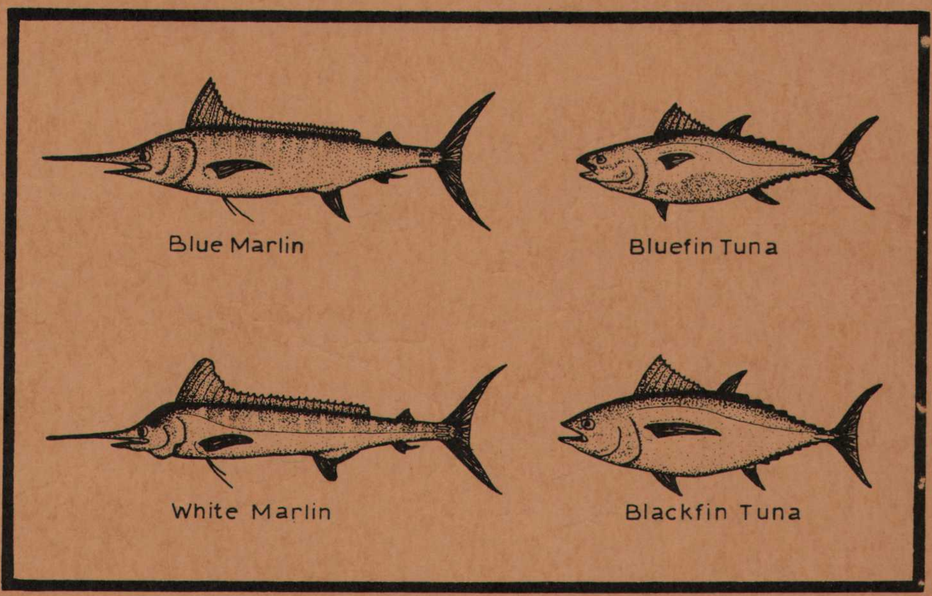
NOAA Technical Memoradum NMFS-SEFC-103

Bioprofiles Sampling Manual for Oceanic Pelagic Fishes

1982–83



Eric D. Prince

Dennis W. Lee

December 1982

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Center, Miami Laboratory
75 Virginia Beach Drive
Miami, Florida 33149

NOAA Technical Memorandum NMFS-SEFC-103

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U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
John V. Byrne, Administrator
NATIONAL MARINE FISHERIES SERVICE
William G. Gordon, Assistant Administrator for Fisheries

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INTRODUCTION

The goal of the bioprofiles task at the Southeast Fisheries Center's Miami Laboratory is to conduct research that will lead to stock assessment of oceanic pelagic fishes. One of the most important objectives within this framework is to determine and validate age and growth of selected target species by examining growth bands on skeletal hardparts and by recovery of tagged fish. In this manual we identify target species, specify priorities, describe the types of samples and procedures for data collection, and provide information for preserving the samples and shipping them to the Miami Laboratory.

SELECTION OF SAMPLES

Species and Size

Major efforts should be directed towards sampling blue and white marlin (Fig. 1) and bluefin tuna (Figs. 2 and 3), as these are our primary target species. Blackfin tuna (Figs. 2 and 3) will become increasingly more important in the future but are of secondary importance at this time. We are interested in collecting data on these species from the Atlantic seaboard, Caribbean Sea, and Gulf of Mexico. Samplers should maintain close communication with the Miami Bioprofiles staff (see page 8) in order to obtain necessary equipment and supplies, to cover related sampling expenses, and to answer questions about the program.

Blue and White Marlin. Increasing emphasis will be placed on marlin research during the next few years. Over 200 samples from blue and white marlin have been collected since 1980. Our needs continue to include all size categories. Since growth rates between males and females can differ greatly, it is necessary to separate specimens by sex in order to fulfill sample size requirements. The most common size range for blue marlin is from 68-182 kg (150-400 lb. Fig. 4a) and for white marlin 15-30 kg (35-65 lb. Fig. 4b). Marlin outside these common sizes are rarely caught and special effort should be directed towards obtaining samples from these specimens.

Bluefin Tuna. We have been collecting hardparts from bluefin tuna since 1974. Except for sampling tagged fish (discussed in the following section), we have satisfied most of our bluefin tuna sample requirements.

Blackfin Tuna. Although obtaining samples from blackfin tuna is a second priority, collections from all size categories should be taken if possible.

Tagged Fish

Our HIGHEST PRIORITY research needs are for the collection of skeletal hardparts (as specified for individual species in the next section) from ALL TAG-RECAPTURED blue and white marlin and bluefin tuna (>200 lb.). Bluefin tuna, as well as blue and white marlin, have been tagged via the Cooperative Game Fish Tagging Program since 1954, and additional bluefin tuna tagging operations have been conducted with the help of commercial seiners since the 1960's. Data on tagged fish are vital for validating estimates of age and growth, particularly if tagged fish have been "at large" for long periods. Cooperators should attempt to collect the tag and skeletal hardparts (as specified by species in the following section) and record the length, weight, sex, capture location, and date. Sex is often difficult to determine and we prefer samplers to include a section of gonad with each specimen. There may be instances when these samples cannot be obtained because they are sold or processed aboard Japanese longliners or tournament-caught fish are saved for mounting. Any tag-recaptured marlin or bluefin tuna (>200 lb.) suspected of having been at large for long periods should be set aside to prevent sale or processing and the Miami Laboratory contacted immediately (see page 8). Tag numbers will be checked to determine the tagging date and a decision made on a further course of action. It is possible that funds can be made available to reimburse fishermen for lost revenues due to our sampling procedures or to buy the fish if samples cannot be obtained by any other arrangement. Clearance for these costs, however, would have to be made through the Miami Laboratory. Buying tagged specimens will be our last resort, if all other means of acquiring the samples fail.

DATA COLLECTION AND PROCESSING

Labeling

Table 1 is an example of the bioprofiles sample log that we supply all cooperators. This log contains the basic information that should accompany ALL samples. Up to 26 individual samples (fish) can be included on each log sheet. All skeletal hardparts should have a collection number to identify the fish sampled. These numbers should be consecutive and continued on additional log sheets if necessary. This will allow cross-referencing parts with the basic data given on the log sheet. Log sheets should be written in pencil which will insure legibility even when soiled or wet. The best way to label parts is to use an embossing (labeling) machine and staple the plastic tapes to the parts. If this is not possible, a paper label tied to the parts will suffice. All parts and labels from EACH fish should be enclosed in one plastic bag to reduce the possibility of mixing the samples. No matter what labeling system is used, it is important to reiterate that all fish sampled for hardparts must have their own collection number for sample identification. The completed log sheet(s) should be enclosed in a separate plastic bag for shipment with the samples.

Equipment

Standard field sampling equipment includes: 1) saw or bone cutter; 2) plastic bags; 3) rubber gloves; 4) knife; 5) tape measure or calipers; 6) data log sheets (Table 1); 7) label machine with plastic label tape or small paper tie labels; 8) pencils; 9) staple gun; 10) pliers; 11) rubber boots; and 12) bucket. We will attempt to supply saws, plastic bags and data log sheets upon request. However, it is expected that many of our cooperators (e.g., foreign longline observers, NMFS samplers) will have most of these materials available to them at their respective duty stations.

Bluefin and Blackfin Tuna

Length and Weight. The measurements required on bluefin and blackfin tuna include round weight (in pounds or kilograms) and fork length (in inches or centimeters). These and other measurements are illustrated in Figure 5. Appropriate scales are usually available aboard ship or at dockside. Length measurements are most conveniently taken with calipers (Fig. 5) but any type of measuring device can be used.

Skeletal Hardparts. The hardparts we use to age bluefin tuna are otoliths (inner ear bones) and caudal vertebrae. Instructions for extracting otoliths from bluefin tuna (same for blackfin) are given in Figure 6. However, since otoliths are occasionally hard to find and are very fragile, we recommend that the entire head be saved and shipped to the Miami Laboratory. Caudal vertebrae from bluefin tuna should be obtained by cutting the caudal peduncle between the 6th and 7th finlet (Fig. 7). To save shipping space, the tail section can be trimmed by removing both lobes of the caudal fin but care should be taken not to cut any of the posterior vertebrae. This section will insure collection of the 35th vertebrae, which we use for ageing.

We are presently collecting five different skeletal hardparts from blackfin tuna: 1) otoliths; 2) vertebrae (the entire column); 3) scales; 4) dorsal spines (1-6); and 5) anal fin rays. Since blackfin tuna are relatively small (usually less than 25 pounds) we would ideally like to obtain the whole fish for our samples. However, this is not always possible because the meat from blackfin is highly prized as food. We, therefore, recommend that fish be filleted after being weighed and measured, leaving the head, vertebral column, dorsal spines, anal rays, tail, and viscera (containing gonads) intact. If the whole fish is not available, scales may be taken by cutting a 2 inch wide strip of skin in back of the pectoral fin prior to filleting. Scales should be kept intact--do not try and remove individual scales in the field. Collection of all hardparts from each fish (i.e. otoliths, vertebrae, spines, rays, and scales) are necessary for determining precision and accuracy of age and growth estimates.

Sex and Maturity. Bluefin and blackfin tuna should be examined to determine sex only after being weighed and measured. Make a 6-8 inch cut in the belly starting from the anal opening and continue forward to the insertion of the pelvic fins. This will allow access into the gut cavity for extraction of the gonads. Examination of the internal structure of the gonads will aid sex determination. A cross section of female gonads exposes a large median lumen (hole) in the center (Fig. 8). In contrast, male gonads are solid in cross section (Fig. 8). Bluefin tuna less than 56.8 kg (125 lb.) are usually immature, and determining sex by superficial examination is difficult. We therefore suggest that a cross section about 2 inches thick from all size categories of tuna be saved for confirmation of sex, particularly bluefin tuna under 125 lb. Gonads from blackfin tuna should be kept with the viscera and carcus when filleted properly. This will alleviate further handling in the field.

Blue and White Marlin

Length and Weight. Required measurements for blue and white marlin are round weight (in pounds or kilograms) and lower jaw fork length (in inches or centimeters). It is important to note that the bills of marlins often break, and thus lower jaw fork length is the most reliable measurement of body length (Fig. 9).

Skeletal Hardparts. Four different skeletal hardparts should be collected for marlin ageing studies: 1) anterior vertebrae (1-5); 2) otoliths; 3) dorsal spines (1-6); and 4) anal spines (1-4). Location of these structures is given in Figure 9. We suggest that two hardparts (i.e., anterior vertebrae and otoliths) be sampled as one unit (Fig. 10). This can be done by cutting off the bill and lower jaw at the nares (nostrils), filleting the meat away from the backbone to the 5th vertebrae, and separating this portion from the rest of the body. Dorsal spines (1-6) and anal spines (1-4) should be taken separately. Grab the tallest spine and pull forward to spread the spine system and cut the tissue separating spines. Continue making a parallel cut along each side of the spines down to the pterygiophores (spine root) so that the entire perimeter of the spines has been encircled. This will release the spines so they can be pulled out by hand. Again, it is important that all four hardparts from the same fish be collected to determine the precision and accuracy of age and growth estimates.

Sex and Maturity. The procedures for examining gonads to determine sex and maturity of blue and white marlin should be handled as described for bluefin tuna (see page 5 and 6). The general location of male and female marlin gonads is illustrated in Figure 10. A 2-inch thick cross section from the middle of the gonad should be taken for confirmation of sex and state of maturity.

PRESERVATION AND SHIPPING OF SAMPLES

Preservation

All samples (operculum, otoliths, vertebrae, spines, fin rays, scales and gonads) should be preserved by freezing before being shipped to the Miami Laboratory. When freezing cannot be accomplished immediately, samples should be refrigerated or kept on ice until they can be frozen. There may be occasions when freezer facilities have to be rented and the Miami Laboratory will assume these costs. However, ARRANGEMENTS will have to be made IN ADVANCE through the Miami Laboratory.

Containers

Styrofoam coolers and liquipacks (plastic sealed cardboard containers) have both proven adequate as shipping containers, but samples should be encased in leak-proof plastic bags as a safety precaution. We will supply liquipacks to cooperators by request only. Container requests should be made to the Miami Laboratory (see address and phone numbers below).

Shipping and Related Costs

We receive most of our samples by air freight, the most efficient method of transportation, unless samples are obtained locally. Frozen samples that are put directly into coolers or liquipacks before flight generally will not spoil before arriving in Miami, even if shipped from distant sampling areas. These containers of frozen material should be marked "scientific specimens (frozen bones)" on the outside shipping label. Cooperators should contact the Bioprofiles Task Project Manager at the Miami Laboratory (see below) before shipping the samples. We will then forward a government bill of lading (GBL), which is accepted as payment by all commercial airlines.

Shipping Address and Phone Numbers

Biological samples should be shipped to:

Bioprofiles Task, Dr. Eric D. Prince
National Marine Fisheries Service, NOAA
Southeast Fisheries Center, Miami Laboratory
75 Virginia Beach Drive
Miami, FL 33149

Call:

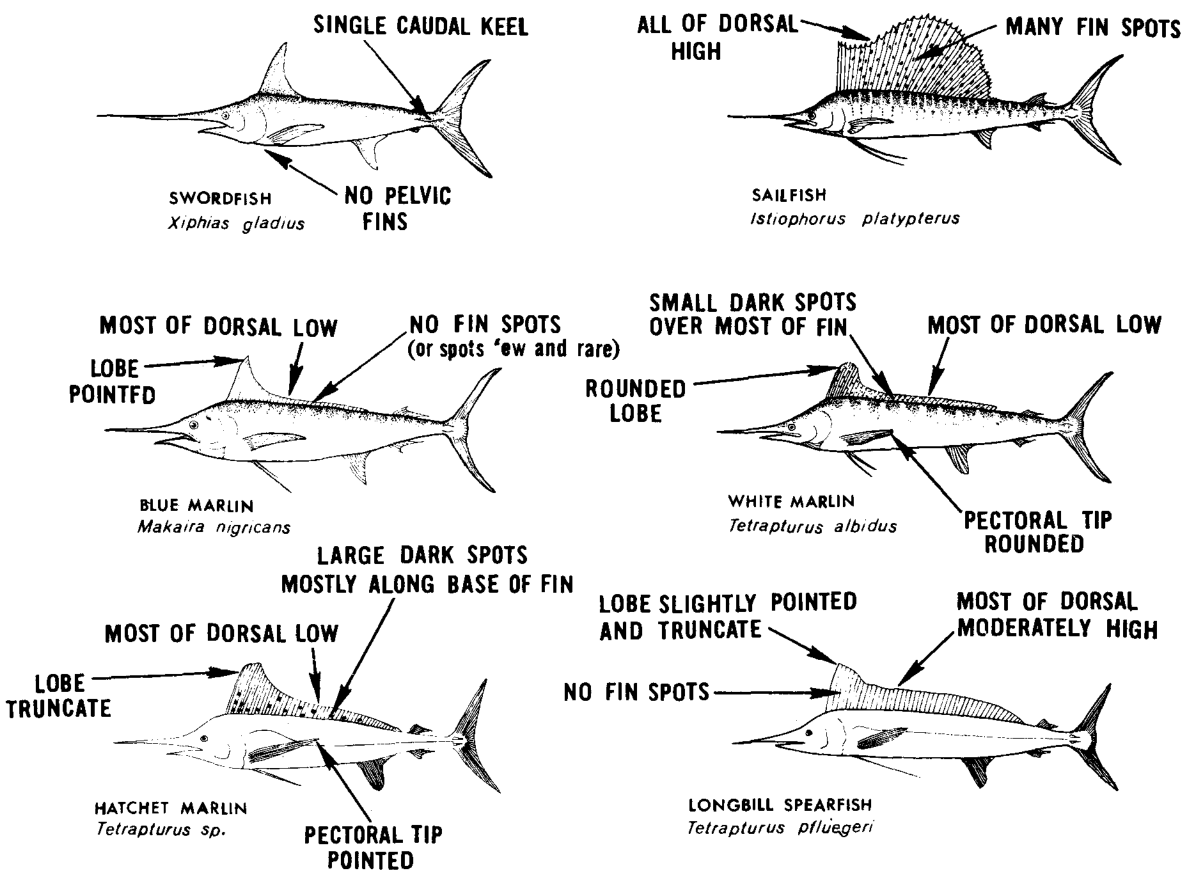
Eric Prince (305) 361-4248 commercial or
350-1248 FTS

Dennis Lee (305) 361-4247 commercial or
350-1247 FTS

Phyllis Fisher (305) 361-4225 commercial or
350-1225 FTS

BILLFISHES OFF THE ATLANTIC U.S.

THESE CHARACTERS ARE FOR FISH LARGER THAN 15 to 20 LBS. (SMALLER BILLFISH MAY DIFFER)



PAIRED CAUDAL KEELS ON EACH SIDE OF TAIL AND PELVIC FINS PRESENT ON ALL BILLFISH EXCEPT SWORDFISH

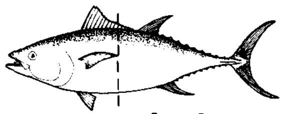
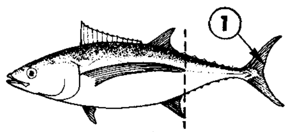
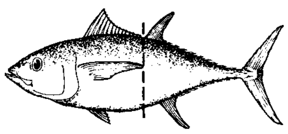
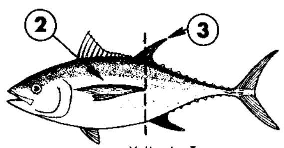
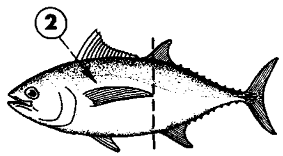
OCEANIC GAMEFISH PROGRAM, SOUTHEAST FISHERIES CENTER, NATIONAL MARINE FISHERIES SERVICE, MIAMI, FLA.
SEFC TECH. SHEET NO. 6 BY FRED BERRY & GRADY REINERT

FIGURE 1

FIGURE 2

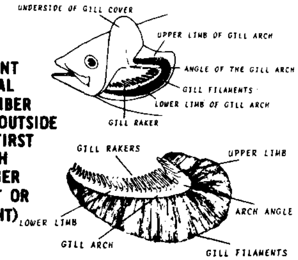
ATLANTIC TUNAS (*Thunnus*)

Ⓐ Ⓑ Ⓒ

Species	Pectoral Fin	Finlet Color	Gill Raker Range	Liver: Bottom Surface	Liver: Length of 3 Lobes	Weight (Estimated Maximum)
 *Bluefin Tuna*	SHORT	YELLOW with narrow black back edge	34–43	STREAKED	LOBES EQUAL or middle lobe slightly longer	1200 Pounds
 *Albacore*	LONG	SILVERY OR DUSKY — DORSAL: All May Have YELLOW in center; ANAL: 1 or 2 May Have YELLOW center	25–31	STREAKED	LOBES EQUAL or middle lobe slightly longer	75 Pounds
 *Bigeye Tuna*	MODERATE	YELLOW with BROAD black back edge	25–29	STREAKED	LOBES EQUAL or middle lobe slightly longer	450 Pounds
 *Yellowfin Tuna*	MODERATE	YELLOW with narrow black back edge	27–33	SMOOTH	RIGHT LOBE LONG	350 Pounds
 *Blackfin Tuna*	MODERATE	WHITE BACK EDGES — DORSAL: DUSKY-BRONZE; ANAL: DUSKY-GREY	19–25	SMOOTH	RIGHT LOBE LONG	40 Pounds

ILL RAKERS

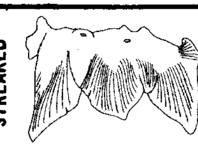
COUNT TOTAL NUMBER ON OUTSIDE OF FIRST ARCH (EITHER LEFT OR RIGHT)



LIVER (Bottom View)

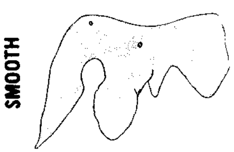
BOTTOM SURFACE — L BES

STREAKED



EQUAL OR MIDDLE SLIGHTLY LONGER

SMOOTH



RIGHT LOBE LONGER

Ⓐ COLOR IN TUNAS MAY FADE OUT RAPIDLY AFTER DEATH, ESPECIALLY THE GOLD HORIZONTAL STRIPES IN YELLOWFIN AND BLACKFIN. THE FIN AND FINLET COLORS USUALLY REMAIN LONGER.

Ⓑ A PATTERN OF VERTICAL WHITISH BARS AND ROWS-OF-SPOTS IS PRESENT ON THE LOWER SIDES AND BELLY OF SMALLER TUNA, UP TO ABOUT 20-30 POUNDS.

Ⓒ THE SECOND DORSAL LOBE AND THE ANAL LOBE ARE USUALLY YELLOW IN LARGER YELLOWFIN, BLUEFIN, AND BIGEYE AND ARE DARK WITH WHITE DISTAL MARGINS IN ALBACORE AND BLACKFIN.

(1) Narrow white margin on trailing edge of caudal fin.

(2) Gold horizontal stripe, fading after death.

(3) Dorsal and anal fin lobes very long at about 60 pounds and heavier.

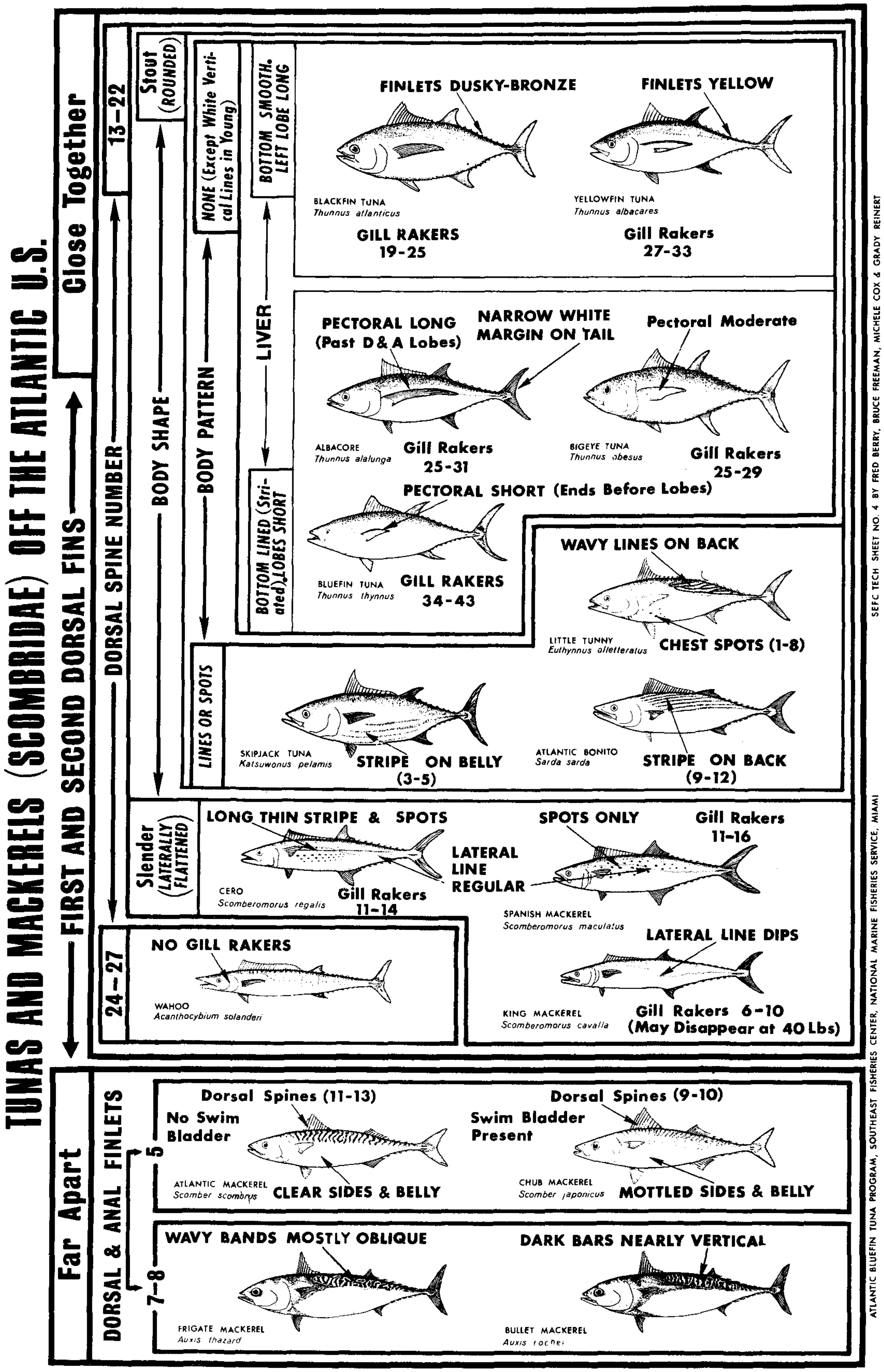

TUNAS AND MACKERELS (SCOMBRIDAE) OFF THE ATLANTIC U.S.
FIRST AND SECOND DORSAL FINS
Close Together
Far Apart
DORSAL SPINE NUMBER
13-22
24-27
BODY SHAPE
Stout (ROUNDED)
Slender (LATERALLY FLATTENED)
BODY PATTERN
NONE (Except White Vertical Lines in Young)
LINES OR SPOTS
LIVER
BOTTOM SMOOTH. LEFT LOBE LONG
BOTTOM LINED (Striated) LOBES SHORT
FINLETS DUSKY-BRONZE
FINLETS YELLOW
BLACKFIN TUNA
Thunnus atlanticus
YELLOWFIN TUNA
Thunnus albacares
GILL RAKERS 19-25
Gill Rakers 27-33
PECTORAL LONG (Past D & A Lobes)
NARROW WHITE MARGIN ON TAIL
Pectoral Moderate
ALBACORE
Thunnus alalunga
Gill Rakers 25-31
BIGEYE TUNA
Thunnus obesus
Gill Rakers 25-29
PECTORAL SHORT (Ends Before Lobes)
BLUEFIN TUNA
Thunnus thynnus
GILL RAKERS 34-43
WAVY LINES ON BACK
LITTLE TUNNY
Euthynnus alletteratus
CHEST SPOTS (1-8)
SKIPJACK TUNA
Katsuwonus pelamis
STRIPE ON BELLY (3-5)
ATLANTIC BONITO
Sarda sarda
STRIPE ON BACK (9-12)
LONG THIN STRIPE & SPOTS
SPOTS ONLY
Gill Rakers 11-16
LATERAL LINE REGULAR
CERO
Scomberomorus regalis
Gill Rakers 11-14
SPANISH MACKEREL
Scomberomorus maculatus
NO GILL RAKERS
WAHOO
Acanthocybium solanderi
LATERAL LINE DIPS
KING MACKEREL
Scomberomorus cavalla
Gill Rakers 6-10 (May Disappear at 40 Lbs)
DORSAL & ANAL FINLETS
5
7-8
Dorsal Spines (11-13)
No Swim Bladder
ATLANTIC MACKEREL
Scomber scombrus
CLEAR SIDES & BELLY
Dorsal Spines (9-10)
Swim Bladder Present
CHUB MACKEREL
Scomber japonicus
MOTTLED SIDES & BELLY
WAVY BANDS MOSTLY OBLIQUE
FRIGATE MACKEREL
Auxis thazard
DARK BARS NEARLY VERTICAL
BULLET MACKEREL
Auxis rochei
ATLANTIC BLUEFIN TUNA PROGRAM, SOUTHEAST FISHERIES CENTER, NATIONAL MARINE FISHERIES SERVICE, MIAMI
SEFC TECH SHEET NO. 4 BY FRED BERRY, BRUCE FREEMAN, MICHELE COX & GRADY REINERT

FIGURE 3

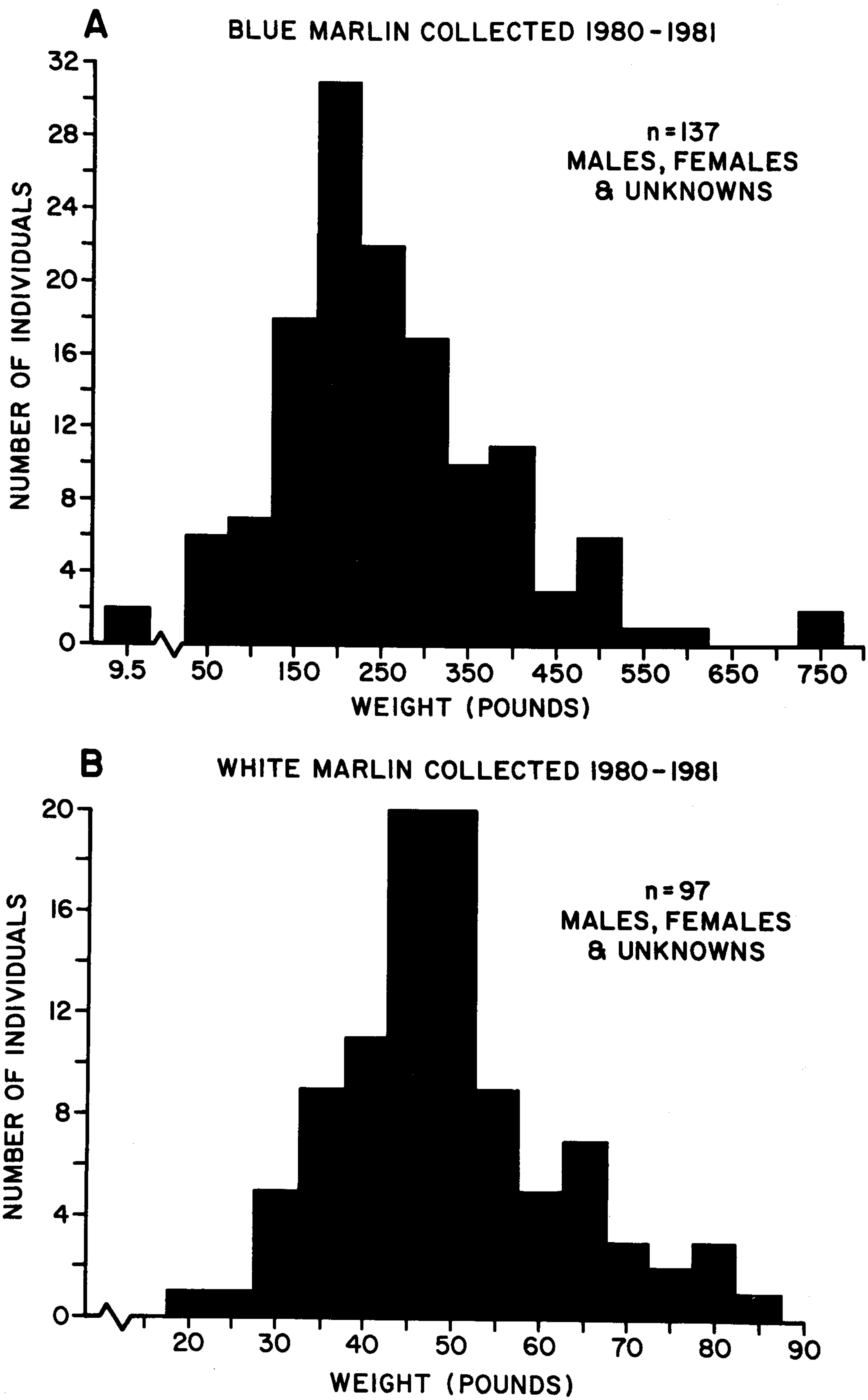

A
BLUE MARLIN COLLECTED 1980-1981
n=137
MALES, FEMALES
& UNKNOWNS
NUMBER OF INDIVIDUALS
32
28
24
20
16
12
8
4
0
9.5
50
150
250
350
450
550
650
750
WEIGHT (POUNDS)
B
WHITE MARLIN COLLECTED 1980-1981
n=97
MALES, FEMALES
& UNKNOWNS
NUMBER OF INDIVIDUALS
20
16
12
8
4
0
20
30
40
50
60
70
80
90
WEIGHT (POUNDS)

FIGURE 4

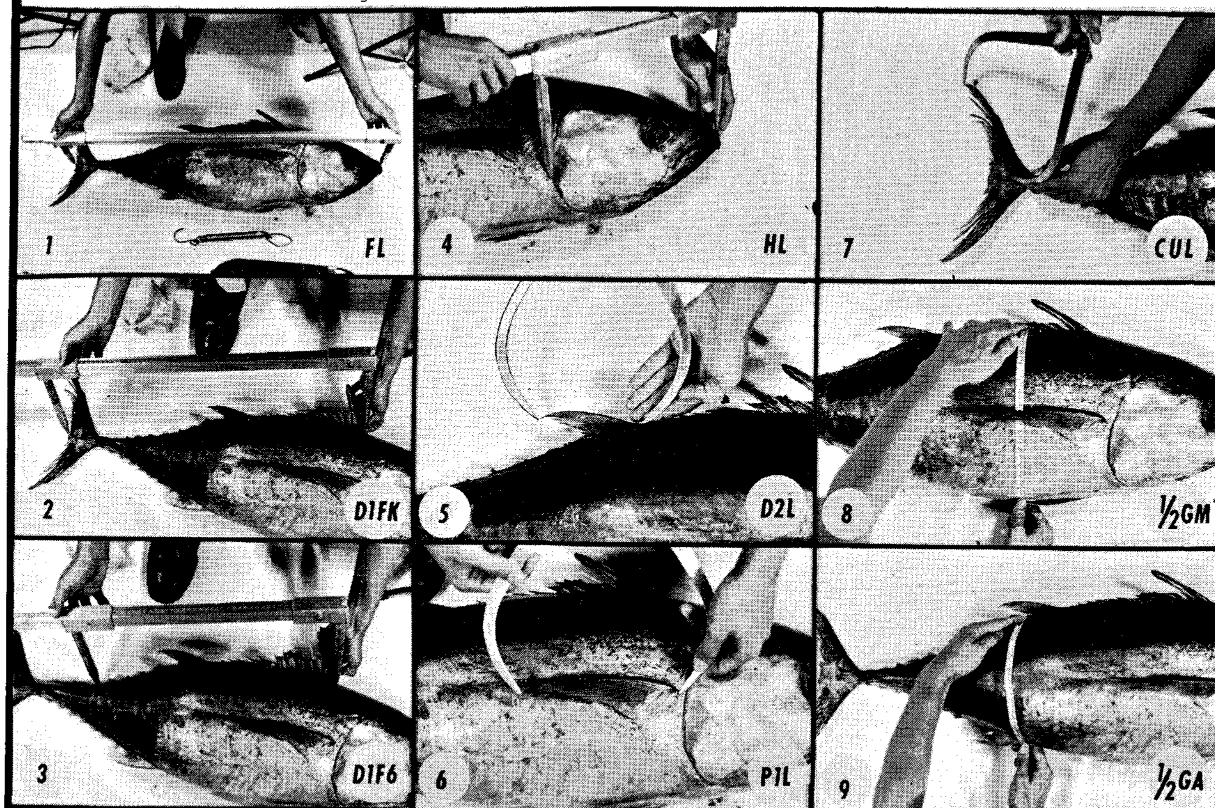
ATLANTIC BLUEFIN TUNA

FIGURE 5

MEASUREMENTS

RECORD IN: either CM - centimeters (tenths) or INS - inches (tenths, quarters)

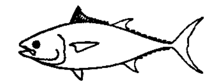
MEASURE PREFERRED: STR - Straight, (with calipers) for lengths in figures 1-7.
MEASURE ALTERNATE: CUR - Curved (with tape or string for lengths in figs. 1-7.
HALF GIRTHS (figs. 8-9): Curved measures (with tape or string).



1. FORK LENGTH (FL)
2. FIRST DORSAL FIN ORIGIN TO CAUDAL FIN FORK (D1FK)
3. FIRST DORSAL FIN ORIGIN TO SIXTH FINLET ORIGIN (D1F6)
4. HEAD LENGTH (HL)
5. SECOND DORSAL FIN LOBE LENGTH (D2L)
6. PECTORAL FIN LENGTH (P1L)
7. UPPER CAUDAL FIN LOBE LENGTH (CUL)
8. HALF GIRTH-MAXIMUM (½GM)
9. HALF GIRTH-AT ANAL FIN ORIGIN (½GA)

WEIGHTS

RECORD IN:
KG - Killograms (tenths)
or
LB - Pounds (tenths or ounces)



ROUND (RD)

GUTTED (GUT)

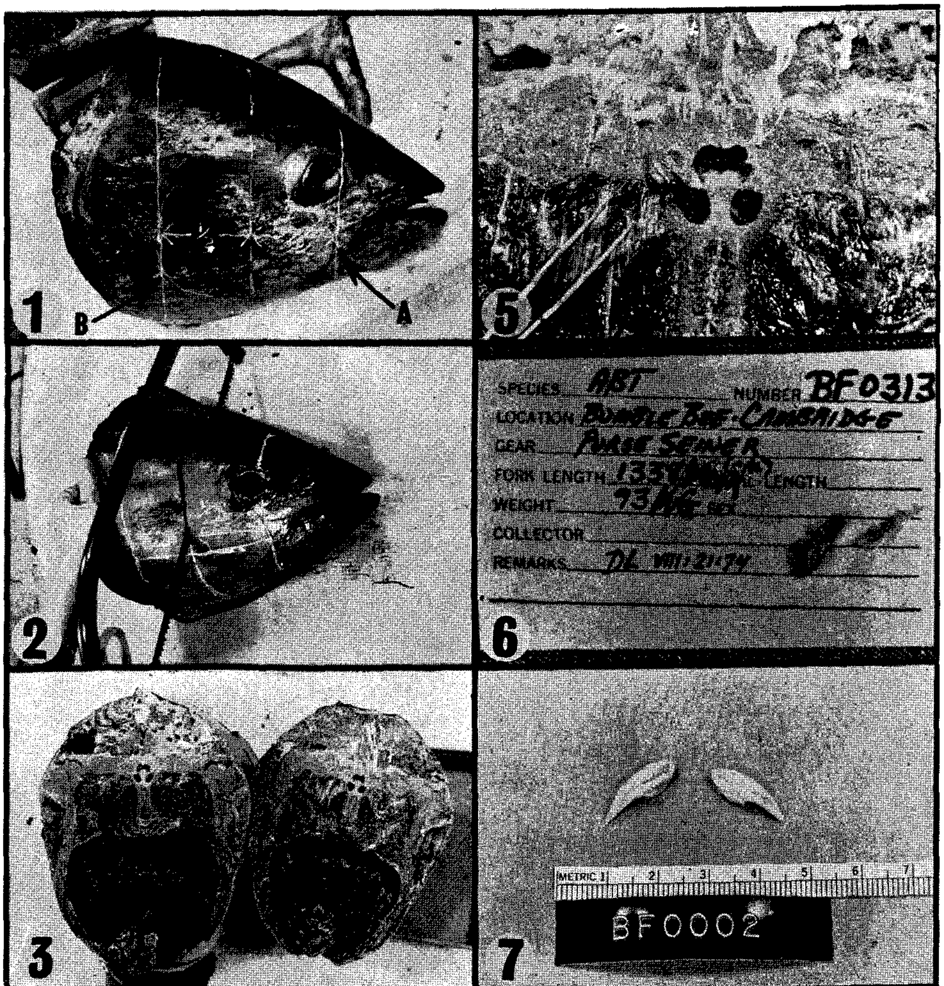
GILLED & GUTTED (GG)

HEADED & GUTTED (DWT)

HEADED, GUTTED & TAILED (DWTT)

ATLANTIC BLUEFIN TUNA PROGRAM
National Marine Fisheries Service
75 Virginia Beach Drive
Miami, Florida 33149
(305) 361-5761

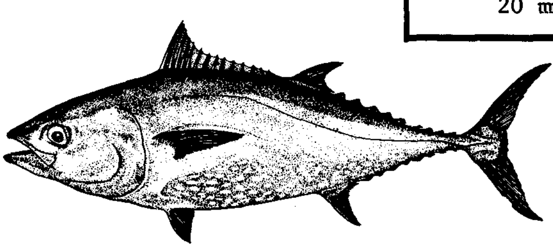
SEFC TECH. SHEET NO.3



OTOLITH REMOVAL

ATLANTIC BLUEFIN TUNA

1. Locate end of upper jaw (A) and rear edge of preoperculum (B). Mark a vertical line half distance between these.
2. Along this line, saw through head in a vertical cut.
3. Front end of the cut head contains the otoliths.
4. Otoliths are in the 2 bilateral cavities on each side of the midline in the upper third of the head.
5. With forceps, gently locate and extract each otolith.
6. Remove fibrous capsule from each otolith (if it is still intact). If an otolith breaks, save both pieces. Rinse briefly in water. Dry in air.
   Store in vial or envelope (no pressure). Include data on Fork Length (caliper or contour specified). Weight (round, or other specified), Location and Date (caught and/or collected), and collection number (if assigned).
7. Otoliths (pair) from a 560-lb Atlantic Bluefin Tuna. Otoliths range in length from 7 mm (1-year-old) to 20 mm (giants).



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National Marine Fisheries Service
75 Virginia Beach Drive
Miami, Florida 33149 USA

ABT TECH SHEET NO. 1

FIGURE 6

CAUDAL PEDUNCLE REMOVAL–
ATLANTIC BLUEFIN TUNA

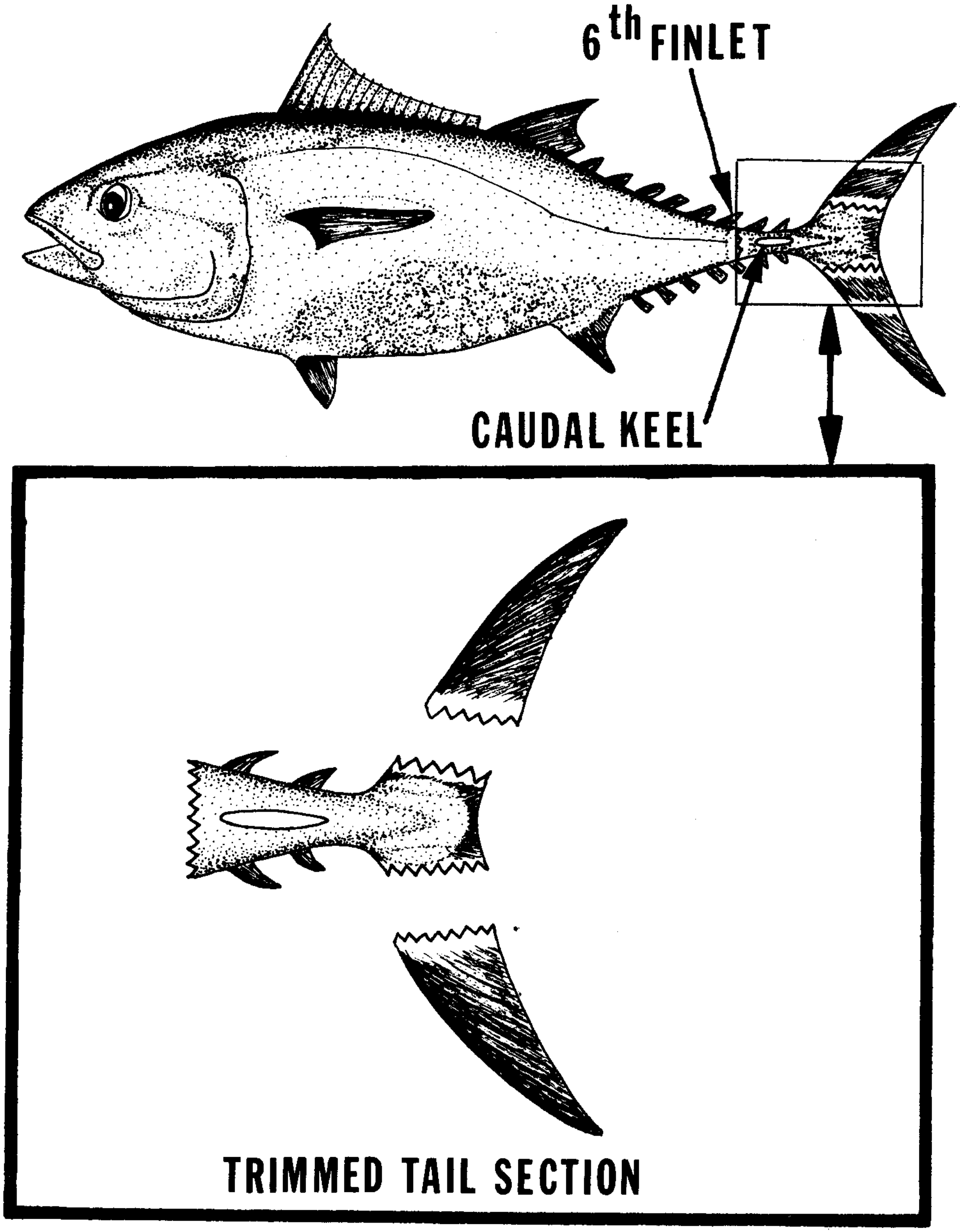
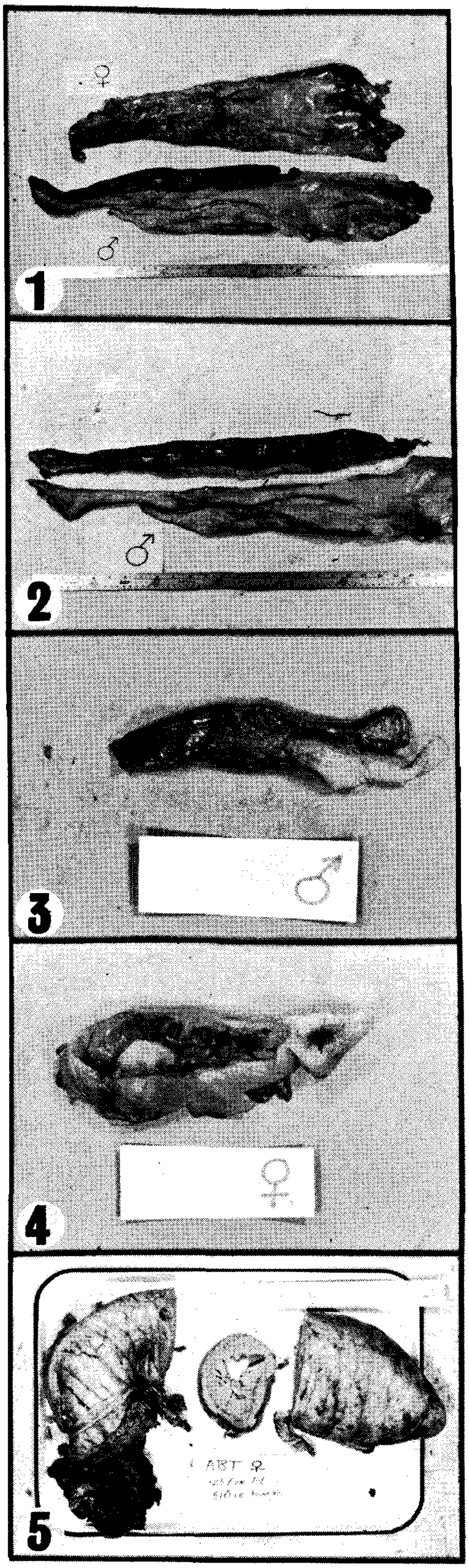
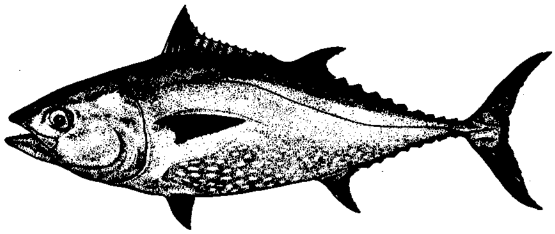


FIGURE 7



SEX DETERMINATION

GIANT ATLANTIC BLUEFIN TUNA



*SPENT OR UNRIPE GIANT TUNA:
The ovary or testis on each side is about 2-ft (600-mm) long and $2\frac{1}{2}$-ins (60-mm) wide, and attached on the posterior part of a large mass of fatty tissue that is about $1\frac{1}{2}$ times as long and $2\frac{1}{2}$ to 3 times as wide as the gonad.

1. Gonads with connected fat mass of unripe female (above) and male (below).

2. Testis of male (from #1) cut away from the fat mass.

3. Testis cross-section (male from #1-2) with no median lumen and relatively smooth internal tissue.

4. Ovary cross-section (female from #1) with a large and irregular median lumen and slightly granular internal tissue.

*RIPE GIANT TUNA:
The ovary and testis on each side are much larger, with a relatively smaller fat mass than in spent or unripe giants and the lumen and grandular tissue of the ovary are more pronounced.

5. Ovary of a ripe female giant tuna.

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Southeast Fisheries Center
National Marine Fisheries Service
75 Virginia Beach Drive
Miami, Florida 33149 USA

SEFC TECH. SHEET NO. 2

FIGURE 8

MARLIN SKELETAL HARD PARTS

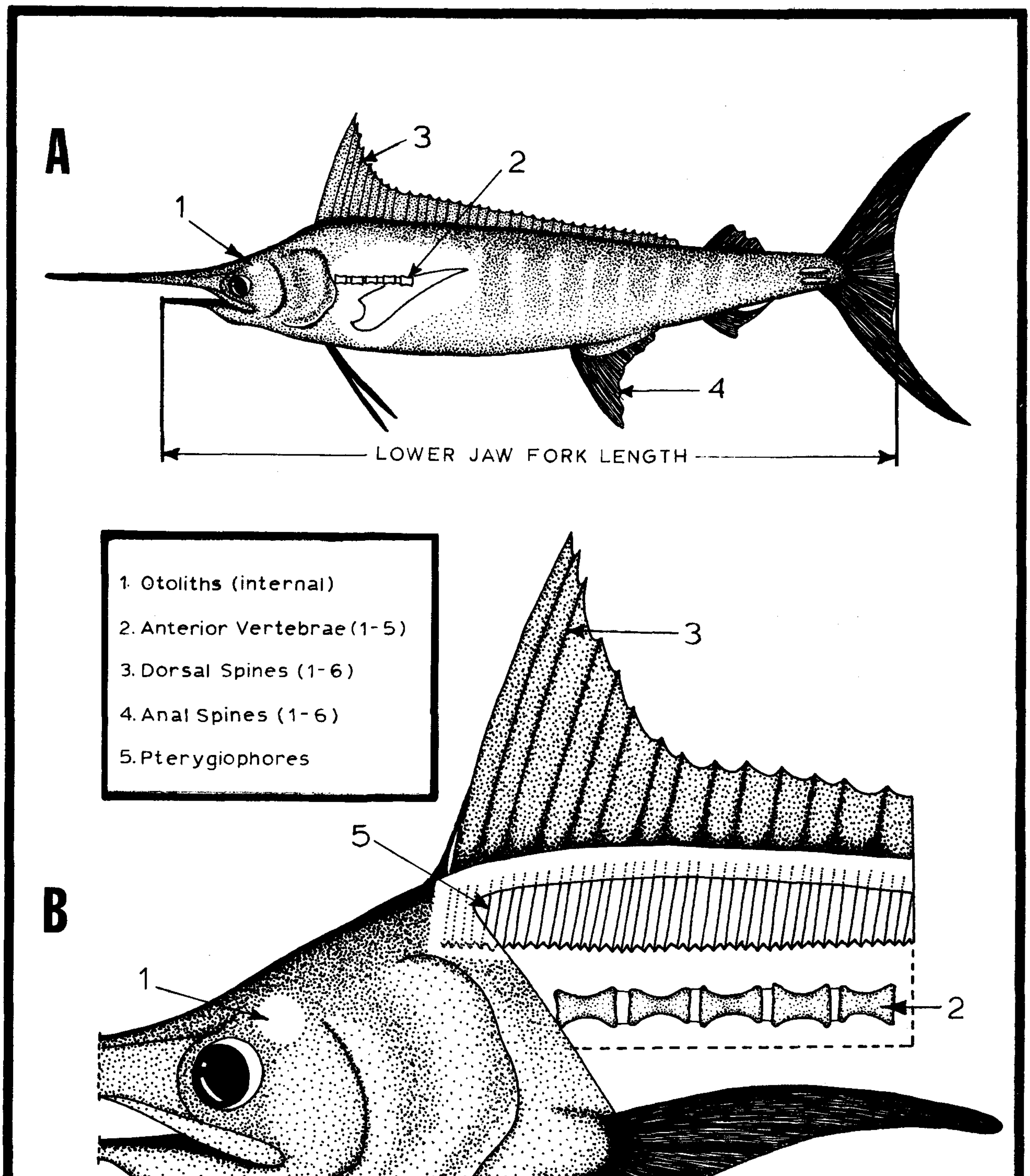

FIGURE 9

SEX DETERMINATION-MARLIN

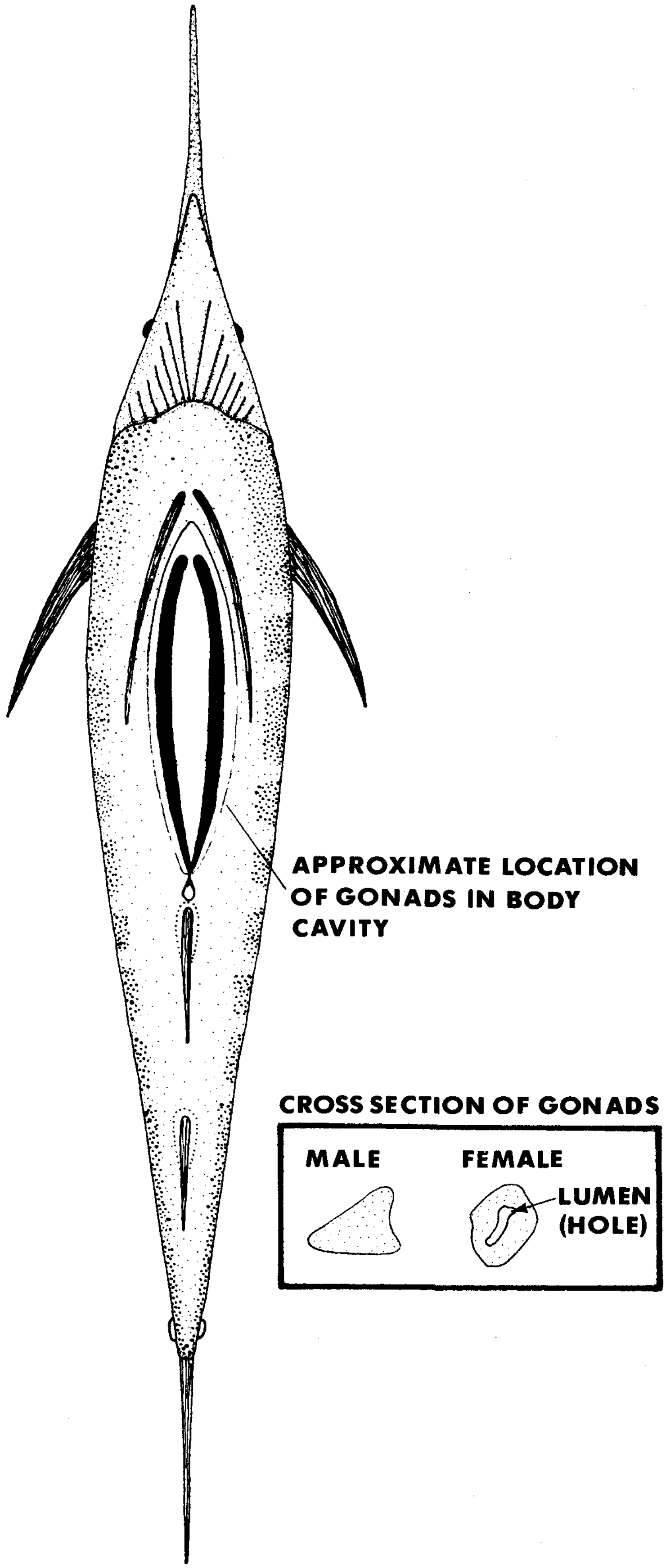

FIGURE 10

BIOPROFILES SAMPLING LOG--OCEANIC PELAGICS

Collection Number____Name of Sampler_______________

	Species	Length Unit		Weight Unit		Sex	Date Caught	Location	Parts Saved					
									Gonads	Vert.	Spines	Oper.	Head	Scales
1.														
2.														
3.														
4.														
5.														
6.														
7.														
8.														
9.														
10.														
11.														
12.														
13.														
14.														
15.														
16.														
17.														
18.														
19.														
20.														
21.														
22.														
23.														
24.														
25.														
26.														

Use "X" to indicate part(s) saved

Use consecutive numbers on additional sheets if necessary

Appendix **1.** Skeletal hardparts for target species - ocenic pelagics

Species	Operculum	Anterior Vertebrae	Caudal Vertebrae	Otoliths	Dorsal Spines	Anal Spines	Scales
Bluefin tuna			X	X			
Blackfin tuna	X	X	X	X	X	X	X
Blue marlin		X		X	X	X	
White marlin		X		X	X	X	