Executive Summary Of The Status Of The Indian Ocean Swordfish Resource

(11 November 2005)

Draft changes reflecting the work of the Working Party on Billfish in 2006 are shown for the consideration of the SC in Nov06

BIOLOGY

Swordfish (*Xiphius gladius*) is a large oceanic apex predator that inhabits all the world's oceans and ~~. They are one of the most widely distributed pelagic fish species and~~ in the Indian Ocean ranges from the northern coastal state coastal waters to 50°S. Swordfish~~The species~~ is known to undertake extensive diel vertical migrations, from surface waters during the night to depths of ~~up to~~ 1000 m during the day, in association with movements of the deep scattering layer and cephalopods, their preferred prey. ~~In~~By contrast ~~to~~ with tunas, swordfish is not a gregarious species, although ~~the~~ densitis~~y of this species~~ increase~~s~~ in areas of oceanic fronts and seamounts.

Genetic studies of the stock structure of swordfish in the Indian Ocean have failed to reveal spatial heterogeneity, and for the purposes of stock assessments one pan-ocean stock has been assumed. However, spatial heterogeneity in stock indicators (CPUE trends), indicate the potential for localised depletion of swordfish in the Indian Ocean.~~, suggesting that mixing across the ocean basin may be limited.~~

As with many species of billfish, swordfish exhibit sexual dimorphism in maximum size, growth rates and size and age at maturity – females reaching larger sizes, growing faster and maturing later than males. Length and age at 50% maturity in SW Indian Ocean swordfish is 170cm (maxillary-fork length = LJFL) for females and 120 cm for males. These sizes correspond to ages of 6-7 years and 1-3 years for females and males, respectively.

Swordfish are highly fecund, batch spawners with large females producing many millions of eggs per spawning event. One estimate for Indian Ocean populations suggests that a female swordfish in equatorial waters may spawn as frequently as once every three days over a period of seven months.

Swordfish are~~The species is also~~ long lived – ~~reaching~~ having a maximum age~~s~~ of more than 30 years.~~However, t~~The species also exhibits ~~phenomenal~~ rapid growth in the first year of life - by one year of age, a swordfish may reach 90 cm (~15 kg). The average size of swordfish taken in Indian Ocean longline fisheries is between 40kg and 80kg (depending on latitude).

The species life history characteristics of relatively late maturity, long life and sexual dimorphism make it vulnerable to over exploitation.

FISHERIES

Swordfish are taken as a target or by-catch of longline fisheries throughout the Indian Ocean (Figure 1). It is~~, are~~ rarely caught by purse seines, but ~~are thought~~ is likely to be a component of the "unidentified Billfish" catch by Sri Lankan gill net fisheries in the central northern Indian Ocean.

Exploitation of swordfish in the Indian Ocean was first recorded by the Japanese in the early 1950's as a by-catch in their tuna longline fisheries. Over the next thirty years, catches in the Indian Ocean increased slowly as the level of coastal state and distant water fishing nation longline effort targeted at tunas increased. In the 1990's, exploitation of swordfish, especially in the western Indian Ocean, increased markedly, peaking in 1998 at around 35,000 tonnes (Figure~~s 1 and~~ 2, Table 1). By 2002, twenty countries were reporting catches of swordfish (Figure 3, Table 1). The annual total catch has averaged 31,400 t in recent years (2000-2004) and in 2004 was 31,000 tonnes. The highest catches are taken in the south west Indian Ocean (Figure 4).

Since the early 1990's China,Taiwan has been the dominant ~~catcher of~~ swordfish catching fleet in the Indian Ocean (41-60 % of total catch). Taiwanese longliners, particularly in the south western and equatorial western Indian Ocean, target swordfish using shallow longlines at night. The night sets for swordfish contrast with the daytime sets used by the Japanese and Taiwanese longline fleets when targeting tunas.

During the 1990's a number of coastal and island states, notably Australia, La Reunion/France, Seychelles and South Africa have developed longline fisheries targeting swordfish, using monofilament gear and light sticks set at night. This gear achieves significantly higher catch rates than traditional Japanese and Taiwanese longlines. As a result, coastal and island fisheries have rapidly expanded to take over 10,000 tonnes of swordfish per annum in the late 1990's.

STOCK STATUS

While the 2006 stock assessments (IOTC-2006-WPB-R) represent a major advance in the assessment of Indian Ocean swordfish the results should be considered preliminary and as such (and as in previous years) the Scientific Committee has considered a range of information (e.g. indicators of abundance and stock status such as trends in CPUE and size composition) to formulate its technical advice in 2006.

The standardised CPUE of swordfish for the Japanese fleet for all areas of the Indian Ocean combined showed a variable but continuous decline over time (Figure 5). However, this result appears to be driven by the declining trend in the areas north of the equator (areas 3 and 4 combined – see Figure 4) as the CPUE trend from the areas south of the equator (areas 6, 7 and 8 combined – see Figure 4) appears to have stabilised in recent years. Catch rates following 1990 are markedly lower than those prior to this time (particularly in southern areas) and this may be due to an apparent regime shift in fishing practices after 1990 (Figure 6). This marked decrease in CPUE also follows substantial increases in catches throughout the 1990's, particularly in the western Indian Ocean (Figure 2). The apparent fidelity of swordfish to particular areas is a matter for concern as this can lead to localised depletion. In previous years, localised depletion was inferred on the basis of decreasing CPUEs following fine scale analyses of the catch effort data. While no fine scale analyses of CPUE were carried out in 2006, localised depletion may still be occurring in some areas. Localised depletion has occurred in other parts of the world where swordfish have been heavily targeted.

The annual average sizes of swordfish in the respective Indian Ocean fisheries are variable but show no trend Figure 7). While there are no clear signals of declines in the size-based indices, these indices should be carefully monitored. It was noted that since females mature at a relatively large size, a reduction in the biomass of large animals could potentially have a strong effect on the spawning biomass.

Notwithstanding the uncertainties in the 2006 assessments using surplus production models, the overall results were consistent, particularly in terms of the current levels of fishing mortality and stock biomass levels (Figure 8). Stock biomass decreased markedly from the early 1990's corresponding to a sharp increase in fishing mortality. Based on the point estimates and confidence limits, on balance the assessment model results (excluding the high productivity scenario which was considered to be the least plausible) indicate that there is probable overfishing of the swordfish stock in Indian Ocean in recent years ($F_{current}/ F_{MSY} > 1$) while the stock currently appears not to be in an overfished state ($B_{current}/ B_{MSY} > 1$). The current catch level (around 31,500 t) is above the MSY and probably not sustainable.

~~Stock assessments of Indian Ocean swordfish stocks are preliminary, and rely heavily on indicators of abundance and stock status such as trends in CPUE and size composition of the catch.~~

~~In 2004, the WPB attempted to fit a spatial production model to the available swordfish data. Unfortunately, trial runs did not lead to sensible parameter estimates and there was insufficient time at the meeting to fully explore the model and alternative assumptions, but it was agreed that this approach is worth further consideration.~~

~~Consideration of the stock indicators suggest that there has been a marked decline in the stocks of Indian Ocean swordfish since targeting of the species began in the early 1990's. Although there is uncertainty, the indicators and previous assessments suggest that the situation may be more serious in the western Indian Ocean than the eastern Indian Ocean.~~

~~The total catches have decreased slightly over the recent five years after reaching a peak of 36,000t in 1998. However, the effective effort (estimated as the catch divided by the standardised Japanese CPUE) has continued to increase over this period. This suggests that the decrease in the catch is not as a result of a reduction in effective effort, but more likely to be as a result of a decrease in the swordfish biomass.~~

~~There is a consistent pattern of declines in catch rates in all areas that have been exploited. While the Japanese CPUE indices show more pronounced declines compared to the Taiwanese indices, the severity of the declines appears to be correlated with the magnitude of the catches in the most heavily exploited areas (Figure 5). This pattern is clear when the CPUE's for the eastern Indian Ocean and the western Indian Ocean (which is relatively heavily exploited) are compared (Figure 6)~~

~~The standardized CPUE series for the Japanese fleet show relatively large declines since 1990 in several areas: 50% decline in the equatorial western Indian Ocean (Area 3), 90% decline in the south western Indian Ocean (Area 7). There is also evidence of recent declines in Area 4 in the north eastern Indian Ocean (Figure 5). The declines in CPUE in the Japanese series coincide with the timing of large increases in swordfish catches by the Taiwanese and other fleets in the west Indian Ocean areas.~~

~~Currently, there is no evidence of any declines in the size-based indices (Figure 7), but the SC recommends that these indices be carefully monitored. Since females mature at a relatively large size, a reduction in the biomass of large animals could potentially have a strong effect on the spawning biomass.~~

~~The apparent fidelity of swordfish to particular areas is a matter for concern as this can lead to localised depletion. The spatial structure of the CPUE suggests that there may already be localised depletion of swordfish in the south-west Indian Ocean.~~

MANAGEMENT ADVICE

On the basis of the 2006 assessments and stock indicators the SC concluded that the current level of catch (about ~~32~~31,000 t) is above the MSY and unlikely to be sustainable. Furthermore, while the assessments indicated that the stock i.e. for the Indian Ocean overall is probably not currently overfished, catch rate data from the southwest Indian Ocean suggest that~~Of particular concern are the trends in abundance of swordfish in the western Indian Ocean, where the highest catches are currently taken. The spatial structure of the CPUE suggests that there may already be~~ overfishing of swordfish may be occurring in localised areas, in particular in the southwest Indian Ocean. Notwithstanding this, the ~~However, these~~ reductions in catch rates have not been accompanied by reductions in average size of the fish in the catch, as has been the case in other oceans. The SC expressed concern regarding the very rapid increase in effort targeting swordfish in other areas of the Indian Ocean and the relatively large incidental catch of swordfish in fisheries targeting bigeye. These increases in effort exploiting swordfish have continued since 2000.

The fact that large, rapid increases in fishing effort followed by a reduction in catch rates have been seen in the southwest Indian Ocean indicates that this might also occur in other areas where fishing effort directed to swordfish is increasing rapidly.

The SC recommends that management measures focussed on controlling and/or reducing effort in the fishery targeting swordfish in the southwest Indian Ocean be implemented. Similar measures may be needed in the future if reductions in catch rates are detected in other areas of the Indian Ocean.

SWORDFISH SUMMARY

Maximum Sustainable Yield :	~~unknown~~estimates range between 23,540 t and 27,000 t.
Current (2004) Catch:	31,~~000~~300 t
Mean catch over the last 5 years (2000-04)	31,~~400~~ 500 t
Current Replacement Yield	-
Relative Biomass ($B_{200\cancel{4}0}/B_{MSY}$)	~~unknown~~estimates range between 1.17 – 1.60
Relative Fishing Mortality ($F_{200\cancel{4}0}/F_{MSY}$)	~~unknown~~estimates range between 0.74 – 1.29
~~Management Measures in Effect~~	~~None~~

Note: This Executive Summary has been updated to take account of recent catch data. The management advice, and stock assessment results are based on data up to ~~2002~~the end of 2004.

***Table 1**. Catches of swordfish by gear and main fleets for the period 1955-2004 (in thousands of tonnes). Data as of 9 October 2006.*

Gear	Fleet	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
Longline	Taiwan,China	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.5	0.3	0.3	0.2	0.6	0.8	1.2	0.9	0.9	0.6	1.0	0.9	0.9	0.9	0.6	1.1	1.3	1.1	1.5
Longline	Indonesia										-									0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
Longline	Japan	0.9	0.6	0.7	0.9	1.2	1.3	1.4	1.1	1.3	1.5	1.7	2.2	1.7	1.6	1.2	1.1	0.9	0.8	0.8	0.8	0.4	0.3	0.9	0.6	0.6	0.8	1.0
Longline	Korea, Republic of										0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.1	0.1	0.3	0.5	0.6	0.7	0.8	0.6	0.3	0.4	0.3
Longline	Other Fleets									0.1	0.2	0.0	0.0	0.1	0.0	0.1					0.0		0.0	0.0	0.0	0.0	0.0	0.0
Longline	Total	1.0	0.7	0.9	1.2	1.4	1.6	1.7	1.6	1.9	2.0	2.0	2.5	2.6	2.6	2.7	2.1	2.0	1.6	2.0	2.3	1.9	1.9	2.4	2.3	2.2	2.3	2.8
Other gears	Total										-					0.0		0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0		-
All	Total	1.0	0.7	0.9	1.2	1.4	1.6	1.7	1.6	1.9	2.0	2.0	2.5	2.6	2.6	2.7	2.1	2.0	1.6	2.0	2.3	1.9	1.9	2.4	2.3	2.3	2.3	2.8

Gear	Fleet	Av01/05	Av56/05	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05
Longline	Taiwan,China	12.1	4.9	1.9	1.7	2.0	3.2	3.8	5.4	4.1	3.8	4.7	9.0	15.3	12.5	18.3	17.6	17.2	16.8	14.7	15.2	12.9	13.5	14.4	12.3	7.5
	Spain	3.8	0.5			-								0.2	0.7	0.0	0.0	0.5	1.4	2.0	1.0	1.9	3.5	4.3	4.7	4.7
	NEI-Deep-freezing	2.6	1.3			0.0	0.2	0.2	0.8	0.6	0.8	0.9	1.4	4.2	3.6	5.4	7.7	5.5	7.0	6.2	5.8	2.2	2.4	2.4	3.0	3.0
	Indonesia	1.8	0.3	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.5	1.0	1.2	1.1	1.3	0.7	0.6	1.3	2.6	2.5	1.8
	Australia	1.3	0.2			-				0.0		0.0	0.0	0.2	0.1	0.1	0.0	0.0	0.3	1.4	1.8	2.9	1.3	1.8	0.4	0.3
	Japan	1.2	1.3	1.2	1.3	2.2	1.3	1.4	1.5	1.0	1.0	0.9	1.7	1.4	2.6	1.7	2.1	2.8	2.2	1.5	1.6	1.2	1.3	1.1	1.3	1.3
	France-Reunion	1.1	0.3			-						0.0	0.1	0.3	0.7	0.8	1.3	1.6	2.1	1.9	1.7	1.6	0.8	0.8	0.9	1.2
	Seychelles	1.0	0.1			-										0.0	0.1	0.2	0.2	0.3	0.5	0.7	0.6	1.4	1.4	1.1
	Portugal	0.8	0.1			-										-			0.1	0.2	0.2	0.6	0.8	0.9	0.9	1.1
	China	0.6	0.1			-										0.1	0.2	0.3	0.1	0.4	0.4	0.3	0.4	0.8	0.7	0.6
	South Africa	0.5	0.1			-										-		0.0	0.4	0.1	0.0	0.3	0.9	0.8	0.2	0.2
	Guinea	0.5	0.0			-										-						0.0	0.5	0.5	0.5	0.8
	Mauritius	0.5	0.0			-										0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.7	0.7
	Korea, Republic of	0.1	0.2	0.3	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.1	0.0	0.0	0.1	0.3	0.3
	NEI-Fresh Tuna	0.1	0.2			-				0.5	0.7	0.6	0.7	0.7	1.1	0.9	0.9	1.1	1.0	0.9	0.9	0.0	0.0	0.1	0.2	0.1
	Other Fleets	0.4	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.4	0.4	0.5	0.4	0.5	0.3	0.2	0.2	0.9	0.7	0.2	0.2	0.3	0.6	0.3	0.8
	Total	28.4	9.8	3.4	3.2	4.2	4.9	5.6	7.9	6.7	7.0	7.8	13.8	23.1	22.3	28.1	31.3	30.8	33.9	31.6	30.1	25.5	27.9	33.0	30.3	25.5
Gillnet	Sri Lanka	1.7	0.4			-	0.0	0.0	0.0	0.0	0.1	0.2	0.3	1.9	0.9	0.9	1.0	1.3	0.9	1.1	2.8	2.4	2.7	1.4	1.4	0.7
	Other Fleets		0.0			-	0.0									-										-
	Total	1.7	0.4			-	0.1	0.0	0.0	0.0	0.1	0.2	0.3	1.9	0.9	0.9	1.0	1.3	0.9	1.1	2.8	2.4	2.7	1.4	1.4	0.7
All	Total	30.2	10.2	3.4	3.2	4.2	4.9	5.6	8.0	6.8	7.1	7.9	14.1	25.1	23.2	29.0	32.3	32.2	34.8	32.7	32.9	28.0	30.6	34.4	31.7	26.2

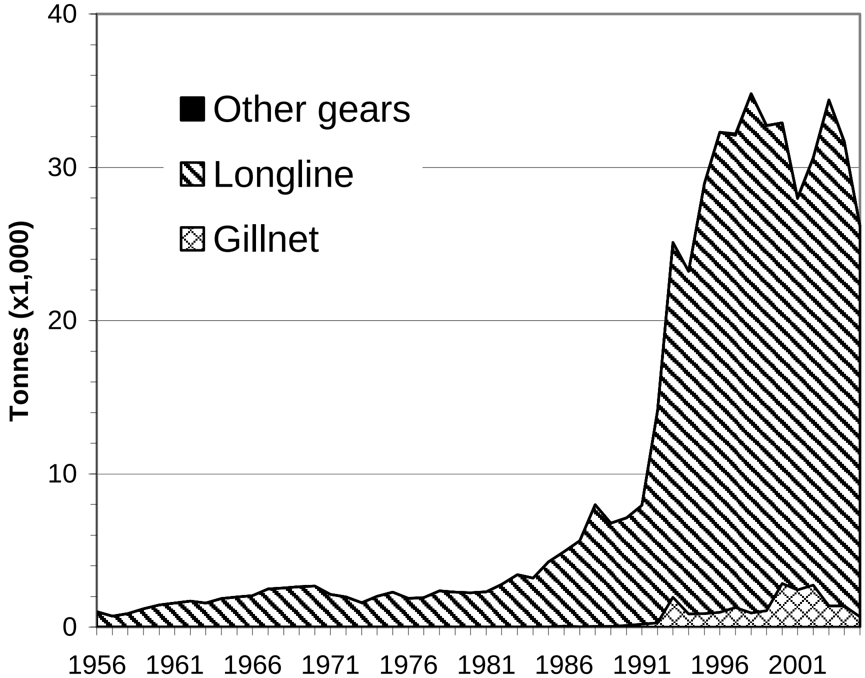


Figure 1: *Catches of Swordfish per gear and year recorded in the IOTC Database (~~1955~~1956-2005).*
Data as of October 2006

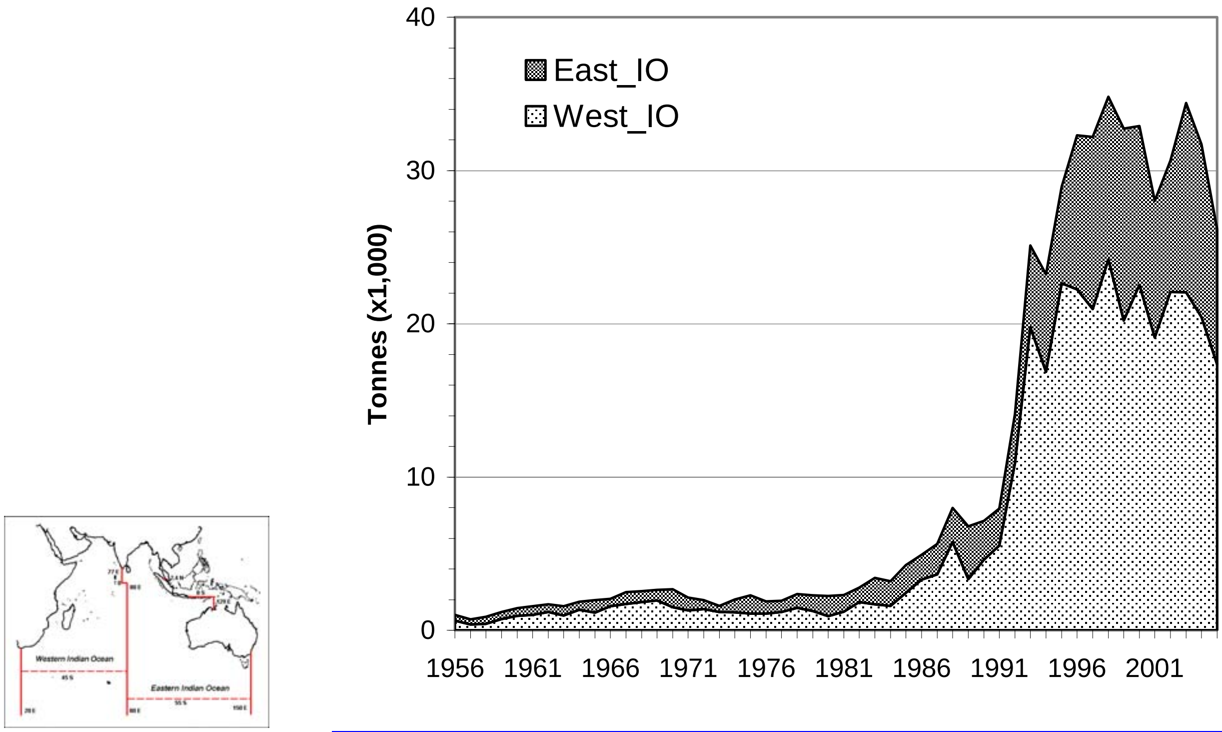


Figure 2: *Trends of the swordfish catches in the western and the eastern area of the Indian Ocean from*

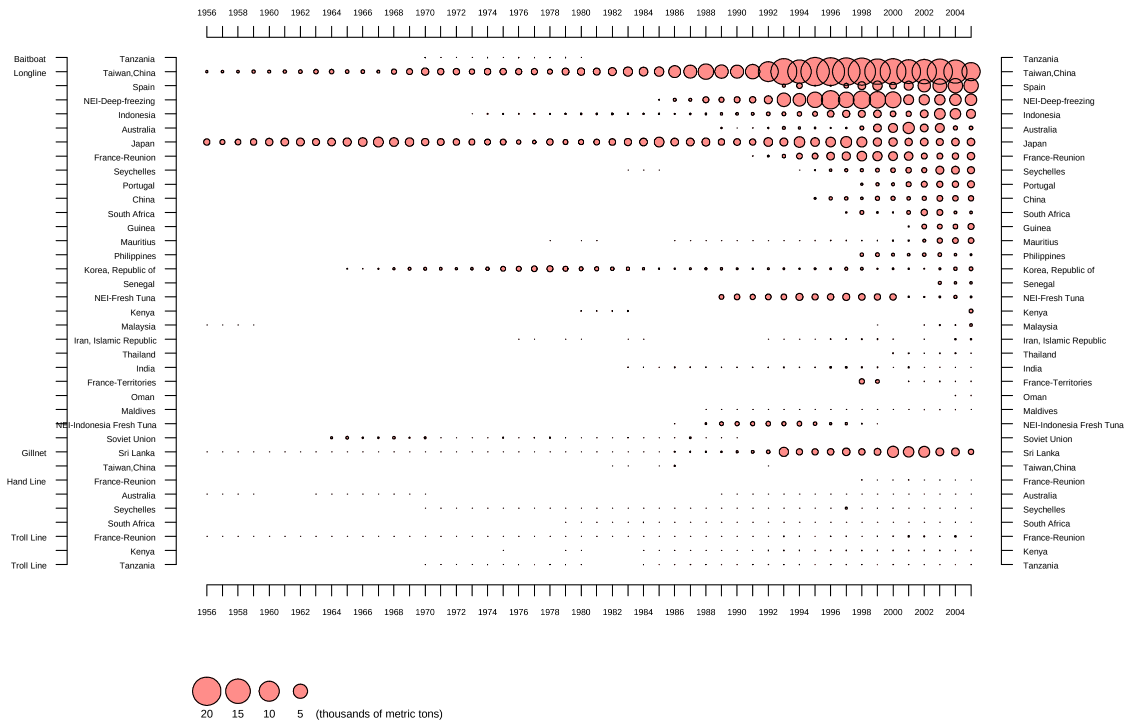


Figure 3: *Catches of swordfish in the Indian Ocean for the period 1956~~5~~-~~2004~~2005, in thousands of metric tons by gear and country/fleet.* *Data as of October 2006*

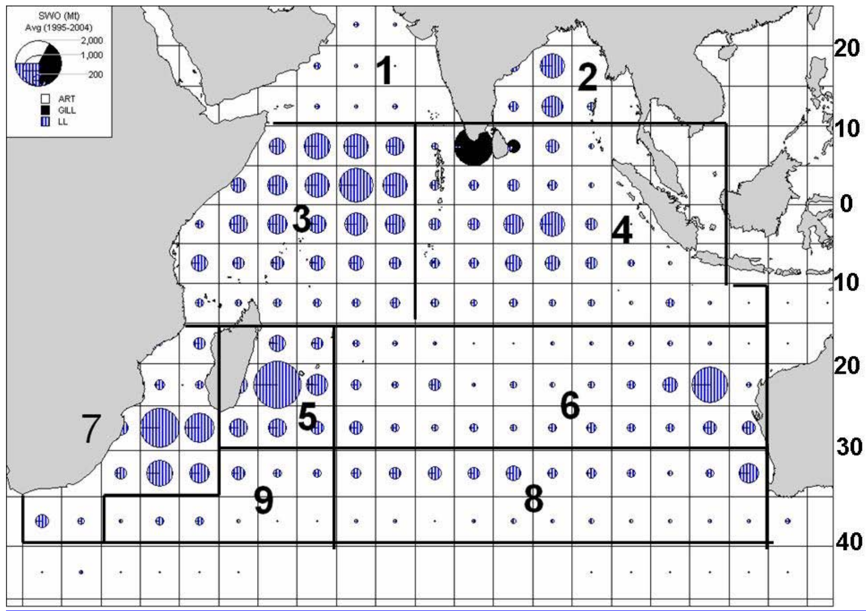


Figure 4: *Average catch of swordfish (tonnes per year) for the period 1995-2004, for longline and gillnet fisheries in the Indian Ocean. Areas used for CPUE analyses are numbered.*

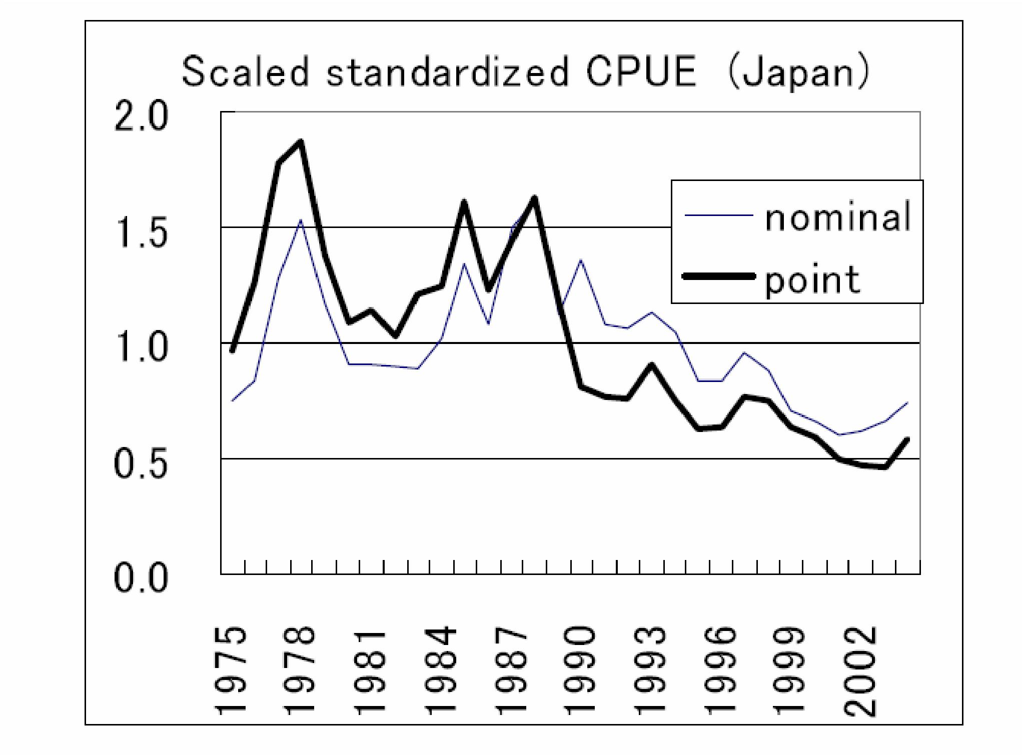


Figure 5: *Catch per unit effort indices (nominal and standardised) for swordfish caught by the Japanese fleet in the Indian Ocean (average set to 1).*

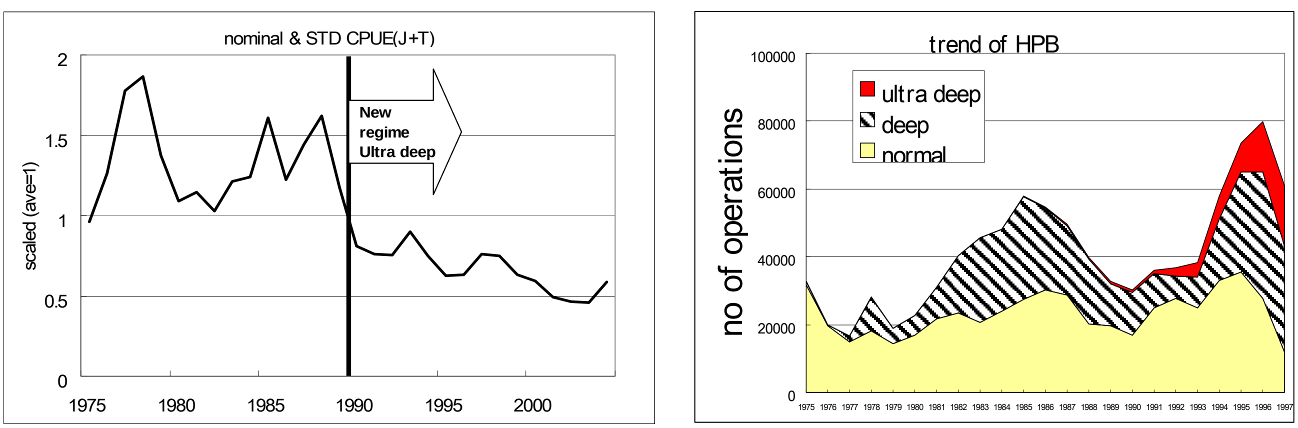


Figure 6: *Indications of a possible regime shift in catch rates related to changes in the setting practices of Japanese longliners over time. Nominal catch rates (left). Number of operations performed using normal, deep and ultra-deep longline sets (right).*

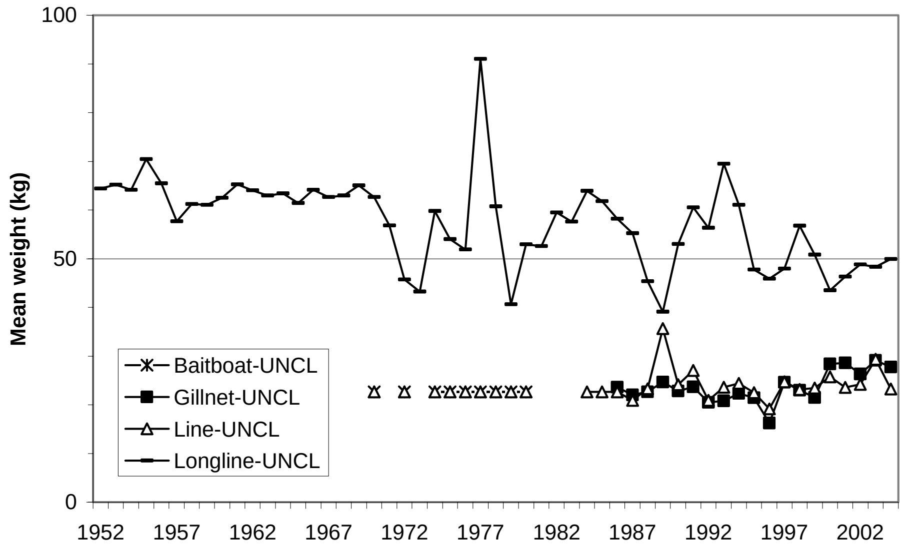
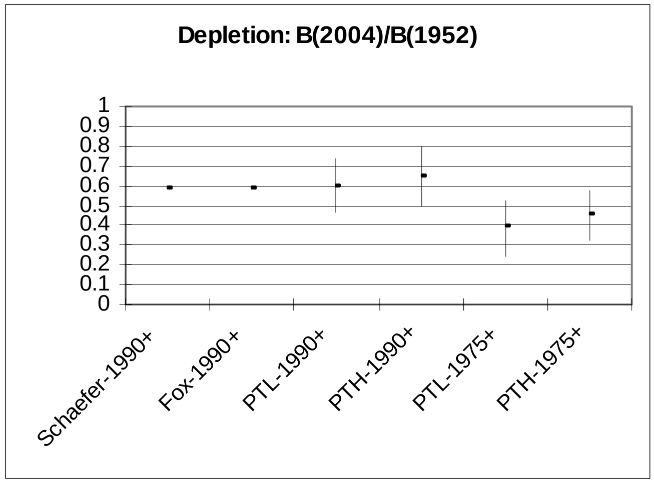
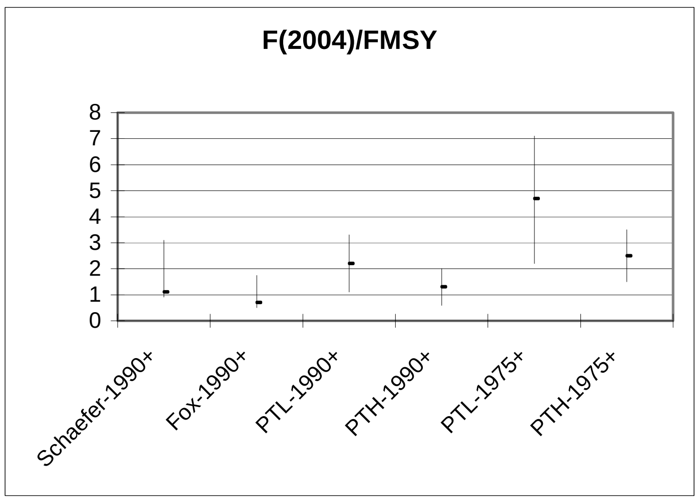


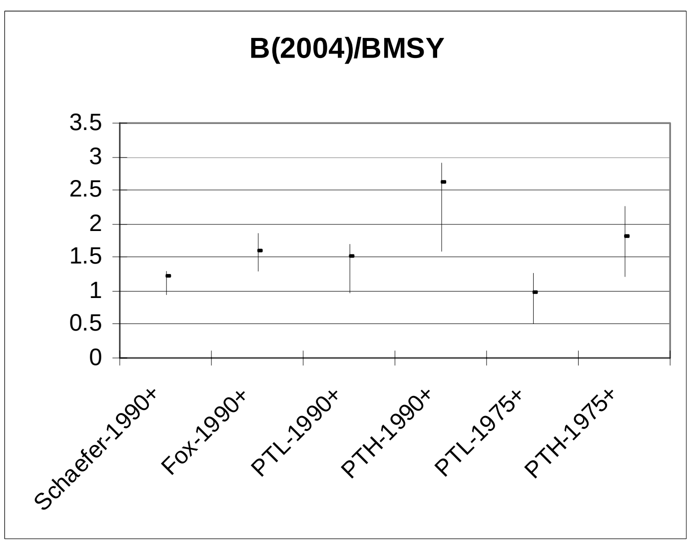
Figure 7: *Trends in average size of swordfish in Indian Ocean fisheries.*



(a)



(b)



(c)

Figure 8. *2006 Indian Ocean swordfish stock assessment results. Stock status estimates from the six successful production model fits. (a) Current biomass levels as a proportion of the biomass in 1952 (when the stock was considered to be at carrying capacity i.e. at equilibrium in an unfished state (b) Current fishing mortality relative to the level of fishing mortality at MSY (c) current biomass relative to the estimated biomass at MSY. Confidence limits are 80% for the Fox and Schaefer models (Confidence limit estimates are not available for the depletion estimates) and 95% for the Pella-Tomlinson models.*

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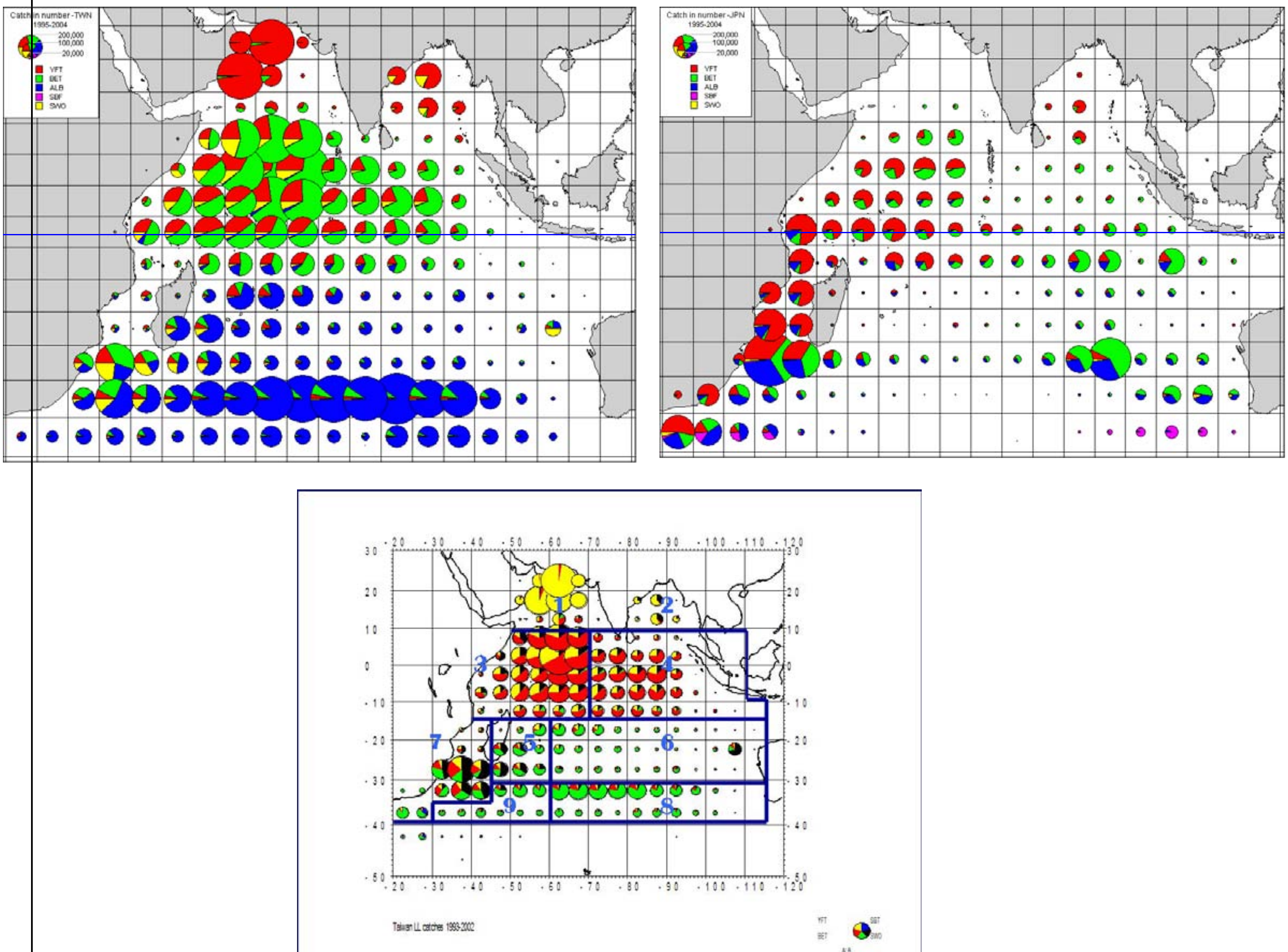
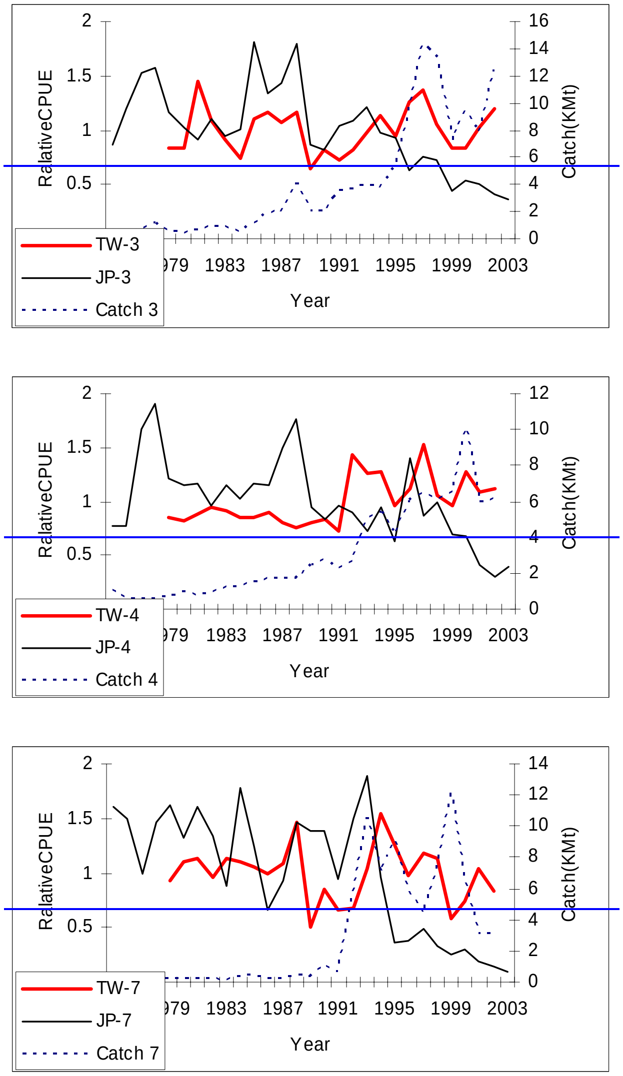
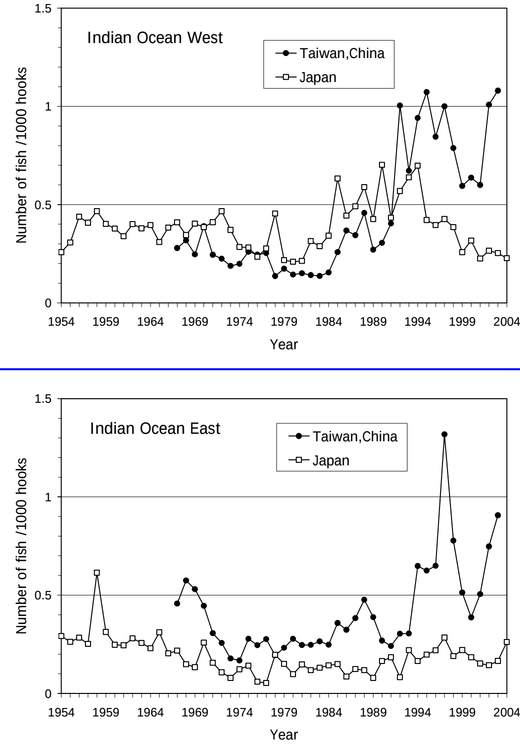


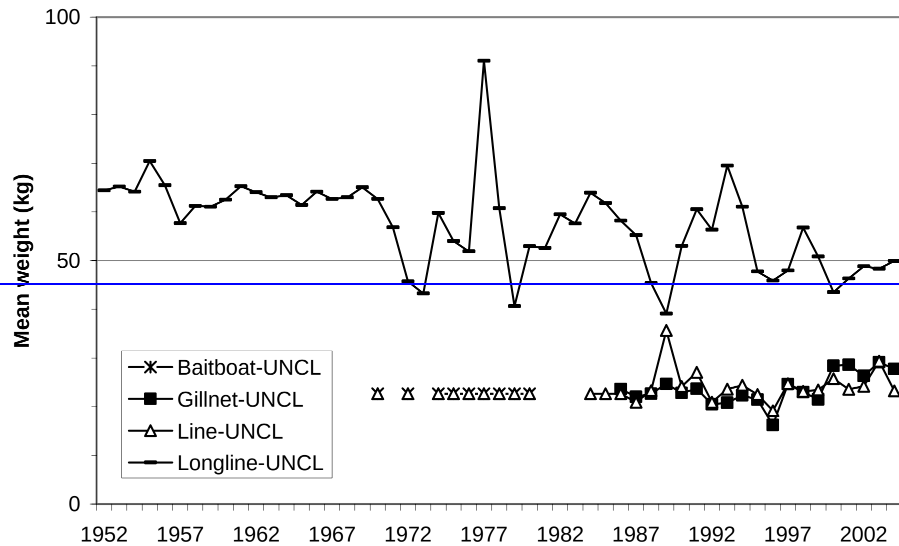
~~**Figure 4:** Areas used in the CPUE standardization for the Japanese and Taiwanese fleets. Total catches of SWO estimated (above) and catches of YFT, BET, ALB, SBF, SWO Taiwanese (below left) and Japanese (below right) longliners~~



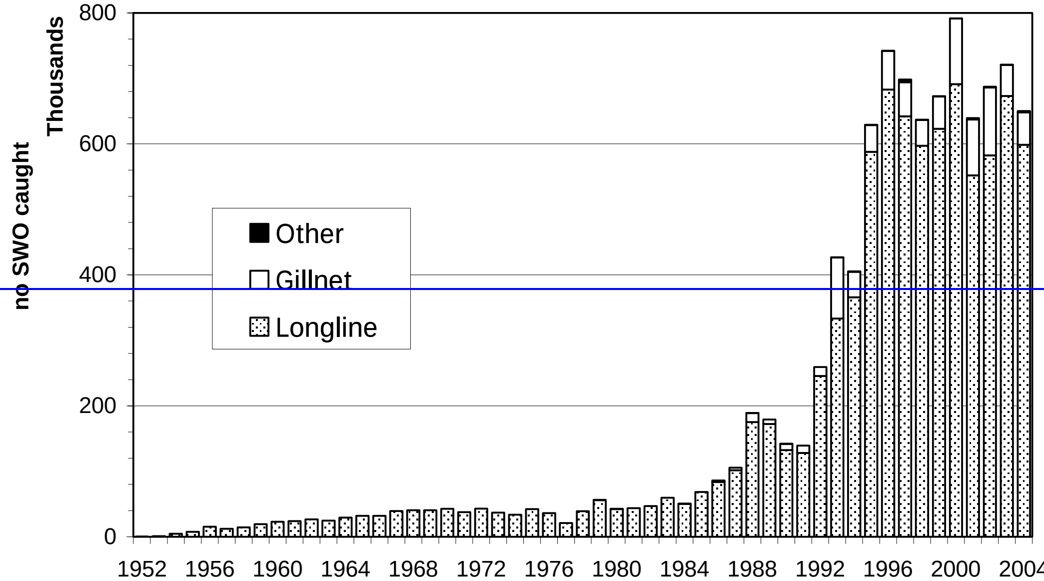
~~**Figure 5:** Total catch and standardized CPUE trends (rescaled to their average) for the Japanese and Taiwanese fleets in areas 3 (equatorial western), 7 (south western) and 4 (equatorial eastern). areas are shown in Figure 4.~~



~~**Figure 6:** trends of the Taiwanese and Japanese fleets Nominal CPUE in the western and eastern areas in Indian Ocean. Areas are shown in Figure 2.~~



~~**Figure 7:** Trends in average size of swordfish in Indian Ocean fisheries.~~



~~**Figure 8:** Number of SWO caught per year.~~