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Preparation of data input files for the stock assessments of Indian Ocean Swordfish

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Summary

This document describes the methods used by the IOTC Secretariat to prepare catch tables, length-frequency samples and catch-at-size and catch-at-age tables for the Swordfish, for the period 1950-2008, using estimates of total catch and the available catch- and effort, size frequency data and other biological data in the IOTC database.

The IOTC Secretariat estimated total catches of swordfish, in number and weight, per year, quarter, and assessment area and fishery, for the period1950-2008, using information from the IOTC database, in particular estimates of total catches by fishery and year, and catch-and-effort and size frequency data by time-area strata. In addition, the Secretariat prepared length-frequency samples from the size frequency data available in the IOTC databases. These datasets were prepared to be used in assessments using estimates of total catches by fishery, area, year and quarter and the samples existing for those strata or estimates of catch-at-size or catch-at-age derived from the referred samples. The results are affected by the lack of information for some fleets, periods and years, and, in particular, by the lack of catch and size data from most artisanal fleets and some industrial fleets.

Rationale

The IOTC database contains estimates of total catches by country, gear, year and IOTC Area (**Figure 1**, page 2). In addition, the IOTC database contains catch-and-effort data and size frequency data by country, gear, time-area strata and species, which generally represent a sample of the total catches estimated by country, gear, year and species.
The Secretariat used the above data to produce the following information for the swordfish:

- Input files for stock assessment, in particular:
  a. Models using estimates of total catches of swordfish, in number and weight, and non-raised length-frequency data (**samples**) available by year, quarter and fishery, for 1950-2008.
  b. Models using estimates of total catches of swordfish, in number and weight, and estimates of total numbers of swordfish caught by length class interval, year, quarter and fishery, or **Catch-at-Size**, for 1950-2008.
  c. Models using estimates of total catches of swordfish, in number and weight, and estimates of total numbers of swordfish caught by age interval, year, quarter and fishery, or **Catch-at-Age**, for 1950-2008.
- Stock status indicators (e.g. trends in average weight per fishery).
- Tables of total catch by fishery, year, month and five degrees square areas.

The construction of a catch-at-size table for a particular species requires that length frequency distributions are assigned to the total catch. Thus, the sampled weight estimated for each stratum (i.e. the weight resulting from summing up the weights estimated for the specimens within each length class) is raised to the nominal catch recorded for that stratum.

Species involved

Catch-at-Size (CAS) and Catch-at-Age (CAA) tables were estimated for the Swordfish only. The estimation of CAS and CAA for marlins or Indo-Pacific sailfish has not been attempted in this paper due to a paucity of data.

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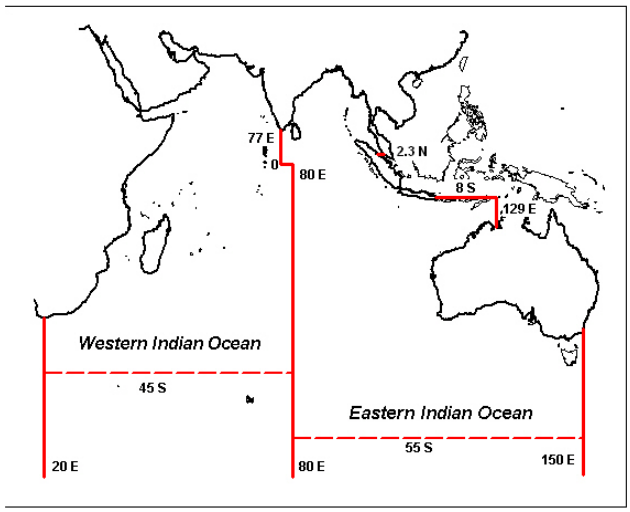
Basic Data

Four datasets are used for the preparation of stock assessment tables for the Swordfish:

- *Nominal catches*: Total catch estimates per Species, Fleet, Year, Gear and IOTC Area (**Figure 1**). The data in this dataset issues from two different sources:
  a. Reports from the flag countries or reports from other countries on the catches of foreign vessels operating within its Economic Exclusive Zone or based in ports within its territory.
  b. Estimates carried out by the IOTC Secretariat: this may involve changes in the catches reported by the above or the estimation of catches for non-reporting fleets (e.g. catches recorded under the NEI[3] category).

Figure 1: IOTC areas used for the Nominal Catches



- *Catches per area* (from catch-and-effort): Catches (in tonnes or/and in number) are recorded per Species, Fleet, Year, Gear, Fishing Mode, Time Interval (month or quarter usually) and area (usually 1^0 square areas for industrial purse seine fisheries, 5^0 square areas for industrial longline fisheries and various regular or irregular areas for artisanal fisheries). Catches per area are not available for all Nominal catches strata. When recorded, the catches in these datasets might represent the total catches of the species in the year for the fleet and gear concerned or represent simply a sample of those.
- *Size data*: Size frequency data (standard or processed length or standard or processed weight) are recorded per Species, Fleet, Year, Gear, Fishing Mode, Time Interval (month or quarter or year usually) and area (usually 5^0 square areas for purse seine fisheries, 10^0 latitude by 20^0 longitude for longline fisheries and various regular or irregular areas for artisanal fisheries). Size data are not available for all Nominal catches strata. When recorded, the size data might represent the total catches of the species in the strata concerned (or Catch-at-Size) or simply a sample of those.
- *Biological data*: includes several types of biological parameters for the swordfish, in particular:
  a. Conversion from non-standard measurements into fork length: Equations (data) used to convert specimens of swordfish measured by using non-standard procedures into the standard length measurement used for the swordfish, representing the distance from the tip of the lower-jaw to the fork of the tail (fork length).
  b. Conversion from fork length into live weight: Equations (data) used to estimate sample weights from the available lengths (length-weight relationships).
  c. Sex-ratio: Data used to estimate numbers of swordfish by sex from the available numbers of swordfish.
  d. Age-Length keys: Data used to estimate numbers of swordfish by age (Catch-at-Age) from the numbers of swordfish by length estimated (Catch-at-Size).

The type of information recorded in each case is summarized in **Table 1** below:

Table 1: Main types of fisheries statistics gathered by the IOTC

Dataset	*Fishery Strata*	*Time Strata*	*Area Strata*	*Represents*
Nominal Catches	Fleet-Gear (or gear aggregate)-Species (or species aggregate)	Year	IOTC Area	Total catches
Catches per area	Fleet-Gear (or gear aggregate)-Fishing Mode (purse seine only)-Species	Month (quarter or year)	1°square area (purse seine) 5°square area (longline) Other regular or irregular areas	Sample
Size data	Species- Fleet-Gear (or gear aggregate)-Fishing Mode (purse seine only)-Type of measurement (length or weight, standard or processed)-Size interval (between size classes)	Quarter (year or month)	5°square area (purse seine) 10°Lat.*20°Lon. area (longline) Other regular or irregular areas	Sample
Biological data	Various, depending on dataset	Various	Various, depending on dataset	Sample

[3] Not elsewhere identified

Fisheries and Areas used for the assessments of swordfish

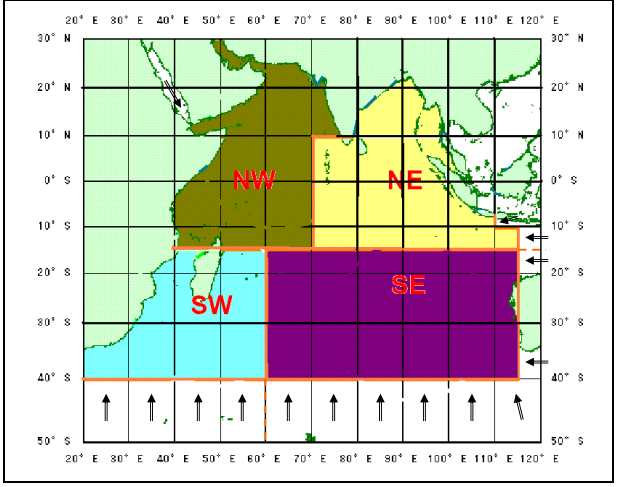
The nominal catches, samples and estimates of Catch-at-Size and Catch-at-Age to be used for the assessments of swordfish were ultimately aggregated by year, quarter, assessment fishery and assessment area.

Assessment Areas: Four areas are used for the assessments of swordfish. These areas are shown in **Table 2** and **Figure 2**. The catches of swordfish from areas outside the four assessment areas were assigned to the closest area, as indicated through the arrows on **Figure 2**. **Table 2** shows also total catches by area accumulated for the entire catch data series (1950-2008) and the contribution that the catches from each area made out of the total accumulated catches for 1950-2008, and in recent years (2004-08).

Table 2: Areas used for the assessments of Indian Ocean swordfish; the total catches (metric tons) accumulated for the period 1950-2008 (Total Catch 50-08), the relative importance of the catches in each area over both the entire catch series (%50-08) and in current years (%04-08), and the catches by assessment fishery (see Table 3) in each of the areas concerned are also shown

Area	*Description*	*Catch (t) 50-08*	*% 50-08*	*% 04-08*	*Catches by Fishery (t)*						
					ALGI	*AUEL*	*EUEL*	*ISEL*	*JPLL*	*TWFL*	*TWLL*
NW	Northwest Indian Ocean	193,515	32	31	6,280		6,830	3,412	27,865	1,660	147,466
SW	Southwest Indian Ocean	171,829	28	27	209		38,805	20,662	23,276	23	88,854
NE	Northeast Indian Ocean	161,208	26	23	29,643		1,264		13,398	42,635	74,268
SE	Southeast Indian Ocean	87,084	14	19	648	10,821	31,762	2,086	10,971	10	30,785

Figure 2: Areas used for the assessments of Indian Ocean swordfish



Assessment Fisheries: Seven fisheries are used for the assessments of swordfish, as indicated in **Table 3**. Details on the fisheries that were assigned to each fleet-gear-catch/length frequency stratum can be found in **Appendix III**. **Table 3**, below, shows the fisheries that are used for the assessment of swordfish. It shows also total catches by fishery accumulated for the entire catch data series (1950-2008) and the contribution that the catches from each fishery made out of the total accumulated catches for 1950-2008, and in recent years (2004-08).

Table 3: Fisheries used for the assessments of Indian Ocean swordfish; the total catches accumulated for the period 1950-2008 (Total Catch 50-08 in metric tons) and the relative importance of each fishery over both the entire catch series (%50-08) and in current years (%04-08) is also shown

Fishery	*Description*	*Total Catch 50-08*	*% 50-08*	*% 04-08*
ALGI	Contains data for all gillnet, trolling and other minor artisanal fisheries	36,781	6	8
AUEL	Contains data for the longline fishery of Australia (target is SWO)	10,821	2	1
EUEL	Contains data for EU longliners (from Spain, Portugal and the UK) plus other longliners assimilated to EU longliners (generally owned by Spanish nationals), all targeting SWO	78,662	13	36
ISEL	Contains data for the semi-industrial longline fleets operating in Reunion(France), Mayotte(France), Madagascar, Mauritius and the Seychelles, which also target SWO	26,160	4	6
JPLL	Contains data for the longline fishery of Japan plus other fleets assimilated to the Japanese fleet (e.g. South Korea, Thailand, Oman)	75,510	12	6
TWFL	Contains data for the fresh-tuna longline fleets of Taiwan and Indonesia, plus other fresh-tuna longline fleets assimilated to those and all sport fisheries and fleets operating hand lines	44,328	7	9
TWLL	Contains data for the large scale tuna longline fleet of Taiwan,China, plus other longline fleets assimilated to the Taiwanese fleet (a component of those fleets may target SWO)	341,374	56	34

Input Tables

The Secretariat has prepared the following input tables for the WPB:

- Stock assessments of swordfish: Three sets of tables were prepared, depending on the type of assessment models to be used:
  Assessment models using non-raised length frequency data (samples)
  a. Estimates of total catches of swordfish, in number of specimens and weight, by year, quarter, fishery and area.
  b. Number of swordfish specimens sampled by length interval, by fishery, area, year, and quarter.
  Assessment models using Catch-at-Size data
  a. Estimates of total catches of swordfish, in number of specimens and weight, by year, quarter, fishery and area.
  b. Estimates of total number of specimens of swordfish caught by length class (Catch-at-Size) by fishery, area, year, and quarter.
  Assessment models using Catch-at-Age data
  a. Estimates of total catches of swordfish, in number of specimens and weight, by year, quarter, fishery and area.
  b. Estimates of total number of specimens of swordfish caught by age class (Catch-at-Age) by fishery, area, year, and quarter.
- Stock status indicators for billfish species: The Secretariat used total catches, catch-and-effort, length frequency samples and Catch-at-Size data in the preparation of sets of stock status indicators for swordfish, marlins and Indo-Pacific sailfish.
- Total catches by time-area strata: The Secretariat prepared a table containing estimates of total catches of swordfish, in number and weight, by fleet, gear, year, quarter, and 5^0 square areas.

An example of the above tables can be found in **Appendix I**.

Data Processing

Estimation procedures used for the preparation of data for the assessments of swordfish

The way in which the Secretariat prepared the information to be used for the assessments of swordfish is summarized below. Details about these procedures are provided in the following sections.

1. Standardizing catch and size frequency tables
   a. Nominal catches (NC): Assigning the catches not reported by species/gear by species/gear (NC→NCst)
   b. Catch-and-effort (CE): Assigning catches not recorded by 5^0 grid/quarter by 5^0 grid/quarter (CE→CEst)
   c. Size frequency (SF→LFst):
      i. Converting non-standard measurements into standard measurements
      ii. Breaking the existing lengths into the standard length class intervals used for the species (e.g. 15-18cm, 18-21cm, etc.)
      iii. Assigning samples not recorded by area (purse seine and other gears)/quarter by area/quarter
2. **Swordfish length frequency samples input file** (LFst →**LF_{INPUT}**) Aggregating the length frequency samples in LFst by fishery-area-year-quarter-number of specimens sampled by length class, for 1950-2008.
3. Breaking the NCst by quarter and 5^0 grid using the CEst (NCst→NCds)
4. Assigning length frequency samples to all NCds strata (Fleet-Gear-Year-Quarter-PS/Other Area) (NCds→LFcv)
5. Deriving Catch-at-Size (CAS) by scaling up length frequency distributions in LFcv from sample weight to total weight for each stratum (LFcv→CAS)
6. Adjusting/estimating NCds weights/numbers by using average weights derived from the CAS (NCds→NCad)
7. **Swordfish total catch input file** (NCad→**NC_{INPUT}**) Aggregating the catches in NCad by fishery-area-year-quarter-total catch of swordfish (in number and weight), for 1950-2008.
8. **Swordfish Catch-at-Size input file** (CAS→**CAS_{INPUT}**): Aggregating the length frequency data in CAS by fishery-area-year-quarter-total number of specimens by length class interval, for 1950-2008.
9. **Swordfish Catch-at-Age input file** (CAS→**CAA_{INPUT}**): Deriving Catch-at-Age for swordfish using CAS_{INPUT} and the existing Length-Age key to obtain estimates of total n umber of specimens caught by age class, fishery, area, year and quarter, for 1950-2008.

Breaking the catches not recorded by gear and/or species by species and gear

The catches in the IOTC nominal catches database are not recorded by species and/or by gear in all cases. The Secretariat conducted a review aiming at estimating catches when data were not available by species or gear in the IOTC database. This process was documented in a paper presented to the WPTT in 2004 (IOTC-2004-WPTT-06).

Standardization of catch-and-effort data

The catches in the catch-and-effort table are recorded under different levels of aggregation.
All the catches from this record were assigned by Species-Fleet-Gear-Fishing Mode-Year-Month-5^o square grid-Catch in number of fish-(and/or)-Catch in metric tons.

i. Grid allocation: All the catches not recorded by 5^o square grid were assigned to 5^o square grids as follows:
   a. Allocation of catches recorded under irregular areas by 5^o square grid: The catches recorded under irregular areas (e.g. port of unloading, fishing district, etc.) were assigned to the neighbouring 5^o square grid(s).

b. Allocation of catches recorded under areas that fell within a single 5° square area: all catches recorded under areas that fell within a 5° square area were assigned to the corresponding 5° square areas.
c. Allocation of catches recorded under areas overlapping two or more 5° square areas: all catches recorded under areas that overlapped two or more 5° square areas were assigned proportionally by 5° square area (i.e. by using the proportions obtained by dividing the amount of 1 degree square grids that fell within each 5° square area over the total amount of squares from the overlapping area).

ii. Time period allocation: The catches available in the catch-and-effort file were assigned by month as follows:
a. Allocation of catches recorded under time period strata that fall within a single month: all catches recorded under time periods that fell within a month were assigned to the corresponding months.
b. Allocation of catches recorded under time period strata overlapping two or more months: all catches recorded under time periods that overlapped two or more months were assigned proportionally by month (e.g. 1/3 of the catches recorded under the first quarter of a year were assigned to each of the months making up that quarter).

Standardization of size frequency data

The following process was used to convert the samples of swordfish available into standard form:

i. Converting non-standard lengths into standard length (**Table 4**): The regression equations presented in **Table 4** were used to estimate the distance from the tip of the lower jaw to the fork of the tail (fork length) for specimens of swordfish that were recorded under non-standard lengths or weights in the IOTC database (deterministic conversion). The equations used for other billfish species are presented in **Appendix IX**.

Table 4: Swordfish: Regression equations used to convert from non-standard measurements into standard lengths

Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size range*	*Source*
Cleithrum to caudal fork length	$\frac{(L+b)}{a}$	a= 0.8087 b= 8.6712	n/a	n/a	***Reference not available***
Cleithrum to keel length	$aL+b$	a= 1.55108 b= 13.5025	179	Min:88 Max:252	***Two step conversion as CKL = (0.690253*EFL) -3.541823 in formula LJFL = 8.00884+(1.07064*EFL); NOAA Data (Pacific Ocean)***
Eye orbit to Fork Length	$aL+b$	a= 1.066 b= 10.449	123	Min:48 Max:255	***Data from Reunion Island, Indian Ocean Poisson 2001 (in IOTC-2005-WPTT-05)***
Pectoral fin to anal fin length	$aL+b$	a= 2.5407 b= 25.698	1,806	Min:18 Max:105	***Data from Reunion Island, Indian Ocean Poisson 2001 (in IOTC-2005-WPTT-05)***
Pectoral fin to caudal fork length	$aL+b$	a= 1.2398 b= 11.204	55	Min:60 Max:157	***Data from Reunion Island, Indian Ocean Poisson 2001 (in IOTC-2005-WPTT-05)***
Weight gilled and gutted	$(w/a)^{(1/b)}$	a= 0.0000043491 b= 3.188	3,608	Min:89 Max:266	***Inverted length-weight equation(ICCAT Mejuto et al 1998 South-East Atlantic Ocean)***
Weight headed and gutted	$(w/a)^{(1/b)}$	a= 0.000004592 b= 3.137	n/a	n/a	***Inverted length-weight equation. Reference not available***
Weight round	$(w/a)^{(1/b)}$	a= 0.000003815 b= 3.188	3,608	Min:89 Max:266	***Converted to GGT (GGT=RND/1.14 (Mejuto et al. 1998)) and inverted length-weight equation (ICCAT Mejuto et al 1998 South-East Atlantic Ocean)***

ii. Breaking the samples according to the standard length frequency intervals used for the swordfish: The length-frequency intervals that are used for billfish species are shown in **Table 5**.

Table 5: Standard length, first length, interval and total number of size classes used for billfish species

Species	*Standard Length*	*First length (cm)*	*Interval between length classes (cm)*	*Total number of size classes*	*Maximum interval allowed (cm)*
Swordfish	Tip lower jaw - Fork of tail length*	15	3	150	5
Blue marlin	Eye orbit - Fork of tail length+	15	3	150	5
Black marlin	Eye orbit - Fork of tail length	15	3	150	5
Striped marlin	Eye orbit - Fork of tail length	15	3	150	5
Indo-Pacific sailfish	Eye orbit - Fork of tail length	15	3	150	5

NOTE: All samples in the IOTC database were assigned according to the specifications above; the samples recorded under length intervals greater than the maximum interval specified above were not used
***Refers to the straight distance measured, to the closest lower centimetre, between the tip of the lower-jaw and the fork of the tail**
+ Refers to the straight distance measured, to the closest lower centimetre, between the front orbit of the eye and the fork of the tail

a. Allocation of specimens recorded under length classes that fall within a single standard length class:
   - Billfish specimens recorded under one centimetre length classes were aggregated under the corresponding three centimetre length classes (e.g. specimens recorded under the classes 15-16cm, 16-17cm and 17-18cm were accumulated under fork length class 15).
   - Billfish specimens recorded under two or three centimetre length classes that fell within standard length classes were assigned to the corresponding standard length classes (e.g. specimens recorded under length classes 15-17cm or 15-18cm -for length frequency data reported by 2cm or 3cm length intervals, respectively-, were assigned to standard length class 15-18cm)

b. Allocation of specimens recorded under length classes overlapping two or more standard length classes: all the specimens recorded under length classes that overlap the standard classes used for the species (**Table 3**) were assigned proportionally to the corresponding standard length classes (e.g. 1/2 of the swordfish specimens recorded under the length class 17-19cm were assigned to length class 15-18cm and 1/2 to length class 18-20cm; 1/5 of the specimens recorded under length class 17-21cm were assigned to length class 15-18cm, 3/5 to length class 18-20cm and 1/5 to length class 20-22cm). The specimens of swordfish from samples using length class intervals 6cm or higher were discarded.

Breaking the nominal catches by month and 5° degree square grid

The aim of this process is to break the catches recorded in the nominal catches table by month and 5° square grid. This information is used:

- For the estimation of total catches by fishery, year, quarter and assessment area: The catches recorded in the nominal catches table (by fleet, gear and year) need to be further broken by fishery, year quarter and assessment area (**Figure 2**).
- For the estimation of catch-at-size tables: The length distributions of tuna species may change depending on the area and/or time fished and therefore the estimation of catches-at-size is likely to be improved if this information is used.
- For the estimation of total catches by time-period and 5° square area for the Tuna Atlas.

The steps given to assign the catches available for each NC stratum per month and 5° square areas are indicated below:

i. Nominal catches strata for which time-area catches exist:
   a. Deleting time-area catches that are not representative of the fishery: Time-area catches for NEI-(deep)-freezing longliners and NEI-fresh tuna longliners were not used because they refer to very limited areas and time-periods and are not considered to be representative of the activities of these fleets.
   b. Breaking the nominal catches by time-period and area: The nominal catches were broken by time and area in years for which spatio-temporal catches are available for the fleet concerned.

ii. Nominal catches strata for which time-area catches do not exist:
   a. Time-area catches exist for the fleet concerned for a period up to 15 years before or after the year concerned:
      i. Time-area catches of the species concerned are available within the period specified: The catches recorded in the five years closest to the year of reference were accumulated and the average values obtained used to break the catches per area in the year concerned. Data extending to up to 15 years above or below the year concerned are used.
      ii. Time-area catches of the species concerned are not available within the period specified: The catches of other species are used, where available:
         a. The catches recorded in the year of reference were accumulated and the average values obtained used to break the catches by time and area in the year concerned.
         b. The catches recorded in the five years closest to the year of reference were accumulated and the average values obtained used to break the catches per area in the year concerned. Data extending to up to 15 years above or below the year concerned are used.
   b. Time-area catches do not exist for the fleet concerned for up to 15 years before or after the year concerned:
      i. Fleets that are presumed to operate as other fleets for which time-area catches exist: This refers mainly to industrial fleets. The catches per area available for other fleets (and years) are used to break the nominal catches per month and 5° square area/s.
         a. Time-area catches exist for the alternative fleet during the year concerned: This information is used to break the nominal catches by time and area.
         b. Time-area catches do not exist for the alternative fleet during the year concerned: The same substitution scheme as the one defined in ii.a. above is used.

      The fisheries for which the above substitution scheme was used and the alternate fleets and gears selected for substitution in each case can be found in **Appendix IV**.
      ii. Fleets that are presumed to operate in specific areas: This refers mainly to artisanal and semi-industrial fleets. One or more 5° square areas were assigned to each fleet.
         a. Time-area catches exist for other fleets in the areas concerned: The nominal catches are broken per month and area according to the proportion that the catches available from other fleets make in the area/s concerned.
         b. Time-area catches do not exist for other fleets in the areas concerned: The catches for the fleet concerned are broken proportionally per month and area.

Estimation of Catch-at-Size (CAS)

The aim of this process is to estimate length frequency distributions for each species, year and gear type. Thus, the accumulated weight estimated from the specimens making up the length frequency shall be the same than the total weight recorded in the stratum concerned and the weight issuing from all the strata shall be equal to the total catches recorded for the species in the year concerned. These data are used to estimate catches-at-age and other information used for stock assessment.

Reformatting of length frequency data

The time-area resolution used for the estimation of catches-at-size depends on the gear type.

i. Allocation of estimation areas: Two different types of estimation areas are used:

- Industrial purse seine fisheries: The statistical areas used for the sampling of EU purse seiners are used; these are shown on **Figure 3**.
- Other fisheries (industrial longline plus all artisanal fisheries): 10° latitude by 20° longitude areas are used, as shown on **Figure 4**[4].

Figure 3: Areas used for industrial purse seiners

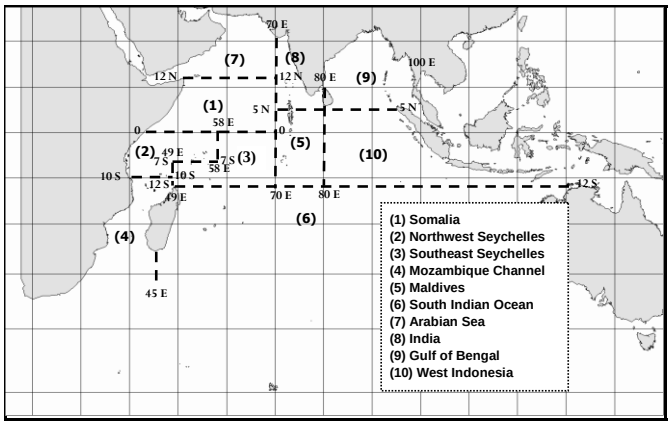
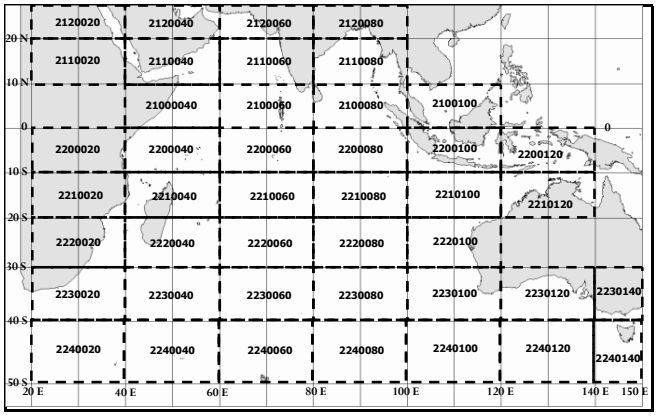


Figure 4: Areas used for other fisheries



The samples in the size frequency table are recorded under different types of geographic areas. The following process was followed to allocate the existing samples by estimation area:

a. Allocation of samples recorded under irregular areas: The samples recorded under irregular areas (e.g. port of unloading, fishing district, etc.) were assigned to regular areas.
b. Allocation of specimens recorded under areas that fall within a single standard area: all specimens recorded under areas that fell within the standard areas were assigned to the corresponding areas (as shown on **Figures 3-4**).
c. Allocation of specimens recorded under areas overlapping two or more standard areas: the specimens recorded under areas overlapping two or more standard areas (**Figures 3-4**) were assigned proportionally by estimation area (i.e. by using the proportions obtained by dividing the amount of 1 degree square grids that fell within each estimation area over the total amount of squares from the overlapping area).

ii. Time period allocation: The available length frequency samples were assigned by quarter as follows:

a. Allocation of specimens recorded under time-periods that fall within a single quarter: all specimens from samples recorded under time periods that fell within a quarter were assigned to the corresponding quarter.
b. Allocation of specimens recorded under time-periods overlapping two or more quarters: all specimens from samples recorded under time-periods that overlapped two or more quarters were assigned proportionally by quarter (e.g. 2/3 of the specimens recorded under the time period February-April of any year were assigned to the first quarter (Jan-Mar) of that year while the remaining 1/3 specimens were assigned to the second quarter (Apr-Jun)).

iii. Estimation of sample weight: The weight for each sample was calculated by adding the weights estimated for all the specimens making it. The equations used to estimate weights from the available lengths are shown in **Table 6** (note that deterministic methods were used for the conversion).

Estimation of catch-at-size tables

The amount of length frequency data available is scarce for some fisheries and/or periods with samples not available for all strata in which catches are recorded or sample numbers too low to be considered. Thus, substitution is required where samples are not available for a fleet-gear(fishing mode)-year-quarter-estimation area (figures 3-4) or where sample numbers are very low.

For this purpose the minimum sample size was set to 30 specimens, i.e. strata with no samples available or with samples made up of less than 30 fish are combined with other strata in order to attain the minimum number of specimens required prior to the estimation of catch-at-size for the strata concerned.

[4] Note that Japan and Taiwan,China have always reported size data for their longline fisheries as per the areas shown on Figure 4

Table 6: Equation used to convert billfish measurements in standard length to round weight

Species	*Gear Type/s*	*From type length – To round weight*	*Equation*	*Parameters*	*Sample size*	*Length*
Swordfish	All gears	Tip of lower-jaw to fork of caudal fin length(cm) – Round Weight(kg)[A]	$w^{live} = aFL^{b}$	a= 0.0000042030 b= 3.21340	2569	Min:80 Max:253
Black marlin	All gears	Front of eye orbit to fork of caudal fin length(cm) – Round Weight(kg)[B]	$w^{live} = aEFL^{b}$	a= 0.0000144217 b= 2.98851	24	Min:95 Max:279
Blue marlin	All gears	Front of eye orbit to fork of caudal fin length(cm) – Round Weight(kg)[B]	$w^{live} = aEFL^{b}$	a= 0.00000272228 b= 3.30967	154	Min:109 Max:269
Striped marlin	All gears	Front of eye orbit to fork of caudal fin length(cm) – Round Weight(kg)[B]	$w^{live} = aEFL^{b}$	a= 0.00000133263 b= 3.41344	17	Min:101 Max:178
Indo-Pac. sailfish	All gears	Front of eye orbit to fork of caudal fin length(cm) – Round Weight(kg)[B]	$w^{live} = aEFL^{b}$	a= 0.0000690103 b= 2.52429	35	Min:86 Max:187

A: Data from the Atlantic Ocean, Spanish longline fishery (Mejuto et al., 1988, ICCAT)

B: PIFSC Administrative report: (Updated Weight-on-Length Relationships for Pelagic Fishes Caught in the Central North Pacific Ocean and Bottom fishes from the Northwestern Hawaiian Islands)

The substitution scheme used to assign length frequency data to all strata having catches is explained below:

i. Length frequency data are available for the stratum concerned:
   a. Deleting samples from the length frequency table: The samples recorded for South Korea were not used because they are presumed to be very incomplete.
   b. Assigning the available length frequency distributions by strata: The remaining length frequency distributions were assigned by strata.

ii. Length frequency data are not available for the stratum concerned:
   a. Length frequency data are available within the year before or after the quarter concerned:
      i. Length frequency data are available for the same fleet and gear. Two substitution schemes are used depending on the gear type:
         a. Industrial purse seiners: The estimation areas defined in **Figure 3** are used. The following latitude and longitude are assigned to each area[5]:

Table 7: Coordinates assigned to PS areas (used for strata substitution)

PS Area	*Q-Lat-Lon*	*PS Area*	*Q-Lat-Lon*
(1) Somalia	1 00 040	(6) S Indian Ocean	2 20 060
(2) NW Seychelles	2 00 020	(7) Arabian Sea	1 20 040
(3) SE Seychelles	2 00 060	(8) India	1 00 080
(4) Moz. Channel	2 10 020	(9) Gulf of Bengal	1 00 100
(5) Maldives	2 00 080	(10) W Indonesia	2 00 100

         b. Other gears: The estimation areas defined in **Figure 4** are used. Two regions are identified:
            i. Areas below 10°S
            ii. Areas above 10°S

Table 8: Time-area substitution scheme used to assign samples to nominal catches strata with less than 30 swordfish lengths measured (note that only the first five steps and the last are shown)

Step	*Lat*	*Long*	*Qtr*	*Description*
1	0	0	-0.25	Length frequency data from the same area and previous quarter are used for substitution, if any
2	0	0	0.25	Length frequency data from the same area and following quarter are used for substitution, if any
3	0	-20	0	Length frequency data from the first area to the West and same quarter are used for substitution, if any
4	0	20	0	Length frequency data from the first area to the East and same quarter are used for substitution, if any
5	0	-20	-0.25	Length frequency data from the first area to the West and previous quarter are used for substitution, if any
764	0	120	1.00	Length frequency data from the area 120 degrees to the East and following year are used for substitution, if any

Note that the latitude and longitude defined above for industrial PS and those from the 10*20 grids for other fisheries are used

[5] Note that the substitution scheme is based on changes in time and/or space (latitude and/or longitude). The areas assigned are used for the substitution.

The sizes of the specimens of yellowfin tuna and bigeye tuna seem to vary markedly depending on the latitude. The substitution scheme is therefore applied independently to each area (i.e. Length frequency data from areas below 10ºS are not used for strata in the North and *vice versa*). **These regions are used for all species, including swordfish. The size data available for the swordfish need to be analyzed in order to assess if the sizes of swordfish vary significantly depending on the area or time fished.**

The substitution process is based on changes in time (quarter) and/or space (latitude and/or longitude). An example of the first substitution steps is shown in **Table 8** (previous page).

ii. No length frequency data are available for the same fleet and gear: Information from other fleet/s is used. The length frequency data available from other fleets that are presumed to operate the same areas and/or use the same fishing techniques are used for substitution. The same substitution scheme in time and area is applied in each case. Three levels of aggregation are established. The complete substitution tables for each species are shown in **Appendix V**. **Table 9** below shows an example of the substitution scheme:

Table 9: Nominal catches strata and alternative fleets from which length frequency samples are used in the case that less than 30 lengths of swordfish are available for the NC strata concerned (example)

Catch Strata			*Level Aggregation 1*		*Level Aggregation 2*		*Level Aggregation 3*	
Species	*Gear*	*Fleet*	*Gear Ag1*	*Fleet Ag1*	*Gear Ag2*	*Fleet Ag2*	*Gear Ag3*	*Fleet Ag3*
SWO	LL	IND	LL	AG3	LL	AG2	LL	AG1
SWO	LL	IRN	LL	AG2	LL	AG2	LL	AG1
SWO	LL	JPN	LL	AG1	LL	AG1	LL	AG1
SWO	LL	KOR	LL	AG1	LL	AG1	LL	AG1
SWO	LL	NEI-DFRZ	LL	AG3	LL	AG2	LL	AG1
SWO	LL	PHL	LL	AG3	LL	AG2	LL	AG1
SWO	LL	SUN	LL	AG2	LL	AG2	LL	AG1
SWO	LL	SYC	LL	AG3	LL	AG2	LL	AG1
SWO	LL	THA	LL	AG1	LL	AG1	LL	AG1
SWO	LL	TWN	LL	AG3	LL	AG2	LL	AG1

For example, if no samples of swordfish are recorded for the longline fishery of South Korea in the NC stratum concerned (or the sample is made up of less than 30 specimens) the samples available for South Korea and/or Japan and/or Thailand are combined. The time-area substitution scheme referred to in the previous section applies also in this case.
If no samples are available for the above fleets the second level of aggregation is used and the third level is used in the case that no samples are found.

b. No length frequency data are available within the year before or after the quarter concerned:

i. Length frequency data are available for the same fleet in other years: The samples for the three years that are closest to the year concerned are used. Only the samples from the 15 years before or after the year concerned are used.

ii. No length frequency data are available for the same fleet in other years or they are very far in time (more than 15 years ahead or behind the year concerned). The available length data for other fleets are used. The information from the fleets and gears specified in **Appendix V** and the above substitution scheme (b.i.) apply in this case.

c. No Length frequency data are available for the gear concerned in the 15 years before or after the year concerned:

i. Length frequency data are available for the same fleet and gear anytime at all: all available samples are used (i.e. the accumulated length frequency for the whole period is used).

ii. No length frequency data are available for the same fleet and gear anytime at all: The available length data for other fleets are used. The information from the fleets and gears specified in **Appendix V** and the above substitution scheme (c.i.) apply in this case.

The average weights estimated from the samples (by using the equation in **Table 6**) are used to estimate the number of specimens or the weight for each stratum in the CAS table:

- Longline fisheries: The catches are usually recorded in numbers. The average weights estimated from the sample are multiplied by the numbers of fish recorded (from the NC table) to obtain the weights per stratum. This method is also used for fisheries other than longline for which only numbers of fish are recorded.
- Other fisheries: The catches are usually recorded in weight. The average weights estimated from the sample are divided by the weight recorded (from the NC table) to obtain the numbers per stratum. This method is also used for longline fisheries for which only the weights are recorded.

The resulting weights are accumulated per fleet, gear, year, species and IOTC Area. The factor resulting from dividing the total catches estimated for the species (nominal catches) and those issuing from the CAS table is used to estimate total weight, total number of fish and number of fish per length class for each stratum in the CAS table (i.e. the numbers of swordfish by length class for each stratum are scaled up/down so as the total number of fish for the stratum matches the number of fish estimated in the NC)

Estimating total catches by year, quarter, assessment fishery and assessment area ($\mathbf{NC_{INPUT}}$)

The catches and numbers of fish in the NC table were weighted by using the method covered in the previous section.
The catches in the resulting NC table are then aggregated as follows:

i. Allocation of assessment fishery: Each Fleet-gear stratum in the NC table was assigned to the corresponding assessment fishery. Details on the fisheries that were assigned to each fleet-gear length frequency stratum can be found in **Appendix III**. The fisheries that are used for the assessment of swordfish are presented in **Table 3** (page3).
ii. Allocation of assessment area: The catches in the NC table were aggregated by assessment area. The areas used for the assessment are shown on **Figure 2** (page 3). The catches of swordfish from areas outside the four assessment areas were assigned to the closest area, as indicated through the arrows on **Figure 2.**

The following process was used to allocate the existing samples by area:

a. Allocation of catches for selected fisheries to specific assessment areas: The catches of swordfish estimated for some selected fisheries were fully assigned to specific assessment areas on the assumption that the majority of the catches from those fisheries came from the area assigned. This is thought to be the case with the majority of the artisanal fisheries having catches of swordfish and with a limited number of industrial fisheries. Details on the areas that were assigned to each fleet-gear catch stratum can be found in **Appendix II**.
b. Allocation of catches for other fisheries: All other catches in the NC table were assigned to the corresponding assessment areas, i.e. the catches recorded under each 5 square area were assigned to the assessment area containing that 5^0 square area. The catches estimated for 5^o squares outside the assessment areas were assigned to the closest assessment area, as indicated through the arrows on **Figure 2**.

iii. Aggregation of catches by year, quarter, assessment area, and assessment fishery: The above catches were aggregated by year, quarter, assessment area, and assessment fishery. An example of the Input Table containing the Total Catches can be found in **Appendix I**.

Assigning samples by year, quarter, assessment fishery and assessment area ($\mathbf{FL_{INPUT}}$)

The length frequency data in standard format (page 5) were used to derive the samples to be used for the assessments of swordfish.
The following process was followed to create the table $\mathbf{FL_{INPUT}}$:

i. Scaling raised length frequency data down to sample numbers: The length frequency data in the IOTC database do not represent sample numbers in all cases as some countries report length frequency data that has been raised in various ways (e.g. to the catches in the stratum covered through sampling, to the total catches estimated for the country, etc.). The sample numbers were used in these cases to scale down the reported length frequency data, i.e. the number of specimens recorded under each length class was multiplied by the number obtained by dividing the total number of specimens sampled (all lengths combined) by the total number of specimens in the raised length frequency (all lengths combined).
ii. Allocation of assessment area: The existing samples were aggregated by assessment area. The following process was used to allocate the existing samples by area:
   a. Allocation of the samples available for selected fisheries to specific assessment areas: The samples available for some selected fisheries were fully assigned to specific assessment areas on the assumption that the majority of the specimens sampled on those fisheries came from the area assigned. This is thought to be the case with the majority of artisanal fisheries for which there is size data available and with a limited number of industrial fisheries. Details on the areas that were assigned to each fleet-gear size frequency stratum can be found in **Appendix II.**
   b. Allocation of the samples available for other fisheries:
      a. Allocation of specimens recorded under areas that fall within a single assessment area: all specimens from samples recorded under areas that fell within one of the areas used for the assessment (**Figure 2**) were assigned to the corresponding assessment area.
      b. Allocation of specimens recorded under areas overlapping two or more assessment areas: all specimens from samples recorded under areas that overlapped two or more assessment areas were assigned proportionally by assessment area using the proportion that the catches in each area made out of the total catches in all overlapping areas.
iii. Time period allocation: The available length frequency samples were assigned by quarter in the same way as indicated in iii.a. and iii.b. (page 6)
iv. Allocation of assessment fishery: Each Fleet-gear stratum in the length frequency data table was assigned to the corresponding assessment fishery (**Appendix III**).

The resulting data were aggregated to obtain the number of swordfish specimens sampled by standard length interval (3cm), year, quarter, assessment fishery, and assessment area. An example of the Input Table containing the samples of swordfish can be found in **Appendix I**.

Assigning Catch-at-Size by year, quarter, assessment fishery and assessment area (**CAS_{INPUT}**)

Catch-at-Size data are estimated for each fleet-gear(fishing mode)-year-quarter strata. The following process was followed to create the table **CAS_{INPUT}**:

i. Allocation of assessment area: CAS were aggregated by assessment area. The following process was used to allocate CAS by area:
   a. Allocation of the CAS for selected fisheries to specific assessment areas: The CAS for some selected fisheries were fully assigned to specific assessment areas on the assumption that the majority of the specimens sampled on those fisheries came from the area assigned. This is thought to be the case with the majority of artisanal fisheries for which there is size data available and with a limited number of industrial fisheries. Details on the areas that were assigned to each fleet-gear size frequency stratum can be found in **Appendix II.**
   b. Allocation of the CAS for other fisheries:
      a. Allocation of specimens recorded under estimation areas that fall within a single assessment area: CAS recorded under estimation areas that fell within one of the areas used for the assessment (**Figure 2**) were assigned to the corresponding assessment area.
      b. Allocation of specimens recorded under estimation areas overlapping two or more assessment areas: CAS recorded under estimation areas that overlapped two or more assessment areas were assigned proportionally by assessment area using the proportion that the catches in each area made out of the total catches in all overlapping areas.
ii. Allocation of assessment fishery: Each Fleet-gear stratum in the length frequency data table was assigned to the corresponding assessment fishery (**Appendix III**).

The resulting data were aggregated to obtain the total number of swordfish specimens caught by standard length interval (3cm), year, quarter, assessment fishery, and assessment area. An example of the Input Table containing CAS of swordfish can be found in **Appendix I**.

Estimating Catch-at-Age (**CAA_{INPUT}**)

The catches-at-age (CAA) for the swordfish were estimated from the available catches-at-size (CAS_{INPUT}).
CAA was estimated using a VB model and swordfish data from the Indian Ocean (Young, J., and A. Drake. 2004[6]):

$$L(t) = L_{\infty}\left(1 - e^{-K[t-t_0]}\right)$$

Where:

Species	Sex	L_{∞}	t_0	k
SWO	Female	323.4	-3.413	0.08148
	Male	260.47	-3.3808	0.1096

An Age-Length key, both sexes combined, was derived from above (Sheng-Ping Wang, *pers.comm.*) and used to convert the numbers of specimens estimated by length (CAS) into age (CAA). The referred Age-Length key is shown in **Appendix VI**.
The resulting Catches-at-Age were aggregated by Age class (0-15+), year, quarter and assessment fishery. An example of the Input Table containing the CAA table to be used in the ASPM stock assessments can be found in **Appendix I**.

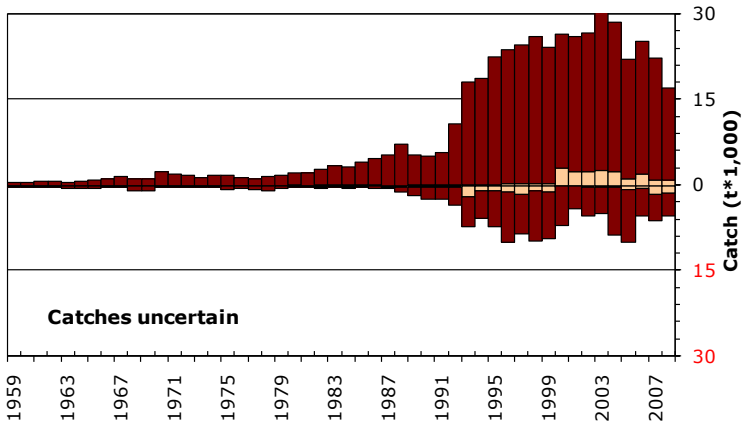
[6] Young, J., and A. Drake. 2004. Age and growth of broadbill swordfish (Xiphias gladius) from Australian waters. Final report for project 2001/014, Fisheries Research Development Corporation, Canberra, Australia. 121 pp.

Results

Total catch by year

The total catches by assessment fishery and year estimated from the process for the swordfish are shown in **Appendix VII**. The catches estimates for 2007-08 are likely to change in the future, especially for some longline fleets that have reported preliminary catches to the Secretariat (Taiwan,China, Japan, Indonesia).
The swordfish is caught by industrial longliners, gillnets and, to a lesser extent, other artisanal or recreational fisheries. **Figure 5** shows the status of the catches of swordfish for 1959-2008.

Figure 5: Uncertainty of annual catch estimates for swordfish (SWO). The amount of the catch below the zero-line has been categorized as uncertain by the Secretariat. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets (1959-2008).



The catches of swordfish estimated are thought to be more uncertain since the mid-90's due to:

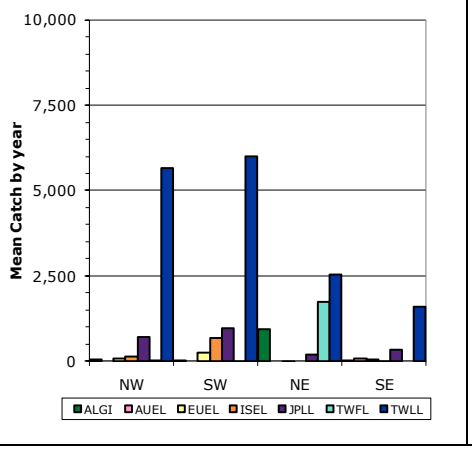
- The catches of swordfish estimated for the fresh tuna longline fishery of Indonesia may have been underestimated in recent years. The majority of the catches of albacore and swordfish are stored and unloaded frozen and are seldom sampled in port. The Secretariat has received information from the export office in Indonesia and some importing markets which confirms that the catches of albacore have been greatly underestimated since the early 2000's. The new catches of albacore estimated by the Secretariat by using the new data represent as much as an eight-fold increase compared to previous catches recorded for the Indonesian fleet. Although no market data for swordfish are available at the moment, the Secretariat believes that the catches of swordfish recorded for the Indonesian fresh-tuna longline fleet are highly uncertain and may need to be revised as more data are collected. The catches recorded for the swordfish may be short of as much as 4,000 tons in recent years.
- To date, Iran has not reported catches of swordfish for its gillnet fishery. In recent years, many Iranian vessels have moved on to the high seas, using drifting gillnets to catch tunas and other species. The fleet is operating in the Northwest Indian Ocean (Figure 2), which is the area that has recorded the highest catches of swordfish in recent years. The Secretariat has little information on the activities of this fleet which has made it impossible to estimate catches of swordfish for the fleet. The catches of swordfish may represent as much as 5,000 tons in recent years.
- Poor reports from IOTC CPC's: The catches of swordfish recorded for the longline fleet of India were estimated by the IOTC Secretariat as India as never reported catches for its commercial longline fleet (around 100 vessels operating since 2004). Malaysia and Indonesia do not report catches for longliners under their flags that are not based in these countries. The catches for this component were estimated by the IOTC Secretariat.
- Non-reporting industrial longliners (NEI): The amount of non-reporting longliners targeting swordfish was high during the 1990's and early 2000's due to the shift of vessels from the Atlantic Ocean to the Indian Ocean. The catches of these vessels were estimated by the Secretariat by using information from various sources.
- Conflicting catch reports: The catches for South Korean longliners reported as nominal catches and catches and effort are conflicting, with higher catches recorded in the CE table for some years. The Secretariat revised the catches of swordfish for the Korean fleet for the period concerned.

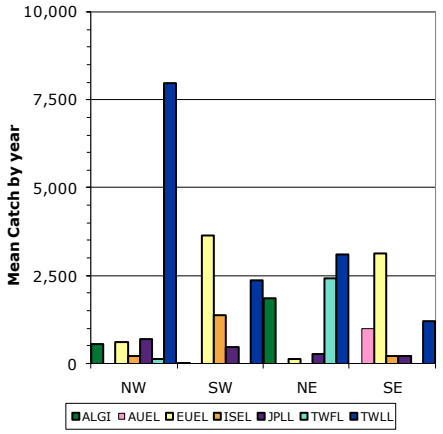
Catches per quarter, fishery and assessment area and Catch-at-Size data (CAS_{INPUT})

The precision of the estimates is likely to vary depending on the quality of the catches (see the above section), the availability of catches in time and space and the amount (coverage) and representativeness of the samples available for swordfish.

Completeness of time-area catches: **Figures 6** and **7** show mean catches (tonnes) of swordfish by year estimated by assessment area and fishery for 1989-98 and 1999-08.

Figures 6-7: Average catches of swordfish by year estimated by Area and Fishery for the entire time series (1989-1998; left) and in current years (1999-2008; right)





The amount of catches that are available in time and space *versus* the total catches of swordfish estimated are shown in the **Figures 8 to 12**. The amount of catches for which time-area information is available has been changing over time. Three different periods can be identified:

- 1954-1966: The total catches of swordfish estimated for this period are low (below 1,500t). Between 20-30% of the total catches estimated come from fisheries for which time-area catches are either not available or poor quality. No time-area catches are available from the Taiwanese longline fleet for this period.
- 1967-1988: The total catches of swordfish estimated for this period range between 1,500t and 3,000t (1967-84) and between 4,000t and 8,000t for subsequent years (1985-88). Time-area information is available from the majority of the fleets with catches of swordfish estimated for this period, representing more than 95% of the total catches of swordfish estimated in most years.
- 1989-2008: The total catches of swordfish estimated for this period range between 6,000t and 35,000t. Between 25-30% of the total catches estimated come from fisheries for which time-area catches are either not available or poor quality. No time-area catches are available for:

Figure 8: Total catches of swordfish (SWO) available in time and space *versus* the total catches recorded for the species (all gears combined).

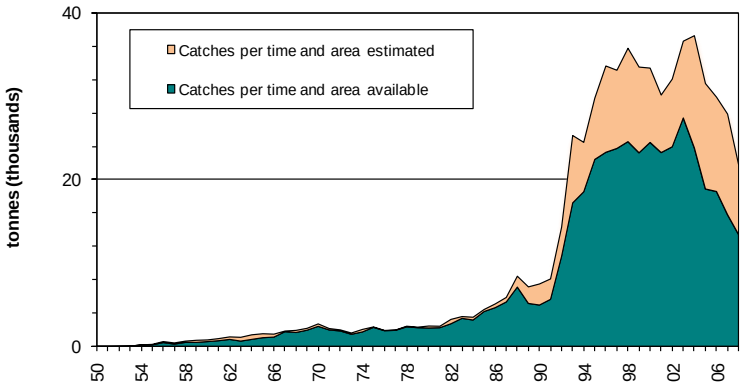


Figure 9: Total catches of swordfish (SWO) available in time and space *versus* the total catches recorded for the species (longline Taiwan,China and assimilated fleets)

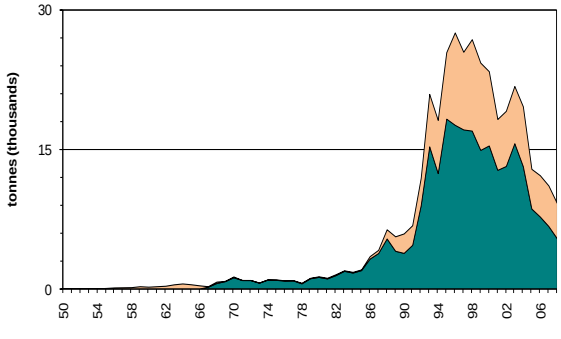


Figure 10: Total catches of swordfish (SWO) available in time and space *versus* the total catches recorded for the species (longline fisheries for swordfish)

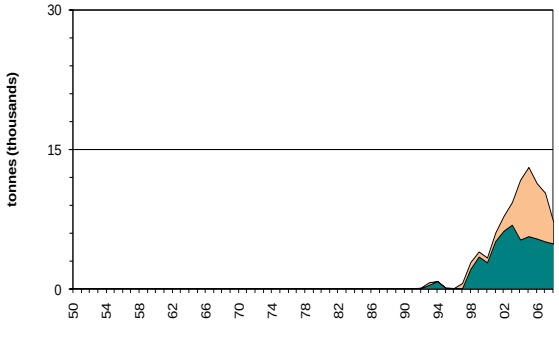


Figure 11: Total catches of swordfish (SWO) available in time and space *versus* the total catches recorded for the species (longline Japan and assimilated fleets)

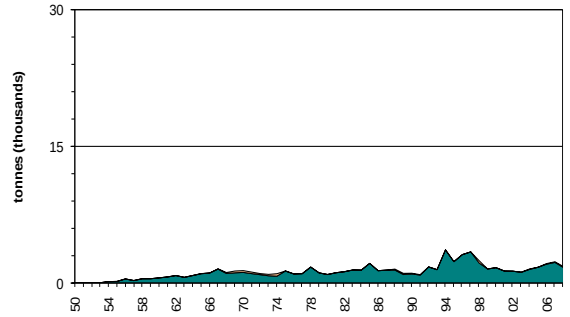
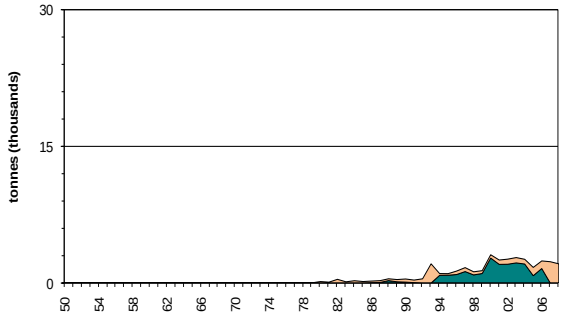


Figure 12: Total catches of swordfish (SWO) available in time and space *versus* the total catches recorded for the species (artisanal fisheries).



- Fresh-tuna longliners from Taiwan,China (1984-2006) and Indonesia (1973-2008)
- Longliners from India (2004-08) and various other fleets, in particular longline fleets targeting swordfish (NEI) (2000's)

The lack of data or poor quality data existing for some periods and/or fisheries may compromises the quality of the catches that are estimated for the assessments of swordfish, as this information is used to break the catches in the nominal catches by quarter and assessment area.

Completeness of length data: The total numbers of swordfish caught and sampling coverage estimated for 1950-2008, by year and fishery, are shown in **Figures 13 to 17**. The coverage was estimated as the amount (expressed as a percentage) that the total amount of swordfish (in number) from strata having at least 30 specimens of swordfish sampled made out of the total amount of swordfish (numbers) estimated for that year, and fishery. The amount of catches for which length frequency samples are available has been changing over time. Four different periods can be identified:

- 1950-1969: The total catches of swordfish estimated for this period are low (below 1,500t in most years). No size frequency data are available for this period. The majority of the catches of swordfish for the period come from the Japanese and Taiwanese longine fleets.
- 1970-1979: The total catches of swordfish estimated for this period range between 2,000t and 3,000t. Size frequency data is only available for the longline fishery of Japan. Between 3-16% of the total catches estimated (in number) are covered through sampling. Samples are not available for the longline fishery of Taiwan,China during this period.
- 1980-1991: The total catches of swordfish estimated for this period range from 2,000t to 8,000t. Samples are available for the majority of the strata having catches of swordfish, representing 55-90% of the total catches of swordfish estimated (in number), depending on the year.
- 1992-2008: The total catches of swordfish estimated for this period range between 14,000t and 35,000t. Between 40-60% of the total catches estimated (in number) come from fisheries for which samples are available. The main problems are:
  - Poor sample sizes and time-are coverage for the longline fishery of Japan
  - Lack of length samples for the longline fisheries of India, Oman and various other flags (NEI)
  - Lack of samples or poor quality samples from gillnet and other artisanal fisheries.

The lack of length samples or low sampling coverage for some periods and/or fisheries may compromise the assessments that use length frequency samples or CAA data derived from estimates of CAS, adding uncertainty to the results.

The numbers of fish measured per strata in relation with the total numbers caught by several longline fisheries, mainly Japan, has been declining in recent years. The representativeness of the samples might be also compromised for this reason.

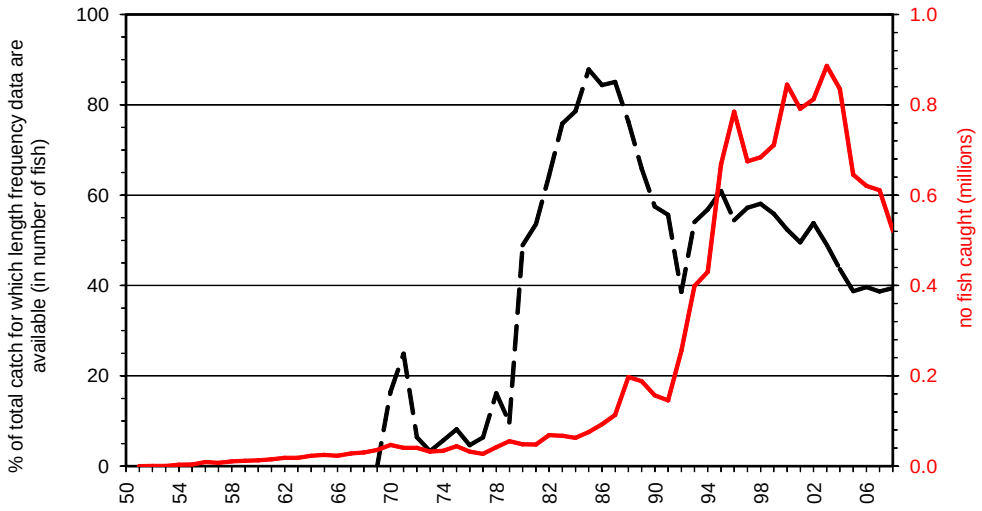
Figures 18-29 show length frequency distributions for original samples (blue line) and catches at size estimated (orange bars) for the entire catch-series, all fisheries combined, and by decade and type of fishery (only periods from which samples are available are shown).

Figures 30-31 show the catches at size estimated for periods in which no samples were available, for the longline fisheries of Taiwan,China and Japan.

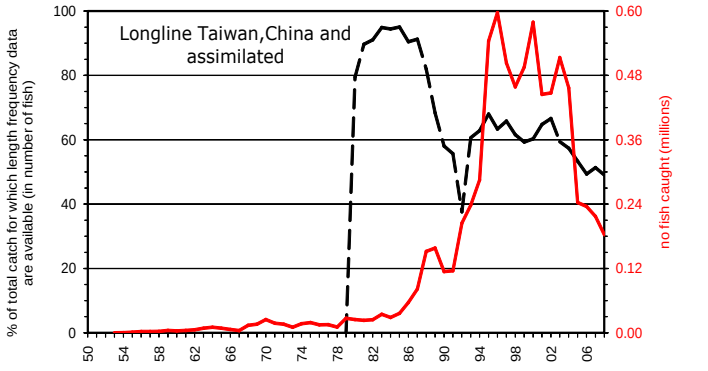
The length frequency distributions for some fisheries and periods differ significantly from the length frequency samples; this is especially the case with:

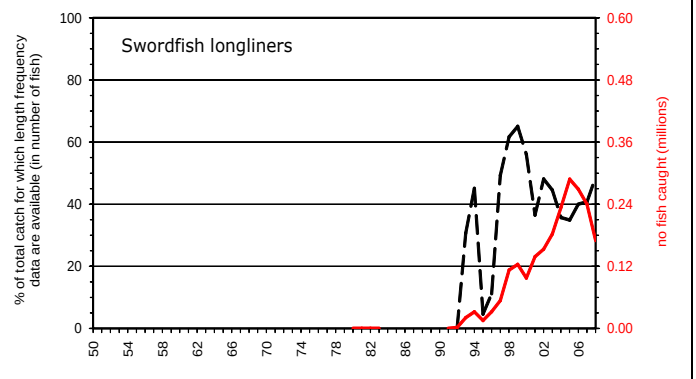
- Longline fishery of Japan and other assimilated fleets for the period 2000-08
- Longline fishery of Taiwan,China and other assimilated fleets for the period 2000-08
- Artisanal fisheries over the entire period

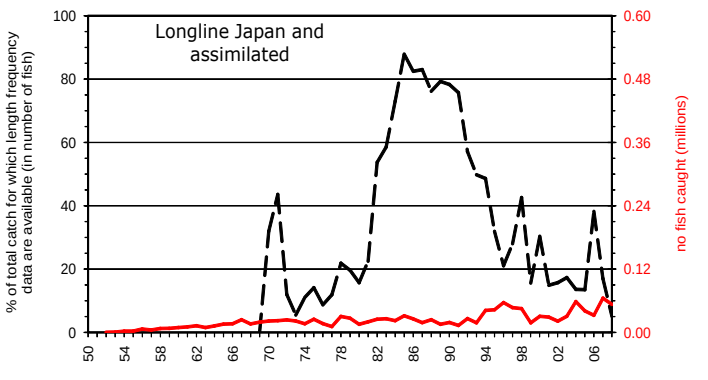
Figure 13: Total numbers of swordfish (SWO) estimated (continuous line) and proportion (in number of fish) estimated (broken line) for strata having length frequency data (all gears combined), by year (1950-2008).



Figures 14-17: Total numbers of swordfish (SWO) estimated (continuous line) and proportion (in number of fish) estimated (broken line) for strata having length frequency data, by year (1950-2008): longline Taiwan,China and assimilated fleets (top left), longline fisheries for swordfish (top right), longline Japan and assimilated fleets (bottom left), and artisanal fisheries (bottom right)







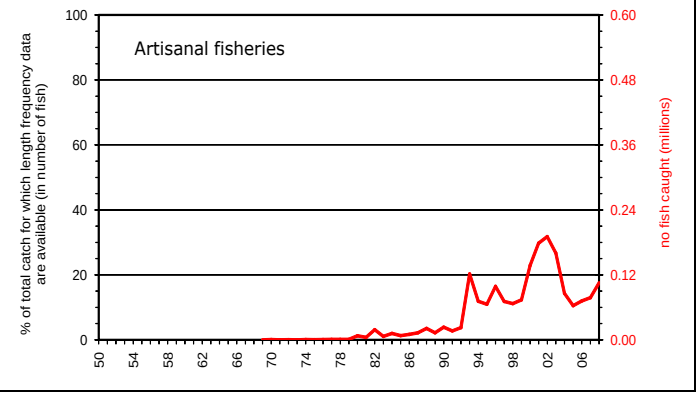
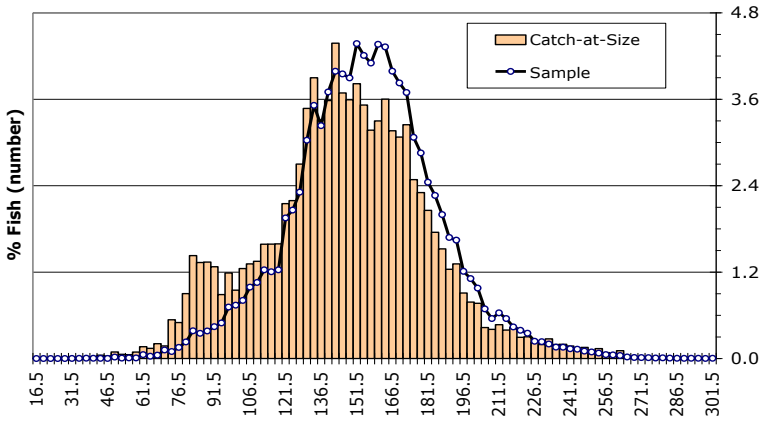
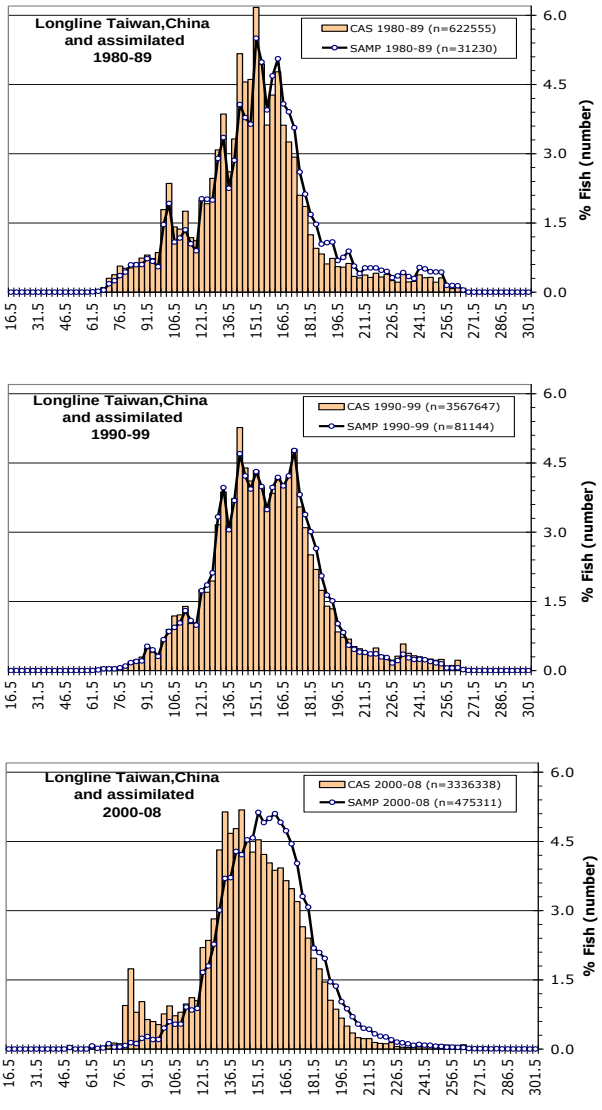
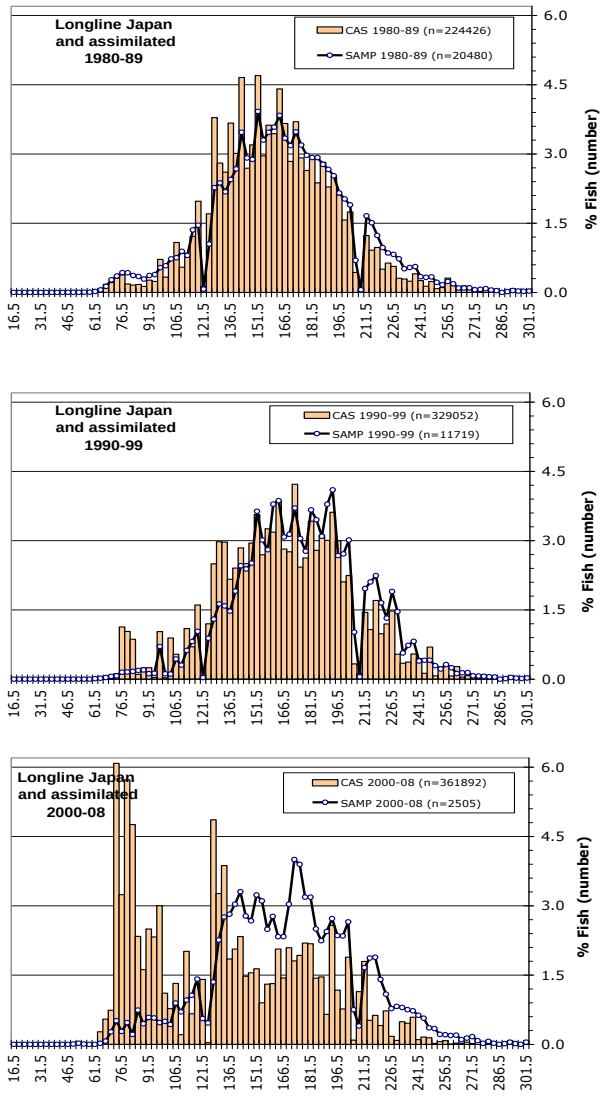


Figure 18: Proportion that the numbers of swordfish sampled (blue line)/estimated (CAS; orange bars) under each 3cm length class (in number) make out of the total numbers of swordfish sampled/ estimated over the entire time-area series (1950-2008), all fisheries combined.



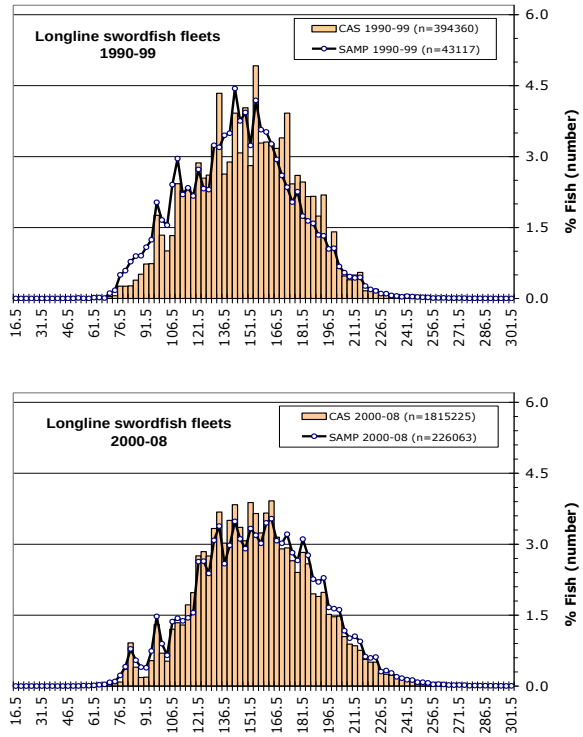
Figures 19-24: Proportion that the numbers of swordfish sampled (blue line)/estimated (CAS; orange bars) under each 3cm length class (in number) make out of the total numbers of swordfish sampled/estimated over different periods, by fishery

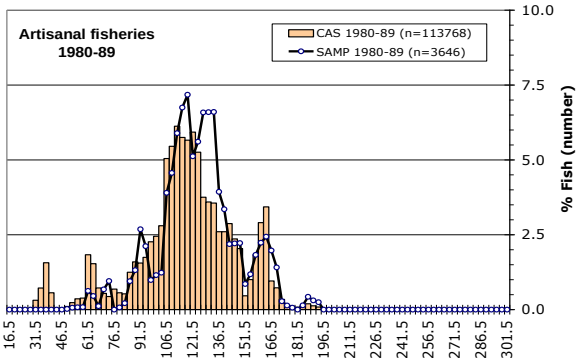


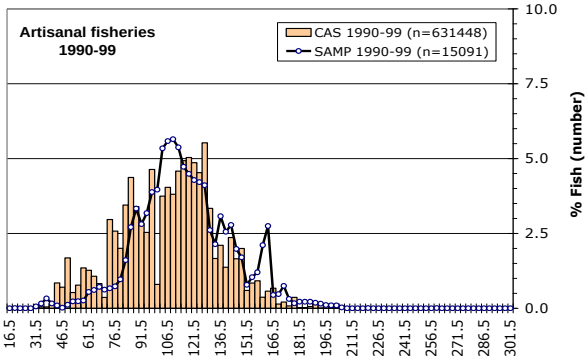


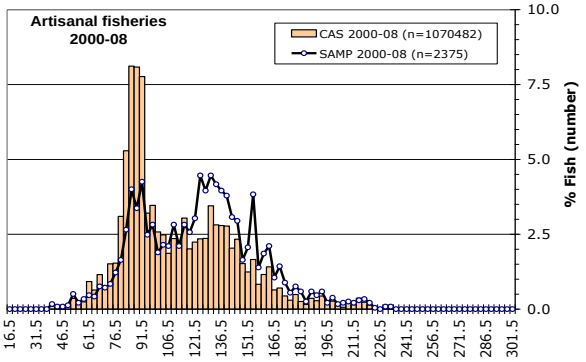
Figures 25-29 (cont.): Proportion that the numbers of swordfish sampled (blue line)/estimated (CAS; orange bars) under each 3cm

length class (in number) make out of the total numbers of swordfish sampled/estimated over different periods, by fishery

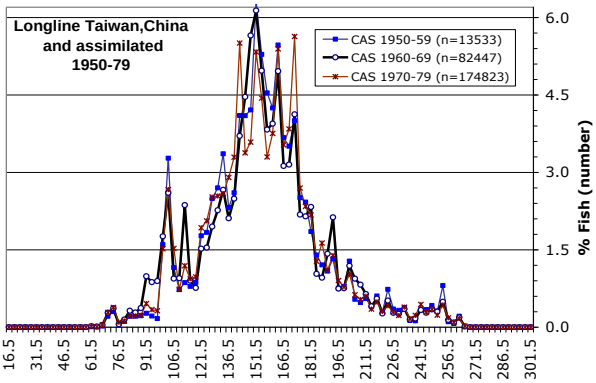


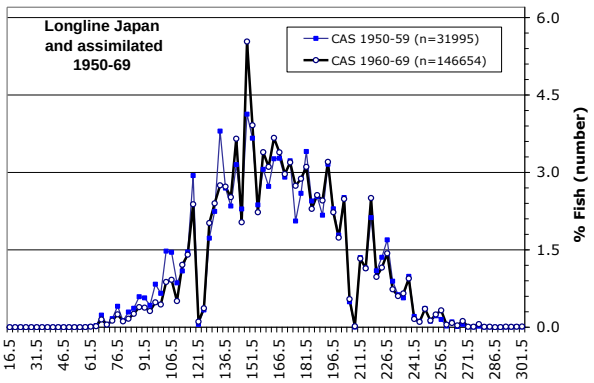






Figures 30-31: Proportion that the numbers of swordfish estimated (CAS) under each 3cm length class (in number) make out of the total numbers of swordfish estimated over periods in which no samples were available, by fishery

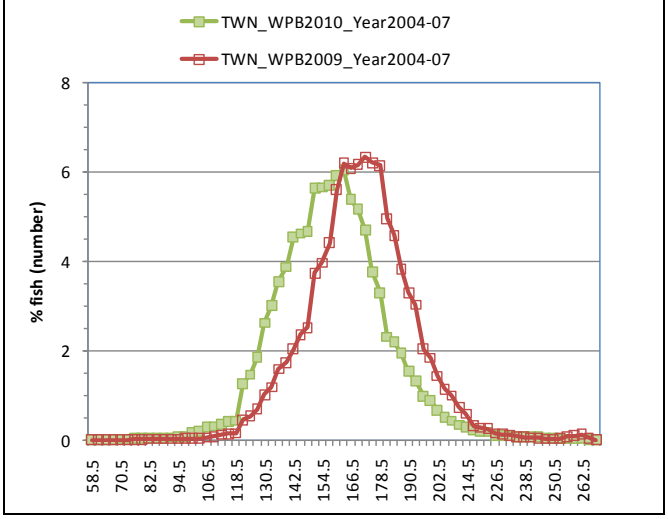




The following reasons may explain the referred discrepancies:

- Review of length frequency dataset for 2004-08 for the Taiwanese longline fishery: Taiwan,China provided new length frequency data for its fishery for 2004-08. It was indicated that the previous dataset for the swordfish contained a significant number of specimens of striped marlin that had been mislabelled as swordfish. In addition, the new dataset contains new lengths of swordfish as derived from logbooks made available since the last WPB. The new length distributions reported are compared with those used in previous WPB meetings in Figure 32.

Figure 32: Length frequency distributions of swordfish for the period 2004-07 (represented as the % of fish (in number) by length class) used by the WPB in 2009 (green line) and new dataset provided for the WPB in 2010 (blue line).



- No weighting applied in the aggregation of samples under the strata selected for the assessment: No weighting procedure is used in the allocation of the individual samples available to the fishery, area and period concerned. The samples available for each assessment area, fishery, year and quarter are aggregated by summing up all the specimens sampled by length class from all the fleets and gears concerned and over the entire area and period. However, the sample weights derived from the samples may represent various levels of coverage, depending on the strata involved.
- Catches at size derived from samples containing a low number of specimens: The shape of some CAS distributions tends to suggest that the number of specimens from which the catches at size were derived is too low. The minimum number of specimens needed for a sample to be raised to total catches, 30 specimens, is the same for all species. This number may be insufficient for species having a wide length frequency distribution, as it is the case with the swordfish.
- The samples available are not representative of the fishery concerned: In recent years the majority of the samples available for the longline fishery of Japan come from training vessels (Figure 33). The representativeness of the samples collected on training vessels is uncertain, as these vessels do not necessarily operate the same areas or use the same fishing techniques as the commercial vessels from Japan and tend to catch swordfish of larger length (Figure 34).

Figure 33: Number of swordfish lengths measured onboard Japanese training vessels *versus* the number of swordfish weights reported by Japanese commercial vessels (1970-2008)

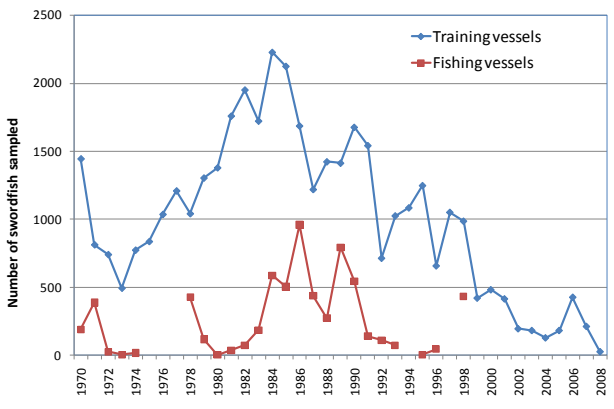
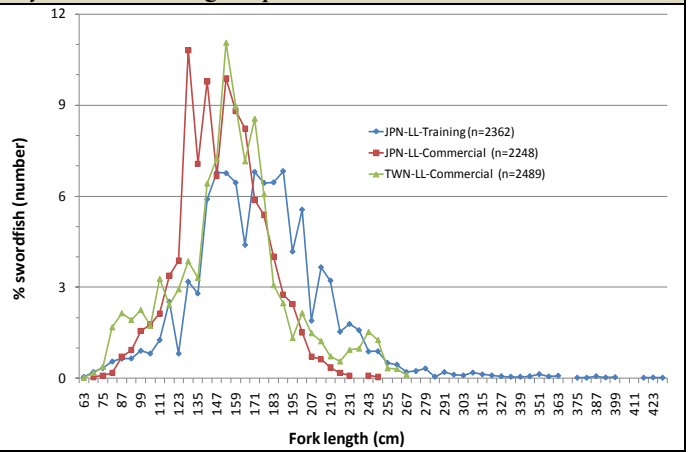


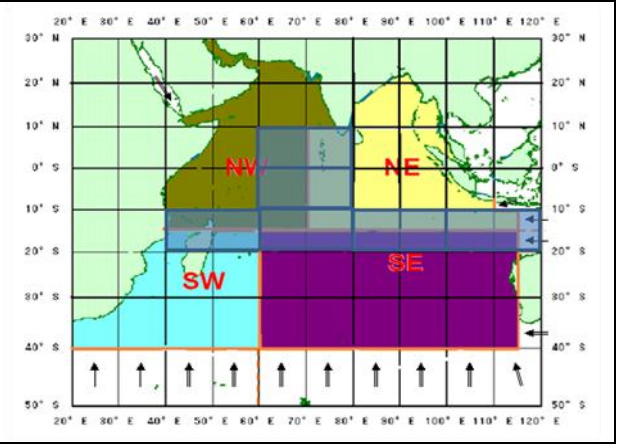
Figure 34: Length frequency distributions of swordfish from samples taken onboard commercial longline vessels from Japan and Taiwan,China and samples from Japanese training vessels. The length frequency distributions represent the proportion (%) of fish (in number) by length class (6cm) over the period 1984-90. Only the strata having samples from the three fisheries were used.



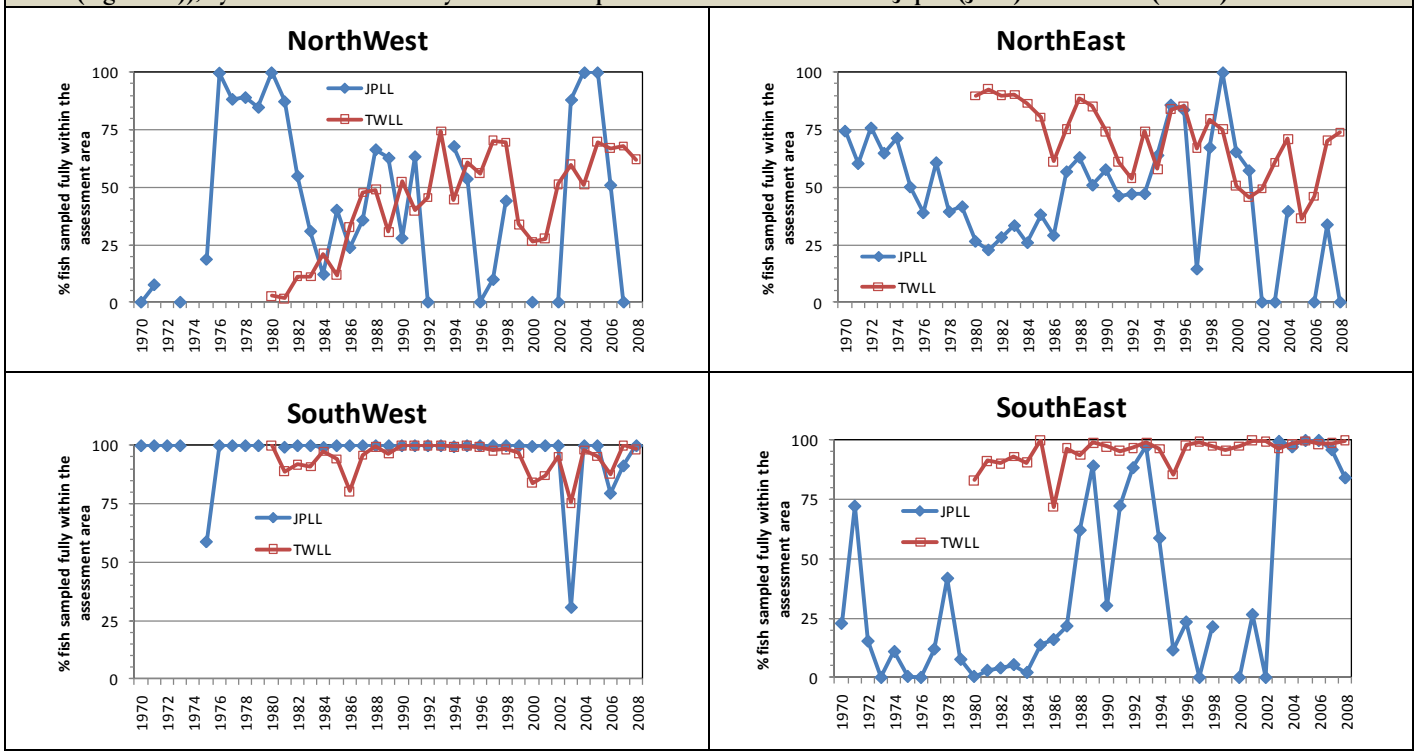
It is important to note that some length classes (120-123cm; 207-210cm) are poorly represented in the length frequency distributions derived from both the samples and the CAS for Japan over the entire time series. These gaps originate in the conversion (deterministic) from measurements of swordfish from the eye to the fork of the tail into lower-jaw fork length, as the measurements reported by Japan for the swordfish refer mostly to eye-fork length measurements aggregated into 5cm length classes.

In addition, the Secretariat had to assign samples/CAS from areas overlapping assessment areas to the assessment areas concerned (Figures 36-39). As much as 40% of the swordfish sampled on the fisheries of Japan and Taiwan,China come from 10 latitude by 20 degrees longitude grids that overlap two or more assessment areas (shown in Figure 35).

Figure 35: 10-20 areas (grey shading) that overlap two or more of the assessment areas used for Indian Ocean swordfish



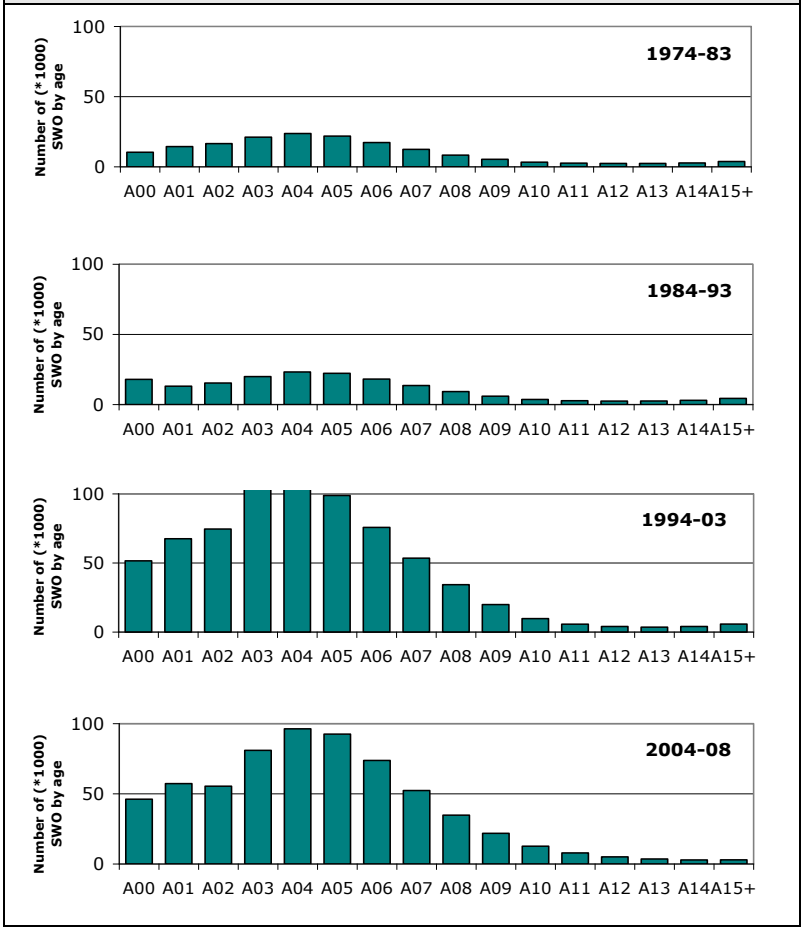
Figures 36-39: Proportion that the number of swordfish from samples that fall fully within an assessment area makes out of the total number of swordfish allocated to the area (following the disaggregation of samples from areas overlapping two or more assessment areas (Figure 34)), by assessment area and year. Data are presented for the fisheries of Japan (JPLL) and Taiwan (TWLL).



Catch-at-age tables (CAA)

The total numbers of swordfish by age class estimated for different periods are shown in **Figure 40**; the numbers of swordfish obtained by age class, fishery, area and year are shown in **Appendix VIII**. The estimates of catches-at-age are likely to be affected by a lack of data for some fisheries and periods (see the previous sections).

Figure 40: Average numbers of swordfish (SWO) by age class (classes 15 and above are represented as 15+) and fishery estimated for 1974-83, 1984-93, 1994-03 and 2004-08



APPENDIX I
Examples of Input Tables

a. NC_{INPUT}

CID	TimeStamp	Species	Fishery	Year	Quarter	Area	TotalMT	TotalNO	SampledMT	SampledNO
3	21-Jun-10	SWO	ALGI	2004	1	NE	1101	34248	2	68

Where:

Field	Description
CID	Unique row identifier (for each stratum Species-Fishery-Year-Quarter-Area)
TimeStamp	The date the table was created
Species	IOTC Species code
Fishery	Assessment Fishery (Appendix III, page 24)
Year	Year
Quarter	Quarter [January-March(1), April-June(2), July-September(3), October-December(4)]
Area	Assessment Area (Figure 4, page 8)
TotalMT	Total catch estimated in metric tons
Totalno	Total catch estimated in number of fish
Sampledno	Catch sampled in number of fish
SampledMT	Catch sampled in metric tons

b. LF_{INPUT}

CID	TimeStamp	Species	Fishery	Year	Quarter	Area	TotalMT	Totalno	Sampledno	FirstClassLow	SizeInterval	L001		L150
3	21-Jun-10	SWO	ALGI	2004	1	NE	1101	34248	68	15	3	0		0

Where:

Field	Description
CID	Unique row identifier (for each stratum Species-Fishery-Year-Quarter-Area)
TimeStamp	The date the table was created
Species	IOTC Species code
Fishery	Assessment Fishery (Appendix III, page 24)
Year	Year
Quarter	Quarter [January-March(1), April-June(2), July-September(3), October-December(4)]
Area	Assessment Area (Figure 4, page 8)
TotalMT	Total catch estimated in metric tons
Totalno	Total catch estimated in number of fish
Sampledno	Catch sampled in number of fish $\left(\sum_{L001}^{L150}\right)$
FirstClassLow	Length corresponding to the first size class bin, in cm (15cm for swordfish)
SizeInterval	Interval (cm) between consecutive length classes (3cm)
L001…L150	Number of fish measured for length class 15cm(inclusive) to 18cm(exclusive), 18-21, 21-24, etc.

Examples of Input Tables (cont.)

a. CAS INPUT

CID	TimeStamp	Species	Fishery	Year	Quarter	Area	TotalMT	Totalno	Sampledno	FirstClassLow	SizeInterval	L001		L150
1	21-Jun-10	SWO	ALGI	2003	4	NW	115	2913	0	15	3	0		0

Where:

Field	Description
CID	Unique row identifier (for each stratum Species-Fishery-Year-Quarter-Area)
TimeStamp	The date the table was created
Species	IOTC Species code
Fishery	Assessment Fishery (Appendix III, page 24)
Year	Year
Quarter	Quarter [January-March(1), April-June(2), July-September(3), October-December(4)]
Area	Assessment Area (Figure 4, page 8)
TotalMT	Total catch estimated in metric tons
Totalno	Total catch estimated in number of fish $\left(\sum_{L001}^{L150}\right)$
Sampledno	Catch sampled in number of fish
FirstClassLow	Length corresponding to the first size class bin, in cm (15cm for swordfish)
SizeInterval	Interval (cm) between consecutive length classes (3cm)
L001…L150	Total number of fish caught estimated for length class 15cm(inclusive) to 18cm(exclusive), 18-21, 21-24, etc.

b. CAA INPUT

METHOD	CID	TimeStamp	Species	Fishery	Year	Quarter	Area	Totalno	A00	..	A15+
DMSP2	**3**	**23-Jun-10**	**SWO**	**ALGI**	**2004**	**1**	**NE**	**34248**	**5011**	**..**	**18**

Where:

Field	Description
Method	Method used to estimate catch at age (Sheng-Ping Wang, pers.com.)
CID	Unique row identifier (for each stratum Species-Fishery-Year-Quarter-Area)
TimeStamp	The date the table was created
Species	IOTC Species code
Fishery	Assessment Fishery (Appendix III, page 24)
Year	Year
Quarter	Quarter [January-March(1), April-June(2), July-September(3), October-December(4)]
Area	Assessment Area (Figure 4, page 8)
Tno	Total catch estimated in number of fish $\left(\sum_{A00}^{A15+}\right)$ (Note that the total numbers shown for each stratum refer to Nominal Catches and may differ from the values obtained by adding the specimens for all age classes due to rounding)
A00…A15+	Number of fish estimated for age class 0 (A00 i.e. fish between 0 and 1 year old) and age class 15+ (A15+ i.e. fish 15 or more year old)

APPENDIX II

Areas allocated to Fleet-Gear strata in the Catch-and-Effort and Size Frequency datasets for the assessments of Swordfish

Fleet	Gear	Assessment Area
AUS	ELL	SE
AUS	HAND	SE
FRA-REU	ELL	SW
FRA-REU	TROL	SW
FRAT	ELL	NW
FRAT	HAND	NW
FRAT	TROL	NW
IDN	FLL	NE
IDN	GILL	NE
IDN	HAND	NE
KEN	TROL	NW
LKA	FLL	NE
LKA	G/L	NE
LKA	GILL	NE
LKA	HAND	NE
LKA	TROL	NE
MDG	ELL	SW
MDV	FLL	NE
MUS	ELL	SW
NEI-DFRZ	TLL	SW
NEI-IDN	FLL	NE
OMN	FLL	NW
PAK	GILL	NW
SYC	ELL	NW
SYC	HAND	NW
THA	FLL	NE
TZA	BB	NW
TZA	OTHER	NW
TZA	PSS	NW
TZA	TROL	NW
ZAF	LL	SW
ZAF	SLL	SW
ZAF	SPOR	SW
ZAF	TLL	SW

APPENDIX III

Fisheries allocated to Fleet-Gear strata in the Nominal Catch, Catch-and-Effort and Size Frequency datasets for the assessments of Swordfish

Artisanal fisheries other than hand line and recreational fisheries

Fishery	Fleet	Gear
ALGI	FRA-REU	TROL
ALGI	FRAT	TROL
ALGI	IDN	GILL
ALGI	IND	GILL
ALGI	IND	LIFT
ALGI	IND	TRAW
ALGI	IND	TROL
ALGI	KEN	TROL
ALGI	LKA	G/L
ALGI	LKA	GILL
ALGI	LKA	HATR
ALGI	LKA	TROL
ALGI	LKA	UNCL
ALGI	PAK	GILL
ALGI	TWN	GILL
ALGI	TZA	BB
ALGI	TZA	OTHER
ALGI	TZA	PSS
ALGI	TZA	TROL

Longline fisheries targeting Swordfish

Fishery	Fleet	Gear
AUEL	AUS	ELL

Fishery	Fleet	Gear
EUEL	ESP	ELL
EUEL	ESP	LLEX
EUEL	GBR	ELL
EUEL	GBR	LL
EUEL	GIN	ELL
EUEL	KEN	ELL
EUEL	NEI-DFRZ	ELL
EUEL	PRT	ELL
EUEL	PRT	LL
EUEL	PRT	LLD
EUEL	PRT	SLL
EUEL	SEN	ELL
EUEL	TZA	ELL
EUEL	TZA	LL
EUEL	URY	ELL
EUEL	ZAF	LL
EUEL	ZAF	SLL
EUEL	ZAF	TLL

Fishery	Fleet	Gear
ISEL	FRA-REU	ELL
ISEL	FRAT	ELL
ISEL	MDG	ELL
ISEL	MUS	ELL
ISEL	MUS	LL
ISEL	SYC	ELL

Other longline fisheries, and handline and recreational fisheries

Fishery	Fleet	Gear
JPLL	JPN	LL
JPLL	KOR	LL
JPLL	OMN	LL
JPLL	THA	LL

Fishery	Fleet	Gear
TWFL	AUS	HAND
TWFL	BLZ	FLL
TWFL	CHN	FLL
TWFL	FRAT	HAND
TWFL	IDN	FLL
TWFL	IDN	HAND
TWFL	IND	FLL
TWFL	IND	HAND
TWFL	LKA	FLL
TWFL	LKA	HAND
TWFL	LKA	LL
TWFL	MDV	FLL
TWFL	MYS	FLL
TWFL	NEI-ICE	FLL
TWFL	NEI-IDN	FLL
TWFL	OMN	FLL
TWFL	SYC	HAND
TWFL	THA	FLL
TWFL	TWN	FLL
TWFL	ZAF	SPOR

Fishery	Fleet	Gear
TWLL	BLZ	LL
TWLL	CHN	LL
TWLL	IDN	LL
TWLL	IND	LL
TWLL	IND	LLEX
TWLL	IRN	LL
TWLL	MDG	LL
TWLL	NEI-DFRZ	LL
TWLL	NEI-DFRZ	TLL
TWLL	PHL	LL
TWLL	SUN	LL
TWLL	SYC	LL
TWLL	TWN	LL

APPENDIX IV

Industrial fleets for which no catches per time and area are available and alternate fleets whose data were used for substitution

Fleet Code	Fleet Name	Gear Code	IOTC Area	Year From	Year To	Alternate Fleet Code	Alternate Gear Code
BLZ	Belize	FLL	IO_Eastern	2001	2008	TWN	LL
BLZ	Belize	FLL	IO_Western	2001	2008	TWN	LL
BLZ	Belize	PS	IO_Eastern	2001	2002	ESP	PS
BLZ	Belize	PS	IO_Western	2001	2002	ESP	PS
GBR	United Kingdom	ELL	IO_Eastern	2005	2008	ESP	ELL
GBR	United Kingdom	ELL	IO_Western	2005	2008	ESP	ELL
GBR	United Kingdom	LL	IO_Western	2004	2004	ESP	ELL
IDN	Indonesia	LL	IO_Eastern	2001	2008	TWN	LL
IRN	Iran, Islamic Republic	LL	IO_Western	1976	2002	TWN	LL
IRN	Iran, Islamic Republic	PS	IO_Eastern	1996	1998	ESP	PS
IRN	Iran, Islamic Republic	PS	IO_Western	1992	2008	ESP	PS
KEN	Kenya	ELL	IO_Eastern	2005	2008	ESP	ELL
KEN	Kenya	ELL	IO_Western	1980	2008	TWN	LL
MDG	Madagascar	ELL	IO_Western	2002	2008	ESP	ELL
MDG	Madagascar	LL	IO_Eastern	2005	2005	TWN	LL
MDG	Madagascar	LL	IO_Western	2005	2005	TWN	LL
MUS	Mauritius	LL	IO_Western	1978	1981	TWN	LL
MYS	Malaysia	FLL	IO_Western	2006	2006	MUS	LL
MYS	Malaysia	PS	IO_Eastern	2008	2008	JPN	PS
NEI-DFRZ	NEI-Deep-freezing	ELL	IO_Eastern	2002	2008	ESP	ELL
NEI-DFRZ	NEI-Deep-freezing	ELL	IO_Western	2002	2007	ESP	ELL
NEI-DFRZ	NEI-Deep-freezing	LL	IO_Eastern	1985	2008	TWN	LL
NEI-DFRZ	NEI-Deep-freezing	LL	IO_Western	1985	2008	TWN	LL
NEI-DFRZ	NEI-Deep-freezing	TLL	IO_Western	2004	2004	TWN	LL
PAK	Pakistan	LL	IO_Western	1991	2000	TWN	LL
PRT	Portugal	ELL	IO_Eastern	2004	2008	ESP	ELL
PRT	Portugal	ELL	IO_Western	2004	2008	ESP	ELL
PRT	Portugal	LL	IO_Western	1998	2003	ESP	ELL
PRT	Portugal	SLL	IO_Western	2004	2004	ESP	ELL
SEN	Senegal	ELL	IO_Western	2003	2004	ESP	ELL
SUN	Soviet Union	LL	IO_Eastern	1977	1985	TWN	LL
SUN	Soviet Union	LL	IO_Western	1964	1989	TWN	LL
SUN	Soviet Union	PS	IO_Eastern	1985	1985	NEI-OTH	PS
TZA	Tanzania	ELL	IO_Western	2005	2008	ESP	ELL

APPENDIX V

Swordfish: Substitution scheme used for the estimation of Catches-at-Size (Fleet-Gear)

Gear	Fleet	GearA	FleetA	GearA2	FleetA2	GearA3	FleetA3
BB	TZA	BB	AG1	BB	AG1	SURF	AG1
ELL	AUS	ELL	AG1	ELL	AG1	LL	AG1
ELL	ESP	ELL	AG2	ELL	AG1	LL	AG1
ELL	FRA-REU	ELL	AG3	ELL	AG1	LL	AG1
ELL	FRAT	ELL	AG3	ELL	AG1	LL	AG1
ELL	GBR	ELL	AG2	ELL	AG1	LL	AG1
ELL	GIN	ELL	AG2	ELL	AG1	LL	AG1
ELL	KEN	ELL	AG2	ELL	AG1	LL	AG1
ELL	MDG	ELL	AG3	ELL	AG1	LL	AG1
ELL	MUS	ELL	AG3	ELL	AG1	LL	AG1
ELL	NEI-DFRZ	ELL	AG2	ELL	AG1	LL	AG1
ELL	PRT	ELL	AG2	ELL	AG1	LL	AG1
ELL	SEN	ELL	AG2	ELL	AG1	LL	AG1
ELL	SYC	ELL	AG4	ELL	AG1	LL	AG1
ELL	TZA	ELL	AG2	ELL	AG1	LL	AG1
ELL	URY	ELL	AG2	ELL	AG1	LL	AG1
FLL	BLZ	FLL	AG1	FLL	AG1	LL	AG1
FLL	CHN	FLL	AG3	FLL	AG1	LL	AG1
FLL	IDN	FLL	AG3	FLL	AG1	LL	AG1
FLL	IND	FLL	AG2	FLL	AG1	LL	AG1
FLL	LKA	FLL	AG3	FLL	AG1	LL	AG1
FLL	MDV	FLL	AG2	FLL	AG1	LL	AG1
FLL	MYS	FLL	AG3	FLL	AG1	LL	AG1
FLL	NEI-ICE	FLL	AG3	FLL	AG1	LL	AG1
FLL	NEI-IDN	FLL	AG3	FLL	AG1	LL	AG1
FLL	OMN	FLL	AG2	FLL	AG1	LL	AG1
FLL	THA	FLL	AG3	FLL	AG1	LL	AG1
FLL	TWN	FLL	AG3	FLL	AG1	LL	AG1
G/L	LKA	GILL	AG1	GILL	AG1	GILL	AG1
GILL	IDN	GILL	AG2	GILL	AG2	GILL	AG1
GILL	IND	GILL	AG1	GILL	AG1	GILL	AG1
GILL	LKA	GILL	AG1	GILL	AG1	GILL	AG1
GILL	PAK	GILL	AG1	GILL	AG1	GILL	AG1
GILL	TWN	GILL	AG3	GILL	AG1	GILL	AG1
HAND	AUS	HAND	AG1	HAND	AG1	LL	AG1
HAND	FRAT	HAND	AG2	HAND	AG1	LL	AG1
HAND	IDN	HAND	AG5	HAND	AG1	LL	AG1
HAND	IND	HAND	AG3	HAND	AG1	LL	AG1
HAND	LKA	HAND	AG3	HAND	AG1	LL	AG1
HAND	SYC	HAND	AG4	HAND	AG1	LL	AG1
HATR	LKA	HAND	AG3	HAND	AG1	LL	AG1

Gear	Fleet	GearA	FleetA	GearA2	FleetA2	GearA3	FleetA3
LIFT	IND	LIFT	AG1	LIFT	AG1	GILL	AG1
LL	BLZ	LL	AG1	LL	AG1	LL	AG1
LL	CHN	LL	AG1	LL	AG1	LL	AG1
LL	GBR	ELL	AG2	ELL	AG1	LL	AG1
LL	IDN	LL	AG1	LL	AG1	LL	AG1
LL	IND	LL	AG2	LL	AG1	LL	AG1
LL	IRN	LL	AG2	LL	AG1	LL	AG1
LL	JPN	LL	AG3	LL	AG2	LL	AG2
LL	KOR	LL	AG4	LL	AG2	LL	AG2
LL	LKA	LL	AG2	LL	AG2	LL	AG2
LL	MDG	LL	AG5	LL	AG2	LL	AG2
LL	MUS	ELL	AG2	ELL	AG1	LL	AG1
LL	NEI-DFRZ	LL	AG1	LL	AG1	LL	AG1
LL	OMN	LL	AG2	LL	AG1	LL	AG1
LL	PHL	LL	AG1	LL	AG1	LL	AG1
LL	PRT	ELL	AG2	ELL	AG1	LL	AG1
LL	SUN	LL	AG1	LL	AG1	LL	AG1
LL	SYC	LL	AG1	LL	AG1	LL	AG1
LL	THA	LL	AG3	LL	AG2	LL	AG2
LL	TWN	LL	AG1	LL	AG1	LL	AG1
LL	TZA	LL	AG1	LL	AG1	LL	AG1
LL	ZAF	ELL	AG3	ELL	AG1	LL	AG1
LLD	PRT	ELL	AG2	ELL	AG1	LL	AG1
LLEX	ESP	ELL	AG2	ELL	AG1	LL	AG1
LLEX	IND	LL	AG2	LL	AG1	LL	AG1
OTHER	TZA	OTHER	AG1	OTHER	AG1	GILL	AG1
PSS	TZA	BB	AG1	BB	AG1	SURF	AG1
SLL	PRT	ELL	AG2	ELL	AG1	LL	AG1
SLL	ZAF	ELL	AG3	ELL	AG1	LL	AG1
SPOR	ZAF	HAND	AG2	HAND	AG1	LL	AG1
TLL	NEI-DFRZ	ELL	AG3	ELL	AG1	LL	AG1
TLL	ZAF	ELL	AG3	ELL	AG1	LL	AG1
TRAW	IND	OTHER	AG1	OTHER	AG1	GILL	AG1
TROL	FRA-REU	TROL	AG1	TROL	AG1	SURF	AG1
TROL	FRAT	TROL	AG1	TROL	AG1	SURF	AG1
TROL	IND	TROL	AG3	TROL	AG1	SURF	AG1
TROL	KEN	TROL	AG2	TROL	AG1	SURF	AG1
TROL	LKA	TROL	AG3	TROL	AG1	SURF	AG1
TROL	TZA	TROL	AG2	TROL	AG1	SURF	AG1
UNCL	LKA	SURF	AG1	SURF	AG1	SURF	AG1

APPENDIX VI

Swordfish: Length-age key used to convert CAS into CAA

FL_Low	FL_High	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15+
	<30	**1.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	33	**0.99**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33	36	**0.99**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
36	39	**0.99**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
39	42	**0.98**	**0.02**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42	45	**0.97**	**0.03**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	48	**0.96**	**0.04**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	51	**0.94**	**0.06**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
51	54	**0.92**	**0.08**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	57	**0.90**	**0.10**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
57	60	**0.87**	**0.13**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	63	**0.83**	**0.17**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	66	**0.79**	**0.21**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	69	**0.75**	**0.25**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
69	72	**0.70**	**0.30**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	75	**0.65**	**0.35**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75	78	**0.60**	**0.39**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	81	**0.55**	**0.43**	**0.02**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
81	84	**0.50**	**0.47**	**0.03**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84	87	**0.45**	**0.50**	**0.05**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87	90	**0.40**	**0.52**	**0.08**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	93	**0.35**	**0.52**	**0.12**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
93	96	**0.31**	**0.51**	**0.17**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
96	99	**0.26**	**0.48**	**0.24**	**0.02**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
99	102	**0.22**	**0.45**	**0.30**	**0.03**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
102	105	**0.18**	**0.40**	**0.36**	**0.05**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
105	108	**0.15**	**0.35**	**0.42**	**0.08**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
108	111	**0.13**	**0.30**	**0.45**	**0.11**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
111	114	**0.10**	**0.25**	**0.47**	**0.16**	**0.02**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
114	117	**0.08**	**0.21**	**0.47**	**0.21**	**0.03**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
117	120	**0.07**	**0.17**	**0.44**	**0.27**	**0.04**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
120	123	**0.06**	**0.14**	**0.40**	**0.33**	**0.07**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
123	126	**0.04**	**0.11**	**0.35**	**0.38**	**0.11**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
126	129	**0.04**	**0.08**	**0.28**	**0.42**	**0.16**	**0.02**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
129	132	**0.03**	**0.06**	**0.22**	**0.44**	**0.21**	**0.04**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
132	135	**0.02**	**0.04**	**0.16**	**0.43**	**0.28**	**0.06**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135	138	**0.02**	**0.03**	**0.11**	**0.40**	**0.34**	**0.09**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
138	141	**0.01**	**0.02**	**0.07**	**0.35**	**0.39**	**0.14**	**0.02**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
141	144	**0.01**	**0.01**	**0.04**	**0.29**	**0.42**	**0.19**	**0.04**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
144	147	**0.01**	**0.01**	**0.02**	**0.22**	**0.42**	**0.25**	**0.06**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147	150	0.00	**0.01**	**0.01**	**0.16**	**0.41**	**0.31**	**0.09**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
150	153	0.00	0.00	**0.01**	**0.11**	**0.36**	**0.35**	**0.13**	**0.03**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
153	156	0.00	0.00	0.00	**0.07**	**0.31**	**0.38**	**0.18**	**0.04**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
156	159	0.00	0.00	0.00	**0.04**	**0.25**	**0.39**	**0.23**	**0.07**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
159	162	0.00	0.00	0.00	**0.03**	**0.19**	**0.38**	**0.28**	**0.10**	**0.02**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
162	165	0.00	0.00	0.00	**0.01**	**0.13**	**0.35**	**0.32**	**0.14**	**0.04**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00
165	168	0.00	0.00	0.00	**0.01**	**0.09**	**0.30**	**0.35**	**0.19**	**0.06**	**0.01**	0.00	0.00	0.00	0.00	0.00	0.00
168	171	0.00	0.00	0.00	0.00	**0.06**	**0.24**	**0.36**	**0.23**	**0.09**	**0.02**	0.00	0.00	0.00	0.00	0.00	0.00
171	174	0.00	0.00	0.00	0.00	**0.03**	**0.19**	**0.34**	**0.28**	**0.12**	**0.03**	0.00	0.00	0.00	0.00	0.00	0.00
174	177	0.00	0.00	0.00	0.00	**0.02**	**0.14**	**0.31**	**0.31**	**0.16**	**0.05**	0.00	0.00	0.00	0.00	0.00	0.00
177	180	0.00	0.00	0.00	0.00	**0.01**	**0.09**	**0.27**	**0.33**	**0.21**	**0.08**	**0.01**	0.00	0.00	0.00	0.00	0.00
180	183	0.00	0.00	0.00	0.00	**0.01**	**0.06**	**0.22**	**0.33**	**0.25**	**0.12**	**0.01**	0.00	0.00	0.00	0.00	0.00
183	186	0.00	0.00	0.00	0.00	0.00	**0.04**	**0.17**	**0.31**	**0.29**	**0.16**	**0.03**	0.00	0.00	0.00	0.00	0.00
186	189	0.00	0.00	0.00	0.00	0.00	**0.02**	**0.12**	**0.28**	**0.31**	**0.20**	**0.05**	**0.01**	0.00	0.00	0.00	0.00
189	192	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.08**	**0.23**	**0.32**	**0.24**	**0.09**	**0.02**	0.00	0.00	0.00	0.00
192	195	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.05**	**0.18**	**0.30**	**0.27**	**0.14**	**0.04**	**0.01**	0.00	0.00	0.00
195	198	0.00	0.00	0.00	0.00	0.00	0.00	**0.03**	**0.14**	**0.26**	**0.28**	**0.20**	**0.07**	**0.02**	0.00	0.00	0.00
198	201	0.00	0.00	0.00	0.00	0.00	0.00	**0.02**	**0.09**	**0.22**	**0.28**	**0.25**	**0.10**	**0.03**	**0.01**	0.00	0.00
201	204	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.06**	**0.17**	**0.26**	**0.29**	**0.15**	**0.05**	**0.01**	0.00	0.00
204	207	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.04**	**0.12**	**0.22**	**0.30**	**0.20**	**0.08**	**0.03**	**0.01**	0.00
207	210	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.02**	**0.09**	**0.18**	**0.29**	**0.24**	**0.12**	**0.05**	**0.01**	0.00
210	213	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.06**	**0.14**	**0.26**	**0.26**	**0.16**	**0.07**	**0.03**	**0.01**
213	216	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.04**	**0.11**	**0.20**	**0.26**	**0.20**	**0.11**	**0.05**	**0.02**
216	219	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.02**	**0.07**	**0.16**	**0.25**	**0.24**	**0.15**	**0.07**	**0.03**
219	222	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.05**	**0.11**	**0.22**	**0.25**	**0.19**	**0.11**	**0.05**
222	225	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.03**	**0.07**	**0.18**	**0.25**	**0.23**	**0.15**	**0.08**
225	228	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.02**	**0.04**	**0.13**	**0.23**	**0.25**	**0.20**	**0.12**
228	231	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.02**	**0.09**	**0.19**	**0.27**	**0.24**	**0.17**
231	234	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.01**	**0.06**	**0.16**	**0.25**	**0.28**	**0.23**

FL_Low	FL_High	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15+
234	237	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.04**	**0.12**	**0.23**	**0.30**	**0.30**
237	240	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.02**	**0.09**	**0.21**	**0.32**	**0.36**
240	243	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.06**	**0.18**	**0.32**	**0.42**
243	246	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.04**	**0.15**	**0.32**	**0.48**
246	249	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.03**	**0.12**	**0.30**	**0.55**
249	252	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.02**	**0.10**	**0.29**	**0.59**
252	255	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.08**	**0.27**	**0.64**
255	258	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.06**	**0.24**	**0.69**
258	261	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.05**	**0.22**	**0.72**
261	264	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.03**	**0.20**	**0.77**
264	267	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.03**	**0.18**	**0.79**
267	270	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.02**	**0.16**	**0.82**
270	273	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.14**	**0.85**
273	276	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.12**	**0.87**
276	279	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.11**	**0.88**
279	282	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.10**	**0.89**
282	285	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.08**	**0.92**
285	288	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.07**	**0.93**
288	291	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.06**	**0.94**
291	294	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.05**	**0.95**
294	297	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.05**	**0.95**
297	300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.04**	**0.96**
>=300		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.00**

APPENDIX VII

Swordfish: Total catches estimated, in number of fish and weight, by fishery (1950-08)

Swordfish catches by fishery in number of fish

Year	TWLL	TWFL	JPLL	AUEL	EUEL	ISEL	ALGI	Total
1950		0					8	8
1951		0					17	17
1952		0	151				19	170
1953		0	459				22	481
1954	376	0	2,446				23	2,845
1955	1,194	0	2,452				24	3,670
1956	2,429	0	6,545				25	9,000
1957	2,422	0	4,627				39	7,088
1958	2,682	0	7,562				26	10,271
1959	4,342	0	7,618				26	11,987
1960	3,568	0	9,146				28	12,743
1961	4,470	0	10,457				27	14,954
1962	5,610	0	12,771				39	18,420
1963	8,699	0	9,420				49	18,168
1964	10,322	0	12,321				62	22,705
1965	8,551	0	15,907				68	24,527
1966	6,333	1	16,384				86	22,804
1967	4,044	1	24,001				87	28,132
1968	14,098	1	16,094				86	30,278
1969	16,241	1	19,322				81	35,644
1970	24,730	1	21,593				418	46,742
1971	17,898	1	22,398				58	40,355
1972	16,203	1	23,928				302	40,433
1973	10,456	1	21,511				66	32,034
1974	16,726	325	16,310				492	33,854
1975	18,512	497	24,911				361	44,280
1976	14,411	376	16,725				513	32,025
1977	14,701	377	11,114				758	26,949
1978	10,116	521	30,232				750	41,619
1979	26,255	871	26,914				940	54,979
1980	23,571	1,263	15,593		126		7,559	48,112
1981	21,726	1,477	20,045		169		4,496	47,913
1982	22,651	1,657	25,171		197		18,844	68,519
1983	33,775	830	25,849		315		6,218	66,987
1984	27,435	1,127	22,316				11,778	62,656
1985	35,367	1,055	31,513				7,687	75,621
1986	56,220	562	25,578				10,007	92,367
1987	80,599	1,095	18,550				13,110	113,354
1988	147,906	3,849	24,260				21,125	197,139
1989	122,196	35,854	15,530	1,559			12,944	188,084
1990	90,673	23,533	18,830				23,529	156,564
1991	95,878	19,682	13,326	41		37	16,593	145,557
1992	180,962	23,657	26,223	474		1,390	22,625	255,330
1993	214,577	23,266	18,258	6,464	5,349	9,087	121,694	398,694
1994	256,448	28,667	41,872	1,897	16,689	13,320	71,345	430,238
1995	509,340	34,997	42,898	1,063	292	14,112	65,617	668,319
1996	548,094	48,815	56,728	397	447	31,323	98,668	784,473
1997	449,356	53,612	46,978	949	11,581	41,317	70,911	674,704
1998	421,394	37,369	45,263	8,028	41,187	63,748	66,743	683,732
1999	450,828	44,649	18,288	22,476	45,152	55,936	73,723	711,053
2000	526,250	52,911	30,754	32,295	23,861	41,329	137,381	844,780
2001	391,457	53,216	29,174	44,704	58,506	35,435	178,542	791,035
2002	389,111	58,061	21,275	19,109	113,321	20,612	190,720	812,209
2003	410,813	102,326	30,618	29,023	127,949	25,042	160,214	885,984
2004	387,420	69,219	58,389	6,974	194,542	32,794	85,680	835,018
2005	189,380	53,676	40,901	4,768	251,831	41,782	62,996	645,333
2006	183,326	52,363	32,377		243,637	36,750	71,827	620,280
2007	171,612	45,335	64,952		205,686	45,295	77,882	610,761
2008	141,028	41,998	53,127	2,277	141,138	36,353	105,240	521,160

Swordfish catches by fishery in weight (tonnes)

Year	TWLL	TWFL	JPLL	AUEL	EUEL	ISEL	ALGI	Total
1950		0					0	0
1951		0					0	0
1952		0	10				0	10
1953		0	31				1	32
1954	19	0	162				1	182
1955	63	0	179				1	242
1956	119	0	460				1	579
1957	136	0	278				1	415
1958	150	0	482				1	633
1959	250	0	484				1	734
1960	200	0	577				1	778
1961	251	0	683				1	935
1962	301	0	839				1	1,141
1963	453	0	637				1	1,091
1964	548	0	843				1	1,392
1965	461	0	1,058				2	1,520
1966	345	0	1,125				2	1,471
1967	249	0	1,591				2	1,842
1968	744	0	1,178				2	1,924
1969	825	0	1,345				2	2,172
1970	1,302	0	1,390				9	2,701
1971	918	0	1,225				1	2,145
1972	916	0	1,060				7	1,983
1973	638	0	969				2	1,608
1974	963	17	1,047				11	2,039
1975	954	26	1,350				8	2,339
1976	867	20	1,016				12	1,915
1977	886	20	1,051				17	1,974
1978	592	27	1,788				17	2,425
1979	1,112	41	1,136				21	2,310
1980	1,257	62	954		8		168	2,449
1981	1,092	66	1,154		11		100	2,422
1982	1,452	90	1,269		14		418	3,243
1983	1,916	47	1,459		22		138	3,583
1984	1,735	62	1,444				261	3,503
1985	2,012	51	2,201				171	4,435
1986	3,460	35	1,384				222	5,100
1987	4,107	62	1,444				268	5,881
1988	6,217	175	1,562				479	8,433
1989	4,655	978	1,084	37			392	7,146
1990	4,669	1,275	1,100				455	7,499
1991	5,623	1,206	936	3		2	334	8,104
1992	10,428	1,516	1,802	32		65	475	14,319
1993	19,516	1,488	1,496	189	207	278	2,159	25,333
1994	16,088	2,104	3,714	115	694	729	1,065	24,508
1995	23,764	1,736	2,391	62	19	793	1,054	29,818
1996	25,326	2,304	3,180	22	29	1,474	1,347	33,682
1997	22,709	2,837	3,485	44	549	1,811	1,732	33,166
1998	24,676	2,226	2,501	337	1,892	2,918	1,263	35,814
1999	21,862	2,514	1,575	1,360	2,307	2,544	1,389	33,552
2000	21,483	1,965	1,727	1,798	1,212	2,066	3,179	33,431
2001	16,687	1,605	1,347	2,900	3,116	1,953	2,585	30,193
2002	16,886	2,285	1,327	1,343	6,442	1,141	2,683	32,107
2003	17,925	3,930	1,220	1,766	7,484	1,477	2,861	36,662
2004	15,883	3,775	1,580	370	11,319	1,726	2,667	37,320
2005	10,170	2,746	1,773	301	13,159	2,165	1,754	32,068
2006	9,779	2,445	2,177		11,851	1,777	2,483	30,513
2007	8,692	2,432	2,382		10,826	1,755	2,396	28,483
2008	7,044	2,160	1,846	142	7,500	1,486	2,157	22,335

Swordfish: Total catches estimated, in number of fish and weight, by area (1950-08)

Swordfish catches by area in number of fish					
Year	NW	SW	NE	SE	Total
1950	6		2		8
1951	6		11		17
1952	6		137	27	170
1953	10		390	81	481
1954	63	13	2,575	195	2,845
1955	1,310	201	2,085	73	3,670
1956	3,610	352	4,505	532	9,000
1957	2,057	343	4,262	426	7,088
1958	2,572	448	5,827	1,423	10,271
1959	3,672	1,181	4,357	2,778	11,987
1960	3,751	1,282	4,818	2,892	12,743
1961	3,998	2,179	5,666	3,112	14,954
1962	5,490	4,594	6,097	2,239	18,420
1963	4,589	3,642	6,449	3,488	18,168
1964	7,578	6,116	6,582	2,428	22,705
1965	7,768	3,329	9,230	4,199	24,527
1966	10,991	3,930	5,559	2,325	22,804
1967	9,976	4,376	10,068	3,712	28,132
1968	15,368	3,444	7,849	3,617	30,278
1969	16,017	6,096	11,714	1,817	35,644
1970	12,632	9,673	17,347	7,090	46,742
1971	15,672	5,942	11,856	6,884	40,355
1972	18,667	9,231	10,594	1,940	40,433
1973	7,776	14,780	5,981	3,497	32,034
1974	10,665	6,423	9,733	7,033	33,854
1975	13,169	5,611	20,213	5,287	44,280
1976	5,364	7,976	14,276	4,409	32,025
1977	7,025	5,329	11,311	3,284	26,949
1978	17,550	4,943	13,029	6,097	41,619
1979	14,026	12,469	22,054	6,430	54,979
1980	5,160	7,582	31,354	4,016	48,112
1981	9,899	7,286	25,270	5,458	47,913
1982	19,131	11,491	34,939	2,958	68,519
1983	16,995	8,737	36,297	4,958	66,987
1984	10,566	11,082	36,426	4,582	62,656
1985	17,368	11,678	39,895	6,681	75,621
1986	37,469	9,353	41,616	3,929	92,367
1987	36,521	8,409	56,811	11,613	113,354
1988	89,625	16,348	73,248	17,919	197,139
1989	49,306	8,036	113,763	16,979	188,084
1990	44,643	31,336	67,284	13,302	156,564
1991	70,444	18,763	49,101	7,248	145,557
1992	59,140	123,532	57,079	15,578	255,330
1993	60,546	152,431	164,650	21,067	398,694
1994	87,659	170,890	142,771	28,918	430,238
1995	140,241	331,180	151,455	45,443	668,319
1996	242,786	218,494	235,033	88,160	784,473
1997	287,986	126,485	187,072	73,161	674,704
1998	236,084	191,568	194,714	61,366	683,732
1999	171,263	179,545	284,999	75,245	711,053
2000	230,333	247,110	287,921	79,415	844,780
2001	215,208	140,570	306,911	128,345	791,035
2002	297,859	126,181	284,114	104,054	812,209
2003	355,902	61,546	324,625	143,910	885,984
2004	301,291	120,758	246,675	166,294	835,018
2005	215,610	190,757	137,843	101,122	645,333
2006	172,776	185,596	187,788	74,121	620,280
2007	202,323	162,565	138,153	107,721	610,761
2008	182,557	128,557	145,925	64,121	521,160

Swordfish catches by area in weight (tonnes)					
Year	NW	SW	NE	SE	Total
1950	0		0		0
1951	0		0		0
1952	0		8	2	10
1953	0		26	5	32
1954	4	1	165	12	182
1955	96	14	128	4	242
1956	257	20	268	33	579
1957	128	22	238	27	415
1958	158	25	350	100	633
1959	244	60	245	184	734
1960	252	67	274	184	778
1961	283	117	333	201	935
1962	336	318	338	149	1,141
1963	261	249	344	237	1,091
1964	438	403	380	171	1,392
1965	462	219	526	313	1,520
1966	712	255	334	170	1,471
1967	693	278	616	255	1,842
1968	976	231	457	261	1,924
1969	983	428	622	140	2,172
1970	723	562	1,003	414	2,701
1971	852	237	634	422	2,145
1972	811	479	565	128	1,983
1973	412	673	313	210	1,608
1974	586	453	545	454	2,039
1975	554	380	1,051	354	2,339
1976	424	482	714	295	1,915
1977	646	404	699	225	1,974
1978	996	358	703	369	2,425
1979	474	637	854	344	2,310
1980	299	501	1,374	275	2,449
1981	675	377	1,029	341	2,422
1982	985	660	1,374	224	3,243
1983	801	656	1,759	367	3,583
1984	504	906	1,762	330	3,503
1985	803	1,294	2,045	293	4,435
1986	2,061	609	2,290	140	5,100
1987	2,227	886	2,337	431	5,881
1988	4,189	995	2,572	677	8,433
1989	2,132	612	3,862	541	7,146
1990	2,129	1,721	2,968	681	7,499
1991	3,937	1,181	2,463	523	8,104
1992	3,119	7,538	2,694	968	14,319
1993	5,495	13,265	5,552	1,021	25,333
1994	4,835	11,941	5,888	1,845	24,508
1995	5,832	16,712	5,220	2,054	29,818
1996	11,959	9,491	7,868	4,364	33,682
1997	14,274	5,855	8,273	4,764	33,166
1998	12,452	10,363	9,244	3,754	35,814
1999	8,863	8,591	12,363	3,735	33,552
2000	9,133	10,670	8,724	4,903	33,431
2001	8,541	8,527	6,869	6,257	30,193
2002	12,849	7,121	6,527	5,611	32,107
2003	15,714	3,579	9,199	8,170	36,662
2004	11,846	6,538	9,194	9,742	37,320
2005	10,481	10,068	5,742	5,777	32,068
2006	9,062	9,553	7,696	4,202	30,513
2007	8,690	7,821	6,276	5,696	28,483
2008	6,865	6,426	5,310	3,733	22,335

APPENDIX VIII

Swordfish: Total numbers of fish estimated by age class and year

Swordfish total number of fish by age group																	
Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15+	Total
1950																	
1951		4	4														8
1952	4	11	13	17	17	19	19	15	12	9	7	6	5	4	3	2	163
1953	12	29	36	41	49	58	59	52	39	29	20	15	13	10	8	7	477
1954	116	177	190	263	342	355	320	272	213	155	104	85	76	64	55	55	2,842
1955	122	197	247	356	450	459	405	342	275	205	136	107	99	89	86	87	3,662
1956	282	475	608	911	1,167	1,156	1,003	842	676	494	323	242	219	207	196	192	8,993
1957	226	394	561	804	1,037	1,042	838	613	440	303	195	145	123	111	111	132	7,075
1958	340	540	765	1,139	1,414	1,386	1,158	910	691	497	338	267	230	198	183	205	10,261
1959	372	646	940	1,294	1,686	1,701	1,372	1,035	767	554	373	283	248	226	221	263	11,981
1960	419	728	1,000	1,348	1,788	1,775	1,427	1,098	833	603	407	317	272	237	232	267	12,751
1961	475	809	1,131	1,565	2,076	2,040	1,645	1,301	1,018	747	505	389	336	296	280	330	14,943
1962	607	988	1,257	1,990	2,834	2,682	2,013	1,530	1,180	859	576	443	376	328	315	425	18,403
1963	623	1,042	1,343	1,931	2,652	2,669	2,121	1,584	1,159	815	545	411	340	290	278	368	18,171
1964	687	1,177	1,560	2,392	3,390	3,371	2,649	2,001	1,498	1,070	709	524	434	379	377	483	22,701
1965	798	1,301	1,738	2,570	3,453	3,459	2,798	2,169	1,672	1,217	822	625	521	448	419	512	24,522
1966	615	1,039	1,507	2,446	3,249	3,185	2,587	2,037	1,571	1,145	764	593	525	474	472	590	22,799
1967	771	1,228	1,814	2,997	3,863	3,740	3,137	2,566	2,044	1,530	1,067	829	706	604	565	677	28,138
1968	861	1,472	1,960	3,116	4,414	4,327	3,424	2,666	2,080	1,542	1,065	816	683	588	565	688	30,267
1969	919	1,561	2,327	3,435	4,727	5,554	5,044	3,760	2,584	1,718	1,080	714	548	505	539	623	35,638
1970	1,955	3,012	3,467	4,719	6,370	6,872	5,749	4,233	2,975	2,059	1,418	1,090	859	675	602	689	46,744
1971	1,908	2,697	3,546	4,632	5,792	5,771	4,724	3,581	2,610	1,791	1,093	657	443	345	337	418	40,345
1972	3,053	4,382	3,735	4,741	5,569	4,823	3,745	2,979	2,325	1,702	1,150	733	472	334	306	377	40,426
1973	1,640	2,686	4,274	4,221	3,957	3,967	3,394	2,433	1,648	1,103	729	500	368	311	338	450	32,019
1974	1,311	2,016	2,771	3,817	4,707	4,482	3,593	2,775	2,125	1,578	1,112	865	757	663	607	674	33,853
1975	2,663	3,811	4,023	5,170	5,868	5,423	4,523	3,776	3,036	2,123	1,173	651	483	459	506	594	44,282
1976	1,797	2,564	2,541	2,904	3,832	4,283	3,841	2,907	2,031	1,375	890	619	496	474	570	905	32,029
1977	886	1,382	1,733	2,212	2,915	3,133	2,838	2,416	1,964	1,507	1,080	916	923	956	990	1,088	26,939
1978	1,297	2,173	3,513	5,276	6,065	5,604	4,769	3,860	2,783	1,803	1,020	732	641	600	631	847	41,614
1979	2,488	3,936	5,977	9,491	10,355	8,154	6,182	4,015	2,095	910	254	149	195	255	280	242	54,978
1980	2,650	3,201	4,286	5,446	7,106	7,464	6,023	4,134	2,673	1,644	912	647	527	456	439	475	48,083
1981	2,318	3,539	5,064	6,366	7,414	6,922	5,021	3,180	2,168	1,613	1,230	896	667	506	461	528	47,893
1982	5,403	5,651	7,845	9,193	9,706	9,112	7,059	4,745	3,043	1,934	1,184	781	574	522	667	1,080	68,499
1983	3,659	4,067	4,672	7,367	9,768	10,420	8,900	6,269	3,978	2,476	1,530	1,046	772	640	641	772	66,977
1984	3,640	3,798	5,272	7,356	9,290	9,392	7,516	5,286	3,456	2,112	1,155	823	719	695	775	1,367	62,652
1985	3,999	5,450	7,691	9,602	10,310	9,770	7,561	5,255	3,755	2,729	1,934	1,439	1,173	1,113	1,332	2,486	75,599
1986	4,745	6,219	8,474	12,020	14,117	13,365	9,983	6,526	4,209	2,743	1,728	1,238	1,103	1,317	1,858	2,712	92,357
1987	5,358	9,621	13,888	15,573	16,528	15,359	11,668	7,486	4,394	2,626	1,692	1,513	1,510	1,586	1,791	2,767	113,360
1988	10,710	15,946	19,891	29,131	35,243	31,402	21,942	13,837	8,336	4,715	2,284	1,308	866	624	485	419	197,139
1989	13,651	20,071	23,039	29,228	35,017	29,432	18,005	9,163	4,317	1,950	741	437	382	488	790	1,364	188,075
1990	9,044	13,110	16,751	20,876	22,590	22,248	18,980	12,965	7,378	3,844	1,801	1,134	918	1,001	1,450	2,473	156,563
1991	5,331	6,354	10,276	16,098	23,219	25,594	21,067	13,931	7,965	4,323	2,268	1,586	1,267	1,263	1,761	3,238	145,541
1992	11,356	13,136	16,603	26,180	34,685	36,329	34,193	28,987	20,988	13,472	7,705	4,311	2,166	1,322	1,431	2,478	255,342
1993	35,752	50,168	43,517	44,869	36,243	25,873	22,002	20,809	18,133	14,720	11,716	12,194	13,620	14,699	15,910	18,447	398,672
1994	32,152	37,799	37,080	45,732	53,823	51,387	43,160	34,014	25,395	17,722	11,217	7,572	6,018	6,037	7,935	13,193	430,236
1995	35,658	43,743	56,271	89,152	119,841	114,275	85,040	55,661	33,475	18,165	7,790	3,954	2,231	1,353	919	773	668,301
1996	52,053	57,594	83,571	115,240	127,582	116,948	90,384	61,280	37,482	20,551	8,988	4,624	2,759	1,861	1,621	1,923	784,461
1997	22,140	39,062	59,800	90,513	109,942	104,112	86,828	65,360	43,252	25,127	11,756	5,974	3,457	2,517	2,274	2,582	674,696
1998	32,529	42,210	61,659	84,082	93,375	95,505	89,897	70,197	44,521	24,318	10,994	6,834	5,641	5,942	7,120	8,911	683,735
1999	33,068	52,636	77,399	108,023	117,943	102,839	78,384	52,655	31,272	16,879	7,867	5,107	4,601	5,557	7,325	9,484	711,039
2000	72,304	93,588	105,698	140,112	135,622	100,886	70,776	47,625	29,310	16,413	8,064	5,105	3,613	3,413	4,729	7,516	844,774
2001	86,644	120,595	99,163	118,749	107,780	78,579	56,822	42,541	29,539	18,194	9,473	5,866	3,897	2,979	3,525	6,675	791,021
2002	78,510	101,002	88,574	120,216	123,779	98,860	71,556	49,189	32,244	19,528	10,106	5,735	3,640	2,722	2,690	3,844	812,195
2003	70,232	86,704	76,094	139,492	159,291	124,678	84,333	56,090	36,675	22,204	11,424	6,552	4,205	2,977	2,411	2,618	885,980
2004	91,003	102,120	65,097	85,501	103,052	106,543	92,011	68,664	46,568	29,308	16,711	10,215	6,478	4,500	3,586	3,643	835,000
2005	34,049	44,199	51,518	80,334	100,564	98,619	78,872	55,937	37,277	23,783	14,329	9,063	5,735	4,002	3,365	3,663	645,309
2006	23,497	37,378	57,648	87,826	100,893	94,568	74,955	52,791	34,246	20,906	11,767	7,581	5,300	4,068	3,423	3,430	620,277
2007	41,580	50,878	51,729	79,451	94,563	88,916	68,904	48,671	32,756	20,727	11,866	7,498	4,943	3,424	2,567	2,276	610,749
2008	40,607	51,728	51,132	71,820	82,294	74,145	54,222	35,574	23,008	14,621	8,638	5,078	3,042	1,973	1,576	1,694	521,152

APPENDIX IX

Marlins and Indo-Pacific sailfish

a. Regression equations used to convert from non-standard lengths into eye orbit to fork length

A/ Black Marlin (standard length is front eye orbit to fork of caudal fin)

Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size range*	*Source*
Cleithrum-Keel length					***No equation available***
Lower-jaw - fork length	$aL+b$	a= 0.8972 b= -4.6673	13	Min:119 Max:314	***BRS (Ward, pers.com.) Eastern and western Australia (on IOTC-2005-WPTT-05)***
Weight gilled and gutted	aW^b	a= 41.56681 b= 0.309442	24	Min:8.6 Max:279	***PIFSC Administrative report: (Updated Weight-on-Length Relationships for Pelagic Fishes Caught in the Central North Pacific Ocean and Bottom fishes from the Northwestern Hawaiian Islands). With value of a (46.9705) divided by 1.13 to account for conversion of gilled-and-gutted weight into round weight***

B/ Blue Marlin (standard length is front eye orbit to fork of caudal fin)

Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size range*	*Source*
Lower-jaw - fork length	$aL+b$	a= 0.9039 b= -7.248	26	Min:143 Max:295	***BRS (Ward, pers.com.) Eastern and western Australia (on IOTC-2005-WPTT-05)***
Weight gilled and gutted	aW^b	a= 46.0356637 b= 0.283377	154	Min:10 Max:381	***PIFSC Administrative report: (Updated Weight-on-Length Relationships for Pelagic Fishes Caught in the Central North Pacific Ocean and Bottom fishes from the Northwestern Hawaiian Islands) Value of a (52.0203) divided by 1.13 to account for conversion of gilled-and-gutted weight into round weight***

C/ Striped Marlin (standard length is front eye orbit to fork of caudal fin)

Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size range*	*Source*
Lower-jaw - fork length	$aL+b$	a= 1.334 b= 0.8395	443	Min: Max:	***BRS (Ward, pers.com.) Eastern and western Australia (on IOTC-2005-WPTT-05)***
Weight round	aW^b	a= 51.3506 b= 0.300417	1427	Min:7 Max:100	***PIFSC Administrative report: (Updated Weight-on-Length Relationships for Pelagic Fishes Caught in the Central North Pacific Ocean and Bottom fishes from the Northwestern Hawaiian Islands)***
Weight gilled and gutted	aW^b	a= 45.443009 b= 0.300417	1427	Min:7 Max:100	***PIFSC Administrative report: (Updated Weight-on-Length Relationships for Pelagic Fishes Caught in the Central North Pacific Ocean and Bottom fishes from the Northwestern Hawaiian Islands) Value of a (51.3506) divided by 1.13 to account for conversion of gilled-and-gutted weight into round weight***

D/ Indo-Pacific sailfish (standard length is front eye orbit to fork of caudal fin)

Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size range*	*Source*
Cleithrum-Keel length					***No equation available***
Lower-jaw - fork length	$\frac{(L+b)}{a}$	a= 0.8845 b= -3.7025	1166	Min:78 Max:232	***Wei-Chuan Chiang et al. , 2004; inverted EFL-FL equation (Male plus Female sexes pooled)***
Weight gilled and gutted	aW^b	a= 45.5076 b= 0.347166	35	Min:5 Max:38	***PIFSC Administrative report: (Updated Weight-on-Length Relationships for Pelagic Fishes Caught in the Central North Pacific Ocean and Bottom fishes from the Northwestern Hawaiian Islands) Value of a (51.4235) divided by 1.13 to account for conversion of gilled-and-gutted weight into round weight***