IOTC-2010-WPTT-08

Preparation of data input files for the stock assessments of Indian Ocean tropical tuna species

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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 tropical tuna species, for the period 1950-2009, 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 tropical tunas, by species, in number and weight, per year, quarter, and assessment area and fishery, for the period1950-2009, 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, tagging 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 tropical tunas:

- Input files for stock assessment, in particular:
  a. Models using estimates of total catches of tropical tunas, by species, in number and weight, tag release-and-recovery data and non-raised length-frequency data (**samples**) available by year, quarter and fishery, for 1950-2009.
  b. Models using estimates of total catches of tropical tunas, by species, in number and weight, tag release-and-recovery data and estimates of total numbers of tropical tunas caught by species, length class interval, year, quarter and fishery, or **Catch-at-Size**, for 1950-2009.
  c. Models using estimates of total catches of tropical tunas, by species, in number and weight, tag release-and-recovery data and estimates of total numbers of tropical tunas caught by species, age interval, year, quarter and fishery, or **Catch-at-Age**, for 1950-2009.
- 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) tables were estimated for the yellowfin tuna, bigeye tuna, and skipjack tuna. Catch-at-Age (CAA) tables were estimated for the yellowfin tuna and bigeye tuna. The estimation of CAA for the skipjack tuna has not been attempted in this paper due to a paucity of data.

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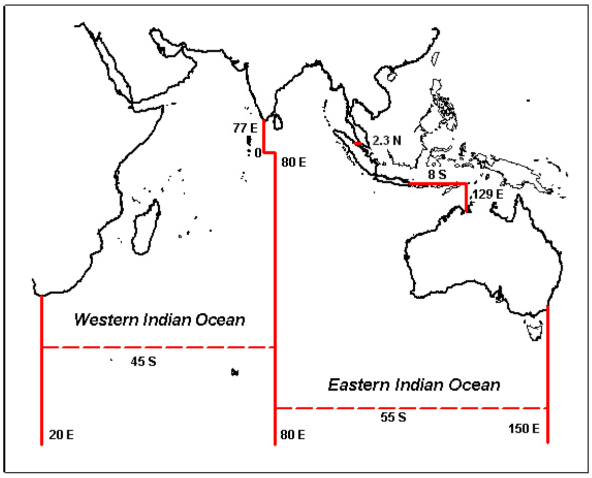
Basic Data

Four datasets are used in 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).
- *Tag release-and-recovery data*::
  a. Tag data at release: the vast majority of the fish tagged in the framework of the Indian Ocean Tuna Tagging Project (IOTTP) were released from two pole-and-line vessels chartered for the Regional Tuna Tagging Project – Indian Ocean (RTTP-IO0. Other releases took place on pole-and-line vessels in Maldives, Lakshadweep (India) and Andaman islands and from hand-line vessel in Mayotte. Several information were collected at tagging, including tag number, species, fork length, date and location of tagging, reliability codes, name of tagger, *etc*…

  b. Tag recovery at recovery: after setting up publicity campaigns and tag recovery scheme in most of the Indian Ocean countries and for the main fisheries, tags were recovered and reported in 28 countries. The main contributor was by far the purse-seine fleet based in Seychelles were more than 95% of the recoveries were made. Tags were recovered at different stage of the fishing and processing line:
     i. Tag recoveries at-sea: tags recovered during the fishing activity directly onboard the fishing vessel by the fishing crew. These recoveries are the most valuable because they can be associated to a unique date and location of catch. At recoveries the information collected included tag number, species, fork length and/or weight, date and location of recovery, gear, name of recover, *etc*…
     ii. Tag recoveries on land: if the tags were not recovered at sea, they could be recovered further down the processing line during:
         1. the unloading or transhipment of the fishing vessel by stevedores
         2. the unloading of the reefer by stevedores
         3. the processing of the fish in the canning factory.

         This is particularly true with the purse-seine fleet on which the quantities caught and the fishing procedure would allow only 20% of the recoveries to be made at sea. The information collected for those recoveries included tag number, species, fork length and/or weight, date of recovery, well number in which the tagged fish was recovered, gear, name of recoverer, *etc*…
  c. Tag seeding data: one difficulty in using tag-return data to estimate exploitation rates is that the number of tags returned will invariably underestimate the number of tagged fish recaptured. This is because some tags from recaptured fish will not be returned. In some cases these tags may simply be overlooked, in other cases the tags may be found but the finders will not be motivated (or able) to return them. In order to correct this, the Tag Reporting Rate has to be

[3] Not elsewhere identified

estimated, and for the purse-seine fleet based in Seychelles, a tag seeding experiment was implemented between 2004 and 2009. This experiment consisted or seeding tags on dead fish on-board and studying their reporting.

d. Tag shedding data: another cause of underestimation of the total number of recapture is the tag shedding, *i.e.* loss of the tag from the fish. In order to estimate the shedding rate, around 19% of the fish tagged by the RTTP-IO were double tagged. The number of double tagged fish recovered with only one tag will allow an estimation of the shedding rate.

- *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
Tag release & recovery data	Species, length or weight, gear	Date of release / recovery	Position of tagging / recovery	Total
Biological data	Various, depending on dataset	Various	Various, depending on dataset	Sample

Fisheries and Areas used for the assessments of tropical tunas

The nominal catches, samples, tag release-and-recovery data and estimates of Catch-at-Size and Catch-at-Age to be used for the assessments of tropical tunas were ultimately aggregated by year, quarter, assessment fishery and assessment area, depending on the species[4].

Bigeye tuna: A combination of areas and fisheries is used:

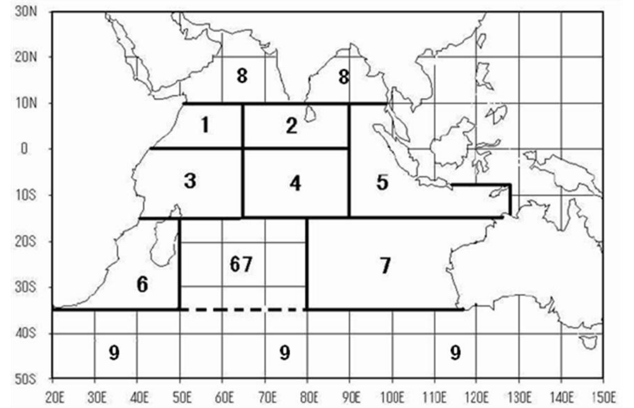
- Purse seiners on free swimming schools (**PSFS**) operating between the equator and 10°N and from the African coast to 65°E
- Purse seiners on associated schools (**PSLS**) operating between 15°S and 10°N and from the African coast to 65°E
- Longliners (**LL**) operating anywhere within the Indian Ocean
- All other fisheries (**OTHER**) operating anywhere within the Indian Ocean, including purse seine fisheries operating outside the areas indicated above

These areas are shown in **Table 2** and **Figure 2**. **Table 2**, below, shows the fisheries that are used for the assessment of bigeye tuna. It shows also total catches by fishery accumulated for the entire catch data series (1950-2009) and the contribution that the catches from each fishery made out of the total accumulated catches for 1950-2009, and in recent years (2005-09).

Table 2: Fisheries used for the assessments of Indian Ocean bigeye tuna; the total catches accumulated for the period 1950-2009 (Total Catch 50-09 in metric tons) and the relative importance of each fishery over both the entire catch series (%50-09) and in current years (%05-09) is also shown

Fishery	*Description*	*Total Catch 50-09*	*% 50-09*	*% 05-09*
PSFS	Contains data for all purse seine fisheries on free swimming schools operating between the equator and 15°S and from the African coast to 65°E	89,539	3	4
PSLS	Contains data for all purse seine fisheries on associated schools operating between 15°S and 10°N and from the African coast to 65°E	350,311	10	14
LL	Contains data for all longline fisheries operating anywhere within the Indian Ocean	2,878,485	82	74
OTHER	Contains data for all other fisheries operating anywhere within the Indian Ocean, including purse seine fisheries operating outside the areas indicated above[5]	164,832	5	8

Figure 2: Areas used for the assessments of Indian Ocean bigeye tuna and skipjack tuna (refer to Table 2-3 for details)



Skipjack tuna: A combination of areas and fisheries is used:

- Pole-and-line fishery of the Maldives (**BB**)
- Purse seiners on free swimming schools (**PSFS**) operating between the equator and 10°N and from the African coast to 65°E
- Purse seiners on associated schools (**PSLS**) operating between 15°S and 10°N and from the African coast to 65°E
- All other fisheries (**OTHER**) operating anywhere within the Indian Ocean, including purse seine fisheries operating outside the areas indicated above and pole-and-line fisheries other than Maldives

[4] Note that the fisheries and areas used in the assessments of yellowfin tuna are presented in a separate document (IOTC-2010-WPTT-07)

[5] Note that 31% of the catches of PSFS and 18% of the catches of PSLS (21% for the combined fisheries), over the period 1950-2009, were recorded outside the areas used for these fisheries and therefore assigned to the fishery OTHER (representing 70% of the total catches under this fishery over the period 1950-2009).

These areas are shown in **Table 3** and **Figure 3**. **Table 3**, below, shows the fisheries that are used for the assessment of skipjack tuna. It shows also total catches by fishery accumulated for the entire catch data series (1950-2009) and the contribution that the catches from each fishery made out of the total accumulated catches for 1950-2009, and in recent years (2005-09).

Table 3: Fisheries used for the assessments of Indian Ocean skipjack tuna; the total catches accumulated for the period 1950-2009 (Total Catch 50-09 in metric tons) and the relative importance of each fishery over both the entire catch series (%50-09) and in current years (%05-09) is also shown

Fishery	*Description*	*Total Catch 50-09*	*% 50-09*	*% 05-09*
BB	Contains data for the pole-and-line fishery operating in the Maldives	2,448,220	23	20
PSFS	Contains data for all purse seine fisheries on free swimming schools operating between the equator and 15°S and from the African coast to 65°E	409,651	4	3
PSLS	Contains data for all purse seine fisheries on associated schools operating between 15°S and 10°N and from the African coast to 65°E	2,737,169	26	25
OTHER	Contains data for all other fisheries operating anywhere within the Indian Ocean, including purse seine fisheries operating outside the areas indicated above and pole-and-line fisheries other than Maldives[6]	4,835,167	46	52

Input Tables

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

- Stock assessments of **yellowfin tuna**: Two sets of tables were prepared, depending on the type of assessment models to be used:

  Assessment models using non-raised length frequency data (samples)[7]

  a. Total catches of yellowfin tuna, in number of specimens and weight, by year, quarter, assessment fishery, and assessment area.
  b. Total effort estimated (industrial fisheries) or available (artisanal fisheries) 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.
  d. Tag release-and-recovery information by length interval, fishery, area, year, and quarter.

  Assessment models using Catch-at-Size data

  a. Estimates of total catches of yellowfin tuna, in number of specimens and weight, by year, quarter, fishery and area.
  b. Estimates of total number of specimens of yellowfin tuna caught by length class (Catch-at-Size) by fishery, area, year, and quarter.
  c. Tag release-and-recovery information by length interval, fishery, area, year, and quarter.

  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

- Stock assessments of **bigeye tuna** and **skipjack tuna**: Two sets of tables were prepared for each species, depending on the type of assessment models to be used:

  Assessment models using non-raised length frequency data (samples)

  a. Estimates of total catches in number of specimens and weight, by species, year, quarter, fishery and area.
  b. Number of specimens sampled by species, length interval, fishery, area, year, and quarter.
  c. Tag release-and-recovery information by species, length interval, fishery, area, year, and quarter.

  Assessment models using Catch-at-Size data

  a. Estimates of total catches in number of specimens and weight, by species, year, quarter, fishery and area.
  b. Estimates of total number of specimens caught by species, length class (Catch-at-Size), fishery, area, year, and quarter.
  c. Tag release-and-recovery information by species, length interval, fishery, area, year, and quarter.

- Stock status indicators for tropical tuna species: The Secretariat used total catches, catch-and-effort, length frequency samples, tagging data 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**.

[6] Note that 42% of the catches of PSFS and 15% of the catches of PSLS (20% for the combined fisheries), over the period 1950-2009, were recorded outside the areas used for these fisheries and therefore assigned to the fishery OTHER (representing 16% of the total catches under this fishery over the period 1950-2009).

[7] The preparation of data for the assessments of yellowfin tuna using MF-CL has been covered in a separate document (IOTC-2010-WPTT-07)

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.

1. Standardizing catch, size frequency and tag release-and-recovery data 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 and so on for YFT and BET and 10-11cm, 11-12cm and so on for SKJ)
        iii. Assigning samples not recorded by area (purse seine and other gears)/quarter by area/quarter
    d. Tag recovery: tag recoveries on-board the purse-seine fleet are assign with a position and date of recovery from the wells they were recovered from (TG➔TGst). Recoveries with no fork length but another measurement type (*e.g.* FDL or weight) are assigned with an estimated Fork Length.
2. **Tropical tunas length frequency samples input files** (LFst ➔$\mathbf{LF_{INPUT}}$) Aggregating the length frequency samples in LFst by species-fishery-area-year-quarter-number of specimens sampled by length class, for 1950-2009.
3. **Tropical tunas tag release input files** (TGrel_st ➔$\mathbf{TG_{Rel\_INPUT}}$) Aggregating the tag release-recovery in TGst by species/area/year and quarter /"length-at-release".
4. **Tropical tunas tag recovery input files** (TGrec_st ➔$\mathbf{TG_{Rec\_INPUT}}$) Aggregating the tag release-recovery in TGst by species/fishery-area/year and quarter of release/year and quarter of recovery/"length-at-release".
5. Breaking the NCst by quarter and 5^0 grid using the CEst (NCst➔NCds)
6. Assigning length frequency samples to all NCds strata (Species-Fleet-Gear-Year-Quarter-PS/Other Area) (NCds➔LFcv)
7. Deriving Catch-at-Size (CAS) by scaling up length frequency distributions in LFcv from sample weight to total weight for each stratum (LFcv➔CAS)
8. Adjusting/estimating NCds weights/numbers by using average weights derived from the CAS (NCds➔NCad)
9. **Tropical tunas total catch input files** (NCad➔$\mathbf{NC_{INPUT}}$) Aggregating the catches in NCad by species-fishery-area-year-quarter-total catch (in number and weight), for 1950-2009.
10. **Tropical tunas Catch-at-Size input files** (CAS➔$\mathbf{CAS_{INPUT}}$): Aggregating the length frequency data in CAS by species-fishery-area-year-quarter-total number of specimens by length class interval, for 1950-2009.
11. **Tropical tunas Catch-at-Age input files** (CAS➔$\mathbf{CAA_{INPUT}}$): Deriving Catch-at-Age for tropical tunas using CAS_{INPUT} and the existing Length-Age key(s) to obtain estimates of total n umber of specimens caught by species, age class, fishery, area, year and quarter, for 1950-2009.

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-5º square grid-Catch in number of fish-(and/or)-Catch in metric tons.

i. Grid allocation: All the catches not recorded by 5º square grid were assigned by grid as follows:
    a. Allocation of catches recorded under irregular areas by 5º square grid: The catches recorded under irregular areas (e.g. port of unloading, fishing district, etc.) were assigned to the neighbouring 5º square grid(s).
    b. Allocation of catches recorded under areas that fell within a single 5º square area: all catches recorded under areas that fell within a 5º square area were assigned to the corresponding 5 º square areas.
    c. Allocation of catches recorded under areas overlapping two or more 5º square areas: all catches recorded under areas that overlapped two or more 5º square areas were assigned proportionally by 5 º square area (i.e. by using the proportions obtained by dividing the amount of 1 degree square grids that fell within each 5 º 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 tropical tunas available into standard form:

i. Converting non-standard measurement types into standard length (**Table 4**):

a. Converting from gilled-and-gutted 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 measurements into standard length: The regression equations presented in **Table 4** were used to estimate the distance from the tip of the snout to the fork of the tail (fork length) for specimens of tropical tunas that were recorded under non-standard lengths or weights (other than the above) in the IOTC database (deterministic conversion).

Table 4: Regression equations used to convert from non-standard measurements into standard lengths, by 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)

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

Table 5: 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

a. All tropical tuna specimens recorded under length classes that do not overlap the length classes selected for the species were assigned to the corresponding length classes (e.g. specimens of YFT recorded under the classes 16-17cm and 17-18cm were accumulated under fork length class 16(-18)).

b. All tropical tuna specimens recorded under length classes that overlap the length classes selected for the species were assigned proportionally to the corresponding standard length classes (e.g. 1/2 of the BET specimens recorded under the length class 17-19cm were assigned to length class 16-18cm and 1/2 to length class 18-20cm). The specimens of tropical tunas from samples using length class intervals over those specified in table 5 (Maximum interval allowed (cm)) were discarded.

Breaking the nominal catches by month and 5^{O} degree square grid

The aim of this process is to break the catches recorded in the nominal catches table by month and 5º 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 2-3**).
- 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 5º square area for the Tuna Atlas.

The steps given to assign the catches available for each NC stratum per month and 5º 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 25 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 25 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 25 years above or below the year concerned are used.
    b. Time-area catches do not exist for the fleet concerned for up to 25 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 5º 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.
        ii. Fleets that are presumed to operate in specific areas: This refers mainly to artisanal and semi-industrial fleets. One or more 5º 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 tables (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 or used as such for the assessments.

Reformatting of length frequency data

The time-area resolution used for the estimation of catch-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): 10º latitude by 20º longitude areas are used, as shown on **Figure 4**[8].

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

Figure 3: Areas used for industrial purse seiners

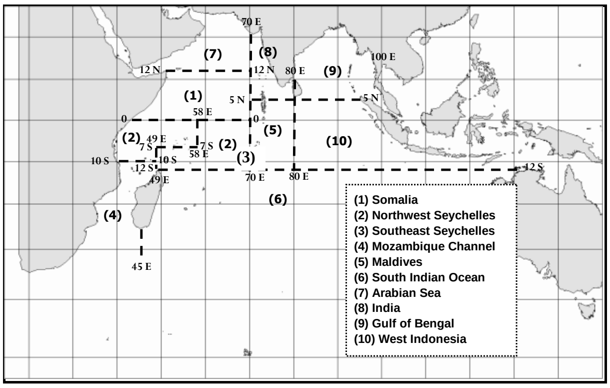
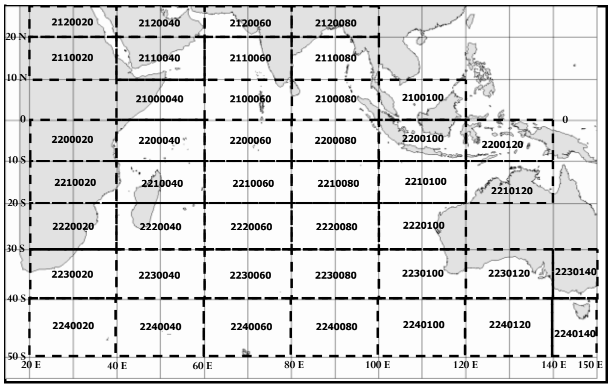


Figure 4: Areas used for other fisheries



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).

Table 6: 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)*

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.
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[9]:

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

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 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). 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. **Table 9** below shows an example of the substitution scheme:

[9] 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.

Table 9: Nominal catches strata and alternative fleets from which length frequency samples are used in the case that less than 30 lengths of tropical tunas 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*
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

For example, if no samples of bigeye tuna 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 for 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.

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 average weights estimated from the samples (by using the equations 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 by 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 tropical tunas by species and 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 (**NC_{INPUT}**)

The catches and numbers of fish in the NC table were weighted by using the same method referred to in the previous section. The catches in the resulting NC table are then aggregated by assessment fishery and assessment area as indicated on Table 2-3. The above catches were aggregated by species, 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 tropical tunas. The following process was followed to create the table $\mathbf{FL_{INPUT}}$:

i. Scaling down raised length frequency data 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 and fishery: The existing samples were aggregated by assessment area and fishery following the specifications in Table 2 (bigeye tuna) and Table 3 (skipjack tuna).
   a. All specimens from samples recorded in areas that do not overlap the areas used for the assessment (**Figure 2-3**) were assigned to the corresponding assessment area.
   b. All specimens from samples recorded under areas that overlap 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 the areas concerned.

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.

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

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

Catch-at-Size data are estimated for each fleet-gear(fishing mode)-year-quarter strata. The CAS were aggregated by assessment area and fishery following the specifications in **Table 2** (bigeye tuna) and **Table 3** (skipjack tuna).

i. All CAS recorded in areas that do not overlap the areas used for the assessment (Figure 2-3) were assigned to the corresponding assessment area.
ii. All CAS recorded under areas that overlap 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 the areas concerned.

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

Estimation of catch-at-age tables ($\mathbf{CAA_{INPUT}}$)

Catch-at-age tables for each species are estimated using the catch-at-size data. Catch-at-age tables were estimated for the yellowfin tuna and the bigeye tuna.

Yellowfin tuna: A deterministic conversion from length to age was applied using the following length-age table (**Table 10**), provided by A.Fonteneau (IOTC-2008-WPTT-4).

Table 10: Nominal catches strata and alternative fleets from which length frequency samples are used in the case that less than 30 lengths of tropical tunas are available for the NC strata concerned (example)

Age	Quarter	LengthFrom	LengthTo	Proportion
0	1	0	22	1
0	2	0	32	1
0	3	0	48	1
0	4	0	52	1
1	1	22	54	1
1	2	32	60	1
1	3	48	68	1
1	4	52	78	1
2	1	54	88	1
2	2	60	98	1
2	3	68	108	1
2	4	78	114	1
3	1	88	120	1
3	2	98	126	1

Age	Quarter	LengthFrom	LengthTo	Proportion
3	3	108	130	1
3	4	114	132	1
4	1	120	136	1
4	2	126	138	1
4	3	130	140	1
4	4	132	140	1
5	1	136	142	1
5	2	138	142	1
5	3	140	144	1
5	4	140	144	1
6	1	142	252	1
6	2	142	252	1
6	3	144	252	1
6	4	144	252	1

Bigeye tuna: CAA was estimated according to the following VB log k model (Laslett, Eveson and Polacheck method, IOTC-2008-WPTT-09) using the following parameter estimates :

$$L(t) = L_\infty \left(1 - e^{-k_2(t-t_0)} \left\{ \frac{1+e^{-\beta(t-t_0-\alpha)}}{1+e^{\beta\alpha}} \right\}^{-(k_2-k_1)/\beta} \right)$$

Species	L_∞	k_1	k_2	α	β	t_0
BET	160	0.071	0.4207	5.6033	2.999	-3.09

An Age-Length key was derived from above and used to convert the numbers of specimens estimated by length (CAS) into age (CAA).

The resulting Catches-at-Age were aggregated by Age class (0-9+), year, quarter and assessment fishery. An example of the Input Table containing the CAA data can be found in **Appendix I**.

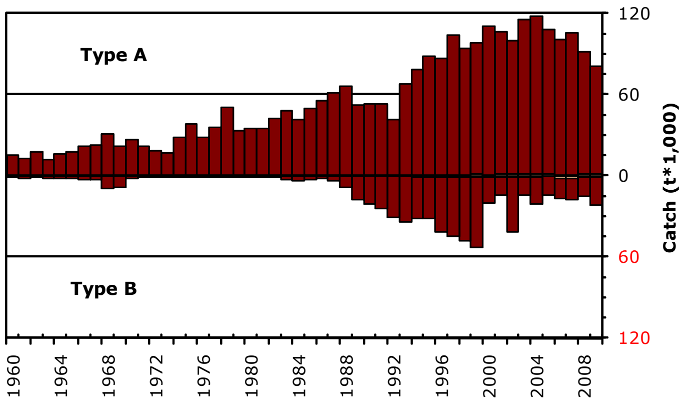
Results

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 2009 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 1960-2009.

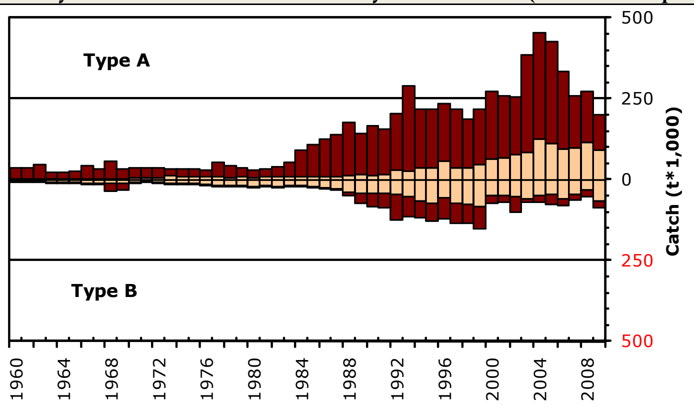
Figure 5: Uncertainty of annual catch estimates for bigeye tuna (Data as of September 2010)



*Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.*

- 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 1960-2009. 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.

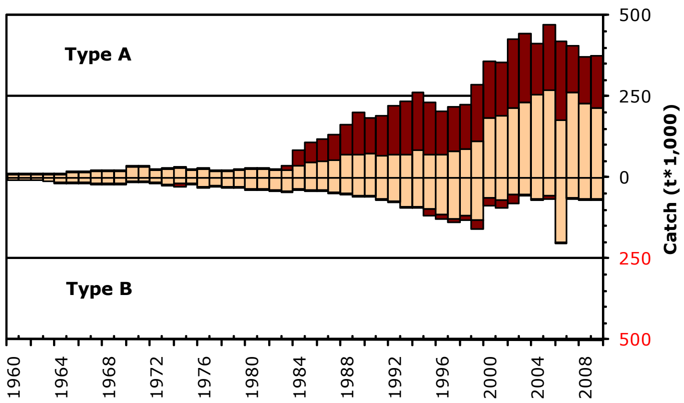
Figure 6: Uncertainty of annual catch estimates for yellowfin tuna (Data as of September 2010)



*Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.*

- 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 1960-2009. 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 (Data as of September 2010)



*Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.*

The catches of tropical tunas estimated are thought to be more uncertain between the mid-1980's and the late-1990's due to:

- To date, **Iran** and **Pakistan** have not reported catches of **bigeye tuna** for their gillnet fisheries. 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 Western Indian Ocean, an area where the catches of bigeye tuna by other surface fisheries are moderate to high, especially between 15°S and 10°N. The little information that the Secretariat has on the activities of this fleet has made it impossible to estimate catches of bigeye tuna. The catches of bigeye tuna may have represented between 1,000 and 5,000 tons in recent years.
- The catches of **yellowfin tuna, skipjack tuna** and, to a lesser extent, bigeye tuna, estimated for the coastal fisheries operated in **Yemen, Madagascar** and **Comoros** are highly uncertain as data collection in these countries is not properly organized. The catches of these fleets were estimated by the Secretariat using information from various sources.
- The catches of **bigeye tuna** for the gillnet-and-longline fisheries of **Sri Lanka** are thought incomplete, due to the likely mislabelling of specimens of bigeye tuna as yellowfin tuna. The proportion of bigeye tuna in the catches is, however, unknown. The catches of bigeye tuna may have represented between 1,000 and 2,000 tons in recent years.
- The catches of **skipjack tuna** and **yellowfin tuna** recorded for the coastal fisheries of **Sri Lanka** and **Indonesia** are uncertain. The coastal fisheries of these countries are not sampled sufficiently, with catches not recorded by gear and, usually, assigned to commercial categories instead of individual species.
- Poor reports from IOTC CPC's: The catches of **yellowfin tuna** and **bigeye tuna** recorded for the longline fleet of **India** were estimated by the IOTC Secretariat as India has not reported complete catches for its commercial longline fleet to date (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 **yellowfin tuna** or **bigeye tuna** was high between the mid-1980's and the late-1990's due to the high numbers of longliners that operated under flags of convenience. The catches of these vessels were estimated by the Secretariat using information from various sources.
- Non-reporting industrial purse seiners (**NEI**): A fleet of non-reporting purse seiners was operating in the Indian Ocean between the early-1990's and the early 2000's, targeting skipjack tuna and yellowfin tuna. The catches of these vessels were estimated by the Secretariat using information from various sources.
- The catches recorded for the purse seiners of **Iran** are likely to be incomplete. The catch rates by vessel by year estimated for Iranian purse seiners are considerably lower than those estimated for other purse seine fleets. This affects the catches of all three tropical tuna species, in particular **skipjack tuna** and **yellowfin tuna**.
- The catches of **bigeye tuna** for the pole-and-line fishery of **Maldives** are uncertain, due to the likely mislabelling of specimens of bigeye tuna as yellowfin tuna. Although the catches of bigeye tuna in recent years have been estimated by the Secretariat using information from sampling surveys in the past, it is unlikely that the proportion of the bigeye tuna in the catches has remained stable over time.

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

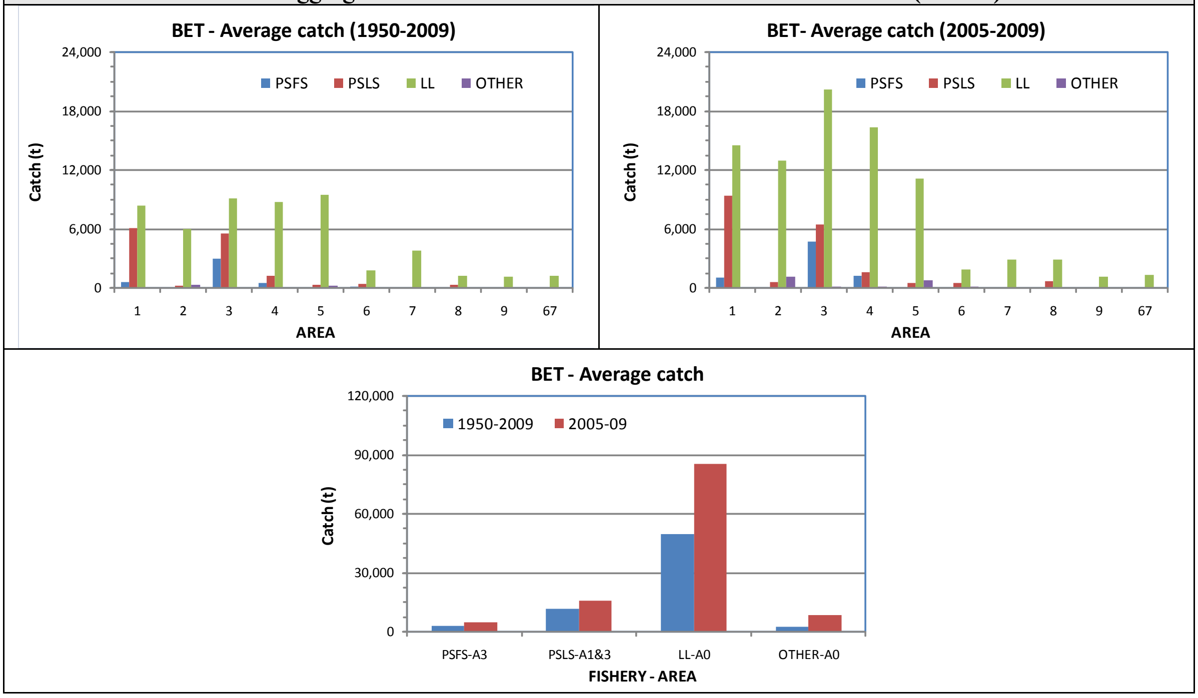
CAS tables are estimated for yellowfin tuna, bigeye tuna and skipjack tuna. The precision of the estimates is likely to vary depending on the quality of the catches (see the above section), the availability of catches in time and space and the amount (coverage) and representativeness of the samples available.

- Bigeye tuna:

Completeness of time-area catches: **Figure 8** shows mean catches (tonnes) of bigeye tuna by year estimated by fishery for 1990-99 and 2000-09.

Figure 8: Average catches of bigeye tuna by year estimated by Area and Fishery for the entire time series (1950-2009; left) and in current years (2005-2009; right)

- **Top: Catches aggregated by fishery and area (Figure 2)**
- **Bottom: Catches aggregated for the fisheries and areas used for the assessment (Table 2)**



The amount of catches that are available in time and space *versus* the total catches of bigeye tuna estimated are shown in the figures 9-11 below. The amount of catches for which time-area information is available has been changing over time. Two different periods can be identified:

- 1950-1988: The total catches of bigeye tuna estimated for this period increase gradually up to around 70,000t. Time-area information is available from the majority of the fleets with catches of bigeye tuna estimated for this period.
- 1989-2009: The total catches of bigeye tuna estimated for this period range between 70,000t and 150,000t. 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 for:
  - Fresh-tuna longliners from Taiwan,China (1984-2006) and Indonesia (1973-2009)
  - Longliners from India (2004-09) and various other fleets (NEI)
  - Purse seiners from Iran (2003-09) or other flags (NEI)

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 bigeye tuna, as this information is used to break the catches in the nominal catches by quarter and assessment area.

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 12-14**. The coverage was estimated as the amount (expressed as a percentage) that the total amount of bigeye tuna (in number) from strata having at least 30 specimens of BET sampled made out of the total amount of BET (numbers) estimated for that year, and fishery.
The estimation of catch-at-size is thought less accurate:

- 1950-1964: No size data are available for the species.
- 1969-1981: 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 9: Total catches of bigeye tuna (BET) available in time and space *versus* the total catches recorded for the species (all gears combined).

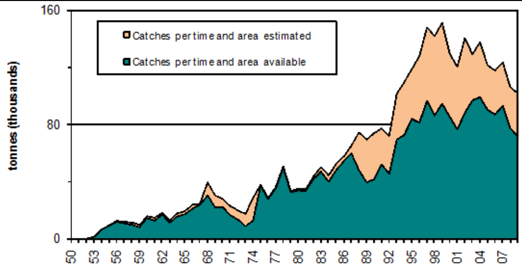


Figure 10: Total catches of bigeye tuna (BET) available in time and space *versus* the total catches recorded for the species (purse seine).

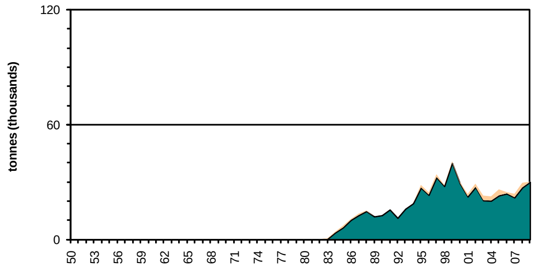


Figure 11: Total catches of bigeye tuna (BET) available in time and space *versus* the total catches recorded for the species (longline).

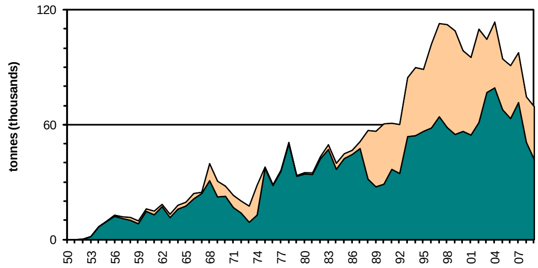
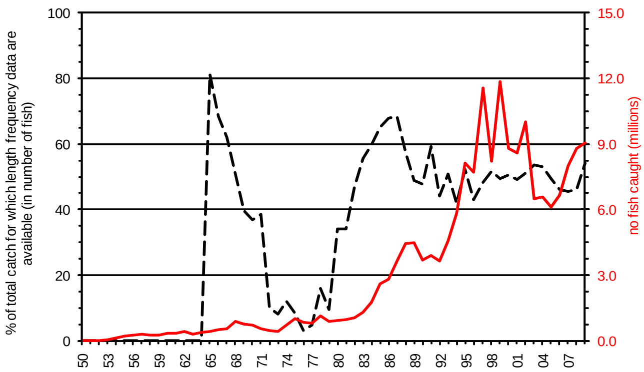
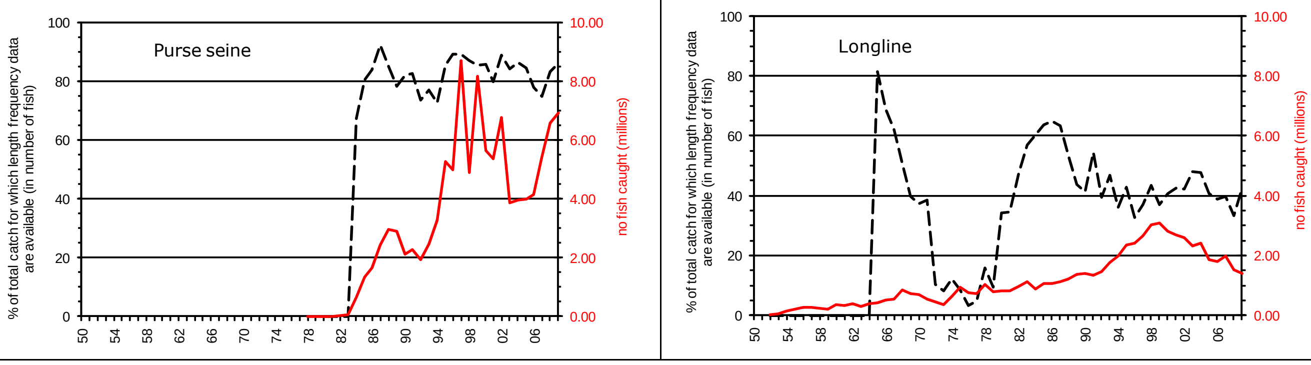


Figure 12: Total numbers of bigeye tuna (BET) estimated and proportion (in weight) estimated for strata having length frequency data (all gears combined).



Figures 13-14: Total numbers of bigeye tuna (BET) estimated and proportion (in weight) estimated for strata having length frequency data: purse seine (left) and longline (right)



- <u>Yellowfin tuna</u>:

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 **Figure 15-18** below. The amount of catches for which time-area information is available has been changing over time. Two different periods can be identified:

- 1950-1982: The total catches of yellowfin tuna estimated for this period are not high (50,000t). Time-area information is available from the majority of the fleets with catches of yellowfin tuna estimated for this period.

- 1982-2009: The total catches of yellowfin tuna estimated for this period range between 50,000t and 500,000t. Between 20-40% 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:
  - Gillnet fisheries of Iran and Pakistan, especially in recent years
  - Gillnet-and-longline fishery of Sri Lanka, especially in recent years
  - Line fisheries of Yemen, Indonesia, Madagascar and Comoros over the catch series
  - Fresh-tuna longliners from Taiwan,China (1984-2006) and Indonesia (1973-2009)
  - Longliners from India (2004-09) and various other fleets (NEI)
  - Purse seiners from Iran (2003-09) or other flags (NEI over the 90'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 yellowfin tuna, as this information is used to break the catches in the nominal catches by quarter and assessment area.

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

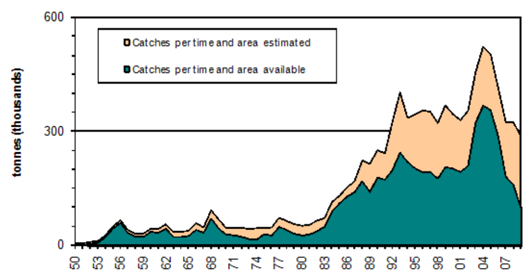


Figure 16: Total catches of yellowfin tuna (YFT) available in time and space *versus* the total catches recorded for the species (purse seine).

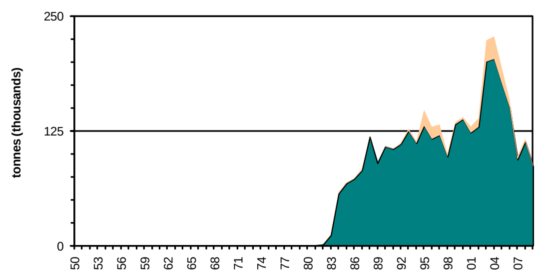


Figure 17: Total catches of yellowfin tuna (YFT) available in time and space *versus* the total catches recorded for the species (longline).

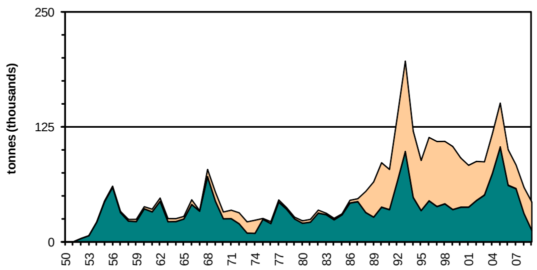
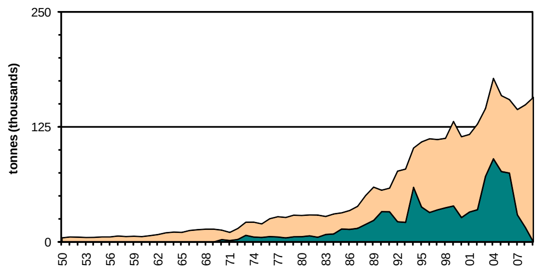


Figure 18: Total catches of yellowfin tuna (YFT) available in time and space *versus* the total catches recorded for the species (artisanal gears).



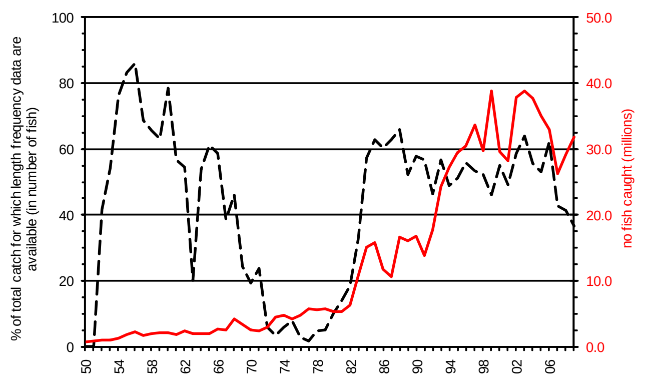
Completeness of length data: The catches estimated for strata having samples available *versus* the total catches estimated for the species by year is shown in **Figure 19-22**. The coverage was estimated as the amount (expressed as a percentage) that the total amount of yellowfin tuna (in number) from strata having at least 30 specimens of YFT sampled made out of the total amount of YFT (numbers) estimated for that year, and fishery.
The estimation of catch-at-size is thought less accurate for 1970-1982 and 2008-09 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 by 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.

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

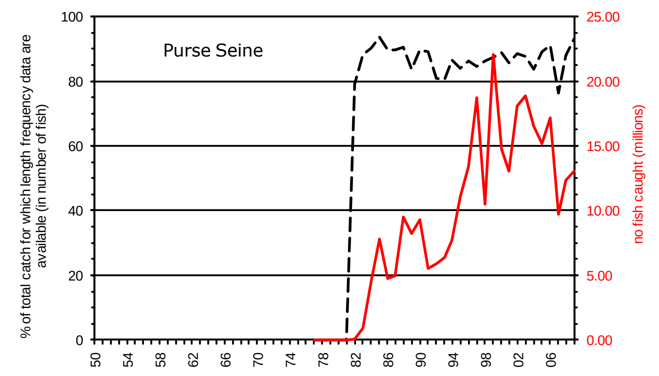
- Gillnet: No size data are available for 1950-1975. The amount of samples available is very low for other years or periods (1976-82; 1994-95; 2000-01; 2008-09).
- Pole-and-line: No size data are available for 1950-1980.
- Hand lines and troll lines: there is an almost complete lack of samples for both gears.

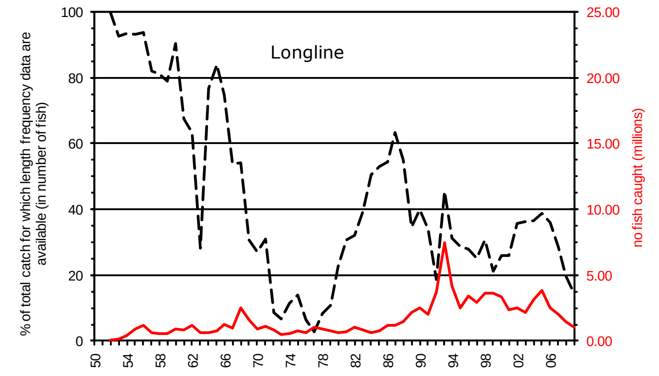
In light of the above, the quality of the CAS estimated for the artisanal gears is likely to be highly compromised.

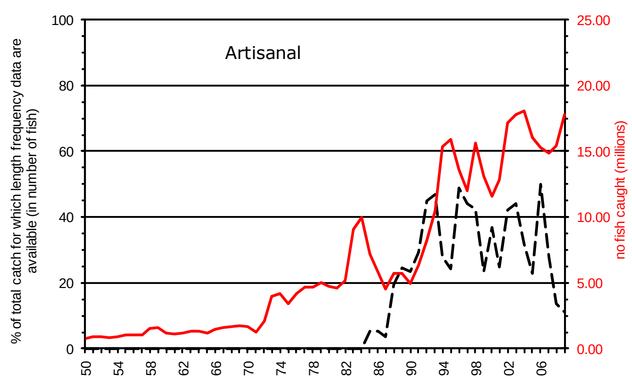
Figure 19: Total numbers of yellowfin tuna (YFT) estimated and proportion (in weight) estimated for strata having length frequency data (all gears combined).



Figures 20-22: 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)







- Skipjack tuna

Completeness of time-area catches: **Figure 23** shows mean catches (tonnes) of skipjack tuna by year estimated by fishery for 1990-99 and 2000-09.

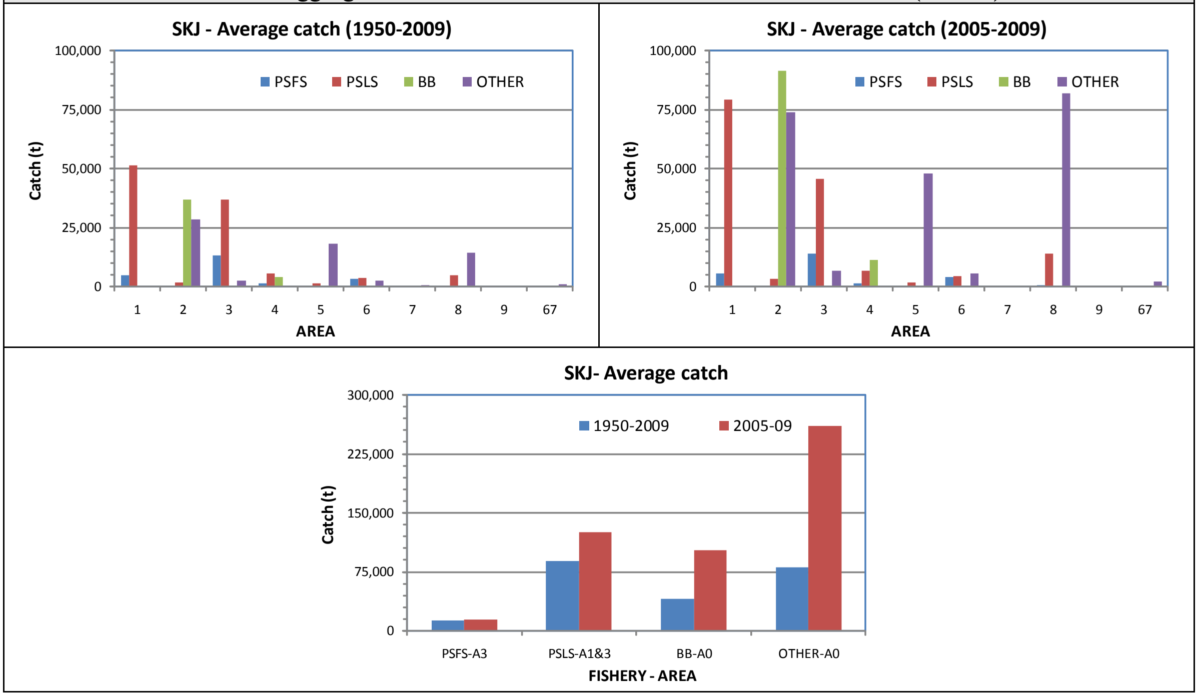
The amount of catches that are available in time and space *versus* the total catches of skipjack tuna estimated are shown in **Figure 24-27**. The amount of catches for which time-area information is available has been changing over time. Two different periods can be identified:

- 1950-1970: The total catches of skipjack tuna estimated for this period are low (50,000t). Time-area catches are not available at all for this period. Catches come from gillnet and pole-and-line fisheries.
- 1971-1990: The total catches of skipjack tuna estimated for this period range from 50,000t and 200,000t. Time-area catches are available from the main fleets excluding gillnet fisheries before the mid-80's.
- 1991-2009: The total catches of skipjack tuna estimated for this period are high ranging between 200,000t and 600,000t. Between 20-60% 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:
    - Gillnet fisheries of Iran and Pakistan, especially in recent years

- Gillnet-and-longline fishery of Sri Lanka, especially in recent years
- Line fisheries of Yemen, Indonesia, Madagascar and Comoros over the catch series
- Pole-and-line fisheries of Maldives (2003-09)
- Purse seiners from Iran (2003-09) or other flags (NEI over the 90's)

Figure 23: Average catches of skipjack tuna by year estimated by Area and Fishery for the entire time series (1950-2009; left) and in current years (2000-2009; right)

- **Top: Catches aggregated by fishery and area (Figure 2)**
- **Bottom: Catches aggregated for the fisheries and areas used for the assessment (Table 3)**



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 skipjack tuna, as this information is used to break the catches in the nominal catches by quarter and assessment area.

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

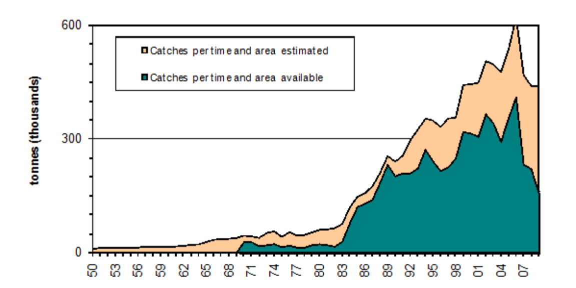


Figure 25: Total catches of skipjack tuna (SKJ) available in time and space *versus* the total catches recorded for the species (purse seine).

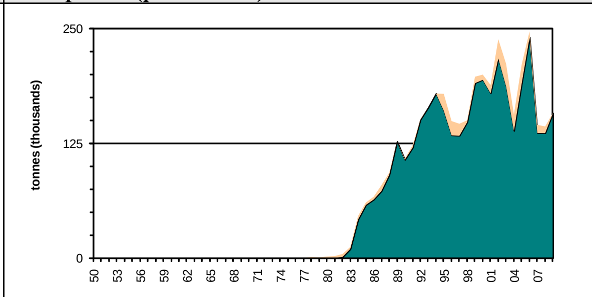


Figure 26: Total catches of skipjack tuna (SKJ) available in time and space *versus* the total catches recorded for the species (gillnet).

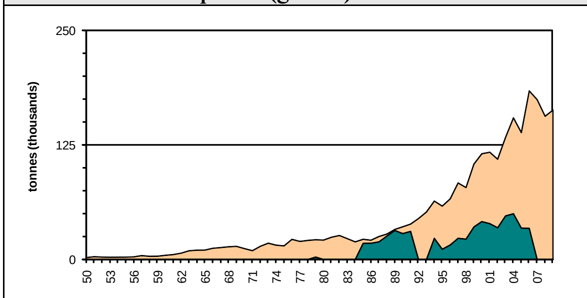
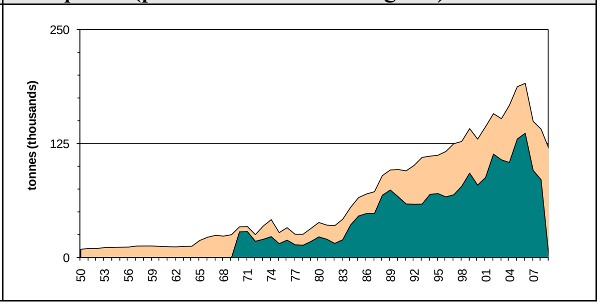
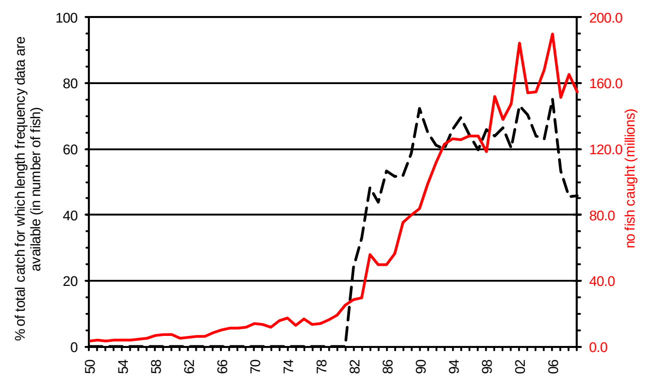


Figure 27: Total catches of skipjack tuna (SKJ) available in time and space *versus* the total catches recorded for the species (pole and line and other gears).

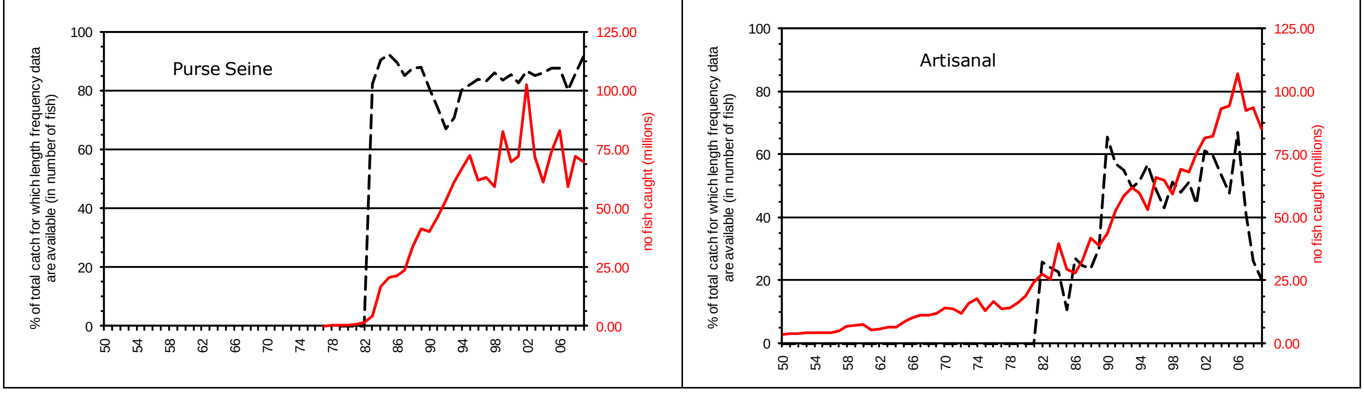


Completeness of length data: The catches estimated for strata having samples available *versus* the total catches estimated for the species per year is shown in **Figure 28-30**. The coverage was estimated as the amount (expressed as a percentage) that the total amount of bigeye tuna (in number) from strata having at least 30 specimens of BET sampled made out of the total amount of BET (numbers) estimated for that year, and fishery.

Figure 28: Total numbers of skipjack tuna (SKJ) estimated and proportion (in weight) estimated for strata having length frequency data (all gears combined).



Figures 29-30: 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)



The estimation of catch-at-size is thought less accurate for 1950-1982 due to a complete lack of samples. The lack of length data from some artisanal fisheries and periods 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; 2008-09).
- Pole-and-line: No size data are available for 1950-1980.
- Hand lines and troll lines: there is an almost complete lack of samples for both gears.

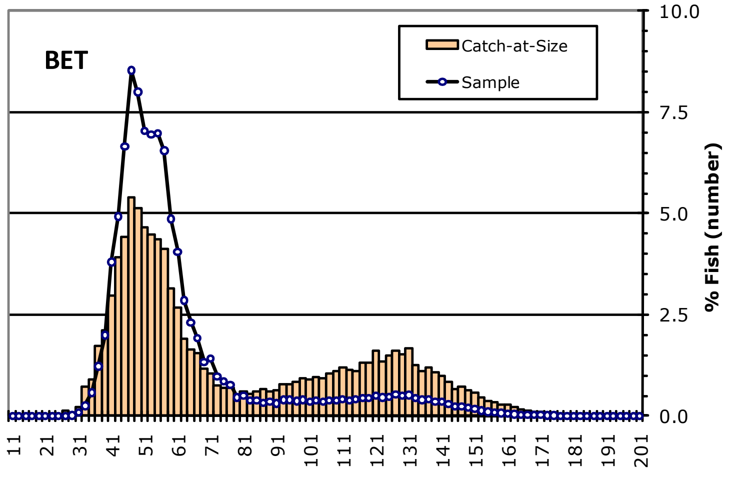
The numbers of fish measured per strata in relation with the total numbers caught by several longline fisheries, mainly Japan, has been declining in recent years. The representativeness of the samples might be also compromised for this reason.

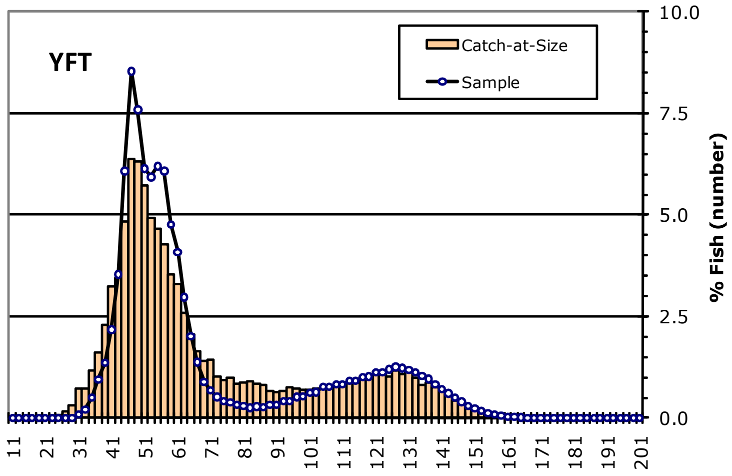
In light of the above, the quality of the CAS estimated for the artisanal gears is likely to be highly compromised.

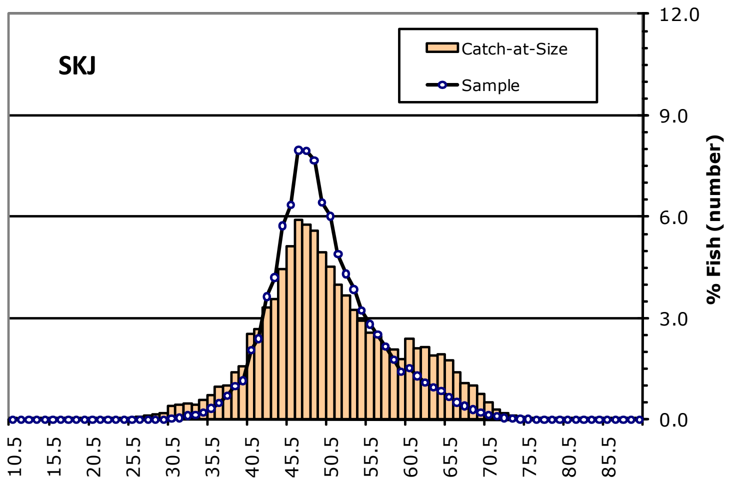
The lack of length samples or low sampling coverage for some periods and/or fisheries may compromise the assessments that use length frequency samples or CAS or CAA derived from those samples, adding uncertainty to the results.

Figures 31-33 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 40-117 (**Appendix III**) show the same by decade and type of fishery, including for decades for which no samples were available.

Figures 31-33: 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 (1950-2009), all fisheries and years combined, by species
Bigeye tuna (top), Yellowfin tuna (centre), and skipjack tuna (bottom)







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

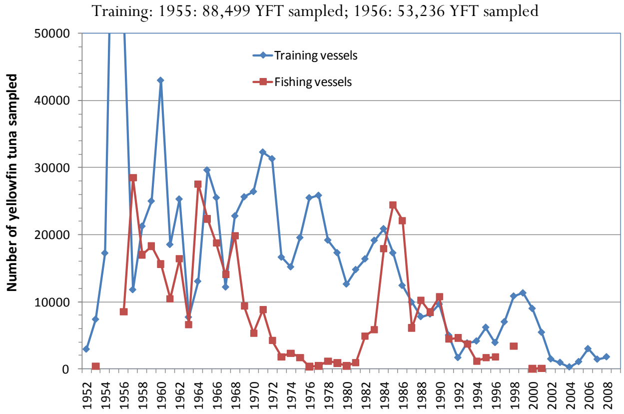
- Longline fisheries since the early 1990's
- Handline, trolling and other small artisanal fisheries over the entire time period

The following reasons may explain the referred discrepancies:

- 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.
- Catch-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 catch-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 bigeye tuna.
- The samples available are not representative of the fishery concerned: Over the years the majority of the samples available for the longline fishery of Japan come from training and/or research vessels (**Figure 34**). 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 a higher proportion of yellowfin tuna and bigeye tuna of small size than the commercial fishery (**Figure 35**). In addition, the Taiwanese longline fishery tends to catch fish of smaller size than both Japan training and commercial vessels.

Figure 34: Number of lengths measured taken onboard Japanese training/research vessels *versus* the number of weights reported by Japanese commercial vessels:

- **Top: Yellowfin tuna (1952-2008)**
- **Bottom: Bigeye tuna (1965-2008)**



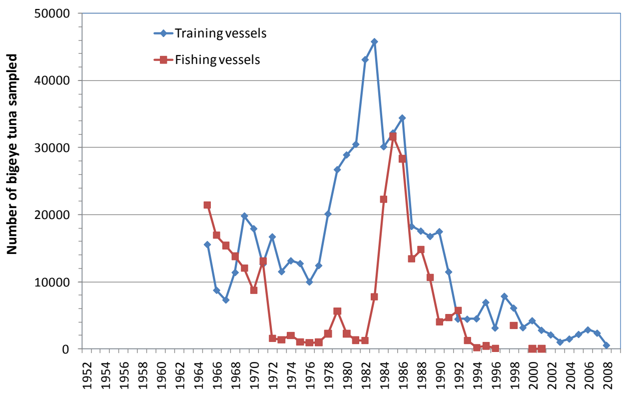
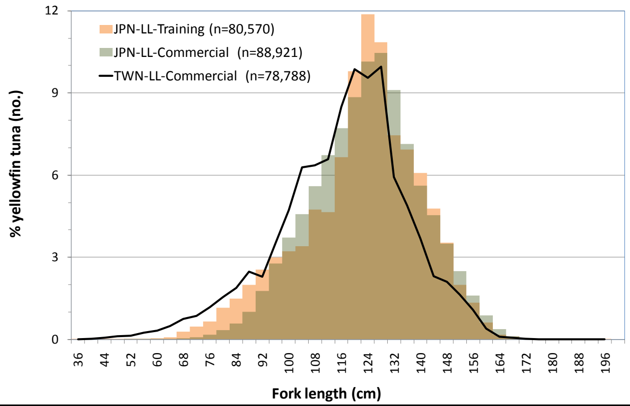
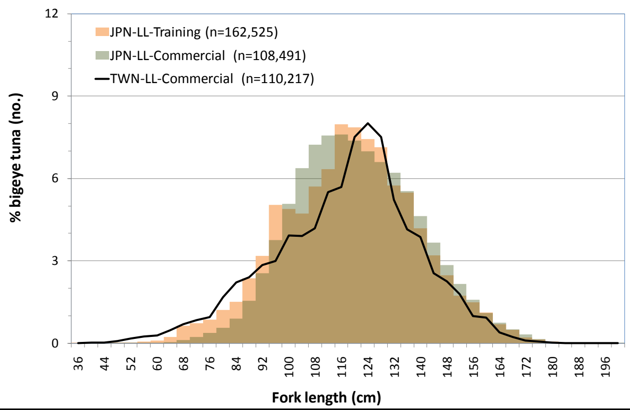


Figure 35: Length frequency distributions derived from samples taken onboard commercial longline vessels from Japan and Taiwan,China and samples from Japanese training/research vessels.

- **Top: Yellowfin tuna (1980-2001)**
- **Bottom: Bigeye tuna (1980-2001)**

The length frequency distributions represent the proportion (%) of fish (in number) by length class (4cm) over the periods indicated. Only the strata (quarter-10°Lat*20°Lon area) in which samples, of 30 or more fish, are available for the three types of vessel were used.





Catch-at-age tables (**CAA$_{INPUT}$**)

CAA tables are estimated for bigeye tuna and yellowfin tuna.

- **Bigeye tuna**:

The numbers of fish estimated per age class are shown in **Figure 36**; the numbers of bigeye tuna obtained by age class, fishery and year are shown in Appendix VIII. The estimation of catches-at-age is likely to be compromised for some fisheries and periods (see the previous section).

Figure 38 shows estimates of CAA used for the WPTT in 2009 versus those estimated for the WPTT in 2010 (combined for 1950-2008).

- **Yellowfin tuna**:

The numbers of fish estimated per age class are shown in **Figure 37**; the numbers of bigeye tuna obtained by age class, fishery and year are shown in Appendix VIII. The estimation of catches-at-age is likely to be compromised for some fisheries and periods (see the previous section).

Figure 39 shows estimates of CAA used for the WPTT in 2009 versus those estimated for the WPTT in 2010 (combined for 1950-2008).

Figure 36-37: Average numbers of bigeye tuna (left; BET) and yellowfin tuna (right; YFT) by age class (classes 8 and above are represented as 8+) and fishery estimated for 1963-82, 1983-92, 1993-02, 2003-06 and 2007-09

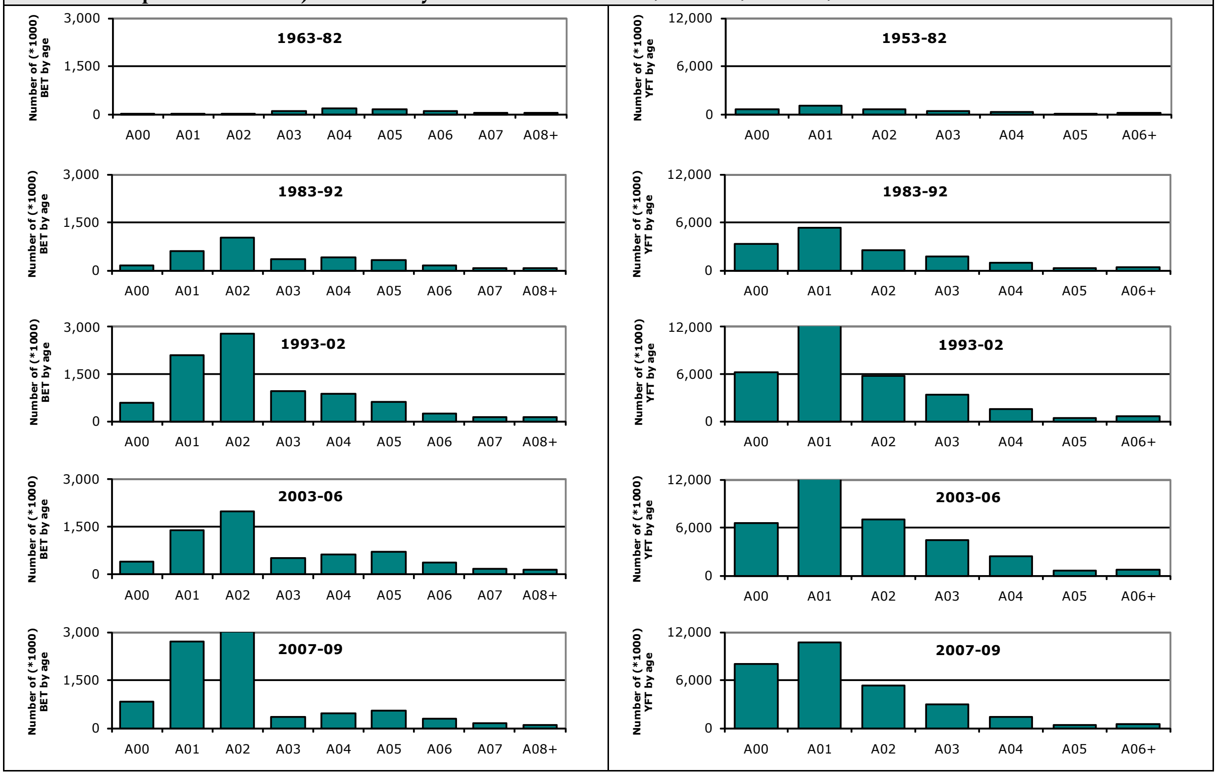
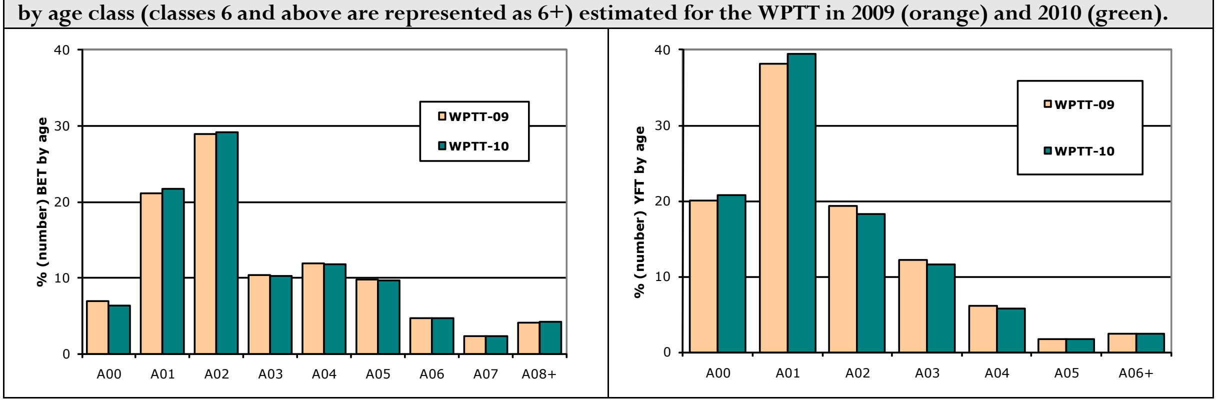


Figure 38-39: Proportion (accumulated number 1950-2008) of bigeye tuna (left; BET) and yellowfin tuna (right; YFT) by age class (classes 6 and above are represented as 6+) estimated for the WPTT in 2009 (orange) and 2010 (green).



APPENDIX I

Input Tables

Species	Fishery	Year	Quarter	Area	FirstClassLow	Sizeinterval	TimeStamp	tno	tmt	T001	…	T150
Species	**Fishery**	**Year**	**Quarter**	**Area**			**TimeStamp**	**tno**	**tmt**	**A01**	**…**	**Aii+**
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 (not in CAA table)
SizeInterval	Interval between length classes (1cm SKJ and 2cm YFT & BET) (not in CAA table)
TimeStamp	The date the file was created
tno	Total number of fish caught
tmt	Total weight caught (metric tons)
T001 / A00	Number of fish measured (samples) / extrapolated to total catch (CAS) / (1st length /age class (i.e. Age 0))
………	Number of fish measured (samples) / extrapolated to total catch (CAS) (2nd length /age class to last length /age class)
T150 / Aii+	Number of fish measured (samples) / extrapolated to total catch (CAS) (Last length /age class (i.e. Age i+)

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					615	615
1951					2,006	2,006
1952			6,433		2,281	8,714
1953			36,776		2,295	39,072
1954			142,620	2,253	2,479	147,352
1955			199,862	5,172	2,479	207,513
1956			252,975	14,961	2,818	270,755
1957			236,355	22,671	34,493	293,519
1958			209,537	37,841	34,401	281,780
1959			173,816	37,439	34,564	245,819
1960			309,472	34,679	18,610	362,761
1961			271,306	49,174	26,576	347,056
1962			368,091	30,965	27,148	426,204
1963			250,224	43,988	27,309	321,521
1964			335,134	43,231	27,385	405,749
1965			375,120	38,830	19,955	433,905
1966			441,206	58,321	28,656	528,183
1967			485,412	54,400	32,032	571,844
1968			651,729	201,576	31,821	885,126
1969			522,899	203,300	33,003	759,202
1970			390,554	292,948	52,581	736,083
1971			378,422	147,160	30,932	556,514
1972			288,515	164,245	35,310	488,070
1973			246,783	111,529	74,060	432,372
1974			476,481	158,948	72,310	707,739
1975			808,637	139,509	62,008	1,010,155
1976			637,658	126,447	91,153	855,258
1977			579,856	139,721	104,569	824,145
1978	94	803	910,428	132,362	87,224	1,130,912
1979	29	204	595,154	196,713	90,329	882,429
1980	735	3,311	560,268	270,878	77,629	912,821
1981	106	2,371	617,460	204,930	154,285	979,152
1982	3,936	16,434	655,826	305,624	90,819	1,072,640
1983	10,968	46,680	784,782	348,902	133,752	1,325,083
1984	126,857	515,633	537,252	348,586	236,052	1,764,381
1985	211,889	1,138,324	657,675	393,581	192,008	2,593,477
1986	271,243	1,393,068	576,515	481,989	74,134	2,796,948
1987	728,785	1,698,387	606,212	502,927	95,395	3,631,706
1988	937,645	2,032,190	575,283	655,042	238,851	4,439,011
1989	692,057	2,210,681	386,891	988,171	213,055	4,490,855
1990	462,421	1,642,235	400,131	986,941	204,683	3,696,410
1991	250,984	2,024,223	222,681	1,117,683	307,591	3,923,162
1992	176,390	1,749,319	227,930	1,247,128	249,806	3,650,572
1993	313,616	2,156,298	252,554	1,517,279	334,785	4,574,531
1994	135,663	3,151,181	455,001	1,533,534	534,489	5,809,869
1995	235,754	5,028,239	607,174	1,739,067	501,060	8,111,295
1996	345,971	4,647,371	549,002	1,875,465	278,226	7,696,036
1997	200,926	8,487,857	581,670	2,060,334	241,119	11,571,905
1998	660,166	4,239,485	474,421	2,535,498	319,673	8,229,243
1999	692,905	7,480,897	362,709	2,734,712	594,740	11,865,963
2000	385,548	5,246,303	391,273	2,415,878	350,203	8,789,205
2001	237,132	5,120,440	408,035	2,271,951	536,775	8,574,334
2002	145,953	6,609,941	245,215	2,353,445	647,617	10,002,171
2003	255,224	3,612,687	255,305	2,052,258	317,763	6,493,238
2004	133,015	3,825,197	334,552	2,084,651	194,597	6,572,012
2005	298,291	3,677,360	351,772	1,498,733	283,954	6,110,111
2006	259,678	3,880,806	361,892	1,451,085	714,037	6,667,499
2007	463,430	4,944,913	411,228	1,572,906	625,239	8,017,716
2008	390,037	6,180,307	298,529	1,208,295	711,939	8,789,107
2009	309,132	6,625,347	190,122	1,206,528	708,736	9,039,864

Bigeye Tuna catches in weight (tonnes)						
Year	Purse Seine-FS	Purse Seine-LS	Longline-Japan	Longline-Taiwan	Artisanal	Grand Total
1950					12	12
1951					24	24
1952			280		26	306
1953			1,653		26	1,679
1954			6,750	100	28	6,878
1955			9,539	201	28	9,767
1956			12,245	601	30	12,876
1957			11,090	901	99	12,090
1958			10,153	1,502	98	11,753
1959			8,366	1,503	101	9,969
1960			14,813	1,302	68	16,183
1961			13,048	1,903	85	15,036
1962			17,279	1,203	88	18,570
1963			11,600	1,703	91	13,394
1964			16,009	2,038	91	18,138
1965			17,735	1,847	86	19,668
1966			21,548	2,621	117	24,285
1967			22,360	2,423	123	24,907
1968			30,421	9,302	121	39,844
1969			22,022	8,530	108	30,660
1970			16,297	11,686	134	28,117
1971			16,108	7,053	90	23,252
1972			13,313	6,843	103	20,259
1973			12,549	5,019	185	17,754
1974			21,654	6,858	185	28,696
1975			31,969	5,993	182	38,145
1976			24,127	4,611	285	29,023
1977			29,492	6,726	335	36,553
1978	1	4	45,211	5,574	329	51,119
1979	0	1	25,721	7,814	291	33,827
1980	6	15	25,351	9,665	281	35,318
1981	1	12	27,274	7,657	472	35,416
1982	34	82	30,987	12,470	417	43,992
1983	125	462	35,772	13,821	502	50,682
1984	1,620	2,400	25,798	14,133	787	44,738
1985	1,718	5,440	30,118	14,786	731	52,793
1986	2,482	8,148	27,657	19,008	661	57,956
1987	4,608	8,793	29,942	21,304	862	65,508
1988	6,504	8,563	29,424	27,615	2,762	74,869
1989	3,575	8,421	19,926	36,690	1,260	69,872
1990	5,807	6,862	18,961	41,526	1,175	74,331
1991	5,274	10,352	10,056	50,766	1,185	77,633
1992	2,227	9,035	10,444	49,714	977	72,398
1993	7,081	8,937	13,614	70,966	1,253	101,851
1994	4,709	14,172	26,364	63,511	1,430	110,187
1995	4,789	23,593	23,781	65,144	1,996	119,303
1996	3,788	20,741	28,308	73,753	1,694	128,284
1997	2,437	31,528	29,861	82,990	1,738	148,554
1998	6,353	21,981	20,726	91,564	1,720	142,343
1999	5,619	35,040	15,472	93,540	2,010	151,681
2000	5,691	24,167	17,366	81,279	1,529	130,032
2001	4,260	19,457	14,693	80,477	1,854	120,741
2002	4,099	24,944	14,091	95,810	2,054	140,998
2003	7,172	15,662	11,217	93,400	2,179	129,631
2004	3,658	18,749	13,288	100,342	2,113	138,149
2005	8,501	17,568	15,299	79,064	1,462	121,895
2006	6,406	18,249	17,261	73,633	2,710	118,260
2007	5,670	18,066	19,630	77,980	2,729	124,075
2008	9,648	19,831	14,431	60,117	2,674	106,700
2009	5,317	24,773	9,836	59,598	2,666	102,189

b/Yellowfin tuna(i)

Yellowfin Tuna catches in number of fish										
Year	Purse Seine-FS	Purse Seine-LS	Longline-Japan	Longline-Taiwan	Baitboat	Gillnet	Handline	Trolling	Other	Total
1950					473,605	167,423	52,778	75,468	2,890	772,165
1951					478,043	239,476	67,630	128,700	8,670	922,519
1952			62,801		480,262	201,161	67,260	154,594	11,561	977,639
1953			120,749		480,522	163,213	59,039	146,338	11,561	981,422
1954			424,884	5,811	483,126	157,155	58,690	163,815	11,561	1,305,040
1955			858,334	20,018	641,643	150,703	49,272	170,195	11,561	1,901,725
1956			1,160,668	32,121	642,163	162,450	42,089	170,468	11,561	2,221,520
1957			613,497	34,630	619,373	216,953	42,066	172,804	11,561	1,710,884
1958			482,358	50,351	1,092,855	196,945	42,927	168,251	12,258	2,045,946
1959			518,828	64,621	1,162,511	212,974	49,353	174,299	12,258	2,194,844
1960			850,041	63,956	675,584	253,723	45,348	190,399	13,177	2,092,228
1961			717,467	80,326	541,390	291,110	47,064	219,475	17,300	1,914,131
1962			1,093,626	98,094	522,390	399,699	47,240	217,189	24,465	2,402,703
1963			530,280	97,296	521,168	486,165	56,086	231,773	23,006	1,945,774
1964			508,551	89,770	519,679	495,018	60,692	225,384	25,356	1,924,451
1965			681,005	76,721	355,181	479,578	54,733	270,916	27,960	1,946,094
1966			1,079,124	137,413	521,498	572,623	57,731	310,572	26,305	2,705,266
1967			852,665	98,107	590,617	625,958	64,352	311,142	26,305	2,569,146
1968			1,850,104	678,468	590,617	673,818	64,156	315,694	26,305	4,199,162
1969			982,215	622,786	625,173	707,660	119,010	252,896	29,514	3,339,254
1970			409,450	475,878	824,633	545,781	90,428	214,859	22,430	2,583,460
1971			683,187	411,247	464,708	445,547	78,176	255,493	21,284	2,359,641
1972			491,834	373,733	958,926	634,189	100,507	352,883	36,097	2,948,169
1973			317,059	199,713	2,569,712	744,236	160,459	448,434	34,976	4,474,589
1974			414,612	155,395	1,995,144	1,637,558	176,617	370,746	27,233	4,777,306
1975			603,712	158,078	1,712,898	1,219,204	172,293	285,732	13,709	4,165,627
1976			452,483	155,402	1,821,008	1,679,648	245,140	382,962	25,605	4,762,249
1977	162	6,278	770,010	291,745	1,789,375	1,496,098	245,672	1,092,226	70,463	5,762,029
1978	3,305	22,116	761,161	162,438	1,419,458	1,462,222	328,544	1,311,618	136,211	5,607,074
1979	3,373	8,746	563,060	178,912	1,690,101	1,683,466	187,865	1,341,156	144,559	5,801,238
1980	3,884	12,530	416,638	214,861	1,766,857	1,686,901	123,590	1,054,700	100,137	5,380,098
1981	10,129	14,487	465,844	220,952	2,165,391	1,892,794	140,639	361,683	9,295	5,281,214
1982	28,889	61,562	828,634	208,013	2,769,200	1,502,088	128,732	682,460	74,750	6,284,327
1983	510,003	409,160	617,686	204,976	5,743,676	2,502,395	124,519	654,122	60,635	10,827,171
1984	2,587,444	1,951,704	432,113	189,376	6,721,230	2,177,702	148,573	842,907	56,695	15,107,744
1985	1,899,074	5,887,635	537,240	255,203	2,201,291	3,356,156	259,396	1,235,319	130,671	15,761,985
1986	2,150,344	2,579,505	645,192	562,233	1,455,641	1,868,536	271,509	2,038,735	146,724	11,718,419
1987	1,514,607	3,413,475	511,634	680,906	1,795,339	605,771	328,086	1,712,769	82,062	10,644,649
1988	2,758,150	6,724,219	541,447	926,630	1,488,052	1,682,425	562,401	1,895,072	80,004	16,658,401
1989	2,993,448	5,260,084	310,870	1,850,778	1,740,639	1,963,602	632,445	1,362,858	18,707	16,133,431
1990	3,759,789	5,524,854	336,053	2,158,035	1,152,536	1,823,983	564,070	1,379,057	25,846	16,724,223
1991	1,989,655	3,512,358	174,573	1,840,321	2,244,534	2,047,256	498,042	1,488,623	73,280	13,868,642
1992	1,869,933	4,017,242	224,359	3,435,315	2,111,533	3,411,792	616,593	2,052,209	42,405	17,781,380
1993	2,016,330	4,331,453	215,871	7,214,918	2,839,156	3,955,190	2,021,611	1,630,718	21,000	24,246,247
1994	1,738,800	5,986,916	283,010	3,922,165	5,961,664	4,686,117	2,827,447	1,799,118	39,867	27,245,104
1995	2,157,286	8,930,993	232,881	2,249,943	5,566,720	5,782,205	2,478,349	2,016,271	48,354	29,463,001
1996	2,200,857	11,221,475	338,655	3,058,552	4,270,305	5,031,911	2,244,929	2,007,060	52,349	30,426,093
1997	1,443,418	17,318,290	425,720	2,518,586	3,911,953	4,629,578	1,475,060	1,953,661	41,686	33,717,953
1998	2,736,716	7,791,601	550,786	3,042,697	5,347,598	5,072,566	2,987,107	2,147,351	59,862	29,736,285
1999	2,509,986	19,525,752	443,105	3,188,271	3,008,989	5,985,596	2,004,295	2,110,683	38,236	38,814,912
2000	2,155,426	12,595,184	440,410	2,886,714	3,056,651	5,071,291	1,383,382	2,004,632	36,460	29,630,151
2001	2,341,109	10,722,262	414,302	1,974,812	3,627,263	5,336,315	1,639,581	2,149,900	56,717	28,262,259
2002	2,137,021	15,984,477	265,840	2,229,876	4,594,437	6,136,540	4,081,831	2,214,111	134,190	37,778,322
2003	3,731,738	15,106,490	413,288	1,746,585	3,831,200	7,534,148	4,141,149	2,190,882	75,323	38,770,802
2004	4,018,748	12,473,547	585,898	2,540,267	4,658,892	7,487,342	3,238,628	2,636,915	39,419	37,679,656
2005	3,306,753	11,849,142	637,298	3,223,915	5,404,595	5,317,405	1,182,690	3,857,595	304,782	35,084,174
2006	2,372,766	14,771,579	554,488	1,945,345	3,916,191	7,208,049	878,174	3,148,080	121,510	34,916,181
2007	2,088,032	7,661,322	470,568	1,582,645	5,973,409	3,838,862	1,364,054	3,479,738	182,875	26,641,504
2008	1,975,041	10,370,293	290,854	1,157,028	7,407,784	3,619,584	1,197,229	2,859,213	352,312	29,229,338
2009	1,233,988	11,850,357	153,975	879,298	6,066,724	6,120,831	2,547,878	2,722,694	300,989	31,876,734

b/Yellowfin tuna(ii)

Yellowfin Tuna catches in weight (tonnes)										
Year	Purse Seine-FS	Purse Seine-LS	Longline-Japan	Longline-Taiwan	Baitboat	Gillnet	Handline	Trolling	Other	Total
1950					1,512	1,807	657	418	19	4,414
1951					1,528	2,431	799	569	58	5,385
1952			3,683		1,536	2,125	813	636	77	8,870
1953			6,757		1,537	1,913	727	577	77	11,588
1954			21,666	210	1,545	1,876	728	698	77	26,801
1955			44,163	690	2,051	1,834	727	742	77	50,284
1956			59,485	1,090	2,053	1,886	676	745	77	66,012
1957			31,864	1,253	1,980	2,900	708	762	77	39,545
1958			22,644	1,827	1,982	2,283	728	760	77	30,301
1959			22,182	2,383	1,980	2,453	841	802	77	30,719
1960			36,055	2,243	1,029	2,883	881	922	77	44,091
1961			32,730	2,880	1,532	3,161	1,003	1,049	97	42,452
1962			44,191	3,471	1,510	4,378	1,067	917	116	55,650
1963			21,981	3,406	1,522	5,918	1,331	1,015	121	35,293
1964			22,163	3,141	1,515	6,518	1,423	1,102	138	36,000
1965			25,007	2,711	1,041	6,530	1,288	1,328	148	38,052
1966			40,902	4,868	1,520	7,849	1,381	1,601	136	58,256
1967			30,525	3,525	1,722	8,271	1,543	1,613	136	47,335
1968			53,612	25,145	1,722	8,750	1,610	1,647	136	92,622
1969			32,306	21,718	1,822	8,891	1,723	1,284	155	67,900
1970			15,623	16,906	2,385	7,455	1,540	1,291	118	45,318
1971			20,850	13,654	1,474	5,861	1,374	1,513	116	44,843
1972			18,211	13,410	2,678	8,075	1,696	1,950	198	46,217
1973			14,783	7,036	7,666	8,854	2,383	2,285	191	43,198
1974			18,188	5,406	6,320	10,066	2,942	1,989	152	45,062
1975			19,972	5,577	4,870	9,895	2,894	1,836	77	45,121
1976			16,635	5,385	5,410	13,577	3,836	2,248	142	47,233
1977	6	28	35,345	10,292	5,147	12,319	3,796	5,744	388	73,065
1978	111	104	31,322	5,833	4,235	12,066	4,105	5,441	710	63,927
1979	63	40	21,361	5,554	4,887	13,863	4,132	5,378	794	56,073
1980	71	59	16,525	6,410	4,888	13,900	4,650	4,763	550	51,814
1981	182	82	17,388	7,114	6,145	15,519	4,807	2,808	51	54,095
1982	698	468	26,680	7,891	4,994	15,437	4,997	3,461	332	64,959
1983	8,264	4,362	24,050	7,167	7,910	11,443	4,358	3,662	276	71,493
1984	46,694	11,546	18,141	7,540	8,487	11,082	5,919	4,655	210	114,274
1985	44,338	24,418	22,003	8,519	7,571	11,095	6,817	5,538	592	130,889
1986	45,498	27,948	26,185	19,047	6,754	12,044	6,942	7,429	945	152,791
1987	44,458	39,339	21,552	25,404	7,914	14,885	8,794	6,566	540	169,450
1988	84,038	34,583	23,448	31,467	6,314	23,173	12,070	8,271	519	223,881
1989	51,657	38,091	13,307	51,944	5,802	30,215	15,573	7,834	113	214,536
1990	77,302	31,395	13,841	72,218	5,300	26,415	16,152	8,186	126	250,935
1991	76,988	28,414	7,549	71,221	7,586	23,548	18,383	8,585	310	242,586
1992	71,656	40,630	10,147	126,539	8,620	38,341	16,426	13,287	235	325,882
1993	80,347	47,050	10,046	186,410	9,933	39,587	15,035	14,132	452	402,993
1994	72,566	40,997	13,593	106,786	12,999	50,156	22,490	15,926	444	335,956
1995	64,449	83,700	10,618	77,962	12,370	56,751	22,933	16,122	433	345,338
1996	66,396	63,275	16,573	96,987	12,149	62,669	20,026	16,749	460	355,283
1997	48,526	83,625	19,576	89,554	12,882	58,005	22,120	17,719	512	352,519
1998	43,220	57,160	19,358	89,919	13,626	58,827	24,001	15,602	477	322,191
1999	47,973	86,793	15,679	88,034	13,304	75,542	25,519	15,987	495	369,325
2000	61,469	78,786	17,616	73,692	10,851	57,440	28,181	17,262	535	345,831
2001	78,970	50,996	15,747	67,515	11,819	56,884	29,951	17,704	443	330,030
2002	77,059	61,933	14,350	73,214	17,068	58,917	34,194	17,363	464	354,563
2003	137,492	86,584	19,387	67,647	16,863	79,637	31,145	16,747	475	455,976
2004	168,799	59,595	20,358	97,184	15,061	96,661	40,576	24,854	483	523,572
2005	124,025	69,871	25,028	125,809	17,644	74,957	39,494	24,686	2,148	503,663
2006	85,020	74,454	25,860	74,446	17,339	83,282	32,390	20,910	715	414,417
2007	53,529	43,842	22,292	61,329	15,568	69,204	34,873	22,877	1,259	324,772
2008	74,991	41,456	11,480	47,875	17,251	74,724	32,319	21,335	3,366	324,797
2009	36,263	51,565	5,993	37,208	16,643	84,967	30,985	21,084	3,366	288,073

c/Skipjack tuna

Skipjack Tuna catches in number of fish								
Year	Purse Seine-FS	Purse Seine-LS	Baitboat	Gillnet	Handline	Trolling	Other	Total
1950			2,576,540	437,247	113,967	134,241	17,613	3,279,608
1951			2,689,813	676,203	140,393	266,599	110,705	3,883,713
1952			2,700,111	579,527	99,022	277,630	119,129	3,775,418
1953			3,031,316	529,573	82,194	288,448	127,935	4,059,466
1954			3,079,328	552,436	79,814	306,840	137,579	4,155,997
1955			3,105,728	558,938	101,949	308,687	138,523	4,213,825
1956			3,123,568	632,131	117,434	320,907	147,666	4,341,706
1957			3,411,549	1,015,816	107,807	325,922	153,581	5,014,676
1958			5,252,044	917,555	116,410	337,683	155,139	6,778,832
1959			5,698,401	865,232	124,925	347,446	146,255	7,182,260
1960			5,756,160	1,109,112	155,187	372,072	148,700	7,541,231
1961			3,058,604	1,347,525	184,971	432,834	185,797	5,209,731
1962			2,996,102	1,726,074	259,105	408,133	184,944	5,574,357
1963			3,065,115	2,211,145	344,487	472,686	199,146	6,292,579
1964			3,040,779	2,313,015	339,349	478,523	273,051	6,444,716
1965			5,149,085	2,323,457	320,151	606,111	223,417	8,622,221
1966			6,106,036	2,752,805	372,571	743,613	246,526	10,221,551
1967			6,814,153	2,993,340	412,658	712,068	232,090	11,164,309
1968			6,358,827	3,226,975	469,980	733,720	259,646	11,049,148
1969			7,078,163	3,357,137	490,369	556,763	256,372	11,738,803
1970			9,846,500	2,775,741	639,168	584,730	195,067	14,041,206
1971			9,921,157	2,187,482	564,648	603,674	215,956	13,492,917
1972			6,693,589	3,328,894	664,516	768,726	349,923	11,805,648
1973			9,558,106	4,226,412	839,730	875,848	352,776	15,852,872
1974			11,798,726	3,614,584	760,893	948,755	400,362	17,523,320
1975			6,843,290	3,451,469	376,695	1,819,234	614,149	13,104,838
1976			7,927,598	5,225,027	693,753	2,110,174	796,639	16,753,190
1977	827	57,547	6,038,169	4,660,592	629,127	1,650,278	596,507	13,633,047
1978	49,355	318,128	6,023,672	5,007,440	610,398	1,640,089	577,662	14,226,744
1979	71,744	161,691	7,850,867	5,078,686	500,491	2,032,332	865,596	16,561,406
1980	146,616	381,514	9,641,265	5,120,922	682,703	2,205,376	942,773	19,121,168
1981	210,814	528,826	8,554,019	11,756,144	748,841	2,263,295	965,564	25,027,503
1982	361,745	1,062,000	12,428,458	10,364,412	368,760	2,975,224	1,272,952	28,833,551
1983	852,363	3,260,228	14,164,526	5,981,219	345,696	3,576,799	1,375,707	29,556,538
1984	4,641,833	12,077,119	28,944,525	5,469,559	403,222	3,594,818	1,057,577	56,188,654
1985	3,769,762	16,912,602	17,436,629	6,467,724	354,419	3,749,270	1,184,868	49,875,274
1986	6,110,136	15,419,315	16,389,035	5,847,183	338,930	4,018,965	1,440,596	49,564,161
1987	7,687,120	16,128,329	20,013,370	6,129,406	371,681	5,048,107	1,322,000	56,700,012
1988	9,267,631	24,469,376	26,877,521	6,582,546	384,993	5,960,794	1,855,308	75,398,169
1989	15,903,942	25,393,118	21,142,675	8,019,247	598,321	6,614,189	2,315,691	79,987,182
1990	9,301,831	30,886,800	26,282,573	8,278,481	603,335	6,264,741	1,994,833	83,612,594
1991	6,641,221	39,794,208	32,730,642	10,934,631	631,375	6,394,339	1,847,040	98,973,456
1992	9,841,229	43,618,347	34,997,908	12,060,872	988,980	8,013,901	2,244,096	111,765,333
1993	12,892,570	48,391,082	36,650,065	14,026,321	493,791	7,421,034	3,059,736	122,934,600
1994	14,569,515	52,160,962	34,796,833	15,276,343	303,487	5,791,665	3,315,358	126,214,162
1995	11,264,534	61,034,955	28,606,866	15,943,437	466,175	5,430,634	2,652,133	125,398,735
1996	11,181,719	50,883,187	35,690,292	19,936,882	354,260	6,094,155	3,662,339	127,802,834
1997	6,849,773	56,144,697	33,765,631	19,723,686	344,554	6,632,305	4,335,337	127,795,983
1998	9,104,844	50,262,329	25,823,056	21,718,690	333,273	7,448,014	3,989,488	118,679,694
1999	15,583,107	66,977,425	30,062,986	28,027,389	194,342	6,815,700	4,106,199	151,767,147
2000	9,381,460	60,305,506	27,752,921	30,002,449	145,594	6,039,561	4,137,223	137,764,714
2001	8,085,724	64,011,371	32,011,755	30,835,561	153,809	6,772,418	5,401,995	147,272,634
2002	7,065,594	95,409,217	42,806,433	27,440,720	189,010	6,898,384	4,172,008	183,981,366
2003	7,994,219	63,857,026	37,222,376	33,817,905	113,794	6,859,475	4,119,261	153,984,056
2004	5,203,707	56,151,022	41,859,603	37,513,246	151,465	9,114,750	4,678,585	154,672,378
2005	13,551,491	60,392,899	44,384,059	31,201,465	222,664	8,438,164	10,012,725	168,203,467
2006	9,721,188	73,197,957	38,338,503	45,099,622	310,911	11,031,932	12,166,475	189,866,587
2007	8,339,417	50,765,008	35,519,518	34,637,401	427,266	10,710,109	11,009,840	151,408,558
2008	5,939,935	65,953,238	35,098,457	42,673,063	418,419	10,483,197	4,730,059	165,296,367
2009	4,488,841	65,156,802	30,672,288	38,818,096	434,366	10,380,924	4,716,680	154,667,996

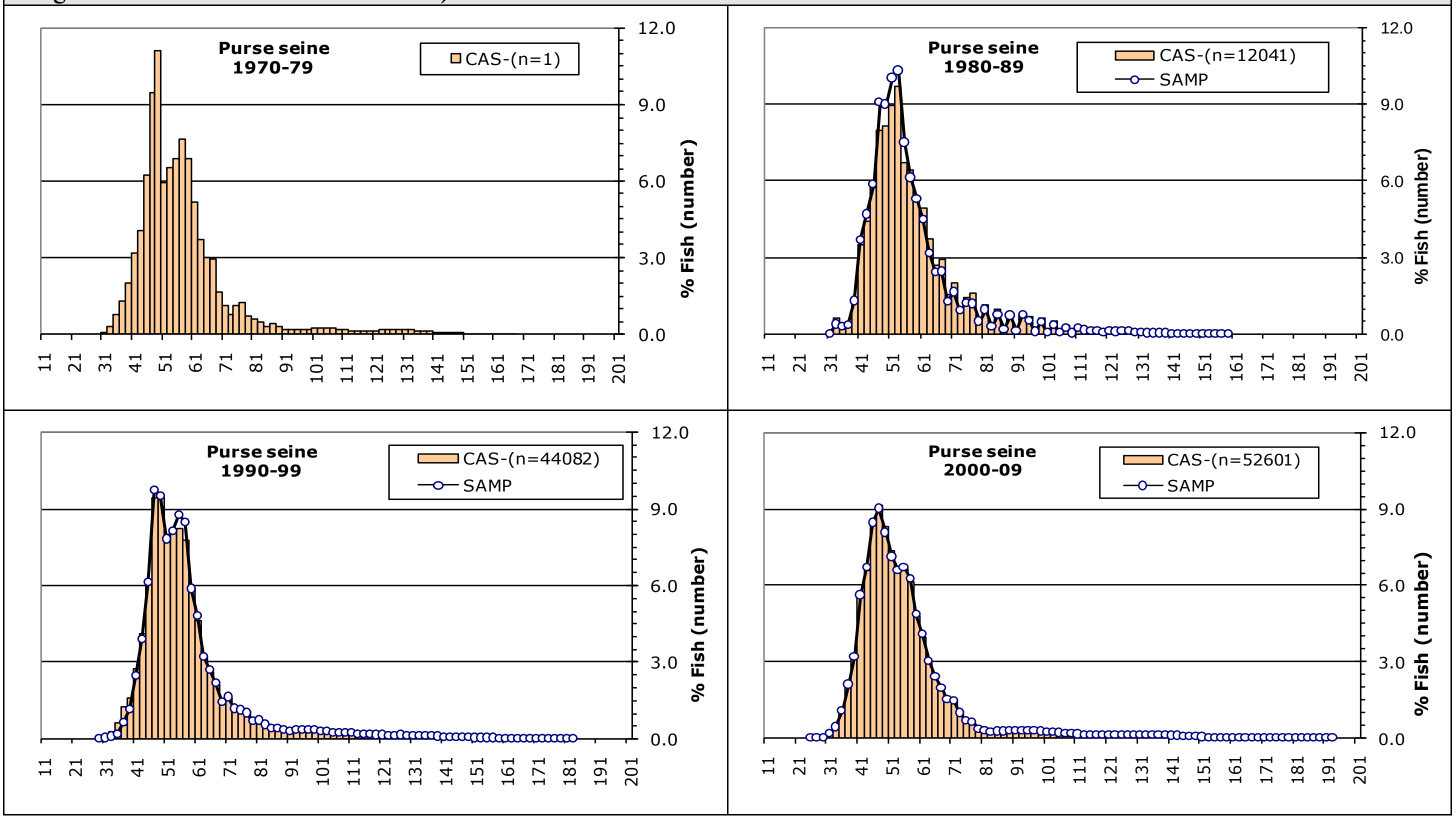
Skipjack Tuna catches in weight (tonnes)								
Year	Purse Seine-FS	Purse Seine-LS	Baitboat	Gillnet	Handline	Trolling	Other	Total
1950			8113	2023	431	384	48	11,000
1951			8414	2996	526	665	301	12,902
1952			8441	2566	367	687	324	12,384
1953			9480	2403	307	708	348	13,246
1954			9625	2502	299	755	374	13,555
1955			9707	2536	390	763	377	13,774
1956			9758	2839	446	790	402	14,235
1957			10672	4192	399	815	644	16,721
1958			10723	3454	430	840	618	16,065
1959			10672	3556	460	879	595	16,162
1960			9884	4552	569	960	755	16,720
1961			9197	5309	676	1095	850	17,127
1962			8762	6923	937	1014	928	18,565
1963			8965	9498	1245	1157	813	21,679
1964			8887	10148	1229	1174	1045	22,483
1965			15081	10249	1156	1526	938	28,949
1966			17888	12222	1349	1916	1168	34,542
1967			19979	12949	1491	1835	1029	37,283
1968			18633	13892	1701	1877	1286	37,388
1969			20729	14295	1876	1412	1042	39,355
1970			28763	11841	2404	1831	720	45,559
1971			29321	9566	2156	1784	700	43,526
1972			19389	14383	2510	2102	1113	39,497
1973			28317	17766	3003	2353	978	52,417
1974			35327	15582	2736	2461	1107	57,212
1975			19878	14801	1233	4578	1676	42,166
1976			23042	21950	2259	5337	2150	54,739
1977	3	129	17417	19690	2188	4320	1608	45,355
1978	201	717	17472	20769	2154	4310	1565	47,189
1979	207	400	22681	21530	1772	5142	2331	54,063
1980	406	1014	27935	21125	2409	5624	2536	61,048
1981	587	1416	24573	24278	2639	5777	2600	61,870
1982	1223	2976	22658	26176	1312	7222	3796	65,364
1983	2336	9515	27583	22733	1237	8762	4435	76,601
1984	13718	32009	40441	19194	1519	9418	3823	120,121
1985	11742	48642	50620	22014	1469	9625	4193	148,305
1986	20327	46344	54261	21034	1459	10190	3992	157,608
1987	29723	49507	54524	25043	1459	11464	4916	176,636
1988	25952	66943	69520	27702	1429	14023	5179	210,747
1989	49498	77334	71317	32754	2300	16633	6100	255,936
1990	26581	81670	72935	35658	2307	16207	5347	240,705
1991	17305	105483	71168	38609	2413	16180	5630	256,787
1992	27823	123509	71181	44722	4050	20109	5995	297,389
1993	38162	125779	79737	51766	2123	21036	7260	325,862
1994	47945	131235	84492	63710	1271	18317	7450	354,420
1995	33315	145622	85708	58245	1396	18237	7181	349,703
1996	34740	114423	85042	66097	1353	20524	9750	331,930
1997	20976	125291	89449	83503	1257	23062	11491	355,030
1998	22655	127385	94269	78466	1108	21767	10627	356,278
1999	37011	160559	108092	104037	702	22172	10934	443,508
2000	28937	170945	96203	115312	579	22705	10827	445,508
2001	28919	159646	104895	117032	578	25524	12963	449,558
2002	22801	215781	127066	109412	706	22150	8459	506,377
2003	30992	180556	121040	133203	451	21858	9457	497,559
2004	18565	137882	122859	154523	579	31516	12498	478,421
2005	43123	168012	152921	138434	834	25017	9279	537,621
2006	34954	211940	147759	183939	1191	29524	13322	622,629
2007	24198	120925	106509	174349	1617	27685	14063	469,346
2008	15421	127963	98157	156301	1609	27205	14371	441,027
2009	10382	147634	76781	162969	1656	26737	14297	440,456

Appendix III

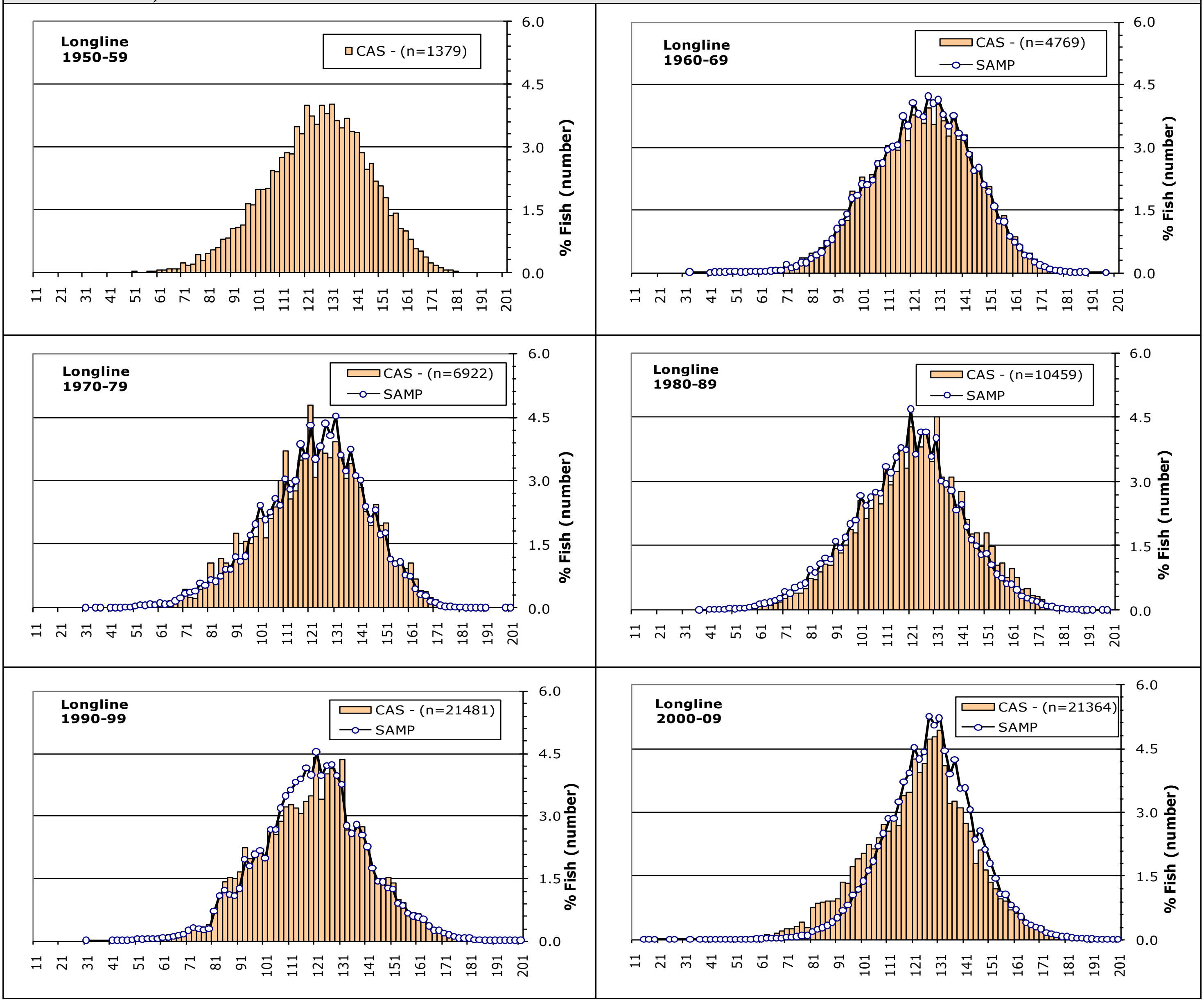
Length frequency distributions derived from samples and estimated as CAS, by fishery and decade

A/ Bigeye tuna (BET)

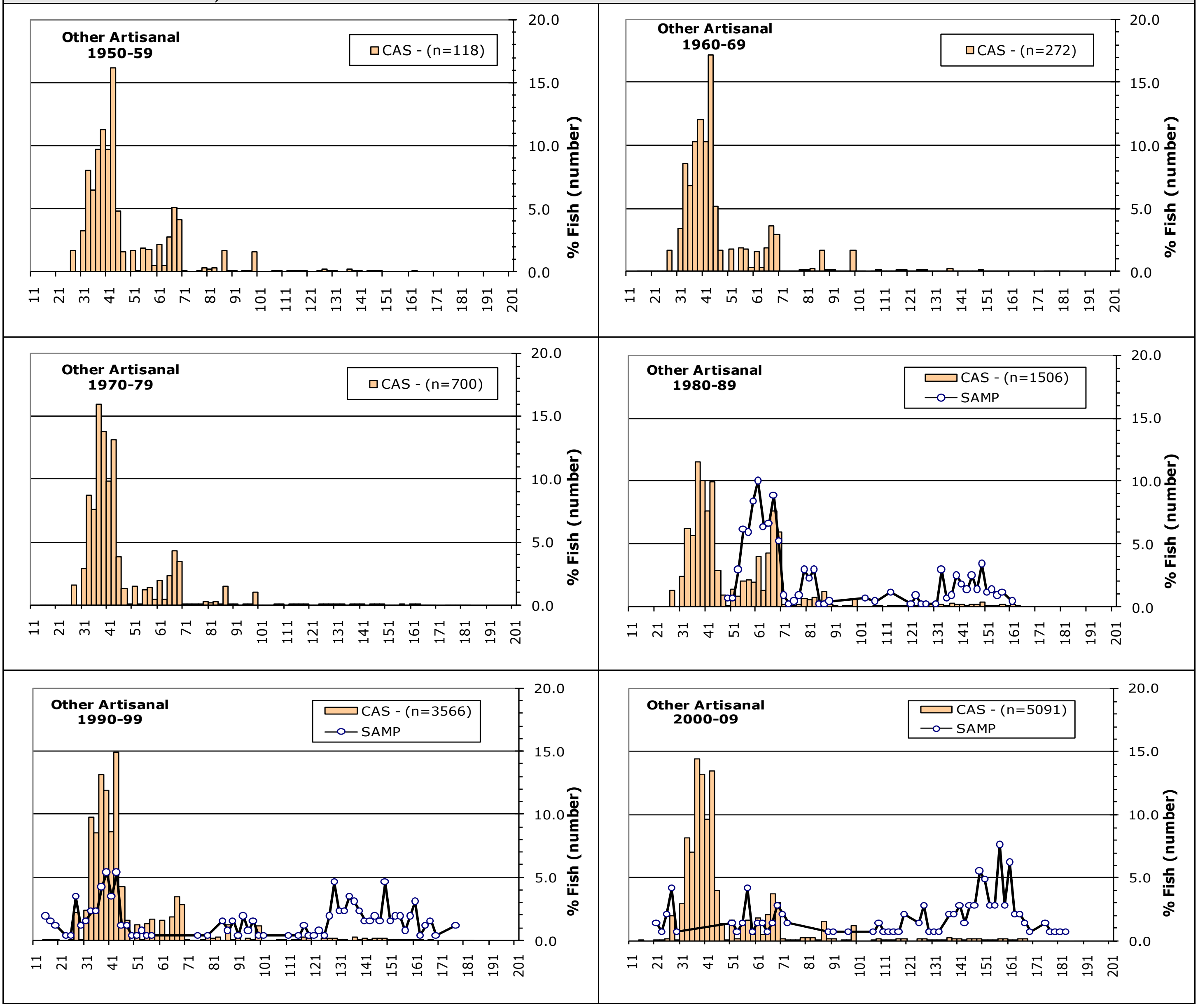
Figures 40-43: Industrial purse seiners: Proportion that the numbers of BIGEYE TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of bigeye tuna sampled/estimated by fishery and ten year period (total number of fish caught estimated for the decade = n*1000)



Figures 44-49: 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 (total number of fish caught estimated for the decade = n*1000)

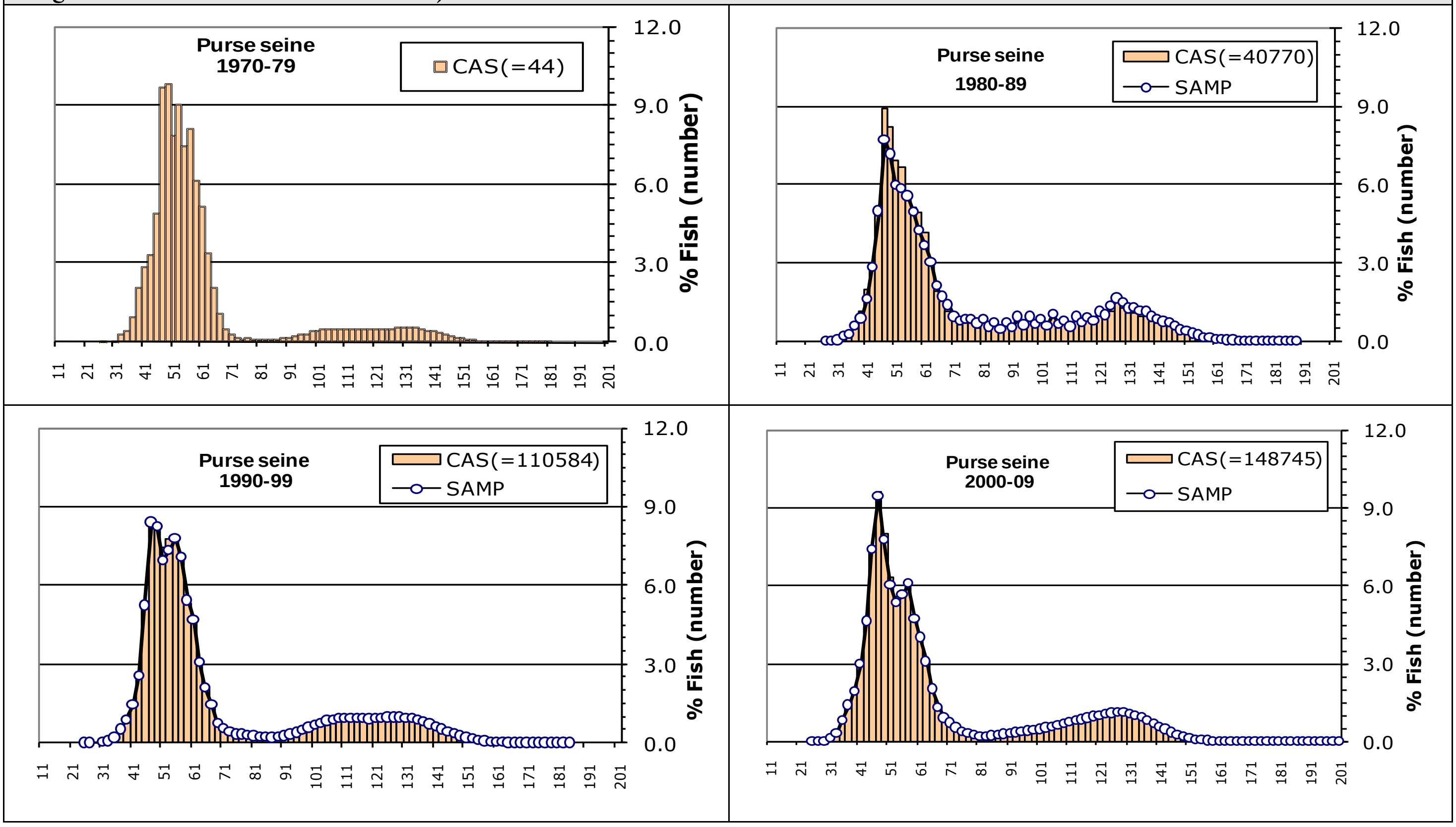


Figures 50-55: Other gears: Proportion that the numbers of BIGEYE TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of bigeye tuna sampled/estimated by fishery and ten year period (total number of fish caught estimated for the decade = n*1000)

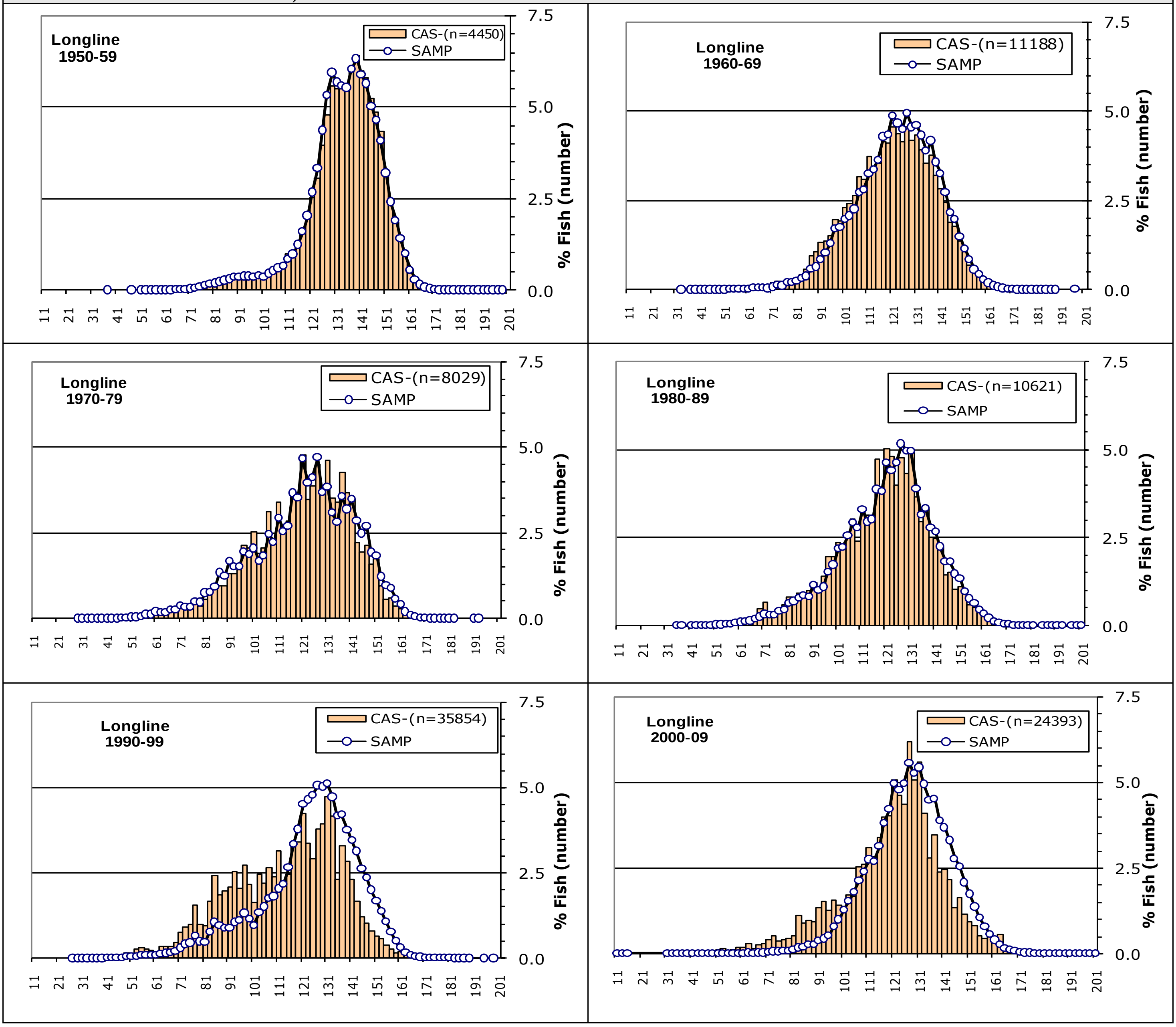


Length frequency distributions derived from samples and estimated as CAS, by fishery and decade
B/ Yellowfin tuna (YFT)

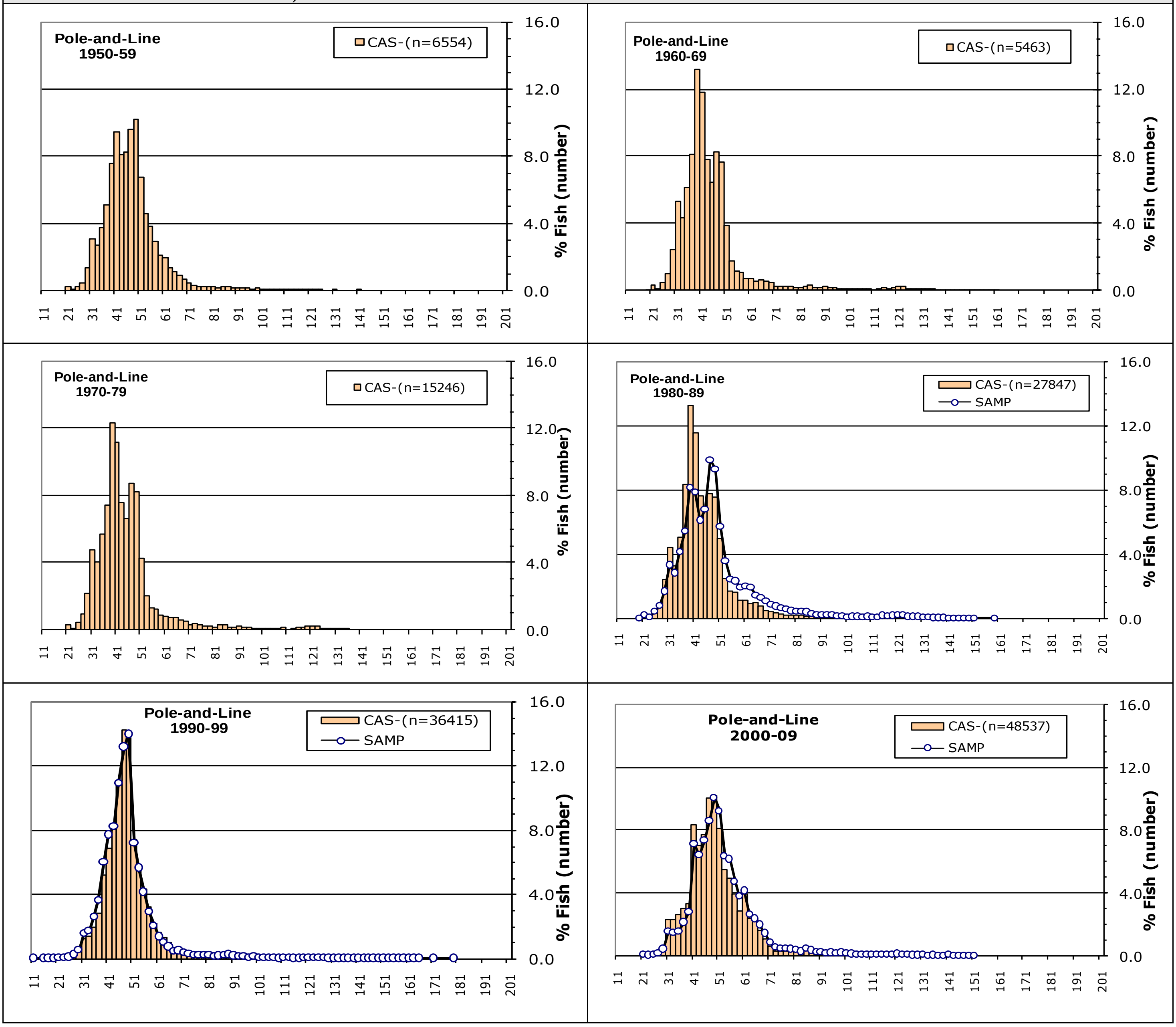
Figures 56-59: Industrial purse seine: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by fishery and ten year period (total number of fish caught estimated for the decade = n*1000)



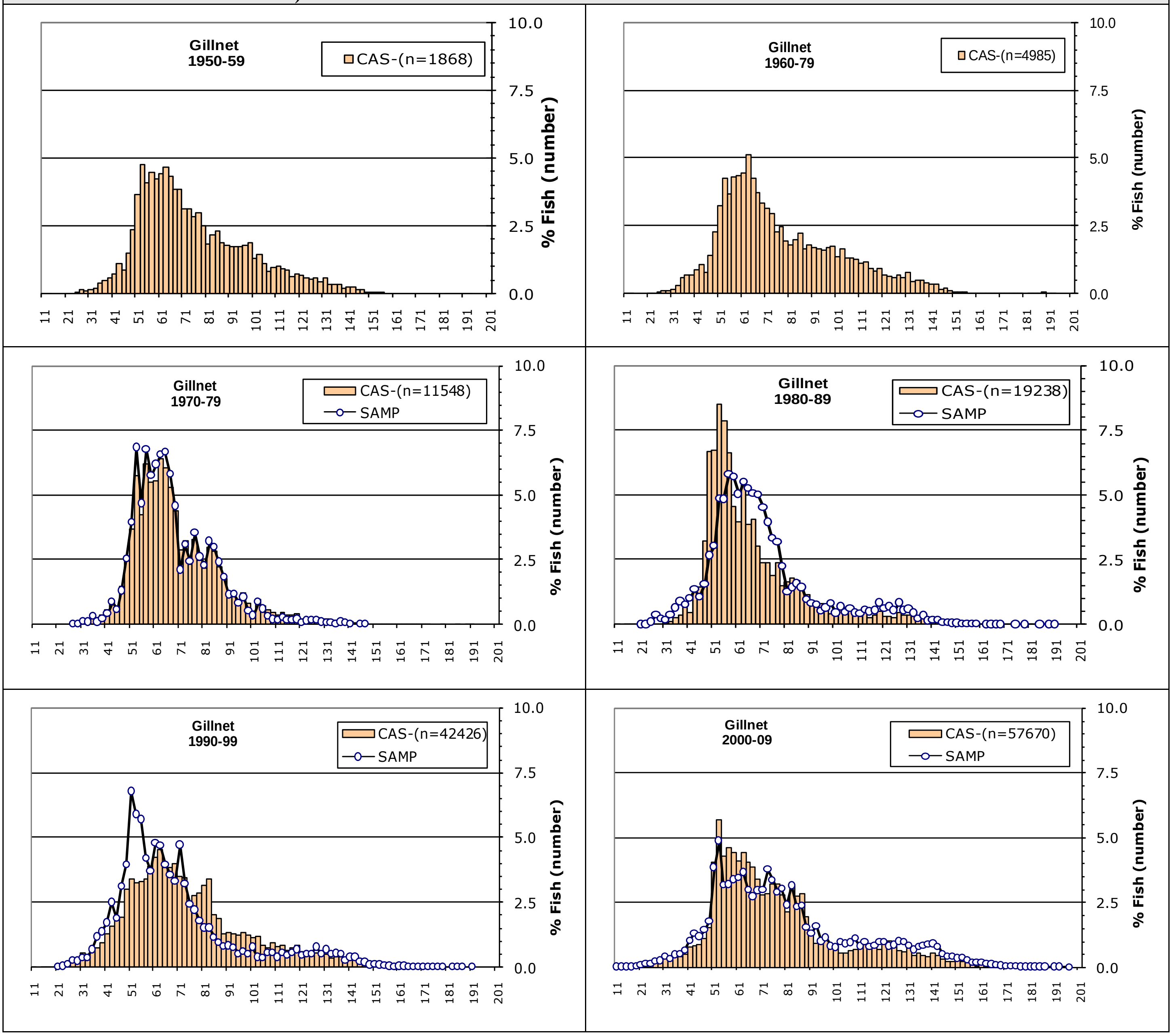
Figures 60-65: Longline: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by fishery and ten year period (total number of fish caught estimated for the decade = n*1000)



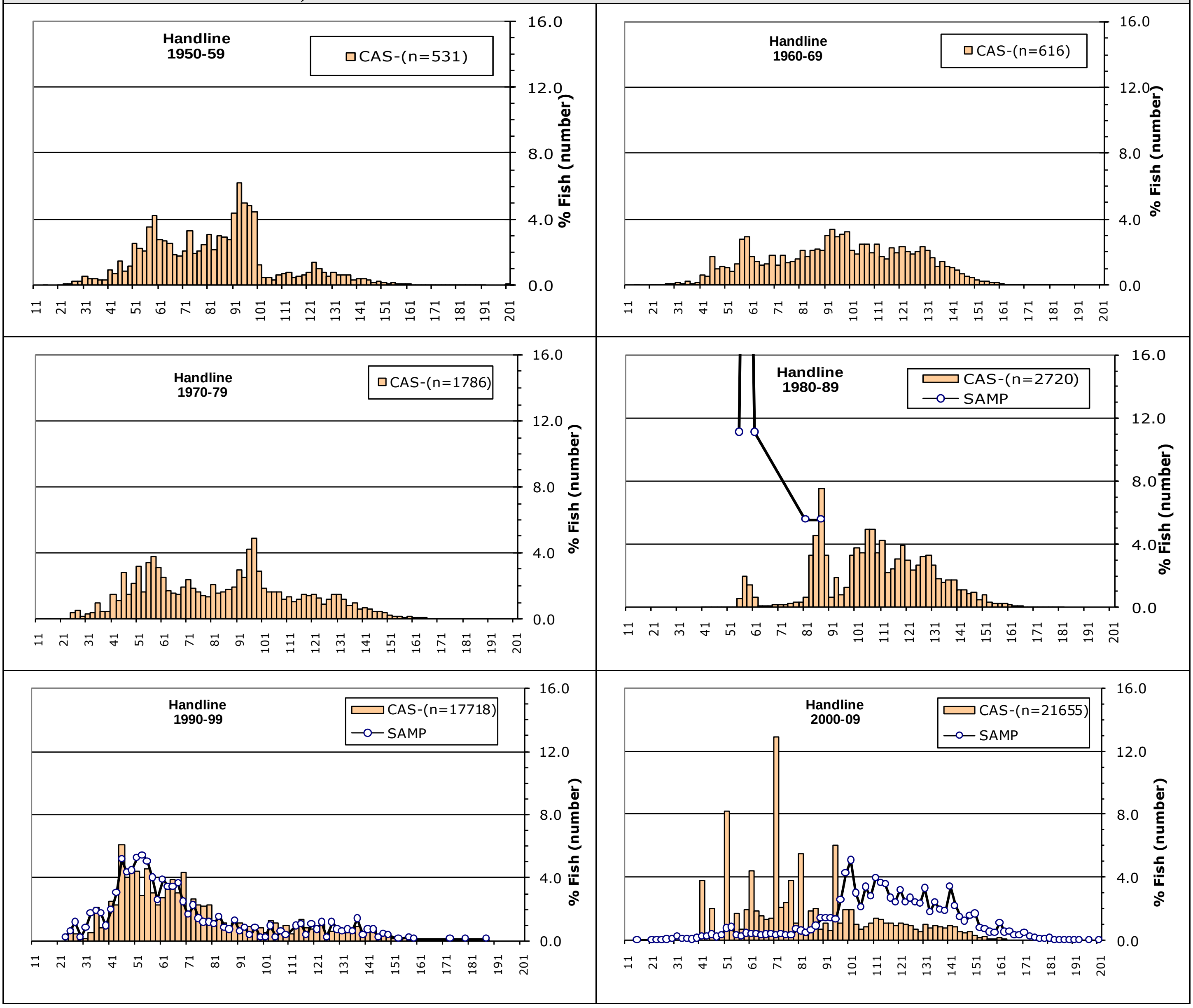
Figures 66-71: Pole-and-line: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by fishery and ten year period (total number of fish caught estimated for the decade = n*1000)



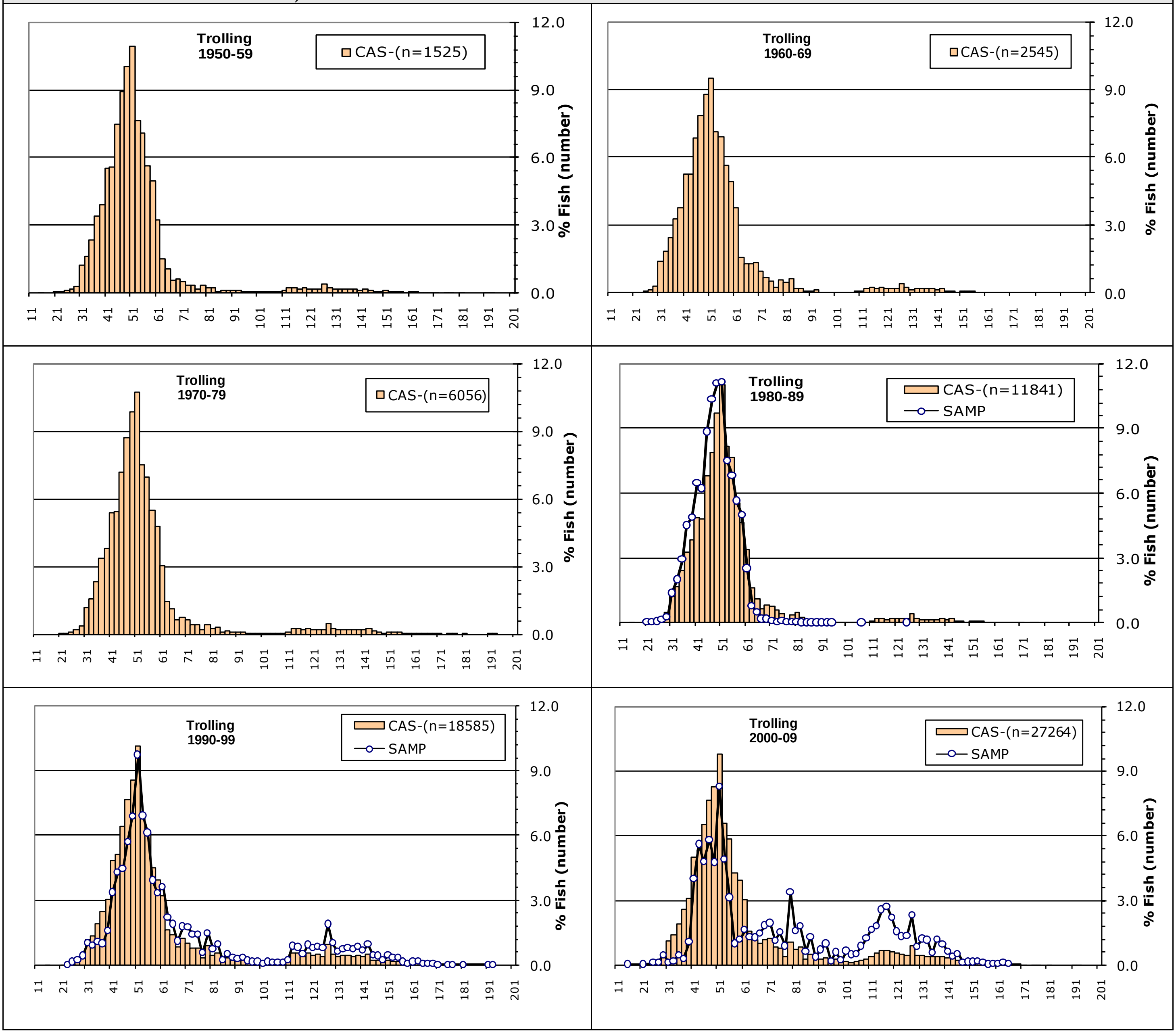
Figures 72-77: Gillnet: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by fishery and ten year period (total number of fish caught estimated for the decade = n*1000)



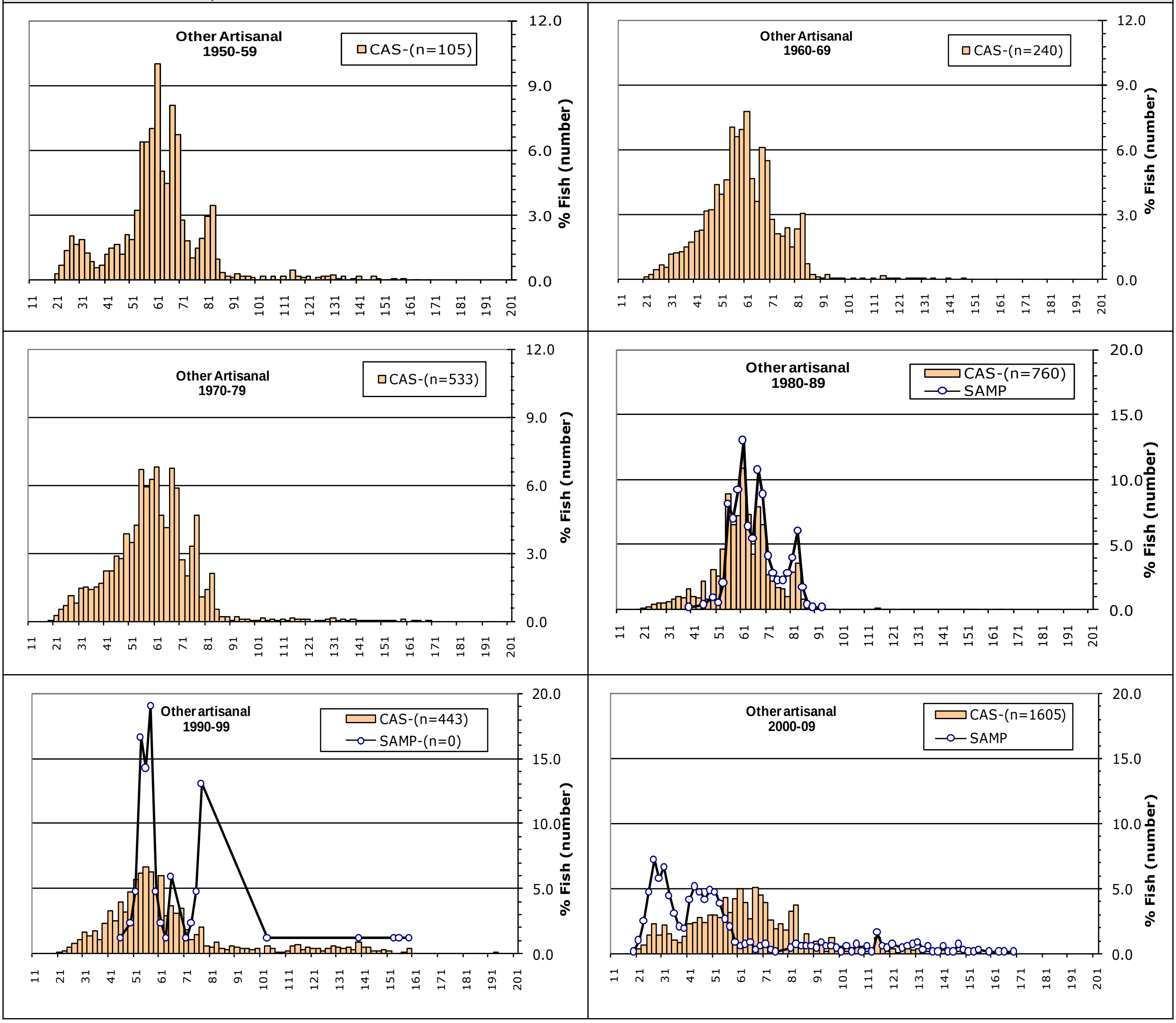
Figures 78-83: Handline: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by fishery and ten year period (total number of fish caught estimated for the decade = n*1000)



Figures 84-89: 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 (total number of fish caught estimated for the decade = n*1000)

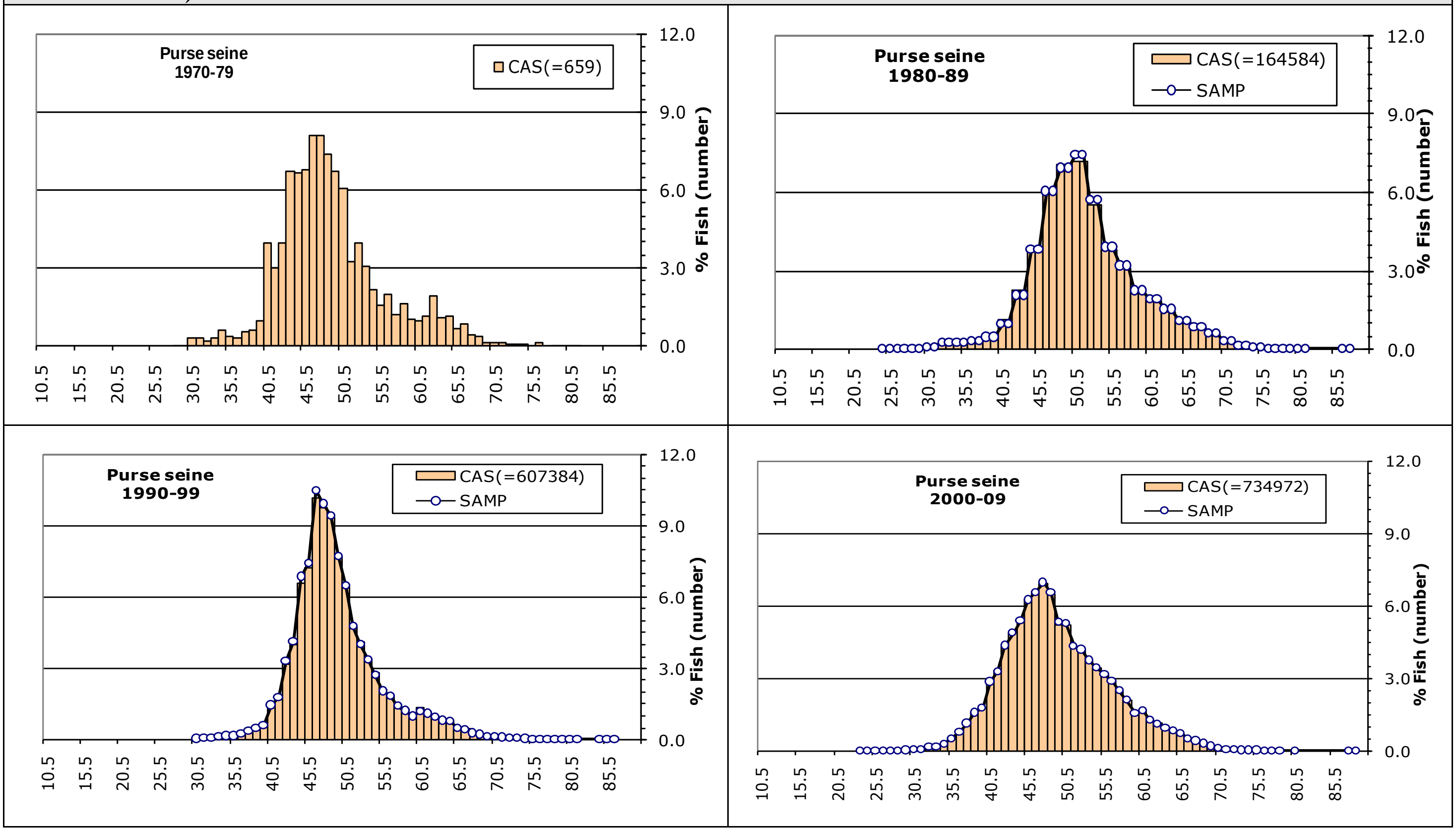


Figures 90-95: Other gears: Proportion that the numbers of YELLOWFIN TUNA sampled (blue line)/estimated (CAS; orange bars) by 2cm length class made out of the total number of yellowfin tuna sampled/estimated by ten year period (total number of fish caught estimated for the decade = n*1000)

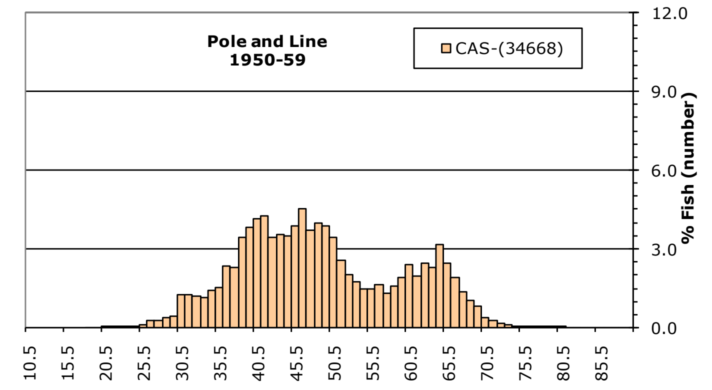


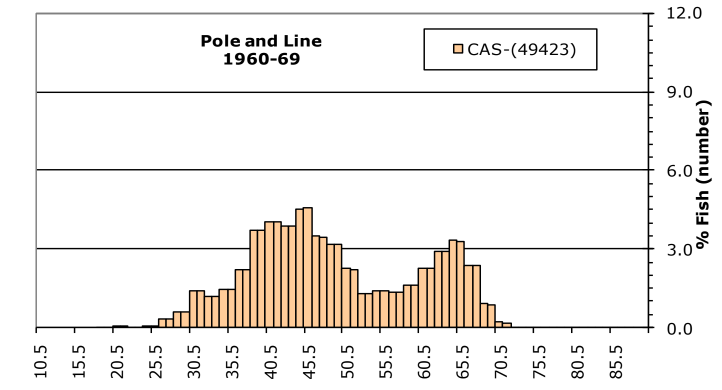
Length frequency distributions derived from samples and estimated as CAS, by fishery and decade
C/ Skipjack tuna (SKJ)

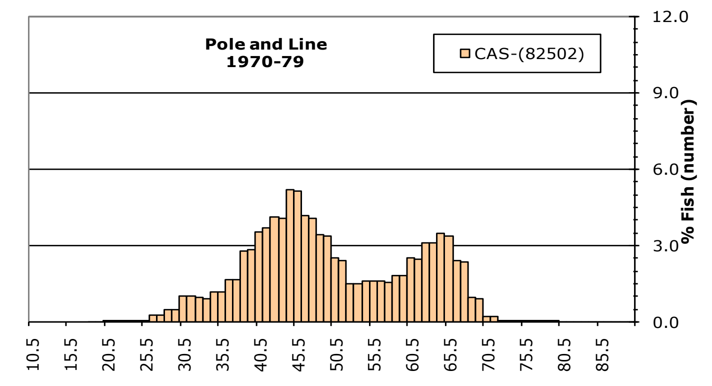
Figures 96-99: Purse seine: Proportion that the numbers of SKIPJACK TUNA sampled (blue line)/estimated (CAS; orange bars) by 1cm length class made out of the total number of skipjack tuna sampled/estimated by ten year period (total number of fish caught estimated for the decade = n*1000)

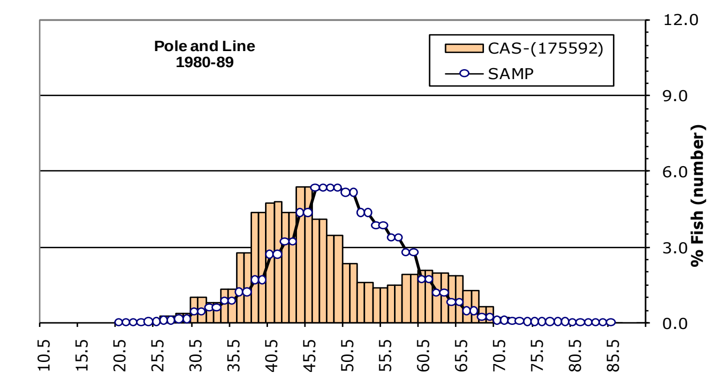


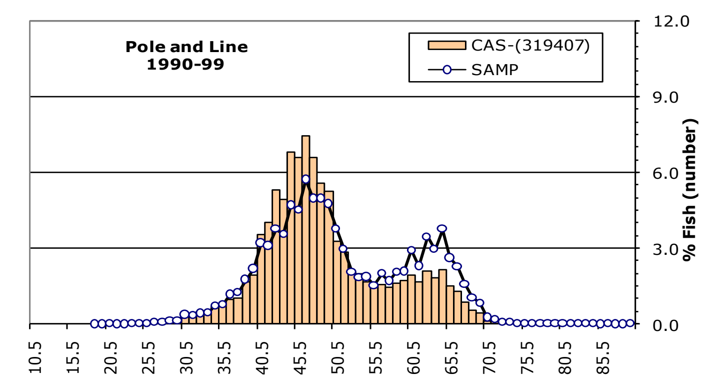
Figures 100-105: Pole-and-line: Proportion that the numbers of SKIPJACK TUNA sampled (blue line)/estimated (CAS; orange bars) by 1cm length class made out of the total number of skipjack tuna sampled/estimated by ten year period (total number of fish caught estimated for the decade = n*1000)

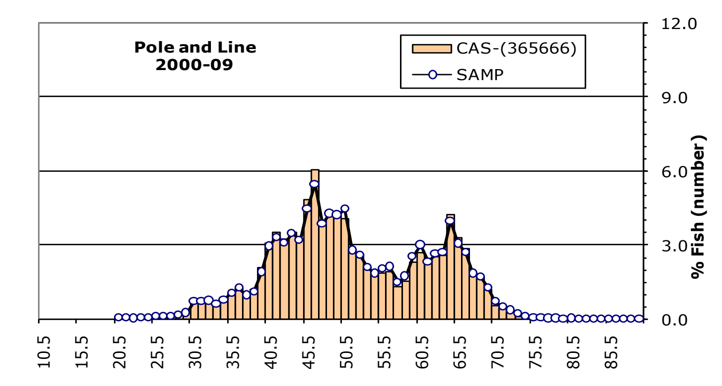




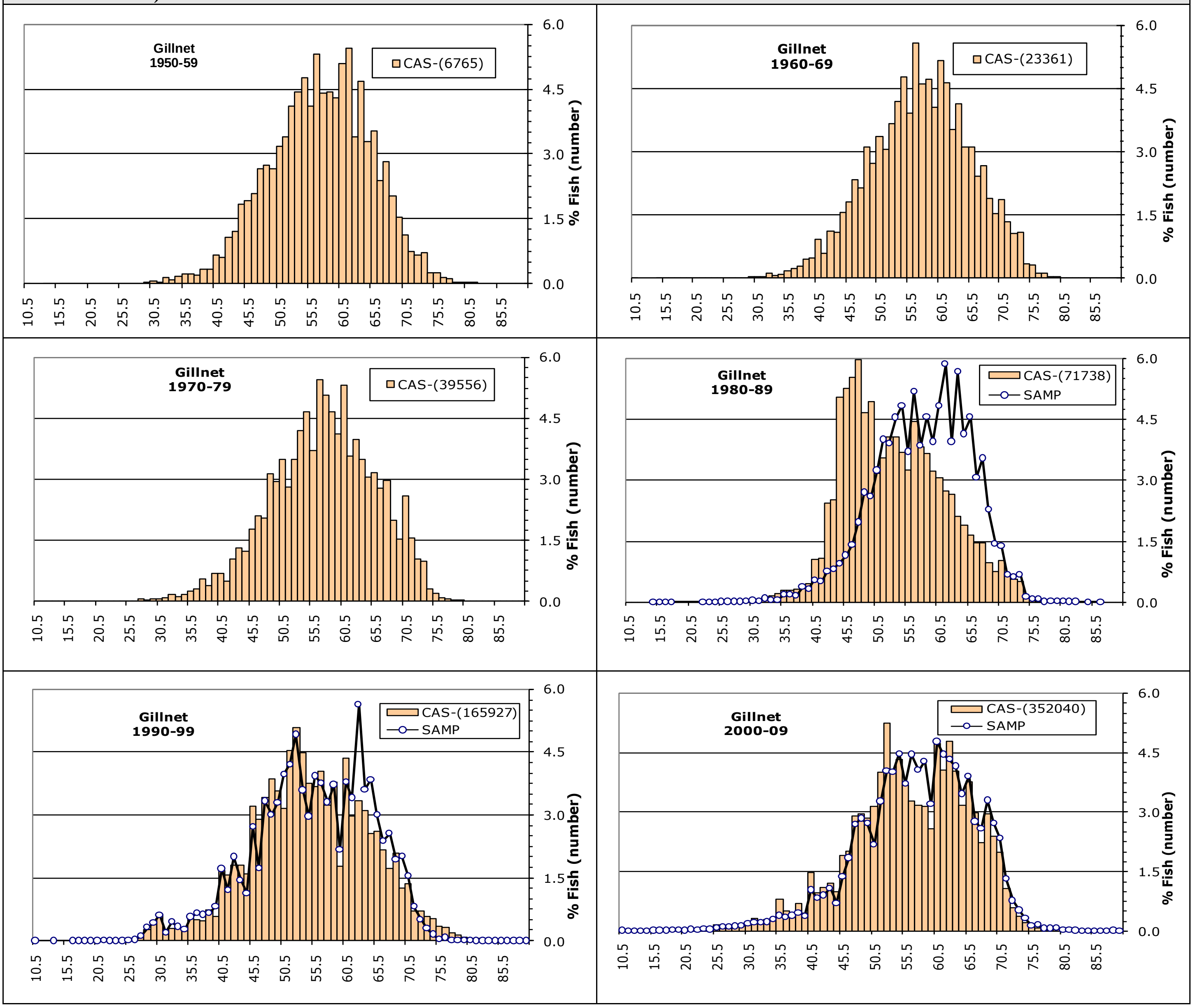








Figures 106-111: Gillnet: Proportion that the numbers of SKIPJACK TUNA sampled (blue line)/estimated (CAS; orange bars) by 1cm length class made out of the total number of skipjack tuna sampled/estimated by ten year period (total number of fish caught estimated for the decade = n*1000)



Figures 112-117: 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 (total number of fish caught estimated for the decade = n*1000)