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Working Paper

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Estimates of longline billfish catch (1980–1997) in the western and central Pacific Ocean

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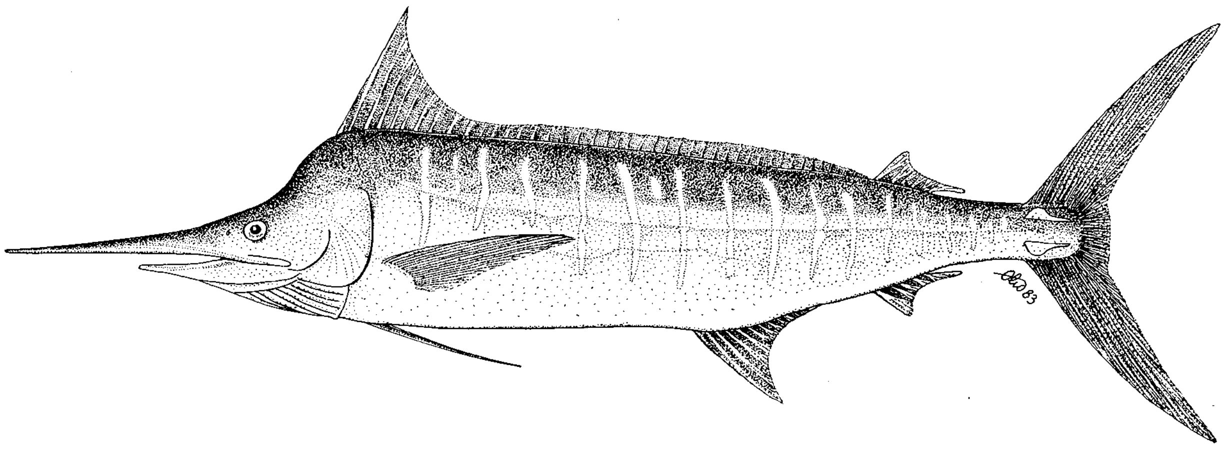

Oceanic Fisheries Programme
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CONTENTS

1. INTRODUCTION

Most of the billfish caught in the western and central Pacific Ocean (WCPO) tuna fisheries are taken by longline fisheries, though billfish may be caught by a variety of other gears (e.g. handline, purse seine, coastal gillnet and recreational game-fishing). This paper is an attempt towards producing the best available estimates of longline billfish catch in the WCPO, in view of interest from, the commercial/industrial, research and recreational fishing sectors.

Longline fisheries provide the longest available time-series of billfish catch. Only recently have billfish been reported on purse seine logsheets; however, indications of catch from this source are likely to be hampered by inevitable problems of non-reporting and species mis-identification (Bailey et al., 1996). Even so, observer data suggests that the purse seine catch is much smaller than that taken by longline gear. Handline fisheries in the Philippines, Indonesia and Hawaii also exploit billfish, but no attempt has been made to include these fisheries at this stage of the estimation process. The increase in significance of game-fisheries in the region during the past 10–15 years also suggests that some work will be required in ensuring game-fish catches are included in future estimates of billfish catch (Pacific Island Gamefish Tournament Symposium, 1998). In fact, substantial work in establishing data collection and obtaining historical information from the game-fisheries has been undertaken by SPC in the past twelve months. The pole-and-line catch of billfish is extremely rare (Bailey et al., 1996).

Billfish, as a group, form the most distinctive part of the by-catch of longline vessels in the WCPO, and, in some cases, may be secondary or even primary target species. Bailey et al. (1996) suggest that estimates of total catch of the four main billfish species, namely blue marlin (*Makaira mazara*), black marlin (*M. indica*), striped marlin (*Tetrapturus audax*) and swordfish (*Xiphias gladius*), can be derived from logsheet data. This study, in fact, attempted to do this for the SPC Statistical Area. Two additional billfish species (shortbill spearfish, *Tetrapturus angustirostris* & sailfish, *Istiophorus platypterus*) occur in the WCPO, but there have been problems in the logsheet reporting of these species (Farman, 1988; Bailey et al., 1996).

This report focuses primarily on the WCPO (the area west of 150^0 W) which covers most of the SPC member countries as well as eastern Indonesia and the Philippines. This paper has been expanded from previous versions to include available data on the longline catch for the main fleets (Japan and Korea) operating in the eastern Pacific Ocean (EPO). This is intended to provide some comparison with WCPO catches as well as providing a more complete picture of the catch of these species throughout the whole Pacific. Figure 1 shows the areas of interest and the distribution of longline effort for 1990–1997.

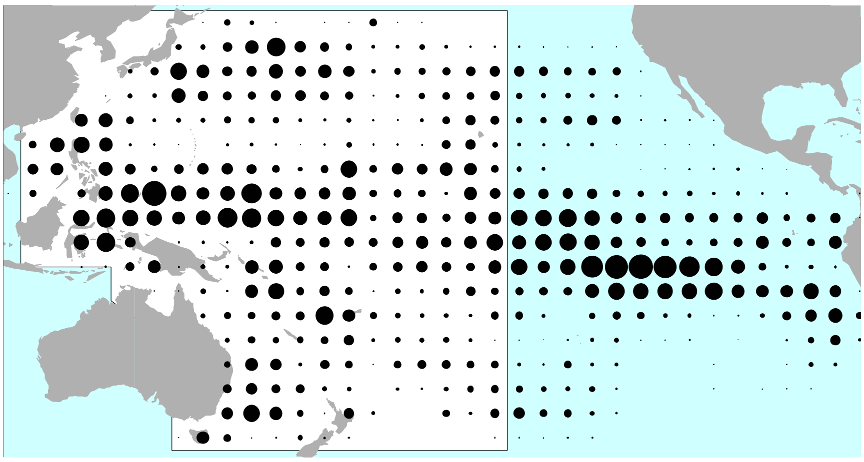


Figure 1. Distribution of longline effort for 1990–1997, showing the WCPO area.

Due to more recent information becoming available during the past year, we are now in a position to provide better estimates of total regional catch for the four main billfish species, and, for the first time, attempt to provide estimates of shortbill spearfish and sailfish catch. Also, this paper attempts to provide time series of nominal longline catch rates for fleets where data are considered valid and consistent.

2. DATA USED

The Oceanic Fisheries Programme (OFP) has been provided with substantial historical aggregated logsheet data for the three main distant-water (DWFN) longline fleets, Japan, Korea and Taiwan, from which estimates of the target tuna species have been derived in the past. Historic catch data for the four main billfish species exist in these aggregate databases, and therefore, have been used as a primary source for this review. Sailfish and short-billed spearfish have only recently been separated in aggregated logsheet data provided by Japan (that is, since 1995; Miyabe, pers. comm.), while Korean aggregate data provide catches for sailfish only. Unfortunately, Taiwanese distant-water aggregate data do not provide a breakdown of catch for either of these species.

Estimates of billfish species catch from the Taiwanese domestically-based offshore longline fleet have now been included. These estimates are based directly on landings from a fleet known to retain most, if not all, of its catch; as such, estimates from this fleet are considered to be reliable. Unfortunately, species composition of billfish catch is only available for the years 1989–1997 at this stage; catch estimates for 1980–1988 have been determined by using the average billfish species composition determined for years 1989–1997 (i.e. for the years where a breakdown of billfish catch is available). The spatial distribution of the catch taken by this fleet has been derived from Sun & Yang (1983).

For the remaining longline fleets operating in the region, the Regional Tuna Fisheries Database (RTFD), in conjunction with estimates of target tuna species (Lawson, 1998) and available observer data have been used to estimate billfish catch, where possible.

Billfish catch information for the Hawaiian longline fishery has been taken from Curran et al. (1996), Curran (pers. comm.) and WPRFMC (1996).

Istiophorid catch in Philippine and Indonesian waters is considered to come mainly from the longline fishery. In earlier versions of this paper, data from the Philippines Tuna Research Programme (PTRP) Landed Catch and Effort Monitoring Programme (LCEM) was used to estimate billfish catch from these fisheries. However, these data were considered lacking, both in coverage by billfish species composition and coverage over time (LCEM data cover 1993 and 1994 only). Information on the species composition of billfish in the Indonesian longline fishery has become available recently (Carrara and Uktolseja, 1997), and these data have been used to estimate the billfish catch for the Indonesian and Philippine longline fleets from estimates of target tuna species presented in Lawson (1998).

3. METHODOLOGY

A table showing (i) problems identified in the estimation process, (ii) how these problems were handled, and (iii) where further work is required, is presented in Appendix A.

Some of the more important points in the methodology for estimating billfish catch are described in detail below.

3.1 Aggregated data for the Japanese, Korean and Taiwanese distant-water longline fleets

Catch by weight for the four main species of billfish are provided for the Taiwanese distant-water fleet. For the Japanese and Korean fleets, catch, in number only, has been provided. For these fleets, it has been therefore been necessary to estimate average weight using the daily logsheet provided to OFP for these fleets; the average weight estimates are stratified by month and year, and have been applied to catch by number to produce estimates of billfish catch by weight.

Catch data for black marlin taken by the Korean distant-water fleet were not available prior to 1988. An estimate of black marlin catch for this fleet was determined by taking the approximate proportion (i.e. species composition) of black marlin to target tuna catch (bigeye+yellowfin) for the Japanese distant-water fleet, fishing in a similar area (i.e. tropical waters of the WCPO), and applying it to the Korean target tuna catch on an annual basis.

3.2 Mainland Chinese and Taiwanese offshore fleets operating in Micronesia.

Observer accounts (e.g. Bailey et al., 1996) suggest that there has been some degree of non-reporting the catch of billfish, and problems with mis-identification of billfish species (e.g. blue and black marlin) for vessels belonging to these fleets. Appendix B provides an indication of the problems with logsheet-reported blue marlin, black marlin and swordfish catch from these fleets. Blue marlin and swordfish catch have probably been under-reported on logsheets submitted by the mainland Chinese fleet during 1996 and 1997, and for the Taiwanese offshore fleet for 1993–1997. The blue marlin and swordfish catch estimates for these fleets/years have been adjusted to better reflect the observer-reported catch for these species.

The problem of black marlin misidentification by some vessels in these fleets (i.e. blue marlin are sometimes misidentified as black marlin) has not been addressed at this stage.

3.3 Other longline fleets operating in the SPC statistical area.

The level of logsheet-reporting of billfish catch by species for other fleets has not been reviewed at this stage, and it has been assumed that fleets have generally complied in reporting billfish catch by species. The billfish catch by weight, as available from logsheets, has been raised using the proportion of target tuna (bigeye, albacore and yellowfin) catch reported on logsheets to the target tuna catch estimate in Lawson (1998), on a fleet by fleet basis.

4. BIASES IN CATCH ESTIMATES

With the exception of a few directed fisheries targeting swordfish, and to a lesser extent striped marlin (Pacific Island Gamefish Tournament Symposium 1998), billfish are usually considered by-catch within longline fisheries. Potential biases in billfish catch estimation comprise three broad categories:

4.1 Discarding and non- or under-reporting

At both the vessel and fleet level, bycatch estimation may be potentially biased downwards due to discarding and non- or under-reporting. Little is known about the non- or under-reporting of billfish, but discard rates vary according to vessel category and species marketability (Bailey et al., 1996). Billfish discard rates varies among the three DWFN fleets, due to marketability of the species; for example, striped marlin command a higher price in Japanese markets than the other billfish species. Within a nation's fishing fleet, discard rates may also vary by vessel size. Larger distant-water vessels catching fish for the frozen market have adequate freezer storage for most of their catch and billfish would probably only be discarded due to low marketability. In contrast, smaller vessels, which have a limited ice supply to chill their catch for the sashimi market, would probably have higher billfish discard rates as space is allocated for more economically valuable species.

This study has not taken into account the non-reported discard of billfish catch.

4.2 Inaccuracies in statistical extrapolation

Catch estimates for the Japanese and Korean fleets may be biased due to extrapolating billfish numbers to weight using average weight estimates. The extrapolation is stratified temporally, but billfish size varies latitudinally as well (Bailey et al., 1996) and the use of average weights across the entire latitudinal range is probably not appropriate.

4.3 Species misidentification

Several accounts of misidentification of billfish species have been reported and as a consequence, some data have been excluded from the estimation process. This was particularly the case for some vessels in the Taiwanese offshore fleet based in Pacific Island countries (PICs), which were considered to have misidentified blue marlin as black marlin (Bailey et al., 1996). It is likely that this problem probably exists at the vessel level and would need to be clarified for all fleets/vessels in order to obtain more reliable estimates in the future.

5. BLUE MARLIN

Blue marlin has been characterised as the predominant marlin of the central tropical Pacific (Yuen and Miyake 1980) and is found principally in the tropical and sub-tropical waters of the Pacific and Indian Oceans. It is the most tropical of the billfish species and is frequently found in equatorial waters (Collette & Nauen 1983). In general, there is very little known about the stock structure of blue marlin in the Pacific Ocean. It is assumed that there is one stock for the Pacific (Suzuki 1989) and that the populations in the Pacific and Indian oceans are separate (Shomura 1993).

Nearly all the longline blue marlin catch is taken between latitudes 15°N–15°S (Figure 2; Bailey et al., 1996), showing a preference for warmer waters. Blue marlin are believed to comprise a single ocean-wide stock, and estimated annual catch in the WCPO since 1980 has been relatively stable, generally within the range 8,000–12,000 t, with 3,000-6,000 t in the eastern Pacific (Table 1).

Blue marlin catch rates appear to be highest in the WCPO equatorial regions (Figure 3), with notably large catches taken by the Taiwanese domestically-based longline fleet.

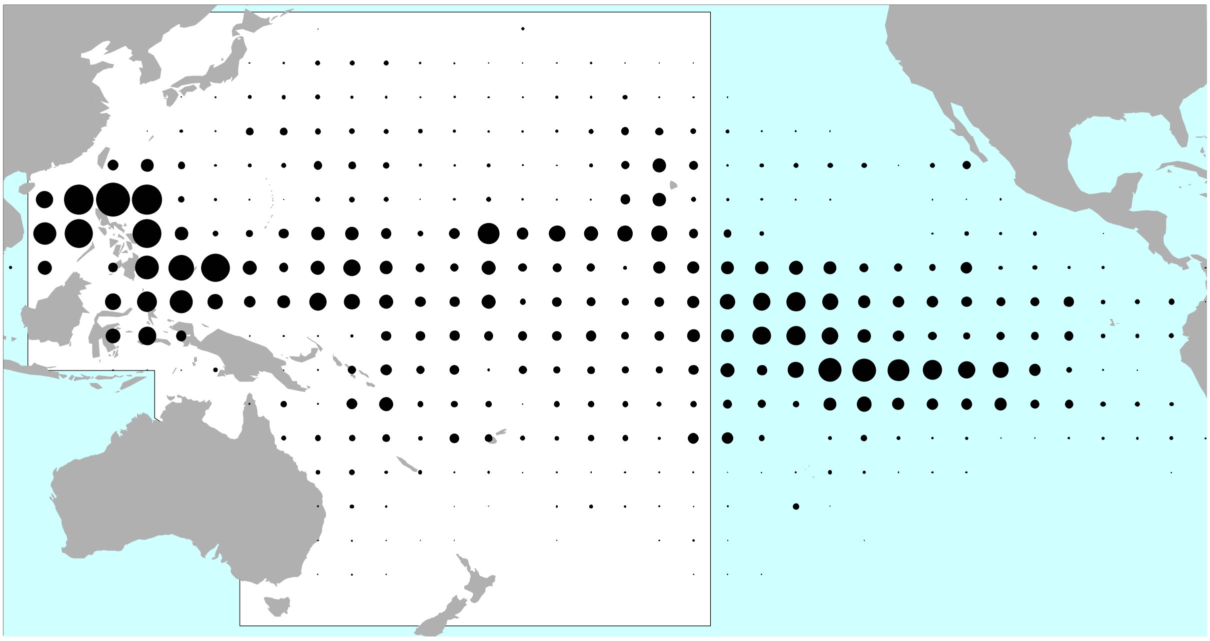


Figure 2. Distribution of longline blue marlin catch in the Pacific Ocean, 1990–1997.

Table 1. Estimated annual blue marlin catch (t.) by longline

YEAR	Japan DWFN	Japan Micr.	Korea DWFN	Taiwan DWFN	Taiwan Dom.	Taiwan Offs.	PRC	Haw.	Phil.	Indon.	Oth.	WPO	EPO	TOTAL Pacific
1980	5,718	0	826	271	5,078	50	0	32	108	135	0	12,218	2,613	14,831
1981	5,522	0	953	271	4,177	0	0	42	148	165	11	11,289	3,823	15,112
1982	5,496	0	890	173	4,434	0	0	136	173	330	28	11,660	3,882	15,542
1983	4,147	0	420	146	4,442	0	0	72	258	96	32	9,613	3,509	13,122
1984	5,916	0	848	210	4,219	0	0	23	117	153	49	11,535	3,985	15,520
1985	5,301	0	893	135	3,447	23	0	26	166	225	33	10,249	3,004	13,253
1986	5,340	0	791	122	2,632	1	0	38	220	223	11	9,378	4,374	13,752
1987	3,922	176	1,453	142	4,436	23	0	45	345	846	55	11,443	5,704	17,147
1988	5,193	225	1,277	196	4,490	126	0	90	290	888	35	12,810	4,441	17,251
1989	4,080	159	1,176	173	2,644	54	0	364	316	468	26	9,460	4,039	13,499
1990	2,908	165	1,103	337	2,769	706	0	318	202	503	37	9,048	4,353	13,401
1991	2,739	198	632	357	2,152	533	0	704	238	554	34	8,141	4,756	12,897
1992	2,266	124	1,060	107	3,913	704	12	348	111	570	92	9,307	4,625	13,932
1993	3,231	174	1,104	230	3,876	630	367	369	95	570	57	10,703	4,379	15,082
1994	3,225	142	690	738	2,952	456	570	378	129	420	182	9,882	6,580	16,462
1995	2,818	171	1,344	398	3,820	277	525	684	121	420	278	10,856	4,976	15,832
1996	1,589	129	818	212	4,336	248	197	520	122	420	300	8,891	2,525	11,416
1997	1,619	91	886	308	4,850	318	46	520	122	420	314	9,494	4,235	13,729

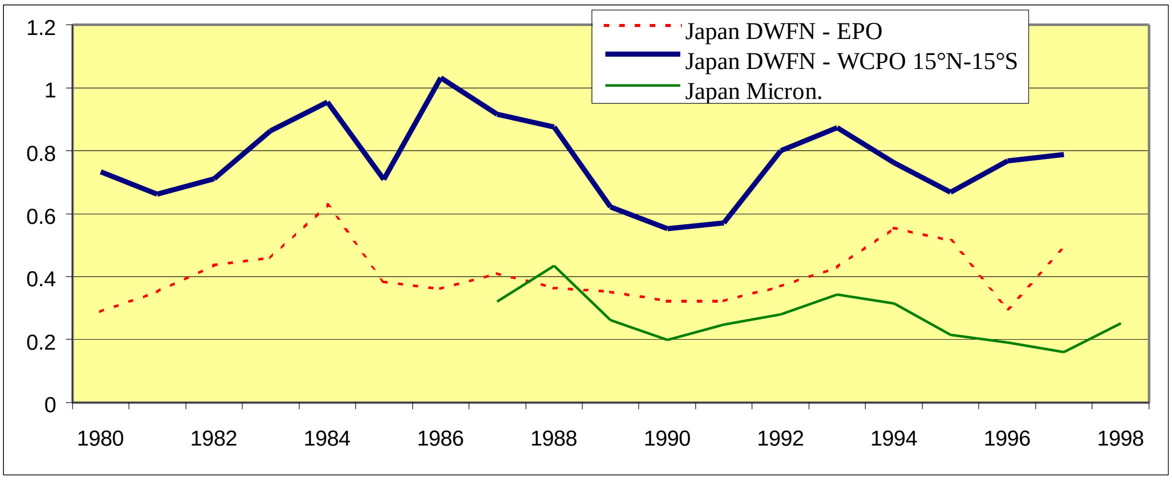


Figure 3. Annual nominal blue marlin CPUE for selected fleets/areas
(CPUE is measured in number per 1,000 hooks)

6. BLACK MARLIN

Black marlin, as with sailfish, are more closely associated with landmasses than other billfishes. Though the stock structure is still uncertain there have been suggestions of two Pacific Ocean stocks – SW Pacific and eastern Pacific, although tag recaptures suggest that there is a high degree of mixing throughout the entire Pacific (Campbell et al. 1998). Potentially some fish also move between the SW Pacific and Indian Ocean stock (Williams, unpl.).

Estimates of catch in and around Indonesia and the Philippines (see Table 2) suggest that a significant proportion of the WCPO black marlin catch comes from these waters (Figure 4). Elsewhere, the main component of the catch is taken in the Coral Sea, known to be a major spawning area for this species, and in the eastern equatorial band of the WCPO (Figure 4). The Coral Sea, especially out of Cairns, supports a major gamefish industry based on black marlin with the main season being from September to January (summer).

Black marlin is the least common marlin species in the Hawaiian longline fishery, and reported logbook catches of this species may include misidentified blue and striped marlin (Curran et al., 1996). Estimates of black marlin catch in the WCPO since 1980 are generally under 2,000 t (Table 2).

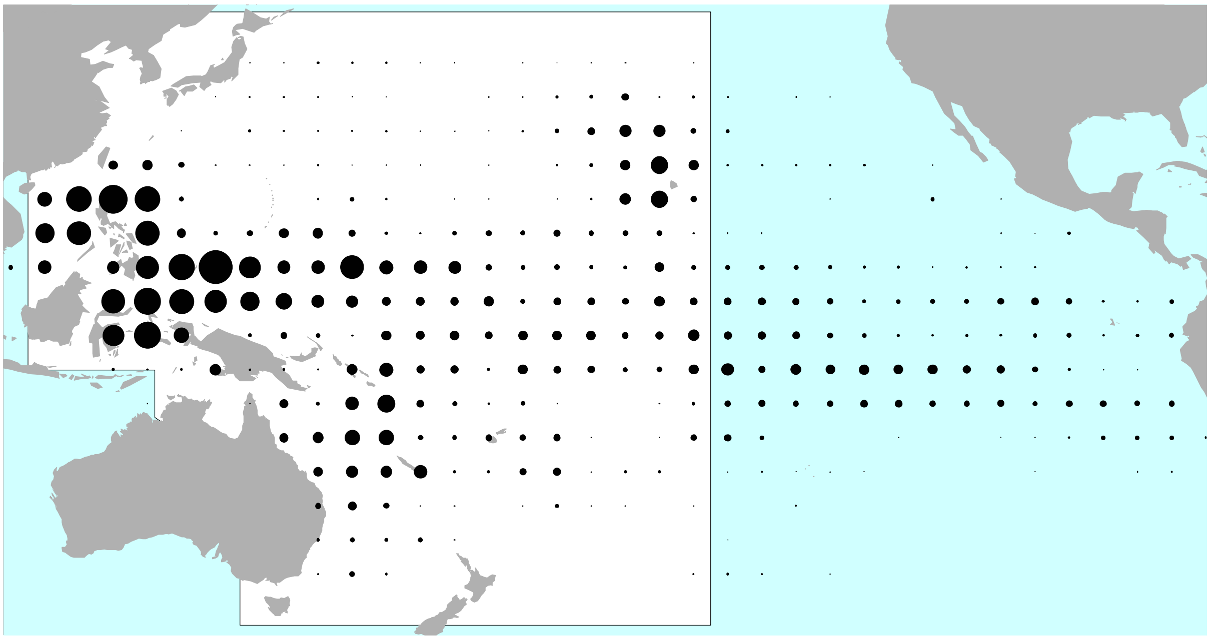


Figure 4. Distribution of longline black marlin catch in the Pacific Ocean, 1990–1997.

Table 2. Estimated annual black marlin catch (t.) by longline

YEAR	Japan DWFN	Japan Micr.	Korea DWFN	Taiwan DWFN	Taiwan Dom.	Taiwan Offs.	PRC	Haw.	Phil.	Indon.	Oth.	WPO	EPO	TOTAL Pacific
1980	789	0	81	32	524	0	0	0	32	41	0	1,499	227	1,726
1981	711	0	46	28	431	0	0	0	44	50	5	1,315	141	1,456
1982	820	0	44	14	458	0	0	0	52	99	24	1,511	162	1,673
1983	618	0	31	7	458	0	0	0	77	29	26	1,246	139	1,385
1984	648	0	32	12	435	0	0	0	35	46	14	1,222	172	1,394
1985	569	0	46	8	356	20	0	0	50	68	107	1,224	113	1,337
1986	341	0	39	4	272	0	0	0	66	67	43	832	199	1,031
1987	352	2	103	2	458	54	0	75	103	254	101	1,504	318	1,822
1988	680	11	162	11	463	125	0	75	87	266	99	1,979	284	2,263
1989	250	12	129	1	306	253	0	75	95	140	115	1,376	153	1,529
1990	166	8	148	10	286	626	0	75	60	151	113	1,643	226	1,869
1991	124	7	47	6	651	311	0	312	71	166	140	1,835	157	1,992
1992	142	2	122	10	787	340	38	142	33	171	76	1,863	167	2,030
1993	197	5	98	65	248	216	238	110	29	171	79	1,456	166	1,622
1994	228	11	115	13	305	57	230	51	39	126	114	1,289	228	1,517
1995	130	4	175	26	209	81	43	92	36	126	45	967	144	1,111
1996	74	4	145	3	193	8	9	73	37	126	61	733	139	872
1997	58	3	172	19	247	186	0	0	37	126	72	920	166	1,086

Black marlin catch rates (Figure 5) and spatial distribution of the longline catch (Figure 4) reflect the notion that this species is more commonly found in the lower latitudes of the WCPO, near continental landmasses.

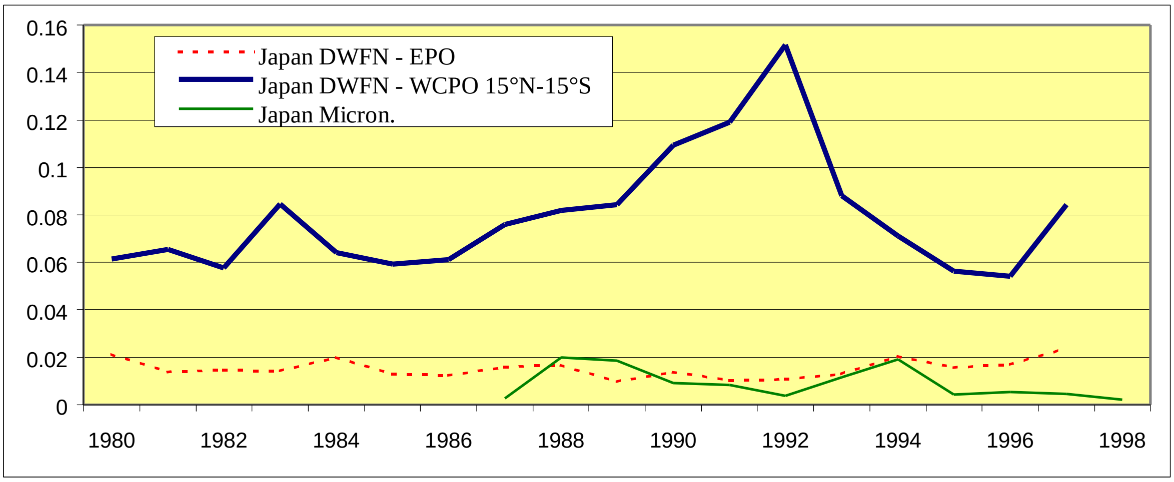


Figure 5. Annual nominal black marlin CPUE for selected fleets/areas
(CPUE is measured in number per 1,000 hooks)

7. SWORDFISH

In the 1990s, the annual swordfish catch in the Pacific ranged between 30,000-35,000 t for all gears and fleets (Sosa-Nishizaki 1997). The annual swordfish catch by longline vessels in the WCPO falls within the range 12,000–18,000 t (Table 3). Most of the longline swordfish catch in the WCPO is taken in the temperate waters to the east of Japan, in the Tasman Sea, off the east coast of Australia (Figure 6), and in the waters around Hawaii. Potentially there are four Pacific stocks (CPUE analysis); one in the western Pacific, one in the eastern north Pacific, one in the eastern south pacific and one east of Australia and NZ (DeMartini[3] unpl). Genetic studies are still being refined to try and define the stock structure. Target fisheries for swordfish exist in Hawaii and Japan (see Figure 6), and more recently in Australia, whose domestic longline fleet catch represents nearly all the swordfish catch presented in the 'Other' fleets category for recent years (Table 3). Swordfish sizes vary significantly with latitude. Smaller, juvenile swordfish occur in equatorial and tropical waters, whereas larger swordfish are more abundant at higher latitudes (Bailey et al, 1996). The highest catch rates for swordfish are in the fishery to the east of Japan in the north Pacific (Figure 7).

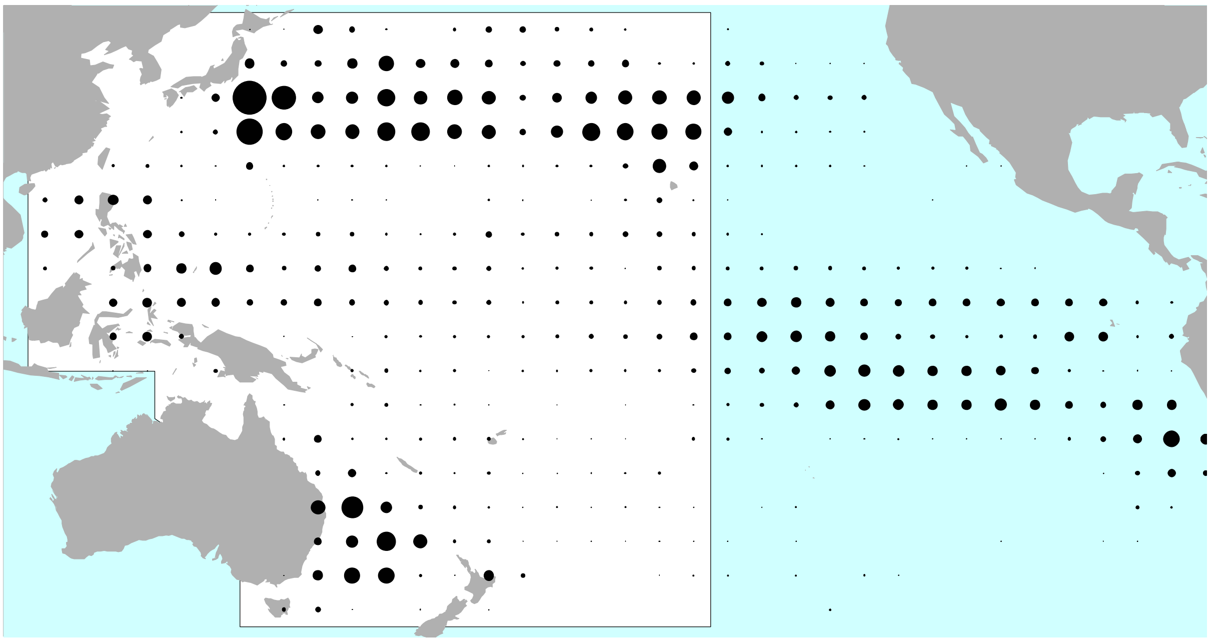


Figure 6. Distribution of longline swordfish catch in the Pacific Ocean, 1990–1997.

Table 3. Estimated annual swordfish catch (t.) by longline

YEAR	Japan DWFN	Japan Micr.	Korea DWFN	Taiwan DWFN	Taiwan Dom.	Taiwan Offs.	PRC	Haw.	Phil.	Indon.	Oth.	WPO	EPO	TOTAL Pacific
1980	10,987	0	227	137	1,147	33	0	0	59	74	0	12,664	5,102	17,766
1981	15,063	0	317	102	943	0	0	0	81	91	1	16,598	5,404	22,002
1982	12,685	0	183	56	1,001	0	0	0	95	181	4	14,205	4,604	18,809
1983	13,983	0	80	44	1,003	0	0	0	142	53	5	15,310	5,140	20,450
1984	11,786	0	144	82	953	0	0	0	65	84	7	13,121	3,242	16,363
1985	15,118	0	219	52	778	15	0	0	91	124	15	16,412	2,343	18,755
1986	14,591	0	180	31	594	0	0	0	121	122	17	15,656	4,726	20,382
1987	15,360	39	292	30	1,002	15	0	0	190	465	23	17,416	6,933	24,349
1988	16,142	27	290	41	1,014	84	0	0	159	488	15	18,260	6,190	24,450
1989	12,368	22	426	31	1,398	36	2	273	174	258	23	15,011	5,208	20,219
1990	10,383	28	465	108	625	471	34	1,909	111	277	42	14,453	5,900	20,353
1991	8,313	34	207	65	366	355	46	4,500	131	305	95	14,417	5,723	20,140
1992	9,498	21	364	117	700	469	39	5,272	61	314	96	16,951	5,155	22,106
1993	9,688	41	386	78	568	420	437	5,909	52	314	103	17,996	4,127	22,123
1994	9,328	25	380	217	667	304	565	3,136	71	231	237	15,161	4,253	19,414
1995	7,506	69	434	312	657	184	228	2,654	67	231	229	12,571	4,091	16,662
1996	7,749	51	325	146	662	165	135	*1,968*	67	231	885	12,384	3,859	16,243
1997	9,787	39	267	132	1,428	212	39	*1,968*	67	231	2,183	16,353	4,324	20,677

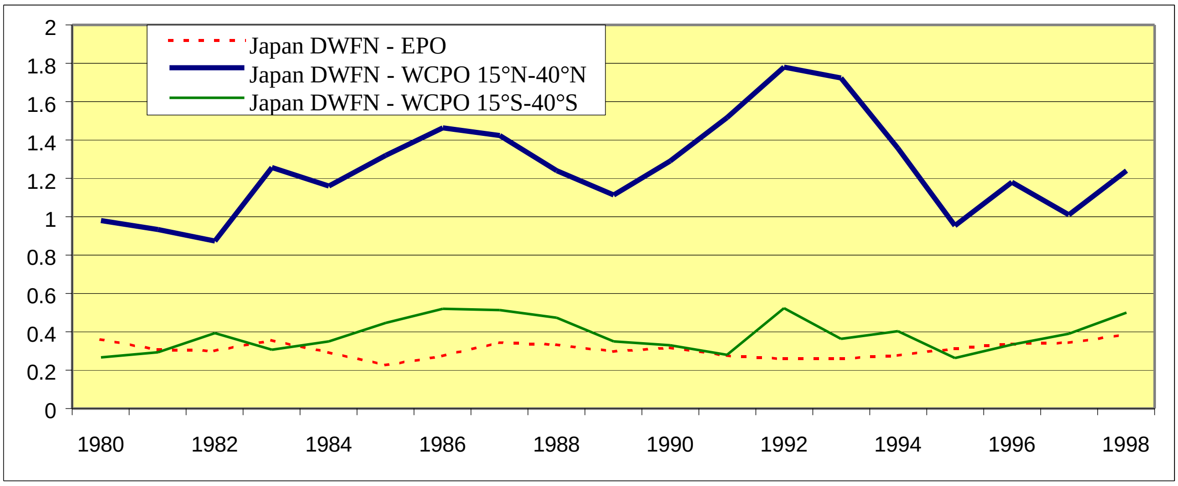


Figure 7. Annual nominal swordfish CPUE for selected fleets/areas
(CPUE is measured in number per 1,000 hooks)

8. STRIPED MARLIN

Striped marlin are a species which occur commonly in subtropical and temperate waters and are considered a true oceanic species as they tend to occur away from land masses unless there is adjacent deep water. Abundance of striped marlin increases with distance from the continental shelf. They are perhaps the shallowest swimming of all marlins as indicated by the proportion of fish caught on the shallowest hooks of longlines and their successful exploitation by shallow drift gill nets in the northern Pacific (Hanamoto, 1979).

Stock structure of striped marlin is still unclear. Some earlier researchers suggested the population may be either a single stock or divided into two separate stocks (north and south), at least for management purposes (Shomura, 1980). A spatial partitioning in genotypes, derived by genetic analysis (mitochondrial DNA) lends more support to the separate stock theory (Graves and McDowell 1994).
Similar to swordfish, most striped marlin catch in the WCPO (Figure 8) comes from temperate waters off the east coast of Japan and Australia, and near the Hawaiian archipelago. However, unlike

swordfish, there is considerable striped marlin catch taken in the EPO (Figure 8). Seasonal targeting of this species by Japanese longline vessels in the Coral Sea has been reported (Bailey et al., 1996).

Estimates of striped marlin catch in the WCPO since 1980 are generally within the range 5,000–10,000t (Table 5). The highest catch rates are found in the waters off the east coast of Japan and the EPO.

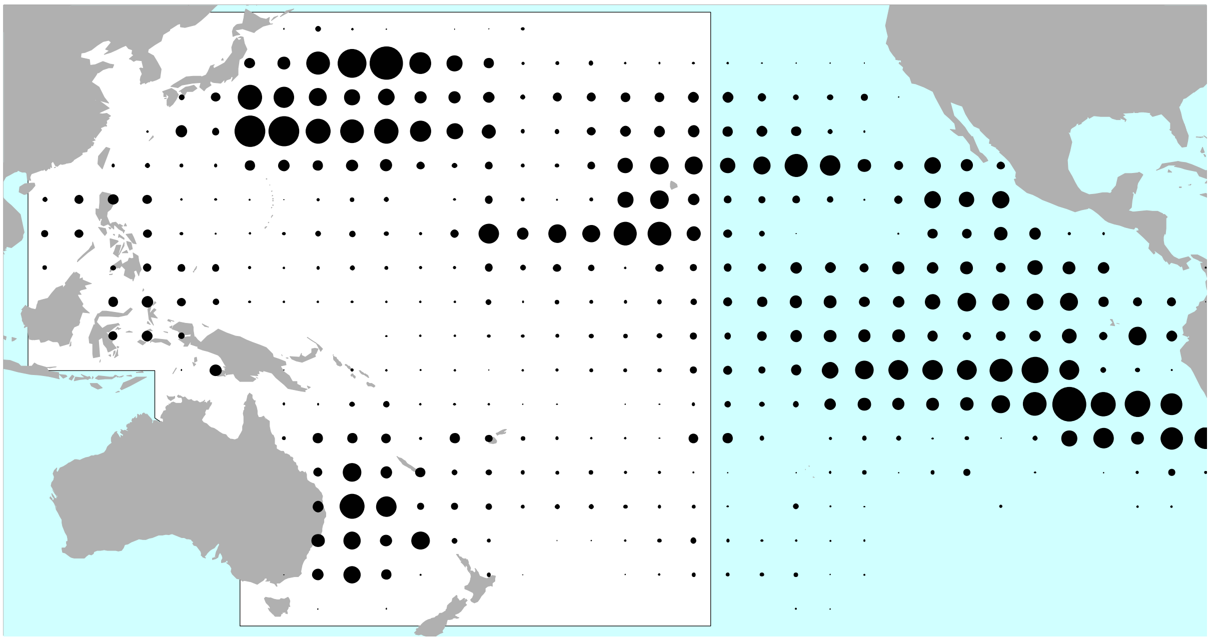


Figure 8. Distribution of longline striped marlin catch in the Pacific Ocean, 1990–1997.

Table 4. Estimated annual striped marlin catch (t.) by longline

YEAR	Japan DWFN	Japan Micr.	Korea DWFN	Taiwan DWFN	Taiwan Dom.	Taiwan Offs.	PRC	Haw.	Phil.	Indon.	Oth.	WPO	EPO	TOTAL Pacific
1980	6,522	0	51	178	277	0	0	105	22	27	0	7,182	10,102	17,284
1981	6,109	0	489	167	228	0	0	94	30	33	1	7,151	12,164	19,315
1982	5,534	0	333	107	242	0	0	140	35	66	1	6,458	13,747	20,205
1983	3,798	0	150	56	243	0	0	114	52	19	22	4,454	9,116	13,570
1984	5,179	0	253	115	230	0	0	91	23	31	23	5,945	4,929	10,874
1985	7,422	0	283	58	188	3	0	75	33	45	74	8,181	3,670	11,851
1986	9,056	0	199	23	144	0	0	191	44	45	82	9,784	6,630	16,414
1987	6,083	2	189	45	242	2	0	273	69	169	129	7,203	12,502	19,705
1988	9,715	14	222	58	245	11	0	500	58	178	95	11,096	7,297	18,393
1989	6,781	8	152	160	184	2	0	591	63	94	127	8,162	7,260	15,422
1990	4,277	4	100	113	151	12	0	500	40	101	238	5,536	5,943	11,479
1991	5,075	4	39	101	254	2	0	524	48	111	122	6,280	5,029	11,309
1992	4,140	3	100	101	253	9	0	545	22	114	128	5,415	4,257	9,672
1993	5,627	17	111	88	221	7	5	631	19	114	93	6,933	4,445	11,378
1994	5,369	11	124	438	161	4	19	384	26	84	352	6,972	5,317	12,289
1995	5,641	7	199	324	83	1	10	727	24	84	299	7,399	5,730	13,129
1996	2,799	5	111	235	136	2	9	524	24	84	378	4,307	4,384	8,691
1997	3,694	4	154	186	267	15	2	*524*	24	84	442	5,396	6,162	11,558

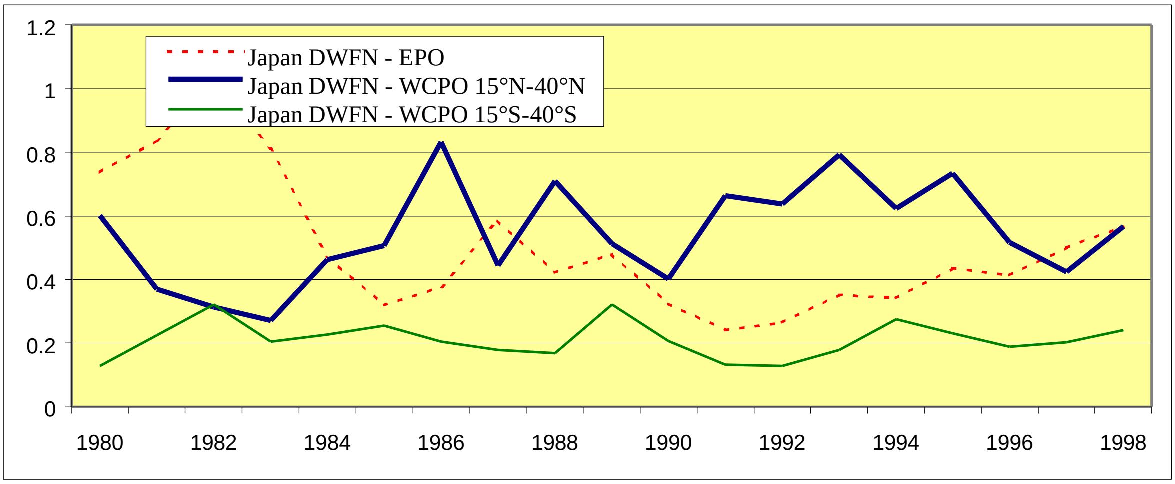


Figure 9. Annual nominal striped marlin CPUE for selected fleets/areas
(CPUE is measured in number per 1,000 hooks)

9. SAILFISH

Sailfish have a circumtropical distribution and represent an important component of both commercial and recreational fisheries (Speare, 1990). The stock structure remains unclear, though some stock discrimination work, using parasites, has been attempted – no conclusions were provided (Speare, 1990).

Sailfish are known to frequent coastal waters, close to islands and reefs (Bailey et al., 1996), and this is reflected in most of the sailfish longline catch in the WCPO being taken in the archipelagic waters surrounding Indonesia, Philippines Papua New Guinea, Solomon Islands, New Caledonia and Fiji (Figure 10). Sailfish appear to be the least 'migratory' of the billfish species (Speare 1990), and are known to form feeding aggregations. At certain times of the year, sailfish species composition for some longline sets have been an order of magnitude larger than normal due to fishing on such aggregations (Bailey et al., 1996). As in the WCPO, EPO sailfish catches occur in greater numbers closer to the west coast of North America. Annual estimates of sailfish catch in the WCPO are under 2,000t (Table 6); the accuracy of these estimates is probably hampered by the lesser importance given to this catch relative to other billfish species in logsheet-reporting, as a result of lower market value.

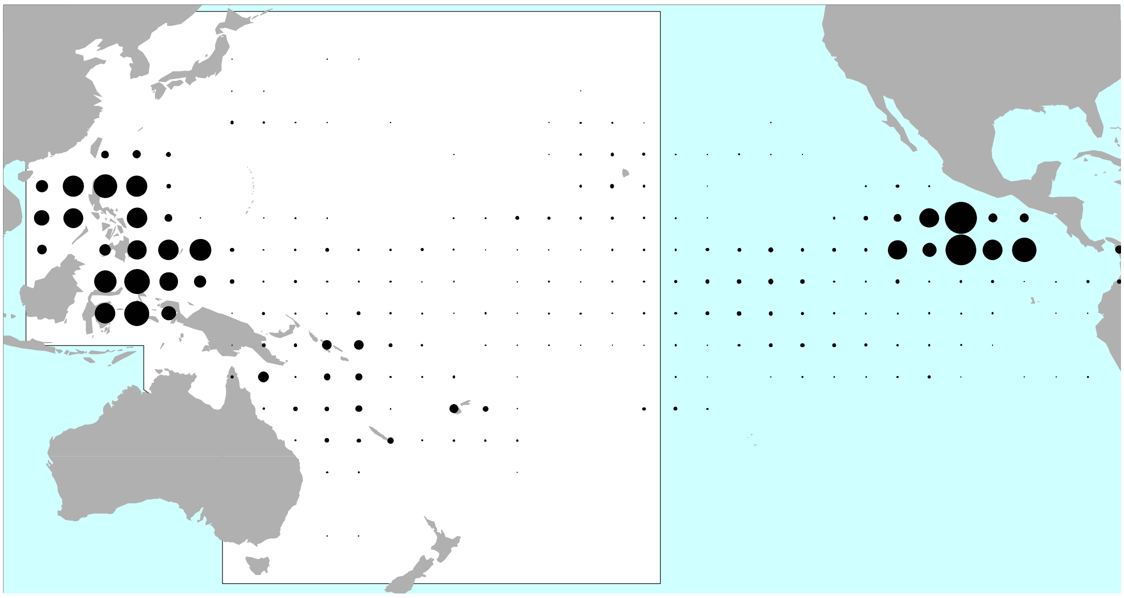


Figure 10. Distribution of longline sailfish catch in the Pacific Ocean, 1990–1997.

Table 5. Estimated annual sailfish catch (t.) by longline

YEAR	Japan DWFN	Japan Micr.	Korea DWFN	Taiwan DWFN	Taiwan Dom.	Taiwan Offs.	PRC	Haw.	Phil.	Indon.	Oth.	WPO	EPO	TOTAL Pacific
1980	0	0	114	0	623	0	0	0	48	61	0	846	498	1,345
1981	405	0	70	0	512	0	0	0	67	74	14	1,142	1,414	2,556
1982	351	0	68	0	544	0	0	0	78	148	29	1,218	3,213	4,431
1983	196	0	34	0	545	0	0	0	116	43	14	948	1,164	2,112
1984	258	0	45	0	517	0	0	0	53	69	22	964	542	1,506
1985	120	0	35	0	423	1	0	0	75	101	9	765	797	1,562
1986	115	0	33	0	323	0	0	0	99	100	8	679	582	1,261
1987	89	0	38	0	544	1	0	0	155	381	14	1,222	300	1,522
1988	119	0	25	0	551	15	0	0	130	400	16	1,256	247	1,504
1989	113	2	24	0	477	6	2	0	142	211	15	991	137	1,128
1990	131	0	19	0	340	167	47	0	91	227	16	1,038	71	1,109
1991	63	0	10	0	585	10	77	19	107	249	29	1,149	99	1,248
1992	41	0	17	0	1,095	23	13	9	50	257	24	1,529	852	2,381
1993	57	2	18	0	242	13	38	8	43	257	30	707	1,943	2,650
1994	115	0	7	0	362	3	51	9	58	189	41	835	234	1,069
1995	90	0	3	0	292	7	7	11	55	189	42	696	238	933
1996	15	0	8	0	151	1	2	6	55	189	26	453	262	715
1997	22	0	6	0	296	17	1	0	55	189	35	621	255	876

10. SHORT-BILLED SPEARFISH

Unlike sailfish, short-billed spearfish are understood to be strongly oceanic, and are only rarely taken in the longline catch close to the coast (Nakamura, 1985). Distribution of longline catches of short-billed spearfish suggests separate northern and southern stocks in sub-tropical areas (Skillman 1989). In the WCPO, the short-billed spearfish catch is predominantly taken in the Coral Sea, and (to a lesser extent) in the oceanic waters to the east off Japan (Figure 11). There are currently no catch records available for short-billed spearfish in the tropical longline fisheries of the Philippines, Indonesia and Micronesia. Observer data suggest that this species is the most rarely encountered billfish species in the tropical longline fisheries of the WCPO.

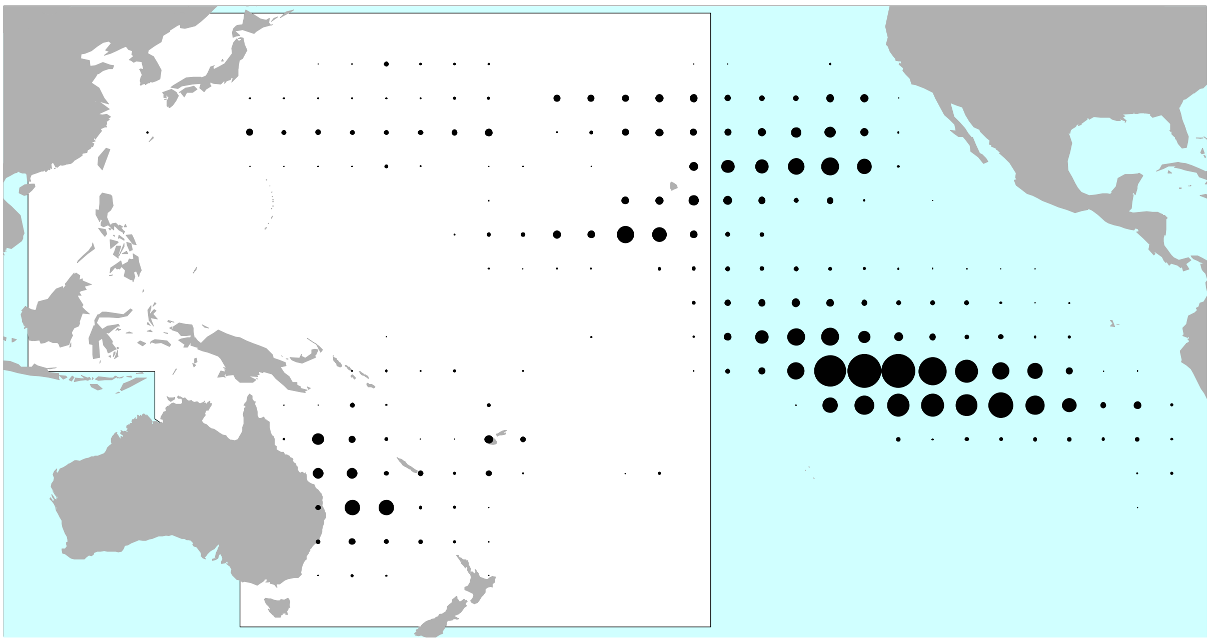


Figure 11. Distribution of longline short-billed spearfish catch in the Pacific, 1990–1997.

In the EPO, there is a clear distinction between the areas of short-billed spearfish catch (oceanic) and sailfish catch (coastal), and their distribution seems somewhat antagonistic. Annual estimates of sailfish catch in the WCPO are under 300 t (Table 6). The accuracy of these estimates is probably hampered by the lesser importance given to this catch than to other billfish species in logsheet-reporting, and perceived problems in misidentification (catch reported as sailfish on logbooks). This is particularly evident when considering observer-reported catch rates which rank this species as the most common billfish species in the Coral Sea (i.e. sub-tropical latitude band 10°S–25°S).

Table 6. Estimated annual short-billed spearfish catch (t.) by longline

YEAR	Japan DWFN	Japan Micr.	Korea DWFN	Taiwan DWFN	Taiwan Dom.	Taiwan Offs.	PRC	Haw.	Phil.	Indon.	Oth.	WPO	EPO	TOTAL Pacific
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	134	0	0	0	0	0	0	0	0	0	0	134	311	446
1982	135	0	0	0	0	0	0	0	0	0	0	135	369	504
1983	119	0	0	0	0	0	0	0	0	0	0	119	417	537
1984	185	0	0	0	0	0	0	0	0	0	0	185	489	674
1985	93	0	0	0	0	0	0	0	0	0	0	93	178	271
1986	84	0	0	0	0	0	0	0	0	0	0	84	302	386
1987	115	0	0	0	0	0	0	0	0	0	0	115	229	344
1988	261	0	0	0	0	0	0	0	0	0	0	261	338	599
1989	206	0	0	0	0	0	0	0	0	0	0	206	327	533
1990	109	0	0	0	0	0	0	0	0	0	0	109	232	342
1991	33	0	0	0	0	0	0	0	0	0	0	33	268	301
1992	30	0	0	0	0	0	0	0	0	0	0	30	234	264
1993	43	0	0	0	0	0	0	0	0	0	0	43	206	250
1994	20	0	0	0	0	0	0	0	0	0	0	20	25	46
1995	59	0	0	0	0	0	0	0	0	0	0	59	138	198
1996	20	0	0	0	0	0	0	0	0	0	2	22	125	148
1997	21	0	0	0	0	9	0	0	0	0	13	43	131	174

11. FUTURE WORK

Future work on improving billfish estimates may include the following components:

- Observer coverage is increasing within the SPC region and data may address the following issues;
    - Improve the catch estimation process by considering billfish discard rates where coverage is considered adequate;
    - Compare logsheet and observer data for billfish misidentification problems;
    - Ascertain what factors (e.g. species marketability, billfish size or vessel constraints) affect billfish discarding;
    - Investigate fishery oceanographic and operational (gear) affects on billfish catch rates;

- Efforts will continue to obtain information that will improve billfish estimates in general;

- Efforts will be made to gain further information on the game-fishery catch of billfish, and to include this in future WPCO billfish catch estimates. In this regard, looking at the feasibility of standardised data collection for this fishery may be investigated.

REFERENCES

Bailey, K.N., P.G. Williams & D.G. Itano (1996). By-catch and discards in the western Pacific tuna fisheries: A review of SPC Data Holdings and Literature. *Oceanic Fisheries Programme Technical Report 34*. South Pacific Commission, Noumea, New Caledonia.

Campbell, R., G.Tuck, J. Pepperell & J. Larcombe. (1998). Synopsis on the billfish stocks and fisheries within the western AFZ and the Indian Ocean. AFMA, Canberra, 123p.

Carrara, G., J. Uktolseja (1997). Review of Indonesian Tuna Statistics (based on the work by J. Moron, 1994). In Report on the Indonesian/FAO/DANIDA Workshop on the Assessment of the Potential of Marine Fishery Resources of Indonesia. FAO, Rome.

Collette, B.B. & C.E. Nauen (1983). FAO Species Catalogue Vol 2. Scombrids of the world, An annotated and illustrated catalogue of tunas, mackerals, bonitos and related species known to date. FAO fisheries Synopsis No 125. Vol. 2. FIR/S125. Vol. 2.

Curran, D., C. Boggs & X. He (1996). Catch and effort from Hawaii's longline fishery summarized by quarters and five degree squares. NOAA Tech. Memo., NMFS, SWFSC -225.

DeMartini, E.E. (unpl.). Session report – Joint biology-oceanography session. Session 2. Stock structure. Second International Pacific Swordfish Symposium, Kahuku, Hawaii, March 3-6, 1996

Farman, R.S. (1988). The adequacy of current billfish fisheries statistics for stock assessment and management purposes. South Pacific Commission Twentieth Regional Technical Meeting on Fisheries, 1–5 August 1988, Information Paper 1.

Graves, J.E. & McDowell, J.R. (1994). Genetic analysis of striped marlin (*Tetraptutus audax*) population structure in the Pacific Ocean. Can. J. Fish. Aquat. Sc. **51**. 1762-1768.

Hanamoto, E. (1979). Fishery oceanography of striped marlin – IV, swimming layer in the tuna longline fishing grounds. Bull. Jap. Soc. Sci. Fish. **45**(6), 687-690.

Joseph, J., W. Bayliff & M.G. Hinton (1994). A review of the information on the biology, fisheries, marketing and utilization, fishing regulations, and stock assessment of swordfish, *Xiphias gladius*, in the Pacific Ocean. IATTC internal report No. 24.

Lawson, T. (1998). 1997 Tuna Fishery Yearbook. *Oceanic Fisheries Programme*. Secretariat of the Pacific Community, Noumea New Caledonia.

Nakamura, I. (1985). Billfishes of the world. An annotated and illustrated catalogue of marlins, sailfishes, spearfishes and swordfishes known to date. FAO Species Synopsis 125, Vol. 5.

Pacific Island Gamefish Tournament Symposium. (1998). Country gamefish reports. Facing the challenges of resource conservation, sustainable development and the sportfishing ethic. July 29-Aug. 1, 1998. Kona, Hawaii.

Shomura, R.S. (ed.). (1980). Summary report of the billfish stock assessment workshop Pacific resources, Honolulu Laboratory, Southwest Fisheries Center, Honolulu, Hawaii, 5-14 December 1977. NMFS. NOAA-TM-NMFS-SWFC-**5**.

Shomura, R.S. (ed.). 1993. Workshop to consider management of blue marlin (*Makaira mazara*) in the Western Pacific Management Council Area. 20-22 April 1993, Keoni Auditorium, East-West Center, Honolulu, Hawaii. 40pp.

Skillman, R.A. (1989). Stock identification and billfish management **In:** Planning the future of billfishes. Research and management in the 90's and beyond. Ed. R.H. Stroud. Proc. Second International Billfish Symposium, Kailua-Kona, Hawaii, August 1-5, 1988. Part 1: Fishery and stock synopsis, data needs and management. National Coalition for Marine Conservation, Inc., Savannah, Georgia. 207-214.

Sosa-Nishizaki, O. (1997). General trends in the Pacific swordfish fisheries. Paper presented at the 2nd International Symposium on Pacific Swordfish, Kahuku, Hawaii, 3-6 March, 1997.

Speare, P. (1990). Parasites of the pacific sailfish (*Istiophorus platypterus*): A preliminary investigation of their usefulness in stock discrimination. *In* Stroud, R.H. (ed.). Planning the future of billfishes. Research and management in the 90's and beyond. Proc. Second International Billfish Symposium, Kailua-Kona, Hawaii, August 1-5, 1988. Part 2: Contributed papers. National Coalition for Marine Conservation, Inc., Savannah, Georgia. 95-102.

Sun, C. L. & R-T Yang. (1983). The Inshore Tuna Longline Fishery of Taiwan. Journal of the Fisheries Society of Taiwan. Taipei, Taiwan.

Suzuki, Z. 1989. Catch and fishing effort relationships for striped marlin, blue marlin and black marlin in the Pacific Ocean, 1952 to 1985. *In* Stroud, R.H. (ed.). Planning the future of billfishes. Research and management in the 90's and beyond. Proc. Second International Billfish Symposium, Kailua-Kona, Hawaii, August 1-5, 1988. Part 1: Fishery and stock synopsis, data needs and management. National Coalition for Marine Conservation, Inc., Savannah, Georgia.

Western Pacific Regional Fishery Management Council (1996). Pelagic fisheries of the western Pacific region, 1995 annual report.

Williams, D. (unpl). Black Marlin, Fisheries Ecology. Australian Institute of Marine Sciences, Townsville, Australia.

Yuen, H.S. & Miyake, P.M. 1980. Blue Marlin, *Makaira nigricans* pp.13-20 *In* Shomura, R.S. (ed.), Summary report of the billfish stock assessment workshop, Pacific Resources. Honolulu Lab., Southwest Fisheries Centre, Honolulu, Hawaii, 5-14 December 1977. NOAA. Tech. Memo., NMFS. NOAA-TM-NMFS-SWFC-5: 63pp.

APPENDIX A – PROBLEMS ENCOUNTERED IN BILLFISH CATCH ESTIMATION

Table A1. Problems encountered in the estimation of blue marlin catch

Fleet	Problem	How problem was treated	Fut
Japan DWFN	Aggregated blue marlin catch provided in numbers only	Estimates of average weight by month for this fleet determined from logsheet data and applied to catch in numbers.	Ne of s
Korean DWFN	Aggregated blue marlin catch provided in numbers only	Estimates of average weight by month for this fleet determined from logsheet data and applied to catch in numbers	Ne of s
Taiwanese offshore (PICs)	1. Misidentification of blue and black marlin	No action	Est cat tun
	2. Under-reporting of blue marlin catch	Blue marlin catch estimated using species composition data collected by observers	
Chinese offshore	1. Misidentification of blue and black marlin and under-reporting of blue marlin catch	No action	Est cat tun
	2. Under-reporting of blue marlin catch	Blue marlin catch estimated using species composition data collected by observers	
Hawaiian	Misidentification of black marlin (some black marlin catch thought to be striped or blue marlin) (Curran et al 1996)	No action	Ne
PICs domestic	Some fleets have been known to misidentify blue and black marlin (e.g. Tonga-Farman, 1988)	No action	Ne
Philippines & Indonesia domestic	No logsheet or reliable landings data for blue marlin catch.	Estimates of species composition from Carrara and Uktolseja, 1997) were applied to target tuna catch estimates for these.	Ne

Table A2. Problems encountered in the estimation of black marlin catch

Fleet	Problem	How problem was treated	Fut
Japan DWFN	Aggregated blue marlin catch provided in numbers only	Estimates of average weight by month for this fleet determined from logsheet data and applied to catch in numbers.	Nee incl (lon
Korean DWFN	1. Aggregated blue marlin catch provided in numbers only	Estimates of average weight by month for this fleet determined from logsheet data and applied to catch in numbers	Nee incl (lon
	2. Black marlin catch only available after 1987	Estimates of species composition relative to target tuna catch estimates where obtained from the Japanese DWFN fleet for fishing in a similar area and applied to target tuna catch estimates for this fleet.	Nee
Taiwanese offshore (PICs)	Misidentification of blue and black marlin	No action	Nee
Chinese offshore	Misidentification of blue and black marlin	No action	Nee
Hawaiian	Misidentification of black marlin (some black marlin catch thought to be striped or blue marlin) (Curran et al 1996)	No action	Nee
PICs domestic	Some fleets have been known to misidentify blue and black marlin (e.g. Tonga-Farman, 1988)	No action	Nee
Philippines & Indonesia domestic	No logsheet or reliable landings data for black marlin marlin catch.	Estimates of species composition from Carrara and Uktolseja, 1997) were applied to target tuna catch estimates for these.	Nee

Table A3. Problems encountered in the estimation of striped marlin catch

Fleet	Problem	How problem was treated	Fut
Japan DWFN	Aggregated blue marlin catch provided in numbers only	Estimates of average weight by month for this fleet determined from logsheet data and applied to catch in numbers.	Nee incl (lon
Korean DWFN	Aggregated blue marlin catch provided in numbers only	Estimates of average weight by month for this fleet determined from logsheet data and applied to catch in numbers	Nee incl (lon
Hawaiian	Misidentification of black marlin (some black marlin catch thought to be striped or blue marlin) (Curran et al 1996)	No action	Nee
Philippines & Indonesia domestic	No logsheet or reliable landings data for striped marlin catch.	Estimates of species composition from Carrara and Uktolseja, 1997) were applied to target tuna catch estimates for these.	Nee

Table A4. Problems encountered in the estimation of swordfish catch

Fleet	Problem	How problem was treated	Fut
Japan DWFN	Aggregated blue marlin catch provided in numbers only	Estimates of average weight by month for this fleet determined from logsheet data and applied to catch in numbers.	Ne incl (lo
Korean DWFN	Aggregated blue marlin catch provided in numbers only	Estimates of average weight by month for this fleet determined from logsheet data and applied to catch in numbers	Ne incl (lo
Taiwanese offshore and mainland Chinese	Under-reporting of swordfish catch	Swordfish catch estimated using species composition data collected by observers.	Ne
Philippines & Indonesia domestic	No logsheet or reliable landings data for swordfish marlin catch.	Estimates of species composition from Carrara and Uktolseja, 1997) were applied to target tuna catch estimates for these.	Ne

Table A5. Problems encountered in the estimation of sailfish catch

Fleet	Problem	How problem was treated	Fut
Japan DWFN	1. Aggregated sailfish catch provided in numbers only	Estimates of average weight by month for this fleet determined from logsheet data and applied to catch in numbers.	Nee incl (lon
	2. Aggregated sailfish catch not provided prior to 1994. (Prior to 1994, sailfish and short-billed spearfish catch were combined).	Estimates of sailfish : short-billed spearfish species composition by broad area (latitudinal bands) and month were determined from Japanese DWFN data post-1994 (i.e. when sailfish and short-billed spearfish catch were reported separately). These proportions were applied to data prior to 1994.	Nee
Korean DWFN	Aggregated sailfish catch provided in numbers only	Estimates of average weight by month for this fleet determined from logsheet data and applied to catch in numbers	Nee incl (lon
Taiwanese DWFN	Aggregated data do not provide for sailfish catch	No action	Nee
Foreign and domestic offshore fleets operating in PICs	Level of under- and non-reporting of sailfish catch largely unknown	No action	Rev det
Philippines & Indonesia domestic	No logsheet or reliable landings data for sailfish catch.	Estimates of species composition from Carrara and Uktolseja, 1997) were applied to target tuna catch estimates for these.	Nee

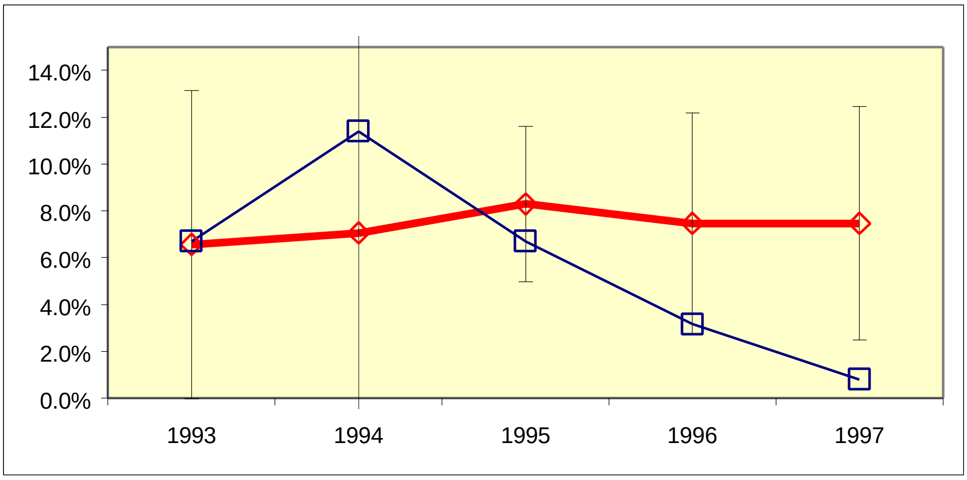
Table A6. Problems encountered in the estimation of short-billed spearfish catch

Fleet	Problem	How problem was treated	Fut
Japan DWFN	1. Aggregated short-billed spearfish catch provided in numbers only	Estimates of average weight by month for this fleet determined from logsheet data and applied to catch in numbers.	Nee incl (lor
	2. Aggregated short-billed spearfish catch not provided prior to 1994. (Prior to 1994, sailfish and short-billed spearfish catch were combined).	Estimates of sailfish : short-billed spearfish species composition by broad area (latitudinal bands) and month were determined from Japanese DWFN data post-1994 (i.e. when sailfish and short-billed spearfish catch were reported separately). These proportions were applied to data prior to 1994.	Nee
Korean DWFN	Aggregated data do not provide for short-billed spearfish catch	No action	Nee
Taiwanese DWFN	Aggregated data do not provide for short-billed spearfish catch	No action	Nee
Foreign and domestic offshore fleets operating in PICs	Level of under- and non-reporting of short-billed spearfish catch largely unknown	No action	Rev log rep
Philippines & Indonesia domestic	No logsheet or reliable landings data for short-billed spearfish catch.	No action	Nee

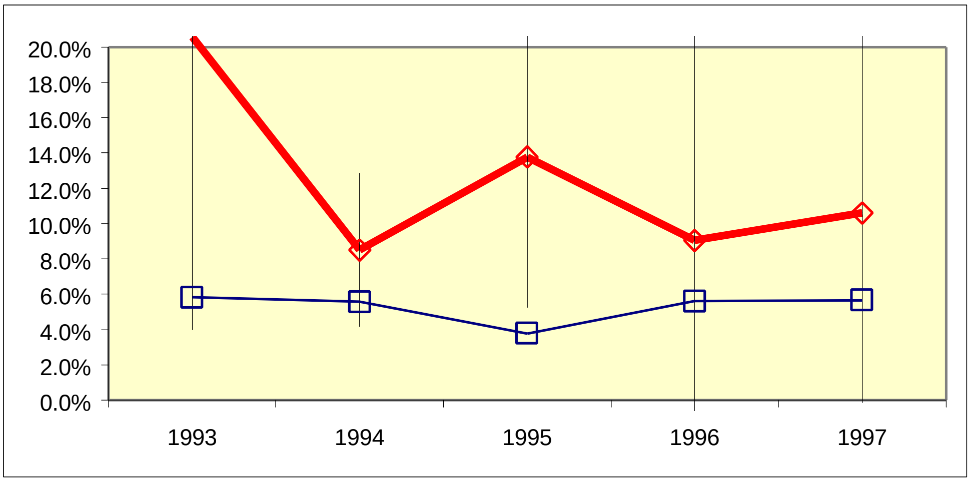
APPENDIX B – SPECIES COMPOSITION COMPARISONS (SELECTED FLEETS)

Figure B1. **Percentage species composition of <u>BLUE MARLIN</u> to target tuna catch (bigeye and yellowfin), by number, for mainland Chinese (top), Taiwanese offshore (middle) and Japanese-Micronesian (bottom) fleets. Thick line represents observer data (with 95% confidence limits); thin line represents logsheet data.**

(i) Mainland Chinese



(ii) Taiwanese Offshore



(iii) Japanese in Micronesia

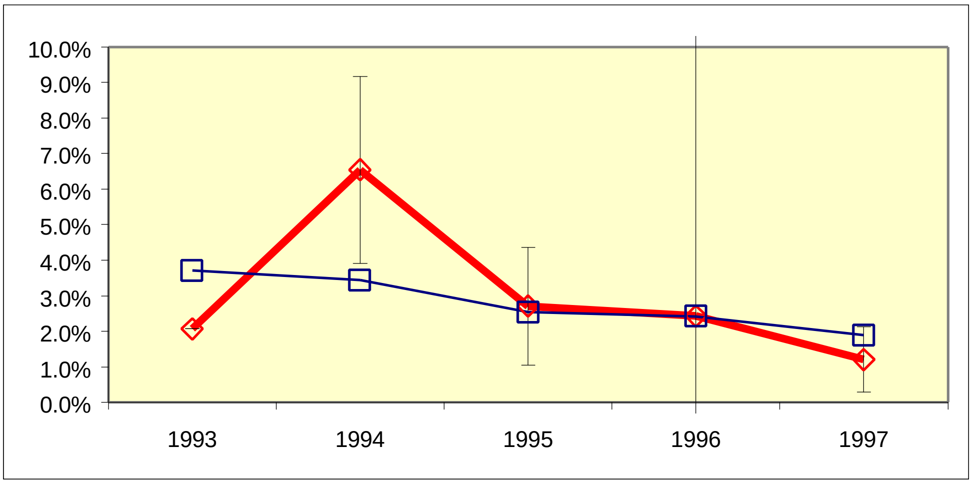
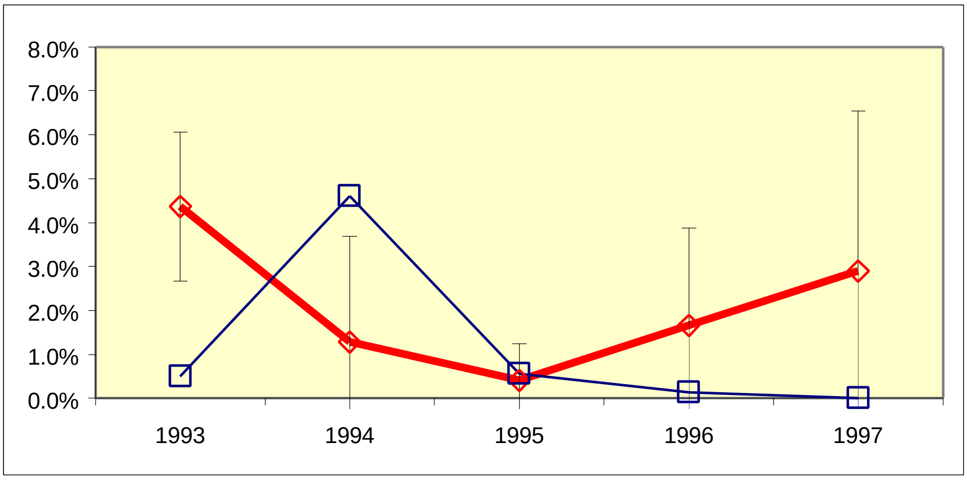
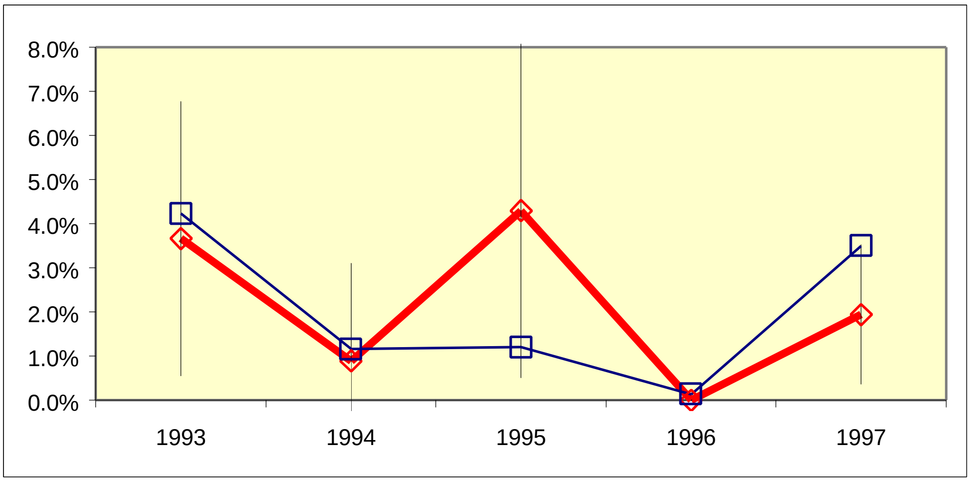


Figure B2. Percentage species composition of <u>BLACK MARLIN</u> to target tuna catch (bigeye and yellowfin), by number, for mainland Chinese (top), Taiwanese offshore (middle) and Japanese-Micronesian (bottom) fleets. Thick line represents observer data (with 95% confidence limits); thin line represents logsheet data.

(i) Mainland Chinese



(ii) Taiwanese Offshore



(iii) Japanese in Micronesia

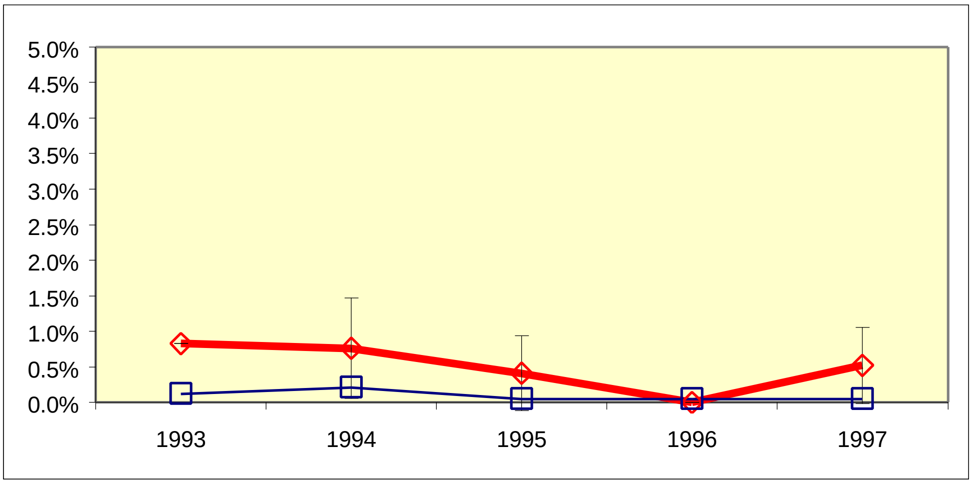
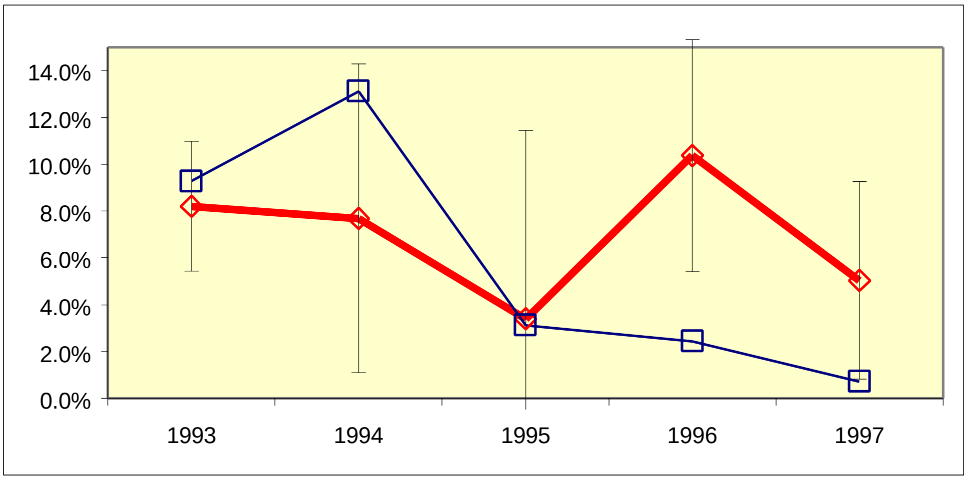
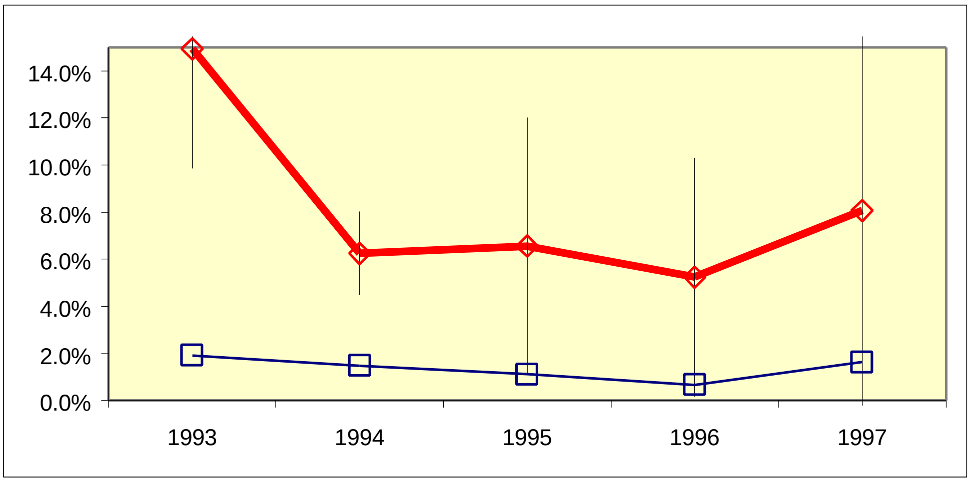


Figure B3. Percentage species composition of <u>SWORDFISH</u> to target tuna catch (bigeye and yellowfin), by number, for mainland Chinese (top), Taiwanese offshore (middle) and Japanese-Micronesian (bottom) fleets. Thick line represents observer data (with 95% confidence limits); thin line represents logsheet data.

(i) Mainland Chinese



(ii) Taiwanese Offshore



(iii) Japanese in Micronesia