Estimation of catches at size for IOTC species

Equations used to convert from non-standard measurement to fork length (Table 1) and from fork length to round weight (Table 2)

Table 1: Regression equations used to convert from non-standard measurements into standard lengths (tunas: tip of the snout to fork length; swordfish: lower-jaw to fork length) per species

Species: Yellowfin tuna — ***Standard length: Tip of snout to fork of tail***

Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size*	*Variance*	*Covariance ab*	*Mean Residual*	*Gradient*
Weight gilled and gutted[A]	a*W^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]	a*L^b	a=2.0759 b=1.1513	7,036	Min: 29 Max: 164				

Species: Bigeye tuna — ***Standard length: Tip of snout to fork of tail***

Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size*	*Variance*	*Covariance ab*	*Mean Residual*	*Gradient*
Weight gilled and gutted[A]	a*W^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 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				

Species: Albacore — ***Standard length: Tip of snout to fork of tail***

Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size*	*Variance*	*Covariance ab*	*Mean Residual*	*Gradient*
Weight round[D]	(W/a)^(1/b)	a= 0.000013718 b= 3.0793	n/a	n/a				

Species: Swordfish — ***Standard length: Tip of lower-jaw to fork of tail***

Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size*	*Variance*	*Covariance ab*	*Mean Residual*	*Gradient*
Cleithrum-Fork length[E]	(L+b)/a	a= 0.8087 b= 8.6712	n/a	n/a				
Cleithrum-keel length[F]	(a*L)+b	a= 1.55108 b= 13.5025	179	Min:88 Max:252				
Eye orbit-fork length[G]	(a*L)+b	a= 1.066 b= 10.449	123	Min:48 Max:255				
Pectoral-anal length[J]	(a*L)+b	a= 2.5407 b= 25.698	1,806	Min:18 Max:105				
Pectoral-fork length[K]	(a*L)+b	a= 1.2398 b= 11.204	55	Min:60 Max:157				
Weight round[L]	(W/a)^(1/b)	a= 0.000003815 b= 3.188	3,608	Min:89 Max:266				
Weight gilled and gutted[H]	(W/a)^(1/b)	a= 0.0000043491 b= 3.188	3,608	Min:89 Max:266				
Weight headed[I]	(W/a)^(1/b)	a= 0.000004592 b= 3.137	n/a	n/a				

A: Data from 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) (ibid. B)

D: Inverted length-weight relationship; ICCAT South Atlantic

E: Reference not available (to be provided)

F: Two step conversion as CKL = (0.690253*EFL) -3.541823 in formula LJFL = 8.00884+(1.07064*EFL); NOAA Data (Pacific Ocean)

G, J, K: Data from Reunion Island, Indian Ocean Poisson 2001 (in IOTC-2005-WPTT-05)

H: Inverted length-weight equation(ICCAT Mejuto et al 1998 South-East Atlantic Ocean)

I: Inverted length-weight equation; Reference not available (to be provided)

L: Converted to GGT (GGT=RND/1.14 (Mejuto et al. 1998)) and inverted length-weight equation (ICCAT Mejuto et al 1998 South-East Atlantic Ocean)

Table 1(cont): Regression equations used to convert from non-standard measurements into standard lengths (eye orbit to fork length), per species

Species: Black marlin								***Standard length: Eye orbit to fork of tail***
Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size*	*Variance*	*Covariance ab*	*Mean Residual*	*Gradient*
Cleithrum-Keel length	No equation available							
Lower-jaw - fork length[M]	(a*L)+b	a= 0.8972 b= -4.6673	13	Min:119 Max:314				
Weight gilled and gutted[N]	a*L^ b	a= 41.56681 b= 0.309442	24	Min:8.6 Max:279				

Species: Blue marlin								***Standard length: Eye orbit to fork of tail***
Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size*	*Variance*	*Covariance ab*	*Mean Residual*	*Gradient*
Lower-jaw - fork length[O]	(a*L)+b	a= 0.9039 b= -7.248	26	Min:143 Max:295				
Weight gilled and gutted[P]	a*L^ b	a= 46.0356637 b= 0.283377	154	Min:10 Max:381				

Species: Striped marlin								***Standard length: Eye orbit to fork of tail***
Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size*	*Variance*	*Covariance ab*	*Mean Residual*	*Gradient*
Lower-jaw - fork length[Q]	(a*L)+b	a= 1.334 b= 0.8395	443	Min: Max:				
Weight round[R]	a*L^ b	a= 51.3506 b= 0.300417	1427	Min:7 Max:100				
Weight gilled and gutted[S]	a*L^ b	a= 45.443009 b= 0.300417	1427	Min:7 Max:100				

Species: Indo-Pacific sailfish								***Standard length: Eye orbit to fork of tail***
Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size*	*Variance*	*Covariance ab*	*Mean Residual*	*Gradient*
Cleithrum-Keel length	No equation available							
Lower-jaw - fork length[T]	(L+b)/a	a= 0.8845 b= -3.7025	1166	Min:78 Max:232				
Weight gilled and gutted[U]	a*L^ b	a= 45.5076 b= 0.347166	35	Min:5 Max:38				

M: BRS (Ward, pers.com.) Eastern and western Australia (on IOTC-2005-WPTT-05)

N: PIFSC Administrative report: (Updated Weight-on-Length Relationships for Pelagic Fishes Caught in the Central North Pacific Ocean and Bottom fishes from the Northwestern Hawaiian Islands). With value of a (46.9705) divided by 1.13 to account for conversion of gilled-and-gutted weight into round weight

O: BRS (Ward, pers.com.) Eastern and western Australia (on IOTC-2005-WPTT-05)

P:PIFSC Administrative report: (Updated Weight-on-Length Relationships for Pelagic Fishes Caught in the Central North Pacific Ocean and Bottom fishes from the Northwestern Hawaiian Islands)Value of a (52.0203) divided by 1.13 to account for conversion of gilled-and-gutted weight into round weight

Q: BRS (Ward, pers.com.) Eastern and western Australia (on IOTC-2005-WPTT-05)

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

S:PIFSC Administrative report: (Updated Weight-on-Length Relationships for Pelagic Fishes Caught in the Central North Pacific Ocean and Bottom fishes from the Northwestern Hawaiian Islands)Value of a (51.3506) divided by 1.13 to account for conversion of gilled-and-gutted weight into round weight

T: Wei-Chuan Chiang et al. , 2004; inverted EFL-FL equation (M+F sexes pooled)

U: PIFSC Administrative report: (Updated Weight-on-Length Relationships for Pelagic Fishes Caught in the Central North Pacific Ocean and Bottom fishes from the Northwestern Hawaiian Islands)Value of a (51.4235) divided by 1.13 to account for conversion of gilled-and-gutted weight into round weight

Table 2: Equations used to convert from standard 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]	RND=a*L^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]	GGT=a*L^b RND=GGT*1.13	a= 0.0000094007 b= 3.126843987	15,133	Min:72 Max:177
Bigeye tuna	Purse seine Pole and Line Gillnet	Fork length(cm) – Round Weight(kg)[D]	RND=a*L^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]	GGT=a*L^b RND=GGT*1.13	a= 0.0000159207 b= 3.0415414023	12,047	Min:70 Max:187
Skipjack tuna	All gears	Fork length(cm) – Round Weight(kg)[E]	RND=a*L^b	a= 0.0000074800 b= 3.25260	14,140	Min:32 Max:78
Albacore	All gears	Fork length(cm) – Round Weight(kg)[F]	RND= a*L^b	a= 0.0000569070 b= 2.75140	2499	Min:46 Max:112
Swordfish	All gears	Tip of lower-jaw to fork of tail(cm) – Round Weight(kg)[G]	RND= a*L^b	a= 0.0000042030 b= 3.21340	2569	Min:80 Max:253
Black marlin	All gears	Eye orbit to fork of tail(cm) – Round Weight(kg)[H]	RND= a*L^b	a= 0.0000144217 b= 2.98851	24	Min:95 Max:279
Blue marlin	All gears	Eye orbit to fork of tail(cm) – Round Weight(kg)[H]	RND= a*L^b	a= 0.00000272228 b= 3.30967	154	Min:109 Max:269
Striped marlin	All gears	Eye orbit to fork of tail(cm) – Round Weight(kg)[H]	RND= a*L^b	a= 0.00000133263 b= 3.41344	17	Min:101 Max:178
Indo-Pac. sailfish	All gears	Eye orbit to fork of tail(cm) – Round Weight(kg)[H]	RND= a*L^b	a= 0.0000690103 b= 2.52429	35	Min:86 Max:187

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)

F: Data from the Indian Ocean, Taiwanese gillnet fishery (Chien-Chung Hsu)

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

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

Table 2: Equations used to convert from standard length into round weight, per species

Species	*Gear Type/s*	*From type measurement – To type measurement*	*Equation*	*Parameters*	*Sample size*	*Length*
Blue shark		Fork length – Round Weight(kg)[A]	RND=a*L^b	a= 0.0000031841 b= 3.1313		Min: Max:
		Precaudal length – Fork Length[C]	FL=PCL+a / b	a= 0.3956 b= 0.9075		Min: Max:
		Total length – Fork length[D]	FL=a*TL+b	a= 0.822 b= 1.754	10	Min:217 Max:265
						Min:70 Max:187
Shortfin Mako Shark		Fork length – Round Weight[A]	RND=a*L^b	a= 0.0000052432 b= 3.1407		Min: Max:
		Precaudal length – Fork Length[C]	FL=a*PCL+b	a= 1.100 b= 0.766	n/a	n/a
		Total length – Fork length	FL=a*TL+b	a= 0.9286 b= -1.7101		Min: Max:
Oceanic whitetip shark		Fork length – Round Weight[B]	RND= a*L^b	a= 0.000018428 b= 2.9245		Min: Max:

		Total length – Fork length	FL=a*TL+b	a= 0.7847 b= 1.211		Min: Max:
Porbeagle		Fork length – Round Weight[A]	RND=a*L^b	a= 0.000014823 b= 2.9641		
		Precaudal length – Fork Length[C]	FL=a*PCL+b			
Silky Shark		Fork length – Round Weight[A]	RND=a*L^b	a= 0.000015406 b= 2.9221		
Bigeye Thresher Shark		Fork length – Round Weight[A]	RND=a*L^b	a= 0.0000091069 b= 3.0802		
Thresher Shark		Fork length – Round Weight[A]	RND=a*L^b	a= 0.00018821 b= 2.5188		

A: Data from Western North Atlantic: NOAA Technical Memorandum NMFS-NE-110 (May 1996)

B: Data from Indian Ocean: Length-weight relationships, conversion factors and analyses of sex-ratio, by length-range, Observers onboard Spanish Longliners in South Western Indian Ocean during 2005; Ariz J, A Delgado de Molina, M.L Ramos, J.C Santana

C: Inverse equation from WCPFC Analysis of North Pacific Shark Data from Japanese Commercial Longline and Research/Training Vessels Record; Shelley Clarke, Kotaro Yokawa, Hiroaki Matsunaga and Hideki Nakano

D: Indian Ocean : Maldivian Oceanic Shark Longline Fishery; R.C. Anderson, M.S. Adam & M. Saleem

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)

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

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

Table 1

Descriptive statistics and Length–weight relation parameters for bigeye tuna, yellowfin tuna, and albacore from the Atlantic, Indian, and eastern Pacific oceans

Species	Area	*FL* range [m]	Mean FL [cm]	Mean *W* [g]	*n*	*a*	*b*	95% CL of *b*	r^2	*t*-test (H_0: $b = 3$)	
										t value	*P* value
BET	Atlantic	43.2–206.0	128.0	36546.2	2280	0.0158	2.997	2.968–3.026	0.9471	9.837	< 0.001
YFT	Atlantic	83.0–176.8	143.2	45309.0	299	0.0166	2.969	2.884–3.054	0.9412	12.411	< 0.001
ALB	Atlantic	99.1–125.0	107.2	23985.1*	94	0.0438*	2.825*	2.499–3.151	0.7628	10.338	< 0.001
BET	Indian Ocean	54.8–201.0	134.0	45195.7	1052	0.0247	2.926	2.898–2.954	0.9649	199.492	< 0.001
YFT	Indian Ocean	78.0–171.0	125.9	32267.9	1033	0.0163	2.985	2.953–3.017	0.9696	29.149	< 0.001
ALB	Indian Ocean	93.0–119.0	105.7	24045.5	88	0.434	2.343	2.066–2.620	0.7644	44.196	< 0.001
BET	Eastern Pacific	60.0–202.0	127.3	41723.5	1436	0.0132	3.043	1.841–3.728	0.9742	123.717	< 0.001
YFT	Eastern Pacific	93.0–170.0	129.5	33211.5	520	0.00418	3.244	3.176–3.312	0.9449	161.705	< 0.001
ALB	Eastern Pacific	70.0–118.0	100.7	18846.9	147	0.0542	2.760	2.552–2.968	0.8256	27.609	< 0.001

* Weight is whole weight [g]; BET = bigeye tuna; YFT = yellowfin tuna; ALB = albacore; *n*: sample size; FL: fork length [cm]; *W*: gilled-gutted weight [g]; CL = confidence limit; *a* = the parameter in the *W L* relation; *b* = slope; r^2 = coefficient of determination.

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