A SUMMARY OF SHORE-BASED AND AT-SEA SAMPLING IN THE WESTERN ATLANTIC OCEAN 1987-1992: ICCAT ENHANCED RESEARCH PROGRAM FOR BILLFISH

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SUMMARY

Shore-based and at-sea sampling activities for the western Atlantic were initiated in 1987 as part of the ICCAT Enhanced Research Program for Billfish. Data acquisition methods, as well as data summaries are presented for both sampling regimes in the western Atlantic Ocean, 1987-1992. Shore-based sampling is presented by geographical location, whereas at-sea sampling conducted in Venezuela is summarized by species and season.

RESUME

Des activités d'échantillonnage à terre et en mer ont été mises en route en 1987 dans l'Atlantique ouest dans le cadre du Programme de Recherche intensive sur les Istiophoridés. Les présent document fait état des méthodes utilisées pour recueillir les données, ainsi que de récapitulations des données, pour les deux régimes d'échantillonnage dans l'Atlantique ouest en 1987-92. L'échantillonnage à terre est présenté par location géographique, alors que l'échantillonnage en mer mené au Venezuela est résumé par espèce et par saison.

RESUMEN

En 1987, en el marco del Programa ICCAT de Investigación Intensiva sobre Marlines, se iniciaron en el Atlántico oeste actividades de muestreo en tierra y de muestreo en la mar. Se presentan los métodos aplicados para obtener datos, así como resúmenes de los datos, para los dos tipos de actividad mencionados, respecto al Atlántico oeste en el período 1987-1992. El muestreo en tierra se presenta por zona geográfica, mientras que el muestreo en la mar realizado en Venezuela, se resume por especies y temporadas.

1. INTRODUCTION

The Enhanced Research Program for Billfish was initiated by the International Commission for the Conservation of Atlantic Tunas (ICCAT) in 1987 with the intention of developing the data necessary to assess the status of billfish stocks. The objectives of the program are to: (1) provide more detailed catch and effort statistics and size frequency data, (2) initiate the ICCAT tagging program for billfish, and (3) assist in collecting data for age and growth studies.

To obtain the data necessary for catch and effort statistics and size frequency data, shore-based and at-sea sampling programs were established in selected western and eastern Atlantic locations in 1987. Data resulting from these activities have been computerized and stored into two databases. The shore-based sampling database includes western Atlantic data from Barbados, Dominican Republic, Grenada, Jamaica, St. Maarten, Trinidad and Venezuela. Additionally, data from Las Palmas, Spain and Dakar, Senegal (eastern Atlantic), are also included. Information on size frequencies, sex, and weights of sampled billfish, by location and date, are included in this database. Presently, the at-sea sampling database includes data from Venezuela and contains information on gear, total landings, size frequencies, sex, weights, and alive-versus-dead percentages for tuna and billfish species.

The purpose of this report is to summarize shore-based and at-sea sampling in the western Atlantic (1987-1992) in order to describe the data files available for future analyses.

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2. METHODS

Data collection forms for shore-based (ICCAT Billfish Form B) and at-sea sampling (ICCAT Billfish Forms C and D) were initially developed in 1986 by the ICCAT secretariat, Program Coordinator, and Area Coordinators (Appendices 1, 2, and 3, respectively). Additional sampling instructions were developed for swordfish (Lee, 1990). Since many different types of methods of dressing billfish were used by ICCAT reporting nations (Prince and Miyake, 1989), these forms were periodically modified to reflect different data needs, particularly different length measurements. The various measures of length for billfish (Istiophoridae) and swordfish (Xiiphidae) obtained during the first five years of the Program are illustrated in Figures 1 and 2. Many of these measurements were used to develop length and weight regressions for conversion purposes and are described by Prager et al. (1992), Lee and Prince (1990), and Prince and Lee (1989). Although the measures of length may vary, the desired measure of length for billfish is lower jaw fork length (LJFL). Other length measurements frequently used include: pectoral fork length (PFL), pectoral second dorsal length (PDL), pectoral anus length (PAL), and, for swordfish, cleithrum keel length (CK).

2.1 Shore-Based Sampling

Trained technicians were used to collect shore-based billfish data from at least nine locations in the western and eastern Atlantic Ocean and consisted of information on size frequencies, sex, and weights of sampled billfish, by location and date. Data from the eastern Atlantic included in this report are incomplete and more reliable information is available from other working documents. Data from shore-based sampling activities were entered on the computer with PC-File, a flat file database manager software package. PC-File was chosen because it contains several features which were found useful to the storage and manipulation of data resulting from shore-based sampling activities. Useful features of PC-File include: compatibility with dBase programs, graphing and calculation capabilities, and the printing of reports for summarizing data.

Fishing techniques and gear varied, depending upon the location, and are listed in Table 1. The dominant gears were longline, hook and line, and gillnet.

2.2 At-Sea Sampling

Trained observers were placed on-board Venezuelan longline vessels starting in 1987 to monitor fishing activities (Form C) and collect size, sex, and fishery related data (Form D). They were responsible for collecting data pertaining to gear specifications and deployment, location (latitude and longitude), environmental conditions, target species (yellowfin tuna or swordfish), numbers and weights of fish caught, condition of species caught (alive or dead), landing times and biological sampling of the catch (length measurements, sex identification, reproductive organs, and hardparts for age and growth assessment).

Data from at-sea sampling activities were entered on the computer with the assistance of a customized program called the Billfish Observer Data (BOD) system which was developed by the Data Management Division of the Southeast Fisheries Science Center in Miami. The BOD system was designed and compiled using FOXPRO Version 1.02, a database manager software package which yields dBase compatible data. The BOD system was developed to store data and produce statistical reports resulting from at-sea fishing activities. This database consists of fishing trips which are divided into sets. For purposes of reports, sets are further divided into seasons; winter, spring, summer, and fall, and are defined as December - February; March - May; June - August; and September - November, respectively. Four reports can be generated by the BOD system: (1) summary of set data by season; (2) counts and weights by season; (3) average lengths by species, sex, and season; and (4) percentage alive by season (see Tables 2, 3, 4, and 5, respectively). These reports can also be generated by year and target species.

3. RESULTS AND DISCUSSION

3.1 Shore-Based Sampling

The largest sample size of length measurements for billfish (643 blue marlin, 1,994 white marlin, 1,715 sailfish, 51 swordfish and 53 spearfish) was collected from Venezuela (Table 6). The second largest sample size of length measurements for billfish (70 blue marlin, 1,064 white marlin, 153 sailfish and 4 spearfish) was collected from St. Maarten. Factors which contributed to these large sample sizes include the abundance of billfish in the landings and the diligence of technicians in these two areas. Notable in Table 6 are the dominate billfish species recorded by each area. For example, in Jamaica, blue marlin dominated the sampling, whereas white marlin were the most prevalent species in the Dominican Republic, St. Maarten and Venezuela. Sailfish catches dominated the sampling in Barbados, Grenada, Senegal and Trinidad. Swordfish catches were most prevalent in Las Palmas.

Sex identification data were consistently collected from the Dominican Republic, Grenada, Jamaica, and Senegal where most of the catches are landed with reproductive organs intact.

3.2 At-Sea Sampling

A total of 46 trips and 346 sets were recorded from Venezuela during the years 1987-1992, of which 16 trips were targeted at swordfish and 30 trips were directed at yellowfin tuna (Table 2). A set consists of a mainline averaging about 45 kilometers and 1,300 hooks. The numbers of hooks and hooks-per-set were higher during the winter and fall seasons.

During the first five years of the study, trips were defined as being swordfish or yellowfin tuna targeted because the bait used was either squid or sardines, respectively. However, beginning in 1992, both baits were used during a single trip, thus the target species were less obvious. Therefore, we also examined the hours the gear was set and retrieved, as well as the bait used to determine the target species for each set. For example, if gear was set primarily from late afternoon to early morning, the trip was defined as a swordfish targeted trip regardless of what bait was used. If fishing was entirely during daylight hours, the trip was considered to be targeting yellowfin tuna.

The percentage of billfish brought along side the boat alive is shown in Figure 3. The highest percentage of alive billfish was observed for white marlin (43%) and the lowest was observed for swordfish (23%).

Billfish and swordfish catch rates and average lower jaw fork lengths, by season, are provided in Table 7. A total of 194 blue marlin, 414 white marlin, 215 sailfish, 858 swordfish, and 47 spearfish were sampled from 1987 to 1992. The winter and fall seasons had consistently higher catch rates than the spring and summer. Billfish and swordfish catch rates average from 5.9 fish/set in peak periods in the winter and fall to 3.7 fish/set in the spring and summer. However, it is interesting to note that in some winter and fall periods the billfish catch rate can exceed 20 fish/set and these figures often exceed the catches of the target species. Average female and male lower jaw fork lengths for billfish and swordfish were consistently larger in the spring and summer.

Total weight, weight per set, and average weight per fish for males and females combined, by species and season, are given in Table 3. The BOD report program, at present, does not compute separate weight statistics for males and females. However, this information can be made available.

4. LITERATURE CITED

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Table 1. Fishing methods (techniques and gear) for shore-based sampling, by location.

Location	Fishing method
Barbados	Artisanal longline Artisanal trolling Recreational hook and line
Dominican Republic	Recreational hook and line
Grenada	Artisanal longline
Jamaica	Artisanal trolling Recreational hook and line
Las Palmas[1]	Industrial longline
Senegal	Artisanal handline Recreational hook and line
St. Maarten[2]	Industrial longline
Trinidad	Artisanal longline Artisanal gillnet Industrial longline
Venezuela	Artisanal gillnet Industrial longline

[1] Transhipment from Taiwanese vessels
[2] Transhipment from Taiwanese and Korean vessels

Table 2. Summary of at-sea trip, set, and gear data for each target species for at-sea sampling in Venezuela by season, 1987-1992.

	Winter	Spring	Summer	Fall	Total
Swordfish					
No. of Trips					16
No. of Sets	23	34	7	24	88
Tuna					
No. of Trips					30
No. of Sets	64	101	21	72	258
Hooks	159,099	126,892	23,886	119,028	428,905
Hooks/Set	1,828.7	939.9	853.1	1,239.9	1,293.6*
Line length (km)	4,127	6,495	1,242	3,635	15,501
Length/Set (km)	47.4	48.1	44.4	37.9	44.8*

* Average for the years 1987-1992.

Table 3. Summary of counts and weights (kg) by species and season for at-sea sampling which was generated by the BOD report program (1987-1992). (ALB=albacore tuna; BET=bigeye tuna; BFT=bluefin tuna; BLT=blackfin tuna; BUM=blue marlin; SAI=sailfish; SPF=spearfish; SWO=swordfish; WHM=white marlin; YFT=yellowfin tuna).

Species		Winter	Spring	Summer	Fall	Total
ALB	Fish Caught	33	53	8	33	127
	Fish Caught/Set	0.4	0.4	0.3	0.3	0.4
	Total Weight	364	184	92	625	1265
	Weight/Set	4.2	1.4	3.3	6.5	3.7
	Number Weighed	17	8	6	33	64
	Avg Wgt/Fish	21.4	23.0	15.3	18.9	19.8
BET	Fish Caught	49	178	27	40	294
	Fish Caught/Set	0.6	1.3	1.0	0.4	0.8
	Total Weight	712	858	326	950	2846
	Weight/Set	8.2	6.4	11.6	9.9	8.2
	Number Weighed	28	37	10	39	114
	Avg Wgt/Fish	25.4	23.2	32.6	24.4	25.0
BFT	Fish Caught		1			1
	Fish Caught/Set		0.0			0.0
	Total Weight					
	Weight/Set					
	Number Weighed					
	Avg Wgt/Fish					
BLT	Fish Caught	7		3	8	18
	Fish Caught/Set	0.1		0.1	0.1	0.1
	Total Weight	27		13	32	72
	Weight/Set	0.3		0.5	0.3	0.2
	Number Weighed	7		3	8	18
	Avg Wgt/Fish	3.9		4.3	4.0	4.0
BUM	Fish Caught	31	67	12	84	194
	Fish Caught/Set	0.4	0.5	0.4	0.9	0.6
	Total Weight	1182	2707	555	3410	7854
	Weight/Set	13.6	20.1	19.8	35.5	22.7
	Number Weighed	31	61	12	84	188
	Avg Wgt/Fish	38.1	44.4	46.3	40.6	41.8
SAI	Fish Caught	46	41	56	72	215
	Fish Caught/Set	0.5	0.3	2.0	0.8	0.6
	Total Weight	859	777	1198	1366	4200
	Weight/Set	9.9	5.8	42.8	14.2	12.1
	Number Weighed	45	38	56	70	209
	Avg Wgt/Fish	19.1	20.4	21.4	19.5	20.1
SPF	Fish Caught	7	18		22	47
	Fish Caught/Set	0.1	0.1		0.2	0.1
	Total Weight	96	373		298	767
	Weight/Set	1.1	2.8		3.1	2.2
	Number Weighed	7	16		22	45
	Avg Wgt/Fish	13.7	23.3		13.5	17.0

Table 3. Continued..

Species		Winter	Spring	Summer	Fall	Total
SWO	Fish Caught	279	291	33	255	858
	Fish Caught/Set	3.2	2.2	1.2	2.7	2.5
	Total Weight	7445	6307	650	6430	20832
	Weight/Set	85.6	46.7	23.2	67.0	60.2
	Number Weighed	263	223	32	251	769
	Avg Wgt/Fish	28.3	28.3	20.3	25.6	27.1
WHM	Fish Caught	101	85	31	197	414
	Fish Caught/Set	1.2	0.6	1.1	2.1	1.2
	Total Weight	1945	1995	647	3672	8259
	Weight/Set	22.4	14.8	23.1	38.3	23.9
	Number Weighed	101	83	31	197	412
	Avg Wgt/Fish	19.3	24.0	20.9	18.6	20.0
YFT	Fish Caught	371	1309	198	783	2661
	Fish Caught/Set	4.3	9.7	7.1	8.2	7.7
	Total Weight	11971	16762	4488	26602	59823
	Weight/Set	137.6	124.2	160.3	277.1	172.9
	Number Weighed	355	524	102	748	1729
	Avg Wgt/Fish	33.7	32.0	44.0	35.6	34.6
TOTAL	Fish Caught	924	2043	368	1494	4829
	Fish Caught/Set	10.6	15.1	13.1	15.6	14.0
	Total Weight	24601	29963	7969	43385	105918
	Weight/Set	282.8	221.9	284.6	451.9	306.1
	Number Weighed	854	990	252	1452	3548
	Avg Wgt/Fish	28.8	30.3	31.6	29.9	29.9

Table 4. Average lengths (cm) by species, sex, and season for at-sea sampling which were generated by the BOD report program (1987-92). (ALB=albacore tuna; BET=big eye tuna; BFT=bluefin tuna; BLT=blackfin tuna; BUM=blue marlin; SAI=sailfish; SPF=spearfish; SWO=swordfish; WHM=white marlin; YFT=yellowfin tuna; LJFL=lower jaw fork length; PAL=pectoral anal length; PFL=pectoral fork length; PDL=pectoral dorsal length; TL=total length; CK-cleithrum keel length; FL=fork length).

		WINTER								SPRING							
		Number	Length							Number	Length						
		Caught	LJFL	PAL	PFL	PDL	TL	CK	FL	Caught	LJFL	PAL	PFL	PDL	TL	CK	FL
ALB	Missing	30							100.7	34							102.3
	Female	1		32.0					103.0	7		32.0					108.5
	Male	2		35.5					111.0	12							108.2
	Totals	33		34.3					101.4	53		32.0					104.5
BET	Missing	20							111.2	111							105.5
	Female	7		39.5					118.8	27		38.4					110.9
	Juvenile	1							55.0								
	Male	21		33.7					104.7	40		41.8					84.3
	Totals	49		35.6					108.3	178		40.0					101.5
BFT	Missing									1							51.0
	Totals									1							51.0
BLT	Missing	7							63.0								
	Totals	7							63.0								
BUM	Missing									2	172.5	58.0	129.0				
	Female	12	192.5	63.2	145.3	95.5				19	192.7	66.9	145.3	110.0			
	Juvenile									3	143.3	46.0	109.0	77.0			
	Male	19	174.5	58.5	133.8	100.8				43	180.0	62.8	135.2	96.0			
	Totals	31	181.5	60.4	138.3	99.6				67	181.7	63.0	136.7	94.8			
SAI	Missing									1	164.0		125.0	81.0			
	Female	21	167.0	63.7	127.7	93.3				22	166.1	63.1	125.8	96.2			
	Juvenile	1	154.0	60.0	114.0					3	150.0	60.0	115.0	75.0			
	Male	24	162.1	60.2	123.4	90.3				15	167.2	61.8	128.8	94.2			
	Totals	46	164.1	61.8	125.2	92.5				41	165.3	62.4	126.1	92.6			
SPF	Missing	1															
	Female	3	162.6	60.3	124.6	95.0				7	168.7	60.3	125.6				
	Juvenile									1	152.0	59.0	114.0	87.0			
	Male	3	163.3	67.6	124.3	97.5				10	168.1	60.8	127.1	95.7			
	Totals	7	163.0	64.0	124.5	96.0				18	167.4	60.5	125.8	94.6			
SWO	Missing	24	125.8	41.8	97.8	69.8		74.0		6	116.2					62.8	
	Female	171	133.1	45.5	100.4	70.6		75.0		147	147.4	35.0	89.0	68.0		83.2	
	Juvenile	13	89.7					50.0		15	90.0	54.0				50.6	
	Male	71	128.9	41.9	99.5	67.3		71.2		123	130.0	47.0	86.4	73.0		73.8	
	Totals	279	129.4	43.7	99.6	69.6		72.3		291	136.5	47.2	86.6	72.2		77.3	
WHM	Missing	15	145.7	53.0	108.8	80.1				3	164.0	58.0	116.6	107.6			
	Female	32	151.9	51.0	112.6	87.3				31	165.1	48.9	124.2	98.0			
	Juvenile	8	136.1	46.0	97.1	70.1				1	161.0	57.0	122.0	93.0			
	Male	46	152.2	49.9	112.4	82.2				50	161.3	53.1	122.2	91.3			
	Totals	101	149.8	50.3	110.7	80.7				85	162.8	51.8	122.7	94.2			
YFT	Missing	141							109.2	667							130.1
	Female	59		40.4					139.6	204		42.2					137.3
	Juvenile	2							71.0	7							84.8
	Male	169		40.7					134.1	431		45.5					129.8
	Totals	371		40.6					125.3	1309		43.9					130.9

Table 4. Continued..

		SUMMER								FALL							
		Number	Length							Number	Length						
		Caught	LJFL	PAL	PFL	PDL	TL	CK	FL	Caught	LJFL	PAL	PFL	PDL	TL	CK	FL
ALB	Missing	5							102.6	13							105.2
	Female									9		45.0	80.0				102.0
	Male	3							102.3	11							100.8
	Totals	8							102.5	33		45.0	80.0				102.8
BET	Missing	12							110.2	34							110.6
	Female	6							128.6	1							106.0
	Juvenile									1							
	Male	9							116.8	4		35.0					116.5
	Totals	27							116.8	40		35.0					109.6
BFT	Missing																
	Totals																
BLT	Missing	3							61.3	8							60.0
	Totals	3							61.3	8							60.0
BUM	Missing	5	156.0	55.6	95.0	81.7				2	178.0	54.0	135.0	92.0			
	Female	3	203.6	59.5	154.6	103.5				38	188.3	63.7	143.7	103.0			
	Juvenile									4	153.3	46.0	110.0	63.0			
	Male	4	202.7	63.0	152.7					40	181.0	59.9	134.3				
	Totals	12	189.0	59.3	132.2	89.0				84	183.3	60.2	137.4	86.0			
SAI	Missing	2	158.5	131.0	86.0					6	152.6	61.6	120.0	94.0			
	Female	27	171.8	75.3	122.3	94.5				33	168.4	64.5	130.7	98.6			
	Juvenile	1	119.0	46.0	90.0					3	148.0	51.0	112.5				
	Male	26	167.3	88.0	110.9	86.0				30	163.9	65.5	125.0				
	Totals	56	168.3	81.6	115.1	93.2				72	165.1	64.2	127.0	96.5			
SPF	Missing									1	178.0	50.0	160.0				
	Female									6	159.3	58.6	117.3				
	Juvenile									4	156.2	51.2	128.7				
	Male									11	165.5	59.2	127.8				
	Totals									22	162.7	57.1	126.5				
SWO	Missing	7	87.7	29.0	63.1	47.1				52	110.5	36.8	80.2	57.4		63.5	
	Female	16	142.8					81.8		105	135.9	46.8	104.4	74.7		76.0	
	Juvenile	4	86.5	19.0	52.0	36.0		50.0		18	89.3	30.0	58.5	47.0		53.2	
	Male	6	108.5					60.1		80	127.5	44.4	113.3	71.8		65.6	
	Totals	33	118.0	27.5	61.7	45.5		72.8		255	125.1	43.2	100.5	68.9		67.6	
WHM	Missing	5	165.0	60.5	126.6	93.6				23	158.2	53.8	116.0	84.3			
	Female	18	157.3	55.5	114.0	90.0				83	158.9	53.5	118.6	94.6			
	Juvenile									1	143.0	46.0	106.0				
	Male	8	156.2		114.3					90	156.9	53.5	116.9	87.1			
	Totals	31	157.6	58.0	115.4	92.2				197	157.9	53.5	117.5	87.1			
YFT	Missing	33							136.8	325		33.0					133.7
	Female	76							135.1	163		35.4	92.8				132.1
	Juvenile	4							83.7	63		24.9	61.7				85.1
	Male	85							133.6	232		38.8	109.3				130.1
	Totals	198							133.6	783		30.9	87.5				128.4

Table 4. Continued..

		ALL SEASONS COMBINED							
		Number Caught	Length LJFL	PAL	PFL	PDL	TL	CK	FL
ALB	Missing	82							102.2
	Female	17		38.5	80.0				104.7
	Male	28		35.5					104.8
	Totals	127		37.7	80.0				103.1
BET	Missing	177							107.4
	Female	41		38.6					114.7
	Juvenile	2							54.5
	Male	74		38.2					95.8
	Totals	294		38.4					105.1
BFT	Missing	1							51.0
	Totals	1							51.0
BLT	Missing	18							61.1
	Totals	18							61.1
BUM	Missing	9	167.0	55.8	113.5	5 83.8			
	Female	72	190.8	64.5	144.8	8 100.1			
	Juvenile	7	148.3	46.0	109.5	5 73.5			
	Male	106	180.3	61.0	135.3	3 97.0			
	Totals	194	182.8	61.3	137.0	0 94.5			
SAI	Missing	9	156.5	71.5	112.1	1 91.4			
	Female	103	168.5	66.3	126.8	8 95.4			
	Juvenile	8	145.5	54.6	110.5	5 75.0			
	Male	95	164.9	67.9	121.3	3 92.6			
	Totals	215	165.8	66.8	123.3	3 93.4			
SPF	Missing	2	178.0	50.0	160.0				
	Female	16	164.0	59.7	122.1	95.0			
	Juvenile	5	155.4	52.8	125.8	87.0			
	Male	24	166.3	60.9	127.0	96.1			
	Totals	47	164.6	59.3	126.0	95.1			
SWO	Missing	89	111.8	37.4	83.4	59.8		64.3	
	Female	439	139.2	46.2	102.8	73.2		79.2	
	Juvenile	50	89.4	39.2	56.3	41.5		51.2	
	Male	280	128.5	44.0	105.1	70.8		71.5	
	Totals	858	130.3	43.0	98.3	68.5		74.1	
WHM	Missing	46	153.6	54.6	114.2	85.7			
	Female	164	158.6	51.6	118.0	94.4			
	Juvenile	10	139.3	48.7	100.5	73.0			
	Male	194	157.0	52.1	117.1	88.5			
	Totals	414	156.9	52.2	116.8	88.6			
YFT	Missing	1166		33.0					128.7
	Female	5402		39.0	92.8				135.5
	Juvenile	76		24.9	61.7				84.6
	Male	917		41.3	109.3				131.0
	Totals	2661		36.2	87.5				129.5

Table 5. **Percentage alive statistics by species and season for at-sea sampling which were generated by the BOD report program (1987-1992). ALB=albcore tuna; BET=bigeye tuna; BFT=bluefin tuna; BLT=blackfin tuna; BUM=blue marlin; SAI=sailfish; SPF=spearfish; SWO=swordfish; WHM=white marlin; YFT=yellowfin tuna).**

	Winter			Spring			Summer			Fall			All seasons combined		
SPECIES	ALIVE	DEAD	% ALIVE	ALIVE	DEAD	% ALIVE	ALIVE	DEAD	% ALIVE	ALIVE	DEAD	% ALIVE	DEAD	ALIVE	% ALIVE
ALB	4	29	12.12	8	44	15.38		8	0.00	8	25	24.24	20	106	15.87
BET	23	26	46.94	91	86	51.41	12	14	46.15	25	13	65.79	151	139	52.07
BFT					1									1	0.00
BLT		7	0.00				1	2	33.33	1	7	12.50	2	16	11.11
BUM	18	13	58.06	25	38	39.68	2	10	16.67	24	59	28.92	69	120	36.51
SAI	12	34	26.09	13	27	32.50	18	37	32.73	19	53	26.39	62	151	29.11
SPF	2	5	28.57	5	13	27.78				8	14	36.36	15	32	31.91
SWO	67	208	24.36	54	237	18.56	7	26	21.21	66	189	25.88	194	660	22.72
WHM	41	59	41.00	26	40	39.39	15	16	48.39	85	111	43.37	167	226	42.49
YFT	115	255	31.08	438	845	34.14	72	121	37.31	315	466	40.33	940	1687	35.78
TOTAL	282	636	30.72	660	1331	33.15	127	234	35.18	551	937	37.03	1620	3138	34.05

Table 6. Summary of shore-based sampling for Istiophoridae and Xiphidae in the western Atlantic Ocean[1]. Total sample size (number of billfish with length and/or weight measurement), sample size of most commonly recorded length measurement and numbers of billfish from this measurement with sex identification, mean length of most commonly recorded length measurement and years sampled for each billfish species and location.

BARBADOS					
Species	Total sample size	PDL[2] sample size	No. with sex data	Mean PDL (cm)	Years
Blue Marlin	67	55	0	96.5	88,89,90
White Marlin	28	18	0	78.5	88,89,90
Sailfish	234	220	0	98.2	89,90
Spearfish	13	12	0	85.7	89,90
DOMINICAN REPUBLIC					
Species	Total sample size	LJFL[3] sample size	No. with sex data	Mean LJFL (cm)	Years
Blue Marlin	27	22	22	199.7	88,90,91
White Marlin	224	96	96	163.6	90,91
Sailfish	38	26	22	160.7	88,90,91
GRENADA					
Species	Total sample size	LJFL sample size	No. with sex data	Mean LJFL (cm)	Years
Blue Marlin	162	117	96	182.2	88-91
White Marlin	9	9	9	169.1	88,91
Sailfish	1370	1156	951	169.3	88-91
Spearfish	1	1	1	170.0	90
JAMAICA					
Species	Total sample size	LJFL sample size	No. with sex data	Mean LJFL (cm)	Years
Blue Marlin	330	261	213	186.7	88,89
White Marlin	5	2	2	161.5	88
Sailfish	7	7	6	166.6	88,89
LAS PALMAS					
Species	Total sample size	PDL sample size	No. with sex data	Mean PDL (cm)	Years
Blue Marlin	120	120	0	123.4	90,91
White Marlin	231	139	0	91.2	90,91
Swordfish	320	320	0	91.0	90,91
Spearfish	64	64	0	94.7	90,91

Table6. Continued..

SENEGAL					
Species	Total sample size	LJFL sample size	No. with sex data	Mean LJFL (cm)	Years
Blue Marlin	5	4	2	206.3	91
Sailfish	540	518	101	178.9	91
Spearfish	2	2	0	137.5	91
ST. MAARTEN					
Species	Total sample size	PFL[4] sample size	No. with sex data	Mean PFL (cm)	Years
Blue Marlin	70	70	0	139.1	88,90,92
White Marlin	1065	1064	4	117.1	88-92
Sailfish	153	153	0	122.0	90-92
Spearfish	4	4	0	112.5	92
TRINIDAD					
Species	Total sample size	PAL[5] sample size	No. with sex data	Mean PAL (cm)	Years
Blue Marlin	30	0	0		87-90
White Marlin	32	31	1	59.3	90,92
Sailfish	103	0	0		87-90
Spearfish	1	0	0		90
VENEZUELA					
Species	Total sample size	PFL sample size	No. with sex data	Mean PFL (cm)	Years
Blue Marlin	644	643	5	140.8	88-91
White Marlin	1996	1994	3	117.1	88-91
Sailfish	1715	1715	50	127.1	88-91
Swordfish	83	51	1	116.2	88-91
Spearfish	53	53	0	121.1	90,91

[1] Data from Las Palmas and Senegal (both in the eastern Atlantic) are included.
[2] PDL = Pectoral/2nd dorsal length
[3] LJFL = Lower jaw fork length
[4] PFL = Pectoral fork length
[5] PAL = Pectoral anal length

Table 7. Numbers of fish caught, fish caught per set, and average lower jaw fork length (LJFL) in centimeters for females and males, by species and season, for at-sea sampling in Venezuela (1987-1992).

	WINTER	SPRING	SUMMER	FALL	TOTAL
BLUE MARLIN					
Fish Caught	31	67	12	84	194
Fish Caught/Set	0.4	0.5	0.4	0.9	0.6
Female Avg. LJFL	192.5	192.7	203.6	188.3	190.8*
Male Avg. LJFL	174.5	180.0	202.7	181.0	180.3*
WHITE MARLIN					
Fish Caught	101	85	31	197	414
Fish Caught/Set	1.2	0.6	1.1	2.1	1.2
Female Avg. LJFL	151.9	165.1	157.3	158.9	158.6*
Male Avg. LJFL	152.2	161.3	156.2	156.9	157.0*
SAILFISH					
Fish Caught	46	41	56	72	215
Fish Caught/Set	0.5	0.3	2.0	0.8	0.6
Female Avg. LJFL	167.0	166.1	171.8	168.4	168.5*
Male Avg. LJFL	162.1	167.2	167.3	163.9	164.9*
SWORDFISH					
Fish Caught	279	291	33	255	858
Fish Caught/Set	3.2	2.2	1.2	2.7	2.5
Female Avg. LJFL	133.1	147.4	142.8	135.9	139.2*
Male Avg. LJFL	128.9	130.0	108.5	127.5	128.5*
SPEARFISH					
Fish Caught	7	18	0	22	47
Fish Caught/Set	0.1	0.1	0.0	0.2	0.1
Female Avg. LJFL	162.6	168.7		159.3	164.0*
Male Avg. LJFL	163.3	168.1		165.5	166.3*

* Average for the years 1987-1992

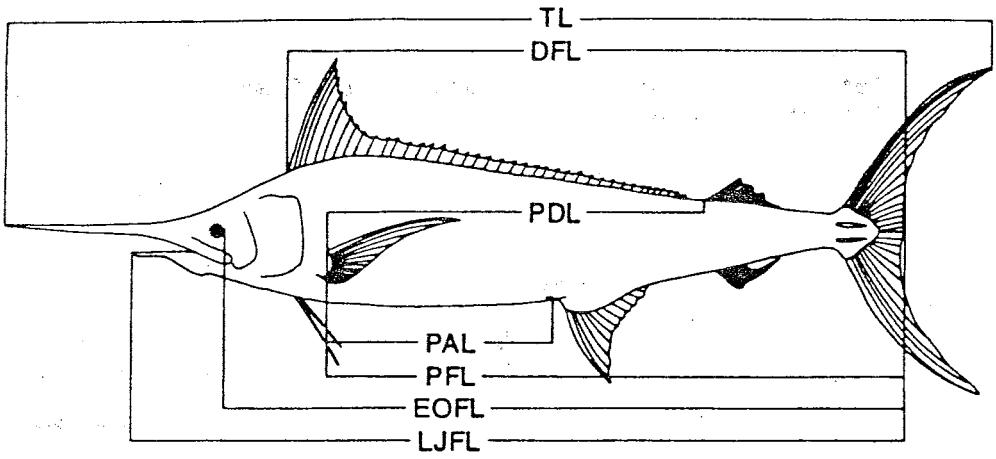


Figure 1. Length measurements collected from Istiophoridae for the ICCAT Enhanced Research Program for Billfish: dorsal fork length (DFL), eye orbit fork length (EOFL), lower jaw fork length (LJFL), pectoral anus length (PAL), pectoral second dorsal length (PDL), pectoral fork length (PFL), total length (TL).

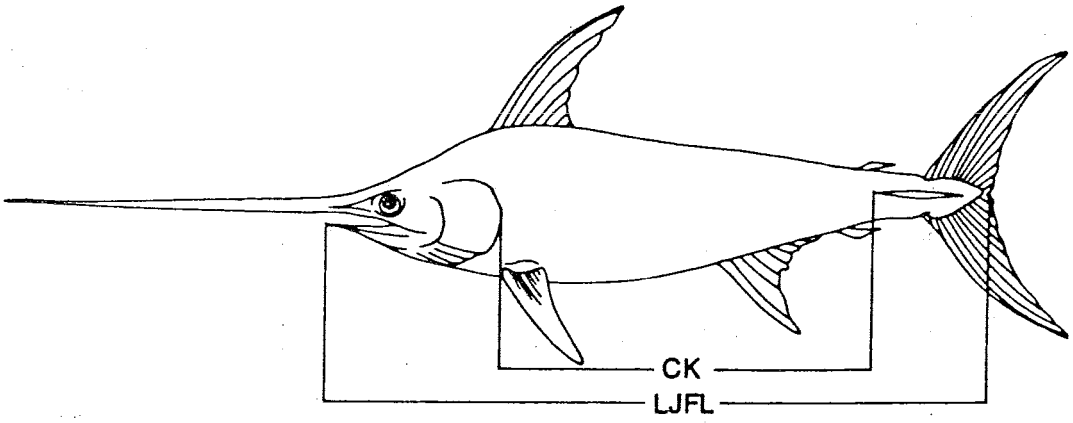


Figure 2. Length measurements from Xiiphidae for the ICCAT Enhanced Research Program for Billfish: cleithrum to keel length (CK), lower jaw fork length (LJFL).

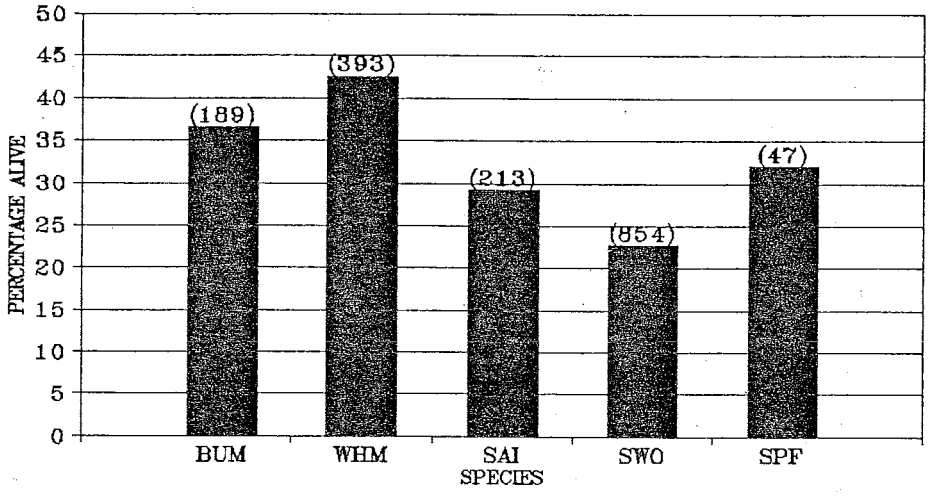


Figure 3. Percentage of billfish caught in an alive condition, by species, for at-sea sampling in Venezuela, 1987-1992. The numbers above each bar represent the total sample size. (BUM=blue marlin; WHM=white marlin; SAI=sailfish; SWO=swordfish; SPF=spearfish).

Appendix 1. Data collection form, ICCAT Billfish Form B, used for shore-based sampling.

ICCAT FORM B

BILLFISH PORT SAMPLING

SAMPLING PORT	NAME OF BOAT	SAMPLING DATE	SAMPLER	LANDING IDENTIFICATION	LOCATION OF SAMPLING

EQUIPMENT USED: ☐ Calipers ☐ Tape

	SPECIES	MEASUREMENTS (cm)					WEIGHT (Kg) Est. or Meas.	SEX (M/F/J)	SAMPLE ID OR REMARKS
		LJFL		PFL	PAL				
5									
10									
15									
20									
25									

INSTRUCTIONS FOR FORM B
(BILLFISH PORT SAMPLING)

This form should be used to record all billfish measurements (in addition to routine tuna sampling).

SAMPLING PORT: Enter the name of the port where sampling is carried out.

NAME OF BOAT: Enter the name of the boat.

SAMPLING DATE: Enter the date (Month/Day/Year) when fish were measured.

SAMPLER: Enter the name of sampler(s).

LANDING IDENTIFICATION: Enter corresponding landing sheet ID number. This will associate fish with the landing from which the samples were taken.

LOCATION OF SAMPLING: Enter location where sampling was carried out (e.g., aboard, transshipper, freezer, on truck, etc.)

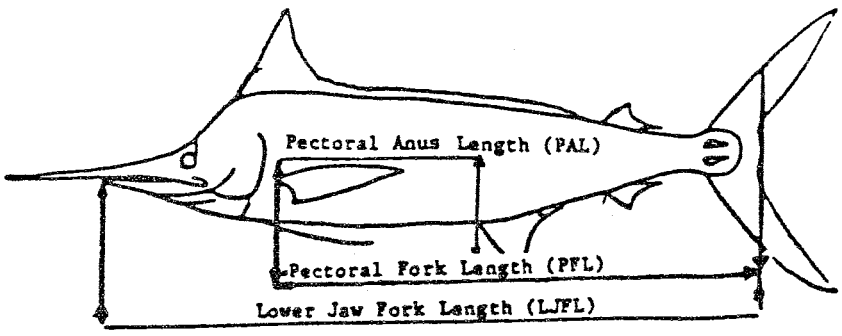
EQUIPMENT USED: Mark the corresponding box of either a pair of calipers or tape used for measuring fish.

SPECIES: Indicate the species for all the billfish caught. The following codes could be used:

WHM = White marlin
BUM = Blue marlin
SAI = Sailfish
SWO = Swordfish
SPF = Spearfish

MEASUREMENTS: All billfish should be measured as described below. The measurements should be in centimeters and millimeters should be truncated (e.g., 85.6 cm should be recorded as 85 cm). If the head of fish has been removed, LJFL cannot be measured. If there is any problem in sampling, weight should have first priority.

LJFL: Lower jaw to fork of the tail
PAL: Pectoral Anus Length
PFL: Pectoral fin to fork of the tail



Appendix 1. (Continued).

FORM B (Continued)

WEIGHT:	Record weight of fish in Kg (grams truncated). If fish cannot be weighed individually, record estimated weight of fish. If weight is estimated circle "est." in the heading of the column.
SEX:	Record sex of fish (Male/Female/Juvenile). In order to know the sex, the gonads of individual fish have to be examined. The illustration provided separately will assist in sex identification. If fish are gutted, identification of sex will be very difficult. In this case, leave the column blank (do not enter "unidentified").
SAMPLE ID NUMBER OR REMARKS:	If the fish are from boats with scientific observers on board, each billfish will have a numbered tape attached. Record the numbers. This is important since the comparison of the observer data with the port sampling data will establish the relationship between measurements at sea and measurements at port. Otherwise, enter the sample ID number which corresponds to the landing sheet record. This will be used to identify where and when fish were caught.

Appendix 2. Data collection form, ICCAT Billfish Form C, used to monitor fishing activities for at-sea sampling.

ICCAT FORM C

19 : :

OBSERVERS DAILY LOG (longliners)

NAME OF BOAT: _____ : : :

NAME OF CAPTAIN: _____ : : :

NAME OF OBSERVER: _____ : : :

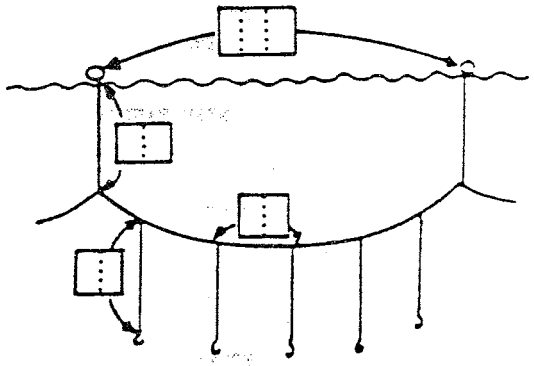
FISHING OPERATION DATA

	MONTH	DAY	HOUR	LATITUDE ° '	LONGITUDE ° '	TEMPERATURE °
Begin to set the line	: :	: :	: :	: : :	: : :	: .
Finish setting the line	: :	: :	: :	: : :	: : :	: .
Begin to haul the line	: :	: :	: :	: : :	: : :	: .
Finish hauling the line	: :	: :	: :	: : :	: : :	: .

BAIT USED: _____ : : :

Number of baskets used : : :

Number of hooks per basket : :



In what direction was the line set?

N W E S

In what direction was the line hauled?

N W E S

CATCH RECORD OF THE DAY

INDICATE THE DIMENSIONS OF THE LONGLINE IN METERS

SPECIES	Number	Kg	SPECIES	Number	Kg
YELLOWFIN TUNA	: :	: : :	WHITE MARLIN	: :	: : :
ALBACORE	: :	: : :	BLUE MARLIN	: :	: : :
BIGEYE TUNA	: :	: : :	SAILFISH	: :	: : :
BLUEFIN TUNA	: :	: : :	SWORDFISH	: :	: : :
BLACKFIN TUNA	: :	: : :	SPEARFISH	: :	: : :
	: :	: : :		: :	: : :
	: :	: : :	SHARKS		

Appendix 2. (Continued).

INSTRUCTIONS FOR FORM C

(OBSERVERS DAILY LOG (LONGLINERS))

One sheet should be used for each longline operation.

NAME OF BOAT:	Enter the name of the boat on the line. The squares are provided for computer coding purposes, and therefore, can be left blank.
NAME OF CAPTAIN:	Enter the name of the captain on the line. The squares are provided for computer coding purposes, and therefore, can be left blank.
NAME OF OBSERVER:	Enter the name of the observer on the line. The squares are provided for computer coding purposes, and therefore, can be left blank.
BEGIN TO SET THE LINE:	Enter the time when the boat started setting the line.
FINISH SETTING THE LINE:	Enter the time when the boat finished setting the line.
BEGIN TO HAUL THE LINE:	Enter the time when the boat started hauling the line.
FINISH HAULING THE LINE:	Enter the time when the boat finished hauling the line.
MONTH:	Record the month in number (January = 1, February = 2, ... December = 12).
DAY:	Record the day of the month when the fishing operation took place.
HOUR:	Record the hour in 0 to 24 hours.
LATITUDE & LONGITUDE:	Record the latitude and longitude in degrees and minutes or in official government fishing area codes.
TEMPERATURE:	If possible, record surface water temperature in centigrade.
BAIT USED:	Record the type of bait used.
NUMBER OF BASKETS USED:	Record the number of baskets (one line from a float to the next).

Appendix 2. (Continued).

FORM C (Continued)

NUMBER OF HOOKS PER BASKET: Record the number of hooks (or branch lines) attached to a basket of longline.

IN WHAT DIRECTION WAS THE LINE SET?: In the space provided, indicate by an arrow the approximate direction in which the line was set.

IN WHAT DIRECTION WAS THE LINE HAULED?: In the space provided, indicate by an arrow the approximate direction in which the boat moved while hauling the line.

CATCH RECORD OF THE DAY: Catch in number and estimated weight (in Kg) should be recorded for each species. The record should be for each set. The Field Manual or Species Identification Sheet may help in species identification.

DIMENSIONS OF THE LONGLINE IN METERS: In the illustrated figure, the length of a basket of mainline, length of float line, length of branch line and distance between branch lines, should be reported in meters. If the gear construction did not change during the trip, the dimensions may be reported only on the first sheet.

Appendix 3. Data collection form, ICCAT Billfish Form D, used to collect size, sex, and fishery related data for at-sea sampling.

ICCAT FORM D

BILLFISH SAMPLING (observers aboard)

NAME OF BOAT	SAMPLING DATE	SAMPLER	EQUIPMENT USED
			☐ Calipers ☐ Tape

SPECIES	DEAD	ALIVE	LANDING TIME hrs.	LANDING TIME min	MEASUREMENTS (cm) LJFL		PFL	PAL		WEIGHT (Kg) Est. Mean	SEX (M/F/J)	ID NO. OR REMARKS
5												
10												
15												
20												
25												

Appendix 3. (Continued).

INSTRUCTIONS FOR FORM D

(BILLFISH SAMPLING (OBSERVERS ABOARD))

All the billfish caught should be measured, weighed if possible, and a mark should be attached before the fish are gutted and beheaded.

NAME OF BOAT: Enter the name of the boat.

SAMPLING DATE: Enter the date of sampling (Month/Day/Year).

SAMPLER: Enter the name of the sampler(s).

EQUIPMENT USED: Mark the corresponding box of either a pair of calipers or tape used in measuring fish.

SPECIES: Enter the species for all billfish caught. The following codes could be used:

WHM = White marlin
BUM = Blue marlin
SAI = Sailfish
SWO = Swordfish
SPF = Spearfish

DEAD/ALIVE: Check the column corresponding to whether fish were dead or alive when brought up on the boat deck.

LANDING TIME: Record the hour (rounded to the closest hour) when the fish are brought on deck. Hours should be recorded in 0 to 24 hours.

MEASUREMENTS: All the billfish should be measured as described below. The measurements should be in centimeters and millimeters should be truncated (e.g., 85.6 cm should be recorded as 85 cm).

LJFL: Lower jaw to fork of the tail
PAL: Pectoral Anus Length
PFL: Pectoral fin to fork of the tail