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ANALYSIS OF SWORDFISH CATCH PER UNIT EFFORT DATA FOR JAPANESE AND CHINESE TAIPEI LONGLINE FLEETS IN THE SOUTHWEST PACIFIC OCEAN

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Executive summary

Indices of standardised catch per unit effort are presented for swordfish in the WCPO from 1952 to 2012, 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 Taiwanese data were only available in significant quantities for the eastern central region, and were divided into albacore-target and bigeye-target effort. The two target types were standardized separately.

The standardised indices were highly variable among regions, with low sample sizes in some regions. During the 1970s and early 1990s, a peak in the western central Japanese index was seen. Toward the end of this time series, a general decline in the 2000s in those series was also seen. The most recent period from 2005 shows an increasing CPUE. The Chinese Taipei albacore-target index is relatively stable but increases after 2000, at the time that the longline fishery begins to target bigeye tuna.

Apart from the western central Japanese index and the eastern central albacore-target Taiwanese index, these indices are not recommended as relative indices of swordfish abundance.

1. Introduction

The last stock assessment of swordfish (*Xiphias gladius*) in the southwest Pacific Ocean was performed in 2008 (Kolody *et al.* 2008) using Multifan-CL (MFCL; Fournier *et al.* 1998), with a parallel assessment (Davies *et al.* 2008) using CASAL (Bull *et al.* 2003). For those assessments, the indices from the key fisheries (Campbell *et al.* 2008) 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 & Archibald 1982,Maunder & Punt 2012), 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 swordfish biomass that is exploited by longline fisheries. These data are collected by the Japan Fisheries Agency and reported to SPC 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.* 2010). 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. Swordfish catch rates vary considerably depending on the fishing method. For this reason effort targeting albacore and bigeye has been separated for this analysis.

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 & 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 2013 stock assessment of swordfish in the WCPO, based upon aggregated distant water fishing nation longline data.

2. Methods

The essentials of the method were as summarised in Langley (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 2012 inclusive were available aggregated by year, month, and 5° spatial cell. Information on longline gear configuration was limited to the total number of hooks deployed (hundreds of hooks). Only data in Region 5 was used for this study, since data for this region was continuously available for the Taiwanese fleet whereas Japanese data had become sparse in recent decades. This region is a typical albacore-targeting fishing ground for the Taiwanese fleet. Historically, vessels fishing in this region mainly targeted albacore until the early 2000s when bigeye-targeting activities started in the tropical regions, and some bigeye-targeting vessels seasonally moved southward to the albacore fishing ground for cold water bigeye tuna. These bigeye-targeting vessels usually had a comparatively higher swordfish bycatch rate and therefore need to be separated for analysis of aggregated data. Bigeye-targeting vessels were separated by assuming that they were (1) new vessels entering the albacore fishing ground after 2000; (2) the remaining vessels after 2000 with annual albacore catch ratio less than 90% (historically albacore-targeting vessels have an average annual albacore catch ratio >90% in the region). The remaining vessels were considered as albacore-targeting.

Analyses were performed separately for the swordfish 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 an offset + catch (in numbers) / effort (in hundreds of hooks). The offset was 1/(the mean number of hooks per stratum).

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. Hooks were included as an independent variable to permit nonlinearity in the catch-effort relationship. In addition, the GLM applied to the Japanese data included the additional continuous variable hooks between floats (HBF).

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

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

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 CPUE per year-quarter (*t*), and stratum (*st*) defined by five degree latitude/longitude (LL) cell was predicted as follows:

$$\log(\mathrm{swo}/\mathrm{effort}_{t,st} + \mathrm{offset}) = c + \alpha_t + \beta_{LL} + g\left(\log(\mathrm{hooks}_{t,st})\right) + \epsilon_{t,st}$$

The resulting CPUE index was the exponentiated year/quarter coefficients (α) from the region-specific GLM. The relationships between predicted CPUE 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 all regions reduced the year/quarter variability seen in the nominal data.

The trends in the indices varied markedly among regions. The two indices at southern latitudes were poorly defined due to lack of data. The north-eastern index increased steeply, and there was concern that increased reporting of this bycatch species may have occurred through time, in an area where swordfish are mostly small. The north western index was generally stable, but catch numbers were very low at fewer than 500 fish per quarter since the year 2000. CPUE in the eastern central region increased to a peak in 1995 and then declined. Effort in this region was very low after 1995 and restricted to a small number of grid squares. The western central (region 2) index increased to a peak in the 1980s and then declined. Catch and effort remained reasonably consistent for most of the time series, with low but relatively stable numbers of grid squares fished.

The Taiwanese time series in the eastern central region showed no clear overall trends. The highest catch rates in the albacore targeted fishery occurred in the mid-2000s, at the same time as the bigeye targeted fishery began. The time series for the bigeye-targeted fishery was short and quite variable. Both time series covered a reasonable number of strata, but total catches were low in both fisheries, with seasonal variation in the albacore targeted fishery and the catch averaging around 100 fish per quarter in the seasons with better catch rates. Catch in the bigeye targeted fishery was also seasonal with catch in the better seasons averaging about less than 500 fish per quarter.

The annualised indices are presented in Figure 7. For the Japanese standardised indices, the steep initial decline in the western equatorial region was not reflected in the other regions. Following this initial decline, there an increase and then a decline in standardised catch rates from the mid-1980s to the end of the time series.

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 swordfish relative catch rates by 5° by 5° square using Japanese (Figure 10) and Chinese Taipei (albacore target) (Figure 11) data. A peak in the catch rate for the Japanese data were found in both data sets at the latitude 20° to 35° S in Region 2. High catch rates were estimated in Region 2 running east north east from 25°-30°S on the Australian coast to 20°-25°S and 200°E. Clear spatial patterns were not apparent in the Taiwanese data.

4. Discussion

This paper updates the CPUE standardisation analysis presented in Campbell *et al.* (2008) 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 (6 Regions) are comparable to those presented for 4 regions in the 2008 southeastern Pacific swordfish CPUE standardization paper (Campbell *et al.* 2008).

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.

The analysis of Japanese data also did not consider the impact of targeting practices, nor changes in those practices during the time series (Hoyle & Okamoto 2011). Using cluster analysis to separate the data based on catch rates of associated species may improve the indices (He *et al.* 1997). However, such analyses need to be carried on operational data, and much of the operational data held by SPC does not report swordfish.

Given the paucity of data, and consequently the highly variable and imprecise indices generated for most regions, we recommend using the only the Japanese index the western central region and the Taiwanese index for the eastern central region as indices of abundance.

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6. Tables

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

	cpue1	cv1	cpue2	cv2	cpue3	cv3	cpue4	cv4	cpue5	cv5	cpue6	cv6
1952.125	0.51	0.4	-	-	-	-	-	-	-	-	-	-
1952.375	0.164	0.31	-	-	-	-	0.413	0.5	-	-	-	-
1952.625	1.33	0.26	-	-	-	-	0.341	0.41	-	-	-	-
1952.875	0.697	0.22	2.9	0.81	-	-	0.152	0.5	-	-	-	-
1953.125	0.607	0.19	-	-	-	-	0.394	0.25	-	-	-	-
1953.375	0.751	0.2	-	-	-	-	1.06	0.35	-	-	-	-
1953.625	0.923	0.2	0.958	0.7	-	-	0.994	0.41	-	-	-	-
1953.875	1.23	0.21	0.438	0.5	-	-	0.615	0.32	-	-	-	-
1954.125	0.943	0.17	0.337	0.4	-	-	0.646	0.18	0.439	0.88	-	-
1954.375	0.633	0.17	0.32	0.7	-	-	0.814	0.21	-	-	-	-
1954.625	0.925	0.19	0.731	0.29	-	-	0.52	0.29	0.986	0.36	-	-
1954.875	1.16	0.17	0.63	0.29	-	-	0.806	0.19	0.797	0.28	-	-
1955.125	1.22	0.17	0.536	0.29	-	-	0.545	0.15	1.26	0.45	-	-
1955.375	1.4	0.26	0.558	0.7	-	-	0.68	0.13	0.673	0.51	-	-
1955.625	1.09	0.18	1.55	0.29	-	-	0.791	0.14	0.726	0.24	-	-
1955.875	1.01	0.17	0.923	0.35	-	-	0.871	0.13	0.871	0.24	-	-
1956.125	0.837	0.17	0.432	0.5	-	-	0.578	0.13	0.471	0.52	-	-
1956.375	0.785	0.18	-	-	-	-	0.509	0.14	0.439	0.4	-	-
1956.625	1	0.25	2.5	0.31	-	-	0.839	0.16	0.885	0.25	-	-
1956.875	0.963	0.17	0.992	0.29	-	-	0.847	0.14	0.897	0.22	-	-
1957.125	0.652	0.19	0.499	0.5	-	-	0.445	0.12	-	-	-	-
1957.375	0.509	0.26	-	-	-	-	0.356	0.15	0.213	0.63	-	-
1957.625	0.726	0.19	0.458	0.29	-	-	0.7	0.13	0.411	0.23	-	-
1957.875	1.26	0.17	0.644	0.31	-	-	0.723	0.12	0.394	0.2	-	-
1958.125	0.821	0.19	0.502	0.35	-	-	0.524	0.13	0.399	0.3	-	-
1958.375	0.843	0.23	-	-	-	-	0.412	0.14	0.174	0.45	-	-
1958.625	1.02	0.18	0.996	0.24	-	-	0.555	0.12	0.523	0.18	-	-
1958.875	1.01	0.16	0.506	0.29	-	-	0.425	0.12	0.337	0.18	0.147	1
1959.125	0.688	0.18	0.49	0.49	-	-	0.388	0.12	0.431	0.4	-	-
1959.375	0.863	0.19	0.94	0.35	-	-	0.451	0.14	0.458	0.3	-	-
1959.625	0.965	0.19	0.821	0.29	-	-	0.494	0.12	0.402	0.19	-	-
1959.875	0.913	0.17	0.747	0.35	-	-	0.566	0.13	0.555	0.21	-	-
1960.125	0.782	0.18	0.27	0.4	-	-	0.292	0.12	0.969	0.51	-	-
1960.375	0.996	0.22	1.11	0.7	-	-	0.268	0.13	0.328	0.23	-	-
1960.625	0.757	0.19	0.665	0.27	-	-	0.492	0.13	0.554	0.18	-	-
1960.875	1.03	0.18	0.637	0.29	-	-	0.41	0.13	0.414	0.21	-	-
1961.125	0.762	0.2	-	-	-	-	0.26	0.12	0.317	0.52	-	-
1961.375	0.56	0.25	-	-	-	-	0.343	0.13	0.494	0.26	-	-
1961.625	1.35	0.18	0.652	0.2	-	-	0.44	0.13	0.606	0.2	-	-
1961.875	1.13	0.16	0.347	0.24	-	-	0.553	0.13	1.03	0.22	-	-
1962.125	0.998	0.17	0.191	0.31	-	-	0.387	0.12	0.693	0.89	-	-
1962.375	0.544	0.18	0.656	0.29	4.91	0.41	0.314	0.12	0.249	0.27	6.52	1
1962.625	0.947	0.17	1.03	0.22	4.64	0.81	0.347	0.12	0.658	0.19	-	-
1962.875	0.909	0.17	0.479	0.21	-	-	0.464	0.11	0.708	0.2	-	-
1963.125	0.771	0.18	0.798	0.5	0.47	0.81	0.417	0.11	0.394	0.37	-	-
1963.375	0.977	0.19	0.678	0.2	4.11	0.36	0.429	0.11	0.463	0.17	0.56	0.72
1963.625	1.23	0.19	0.68	0.21	1.13	0.57	0.636	0.11	0.652	0.15	-	-
1963.875	0.899	0.17	0.397	0.21	0.196	0.58	0.86	0.11	0.567	0.18	-	-
1964.125	0.9	0.17	0.458	0.27	-	-	0.408	0.11	0.536	0.24	0.24	0.72
1964.375	0.673	0.19	0.578	0.24	4.08	0.41	0.409	0.12	0.837	0.24	1.54	1
1964.625	0.691	0.18	0.654	0.2	1.12	0.47	0.528	0.11	0.597	0.18	0.261	1
1964.875	0.917	0.16	0.305	0.2	0.218	0.48	0.773	0.11	0.513	0.2	-	-
1965.125	0.654	0.19	0.519	0.24	0.676	0.41	0.47	0.11	0.452	0.4	-	-
1965.375	1.1	0.18	0.782	0.21	2.44	0.41	0.453	0.12	0.367	0.28	1	0.72
1965.625	0.69	0.16	1.11	0.21	0.387	0.57	0.608	0.11	0.402	0.16	-	-
1965.875	0.999	0.17	0.571	0.2	0.144	0.47	0.664	0.11	0.482	0.18	0.169	0.72
1966.125	0.956	0.17	0.545	0.22	0.606	0.47	1.16	0.11	0.452	0.28	0.653	1
1966.375	0.802	0.17	0.96	0.21	1.09	0.41	0.901	0.12	0.706	0.2	1.33	0.5
1966.625	0.947	0.18	0.983	0.2	0.35	0.34	0.601	0.11	0.796	0.16	0.136	1
1966.875	1.17	0.17	0.347	0.2	0.202	0.36	1.08	0.11	0.713	0.16	0.613	1
1967.125	0.696	0.17	0.28	0.24	0.347	0.47	0.812	0.11	0.588	0.24	-	-
1967.375	0.884	0.18	0.913	0.21	2.9	0.47	0.917	0.11	0.793	0.17	1.47	0.42

1967.625	1.06	0.17	1.05	0.2	1.32	0.47	0.892	0.12	0.827	0.15	0.346	0.79
1967.875	1.31	0.17	0.699	0.22	0.423	0.47	1.38	0.11	0.97	0.2	-	-
1968.125	1.51	0.17	0.856	0.21	0.499	0.41	1.24	0.11	0.531	0.24	0.517	0.59
1968.375	0.879	0.17	1.25	0.21	1.51	0.41	0.932	0.12	0.935	0.17	1.29	0.45
1968.625	1.02	0.17	1.49	0.21	0.482	0.57	0.585	0.16	0.651	0.17	1.47	1
1968.875	1.26	0.17	1.42	0.24	0.0667	0.47	0.667	0.13	0.854	0.22	-	-
1969.125	0.861	0.18	0.603	0.21	0.468	0.37	0.841	0.13	0.653	0.27	0.356	0.41
1969.375	0.655	0.19	0.926	0.21	2.81	0.47	0.796	0.16	0.55	0.23	0.879	0.34
1969.625	1.01	0.18	1.69	0.21	0.541	0.37	0.757	0.16	0.696	0.19	3.29	0.71
1969.875	1.45	0.2	0.612	0.2	0.569	0.57	0.915	0.13	0.468	0.34	0.469	0.65
1970.125	1.31	0.22	0.749	0.21	0.455	0.29	0.954	0.14	0.799	0.22	0.314	0.36
1970.375	1.16	0.25	1.59	0.21	0.996	0.29	0.903	0.15	0.851	0.21	0.995	0.36
1970.625	1.01	0.18	1.92	0.21	0.829	0.37	1.03	0.15	0.689	0.16	1.13	0.71
1970.875	1.21	0.17	0.803	0.2	0.15	0.37	0.625	0.15	0.82	0.19	0.549	0.58
1971.125	1.03	0.17	0.807	0.2	0.938	0.37	0.739	0.14	0.858	0.23	0.236	0.39
1971.375	1.6	0.19	1.04	0.21	2.85	0.41	0.748	0.16	0.729	0.23	2.27	0.39
1971.625	1.87	0.18	1.57	0.21	1.76	0.41	0.499	0.16	0.8	0.22	0.137	1
1971.875	1.5	0.16	1.47	0.21	0.244	0.29	0.824	0.17	0.75	0.24	-	-
1972.125	1.26	0.19	1.01	0.21	0.504	0.34	0.537	0.16	0.692	0.25	0.6	0.38
1972.375	1.64	0.21	1.49	0.25	5.6	0.41	0.741	0.18	0.327	0.27	4.31	0.42
1972.625	1.21	0.17	1.7	0.21	2.63	0.47	0.796	0.16	0.619	0.21	1.17	1
1972.875	1.08	0.19	1.09	0.22	0.178	0.41	0.732	0.15	0.701	0.25	0.663	0.52
1973.125	1.88	0.21	0.81	0.21	0.631	0.41	0.893	0.15	1.19	0.31	0.181	0.41
1973.375	1.08	0.2	1.97	0.27	1.21	0.41	0.851	0.21	0.788	0.28	0.546	0.36
1973.625	1.17	0.19	2.08	0.2	0.19	0.57	0.584	0.16	0.95	0.28	0.277	1
1973.875	1.02	0.2	0.783	0.2	0.184	0.47	1.28	0.23	0.89	0.4	1.73	1
1974.125	0.815	0.18	0.676	0.21	0.586	0.47	0.831	0.2	0.752	0.31	0.261	0.45
1974.375	1.79	0.22	1.05	0.21	1.92	0.37	0.935	0.21	1.67	0.33	1.3	0.38
1974.625	0.992	0.18	1.89	0.21	2.94	0.47	1.05	0.16	1.13	0.23	-	-
1974.875	0.921	0.17	0.723	0.22	0.574	0.57	0.916	0.18	0.666	0.3	0.58	0.59
1975.125	1.27	0.28	0.57	0.15	0.984	0.26	0.943	0.095	0.669	0.24	0.576	0.29
1975.375	0.929	0.21	1.64	0.18	0.693	0.26	0.996	0.11	1.25	0.29	1.01	0.28
1975.625	0.928	0.12	2.27	0.18	1.02	0.27	0.865	0.075	1.34	0.3	-	-
1975.875	0.909	0.099	0.684	0.21	0.455	0.23	1.08	0.074	1.01	0.51	-	-
1976.125	0.879	0.1	0.843	0.14	0.791	0.24	0.941	0.08	0.804	0.19	0.407	0.25
1976.375	1.1	0.15	1.17	0.18	0.812	0.26	0.943	0.077	1.44	0.26	0.762	0.24
1976.625	1.29	0.13	2.37	0.18	1.08	0.25	1.15	0.07	1.15	0.25	-	-
1976.875	1.16	0.11	1.5	0.22	0.492	0.22	1.2	0.061	1.18	0.31	-	-
1977.125	0.777	0.1	0.705	0.21	1.01	0.33	1.16	0.085	0.774	0.24	0.518	0.21
1977.375	0.933	0.11	1.78	0.22	0.685	0.25	0.99	0.09	1.96	0.24	0.566	0.21
1977.625	1.24	0.11	1.66	0.24	-	-	1.11	0.07	1.41	0.44	-	-
1977.875	1.06	0.1	0.599	0.22	0.234	0.25	1.08	0.069	0.973	0.28	-	-
1978.125	0.906	0.12	0.804	0.17	1.38	0.31	1.12	0.08	0.578	0.21	0.651	0.3
1978.375	1.28	0.13	1.52	0.17	1.17	0.24	0.831	0.099	-	-	1.14	1
1978.625	1.01	0.098	1.49	0.17	1.06	0.41	0.921	0.079	0.751	0.53	-	-
1978.875	1.15	0.09	1.17	0.19	0.245	0.27	0.901	0.066	1.28	0.4	-	-
1979.125	0.896	0.11	1.05	0.17	0.806	0.31	0.976	0.085	0.27	0.63	0.577	0.3
1979.375	0.878	0.13	2.08	0.15	0.763	0.47	0.95	0.084	1.8	0.3	0.683	0.24
1979.625	0.936	0.1	1.41	0.13	0.823	0.36	0.979	0.074	1.48	0.19	0.0961	1
1979.875	1.19	0.092	1.42	0.19	0.354	0.27	1.15	0.061	1.02	0.4	-	-
1980.125	0.899	0.086	0.965	0.19	1.04	0.33	1.04	0.067	0.968	0.28	0.422	0.29
1980.375	0.987	0.086	3	0.16	1.85	0.81	0.848	0.072	0.934	0.28	1.04	0.24
1980.625	1.24	0.076	1.93	0.16	-	-	1.12	0.061	0.975	0.17	0.676	1
1980.875	1.09	0.073	1.22	0.17	0.442	0.25	0.968	0.061	0.497	0.26	-	-
1981.125	0.837	0.066	1.43	0.17	0.719	0.27	1.06	0.073	0.949	0.19	0.506	0.26
1981.375	0.948	0.074	1.42	0.18	1.89	0.27	0.931	0.077	2.19	0.26	1.38	0.27
1981.625	0.954	0.072	1.31	0.15	0.745	0.47	0.711	0.088	1.17	0.17	0.341	1
1981.875	0.828	0.067	0.788	0.14	0.346	0.24	0.814	0.065	0.675	0.4	-	-
1982.125	0.584	0.075	0.742	0.14	0.984	0.29	0.78	0.071	1.05	0.19	0.491	0.24
1982.375	0.73	0.076	1.32	0.12	0.94	0.47	0.91	0.076	1.55	0.22	0.761	0.26
1982.625	0.997	0.084	1.28	0.13	0.61	0.31	0.909	0.063	0.983	0.17	0.572	0.59
1982.875	1.06	0.094	1.3	0.15	0.44	0.29	1.02	0.063	1.9	0.34	-	-
1983.125	0.706	0.088	0.72	0.14	0.763	0.31	0.813	0.076	1.09	0.21	0.355	0.29
1983.375	0.862	0.095	1.29	0.16	0.892	0.81	0.68	0.13	1.65	0.27	0.534	0.25
1983.625	0.897	0.099	1.25	0.12	0.397	0.4	0.84	0.092	1.16	0.19	-	-
1983.875	0.782	0.076	0.545	0.15	0.282	0.26	0.756	0.073	0.278	0.62	-	-
1984.125	0.697	0.088	0.676	0.19	0.709	0.25	0.711	0.073	1	0.25	0.489	0.33
1984.375	0.811	0.1	1.44	0.14	0.61	0.23	0.602	0.074	1.45	0.28	0.57	0.29
1984.625	0.753	0.11	1.38	0.12	0.747	0.33	0.74	0.084	1.05	0.17	0.162	1
1984.875	1.03	0.086	1.5	0.19	0.982	0.33	1.02	0.069	4.46	0.88	-	-
1985.125	0.808	0.1	0.72	0.17	1.33	0.81	0.944	0.072	1.11	0.28	0.614	0.38

1985.375	0.929	0.09	1.74	0.18	0.914	0.37	0.857	0.075	1.11	0.25	0.594	0.26
1985.625	1.07	0.093	2.6	0.12	1.87	0.81	1.17	0.08	0.927	0.22	-	-
1985.875	1.34	0.088	2	0.2	0.407	0.23	1.3	0.064	0.736	0.89	-	-
1986.125	0.739	0.084	0.64	0.19	1.08	0.31	1.02	0.07	1.86	0.19	0.358	0.35
1986.375	1.16	0.098	2.39	0.17	1.6	0.31	1.07	0.1	2.47	0.19	0.524	0.32
1986.625	1.3	0.13	1.92	0.13	0.88	0.31	1.01	0.077	1.59	0.21	-	-
1986.875	1.15	0.12	1.2	0.19	0.926	0.29	1.07	0.089	0.878	0.36	-	-
1987.125	0.97	0.14	0.925	0.17	1.22	0.37	1.21	0.1	1.38	0.19	0.466	0.36
1987.375	0.934	0.4	1.84	0.16	0.882	0.23	0.973	0.15	1.98	0.22	0.534	0.27
1987.625	1.15	0.17	1.33	0.14	0.811	0.36	0.991	0.08	1.33	0.17	-	-
1987.875	1.18	0.15	1.62	0.19	0.486	0.31	1.02	0.078	0.305	0.89	-	-
1988.125	0.854	0.11	0.608	0.14	0.815	0.27	1.22	0.089	1.07	0.44	0.437	0.34
1988.375	0.723	0.15	2.26	0.15	1.01	0.27	0.895	0.092	1.08	0.19	0.396	0.27
1988.625	0.915	0.12	1.58	0.12	0.969	0.36	1.01	0.077	0.914	0.19	-	-
1988.875	1.03	0.11	0.873	0.2	0.391	0.26	1.28	0.098	0.5	0.44	-	-
1989.125	1.08	0.14	0.759	0.25	1.03	0.41	1.23	0.086	1.25	0.36	0.71	0.36
1989.375	1.12	0.12	1.71	0.14	1.94	0.23	0.811	0.1	0.96	0.24	0.522	0.28
1989.625	1.22	0.1	1.38	0.12	0.686	0.33	0.968	0.09	0.721	0.21	-	-
1989.875	1.38	0.13	0.691	0.2	0.705	0.57	1.08	0.084	1.97	0.31	-	-
1990.125	0.973	0.14	0.601	0.18	0.715	0.57	1.23	0.092	0.64	0.32	0.757	0.45
1990.375	0.82	0.13	1.14	0.16	1	0.2	1.11	0.11	1.69	0.26	0.592	0.25
1990.625	0.86	0.11	1.22	0.11	0.238	0.57	0.822	0.084	1.73	0.16	-	-
1990.875	0.821	0.13	1.77	0.2	-	-	1.08	0.076	2.13	0.32	-	-
1991.125	0.877	0.13	0.693	0.21	-	-	1.07	0.085	1.05	0.24	0.433	0.34
1991.375	0.547	0.13	1.88	0.16	1.01	0.23	0.804	0.11	1.79	0.21	0.563	0.29
1991.625	0.954	0.15	1.83	0.13	0.681	0.33	0.811	0.095	1.43	0.2	-	-
1991.875	0.823	0.12	0.582	0.31	-	-	0.875	0.1	1.04	0.25	-	-
1992.125	0.98	0.19	0.711	0.16	-	-	1.17	0.11	0.876	0.34	0.455	0.59
1992.375	0.655	0.25	1.71	0.17	0.838	0.21	0.92	0.13	1.7	0.28	0.586	0.36
1992.625	1.14	0.1	1.55	0.12	0.358	0.31	0.982	0.094	0.914	0.16	2.77	0.6
1992.875	0.83	0.13	1.13	0.4	0.529	0.36	1.36	0.093	7.44	0.45	-	-
1993.125	0.782	0.16	1.02	0.18	-	-	1.38	0.095	1.37	0.34	0.834	0.72
1993.375	0.661	0.099	1.7	0.12	0.882	0.23	1.03	0.089	1.15	0.27	0.677	0.39
1993.625	0.887	0.083	1.41	0.12	0.515	0.47	1.01	0.079	0.769	0.34	0.505	0.73
1993.875	1.03	0.12	0.299	0.4	-	-	1.08	0.073	1.16	0.89	-	-
1994.125	0.813	0.1	1.17	0.14	-	-	0.975	0.08	1.12	0.51	-	-
1994.375	0.644	0.092	1.48	0.11	0.712	0.21	0.832	0.077	2.09	0.31	0.391	0.39
1994.625	1.04	0.081	1.19	0.11	0.764	0.27	0.898	0.067	0.728	0.44	-	-
1994.875	1.04	0.091	0.999	0.27	-	-	1.12	0.07	-	-	-	-
1995.125	0.915	0.082	1.13	0.14	-	-	1.35	0.078	1.76	0.34	-	-
1995.375	0.775	0.091	1.19	0.11	0.456	0.23	0.755	0.082	1.5	0.22	0.314	0.54
1995.625	0.845	0.1	1.2	0.12	0.296	0.41	0.866	0.081	1.62	0.32	-	-
1995.875	0.784	0.11	0.666	0.17	-	-	1.04	0.081	-	-	-	-
1996.125	0.783	0.14	1.36	0.13	-	-	1.39	0.1	0.582	0.34	-	-
1996.375	0.544	0.13	1.47	0.11	0.687	0.2	0.937	0.081	1.6	0.23	-	-
1996.625	0.966	0.13	1.97	0.12	0.615	0.21	0.868	0.078	1.55	0.24	-	-
1996.875	-	-	0.461	0.4	0.62	0.42	1.36	0.1	-	-	-	-
1997.125	0.466	0.69	1.18	0.17	-	-	1.44	0.097	1.68	0.34	-	-
1997.375	0.863	0.4	1.73	0.12	0.971	0.22	1.22	0.1	2.71	0.28	-	-
1997.625	0.917	0.13	1.33	0.12	1.08	0.47	0.988	0.08	1.49	0.4	-	-
1997.875	0.802	0.21	1.76	0.49	-	-	1.12	0.11	1.57	0.88	-	-
1998.125	1.05	0.25	0.71	0.17	-	-	1.37	0.096	0.892	0.23	-	-
1998.375	0.664	0.31	0.757	0.14	1.55	0.25	0.915	0.097	2.08	0.28	-	-
1998.625	1.13	0.11	1.03	0.14	0.582	0.81	1.13	0.064	1.33	0.19	-	-
1998.875	1.21	0.19	0.673	0.31	-	-	1.43	0.083	0.928	0.63	-	-
1999.125	3.58	0.69	0.696	0.17	-	-	1.4	0.13	0.69	0.3	-	-
1999.375	0.7	0.69	0.932	0.13	1.8	0.22	1.2	0.083	2.02	0.34	-	-
1999.625	1.89	0.21	1.36	0.14	0.913	0.41	1.39	0.073	1.07	0.17	12.7	1
1999.875	-	-	0.944	0.7	-	-	1.59	0.096	-	-	-	-
2000.125	0.95	0.35	0.538	0.18	-	-	1.56	0.07	1.22	0.34	-	-
2000.375	1.53	0.35	0.701	0.12	1.86	0.22	1.15	0.076	2.57	0.32	-	-
2000.625	1.88	0.19	0.709	0.15	0.501	0.41	1.26	0.074	0.691	0.26	3.85	1.1
2000.875	2.09	0.49	0.559	0.4	-	-	1.38	0.084	0.25	0.88	-	-
2001.125	0.974	0.4	0.392	0.35	1.05	0.84	2.41	0.088	0.325	0.63	-	-
2001.375	0.915	0.35	0.738	0.17	1.34	0.23	0.917	0.11	3.12	0.29	3.23	1.1
2001.625	1.49	0.19	0.804	0.14	0.748	0.32	1.29	0.077	1.16	0.22	0.689	1
2001.875	1.1	0.15	0.376	0.21	-	-	1.74	0.08	0.427	0.4	-	-
2002.125	1.24	0.19	0.811	0.19	-	-	1.6	0.081	1.8	0.3	-	-
2002.375	0.637	0.17	0.72	0.15	1.02	0.24	1.24	0.089	0.501	0.27	-	-
2002.625	0.955	0.14	0.933	0.12	0.246	0.58	1.4	0.075	1.2	0.22	0.689	1
2002.875	0.882	0.12	0.453	0.29	-	-	1.42	0.074	-	-	-	-

2003.125	0.738	0.12	0.366	0.22	-	-	1.35	0.083	1.03	0.4	-	-
2003.375	0.551	0.16	0.4	0.16	0.689	0.32	0.999	0.092	0.819	0.32	-	-
2003.625	0.99	0.13	0.419	0.14	-	-	1.2	0.089	1.01	0.2	-	-
2003.875	1.06	0.16	0.185	0.23	-	-	1.42	0.084	0.355	0.27	-	-
2004.125	0.797	0.17	0.275	0.22	-	-	1.94	0.088	0.585	0.37	-	-
2004.375	0.856	0.16	0.455	0.15	0.69	0.3	1.19	0.099	0.67	0.52	-	-
2004.625	0.797	0.14	0.787	0.13	-	-	1.05	0.085	0.835	0.23	-	-
2004.875	1.07	0.15	0.269	0.29	-	-	1.36	0.085	0.503	0.52	-	-
2005.125	0.753	0.19	0.24	0.22	-	-	1.33	0.092	1.5	0.45	-	-
2005.375	0.781	0.17	0.373	0.15	0.732	0.29	0.791	0.11	0.194	0.52	-	-
2005.625	1.04	0.16	0.54	0.13	-	-	1.1	0.1	0.763	0.25	-	-
2005.875	1.22	0.25	0.313	0.49	-	-	1.66	0.14	0.423	0.34	-	-
2006.125	1.46	0.19	0.25	0.22	-	-	1.85	0.13	0.486	0.45	-	-
2006.375	0.897	0.15	0.417	0.13	1.12	0.42	0.931	0.11	0.514	0.4	-	-
2006.625	0.911	0.11	0.732	0.18	0.482	0.58	1.17	0.097	1.04	0.25	-	-
2006.875	1.2	0.16	0.657	0.35	-	-	2.24	0.11	0.439	0.52	-	-
2007.125	0.852	0.13	0.611	0.27	-	-	1.9	0.11	0.313	0.63	-	-
2007.375	0.778	0.16	0.689	0.17	0.897	0.35	1.18	0.16	2.32	0.4	-	-
2007.625	1.23	0.15	0.6	0.18	-	-	1.81	0.1	0.839	0.24	-	-
2007.875	1.14	0.17	0.292	0.35	-	-	1.94	0.11	0.579	0.45	-	-
2008.125	1.19	0.15	0.908	0.27	-	-	2.46	0.16	0.521	0.62	-	-
2008.375	1.3	0.13	0.968	0.18	0.605	0.31	1.17	0.16	0.937	0.37	-	-
2008.625	0.989	0.14	0.584	0.17	-	-	1.75	0.12	0.705	0.24	-	-
2008.875	1.61	0.19	0.333	0.31	-	-	2.43	0.11	0.423	0.45	-	-
2009.125	1.14	0.16	0.791	0.22	-	-	2.81	0.097	1.36	0.63	-	-
2009.375	0.943	0.14	0.784	0.16	0.437	0.33	1.81	0.17	1.37	0.34	-	-
2009.625	1.1	0.14	0.865	0.2	-	-	1.72	0.11	1.05	0.25	-	-
2009.875	1.14	0.16	0.825	0.35	-	-	2.07	0.11	0.698	0.88	-	-
2010.125	0.738	0.14	0.693	0.22	1.06	0.81	1.9	0.11	0.924	0.45	-	-
2010.375	0.646	0.12	1.05	0.18	1.61	0.42	1.31	0.11	1.33	0.4	-	-
2010.625	0.865	0.13	0.493	0.35	-	-	1.46	0.095	1.07	0.3	-	-
2010.875	0.828	0.15	0.568	0.7	-	-	1.65	0.075	-	-	-	-
2011.125	0.826	0.15	0.738	0.24	0.263	0.58	1.72	0.091	0.417	0.63	-	-
2011.375	0.791	0.13	1.06	0.13	1.58	0.3	1.64	0.12	0.851	0.4	-	-
2011.625	1.3	0.14	0.609	0.21	-	-	1.84	0.1	1.14	0.23	-	-
2011.875	1.6	0.2	0.623	0.29	-	-	1.85	0.15	0.675	0.37	-	-

Table 2: Estimated swordfish CPUE and CV from TW LL data

	ALB target		BET target	
	CPUE	CV	CPUE	CV
1964.125	-	-		
1964.375	-	-		
1964.625	2.4	0.55		
1964.875	-	-		
1965.125	-	-		
1965.375	4.83	0.78		
1965.625	5.34	0.55		
1965.875	0.508	0.35		
1966.125	0.579	0.78		
1966.375	1.66	0.45		
1966.625	0.603	0.14		
1966.875	1.52	0.28		
1967.125	0.591	0.32		
1967.375	0.726	0.1		
1967.625	0.952	0.12		
1967.875	0.783	0.17		
1968.125	1.1	0.16		
1968.375	0.716	0.12		
1968.625	0.802	0.13		
1968.875	3.74	0.55		
1969.125	0.621	0.39		
1969.375	0.986	0.22		
1969.625	0.618	0.25		
1969.875	0.682	0.56		
1970.125	-	-		
1970.375	0.744	0.17		
1970.625	0.826	0.12		
1970.875	6.73	0.55		
1971.125	0.709	0.78		
1971.375	0.661	0.13		
1971.625	0.613	0.1		
1971.875	0.69	0.27		
1972.125	3.94	0.36		
1972.375	0.571	0.14		
1972.625	0.769	0.1		
1972.875	1.35	0.23		
1973.125	1.13	0.21		
1973.375	0.55	0.1		
1973.625	0.614	0.097		
1973.875	0.937	0.24		
1974.125	0.645	0.23		
1974.375	0.698	0.091		
1974.625	0.764	0.1		
1974.875	1.68	0.2		
1975.125	0.785	0.35		
1975.375	0.647	0.15		
1975.625	0.654	0.15		
1975.875	-	-		
1976.125	0.546	0.35		
1976.375	0.682	0.17		
1976.625	0.762	0.14		
1976.875	1	0.35		
1977.125	0.671	0.3		
1977.375	0.528	0.12		
1977.625	0.627	0.11		
1977.875	0.575	0.25		
1978.125	0.638	0.35		
1978.375	0.518	0.13		
1978.625	0.631	0.14		
1978.875	-	-		
1979.125	0.686	0.29		
1979.375	0.68	0.11		
1979.625	0.925	0.095		
1979.875	0.89	0.45		
1980.125	0.576	0.27		
1980.375	0.812	0.095		
1980.625	0.88	0.11		

1980.875	1.32	0.26
1981.125	1.55	0.21
1981.375	0.986	0.085
1981.625	0.883	0.095
1981.875	0.794	0.2
1982.125	0.692	0.2
1982.375	0.793	0.097
1982.625	1.08	0.099
1982.875	1.7	0.35
1983.125	0.71	0.24
1983.375	0.627	0.11
1983.625	0.768	0.14
1983.875	0.786	0.39
1984.125	0.571	0.26
1984.375	0.82	0.11
1984.625	0.959	0.11
1984.875	2.1	0.35
1985.125	0.511	0.3
1985.375	0.82	0.13
1985.625	0.98	0.14
1985.875	0.613	0.55
1986.125	0.515	0.45
1986.375	0.586	0.14
1986.625	0.679	0.16
1986.875	-	-
1987.125	0.512	0.28
1987.375	0.596	0.13
1987.625	0.54	0.14
1987.875	0.476	0.28
1988.125	0.608	0.25
1988.375	0.587	0.14
1988.625	0.79	0.14
1988.875	0.471	0.39
1989.125	0.617	0.25
1989.375	0.663	0.12
1989.625	0.585	0.14
1989.875	-	-
1990.125	-	-
1990.375	0.621	0.21
1990.625	0.855	0.15
1990.875	1.04	0.55
1991.125	-	-
1991.375	0.678	0.17
1991.625	0.697	0.16
1991.875	0.286	0.78
1992.125	0.474	0.16
1992.375	0.464	0.13
1992.625	0.579	0.15
1992.875	0.505	0.15
1993.125	0.517	0.12
1993.375	0.554	0.11
1993.625	0.652	0.11
1993.875	0.642	0.15
1994.125	0.989	0.14
1994.375	0.766	0.094
1994.625	0.752	0.11
1994.875	1.25	0.3
1995.125	1.53	0.55
1995.375	1.03	0.2
1995.625	0.867	0.14
1995.875	0.722	0.22
1996.125	0.564	0.17
1996.375	0.751	0.089
1996.625	0.879	0.11
1996.875	0.985	0.26
1997.125	0.663	0.22
1997.375	0.821	0.097
1997.625	0.74	0.11
1997.875	0.75	0.26
1998.125	1.11	0.39
1998.375	0.731	0.1

1998.625	0.814	0.12		
1998.875	0.639	0.28		
1999.125	0.816	0.12		
1999.375	0.599	0.086		
1999.625	0.681	0.099		
1999.875	0.629	0.26		
2000.125	0.586	0.19	0.312	0.28
2000.375	0.581	0.13	0.297	0.28
2000.625	0.592	0.13	0.156	0.36
2000.875	0.49	0.32	0.202	0.52
2001.125	0.461	0.3	0.686	0.48
2001.375	0.887	0.081	0.663	0.19
2001.625	0.689	0.091	0.742	0.18
2001.875	1.46	0.24	0.777	0.41
2002.125	0.49	0.32	1.21	0.41
2002.375	1.12	0.13	0.774	0.11
2002.625	1.63	0.14	0.936	0.21
2002.875	3.2	0.3	2.79	0.51
2003.125	0.639	0.24	1.32	0.28
2003.375	0.765	0.14	0.962	0.11
2003.625	1.02	0.11	1.11	0.1
2003.875	-	-	0.727	0.32
2004.125	0.512	0.32	0.964	0.25
2004.375	2.13	0.12	1.06	0.17
2004.625	1.9	0.16	0.851	0.19
2004.875	0.475	0.78	0.203	0.57
2005.125	-	-	7.22	1.1
2005.375	1.25	0.098	0.621	0.12
2005.625	1.01	0.1	0.514	0.13
2005.875	2.03	0.45	0.0915	1.1
2006.125	0.911	0.39	0.369	0.39
2006.375	1.23	0.1	0.468	0.14
2006.625	1.37	0.1	0.506	0.15
2006.875	2.3	0.28	0.355	0.46
2007.125	-	-	-	-
2007.375	0.89	0.13	0.304	0.22
2007.625	1.58	0.11	0.546	0.16
2007.875	0.93	0.39	1.5	0.57
2008.125	1.05	0.45	0.213	1.1
2008.375	0.79	0.2	0.643	0.23
2008.625	0.955	0.2	0.738	0.21
2008.875	0.472	0.56	1.43	0.32
2009.125	2.26	0.45	1.92	0.32
2009.375	1.06	0.14	2.49	0.28
2009.625	1.49	0.13	0.825	0.16
2009.875	0.541	0.56	-	-
2010.125	0.94	0.32	6.11	1.1
2010.375	0.669	0.22	0.421	0.25
2010.625	2.18	0.15	0.709	0.2
2010.875	2	0.45	0.478	0.38
2011.125	-	-	-	-
2011.375	1.48	0.23	0.564	0.2
2011.625	0.973	0.25	0.38	0.14
2011.875	-	-	0.877	1.1
2012.125	-	-	0.341	0.51
2012.375	-	-	0.383	0.26
2012.625	-	-	0.25	0.4

7. Figures

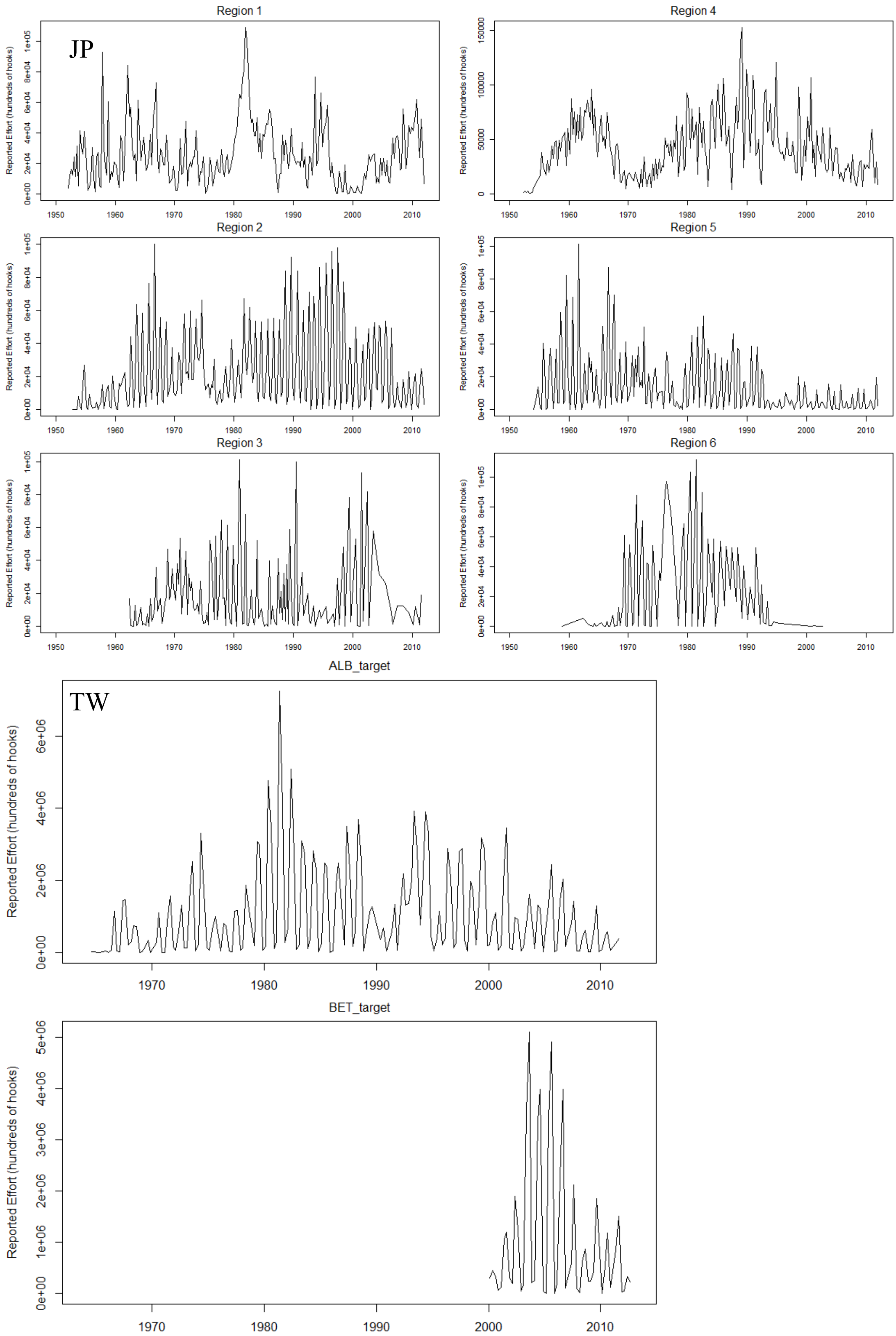

Figure 1: Effort by region and year-quarter by the Japanese (top) and Taiwanese (bottom) distant-water longline fleets, as recorded in the aggregated dataset.

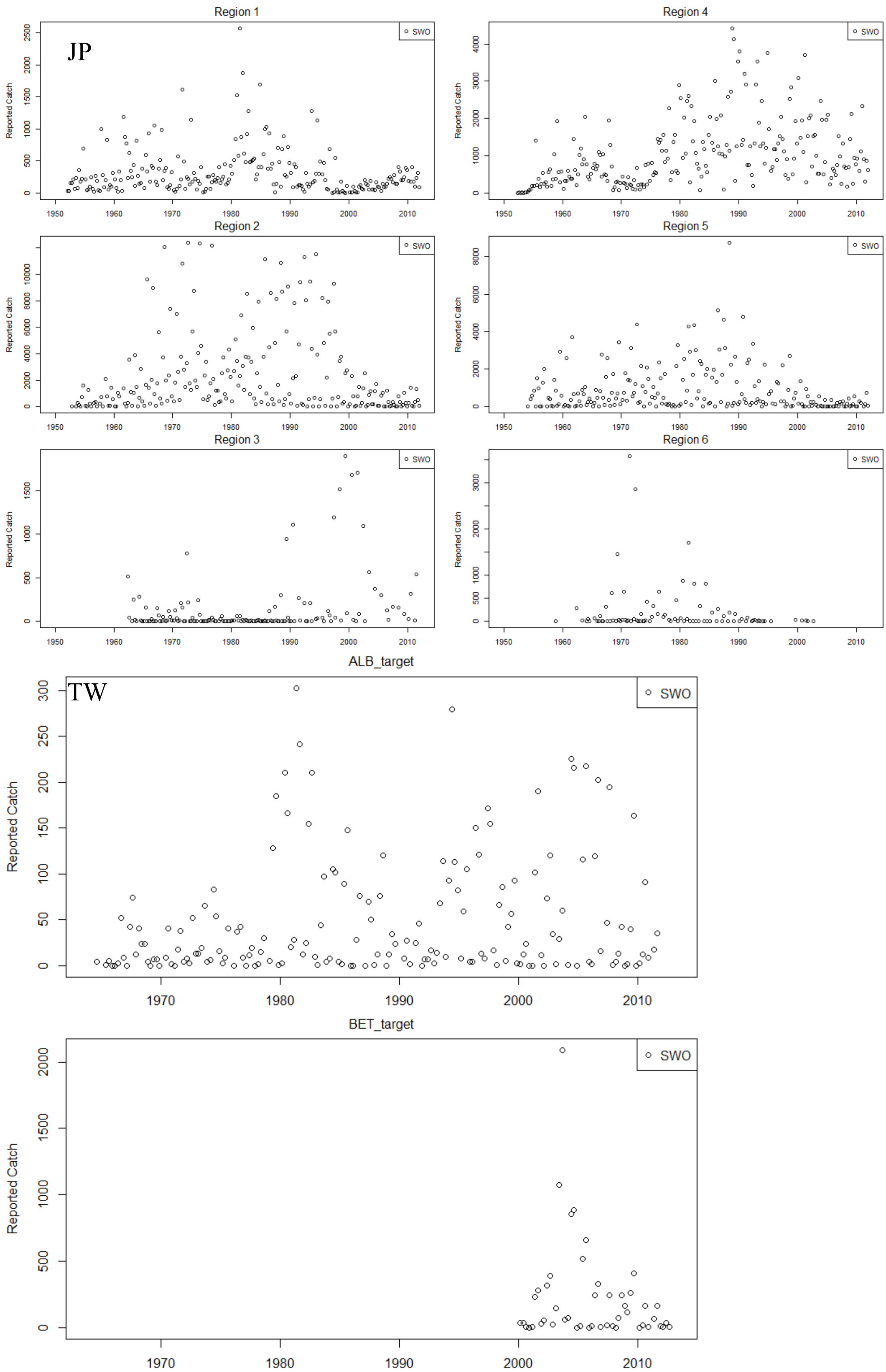

Figure 2: Catch of southwest Pacific swordfish by region and year-quarter, by the Japanese (top) and Taiwanese (bottom) distant-water longline fleets, as recorded in the aggregated dataset.

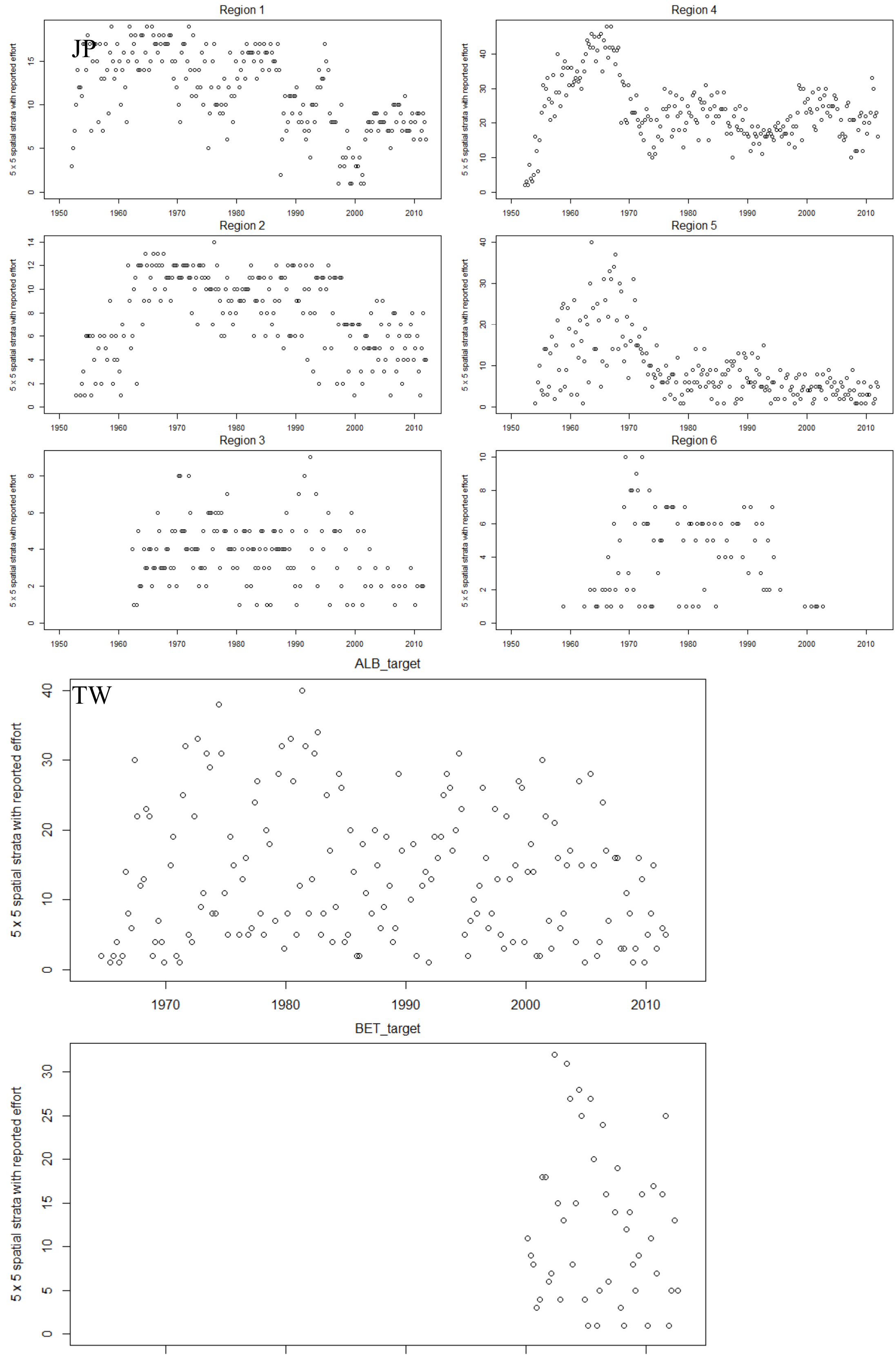

Figure 3: The number of 5° x 5°spatial strata in which effort is reported, by region and year-quarter, for the Japanese (top) and Taiwanese (bottom) distant-water longline fleets, as recorded in the aggregated dataset.

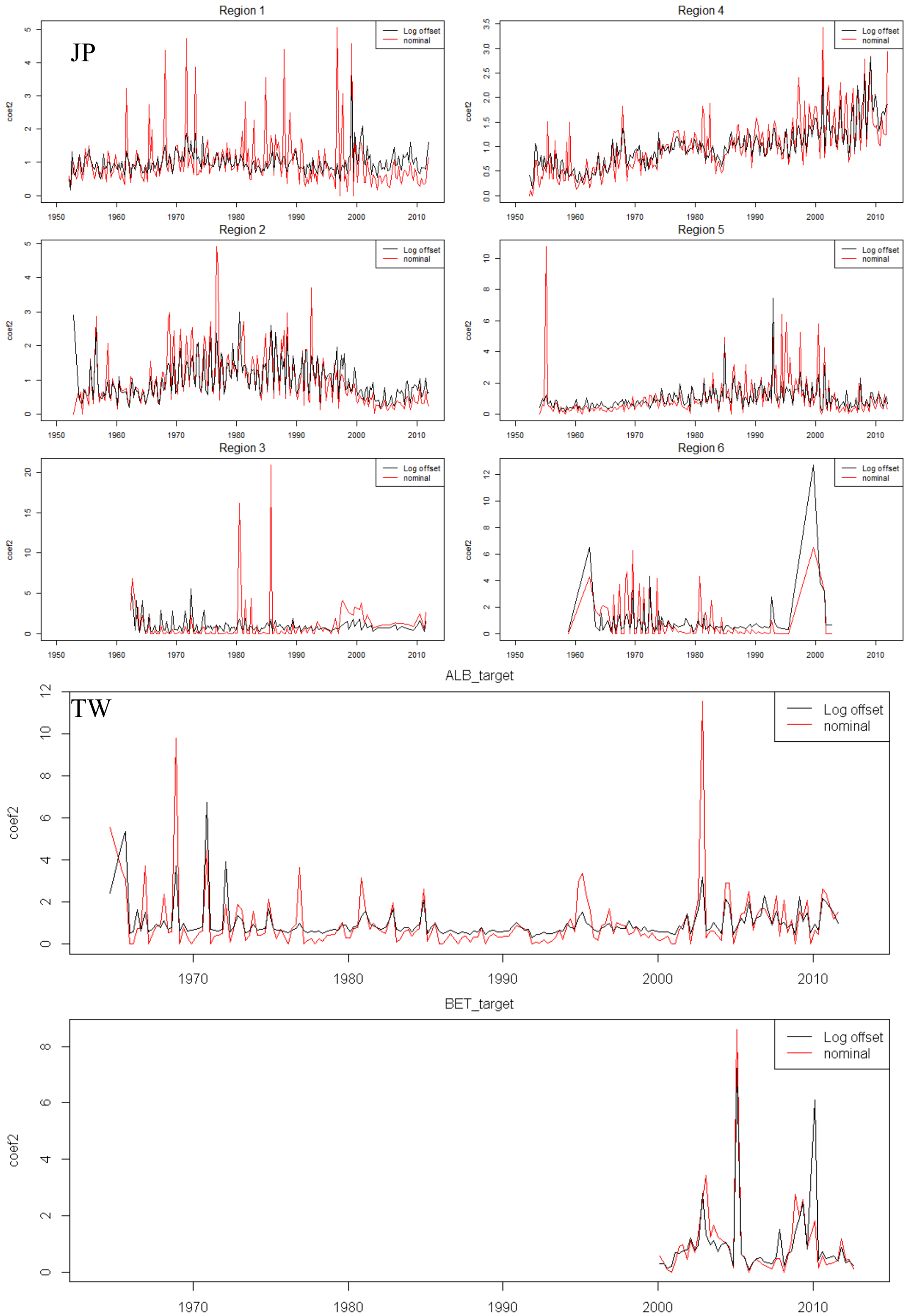

Figure 4: Standardized indices of southwest Pacific swordfish CPUE by region for the Japanese (top) and Taiwanese (bottom) distant-water longline fleets.

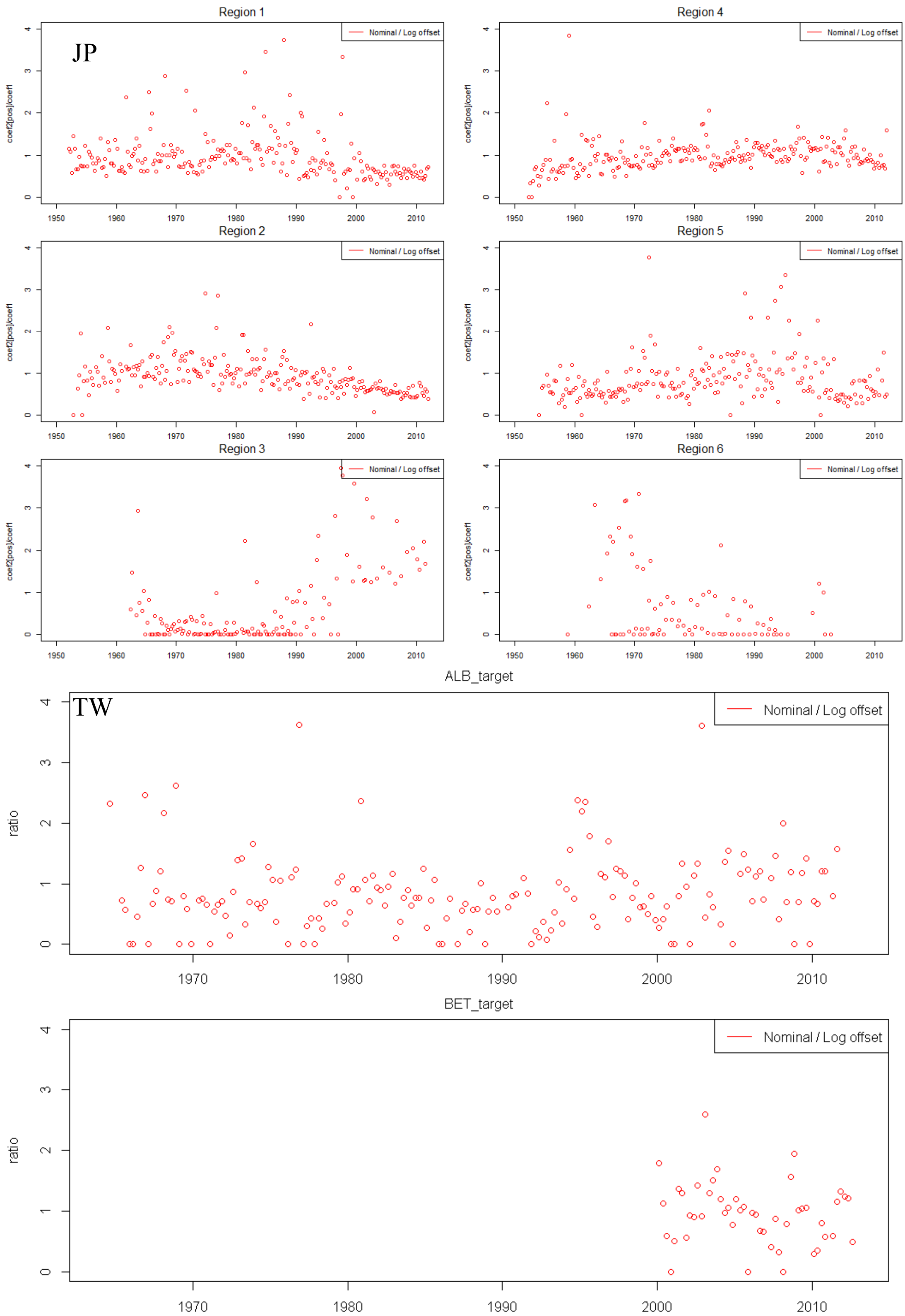

Figure 5: Ratios of the 2012 southwest Pacific swordfish indices versus the nominal CPUE, by year-quarter and region, Japanese (top) and Taiwanese (bottom) distant-water longline fleets.

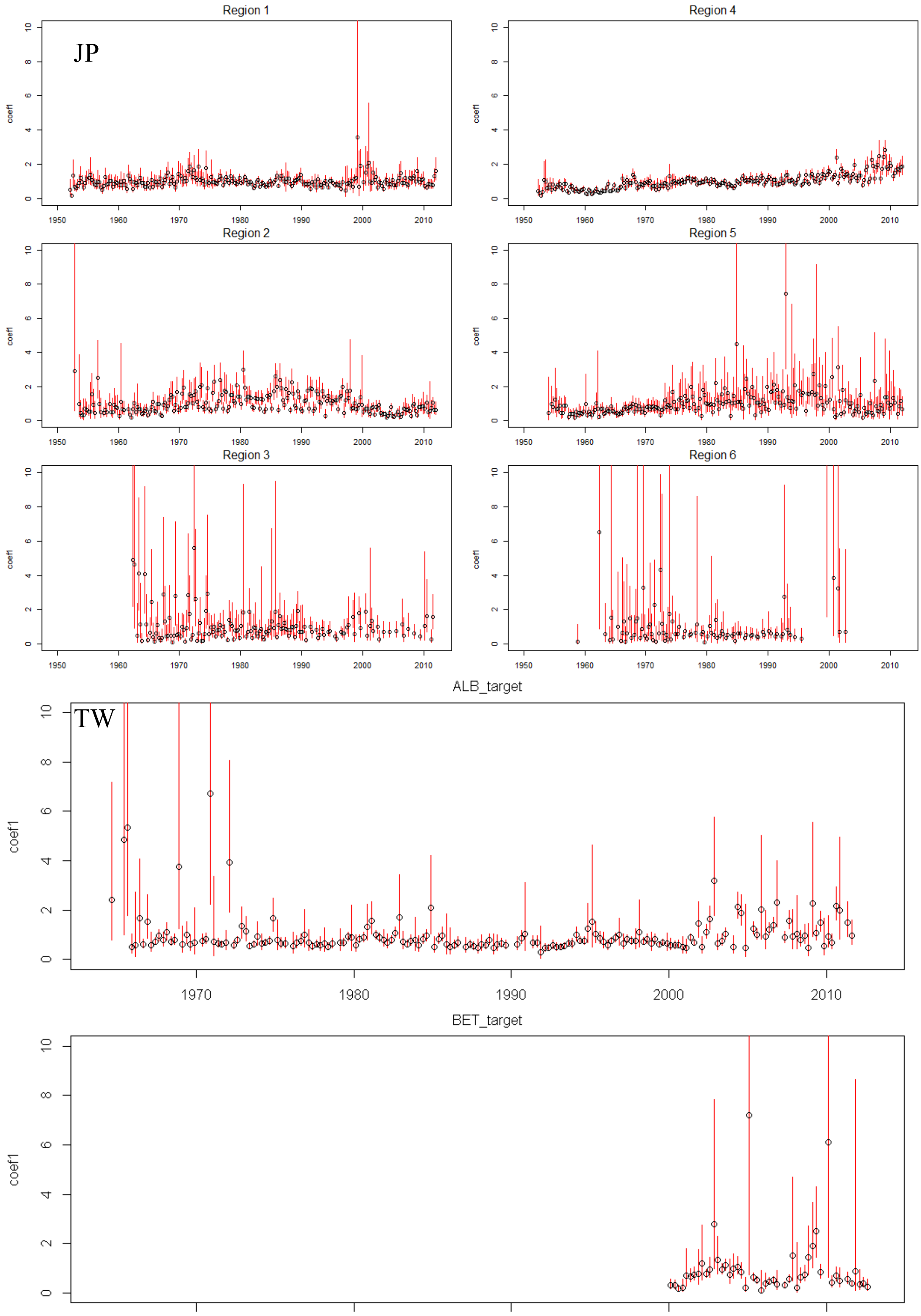

Figure 6: Log offset quarterly indices of abundance for southwest Pacific swordfish (black circles), with 95% CI in red, for the Japanese (top) and Taiwanese (bottom) distant-water longline fleets.

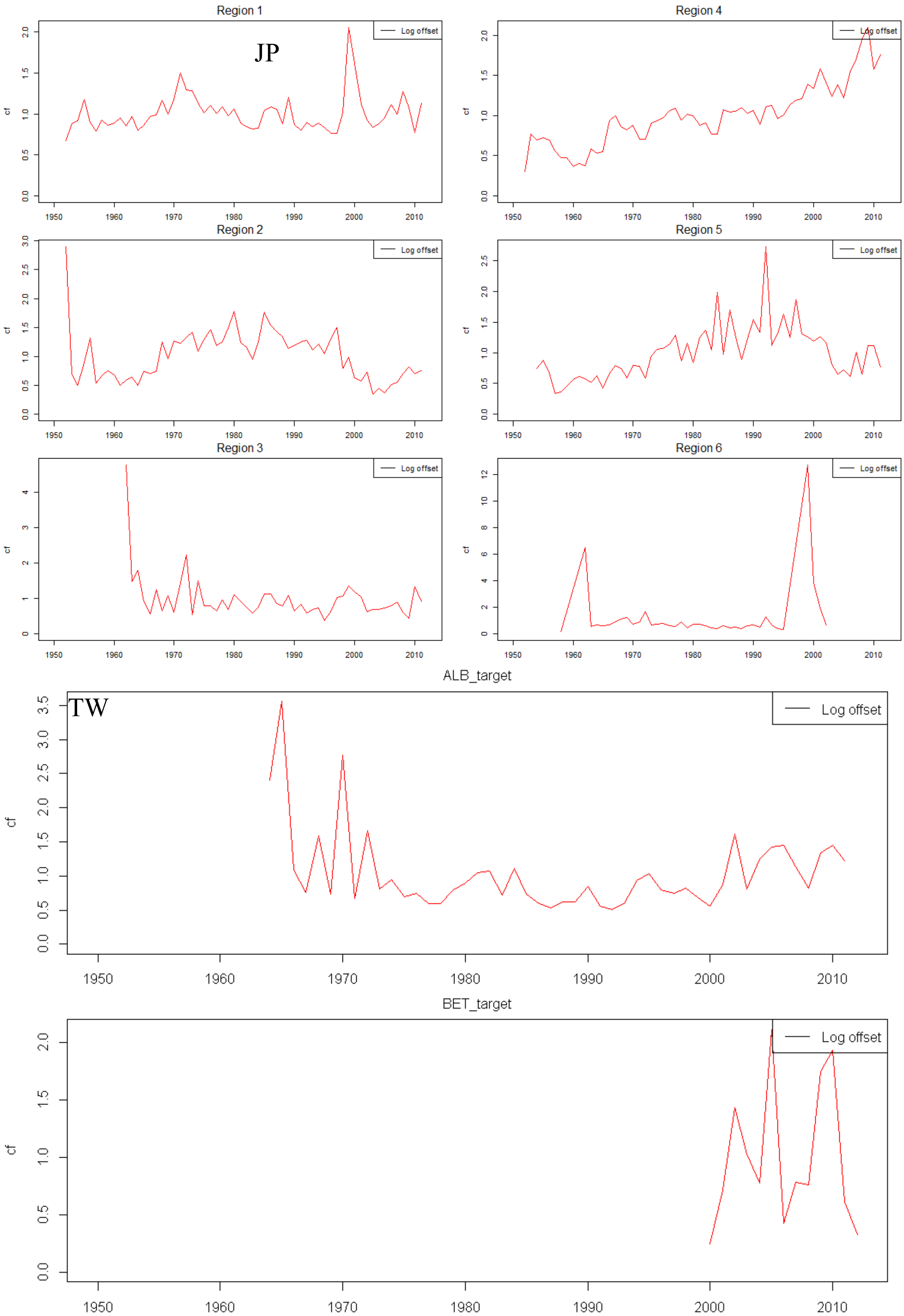

Figure 7: Annualised indices of abundance for southwest Pacific swordfish, for the Japanese (top) and Taiwanese (bottom) distant-water longline fleets.

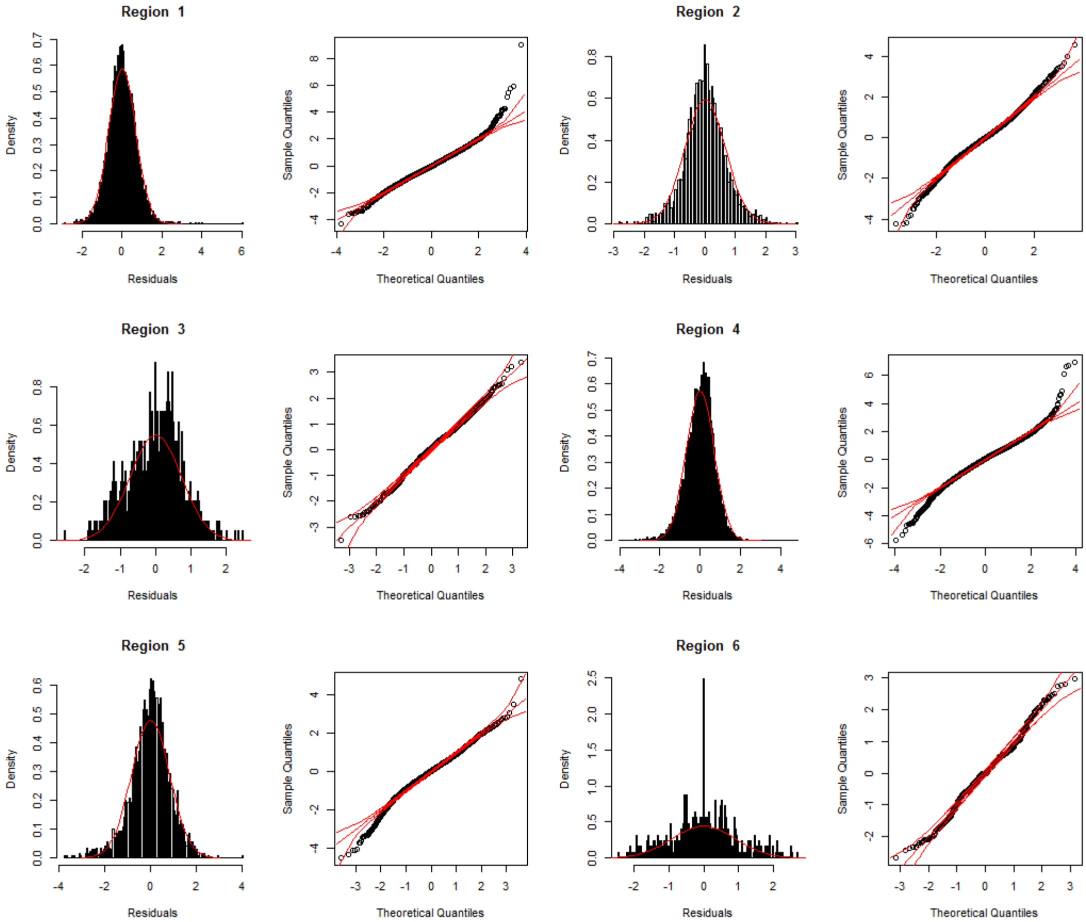

Figure 8: Diagnostic plots for 2012 swordfish CPUE indices using Japanese longline data. Density histograms (left) of residual sizes by region from the GLMs (black), compared with a normal distribution with mean zero and the same standard deviation as the residuals. Q-Q plots (right) of residuals by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

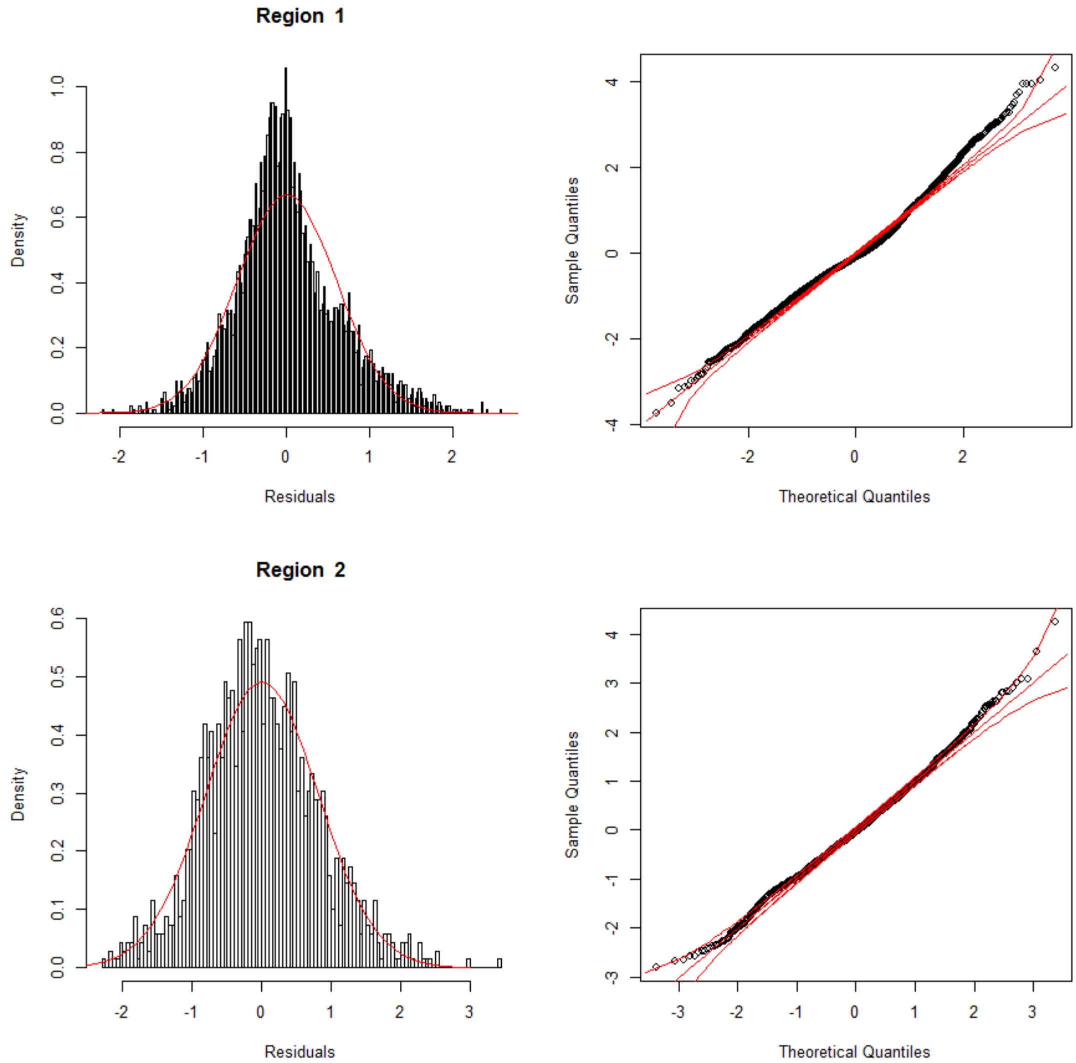

Figure 9: Diagnostic plots for 2012 swordfish CPUE indices using Taiwanese longline data. Density histograms (left) of residual sizes by region from the GLMs (black), compared with a normal distribution with mean zero and the same standard deviation as the residuals. Q-Q plots (right) of residuals by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

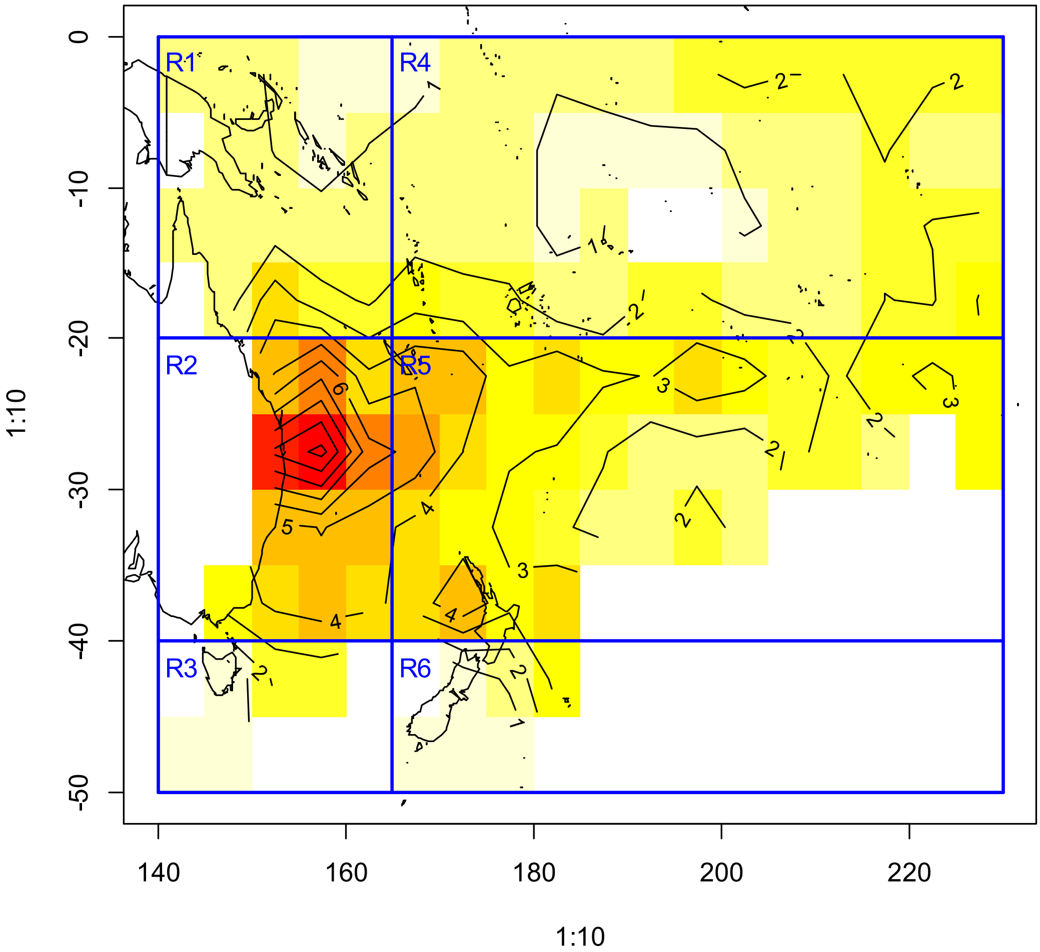

Figure 10: Spatial distribution of southwest Pacific swordfish relative catch rates, as estimated in the regional rescaling analysis using Japanese longline data. Darker colours signify higher catch rates. Numbers are relative and not comparable with TW.

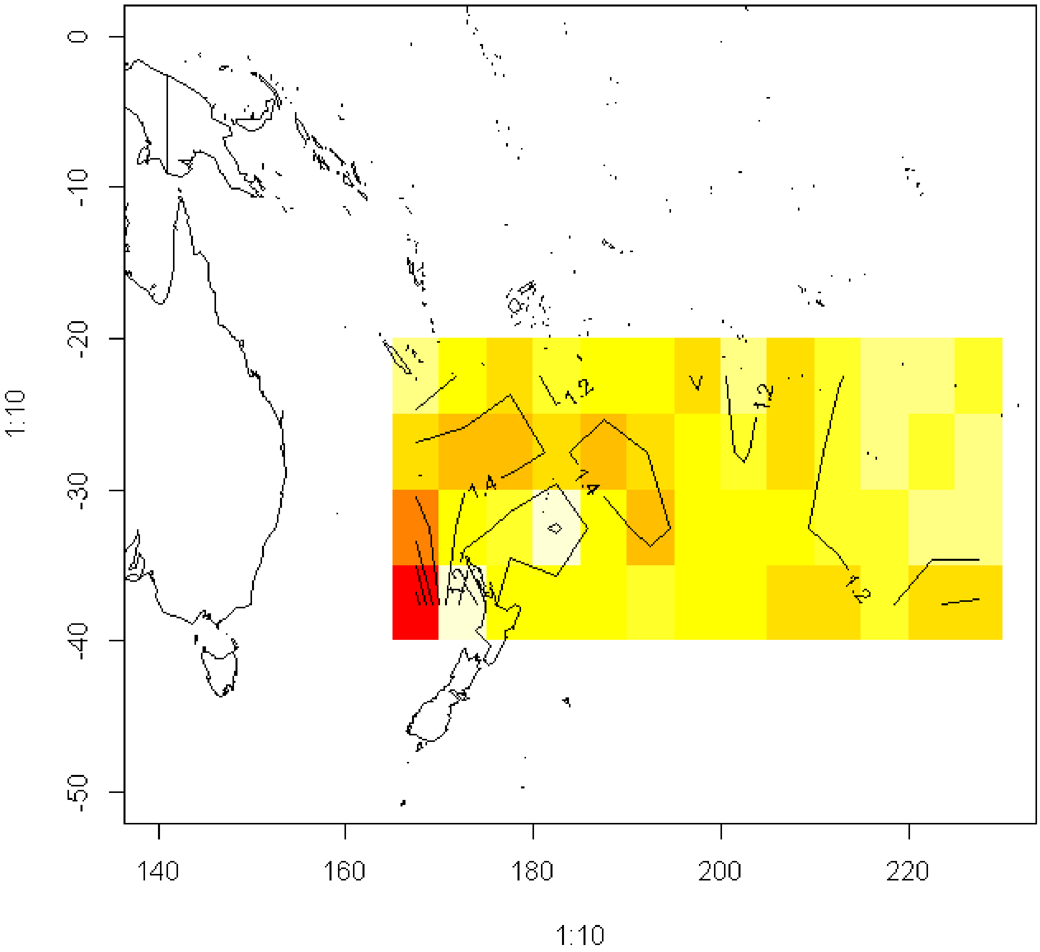

Figure 11: Spatial distribution of southwest Pacific swordfish relative catch rates, as estimated in the regional rescaling analysis based on the ALB targeting Taiwanese longline data. Darker colours signify higher catch rates. Numbers are relative and not comparable with JP.