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Biological data on tuna and tuna-like species gathered at the IOTC Secretariat: Status Report

IOTC Secretariat

Introduction

Catch and size data are available at the IOTC Secretariat in various formats.

Nominal catches, i.e. total catches in live weight, per year, gear, species and area are usually estimated when a vessel unloads. Catch estimates have to be adjusted, in most cases, to account for changes in weight that can occur after capture and due to different types of fish processing and/or preservation.

Size frequency data: Data on the size distribution of the catch may be available in weight or length. Weights and/or lengths refer to fish that are processed or whole.

Basic biological data on fish size (i.e., minimum, maximum, and mean) and size relationships/conversions (i.e., length-to-weight and length-to-length) are essential for understanding growth rate, age structure, and other aspects of population dynamics.

In artisanal and industrial tuna fisheries, tuna, billfish, tuna-like species and by-catch species are processed in many different ways and landed in different states (round, gilled and gutted etc). Measurements of actual size (length and weight) are recorded before processing only when observers are onboard fishing vessels or when fish are landed whole. Given that processing is common practice, being able to convert different measures of dressed and undressed fish to whole fish is essential.

As information about conversion factors for fish from the Indian Ocean is limited, a review of conversion factors data available for tuna, billfish, tuna-like species has been carried out. Information has been obtained from a range of sources including, IOTC, other regional fisheries bodies and the scientific literature.

The aims of this document are to present definitions of the standard and processed lengths of tuna and tuna-like species, to identify the various states of fish for which measurements might be available, to highlight the data already available for the purpose of reporting size frequency and for scientific research; and to point out where deficiencies in the current databases exist.

Updated data will be made available in the near future on the IOTC website. Users will be able to access raw datasets as well as tables containing developed equations and conversion factors. This information will be included in the IOTC Field Manual (e.g. see IOTC-2004-SC-INFO8).

Measurements types

- Species and measurement types

For tuna, tuna-like species and the more common by-catch species (see list of species, Appendix VIII, table13) such as sharks and dolphinfish fork length (FL) is considered to be the ‘standard length’ and is used to construct size frequency distributions. For billfish, lower jaw fork length (LJFL) is used but references to eye-fork length (EFL) can also be found in the literature (portrayal and definitions of the measurement types are shown in figure 1, 2 and

3 and in table 1 (Appendix I). While variations to these measurements result due to people measuring either "projected straight" or "curved-body distance" measurements, greater challenges in deriving the standard length arise when alternate length measurements are provided — this usually occurs when the measurements are taken on processed fish. Because of this a range of length alternates need to be collected. In order to construct size frequencies distributions from these alternate lengths data, the relationships between alternate length and the standard length needs to be determined. A list of the different processing types is given in appendix II (table 2).

Datasets, Relationships and conversions

- Datasets

Data provided to IOTC are of variable quantity and quality but the database is set up to contain the following information for each individual fish sampled:
Species, data source, type of fleet, gear, year, time strata (month, quarter,..), period covered, geographical area definition (size of rectangle area; from 1°x1° to FAO area) length measurements (standard length and alternate lengths), weight (dressed or round), sex and maturity. Table 3 outlines the content of the current database and table 4 shows the number of measurements available (length-length or length-weight) reported by Malaysia, Korea and United Kingdom and data collected in the framework of the IOTC/ OFCF sampling program carried out in Thailand and in Indonesia in partnership respectively with SEAFDEC (Southeast Asian Fisheries Development Center) and RCCF (Research Center for Capture Fisheries) (Appendix III, tables 3,4).

- Length-Length conversion

Linear regressions of length-length equations are documented and presented with their corresponding regression coefficients, sample sizes, size ranges, geographic area and original sources referenced,. Separate relationships for each sex are also presented when available (Appendix IV, tables 5,6,7).
For some species, there is need to use more than one–step conversion to obtain the standard length of measurement ("projected straight distance") because no one relationship is available to convert from the alternate length measurement to standard length (Appendix V, table8).

- Length –weight conversion

The form of allometric length-weight equation is $WT = (a)L^b$, where WT = round or dressed carcass weight (kg), L = length (cm), and a and b are constants for each species (Appendix VI, table 12).

- Weight-weight conversion

Factors to convert from processed to round weight have been published by the Food and Agriculture Organisation of the United Nations (FAO, 1992) and the International Commission for the Conservation of Atlantic Tunas (ICCAT website[1]) (Appendix VII).

The ongoing OFCF –IOTC project tasks

The biological information available at the IOTC Secretariat is still insufficient and there is often a need to use data for other oceans or species to obtain a required measure. Data are also likely to be incomplete with respect to area, time interval, fishing gear and/or gender.
As the need for information to convert the lengths of processed fish to standard lengths and weights of processed fish to whole weight, and lengths to whole weight varies regionally, specialised regional sampling is currently being carried out by the IOTC-OFCF Sampling Programme.
For example, in **Indonesia** and in **Thailand,** samples are being taken so "curved-body length" can be converted into "projected straight distance" and t various weight-on-length predictors for tuna and billfish can be developed In **Sri Lanka** sampling provides various length-length relationships to convert other length measurements to standard-length for indo-Pacific sailfish, blue marlin, black marlin and striped marlin.

[1] http://www.iccat.es/Data/forms/convers.pdf

During the preparation of this document, the lack of data for many conversions was obvious. We are expecting that current and future studies on large pelagics as well as the Indian Ocean Tagging Program (IOTTP) and observer programs conducted in Indian Ocean will improve our database and, ultimately, improve the accuracy of the current conversion equations.

Acknowledgement:
We thank Dr Dennis Lee, Project leader of the Observer Program at the NMFS Miami Laboratory, Miami, FL (USA) for having providing us with additional documentation on the data available on the NOAA's fisheries Service web site[2] .Dr Ward, Bureau of Rural Sciences for having providing datasets collected by Australian observers on Japanese longliners (1980-97).

References cited

FAO, 1992. Conversion factors-landed weight to live weight, FAO Fisheries Circular No.847. Food and Agriculture Organisation of the United Nations, Rome, Italy.378 p.

IPTP, 1989. Tuna sampling programme in Sri Lanka. Indo-Pacific Tuna Development and Management Programme .111 p.

J. H. Meneses de Lima , C. A. Arfelli and A. F. Amorim, 2000. Swordfish catch at size from the Brazilian longline fleet. Col.Vol.Sci.Pap. ICCAT, 51 (5) : 1683-1687 (2000).

Kohler N. E., Casey J. G., and Turner P. A., 1996. Length-Length and Length-Weight Relationships for 13 Shark Species from the Western North Atlantic. NOAA Technical Memorandum NMFS-NE-110.

Poisson, 2001. Structuration et mise en place d'une base de données halieutiques spatio-temporelles géoréférencées pour le suivi des pêcheries palangrières dans le sud-ouest de l'océan Indien In: L'espadon: de la recherche à l'exploitation durable. Poisson F., Taquet M. (coord). Programme Palangre Réunionnais, Rapport final, 9-58

Prager M H., Lee D. W., Prince E. D, 1994. Length and weight conversion equations for blue marlin, white marlin and sailfish from north Atlantic , in Report of the second ICCAT billfish workshop. ICCAT vol XLI, 325-330.

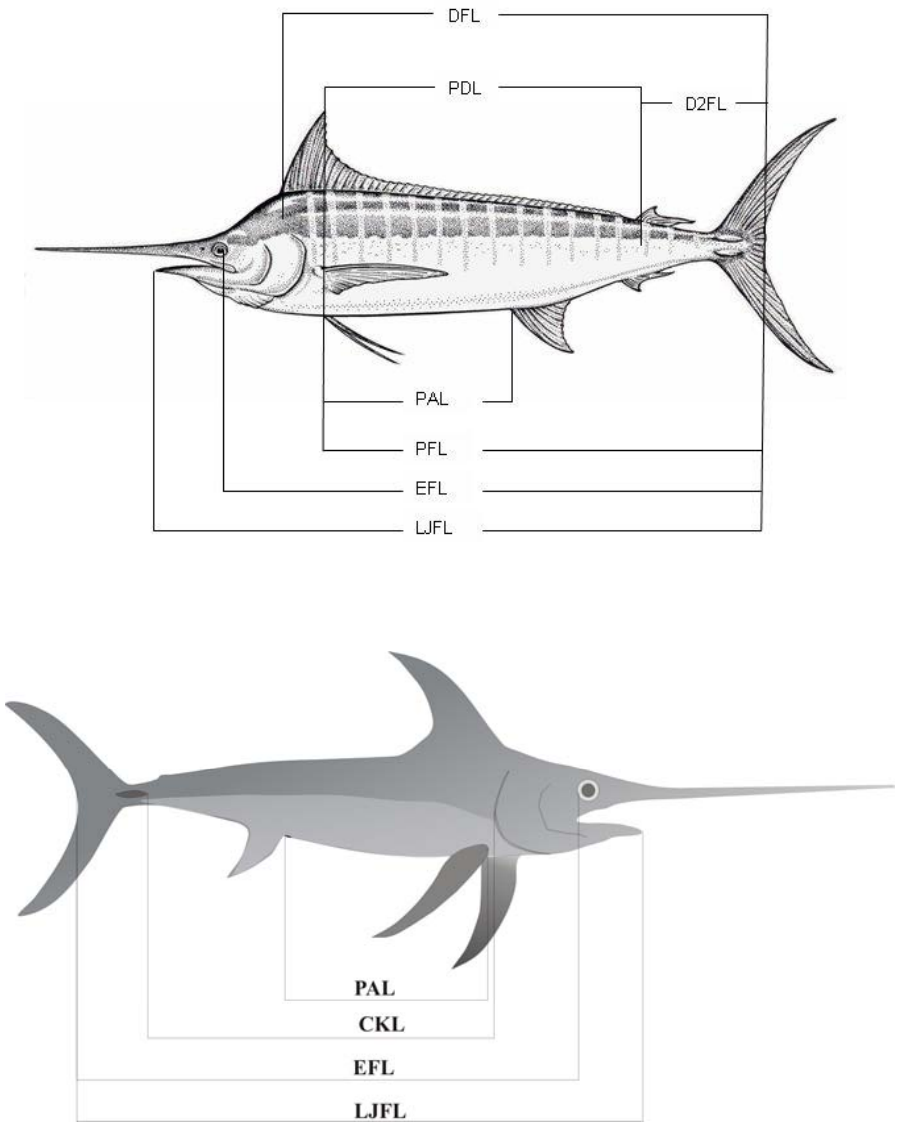
Uchiyama, J. H., and T. K. Kazama, 1999. Length-weight relationships of Pelagic Management Unit Species from Hawaiian waters. In National Marine Fisheries Service and Ecosystem Principles Advisory Panel. 1999. Ecosystem-based Fishery Management. A report to congress by the Ecosystem Principles Advisory Panel as mandated by the Sustainable Fisheries Act amendments to the Magnuson-Stevens Fishery Conservation and Management Act of 1996. National Marine Fisheries Service, Washington, D.C.

Wei-Chuan Chiang, Chi-Lu Sun, Su-Zan Yeh, Wei-Cheng Su, 2004. Age and growth of sailfish (*Istiophorus platypterus*) in waters off eastern Taiwan. Fish. Bull. 102(2): 251–263 (2004).

[2] http://www.sefsc.noaa.gov/observerdata.jsp

APPENDIX I

Figure 1: Types of measurements used for billfish



Source: Poisson and Taquet,2001

Figure 2: Types of measurements used for tuna

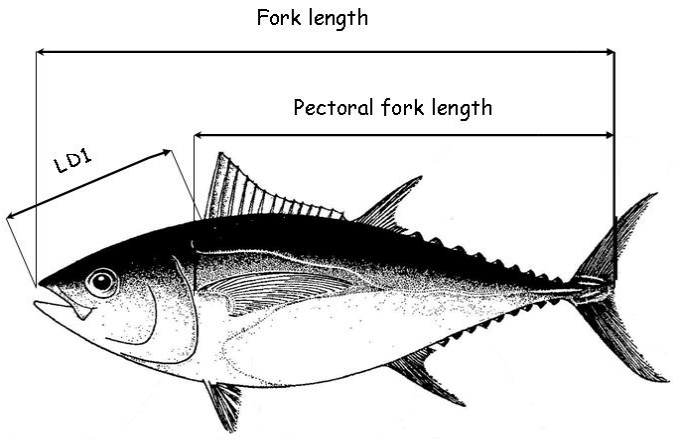


Figure 3: Types of measurements used for shark

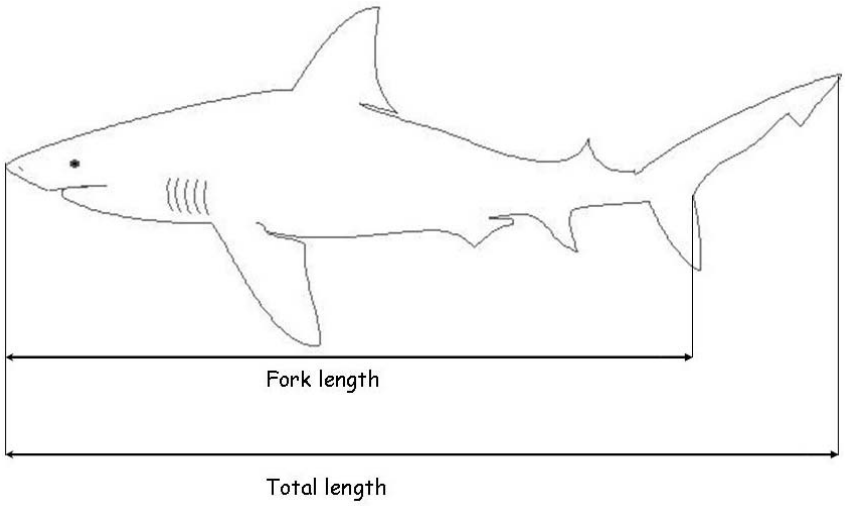


Table 1:Definitions of lengths measurements

Length	tools	Type	Description
CKL	caliper	Cleithrum-Keel length	Projected straight distance between the point on the cleithrum that provides the shortest possible measurement to the anterior portion of the caudal keel. The cleithrum is the semicircular bony structure at the posterior edge of the gill opening.
D2FL	caliper	Second dorsal fork length	Projected straight distance between the most anterior insertion of the second dorsal fin and the fork of the tail
DFL	caliper	Dorsal Fork Length	Projected straight distance between the most anterior insertion of the dorsal fin and the fork of the tail
EFL	caliper	Eye Fork Length	Projected straight distance from the caudal margin of orbit to the fork of the tail.
FL	caliper	Fork Length	Projected straight distance from the tip of the upper jaw (snout) to the shortest caudal ray (fork)
IDS	caliper	Interdorsal space	First Dorsal-Second Dorsal Calliper (Projected straight distance between the most posterior insertion of the first dorsal fin and the most ante insertion of the second dorsal fin)
LD1	caliper	Pre-dorsal length	Length to the first dorsal fin Calliper (Projected straight distance from the tip of the snout to the anterior base of the first dorsal fin)
LJFL	caliper	Lower jaw-fork length	Projected straight distance from the tip of the lower jaw to the shortest caudal ray (fork of the caudal fin.).
P1A	caliper	Pectoral anterior margin	(shark fins) Projected straight distance between the tip and the base of the anterior margin of the pectoral fin
PAL	caliper	Pectoral- anal length	Projected straight distance between the most anterior insertion of the pectoral fin to the most posterior rim of the anal sphincter.
PDL	caliper	Pectoral dorsal length	Projected straight distance between the most anterior insertion of the pectoral fin and the most anterior insertion of the second dorsal fin.
PFL	caliper	Pectoral-fork length	Projected straight distance between the most anterior insertion of the pectoral fin and the fork of the tail.
PPS	caliper	Pectoral-pelvic space	Projected straight distance between the most posterior insertion of the pectoral fin to the most anterior insertion of the pelvic fin.
TL	caliper	Total Length (relaxed)	Projected straight distance from the most forward point of the head to the tip of the tail when the tail is left in the “natural position” (unsquee
CKLT	tape measure	Curved Cleithrum-Keel length	Projected curved-body distance between the point on the cleithrum that provides the shortest possible measurement to the anterior portion caudal keel. The cleithrum is the semicircular bony structure at the posterior edge of the gill opening.
D2FLT	tape measure	Curved Second dorsal fork length	Projected curved-body distance between the most anterior insertion of the second dorsal fin and the fork of the tail.
DFLT	tape measure	Curved Dorsal Fork Length	Projected curved-body distance between the most anterior insertion of the dorsal fin and the fork of the tail.
EFLT	tape measure	Curved Eye Fork Length	Projected curved-body distance from the caudal margin of orbit to the fork of the tail along the contour of the body in a line that runs along t of the pectoral fin and the top of the caudal keel
FLT	tape measure	Curved Fork Length	Projected curved-body distance from the tip of the upper jaw (snout) to the shortest caudal ray (fork)
IDST	tape measure	Curved Interdorsal space	First Dorsal-Second Dorsal Tape (Projected curved-body distance between the most posterior insertion of the first dorsal fin and the most a insertion of the second dorsal fin)
LD1T	tape measure	Curved Pre-dorsal length	Length to the first dorsal fin Tape (Projected curved-body distance from the tip of the snout to the anterior base of the first dorsal fin)
LJFLT	tape measure	Curved Lower jaw-fork length	Projected curved-body distance from the tip of the lower jaw to the shortest caudal ray (fork of the caudal fin.).
P1AT	tape measure	Curved Pectoral anterior margin	(shark fins) Projected curved body distance between the tip and the base of the anterior margin of the pectoral fin .
PALT	tape measure	Curved Pectoral- anal length	Projected curved-body distance between the most anterior insertion of the pectoral fin to the most posterior rim of the anal sphincter.
PDLT	tape measure	Curved Pectoral dorsal length	Projected curved-body distance between the most anterior insertion of the pectoral fin and the most anterior insertion of the second dorsal f
PFLT	tape measure	Curved Pectoral-fork length	Projected curved-body distance between the most anterior insertion of the pectoral fin and the fork of the tail.
PPST	tape measure	Curved Pectoral-pelvic space	Projected curved body distance between the most posterior insertion of the pectoral fin to the most anterior insertion of the pelvic fin.
TLT	tape measure	Total Length (relaxed)	Projected curved-body distance from the most forward point of the head to the tip of the tail when the tail is left in the “natural position” (unsqueezed).

APPENDIX II

Table 2: List of the different processing types and definitions.

Diagnostic Features	Code for measured and Estimated weight
Fish not processed Small tuna, tuna-like and shark By-catch species are commonly not processed.	WHO /EWHO
Bills (if any), gills and fins off, gutted. Tuna specimens usually undergo this form of processing.	GGT/EGGT
Dressed carcasses with heads and fins off and tail present	HDD/EHDD
Dressed carcasses with fins and caudal peduncles off Gutted with gills Billfish (mainly sailfish) and by-catch specimens are sometimes processed this way	GWG/EGWG
Dressed carcasses with heads and fins off and caudal peduncles present. Billfish (mainly sailfish) and by-catch specimens are sometimes processed this way as are some shark by-catch specimens.	TAL/ETAL
Dressed carcasses with heads, fins and caudal peduncles off. Billfish export, reject and by-catch specimens are usually processed this way as are some shark by-catch specimens.	PDD/EPDD
Fish processed and dried on-board (skipjack)	DRY/EDRY

APPENDIX III

Table 3 : Contents of length, weight and sex data held by IOTC , for yellowfin, bigeye and skipjack tunas, by gear, area, fleet and year.

Species	Source	Gear	Fleet	Year	Time strata	Period	Area	Sample size	Sex data
BET	GBR	PS	FRA,SYC	2001	Month	1	BIOT	2	0
SKJ	GBR	PS	FRA,SYC	2001	Month	1	BIOT	142	56
YFT	GBR	PS	FRA,SYC	2001	Month	1	BIOT	578	22
BET	GBR	LL	JPN, NEI,TWN	2000	Month	1	BIOT	258	52
BET	GBR	LL	JPN, NEI,TWN	2001	Month	1	BIOT	631	405
BET	GBR	LL	JPN, NEI,TWN	2002	Month	1	BIOT	136	106
BET	GBR	LL	JPN, NEI,TWN	2003	Month	1	BIOT	165	145
BET	GBR	LL	JPN, NEI,TWN	2003	Month	3	BIOT	835	829
BET	KOR	LL	KOR	2001	Month	1	F51	736	300
BET	KOR	LL	KOR	2002	Month	1	F51	12	5
BET	KOR	LL	KOR	2003	Month	1	F51	40	20
BET	KOR	LL	KOR	2001	Month	1	F57	64	28
BET	KOR	LL	KOR	2002	Month	1	F57	3	0
BET	MYS	LL	TWN	1992	Month	1	F57	122	109
BET	MYS	LL	TWN	1993	Month	1	F57	383	381
SKJ	GBR	LL	JPN, NEI,TWN	2000	Month	1	BIOT	3	0
SKJ	GBR	LL	JPN, NEI,TWN	2001	Month	1	BIOT	6	1
SKJ	GBR	LL	JPN, NEI,TWN	2002	Month	1	BIOT	1	1
SKJ	GBR	LL	JPN, NEI,TWN	2003	Month	1	BIOT	6	1
SKJ	GBR	LL	JPN, NEI,TWN	2003	Month	3	BIOT	18	18
YFT	GBR	LL	JPN, NEI,TWN	2000	Month	1	BIOT	743	330
YFT	GBR	LL	JPN, NEI,TWN	2001	Month	1	BIOT	236	113
YFT	GBR	LL	JPN, NEI,TWN	2002	Month	1	BIOT	245	167
YFT	GBR	LL	JPN, NEI,TWN	2003	Month	1	BIOT	127	101
YFT	GBR	LL	JPN, NEI,TWN	2003	Month	3	BIOT	319	316
YFT	KOR	LL	KOR	2001	Month	1	F51	800	328
YFT	KOR	LL	KOR	2003	Month	1	F51	24	14
YFT	MYS	LL	TWN	1992	Month	1	F57	716	756
YFT	MYS	LL	TWN	1993	Month	1	F57	1646	1638
BET	IDN	LL	IDN	2002	Month	6	F57	10677	0
BET	IDN	LL	IDN	2003	Month	12	F57	26319	0
BET	IDN	LL	IDN	2004	Month	12	F57	12349	0
YFT	IDN	LL	IDN	2002	Month	6	F57	10786	0
YFT	IDN	LL	IDN	2002	Month	6	F57	45214	0
YFT	IDN	LL	IDN	2003	Month	6	F57	18165	0
BET	THA	LL	NEI	2001	Month	8	F57	1794	0
BET	THA	LL	NEI	2002	Month	12	F57	2644	0
BET	THA	LL	NEI	2003	Month	12	F57	1003	0
YFT	THA	LL	NEI	2001	Month	8	F57	2388	0
YFT	THA	LL	NEI	2001	Month	12	F57	1958	0
YFT	THA	LL	NEI	2001	Month	12	F57	2301	0

Table 4: Numbers of size measurements by type and species provided by Indonesia, Korea, Malaysia, Thailand and United Kingdom.

Species	CountryRep	Flag	YEAR	ACode	Area	MONTH	FL	LD1	TL	GGT	WHO
BET	GBR	FRA,SEY	2001	PS	BIOT	1	2	2			2
SKJ	GBR	FRA,SEY	2001	PS	BIOT	1	142				142
YFT	GBR	FRA,SEY	2001	PS	BIOT	1	578	553			326
BET	GBR	JPN	2000	LL	BIOT	1	94	94			50
BET	GBR	JPN	2001	LL	BIOT	1	562	536			557
BET	GBR	JPN	2002	LL	BIOT	1	11				11
BET	GBR	NEI	2002	LL	BIOT	1	119		124	57	125
BET	GBR	NEI	2003	LL	BIOT	3	835	835		830	835
BET	GBR	NEI	2003	LL	BIOT	1	165		164	114	165
BET	GBR	TWN	2000	LL	BIOT	1	164	164			163
BET	GBR	TWN	2001	LL	BIOT	1	69	65			69
BET	KOR	KOR	2001	LL	F57	1	64			64	
BET	KOR	KOR	2001	LL	F51	1	736			736	
BET	KOR	KOR	2002	LL	F57	1	3			3	
BET	KOR	KOR	2002	LL	F51	1	12			12	
BET	KOR	KOR	2003	LL	F51	1	40			40	
BET	MYS	TWN	1992	LL	F57	1	122				122
BET	MYS	TWN	1993	LL	F57	1	383				383
SKJ	GBR	JPN	2000	LL	BIOT	1	2	2			2
SKJ	GBR	JPN	2001	LL	BIOT	1	4	2			4
SKJ	GBR	NEI	2002	LL	BIOT	1	1		1		1
SKJ	GBR	NEI	2003	LL	BIOT	1	6		6		6
SKJ	GBR	NEI	2003	LL	BIOT	3	18	18		18	18
SKJ	GBR	TWN	2000	LL	BIOT	1	1	1			1
SKJ	GBR	TWN	2001	LL	BIOT	1	2				2
YFT	GBR	JPN	2000	LL	BIOT	1	407	406			323
YFT	GBR	JPN	2001	LL	BIOT	1	161	146			153
YFT	GBR	JPN	2002	LL	BIOT	1	10				10
YFT	GBR	NEI	2002	LL	BIOT	1	190		226	92	235
YFT	GBR	NEI	2003	LL	BIOT	1	127		125	76	126
YFT	GBR	NEI	2003	LL	BIOT	3	319	319		314	319
YFT	GBR	TWN	2000	LL	BIOT	1	336	336			334
YFT	GBR	TWN	2001	LL	BIOT	1	75	71			75
YFT	KOR	KOR	2001	LL	F51	1	800			800	
YFT	KOR	KOR	2003	LL	F51	1	24			24	
YFT	MYS	TWN	1992	LL	F57	1	716				716
YFT	MYS	TWN	1993	LL	F57	1	1646				1646
BET	IDN	IDN	2002	LL	F57	6	10650			10650	16
BET	IDN	IDN	2003	LL	F57	12	26312			26321	
BET	IDN	IDN	2004	LL	F57	12	12348			12348	
YFT	IDN	IDN	2002	LL	F57	6	10776			10776	5
YFT	IDN	IDN	2003	LL	F57	12	45177			45177	5
YFT	IDN	IDN	2004	LL	F57	12	18165			18165	23
BET	THAI	NEI	2001	LL	F57	8		1744	46	1744	4
BET	THAI	NEI	2002	LL	F57	12		2644		2644	
BET	THAI	NEI	2003	LL	F57	12		1003		1003	
YFT	THAI	NEI	2001	LL	F57	8		2358		2358	30
YFT	THAI	NEI	2002	LL	F57	12		1958		1958	30
YFT	THAI	NEI	2003	LL	F57	12		2301		2301	

APPENDIX IV

Table 5: Regression equation for predicting Standard length from an other measurement L (in cm) for tuna using the equation Y=a*L+b

Bigeye tuna

L	a	b	R^2	Sex	tool	Standard Length	Area	Range (cm)	n	Dataset available	reference
PFL	1.2129	18.191	0.8988	Combined	calliper	FL	Atlantic	33-141	3174	Yes	NMFS Pelagic Observer Program
CKL	0.6215	-5.5109	0.9255	Combined	calliper	FL	Atlantic	29-110	570	Yes	NMFS Pelagic Observer Program
PFLT	1.4572	-2.287	0.9564	Combined	Calliper/Tape measure	FL	Atlantic	44-110	59	Yes	NMFS Pelagic Observer Program
PFLT	1.3418	7.1818	0.9733	Combined	Tape measure	FLT	Atlantic	44-110	59	Yes	NMFS Pelagic Observer Program

Yellowfin tuna

L	a	b	R^2	Sex	tool	Standard Length	Area	Range (cm)	n	Dataset available	reference
PFL	1.2211	10.733	0.9729	Combined	calliper	FL	Atlantic	31-127	5153	Yes	NMFS Pelagic Observer Program
CKL	1.3693	21.399	0.9208	Combined	calliper	FL	Atlantic	31-111	1814	Yes	NMFS Pelagic Observer Program
PFLT	1.1566	15.667	0.9122	Combined	Calliper/Tape measure	FL	Atlantic	45-120	258	Yes	NMFS Pelagic Observer Program
PFLT	1.2596	8.527	0.9656	Combined	Tape measure	FLT	Atlantic	45-120	59	Yes	NMFS Pelagic Observer Program

Table 6: Regression equation for predicting Standard length from an other measurement L (in cm) for billfish using the equation Y=a*L+b

Blue Marlin

L	a	b	R^2	Sex	tool	Standard Length	Area	Range (cm)	n	Dataset available	reference
LJFL	0.9039	-7.248	0.95	Combined	calliper	EFL	East and western Australia	143-295	26	Yes	BRS (Ward, pers.com)
EFLT	1.092	10.127		Combined	tape measure	LJFLT	North Atlantic	120-300	250	No	Prager et al., 1994
PFLT	1.248	9.486		Combined	tape measure	LJFLT	North Atlantic	65-280	732	No	Prager et al., 1994
PDLT	1.738	12.626		Combined	tape measure	LJFLT	North Atlantic	60-190	482	No	Prager et al., 1994
PALT	1.92	72.161		Combined	tape measure	LJFLT	North Atlantic	30-120	453	No	Prager et al., 1994
DFLT	1.206	8.303		Combined	tape measure	LJFLT	North Atlantic	100-280	271	No	Prager et al., 1994
EFL	1.09	10.52	0.97	female	caliper	LJFL	Atlantic			No	ICCAT[3]
PFL	2.2	19.23	0.97	female	caliper	LJFL	Atlantic			No	ICCAT
D2FL	1.2	10.02	0.96	female	caliper	LJFL	Atlantic			No	ICCAT
PDL	1.61	33.29	0.90	female	caliper	LJFL	Atlantic			No	CCAT
EFL	1.1	7.15	0.97	male	caliper	LJFL	Atlantic			No	ICCAT
PFL	1.24	9.34	0.95	male	caliper	LJFL	Atlantic			No	ICCAT
D2FL	1.2	9.08	0.95	male	caliper	LJFL	Atlantic			No	ICCAT
PDL	1.33	50.15	0.75	male	caliper	LJFL	Atlantic			No	ICCAT

[3] ICCAT Conversion factor

Black Marlin

L	a	b	R^2	Sex	tool	Standard Length	Area	Range (cm)	n	Dataset available	reference
LJFL	0.8972	-4.6673	0.99	Combined	caliper	EFL	East and western Australia	119-314	13	Yes	BRS (Ward, pers.com)
EFL				male	caliper	LJFL	Atlantic			No	ICCAT
PFL				male	caliper	LJFL	Atlantic			No	ICCAT
D2FL				male	caliper	LJFL	Atlantic			No	ICCAT
PDL				male	caliper	LJFL	Atlantic			No	ICCAT

Sailfish

L	a	b	R^2	Sex	tool	Standard Length	Area	Range (cm)	n	Dataset available	reference
EFLT	1.076	11.24		Combined	tape measure	LJFLT	North Atlantic	85-175	251	No	Prager et al., 1994
PFLT	1.083	29.441		Combined	tape measure	LJFLT	North Atlantic	75-180	1810	No	Prager et al., 1994
PDLT	1.332	38.322		Combined	tape measure	LJFLT	North Atlantic	55-180	330	No	Prager et al., 1994
PALT	0.999	107.196		Combined	tape measure	LJFLT	North Atlantic	30-100	1553	No	Prager et al., 1994
DFLT	0.958	38.438		Combined	tape measure	LJFLT	North Atlantic	75-165	252	No	Prager et al., 1994
EFL	1.08	9.14	0.98	female	calliper	LJFL	Atlantic			No	ICCAT
PFL	1.23	10.02	0.98	female	calliper	LJFL	Atlantic			No	ICCAT
D2FL	1.14	11.75	0.96	female	calliper	LJFL	Atlantic			No	ICCAT
PDL	1.55	18.79	0.93	female	calliper	LJFL	Atlantic			No	
EFL	1.10	8.01	0.98	male	calliper	LJFL	Atlantic			No	ICCAT
PFL	1.27	5.06	0.97	male	calliper	LJFL	Atlantic			No	ICCAT
D2FL	1.23	-0.18	0.96	male	calliper	LJFL	Atlantic			No	ICCAT
PDL	1.64	9.83	0.92	male	calliper	LJFL	Atlantic			No	ICCAT
EFL	0.893	-5.196	0.983	male	calliper	LJFL	Pacific, East Taiwan	78-221	720	No	Wei-Chuan Chiang et al., 2004
EFL	0.876	-2.209	0.983	female	calliper	LJFL	Pacific, East Taiwan	80-232	446	No	Wei-Chuan Chiang et al., 2004

Shortbill spearfish

L	a	b	R^2	Sex	tool	Standard Length	Area	Range (cm)	n	Dataset available	reference
LJFL	0.9524	-13.4441	0.99	Combined	caliper	EFL	East and western Australia	61-197	106	Yes	BRS (Ward, pers.com)

Striped Marlin

L	a	b	R^2	Sex	tool	Standard Length	Area	Range (cm)	n	Dataset available	reference
LJFL	1.334	0.8395	0.87	Combined	calliper	EFL	East and western Australia		443	Yes	BRS (Ward, pers.com)

Swordfish:

L	a	b	R^2	Sex	tool	Standard Length	Area	Range (cm)	n	Dataset Available	reference
EFLT	1.066	10.449	0.99	Combined	tape measure	LJFLT	Reunion Island , Indian Ocean	48-255	123	Yes	Poisson , 2001
PFLT	1.2398	11.204	0.98	Combined	tape measure	LJFLT	Reunion Island , Indian Ocean	60-157	55	Yes	Poisson , 2001
CKLT	1.5411	19.605	0.97	Combined	tape measure	LJFLT	Reunion Island , Indian Ocean	32-180	801	Yes	Poisson , 2001
PALT	2.5407	25.698	0.94	Combined	tape measure	LJFLT	Reunion Island , Indian Ocean	18-105	1806	Yes	Poisson , 2001
PFLT	1.138	3.625	0.99	Combined	tape measure	EFLT	Reunion Island , Indian Ocean	60-157	55	Yes	Poisson , 2001
CKLT	1.4419	8.6256	0.97	Combined	tape measure	EFLT	Reunion Island , Indian Ocean	32-147	483	Yes	Poisson , 2001
PALT	2.4444	11.954	0.94	Combined	tape measure	EFLT	Reunion Island , Indian Ocean	19-89	613	Yes	Poisson , 2001
LJFLT	0.9295	-7.5732	0.99	Combined	tape measure	EFLT	Reunion Island , Indian Ocean	69-252	646	Yes	Poisson , 2001
LJFL	0.9114	-4.1547	0.96	Combined	calliper	EFL	East and western Australia	53-260	1114	Yes	BRS (Ward, pers.com)
CKL	1.509349	210.654286	0.97	Combined	calliper	LJFL	Brazilian coast, Atlantic	32-147	483	No	Meneses de Lima et al, 2000

Table 7: Regression equation for predicting Standard length from an other measurement L (in cm) for shark using the equation Y=a*L+b

L	a	b	r^2	Sex	tool	Standard Length	Area	Range (cm)	n	Dataset available	reference
Bigeye Thresher											
TL	0.5598	17.6660	0.8944	Combined	Calliper	FL	North Atlantic	155-371	56	No	Kohler N. E. *et al*, 1996
Thresher Shark											
TL	0.5474	7.0262	0.8865	Combined	Calliper	FL	North Atlantic	291-450	13	No	Kohler N. E. *et al*, 1996
Shortfin Mako											
TL	0.9286	-1.7101	0.9972	Combined	Calliper	FL	North Atlantic	70-368	199	No	Kohler N. E. *et al*, 1996
Portbeagle											
TL	0.8971	1.7939	0.9877	Combined	Calliper	FL	North Atlantic	119-247	13	No	Kohler N. E. *et al*, 1996
Silky Shark											
TL	0.8388	-2.6510	0.9972	Combined	Calliper	FL	North Atlantic	90-258	15	No	Kohler N. E. *et al*, 1996
Dusky shark											
TL	0.8396	-3.1902	0.9947	Combined	Calliper	FL	North Atlantic	92-330	148	No	Kohler N. E. *et al*, 1996
Sandbar Shark											
TL	0.8175	2.5675	0.9933	Combined	Calliper	FL	North Atlantic	51-249	3734	No	Kohler N. E. *et al*, 1996
Tiger Shark											
TL	0.8761	-13.3535	0.9887	Combined	Calliper	FL	North Atlantic	145-375	44	No	Kohler N. E. *et al*, 1996
Blue Shark											
TL	0.8313	1.3908	0.9932	Combined	Calliper	FL	North Atlantic	64-337	572	No	Kohler N. E. *et al*, 1996
Scalloped Hammerhead											
TL	0.7756	-0.3132	0.9868	Combined	Calliper	FL	North Atlantic	82-278	111	No	Kohler N. E. *et al*, 1996

APPENDIX V

Table 8: Relationships between straight and curved body measurements for bigeye and yellowfin tuna using the equation Y=a*L+b

Bigeye tuna

L	a	b	R²	Sex	tool	Standard Length	Area	Range (cm)	n	Dataset available	reference
FLT	0.9676	0.9082	0.9891	Combined	Calliper/Tape measure	FL	Atlantic	63-169	304	Yes	NMFS Pelagic Observer Program

Yellowfin tuna

L	a	b	R²	Sex	tool	Standard Length	Area	Range (cm)	n	Dataset available	reference
FLT	0.9749	1.7998	0.9702	Combined	Calliper/Tape measure	FL	Atlantic	64-206	581	Yes	NMFS Pelagic Observer Program

APPENDIX VI :

Table 9: Coefficients of the general equation used *(W=a Lb)* for predicting fish weight (whole or process, kg) from standard length (cm) for billfish..

Species	a	b		Sex	Length	Weight	N	W-range Kg	L-range cm	Area	Reference
SFA	1.577E-05	2.819		Combined	EFL	RND				North Indian Ocean	IPTP, 1989
	1.2869-06	3.2439		Combined	LJFLT	RND	2187	0.04-52.7	27.1-204.5	North Atlantic	Prager et al., 1994
MLS	1.33263-06	3.41344	0.9621	Combined	EFL	RND	17	8.6-68.0	101.5-178.2	North Pacific, Hawaii	Uchiyama, J. H., and T. K. Kazama. 1999
BLM	1.1955-06	3.3663		Combined	LJFLT	RND	5245	0.06-540.9	23.0-378.5	North Atlantic	Prager et al.,1994
	6.61E-05	2.611088	0.742	Combined	LJFL	RND	19			South Pacific	SPC[4]
	0.0000081	3.033		Combined	EFL	RND				North Indian Ocean	IPTP, 1989
	1.44217-05	2.98851	0.9565	Combined	EFL	RND	24			North Pacific, Hawaii	Uchiyama, J. H., and T. K. Kazama. 1999
							199				
							19				
BUM	1.73E-06	3		Combined	EFL	RND				North Indian Ocean	IPTP, 1989
SSP	0.000188756	2.30582	0.511	Combined	EFL	RND	80			North Pacific, Hawaii	Uchiyama, J. H., and T. K. Kazama. 1999
SWO	5.47E-06	3.17439	0.9395	Combined	LJFL	RND	1965			South Pacific	SPC
	6.33E-06	3.1605		Combined	EFL	RND				North Indian Ocean	IPTP, 1989

[4] SPC: South Pacific Commission

Table 10: Coefficients of the general equation used: $W=(a)FL^{b}$. for predicting fish weight (round or process, kg) from standard length (cm) for tuna and tuna like species.

Species	a	b	r^2	Sex	Length	N	W-range Kg	L-range cm	Area	Reference
ALB	000006303	3.28250		Combined	FL				Indian Ocean	IRD
BET	2.396E-05	2.98		Combined	FL				North Indian Ocean	IPTP, 1989
	2.70-05	2.951		Combined					Indian Ocean	IRD
YFT	0.000041	2.8		Combined	FL				North Indian Ocean	IPTP, 1989
	0.000015849	3.04600		Combined	FL				Indian Ocean	IRD
SKJ	0.000006	3.3		Combined	FL				North Indian Ocean	IPTP, 1989
	0.00000532	3.34958		Combined	FL				Indian Ocean	IRD
TUX	0.000041	2.8		Combined	FL				North Indian Ocean	IPTP, 1989
KAW	0.000026	2.9		Combined	FL				North Indian Ocean	IPTP, 1989
FRI	0.000017	3		Combined	FL				North Indian Ocean	IPTP, 1989
BLT	0.000017	3		Combined	FL				North Indian Ocean	IPTP, 1989
KGX	1.176E-05	2.9002		Combined	FL				North Indian Ocean	IPTP, 1989
COM	1.176E-05	2.9002		Combined	FL				North Indian Ocean	IPTP, 1989
WAH	1.544E-06	3.2945		Combined	FL				North Indian Ocean	IPTP, 1989

Table 11: Fork length (FL) - total weight (WT) relationships for 13 shark species from the western North Atlantic, based on WT = (a)FL ^{b}.

Species	Code	a	b	r^2	Sex	Length	N	W-range Kg	L-range cm	Area	Reference
Bigeye Thresher	BTH	9.1069-06	3.0802	0.9059	Combined	FL	55	11-170	100-228	North Atlantic	Kohler N. E. *et al*, 1996
Thresher Shark	THR	1.8821-04	2.5188	0.8795	Combined	FL	88	54-211	154-262	North Atlantic	Kohler N. E. *et al*, 1996
Shortfin Mako	SMA	5.2432-06	3.1407	0.9587	Combined	FL	2081	2-531	65-338	North Atlantic	Kohler N. E. *et al*, 1996
Porbeagle	POR	1.4823-05	2.9641	0.9437	Combined	FL	15	19-143	106-207	North Atlantic	Kohler N. E. *et al*, 1996
Silky Shark	FAL	1.5406-06	2.9221	0.9720	Combined	FL	85	4-88	73-212	North Atlantic	Kohler N. E. *et al*, 1996
Dusky shark	DUS	3.2415-05	2.7862	0.9649	Combined	FL	247	5-270	79-287	North Atlantic	Kohler N. E. *et al*, 1996
Sandbar Shark	CCP	1.0885-06	3.0124	0.9385	Combined	FL	1548	1-104	44-201	North Atlantic	Kohler N. E. *et al*, 1996
Tiger Shark	TIG	2.5281-06	3.2603	0.9550	Combined	FL	187	92-339	5-499	North Atlantic	Kohler N. E. *et al*, 1996
Blue Shark	BSH	3.1841-06	3.1313	0.9521	Combined	FL	4529	52-288	1-174	North Atlantic	Kohler N. E. *et al*, 1996
Scalloped Hammerhead	SPL	7.7745-06	3.0669	0.9255	Combined	FL	390	79-243	5-166	North Atlantic	Kohler N. E. *et al*, 1996

Bigeye thresher (*Alopias superciliosus*)
Thresher shark (*Alopias vulpinus*)
Shortfin mako (*Isurus oxyrinchus*),
Porbeagle (*Lamna nasus*)
Silky Shark (*Carcharhinus falciformis)*
Sandbar shark (*Carcharhinus plumbeus*),
Dusky shark (*Carcharhinus obscurus)*
Scalloped hammerhead (*Sphyrna lewini*).
Tiger shark (*Galeocerdo cuvier*),
Blue shark (*Prionace glauca*)

APPENDIX VII

Table 12: conversion factors for estimating live weight from landed weight, for species sampled in Indonesian in the framework of the IOTC/OFCF .sampling program.

Species	Commonname	Processing	Raising Factor
ALB	Albacore	GGT	1.1
BET	Bigeye tuna	GGT	1.09
BET	Bigeye tuna	HDD	1.43
BIL	Billfish	GGT	1.33
BIL	Billfish	TAL	1.43
BLM	Black Marlin (White marlin; WM)	GGT	1.33
BLM	Black Marlin (White marlin; WM)	TAL	1.43
BLS	Black Shark (Silky shark)	HDD	1.33
BLZ	Indo-Pacific Blue Marlin (BUM)	GGT	1.13
BLZ	Indo-Pacific Blue Marlin (BUM)	TAL	1.43
BSH	Blue shark	HDD	1.33
BSH	Blue shark	GGT	1.13
BTS	Bigeye Thresher shark	GGT	1.13
FAL	Silky shark (black shark)	HDD	1.33
FAL	Silky shark (black shark)	TAL	1.55
FAL	Silky shark (black shark)	GGT	1.13
LEC	Black Escolar	HDD	1.33
MLS	Stripped Marlin	GGT	1.13
MLS	Stripped Marlin	TAL	1.2
MSK	Mackerel sharks, Porbeagles, White sharks	HDD	1.33
MSK	Mackerel sharks, Porbeagles, White sharks	PDD	1.55
OIL	Oilfish	HDD	1.33
OIL	Oilfish	GGT	1.13
SBF	Southern bluefin tuna	GGT	1.15
SBF	Southern bluefin tuna	HDD	1.43
SFA	Indo-Pacific sailfish	HDD	1.33
SFA	Indo-Pacific sailfish	GGT	1.13
SFA	Indo-Pacific sailfish	TAL	1.43
SKH	Sharks nei	TAL	1.55
SKH	Sharks nei	GGT	1.13
SKH	Sharks nei	HDD	1.33
SKJ	Skipjack tuna	GGT	1.09
SPY	Hammerhead sharks	HDD	1.33
SSD	Shortnose spurdog	HDD	1.33
SSP	Shortbill spearfish	HDD	1.43
SWO	Swordfish	HDD	1.33
SWO	Swordfish	GGT	1.18
SWO	Swordfish	TAL	1.43
THR	Thresher sharks nei	HDD	1.33
TIG	Tiger shark	HDD	1.33
WAH	Wahoo	HDD	1.33
WAH	Wahoo	GGT	1.13
YFT	Yellowfin tuna	GGT	1.09
YFT	Yellowfin tuna	HDD	1.43
BILL	Billfish nei	GGT	1.13
BILL	Billfish nei	PDD	1.43
MARL	Marlins nei	GGT	1.13
MARL	Marlins nei	TAL	1.43

APPENDIX VII

Table 13: Code, species group, English and scientific names of the species.

ACode	SppGroup	LargeGroup	EngName	ScientName
ALB	ALB	TUNAS	Albacore	Thunnus alalunga
BAU	NTAD	OTHERS	Australian bonito	Sarda australis
BET	BET	TUNAS	Bigeye tuna	Thunnus obesus
BFT	SBF	TUNAS	Northern bluefin tuna	Thunnus thynnus
BIL	BILL	BILLFISH	Marlins, sailfish, spearfish nei	Istiophoridae
BILL	BILL	BILLFISH	Billfish nei	Xiphioidei
BIP	NTAD	OTHERS	Striped bonito	Sarda orientalis
BLM	BLM	BILLFISH	Black Marlin	Makaira indica
BLR	SKH	OTHERS	Blacktip reef shark	Carcharhinus melanopterus
BLT	BLT	TUNAS	Bullet tuna	Auxis rochei
BRO	SKH	OTHERS	Copper shark	Carcharhinus brachyurus
BSH	SKH	OTHERS	Blue shark	Prionace glauca
BTH	SKH	OTHERS	Bigeye thresher	Alopias Sperciliosus
BUK	NTAD	OTHERS	Butterfly kingfish	Gasterochisma melampus
BUM	BUM	BILLFISH	Blue Marlin	Makaira nigricans
CCP	SKH	OTHERS	Sandbar shark	Carcharhinus plumbeus
COM	COM	SEERFISH	Narrow-barred Spanish mackerel	Scomberomorus commerson
DBM	NTAD	OTHERS	Double-lined mackerel	Grammatorcynus bilineatus
DGZ	SKH	OTHERS	Dogfishes nei	Squalus spp.
DLP	NTAD	OTHERS	Dolphins nei	Delphinidae
DOL	NTAD	OTHERS	Common dolphinfish	Coryphaena hippurus
DOT	NTAD	OTHERS	Dogtooth tuna	Gymnosarda unicolor
DUS	SKH	OTHERS	Dusky shark	Carcharhinus obscurus
FAL	SKH	OTHERS	Silky shark	Carcharhinus falciformis
FRI	FRI	TUNAS	Frigate tuna	Auxis thazard
FRZ	FRZ	TUNAS	Frigate and bullet tunas	Auxis spp.
GAG	SKH	OTHERS	Tope shark	Galeorhinus galeus
GUT	GUT	SEERFISH	Indo-Pacific king mackerel	Scomberomorus guttatus
KAFR	TUN	TUNAS	Kawakawa and Frigate and bullet tunas	Euthynnus affinis; Auxis spp.
KAK	KGX	SEERFISH	Kanadi kingfish	Scomberomorus plurilineatus
KAW	KAW	TUNAS	Kawakawa	Euthynnus affinis
KGX	KGX	SEERFISH	Seerfishes nei	Scomberomorus spp.
LMA	SKH	OTHERS	Longfin mako	Isurus paucus
LOT	LOT	TUNAS	Longtail tuna	Thunnus tonggol
MAA	NTAD	OTHERS	Blue mackerel	Scomber australasicus
MARL	BILL	BILLFISH	Marlins nei	Tetrapturus audax; Makaira spp.
MLS	MLS	BILLFISH	Striped marlin	Tetrapturus audax
MLW	BILL	BILLFISH	Atlantic white marlin	Tetrapturus albidus
MSK	SKH	OTHERS	Sharks mackerel, porbeagles nei	Lamnidae
NTAD	NTAD	OTHERS	Non targeted, associated and dependent species	
NTC	SKH	OTHERS	Broadnose sevengill shark	Notorhynchus cepedianus
OBIL	BILL	BILLFISH	Billfish nei	Xiphioidei
OCS	SKH	OTHERS	Oceanic whitetip shark	Carcharhinus longimanus
OTHR	NTAD	OTHERS	Other non tuna-like fishes nei	Fishes non Scombroidei
POR	SKH	OTHERS	Porbeagle	Lamma nasus

RAG	NTAD	OTHERS	Indian mackerel	Rastrelliger kanagurta
RAX	NTAD	OTHERS	Mackerels Indian, nei	Rastrelliger spp.
RRU	NTAD	OTHERS	Rainbow runner	Elagatis bipinnulata
RSK	SKH	OTHERS	Requiem sharks nei	Carcharhinidae
SAI	BILL	BILLFISH	Atlantic sailfish	Istiophorus albicans
SASP	BILL	BILLFISH	Indo-Pacific sailfish and shortbill spearfish	Istiophorus platypterus; Tetrapturus angustirostris
ACode	**Species Group**	**Large Group**	**English Name**	**Scientific Name**
SBF	SBF	TUNAS	Southern bluefin tuna	Thunnus maccoyii
SEER	KGX	SEERFISH	Wahoo and seerfishes nei	Scomberomorini
SFA	SFA	BILLFISH	Indo-Pacific sailfish	Istiophorus platypterus
SHRK	SKH	OTHERS	Sharks various nei	Selachimorpha (Pleurotremata)
SHXX	SKH	OTHERS	Sharks nei other than oceanic whitetip shark and blue shark	
SKH	SKH	OTHERS	Sharks various nei	Selachimorpha (Pleurotremata)
SKJ	SKJ	TUNAS	Skipjack tuna	Katsuwonus pelamis
SKJL	SKJ	TUNAS	Large skipjack tuna	Katsuwonus pelamis
SKJM	SKJ	TUNAS	Medium skipjack tuna	Katsuwonus pelamis
SKJS	SKJ	TUNAS	Small skipjack tuna	Katsuwonus pelamis
SKKA	TUN	TUNAS	Skipjack tuna and Kawakawa	Katsuwonus pelamis, Euthynnus affinis
SMA	SKH	OTHERS	Shortfin mako	Isurus oxyrinchus
SMD	SKH	OTHERS	Smooth-hound	Mustelus mustelus
SPN	SKH	OTHERS	Hammerhead sharks nei	Sphyrna spp.
SPL	SKH	OTHERS	Scalloped hammerhead	Sphyrna lewini
SPZ	SKH	OTHERS	Smooth hammerhead	Sphyrna zygaena
SRX	NTAD	OTHERS	Rays, stingrays, mantas nei	Rajiformes
SSP	SSP	BILLFISH	Short-billed spearfish	Tetrapturus angustirostris
STS	STS	SEERFISH	Streaked seerfish	Scomberomorus lineolatus
SWO	SWO	BILLFISH	Swordfish	Xiphias gladius
THR	SKH	OTHERS	Thresher sharks nei	Alopias spp.
TIG	SKH	OTHERS	Tiger shark	Galeocerdo cuvier
TUN	TUN	TUNAS	Tunas nei	Thunnini
TUNA	TUN	TUNAS	Tunas nei	Thunnini
TUS	TUN	TUNAS	True tunas nei	Thunnus spp.
TUX	TUX	OTHER NEI	Tuna-like fishes nei	Scombroidei
WAH	WAH	SEERFISH	Wahoo	Acanthocybium solandri
YFT	YFT	TUNAS	Yellowfin tuna	Thunnus albacares
YFTL	YFT	TUNAS	Large Yellowfin tuna	Thunnus albacares
YFTM	YFT	TUNAS	Medium Yellowfin tuna	Thunnus albacares
YFTS	YFT	TUNAS	Small Yellowfin tuna	Thunnus albacares
YOUN	TUN	TUNAS	True tunas nei, juveniles	Thunnus spp.