IOTC-2009-WPTT-12

Estimation of Catch-at-Size, Catch-at-Age and Total Catch per Area for tropical tuna species

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Summary

This document describes the methods used by the IOTC Secretariat to produce catch-at-size tables for yellowfin tuna, bigeye tuna, and skipjack tuna, for the period 1950-2008 using estimates of total catch and the available catch and effort data and size frequency data in the IOTC database. Estimates of catch-at-size, catch-at-age and total catch per area are provided. 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

Catch-At-Size (CAS) and Catch-at-Age (CAA) has three main uses:

- Input for stock assessment models being currently used by the Commission's technical groups, in particular Multifan-CL (MFCL), Stock Synthesis III (SS3) and Age-Structured Production Model (ASPM).
  a. **MF-CL**: Estimates of total catches of **yellowfin tuna**, in number and weight, and the effort and length-frequency samples available by fishery, assessment area, year and quarter.
  b. **SS3**: Estimates of total catches of **bigeye tuna**, in number and weight and the total number of fish estimated by length class interval (or catch-at-size), by fishery, assessment area, year, and quarter.
  c. **ASPM**: Estimates of total catches of yellowfin tuna and bigeye tuna, in number and weight, and numbers of yellowfin tuna and bigeye tuna estimated by age interval (or catch-at-age), year, quarter and fishery (which requires the estimation of total numbers of length interval, year, quarter and fishery, or catch-at-size).
- Stock status indicators (e.g. trends in average weight per fishery)
- Production of tables of total catch by fleet, species, gear, 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 sample weight estimated for each stratum (i.e. the weight resulting from summing up the weights estimated for the specimens within each length class) is used to raise each sample to the nominal catch recorded for the stratum.

Species involved

CAS tables are estimated for yellowfin tuna, bigeye tuna, and skipjack tuna.

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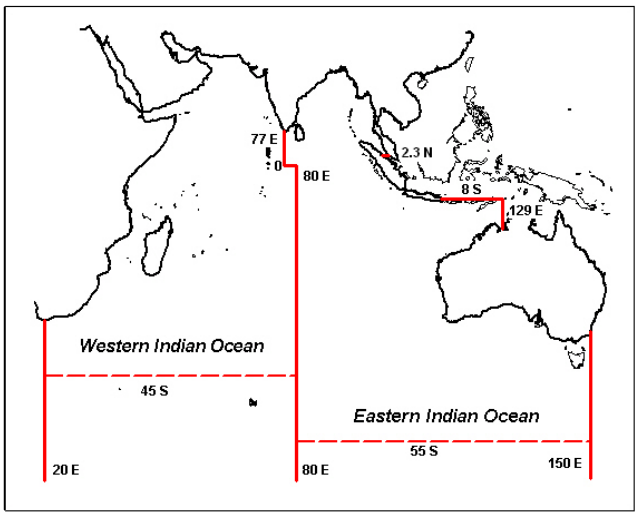
Basic Data

Four datasets are used for the preparation of stock assessment tables for tropical tuna species:

- *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* (derived from the catch-and-effort table): Catches (in tonnes or/and in number) are recorded by 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 lengths or standard or processed weights) are recorded by 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 (Catch-at-Size) or simply a sample of those (non-raised or partially raised samples).
- *Biological data*: includes several types of biological parameters for the tropical tunas, in particular:
  a. Conversion from non-standard measurements into fork length: Equations (data) used to convert specimens of tropical tunas measured by using non-standard procedures into the standard length measurement used for these species, representing the distance from the tip of the snout 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. Age-Length keys: Data used to estimate numbers of tropical tunas by age (Catch-at-Age), from the numbers by length estimated for each species (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)	Month (quarter or year)	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

Input Tables

The Secretariat prepared the following input tables for tropical tuna species:

- Stock assessments of bigeye tuna: Two sets of tables were prepared, depending on the type of assessment models to be used:
  ASPM or assessment models using Catch-at-Age data
  a. Total catches of bigeye tuna, in number of specimens and weight, by year, quarter and assessment fishery.
  b. Total number of specimens of bigeye tuna estimated by age (Catch-at-Age), fishery, year, and quarter
  SS3[4] or assessment models using Catch-at-Size data
  a. Total catches of bigeye tuna, in number of specimens and weight, by year, quarter, assessment fishery, and assessment area.
  b. Total number of bigeye tuna specimens estimated by length interval, year, quarter, assessment fishery, and assessment area.
- Stock assessments of yellowfin tuna: Two sets of tables were prepared, depending on the type of assessment models to be used:
  ASPM or assessment models using Catch-at-Age data
  a. Total catches of yellowfin tuna, in number of specimens and weight, by year, quarter and assessment fishery.
  b. Total number of specimens of yellowfin tuna estimated by age (Catch-at-Age), fishery, year, and quarter
  MF-CL[5] or assessment models using non-raised length frequency data (samples)
  a. Total catches of yellowfin tuna, in number of specimens and weight, by year, quarter, assessment fishery, and assessment area.
  b. Effort data available by year, quarter, assessment fishery, and assessment area.
  c. Number of yellowfin tuna specimens sampled by length interval, year, quarter, assessment fishery, and assessment area.
- Stock status indicators for tropical tuna 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 tropical tuna species.
- Total catches by time-area strata: The Secretariat prepared a table containing estimates of total catches of yellowfin tuna, bigeye tuna, and skipjack tuna, in number and weight, by fleet, gear, year, quarter, and 5^0 square areas.

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

Data Processing

Estimation procedures used for the preparation of data for the assessments of tropical tuna species

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

Assessment models using estimates of Catch-at-Age (ASPM)

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. 10-12cm, 12-14cm, etc.)
      iii. Assigning samples not recorded by area (purse seine and other gears)/quarter by area/quarter
2. Breaking the NCst by quarter and 5^0 grid using the CEst (NCst➔NCds)
3. Assigning length frequency samples to all NCds strata (Fleet-Gear-Year-Quarter-PS/Other Area) (NCds➔LFcv)
4. Deriving Catch-at-Size (CAS) by scaling up length frequency distributions in LFcv from sample weight to total weight for each stratum (LFcv➔CAS)
5. Adjusting/estimating NCds weights/numbers by using average weights derived from the CAS (NCds➔NCad)
6. **Yellowfin tuna and bigeye tuna catch input files** (NCad➔$\mathbf{NC_{ASPM}}$) Aggregating the catches in NCad by fishery (Fishery-Year-Quarter-Total catch of yellowfin tuna and bigeye tuna (in number and weight))
7. **Yellowfin tuna and bigeye tuna Catch-at-Age input files** (CAS➔$\mathbf{CAA_{ASPM}}$): Estimating CAA for yellowfin tuna and bigeye tuna by using the existing CAS (Fishery-Year-Quarter-Age class interval (0-15+)-Total number of YFT/BET specimens) and the existing length-age matrices for each species.

[4] SS3 can use length samples or catch-at-size data indistinctly; catch-at-size data was used for the assessments of Indian Ocean bigeye tuna.

[5] The preparation of data for the assessments of yellowfin tuna using MF-CL has been covered in a separate document (IOTC-2009-WPTT-11)

Assessment models using Catch-at-Size (SS3)

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
2. Breaking NCst by quarter and 5^0 grid using the CEst (NCst➔NCds)
3. Assigning length frequency samples to all NCds strata (Fleet-Gear-Year-Quarter-PS/Other Area) (NCds➔LFcv)
4. Deriving Catch-at-Size (CAS) by scaling up/down length frequency distributions (LFcv) from sample weight to total weight for each stratum (LFcv➔CAS)
5. Adjusting/estimating total weights/numbers by stratum by using average weights derived from the CAS (CAS)
6. **Bigeye tuna SS3 input file (CAS/NCL_{ss3})**: Assigning the catch-at-size of bigeye tuna in CAS by assessment area and fishery (Fishery-Year-Quarter-Assessment Area-Total catch of bigeye tuna (in number and weight))

Estimating total catches by species and gear

The catches in the IOTC nominal catches database are not recorded by species and/or per 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).

Standardizing the data in the catch and effort table

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

i. Area allocation: All the catches not recorded per 5° square areas were assigned to 5° square areas as follows:
    a. Allocation of catches recorded under irregular areas to regular grids: The catches recorded under irregular areas (e.g. port of unloading, fishing district, etc.) were assigned to regular grids.
    b. Aggregation of catches recorded under lower resolution areas: all catches recorded under areas smaller than the standard were aggregated under the corresponding 5° square areas.
    c. Disaggregation of catches recorded under higher resolution areas: all catches recorded under areas larger than the standard were evenly assigned per 5° square area.
ii. Time allocation: The catches recorded by time intervals higher than a month were assigned proportionally by month.

Standardizing the available size frequency data

The samples in the size frequency table are recorded under different levels of aggregation. The samples from this record were aggregated depending on the species and type of fishery. The level of aggregation chosen in each case is indicated below:

- Industrial purse seine fisheries: Species-Fleet-Gear-Type of School-Year-Quarter-Purse Seine Statistical Area (Figure 2)-Fork length class (in centimetres)-Number of fish.
- Other fisheries (industrial longline plus all artisanal fisheries): Species-Fleet-Gear-Type of School-Year-Quarter-10° latitude by 20° longitude areas (Figure 3)-Fork length class (in centimetres)-Number of fish.

The areas referred to above are shown in Figures 2 and 3.

Figure 2: Areas used for industrial purse seiners

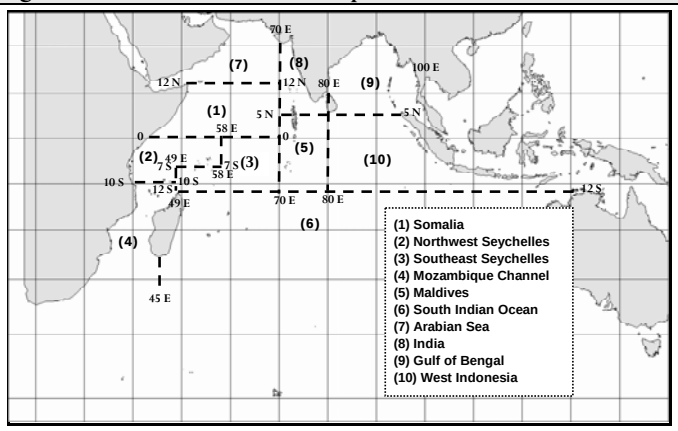
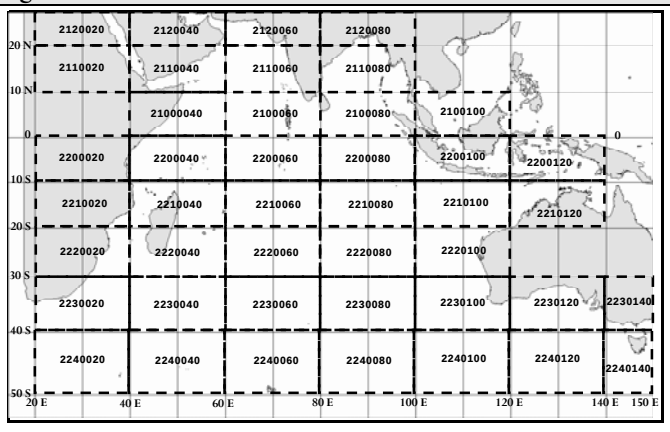


Figure 3: Areas used for other fisheries



Most of the size data in the IOTC database for industrial longline fisheries (Japan, Taiwan,China) is recorded as per the areas shown in **Figure 3** above.

The intervals used between consecutive size classes were assigned depending on the species (Table 2).

Table 2: Standard length, first length, interval and total number of size classes used for tropical tuna species

Species	*Standard Length*	*First length (cm)*	*Interval between length classes (cm)*	*Total number of size classes*	*Maximum interval allowed (cm)*
Yellowfin tuna	Fork length	10	2	150	4
Bigeye tuna	Fork length	10	2	150	4
Skipjack tuna	Fork length	10	1	150	2

NOTE: All samples in the IOTC database were assigned according to the specifications above; the samples recorded under length intervals higher than the maximum interval specified above were not used
***Refers to lower-jaw fork-length**

The steps given to put the samples available for each species into standard form are indicated below:

i. Converting from non-standard measurement types into standard length (**Table 3**):
   a. Converting from weight into standard-length: The process used to estimate fork length from the gilled and gutted weights recorded for yellowfin tuna and bigeye tuna is documented in a separate document (IOTC-2006-WPTT-INF06).
   b. Converting from non-standard length into standard length: The regression equations indicated in Table 3 are used to estimate fork length from the lengths to the first dorsal fin recorded for yellowfin tuna and bigeye tuna, respectively (deterministic).

ii. Assigning the existing lengths by standard length class interval:
   a. Aggregation of lengths recorded under classes lower than the standard class: all lengths recorded under classes lower than the standard were aggregated to the closest lower class (e.g. YFT specimens recorded under the classes 10-11 cm and 11-12 cm were accumulated under the length class 10).
   b. Disaggregation of lengths recorded under classes higher than the standard class: all the specimens recorded under length classes below the standard classes defined in table 2 above were assigned proportionally to the length classes making the aggregate (e.g. 2/3 of the YFT specimens recorded under the length class 10-13 were assigned to the class 10-12 and 1/3 to the class 12-14). The samples recorded under length intervals over the maximum interval recorded in table 2 were not used.

iii. Area allocation: All the samples not recorded by area (see figure 2 and figure 3 above) were assigned to the corresponding areas as follows:
   a. Allocation of samples recorded under irregular areas to regular grids: The samples recorded under irregular areas (e.g. port of unloading, fishing district, etc.) were assigned to regular areas. The areas assigned are shown in Appendix I.
   b. Aggregation of samples recorded within the standard areas: all samples recorded within the standard areas were aggregated under the corresponding areas.
   c. Disaggregation of samples recorded under two or more standard areas: the samples recorded under two or more standard areas were assigned proportionally to the areas concerned.

Table 3: Regression equations used to convert from non-standard measurements into standard lengths, per species

Species: Yellowfin tuna

Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size range*	*Variance*	*Covariance ab*	*Mean Residual*	*Gradient*
Weight gilled and gutted[A]	aW^b	a= 44.28699 b= 0.3008591	2,361	Min:14 Max:71	a=0.00752476509 b=2.86244E-07	-4.626246E-05	4.095958	a=3.033852 b=495.6385
Length to the base of the 1st dorsal fin[B]	aL^b	a=2.0759 b=1.1513	7,036	Min: 29 Max: 164				
Length base of first dorsal fin to fork of of caudal fin	No equation available							

Species: Bigeye tuna

Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size range*	*Variance*	*Covariance ab*	*Mean Residual*	*Gradient*
Weight gilled and gutted[A]	aW^b	a= 42.2186 b= 0.3012349	316	Min:12 Max:107	a=0.0321755341 b=1.299934E-06	-0.0002034041	3.98137	a=3.03806 b=473.1455
Length tip of the mouth to the base of the 1st dorsal fin[C]	$\frac{(L+a)^2}{b^2}$	a=21.45108 b=5.28756	2,858	Min:13 Max:48				
Length base of first dorsal fin to fork of of caudal fin	No equation available							

*A: **Data from IPTP Penang Sampling Programme (1992-93)***
B: Data from the Indian Ocean (Marsac, F. et al in IOTC-2006-WPTT-09)
C: Data from the Atlantic Ocean, Champagnat et Pianet (1974)

Table 4: Equations used to convert from standard (fork) length into round weight, per species

Species	*Gear Type/s*	*From type measurement – To type measurement*	*Equation*	*Parameters*	*Sample size*	*Length*
Yellowfin tuna	Purse seine Pole and Line Gillnet	Fork length – Round Weight(kg)[A]	$w^{live} = aL^{b}$	a= 0.00001886 b= 3.0195	6,752	Min: 29 Max: 164
	Longline Line Other Gears	Fork length(cm) – Gilled and gutted weight(kg)[B] Gilled and gutted weight(kg) - Round Weight(kg)[C]	$w^{GGT} = aL^{b}$ $w^{live} = 1.13w^{GGT}$	a= 0.0000094007 b= 3.12684	15,133	Min:72 Max:177
Bigeye tuna	Purse seine Pole and Line Gillnet	Fork length(cm) – Round Weight(kg)[D]	$w^{live} = aL^{b}$	a= 0.000027000 b= 2.95100	n/a	n/a
	Longline Line Other Gears	Fork length(cm) – Gilled and gutted weight(kg)[B] Gilled and gutted weight(kg) - Round Weight(kg)[C]	$w^{GGT} = aL^{b}$ $w^{live} = 1.13w^{GGT}$	a= 0.0000159207 b= 3.04154	12,047	Min:70 Max:187
Skipjack tuna	All gears	Fork length(cm) – Round Weight(kg)[E]	$w^{live} = aL^{b}$	a= 0.0000074800 b= 3.25260	14,140	Min:32 Max:78

*A: **Data from the Indian Ocean (Marsac, F. et al in IOTC-2006-WPTT-09)***
B: Multilateral catch monitoring Benoa (2002-04)
C: ICCAT Field Manual (Appendix 4: Population parameters for key ICCAT species. Product Conversion Factors)
D: Cort (1986)
*E: **Data from the Atlantic Ocean,** Cayré et Laloë (**Fonteneau, A. et J. Marcille (eds), 1988: Ressources, pêche et biologie des thonidés tropicaux de l'Atlantique Centre-Est. FAO Doc.Tech.Pêches, (292)**, page262)*

iv. Time allocation: The catches not recorded per quarter were aggregated or proportionally disaggregated per quarter.
v. 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 weight from the available lengths are shown in **Table 4**.

Breaking the nominal catches by time-period and area (CTA)

The aim of this process is to break the catches recorded in the nominal catches table by time-period and area. This information is used:

- 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 area for the Tuna Atlas.

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

i. Nominal catches strata for which time-area catches (CTA) exist:
  a. Deleting strata from the CTA table: The time-area catches available for NEI-(deep)-freezing longliners and NEI-fresh tuna longliners were not used because they refer to very specific areas and times and are not considered to cover all the areas of operation of these fleets. The catches for industrial purse seiners operating under the flag of the Soviet Union and other flags in recent times (NEI-ex-Soviet) were deleted for some years for the same reason.
  b. Breaking the nominal catches by time-period and area: The nominal catches were broken by time-period and area in years for which time-area catches are available for the fleet concerned.
ii. Nominal catches strata for which time-area catches do not exist:
  a. Catches by area are available for the same fleet in years before or after the year concerned:
    i. Catches for the same species are available: 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 by area for the year concerned. Data extending to up to 25 years above or below the year concerned are used.
    ii. Catches for other species are available:
      a. The catches recorded for the year of reference were accumulated and the average values obtained were used to break the catches by area for the year concerned
      b. The catches recorded in the five years closest to the year of reference were accumulated and the average values obtained were used to break the catches by area for the year concerned. Data extending to up to 25 years above or below the year concerned are used.
  b. Catches by area are not available for the same fleet in years before or after the year concerned or they are available but very far in time (more than 25 years before or after the year concerned):

i. Fleets that are presumed to operate as other fleets for which catches by area exist: This refers mainly to industrial fleets. The catches by area available for other fleets (and years) are used to break the nominal catches by month and 5° square area/s.
   a. Catches by area for the alternative fleet are available for the same year: This information is used to break the nominal catches by month and 5° square grid.
   b. Catches by area for the alternative fleet are not available for the same year: The same substitution scheme as the one defined in ii.a. above is used.

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.
   c. Time-area catches exist for other fleets in the areas concerned: The nominal catches are broken by month and area according to the proportion that the catches available from other fleets make in the area/s concerned.
   d. Time-area catches do not exist for other fleets in the areas concerned: The catches for the fleet concerned are broken proportionally by month and area.

Estimating catches-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 catch-at-age and other information used for stock assessment.
The time-area resolution used for the estimation of catch-at-size depends on the gear type (see 'Standardizing the available size frequency data' on page 2 for details). The minimum sample size was set to 30 specimens. The samples that were made up of less than 30 fish were completed with specimens from other stratum/a until a total of 30 or more specimens were attained.
The amount of length frequency data available is scarce for some fisheries and/or periods. The use of length frequency data from fleets and/or gears other than the one for which nominal catches are recorded was required in many cases. The substitution scheme that was used to assign length frequency data by CTA stratum 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 thought to be of poor quality.
   b. Assigning the available length frequency distributions by stratum: The remaining length frequency distributions were assigned by stratum.

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 areas defined in Figure 2 are used. The following latitude and longitude are assigned to each area[6]:

PS Area	*Q-Lat-Lon*
(1) Somalia	1 00 040
(2) NW Seychelles	2 00 020
(3) SE Seychelles	2 00 060
(4) Moz. Channel	2 10 020
(5) Maldives	2 00 080

PS Area	*Q-Lat-Lon*
(6) S Indian Ocean	2 20 060
(7) Arabian Sea	1 20 040
(8) India	1 00 080
(9) Gulf of Bengal	1 00 100
(10) W Indonesia	2 00 100

         b. Other gears: The areas defined in Figure 3 are used. Two regions are identified:
            i. Areas below 10°S
            ii. Areas above 10°S

            The lengths of 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 10°S are not used for strata in the North and *vice versa*).

      The substitution process is based on changes in time (quarter) and/or space (latitude and/or longitude). Below is an example of the first substitution steps.

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

[6] 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.

Step	*Lat*	*Long*	*Qtr*	*Description*
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				

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. Below is an example of the substitution scheme:
If no samples of bigeye tuna are recorded for the longline fishery of South Korea in the 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 aggregated. The substitution scheme referred to in a.i. above is also used 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 at the second level.

CTA 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*
BET	LL	IND	LL	AG3	LL	AG2	LL	AG1
BET	LL	IRN	LL	AG2	LL	AG2	LL	AG1
BET	LL	JPN	LL	AG1	LL	AG1	LL	AG1
BET	LL	KOR	LL	AG1	LL	AG1	LL	AG1
BET	LL	NEI-DFRZ	LL	AG3	LL	AG2	LL	AG1
BET	LL	PHL	LL	AG3	LL	AG2	LL	AG1
BET	LL	SUN	LL	AG2	LL	AG2	LL	AG1
BET	LL	SYC	LL	AG3	LL	AG2	LL	AG1
BET	LL	THA	LL	AG1	LL	AG1	LL	AG1
BET	LL	TWN	LL	AG3	LL	AG2	LL	AG1

b. Length frequency data are not 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 25 years before or after the year concerned are used.
ii. Length frequency data are not available for the same fleet in other years or they are very far in time (more than 25 years ahead or behind the year concerned). The length data available for other fleets are used. The information from other fleets and/or gears is used, as specified in a.ii. (page 8), following the above substitution scheme (b.i.).
c. No Length frequency data are available for the gear concerned in the 25 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 data for the whole time series are used).
ii. No length frequency data are available for the same fleet and gear anytime at all: The length data available for other fleets are used, following the substitution scheme specified in a.ii. (page 8) and c.i. above.

The average weights estimated from the samples (by using the equations in Table 4) 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 number. The average weights estimated from the sample are multiplied by the numbers of fish recorded (from the CTA table) to obtain the weights by stratum. This method is also used for fisheries for which catches are only available in number of fish.
- Other fisheries: The catches are usually recorded in weight. The average weights estimated from the sample are divided by the weight recorded (from the CTA table) to obtain the numbers by stratum. This method is also used for longline fisheries for which catches are only available in weight.

The weights resulting from the above process are summed-up for each fleet, gear, year, species and IOTC Area stratum. The length frequency distributions from the CAS are subsequently adjusted to match the weights estimated for each stratum in the CAS table (by using the sample weights and the weights corresponding to the catches estimated for each stratum).

Estimating total catches by fleet, gear, 5° square grid and month

The catches and numbers of fish in the CTA table are weighted by following the same approach (as explained in the last paragraph of the previous section).

Estimation of catch-at-age tables

Catch-at-age tables for each species are estimated using the catch-at-size data. Catch-atr-age tables were estimated for the yellowfin tuna and the bigeye tuna. The estimation of Catch-at-Age is covered in a separate document (IOTC-2009-WPTT-??).

Preparation of data input files for SS3 and ASPM

Assessment models using estimates of Catch-at-Age (ASPM)

i. Allocation of assessment fishery: Each Fleet-gear stratum was assigned to the corresponding assessment fishery. The fisheries that are used for the assessments of bigeye tuna and yellowfin tuna are presented in **Table 5** and **Table 6,** respectively.

Table 5: Fisheries used for the assessments of Indian Ocean bigeye tuna using ASPM or SS3; the total catches accumulated for the period 1950-2008 (Total Catch 50-08) 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 (,000 t)*	*% 50-08*	*% 04-08*
Longline-Japan	Industrial longlines from Japan and other longline fleets assimilated to the Japanese	1,099	33	13
Longline-Taiwan	Industrial longlines from Taiwan,China and other longline fleets assimilated to the Taiwanese	1,708	51	64
Purse seine-FS	Industrial purse seines on free-swimming schools	125	4	6
Purse seine-LS	Industrial purse seines on associated schools (e.g. Fish Aggregating Devices)	400	12	15
Artisanal	Pole-and-lines, Gillnets, Hand lines, Trolling and other artisanal gears	40	1	2

Table 6: Fisheries used for the assessments of Indian Ocean yellowfin tuna using ASPM; the total catches accumulated for the period 1950-2008 (Total Catch 50-08) 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 (,000 t)*	*% 50-08*	*% 04-08*
Longline-Japan	Industrial longlines from Japan and other longline fleets assimilated to the Japanese	1,282	14	5
Longline-Taiwan	Industrial longlines from Taiwan,China and other longline fleets assimilated to the Taiwanese	2,038	22	20
Purse Seine-FS	Industrial purse seines on free-swimming schools	1,871	20	25
Purse Seine-LS	Industrial purse seines on associated schools (e.g. Fish Aggregating Devices)	1,278	14	14
Baitboat	Pole-and-lines	393	4	4
Gillnet	Gillnets	1,499	16	20
Hand line	Hand lines	629	7	9
Trolling	Trolling	262	3	4
Other	Other artisanal gears	23	0	0

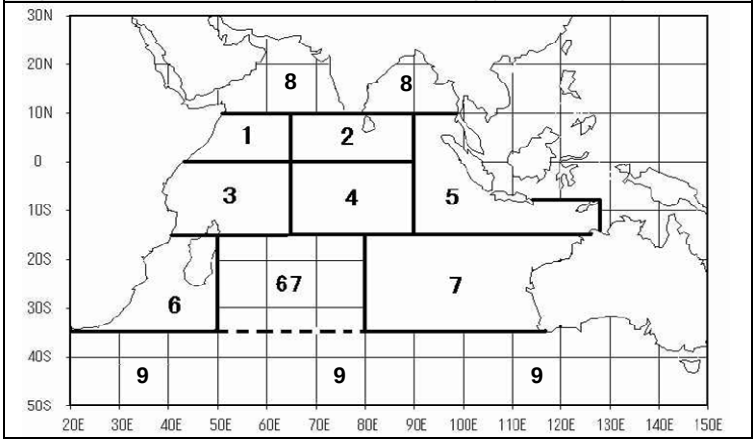
ii. Aggregation of CAA by year, quarter and assessment fishery: The available CAA were assigned by year, quarter and assessment fishery. An example of the Input Table containing the Total Catches table to be used in the ASPM stock assessments can be found in **Appendix I**.

Assessment models using estimates of Catch-at-Size (SS3)

i. Allocation of assessment fishery: As in i. above. The fisheries that are used for the assessments of bigeye tuna are presented in **Table 5** (page 9).

ii. Allocation of assessment area: The catches in the CAS table were broken by assessment area. The areas used for the assessment are shown in **Figure 4**.

Figure 4: Areas used for the assessments of bigeye tuna using SS3



iii. Aggregation of catches by year, quarter, assessment area, and assessment fishery: The resulting CAS were aggregated by year, quarter, assessment area, and assessment fishery. An example of the Input Table containing the CAS table to be used in the SS3 stock assessments can be found in **Appendix I**.

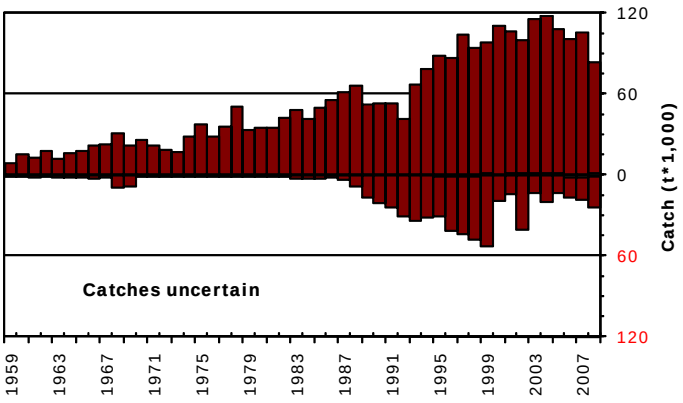
Results

Total catches by species

The total catches by species, gear type and year estimated from the process are shown in **Appendix II**. **The catches estimates for 2008 are preliminary** due to the data being incomplete.

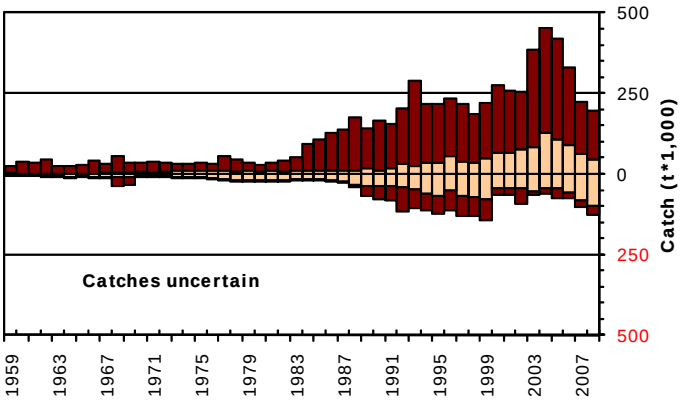
- Bigeye tuna: This species is caught by longliners, purse seiners and, to a lesser extent, bait boats and other artisanal fleets. The catches are likely to be of good quality. **Figure 5** shows the status of the catches of bigeye tuna for 1959-2008.

Figure 5: Uncertainty of annual catch estimates for bigeye tuna (BET). 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).



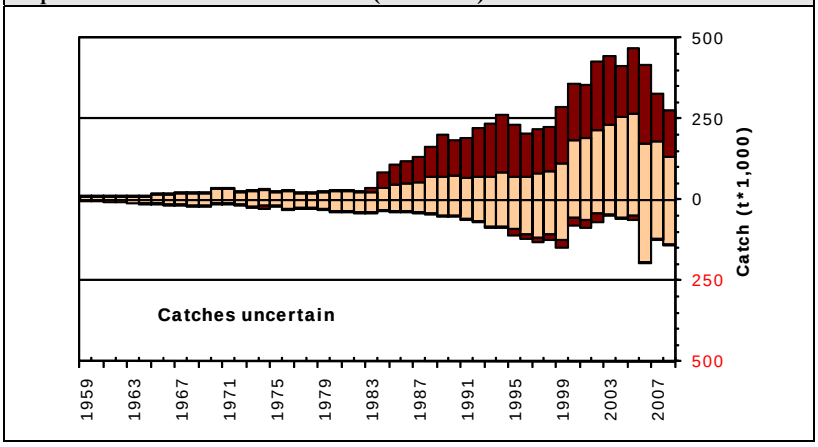
- Yellowfin tuna: This species is caught by several industrial (PS, LL) and artisanal (GILL, BB, LINE) fleets. Figure 6 shows the status of the catches of yellowfin tuna for 1959-2008. The amount of catches of yellowfin tuna that is not reported by gear is of concern, mainly since the early 90's. The majority of these catches is presumed to refer to artisanal gears, mainly gillnets, hand lines and troll lines. The catches recorded under those gears are thought, for this reason, less accurate.

Figure 6: Uncertainty of annual catch estimates for yellowfin tuna (YFT). 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).



- Skipjack tuna: This species is caught by industrial purse seiners and several artisanal fleets (GILL, BB, LINE and other). Figure 7 shows the status of the catches of skipjack tuna for 1959-2008. The amount of catches of skipjack tuna that is not reported by gear is of concern. The majority of these catches is presumed to refer to artisanal gears, mainly gillnets, hand lines and troll lines. The catches recorded under those gears are thought, for this reason, less accurate.

Figure 7: Uncertainty of annual catch estimates for skipjack tuna (SKJ). 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).



Catch-at-size tables (CAS)

CAS tables are estimated for yellowfin tuna, bigeye tuna and skipjack tuna. 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.

- Bigeye tuna:

Completeness of time-area catches: The amount of catches that are available in time and space *versus* the total catches of bigeye tuna estimated are shown in the figures 8 to 10 below. The amount of catches not available in time and space for longline fisheries is of concern making up between the 30-50% in recent years. This refers mainly to fleets operating under the flags of various non-reporting countries (NEI fleets).

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

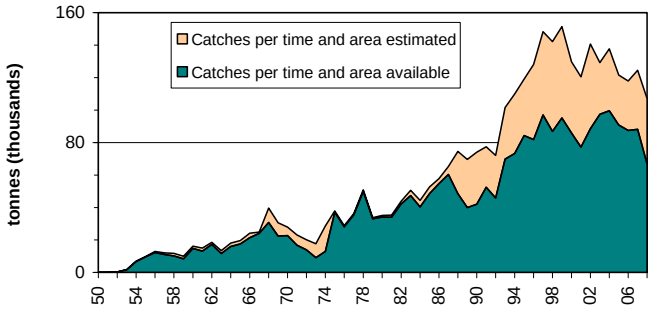


Figure 9: Total catches of bigeye tuna (BET) available in time and space *versus* the total catches recorded for the species (purse seine).

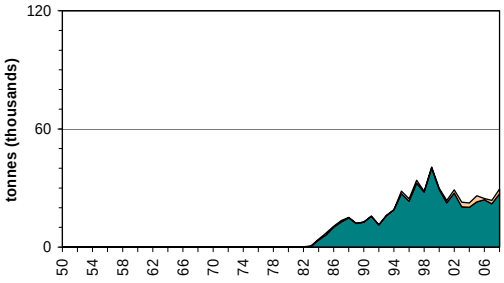
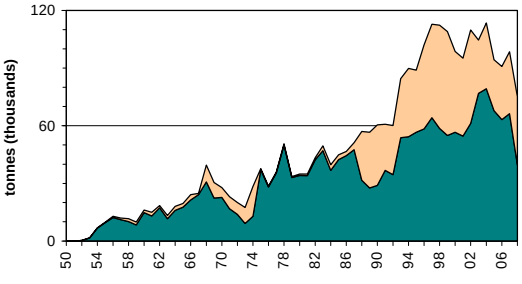


Figure 10: Total catches of bigeye tuna (BET) available in time and space *versus* the total catches recorded for the species (longline).



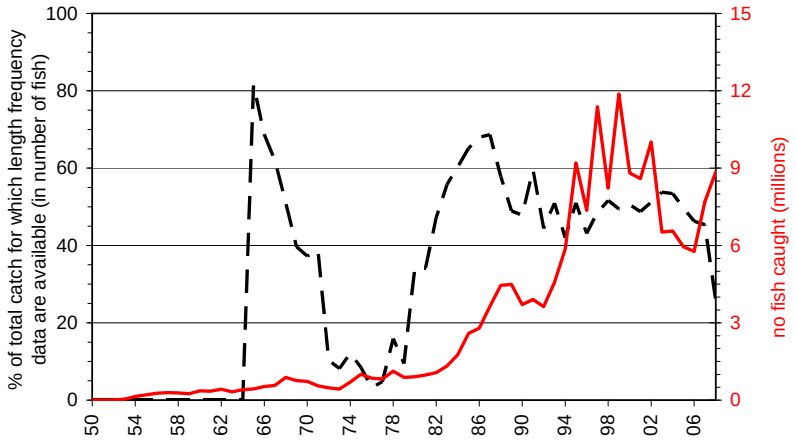
Completeness of length data: The catches estimated for strata having samples available *versus* the total catches estimated for the species per year is shown in Figures 11-13. The estimation of catches-at-size is thought less accurate:

- 1950-1964: No size data are available for the species.
- 1969-1981 and 2007-08: The amount of samples available is very low.

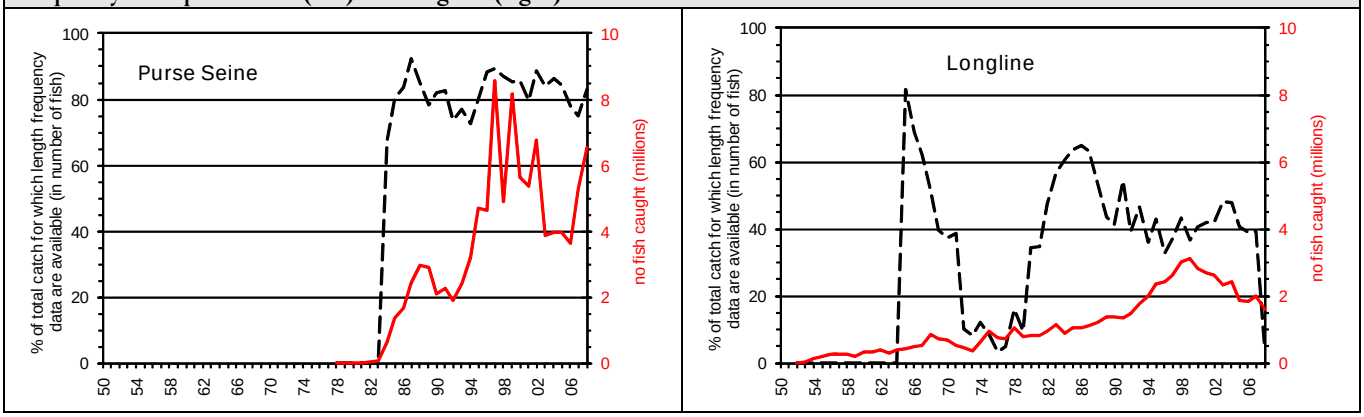
The lack of data is likely to affect in the estimation of CAS for longline fisheries during the referred periods.

The numbers of fish measured per strata over 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.

Figure 11: Total numbers of bigeye tuna (BET) estimated and proportion (in weight) estimated for strata having length frequency data (all gears combined).



Figures 12-13: Total numbers of bigeye tuna (BET) estimated and proportion (in weight) estimated for strata having length frequency data: purse seine (left) and longline (right)



- Yellowfin tuna:

Completeness of time-area catches: The amount of catches that are available in time and space *versus* the total catches of yellowfin tuna estimated are shown in the figures 14 to 17 below. The amount of catches not available in time and space since the mid 80's for longline fisheries is of concern making up between 30-60% of the total catches estimated. The coverage in time and space is also very low for most artisanal fisheries, notably gillnet, hand line and troll line. The lack of spatial coverage is likely to be important for fleets operating in island countries or in countries having a large coastline, notably Indonesia and Sri Lanka. The lack of coverage in time is likely to be important for fleets operating in regions with a marked seasonality, notably the countries in the Arabian Peninsula (Yemen, Oman, Iran, and Pakistan) and Indonesia.

Figure 14: Total catches of yellowfin tuna (YFT) available in time and space *versus* the total catches recorded for the species (all gears combined).

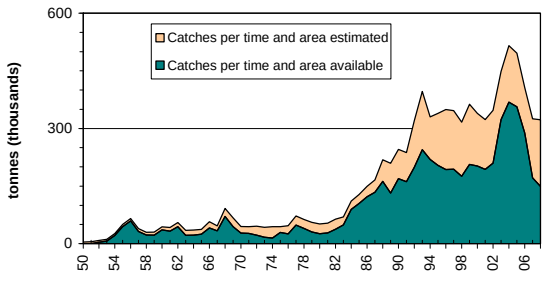


Figure 15: Total catches of yellowfin tuna (YFT) available in time and space *versus* the total catches recorded for the species (purse seine).

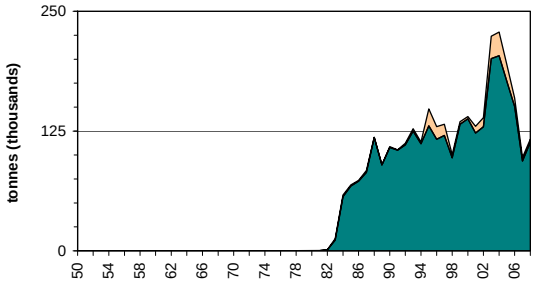


Figure 16: Total catches of yellowfin tuna (YFT) available in time and space *versus* the total catches recorded for the species (longline).

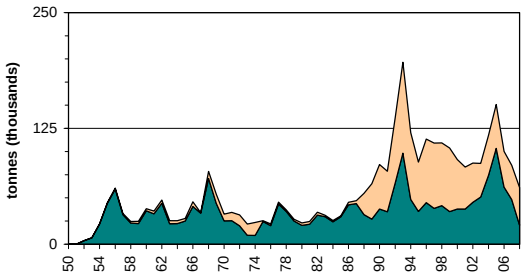
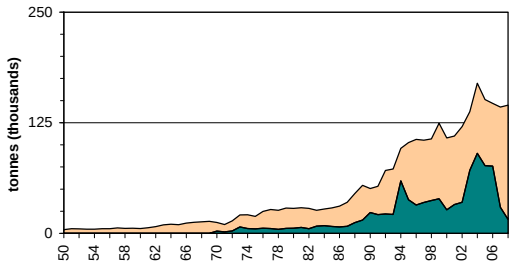


Figure 17: Total catches of yellowfin tuna (YFT) available in time and space *versus* the total catches recorded for the species (artisanal gears).

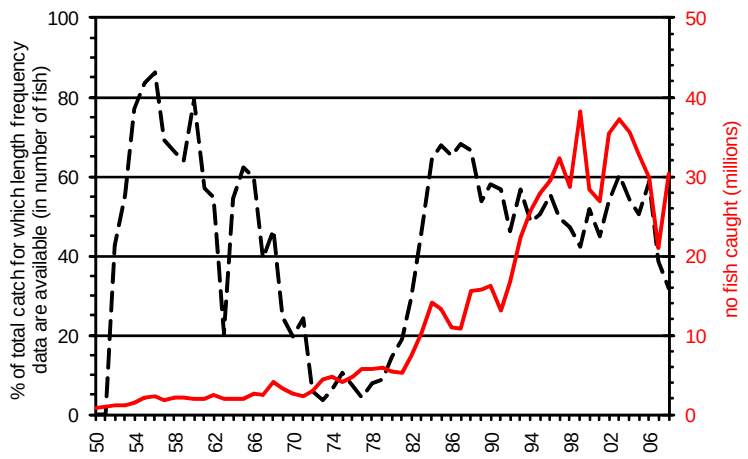


Completeness of length data: The catches estimated for strata having samples available *versus* the total catches estimated for the species per year is shown in Figure 18-21. The estimation of catches-at-size is thought less accurate for 1970-1982 and 2007-08 due to the paucity of the samples available.

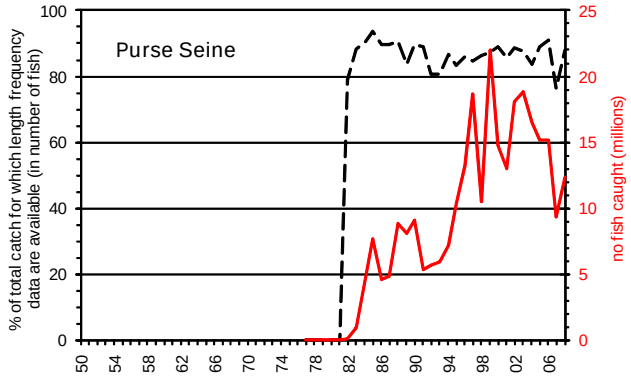
This lack of data is likely to affect in the estimation of CAS for longline fisheries during the referred periods.

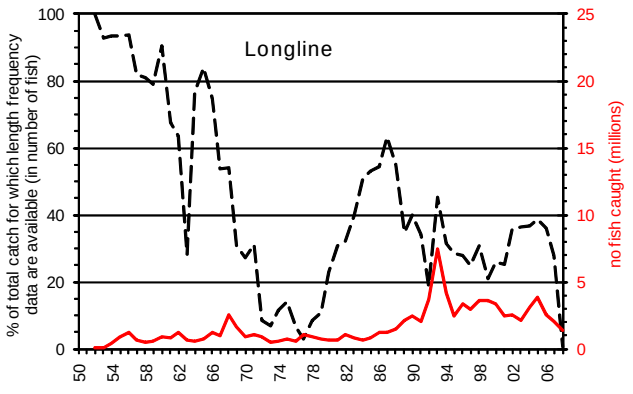
The numbers of fish measured per strata in relation with the total numbers caught by several longline fisheries, mainly Japan, has been declining in recent years. The representativeness of the samples might be also compromised for this reason.

Figure 18: Total numbers of yellowfin tuna (YFT) estimated and proportion (in weight) estimated for strata having length frequency data (all gears combined).

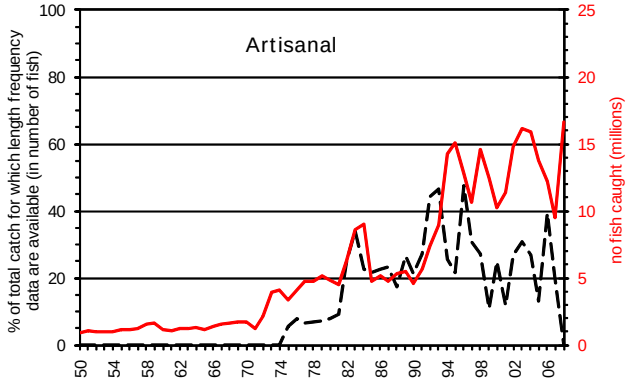


Figures 19-21: Total numbers of yellowfin tuna (YFT) estimated and proportion (in weight) estimated for strata having length frequency data: purse seine (top left), longline (top right) and artisanal gears (next page)





Figures 19-21: Total numbers of yellowfin tuna (YFT) estimated and proportion (in weight) estimated for strata having length frequency data: purse seine (top left), longline (top right) and artisanal gears (next page)



The lack of length data for artisanal fisheries is of concern:

- Gillnet: No size data are available for 1950-1975. The amount of samples available is very low for other years or periods (1976-82, 1994-95, 2000-01).
- Pole and line: No size data are available for 1950-1980. Size data not available by gear type since 1998.
- Hand lines and troll lines: there is an almost complete lack of samples for both gears.

In light of the above, the quality of the CAS estimated for the artisanal gears is likely to be highly compromised.

- Skipjack tuna

Completeness of time-area catches: The amount of catches that are available in time and space *versus* the total catches of skipjack tuna estimated are shown in the figures 22 to 25 below. The amount of catches not available in time and space since the early 90's (notably gillnets) is of concern. The coverage in time and space is also very low for most artisanal fisheries, notably gillnets.

Figure 22: Total catches of skipjack tuna (SKJ) available in time and space *versus* the total catches recorded for the species (all gears combined).

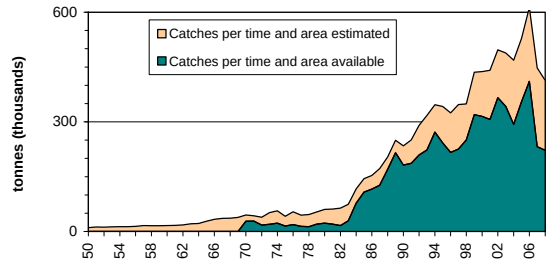


Figure 23: Total catches of skipjack tuna (SKJ) available in time and space *versus* the total catches recorded for the species (purse seine).

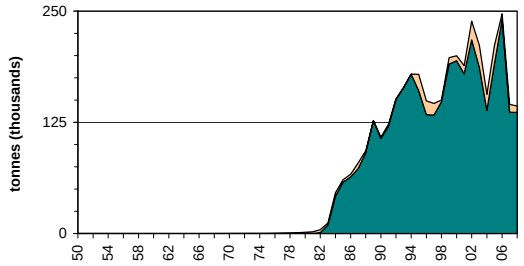


Figure 24: Total catches of skipjack tuna (SKJ) available in time and space *versus* the total catches recorded for the species (gillnet).

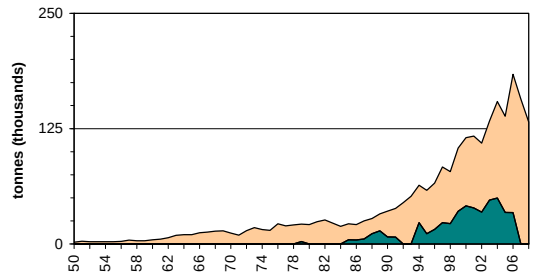
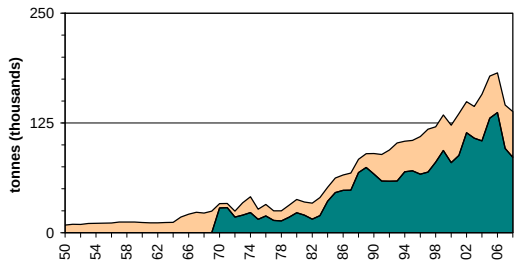


Figure 25: Total catches of skipjack tuna (SKJ) available in time and space *versus* the total catches recorded for the species (pole and line and other gears).



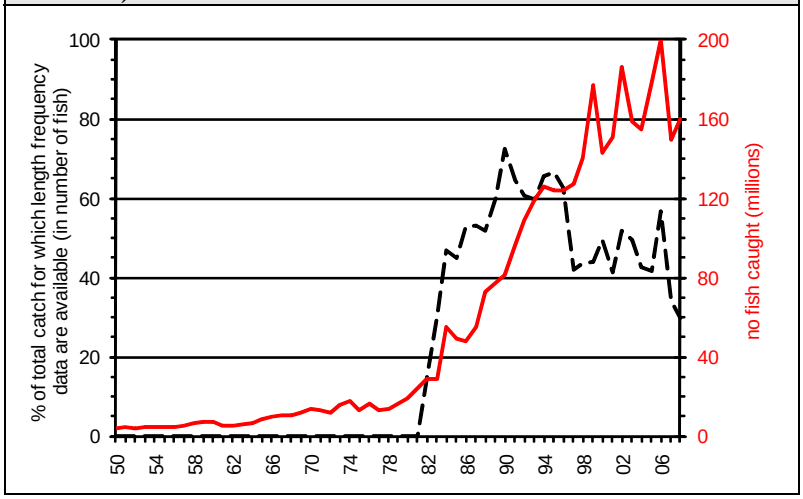
Completeness of length data: The catches estimated for strata having samples available *versus* the total catches estimated for the species per year is shown in Figure 26-28. The estimation of catches-at-size is thought less accurate for 1950-1982 due to the paucity of the samples available.

This lack of data is likely to affect in the estimation of CAS for all artisanal fisheries during the referred periods.

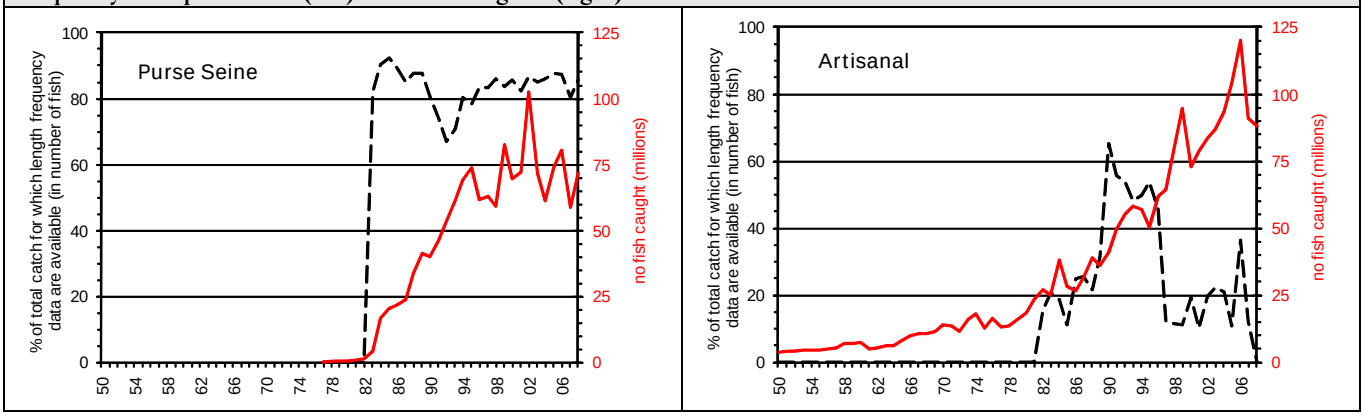
The representativeness of the samples is unknown for most artisanal fisheries.

The quality of the CAS estimated for the artisanal gears is likely to be highly compromised due to the above.

Figure 26: Total numbers of skipjack tuna (SKJ) estimated and proportion (in weight) estimated for strata having length frequency data (all gears combined).



Figures 27-28: Total numbers of skipjack tuna (SKJ) estimated and proportion (in weight) estimated for strata having length frequency data: purse seine (left) and artisanal gears (right)



Figures 29-31 (page 17) show length frequency distributions for original samples (blue line) and catch-at- size estimated (orange bars) for the entire catch-series, all fisheries combined,
Figures 32-97 (**Appendix III**) show the same by decade and type of fishery, including for decades for which no samples were available.

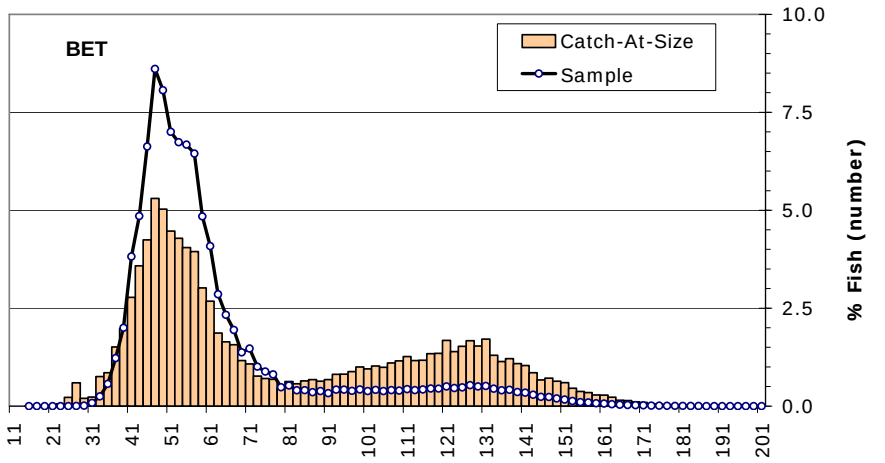
The length frequency distributions for some fisheries and periods differ significantly from the length frequency samples; this is especially the case with:

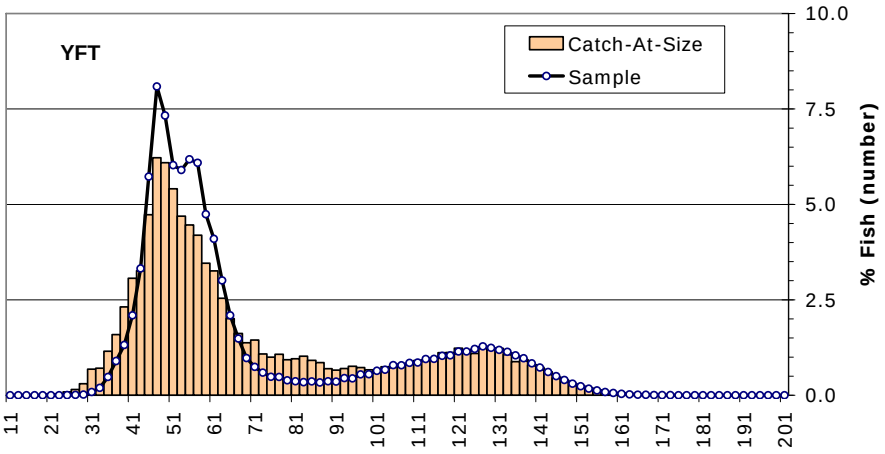
- Longline fisheries since the early 1990's
- Handline, trolling and other small artisanal fisheries over the entire time-series

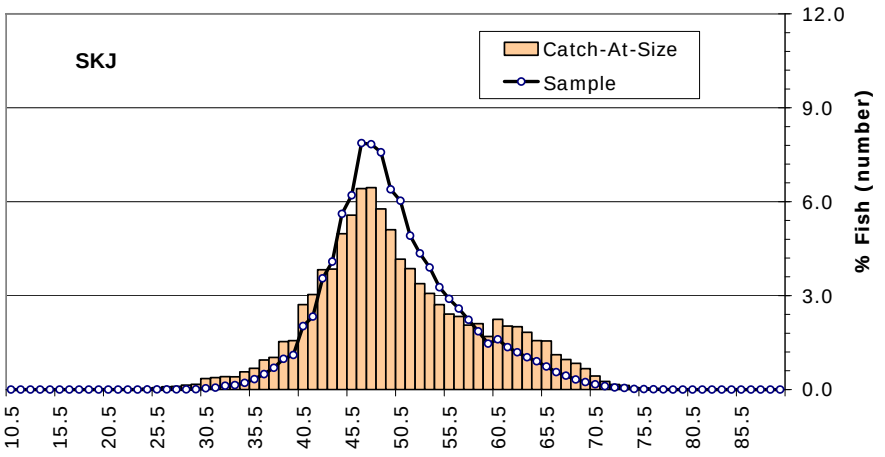
The following reasons may explain the referred discrepancies:

- <u>The length distributions used for the estimation of CAS represent CAS instead of samples for some fisheries, especially industrial purse seiners</u>: The EC and the Seychelles have always reported CAS for their industrial purse seine fisheries instead of samples.
- <u>No weighting applied in the aggregation of samples under the strata selected for the assessment</u>: 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.
- <u>Catches at size derived from samples containing a low number of specimens</u>: 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 yellowfin tuna and the bigeye tuna.

Figures 29-31: Proportion that the numbers of tropical tunas sampled (blue line)/estimated (CAS; orange bars) by 2cm (YFT, BET)/1cm (SKJ) length class made out of the total numbers of tropical tunas sampled/estimated over the entire time and area (1950-2008), all fisheries and years combined, by species
Bigeye tuna (top), Yellowfin tuna (center), and skipjack tuna (bottom)







APPENDIX I
ASPM and SS3 Input Tables

a/ ASPM

Fishery	Year	Quarter	FirstClassLow	SizeInterval	TimeStamp	tno	tmt	T001	…	T150
Baitboat	1950	1	10	2	2009-09-14	154,649	378	0	…	0

Where:

Field	Description
Fishery	Type of fishery (Table 5 (BET), Table 6 (YFT))
Year	Year
Quarter	Quarter
FirstClassLow	First length class
SizeInterval	Interval between length classes
TimeStamp	The data the file was created
tno	Total number of fish caught
tmt	Total weight caught (metric tons)
T001	Number of fish measured (1st length class)
……	Number of fish measured (2nd length class to 149th length class)
T150	Number of fish measured (150th length class)

b/ SS3

Species	Fishery	Year	Quarter	Area	FirstClassLow	Sizeinterval	TimeStamp	tno	tmt	T001	…	T150
BET	ART	1950	1	5	10	2	21/09/2009	72	1	0	…	0

Where:

Field	Description
Species	Species code
Fishery	Type of fishery (Table 5)
Year	Year
Quarter	Quarter
Area	Area used for the assessment (Figure 4)
FirstClassLow	First length class
SizeInterval	Interval between length classes
TimeStamp	The data the file was created
tno	Total number of fish caught
tmt	Total weight caught (metric tons)
T001	Number of fish measured (1st length class)
……	Number of fish measured (2nd length class to 149th length class)
T150	Number of fish measured (150th length class)

APPENDIX II
Total catches and total number of fish estimated by species, gear and year

a/Bigeye tuna

Bigeye Tuna catches in number of fish

Year	Purse Seine-FS	Purse Seine-LS	Longline-Japan	Longline-Taiwan	Artisanal	Total
1950					287	287
1951					1,719	1,719
1952			6,433		2,006	8,438
1953			36,776		2,005	38,782
1954			142,620	2,251	2,196	147,068
1955			199,862	5,169	2,196	207,227
1956			252,975	14,955	2,550	270,480
1957			236,355	22,665	37,247	296,267
1958			209,537	37,830	37,151	284,519
1959			173,816	37,426	37,247	248,489
1960			309,472	34,668	19,674	363,814
1961			271,306	49,162	28,413	348,881
1962			368,091	30,951	29,081	428,123
1963			250,224	43,973	29,191	323,389
1964			335,134	42,932	29,254	407,320
1965			375,048	38,274	20,708	434,031
1966			441,170	57,730	29,827	528,727
1967			485,254	54,217	33,608	573,079
1968			651,071	198,802	33,678	883,551
1969			521,545	202,489	35,630	759,663
1970			389,202	290,250	52,145	731,597
1971			377,264	145,057	30,417	552,738
1972			287,770	162,367	34,763	484,899
1973			245,965	110,012	73,528	429,505
1974			474,783	158,173	71,840	704,797
1975			802,866	139,103	62,778	1,004,746
1976			633,295	126,244	92,638	852,177
1977			575,220	138,347	106,397	819,965
1978	94	803	906,193	132,024	88,774	1,127,888
1979	29	171	593,875	196,677	90,385	881,136
1980	734	2,919	557,091	270,828	77,758	909,329
1981	104	2,319	615,824	204,650	154,840	977,736
1982	3,907	15,431	654,728	305,385	90,817	1,070,267
1983	10,967	46,678	783,548	348,511	132,941	1,322,646
1984	126,854	515,628	536,810	343,250	233,775	1,756,318
1985	212,090	1,138,015	657,082	393,331	189,703	2,590,220
1986	276,449	1,388,932	575,819	482,289	71,243	2,794,732
1987	728,783	1,698,374	605,405	502,524	99,027	3,634,113
1988	946,323	2,016,460	574,209	654,957	258,902	4,450,850
1989	699,140	2,204,066	386,064	988,126	211,872	4,489,269
1990	466,214	1,623,452	399,507	986,777	227,531	3,703,480
1991	253,642	2,007,183	222,486	1,117,453	309,214	3,909,977
1992	182,248	1,726,802	227,372	1,247,035	246,658	3,630,115
1993	325,467	2,063,984	252,210	1,516,628	403,047	4,561,336
1994	137,654	3,057,849	455,001	1,533,308	676,431	5,860,243
1995	242,667	4,460,652	607,174	1,740,993	2,151,038	9,202,524
1996	348,716	4,280,617	549,002	1,873,761	308,703	7,360,799
1997	203,059	8,347,536	581,670	2,053,445	196,074	11,381,784
1998	660,166	4,239,482	474,421	2,534,533	307,754	8,216,356
1999	692,905	7,480,889	362,709	2,744,336	599,491	11,880,330
2000	385,548	5,247,775	414,145	2,414,962	347,760	8,810,191
2001	237,505	5,115,791	420,323	2,283,860	539,211	8,596,690
2002	145,967	6,609,700	245,246	2,362,980	651,821	10,015,714
2003	255,224	3,612,687	255,305	2,056,804	343,561	6,523,582
2004	133,015	3,825,197	334,552	2,092,666	178,942	6,564,372
2005	307,025	3,660,943	351,772	1,500,838	131,758	5,952,336
2006	229,818	3,389,964	361,892	1,463,652	321,411	5,766,738
2007	390,535	4,880,999	411,307	1,593,567	413,024	7,689,432
2008	352,797	6,170,041	321,281	1,270,310	738,175	8,852,605

Bigeye Tuna catches in weight (tonnes)

Year	Purse Seine-FS	Purse Seine-LS	Longline-Japan	Longline-Taiwan	Artisanal	Total
1950					2	2
1951					13	13
1952			280		15	295
1953			1,653		15	1,668
1954			6,750	100	17	6,867
1955			9,539	201	17	9,756
1956			12,245	601	20	12,866
1957			11,090	901	86	12,077
1958			10,153	1,502	85	11,740
1959			8,366	1,502	86	9,954
1960			14,813	1,302	51	16,166
1961			13,048	1,903	68	15,019
1962			17,279	1,202	73	18,555
1963			11,600	1,703	74	13,377
1964			16,009	2,023	75	18,107
1965			17,731	1,819	59	19,610
1966			21,546	2,595	79	24,220
1967			22,353	2,415	88	24,856
1968			30,391	9,173	87	39,651
1969			21,966	8,497	92	30,554
1970			16,241	11,576	116	27,933
1971			16,061	6,954	72	23,087
1972			13,279	6,762	83	20,123
1973			12,506	4,954	165	17,625
1974			21,576	6,821	164	28,562
1975			31,733	5,976	162	37,871
1976			23,960	4,604	265	28,828
1977			29,284	6,662	314	36,260
1978	1	4	45,015	5,559	308	50,888
1979	0	1	25,670	7,813	270	33,753
1980	6	15	25,212	9,663	260	35,156
1981	1	12	27,207	7,646	451	35,316
1982	34	82	30,938	12,460	375	43,890
1983	125	462	35,717	13,806	439	50,549
1984	1,620	2,400	25,777	13,917	673	44,386
1985	1,719	5,439	30,089	14,776	617	52,640
1986	2,516	8,114	27,623	19,000	527	57,779
1987	4,608	8,792	29,901	21,288	719	65,308
1988	6,578	8,489	29,371	27,607	2,550	74,595
1989	3,612	8,384	19,885	36,689	1,051	69,621
1990	5,883	6,785	18,931	41,519	959	74,077
1991	5,349	10,276	10,048	50,756	978	77,407
1992	2,340	8,922	10,420	49,708	743	72,132
1993	7,464	8,551	13,594	70,936	994	101,540
1994	4,791	14,090	26,364	63,501	1,194	109,940
1995	4,869	23,513	23,781	65,136	1,754	119,053
1996	3,823	20,706	28,308	73,754	1,458	128,049
1997	2,446	31,519	29,861	82,993	1,495	148,313
1998	6,353	21,981	20,726	91,568	1,482	142,109
1999	5,619	35,040	15,472	93,522	1,753	151,405
2000	5,691	24,167	17,366	81,273	1,269	129,766
2001	4,267	19,451	14,693	80,480	1,580	120,471
2002	4,100	24,943	14,091	95,791	1,760	140,685
2003	7,172	15,662	11,217	93,385	1,885	129,322
2004	3,658	18,749	13,288	100,222	1,794	137,711
2005	8,577	17,492	15,299	79,064	1,154	121,586
2006	6,406	18,249	17,261	73,568	2,398	117,883
2007	5,734	18,002	19,630	78,857	2,301	124,523
2008	9,753	19,726	14,791	60,340	2,429	107,039

b/Yellowfin tuna(i)

Yellowfin Tuna catches in number of fish										
Year	Purse Seine-FS	Purse Seine-LS	Longline-Japan	Longline-Taiwan	Baitboat	Gillnet	Hand line	Trolling	Other	Total
1950					618,595	158,668	43,808	44,697	2,890	868,659
1951					623,033	229,990	58,779	104,689	8,670	1,025,161
1952			62,801		625,252	190,225	56,358	134,728	11,561	1,080,925
1953			120,749		625,467	152,794	48,068	124,075	11,561	1,082,714
1954			424,884	5,768	627,619	147,118	47,274	143,156	11,561	1,407,379
1955			858,334	19,924	834,225	141,020	37,986	150,122	11,561	2,053,172
1956			1,160,668	31,999	834,656	154,571	32,825	150,417	11,561	2,376,696
1957			613,497	34,581	805,453	208,740	32,903	146,391	11,561	1,853,126
1958			482,358	50,286	1,166,903	188,666	33,730	141,002	12,258	2,075,203
1959			518,828	64,540	1,236,627	202,612	38,261	139,385	12,258	2,212,511
1960			850,041	63,897	674,650	253,261	37,589	148,647	13,177	2,041,262
1961			717,467	80,270	541,782	306,456	40,675	181,729	17,300	1,885,677
1962			1,093,626	98,080	522,965	423,204	41,805	189,421	24,465	2,393,565
1963			530,280	97,281	521,707	475,642	50,356	197,234	23,006	1,895,506
1964			508,551	89,393	520,218	537,338	54,062	190,185	25,356	1,925,103
1965			680,916	76,030	355,540	526,026	50,028	200,203	27,960	1,916,703
1966			1,079,081	136,761	522,037	614,512	52,992	200,840	26,305	2,632,527
1967			852,482	97,898	591,227	669,927	58,984	211,192	26,305	2,508,015
1968			1,849,258	675,362	591,227	721,676	63,809	219,428	26,305	4,147,064
1969			980,779	621,952	625,820	758,041	118,602	219,350	29,514	3,354,058
1970			408,201	473,278	822,927	620,983	90,349	166,389	22,402	2,604,530
1971			681,857	408,600	464,522	476,716	78,185	212,606	21,284	2,343,770
1972			491,069	371,731	956,990	693,436	100,548	308,637	36,025	2,958,435
1973			316,282	198,181	2,539,273	809,222	157,556	423,268	34,976	4,478,757
1974			413,111	154,449	1,929,784	1,652,271	176,589	331,407	27,186	4,684,797
1975			598,682	157,646	1,702,874	1,234,360	170,668	215,323	13,656	4,093,211
1976			449,142	155,181	1,822,632	1,707,583	243,471	327,052	25,605	4,730,665
1977	162	6,278	766,340	290,311	1,792,437	1,521,470	245,911	1,120,719	70,463	5,814,092
1978	3,305	22,095	757,274	162,055	1,419,815	1,485,831	326,575	1,389,393	136,211	5,702,554
1979	3,373	7,516	562,005	178,874	1,690,028	1,708,282	192,940	1,435,981	144,559	5,923,558
1980	3,884	10,113	413,963	214,810	1,766,799	1,716,712	127,790	1,100,744	100,137	5,454,952
1981	10,131	14,497	464,464	220,630	2,145,139	1,925,625	144,656	296,038	9,295	5,230,474
1982	28,888	61,567	827,433	207,775	2,767,871	2,641,178	131,864	590,760	74,750	7,332,086
1983	523,251	394,570	616,503	204,473	5,741,403	2,211,307	126,889	470,882	60,635	10,349,913
1984	2,590,580	1,931,656	431,694	185,171	6,721,230	1,599,848	148,682	485,582	56,695	14,151,137
1985	1,966,807	5,686,006	536,643	254,361	2,201,291	1,244,617	259,530	941,896	130,671	13,221,821
1986	2,209,018	2,392,554	644,458	565,969	1,455,641	1,480,226	271,146	1,805,725	146,724	10,971,461
1987	1,589,147	3,225,287	510,800	679,697	1,795,339	1,175,727	328,547	1,388,213	82,062	10,774,820
1988	2,869,062	5,934,887	540,413	925,916	1,488,052	1,869,831	562,614	1,304,348	80,004	15,575,127
1989	3,053,601	5,068,266	310,057	1,849,986	1,740,584	2,366,924	631,717	697,244	18,707	15,737,086
1990	3,892,842	5,170,058	335,418	2,157,885	1,151,938	2,202,758	563,411	673,423	25,846	16,173,580
1991	2,034,282	3,314,050	174,404	1,839,244	2,244,534	2,028,080	497,185	843,624	73,280	13,048,683
1992	1,943,996	3,702,213	223,869	3,434,420	2,111,533	3,232,751	616,679	1,335,659	42,409	16,643,528
1993	2,136,720	3,807,893	215,517	7,214,390	2,839,156	3,317,189	2,023,643	760,086	21,000	22,335,593
1994	1,840,920	5,327,820	283,010	3,921,805	5,961,664	4,427,442	2,830,371	1,032,111	39,867	25,665,010
1995	2,292,628	8,041,736	232,881	2,248,090	5,566,720	5,705,377	2,479,006	1,245,782	48,354	27,860,574
1996	2,254,599	11,012,066	338,655	3,053,985	4,270,251	4,952,121	2,245,394	1,261,410	52,110	29,440,591
1997	1,468,030	17,230,788	425,720	2,509,723	3,562,046	4,434,648	1,475,408	1,175,358	41,686	32,323,408
1998	2,736,716	7,791,606	550,786	3,050,978	5,347,585	4,740,533	2,987,285	1,418,572	59,555	28,683,618
1999	2,509,986	19,525,771	443,105	3,191,833	3,008,989	6,110,787	2,003,710	1,301,388	37,929	38,133,498
2000	2,155,426	12,594,542	443,324	2,954,450	2,980,593	4,701,870	1,383,041	1,166,836	36,323	28,416,404
2001	2,345,294	10,692,215	430,901	1,987,167	3,617,150	4,819,729	1,638,823	1,266,873	56,408	26,854,559
2002	2,137,023	15,984,578	264,450	2,241,274	4,164,317	5,034,559	4,235,385	1,253,230	134,190	35,449,006
2003	3,731,738	15,106,490	413,288	1,750,964	3,428,720	7,162,533	4,264,015	1,231,940	75,323	37,165,011
2004	4,018,748	12,473,547	585,898	2,543,599	4,070,802	6,605,057	3,578,500	1,613,103	39,419	35,528,672
2005	3,307,081	11,831,315	649,863	3,201,841	3,101,109	5,284,874	1,971,717	3,080,459	304,782	32,733,041
2006	2,223,358	12,928,096	571,760	1,946,374	1,359,931	7,128,940	1,394,565	2,233,494	121,510	29,908,029
2007	1,759,859	7,607,683	473,749	1,555,376	1,365,665	4,324,171	919,210	2,676,133	235,949	20,917,795
2008	1,939,122	10,364,296	268,206	1,165,981	7,172,928	5,811,393	751,939	2,379,765	526,773	30,380,404

b/Yellowfin tuna(ii)

Yellowfin Tuna catches in weight (tonnes)										
Year	Purse Seine-FS	Purse Seine-LS	Longline-Japan	Longline-Taiwan	Baitboat	Gillnet	Hand line	Trolling	Other	Total
1950					1,512	1,806	659	167	19	4,164
1951					1,528	2,430	802	307	58	5,124
1952			3,683		1,536	2,124	816	374	77	8,610
1953			6,757		1,537	1,912	730	305	77	11,318
1954			21,666	210	1,545	1,875	731	426	77	26,531
1955			44,163	690	2,051	1,834	730	470	77	50,015
1956			59,485	1,090	2,053	1,885	679	473	77	65,742
1957			31,864	1,253	1,980	2,900	710	448	77	39,232
1958			22,644	1,827	1,982	2,282	730	446	77	29,988
1959			22,182	2,382	1,980	2,452	844	436	77	30,354
1960			36,055	2,243	1,029	2,882	884	503	77	43,674
1961			32,730	2,880	1,532	3,160	1,005	630	97	42,034
1962			44,191	3,471	1,510	4,376	1,069	551	116	55,284
1963			21,981	3,405	1,522	5,916	1,333	596	121	34,875
1964			22,163	3,128	1,515	6,516	1,426	694	138	35,579
1965			25,004	2,686	1,041	6,528	1,291	658	148	37,356
1966			40,901	4,845	1,520	7,847	1,383	659	136	57,290
1967			30,519	3,518	1,722	8,269	1,546	734	136	46,443
1968			53,586	25,029	1,722	8,748	1,613	789	136	91,623
1969			32,258	21,689	1,822	8,889	1,726	865	155	67,405
1970			15,575	16,809	2,386	7,454	1,543	816	118	44,700
1971			20,810	13,567	1,474	5,860	1,377	1,053	116	44,256
1972			18,181	13,338	2,680	8,075	1,699	1,395	198	45,566
1973			14,746	6,979	7,666	8,852	2,386	1,761	191	42,582
1974			18,121	5,373	6,322	10,063	2,946	1,446	152	44,424
1975			19,792	5,562	4,873	9,893	3,005	1,188	77	44,390
1976			16,510	5,378	5,410	13,578	3,977	1,605	142	46,601
1977	6	28	35,184	10,245	5,147	12,315	3,968	5,082	388	72,364
1978	111	104	31,173	5,821	4,235	12,062	4,278	4,779	710	63,273
1979	63	40	21,323	5,553	4,887	13,860	4,256	4,763	794	55,539
1980	71	59	16,421	6,408	4,888	13,896	4,774	4,148	550	51,215
1981	182	82	17,335	7,103	6,145	15,515	4,941	2,185	51	53,539
1982	698	468	26,640	7,882	4,994	15,435	5,122	2,327	332	63,898
1983	8,379	4,246	24,005	7,153	7,910	11,441	4,467	2,009	276	69,888
1984	46,789	11,451	18,123	7,380	8,487	11,081	5,924	1,769	210	111,214
1985	44,964	23,791	21,978	8,511	7,571	11,095	6,817	2,644	592	127,964
1986	47,209	26,237	26,155	19,039	6,754	12,043	6,944	4,055	945	149,382
1987	46,944	36,852	21,516	25,390	7,914	14,883	8,796	2,970	540	165,806
1988	87,399	31,223	23,404	31,460	6,314	23,171	12,070	2,900	519	218,459
1989	52,868	36,881	13,273	51,943	5,802	30,213	15,539	2,618	113	209,251
1990	78,980	29,719	13,815	72,213	5,300	26,413	16,120	2,770	126	245,456
1991	78,753	26,651	7,542	71,214	7,586	23,547	18,343	3,422	310	237,367
1992	74,782	37,506	10,126	126,535	8,620	38,339	16,420	7,426	235	319,991
1993	85,468	41,936	10,029	186,386	9,933	39,583	15,032	7,669	452	396,488
1994	77,542	36,022	13,593	106,777	12,999	50,153	22,497	10,046	444	330,072
1995	68,869	79,282	10,618	77,958	12,370	56,744	22,909	10,095	433	339,276
1996	68,453	61,218	16,573	96,991	12,149	62,660	19,988	10,889	458	349,378
1997	49,431	82,720	19,576	89,560	12,882	58,001	22,084	11,688	512	346,454
1998	43,220	57,160	19,358	89,929	13,626	58,821	23,961	9,709	475	316,259
1999	47,973	86,793	15,679	88,029	13,304	75,535	25,486	9,600	492	362,890
2000	61,469	78,786	17,616	73,692	10,851	57,431	28,162	10,799	534	339,339
2001	79,067	50,899	15,747	67,526	11,819	56,876	29,942	10,867	440	323,184
2002	77,058	61,934	14,350	73,229	17,068	58,905	34,186	9,993	464	347,188
2003	137,492	86,584	19,387	67,699	16,863	79,625	31,136	9,393	475	448,653
2004	168,799	59,595	20,358	97,245	15,061	96,650	40,571	16,882	483	515,645
2005	124,137	69,759	25,028	125,810	17,644	74,949	39,473	16,970	2,148	495,919
2006	85,020	74,454	25,860	74,425	17,339	83,272	32,395	13,088	715	406,568
2007	53,576	43,795	22,292	62,734	15,474	76,688	33,664	15,322	1,517	325,061
2008	75,035	41,411	12,210	48,937	17,216	79,667	31,067	13,302	3,624	322,469

c/Skipjack tuna

Skipjack Tuna catches in number of fish								
Year	Purse Seine-FS	Purse Seine-LS	Baitboat	Gillnet	Handline	Trolling	Other	Total
1950			3,042,183	453,483	113,976	30,634	17,518	3,657,795
1951			3,155,456	699,748	140,413	158,675	110,610	4,264,901
1952			3,165,753	598,262	99,034	169,706	119,046	4,151,802
1953			3,555,403	543,677	82,201	176,207	127,805	4,485,294
1954			3,609,811	567,177	79,819	194,599	137,317	4,588,723
1955			3,640,688	573,841	101,953	196,446	138,192	4,651,119
1956			3,659,807	650,687	117,440	208,666	147,196	4,783,796
1957			4,002,396	1,026,377	107,814	196,413	152,981	5,485,981
1958			5,377,035	929,128	116,417	208,174	154,596	6,785,350
1959			5,822,539	873,360	124,932	196,353	145,761	7,162,944
1960			5,792,087	1,121,081	155,196	199,393	147,887	7,415,644
1961			3,074,225	1,358,789	184,982	260,156	184,819	5,062,971
1962			3,014,921	1,737,282	259,122	257,040	184,259	5,452,624
1963			3,085,498	2,178,867	344,482	300,066	198,479	6,107,392
1964			3,061,162	2,270,899	339,350	310,202	271,964	6,253,577
1965			5,185,010	2,282,506	320,170	329,828	222,657	8,340,170
1966			6,149,095	2,703,907	372,591	355,089	245,580	9,826,262
1967			6,862,308	2,935,496	412,680	349,445	231,253	10,791,182
1968			6,403,414	3,163,642	470,004	379,734	258,693	10,675,488
1969			7,128,100	3,290,478	490,374	384,127	255,685	11,548,764
1970			9,884,483	2,715,882	639,196	394,786	194,034	13,828,381
1971			9,986,841	2,194,795	564,672	411,301	215,490	13,373,099
1972			6,739,670	3,334,514	664,570	549,797	347,714	11,636,264
1973			9,845,147	4,154,263	839,752	654,900	352,789	15,846,851
1974			12,451,599	3,598,272	762,099	725,746	398,700	17,936,416
1975			6,995,698	3,432,367	696,611	1,162,404	612,269	12,899,350
1976			7,963,085	5,201,109	1,006,081	1,451,071	795,642	16,416,987
1977	827	57,547	6,110,270	4,656,000	958,498	963,847	595,744	13,342,733
1978	49,355	318,261	6,115,118	4,969,749	939,773	957,436	576,644	13,926,336
1979	71,742	168,513	7,872,099	5,060,155	607,089	1,653,462	864,314	16,297,373
1980	146,610	389,918	9,696,910	5,166,862	777,683	1,837,551	942,726	18,958,261
1981	210,257	529,928	8,591,585	11,263,467	853,447	1,878,257	965,535	24,292,476
1982	360,685	1,061,987	12,429,433	10,606,020	464,936	2,400,755	1,272,931	28,596,747
1983	862,079	3,250,798	14,131,237	6,186,537	434,467	2,795,449	1,375,688	29,036,255
1984	4,733,051	11,987,307	28,944,525	5,512,393	405,751	2,394,390	1,057,500	55,034,918
1985	3,898,196	16,717,780	17,436,629	6,765,840	357,007	2,550,562	1,184,849	48,910,863
1986	6,246,980	15,233,376	16,389,035	5,702,054	341,552	2,605,329	1,440,563	47,958,890
1987	8,336,314	15,433,511	20,013,370	6,175,694	374,106	3,571,147	1,321,963	55,226,105
1988	9,591,328	24,106,439	26,877,521	6,302,798	387,521	3,723,473	1,855,270	72,844,350
1989	16,262,478	24,929,050	21,142,675	7,692,688	610,784	4,461,824	2,315,673	77,415,172
1990	9,590,633	30,565,301	26,282,573	8,170,680	615,777	4,019,862	1,994,826	81,239,651
1991	6,976,646	39,453,611	32,730,642	10,245,350	643,821	4,258,163	1,847,035	96,155,268
1992	10,652,665	42,769,283	34,997,908	11,444,483	993,899	5,560,660	2,244,094	108,662,992
1993	13,604,394	47,554,479	36,650,065	13,179,755	498,515	4,707,597	3,059,758	119,254,564
1994	15,332,576	53,714,643	34,796,833	15,118,478	308,877	3,309,159	3,315,353	125,895,919
1995	11,896,327	61,861,174	28,606,866	15,748,891	475,176	2,919,771	2,652,150	124,160,355
1996	11,404,568	50,392,566	35,690,292	19,534,484	363,925	3,649,657	2,692,345	123,727,837
1997	6,939,718	56,145,844	35,882,662	19,943,982	354,007	4,122,022	4,130,071	127,518,306
1998	9,104,842	50,262,319	49,558,576	21,866,992	345,350	4,975,331	3,989,101	140,102,510
1999	15,583,107	66,977,405	59,193,911	26,999,884	205,963	4,165,485	4,105,970	177,231,724
2000	9,381,460	60,368,565	36,379,795	29,478,241	155,584	3,359,432	3,613,645	142,736,722
2001	8,122,274	63,910,378	39,636,484	29,987,192	154,644	3,940,905	4,819,636	150,571,512
2002	7,063,064	95,412,246	48,168,305	27,262,402	195,682	3,833,110	4,171,982	186,106,791
2003	7,994,219	63,857,026	45,594,289	33,291,222	121,111	3,812,952	4,121,192	158,792,009
2004	5,203,707	56,151,022	46,329,573	36,674,386	160,678	5,815,208	4,679,450	155,014,025
2005	13,598,113	60,374,706	57,960,024	30,916,139	233,329	5,242,786	10,013,115	178,338,212
2006	9,475,998	70,798,996	55,304,538	44,427,971	316,435	7,794,118	12,166,821	200,284,877
2007	8,393,029	50,476,088	43,571,322	30,829,028	395,588	6,675,592	9,418,270	149,758,918
2008	5,904,981	65,952,685	40,827,683	35,885,690	439,249	6,765,660	4,119,365	159,895,313

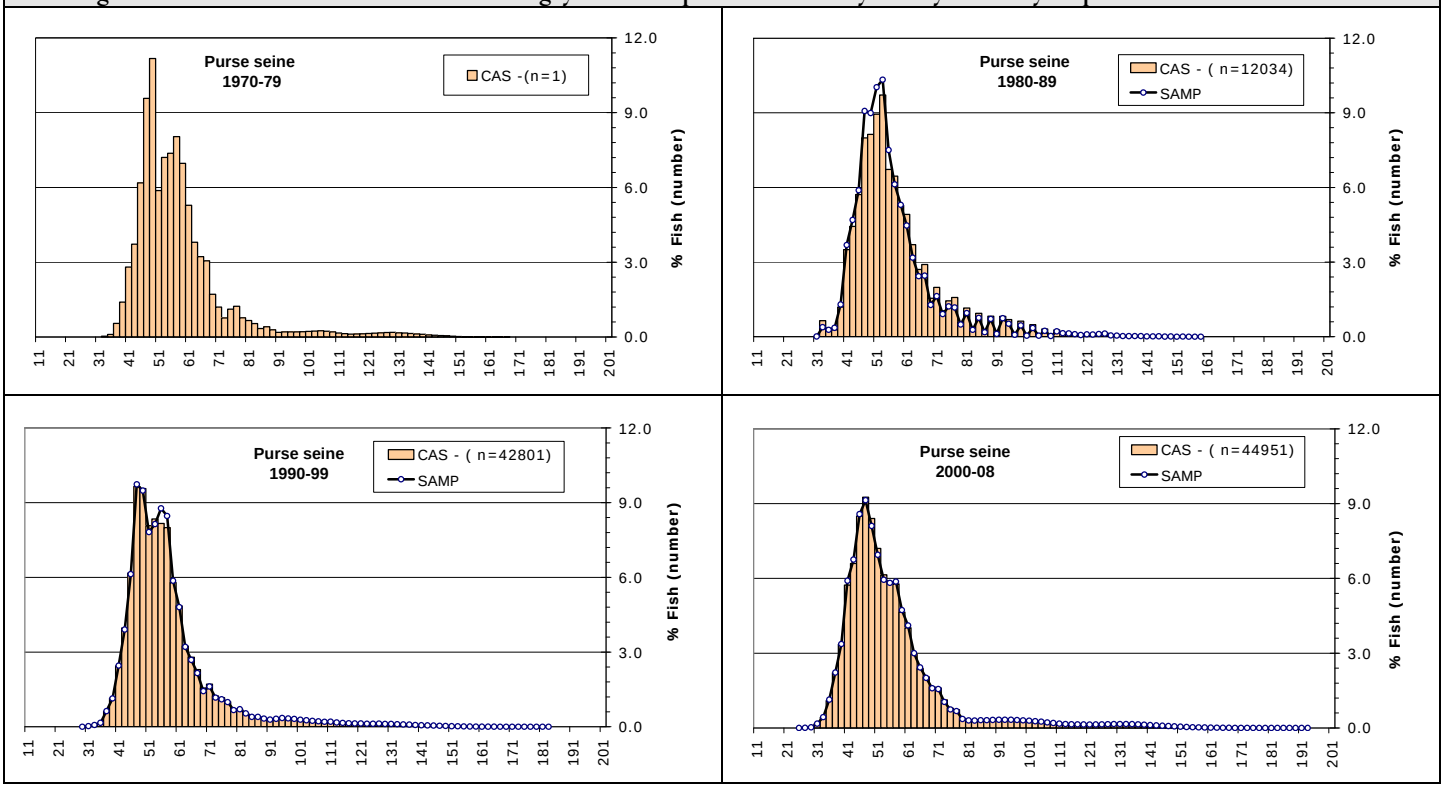
Skipjack Tuna catches in weight (tonnes)								
Year	Purse Seine-FS	Purse Seine-LS	Baitboat	Gillnet	Handline	Trolling	Other	Total
1950			8,113	2,019	431	74	48	10,686
1951			8,414	2,990	526	341	301	12,572
1952			8,441	2,561	367	363	324	12,056
1953			9,480	2,400	307	372	348	12,907
1954			9,625	2,500	299	419	374	13,217
1955			9,707	2,534	390	427	377	13,436
1956			9,758	2,837	446	454	402	13,896
1957			10,672	4,189	399	427	644	16,331
1958			10,723	3,451	430	451	619	15,674
1959			10,672	3,553	460	426	595	15,706
1960			9,884	4,548	569	443	755	16,199
1961			9,197	5,304	676	578	851	16,606
1962			8,762	6,918	937	561	928	18,107
1963			8,965	9,491	1,245	640	813	21,155
1964			8,887	10,140	1,229	669	1,046	21,972
1965			15,081	10,243	1,156	698	938	28,116
1966			17,888	12,216	1,349	751	1,168	33,372
1967			19,979	12,942	1,491	748	1,029	36,190
1968			18,633	13,884	1,701	815	1,285	36,319
1969			20,729	14,287	1,876	894	1,042	38,829
1970			28,775	11,835	2,404	1,262	720	44,995
1971			29,321	9,562	2,156	1,214	699	42,952
1972			19,412	14,377	2,510	1,455	1,117	38,872
1973			28,317	17,758	3,003	1,706	978	51,762
1974			35,348	15,574	2,740	1,811	1,109	56,582
1975			19,901	14,794	2,533	2,628	1,680	41,537
1976			23,042	21,937	3,529	3,405	2,151	54,064
1977	3	129	17,417	19,677	3,527	2,312	1,607	44,672
1978	201	717	17,472	20,753	3,493	2,313	1,565	46,514
1979	207	400	22,681	21,512	2,205	4,051	2,331	53,388
1980	406	1,014	27,935	21,106	2,795	4,587	2,536	60,378
1981	586	1,416	24,573	24,253	3,064	4,702	2,600	61,194
1982	1,219	2,976	22,658	26,148	1,703	5,535	3,796	64,036
1983	2,363	9,487	27,583	22,717	1,597	6,457	4,435	74,639
1984	13,956	31,771	40,441	19,182	1,529	5,846	3,823	116,546
1985	12,337	48,029	50,620	22,002	1,479	6,045	4,193	144,705
1986	20,844	45,808	54,261	21,022	1,470	6,017	3,992	153,415
1987	31,794	47,422	54,524	25,033	1,468	7,016	4,916	172,173
1988	26,849	66,045	69,520	27,692	1,439	7,379	5,178	204,102
1989	50,686	76,145	71,317	32,742	2,351	10,157	6,099	249,497
1990	27,462	80,789	72,935	35,646	2,357	9,492	5,347	234,029
1991	18,174	104,613	71,168	38,595	2,463	9,777	5,630	250,418
1992	29,993	121,331	71,181	44,705	4,069	12,831	5,995	290,105
1993	40,274	123,654	79,737	51,748	2,143	13,011	7,260	317,825
1994	50,947	128,229	84,492	63,689	1,294	10,993	7,450	347,093
1995	35,136	143,801	85,708	58,208	1,437	10,742	7,181	342,212
1996	35,414	113,749	85,042	66,067	1,405	13,239	9,750	324,666
1997	21,198	125,068	89,449	83,473	1,310	15,566	11,491	347,555
1998	22,655	127,385	94,258	78,434	1,166	14,442	10,626	348,966
1999	37,011	160,559	108,092	104,008	752	14,232	10,933	435,587
2000	28,937	170,945	96,203	115,282	620	14,672	10,827	437,485
2001	29,012	159,554	104,895	117,001	607	17,038	12,962	441,068
2002	22,794	215,789	127,066	109,379	733	12,976	8,459	497,196
2003	30,992	180,556	121,040	133,172	481	12,728	9,457	488,427
2004	18,565	137,882	122,859	154,496	616	21,625	12,498	468,541
2005	43,308	167,827	152,921	138,427	878	15,440	9,279	528,080
2006	34,954	211,940	147,759	183,918	1,213	19,819	13,320	612,923
2007	24,369	120,754	115,786	156,976	1,488	15,979	12,122	447,473
2008	15,559	127,825	107,644	132,208	1,655	16,388	12,289	413,567

APPENDIX III

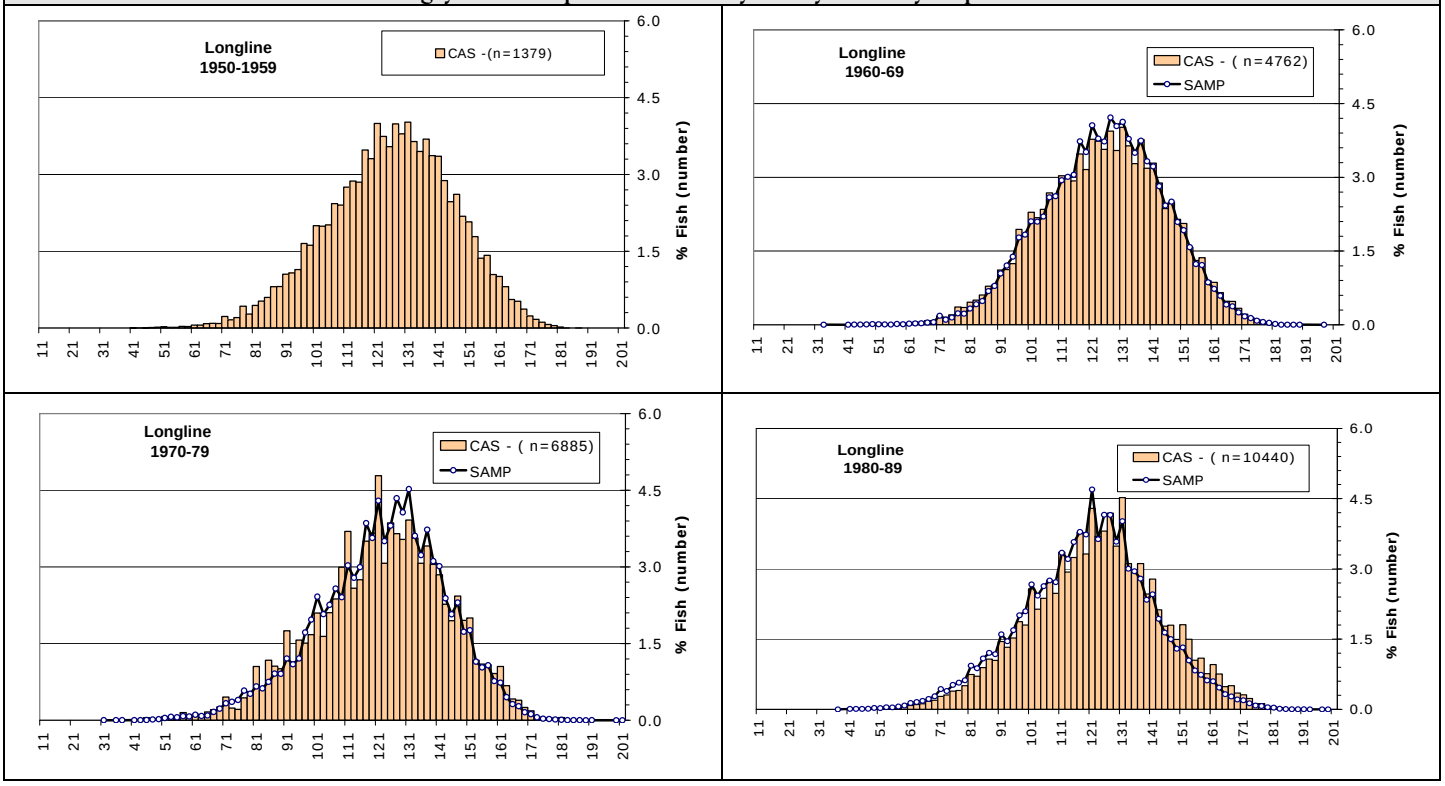
Length frequency distributions derived from samples and estimated as CAS, by fishery and decade

A/ Bigeye tuna (BET)

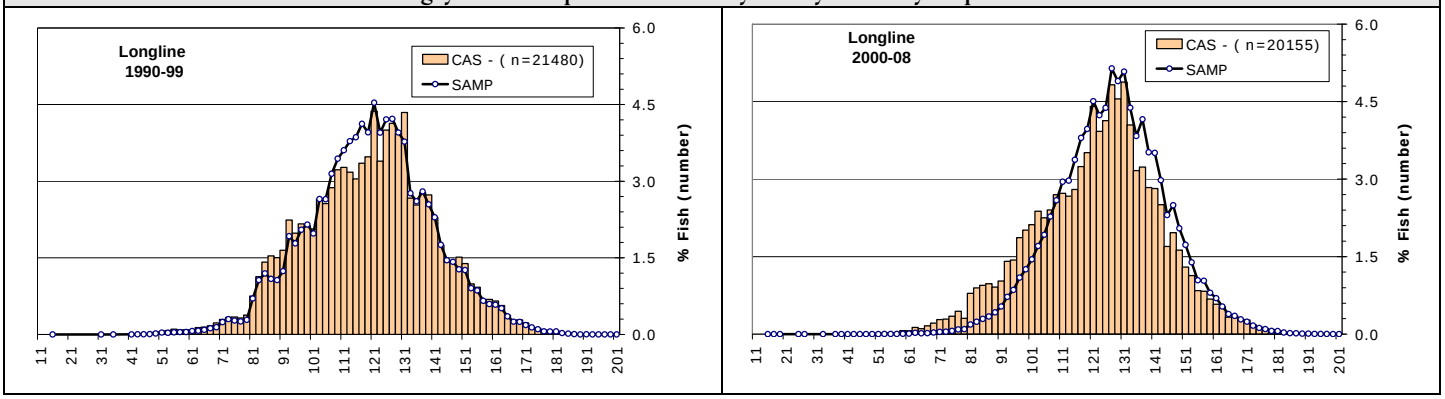
Figures 32-35: Industrial purse seiners: Proportion that the numbers of BIGEYE TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of bigeye tuna sampled/estimated by fishery and ten year period



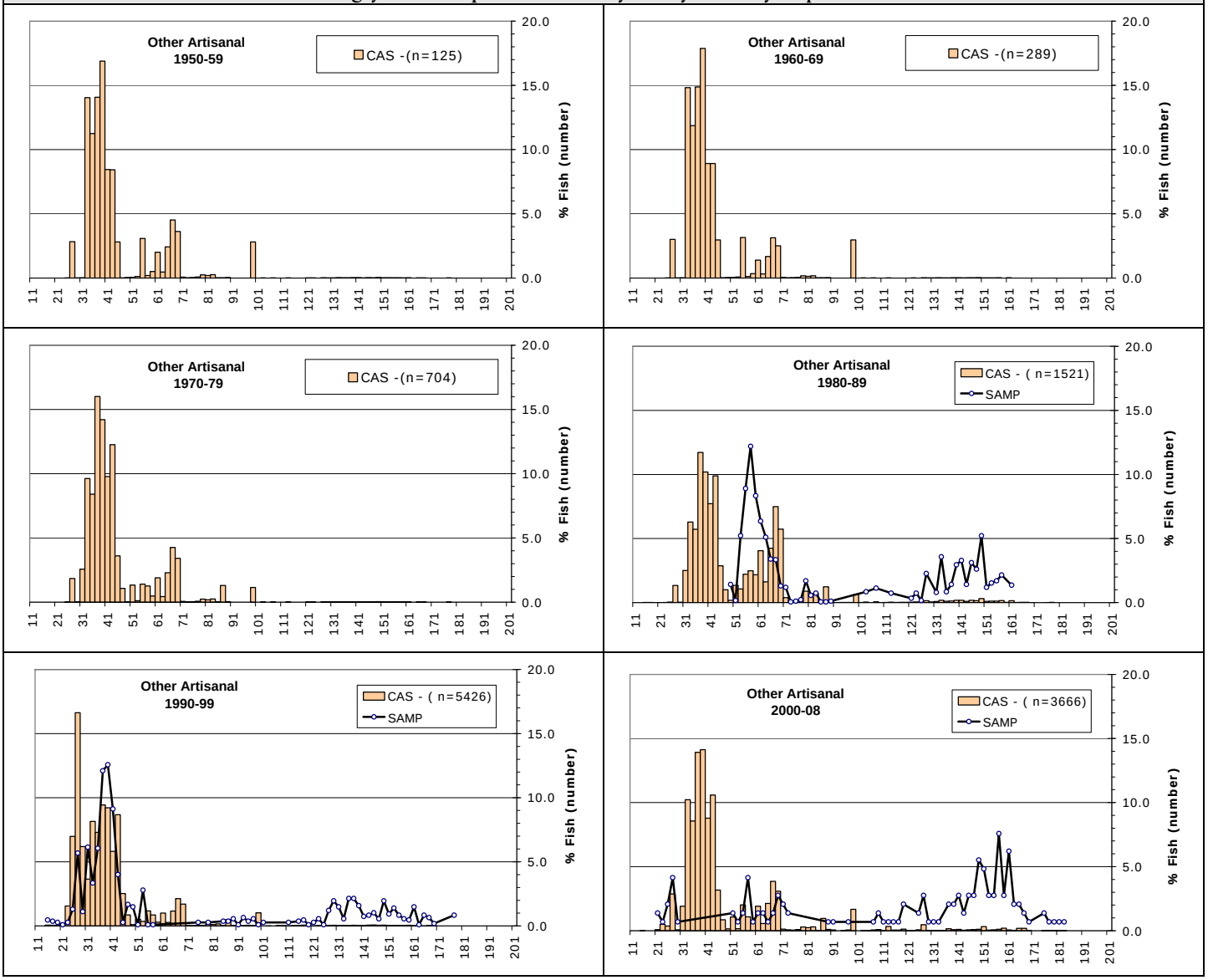
Figures 36-41: Longline: Proportion that the numbers of BIGEYE TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of bigeye tuna sampled/estimated by fishery and ten year period



Figures 36-41: Longline: Proportion that the numbers of BIGEYE TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of bigeye tuna sampled/estimated by fishery and ten year period

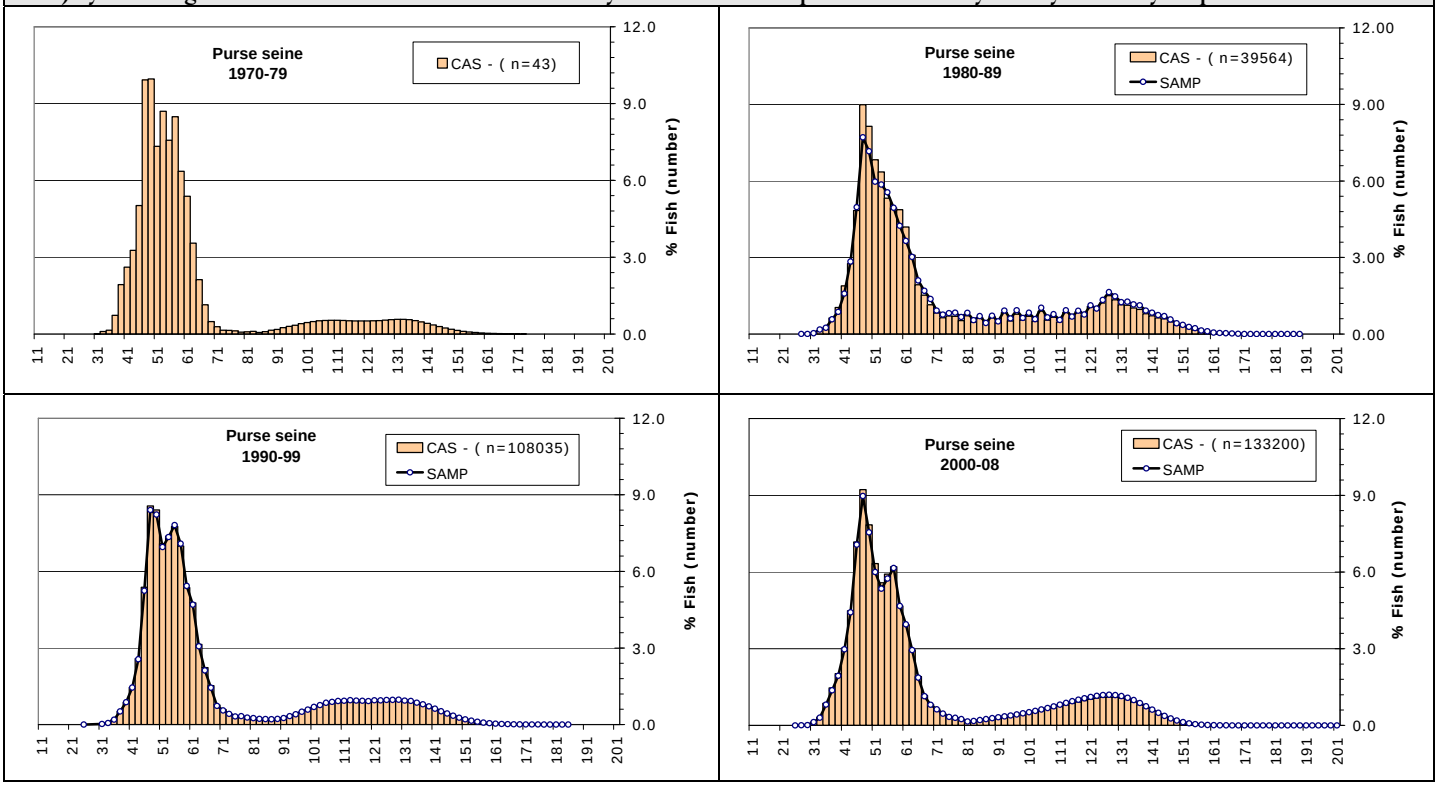


Figures 36-41: Other gears: Proportion that the numbers of BIGEYE TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of bigeye tuna sampled/estimated by fishery and ten year period

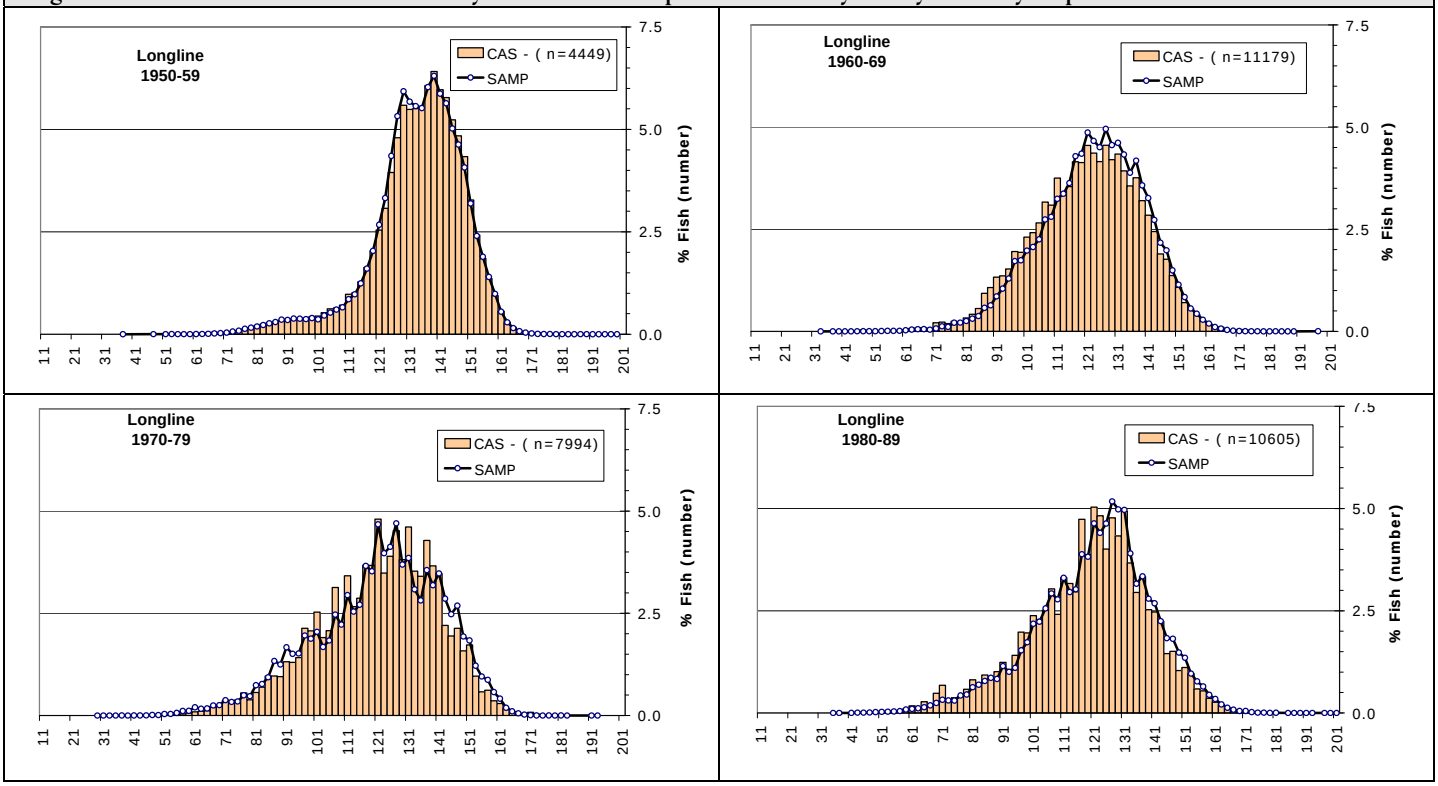


Length frequency distributions derived from samples and estimated as CAS, by fishery and decade
B/ Yellowfin tuna (YFT)

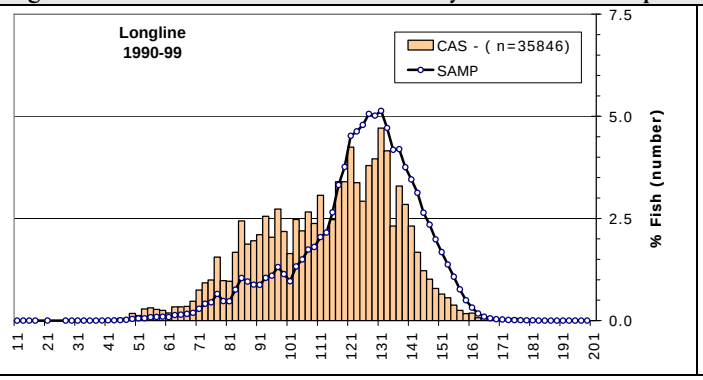
Figures 42-45: Industrial purse seine: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by fishery and ten year period

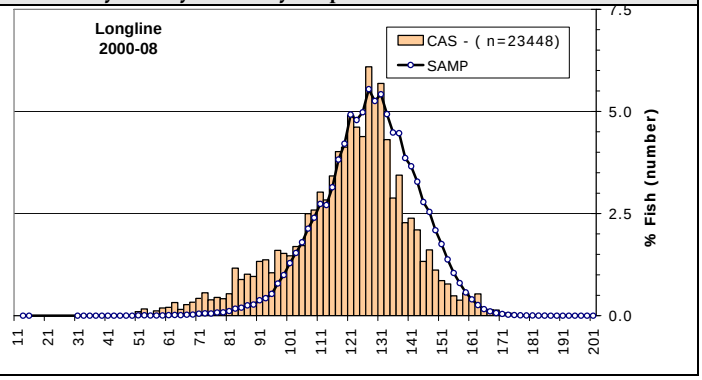


Figures 46-51: Longline: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by fishery and ten year period

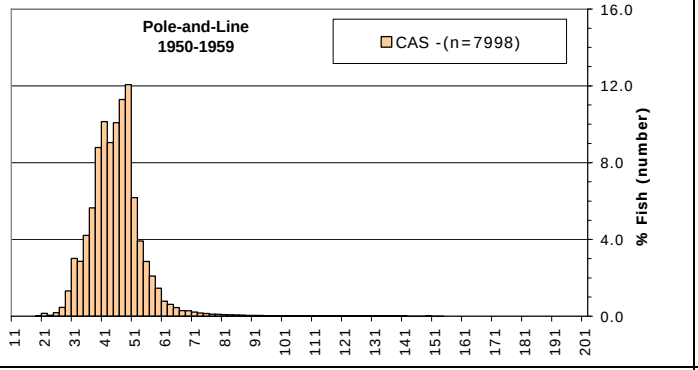


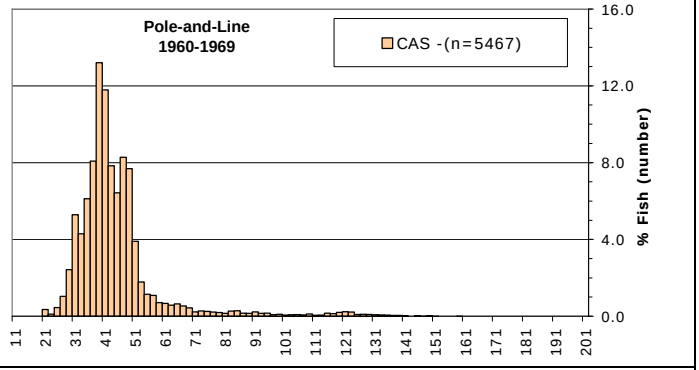
Figures 46-51: Longline: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by fishery and ten year period

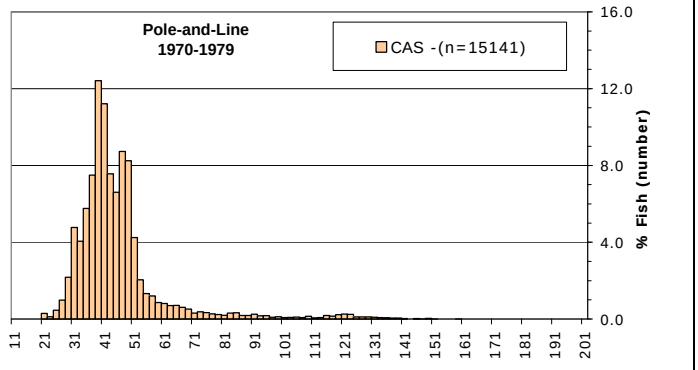


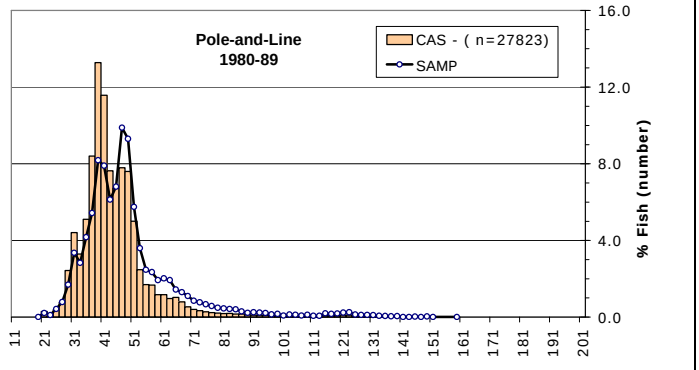


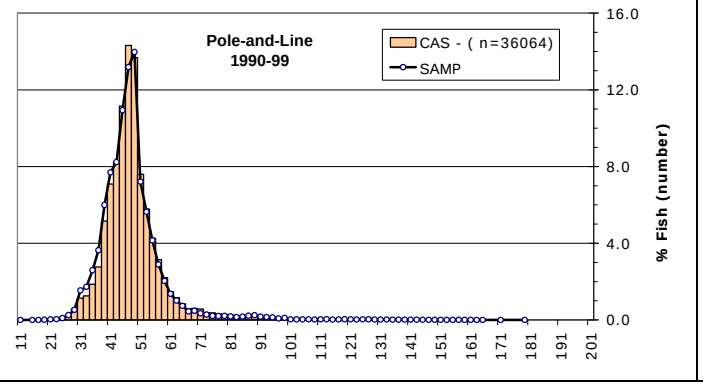
Figures 52-57: Pole-and-line: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by fishery and ten year period

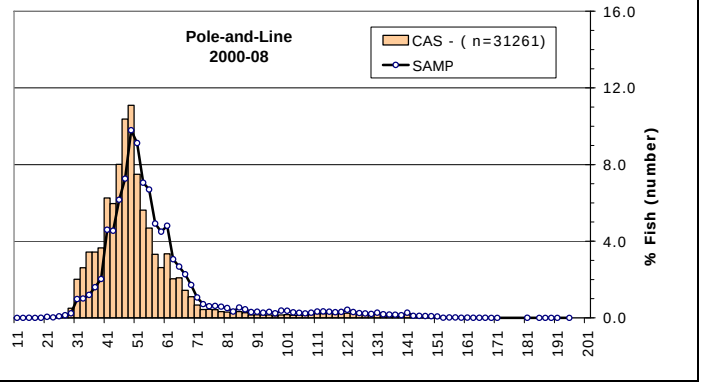




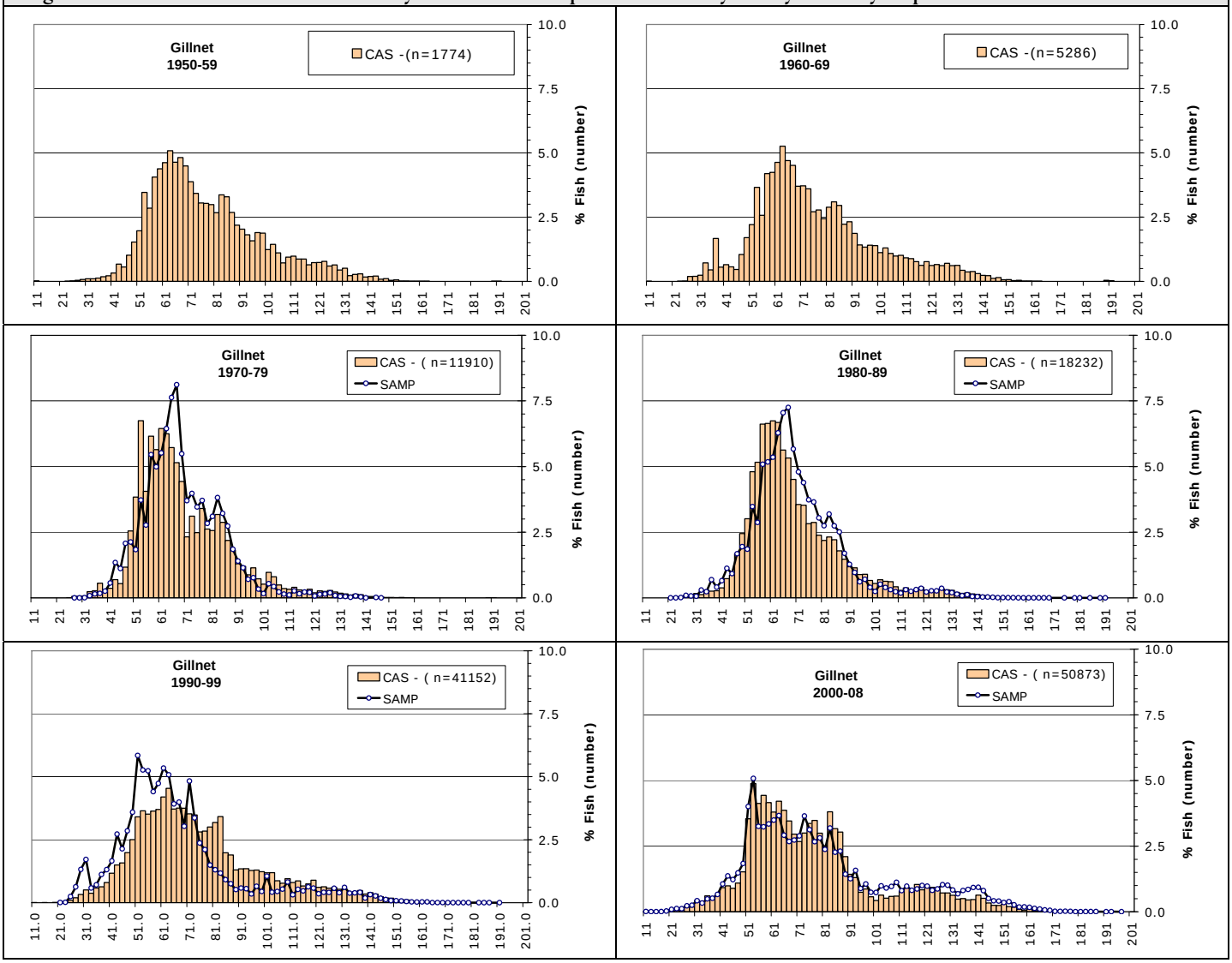




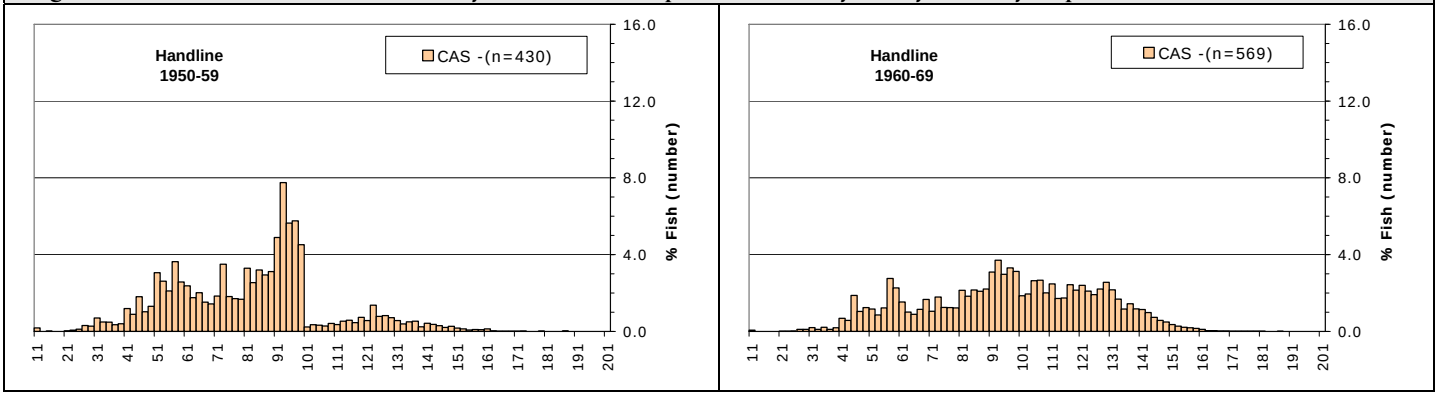




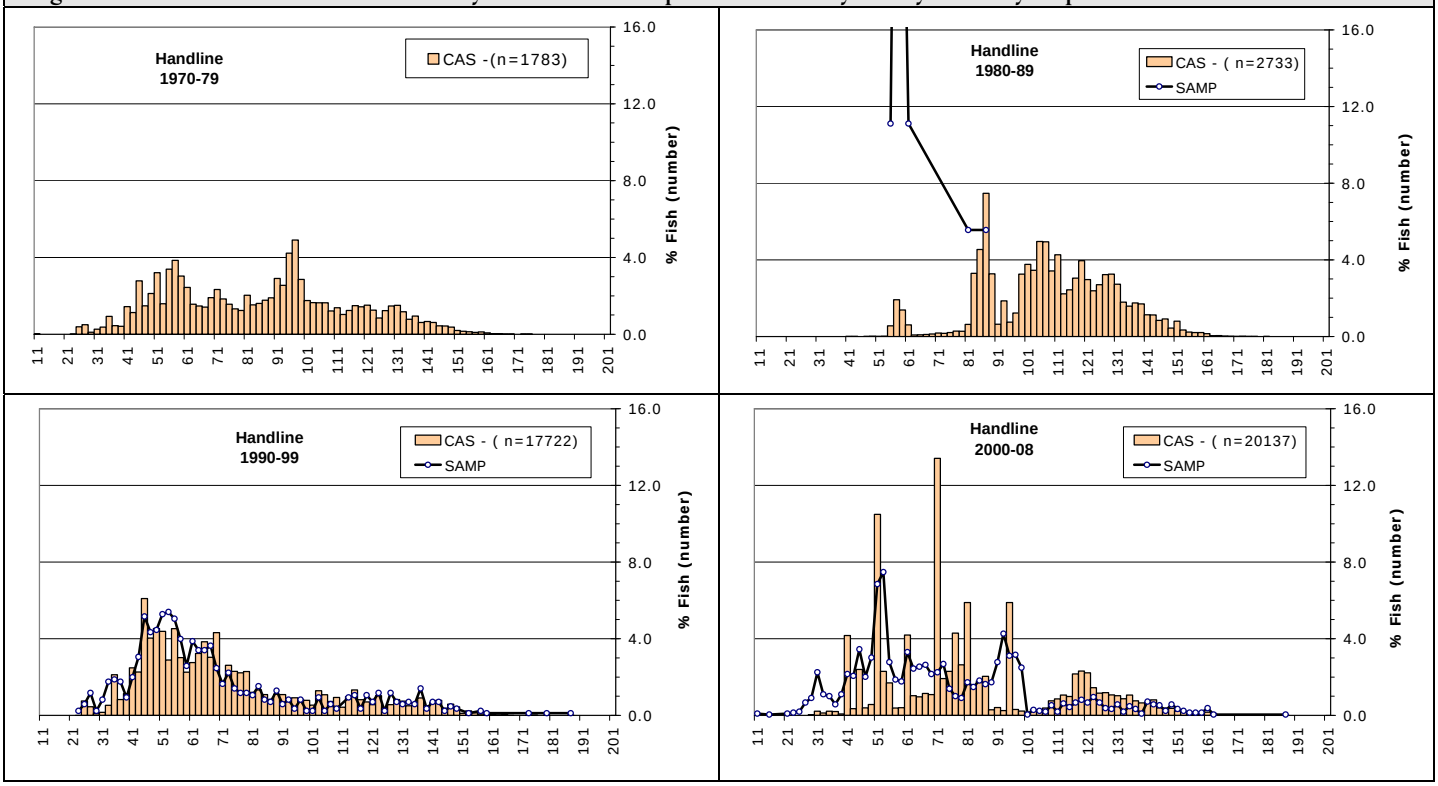
Figures 58-63: Gillnet: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by fishery and ten year period



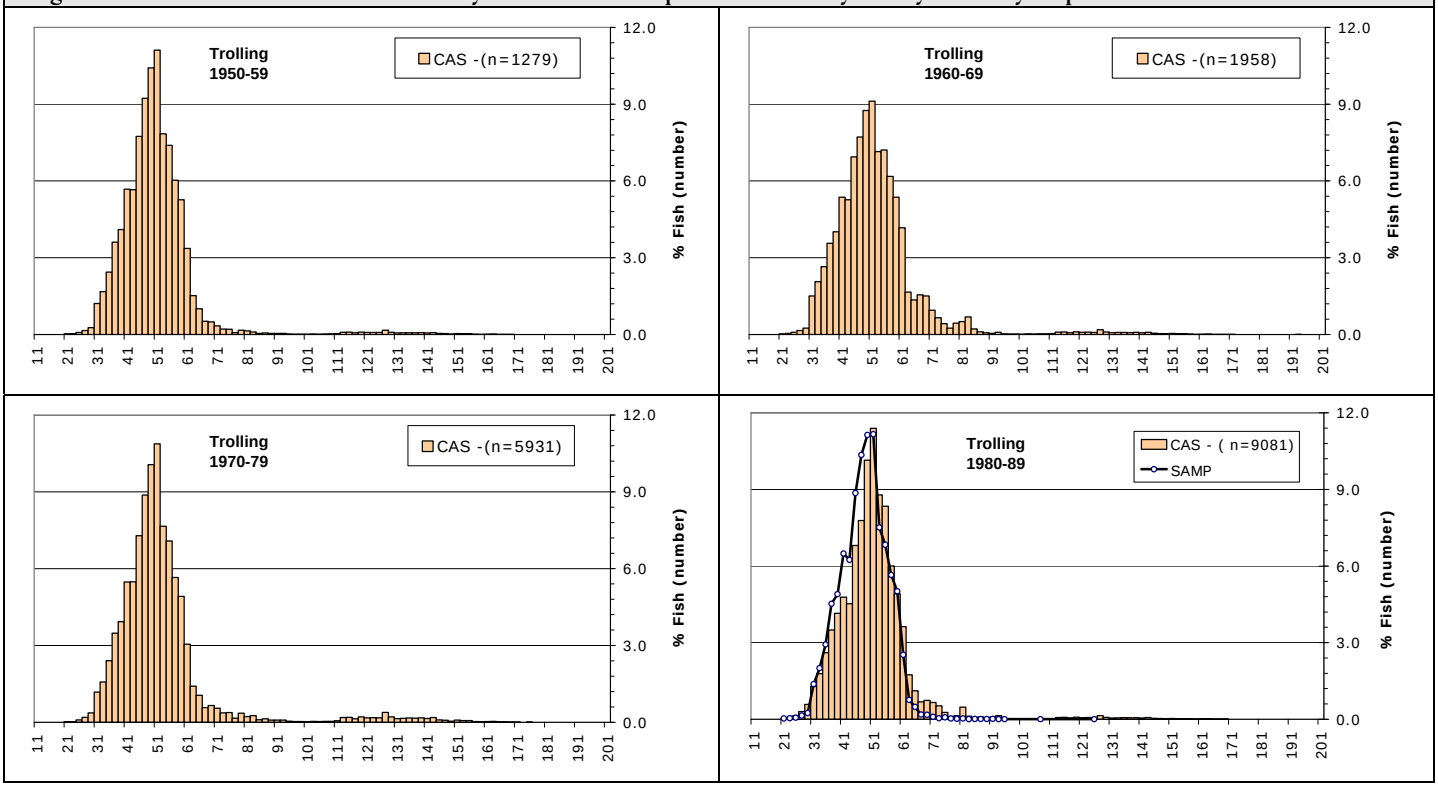
Figures 64-69: Handline: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by fishery and ten year period



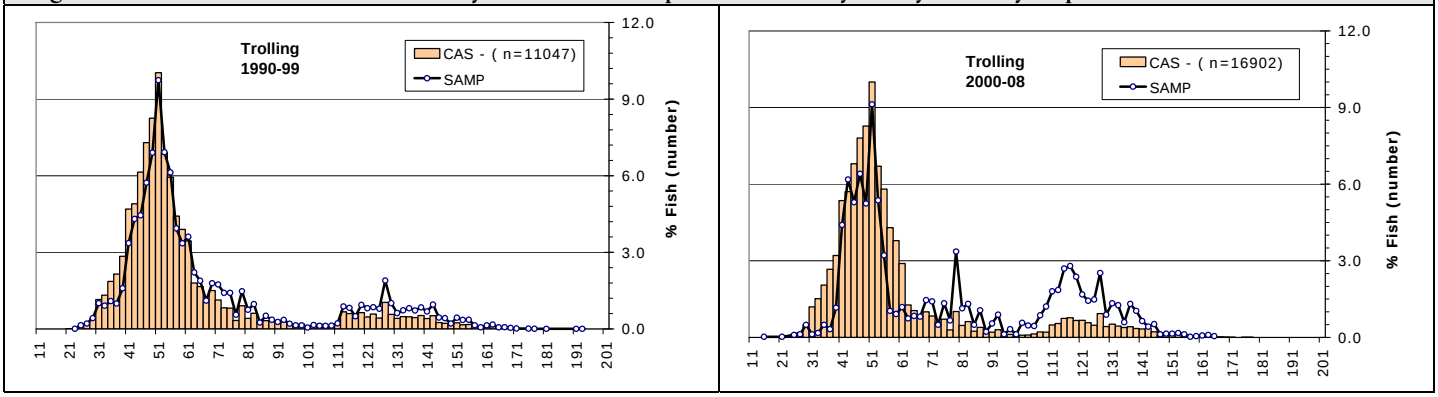
Figures 64-69: Handline: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by fishery and ten year period



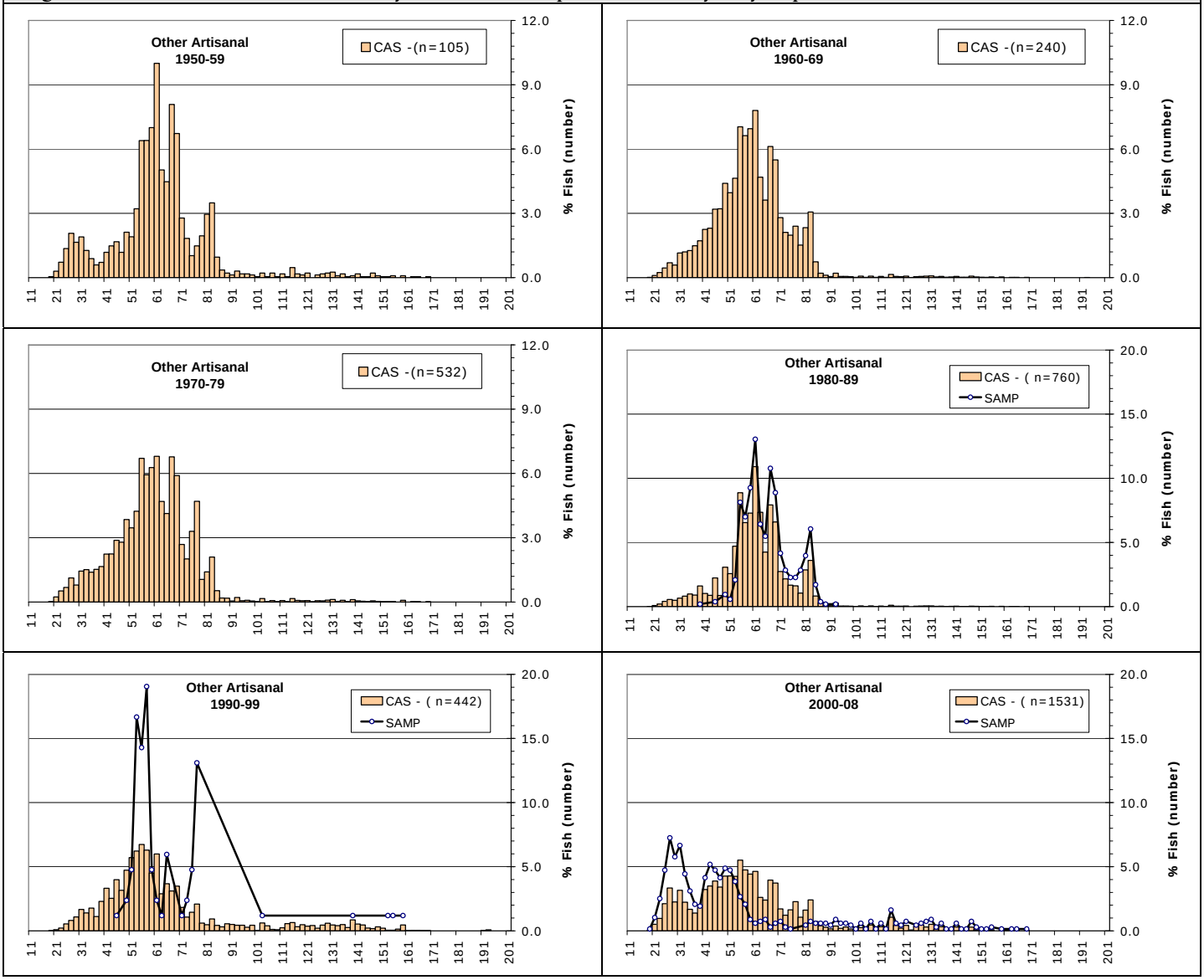
Figures 70-75: Trolling: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by fishery and ten year period



Figures 70-75: Trolling: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by fishery and ten year period

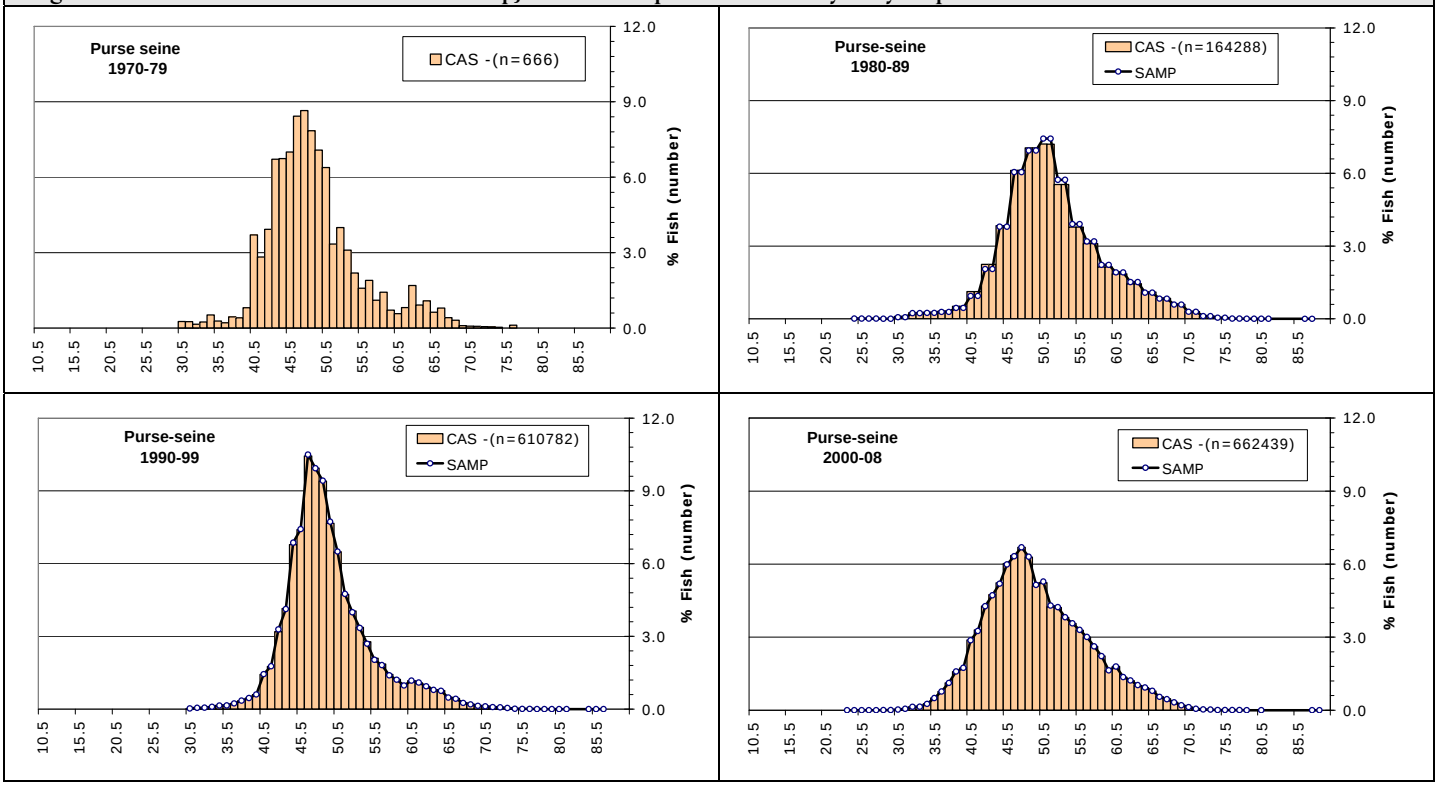


Figures 76-81: Other gears: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by ten year period

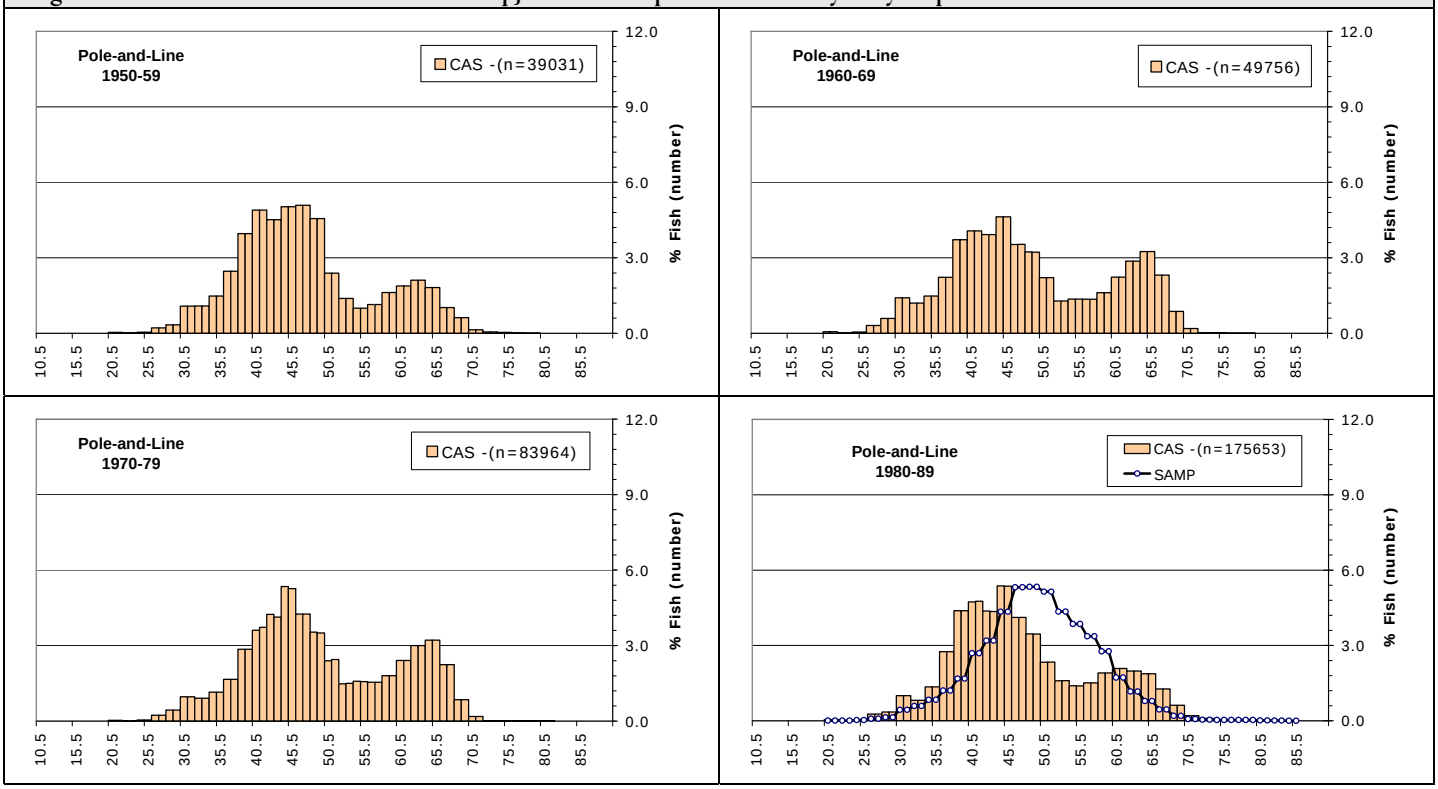


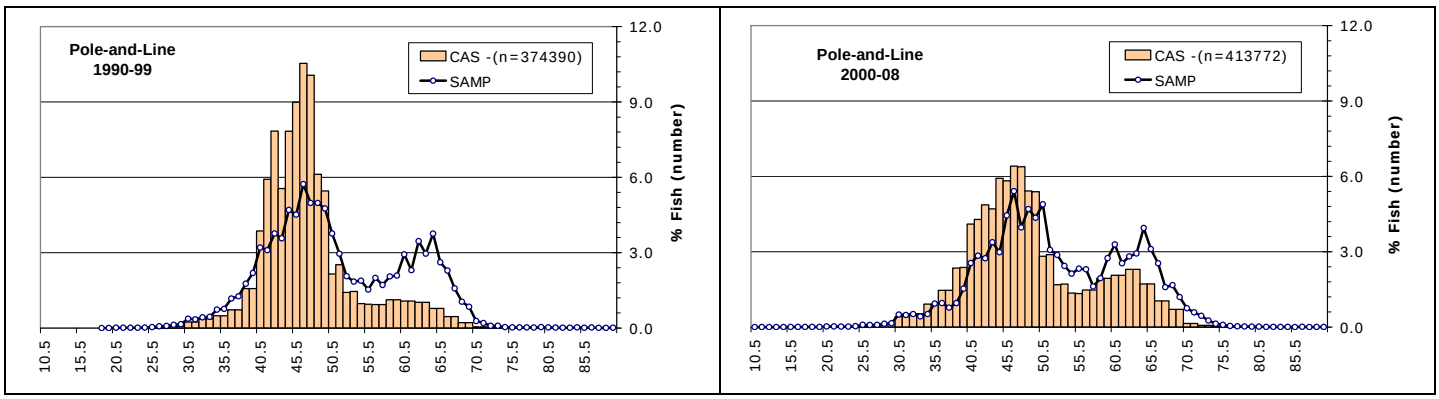
Length frequency distributions derived from samples and estimated as CAS, by fishery and decade
C/ Skipjack tuna (YFT)

Figures 82-85: Purse seine: Proportion that the numbers of SKIPJACK TUNA sampled (blue line)/estimated (CAS; orange bars) by 1cm length class made out of the total number of skipjack tuna sampled/estimated by ten year period

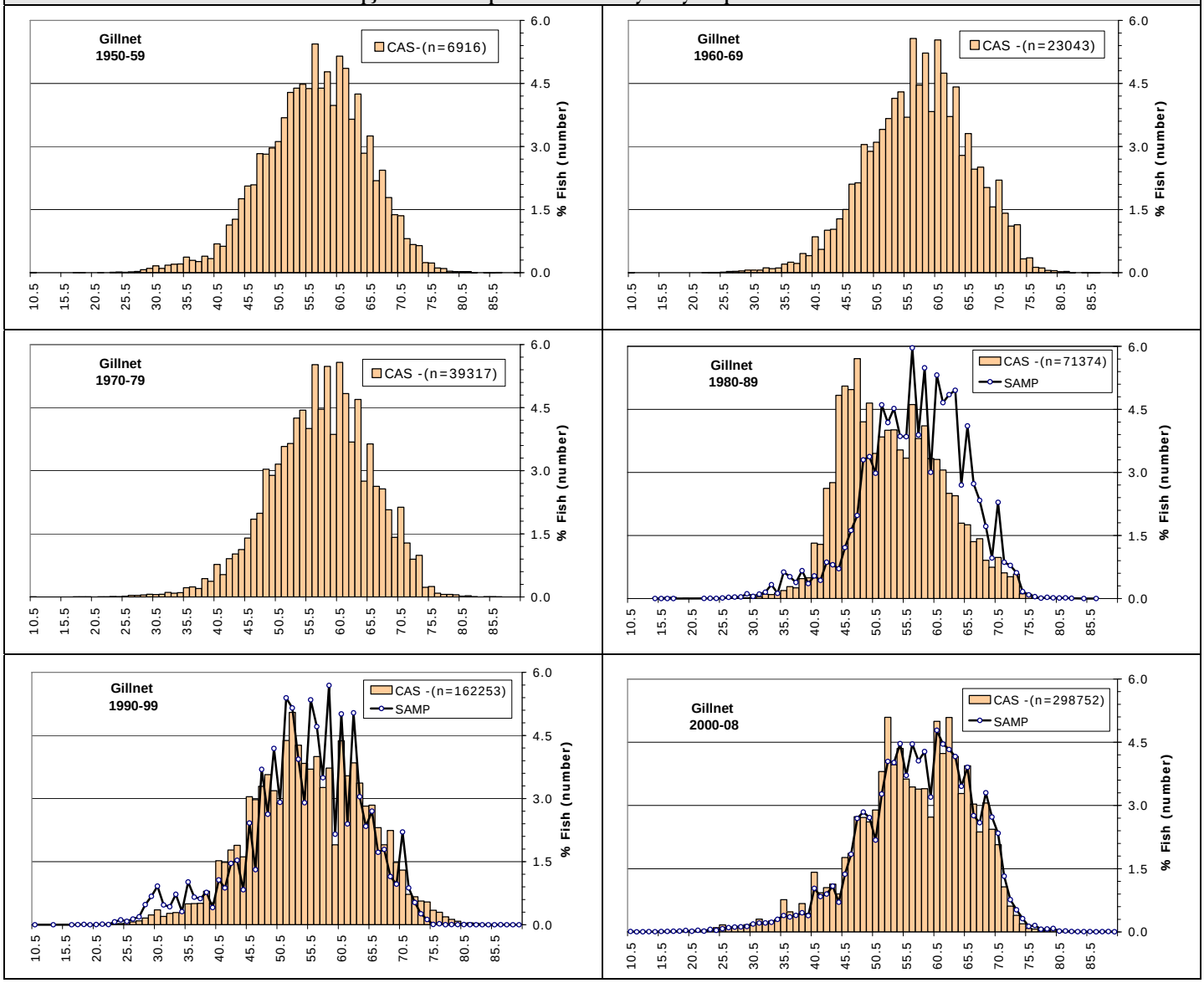


Figures 86-91: Pole-and-line: Proportion that the numbers of SKIPJACK TUNA sampled (blue line)/estimated (CAS; orange bars) by 1cm length class made out of the total number of skipjack tuna sampled/estimated by ten year period





Figures 86-91: Gillnet: Proportion that the numbers of SKIPJACK TUNA sampled (blue line)/estimated (CAS; orange bars) by 1cm length class made out of the total number of skipjack tuna sampled/estimated by ten year period



Figures 92-97: Other gears: Proportion that the numbers of SKIPJACK TUNA sampled (blue line)/estimated (CAS; orange bars) by 1cm length class made out of the total number of skipjack tuna sampled/estimated by ten year period