

## Estimation of catches at size for IOTC billfish species

**Table 1: Current IOTC equations to convert from non-standard measurements into standard lengths, by species**

<i>Species: Swordfish</i>				<i>Standard length: Lower jaw fork length</i>	
<i>Type Measurement</i>	<i>Equation</i>	<i>Parameters</i>	<i>Sample size</i>	<i>Size (cm)</i>	<i>IOTC Secretariat size frequency data</i>
Cleithrum-caudal fork length <sup>A</sup>	$(L+b)/a$	a= 0.8087 b= 8.6712	n/a	n/a	No. of samples: 1,241,418 Min: 17 cm Max: 452 cm Lower quartile: 134 cm Average: 155 cm Upper quartile: 176 cm
Cleithrum-keel length <sup>B</sup>	$(a*L)+b$	a= 1.55108 b= 13.5025	179	Min:88 Max:252	
Eye orbit-fork length <sup>C</sup>	$(a*L)+b$	a= 1.066 b= 10.449	123	Min:48 Max:255	
Pectoral-anal length <sup>D</sup>	$(a*L)+b$	a= 2.5407 b= 25.698	1,806	Min:18 Max:105	
Pectoral-caudal fork length <sup>E</sup>	$(a*L)+b$	a= 1.2398 b= 11.204	55	Min:60 Max:157	
**Weight round <sup>F</sup>	$(W/a)^{(1/b)}$	a= 0.000004203 b= 3.2134	3,608	Min:89 Max:266	
Weight gilled and gutted <sup>G</sup>	$(W/a)^{(1/b)}$	a= 0.0000043491 b= 3.188	3,608	Min:89 Max:266	
**Weight headed <sup>H</sup>	$(W/a)^{(1/b)}$	a= 0.000002032 b= 3.3104	2,569	Min:80 Max:253	

**\*\* Denotes new or updates to existing equations in 2014.**

**Sources:**

**A:** Reference not available.

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

**C, D, E:** Data from Reunion Island, Indian Ocean Poisson 2001 (in IOTC-2005-WPTT-05).

**F:** 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).

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

**H:** Inverted length-weight equation. Length-weight interrelationships for Swordfish caught in the Central North Pacific, NOAA.

**Sources of alternative equations:**

Poisson, 2001; BRS (Ward, pers.com); Meneses de Lima et al, 2000.

**Table 1(cont): Current IOTC equations to convert from non-standard measurements into standard lengths by species**

<i>Species: Black marlin</i>						<i>Standard length: Eye orbit to fork of tail</i>
Type Measurement	Equation	Parameters	Sample size	Size	IOTC Secretariat size frequency data	
Cleithrum-Keel length	No equation available				No. of samples: 63,755 Min: 41 cm Max: 395 cm Lower quartile: 146 cm Average: 165 cm Upper quartile: 176 cm	
Lower-jaw - fork length <sup>l</sup>	(a*L)+b	a= 0.8972 b= -4.6673	13	Min:119 Max:314		
<i>Species: Blue marlin</i>						<i>Standard length: Eye orbit to fork of tail</i>
Type Measurement	Equation	Parameters	Sample size	Size	IOTC Secretariat size frequency data	
Lower-jaw - fork length <sup>l</sup>	(a*L)+b	a= 0.9039 b= -7.248	26	Min:143 Max:295	No. of samples: 212,368 Min: 38 cm Max: 404 cm Lower quartile: 143 cm Average: 161 cm Upper quartile: 179 cm	
**Weight gilled and gutted <sup>k</sup>	(W/a) <sup>(1/b)</sup>	a= 0.000010242 b= 2.9749	24	Min:98 Max:234		
<i>Species: Striped marlin</i>						<i>Standard length: Lower jaw fork length</i>
Type Measurement	Equation	Parameters	Sample size	Size	IOTC Secretariat size frequency data	
**Eye orbit to fork of tail <sup>m</sup>	(a*L)+b	a= 1.1178 b= 7.7696	263	Min:104 Max:231	No. of samples: 191,294 Min: 50 cm Max: 410 cm Lower quartile: 161 cm Average: 180 cm Upper quartile: 203 cm	
**Weight round <sup>n</sup>	(W/a) <sup>(1/b)</sup>	a= 0.000001 b= 3.3	802	Min:150 Max:290		
**Weight gilled and gutted <sup>n</sup>	(W/a) <sup>(1/b)</sup>	a= 0.000000885 b= 3.3	802	Min:150 Max:290		
<i>Species: Indo-Pacific sailfish</i>						<i>Standard length: Lower jaw fork length</i>
Type Measurement	Equation	Parameters	Sample size	Size	IOTC Secretariat size frequency data	
Cleithrum-Keel length	No equation available				No. of samples: 54,253 Min: 17 cm Max: 299 cm Lower quartile: 137 cm Average: 162 cm Upper quartile: 188 cm	
**Eye orbit to fork of tail <sup>o</sup>	(a*L)+b	a= 1.076 b= 11.24	n/a	n/a		

**Notes**

\*\* Denotes new or amendments to existing equations in 2014.

Equations to convert Black marlin and Indo-Pacific sailfish from gilled and gutted weights to eye orbit to fork of tail removed due to issues of reliability of the estimated lengths. Standard length for Striped marlin and Indo-Pacific sailfish changed from Eye orbit to fork of tail, to Lower jaw fork length.

**Sources:**

I, J: BRS (Ward, pers.com.) Eastern and western Australia (cited in IOTC-2005-WPTT-05).

K: \*\* Inverted length weight equation, taken from Review of Life History Parameters for Blue Marlin, ISC/13/BILLWG-1/12.

L: 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.

M: Su, N.J., C.L. Sun, S.Z. Yeh, W.C. Chiang, S.P. Wang, and C.H. Liu (2005), LJFL and EFL relationships for the billfishes caught by the Taiwanese offshore and coastal fisheries (ISC/05/MAR&SWO-WGs/\_4).

N: Su, N.J., C.L. Sun, S.Z. Yeh, W.C. Chiang, S.P. Wang, and C.H. Liu (2006), An update on landing and sex-specific size composition data of striped marlin and swordfish in the Taiwanese offshore and coastal fisheries, ISC/06/MARWG&SWOWG-2/02. Gilled and gutted conversion estimated by applying a conversion factor of 1.13 to the round weight value a (i.e., 0.000001 / 1.13).

O: ICCAT Field Manual, Chapter 2.

**Sources of alternative equations:**

Black marlin: ICCAT Field Manual; Su, et al, 2005.

Blue marlin: ICCAT Field Manual; Lenarz, et al, 1974; Prager et al., 1995; Su, et al, 2005; Thomas, et al, 2013.

Striped marlin: Hinton et al, 2002, Status of striped marlin in the eastern Pacific Ocean in 2001 and outlook for 2002; Su, et al, 2005.

Indo-Pacific Sailfish: Lenarz, et al, 1974; Prager et al., 1995; Su, et al, 2005; Wei-Chuan Chiang et al., 2004.

**Table 2: IOTC 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
Swordfish	All gears	Tip of lower-jaw to fork of tail(cm) – Round Weight(kg) <sup>P</sup>	$RND = a * L^b$	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) <sup>Q</sup>	$RND = a * L^b$	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) <sup>R</sup>	$RND = a * L^b$	a= 0.00000272228 b= 3.30967	154	Min:109 Max:269
**Striped marlin	All gears	Lower jaw fork length(cm) – Round Weight(kg) <sup>S</sup>	$RND = a * L^b$	a= 0.000001 b= 3.3	802	Min:150 Max:290
**Indo-Pac. sailfish	All gears	Lower jaw fork length(cm) – Round Weight(kg) <sup>T</sup>	$RND = a * L^b$	a= 0.00005 b= 2.583	85	Min: 125 Max:199

\*\* Denotes new or amendments to existing equations in 2014.

**Sources:**

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

*Q, 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:* Su, N.J., C.L. Sun, S.Z. Yeh, W.C. Chiang, S.P. Wang, and C.H. Liu (2006), An update on landing and sex-specific size composition data of striped marlin and swordfish in the Taiwanese offshore and coastal fisheries, ISC/06/MARWG&SWOWG-2/02.

*T:* IOTC-2009-WPB-Inf01.

**Sources of alternative equations:**

*Swordfish:* SPC (cited in IOTC-2005-WPTT-05); IPTP, 1989 (cited in IOTC-2005-WPTT-05); Romanov, et al, 2012; Setyadji, et al, 2012; Skillman, et al, 1974.

*Black marlin:* IPTP, 1989 (cited in IOTC-2005-WPTT-05); Prager et al.,1995; SPC (cited in IOTC-2005-WPTT-05); Romanov, et al, 2012; Setyadji, et al, 2012; Skillman, et al, 1974; Uchiyama, et al, 1999.

*Blue marlin:* IPTP, 1989 (cited in IOTC-2005-WPTT-05); Romanov, et al, 2012; Setyadji, et al, 2012; Skillman, et al, 1974; Thomas, et al, 2013; Uchiyama, et al, 1999.

*Striped marlin:* Kopf, et al, 2013; Romanov, et al, 2012; Setyadji, et al, 2012; Skillman, et al, 1974; Uchiyama, et al, 1999.

*Indo-Pacific Sailfish:* IPTP, 1989 (cited in IOTC-2005-WPTT-05); Prager, et al, 1995; Ravi, et al, 2012; Setyadji, et al, 2012; Skillman, et al, 1974; Uchiyama, et al, 1999.

**Table 3: Number and proportion of samples reported to the IOTC Secretariat by measurement type and species.**

Measurement type	BLM	BUM	MLS	SFA	SWO
Cleithrum to caudal fork length					12,919
Cleithrum-keel length	4			11	2,137
Eye-Fork Length	42,028	24,623	57,351	11,453	39,651
Lower jaw fork length	19,483	169,615	132,954	10,577	1,102,400
Gilled and gutted	9,340	8,486	15,804	1,035	6,346
Headed and gutted weight					17,282
Pectoral-anal length (by using a calliper)					5,010
Pectoral-anal length (by using a tape measure)					1,880
Pectoral-caudal (fork) length					1,431
Round Weight			831		52,362
Total no. of samples	70,855	202,724	206,940	23,076	1,241,418

Measurement type	BLM	BUM	MLS	SFA	SWO
Cleithrum to caudal fork length					1.0%
Cleithrum-keel length	0.0%			0.0%	0.2%
Eye-Fork Length	59.3%	12.1%	27.7%	49.6%	3.2%
Lower jaw fork length	27.5%	83.7%	64.2%	45.8%	88.8%
Gilled and gutted	13.2%	4.2%	7.6%	4.5%	0.5%
Headed and gutted weight					1.4%
Pectoral-anal length (by using a calliper)					0.4%
Pectoral-anal length (by using a tape measure)					0.2%
Pectoral-caudal (fork) length					0.1%
Round Weight			0%		4.2%
Total no. of samples	100%	100%	100%	100%	100%

**Figure i: Charts showing conversion equations from non-standard lengths, and weights, to standard length by billfish species.**

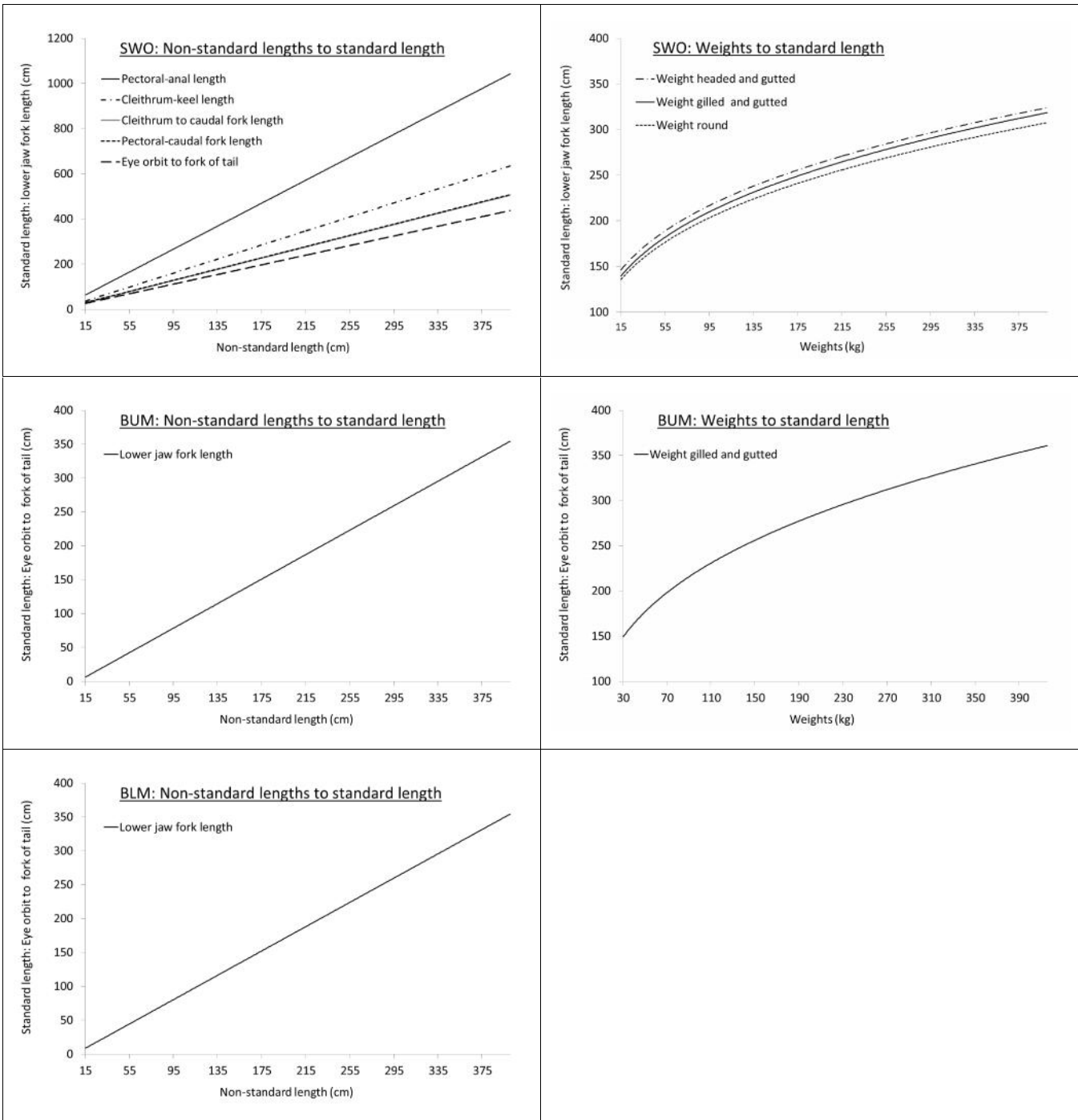
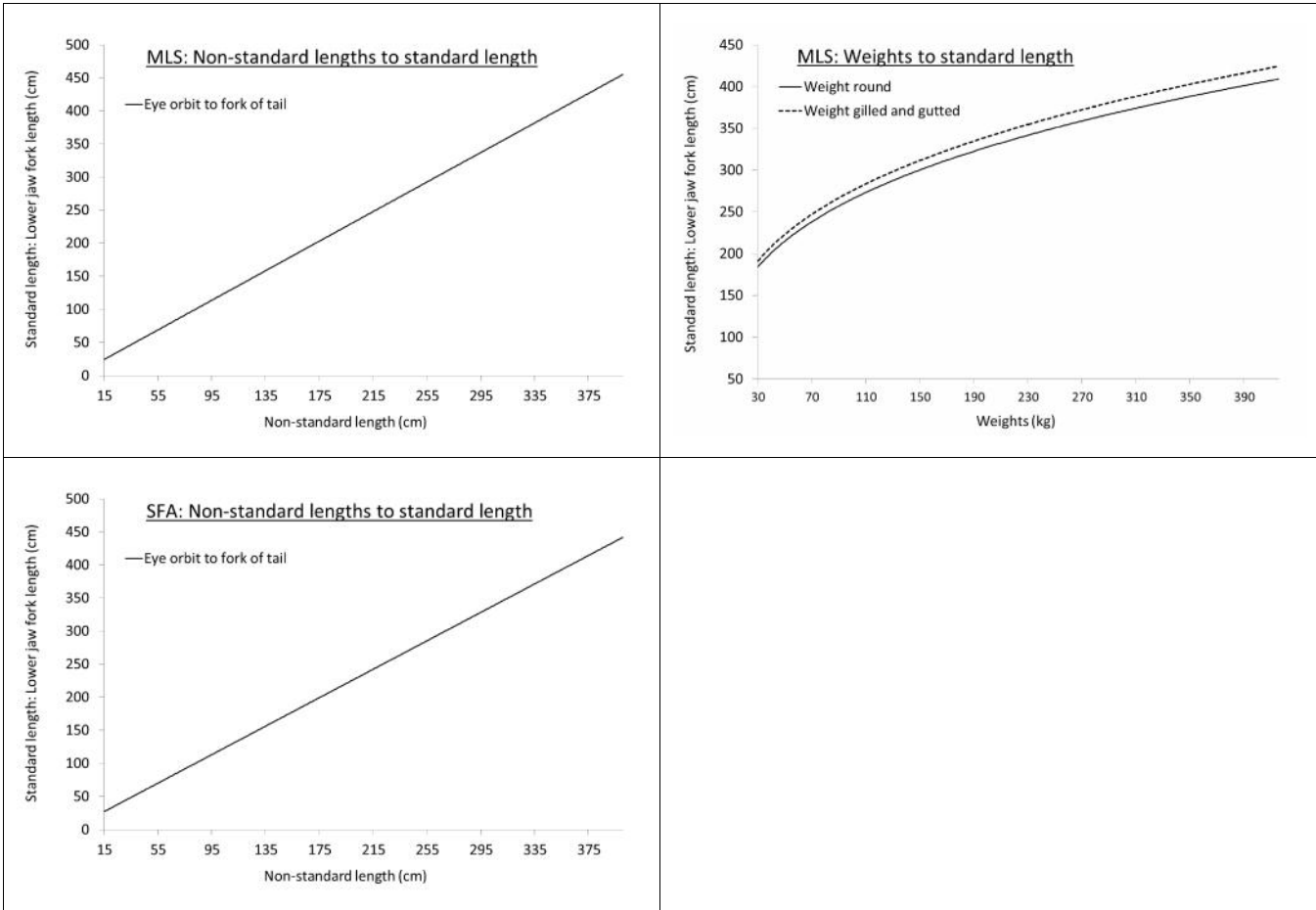
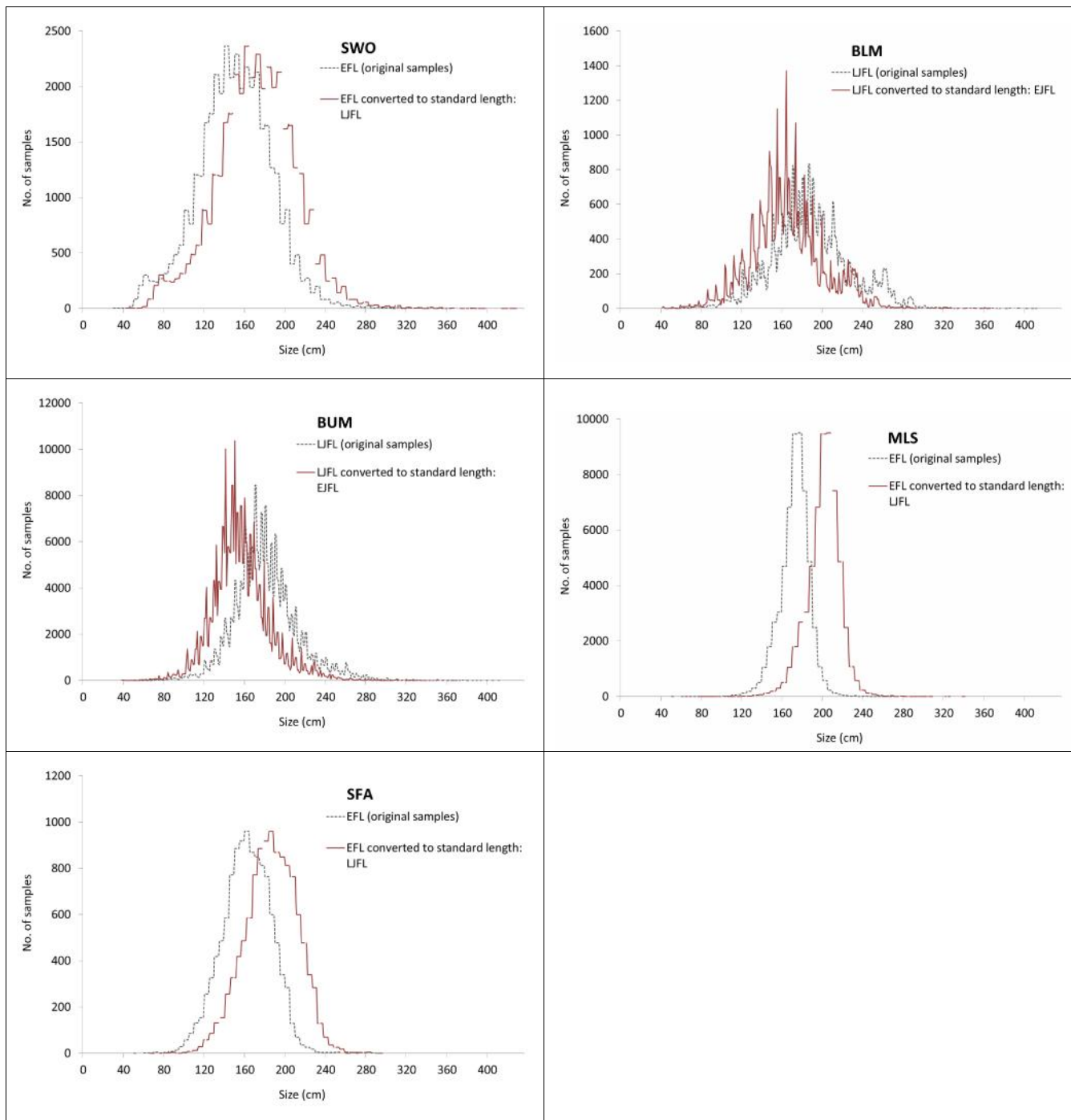


Figure i (continued): Charts showing conversion equations from non-standard lengths and weights, to standard length, by billfish species.

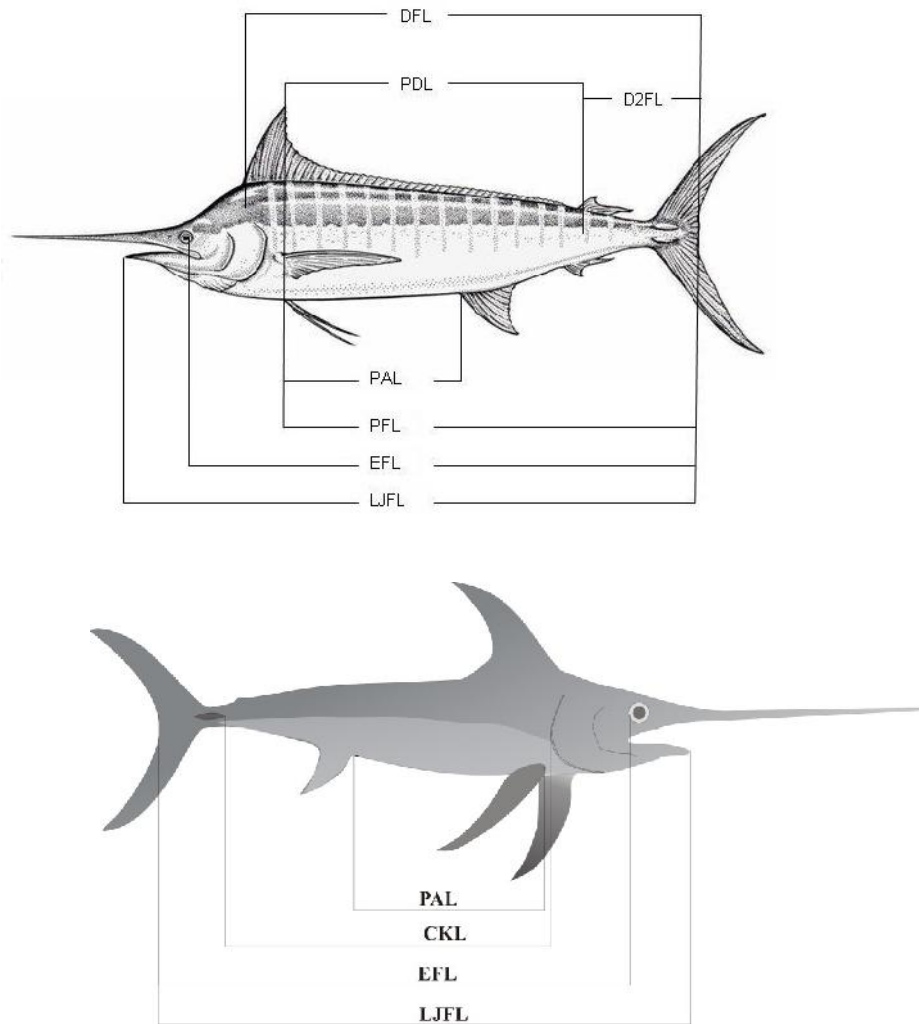


**Figure ii. Charts showing the comparison of non-standard lengths and standard lengths, for the main length measurements for each billfish species.**



**Notes:** in some cases the conversion between length units – specifically from smaller measurement types to larger measurement types such as Eye orbit to fork of tail (EFL) to Lower jaw fork length (LJFL) – can result in systematic gaps in the length distribution of the converted length frequency. This is partly related to the precision of the original size data recorded (i.e., 1cm size interval classes, rather than as a continuous distribution). The charts for SWO, MLS and SFA above are examples of converting from smaller to larger measurement units.

Figure iii. Definition of length measurements for billfish species.



Source: Poisson and Taquet, 2001