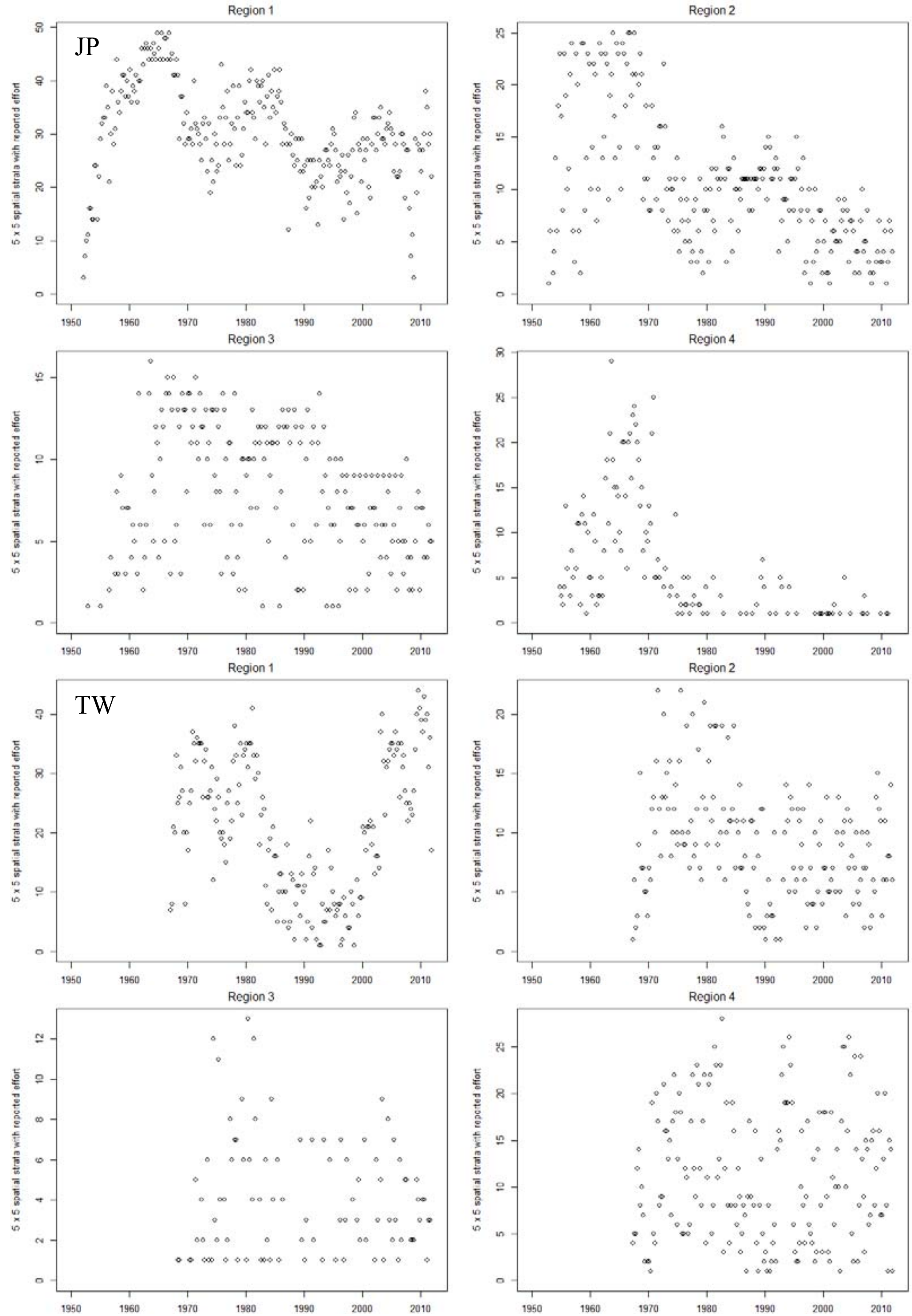

Figure 3: The number of 5° x 5°spatial strata in which effort is reported, by region and year-quarter, for the Japanese (top) and Taiwanese (bottom) distant-water longline fleets, as recorded in the aggregated dataset.

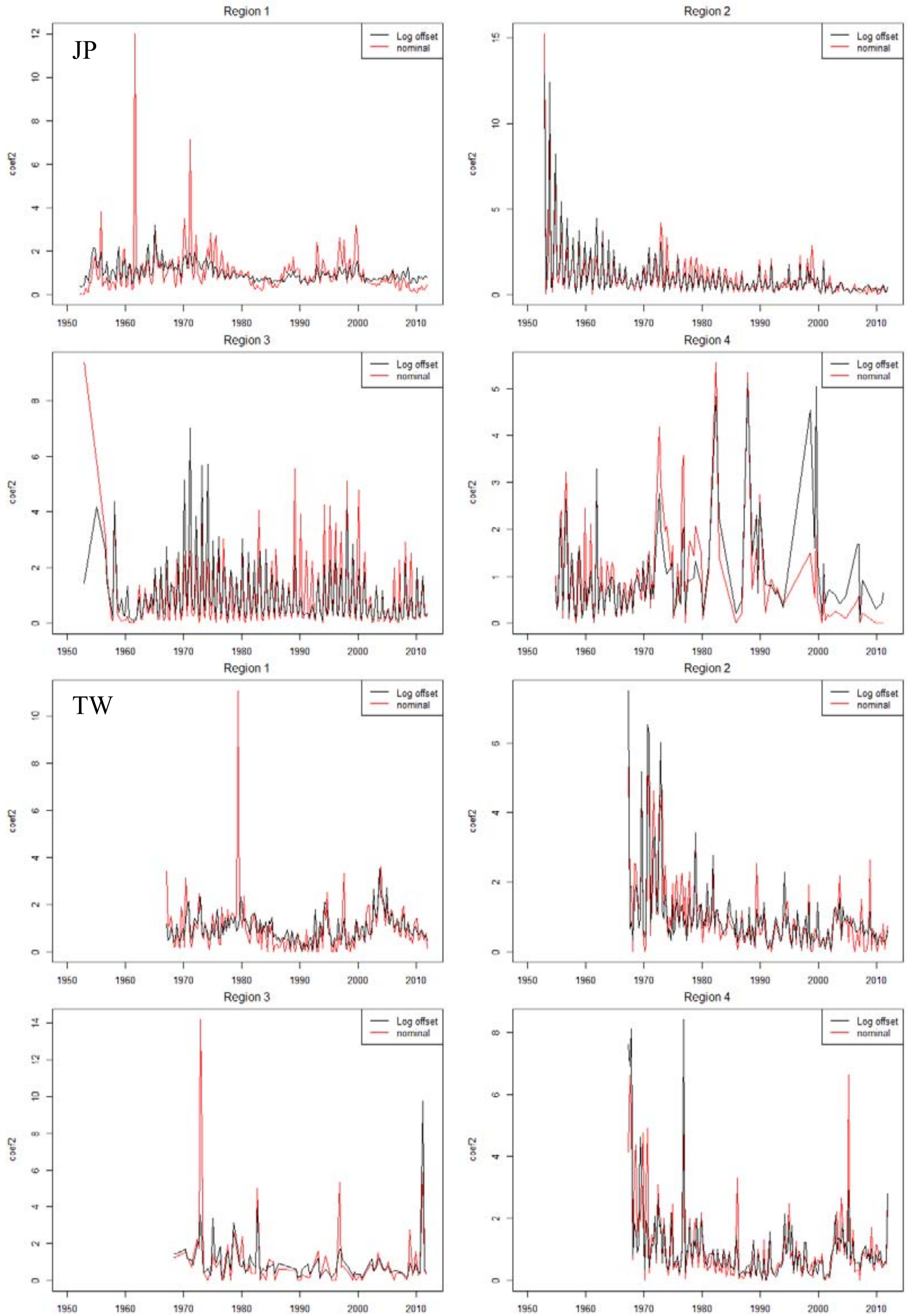

Figure 4: Standardized indices of southwest Pacific striped marlin CPUE by region for the Japanese (top) and Taiwanese (bottom) distant-water longline fleets.

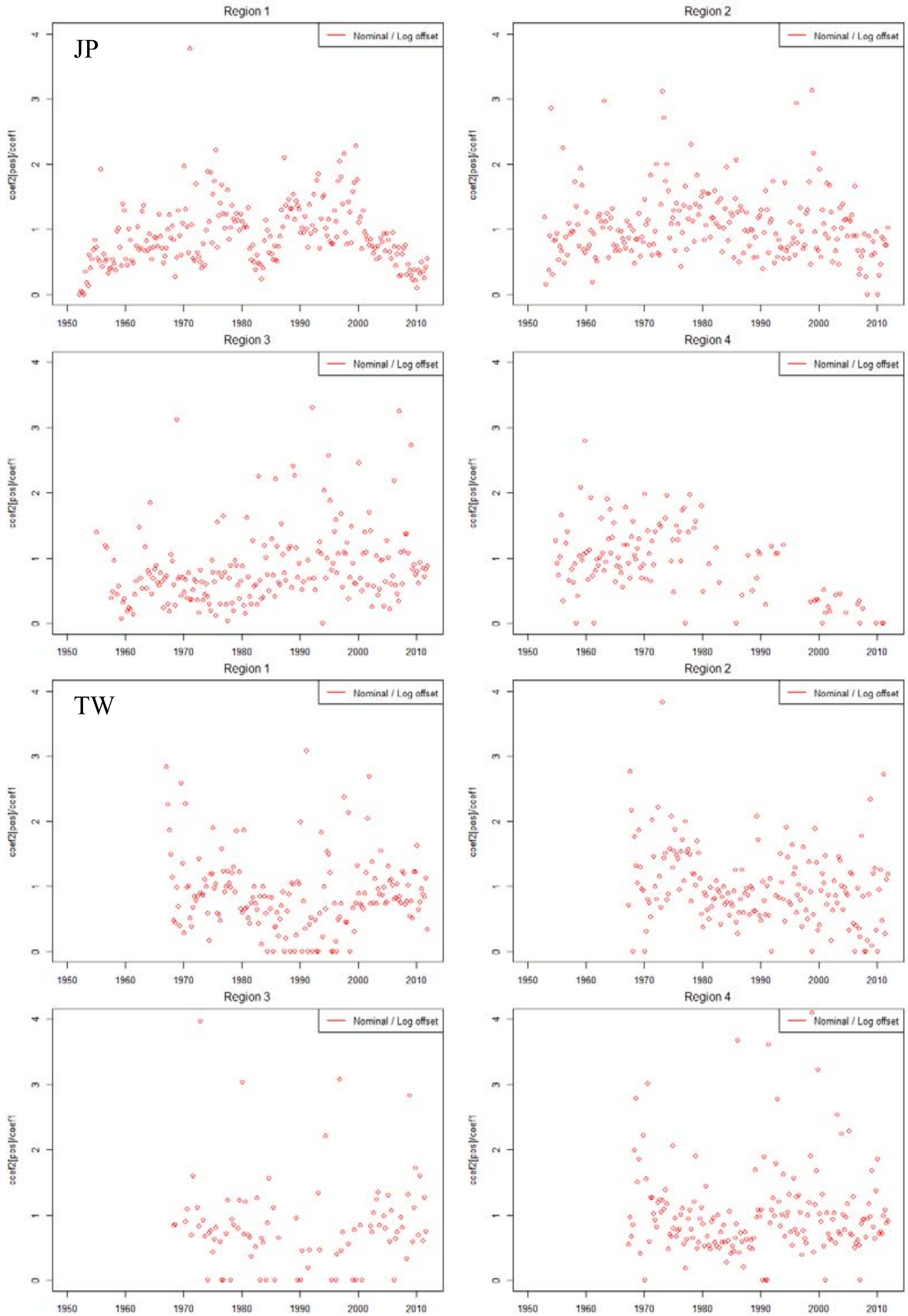

Figure 5: Ratios of the 2012 southwest Pacific striped marlin indices versus the nominal CPUE, by year-quarter and region, Japanese (top) and Taiwanese (bottom) distant-water longline fleets.

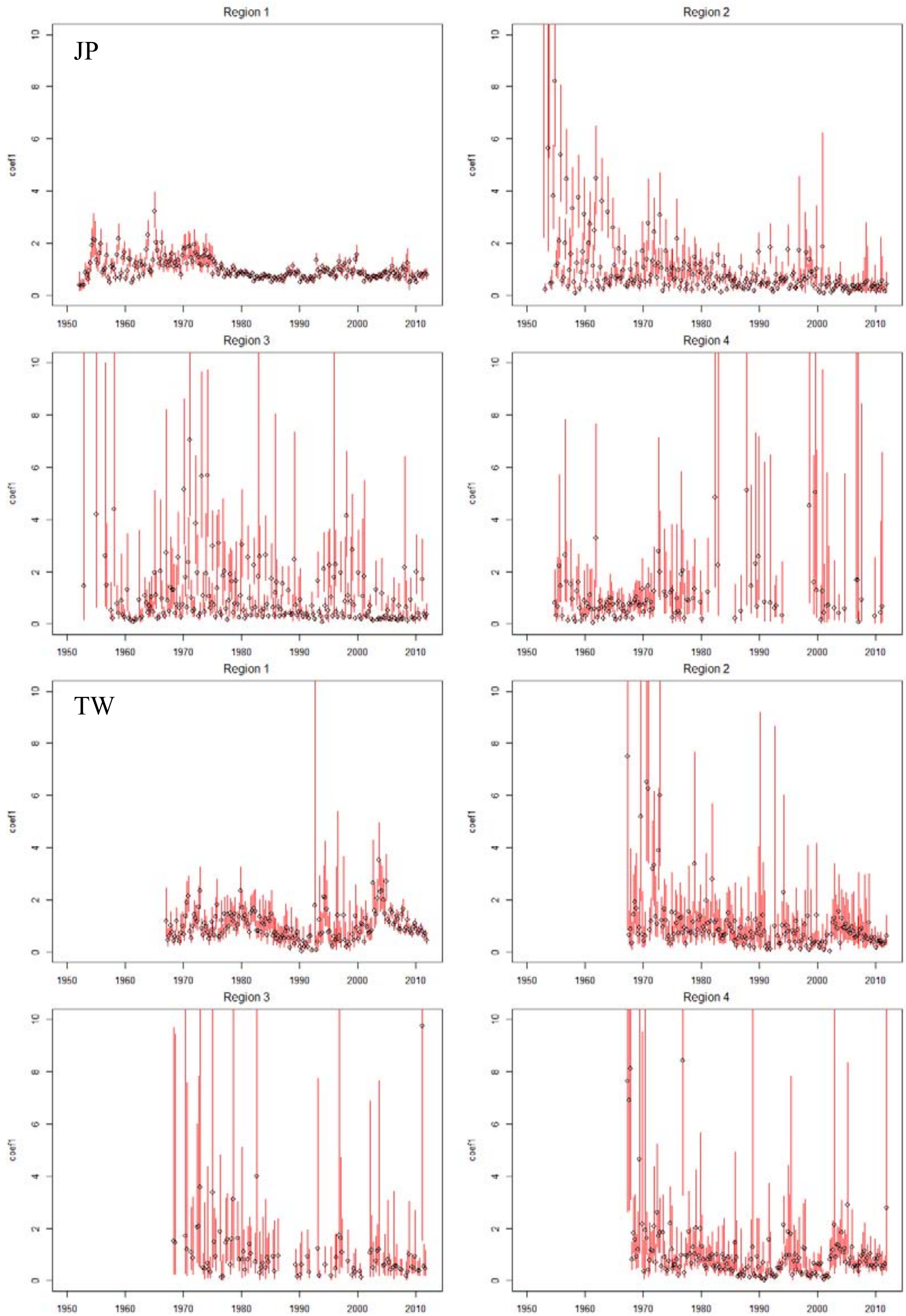

Figure 6: Standardized quarterly indices of abundance for southwest Pacific striped marlin (black circles), with 95% CI in red, for the Japanese (top) and Taiwanese (bottom) distant-water longline fleets.

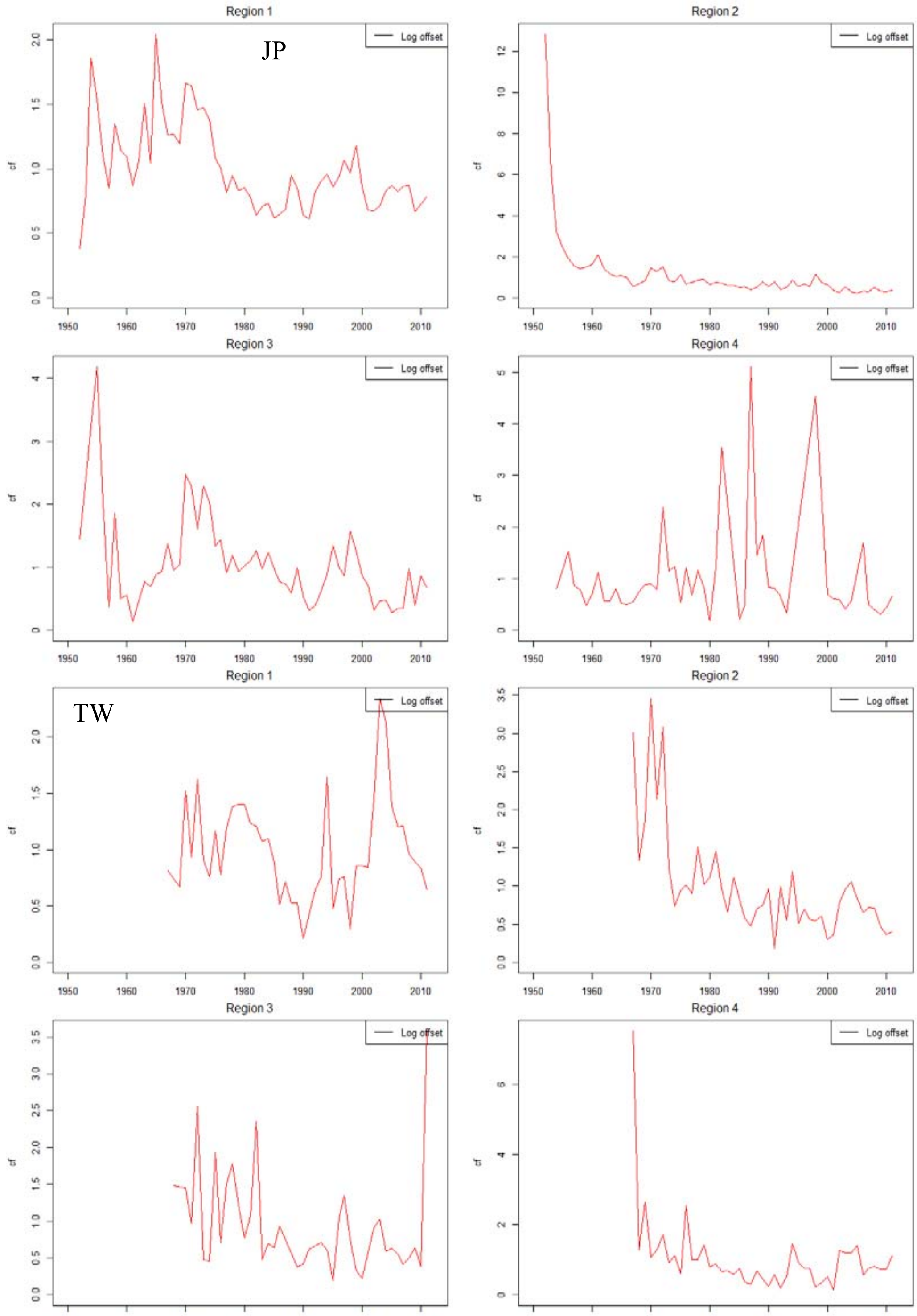

Figure 7: Annualised indices of abundance for southwest Pacific striped marlin, for the Japanese (top) and Taiwanese (bottom) distant-water longline fleets.

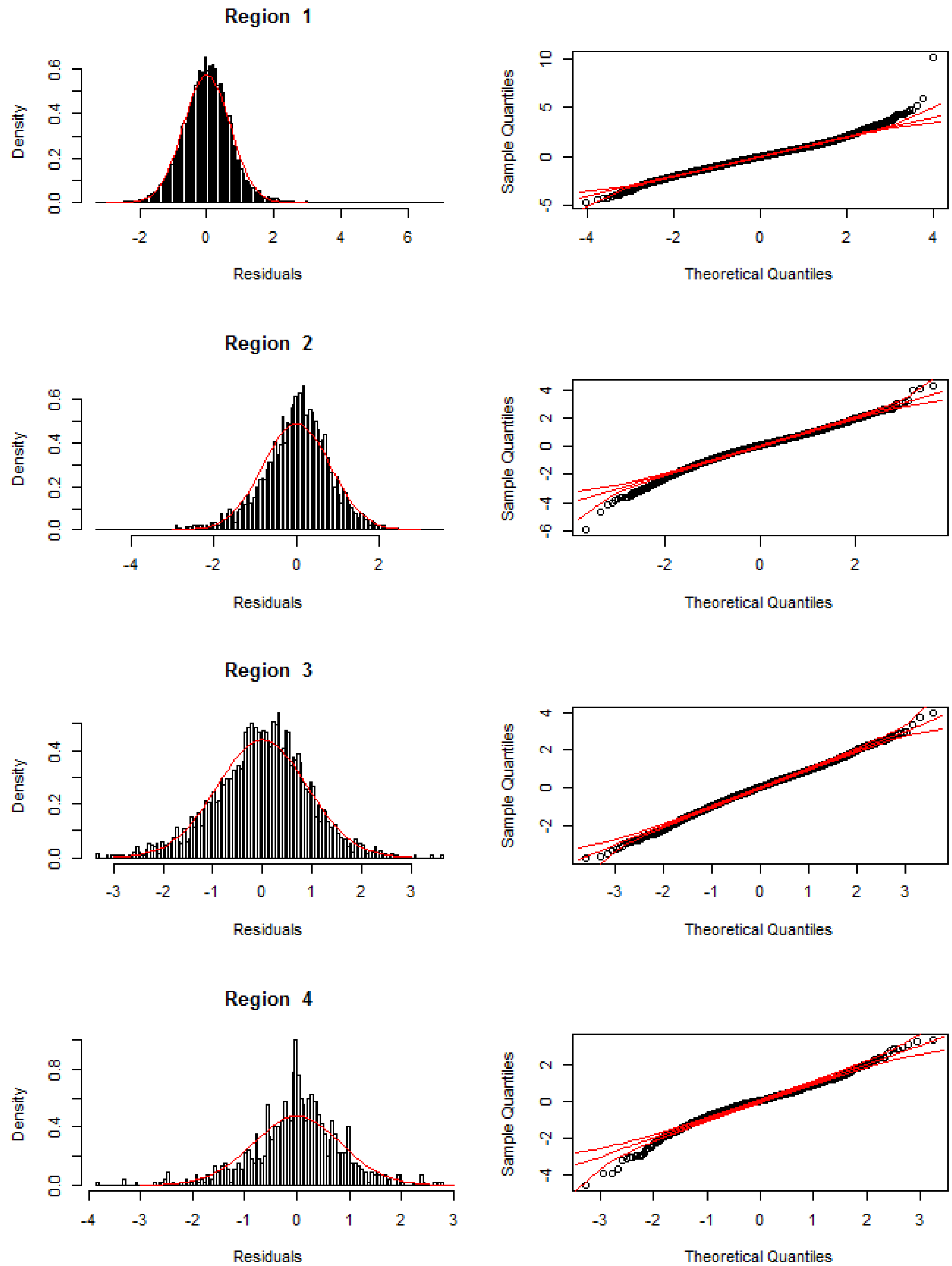

Figure 8: Diagnostic plots for 2012 striped marlin CPUE indices using Japanese longline data. Density histograms (left) of residual sizes by region from the GLMs (black), compared with a normal distribution with mean zero and the same standard deviation as the residuals. Q-Q plots (right) of residuals by region from the GLMs (black), compared with the expected distribution assuming normality, with median and ± 2SD's.

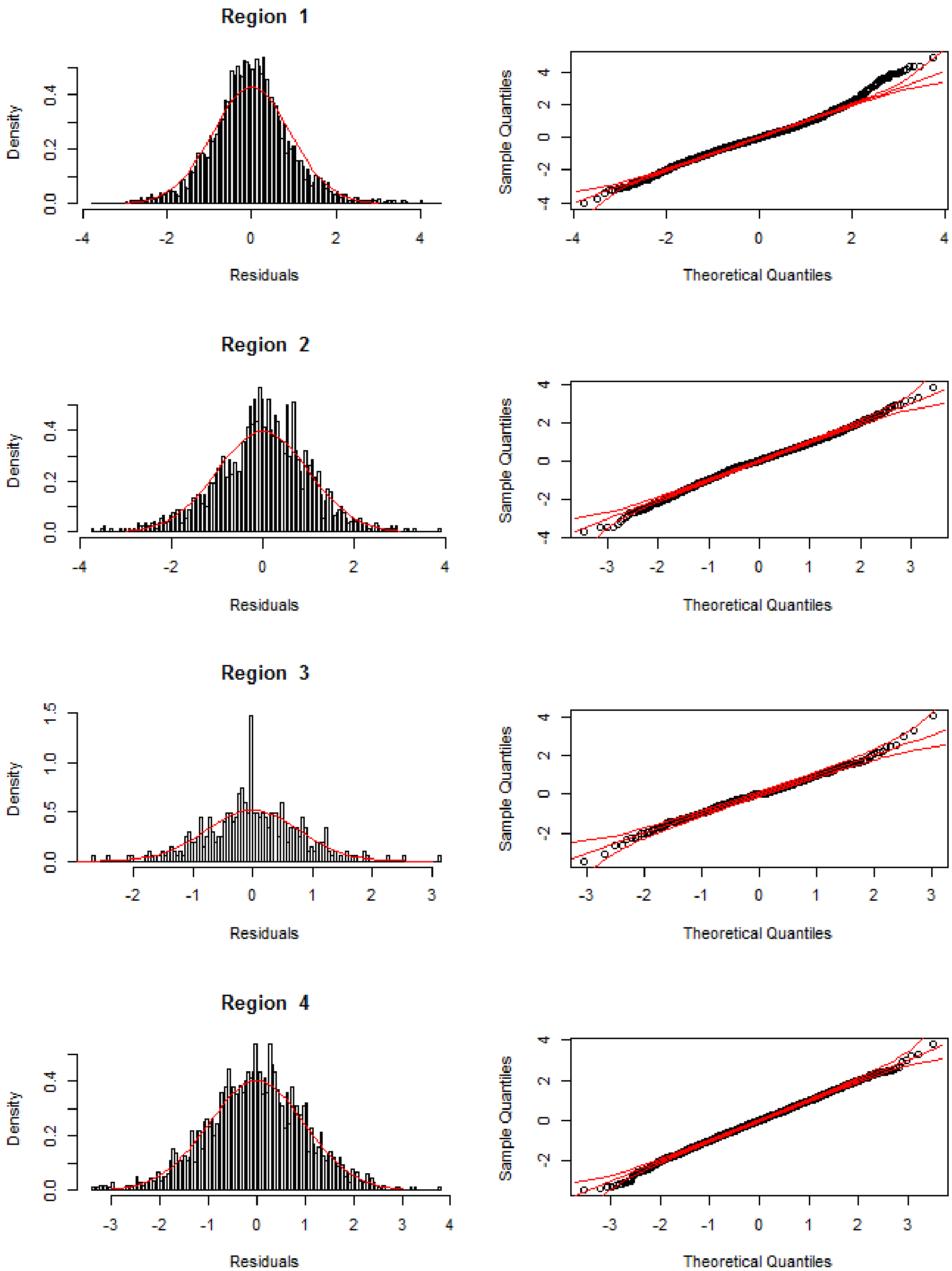

Figure 9: Diagnostic plots for 2012 striped marlin CPUE indices using Taiwanese longline data. Density histograms (left) of residual sizes by region from the GLMs (black), compared with a normal distribution with mean zero and the same standard deviation as the residuals. Q-Q plots (right) of residuals by region from the GLMs (black), compared with the expected distribution assuming normality, with median and ± 2SD's.

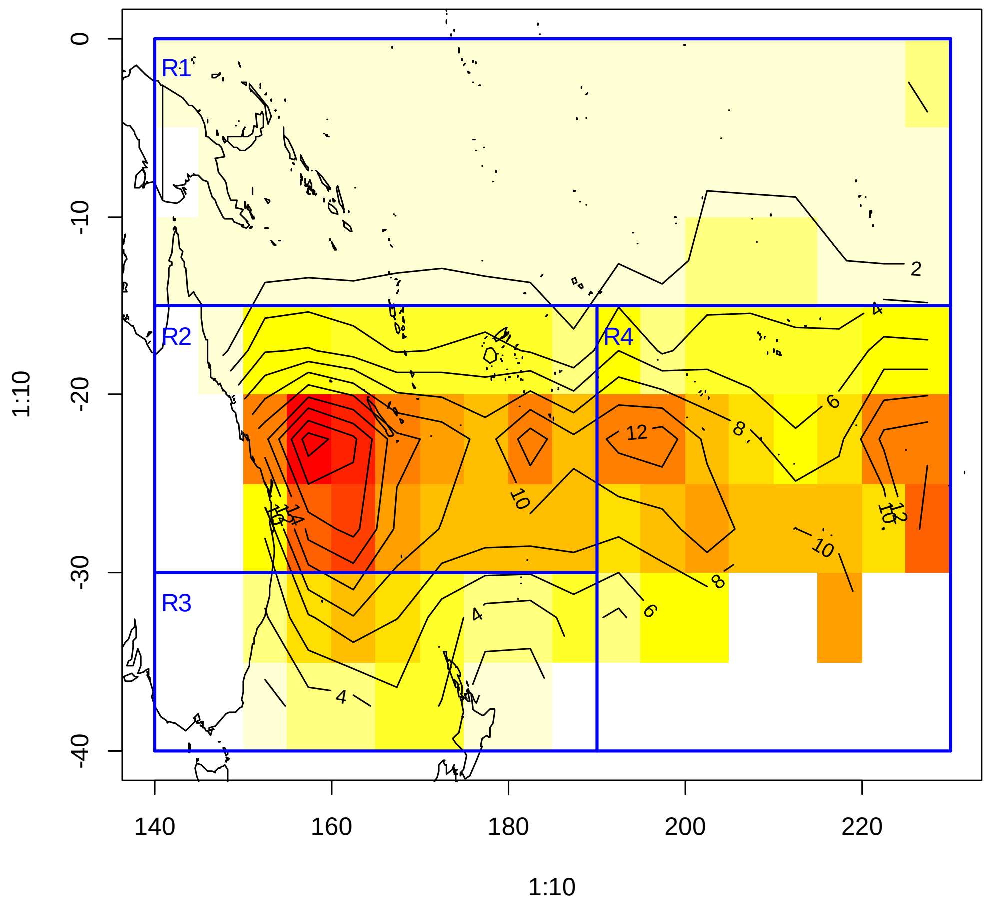

Figure 10: Spatial distribution of southwest Pacific striped marlin relative catch rates, as estimated in the regional rescaling analysis using Japanese longline data. Darker colours signify higher catch rates. Numbers are relative and not comparable with TW.

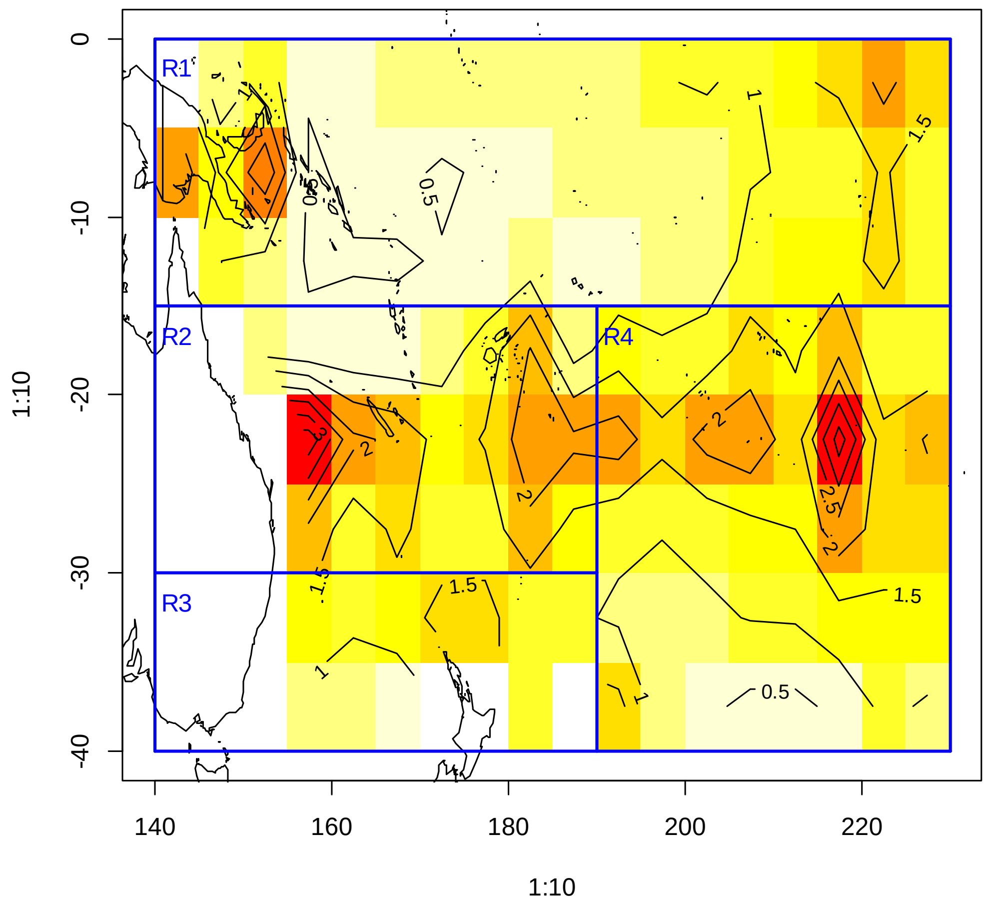

Figure 11: Spatial distribution of southwest Pacific striped marlin relative catch rates, as estimated in the regional rescaling analysis based on Taiwanese longline data. Darker colours signify higher catch rates. Numbers are relative and not comparable with JP.