Coordination of the ICCAT Enhanced Research Program for Billfish (ERPB), 1987-1998: Progress and Future Needs

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ABSTRACT

The International Commission for the Conservation of Atlantic Tunas (ICCAT) implemented the Enhanced Research Program for Billfish (ERPB) in 1987 in order to obtain the data necessary for assessing the status of Atlantic billfish (Istiophoridae) stocks. This program was designed to provide more detailed billfish catch and effort statistics, develop an international tagging program for billfishes, and assist in collecting data for billfish age and growth studies. Research activities include at-sea sampling with observers on Venezuelan industrial longline vessels during 1987 - 1998. This large database is comprised of fishing trips divided into sets, and organized by season. More recently, at-sea sampling is planned to start in 1999 on longline vessels fishing out of Brazil and Uruguay. Biological sampling is also conducted by observers and includes sampling of swordfish, istiophorids, and yellowfin tuna for reproductive and age determination studies, as well as genetics research. Size frequency data have been collected (1987 - 1998) through shore-based sampling of billfish landings in the West Atlantic from Venezuela, Grenada, Barbados, Trinidad, Jamaica, St. Martin, and the U.S. Virgin Islands, and in the East Atlantic from Senegal, Cote d'Ivoire, and Ghana. Sampling of billfish tournaments has occurred in Barbados, Bermuda, Brazil, Grenada, Jamaica, St. Martin, Tobago, U.S. Virgin Islands, and Venezuela. Tagging of juvenile swordfish off Venezuelan longline vessels has resulted in 68 releases since 1996. Program participants in Barbados, Grenada, and Venezuela continued to assist in obtaining information on tag-recaptured billfish, as well as numerous sharks, in the Western Atlantic Ocean during 1998.

KEY WORDS: At-sea sampling, ICCAT, shore-based sampling

INTRODUCTION

The International Commission for the Conservation of Atlantic Tunas (ICCAT), headquartered in Madrid, Spain, currently has 26 member countries: Angola, Brazil, Canada, Cape Verde, People's Republic of China, Cote d'Ivoire,

Croatia, Equatorial Guinea, European Community, France[1], Gabon, Ghana, Republic of Guinea, Japan, Republic of Korea, Libya, Morocco, Russia, Sao Tome & Principe, South Africa, Spain, Tunisia, United Kingdom[1], United States, Uruguay, and Venezuela. The ICCAT was established in 1966 with the object of maintaining the populations of tunas and tuna-like fishes, including billfishes (Istiophoridae) and swordfish (Xiphiidae), at levels that would permit maximum sustainable catch.

Various problems with ICCAT billfish data sets had historically made rigorous stock assessment of this species group very difficult at best. For example, uncertainties in catch and effort statistics are often encountered in species such as billfish, where the primary landings are the result of incidental catches from fisheries targeting other species (Prince and Brown 1991). These problems persisted for many years and were well documented in ICCAT reports (Conser and Beardsley 1979, Farber 1982, Conser 1989). The Enhanced Research Program for Billfish (ERPB) was formulated by the ICCAT in 1986 and implemented in 1987. The objective was to resolve these problems and obtain the data necessary for stock assessments (Brown et al. 1988). The specific objectives were:

i) to provide more detailed billfish catch and effort statistics, and particularly size frequency data
ii) to develop an international tagging program for billfishes, and
iii) to assist in collecting data for billfish age and growth studies.

To address these objectives, an at-sea sampling program began in 1987, putting observers on Venezuelan industrial longline vessels. The data were collected by set, organized by season, and included: species composition, gear, bait, time of landing, sex, various measurements, weight, and the condition of the fish (living vs. dead) when brought alongside the boat. Biological sampling is also conducted by observers and includes sampling of swordfish, istiophorids, and yellowfin tuna for reproductive and age determination studies, as well as genetics research. Additionally, a shore-based sampling program also began in 1987 to collect size-frequency data. Landings have been sampled in the West Atlantic from Venezuela, Grenada, Barbados, Trinidad, Jamaica, St. Martin, and the U.S. Virgin Islands, and in the East Atlantic from Senegal, Cote d'Ivoire, and Ghana. Sampling at billfish tournaments has occurred in Barbados, Bermuda, Brazil, Grenada, Jamaica, St. Martin, Tobago, U.S. Virgin Islands, and Venezuela.

An international tagging program, established under the auspices of ICCAT, became fully operational in 1990, with participation on both sides of the

[1] France and the United Kingdom are members in the name of their overseas territories not covered by the Treaty of Rome.

Atlantic Ocean, although the emphasis was clearly given to the eastern Atlantic. Continued promotion of the tagging program has substantially increased the number of tag returns from both the major Atlantic off-shore longline fleets fishing for tunas and swordfish, and the recreational fisheries throughout the Caribbean and west Africa targeting billfish.

Samples of skeletal structures have been collected over the years to be used in age and growth studies. This includes calcified structures from very large and small istiophorids, as well as anal fin spines from swordfish.

PROBLEMS UNIQUE TO BILLFISH

Why the need for an "enhanced" research program? Although billfishes were among the original species identified in the ICCAT charter as being part of the group of highly migratory fishes under its jurisdiction, billfish landings were historically a very small percentage of the total reported landings to ICCAT. Furthermore, billfishes have always been a bycatch of the commercially more valuable tuna- and swordfish-directed high-seas longline fleets. Concern for the status of Atlantic blue marlin (*Makaira nigricans)* and white marlin (*Tetrapturus albidus)* was first expressed by the ICCAT in the late 1970s and early 1980s, when preliminary stock-production model analyses indicated possible full- or over-exploitation (Conser and Beardsley 1979, Farber and Conser 1983). However, the quality of the database used in those early assessments was considered less than adequate.

It was also recognized that the unique biology and characteristics of the fisheries for billfish contribute to the difficulty of working with these species and in acquiring the data necessary for rigorous stock assessment (Prince and Brown 1991). For example, billfish are usually dressed at sea (with heads, spines, fins, tails, and viscera removed) and frozen for many months before being off-loaded at trans-shipment ports. This confounds species identification and prevents acquisition of size frequency and sex ratio data. Further, many non-ICCAT nations were not reporting billfish landings to the Commission. The "rare event" status of billfishes makes them difficult to sample and expensive to collect and study. They exhibit extreme sexual dimorphism (Wilson et al. 1991), making identification of sex (done only by internal examination) of landed fish critical, yet most landings come from offshore longline fisheries where carcasses are landed without gonads. Billfishes have not been reared in captivity, are exceptionally fast growing, have very small and delicate otoliths, and are difficult to age – all factors impeding age and growth studies. Historically, the extremely low tag-recapture rates for billfishes (less than 1% for blue marlin and less than 2% for white marlin) hindered the amount and quality of data on movements, migration routes, and stock structure, thus reducing the probability of success of age validation methods. A detailed table

listing the unique aspects of the fisheries and biology of Atlantic billfishes hindering data acquisition is presented in Prince and Brown (1991).

During the mid-1980s, certain ICCAT member countries (led by the United States) expressed growing concern that problems inherent in the billfish database would not be addressed without a special research effort. At the 1986 ICCAT Commission Meeting, a member of the U.S. delegation recommended that an "Enhanced Research Program for Billfish (ERPB)" be initiated to address the problems inherent in the billfish database. This was approved with the proviso that funding had to come from external sources. The U.S. delegation accepted the obligation to obtain international financial backing to run the program – and the ICCAT "Enhanced Research Program for Billfish" was initiated in 1987. For many years, the ERPBF was run on a budget of $25,000 annually. The financial status of the ERPBF changed in 1997 and funds covering research activities in this program now come from the main ICCAT budget, as well as from outside sources (for example, The Billfish Foundation).

PROGRESS IN ACCOMPLISHING PROGRAM OBJECTIVES

In July 1992, the Second ICCAT Billfish Workshop was convened in Miami, FL (ICCAT 1994). This meeting was attended by over a dozen nations and more than 30 scientists. This was the first time that so many ICCAT member countries had attended an ICCAT intersessional meeting with the objective of conducting stock assessments for the billfish species grouping. The scientific papers and stock assessments presented at that workshop were evidence of the significant progress that had been made in addressing the ERPBF Program objectives, as well as the development of an Atlantic-wide sampling program for continuous monitoring of billfish populations. At that time an exploratory stock assessment for blue marlin and white marlin (Cramer and Prager 1994a) was presented and later refined as separate assessments (Cramer and Prager 1994b Farber and Jones 1994). Data collected through the Program facilitated the generation of length and weight conversion equations for blue marlin, white marlin, and sailfish (*Istiophorus platypterus*) from the North Atlantic (Prager et al. 1994). Because billfishes are dressed in many different ways (ICCAT-member nations dress billfishes in at least ten different ways [Prince and Miyake 1989]), and measurements of size are usually not obtained before processing, there was a need to develop empirical equations for conversion among numerous different measures of dressed or whole fish. Assessment results resulting from the Second ICCAT Billfish Workshop identified Atlantic blue marlin and white marlin as being overexploited.

In July 1996, a Third ICCAT Billfish Workshop was convened (in Miami) which was preceded by a three day Data Preparatory Session (ICCAT 1998) (Funds for the hardcover publication of the Workship Report were contributed by the Billfish Foundation, Ft. Lauderdale, FL. That Workshop included participants from Brazil, Japan, Korea, United Kingdom (Bermuda), United States, Venezuela, and the National Taiwan University. The need for this Third Billfish Workshop, and the multi-national interest and participation (particularly from the major Asian offshore longline fleets), was in large part due to the on-going success of the ERPBF. Updated assessments for blue marlin and white marlin were accomplished and presented (ICCAT 1998, Jones and Farber 1998). Estimated parameters from these recent marlin assessments were used to make future projection of relative biomass and relative fishing mortality. Assessment results again indicated that both blue marlin and white marlin continued to be overexploitated and there was a need to reduce fishing mortality.

Some progress was also made at the Third Billfish Workshop concerning sailfish/spearfish (*Tetrapturus pfluegeri*) distribution in the Atlantic (Uozumi 1998), as well as standardization of CPUEs for east Atlantic sailfish CPUE (Yokawa and Uozumi 1998; Jones et al. 1998). However, problems with landing statistics from West Africa still persist.

SOME PROGRAM RESULTS

At-Sea Observers

The biological observer database (BOD) from at-sea sampling of industrial longline vessels fishing out of the port of Cumaná, Venezuela has grown impressively during the ERPBF. The database is comprised of fishing trips divided into sets, and organized by season where winter = (December - February), spring = (March - May), summer = (June - August), and fall = (September-November). Trips have a target catch and are designated as targeting tunas, tunas/billfish, or swordfish. Trips targeting tunas and tunas/billfish use sardines for bait and generally occur during the day. Trips targeting swordfish generally bait with squid, and occur in the late evening through the early morning.

From 1987-1997, there were a 236 trips involving 2,464 sets (Figure 1a). The sampling intensity grow progressively during the program as more funds became available and sampling protocols became well established. The total sets sampled during the most recent year shown (1997) are incomplete and this accounts for the decrease in number of trips between 1996 and 1997. However, the number of sets/trip remained nearly constant, 11.8 in 1996 and 11.0 in 1997. The number of trips has ranged from 3 in 1987, to a high of 42 in 1996. The number of sampled sets per year has ranged from 43 to 488 (Figure 1a). From 1987–1997, the vessels sampled used an average of 1,496 hooks per set

(Figure 1b), with a mean line length (Figure 1c) of 57 km (34 mi). The average length per set increased by about 19% from 74 km (44.4 mi) in 1996 to 88 km (52.8 mi) in 1997 (Figure 1c), while the average number of hooks increased only 5% from 1,667 in 1996 to 1,752 in 1997. From 1987 to 1997, the total sampled catch from the observer program was 1,151 blue marlin, 2,346 white marlin, 1,231 sailfish, and 670 spearfish (Figure 2a-c). The percent of billfish dead when brought to the boat, for each species, averaged over all years, ranged between 54-60%.

Shore-Based Sampling

From 1987 - 1997, shore-based sampling from no less than 13 Caribbean locations (Table 1) documented size frequency of at least 30,561 billfishes, including 4,473 blue marlin, 10,762 white marlin, and 15,326 sailfish. In many locations, shore-based sampling was targeted at artisanal fisheries and commercial longline fisheries, but recreational fisheries involving billfish were also sampled. In most cases the measurements were taken from fish that had already been dressed, except for billfish from recreational fisheries which are normally landed whole.

Hardpart Sampling for Age and Growth Studies

Sampling calcified structures for age and growth studies focused primarily on extreme size ranges for each billfish species. For example, age and growth samples were pursued for Atlantic blue marlin that were over 1,000 pounds (~500 kgs) and under 50 pounds (~25 kgs). During the years of the program (1987 - 1998), calcified structures from at least 5 Atlantic blue marlin over 1,000 were obtained since 1987. In addition, samples from extremely small marlin and sailfish were also obtained for age and growth analysis. For example, a 9 inch juvenile blue marlin are collected by Dr. Guy Harvey in Jamaica in 1988 and more recently, a 10 inch juvenile blue marlin was obtained from Dr. Brian Luckhurst off Bermuda in 1995.

ICCAT Tagging Program

The ICCAT billfish tagging program was formed primarily to encourage the tag and release of billfish off West Africa. In addition, this program also had the objective of increasing tag recovered billfish throughout the Atlantic. The tag release effort has been particularly effective off Senegal and Cote d'Ivoire, while tagging efforts have also increased off Brazil and several Caribbean locations, including Jamaica, Barbados, and Venezuela. Tag recovery efforts have been particularly effective in Venezuela, Barbados, and Grenada. For example, over the last five years, the number of tag recaptured marlin and sailfish from these three eastern Caribbean locations has averaged over 100 tag recovered billfish per

year. This is an increase of almost 20% of the recaptures in the same area before the ICCAT ERPBF was initiated in 1987.

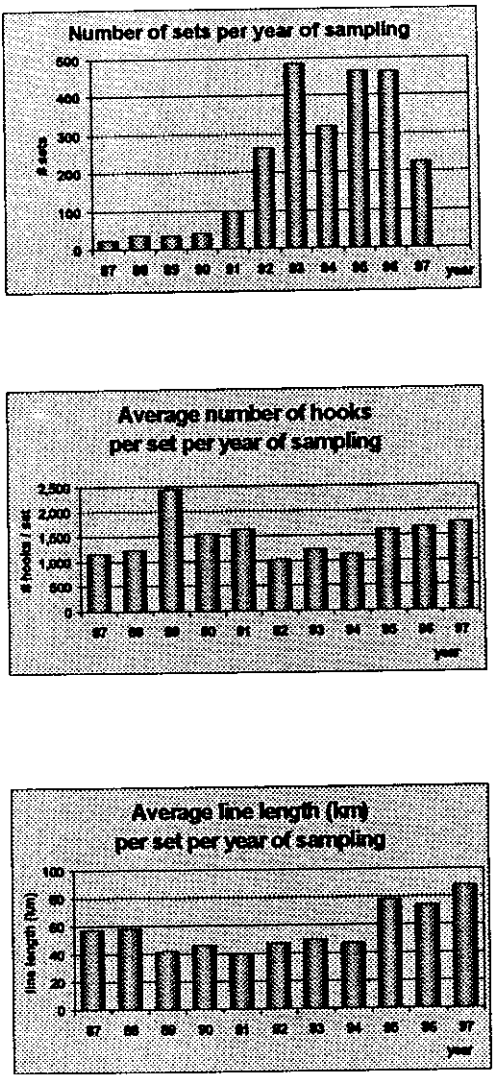
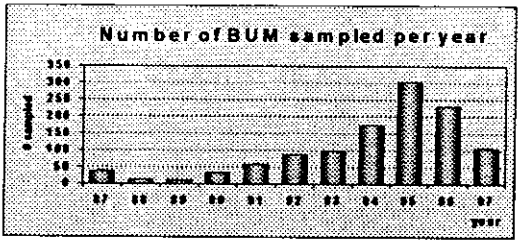


Figure 1. Number of sampled: (a) sets per year; (b) number of hooks per year; and (c) average line length (km) per set per year from Venezuelan longline vessels, obtained under the ICCAT ERPB, 1987-1997. Note: 1997 is incomplete.



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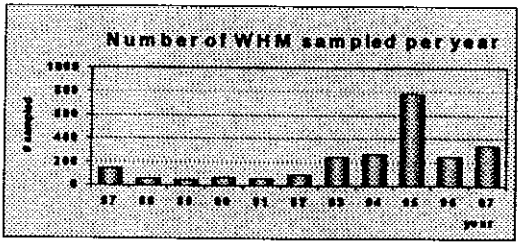

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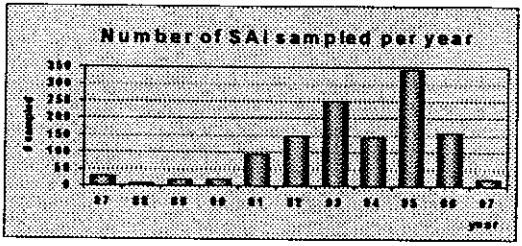

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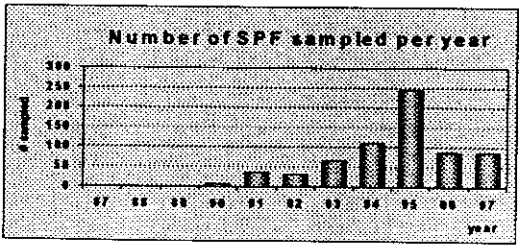

(d)

Figure 2. Annual sampled catch for: (a) blue marlin (BUM); (b) white marlin (WHM); (c) sailfish (SAI); and (d) spearfish (SPF), from Venezuelan longline vessels, obtained under the ICCAT Enhanced Research Program for Billfish (ERPB), 1987 - 1997. Note: 1997 is incomplete.

Table 1. Summary of shore-based sampling from the ICCAT Enhanced Research Program for Billfish (ERPB) 1987 - 1998
X = data entered for that year Δ = data to be entered — = no data received

Country	Port or Location	87	88	89	90	91	92	93	94	95	96	97	98
Barbados	Bridgetown	—	—	X	X	X	X	X	—	—	—	—	—
Benin	Benin	—	—	—	—	X	—	—	—	—	—	—	—
Cuba	Cuba	—	—	—	X	—	—	—	—	—	—	—	—
Dom. Republic	Dom. Republic	—	—	—	X	X	—	—	—	—	—	—	—
Grenada	Gouyave	—		X	X	Δ	X	X	—	Δ	Δ	—	—
Jamaica	per Guy Harvey	—	X	X	—	—	—	—	—	—	—	—	—
Margarita Isl.	Juangriego	—	—	—	—	X	X	X	X	X	X	—	—
St. Marteen	St. Marteen	—	—	X	X	X	X	X	—	—	—	X	X
Senegal	Dakar	—	—	—	—	X	—	—	—	—	—	—	—
Trinidad	Port of Spain	X	X	X	X	—	X	X	X	—	—	—	—
Venezuela	Cumana	X	X	X	X	X	—	X	Δ	Δ	—	Δ	X
Venezuela	La Guaira	—	—	—	—	X	—	—	—	—	—	—	—
Venezuela	Las Palmas	—	—	—	X	X	X	—	—	—	—	—	—
Venezuela	Playa Verde	—	—	—	X	Δ	X	X	Δ	Δ	Δ	Δ	Δ
Venezuela	Tucacas	—	—	—	—	—	—	—	—	X	—	—	—

CURRENT PROGRESS AND FUTURE PLANS

At the October, 1998, meeting of the ICCAT Standing Committee on Research and Statistics, (SCRS, the scientific body of ICCAT), it was recognized that the ERPBF needs to be continued because many of the data acquisition problems for all billfish species remain. In addition, maintenance of important elements of the billfish databases, to insure uninterrupted time series, also requires the ERPBF be continued and expanded.

The following summarizes shore-based and at-sea research progress in 1998, and future activities in the West and East Atlantic approved at the 1998 SCRS meeting, according to location and/or type of research activity:

Barbados: The shore-base sampling of the artisanal fishing fleet in Barbados was not conducted in 1998 due to low fishing effort, but at least 7 recreational billfish tournament were covered in 1998—recreational tournaments will also be covered in 1999.

Bermuda: Catch and effort statistics from billfish tournaments continue to be collected by the Bermuda Division of Fisheries. Shore-based sampling of the annual billfish tournament will be conducted in Bermuda in 1999. At-sea sampling of home based longline vessels targeting pelagic species will be initiated in 1999 by the Department of Agriculture and Fisheries, provided this fishing activity takes place. In addition to implementing ICCAT at-sea sampling activities, possible biological sampling opportunities will also be assessed. Bermuda also proposed a pilot study using pop-up satellite tags to evaluate the post-release survival of blue marlin caught in the Bermuda recreational fishery in 1999.

Brazil: Billfish tagging activities continued under the auspices of the Institute de Pesca, as well as biological sampling of billfish heart tissue for mitochondrial DNA (mtDNA) research. The heart tissue samples were shipped to Dr. John Graves (Virginia Institute of Marine Science) for his work on stock structure on Atlantic billfish. The first observer trip aboard a Brazilian longline vessel targeting swordfish was made during the summer of 1998. Shore-based sampling of selected billfish tournaments will be continued in Brazil for 1999. in the general vicinity of Santos, as well as other locations. At-sea sampling on Brazilian, Spanish, and U.S. longline vessels will be continued in 1999.

Canary Islands (Spain): Shore-based sampling of size frequency of off-loaded billfish carcasses from Chinese Taipei longline vessels may be continued in 1999.

Côte d'Ivoire (Abidjan): Shore-based sampling of the artisanal and recreational fisheries for billfish will be continued in 1999, as they have been in previous years.

Grenada: The Ministry of Industrial Development and Fisheries continued shore-based sampling activities of the artisanal fisheries during the 1998 season. Data from the 1998 Spice Island Billfish Tournament were also collected, including CPUE, size, and sex information of billfish landings. Shore-based sampling of size frequency and total landings from the artisanal and recreational fishery for billfish will be continued by the Ministry of Agriculture, Lands, Forestry, and Fisheries in 1999.

Ghana: Shore-based sampling of size frequency and sex determination, and catch and effort of the artisanal gillnet fisheries for billfish will be continued in 1999.

Jamaica: Dr. Guy Harvey continues to collect data at recreational tournaments including size and sex information of the landed fish, as well as catch and effort data. Most of this activity takes place in the fall to coincide with the billfish tournament schedule. These activities will be continued in 1999.

Morocco: Inquiries will be made by the Institut National de Recherche Halieutique to improve the knowledge of the recreational fishery for billfish in Morocco and for establishing a sampling program in 2000.

St. Martin, FWI / St. Maarten, NA: The billfish tournament normally held on St Martin was canceled for 1998 due to the world soccer tournament. This cancellation also prevented normal sampling of size frequency data from the Nichirei Carib Corporation at St. Maarten (Dutch side). Shore-based sampling of billfish off-loaded from the offshore longline fleet are planned in 1999.

St. Vincent: Research cruises aboard the St. Vincent Department of Fisheries longline vessel were not made during 1998. This activity will be re-evaluated at the end of this year to determine if it is appropriate to continue this research next year.

Senegal (Dakar): Shore-based sampling of the Senegalese artisanal, recreational and industrial fisheries for billfish will be continued in 1999. Travel by the East Atlantic Coordinator to Gabon, Ghana, Sao Tome & Principe, and other West African countries will be made in late 1998 or early 1999 to verify species identification of recent reported landings.

Trinidad and Tobago: Shore-based sampling of the industrial longline vessels (mostly Taiwanese) that off-load in the Port of Spain is normally carried out by the Ministry of Food Production and Marine Exploitation. However, due to recent changes in the ownership of the large freezer facility in Port of Spain, shore-based sampling was not conducted during 1998. This work may be re-activated next year based on budgetary considerations. Shore-based sampling of size frequency data for off-loaded billfish carcasses from China-Taiwan and longline vessels from Trinidad may be re-initiated in 1999.

U.S. Virgin Islands: Shore-based sampling of billfish tournaments continued during 1998 (normally at least 4 tournaments are held each year). Arrangements were made through the Virgin Islands Game Fishing Club in St.

Thomas to sample tournament and non-tournament billfish activities during the 1998 fishing season. Shore-based sampling of recreational billfish tournament and non-tournament fishing will be continued in 1999 by the Virgin Islands Big Game Fishing Club in St. Thomas.

Uruguay: At-sea sampling aboard home based longline vessels was initiated in 1998, supported by the Instituto Nacional de Pesca (INAPE). However, detailed data collection were not currently planned for billfish, except for measuring length. Starting in 1999, detailed data collection for billfish will be initiated from the existing observer program on a trial basis. An evaluation of the historical billfish landings and CPUE database from Uruguay will be conducted by Instituto Nacional de Pesca (INAPE) in order to assess the possibility of initiating shore-based sampling.

Venezuela: At-sea sampling activities of Fondo Nacional de Investigaciones Agropecuarias (FONAIAP) continued at the Port of Cumana, where the fleet of industrialized longline vessels target yellowfin tuna and swordfish, but also catch billfish. In addition, the fleet of smaller artisanal vessels often target billfish. There were a total of 24 at-sea observer trips reported during mid-1997 through mid-1998. A summary of at-sea sampling on Venezuelan longline vessels is given in Table 2. Several of these trips were made on the larger Korean type longline vessels and smaller artisanal boats, but most were made on the mid-size industrialized longline boats. Biological sampling of billfish consisted of collecting heart tissue, reproductive tissue, and anal spines for ongoing age and growth studies from about 224 fish during 1998 at-sea sampling activities. The 1998 sampling year was rather slow for the acquisition of calcified structures from very large and small istiophorids for age and growth studies. Shore-based sampling in Venezuela continued during 1998, with harbor sampling in Juangriego and Playa Verde, in addition to Cumaná and La Guaira. Sampling of 3 recreational tournaments held at Playa Grande Marina, as well as Puerto Cabello and Punto Fijo, continued in 1998. A major effort to obtain reports of tag recaptured billfish, as well as tagging of juvenile swordfish off Venezuelan longline vessels, continued during 1998. All at-sea and shore-based sampling efforts will be continued during 1999.

Table 2. Summary of at-sea sampling in Venezuela, 1987 - August 1997: Data include number of trips and sets; average numbers of hooks-per-set; longline length-per-set (km); numbers of blue marlin (BUM), white marlin (WHM), SAILFISH (SAI), and spearfish (SPF) caught; and estimated percent of billfish dead (by species) when brought alongside the boat.

Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	All Years
# Trips	3	3	3	7	16	32	37	34	40	42	19	236
# Sets	23	37	34	43	99	265	488	320	466	464	225	2,464
Average hooks/set	1,171	1,225	2,439	1,552	1,646	1,036	1,231	1,125	1,613	1,667	1,752	1,496
Average length/set	57	58	42	46	39	47	59	47	78	74	88	56.9
# BUM caught	38	13	11	34	59	87	96	174	303	231	105	1,151
#WHM caught	144	60	47	69	60	92	242	266	779	251	336	2,346
# SAI caught	30	7	18	19	94	148	250	144	343	157	21	1,231
# SPF caught	0	0	0	8	36	31	66	111	245	86	76	670
BUM % deat	68	40	64	76	67	52	38	44	49	41	60	54.5
WHM % dead	55	55	65	56	57	65	61	55	46	45	47	55.2
SAI % dead	50	67	72	68	78	66	67	75	32	22	52	60.0
SPF % dead				75	67	61	65	61	29	42	29	53.6

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