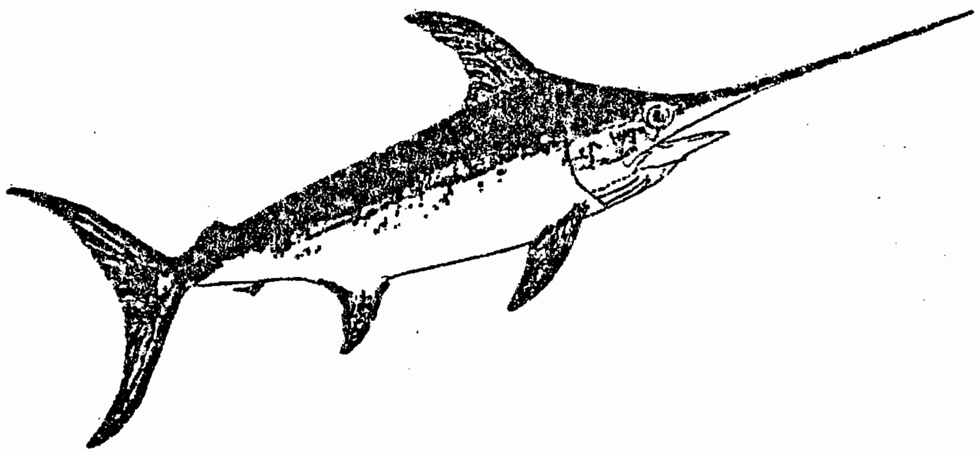
SOURCE DOCUMENT
FOR THE
SWORDFISH
FISHERY MANAGEMENT PLAN

FEBRUARY 1985



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SOURCE DOCUMENT
FOR THE
SWORDFISH FISHERY MANAGEMENT PLAN

PART I: ADDENDUM TO THE SOURCE DOCUMENT (FEBRUARY 1985)

PART II: SOURCE DOCUMENT (MAY 1982)

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Gulf of Mexico Fishery Management Council
Mid-Atlantic Fishery Management Council
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Without the data supplied by these individuals we would still be using recorded catch by month and would not have as detailed an understanding of the swordfish fishery as we now have.

PART I

ADDENDUM TO THE SOURCE DOCUMENT FOR THE SWORDFISH FISHERY MANAGEMENT PLAN

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8.1.2.1 Reproduction

Wilson and Dean (1983) report that males become reproductively active between year 2 (LJFL*=114 cm, dressed weight=12.7 kg; 28 lb) and year 3 (LJFL=126 cm, dressed weight=17 kg; 37.5 lb) with all observed males greater than 3 years old reported as mature. Females become reproductively active between years 4 (LJFL=135 cm, dressed weight=21 kg; 46 lb) and 5 (LJFL=151 cm, dressed weight=28.8 kg; 63.4 lb). These estimates indicate that both males and females reach reproductive maturity at smaller sizes than reported by Berkeley and Houde (1981).

In the South Carolina sample (catches from Jacksonville, FL to Cape Lookout, NC; Wilson and Dean, 1983) all mature fish showed evidence of recent sexual activity or were ripe. Of 109 swordfish captured north of Cape Hatteras (47 males:62 females) none were ripe or showed evidence of sexual activity (C. Stillwell, NMFS, Narragansett, RI; pers. comm.). Beckett (1974) also reports that the vast majority of gonads from fish captured north of Cape Hatteras (35° N Latitude) have been in an inactive or recovery stage. He reports that ripening ovaries have been rarely reported, numbering only 1 or 2 per year.

Wilson and Dean (1983) estimated fecundity for several females with values ranging from 1×10^6 to 2.6×10^7 eggs ready for release. The highest egg estimate was 29×10^6 eggs from a 272 kg (600 lb) female (round weight). Wilson (U.S.C. Baruch Institute, Columbia, SC; pers. comm.) considers females to be continuous pulse spawners with spawning activity occurring primarily during March and April but possibly as late as October. This extended spawning season agrees with Grall et al.'s (1983) observation that swordfish larvae were present in all months.

8.1.2.2 Age and Growth

Wilson and Dean (1983) examined swordfish otoliths to disclose age-associated features. They observed daily growth increments and determined the ages of 210 swordfish. Daily growth increments formed areas characterized as "rapid-growth zones" and "slow-growth zones." These zones were differentiated as translucent or opaque with transmitted light and the number

*LJFL = lower jaw to fork length.

of opaque zones were assumed to correspond to age assuming annual formation of opaque zones during December-February which agrees with annulus formation in spines of swordfish (Berkeley and Houde, 1983) and in sailfish (Jolley, 1977). Age estimates ranged from 5 days to 21 years. The smallest individuals examined and the number of daily increments are as follows:

LJFL (cm)	LJFL (in)	Number of Increments (days)
0.82	0.32	5
2.00	0.79	11
25.50	10.04	53

Estimated growth rates of larval fish indicated very rapid growth rates throughout the first six months (2-6 mm/day; 0.08-0.24 in/day). The following whole weight values are compared with the number of daily increments observed:

Whole Weight (kg)	Whole Weight (lb)	Number of Increments (days)
4.5	10	185
6.4	14	170
7.3	16	180
8.2	18	210

Swordfish less than 9.1 kg (20 lb) round weight (6.8 kg dressed weight; 15 lb) are approximately 6 or 7 months old.

Wilson and Dean (1983) compared their age estimates (based on otoliths) to age estimates from anal spines from the same fish (Berkeley's method). They found no significant differences in the counts (age estimates) for fish less than 6 years old. Age estimates based on spines from older fish, however, gave statistically lower estimates than those based on otoliths. Beyond year class 3, mean lengths at age based on otoliths were less than those based on spines. Wilson, Dean, and Berkeley (pers. comm.) agree that Berkeley's methodology may underestimate age in older fish (age 8) because increasing calcification near the focus obscures inner annulae. Wilson and Dean's (1983) age estimates ranged from 1 to 14 years for males and 2 to 21 years for females. Eighty-five percent of fish beyond 11 years were female, suggesting as Berkeley and Houde (1981) did, that females live longer. A major difference between this more recent study and those conducted by Berkeley and Houde (1980, 1981) was that Wilson and Dean found no significant difference between the growth rates of males and females. They believe that males are subject to differential mortality and die at an earlier age than females. It is important to note, however, that males enter the reproductive stage of their lives at a smaller size and younger age than females. Results from Wilson and Dean's study are compared to Berkeley and Houde's results in Table 1. In comparing these results, Wilson and Dean (1983) suggest that the most important points to consider are that swordfish grow old and that "whether a 200 cm (78.7 in) fish was 8 or 10 years old was not as important as knowing that a 200 cm fish was of middle age which, based on existing data, had been potentially reproductively active for 4 to 6 years."

Based on 1983 weight frequency data from South Carolina (S.C. Wildlife and Marine Resources), 54 percent of the commercial harvest consists of swordfish less than or equal to 18.1 kg (40 lb) dressed weight. In the area north of 35° N, based on a sample of 10,232 carcass weights, 23 percent are less than or equal to 18.1 kg (40 lb) dressed weight. The comparable value for Florida east coast landings (catches from Florida Keys to Cape Canaveral, Florida) based on 17,481 carcass weights is 33 percent. These proportions consist of pre-reproductive females and males some of which may have been reproductively active for the first time. Two and three year old fish predominate in the commercial harvest.

Wilson and Dean's (U.S.C. Baruch Institute, Columbia, SC; pers. comm.) von Bertalanffy parameters for males and females combined are as follows: L_{oo} = 277 cm (109.1 in), K = 0.13, and t_o = -2.83. Berkeley and Houde's (1981) parameter estimates were L_{oo} = 297 cm (116.9 in), K = 0.1054, and t_o = -2.87. A comparison of the parameter estimates from both studies is presented in Table 2. Although parameter estimates for K and t_o appear similar, the estimates for L_{oo} differ by 20 cm (7.9 in). The estimation of L_{oo} in both studies may be influenced by the size range of sampled swordfish, which may also influence the length-weight regressions. In Figure 1, predicted round weight of swordfish is plotted against lengths from 4 different length-weight regressions. Wilson and Dean's (1983) predicted regression line does not correspond well to the other 3 lines producing lower weights at lengths greater than 150 cm (59.1 in) LJFL. The other 3 lines are more similar despite differences in the areas from which the samples were obtained. Whereas Berkeley and Houde's (1980) sample is based on Florida east coast landings, the NMFS-Narragansett regression (Jack Casey, NMFS,

Table 1. Comparison of age and growth results based on otoliths (Wilson and Dean, 1983) and anal spines (Berkeley and Houde, 1981).

Age & Growth - Males and Females Combined

	Wilson and Dean (1983)			Berkeley & Houde (1981)	Wilson and Dean (1983)	Berkeley and Houde (1981)
Estimated Age	Lower Jaw Fork Length	Estimated Round Weight (lb)	Estimated Dressed Weight (lb)	Estimated Dressed Weight (lb)	Dressed Weight Groups (lb)	Dressed Weight Groups (lb)
1	75	11.1	8.3	18.1	18	18
2	114	37.4	28.0	34.2	19-33	19-34
3	126	50.0	37.5	54.0	34-42	35-53
4	135	61,0	46.0	75.2	43-55	54-75
5	151	84.5	63.4	101.0	56-68	76-101
6	158	96.4	72.3	126.0	69-81	102-126
7	170	119.2	89.4	153.0	82-93	127-153
8	180	140.7	106.0	180.0	99-113	154-180
9	188	159.6	119.7		114-139	
10	207	211.0	158.3		140-168	
11	215	236.0	177.0		169-187	
12	223	262.0	196.5		188-237	
13	251	369.0	277.0		238-300	

Table 2. Comparative YPR parameters from two sources.

	BERKELEY & HOUDE (1980, 1981)			WILSON & DEAN (pers.comm.)		
	male	female	combined*** sexes	male	female	combined**** sexes
L_{oo}	217	340	297	155	291	277
t_o	-2.04	-2.59	-2.87	0.42	-3.20	-2.83
K	0.195	0.095	0.1054	0.66	0.10	0.13
b_o			$2.94X10^{-6}$			$1.83X10^{-5}$
b_1			3.2828			2.901
M	0.27	0.14	0.16			0.185*
L'**			130.0 cm			variable (computer run)
$\bar{L}$**			68.0 kg			variable (computer run)
F	0.17	0.19	0.24			
Z			0.40			

$l_t = L_{oo}\ 1 - e^{-K(t-to)}$

$l_t = 297\ 1 - e^{-.1054(t+2.87)}$

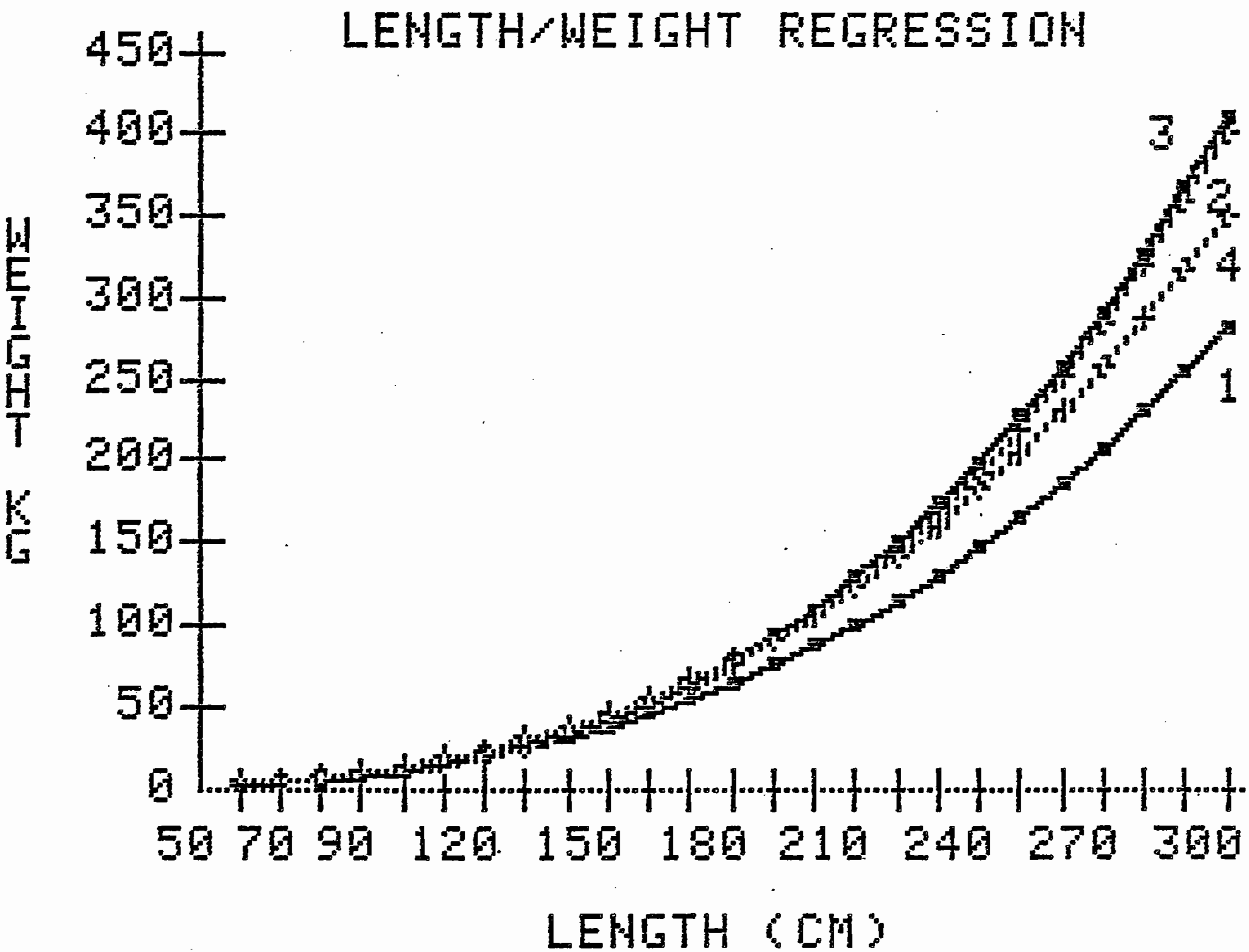
$Wt = .0000026\ l_t^{3.2828}$

*Calculated by John Hoey based on Wilson and Dean's (pers. comm.) K = 0.13 substituted into the equation used by Berkeley and Houde.

**Length and also corresponding weight

***Based on a hypothetical sex ratio of 1:1 at all ages.

****Based on the sex ratio in the sample.



1) WILSON AND DEAN (1983) - S.C.
2) BERKELEY AND HOUDE (1980) - FL.
3) GARCES AND REY (1983) - ICCAT
4) JACK CASEY, NMFS NARR., UNPUBL. DATA

Figure 1. Length-weight regressions for swordfish landed in the western North Atlantic.

Narragansett, RI; unpubl. data) is based on landings north of Cape Hatteras. Both of these western North Atlantic regressions compare favorably with the ICCAT regression from an eastern North Atlantic sample from the Spanish fishery (Garces and Rey, 1983). We believe that Wilson and Dean's (1983) regression (based on a South Carolina sample) predicts lower weights because the sample did not include some of the very large swordfish which are more common in samples from Florida and the area north of Cape Hatteras. This highlights the critical nature of the size ranges represented in the different samples. This is especially important when different L_{oo} values must be evaluated because they are used directly in mortality estimates. Zweifel and Slater (1982) emphasize this consideration and further point out that the von Bertalanffy model produces L_{oo} values which are higher than those produced by the Gompertz (Ricklefs, 1967) growth equation. Utilizing Berkeley and Houde's (1981) data, Zweifel and Slater (1982) state that the female L_{oo} of 339 cm (133.5 in) predicted by the von Bertalanffy model is too large. Based on the Gompertz equation, Zweifel and Slater (1982) derive an L_{oo} of 262.6 cm (103.4 in) for females, which they maintain compares favorably with a length of 236 cm (92.9 in) corresponding to a largest fish weight of 181.4 kg (400 lb). This female L_{oo} (263 cm) is very close to Wilson and Dean's (USC Baruch Institute, Columbia, SC; pers. comm.) L_{oo} (277 cm; 109.1 in) for males and females combined. L_{oo} values for males and females combined are intermediate between L_{oo} values for females only and males only. This would lead us to believe that the Gompertz equation would predict an L_{oo} for males and females combined lower than that predicted by Wilson and Dean (probably less than 240 cm; 94.5 in). We believe that Wilson and Dean's L_{oo} value of 277 cm is low because the South Carolina sample does not adequately reflect the larger fish in the population which are more common along the Florida east coast and in the area north of Cape Hatteras. Zweifel and Slater (1982) raise valid concerns about the different values produced by the Gompertz versus the von Bertalanffy models. We feel however that their Gompertz L_{oo} value (262 cm) is also too low based on reported capture weights of swordfish in the western North Atlantic. By way of explanation, a 262 cm (103.1 in) swordfish would weigh approximately 257 kg (567 lb based on Berkeley and Houde's regression which would yield a dressed carcass weight of 192.8 kg (425 lb). In 1979, 38 out of 7,985 (0.5 percent) swordfish landed along the east coast of Florida, exceeded 181.4 kg (400 lb) dressed weight. In 1980, 77 out of 14,837 (0.5 percent) exceeded 181.4 kg (400 lb) dressed weight. Maximum dressed carcass weights reported in landings data from different areas in the western North Atlantic are listed in Table 3. Therefore fish exceeding the dressed weight corresponding to Zweifel and Slater's (1982) L_{oo} are captured in the fishery. If L_{oo} represents the length that an average swordfish would achieve if it continues to live and grow indefinitely (Ricker, 1975 - p 221 citing Fabens, 1965), maximum sizes recorded in the landings data and published literature should be considered when L_{oo} estimates are evaluated. The maximum dressed carcass weight in S.C. landings (1981 -393.7 kg; 868 lb) is double Zweifel and Slater's (1982) predicted dressed carcass weight corresponding to L_{oo}. The IGFA all tackle record for swordfish is 536 kg (1,182 lb) or approximately 402 kg (886 lb) dressed (Pacific Ocean). Beckett (1974) reports a swordfish landed in Cape Breton, Nova Scotia which weighed 415.0 kg (915 lb) dressed, approximately 550 kg (1,213 lb) round weight. Both of these maximum values are also double the size corresponding to Zweifel and Slater's (1982)L_{oo}.

In subsequent calculations we have chosen an L_{oo} for males and females combined of 297 cm (116.9 in). Rounding this value to 300 cm (118.1 in) would produce round weights of between 350 - 400 kg (771.6 -881.8 lb) (based on the particular length-weight regression used, Berkeley & Houde or NMFS-NARR) which would correspond to dressed weights of between 262.2 and 299.8 kg (578 and 661 lb). We feel that this range is more realistic for L_{oo} based on the rather frequent occurrence of dressed weights exceeding 181.4 kg (400 lb) (Zweifel & Slater's L_{oo}) and maximum sizes which exceed 362.9 kg (800 lb) dressed weight.

8.1.2.3 Mortality

The reliability of mortality estimates derived from any of the available procedures (Beverton & Holt, 1956; Robson and Chapman, 1961; Ssentongo & Larkin, 1973; Pauly, 1980) is critically dependent on the choice of the numerical input values for L_{oo}, $\bar{L}$, L' , and K. As noted in the previous section, there are a number of choices for L_{oo} alone. We believe that L_{oo} = 297 cm (116.9 in) for males and females combined represents a reasonable choice. Of the remaining values ($\bar{L}$, L', and K) the choice of L' is very important because it then establishes the value of $\bar{L}$. Once these values are chosen different values of K can be easily compared. L' represents the length of the smallest fish fully represented in the sample while $\bar{L}$ represents

Table 3. Maximum dressed carcass weights reported in landings data from different areas in the western North Atlantic.

Year	Canada[1] kg	Canada[1] lb	Florida East Coast[2] kg	Florida East Coast[2] lb	South Carolina[3] kg	South Carolina[3] lb	North of North Carolina[4] kg	North of North Carolina[4] lb
1959	260.8	575						
1960	215.5	475						
1961	226.8	500						
1962	238.1	525						
1963	294.8	650						
1964	215.5	475						
1965	272.2	600						
1966	351.5	775						
1967	340.2	750						
1978					193.7	427		
1979			238.1	525	196.0	432		
1980			265.4	585	256.3	565	261.3	576
1981					393.7	868		
1982					264.0	582		
1983			297.6	656	272.6	601	240.4	530

1. Beckett and Tibbo (1968)
2. Data volunteered by dealers
3. Data from the Division of Marine Resources, South Carolina Wildlife and Marines Resources Department
4. Data volunteered by dealers and individual vessel operators

the average length of fish caught greater than L'. L' and $\bar{L}$ measurements refer to lower jaw fork length (LJFL) in cm. In practice L' is usually chosen based on the modal size from either length or weight histograms. Berkeley and Houde (1981) specified L' = 130 cm (51.2 in) for males and females combined. This length corresponds to a round weight of approximately 25.6 kg (56.4 lb) or a dressed carcass weight of 19.1 kg (42 lb). We note however that the mode of the 10 lb weight frequencies for Florida east coast landings for 1979 (N = 7,985) and 1980 (N = 14,837) occurs in the 31-40 lb group. Whereas the 31-40 lb group represented the mode in the 1979 South Carolina landings, in 1980 the 41-50 lb group was the mode. In a sample of 15,358 swordfish landed north of 35° N in 1980, the 21-30 lb group represented the mode. We believe that for the years 1979 and 1980 the L' was in all likelihood between 120 cm and 130 cm (47.2-51.2 in) corresponding either to the 31-40 or 41-50 lb dressed weight groups. We note, however, that based on 1983 landings data from South Carolina (N= 12,229) the mode has decreased to the 21-30 lb dressed weight group. That group also represents the mode in a sample of 10,232 swordfish landed north of 35° N in 1983, and in a sample of 17,481 swordfish landed along Florida's east coast in 1983. This implies a decrease in the age liable to capture from 1979-80 to 1983 which may have resulted from increased effort on small fish or a change in gear or fishing strategy which has increased the vulnerability of smaller fish. Based on conversations with commercial fishermen and equipment dealers, the size and type of hooks used has changed from large mustad shark hooks to large (#42 or #40) and then progressively to smaller (#38 or #36) Japanese style hooks. Increased competition and congestion on the longline grounds now forces many operators to fish in less than optimal areas where they report increased catches of the less desirable, smaller fish. This decrease in age liable to capture could also reflect the occurrence of a dominant year class. In either case, if we assume swordfish in the 21-30 lb weight group are fully represented in the sample, L' for 1983 is between 101 cm (39.8 in; dressed weight 20 lb) and 116 cm (45.7 in; dressed weight 30 lb). Caddy (1976) suggested a size at first capture for the longline fishery of 80 cm (31.5 in). In subsequent calculations we have chosen to calculate mortality rates for three different L' values corresponding to 100 cm (39.4 in; dressed weight = 20 lb), 116 cm (45.7 in; dressed weight = 30 lb), and 130 cm (51.2 in; dressed weight = 42 lb). Corresponding $\bar{L}$ will then reflect the average lengths of all fish greater than 20 lb, greater than 30 lb, and greater than 40 lb. Calculations will also use Berkeley and Houde's (1981) K = 0.1054 and Wilson and Dean's (USC Baruch Institute, Columbia, SC; pers. comm.) K = 0.13. Calculations will utilize frequency distributions for 1980 and 1983 from different areas. In all cases L_{∞} = 297 cm (116.9 in). L' values (LJFL-cm) correspond to weight groups for the 21-30, 31-40, and 41-50 lb increments. $\bar{L}$ values are derived by calculating the average weight of all swordfish carcasses greater than 20 lb, greater than 30 lb, and greater than 40 lb. That average weight value is then converted to whole weight (dressed weight X 1.333) and the length corresponding to that weight ($\bar{L}$) is determined from Berkeley and Houde's length-weight regression. Z values derived from calculations based on the different input parameters (L', $\bar{L}$, K) previously described are listed in Table 4.

Berkeley and Houde (1981) estimated natural mortality rates (M) based on Pauly's (1980) relationship between natural mortality, growth parameters and mean environmental temperature. Utilizing a mean environmental temperature of 15°C and K = 0.1054 they estimated M = 0.16 for both sexes combined. We used that same relationship but substituted Wilson and Dean's (pers. comm.) K = 0.13 and a mean environmental temperature of 20 °C (Hoey and Casey, 1983a) to derive estimates of M which ranged between 0.17 and 0.20.

8.1.3 Ecological Relationships

8.1.3.1 Larval Ecology

8.1.3.2 Food-Chain Relationships

Stillwell and Kohler (1983) analyzed stomach contents of 182 swordfish (162 contained food - 89 percent) caught from off Cape Hatteras, North Carolina to the Tail of the Grand Banks of Newfoundland. Cephalopods (squids) were the dominant food item (82 percent by frequency of occurrence) followed by fish (53 percent) consisting primarily of gadids, scombrids, butterfish, bluefish and sand lance. Table 5 (from Stillwell and Kohler, 1983) lists the families and species of prey represented in the stomach samples and it documents the considerable diversity in the swordfish diet which includes near surface, demersal, and mesopelagic species. Cephalopod dominance was not documented in earlier reports from the same general area (Goode, 1883; Rich, 1947; Bigelow and Schroeder, 1953; Tibbo et al., 1961; Scott and Tibbo, 1968; Beckett, 1974). Although these studies represent a mix of qualitative

Table 4. Input parameters (L', $\bar{L}$, L_{∞}, K) and derived mortality rates (Z values*) for 1980 and 1983 samples from the east coast of Florida, South Carolina, and ports located north of 35° N.

REGION	YEAR	NUMBER OF CARCASSES	L_{∞}(cm)	K	L'(cm)	$\bar{L}$(cm)	Z
FLORIDA EAST COAST	1980	14,837	297	.13	100	168	.2466
					116	171	.2978
					130	177	.3319
				.1054	100	168	.2000
					116	171	.2415
					130	177	.2691
	1983	17,737	297	.13	100	166	.2580
					116	172	.2902
					130	177	.3319
				.1054	100	166	.2092
					116	172	.2353
					130	177	.2691
SOUTH CAROLINA	1980	3,598	297	.13	100	156	.3273
					116	158	.4302
					130	165	.4903
				.1054	100	156	.2654
					116	158	.3488
					130	165	.3975
	1983	12,229	297	.13	100	154	.3443
					116	163	.3706
					130	174	.3634
				.1054	100	154	.2791
					116	163	.3005
					130	174	.2946
NORTH OF 35°N	1980	15,358	297	.13	100	165	.2640
					116	169	.3140
					130	173	.3749
				.1054	100	165	.2140
					116	169	.2546
					130	173	.3039
	1983	9,172	297	.13	100	168	.2466
					116	172	.2902
					130	177	.3319
				.1054	100	168	.2000
					116	172	.2353
					130	177	.2691

*The coefficient of mortality, Z, was derived from Beverton and Holt's (1956) formula:

$$Z = \frac{K(L\infty - \bar{L})}{\bar{L} - L'}$$

Table 5. List of prey species or family groups occurring in 182 swordfish stomachs from the western North Atlantic (1975-81) by number, volume, and frequency of occurrence. (Source: Stillwell and Kohler, 1983.)

	Number	% No.	Vol. (ml)	% Vol.	Frequency	% Frequency
Cephalopoda						
Ommastrephidae	626	27.95	24,422	20.70	52	28.57
Illex illecebrosus (short-finned squid)	665	29.69	30,036	25.46	48	26.37
Gonatidae	13	0.58	12	0.01	5	2.75
Octopoteuthidae	19	0.85	301	0.26	4	2.20
Histioteuthidae	3	0.13	7	0.01	3	1.65
Onychoteuthidae	30	1.34	163	0.14	2	1.10
Sepiolidae	9	0.40	2	0.00	2	1.10
Octopoda	3	0.13	2	0.00	2	1.10
Loligo pealei (long-finned squid)	3	0.13	60	0.05	1	0.55
Thysanoteuthidae	4	0.18	1	0.00	1	0.55
Chiroteuthidae	2	0.09	1	0.00	1	0.55
Architeuthidae	1	0.04	1	0.00	1	0.55
Unidentified Cephalopoda	467	20.85	24,423	20.70	56	30.77
Teleosts						
Merluccius bilinearis (silver hake)	72	3.21	11,126	9.43	11	6.04
Scomber scombrus (Atlantic mackerel)	25	1.12	6,385	5.41	9	4.94
Gadidae (codfishes)	16	0.71	3,090	2.62	6	3.30
Pomatomus saltatrix (bluefish)	10	0.45	4,735	4.01	5	2.75
Ammodytes americanus (sand lance)	18	0.80	195	0.16	5	2.75
Peprilus triacanthus (butterfish)	55	2.46	1,800	1.53	3	1.65
Cubiceps athenae (bigeye cigarfish)	6	0.27	750	0.64	3	1.65
Gempylidae (snake mackerels)	10	0.45	234	0.20	3	1.65
Stromateidae (butterfishes)	5	0.22	65	0.06	3	1.65
Myctophidae (lanternfishes)	4	0.18	18	0.02	3	1.65
Alepisauridae (lancetfishes)	2	0.09	615	0.52	2	1.10
Brevoortia tyrannus (Atlantic menhaden)	2	0.09	574	0.49	2	1.10
Paralepis atlantica (duckbill barracudina)	4	0.18	310	0.26	2	1.10
Scopelosauridae	4	0.18	51	0.04	2	1.10
Nemichthys scolopaceus (snipe eel)	4	0.18	20	0.02	2	1.10
Sebastes marinus (redfish)	8	0.36	2,775	2.35	1	0.55
Scorpaenidae (scorpionfishes)	1	0.04	400	0.34	1	0.55
Clupea harangus (Atlantic herring)	1	0.04	200	0.17	1	0.55
Hyperoglyphe perciformis (barrelfish)	1	0.04	95	0.08	1	0.55
Cottidae (sculpins)	1	0.04	15	0.01	1	0.55
Unidentified teleosts	123	5.49	4,914	4.16	41	22.53
Miscellaneous						
Animal remains	2	0.09	190	0.16	2	1.10
Salpidae	4	0.18	1	0.00	1	0.55
Nematoda	17	0.76	1	0.00	1	0.55
Total	2,240		117,990			

and quantitative studies, they generally reported a higher utilization of various fish species. Toll and Hess (1981) report a similar cephalopod dominance in the stomachs of swordfish sampled in the Florida Straits. Stillwell and Kohler (1983) hypothesize that the current dietary importance of cephalopods reflects their steadily increasing abundance (Illex sp. in particular) along the continental margin from Cape Hatteras to the Gulf of Maine. Lange (1982) has documented an increase in estimated biomass of Illex sp. from 1,845 to 68,611 metric tons between 1968 and 1981. Within the teleost category, the silver hake (Merluccius bilinearis) provided the largest single species component. Stillwell and Kohler (1983) report an overall average food volume of 648 milliliters corresponding to approximately 1.1 percent of the average body weight (58 kg; 127.9 lb). Daily ration was estimated to range from 0.585 kg (1.0 percent body weight) to 0.993 kg (1.7 percent body weight) with yearly food consumption ranging from 214 to 363 kg (471.8 -800.3 lb).

Examinations of stomach contents revealed that swordfish engulfed whole food items, as well as slashed and maimed a variety of prey types before ingesting them. Approximately 25-30 percent of the squid with mantle lengths of 7-25 cm (2.8 - 9.8 in) that were found in the stomachs were decapitated or showed slash marks across the mantle. Lancetfish, redfish, and many mesopelagics were either cut in two or had been slashed (Stillwell and Kohler, 1983).

8.1.3.3 Predator-Prey Relationships

Recent studies have increased our understanding of intraspecific and interspecific relationships of swordfish. Intraspecific relationships of swordfish were investigated by Hoey and Casey (1983a) through the analysis of spatial statistics for four size groups of swordfish: very small less than 9 kg (19.8 lb); small 9.1 - 33.6 kg (20.1 - 74.1 lb); medium 34-68 kg (75.0 - 149.9 lb); and large greater than 68 kg (> 149.9 lb). Results document size stratification on the longline grounds with distinct central moments for each size group. Central moments are the average location parameters (latitude and longitude) for the different size groups of swordfish caught in each season. They are calculated by weighting each latitude and longitude by the numbers of swordfish in each group. In all seasons, the central moment of the largest size group occurs further north and east of the central moments of the smaller size groups. These results should not be interpreted as indicating complete size segregation but only a strong tendency within the population for larger fish to predominate in colder water. In terms of fishing practices, these results and additional analyses of swordfish catches correlated with surface water temperature data indicate that fishermen could probably reduce the proportion of small swordfish caught through focusing effort in the coldest water available. The mean weight of 7,181 swordfish caught where surface temperatures were below 20°C was 52 kg (114.6 lb) and only 26.3 percent were less than 34 kg (75.0 lb). The mean weight of 4,784 swordfish caught where surface temperatures were above 20°C was 34 kg and 61 percent were less than 34 kg (Hoey and Casey, 1983a).

In terms of interspecific relations, similarities in temporal and spatial distribution patterns between swordfish and other species susceptible to pelagic longline gear were analyzed by forming recurrent species groups based on abundance correlation values (Hoey, 1983). Swordfish were closely associated with blue and mako sharks in areas north of Cape Hatteras, and with hammerhead and blacktip sharks in the Gulf of Mexico and Atlantic south of Cape Hatteras. Associated species which share similar ecological preferences and distribution patterns, naturally compete for available food resources and may prey upon one another. Competition for food may not be important in a limiting sense because of the dietary diversity and opportunistic feeding habits of these large predators (swordfish, tuna, sharks, billfish). The Swordfish Source Document (SAFMC, 1982) notes that larval and juvenile swordfish are preyed upon by competing species and larger swordfish. Stillwell and Kohler (1983) cite several previous reports on mako shark feeding habits, which document the occurrence of large volumes of swordfish flesh in the stomachs of makos. In their study, two stomachs from the largest makos examined contained swordfish remains. Twenty six kilograms (57.3 lb) of swordfish were found in the stomach of a 158 kg (348.3 lb) mako.

8.1.3.4 Movement Patterns

8.1.3.4.1 Horizontal and Vertical Movements

An analysis of spatial statistics for 4 size groups of swordfish (Hoey and Casey, 1983a), revealed seasonal shifts in the central moments of each group consistent with a dominant north-south component to the annual migrations. Hoey and Casey (1983a) report that New England longline effort concentrates along the edge of the shelf and along frontal zones between water masses. Previous reports document this effort distribution pattern throughout the range of the U.S. swordfish fishery. Assuming that the prevalent effort distribution pattern reflects economic forces which have sought maximization of catch rates, then swordfish are apparently restricted to a rather narrow horizontal zone.

Dr. Frank Carey (Woods Hole Oceanographic Institute) has continued his sonic tracking work with swordfish (Carey and Robison, 1981). Subsequent experiments have shown that vertical movements of swordfish tagged in oceanic waters near the edge of the continental shelf appear to correspond to vertical movements of the deep scattering layer. Vertical movements of swordfish tagged beyond the edge of the shelf appear to be related to light intensity (Casey et al., 1982).

8.1.3.4.2 Migrations

As previously mentioned, analysis of spatial statistics revealed seasonal shifts in the central moments for the different size groups of swordfish which were consistent with a dominant south-north migration (Hoey and Casey, 1983a). The central moments for the largest size group (swordfish greater than 68 kg; 149.9 lb) occurred further north and east of the central moments for the smaller size groups in all seasons. Central moments for all groups are located the furthest south during the winter season and the furthest north during the summer season. This north-south migration would typify a response to seasonal warming of the surface waters. The apparent rate of movement of the central moments ranged between 5.3 and 18.3 km/day (3.3 -11.4 mi/day) with an overall average of 12.6 km/day (7.8 mi/day). The apparent rate of movement can be used as an index of relative speed along the dominant migration axis. It indicates the rate of progression of the population rather than the speed of an individual involved in its normal activity. The calculated values were well within the swimming speed values presented by Carey and Robison (1981).

The preceding should not be interpreted as indicating that the whole population participates in long range migrations. Some elements of the population occur year-round in specific areas. Different age groups in the population may migrate differently as has been noted for tuna (Nakamura, 1969). Large female swordfish participate in a reproductive migration predominantly along a north-south axis either along the Gulf Stream or further offshore, presumably seeking water optimal for larval survival.

Young swordfish are limited in their ability to travel because of their small size, and migrate relatively short distances (again, along a north-south axis) in response to temperature and feeding preferences. Intermediate sized fish (males and females) are capable of longer migrations, motivated primarily by the search for food on either a north-south or inshore-offshore axis. Intermediate sized fish may overwinter in the Gulf Stream or along its northern boundary and move onto the shelf as seasonal warming occurs, agreeing with the idea of hypothetical local "races" or "sub-stocks" as described by Caddy (1976). It may be more appropriate to consider these groups "changing resident populations," thereby avoiding the genetic basis of "races" and "sub-stocks" which cannot be substantiated at this time. The inshore-offshore pattern in response to seasonal warming would account for seasonal changes in availability to the commercial fishery, which concentrates along the edge of the shelf. The preceding is consistent with the generalization that temperature sets limits of total species range, and food supply determines distribution within the range limits (Blackburn, 1969).

8.1.4 Stock Definition

Hoey and Casey (1983a) noted a continuous distribution of swordfish from Cape Hatteras to the Tail of the Grand Banks during the summer. They examined capture locations for over 25,000 swordfish and compared their data to data from the Florida fishery. They maintained that there was no evidence to indicate any stock breaks between the Gulf of Mexico and the entire east coast of the U.S. and Canada. In terms of the Atlantic Ocean, the recent NMFS stock assessment workshop (Powers, 1982) still recognized the three distinct seasonal concentrations (described in the May 1982 Swordfish Source Document) which suggest three populations in the Atlantic Ocean. Clear-cut dividing lines between the seasonal concentrations of swordfish were not apparent. The widespread distribution of swordfish throughout the Atlantic Ocean, and the lack of any clear divisions between the presumed populations, implies the possibility of considerable interchange between these groups. Despite large active fisheries in the western and eastern North Atlantic, there have been no trans-Atlantic tag recaptures for swordfish. There have been a number of trans-Atlantic recaptures reported for blue sharks and two trans-Atlantic blue marlin recaptures have also been documented. This would add credibility to the assumption of a distinct stock of swordfish in the western North Atlantic. The NMFS stock assessment workshop (Powers, 1982) has recommended that various stock structure hypotheses be examined in conjunction with all stock assessment work on swordfish. The similarities between the length-weight regressions from the western and eastern North Atlantic probably reflect similarities in genetically constrained growth patterns. These similarities should not be used at this time to substantiate a single North Atlantic stock.

8.1.5 Abundance, Historical Fluctuations, and Present Condition

The Canadian fishery reopened once the U.S. mercury restrictions were relaxed in 1978. The Canadian fishery operates under both a quota restriction (3,500 tons; 7 million lb) and an effort restriction (only 65 vessels). Based on data provided by F. Gregory Peacock (Fisheries Operations Branch, Canadian Department of Fisheries and Oceans, Halifax, Nova Scotia; pers. comm.) the following estimates can be derived. In 1981, Canadian effort of approximately 1.1 million hooks produced 1.3 million kg (2.9 million lb) of swordfish. In 1982, approximately 2.4 million hooks produced 2.7 million kg (6.0 million lb), while in 1983, 2.4 million hooks produced 2.2 million kg (4.9 million lb) of swordfish. Estimates of the total Canadian harvest for 1981 ranged from 1.3 to 1.8 million kg (2.9-3.9 million lb), for 1982 estimates ranged from 2.1 to 2.8 million kg (4.6-6.2 million lb), and for 1983 the point estimate was 2.2 million kg (4.9 million lb). These estimates were derived from expanding 1981 and 1982 logbook records from landings data from a 15-20 percent sample of the Canadian fleet. The 1983 estimates were based on records from a 25 percent sample. In terms of catch rates, measured as both kg landed per day and kg landed per 100 hooks, values for 1981 were the highest and they progressively declined through 1983. Individual set records from Canadian log books for 1982 and 1983 (June-September) indicate that mean size and mean pounds caught per 100 hooks has also declined. The trans-shipment of Canadian caught swordfish carcasses at sea to U.S. vessels to circumvent FDA mercury restrictions is a continuing problem which would bias some of the Canadian and U.S. data. Because this practice is almost impossible to control, Canadian and U.S. data, especially weight frequency information, should be combined to get a more accurate portrayal of the swordfish fishery north of Cape Hatteras.

Hoey and Casey (1983a) analyzed catch and effort data from 1,588 sets of New England style swordfish gear from 1963 through 1982. Effort exceeded 1.8 million hooks and accounted for the capture of 25,914 swordfish and 61,748 sharks and other teleosts. These data compliment the data on New England longline effort presented in the May 1982 Swordfish Source Document Appendix B (approximately 500 sets). Most of the data were provided by a single captain who operated two different vessels. The authors realized that this limited the generality of conclusions which could be drawn about stock status; however, they felt that the records represented a continuous record of standard effort and could be used to investigate changes in relative abundance in the area exploited by the U.S. swordfish fishery, especially along the edge of the shelf north of Cape Hatteras. The extrapolation of these data to the entire stock must take into account the limited nature of this data set both in terms of area and the fact that these records are from one captain.

A second data set included the fisherman's estimated dressed weights of swordfish caught on each set, classified into 14 weight groups with both sexes combined. Dressed weights were recorded for 14,064 swordfish caught on 659 sets from 1970 through 1982. These data were used to examine size stratification on the longline grounds, regional and seasonal differences in mean size, and changes in mean size over time.

Catch per unit effort (CPUE), the number of fish caught per 100 hooks, was calculated for each individual set. Because of non-normal characteristics of the CPUE values, the individual set values for CPUE were rank-transformed (Conover and Iman, 1981) and nonparametric statistical procedures were used for CPUE comparisons.

Estimates of the total weight landed per set were obtained by multiplying the number of swordfish in each weight group by the central weight value, or class mark, of that group and then summing over all groups. Average weights by set, year and region, etc. were obtained by dividing the total estimated weight caught by the total number of swordfish in all groups. The average weight landed per hundred hooks (CPUE-WT) was calculated by dividing the estimated total weight landed for a set by the total hooks from that set and multiplying by 100. Individual set values for CPUE-WT were averaged to provide $\bar{X}$ CPUE-WT.

The overall distribution of effort (numbers of sets by one degree quadrangles of latitude and longitude) is shown in Figure 2 while Table 6 lists the number of sets and the number of hooks fished along with the number of swordfish caught by region and year. Data are available for 17 years between

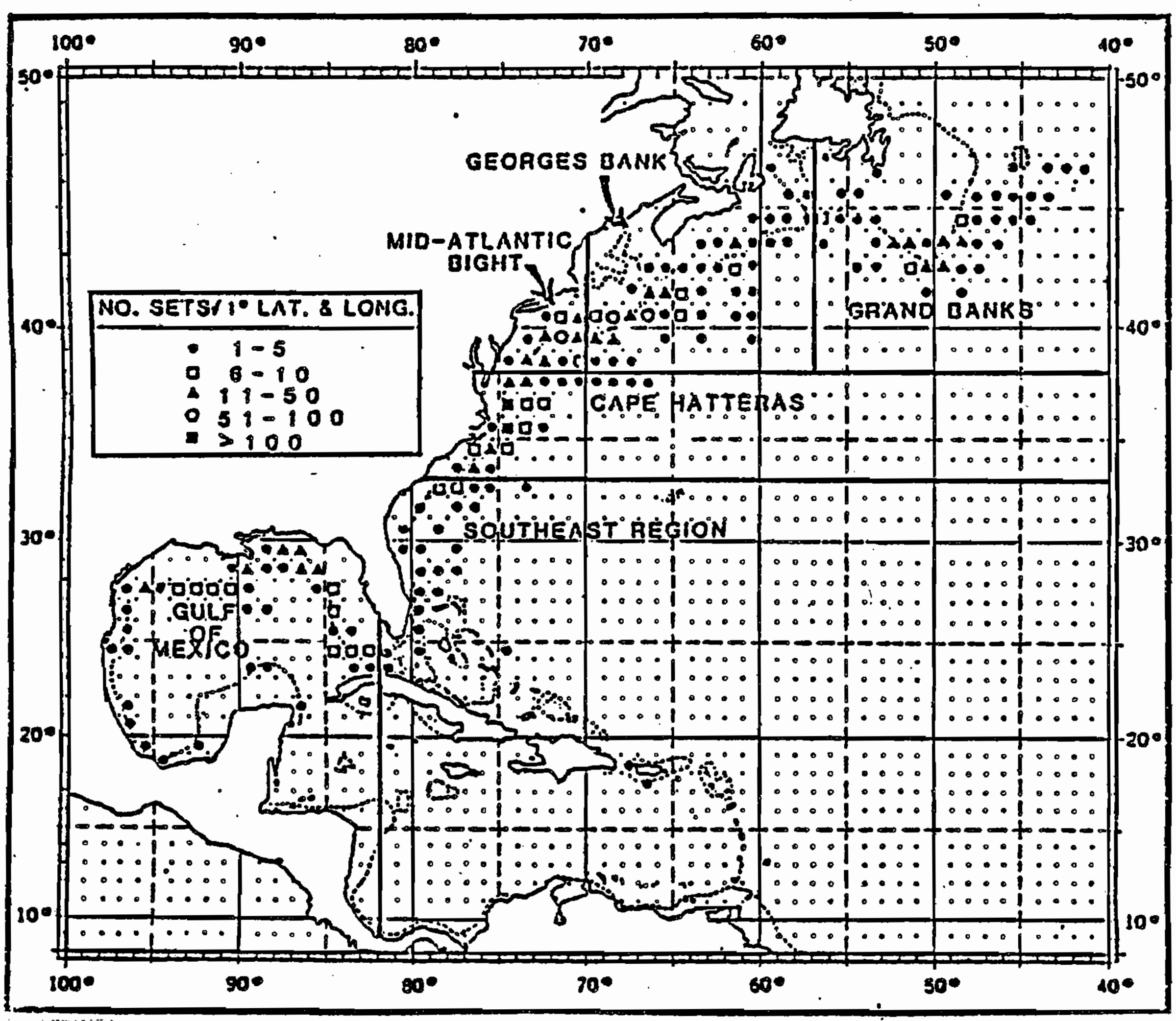


Figure 2. Geographical distribution of swordfish effort for 1,588 sets from 1963 through 1982. Numbers of sets by 1° quadrangles of latitude and longitude (Source: Hoey and Casey, 1983a).

Table 6. Effort totals (sets and hooks) and the number of swordfish caught listed by year and region (Source: Hoey and Casey, 1983a).

Regions	Effort/ Catch	1963	1964	1965	1966	1968	1970	1971	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	Regional Total
		Years																	
Grand Banks	Sets									1	15	7	11	17	31	39	39	38	198
	Hooks									1,680	29,310	10,320	20,390	32,640	55,645	59,591	59,318	48,662	317,556
	Swordfish									15	736	98	277	546	811	917	707	825	4,932
Georges Bank-Scotian Shelf	Sets	5	40	25	27	22	1		27	21	37	43	21	28	16	2	31	26	372
	Hooks	1,860	35,977	26,415	36,869	32,269	850		40,831	36,280	48,905	59,944	31,820	43,940	19,870	2,400	48,877	34,163	501,270
	Swordfish	26	370	305	299	214	0		1,388	1,317	558	763	371	646	151	20	312	231	6,971
Mid-Atlantic	Sets	8	29	20	20	30	21		6	13	9	1	6	24	8	3		7	205
	Hooks	3,060	23,835	19,842	24,357	35,075	27,582		5,347	12,786	5,820	240	3,320	36,225	5,765	720		4,661	208,635
	Swordfish	25	251	124	142	386	557		47	101	34	0	12	612	78	0		29	2,398
Hatteras	Sets	2	43	79	58	15	3		1	14	25	26	22	33	54	25	37	31	468
	Hooks	795	30,025	67,740	61,258	17,943	3,460		1,375	17,410	27,507	24,190	26,880	49,275	49,055	21,514	31,107	34,051	463,585
	Swordfish	10	603	1,044	572	245	53		93	539	232	131	728	1,383	532	154	196	174	6,689
S.E. Region	Sets			2							3	21		1	14	14	11	1	67
	Hooks			800							680	23,660		1,665	13,800	17,834	9,829	1,152	69,420
	Swordfish			5							0	254		50	79	214	71	4	677
Gulf of Mexico	Sets						89	10	6	54	44				23	48	4		278
	Hooks						95,012	11,915	7,019	76,173	32,655				30,714	66,537	3,203		323,228
	Swordfish						1,150	128	62	1,460	215				613	608	11		4,247
Total	Sets	15	112	126	105	67	114	10	40	103	133	98	60	103	146	131	122	103	1,588
	Hooks	5,715	89,837	114,797	122,484	85,287	126,904	11,915	54,572	144,329	144,877	118,354	82,410	163,745	174,849	168,596	152,334	122,689	1,883,694
	Swordfish	61	1,224	1,478	1,013	845	1,760	128	1,590	3,432	1,775	1,246	1,388	3,237	2,264	1,913	1,297	1,263	25,914

1963 and 1982 (no data for 1967 and 1969) with 11 years represented by more than 100 individual sets. Table 7 lists the numbers of swordfish, $\bar{X}$ dressed weights and $\bar{X}$ CPUE-WT by region and season.

The following paragraphs are taken from the results and discussion sections in Hoey and Casey's (1983a) manuscript. While it is recognized that this data set is primarily from one fishermen, this represents very valuable information. The trends indicated and conclusions drawn should not be extrapolated to the entire stock in the western North Atlantic without appropriate qualification with respect to the limited area of coverage and possible biases due to only having the records of primarily one captain. It may however be an accurate indication of the catch rates and average sizes in the area north of Cape Hatteras and the trends may be further substantiated as supporting data become available.

Results

Yearly trends may provide valuable information about the status of a fishery. An analysis of variance on rank transformed CPUE values indicates that effects of year on CPUE are significant. Multiple range tests indicate that mean CPUE ranks for the years 1979 through 1982 are all located in the lower half of the ordered (highest to lowest CPUE rank) 17-year array. Trends within a specific region may reflect relative abundance over a smaller seasonal time period in a reduced area (Figure 3). Regional effort has a high degree of consistency because the records are primarily from a single fishing vessel. When mean yearly CPUE ranks are compared within regions, the results from an ANOVA indicate that effects of year on CPUE are significant for all regions except the Southeast. In the Southeast region, catch rates were available for only 8 years and mean yearly CPUE values were based on small sample sizes (N less than or equal to 3 for 4 years). In the Gulf of Mexico, mean yearly CPUE ranks for 1980 and 1981 are 6th and 7th in the ordered (highest to lowest) 8-year array, significantly lower than values from the 1970s. In the Georges Bank-Scotian Shelf, Mid-Atlantic, and Cape Hatteras region, mean CPUE ranks for the years 1979 through 1982 are all located in the bottom half of each region's array of yearly CPUE ranks. In the Grand Banks regions, yearly CPUE ranks for 1982, 1981 and 1979 were 2nd, 3rd and 4th in the array behind the top value for 1975. These high catch rates explain the increased importance of and reliance on Grand Banks effort as catches have decreased in other areas in recent years.

Table 7. Number of swordfish, average dressed weight (kg), and $\bar{X}$ weight-CPUE (kg/100 hooks) by region and year (Source: Hoey and Casey, 1983a).

Region	Grand Banks Region			Georges Bank-Scotian Shelf Region			Mid-Atlantic Region			Hatteras Region			Southeast Region			Gulf of Mexico			Yearly totals All Regions		
Year	Swordfish N	$\bar{X}$-WT	$\bar{X}$-WT CPUE	Swordfish N	$\bar{X}$-WT	$\bar{X}$-WT CPUE	Swordfish N	$\bar{X}$-WT	$\bar{X}$-WT CPUE	Swordfish N	$\bar{X}$-WT	$\bar{X}$-WT CPUE	Swordfish N	$\bar{X}$-WT	$\bar{X}$-WT CPUE	Swordfish N	$\bar{X}$-WT	$\bar{X}$-WT CPUE	Swordfish N	$\bar{X}$-WT	$\bar{X}$-WT CPUE
1970							371	23.8	36.9	41	23.9	26.7				308	36.0	35.2	720	29.0	35.3
1971																115	30.1	29.2	115	30.0	29.2
1972																					
1973				924	36.4	115.8	42	39.0	40.5										966	36.5	106.0
1974	15	40.9	36.5	1279	45.7	156.2	17	37.9	17.9	484	28.5	88.4							1795	40.9	123.8
1975	721	58.7	144.7	534	54.0	62.0	28	40.1	29.4	207	44.7	38.7				161	31.7	22.5	1651	52.5	65.4
1976				133	54.8	78.3				65	39.9	15.2	212	36.8	37.7				410	43.1	38.1
1977	278	64.1	87.2	320	62.5	69.5	11	55.6	36.4	597	27.2	66.7							1206	45.3	72.2
1978	524	62.3	106.3	385	42.9	56.7	420	32.4	47.1	440	32.7	67.9							1769	43.6	69.5
1979	499	62.0	101.6	12	34.3	28.6				107	44.7	34.0	66	43.2	22.3	556	41.1	75.0	1240	49.8	65.7
1980	897	54.0	79.2	19	40.2	39.0				135	31.7	22.7	178	30.5	32.8	537	32.8	28.8	1766	43.4	48.3
1981	682	48.9	53.9	305	46.4	30.4				177	41.1	26.2	56	30.1	29.5	10	21.5	7.5	1230	46.1	37.3
1982	800	44.5	80.2	217	42.8	27.1	26	30.1	28.1	151	55.7	31.3	2	35.4	5.9				1196	45.3	50.4
Regional Totals	4416	54.8	84.6	4128	45.9	68.8	915	29.8	38.8	2404	34.1	39.6	514	34.7	30.9	1687	35.8	36.2			

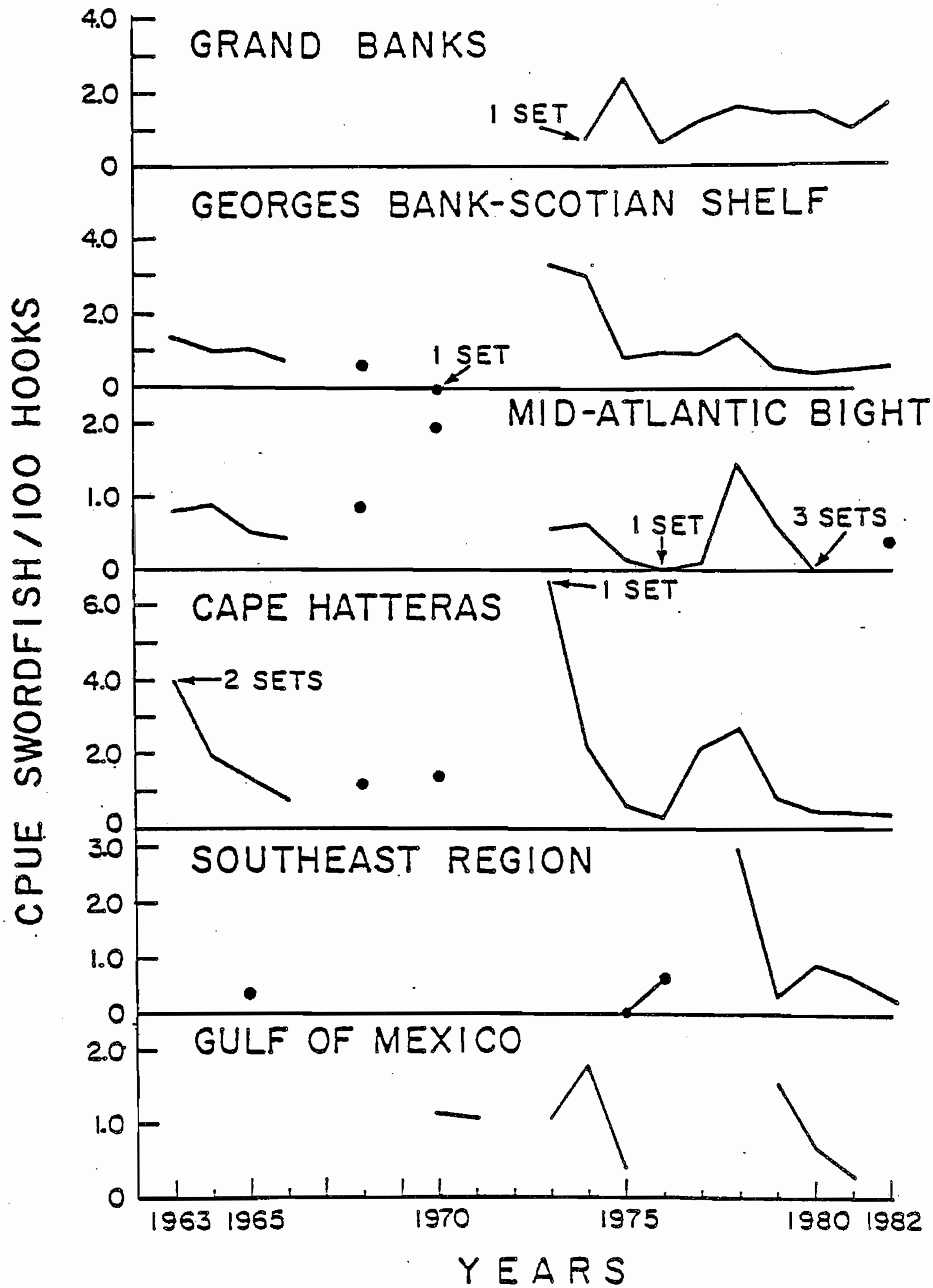


Figure 3. Mean swordfish CPUE plotted by year and region (Source: Hoey and Casey, 1983a).

Yearly differences in regional effort distribution are large, contributing substantially to yearly variability in CPUE and also in $\bar{X}$ CPUE-WT. To reduce the influence of seasonal differences in effort distribution, as was done with CPUE, average weights and $\bar{X}$ CPUE-WT values are listed by year for each region (Table 7). Significant effects of years within regions, on both rank transformed average weights (from individual sets) and rank transformed CPUE-WT values, were identified by analysis of variance and multiple range tests. Yearly effects on average weights were not significant in the Gulf of Mexico and Southeast region. Yearly effects on CPUE-WT were also not significant in the Southeast and Mid-Atlantic regions. These results are undoubtedly influenced by the small number of weight samples available from those regions. Average weights and CPUE-WT values for 1980-1982 are lower than values for the mid-1970s in the Grand Banks and Georges Bank-Scotian Shelf regions. In the Hatteras region, average weights for 1978, 1980, and 1981 are lower than values for 1982 and 1979 which were not different from 1975-1976 values. CPUE-WT values, however, were significantly lower than values for 1974, 1975 and 1978. The average weight and CPUE-WT values for the Mid-Atlantic, Southeast Region, and Gulf of Mexico in recent years also appear lower than values for the mid 1970s, although the samples are much smaller and the yearly values are not consecutive. We interpret these results as indicating both a decline in the number or density of swordfish over time and a decline in the average size caught.

Discussion

Trends in catch rates, both in terms of numbers and weight, provide a preliminary description of the status of the stocks and can aid in monitoring the effect of future fishing effort. It is not our intention to provide surplus production or absolute abundance estimates but only to investigate changes in relative abundance and mean size. Yearly catch rates in terms of numbers and average dressed weights from the Canadian fishery from 1963 through 1969 are provided by Beckett (1971). Caddy (1976) and Hurley and Iles (1980) reviewed Beckett's original data and provided some catch rate and average weight values from 1974, 1975 and 1979. Our catch rate values from 1964, 1965, 1966 and 1968 were recalculated to correspond to Beckett's yearly values (the ratio of averages described by Rothschild and Yong, 1970). The yearly mean values from the two sets of data were highly correlated (r=0.955). Beckett (1971) also presented yearly CPUE values for ten 5 degree quadrangles. Although we did not recalculate our data for these quadrangles, Beckett's CPUE values were generally contained within bounds set by our lower 25th and upper 75th percentiles (14 out of 18 matched pairs). Catch rate values from these two sources for the early years of the fishery (1964-1969), agree remarkably well considering the high degree of variability in CPUE data. This close agreement in catch rates between the Canadian and United States data indicate that both fisheries exploited the same stock of swordfish. Weight data from the Canadian fishery indicate changes in average size prior to 1970. Beckett (1971 - Table 2) reports that mean dressed weight declined from 76 kg (167.6 lb) in 1963 to 45.3 kg (99.9 lb) in 1969. Canadian weight values from 1963 through 1967 exceed all mean weight values in our data from 1970 through 1982. Our peak yearly values during 1975 and 1979 are only slightly greater than Beckett's lowest values in 1968 and 1969. Although our yearly average weight values for 1976 through 1982 appear to fluctuate around 45 kg (99.2 lb) with no distinct trend, the weight values from the Canadian data for the early 1960s (1963-1966) average 67.5 kg (148.8 lb). This reflects a 22 kg (48.5 lb) decrease in average weight from the mid-1960s through the late 1970s. When Canadian weight data presented by 5 degree squares (Beckett, 1971 - Appendix; Hurley and Iles, 1980 -Table 3) are combined, so that it is comparable to our Georges Bank-Scotian Shelf and Grand Banks area, declining average weights are clearly evident. In the Georges Bank-Scotian Shelf region, the Canadian data indicate an average weight decline from 79.2 kg (174.6 lb) in 1963 to 51 kg (112.4 lb) in 1969. Canadian average weights from 1963 through 1966 (average 73.8 kg; 162.7 lb) exceed all our yearly average weights from 1973 through 1982. The Canadian average weight for the Georges Bank-Scotian Shelf area from 1963 through 1969 is approximately 64.5 kg (142.2 lb), compared to our average of 45.8 kg (101.0 lb) from 1973 through 1982. On the Grand Banks, Canadian data indicate a decline in average weight from 94 kg (207.2 lb) in 1963 to a low of approximately 44 kg (97.0 lb) in 1967, which then increased to 59.5 kg (131.2 lb) in 1969. The Canadian average weight for the Grand Banks from 1963 through 1969 is approximately 67.4 kg (148.6 lb) compared to our average of 54.7 kg (120.6 lb) from 1974 through 1982.

Although these trends indicate declining average sizes in small samples from restricted areas in the western North Atlantic swordfish stock, the data are extremely variable and size data appear to have a cyclic quality. The mercury ban in 1970 drastically reduced effort, arrested the development of the swordfish fishery and separated two distinct periods of rapid effort expansion (mid and late 1960s and late 1970s). Caddy (1976) maintains that there was limited evidence of an increase in the catch per unit effort and average weight of swordfish during the years of reduced effort, indicating that the population may have recovered slightly from the initial period of rapid expansion of the fishery. Our data also document an increase in average weights during the mid and late 1970s on Georges Bank and Grand Banks. Those values exceeded average weights from the same areas during the late 1960s (Canadian data) and early 1980s. At the present time, following the recent expansion of the fishery (1977 through 1980), the condition of the swordfish stock in terms of the average sizes and size proportions in the catch may be very similar to the conditions which preceded the mercury ban. The fact that Berkeley and Houde (1980) found no difference between the age structure in 1970 Canadian data and 1979 Florida data may reflect the condition of the swordfish stock after three to four years of intensive fishing effort. The major difference between the late 1960s and the early 1980s, however, is that the total fishing effort appears to be greater with a major part of the increase resulting from expanded effort in the southern areas. Berkeley and Houde (1981) report an 18.5 percent decline in the CPUE (based on numbers caught) from 1979 to 1980. Berkeley and Irby (1982) report a 26 percent decline in the weight caught per hundred hooks. Although Berkeley and Houde (1981) and Berkeley and Irby (1982) maintain that the average size and age structure of the population have remained constant, these declining catch rates are of concern, especially when we consider, as Berkeley and Irby (1982) did, that the effectiveness of the effort also increased between 1979 and 1980. The actual decline in CPUE may therefore have been greater than the decline observed in the data.

Farber and Conser (1983) using Japanese longline catch and effort data as an index of swordfish abundance found no significant change in abundance since 1957 on an Atlantic or North Atlantic-wide basis. They did, however, detect a decline in abundance in the Northwest Atlantic area between 1977 and 1980. These data must be used with caution, though since swordfish are an incidental species in the Japanese longline fishery, and as was noted by Kikawa and Honma (1983), Japan's share of the total Atlantic catch is so small that it is unlikely that longline CPUE data will reflect the general condition of the stocks.

Data from the Canadian, New England and Florida fisheries were compared and appear to reflect effort on the same swordfish stock. Catch rates and average sizes were consistent between fleets, especially when standardized by region and season. Data from each fishery documented declining trends in relative abundance (CPUE) and average size in response to increasing effort. Declining trends in relative abundance have persisted, despite reported increased effectiveness of the gear in the last few years (Berkeley et al., 1981). Furthermore, differences between the distribution of effort in 1969 and 1980, and the resultant increase in the catch of small individuals (less than 4 years old) and large females should be of concern. These changes highlight the need for careful monitoring of the fishery.

8.1.5.6 Abundance and Present Condition

Commercial landings decreased slightly from 8.4 million lb in 1980 to 7.7 million lb in 1981 (Table 8). Recorded landings in 1982 and 1983 were almost the same, 9.0 and 9.3 million lb respectively. The stock assessment in the swordfish FMP presented at public hearings in March 1983 (draft dated February 1983) was based on yield-per-recruit (YPR) analyses done by Berkeley and Houde (1980, 1981). The major limitation of this work for the five Council management plan was that the analyses were based on fish exclusively from the Straits of Florida. There were no data to verify if the size frequency observed by Berkeley and Houde in 1979-80 in Florida was representative of the entire western North Atlantic fishery (five Council areas developing the swordfish plan).

The Source Document (May 1982) also relied heavily on samples obtained from the swordfish fishery off the East Coast of Florida during 1979 (N = 7,985) and 1980 (N = 14,837) (Figure 4). Additional weight frequency data have been made available through contacts with State agencies, swordfish dealers, and commercial fishermen. Unfortunately, there is no way to identify the sexes from the carcasses. These new data have been volunteered to improve the data base on which the plan is founded to insure that the plan is based on data from the entire range of the fishery and not a restricted area (Florida's east coast) over a short time span. In all cases, fishermen and dealers have supplied vessel trip sheets which record individual carcass weights.

Table 8. Annual domestic swordfish landings.

	GMFMC*	SAFMC**	MAFMC	NEFMC+	TOTAL ALL AREAS
	'000 lb	'000 lb	'000 lb	'000 lb	'000 lb
1960	-	-	69	942	1,011
1961	-	-	72	829	901
1962	-	-	67	867	934
1963	-	1	423	2,331	2,755
1964	-	483	1,113	1,456	3,052
1965	-	524	1,391	788	2,703
1966	-	77	425	855	1,357
1967	-	-	404	641	1,045
1968	-	-	216	389	605
1969	2	-	40	336	378
1970	346	-	18	268	632
1971	1	1	4	73	78
1972	-	-	-	541	541
1973	14	-	7	873	894
1974	86	-	76	3,353	3,515
1975	149	-	149	4,294	4,592
1976	391	262	187	3,408	4,248

	TX	FL W.C.	FL E.C.	NC	SC	VA	MD	NY	NJ	RI	MA	ME	TOTAL ALL AREAS
1977	0	2,321	113,000	120,000	0	-	222,278	-	0	81,000	845,000	380,000	1,763,599
1978	0	52,708	536,000	439,306	581,542	-	0	-	511,000	668,000	3,985,000	369,000	7,145,178
1979	60,000	318,000	1,391,000	170,436	822,711	-	72,554	-	271,000	511,000	3,509,000	392,000	7,517,701
1980	965,500	760,475	2,308,042	316,576	845,097	-	488,098	-	101,215	454,000	1,587,000	610,000	8,436,003
1981	435,300	723,204	2,718,871	251,428	688,345	54,819	311,520	126,811	103,082	596,565	1,112,440	567,463	7,689,848
1982	271,500	984,275	2,946,805	146,565	1,158,358	66,570	350,226	350,677	314,419	275,355	1,727,524	439,376	9,031,650
1983	118,400	598,331	2,817,983	163,915	1,181,144	19,214	485,921	402,670	550,350	275,633	2,334,068	316,253	9,263,882

* MS landed 6,000 lb in 1981
** GA landed 2,622 lb in 1978; GA 1982 landings are confidential
+NH landed 96,561 lb in 1981

	% Less Than Or Equal To 50 lb	% Greater Than 50 lb
1979	32%	68%
1980	32%	68%
1983	41%	59%

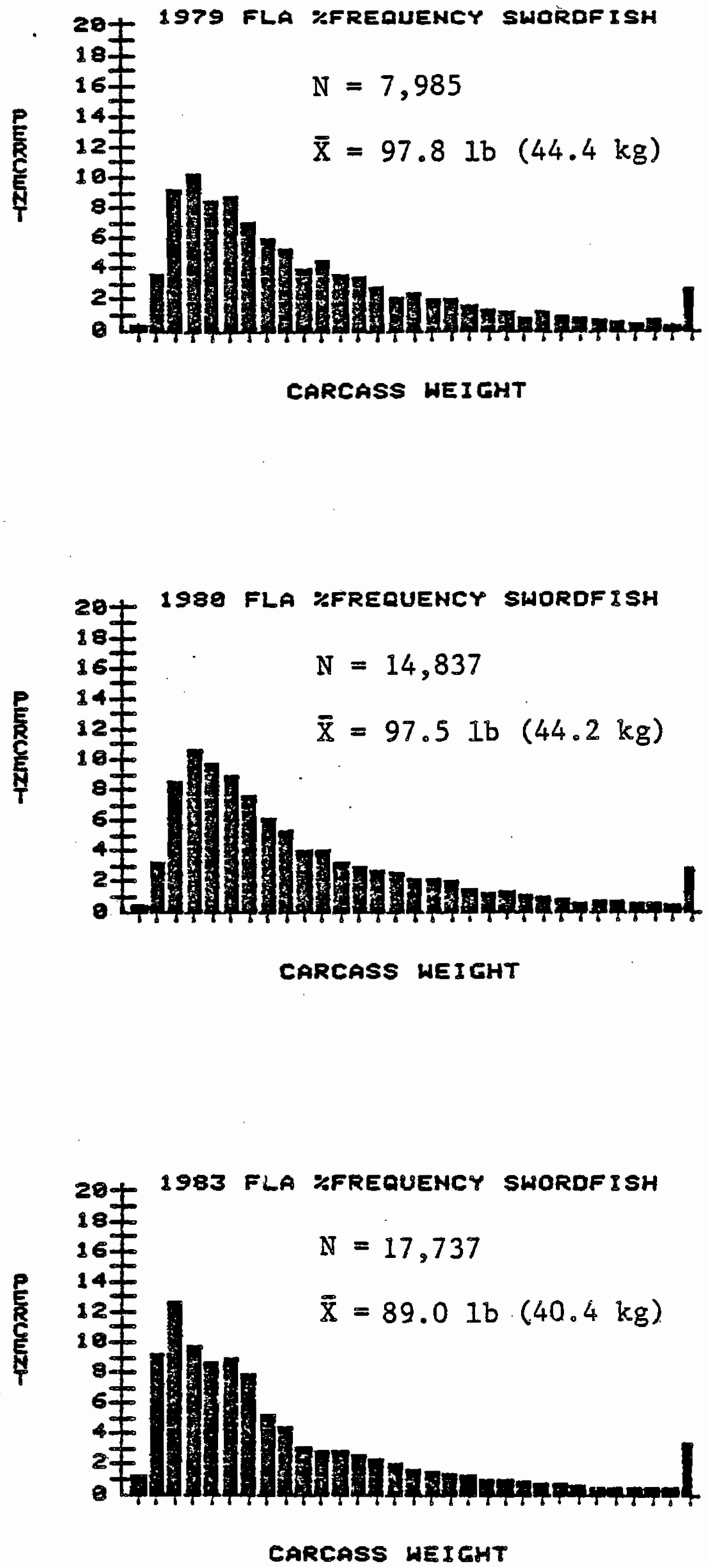


Figure 4. The weight-frequency distribution for 7,985 swordfish landed by longline in Florida in 1979 (mean weight = 97.8 lb, 44.4 kg), 14,837 swordfish landed in 1980 (mean weight = 97.5 lb, 44.2 kg), and 17,737 swordfish landed in 1983 (mean weight = 89.0 lb, 40.4 kg). Weight is shown in 10 lb increments, beginning with the 1-10 lb group and ending with the over 300 lb group. Dressed weight equals whole weight X 0.75 (Source: Berkeley and Houde, 1981)

The Marine Resources Division of the South Carolina Wildlife and Marine Resources Department has collected carcass weights for 40,366 swordfish landed in South Carolina from 1978 through 1983. Yearly weight histograms for these data are displayed in Figure 5.

Carcass weights are also available for 15,358 swordfish landed in ports located north of 35° N in 1980 and an additional 9,172 carcasses landed in 1983 (Figure 6).

More recent data have also become available from landings along the east coast of Florida. As of April 1984, 17,737 carcass weights were available for swordfish landed in 1983 (Figure 4). A small sample from the Gulf of Mexico is also available for 1980 (7,637 carcasses) and for 1983 (1,229 carcasses) (Figure 7).

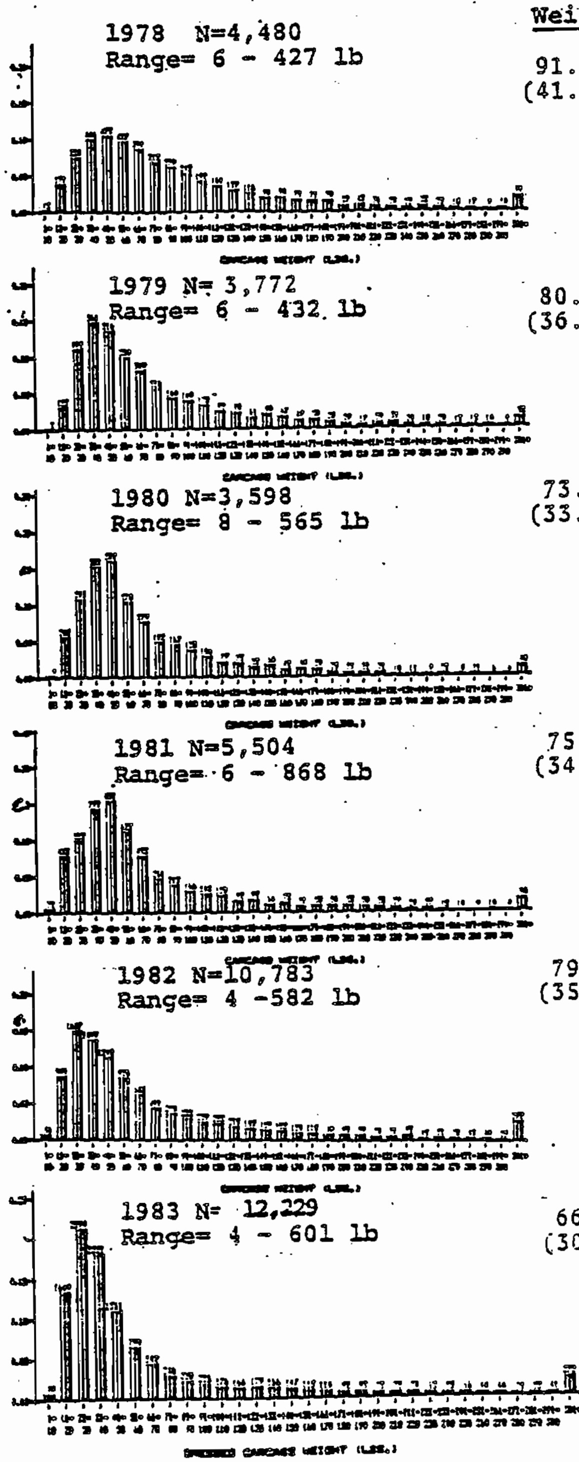
SUMMARY OF AVAILABLE SWORDFISH WEIGHT DATA

numbers of dressed carcass weights

Year	Gulf of Mexico	Fla. East Coast	S.C.[1]	North Carolina and North
1978			4,480	853[2]
1979		7,985[3]	3,772	
1980	7,637[4]	14,837[3]	3,598	15,358[4]
1981		X[5]	5,504	800[2]
1982		X[5]	10,783	1,082[2]
1983	1,229[4]	17,737[4]	12,229	9,172[4]

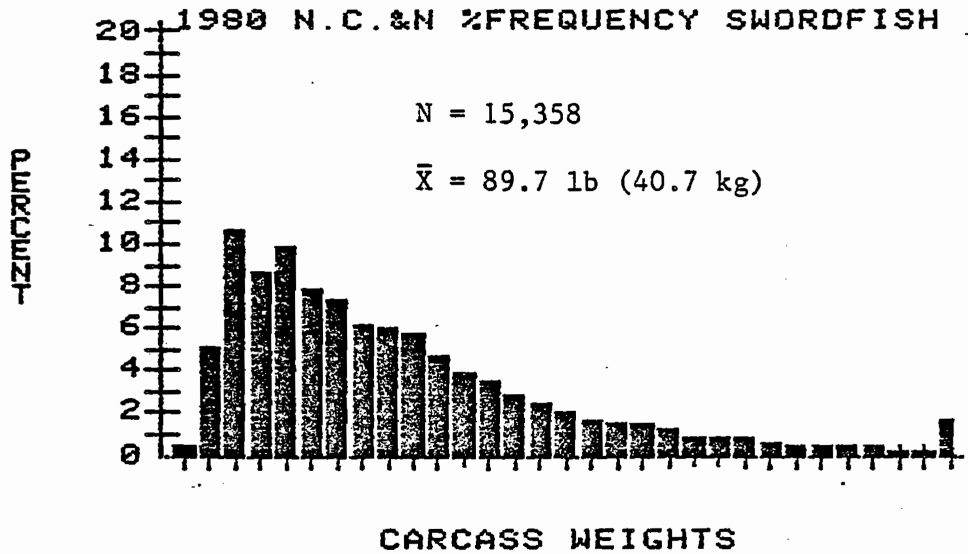
Annual totals	- 1978	5,333			
	- 1979	11,757	Region totals	Gulf of Mexico	8,866
	1980	41,430		Florida	40,559
	- 1981	6,304		S.C.	40,366
	1982	11,865		N.C. and North	27,265
	1983	40,367			
Grand total	-	117,056			

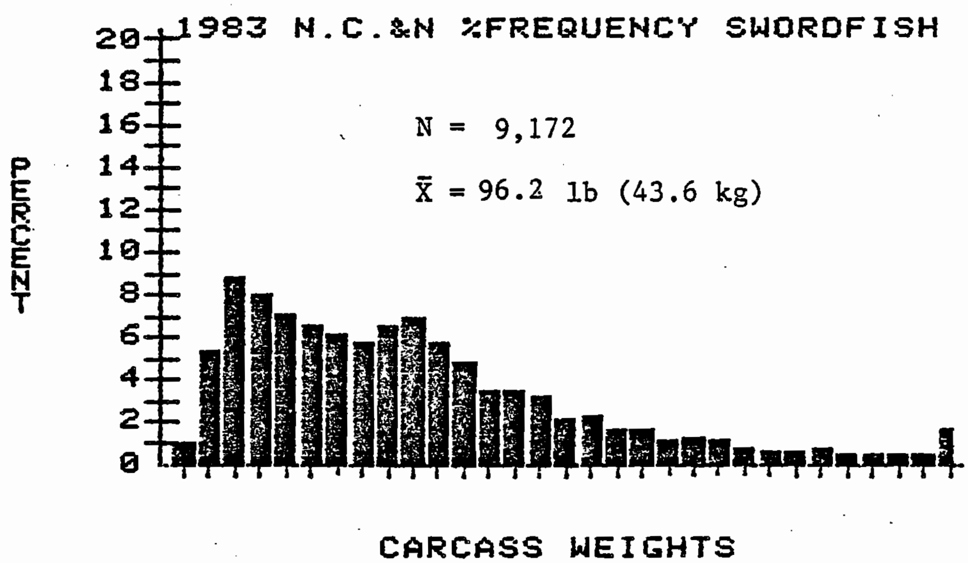
Sources:
1. S.C. Marine Resources Division
2. New England fishermen
3. Berkeley & Houde
4. Dealer
5. Data being prepared by dealers, number of carcasses still unknown



Mean Weight	% Less Than Or Equal To 50 lb	% Greater Than 50 lb
91.0 lb (41.3 kg)	33%	67%
80.7 lb (36.6 kg)	44%	56%
73.4 lb (33.3 kg)	48%	52%
75.0 lb (34.0 kg)	48%	52%
79.0 lb (35.8 kg)	50%	50%
66.1 lb (30.0 kg)	65%	35%

Figure 5. South Carolina's swordfish size distribution 1978-83. Weight is shown in 10 lb increments, beginning with the 1-10 lb group and ending with the group over 300 lb. (Source: S.C. Marine Resources Division, unpubl. data)

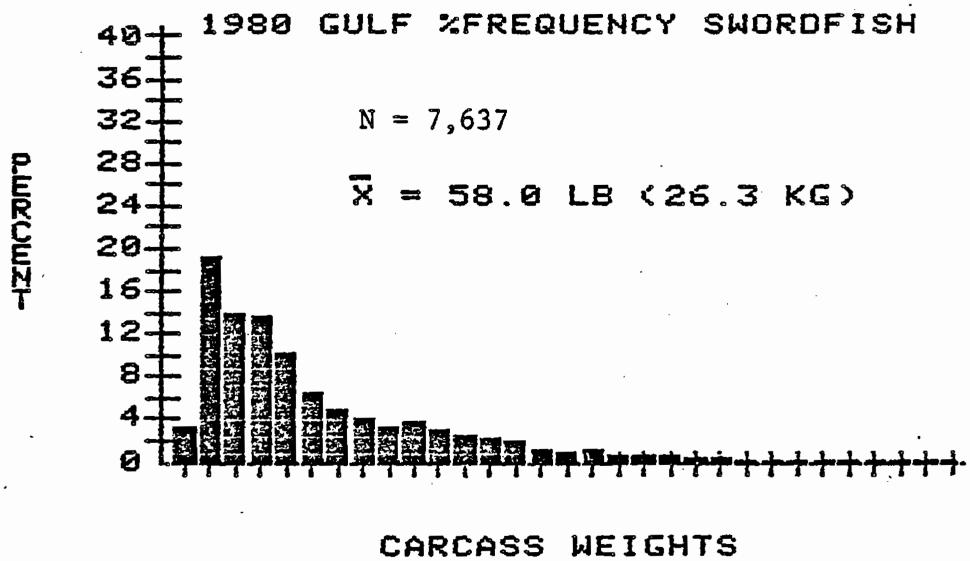




	% Less Than or Equal To 50 lb	% Greater Than 50 lb
1980	35%	65%
1983	31%	69%

Figure 6. Landings North of 35° N. 1980 sample based on 15,358 swordfish with mean dressed carcass weight of 89.7 lb (40.7 kg). 1983 sample based on 9,172 swordfish with mean dressed carcass weight of 96.2 lb (43.6 kg). Weight is shown in 10 lb increments, beginning with the 1-10 lb group and ending with the group over 300 lb.

% Less Than or Equal to 50 lb	% Greater Than 50 lb
61%	39%
79%	21%



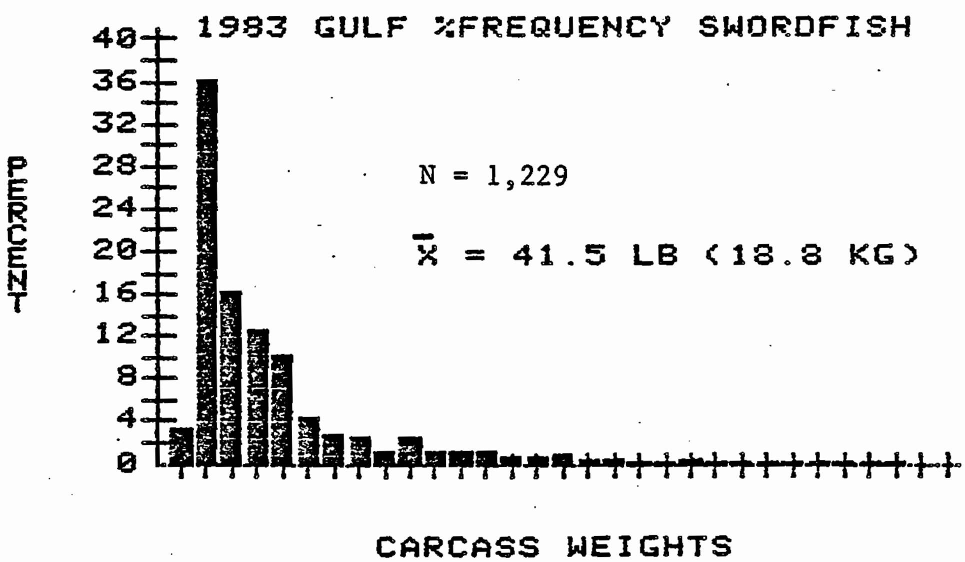


Figure 7. The weight-frequency distribution for 7,637 swordfish landed by longline in the Gulf of Mexico in 1980 (mean weight = 58.0 lb, 26.3 kg) and 1,229 swordfish landed in 1983 (mean weight = 41.5 lb, 18.8 kg). Weight is shown in 10 lb increments, beginning with the 1-10 lb group and ending with the group over 300 lb.

In terms of the average carcass weights, the following facts are apparent:

1. In the Florida east coast sample, the mean dressed weight was essentially the same in 1979, 97.8 lb (44.4 kg) and 1980, 97.5 lb (44.2 kg) and then declined to 89 lb (40.4 kg) in 1983. The proportion of carcasses weighing 50 lb or less which was constant at 32 percent in 1979 and 1980 has increased to 41 percent in 1983.
2. In the South Carolina data, the mean dressed weight has declined from 91 lb (41.3 kg) in 1978 to 73.4 lb (33.3 kg) in 1980 and then to 66.1 lb (30 kg) in 1983. Concomitant with this decline in average size, the proportion of carcasses 50 lb or less has increased from 33 percent in 1978 to 48 percent in 1980 and then to 65 percent in 1983.
3. In the sample from landings north of 35^{o} N, the mean dressed weight has increased from 89.7 lb (40.7 kg) in 1980 to 96.2 lb (43.6 kg) in 1983. The proportion of carcasses weighing 50 lb or less has decreased from 35 percent in 1980 to 31 percent in 1983.

Approach 1: Cap Fishing Mortality at the Maximum Yield-Per-Recruit for Female Swordfish - No Closure Initially

The swordfish plan initially used the variable season closure to cap fishing mortality at the maximum YPR for females. The variable season closure caps mortality by a method that is equitable to all fishing areas in the management unit. Based on the 1980 YPR analysis, this would have required restricting fishing mortality at approximately what occurred in 1980. Subsequent YPR analyses may have produced new YPR parameters that would have indicated that in 1980 the fishery was not at maximum YPR for females. The variable season closure would have capped effort at whatever was the maximum YPR for females based on the best available YPR analysis at the time.

Initially, no closure was proposed because no estimate of fishing mortality was available other than Berkeley and Houde's (1981) estimate for 1980. The plan described a procedure whereby a working panel would review information on an annual basis and as soon as the most recent YPR analysis indicated the need for a closure to restrict fishing mortality, the

Councils would request the NMFS Southeast Regional Director to implement regulations closing each Council region based on the number of closed days called for by the swordfish calendar. This would have been done by field order.

Prior to the second round of public hearings (March/April, 1984) weight frequency information from South Carolina became available. This allowed us to perform the first YPR analysis as called for in the plan. These calculations are discussed under Approach 2.

Approach 2: Cap Fishing Mortality at the Maximum Yield-Per-Recruit for Female Swordfish - Closure with Plan Implementation Based on South Carolina Data

The South Carolina data (particularly 1980-83; 32,114 fish) show three things. First, the size frequency Berkeley and Houde observed in the Straits of Florida in 1979-80 was also occurring in South Carolina. Second, since 1980 the size frequency of the catch in South Carolina has shifted considerably (average size declined) as shown in Figure 5. Third, since 1979 the age liable to capture has decreased from the 40-50 to 20-30 pound dressed weight class. "Age liable to capture" is the term used on the computer printout of the Beverton and Holt yield-per-recruit analyses (Appendix A). It is equivalent to L' (fork length) in Beverton and Holt terminology (Ricker, 1975). In the case of the South Carolina data (Figure 5), age liable to capture (L') is interpreted to be in the range of the 10 pound (dressed weight) categories that comprise the mode of the frequency*.

1978	L' =	41-50 pounds	(18.6 - 22.7 kg)
1979	L' =	31-40 pounds	(14.1 - 18.1 kg)
1980	L' =	41-50 pounds	(18.6 - 22.7 kg)
1981	L' =	41-50 pounds	(18.6 - 22.7 kg)
1982	L' =	21-30 pounds	(9.5 - 13.6 kg)
1983	L' =	21-30 pounds	(9.5 - 13.6 kg)

The five Council swordfish FMP is built on the premise that there is a group of swordfish that can be managed as a unit and that the status of the stock can be adequately monitored for management purposes by YPR analysis. This is a scientifically established method to calculate relative fishing pressure (instantaneous fishing mortality) from the sizes of fish (size frequency) in the catch.

*Note, all lengths are converted to weights according to the Berkeley and Houde length-weight equation (Table 2).

Total landings (weight) could also be an important indicator of stock condition (especially when used with size frequency data). However, at this time, historical landings are suspect due to likely under-reporting. Also, both Berkeley and Houde YPR parameters and those of Wilson and Dean theoretically indicate that total landings will not significantly change when growth overfishing occurs (Figure 8).

A complicating feature of YPR analysis for swordfish is that males and females have different growth rates (females live longer and grow larger). There is no way for fishermen to target swordfish by sex, consequently the strategy of the plan was to prevent growth overfishing of the most vulnerable sex (sex with the lowest fishing mortality to maximize YPR). This means that if fishing mortality on females does not exceed that which produces maximum YPR for females it will automatically prevent growth overfishing of males.

Since the sexes could not be identified from the carcasses, the only YPR analyses that could be done was for sexes combined. YPR analyses on sexes combined causes two problems. First, the chosen YPR parameters are hybrid values of those that actually occur for males and females. If Wilson and Dean (1983) are correct and there are no real differences in the growth rates of males and females, this may turn out not to be too important. However, the main reason for the onboard technician program in the FMP is to identify sexes and further substantiate the growth rates of males and females.

The second problem with YPR on combined sexes is that the measure of "growth overfishing" which triggers the variable season closure in the FMP is for females, not sexes combined. The result is that the estimate of instantaneous fishing mortality (F) on combined sexes is higher than would occur if it could be done solely on females. At the same time, the estimate of the maximum YPR F for sexes combined is also higher than it would be for females.* These factors work in opposite directions so that it is difficult to say if the estimate of growth overfishing for sexes combined is much lower than would be the estimate solely for females. Berkeley and Houde (1981) estimates indicate that if we would have used this measure of

*This assumes no significant differences in age liable to capture between the sexes.

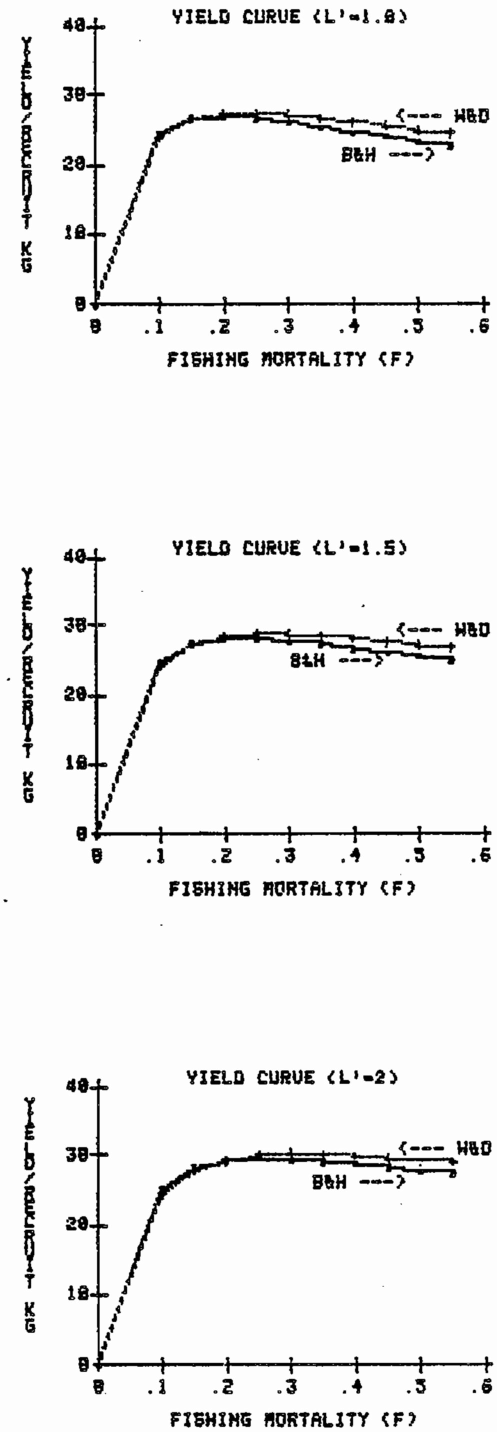


Figure 8. Yield curves for swordfish given different ages first liable to capture (L').

growth overfishing in the FMP with their data (comparing existing F to maximum YPR F) we would have drawn the same conclusions with sexes combined as we would have with females. This may not be the case in 1983 because the decrease in age liable to capture is a strong influence on estimated fishing mortality and it may not be the same for females or males (or sexes combined).

In accordance with the methods outlined in the FMP, YPR analyses were performed on the 1983 data (Figure 9). The results were also compared to the 1979-80 analysis from the Straits of Florida (Berkeley and Houde, 1980, 1981) and the 1980 data (Figure 10). Plots of all areas combined for 1980 and 1983 are shown in Figure 11.

Preliminary results show that fishing pressure (fishing mortality estimated by YPR) in 1983 was approximately 25 percent above that which maximizes YPR at the prevailing age liable to capture (20-30 pound dressed weight) based on data from South Carolina. This preliminary "best estimate" is of course dependent on all the assumptions that are inherent in YPR analysis.

It must be emphasized that these conclusions are tentative pending scientific review and the analysis of the remaining data from other areas. Also, these are simply mechanistic calculations that should be balanced with some judgement and history about the plan. For example, it was not anticipated that age liable to capture (especially in all areas) would substantially decline resulting in 20-30 lb (dressed weight) fish being the biggest size class (by number) in the catch.

An examination of the YPR values (column 3, Appendix A) clearly indicates that controlling fishing pressure (instantaneous fishing mortality, Column 1) has little impact on increasing total landings (YPR, Column 3). At the smaller 1983 age liable to capture (around L' = 118.5 cm, 27.5 pounds dressed weight, age 2.0 on the printout) the only thing that even modestly influences YPR is increasing or decreasing the age liable to capture.

	% Less Than Or Equal To 50 lb	% Greater Than 50 lb
1983 Gulf	79%	21%
1983 FLA	41%	59%
1983 S.C.	65%	35%
1983 N.C.&N	31%	69%

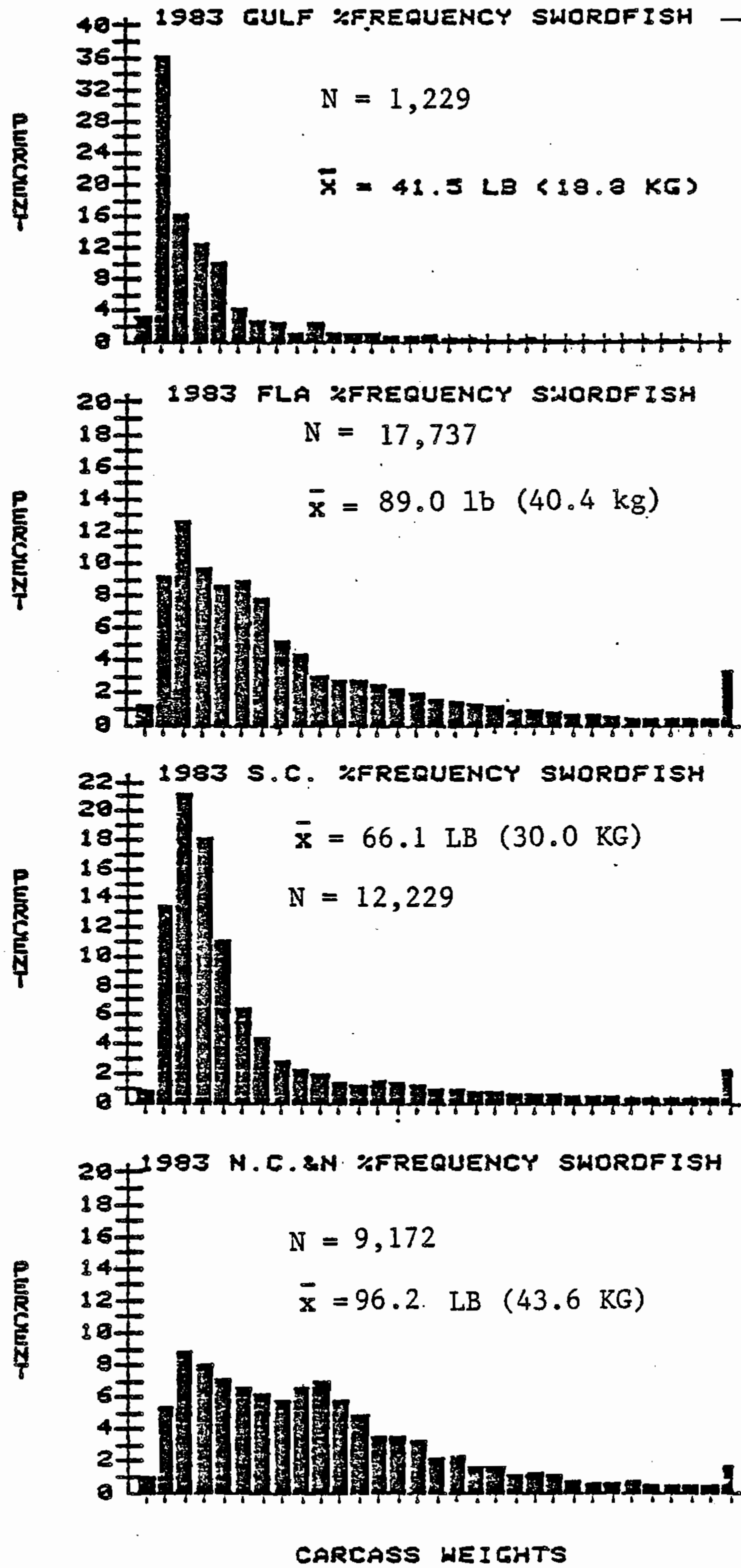
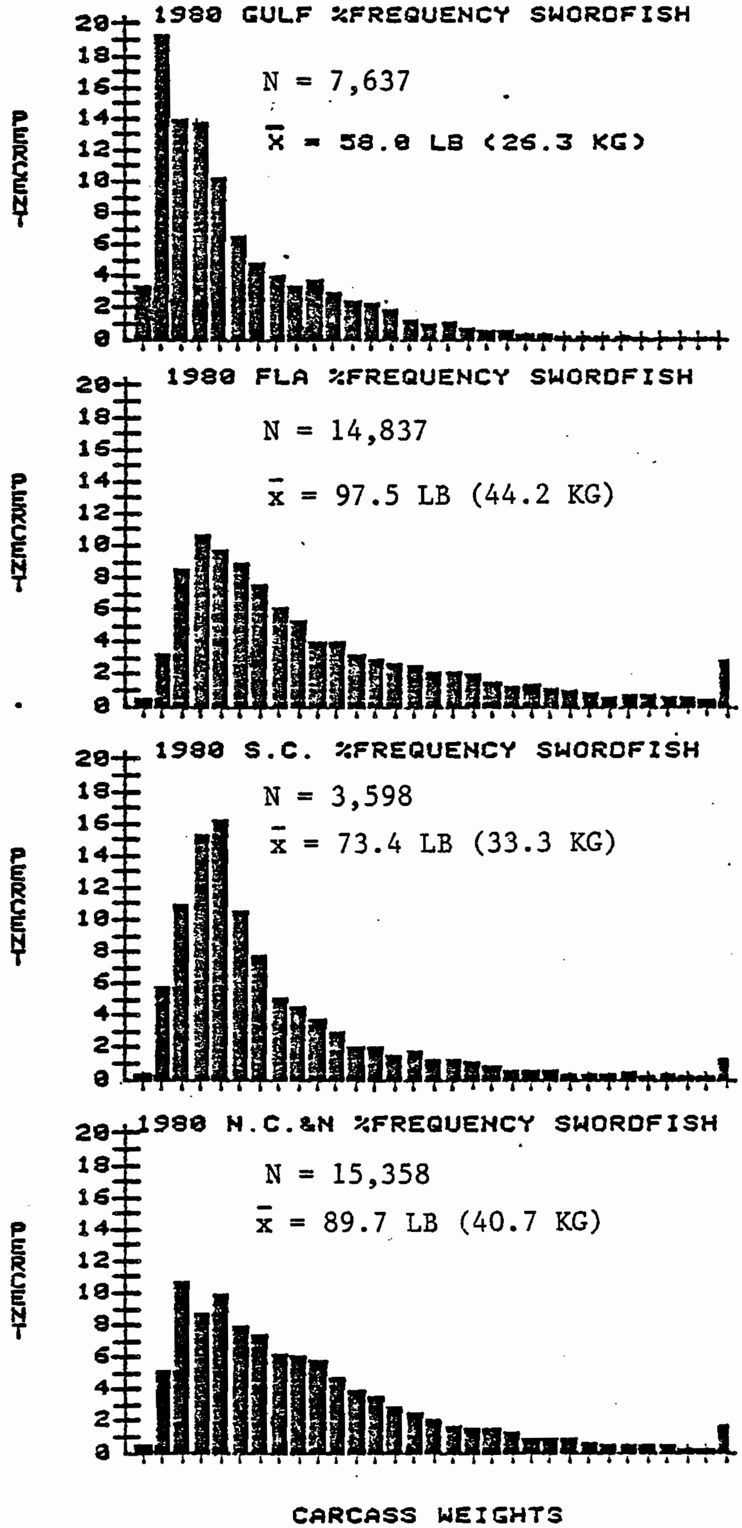
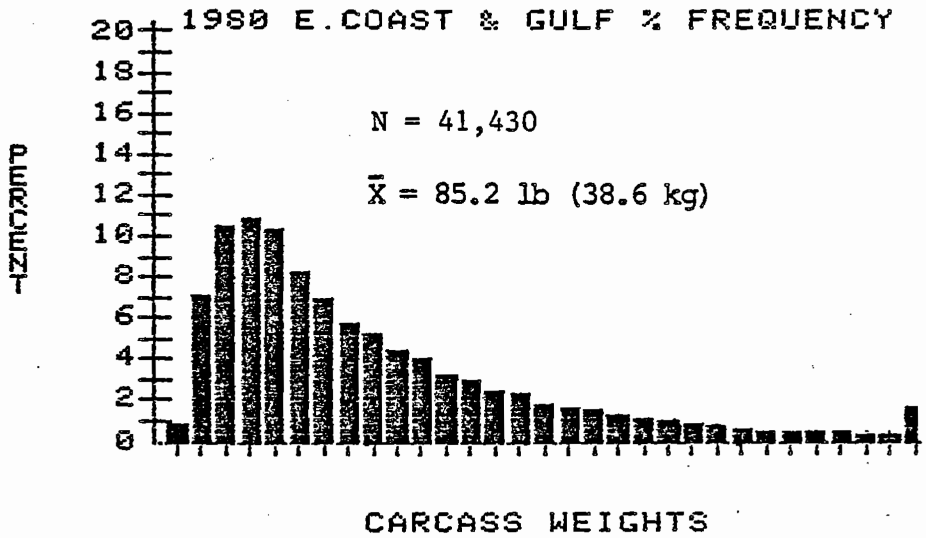


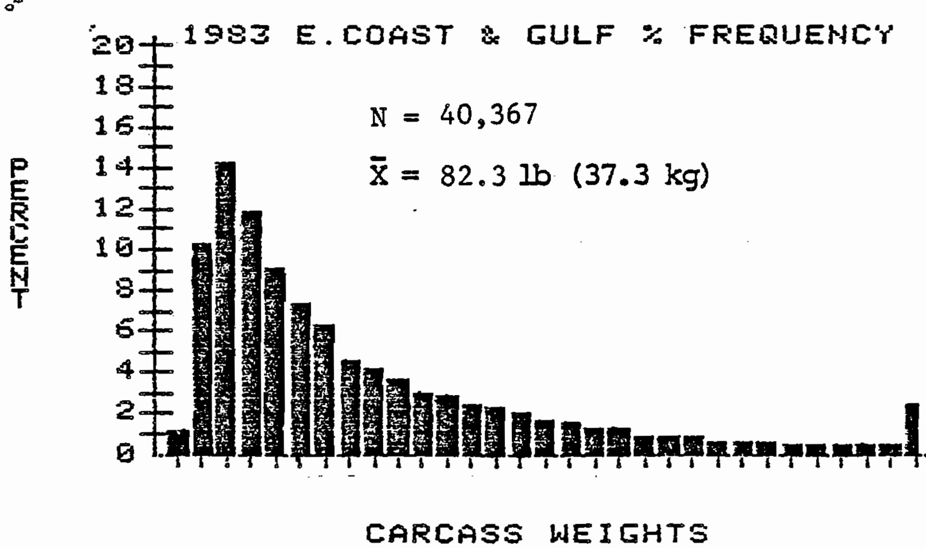
Figure 9. Weight-frequency plots for 1983 by area. Weights are shown in 10 lb increments, beginning with the 1-10 lb group and ending with the group over 300 lb.



Area	% Less Than Or Equal To 50 lb	% Greater Than 50 lb
1980 GULF	61%	39%
1980 FLA	32%	68%
1980 S.C.	48%	52%
1980 N.C.&N	35%	65%

Figure 10. Weight-frequency plots for 1980 by area. Weights are shown in 10 lb increments, beginning with the 1-10 lb group and ending with the group over 300 lb.





% Less Than or Equal to 50 lb.	% Greater Than 50 lb.
44%	56%
54%	46%

Figure 11. Composite histograms for 1980 and 1983 produced by combining data from the Gulf of Mexico, the east coast of Florida, South Carolina, and north of 35° N. 1980 histogram based on 41,430 swordfish carcasses with a mean dressed weight of 85.2 lb (38.6 kg). 1983 histogram based on 40,367 swordfish carcasses with a mean dressed weight of 82.3 lb (37.3 kg).

However, controlling fishing pressure does have a significant influence on the size of the fish in the catch (average size, Column 6). The economic goal of the plan is to keep the size of fish from substantially declining because larger fish are preferred in the market. The resulting biological advantage is that if growth overfishing is prevented, it is anticipated that there will be little chance of recruitment overfishing. But the printout shows that the maximum YPR for different ages liable to capture produces very different average sizes (and percent surviving to sexual maturity). For example, the average size associated with maximum YPR was 66.62 kg (Column 6) when the age liable to capture was 2.5 in 1979. When the age liable to capture dropped to 2.0 in 1983, the maximum YPR only produced an average size of 61.67 kg. To maintain an average size of 66 kg would require moving below maximum YPR to a fishing mortality of 0.20-0.21. Therefore, 1983 fishing mortality (0.33-0.34) would have to decrease by approximately 40 percent instead of 25 percent to return us to the sizes occurring in 1979. Maintaining preferred sizes of fish, not total pounds landed (which does not change substantially with growth overfishing) is the intent of this plan. Unfortunately, at this stage of growth overfishing, returning to any historical sizes (even 1979) would require percent reductions based on pounds of swordfish in excess of 30 percent.

Figure 12 is a summary of how, conceptually, YPR is done. This discussion refers to new information on each of the components in the table. Also, refer to the computer printouts in Appendix A.

I. Wilson and Dean (U.S.C. Baruch Institute, Columbia, SC; pers. comm.) indicate slightly different growth rates (K) and maximum sizes (L_{∞}) than Berkeley and Houde (1980, 1981) as shown in Table 2. Our analysis is restricted to sexes combined because the sexes are not identified in the weight-frequency data. The computer run uses Berkeley and Houde sexes combined estimates of K = .1054 and L_{∞} = 297 cm.

II. Wilson and Dean did not calculate a new natural mortality (M) value. John Hoey did this based on their K value (0.13) and alternative temperatures to produce an estimate of M = 0.185 from the same equation

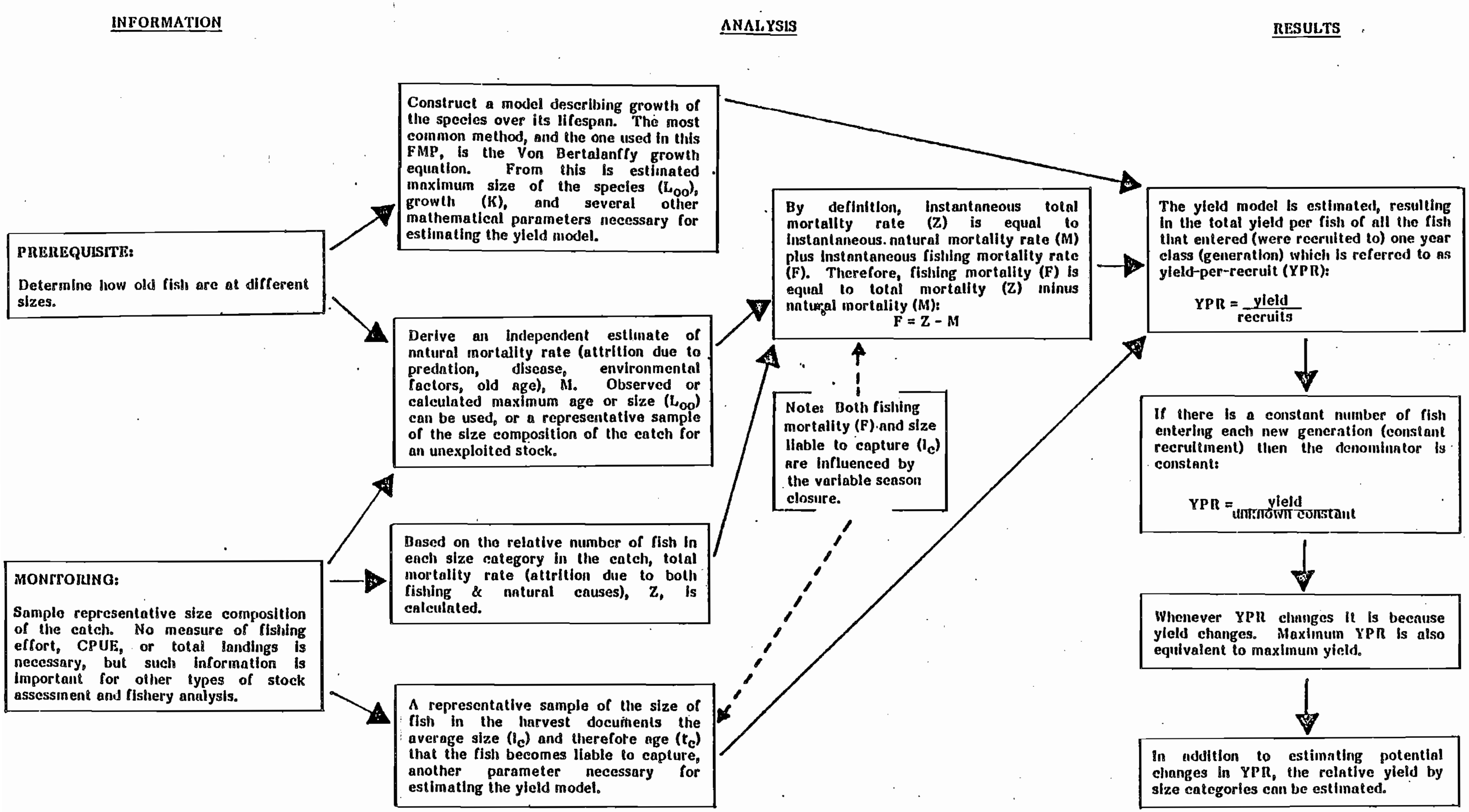


Figure 12. How yield-per-recruit works.

used by Berkeley and Houde. The computer run uses the Berkeley and Houde estimate of M = 0.16. Ultimately sensitivity analysis will be done on all the alternative parameter values.

III. The age (or size) liable to capture (L') is the most problematical parameter. Berkeley and Houde used L'= 130 cm for sexes combined in 1979-80 data. Our best estimate is that in 1983 this is a lower value (around 100-120 cm). This is supported by the mode in the South Carolina size frequency data. It is also indirectly supported by the theoretical calculations from the YPR analysis (discussed next under IV).

IV. Total mortality (Z) was calculated on the S.C. data by the same three methods used by Berkeley and Houde (1981), (Beverton and Holt, 1956; Robson and Chapman, 1961; and Ssentongo and Larkin, 1973). It is not necessary to do this calculation when the computer calculates alternative individual mean weights (column 6) for a range of fishing mortality values (see the attached printout). Fishing mortality can be determined by simply finding the theoretical "instantaneous fishing mortality" (Column 1) that matches (same row) the actually observed (from the catch) "individual mean weight" (column 6) on the computer run for the appropriate "age liable to capture."

Age liable to capture in the computer model is (t) in the von Bertalanffy growth equation for calculating L' (Table 2). Average size (above L') is interpreted in kilos (Column 6) by converting $\bar{L}$ in cm (Beverton and Holt terminology) into weight with the length weight equation (Table 2).

Age liable to capture of 2.5 (L' = 127.7 cm, 35.3 pounds dressed weight) approximately replicates the Berkeley and Houde calculations (done by a different method) on 1979-80 data. They reported L' = 130 cm and $\bar{L}$ = 72.1 kg.*

The $\bar{L}$ (converted to kilos) associated with alternative L' on 1979-80 Florida data (Berkeley and Houde) and with the 1983 South Carolina data

*Their reported value was slightly different, 72.1 kg is our calculation of $\bar{L}$ on their data, given L' = 130 cm. The terminology is somewhat confusing because of the way the computer print-out is interpreted. L' is converted to age and then read as "age liable to capture" on the print-out. L is converted to weight and then read as average weight on the print-out.

are indicated on the computer printout. In order for $\bar{L}$ to decline from what Berkeley and Houde observed in 1979-80 (72.1 kg) to the 1983 observed value in South Carolina (68.0 kg) requires fishing mortality to increase from approximately 0.22-0.23 in 1979 to 0.26 - 0.27 in 1983. This would have been an increase of 13-23 percent. Note however that both the 1979 and 1983 F levels are still below the theoretical maximum YPR level. This is not likely to be the situation because the 1983 length frequency mode is around 100-120 cm which implies that age liable to capture is now smaller than 130 cm.

For comparative purposes, we can find the fishing mortality value (column one) that corresponds with the observed $\bar{L}$ (column six in kilos) for the 1983 South Carolina data given different assumed L'. These rows are indicated on the printout for ages liable to capture of 2.0 (L' = 118.5 cm), 1.5 (L' = 109.0 cm), and 1.0 (L' = 98.6 cm). These fishing mortality rates (column one) are then compared with the mortality rate (column one) that maximizes YPR (column three) for the same age liable to capture.

SUMMARY OF THE PERCENT THAT 1983 FISHING MORTALITY IS OVER MAXIMUM YPR GIVEN DIFFERENT ASSUMED AGES LIABLE TO CAPTURE

L' (cm)	$\bar{L}$ (kg)	F	F_{max}	$(F_{max}-F)/F$
127.7	68.0	.25-.30	.20	-6% (below F_{max})
118.5	55.0	.30-.35	.25	24% (above F_{max})
98.6	45.1	.25-.30	.20	30% (above F_{max})

The percentages in the last column in the foregoing table are the critical information for decision making. We believe that the best estimate of L' is around 118.5 cm. Therefore, the best estimate of the percent reduction that would be applied to the variable season closure would be approximately 25 percent.

Approach 3: Delaying the Harvest of Small Fish - Closure with Plan Implemented Based on Data from the Range of the Fishery

Members of the swordfish industry submitted data under the auspices of a data collection program developed by John Hoey while serving as a visiting scientist with the South Atlantic Council. These data allowed the Councils to expand the data set provided by the State of South Carolina and for the first time examine the size composition of the commercial catch from the New England, Mid-Atlantic, South Atlantic, Florida, and Gulf of Mexico areas. Without the cooperation of these individuals, the swordfish source document and plan would not contain the large amount of original data and detailed technical analyses that they currently contain.

The variable season closure approach was initially based on a monthly landings index calculated using pounds of catch as recorded by the NMFS. The monthly landings index (MLI) represents the percentage of annual landings that occur in a particular month. Public hearing comments suggested that the Councils use the volunteered data based on pounds of swordfish or better yet numbers of swordfish. This was done using both the average (1980-83) and latest (1983) MLI values calculated using NMFS recorded pounds of catch as well as the voluntary data submitted for 1983 (both pounds and numbers). The results (Tables 1-4; Appendix B) illustrate that the MLI values are not greatly influenced by the method of calculation based on: 1) NMFS average 1980-83 or 1983 recorded pounds of catch, 2) 1983 volunteered pounds of catch, or 3) 1983 volunteered numbers of swordfish caught. (Note: Table 14 (Appendix B) contains the MLI values by area by year for 1980-1983 based on NMFS recorded pounds of catch.)

The next step was to use the weight frequency data to look at the importance of small fish to the catch composition. There are currently four market categories present in the swordfish fishery: 1) pups - less than 25 pounds dressed weight, 2) small - 25 to 49 pounds dressed weight, 3) medium - 50 to 99 pounds dressed weight, and 4) large - over 100 pounds dressed weight. A small fish index was calculated from the 1983 volunteered data for fish ≤ 25 lb, ≤ 50 lb and ≤ 70 lb dressed weight (Tables 5-8; Appendix B). The small fish index is calculated by multiplying the monthly landings index based on numbers of swordfish by the percentage of swordfish that are within the particular size category that month. For example if the MLI was 5.00 for the month of January (i.e. 5% of the annual catch occurs in January) and the percentage of swordfish ≤ 50 lb was 20%, then the small fish index (SFI) would be equal to 1.00.

The choice of which size group to use was based on the price for different market categories, the rate of growth from one category to another, and the magnitude of the absolute change in size composition. Using the category of ≤ 25 lb dressed weight would result in large closures because the percent of the catch in this category has changed by a large amount from 1980 to 1983. Currently there is no market category at 70 lb dressed weight and again the magnitude of the closures would be large based on the changes in size composition of this category. The Councils chose the small fish index based on swordfish ≤ 50 lb dressed weight. This corresponds to an existing market category and the magnitude of change for this size grouping was not as great as the others. The changes in size composition from 1980 to 1983 are summarized in Table 9 (Appendix B).

The percentage of swordfish ≤ 50 lb dressed weight by area was used to calculate the numbers of fish in this category (Table 10; Appendix B). This was done by calculating the numbers of swordfish caught in each area (NMFS recorded pounds of catch divided by the average size from the volunteered data) and multiplying by the percent ≤ 50 lb dressed weight. The number of small fish in each area was summed to estimate the total numbers caught. Estimates are that 33,750 swordfish ≤ 50 lb dressed weight were caught in 1980 and that 39,718 were caught in 1983, an increase of about 18 percent.

Time and area closures ("variable season closure") are calculated to reduce the catch of small fish in all areas. The Swordfish Fishery Management Plan goes into more detail about the dates chosen, impacts of the closure, benefits of the closure, etc. The reader is encouraged to review that document for a more complete discussion of the variable season closure.

8.1.6 Probable Future Condition

8.1.7 Interdependence on Other Species

8.1.7.1 Incidental Species

Species composition of the incidental bycatch from 1,588 sets of New England style swordfish effort is shown in Table 9. The incidental bycatch of sharks accounted for the largest single component of the total catch (68.5 percent), more than twice the catch of swordfish (29.6 percent). Tuna accounted for 0.8 percent of the total catch, miscellaneous teleosts (primarily lancetfish) added an additional 0.6 percent and billfish (primarily white marlin) added only 0.5 percent. In comparing the number of billfish caught versus the number of swordfish caught, the data in Table 9 indicate that the billfish bycatch is 1.7 percent of the swordfish catch while it accounts for only half of one percent of the total catch. The value of 1.7 percent agrees well with the data presented in the Swordfish Source Document (May 1982) which predicts 1.5 percent of the swordfish catch.

Table 9. Species and effort totals for swordfish effort 1963-82. Species totals, percentages, and mean CPUE values (mean CPUE calculated by averaging individual sets) listed in descending order of percentage of species composition. (Source: Hoey and Casey, 1983a)

Species	Number	Percent	Mean CPUE
Blue shark	32,467	37.0	1.65
Swordfish	25,914	29.6	1.17
Misc. sharks	14,042	16.0	.80
Hammerhead shark	3,989	4.5	.29
Blacktip shark	3,407	3.9	.18
Mako shark	2,974	3.4	.16
Sandbar shark	1,226	1.4	.08
Dusky shark	1,185	1.4	.06
Tuna	683	.8	.04
Misc. Teleosts	565	.6	.03
Marlin	441	.5	.02
Tiger	313	.4	.02
Thresher	296	.3	.03
Lamnids	133	.2	<.01
Silky	27	<.1	<.01
Effort			
Total Catch	87,662		
Total Hooks	1,883,694		
Total Sets	1,588		
No. Caught/Set[1]	55.2		
No. Hooks/Set[2]	1,186		
Avg. Total CPUE	4.53		

[1]Calculated by dividing total catch by total sets.

[2]Calculated by dividing total hooks by total sets.

To gain a better understanding of the incidental bycatch associated with longline effort directed at swordfish, it is helpful to compare that data to effort targeting tunas and sharks. Species composition and effort data are provided for longline fisheries targetting sharks, swordfish, and tuna in Table 10 (Hoey and Casey, 1983b). Records from over 2,500 sets of gear accounting for 1.9 million hooks and the capture of over 92,000 sharks and teleosts were analyzed. The fishing area included the Gulf of Mexico and the east coast of North America to the Tail of the Grand Banks. Information was also obtained from U.S. observers stationed aboard Japanese vessels fishing within the U.S. Fishery Conservation Zone (FCZ). The observers recorded catches of 143,000 sharks and teleosts on 2,272 sets with total effort exceeding 4.9 million hooks. Data from the inshore (depth less than 100 meters) and offshore shark fisheries were combined to form a single NMFS shark effort category. The relative proportions of the different species caught by each longline fishery are shown in Figure 13 (Casey et al., 1983).

The U.S. swordfish effort and the Japanese tuna effort are established commercial fisheries, whereas the NMFS shark and tuna effort was more exploratory in nature. Directed tuna effort (both NMFS and Japanese) produces a larger proportional catch of teleosts than does effort directed at swordfish and sharks. Tuna fisheries produce higher proportions of billfish (excluding swordfish) and other teleosts, whereas the swordfish fishery produces a higher shark bycatch. These results indicate similarities in activity patterns between swordfish and sharks which are more active at night, and tunas and billfish which are more active during the day. Fishermen exploit these differences by fishing primarily during the nighttime for swordfish and during the daytime for tunas. Fishermen also attempt to fish within the preferred temperature range of their target species by regulating the depth of the line and fishing in different geographic areas. Differences in fishing grounds partially account for differences in the proportions of swordfish caught by the Japanese and NMFS tuna fisheries (3.4 percent vs 12.4 percent, respectively). The NMFS tuna effort occurred primarily north of Cape Hatteras and was directed at bluefin tuna. The Japanese effort was more evenly distributed throughout the Gulf of Mexico and Atlantic FCZ, and was primarily directed at yellowfin, bigeye, and albacore tuna. Relatively large catches of bluefin

Table 10. Species and effort summaries by fishery. (Mean CPUE was calculated by averaging individual sets.) (Source: Hoey and Casey, 1983b.)

Species	Inshore Shark Fishery Number	Inshore Shark Fishery Percent	Inshore Shark Fishery CPUE[1]	Offshore Shark Fishery Number	Offshore Shark Fishery Percent	Offshore Shark Fishery CPUE	Commercial Swordfish Fishery Number	Commercial Swordfish Fishery Percent	Commercial Swordfish Fishery CPUE	NMFS Tuna Fishery Number	NMFS Tuna Fishery Percent	NMFS Tuna Fishery CPUE[2]	Japanese Tuna Fishery Number	Japanese Tuna Fishery Percent	Japanese Tuna Fishery CPUE[3]
Sharks															
Blue shark	2,724	59.0	5.04	4,129	65.2	5.41	25,413	33.8	1.42	1,166	17.9	.83	22,620	15.7	
Hammerhead	75	1.6	.18	336	5.3	.47	3,619	4.8	.31	108	1.7	.08	369	.3	
Blacktip	57	1.2	.35	-	-	-	3,308	4.4	.20	-	-	-	49	<.1	
Mako	93	2.0	.18	362	5.7	.56	2,152	2.9	.13	101	1.6	.08	1,817	1.3	
Sandbar	664	14.4	1.62	68	1.1	.13	1,164	1.5	.08	1	<.1	<.01	71	<.1	
Dusky	179	3.9	.46	91	1.4	.11	1,105	1.6	.07	78	1.2	.07	587	.4	
Tiger	142	3.1	.30	22	.3	.03	297	.4	.02	4	.1	<.01	285	.2	
Thresher	17	.4	.03	77	1.2	.10	216	.3	.02	3	<.1	<.01	919	.6	
Silky	50	1.1	.12	126	2.0	.17	27	<.1	<.01	124	1.9	.08	487	.3	
Lamnids	35	.8	.09	19	.3	.02	110	.1	<.01	31	.5	.02	255	.2	
Misc. sharks	522	11.3	1.41	193	3.0	.25	12,764	17.0	.85	171	2.6	.13	2,787	1.9	
Teleosts															
Swordfish	7	.2	.01	413	6.5	.35	23,354	31.1	1.22	806	12.4	.46	4,934	3.4	
Tuna	8	.2	<.01	298	4.7	.26	627	.8	.04	3,377	51.9	2.33	70,151	48.8	
Billfish	4	<.1	<.01	21	.3	.02	438	.6	.02	78	1.2	.05	4,591	3.2	
Misc. Teleosts	41	.9	.11	177	2.8	.24	518	.7	.03	463	7.1	.34	33,728	23.5	

Effort	Inshore Shark Fishery	Offshore Shark Fishery	Commercial Swordfish Fishery	NMFS Tuna Fishery	Japanese Tuna Fishery
Total Catch	4,618	6,332	75,192	6,511	143,650
Total Hooks	47,356	80,252	1,609,411	144,890	4,975,181
Total Sets	538	309	1,368	331	2,272
No. Caught/Set[4]	8.6	20.5	54.9	19.7	63.2
No. Hooks/Set[5]	88	260	1,176	438	2,190
Avg. Total CPUE	9.91	8.12	4.44	4.48	N/A

[1]Based on 527 sets.

[2]Based on 330 sets.

[3]No CPUE values availab.e

[4]Calculated by dividing total catch by total sets.

[5]Calculated by dividing total hooks by total sets.

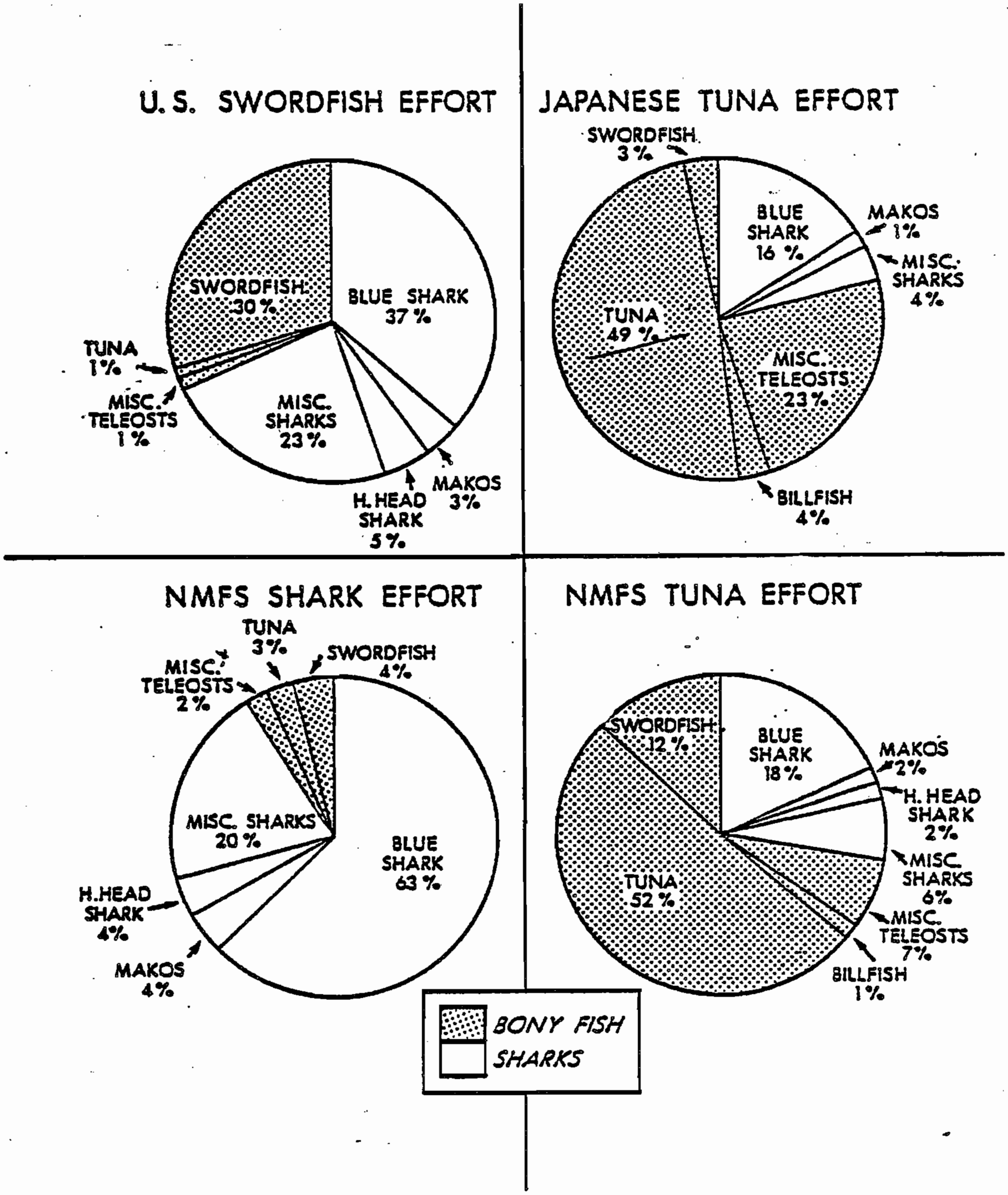


Figure 13. Species composition (%) from longline fisheries in the western North Atlantic. (Source: Casey et al., 1983.)

tuna were often associated with large catches of swordfish in both the NMFS and Japanese data. This relationship reflects greater similarities in temperature preferences, between swordfish and bluefin tuna than between swordfish and the other more tropical tunas. It may also reflect preferences for regions characterized by sharp thermal gradients. With respect to differences in catch during the day and night, the proportion of billfish (marlins) caught by the NMFS tuna effort (primarily daytime effort) was double that produced by the commercial swordfish effort (night), despite greater swordfish effort in southern areas where billfish are more abundant.

Based on the values in Table 10, the NMFS tuna fishery occupies a position midway between the swordfish and Japanese tuna fisheries, in terms of the proportion of swordfish and billfish caught. As previously mentioned, this can be partially attributed to differences in the areas exploited and target species sought. Of greater importance, however, is that night sets were made during some of the NMFS tuna cruises. These sets established the commercial feasibility of longline exploitation of swordfish stocks off the U.S. east coast. The published fishing records from these early Bureau of Commercial Fisheries and NMFS cruises (Wilson and Bartlett, 1967; Casey and Hoenig, 1977 - Appendix 9) did however list time at the start and end of the set. These data allow for a more thorough examination of day versus night sets. In Table 10, 331 sets of NMFS tuna effort produced 3,377 tuna, 78 billfish, and 806 swordfish. Of the 331 sets summarized, 226 sets occurred between 0500 and 1800 hours. Those sets produced 2,964 tuna, 73 billfish, and only 6 swordfish. Sixty eight percent of the sets (all daytime sets) produced 88 percent of the tunas, 94 percent of the billfish and only 0.7 percent of the swordfish. The remaining night sets (105 -32 percent) produced 413 tuna (12 percent), 5 billfish (6 percent) and 800 swordfish (99 percent). These data dramatically substantiate the temporal segregation between tuna and billfish which are more vulnerable to daytime longline effort, and swordfish which are more vulnerable to nighttime effort.

8.1.8 Estimate of MSY

8.1.8.1 Yield-per-Recruit Analysis

8.2 Description of Habitat

8.2.1 Condition of Habitat

Effort distribution data from various areas in the U.S. commercial swordfish fishery (Berkeley and Irby, 1982 - Florida East Coast; Hoey and Casey, 1983a - North of 35° N) indicate a rather narrow concentration of effort along the edge of the shelf and along frontal zones between water masses (Section 8.1.3.4). Assuming that the prevalent effort distribution pattern reflects economic forces which have sought maximization of catch rates, then swordfish are apparently restricted to a rather narrow horizontal zone. In the Swordfish Source Document (May 1982) the importance of the Gulf Stream system is emphasized as the primary hydrographic habitat of the swordfish. The importance of the position of the "North Wall" and the location of meanders and eddies is especially important north of Cape Hatteras. Hoey and Casey (1983a) classified 165 longline sets from 1978-1980 into seven water mass types. All sets were located north of 35° N and west of 55° W, and classification was based on the date and location of the set, surface water temperature and the correlation and plotting of these values on weekly National Earth Satellite Service oceanographic analyses charts (modified by the Atlantic Environmental Group (AEG), Narragansett, Rhode Island). Water mass totals for sets and swordfish along with the mean swordfish CPUE and the CPUE rank were calculated (Table 11). The following is taken directly from the manuscript:

There were 59 autumn sets, 58 summer sets, 32 spring sets and 16 winter sets. An analysis of variance on rank transformed CPUE values indicates that effects of season, water mass, and season-water mass interaction on CPUE are all significant. The multiple range tests indicate that the summer and autumn CPUE ranks do not differ significantly, but they are significantly greater than the winter and spring ranks. With regard to the water mass ranks, the slope, shelf-slope front, ring edge and northwall values do not differ significantly from each other, but are significantly greater than the ring, Gulf Stream, and shelf rank values. Only the highest average rank from the slope and the lowest average rank from the shelf are distinctly different, while there is some overlap between the remaining ranks in the two major groupings. The mean CPUE rank for the slope is clearly the highest value; however the remaining values indicate that frontal zones between water masses are more productive than the water masses themselves. When the water mass ranks are compared within seasons, the results from an

Table 11. Total number of sets and swordfish, and mean swordfish CPUE values and mean CPUE rank, by water mass (Source: Hoey and Casey, 1983a).

Water mass	Sets	Total Swordfish Caught	Mean CPUE	Mean CPUE Rank
Shelf	10	55	.36	42.7
Shelf/slope front	43	975	1.53	88.9
Gulf Stream	13	69	.52	53.3
Northwall of Gulf Stream	26	511	1.35	78.4
Ring	7	72	.91	72.4
Ring edge	44	973	1.35	88.6
Slope	22	657	1.87	105.1
	165	3,312		

ANOVA indicate that the water masses are not significantly different from each other during the spring, summer and winter. Autumn water mass ranks form two groups with the northwall, shelf-slope front, and slope ranks exceeding the ring edge, ring, Gulf Stream and shelf ranks. There is some overlap between these groups with the average rank from the ring edge not significantly different from the average ranks from the shelf-slope front and slope.

The water mass data (Table 11) indicate that swordfish catch rates are significantly greater in the slope water and along frontal zones. Effort in the slope water mass is the most productive. The areal extent of the slope water is seasonally controlled by the extent and offshore boundary of the shelf water. When the shelf-slope front is further offshore, the areal extent of the slope water is reduced, and this may act to further concentrate swordfish, increasing the productivity of effort in that area. Additional data are necessary before this hypothesis can be tested. Effort along frontal zones delineating two water masses however, is generally very productive, indicating that swordfish may concentrate there. Squire (1962), Laurs and Lynn (1977), Sharp (1978), and Roberts (1980) have all documented a similar tendency for tunas to aggregate along frontal zones. These productive areas between water masses may represent the feeding habitat of large oceanic predators. Swordfish are commercially concentrated along frontal zones which can be very effectively exploited by wide-ranging longline vessels. This may partially account for the responsiveness of the swordfish stocks, in terms of changing catch rates and average sizes, to increasing fishing effort.

8.4 Description of Fishery Activity

8.4.1 History of Exploitation

8.4.1.1 Recreational

No new information on the historical recreational fishery is available.

8.4.1.2 Commercial

Hoey and Casey (1983a) provide additional information on the catch rates and average sizes caught from 1963-1982 including additional records from the clandestine fishery in the early 1970's.

8.4.2 Domestic Recreational and Commercial Fishery Activities

8.4.2.1 Participating User Groups

8.4.2.1.1 Recreational

In the Swordfish Source Document (May 1982) the rapid expansion and the decline of the recreational swordfish fishery was described. Poor recreational fishing success in 1979 and subsequent years has caused the cancellation of tournaments and reduced recreational interest in swordfish. Data provided by the Stuart Sailfish Club (Figure 14) confirm decreasing angler interest and also decreasing catches. This trend is also apparent in the South Carolina recreational records (Figure 15) which indicate that 1978 was the banner year for the recreational swordfish fishery. In a survey of New Jersey's offshore recreational canyon fishery which primarily targets tuna, 86 swordfish were reported captured in 1981 and 53 were reported in 1982 (Figley et al., 1983).

8.4.2.1.2 Commercial

Changes have occurred in the characteristics of the commercial effort directed at swordfish in the western North Atlantic. Most Cuban-American type effort (Berkeley et al., 1981) has been replaced by the primarily monofilament gear first popularized by Florida east coast fishermen. This southern style gear has been widely accepted, it has replaced the older New England style gear (Ruhle, 1969), and it now represents the dominant gear type used in the U.S. commercial fishery. Another major change which has occurred since 1980 involves the sizes and numbers of vessels which characterize the highly mobile component of the fleet. In 1979 and 1980, the highly mobile vessels were primarily larger New England boats which fished from the Gulf of Mexico and the Florida Keys (winter months) to the Tail of the Grand Banks (summer-fall). At that time (1979-80), the smaller southern vessels (particularly Florida boats) were not considered to be very mobile. Between 1980 and 1983 many of the smaller vessels, which had primarily operated off the east coast of Florida, expanded their range through the Carolinas and into the Mid-Atlantic area. Currently the smaller vessels operate throughout the entire range of the U.S. fishery from the Straits of Florida to the U.S.-Canadian boundary. Some of these vessels have even made trips to the Tail of the Grand Banks, an area which previously had only been exploited by the largest and most weather safe vessels. In general terms, the number of vessels which would be classified as highly mobile, moving up and down the east coast focusing effort on the most productive areas, has surely increased. The effectiveness of each of these vessels has

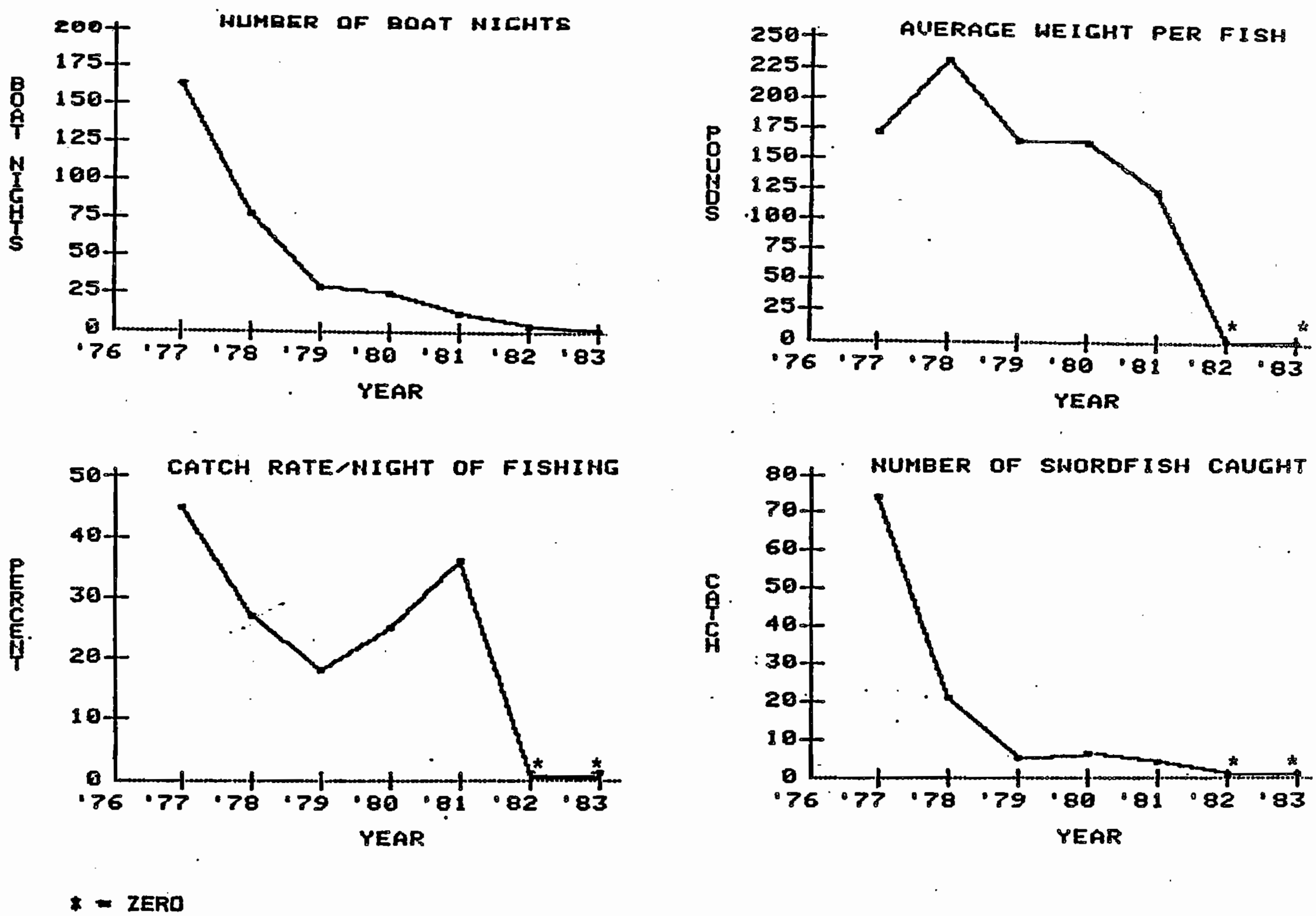


Figure 14. Swordfish statistics from the Stuart Sailfish Club. (Source: Robert Pelosi, Stuart Sailfish Club, Stuart, FL; pers. comm.)

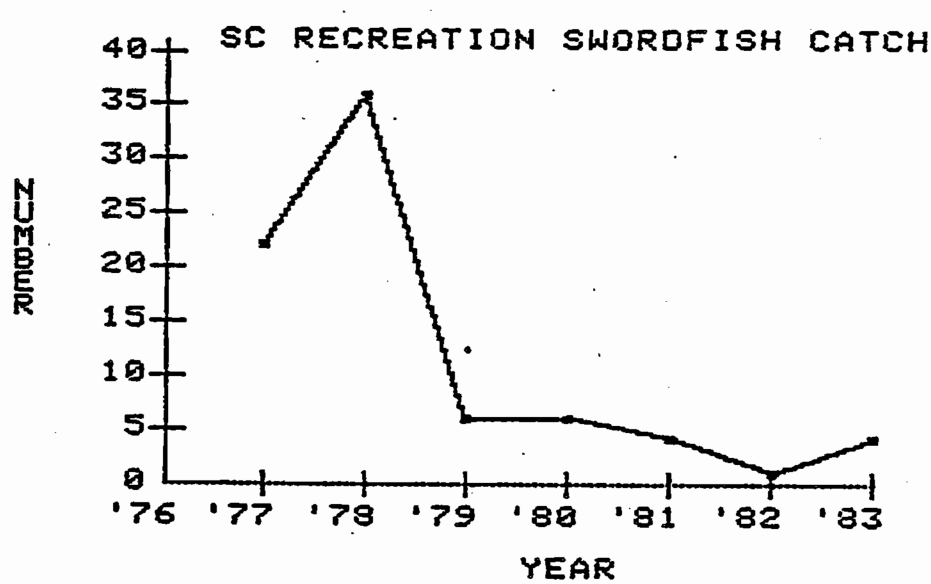


Figure 15. South Carolina recreation swordfish catch (Source: S.C. Wildlife and Marine Resources Department, unpubl. data).

also increased as they have shifted to the more sophisticated monofilament gear. These highly mobile vessels probably account for more landings than would be indicated by their proportional importance in the total fleet. Resident smaller vessels, (fishing year round in their respective areas) were primarily confined to Florida's east coast in 1979-1980. In 1983 resident vessels operated out of Florida, South Carolina, Virginia, Maryland, and New Jersey. Many of these operators are either part-time commercial fishermen, supplementing income from charter boat fishing; or full-time commercial fishermen who fish for snappers, groupers, tilefish, and other species when they are not targeting swordfish or tuna.

Since 1979-80 the number of individuals participating in each of these user groups has probably increased. This has occurred because of the high value of the product and because gear modifications, the use of smaller boats, and diversification into other longline fisheries (tunas or bottom fish) has reduced the initial cost of entering the fishery. Although accurate estimates of the numbers of vessels in each user group category are not currently available, the Management Councils and the National Marine Fisheries Service are planning to remedy this deficiency by the end of 1984 through a data collection plan which has a swordfish fishery survey as one of its components.

8.4.3 Vessels and Fishing Gear

8.4.3.1 Recreational

No new information.

8.4.3.2 Commercial

As mentioned in Section 8.4.2.1.2, the southern style monofilament longline has become widely accepted throughout the U.S. fishery. Currently, fewer hooks are used per set, hook spacing is wider, the total length of the mainline fished per set is longer, and the sophistication of the individual branch lines (gangions) complete with cyalume light sticks is greater than was used during the late 1970's. The use of sea surface temperature analysis charts has also become more widespread (Figure 16). The traditional New England harpoon fishery remains relatively unchanged (Figure 17). Large mesh entanglement nets are used by a small number of vessels primarily in the New England area. Documentation of the effectiveness of the gear is lacking. The Councils and the National Marine Fisheries Service are working towards establishing an observer program for these vessels so that data can

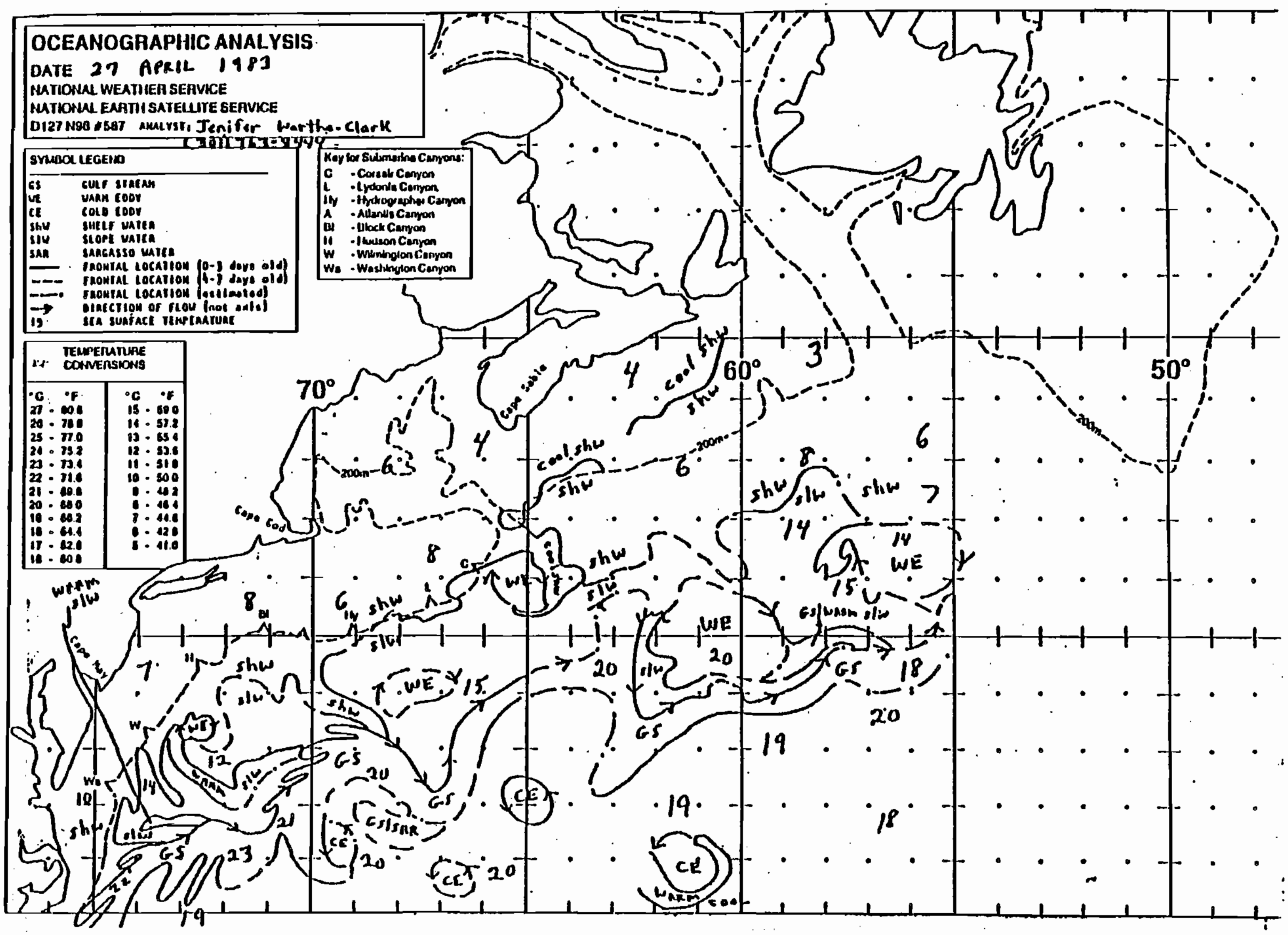


Figure 16. Oceanographic Analysis for 27 April 1983. (Source: Clark et al., 1983.)

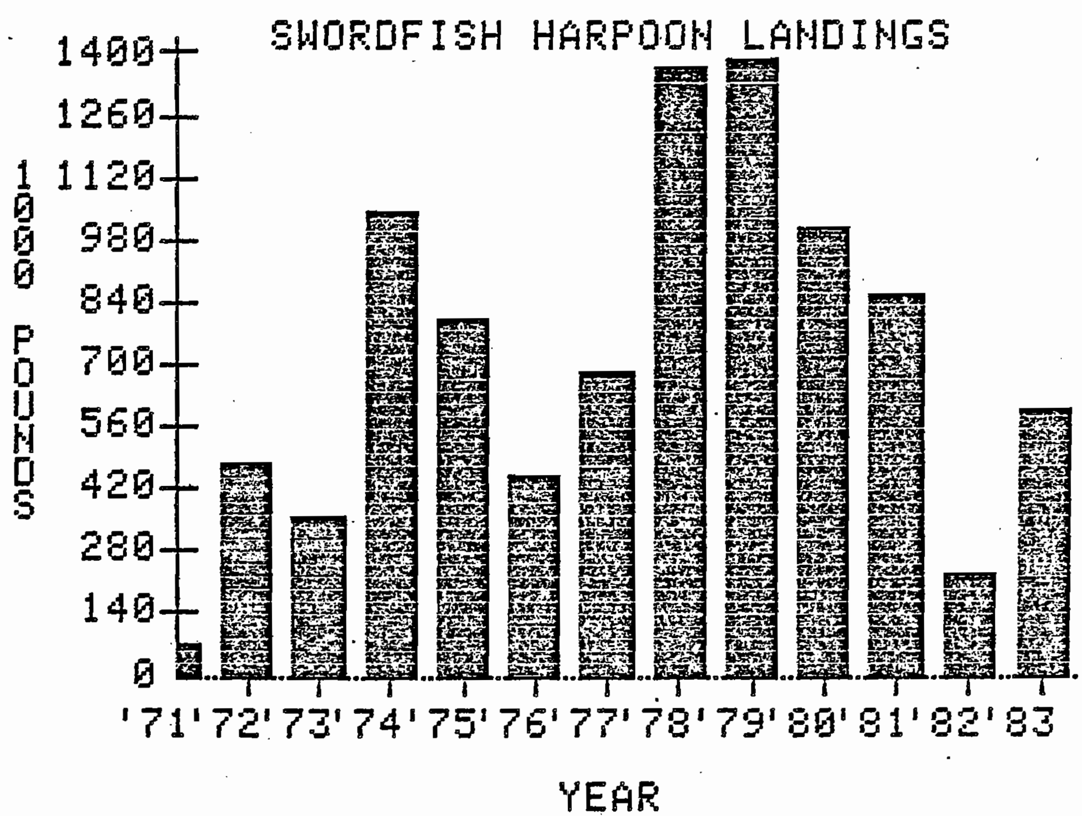


Figure 17. Harpoon landings for the years 1971 through 1983. (Source: 1971-76 Fishery Statistics of the U.S.; 1977-83 NMFS Unpubl. Data)

be collected to help resolve this contentious issue. The recent use of these large mesh entanglement nets by U.S. fishermen started in California. This gear was originally used in a directed fishery for pelagic sharks, primarily the common thresher, Alopias vulpinus, and the bonito shark, Isurus oxyrinchus (Cailliet and Bedford, 1983). Blue sharks, Prionace glauca, are also taken in large numbers; however, marketing problems currently limit their retention for sale. Swordfish were at first a relatively small but desirable bycatch. As fishermen gained experience with the net and expanded their range of operation, the gear became very effective to use during the late summer and early fall to harvest swordfish (Bedford and Hagerman, 1983). In response to the market demand for sharks and swordfish, the number of vessels participating in the fishery increased from 15 in 1976 to about 200 vessels in 1981. Bedford and Hagerman (1983) review the history of California swordfish management, which has been primarily based on social and economic considerations, and they maintain that the limited activities of the commercial swordfish fleet pose no threat to the stability of the swordfish stock. At the present time there are no quotas or limits placed on the harvest of sharks and swordfish by the entanglement nets, although entry into the fishery is limited and there are gear size restrictions and some closed areas (Bedford and Hagerman, 1983). The only other known new development in the swordfish fishery has been the use of a small number (less than 4) of ultra-light airplanes in conjunction with offshore harpooning.

8.4.4 Foreign Fishing Activities

8.4.4.1 Foreign Fishing Within the FCZ

Japanese longliners fish for tunas within the U.S. FCZ, although the number of vessels deployed has been reduced over levels observed in the mid-1970's. Table 12 updates swordfish bycatch values presented in the Swordfish Source Document (May 1982) Tables 8-20 and 8-21. Table 13 documents the swordfish bycatch by area for 1978-1980.

Based on observer records from July 1982 through December 1982, with coverage ranging from a low of 63 percent (December) to 100 percent (August and November), 1,020 swordfish were reportedly captured of which 537 (53 percent) were released alive, 459 (45 percent) were released dead, and 24 (2 percent) were released with status undetermined. During that period, the swordfish bycatch accounted for 77 percent of the total incidental catch of billfish and 5.1 percent of the total catch of tunas.

Table 12. Total incidental swordfish catch (number of fish) extrapolated from observer data and data reported by the Japanese. (Source: NMFS Observer Program Data.)

	ATLANTIC		GULF		TOTAL	
	Japanese data	Observer data	Japanese data	Observer data	Japanese data	Observer data
1978	4,222	5,639	770	987	4,992	6,626
1979	1,347	1,999	2,450	2,426	3,797	4,425
1980	2,843	3,660	2,068	4,415	4,911	8,075
1981	6,314	1,321*	2,148	480*	8,462	1,801*
1982	1,136	1,028*	0	0	1,136	1,028*
1983		249		0		249

*These are preliminary data obtained with less than 100 percent observer coverage. Near 100 percent coverage was accomplished in 1982.

Table 13. Longline incidental swordfish catch (number of fish) by area as reported by the Japanese and extrapolated from Observer data. (Source: NMFS Observer Program Data)

	1978	1979	1980
Japanese Data			
Gulf	770	2,450	2,068
South Atlantic	828	394	558
Mid-Atlantic	3,382	953	2,285
New England	12	-	-
Total	4,992	3,797	4,911
Observer Data			
Gulf	987	2,426	4,415
South Atlantic	1,106	526	524
Mid-Atlantic	4,533	1,473	3,136
New England	-	-	-
Total	6,626	4,425	8,075

With 100 percent coverage in 1983, 249 swordfish were recorded of which 79 (32 percent) were released alive, 169 (68 percent were released dead, and 1 was released with status undetermined. Swordfish account for 67 percent of the total incidental catch of billfish, and 2.1 percent of the total catch of tunas.

A more detailed species account of the catches associated with Japanese longline effort in the U.S. FCZ, based on observer records from 1978-1981, is provided in Table 14. Tunas account for 49 percent of the total catch in all areas combined, followed by miscellaneous teleosts (23 percent), sharks (21 percent), swordfish (3.4 percent), and other billfish (3.2 percent). The swordfish bycatch represents 7 percent of the tuna catch based on the numbers of individuals caught.

The largest proportional catch of tunas (58 percent of the total catch) occurred in the Gulf of Mexico. Effort there also produced the largest percentages of billfish (6.7 percent) and swordfish (7.4 percent). In the Atlantic south of Cape Hatteras, the proportion of tunas (55.6 percent) and billfish (5.9 percent) remained high, but the swordfish bycatch (2.1 percent) was much lower. The reduction in the proportional catch of swordfish from 7.4 percent to 2.1 percent can be partially explained by a change in the relative importance of the different species of tunas caught. Whereas bluefin tuna account for 0.2 and 1.5 percent of the total tuna catch in the Atlantic south of Hatteras and Atlantic north of Hatteras, respectively, in the Gulf of Mexico bluefin account for 37 percent of the total catch of tunas (tuna species composition data not provided in Table 14).

Sharks accounted for 13 and 17 percent of the total catch in the Gulf of Mexico and Atlantic south of Cape Hatteras, respectively. In the Atlantic north of Cape Hatteras, the shark bycatch was the highest (25 percent) while the proportions of tunas (43.5 percent) and billfish (1.2 percent) were lower than values for the more southern areas. The proportions of swordfish landed north of Cape Hatteras, (3.0 percent) exceeded the value in the Atlantic south of Cape Hatteras, but was lower than the corresponding value in the Gulf of Mexico. North of Cape Hatteras, swordfish account for 72 percent of the total billfish catch with white marlin contributing an additional 24 percent. Swordfish account for 6.8 percent of the total catch of tunas north of Cape Hatteras.

Table 14. Summary of U.S. observer records of Japanese longline effort in the U.S. Fishery Conservation Zone 1978-1981. Data provided by the Southeast Fisheries Center of NMFS.

	Gulf of Mexico		Atlantic South of Cape Hatteras		Atlantic North of Cape Hatteras		Total All Areas	
	Number	%	Number	%	Number	%	Number	%
Blue shark	136	.6	3,903	10.9	18,581	21.7	22,620	15.7
Hammerhead	69	.3	208	.6	92	.1	369	.3
Blacktip	25	.1	22	.1	2	<.1	49	<.1
Mako	607	2.7	391	1.1	819	1.0	1,817	1.3
Sandbar	19	.1	48	.1	4	<.1	71	<.1
Dusky	387	1.7	90	.3	110	.1	587	.4
Tiger	92	.4	118	.3	75	.1	285	.2
Thresher	245	1.1	401	1.1	273	.3	919	.6
Silky	453	2.0	29	.1	5	<.1	487	.3
Lamnids	118	.5	37	.1	100	.1	255	.2
Misc. sharks	717	3.2	976	2.7	1,094	1.3	2,787	1.9
Swordfish	1,641	7.4	753	2.1	2,540	3.0	4,934	3.4
Tuna	13,011	58.3	19,960	55.6	37,180	43.5	70,151	48.8
Billfish	1,486	6.7	2,101	5.9	1,004	1.2	4,591	3.2
Misc. Teleost	3,310	14.8	6,839	19.1	23,579	27.6	33,728	23.5
Total Catch	22,316		35,876		85,458		143,650	
Total Hooks	1,596,052		822,140		2,556,989		4,975,181	
Total Sets	768		374		1,130		2,272	

Data on the incidental catch of swordfish in the foreign squid trawl fishery are updated in Table 15. Although the observed bycatch (42,000 lb) is only slightly lower than 1981 and 1982 levels, the extrapolated total bycatch is about half the reported 1982 value. This is most likely due to a reduction in the number of foreign vessels trawling for squid off our coast as joint ventures have increased in importance.

8.4.4.2 Foreign Swordfish Fishing in the North Atlantic

Total reported commercial landings of swordfish from the North Atlantic are listed by country in Table 16. From 1978 to 1982, Spain and the U.S. accounted for between 42 and 71 percent of the total reported landings. Adding Canada and Japan raises the proportion of the total catch accounted for between 69 and 85 percent. These FAO statistics however do not correspond exactly to data presented in other sections of this addendum. U.S. reported commercial landings (Table 8, Section 8.1.5.6) for 1978, 1979, and 1980 exceed values in the FAO statistics by a few hundred thousand pounds. In 1981, the FAO landings for the U.S. are greater than those listed in Table 8; then in 1982, the U.S. catch in Table 8 exceeds that reported in the FAO statistics. The estimated 1981 Canadian harvest was reported to range between 2.9 and 3.9 million pounds (Section 8.1.5), almost triple the FAO reported value. Although these discrepancies need to be addressed, the relative magnitudes of each nation's total landings may be fairly accurate.

8.4.4.3 Foreign Swordfish Fishery in the Western North Atlantic

Total reported commercial landings of swordfish from the western North Atlantic are listed by country and year (1978-1982) in Table 17. The U.S. accounted for between 45 percent (1978) and 75 percent (1981) of the total landings. This percentage decreased slightly to 71 percent in 1982. Combining the U.S. and Canada accounted for between 87 and 89 percent of the total landings between 1978 and 1982 (Table 18). Western North Atlantic landings (FAO areas 21 and 31) accounted for 53 percent of the total reported landings in the North Atlantic (FAO areas 21, 31, 27, and 34) in 1978. This increased to a peak of 73 percent in 1979 and has decreased each year since to 42 percent in 1982.

8.4.5 Conflicts Between Domestic and Foreign Fishing

Recent revisions to the PMP for Atlantic Billfishes and Sharks (June, 1983) present the following material which summarizes reported conflicts:

Table 15. Foreign squid trawls swordfish bycatch. (Source: NMFS Observer Program Data.)

Year	Observed Bycatch (lb)	Extrapolated Total Bycatch (lb)
1980	43,793	144,522
1981	49,152	162,207
1982	47,366	176,298
1983	42,022	85,888

Table 16. Swordfish catches (pounds) from the North Atlantic.* (Source: FAO, Yearbook of Fishery Statistics)

	1978	1979	1980	1981	1982
Canada	6,730,643	6,547,662	4,153,466	1,272,054	2,078,938
Cuba	1,322,760	881,840	1,309,532	824,520	1,512,355
Japan	1,265,440	1,194,894	2,422,855	1,483,696	1,990,754
Korea Republic	2,204,600	961,205	1,463,854	961,206	1,430,786
Morocco	394,623	458,557	299,826	275,575	224,869
Poland	13,228	a	2,205	a	a
Spain	5,222,697	2,202,395	3,919,778	6,375,703	10,809,153
Togo/Ghana	4,160,080	a	242,506	22,046	11,023
USA	7,125,267	7,321,476	8,095,291	8,004,903	8,258,431
USSR	321,871	127,867	308,644	79,366	198,414
Venezuela	101,412	147,708	88,184	55,115	55,115
Portugal	37,478	63,933	33,069	a	a
France	a	a	11,023	8,818	a
Liberia	a	a	11,023	83,775	74,956
Other[b]	705,472	1,234,576	714,290	709,882	652,562
Total	29,605,571	21,142,113	23,075,546	20,156,659	27,297,356

* FAO statistical reporting areas 21, 27, 31 and 34.
a None reported
b FAO estimate

Table 17. Swordfish catches (pounds) from the western North Atlantic.* (Source: FAO, Yearbook of Fishery Statistics)

	1978	1979	1980	1981	1982
Canada	6,730,643	6,547,662	4,153,466	1,272,054	2,078,938
Cuba	881,840	220,460	471,784	350,531	235,892
Japan	593,037	577,606	815,702	683,426	568,787
Korea Republic	24,251	a	a	a	57,320
Morocco	a	a	a	a	a
Poland	13,228	a	2,205	a	a
Spain	a	a	a	a	4,409[b]
Togo/Ghana	a	a	a	a	a
USA	7,125,267	7,321,476	8,095,291	8,004,903	8,258,431
USSR	a	a	a	a	a
Venezuela	101,412	147,708	88,184	55,115	55,115
Portugal	a	a	a	a	a
France	a	a	a	a	a
Liberia	a	a	a	a	a
Other[b]	352,736	617,288	357,145	354,941	326,281
Totals	15,822,414	15,432,200	13,983,777	10,720,970	11,585,173

* FAO statistical reporting areas 21 and 31
a None reported
b FAO estimate

Table 18. Percent swordfish catch from the western North Atlantic taken by the USA, by Canada, and by both combined. (Source: FAO, Yearbook of Fishery Statistics)

	1978	1979	1980	1981	1982
USA	45	47	58	75	71
Canada	43	42	30	12	18
US and Canada	88	89	88	87	89

A conflict is a direct encounter between the vessels or gear of foreign longliners and the vessels or gear of domestic fishermen that results in: damage or destruction of fishing gear, loss of gear and associated catch through disappearance of the gear or its location buoys, preemption of fishing grounds, removal of catch from the gear, or vessel collision. Such encounters are generally inadvertent (e.g., vessel severing an unseen longline, drifting longline gear entangling longline or lobster trap buoy) but may be hostile because of differing uses of Atlantic billfishes or the fishing grounds in the FCZ as each group pursues its legitimate interests. Also, similar encounters may occur between domestic vessels and gear.

Four sources on gear conflicts were used to document whether or not gear conflicts occurred in which areas. These sources were the U.S. Coast Guard reported conflicts; Gear Compensation Files, National Marine Fisheries Service (NMFS); conflicts involving Japanese longline vessels reported by NMFS observers on Japanese or domestic vessels; and informal reports to NMFS.

There are numerous areas along the Atlantic and Gulf coasts of the United States where U.S. sportfishermen come into direct contact with foreign longliners. Some of these are in the Gulf of Mexico off Port Aransas, Texas, the Mississippi Delta off Louisiana, and the Dry Tortugas, Florida; off Cape Hatteras, North Carolina; and off New Jersey and Maryland. U.S. fishermen have reportedly destroyed longline gear, although there is no record of U.S. sportfishing gear being damaged by foreign fishermen (Charles Fuss, Jr., Southeast Regional Office, NMFS, 1982; pers. comm.). Conflicts between foreign commercial and U.S. sportfishermen reached a peak in the late 1960s and prompted private negotiations between representatives of the Japanese fishing industry and the U.S. sportfishing industry. These negotiations resulted in an informal understanding between the two parties that Japanese vessels would restrict their fishing to areas other than those where U.S. sportfishermen fished for billfishes, and U.S. sportfishing representatives would discourage the destruction of Japanese longline gear. Subsequent negotiations were conducted between the Japanese fishing industry and the U.S. commercial and sportfishing industries.

The U.S. Coast Guard provided information on reported conflicts between Japanese longline vessels (JAPLL) and domestic commercial and recreational fishermen (Table 19). Based on this information, there were 21

Table 19. Gear conflicts involving domestic and Japanese longline fishing vessels as reported by the Coast Guard. (Source: NMFS PMP for Atlantic Billfishes and Sharks, June, 1983.)

DATE	REPORTING VESSEL	LONGLINER VESSEL INVOLVED	LOCATION: LATITUDE	LOCATION: LONGITUDE	GEAR LOST	$ VALUE	PREVENTED BY CLOSURE: YES	PREVENTED BY CLOSURE: NO	FIXED GEAR BROADCASTING
1978									
1/ 3/1	Phoenix	JAPLL	39° 19'N	72° 20'W	380 pots			X	X
1979									
1/12	Yankee Clipper	JAPLL	37° 58'N	73° 54'W	—	200		X	X
1980									
2/ 9/21	Sophie G	JAPLL	--	--	160 pots	8,000	X		X
9/21	Sea Fisher I	JAPLL	39° 50'N	71° 31'W	none-entanglement		X		X
1/ 10/6	Independence	JAPLL	39° 13'N	72° 05'W	12 nautical miles of longline gear	20,000	X		
1981									
3/2	Sophie G	JAPLL	39° 30'N	72° 09'W	270 pots	19,310		X	X
6/19	Audrey Lynn	JAPLL	40° 02'N	68° 44'W	none-entanglement		X		
7/27	Reliance	JAPLL	40° 20'N	68° 10'W	3 high flyers	250	X		
8/2	JAPLL	Western Boy	39° 53'N	70° 31'W	vessel collision	43,500	X		
8/29	JAPLL	Western Boy	39° 52'N	71° 21'W	vessel collision	none	X		
8/30	JAPLL	American Boy	40° 04'N	68° 48'W	none-entanglement		X		
1/ 9/19	Colleen	JAPLL	36° 49'N	74° 38'W	Pots	25,745	X		X
9/11	Patriot	JAPLL	40° 04'N	70° 14'W	none-entanglement		X		
9/25	Taurus	JAPLL	39° 52'N	70° 40'W	none-entanglement		X		
10/8	Colleen	JAPLL	36° 50'N	74° 39'W	none-entanglement		X		
11/21	Calico Jack	JAPLL	36° 31'N	74° 09'W	none-entanglement		X		
	Venka M	JAPLL	36° 00'N	74° 03'W	5 miles of lost gear		X		
11/20	Original Jackson	JAPLL	37° 41'N	74° 09'W	3conflicts 75 pots	2,600	X		X
11/22	Dealer's Choice	JAPLL	37° 43'N	71° 56'W	7.5nm longline gear	9,000	X		
11/27	JAPLL	Happy Glen	36° 28'N	74° 16'W	none-entanglement		X		
							19	3	7

1/ Included in damage to domestic vessels and fishing gear. Attributed to foreign fishing vessels.
2/ Normal fishing grounds are covered by the closure.

gear conflict incidents involving domestic and JAPLL vessels from March 1978 through May 1982. One conflict occurred in 1978 and in 1979, three occurred in 1980, and 16 occurred in 1981. Because of no JAPLL fishing, none occurred in 1982. Of the 21 conflicts, 18 would be preventable by the proposed Atlantic closures.

The Gear Compensation Files showed that NMFS paid 15 claims between March 1978 and September 1981 for gear damage attributed to foreign vessels (Table 20). Incidents by unknown vessels and identified foreign trawlers were excluded. Of the 15 claims, nine incidents might have been prevented by the proposed closures. Of the remaining incidents, six involved crab or lobster pot fishermen and might have been prevented by the fixed gear broadcast.

Twenty-seven incidents were reported to NMFS or other government officials involving JAPLL and domestic vessels involved in conflicts that might have been prevented by the proposed Atlantic and Dry Tortugas closures (Table 21). NMFS observers on JAPLL and domestic vessels report gear conflicts involving the two groups. Under these circumstances, four conflicts were reported, all of which might have been prevented by the proposed closures.

Since 1977 when the domestic swordfishery expanded, conflicts between Japanese and U.S. longline fishermen have grown rapidly in number and severity. In 1980, bluefin tuna and swordfish were concentrated in a small area northwest of the Dry Tortugas, Florida. U.S. swordfish longliners (at least 17 vessels) and Japanese tuna longliners (at least 18 vessels) attempted to fish in this area. Conflicts and gear loss was experienced by both groups (Table 22). The domestic fishermen lost at least 77 miles of gear valued at $77,000. Some U.S. fishermen were forced to leave the area due to gear losses. Domestic longline fishermen have reported that similar situations occurred along the Atlantic coast in 1980 and 1981 during the summer and fall when the foreign tuna fishery was active. U.S. fishermen using lobster and crab traps along the Atlantic coast also reported gear losses from Japanese longlines in 1980 and 1981. The above incidents were reported at the Gulf of Mexico Fishery Management Council, Swordfish Management Committee, Fact-Finding Meeting, Naples, Florida, June 3, 1980, and South Atlantic Fishery Management Council, Inter-Council Swordfish Fishery Management Plan Meeting, Atlanta, Georgia, December 1-3, 1981. Also,

Table 20. Damage to domestic vessels and fishing gear attributed to foreign vessels as reported by the NMFS gear compensation fund. (Source: NMFS PMP for Atlantic Billfishes and Sharks, June, 1983)

No.	Date of Incident		Vessel	Location	Damage Type	Amount Reimbursed	Prevented by Closure Yes	Prevented by Closure No	Fixed Gear Broadcast
1.	1978	March 1	Phoenix	39°10'N/72°20'W	Lobster pots	$ 15,998.12		X	X
2.	1979	June 10	Saturn	38°10'N/74°10'W	Traps	5,207.44	X		X
3.	1980	March 22	Aladdin	25°13'N/84°15'W	Longline gear/hooks	3,310.40	X		
4.		March 24	Independence	24°50'N/84°21'W	Longline gear/hooks	3,514.63	X		
5.		March 27	Dan's Plan	25°00'N/84°00'W	Longline gear	3,410.69	X		
6.		May 2	Fair Wind	40°45'N/67°22'W	Pots	3,594.14		X	X
7.		June 18	Phoenix	39°10'N/72°30'W	Lobster pots	7,663.81	X		X
8.		June 27	Lady Janet	39°03'N/73°55'W	Lobster pots	3,510.98	X		X
9.		Oct 6	Independence	39°15'N/72°02'W	Longline gear/hooks	5,662.42	X		
10.		Oct 17	Original Jackson	38°26'N/73°45'W	Red crab pots	5,309.96	X		X
11.		Oct 24	Ari D	38°10'N/73°40'W	Longline gear/hooks	4,061.44	X		
12.		Dec 1	Colleen	37°10'N/74°32'W	Lobster pots	587.66		X	X
13.		Dec 4	Fishing Lady	37°32'N/74°11'W	Lobster pots	5,143.62		X	X
14.	1981	Jan 21	Phyllis Ann	39°30'N/72°26'W	Lobster pots	9,309.26		X	X
15.		Sept 16	Phyllis Ann	38°30'N/72°00'W	Lobster pots	11,387.88		X	X
					Total Amount Reimbursed	$ 87,672.45			

15 Claims Actually Paid out	
10 Claims for damage to pots/traps:	$ 67,712.87
5 Claims for damage to longline gears:	19,959.58
Total Amount Reimbursed for damage Caused by foreign vessels	$ 87,672.45

SOURCE: National Marine Fisheries Service
Gear Compensation Files Washington, DC.

Table 21. Japanese/U.S. vessel longline conflicts reported to NMFS. (Source: NMFS PMP for Atlantic Billfishes and Sharks, June, 1983)

A.

Date of Incident	U.S. Vessels' Names	Location 1/	Prevented by Closure Yes	Prevented by Closure No	Type of Incident	Damage	Type of Foreign Vessel	Fixed Gear Broadcast
1980 Aug. 2/	L & H	Hudson Canyon	X		Longline entanglement	Unknown	Japanese longliner	No
Oct. 12 2/	Bobby Gale III, Proud Rebel, Shiloh, Darana R	30°00'N/74°44'W	X		Gear entanglement, preemption of fishing grounds	Longline gear/lost catches	Japanese longliner	No
Oct. 13 2/	Bobby Gale III	35°00'N/74°44'W	X		Gear entanglement, preemption of fishing grounds	12 miles longline gear	Japanese longliner	No
1981 Jan 13 3/	Miss Eunice	Dry Tortugas Area	X		Longline gear cut	Unknown	Japanese longliner	No
Feb. 15 3/	Edith	Dry Tortugas Area	X		Longline gear cut	Unknown	Japanese longliner	No
June-Oct. 2/ (10 incidents)	Vivian III, Frances Anne	Hudson Canyon Veach Canyon	X		Longline entanglement, preemption of fishing grounds	Unknown	Japanese longliner	No
Aug. 11-18 4/	Heather Anne, Donna Marie, Sundance II, Dearest Choice	Hudson Canyon Block Canyon	X		Longline entanglement, preemption of fishing grounds	3 miles line	2-10 Japanese longliners	No
July-Aug. 2/ (4 incidents)	L & H	Hudson Canyon	X		Longline entanglement	Unknown	Japanese longliner	No
Oct. 22 2/	Heather Anne	Carteret Canyon	X		Longline entanglement	Unknown	Japanese longliner	No

1./ Only some reports provided latitude and longitude, others just provided the general areas and depth of water.

2./ As reported to Richard Stone, NMFS, Washington, DC.

3./ As reported to Charles Fuss Law Enforcement Division, NMFS, St. Petersberg, FL

4./ Reported by William H. Feinberg in a memo of 8/20/81 to Theodore Kronmiller, Department Of State, Washington, DC.

B.

Japanese/U.S. Vessels Longline Conflicts Reported by NMFS Observers

Date of Incident	U.S. Vessel Name	Location	Prevented by Closure Yes	Prevented by Closure No	Type of Incident	Damage	Fixed Gear Broadcast
1981 Aug. 29	Unknown/Longline	39°35'N/71°10'W	X		Gear Entanglement	Unknown	No
Aug. 30	Unknown/Longline	40°03'N/68°48'W	X		Gear Entanglement	Unknown	No
Aug. 30	Unknown/Longline	36°27'N/74°22'W	X		Gear Entanglement	Unknown	No
Aug. 31	Unknown/Longline	39°58'N/68°54'W	X		Gear Entanglement	Unknown	No

SOURCE: NMFS-SOUTHEAST REGIONAL OFFICE, LAW ENFORCEMENT FILES, ST. PETERSBURG, FL.

Table 22. Japanese/U.S. vessel longline conflicts reported to the Gulf of Mexico Council. (Source: NMFS PMP for Atlantic Billfishes and Sharks, June 1983.)

DATE 1980	U.S. VESSEL NAME	LOCATION	PREVENTED BY CLOSURE YES	PREVENTED BY CLOSURE NO	TYPE OF INCIDENT	DAMAGE	FIXED GEAR BROADCAST
Feb 22-25	Sea Hunter	Dry Tortugas Area	X		longline gear entanglement	Unknown	No
"	Big O	"	X		longline gear entanglement	Unknown	No
"	Sea Gull	"	X		longline gear entanglement	Unknown	No
"	Full House	"	X		longline gear entanglement	Unknown	No
"	Martha Ingeham	"	X		longline gear entanglement	Unknown	No
"	Flying Cloud	"	X		longline gear lost	Unknown	No
"	Independent	"	X		longline gear lost	Unknown	No
"	Empress	"	X		longline gear lost	Unknown	No
"	Olympic Champion	"	X		longline gear lost	Unknown	No
"	Tiki 12	"	X		longline gear cut	Unknown	No
"	Tiki 13	"	X		longline gear cut	Unknown	No
"	Benga	"	X		longline gear lost	Unknown	No
Mar 20-24	Flying Cloud	"	X		Near collision	Unknown	No
"	Jesse Bell	"	X		Near collision	Unknown	No

1. These incidents were reported to the Gulf of Mexico Council at the Fact Finding Meeting in Naples, FL, on June 3, 1980.

incidents were reported by U.S. observers on board foreign vessels, by U.S. vessel operators to the NMFS through requests for compensation under the Fishing Vessel and Gear Damage Fund, and by U.S. vessel operators to the U.S. Coast Guard or NMFS. Few incidents can be documented involving damage or entanglement of U.S. recreational fishing gear by foreign longline gear. However, the adverse impact on U.S. recreational fishing results from pre-emption of fishing grounds and lower availability of swordfish and other billfishes.

There are several major factors causing increased conflicts: an increasing U.S. fleet, expansion of the geographical area fished by the U.S. fleet, and changes in Japanese fishing strategy. The number of vessels in the U.S. longline fleet has increased from 115 in 1976 to 411 in 1981. The Japanese appear to have changed their fishing strategy in such a way that catch rates and total catches of marlins decreased, while swordfish catches fluctuated (Table 23). Japanese vessels have been concentrating in areas where swordfish abundance is high, apparently because of high tuna abundance. These areas are highly desirable to U.S. swordfish fishermen.

In addition, Table 24 supplements the information presented in Table 19.

Table 23. Changes in incidental catches of billfishes by Japanese longline vessels (1978-1980) (Source: NMFS PMP for Atlantic Billfishes and Sharks, June, 1983)

Area	Species	U.S. Observer Reported Catches 1978	1980	Annual[1/] Change
Gulf of Mexico	Swordfish	987	3,867	98
	Blue Marlin	346	196	-25
	White Marlin	1,803	936	-28
	Sailfish	326	70	-54
	Spearfish	182	55	-45
	TOTAL	3,644	5,124	
Atlantic	Swordfish	5,639	3,771	-18
	Blue Marlin	851	488	-24
	White Marlin	1,110	1,324	9
	Sailfish	125	333	63
	Spearfish	158	492	76
	TOTAL	7,883	6,408	

1/ Based on the formula $C_T = (1+g)^T C_B$ where:
C_T = catches in 1980
C_B = catches in 1978
T = two years
g = annual percentage change.

solving for g:

$$(1+g)^T = \frac{C_T}{C_B}$$

$$\ln(1+g) = \frac{\ln C_T - \ln C_B}{T}$$

$$g = e^x - 1 \text{ where } x = \frac{\ln C_T - \ln C_B}{T}$$

Table 24. Gear conflicts involving domestic and Japanese longline fishing vessels. (Source: NMFS PMP for Atlantic Billfishes and Shark, June, 1983.)

DATE	REPORTING VESSEL	JAPANESE LONGLINER (JAPLL) AND U. S. VESSELS INVOLVED	LOCATION LATITUDE	LOCATION LONGITUDE	GEAR LOST	PREVENTABLE BY CLOSURE Yes	PREVENTABLE BY CLOSURE No
1982							
July 3	CANCHEN TOO	JAPLL	40°00'N	66°42'W	None, gear entanglement		X
July 13	LINDA MARIE	JAPLL	(4)	(4)	Unknown gear lost	X	
July 18	SEA DOG V	JAPLL	(4)	(4)	Unknown gear lost	X	
August 4	JAPLL	JAPLL, Unknown U.S.Longliner	39°52'N	69°58'W	Gear entanglement, JAPLL lost lt.buoy &4 floats	X	
August 7	JAPLL	JAPLL, Unknown U.S.Longliner	39°53'N	69°43'N	Gear entanglement	X	
August 9	JAPLL	JAPLL, Unknown U.S. Longliner	39°53'N	70°04'W	Gear entanglement	X	
August 10	JAPLL	JAPLL, Unknown U.S. Longliner	39°51'N	69°42'W	Gear entanglement	X	
August 13	JAPLL	JAPLL, Unknown U.S.Trapper	39°22'N	72°05'W	U.S. fixed gear (3) Gear entanglement	X	
August 18	JAPLL	JAPLL, Unknown U.S. Longliner	39°49.9N	71°03.6W	Gear entanglement	X	
August 20	JAPLL	JAPLL, Unknown U.S. Longliner	39°54.N	70°04.N	Gear entanglement	X	
August 24	JAPLL	JAPLL, Unknown U.S. Longliner	39°53.2N	69°37.7W	Gear entanglement	X	
August 26	JAPLL	JAPLL, PROVIDER	39°47.N	71°07.W	Gear entanglement	X	
August 26	JAPLL	JAPLL, Unknown U.S. Longliner	39°48.8N	70°46.8W	Gear entanglement	X	
August 26	LINDA MARIE	JAPLL, Unknown U.S. Longliner	40°46.3N	71°07.6W	LINDA MARIE had line cut in eight places, JAPLL lost flag with radar reflect.	X	
August 28	JAPLL	JAPLL, PROVIDER	39°51.N	71°11.W	Gear entanglement	X	
August 28	JAPLL	JAPLL, WOBBEGONG II	39°50.N	71°00.W	Gear entanglement	X	
August 29	JAPLL	JAPLL, WOBBEGONG II	39°49.N	71°15.W	Gear entanglement, JAPLL lost 20 orange floats, no damage to U.S. Longliner	X	
August 29	JAPLL	JAPLL, WHITE SAIL	39°51.N	70°45.W	Gear entanglement, JAPLL lost 2 floats and 1 radio buoy	X	
August 30	JAPLL	JAPLL, LADY LAURA	39°54.N	70°29.W	Gear entanglement	X	
August 30	JAPLL	JAPLL, WHITE SAIL	39°25.N	70°07.W	JAPLL caught U.S.Longliner gear in prop. gear retied		X
Sept. 1	JAPLL	JAPLL, PENOBSCOT GULF	40°11.9N	68°02.2W	Gear entanglement	X	
Sept. 11	JAPLL	JAPLL, MARION FRANCIS	39°55.3N	70°08.1W	Gear entanglement	X	
Sept. 15	JAPLL	JAPLL, GRACIE II, FRANCIS ANNE	39°53.N	71°15:W	Gear entanglement	X	
Sept. 19	JAPLL	JAPLL, CALICO JACK	39°52.4N	69°53.6W	Gear entanglement	X	
Sept. 19	JAPLL	JAPLL, FRANCIS ANNE	39°52.6N	70°19.9W	Gear entanglement	X	
Sept. 20	JAPLL	JAPLL, GRACIE III	40°03.2N	68°24.4W	Gear entanglement, JAPLL1 lost gear, U.S.Longliner lost unknown anouth of gear,also	X	
						24	2

Source: U. S. Coast Guard, Governor's Island, N. Y.

(1) July 1, 1982 Japanese resumed tuna longline fishing within the FCZ. On September 24, all of Japanese vessels left FCZ.

(2) Coordinates are located in area that Japanese industry voluntarily agreed would be closed o Japanese longlines from June 1 through August 31

(3) Coordinates were reported to the U. S. Coast Guard when gear was set. The Coast Guard bro dcast the location of this gear to all vessels.

(4) Just beyond 1,000 fathom curve - Southeast edge of Georges Bank

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APPENDIX A

SWORDFISH YIELD-PER-RECRUIT ANALYSIS

SOUTHEAST FISHERIES CENTER/BEAUFORT LABORATORY

BEVERTON & HOLT YIELD PER RECRUIT ANALYSIS — SWORDFISH

INPUT PARAMETERS

INSTANTANEOUS NATURAL MORTALITY	0.1600000
INSTANTANEOUS FISHING MORTALITY	
MINIMUM VALUE	0.1500000
MAXIMUM VALUE	0.4000000
INCREMENTING VALUE	0.0100000
AGE AT FIRST RECRUITMENT	0.5000000
AGE LIABLE TO CAPTURE	
MINIMUM VALUE	1.0000000
MAXIMUM VALUE	5.5000000
INCREMENTING VALUE	0.1000000

MAXIMUM AGE IN FISHERY	25.0000000
THEORETICAL AGE AT LENGTH ZERO	-2.8671999
GROWTH RATE	0.1054000
MAXIMUM ASYMPTOTIC VALUES	
WEIGHT	385.0000000
LENGTH	297.0000000

AGE LIABLE TO CAPTURE (1.0000000)

INSTANTANEOUS FISHING MORTALITY	YIELD IN NUMBERS PER RECRUIT	YIELD IN WEIGHT PER RECRUIT	ABUNDANCE PER RECRUIT	BIOMASS PER RECRUIT	INDIVIDUAL MEAN WEIGHT	INDIVIDUAL MEAN LENGTH
0.1500000	0.4464069	26.5949015	2.9760459	177.2993433	59.5754744	149.4746095
0.1600000	0.4613449	26.7697405	2.8834059	167.3108780	58.0254336	148.3126740
0.1700000	0.4753720	26.8881497	2.7963057	158.1655864	56.5623372	147.2014678
0.1800000	0.4885690	26.9592818	2.7142719	149.7737880	55.1800965	146.1380404
0.1900000	0.5010076	26.9908195	2.6368822	142.0569448	53.8730722	145.1196208
0.2000000	0.5127517	26.9892229	2.5637585	134.9461144	52.6360476	144.1436112
0.2100000	0.5238580	26.9599338	2.4945619	128.3806372	51.4642020	143.2075794
0.2200000	0.5343773	26.9075440	2.4289876	122.3070180	50.3530835	142.3092510
0.2300000	0.5443551	26.8359337	2.3667612	116.6779727	49.2985828	141.4465001
0.2400000	0.5538323	26.7483872	2.3076346	111.4516131	48.2969076	140.6173412
0.2500000	0.5628458	26.6476874	2.2513833	106.5907495	47.3445584	139.8199202
0.2600000	0.5714290	26.5361958	2.1978040	102.0622915	46.4383056	139.0525057
0.2700000	0.5796121	26.4159180	2.1467114	97.8367334	45.5751678	138.3134811
0.2800000	0.5874224	26.2885591	2.0979373	93.8877112	44.7523916	137.6013365
0.2900000	0.5948851	26.1555695	2.0513278	90.1916190	43.9674335	136.9146612
0.3000000	0.6020227	26.0181836	2.0067425	86.7272788	43.2179417	136.2521367
0.3100000	0.6088563	25.8774523	1.9640525	83.4756527	42.5017412	135.6125300
0.3200000	0.6154048	25.7342702	1.9231400	80.4195944	41.8168184	134.9946877
0.3300000	0.6216857	25.5893985	1.8838962	77.5436319	41.1613082	134.3975297
0.3400000	0.6277153	25.4434848	1.8462213	74.8337787	40.5334814	133.8200442
0.3500000	0.6335082	25.2970790	1.8100233	72.2773686	39.9317337	133.2612828
0.3600000	0.6390781	25.1506480	1.7752170	69.8629110	39.3545754	132.7203556
0.3700000	0.6444378	25.0045868	1.7417237	67.5799643	38.8006217	132.1964274
0.3800000	0.6495989	24.8592292	1.7094707	65.4190242	38.2685848	131.6887131
0.3900000	0.6545722	24.7148562	1.6783903	63.3714261	37.7572654	131.1964749
0.4000000	0.6593679	24.5717033	1.6484196	61.4292583	37.2655461	130.7190182

AGE LIABLE TO CAPTURE (1.1000000)

0.1500000	0.4393131	26.7906261	2.9287538	178.6041743	60.9829928	151.0189503
0.1600000	0.4540153	26.9814389	2.8375959	168.6339930	59.4284740	149.8696326
0.1700000	0.4678208	27.1152231	2.7518873	159.5013123	57.9606998	148.7704359
0.1800000	0.4808093	27.2011260	2.6711628	151.1173668	56.5736274	147.7184537
0.1900000	0.4930513	27.2468335	2.5950070	143.4043868	55.2616567	146.7109547
0.2000000	0.5046097	27.2588153	2.5230484	136.2940765	54.0196040	145.7453774
0.2100000	0.5155403	27.2425274	2.4549536	129.7263211	52.8426767	144.8193228
0.2200000	0.5258931	27.2025788	2.3904230	123.6480856	51.7264463	143.9305466
0.2300000	0.5357129	27.1428692	2.3291864	118.0124747	50.6668234	143.0769504
0.2400000	0.5450400	27.0667032	2.2709999	112.7779299	49.6600321	142.2565740
0.2500000	0.5539107	26.9768852	2.2156429	107.9075407	48.7025868	141.4675862
0.2600000	0.5623579	26.8757980	2.1629150	103.3684540	47.7912691	140.7082769
0.2700000	0.5704113	26.7654687	2.1126343	99.1313657	46.9231071	139.9770488
0.2800000	0.5780978	26.6476233	2.0646350	95.1700834	46.0953552	139.2724098
0.2900000	0.5854421	26.5237327	2.0187658	91.4611472	45.3054758	138.5929657
0.3000000	0.5924666	26.3950511	1.9748886	87.9835035	44.5511225	137.9374132
0.3100000	0.5991917	26.2626484	1.9328766	84.7182207	43.8301241	137.3045335
0.3200000	0.6056364	26.1274376	1.8926136	81.6482426	43.1404701	136.6931859
0.3300000	0.6118177	25.9901975	1.8539930	78.7581743	42.4802979	136.1023025
0.3400000	0.6177515	25.8515923	1.8169163	76.0340950	41.8478799	135.5308828
0.3500000	0.6234525	25.7121880	1.7812929	73.4633942	41.2416132	134.9779887
0.3600000	0.6289341	25.5724663	1.7470392	71.0346287	40.6600088	134.4427402
0.3700000	0.6342087	25.4328369	1.7140776	68.7373972	40.1016823	133.9243109
0.3800000	0.6392879	25.2936472	1.6823366	66.5622294	39.5653460	133.4219246
0.3900000	0.6441823	25.1551909	1.6517495	64.5004896	39.0498005	132.9348511
0.4000000	0.6489019	25.0177160	1.6222547	62.5442900	38.5539281	132.4624035

AGE LIABLE TO CAPTURE (1.2000000)

0.1500000	0.4323317	26.9798365	2.8822117	179.8655770	62.4054019	152.5470524
0.1600000	0.4468020	27.1864429	2.7925123	169.9152682	60.8467396	151.4102266
0.1700000	0.4603895	27.3354438	2.7081733	160.7967281	59.3746077	150.3229193
0.1800000	0.4731727	27.4359790	2.6287374	152.4221058	57.9830106	149.2822672
0.1900000	0.4852213	27.4957360	2.5537961	144.7144000	56.6663875	148.2855786
0.2000000	0.4965968	27.5211925	2.4829842	137.6059625	55.4195888	147.3303281
0.2100000	0.5073545	27.5178172	2.4159738	131.0372248	54.2378503	146.4141494
0.2200000	0.5175434	27.4902349	2.3524702	124.9556133	53.1167680	145.5348280
0.2300000	0.5272078	27.4423635	2.2922078	119.3146240	52.0522724	144.6902930
0.2400000	0.5363872	27.3775271	2.2349467	114.0730296	51.0406051	143.8786090
0.2500000	0.5451174	27.2985503	2.1804696	109.1942010	50.0782945	143.0979678
0.2600000	0.5534307	27.2078364	2.1285798	104.6455245	49.1621342	142.3466801
0.2700000	0.5613565	27.1074330	2.0790980	100.3978999	48.2891621	141.6231680
0.2800000	0.5689211	26.9990863	2.0318612	96.4253081	47.4566406	140.9259570
0.2900000	0.5761490	26.8842869	1.9867207	92.7044375	46.6620390	140.2536693
0.3000000	0.5830621	26.7643083	1.9435403	89.2143609	45.9030162	139.6050165
0.3100000	0.5896806	26.6402389	1.9021954	85.9362544	45.1774052	138.9787937
0.3200000	0.5960230	26.5130094	1.8625718	82.8531542	44.4831991	138.3738733
0.3300000	0.6021063	26.3834156	1.8245644	79.9497442	43.8185379	137.7891992
0.3400000	0.6079460	26.2521380	1.7880764	77.2121707	43.1816962	137.2237821
0.3500000	0.6135565	26.1197582	1.7530186	74.6278805	42.5710723	136.6766941
0.3600000	0.6189511	25.9867726	1.7193086	72.1854794	41.9851784	136.1470649
0.3700000	0.6241420	25.8536049	1.6868703	69.8746078	41.4226309	135.6340773
0.3800000	0.6291406	25.7206157	1.6556332	67.6858309	40.8821422	135.1369631
0.3900000	0.6339573	25.5881117	1.6255317	65.6105428	40.3625131	134.6550003
0.4000000	0.6386020	25.4563525	1.5965050	63.6408812	39.8626256	134.1875093

AGE LIABLE TO CAPTURE (1.3000000)

0.1500000	0.4254611	27.1624120	2.8364074	181.0827467	63.8422911	154.0590852
0.1600000	0.4397030	27.3846209	2.7481436	171.1538803	62.2798168	152.9346268
0.1700000	0.4530759	27.5486690	2.6651526	162.0509941	60.8036452	151.8590900
0.1800000	0.4656573	27.6636871	2.5869849	153.6871507	59.4078276	150.8296542
0.1900000	0.4775154	27.7373624	2.5132389	145.9861177	58.0868441	149.8436672
0.2000000	0.4887111	27.7761790	2.4435555	138.8808949	56.8355794	148.8986390
0.2100000	0.4992986	27.7856168	2.3776124	132.3124611	55.6492985	147.9922360
0.2200000	0.5093263	27.7703154	2.3151196	126.2287063	54.5236223	147.1222731
0.2300000	0.5188377	27.7342093	2.2558160	120.5835187	53.4545022	146.2867068
0.2400000	0.5278717	27.6806411	2.1994655	115.3360046	52.4381973	145.4836262
0.2500000	0.5364636	27.6124546	2.1458546	110.4498184	51.4712510	144.7112459
0.2600000	0.5446452	27.5320727	2.0947894	105.8925874	50.5504691	143.9678973
0.2700000	0.5524454	27.4415627	2.0460939	101.6354174	49.6728998	143.2520215
0.2800000	0.5598901	27.3426902	1.9996076	97.6524649	48.8358141	142.5621618
0.2900000	0.5670034	27.2369648	1.9551841	93.9205683	48.0366883	141.8969562
0.3000000	0.5738069	27.1256786	1.9126895	90.4189286	47.2731870	141.2551316
0.3100000	0.5803204	27.0099378	1.8720013	87.1288317	46.5431480	140.6354967
0.3200000	0.5865622	26.8906905	1.8330069	84.0334077	45.8445682	140.0369366
0.3300000	0.5925490	26.7687489	1.7956029	81.1174209	45.1755904	139.4584072
0.3400000	0.5982960	26.6448094	1.7596942	78.3670864	44.5344916	138.8989300
0.3500000	0.6038175	26.5194685	1.7251930	75.7699101	43.9196720	138.3575876
0.3600000	0.6091266	26.3932373	1.6920182	73.3145481	43.3296448	137.8335192
0.3700000	0.6142351	26.2665530	1.6600949	70.9906837	42.7630276	137.3259162
0.3800000	0.6191544	26.1397892	1.6293536	68.7889190	42.2185331	136.8340192
0.3900000	0.6238947	26.0132649	1.5997299	66.7006792	41.6949625	136.3571137
0.4000000	0.6284656	25.8872515	1.5711640	64.7181289	41.1911978	135.8945275

AGE LIABLE TO CAPTURE (1.4000000)

0.1500000	0.4186994	27.3382436	2.7913293	182.2549571	65.2932477	155.5552163
0.1600000	0.4327166	27.5758533	2.7044785	172.3490834	63.7272902	154.4430023
0.1700000	0.4458784	27.7547690	2.6228142	163.2633470	62.2473937	153.3791183
0.1800000	0.4582610	27.8841101	2.5458946	154.9117229	60.8476576	152.3607865
0.1900000	0.4699318	27.9715620	2.4733251	147.2187475	59.5226032	151.3853933
0.2000000	0.4809505	28.0236138	2.4047524	140.1180691	58.2671503	150.4504842
0.2100000	0.4913705	28.0457552	2.3398596	133.5512153	57.0765939	149.5537576
0.2200000	0.5012396	28.0426389	2.2783616	127.4665404	55.9465800	148.6930582
0.2300000	0.5106004	28.0182152	2.2200016	121.8183271	54.8730818	147.8663689
0.2400000	0.5194914	27.9758440	2.1645473	116.5660167	53.8523763	147.0718037
0.2500000	0.5279472	27.9183872	2.1117888	111.6735488	52.8810222	146.3075995
0.2600000	0.5359992	27.8482865	2.0615353	107.1087942	51.9558384	145.5721083
0.2700000	0.5436757	27.7676279	2.0136136	102.8430661	51.0738835	144.8637902
0.2800000	0.5510024	27.6781956	1.9678658	98.8506987	50.2324378	144.1812057
0.2900000	0.5580029	27.5815178	1.9241480	95.1086822	49.4289847	143.5230091
0.3000000	0.5646985	27.4789043	1.8823284	91.5963477	48.6611951	142.8879418
0.3100000	0.5711088	27.3714787	1.8422863	88.2950926	47.9269118	142.2748263
0.3200000	0.5772516	27.2602057	1.8039111	85.1881427	47.2241356	141.6825604
0.3300000	0.5831434	27.1459136	1.7671011	82.2603443	46.5510129	141.1101117
0.3400000	0.5887992	27.0293142	1.7317625	79.4979829	45.9058230	140.5565127
0.3500000	0.5942332	26.9110186	1.6978091	76.8886247	45.2869683	140.0208560
0.3600000	0.5994579	26.7915520	1.6651610	74.4209778	44.6929636	139.5022902
0.3700000	0.6044854	26.6713648	1.6337444	72.0847697	44.1224273	139.0000158
0.3800000	0.6093266	26.5508434	1.6034911	69.8706406	43.5740732	138.5132813
0.3900000	0.6139917	26.4303188	1.5743377	67.7700483	43.0467028	138.0413803
0.4000000	0.6184901	26.3100739	1.5462253	65.7751848	42.5391983	137.5836475

AGE LIABLE TO CAPTURE (1.5000000)

0.1500000	0.4120449	27.5072338	2.7469659	183.3815590	66.7578575	157.0356116
0.1600000	0.4258409	27.7600332	2.6615057	173.5002075	65.1887424	155.9355202
0.1700000	0.4387950	27.9536267	2.5811472	164.4330981	63.7054331	154.8831727
0.1800000	0.4509821	28.0971211	2.5054560	156.0951173	62.3020779	153.8758337
0.1900000	0.4624684	28.1981982	2.4340444	148.4115696	60.9732397	152.9109278
0.2000000	0.4733130	28.2633505	2.3665648	141.3167527	59.7138741	151.9860356
0.2100000	0.4835682	28.2980761	2.3027057	134.7527432	58.5193067	151.0988875
0.2200000	0.4932811	28.3070395	2.2421868	128.6683616	57.3852094	150.2473573
0.2300000	0.5024938	28.2942058	2.1847554	123.0182862	56.3075775	149.4294547
0.2400000	0.5112440	28.2629508	2.1301832	117.7622952	55.2827066	148.6433178
0.2500000	0.5195659	28.2161538	2.0782636	112.8646152	54.3071713	147.8872058
0.2600000	0.5274903	28.1562742	2.0288089	108.2933621	53.3778036	147.1594912
0.2700000	0.5350452	28.0854159	1.9816487	104.0200587	52.4916736	146.4586529
0.2800000	0.5422558	28.0053811	1.9366278	100.0192183	51.6460705	145.7832685
0.2900000	0.5491453	27.9177156	1.8936045	96.2679850	50.8384859	145.1320083
0.3000000	0.5557347	27.8237465	1.8524491	92.7458216	50.0665969	144.5036284
0.3100000	0.5620433	27.7246140	1.8130429	89.4342388	49.3282518	143.8969647
0.3200000	0.5680887	27.6212991	1.7752772	86.3165597	48.6214559	143.3109276
0.3300000	0.5738870	27.5146457	1.7390516	83.3777141	47.9443589	142.7444963
0.3400000	0.5794532	27.4053802	1.7042741	80.6040595	47.2952432	142.1967142
0.3500000	0.5848009	27.2941284	1.6708598	77.9832241	46.6725133	141.6666839
0.3600000	0.5899428	27.1814288	1.6387300	75.5039689	46.0746859	141.1535633
0.3700000	0.5948905	27.0677449	1.6078122	73.1560672	45.5003807	140.6565618
0.3800000	0.5996549	26.9534754	1.5780392	70.9301985	44.9483124	140.1749361
0.3900000	0.6042459	26.8389632	1.5493486	68.8178543	44.4172833	139.7079871
0.4000000	0.6086730	26.7245022	1.5216824	66.8112554	43.9061759	139.2550571

AGE LIABLE TO CAPTURE (1.6000000)

0.1500000	0.4054959	27.6692967	2.7033058	184.4619778	68.2357054	158.5004351
0.1600000	0.4190743	27.9370650	2.6192142	174.6066566	66.6637550	157.4123459
0.1700000	0.4318240	28.1451375	2.5401409	165.5596322	65.1773420	156.3714200
0.1800000	0.4438186	28.3026062	2.4656588	157.2367010	63.7706640	155.3749637
0.1900000	0.4551235	28.4171478	2.3953867	149.5639357	62.4383264	154.4204398
0.2000000	0.4657966	28.4952566	2.3289830	142.4762830	61.1753213	153.5054635
0.2100000	0.4758897	28.5424377	2.2661413	135.9163700	59.9770053	152.6277971
0.2200000	0.4854489	28.5633665	2.2065860	129.8334839	58.8390767	151.7853430
0.2300000	0.4945158	28.5620211	2.1500686	124.1827005	57.7575536	150.9761375
0.2400000	0.5031275	28.5417927	2.0963644	118.9241361	56.7287507	150.1983427
0.2500000	0.5113176	28.5055765	2.0452703	114.0223061	55.7492589	149.4502400
0.2600000	0.5191165	28.4558491	1.9966018	109.4455733	54.8159238	148.7302222
0.2700000	0.5265516	28.3947313	1.9501912	105.1656716	53.9258273	148.0367866
0.2800000	0.5336480	28.3240427	1.9058856	101.1572955	53.0762683	147.3685281
0.2900000	0.5404283	28.2453459	1.8635457	97.3977445	52.2647465	146.7241326
0.3000000	0.5469132	28.1599845	1.8230440	93.8666149	51.4889459	146.1023707
0.3100000	0.5531218	28.0691150	1.7842637	90.5455323	50.7467205	145.5020919
0.3200000	0.5590713	27.9737340	1.7470977	87.4179186	50.0360802	144.9222189
0.3300000	0.5647776	27.8747003	1.7114473	84.4687889	49.3551786	144.3617425
0.3400000	0.5702555	27.7727551	1.6772221	81.6845739	48.7023013	143.8197166
0.3500000	0.5755184	27.6685378	1.6443382	79.0529651	48.0758553	143.2952541
0.3600000	0.5805787	27.5626001	1.6127185	76.5627781	47.4743592	142.7875220
0.3700000	0.5854479	27.4554183	1.5822916	74.2038332	46.8964344	142.2957384
0.3800000	0.5901367	27.3474031	1.5529912	71.9668503	46.3407968	141.8191679
0.3900000	0.5946549	27.2389087	1.5247560	69.8433557	45.8062494	141.3571193
0.4000000	0.5990116	27.1302401	1.4975291	67.8256003	45.2916755	140.9089418

AGE LIABLE TO CAPTURE (1.7000000)

0.1500000	0.3990507	27.8243568	2.6603378	185.4957123	69.7263756	159.9498491
0.1600000	0.4124149	28.1068651	2.5775933	175.6679069	68.1519089	158.8736431
0.1700000	0.4249634	28.3292089	2.4997849	166.6424051	66.6626980	157.8440251
0.1800000	0.4367687	28.5004641	2.4264928	158.3359117	65.2529908	156.8583428
0.1900000	0.4478950	28.6283007	2.3573422	150.6752667	63.9174356	155.9140967
0.2000000	0.4583995	28.7192133	2.2919973	143.5960664	62.6510615	155.0089365
0.2100000	0.4683330	28.7787126	2.2301570	137.0414886	61.4492567	154.1406559
0.2200000	0.4777410	28.8114835	2.1715500	130.9612886	60.3077468	153.3071859
0.2300000	0.4866644	28.8215163	2.1159321	125.3109405	59.2225728	152.5065889
0.2400000	0.4951397	28.8122161	2.0630823	120.0509005	58.1900693	151.7370511
0.2500000	0.5032002	28.7864936	2.0128007	115.1459744	57.2068438	150.9968757
0.2600000	0.5108755	28.7468411	1.9649059	110.5647733	56.2697562	150.2844756
0.2700000	0.5181929	28.6953959	1.9192328	106.2792441	55.3759002	149.5983666
0.2800000	0.5251767	28.6339939	1.8756312	102.2642639	54.5225851	148.9371604
0.2900000	0.5318496	28.5642140	1.8339640	98.4972895	53.7073190	148.2995586
0.3000000	0.5382317	28.4874157	1.7941056	94.9580523	52.9277933	147.6843463
0.3100000	0.5443418	28.4047713	1.7559413	91.6282944	52.1818676	147.0903861
0.3200000	0.5501969	28.3172922	1.7193654	88.4915380	51.4675572	146.5166132
0.3300000	0.5558128	28.2258520	1.6842812	85.5328848	50.7830196	145.9620297
0.3400000	0.5612038	28.1312058	1.6505993	82.7388405	50.1265439	145.4257003
0.3500000	0.5663832	28.0340064	1.6182376	80.0971610	49.4965398	144.9067475
0.3600000	0.5713632	27.9348184	1.5871199	77.5967179	48.8915282	144.4043478
0.3700000	0.5761551	27.8341305	1.5571760	75.2273796	48.3101323	143.9177275
0.3800000	0.5807695	27.7323649	1.5283408	72.9799077	47.7510693	143.4461596
0.3900000	0.5852160	27.6298872	1.5005539	70.8458646	47.2131433	142.9889602
0.4000000	0.5895036	27.5270128	1.4737591	68.8175320	46.6952384	142.5454855

AGE LIABLE TO CAPTURE (1.8000000)

0.1500000	0.3927076	27.9723499	2.6180509	186.4823327	71.2294522	161.3840142
0.1600000	0.4058612	28.2693608	2.5366323	176.6835052	69.6527845	160.3195737
0.1700000	0.4182117	28.5057602	2.4600688	167.6809424	68.1610785	159.3011513
0.1800000	0.4298306	28.6906060	2.3879479	159.3922557	66.7486325	158.3261354
0.1900000	0.4407812	28.8315598	2.3199011	151.7450518	65.4101385	157.3920641
0.2000000	0.4511197	28.9351152	2.2555984	144.6755762	64.1406633	156.4966213
0.2100000	0.4608961	29.0067872	2.1947435	138.1275582	62.9356271	155.6376316
0.2200000	0.4701554	29.0512698	2.1370699	132.0512220	61.7907834	154.8130547
0.2300000	0.4789376	29.0725615	2.0823372	126.4024412	60.7021968	154.0209787
0.2400000	0.4872788	29.0740832	2.0303282	121.1420132	59.6662219	153.2596137
0.2500000	0.4952116	29.0587589	1.9808463	116.2350356	58.6794836	152.5272845
0.2600000	0.5027653	29.0290960	1.9337129	111.6503694	57.7388563	151.8224240
0.2700000	0.5099667	28.9872476	1.8887657	107.3601762	56.8414463	151.1435661
0.2800000	0.5168400	28.9350649	1.8458570	103.3395174	55.9845733	150.4893396
0.2900000	0.5234070	28.8741424	1.8048518	99.5660084	55.1657543	149.8584614
0.3000000	0.5296880	28.8058552	1.7656265	96.0195174	54.3826883	149.2497308
0.3100000	0.5357012	28.7313904	1.7280683	92.6819044	53.6332412	148.6620238
0.3200000	0.5414635	28.6517740	1.6920733	89.5367936	52.9154335	148.0942877
0.3300000	0.5469903	28.5678937	1.6575462	86.5693747	52.2274273	147.5455359
0.3400000	0.5522957	28.4805181	1.6243992	83.7662296	51.5675152	147.0148436
0.3500000	0.5573929	28.3903130	1.5925512	81.1151801	50.9341100	146.5013431
0.3600000	0.5622939	28.2978557	1.5619276	78.6051548	50.3257350	146.0042201
0.3700000	0.5670099	28.2036466	1.5324591	76.2260719	49.7410154	145.5227093
0.3800000	0.5715510	28.1081195	1.5040817	73.9687355	49.1786701	145.0560917
0.3900000	0.5759270	28.0116506	1.4767358	71.8247451	48.6375044	144.6036908
0.4000000	0.5801466	27.9145659	1.4503664	69.7864147	48.1164032	144.1648698

AGE LIABLE TO CAPTURE (1.9000000)

0.1500000	0.3864652	28.1132217	2.5764343	187.4214779	72.7445196	162.8030893
0.1600000	0.3994113	28.4244906	2.4963207	177.6530665	71.1659627	161.7502980
0.1700000	0.4115670	28.6747223	2.4209825	168.6748371	69.6720608	160.7429599
0.1800000	0.4230026	28.8729551	2.3500142	160.4053061	68.2571633	159.7785041
0.1900000	0.4337802	29.0268407	2.2830538	152.7728457	66.9160065	158.8545059
0.2000000	0.4439554	29.1428702	2.2197768	145.7143508	65.6436951	157.9686827
0.2100000	0.4535773	29.2265615	2.1598916	139.1741023	64.4356825	157.1188903
0.2200000	0.4626901	29.2826147	2.1031368	133.1027940	63.2877501	156.3031164
0.2300000	0.4713333	29.3150411	2.0492753	127.4567002	62.1959865	155.5194749
0.2400000	0.4795425	29.3272706	1.9980938	122.1969607	61.1567675	154.7661993
0.2500000	0.4873497	29.3222416	1.9493989	117.2889664	60.1667351	154.0416361
0.2600000	0.4947839	29.3024757	1.9030149	112.7018296	59.2227791	153.3442379
0.2700000	0.5018712	29.2701405	1.8587822	108.4079279	58.3220185	152.6725567
0.2800000	0.5086355	29.2271024	1.8165553	104.3825087	57.4617841	152.0252379
0.2900000	0.5150984	29.1749708	1.7762015	100.6033476	56.6396020	151.4010139
0.3000000	0.5212798	29.1151353	1.7375994	97.0504510	55.8531790	150.7986980
0.3100000	0.5271977	29.0487975	1.7006377	93.7057984	55.1003878	150.2171794
0.3200000	0.5328686	28.9769975	1.6652144	90.5531171	54.3792544	149.6554174
0.3300000	0.5383077	28.9006366	1.6312356	87.5776865	53.6879455	149.1124367
0.3400000	0.5435291	28.8204964	1.5986149	84.7661659	53.0247578	148.5873229
0.3500000	0.5485454	28.7372555	1.5672726	82.1064444	52.3881072	148.0792180
0.3600000	0.5533687	28.6515032	1.5371352	79.5875089	51.7765198	147.5873166
0.3700000	0.5580098	28.5637514	1.5081345	77.1993281	51.1886230	147.1108621
0.3800000	0.5624789	28.4744451	1.4802076	74.9327503	50.6231374	146.6491432
0.3900000	0.5667854	28.3839710	1.4532958	72.7794128	50.0788698	146.2014906
0.4000000	0.5709380	28.2926652	1.4273450	70.7316630	49.5547063	145.7672747

AGE LIABLE TO CAPTURE (2.0000000)

0.1500000	0.3803216	28.2469281	2.5354774	188.3128541	74.2711627	164.2072317
0.1600000	0.3930637	28.5722035	2.4566482	178.5762721	72.6910248	163.1659745
0.1700000	0.4050277	28.8360371	2.3825159	169.6237479	71.1952228	162.1696108
0.1800000	0.4162828	29.0474461	2.3126822	161.3747008	69.7781579	161.2156100
0.1900000	0.4268903	29.2140708	2.2467910	153.7582675	68.4346110	160.3015840
0.2000000	0.4369047	29.3423984	2.1845234	146.7119920	67.1597258	159.4252841
0.2100000	0.4463745	29.4379485	2.1255930	140.1807069	65.9489887	158.5845962
0.2200000	0.4553432	29.5054268	2.0697420	134.1155765	64.7982100	157.7775363
0.2300000	0.4638497	29.5488536	2.0167380	128.4732765	63.7035030	157.0022436
0.2400000	0.4719290	29.5716697	1.9663710	123.2152903	62.6612645	156.2569752
0.2500000	0.4796126	29.5768258	1.9184505	118.3073032	61.6681547	155.5400987
0.2600000	0.4869290	29.5668569	1.8728040	113.7186806	60.7210790	154.8500863
0.2700000	0.4939041	29.5439447	1.8292744	109.4220173	59.8171694	154.1855080
0.2800000	0.5005612	29.5099695	1.7877186	105.3927482	58.9537681	153.5450259
0.2900000	0.5069217	29.4665550	1.7480060	101.6088104	58.1284109	152.9273873
0.3000000	0.5130051	29.4151050	1.7100171	98.0503501	57.3388127	152.3314199
0.3100000	0.5188292	29.3568349	1.6736425	94.6994676	56.5828531	151.7560256
0.3200000	0.5244102	29.2927984	1.6387817	91.5399950	55.8585640	151.2001757
0.3300000	0.5297630	29.2239098	1.6053425	88.5573023	55.1641170	150.6629062
0.3400000	0.5349015	29.1509634	1.5732398	85.7381278	54.4978131	150.1433129
0.3500000	0.5398383	29.0746501	1.5423952	83.0704289	53.8580717	149.6405474
0.3600000	0.5445850	28.9955708	1.5127362	80.5432521	53.2434217	149.1538133
0.3700000	0.5491525	28.9142486	1.4841960	78.1466179	52.6524930	148.6823623
0.3800000	0.5535507	28.8311394	1.4567124	75.8714194	52.0840081	148.2254908
0.3900000	0.5577889	28.7466401	1.4302279	73.7093335	51.5367755	147.7825371
0.4000000	0.5618756	28.6610966	1.4046890	71.6527414	51.0096825	147.3528781

AGE LIABLE TO CAPTURE (2.1000000)

0.1500000	0.3742754	28.3734349	2.4951696	189.1562325	75.8089675	165.5965970
0.1600000	0.3868167	28.7124588	2.4176045	179.4528675	74.2275530	164.5667600
0.1700000	0.3985921	28.9896575	2.3446592	170.5273970	72.7301431	163.5812620
0.1800000	0.4096696	29.2140253	2.2759421	162.3001406	71.3111914	162.6376122
0.1900000	0.4201096	29.3931897	2.2111033	154.7009984	69.9655242	161.7334590
0.2000000	0.4299658	29.5336326	2.1498292	147.6681630	68.6883243	160.8665868
0.2100000	0.4392860	29.6408740	2.0918382	141.1470189	67.4751121	160.0349119
0.2200000	0.4481129	29.7196243	2.0368770	135.0892012	66.3217270	159.2364779
0.2300000	0.4564849	29.7739113	1.9847169	129.4517881	65.2243075	158.4694495
0.2400000	0.4644363	29.8071858	1.9351514	124.1966076	64.1792719	157.7321066
0.2500000	0.4719983	29.8224101	1.8879932	119.2896405	63.1832992	157.0228384
0.2600000	0.4791989	29.8221317	1.8430726	114.7005064	62.2333104	156.3401362
0.2700000	0.4860634	29.8085451	1.8002349	110.4020190	61.3264515	155.6825880
0.2800000	0.4926151	29.7835445	1.7593395	106.3698018	60.4600760	155.0488722
0.2900000	0.4988748	29.7487670	1.7202579	102.5819551	59.6317298	154.4377512
0.3000000	0.5048618	29.7056298	1.6828725	99.0187661	58.8391362	153.8480666
0.3100000	0.5105935	29.6553618	1.6470757	95.6624573	58.0801823	153.2787332
0.3200000	0.5160860	29.5990294	1.6127686	92.4969668	57.3529060	152.7287342
0.3300000	0.5213539	29.5375597	1.5798604	89.5077567	56.6554842	152.1971165
0.3400000	0.5264109	29.4717594	1.5482674	86.6816452	55.9862221	151.6829863
0.3500000	0.5312694	29.4023309	1.5179126	84.0066596	55.3435429	151.1855047
0.3600000	0.5359408	29.3298865	1.4887245	81.4719070	54.7259789	150.7038841
0.3700000	0.5404358	29.2549604	1.4606374	79.0674606	54.1321622	150.2373844
0.3800000	0.5447642	29.1780188	1.4335901	76.7842599	53.5608179	149.7853099
0.3900000	0.5489352	29.0994685	1.4075261	74.6140218	53.0107560	149.3470059
0.4000000	0.5529571	29.0196650	1.3823926	72.5491625	52.4808655	148.9218562

AGE LIABLE TO CAPTURE (2.2000000)

0.1500000	0.3683251	28.4927170	2.4555007	189.9514467	77.3575215	166.9713390
0.1600000	0.3806688	28.8452257	2.3791798	180.2826606	75.7751308	165.9528098
0.1700000	0.3922585	29.1355466	2.3074027	171.3855681	74.2764016	164.9780700
0.1800000	0.4031612	29.3726497	2.2397846	163.1813871	72.8558404	164.0446685
0.1900000	0.4134365	29.5641482	2.1759815	155.6007798	71.5083193	163.1502896
0.2000000	0.4231370	29.7165173	2.1156852	148.5825866	70.2290608	162.2927506
0.2100000	0.4323100	29.8352762	2.0586189	142.0727440	69.0136199	161.4699981
0.2200000	0.4409973	29.9251388	2.0045334	136.0233583	67.8578655	160.6801030
0.2300000	0.4492369	29.9901395	1.9532039	130.3919108	66.7579618	159.9212551
0.2400000	0.4570625	30.0337380	1.9044272	125.1405751	65.7103492	159.1917573
0.2500000	0.4645048	30.0589072	1.8580192	120.2356287	64.7117255	158.4900197
0.2600000	0.4715913	30.0682061	1.8138129	115.6469466	63.7590283	157.8145530
0.2700000	0.4783472	30.0638419	1.7716562	111.3475626	62.8494174	157.1639628
0.2800000	0.4847950	30.0477213	1.7314108	107.3132902	61.9802584	156.5369437
0.2900000	0.4909556	30.0214943	1.6929502	103.5223940	61.1491075	155.9322732
0.3000000	0.4968476	29.9865911	1.6561588	99.9553037	60.3536968	155.3488065
0.3100000	0.5024885	29.9442532	1.6209305	96.5943651	59.5919210	154.7854713
0.3200000	0.5078939	29.8955596	1.5871683	93.4236239	58.8618242	154.2412625
0.3300000	0.5130783	29.8414497	1.5547828	90.4286353	58.1615890	153.7152381
0.3400000	0.5180551	29.7827416	1.5236915	87.5962989	57.4895253	153.2065142
0.3500000	0.5228365	29.7201495	1.4938186	84.9147127	56.8440602	152.7142615
0.3600000	0.5274338	29.6542964	1.4650940	82.3730456	56.2237292	152.2377011
0.3700000	0.5318575	29.5857272	1.4374527	79.9614249	55.6271675	151.7761011
0.3800000	0.5361173	29.5149180	1.4108349	77.6708369	55.0531023	151.3287735
0.3900000	0.5402220	29.4422856	1.3851846	75.4930399	54.5003457	150.8950707
0.4000000	0.5441801	29.3681945	1.3604502	73.4204862	53.9677883	150.4743832

AGE LIABLE TO CAPTURE (2.3000000)

0.1500000	0.3624691	28.6047587	2.4164604	190.6983910	78.9164138	168.3316101
0.1600000	0.3746183	28.9704830	2.3413642	181.0655189	77.3333433	167.3242773
0.1700000	0.3860253	29.2736777	2.2707369	172.1981042	75.8335797	166.3601895
0.1800000	0.3967561	29.5232869	2.2042004	164.0182608	74.4116827	165.4369346
0.1900000	0.4068692	29.7269082	2.1414167	156.4574113	73.0625709	164.5522326
0.2000000	0.4164166	29.8910086	2.0820828	149.4550432	71.7815069	163.7039336
0.2100000	0.4254446	30.0211054	2.0259266	142.9576449	70.5640806	162.8900139
0.2200000	0.4339946	30.1219147	1.9727029	136.9177942	69.4061912	162.1085716
0.2300000	0.4421039	30.1974765	1.9221908	131.2933761	68.3040290	161.3578215
0.2400000	0.4498057	30.2512586	1.8741904	126.0469106	67.2540568	160.6360891
0.2500000	0.4571302	30.2862433	1.8285208	121.1449731	66.2529919	159.9418054
0.2600000	0.4641045	30.3050006	1.7850175	116.5576948	65.2977885	159.2735002
0.2700000	0.4707534	30.3097493	1.7435311	112.2583309	64.3856208	158.6297968
0.2800000	0.4770991	30.3024082	1.7039253	108.2228863	63.5138670	158.0094056
0.2900000	0.4831620	30.2846394	1.6660759	104.4297911	62.6800937	157.4111191
0.3000000	0.4889607	30.2578856	1.6298689	100.8596186	61.8820422	156.8338062
0.3100000	0.4945121	30.2234003	1.5952003	97.4948396	61.1176149	156.2764071
0.3200000	0.4998318	30.1822746	1.5619744	94.3196080	60.3848628	155.7379287
0.3300000	0.5049340	30.1354593	1.5301031	91.3195738	59.6819742	155.2174394
0.3400000	0.5098319	30.0837844	1.4995055	88.4817187	59.0072638	154.7140657
0.3500000	0.5145374	30.0279745	1.4701070	85.7942129	58.3591630	154.2269875
0.3600000	0.5190618	29.9686637	1.4418384	83.2462880	57.7362108	153.7554346
0.3700000	0.5234154	29.9064068	1.4146361	80.8281264	57.1370454	153.2986833
0.3800000	0.5276075	29.8416897	1.3884408	78.5307625	56.5603966	152.8560530
0.3900000	0.5316471	29.7749387	1.3631977	76.3459966	56.0050787	152.4269035
0.4000000	0.5355424	29.7065272	1.3388559	74.2663180	55.4699839	152.0106316

AGE LIABLE TO CAPTURE (2.4000000)

0.1500000	0.3567058	28.7095527	2.3780389	191.3970181	80.4852354	169.6775608
0.1600000	0.3686637	29.0882188	2.3041479	181.9013678	78.9017776	168.6813145
0.1700000	0.3798909	29.4040340	2.2346523	172.9649057	77.4012606	167.7277736
0.1800000	0.3904525	29.6659150	2.1691805	164.8106388	75.9782980	166.8145648
0.1900000	0.4004060	29.8814422	2.1074001	157.2707485	74.6278551	165.9394436
0.2000000	0.4098027	30.0570737	2.0490134	150.2853687	73.3452355	165.1002923
0.2100000	0.4186881	30.1983233	1.9937528	143.8015393	72.1260643	164.2951168
0.2200000	0.4271030	30.3099081	1.9413773	137.7723097	70.9662713	163.5220422
0.2300000	0.4350840	30.3958730	1.8916697	132.1559694	69.8620735	162.7793079
0.2400000	0.4426640	30.4596924	1.8444334	126.9153852	68.8099566	162.0652623
0.2500000	0.4498726	30.5043578	1.7994904	122.0174313	67.8066576	161.3783566
0.2600000	0.4567365	30.5324491	1.7566790	117.4324965	66.8491480	160.7171399
0.2700000	0.4632801	30.5461957	1.7158522	113.1340583	65.9346166	160.0802525
0.2800000	0.4695253	30.5475280	1.6768760	109.0983142	65.0604543	159.4664212
0.2900000	0.4754921	30.5381197	1.6396280	105.3038610	64.2242389	158.8744531
0.3000000	0.4811989	30.5194251	1.6039964	101.7314169	63.4237209	158.3032305
0.3100000	0.4866623	30.4927093	1.5698785	98.3635785	62.6568109	157.7517063
0.3200000	0.4918977	30.4590751	1.5371802	95.1846096	61.9215668	157.2188988
0.3300000	0.4969190	30.4194844	1.5058151	92.1802556	61.2161830	156.7038874
0.3400000	0.5017392	30.3747779	1.4757035	89.3375821	60.5389793	156.2058083
0.3500000	0.5063701	30.3256912	1.4467717	86.6448319	59.8883915	155.7238508
0.3600000	0.5108227	30.2728683	1.4189520	84.0913009	59.2629623	155.2572533
0.3700000	0.5151072	30.2168740	1.3921816	81.6672270	58.6613333	154.8053001
0.3800000	0.5192328	30.1582038	1.3664022	79.3636942	58.0822368	154.3673183
0.3900000	0.5232083	30.0972928	1.3415598	77.1725456	57.5244896	153.9426744
0.4000000	0.5270418	30.0345233	1.3176045	75.0863083	56.9869858	153.5307720

AGE LIABLE TO CAPTURE (2.5000000)

0.1500000	0.3510339	28.8071005	2.3402262	192.0473364	82.0635796	171.0093404
0.1600000	0.3628035	29.1984301	2.2675216	182.4901882	80.4800228	170.0240717
0.1700000	0.3738538	29.5266077	2.1991398	173.6859279	78.9790297	169.0809738
0.1800000	0.3842488	29.8005215	2.1347158	165.5584528	77.5552680	168.1777118
0.1900000	0.3940453	30.0277333	2.0739229	158.0407013	76.2037504	167.3120761
0.2000000	0.4032937	30.2146905	2.0164684	151.0734527	74.9198217	166.4819813
0.2100000	0.4120387	30.3669026	1.9620893	144.6042979	73.6991429	165.6854624
0.2200000	0.4203207	30.4890868	1.9105487	138.5867583	72.5376749	164.9206714
0.2300000	0.4281756	30.5852914	1.8616329	132.9795278	71.4316616	164.1858721
0.2400000	0.4356357	30.6589971	1.8151486	127.7458211	70.3776121	163.4794352
0.2500000	0.4427302	30.7132030	1.7709207	122.8528120	69.3722838	162.7998326
0.2600000	0.4494855	30.7504984	1.7287902	118.2711476	68.4126654	162.1456320
0.2700000	0.4559254	30.7731228	1.6886126	113.9745291	67.4959611	161.5154911
0.2800000	0.4620717	30.7830172	1.6502559	109.9393472	66.6195747	160.9081524
0.2900000	0.4679440	30.7818664	1.6135999	106.1443669	65.7810952	160.3224376
0.3000000	0.4735603	30.7711357	1.5785344	102.5704524	64.9782830	159.7572425
0.3100000	0.4789371	30.7521015	1.5449585	99.2003273	64.2090570	159.2115325
0.3200000	0.4840895	30.7258772	1.5127796	96.0183661	63.4714826	158.6843373
0.3300000	0.4890312	30.6934357	1.4819127	93.0104112	62.7637600	158.1747469
0.3400000	0.4937749	30.6556283	1.4522792	90.1636126	62.0842146	157.6819075
0.3500000	0.4983324	30.6132005	1.4238069	87.4662872	61.4312869	157.2050175
0.3600000	0.5027144	30.5668065	1.3964289	84.9077958	60.8035235	156.7433238
0.3700000	0.5069309	30.5170204	1.3700834	82.4784335	60.1995692	156.2961189
0.3800000	0.5109911	30.4643469	1.3447133	80.1693339	59.6181597	155.8627370
0.3900000	0.5149035	30.4092299	1.3202654	77.9723843	59.0581138	155.4425517
0.4000000	0.5186761	30.3520602	1.2966903	75.8801504	58.5183280	155.0349733

AGE LIABLE TO CAPTURE (2.6000000)

0.1500000	0.3454519	28.8974112	2.3030126	192.6494083	83.6510423	172.3270961
0.1600000	0.3570361	29.3011223	2.2314757	183.1320145	82.0676708	171.3526977
0.1700000	0.3679123	29.6414005	2.1641902	174.3611793	80.5664749	170.4199401
0.1800000	0.3781435	29.9271037	2.1007975	166.2616870	79.1421769	169.5265265
0.1900000	0.3877855	30.1657740	2.0409765	158.7672316	77.7898375	168.6702824
0.2000000	0.3968879	30.3638472	1.9844396	151.8192362	76.5048429	167.8491538
0.2100000	0.4054949	30.5268270	1.9309280	145.3658427	75.2828906	167.0612049
0.2200000	0.4136460	30.6594297	1.8802090	139.3610439	74.1199732	166.3046143
0.2300000	0.4213767	30.7657059	1.8320725	133.7639389	73.0123617	165.5776700
0.2400000	0.4287188	30.8491417	1.7863283	128.5380906	71.9565891	164.8787649
0.2500000	0.4357011	30.9127433	1.7428042	123.6509731	70.9494335	164.2063911
0.2600000	0.4423494	30.9591081	1.7013440	119.0734929	69.9879014	163.5591351
0.2700000	0.4486874	30.9904854	1.6618052	114.7795754	69.0692125	162.9356717
0.2800000	0.4547363	31.0088258	1.6240583	110.7458063	68.1907839	162.3347590
0.2900000	0.4605156	31.0158246	1.5879848	106.9511193	67.3502164	161.7552333
0.3000000	0.4660429	31.0129577	1.5534764	103.3765257	66.5452803	161.1960037
0.3100000	0.4713345	31.0015120	1.5204340	100.0048774	65.7739032	160.6560478
0.3200000	0.4764052	30.9826115	1.4887663	96.8206608	65.0341578	160.1344069
0.3300000	0.4812686	30.9572392	1.4583896	93.8098159	64.3242512	159.6301814
0.3400000	0.4859371	30.9262566	1.4292267	90.9595784	63.6425141	159.1425273
0.3500000	0.4904223	30.8904191	1.4012065	88.2583404	62.9873918	158.6706521
0.3600000	0.4947348	30.8503902	1.3742632	85.6955284	62.3574353	158.2138113
0.3700000	0.4988843	30.8067533	1.3483361	83.2614954	61.7512929	157.7713051
0.3800000	0.5028801	30.7600219	1.3233687	80.9474260	61.1677032	157.3424752
0.3900000	0.5067305	30.7106484	1.2993089	78.7452523	60.6054879	156.9267022
0.4000000	0.5104433	30.6590318	1.2761081	76.6475795	60.0635457	156.5234025

AGE LIABLE TO CAPTURE (2.7000000)

0.1500000	0.3399583	28.9805022	2.2663888	193.2033478	85.2472223	173.6309741
0.1600000	0.3513602	29.3963092	2.1960011	183.7269323	83.6643160	172.6673394
0.1700000	0.3620651	29.7484222	2.1297947	174.9907188	82.1631866	171.7448206
0.1800000	0.3721351	30.0456677	2.0674170	166.9203760	80.7386115	170.8611585
0.1900000	0.3816250	30.2955667	2.0085526	159.4503510	79.3856995	170.0142128
0.2000000	0.3905837	30.5045420	1.9529186	152.5227099	78.0998790	169.2019612
0.2100000	0.3990548	30.6780903	1.9002610	146.0861445	76.8768843	168.4224968
0.2200000	0.4070771	30.8209262	1.8503507	140.0951192	75.7127397	167.6740243
0.2300000	0.4146856	30.9371018	1.8029811	134.5091382	74.6037444	166.9548559
0.2400000	0.4219117	31.0301072	1.7579653	129.2921133	73.5464555	166.2634063
0.2500000	0.4287835	31.1029549	1.7151339	124.4118195	72.5376720	165.5981881
0.2600000	0.4353266	31.1582501	1.6743332	119.8394235	71.5744188	164.9578060
0.2700000	0.4415643	31.1982505	1.6354232	115.5490760	70.6539312	164.3409519
0.2800000	0.4475174	31.2249163	1.5982763	111.5175582	69.7736402	163.7463994
0.2900000	0.4532051	31.2399525	1.5627762	107.7239740	68.9311584	163.1729992
0.3000000	0.4586449	31.2448448	1.5288162	104.1494826	68.1242665	162.6196737
0.3100000	0.4638526	31.2408902	1.4962987	100.7770651	67.3509011	162.0854126
0.3200000	0.4688429	31.2292227	1.4651340	97.5913208	66.6091425	161.5692685
0.3300000	0.4736291	31.2108352	1.4352398	94.5782886	65.8972046	161.0703523
0.3400000	0.4782236	31.1865989	1.4065400	91.7252908	65.2134239	160.5878298
0.3500000	0.4826377	31.1572785	1.3789648	89.0207956	64.5562508	160.1209174
0.3600000	0.4868818	31.1235466	1.3524493	86.4542961	63.9242406	159.6688791
0.3700000	0.4909655	31.0859956	1.3269339	84.0162043	63.3160454	159.2310227
0.3800000	0.4948979	31.0451474	1.3023629	81.6977564	62.7304071	158.8066974
0.3900000	0.4986872	31.0014628	1.2786851	79.4909303	62.1661503	158.3952905
0.4000000	0.5023410	30.9553486	1.2558526	77.3883714	61.6221760	157.9962250

AGE LIABLE TO CAPTURE (2.8000000)

0.1500000	0.3345518	29.0563977	2.2303452	193.7093181	86.8517212	174.9211187
0.1600000	0.3457742	29.4840122	2.1610887	184.2750761	85.2695560	173.9681426
0.1700000	0.3563105	29.8476913	2.0959443	175.5746545	83.7687585	173.0557621
0.1800000	0.3662218	30.1562285	2.0345657	167.5346030	82.3441615	172.1817554
0.1900000	0.3755621	30.4171227	1.9766427	160.0901196	80.9909226	171.3440162
0.2000000	0.3843795	30.6367824	1.9218976	153.1839120	79.7045127	170.5405535
0.2100000	0.3927169	30.8206965	1.8700804	146.7652214	78.4807032	169.7694889
0.2200000	0.4006125	30.9735764	1.8209659	140.7889835	77.3155510	169.0290532
0.2300000	0.4081008	31.0994748	1.7743511	135.2151077	76.2053833	168.3175824
0.2400000	0.4152125	31.2018852	1.7300522	130.0078550	75.1467820	167.6335132
0.2500000	0.4219756	31.2838255	1.6879026	125.1353019	74.1365673	166.9753780
0.2600000	0.4284153	31.3479078	1.6477510	120.5688760	73.1717829	166.3417999
0.2700000	0.4345541	31.3963976	1.6094598	116.2829542	72.2496801	165.7314876
0.2800000	0.4404130	31.4312639	1.5729035	112.2545140	71.3677041	165.1432303
0.2900000	0.4460106	31.4542208	1.5379677	108.4628304	70.5234796	164.5758927
0.3000000	0.4513642	31.4667635	1.5045473	104.8892117	69.7147979	164.0284105
0.3100000	0.4564894	31.4701984	1.4725464	101.5167691	68.9396048	163.4997856
0.3200000	0.4614006	31.4656690	1.4418768	98.3302157	68.1959887	162.9890815
0.3300000	0.4661109	31.4541778	1.4124574	95.3156904	67.4821704	162.4954197
0.3400000	0.4706326	31.4366050	1.3842134	92.4606028	66.7964924	162.0179756
0.3500000	0.4749766	31.4137244	1.3570761	89.7534982	66.1374104	161.5559745
0.3600000	0.4791534	31.3862175	1.3309817	87.1839374	65.5034843	161.1086886
0.3700000	0.4831724	31.3546850	1.3058713	84.7423920	64.8933701	160.6754337
0.3800000	0.4870424	31.3196573	1.2816905	82.4201508	64.3058132	160.2555661
0.3900000	0.4907716	31.2816029	1.2583886	80.2092383	63.7396411	159.8484798
0.4000000	0.4943674	31.2409363	1.2359186	78.1023408	63.1937575	159.4536043

AGE LIABLE TO CAPTURE (2.9000000)

0.1500000	0.3292309	29.1251295	2.1948726	194.1675297	88.4641440	176.1976727
0.1600000	0.3402767	29.5642604	2.1267296	184.7766274	86.8829914	175.2552512
0.1700000	0.3506472	29.9392339	2.0626305	176.1131407	85.3827871	174.3529099
0.1800000	0.3604023	30.2588094	2.0022351	168.1044969	83.9584198	173.4884635
0.1900000	0.3695954	30.5304621	1.9452389	160.6866428	82.6050961	172.6598400
0.2000000	0.3782737	30.7605853	1.8913685	153.8029263	81.3183298	171.8650790
0.2100000	0.3864795	30.9546587	1.8403784	147.4031368	80.0939299	171.1023305
0.2200000	0.3942504	31.1173898	1.7920473	141.4426811	78.9279863	170.3698511
0.2300000	0.4016203	31.2528310	1.7461754	135.8818737	77.8168548	169.6660006
0.2400000	0.4086197	31.3644781	1.7025820	130.6853254	76.7571421	168.9892373
0.2500000	0.4152758	31.4553536	1.6611033	125.8214144	75.7456903	168.3381134
0.2600000	0.4216135	31.5280758	1.6215905	121.2618299	74.7795620	167.7112702
0.2700000	0.4276553	31.5849175	1.5839084	116.9811758	73.8560251	167.1074330
0.2800000	0.4334213	31.6278556	1.5479334	112.9566270	72.9725390	166.5254065
0.2900000	0.4389303	31.6586127	1.5135528	109.1676301	72.1267410	165.9640694
0.3000000	0.4441991	31.6786930	1.4806636	105.5956435	71.3164333	165.4223705
0.3100000	0.4492430	31.6894119	1.4491711	102.2239094	70.5395711	164.8993236
0.3200000	0.4540764	31.6919219	1.4189887	99.0372560	69.7942512	164.3940034
0.3300000	0.4587121	31.6872344	1.3900366	96.0219225	69.0787013	163.9055417
0.3400000	0.4631620	31.6762385	1.3622412	93.1654072	68.3912705	163.4331233
0.3500000	0.4674372	31.6597166	1.3355348	90.4563331	67.7304198	162.9759825
0.3600000	0.4715477	31.6383587	1.3098548	87.8843298	67.0947138	162.5333998
0.3700000	0.4755030	31.6127738	1.2851431	85.4399291	66.4828127	162.1046985
0.3800000	0.4793116	31.5834999	1.2613462	83.1144734	65.8934656	161.6892421
0.3900000	0.4829816	31.5510134	1.2384143	80.9000344	65.3255029	161.2864315
0.4000000	0.4865204	31.5157361	1.2163010	78.7893402	64.7778313	160.8957023

AGE LIABLE TO CAPTURE (3.0000000)

0.1500000	0.3239943	29.1867357	2.1599621	194.5782379	90.0840992	177.4607774
0.1600000	0.3348664	29.6370900	2.0929149	185.2318123	88.5042265	176.5288078
0.1700000	0.3450736	30.0230840	2.0298447	176.6063762	87.0048726	175.6364074
0.1800000	0.3546751	30.3534416	1.9704171	168.6302312	85.5809826	174.7814276
0.1900000	0.3637232	30.6356134	1.9143329	161.2400704	84.2278124	173.9618298
0.2000000	0.3722647	30.8759760	1.8613235	154.3798800	82.9409194	173.1756844
0.2100000	0.3803410	31.0799994	1.8111474	147.9999971	81.7161503	172.4211693
0.2200000	0.3879892	31.2523858	1.7635873	142.0562989	80.5496284	171.6965668
0.2300000	0.3952427	31.3971862	1.7184465	136.5095052	79.4377384	171.0002601
0.2400000	0.4021314	31.5178983	1.6755475	131.3245762	78.3771125	170.3307290
0.2500000	0.4086823	31.6175482	1.6347292	126.4701929	77.3646150	169.6865455
0.2600000	0.4149197	31.6987596	1.5958452	121.9183063	76.3973275	169.0663688
0.2700000	0.4208658	31.7638120	1.5587624	117.6437482	75.4725349	168.4689408
0.2800000	0.4265406	31.8146895	1.5233594	113.6238912	74.5877113	167.8930814
0.2900000	0.4319624	31.8531229	1.4895254	109.8383549	73.7405067	167.3376835
0.3000000	0.4371476	31.8806245	1.4571588	106.2687483	72.9287345	166.8017084
0.3100000	0.4421117	31.8985182	1.4261668	102.8984459	72.1503597	166.2841821
0.3200000	0.4468684	31.9079652	1.3964639	99.7123911	71.4034874	165.7841903
0.3300000	0.4514306	31.9099853	1.3679716	96.6969251	70.6863530	165.3008749
0.3400000	0.4558100	31.9054760	1.3406177	93.8396353	69.9973119	164.8334302
0.3500000	0.4600174	31.8952282	1.3143354	91.1292235	69.3348307	164.3810994
0.3600000	0.4640627	31.8799399	1.2890631	88.5553885	68.6974791	163.9431709
0.3700000	0.4679552	31.8602277	1.2647439	86.1087235	68.0839216	163.5189759
0.3800000	0.4717034	31.8366376	1.2413248	83.7806253	67.4929108	163.1078849
0.3900000	0.4753152	31.8096532	1.2187569	81.5632133	66.9232809	162.7093054
0.4000000	0.4787979	31.7797033	1.1969947	79.4492583	66.3739409	162.3226791

AGE LIABLE TO CAPTURE (3.1000000)

0.1500000	0.3188407	29.2412611	2.1256045	194.9417407	91.7111988	178.7105727
0.1600000	0.3295418	29.7025439	2.0596360	185.6408994	90.1328688	177.7889534
0.1700000	0.3395883	30.0992824	1.9975784	177.0546023	88.6346186	176.9063968
0.1800000	0.3490386	30.4401639	1.9391034	169.1120215	87.2114496	176.0607909
0.1900000	0.3579442	30.7326128	1.8839169	161.7505937	85.8586677	175.2501299
0.2000000	0.3663510	30.9829884	1.8317549	154.9149421	84.5718740	174.4725148
0.2100000	0.3742998	31.1967495	1.7823801	148.5559502	83.3469536	173.7261513
0.2200000	0.3818273	31.3785923	1.7355787	142.6299652	82.1800632	173.0093471
0.2300000	0.3889662	31.5325657	1.6911575	137.0981117	81.0676172	172.3205086
0.2400000	0.3957461	31.6621680	1.6489419	131.9256999	80.0062734	171.6581370
0.2500000	0.4021934	31.7704284	1.6087735	127.0817134	78.9929185	171.0208238
0.2600000	0.4083322	31.8599752	1.5705083	122.5383661	78.0246539	170.4072460
0.2700000	0.4141842	31.9330938	1.5340154	118.2707177	77.0987816	169.8161621
0.2800000	0.4197691	31.9917752	1.4991754	114.2563398	76.2127905	169.2464069
0.2900000	0.4251050	32.0377574	1.4658792	110.4750254	75.3643439	168.6968872
0.3000000	0.4302081	32.0725605	1.4340271	106.9085351	74.5512665	168.1665773
0.3100000	0.4350935	32.0975166	1.4035275	103.5403760	73.7715333	167.6545148
0.3200000	0.4397749	32.1137947	1.3742965	100.3556084	73.0232582	167.1597964
0.3300000	0.4442648	32.1224230	1.3462568	97.3406756	72.3046841	166.6815742
0.3400000	0.4485747	32.1243068	1.3193374	94.4832554	71.6141733	166.2190517
0.3500000	0.4527154	32.1202451	1.2934725	91.7721289	70.9501981	165.7714809
0.3600000	0.4566966	32.1109434	1.2686015	89.1970650	70.3113333	165.3381584
0.3700000	0.4605273	32.0970261	1.2446684	86.7487193	69.6962480	164.9184228
0.3800000	0.4642161	32.0790464	1.2216212	84.4185432	69.1036987	164.5116518
0.3900000	0.4677705	32.0574949	1.1994116	82.1987050	68.5325230	164.1172593
0.4000000	0.4711980	32.0328075	1.1779949	80.0820187	67.9816330	163.7346933

AGE LIABLE TO CAPTURE (3.2000000)

0.1500000	0.3137687	29.2887566	2.0917913	195.2583771	93.3450587	179.9471969
0.1600000	0.3243015	29.7606717	2.0268844	186.0041982	91.7685301	179.0358273
0.1700000	0.3341900	30.1678771	1.9658235	177.4581006	90.2716325	178.1630188
0.1800000	0.3434915	30.5190222	1.9082861	169.5501232	88.8494245	177.3266949
0.1900000	0.3522568	30.8215044	1.8539831	162.2184440	87.4972620	176.5248829
0.2000000	0.3605310	31.0816642	1.8026551	155.4083211	86.2107900	175.7557139
0.2100000	0.3683545	31.3049485	1.7540689	149.0711833	84.9859327	175.0174211
0.2200000	0.3757631	31.4960463	1.7080143	143.1638470	83.8188806	174.3083375
0.2300000	0.3827893	31.6590036	1.6643014	137.6478416	82.7060780	173.6268925
0.2400000	0.3894620	31.7973185	1.6227584	132.4888272	81.6442086	172.9716085
0.2500000	0.3958074	31.9140226	1.5832296	127.6560903	80.6301820	172.3410962
0.2600000	0.4018491	32.0117481	1.5455734	123.1221079	79.6611196	171.7340505
0.2700000	0.4076085	32.0927855	1.5096611	118.8621686	78.7343408	171.1492462
0.2800000	0.4131050	32.1591321	1.4753751	114.8540433	77.8473499	170.5855329
0.2900000	0.4183564	32.2125327	1.4426083	111.0776991	76.9978233	170.0418314
0.3000000	0.4233787	32.2545147	1.4112624	107.5150490	76.1835977	169.5171285
0.3100000	0.4281867	32.2864175	1.3812475	104.1497339	75.4026582	169.0104737
0.3200000	0.4327939	32.3094180	1.3524809	100.9669312	74.6531276	168.5209744
0.3300000	0.4372126	32.3245518	1.3248867	97.9531873	73.9332568	168.0477927
0.3400000	0.4414542	32.3327322	1.2983948	95.0962712	73.2414148	167.5901417
0.3500000	0.4455292	32.3347654	1.2729407	92.3850439	72.5760801	167.1472816
0.3600000	0.4494473	32.3313645	1.2484647	89.8093457	71.9358328	166.7185173
0.3700000	0.4532173	32.3231610	1.2249116	87.3598946	71.3193466	166.3031948
0.3800000	0.4568475	32.3107152	1.2022303	85.0281979	70.7253821	165.9006987
0.3900000	0.4603456	32.2945245	1.1803734	82.8064732	70.1527805	165.5104497
0.4000000	0.4637187	32.2750314	1.1592967	80.6875784	69.6004572	165.1319017

AGE LIABLE TO CAPTURE (3.3000000)

0.1500000	0.3087770	29.3292786	2.0585135	195.5285242	94.9852989	181.1707869
0.1600000	0.3191443	29.8115290	1.9946516	186.3220561	93.4108259	180.2695677
0.1700000	0.3288772	30.2289224	1.9345719	177.8171907	91.9155260	179.4064123
0.1800000	0.3380323	30.5900694	1.8779572	169.9448302	90.4945148	178.5792798
0.1900000	0.3466595	30.9023392	1.8245238	162.6438906	89.1431989	177.7862300
0.2000000	0.3548033	31.1720527	1.7740167	155.8602634	87.8572677	177.0254239
0.2100000	0.3625034	31.4046434	1.7262067	149.5459211	86.6326845	176.2951219
0.2200000	0.3697952	31.6047927	1.6808871	143.6581488	85.4656742	175.5936820
0.2300000	0.3767104	31.7765425	1.6378712	138.1588804	84.3527112	174.9195567
0.2400000	0.3832777	31.9233901	1.5969903	133.0141256	83.2905056	174.2712891
0.2500000	0.3895227	32.0483686	1.5580909	128.1934743	82.2759901	173.6475092
0.2600000	0.3954689	32.1541134	1.5210341	123.6696668	81.3063065	173.0469295
0.2700000	0.4011372	32.2429196	1.4856932	119.4182208	80.3787920	172.4683410
0.2800000	0.4065467	32.3167901	1.4519525	115.4171076	79.4909663	171.9106082
0.2900000	0.4117149	32.3774760	1.4197067	111.6464688	78.6405196	171.3726653
0.3000000	0.4166577	32.4265112	1.3888590	108.0883707	77.8253004	170.8535121
0.3100000	0.4213895	32.4652424	1.3593211	104.7265883	77.0433043	170.3522093
0.3200000	0.4259237	32.4948535	1.3310116	101.5464171	76.2926635	169.8678754
0.3300000	0.4302724	32.5163875	1.3038557	98.5345075	75.5716367	169.3996823
0.3400000	0.4344468	32.5307648	1.2777846	95.6787201	74.8786001	168.9468522
0.3500000	0.4384572	32.5387990	1.2527347	92.9679970	74.2120386	168.5086541
0.3600000	0.4423131	32.5412100	1.2286474	90.3922500	73.5705375	168.0844007
0.3700000	0.4460233	32.5386365	1.2054683	87.9422608	72.9527754	167.6734455
0.3800000	0.4495959	32.5316453	1.1831472	85.6095930	72.3575174	167.2751800
0.3900000	0.4530385	32.5207405	1.1616373	83.3865141	71.7836081	166.8890313
0.4000000	0.4563581	32.5063707	1.1408952	81.2659268	71.2299664	166.5144594

AGE LIABLE TO CAPTURE (3.4000000)

0.1500000	0.3038644	29.3628894	2.0257629	195.7525960	96.6315435	182.3814781
0.1600000	0.3140687	29.8551772	1.9629295	186.5948572	95.0593758	181.4903111
0.1700000	0.3236486	30.2824789	1.9038154	178.1322290	93.5659143	180.6367150
0.1800000	0.3326596	30.6533650	1.8481091	170.2964723	92.1463321	179.8186842
0.1900000	0.3411510	30.9751754	1.7955316	163.0272388	90.7960863	179.0343108
0.2000000	0.3491665	31.2542102	1.7458324	156.2710509	89.5109114	178.2817852
0.2100000	0.3567451	31.4958890	1.6987863	149.9804239	88.2868100	177.5593950
0.2200000	0.3639218	31.7048843	1.6541901	144.1131106	87.1200417	176.8655230
0.2300000	0.3707279	31.8852332	1.6118603	138.6314488	86.0071114	176.1986442
0.2400000	0.3771914	32.0404315	1.5716308	133.5017978	84.9447559	175.5573227
0.2500000	0.3833378	32.1735127	1.5333511	128.6940509	83.9299317	174.9402075
0.2600000	0.3891899	32.2871151	1.4968842	124.1812121	82.9598007	174.3460286
0.2700000	0.3947685	32.3835378	1.4621055	119.9390289	82.0317184	173.7735928
0.2800000	0.4000924	32.4647884	1.4289015	115.9456729	81.1432205	173.2217795
0.2900000	0.4051788	32.5326238	1.3971684	112.1814613	80.2920110	172.6895366
0.3000000	0.4100433	32.5885842	1.3668111	108.6286141	79.4759505	172.1758761
0.3100000	0.4147002	32.6340228	1.3377426	105.2710412	78.6930454	171.6798706
0.3200000	0.4191625	32.6701302	1.3098829	102.0941568	77.9414373	171.2006489
0.3300000	0.4234423	32.6979564	1.2831584	99.0847162	77.2193933	170.7373929
0.3400000	0.4275505	32.7184285	1.2575015	96.2306721	76.5252968	170.2893340
0.3500000	0.4314973	32.7323670	1.2328495	93.5210485	75.8576389	169.8557496
0.3600000	0.4352921	32.7404986	1.2091447	90.9458294	75.2150109	169.4359604
0.3700000	0.4389435	32.7434685	1.1863337	88.4958607	74.5960963	169.0293272
0.3800000	0.4424594	32.7418500	1.1643669	86.1627631	73.9996645	168.6352483
0.3900000	0.4458474	32.7361534	1.1431985	83.9388548	73.4245642	168.2531572
0.4000000	0.4491143	32.7268334	1.1227858	81.8170836	72.8697175	167.8825200

AGE LIABLE TO CAPTURE (3.5000000)

0.1500000	0.2990296	29.3896561	1.9935309	195.9310407	98.2834207	183.5794045
0.1600000	0.3090736	29.8916832	1.9317100	186.8230202	96.7138039	182.6981925
0.1700000	0.3185029	30.3286130	1.8735463	178.4036058	95.2224175	181.8540631
0.1800000	0.3273721	30.7089745	1.8187339	170.6054137	93.8044923	181.0450454
0.1900000	0.3357298	31.0400773	1.7669989	163.3688280	92.4555365	180.2692635
0.2000000	0.3436190	31.3282000	1.7180949	156.6409999	91.1713297	179.5249371
0.2100000	0.3510781	31.5787471	1.6718007	150.3749860	89.9479143	178.8103805
0.2200000	0.3581416	31.7963813	1.6279165	144.5290059	88.7815850	178.1240013
0.2300000	0.3648402	31.9851342	1.5862619	139.0658008	87.6688773	177.4642969
0.2400000	0.3712017	32.1484991	1.5466737	133.9520795	86.6065555	176.8298520
0.2500000	0.3772509	32.2895097	1.5090037	129.1580386	85.5915994	176.2193344
0.2600000	0.3830105	32.4108060	1.4731173	124.6569461	84.6211923	175.6314916
0.2700000	0.3885009	32.5146905	1.4388921	120.4247796	83.6927078	175.0651463
0.2800000	0.3937406	32.6031753	1.4062163	116.4399116	82.8036976	174.5191924
0.2900000	0.3987465	32.6780222	1.3749878	112.6828353	81.9518800	173.9925913
0.3000000	0.4035339	32.7407775	1.3451131	109.1359250	81.1351282	173.4843675
0.3100000	0.4081170	32.7928001	1.3165066	105.7832261	80.3514594	172.9936048
0.3200000	0.4125087	32.8352872	1.2890896	102.6102725	79.5990248	172.5194428
0.3300000	0.4167206	32.8692951	1.2627897	99.6039245	78.8761001	172.0610731
0.3400000	0.4207637	32.8957575	1.2375402	96.7522280	78.1810761	171.6177361
0.3500000	0.4246479	32.9155013	1.2132798	94.0442893	77.5124507	171.1887177
0.3600000	0.4283825	32.9292596	1.1899515	91.4701656	76.8688208	170.7733464
0.3700000	0.4319760	32.9376839	1.1675027	89.0207674	76.2488751	170.3709903
0.3800000	0.4354362	32.9413537	1.1458848	86.6877730	75.6513876	169.9810545
0.3900000	0.4387705	32.9407853	1.1250525	84.4635521	75.0752109	169.6029789
0.4000000	0.4419855	32.9364393	1.1049638	82.3410983	74.5192710	169.2362354

AGE LIABLE TO CAPTURE (3.6000000)

0.1500000	0.2942714	29.4096509	1.9618094	196.0643390	99.9405633	184.7646986
0.1600000	0.3041576	29.9211193	1.9009849	187.0069958	98.3737386	183.8933457
0.1700000	0.3134386	30.3673965	1.8437567	178.6317441	96.8846598	183.0585913
0.1800000	0.3221684	30.7569692	1.7898243	170.8720509	95.4686157	182.2584991
0.1900000	0.3303945	31.0971156	1.7389184	163.6690297	94.1211660	181.4912248
0.2000000	0.3381594	31.3940917	1.6907972	156.9704585	92.8381356	180.7550171
0.2100000	0.3455010	31.6532861	1.6452430	150.7299336	91.6156070	180.0482170
0.2200000	0.3524531	31.8793508	1.6020595	144.9061402	90.4499103	179.3692563
0.2300000	0.3590460	32.0763111	1.5610695	139.4622223	89.3376123	178.7166549
0.2400000	0.3653070	32.2476572	1.5221124	134.3652382	88.2755044	178.0890179
0.2500000	0.3712606	32.3964219	1.4850425	129.5856875	87.2605908	177.4850318
0.2600000	0.3769292	32.5252466	1.4497276	125.0971025	86.2900758	176.9034613
0.2700000	0.3823327	32.6364366	1.4160471	120.8756910	85.3613517	176.3431448
0.2800000	0.3874895	32.7320076	1.3838911	116.9000270	84.4719868	175.8029908
0.2900000	0.3924162	32.8137263	1.3531591	113.1507802	83.6197135	175.2819741
0.3000000	0.3971278	32.8831439	1.3237594	109.6104796	82.8024179	174.7791313
0.3100000	0.4016383	32.9416252	1.2956076	106.2633070	82.0181284	174.2935577
0.3200000	0.4059604	32.9903731	1.2686262	103.0949161	81.2650060	173.8244034
0.3300000	0.4101056	33.0304502	1.2427442	100.0922733	80.5413350	173.3708697
0.3400000	0.4140846	33.0627962	1.2178958	97.2435181	79.8455140	172.9322059
0.3500000	0.4179072	33.0882440	1.1940207	94.5378399	79.1760477	172.5077063
0.3600000	0.4215826	33.1075329	1.1710629	91.9653693	78.5315389	172.0967072
0.3700000	0.4251191	33.1213205	1.1489706	89.5170824	77.9106817	171.6985838
0.3800000	0.4285245	33.1301920	1.1276959	87.1847158	77.3122547	171.3127481
0.3900000	0.4318058	33.1346695	1.1071944	84.9606911	76.7351149	170.9386462
0.4000000	0.4349699	33.1352193	1.0874247	82.8380481	76.1781916	170.5757559

AGE LIABLE TO CAPTURE (3.7000000)

0.1500000	0.2895885	29.4229504	1.9305902	196.1530023	101.6026087	185.9374915
0.1600000	0.2993195	29.9435625	1.8707466	187.1472656	100.0388127	185.0759028
0.1700000	0.3084547	30.3989065	1.8144392	178.8170973	98.5522699	184.2504329
0.1800000	0.3170471	30.7974260	1.7613728	171.0968109	97.1383271	183.4591795
0.1900000	0.3251438	31.1463668	1.7112831	163.9282462	95.7925957	182.7003299
0.2000000	0.3327864	31.4519611	1.6639322	157.2598054	94.5109464	181.9721614
0.2100000	0.3400123	31.7195808	1.6191063	151.0456231	93.2895021	181.2730415
0.2200000	0.3468548	31.9538668	1.5766126	145.2448489	92.1246285	180.6014260
0.2300000	0.3533436	32.1588367	1.5362766	139.8210293	91.0129238	179.9558571
0.2400000	0.3595058	32.3379770	1.4979407	134.7415710	89.9512073	179.3349599
0.2500000	0.3653654	32.4943193	1.4614614	129.9772772	88.9365075	178.7374399
0.2600000	0.3709443	32.6305055	1.4267089	125.5019441	87.9660502	178.1620785
0.2700000	0.3762624	32.7488428	1.3935644	121.2920102	87.0372466	177.6077299
0.2800000	0.3813376	32.8513504	1.3619200	117.3262515	86.1476817	177.0733171
0.2900000	0.3861863	32.9397991	1.3316769	113.5855142	85.2951028	176.5578278
0.3000000	0.3908234	33.0157449	1.3027445	110.0524829	84.4774085	176.0603112
0.3100000	0.3952625	33.0805576	1.2750402	106.7114761	83.6926389	175.5798737
0.3200000	0.3995160	33.1354458	1.2484876	103.5482680	82.9389650	175.1156756
0.3300000	0.4035955	33.1814774	1.2230168	100.5499316	82.2146801	174.6669281
0.3400000	0.4075115	33.2195982	1.1985632	97.7047007	81.5181905	174.2328894
0.3500000	0.4112735	33.2506468	1.1750673	95.0018481	80.8480079	173.8128619
0.3600000	0.4148907	33.2753684	1.1524741	92.4315789	80.2027413	173.4061897
0.3700000	0.4183711	33.2944260	1.1307326	89.9849351	79.5810903	173.0122552
0.3800000	0.4217224	33.3084106	1.1097958	87.6537120	78.9818383	172.6304771
0.3900000	0.4249517	33.3178497	1.0896198	85.4303838	78.4038466	172.2603075
0.4000000	0.4280656	33.3232149	1.0701640	83.3080373	77.8460484	171.9012304

AGE LIABLE TO CAPTURE (3.8000000)

0.1500000	0.2849798	29.4296356	1.8998653	196.1975706	103.2691988	187.0979131
0.1600000	0.2945579	29.9590944	1.8409871	187.2443398	101.7086639	186.2459946
0.1700000	0.3035496	30.4232251	1.7855860	178.9601477	100.2248813	185.4297196
0.1800000	0.3120070	30.8304269	1.7333722	171.2801495	98.8132561	184.6472196
0.1900000	0.3199763	31.1879125	1.6840857	164.1469081	97.4694516	183.8967126
0.2000000	0.3274986	31.5018896	1.6374930	157.5094480	96.1893846	183.1765048
0.2100000	0.3346107	31.7777123	1.5933841	151.3224396	94.9692184	182.4849896
0.2200000	0.3413452	32.0200092	1.5515692	145.5454963	93.8053550	181.8206468
0.2300000	0.3477317	32.2327901	1.5118770	140.1425659	92.6944243	181.1820406
0.2400000	0.3537966	32.4195368	1.4741523	135.0814035	91.6332735	180.5678162
0.2500000	0.3595636	32.5832788	1.4382544	130.3331154	90.6189559	179.9766974
0.2600000	0.3650544	32.7266581	1.4040553	125.8717619	89.6487191	179.4074828
0.2700000	0.3702884	32.8519834	1.3714385	121.6740126	88.7199935	178.8590419
0.2800000	0.3752833	32.9612766	1.3402976	117.7188451	87.8303809	178.3303120
0.2900000	0.3800553	33.0563121	1.3105354	113.9872833	86.9776436	177.8202941
0.3000000	0.3846189	33.1386502	1.2820631	110.4621673	86.1596935	177.3280493
0.3100000	0.3889877	33.2096654	1.2547991	107.1279529	85.3745821	176.8526953
0.3200000	0.3931739	33.2705714	1.2286685	103.9705356	84.6204909	176.3934027
0.3300000	0.3971888	33.3224414	1.2036024	100.9770953	83.8957221	175.9493922
0.3400000	0.4010427	33.3662266	1.1795373	98.1359606	83.1986903	175.5199308
0.3500000	0.4047451	33.4027710	1.1564146	95.4364885	82.5279140	175.1043293
0.3600000	0.4083049	33.4328252	1.1341803	92.8689589	81.8820088	174.7019393
0.3700000	0.4117301	33.4570578	1.1127841	90.4244804	81.2596798	174.3121503
0.3800000	0.4150283	33.4760649	1.0921797	88.0949077	80.6597155	173.9343876
0.3900000	0.4182064	33.4903795	1.0723241	85.8727680	80.0809814	173.5681096
0.4000000	0.4212709	33.5004781	1.0531772	83.7511953	79.5224149	173.2128059

AGE LIABLE TO CAPTURE (3.9000000)

0.1500000	0.2804440	29.4297916	1.8696269	196.1986104	104.9399803	188.2460917
0.1600000	0.2898718	29.9678009	1.8116990	187.2987556	103.3829346	187.4037507
0.1700000	0.2987223	30.4404387	1.7571900	179.0614041	101.9021322	186.5965820
0.1800000	0.3070467	30.8560589	1.7058152	171.4225493	100.4930369	185.8227506
0.1900000	0.3148907	31.2218399	1.6573193	164.3254734	99.1513642	185.0805054
0.2000000	0.3222946	31.5439640	1.6114730	157.7198202	97.8730768	184.3681805
0.2100000	0.3292946	31.8277669	1.5680696	151.5607949	96.6543795	183.6841954
0.2200000	0.3359230	32.0778641	1.5269228	145.8084731	95.4917102	183.0270538
0.2300000	0.3422088	32.2982567	1.4878642	140.4272030	94.3817309	182.3953412
0.2400000	0.3481779	32.4924211	1.4507413	135.3850878	93.3213172	181.7877233
0.2500000	0.3538539	32.6633841	1.4154155	130.6535364	92.3075473	181.2029418
0.2600000	0.3592579	32.8137871	1.3817612	126.2068735	91.3376909	180.6398122
0.2700000	0.3644092	32.9459398	1.3496636	122.0219994	90.4091979	180.0972194
0.2800000	0.3693251	33.0618664	1.3190182	118.0780942	89.5196874	179.5741150
0.2900000	0.3740215	33.1633442	1.2897294	114.3563592	88.6669366	179.0695129
0.3000000	0.3785130	33.2519373	1.2617099	110.8397909	87.8488710	178.5824863
0.3100000	0.3828126	33.3290247	1.2348793	107.5129828	87.0635539	178.1121638
0.3200000	0.3869325	33.3958246	1.2091640	104.3619518	86.3091773	177.6577264
0.3300000	0.3908837	33.4534152	1.1844962	101.3739855	85.5840526	177.2184042
0.3400000	0.3946766	33.5027527	1.1608134	98.5375079	84.8866027	176.7934731
0.3500000	0.3983203	33.5446862	1.1380580	95.8419606	84.2153534	176.3822520
0.3600000	0.4018237	33.5799716	1.1161768	93.2776988	83.5689268	175.9840998
0.3700000	0.4051946	33.6092824	1.0951205	90.8358983	82.9460337	175.5984134
0.3800000	0.4084405	33.6332200	1.0748433	88.5084736	82.3454677	175.2246245
0.3900000	0.4115681	33.6523221	1.0553029	86.2880054	81.7660991	174.8621977
0.4000000	0.4145840	33.6670703	1.0364601	84.1676758	81.2068692	174.5106282

AGE LIABLE TO CAPTURE (4.0000000)

0.1500000	0.2759801	29.4235071	1.8398672	196.1567137	106.6146046	189.3821542
0.1600000	0.2852599	29.9697720	1.7828746	187.3110750	105.0612718	188.5492990
0.1700000	0.2939714	30.4506382	1.7292437	179.1214011	103.5836656	187.7511492
0.1800000	0.3021651	30.8744133	1.6786948	171.5245182	102.1773087	186.9859028
0.1900000	0.3098857	31.2482407	1.6309772	164.4644247	100.8379687	186.2518391
0.2000000	0.3171731	31.5782763	1.5858654	157.8913815	99.5616551	185.5473204
0.2100000	0.3240629	31.8698365	1.5431565	151.7611263	98.3446137	184.8707918
0.2200000	0.3305868	32.1275230	1.5026673	146.0341954	97.1833190	184.2207804
0.2300000	0.3367734	32.3553275	1.4642323	140.6753368	96.0744654	183.5958935
0.2400000	0.3426484	32.5567202	1.4277015	135.6530010	95.0149572	182.9948162
0.2500000	0.3482347	32.7347249	1.3929389	130.9388996	94.0018977	182.4163089
0.2600000	0.3535534	32.8919815	1.3598206	126.5076210	93.0325790	181.8592033
0.2700000	0.3586232	33.0308001	1.3282341	122.3362968	92.1044706	181.3223999
0.2800000	0.3634614	33.1532067	1.2980764	118.4043096	91.2152092	180.8048641
0.2900000	0.3680835	33.2609811	1.2692536	114.6930384	90.3625874	180.3056228
0.3000000	0.3725039	33.3556909	1.2416796	111.1856364	89.5445442	179.8237612
0.3100000	0.3767354	33.4387189	1.2152756	107.8668352	88.7591551	179.3584189
0.3200000	0.3807901	33.5112876	1.1899690	104.7227737	88.0046226	178.9087871
0.3300000	0.3846788	33.5744797	1.1656932	101.7408475	87.2792679	178.4741051
0.3400000	0.3884115	33.6292560	1.1423867	98.9095765	86.5815219	178.0536576
0.3500000	0.3919975	33.6764706	1.1199928	96.2184876	85.9099183	177.6467716
0.3600000	0.3954453	33.7168842	1.0984591	93.6580116	85.2630854	177.2528136
0.3700000	0.3987627	33.7511750	1.0777371	91.2193920	84.6397403	176.8711873
0.3800000	0.4019572	33.7799494	1.0577820	88.8946037	84.0386816	176.5013310
0.3900000	0.4050353	33.8037497	1.0385519	86.6762814	83.4587844	176.1427154
0.4000000	0.4080033	33.8230622	1.0200082	84.5576555	82.8989943	175.7948413

AGE LIABLE TO CAPTURE (4.1000000)

0.1500000	0.2715868	29.4108743	1.8105786	196.0724953	108.2927284	190.5062263
0.1600000	0.2807211	29.9651014	1.7545067	187.2818837	106.7433277	189.6827662
0.1700000	0.2892958	30.4539184	1.7017401	179.1406962	105.2691296	188.8935488
0.1800000	0.2973607	30.8855858	1.6520041	171.5865876	103.8657155	188.1368047
0.1900000	0.3049600	31.2672111	1.6050524	164.5642689	102.5289056	187.4108435
0.2000000	0.3121327	31.6049230	1.5606636	158.0246150	101.2547561	186.7140551
0.2100000	0.3189140	31.9040178	1.5186383	151.9238944	100.0395543	186.0449100
0.2200000	0.3253352	32.1690826	1.4787963	146.2231029	98.8798116	185.4019588
0.2300000	0.3314243	32.4040990	1.4409751	140.8873870	97.7722550	184.7838301
0.2400000	0.3372065	32.6125305	1.4050272	135.8855440	96.7138175	184.1892288
0.2500000	0.3427047	32.7973969	1.3708188	131.1895875	95.7016281	183.6169330
0.2600000	0.3479393	32.9613363	1.3382282	126.7743702	94.7330015	183.0657912
0.2700000	0.3529290	33.1066587	1.3071446	122.6172544	93.8054272	182.5347189
0.2800000	0.3576907	33.2353911	1.2774669	118.6978254	92.9165593	182.0226955
0.2900000	0.3622398	33.3493157	1.2491026	114.9976405	92.0642064	181.5287609
0.3000000	0.3665902	33.4500028	1.2219672	111.5000095	91.2463212	181.0520118
0.3100000	0.3707547	33.5388388	1.1959829	108.1898025	90.4609914	180.5915989
0.3200000	0.3747452	33.6170499	1.1710786	105.0532811	89.7064306	180.1467234
0.3300000	0.3785722	33.6857232	1.1471886	102.0779492	88.9809693	179.7166341
0.3400000	0.3822458	33.7458238	1.1242523	99.2524230	88.2830474	179.3006242
0.3500000	0.3857750	33.7982103	1.1022142	96.5663150	87.6112058	178.8980287
0.3600000	0.3891681	33.8436477	1.0810226	94.0101325	86.9640800	178.5082215
0.3700000	0.3924330	33.8828191	1.0606297	91.5751868	86.3403929	178.1306134
0.3800000	0.3955768	33.9163353	1.0409915	89.2535138	85.7389486	177.7646490
0.3900000	0.3986060	33.9447430	1.0220668	87.0378027	85.1586270	177.4098050
0.4000000	0.4015270	33.9685331	1.0038175	84.9213327	84.5983781	177.0655880

AGE LIABLE TO CAPTURE (4.2000000)

0.1500000	0.2672630	29.3919888	1.7817536	195.9465919	109.9740129	191.6184324
0.1600000	0.2762541	29.9538862	1.7265879	187.2117889	108.4287595	190.8042777
0.1700000	0.2846942	30.4503778	1.6746720	179.1198691	106.9581771	190.0239071
0.1800000	0.2926325	30.8896760	1.6257362	171.6093110	105.5579065	189.2755835
0.1900000	0.3001123	31.2788515	1.5795385	164.6255344	104.2238203	188.5576466
0.2000000	0.3071723	31.6240051	1.5358613	158.1200257	102.9520218	187.8685134
0.2100000	0.3138468	31.9304122	1.4945087	152.0495820	101.7388400	187.2066800
0.2200000	0.3201668	32.2026446	1.4553038	146.3756571	100.5808233	186.5707198
0.2300000	0.3261599	32.4446729	1.4180867	141.0637951	99.4747317	185.9592828
0.2400000	0.3318510	32.6599534	1.3827124	136.0831393	98.4175273	185.3710933
0.2500000	0.3372624	32.8515013	1.3490495	131.4060051	97.4063649	184.8049473
0.2600000	0.3424143	33.0219523	1.3169782	127.0075087	96.4385819	184.2597096
0.2700000	0.3473252	33.1736158	1.2863896	122.8652436	95.5116883	183.7343109
0.2800000	0.3520116	33.3085193	1.2571843	118.9589977	94.6233560	183.2277444
0.2900000	0.3564887	33.4284469	1.2292713	115.2705065	93.7714093	182.7390627
0.3000000	0.3607703	33.5349712	1.2025675	111.7832373	92.9538152	182.2673742
0.3100000	0.3648689	33.6294816	1.1769964	108.4821988	92.1686738	181.8118405
0.3200000	0.3687961	33.7132081	1.1524880	105.3537753	91.4142097	181.3716729
0.3300000	0.3725626	33.7872413	1.1289776	102.3855797	90.6887633	180.9461291
0.3400000	0.3761780	33.8525505	1.1064058	99.5663250	89.9907833	180.5345112
0.3500000	0.3796512	33.9099984	1.0847178	96.8857096	89.3188183	180.1361620
0.3600000	0.3829906	33.9603544	1.0638628	94.3343177	88.6715108	179.7504629
0.3700000	0.3862037	34.0043057	1.0437938	91.9035290	88.0475899	179.3768313
0.3800000	0.3892976	34.0424675	1.0244674	89.5854407	87.4458652	179.0147185
0.3900000	0.3922789	34.0753908	1.0058432	87.3727969	86.8652217	178.6636071
0.4000000	0.3951535	34.1035704	0.9878838	85.2589261	86.3046136	178.3230091

AGE LIABLE TO CAPTURE (4.3000000)

0.1500000	0.2630077	29.3669490	1.7533848	195.7796597	111.6581248	192.7188953
0.1600000	0.2718578	29.9362269	1.6991112	187.1014179	110.1172293	191.9139575
0.1700000	0.2801656	30.4401183	1.6480327	179.0595196	108.6504664	191.1423491
0.1800000	0.2879792	30.8867872	1.5998844	171.5932620	107.2535358	190.4023654
0.1900000	0.2953415	31.2832663	1.5544288	164.6487701	105.9223633	189.6923752
0.2000000	0.3022904	31.6356278	1.5114520	158.1781392	104.6530990	189.0108233
0.2100000	0.3088599	31.9491254	1.4707616	152.1386926	103.4421142	188.3562303
0.2200000	0.3150804	32.2283149	1.4321838	146.4923405	102.2859944	187.7271927
0.2300000	0.3209791	32.4771554	1.3955612	141.2050236	101.1815328	187.1223816
0.2400000	0.3265804	32.6990953	1.3607516	136.2462304	100.1257207	186.5405406
0.2500000	0.3319064	32.8971444	1.3276254	131.5885775	99.1157393	185.9804833
0.2600000	0.3369770	33.0739356	1.2960653	127.2074447	98.1489489	185.4410909
0.2700000	0.3418103	33.2317772	1.2659639	123.0806562	97.2228799	184.9213089
0.2800000	0.3464226	33.3726968	1.2372235	119.1882027	96.3352224	184.4201444
0.2900000	0.3508289	33.4984795	1.2097547	115.5119983	95.4838169	183.9366624
0.3000000	0.3550427	33.6107002	1.1834756	112.0356675	94.6666446	183.4699833
0.3100000	0.3590765	33.7107510	1.1583112	108.7443582	93.8818183	183.0192792
0.3200000	0.3629415	33.7998649	1.1341923	105.6245777	93.1275738	182.5837713
0.3300000	0.3666483	33.8791360	1.1110556	102.6640484	92.4022617	182.1627266
0.3400000	0.3702064	33.9495373	1.0888425	99.8515802	91.7043392	181.7554556
0.3500000	0.3736247	34.0119353	1.0674990	97.1769581	91.0323633	181.3613090
0.3600000	0.3769111	34.0671036	1.0469753	94.6308432	90.3849834	180.9796755
0.3700000	0.3800733	34.1157332	1.0272251	92.2046844	89.7609349	180.6099795
0.3800000	0.3831181	34.1584434	1.0082056	89.8906406	89.1590333	180.2516785
0.3900000	0.3860521	34.1957893	0.9898772	87.6815110	88.5781683	179.9042609
0.4000000	0.3888812	34.2282696	0.9722029	85.5706739	88.0172990	179.5672445

AGE LIABLE TO CAPTURE (4.4000000)

0.1500000	0.2588197	29.3358560	1.7254650	195.5723736	113.3447354	193.8077368
0.1600000	0.2675311	29.9122267	1.6720694	186.9514166	111.8084044	193.0119282
0.1700000	0.2757086	30.4232452	1.6218152	178.9602661	110.3456606	192.2489985
0.1800000	0.2833996	30.8770260	1.5744421	171.5390331	108.9522630	191.5172747
0.1900000	0.2906462	31.2805634	1.5297169	164.6345441	107.6241903	190.8151550
0.2000000	0.2974859	31.6399000	1.4874296	158.1995000	106.3576401	190.1411110
0.2100000	0.3039521	31.9602672	1.4473910	152.1917484	105.1490258	189.4936880
0.2200000	0.3100746	32.2462040	1.4094302	146.5736544	103.9949705	188.8715055
0.2300000	0.3158804	32.5016574	1.3733929	141.3115539	102.8923006	188.2732553
0.2400000	0.3213933	32.7300671	1.3391389	136.3752797	101.8380374	187.6977001
0.2500000	0.3266353	32.9344373	1.3065412	131.7377493	100.8293880	187.1436712
0.2600000	0.3316259	33.1173974	1.2754841	127.3746055	99.8637362	186.6100658
0.2700000	0.3363828	33.2812539	1.2458622	123.2639033	98.9386332	186.0958444
0.2800000	0.3409222	33.4280341	1.2175794	119.3858360	98.0517874	185.6000275
0.2900000	0.3452588	33.5595240	1.1905477	115.7224965	97.2010555	185.1216929
0.3000000	0.3494060	33.6773000	1.1646867	112.2576667	96.3844333	184.6599724
0.3100000	0.3533759	33.7827565	1.1399224	108.9766339	95.6000464	184.2140488
0.3200000	0.3571798	33.8771292	1.1161870	105.8660289	94.8461422	183.7831531
0.3300000	0.3608279	33.9615155	1.0934180	102.9136834	94.1210813	183.3665615
0.3400000	0.3643297	34.0368917	1.0715579	100.1085050	93.4233301	182.9635928
0.3500000	0.3676937	34.1041280	1.0505535	97.4403656	92.7514537	182.5736056
0.3600000	0.3709281	34.1640013	1.0303558	94.9000037	92.1041087	182.1959960
0.3700000	0.3740402	34.2172069	1.0109193	92.4789375	91.4800369	181.8301949
0.3800000	0.3770367	34.2643674	0.9922019	90.1693880	90.8780598	181.4756662
0.3900000	0.3799242	34.3060420	0.9741646	87.9642102	90.2970722	181.1319042
0.4000000	0.3827084	34.3427330	0.9567709	85.8568325	89.7360378	180.7984322

AGE LIABLE TO CAPTURE (4.5000000)

0.1500000	0.2546981	29.2988137	1.6979870	195.3254249	115.0335217	194.8850772
0.1600000	0.2632729	29.8819916	1.6454557	186.7624477	113.5019573	194.0983112
0.1700000	0.2713222	30.3998665	1.5960128	178.8227441	112.0434282	193.3439776
0.1800000	0.2788925	30.8605021	1.5494028	171.4472341	110.6537525	192.6204348
0.1900000	0.2860253	31.2708539	1.5053965	164.5834416	109.3289623	191.9261100
0.2000000	0.2927576	31.6369340	1.4637878	158.1846702	108.0653025	191.2595014
0.2100000	0.2991220	31.9639508	1.4243907	152.2092897	106.8592289	190.6191791
0.2200000	0.3051482	32.2564260	1.3870374	146.6201180	105.7074025	190.0037849
0.2300000	0.3108625	32.5182936	1.3515760	141.3838852	104.6066832	189.4120312
0.2400000	0.3162886	32.7529842	1.3178690	136.4707676	103.5541221	188.8426999
0.2500000	0.3214478	32.9634957	1.2857913	131.8539828	102.5469529	188.2946397
0.2600000	0.3263596	33.1524534	1.2552293	127.5094363	101.5825832	187.7667639
0.2700000	0.3310414	33.3221617	1.2260794	123.4154136	100.6585847	187.2580475
0.2800000	0.3355091	33.4746471	1.1982469	119.5523110	99.7726848	186.7675246
0.2900000	0.3397772	33.6116959	1.1716455	115.9023997	98.9227565	186.2942855
0.3000000	0.3438588	33.7348858	1.1461959	112.4496193	98.1068103	185.8374734
0.3100000	0.3477659	33.8456130	1.1218254	109.1793968	97.3229849	185.3962818
0.3200000	0.3515096	33.9451157	1.0984674	106.0784866	96.5695393	184.9699513
0.3300000	0.3550999	34.0344941	1.0760603	103.1348305	95.8448445	184.5577673
0.3400000	0.3585462	34.1147274	1.0545476	100.3374335	95.1473763	184.1590569
0.3500000	0.3618569	34.1866892	1.0338769	97.6762549	94.4757077	183.7731865
0.3600000	0.3650400	34.2511600	1.0140001	95.1421111	93.8285029	183.3995592
0.3700000	0.3681028	34.3088383	0.9948723	92.7265900	93.2045103	183.0376129
0.3800000	0.3710519	34.3603505	0.9764522	90.4219750	92.6025572	182.6868175
0.3900000	0.3738935	34.4062591	0.9587013	88.2211771	92.0215440	182.3466733
0.4000000	0.3766336	34.4470701	0.9415839	86.1176753	91.4604389	182.0167089

AGE LIABLE TO CAPTURE (4.6000000)

0.1500000	0.2506416	29.2559281	1.6709438	195.0395204	116.7241656	195.9510356
0.1600000	0.2590821	29.8456303	1.6192633	186.5351895	115.1975658	195.1732266
0.1700000	0.2670052	30.3700929	1.5706189	178.6476050	113.7434429	194.4274074
0.1800000	0.2744568	30.8373283	1.5247600	171.3184906	112.3576744	193.7119676
0.1900000	0.2814777	31.2542522	1.4814614	164.4960639	111.0363455	193.0253631
0.2000000	0.2881041	31.6268456	1.4405206	158.1342282	109.7757489	192.3661184
0.2100000	0.2943685	31.9602933	1.4017549	152.1918727	108.5723829	191.7328280
0.2200000	0.3002999	32.2590987	1.3649995	146.6322668	107.4229466	191.1241560
0.2300000	0.3059242	32.5271826	1.3301051	141.4225332	106.3243335	190.5388354
0.2400000	0.3112647	32.7679658	1.2969363	136.5331909	105.2736250	189.9756669
0.2500000	0.3163426	32.9844392	1.2653705	131.9377568	104.2680816	189.4335165
0.2600000	0.3211769	33.1792237	1.2352958	127.6123988	103.3051344	188.9113132
0.2700000	0.3257848	33.3546209	1.2066103	123.5356328	102.3823766	188.4080469
0.2800000	0.3301819	33.5126561	1.1792211	119.6880575	101.4975541	187.9227651
0.2900000	0.3343825	33.6551156	1.1530431	116.0521228	100.6485569	187.4545702
0.3000000	0.3383995	33.7835779	1.1279984	112.6119262	99.8334103	187.0026170
0.3100000	0.3422448	33.8994407	1.1040156	109.3530344	99.0502662	186.5661093
0.3200000	0.3459292	34.0039442	1.0810289	106.2623256	98.2973953	186.1442976
0.3300000	0.3494627	34.0981911	1.0589780	103.3278517	97.5731794	185.7364762
0.3400000	0.3528544	34.1831634	1.0378072	100.5387160	96.8761034	185.3419805
0.3500000	0.3561128	34.2597378	1.0174650	97.8849652	96.2047490	184.9601846
0.3600000	0.3592454	34.3286978	0.9979039	95.3574938	95.5577878	184.5904988
0.3700000	0.3622596	34.3907451	0.9790800	92.9479599	94.9339749	184.2323675
0.3800000	0.3651620	34.4465096	0.9609525	90.6487095	94.3321437	183.8852669
0.3900000	0.3679586	34.4965570	0.9434835	88.4527102	93.7512000	183.5487030
0.4000000	0.3706551	34.5413967	0.9266379	86.3534917	93.1901169	183.2222100

AGE LIABLE TO CAPTURE (4.7000000)

0.1500000	0.2466493	29.2073071	1.6443285	194.7153804	118.4163542	197.0057298
0.1600000	0.2549577	29.8032535	1.5934854	186.2703343	116.8949129	196.2367931
0.1700000	0.2627566	30.3340374	1.5456271	178.4355144	115.4453838	195.4994077
0.1800000	0.2700913	30.8076197	1.5005075	171.1534430	114.0637039	194.7919938
0.1900000	0.2770020	31.2308752	1.4579055	164.3730272	112.7460116	194.1130357
0.2000000	0.2835244	31.6097534	1.4176221	158.0487669	111.4886476	193.4610842
0.2100000	0.2896904	31.9494144	1.3794779	152.1400687	110.2881528	192.8347578
0.2200000	0.2955284	32.2543433	1.3433109	146.6106512	109.1412644	192.2327428
0.2300000	0.3010641	32.5284466	1.3089745	141.4280286	108.0449103	191.6537926
0.2400000	0.3063205	32.7751347	1.2763356	136.5630614	106.9962019	191.0967264
0.2500000	0.3113184	32.9973913	1.2452735	131.9895653	105.9924267	190.5604274
0.2600000	0.3160764	33.1978322	1.2156784	127.6839701	105.0310400	190.0438406
0.2700000	0.3206115	33.3787558	1.1874501	123.6250214	104.1096562	189.5459701
0.2800000	0.3249392	33.5421858	1.1604971	119.7935207	103.2260403	189.0658769
0.2900000	0.3290734	33.6899079	1.1347358	116.1720963	102.3780992	188.6026755
0.3000000	0.3330269	33.8235011	1.1100896	112.7450037	101.5638733	188.1555322
0.3100000	0.3368114	33.9443643	1.0864883	109.4979492	100.7815279	187.7236610
0.3200000	0.3404375	34.0537393	1.0638672	106.4179354	100.0293458	187.3063223
0.3300000	0.3439150	34.1527311	1.0421668	103.4931245	99.3057193	186.9028190
0.3400000	0.3472530	34.2423242	1.0213325	100.7127181	98.6091430	186.5124949
0.3500000	0.3504597	34.3233977	1.0013135	98.0668506	97.9382070	186.1347317
0.3600000	0.3535428	34.3967383	0.9820632	95.5464952	97.2915907	185.7689468
0.3700000	0.3565092	34.4630506	0.9635384	93.1433801	96.6680562	185.4145912
0.3800000	0.3593655	34.5229676	0.9456987	90.8499146	96.0664428	185.0711473
0.3900000	0.3621178	34.5770580	0.9285072	88.6591230	95.4856619	184.7381268
0.4000000	0.3647716	34.6258344	0.9119291	86.5645860	94.9246918	184.4150691

AGE LIABLE TO CAPTURE (4.8000000)

0.1500000	0.2427201	29.1530607	1.6181342	194.3537379	120.1097799	198.0492763
0.1600000	0.2508985	29.7549739	1.5681154	185.9685871	118.5936868	197.2891283
0.1700000	0.2585753	30.2918156	1.5210309	178.1871506	117.1489351	196.5600968
0.1800000	0.2657950	30.7714940	1.4766390	170.9527443	115.7715214	195.8606326
0.1900000	0.2725973	31.2008425	1.4347226	164.2149607	114.4576375	195.1892481
0.2000000	0.2790173	31.5857786	1.3950863	157.9288930	113.2036719	194.5445199
0.2100000	0.2850863	31.9314371	1.3575539	152.0544626	112.0062087	193.9250904
0.2200000	0.2908325	32.2422838	1.3219661	146.5558356	110.8620232	193.3296680
0.2300000	0.2962811	32.5222107	1.2881789	141.4009161	109.7680776	192.7570260
0.2400000	0.3014548	32.7746173	1.2560615	136.5609052	108.7215139	192.2060025
0.2500000	0.3063738	33.0024791	1.2254953	132.0099165	107.7196467	191.6754974
0.2600000	0.3110568	33.2084067	1.1963722	127.7246411	106.7599556	191.1644714
0.2700000	0.3155203	33.3946947	1.1685938	123.6840544	105.8400766	190.6719432
0.2800000	0.3197796	33.5633648	1.1420701	119.8691599	104.9577939	190.1969866
0.2900000	0.3238485	33.7162018	1.1167190	116.2627647	104.1110315	189.7387288
0.3000000	0.3277395	33.8547846	1.0924650	112.8492821	103.2978451	189.2963468
0.3100000	0.3314641	33.9805131	1.0692391	109.6145583	102.5164136	188.8690654
0.3200000	0.3350329	34.0946305	1.0469777	106.5457202	101.7650319	188.4561541
0.3300000	0.3384554	34.1982434	1.0256224	103.6310406	101.0421032	188.0569250
0.3400000	0.3417405	34.2923387	1.0051192	100.8598196	100.3461318	187.6707300
0.3500000	0.3448964	34.3777979	0.9854183	98.2222797	99.6757167	187.2969582
0.3600000	0.3479306	34.4554102	0.9664739	95.7094728	99.0295447	186.9350342
0.3700000	0.3508500	34.5258832	0.9482433	93.3131978	98.4063851	186.5844155
0.3800000	0.3536611	34.5898524	0.9306871	91.0259275	97.8050836	186.2445905
0.3900000	0.3563697	34.6478898	0.9137686	88.8407431	97.2245571	185.9150767
0.4000000	0.3589815	34.7005107	0.8974537	86.7512768	96.6637892	185.5954188

AGE LIABLE TO CAPTURE (4.9000000)

0.1500000	0.2388531	29.0933005	1.5923542	193.9553367	121.8041405	199.0817905
0.1600000	0.2469035	29.7009062	1.5431469	185.6306640	120.2935812	198.3303484
0.1700000	0.2544601	30.2435446	1.4968240	177.9032037	118.8537866	197.6095920
0.1800000	0.2615667	30.7290708	1.4531484	170.7170597	117.4808130	196.9180022
0.1900000	0.2682623	31.1642761	1.4119069	164.0225058	116.1709056	196.2541191
0.2000000	0.2745815	31.5550451	1.3729076	157.7752253	114.9205010	195.6165452
0.2100000	0.2805552	31.9064868	1.3359773	151.9356516	113.7262263	195.0039464
0.2200000	0.2862111	32.2230473	1.3009596	146.4683967	112.5848955	194.4150527
0.2300000	0.2915740	32.5086032	1.2677129	141.3417529	111.4935050	193.8486578
0.2400000	0.2966661	32.7665426	1.2361088	136.5272609	110.4492276	193.3036178
0.2500000	0.3015076	32.9998328	1.2060306	131.9993312	109.4494055	192.7788498
0.2600000	0.3061167	33.2110781	1.1773721	127.7349158	108.4915425	192.2733298
0.2700000	0.3105099	33.4025692	1.1500365	123.7132194	107.5732965	191.7860907
0.2800000	0.3147019	33.5763253	1.1239354	119.9154476	106.6924710	191.3162197
0.2900000	0.3187065	33.7341298	1.0989879	116.3245857	105.8470075	190.8628558
0.3000000	0.3225360	33.8775615	1.0751200	112.9252049	105.0349769	190.4251873
0.3100000	0.3262017	34.0080204	1.0522636	109.7032917	104.2545722	190.0024493
0.3200000	0.3297140	34.1267511	1.0303563	106.6460970	103.5041005	189.5939207
0.3300000	0.3330823	34.2348615	1.0093404	103.7420046	102.7819759	189.1989223
0.3400000	0.3363155	34.3333405	0.9891631	100.9804133	102.0867127	188.8168141
0.3500000	0.3394214	34.4230719	0.9697754	98.3516339	101.4169186	188.4469929
0.3600000	0.3424075	34.5048470	0.9511320	95.8467973	100.7712885	188.0888902
0.3700000	0.3452807	34.5793761	0.9331910	93.4577733	100.1485986	187.7419699
0.3800000	0.3480472	34.6472974	0.9159136	91.1770983	99.5477012	187.4057266
0.3900000	0.3507129	34.7091853	0.8992638	88.9979110	98.9675190	187.0796834
0.4000000	0.3532832	34.7655580	0.8832081	86.9138951	98.4070405	186.7633902

AGE LIABLE TO CAPTURE (5.0000000)

0.1500000	0.2350473	29.0281395	1.5669820	193.5209303	123.4991391	200.1033864
0.1600000	0.2429717	29.6411667	1.5185734	185.2572916	121.9942949	199.3605685
0.1700000	0.2504100	30.1893436	1.4730003	177.5843742	120.5596334	198.6480092
0.1800000	0.2574054	30.6804717	1.4300298	170.4470649	119.1912700	197.9642193
0.1900000	0.2639960	31.1212998	1.3894526	163.7963146	117.8855037	197.3077665
0.2000000	0.2702160	31.5176787	1.3510801	157.5883933	116.6388193	196.6772786
0.2100000	0.2760959	31.8746913	1.3147425	151.7842442	115.4478869	196.0714449
0.2200000	0.2816629	32.1967629	1.2802859	146.3489225	114.3095593	195.4890172
0.2300000	0.2869414	32.4877548	1.2475713	141.2511078	113.2208676	194.9288087
0.2400000	0.2919534	32.7510429	1.2164724	136.4626786	112.1790154	194.3896939
0.2500000	0.2967186	32.9895855	1.1868746	131.9583421	111.1813725	193.8706067
0.2600000	0.3012551	33.2059806	1.1586733	127.7153101	110.2254674	193.3705384
0.2700000	0.3055789	33.4025144	1.1317736	123.7130162	109.3089799	192.8885361
0.2800000	0.3097047	33.5812030	1.1060884	119.9328679	108.4297334	192.4237000
0.2900000	0.3136461	33.7438283	1.0815382	116.3580287	107.5856865	191.9751812
0.3000000	0.3174150	33.8919683	1.0580502	112.9732277	106.7749259	191.5421789
0.3100000	0.3210228	34.0270233	1.0355574	109.7645913	105.9956586	191.1239383
0.3200000	0.3244795	34.1502384	1.0139985	106.7194950	105.2462041	190.7197480
0.3300000	0.3277946	34.2627230	0.9933169	103.8264334	104.5249878	190.3289374
0.3400000	0.3309765	34.3654674	0.9734603	101.0749042	103.8305339	189.9508745
0.3500000	0.3340332	34.4593574	0.9543807	98.4553068	103.1614591	189.5849635
0.3600000	0.3369721	34.5451865	0.9360335	95.9588513	102.5164663	189.2306429
0.3700000	0.3397997	34.6236671	0.9183776	93.5774787	101.8943392	188.8873831
0.3800000	0.3425224	34.6954399	0.9013747	91.3037892	101.2939363	188.5546846
0.3900000	0.3451458	34.7610819	0.8849893	89.1309792	100.7141862	188.2320761
0.4000000	0.3476754	34.8211137	0.8691886	87.0527843	100.1540830	187.9191127

AGE LIABLE TO CAPTURE (5.1000000)

0.1500000	0.2313017	28.9576921	1.5420111	193.0512810	125.1944839	201.1141769
0.1600000	0.2391022	29.5758728	1.4943887	184.8492048	123.6955322	200.3799022
0.1700000	0.2464241	30.1293331	1.4495536	177.2313714	122.2661757	199.6754631
0.1800000	0.2533099	30.6258201	1.4072771	170.1434449	120.9025891	198.9993995
0.1900000	0.2597972	31.0720393	1.3673538	163.5370489	119.6011251	198.3503066
0.2000000	0.2659197	31.4738074	1.3295985	157.3690368	118.3583166	197.7268372
0.2100000	0.2717073	31.8361803	1.2938442	151.6008586	117.1708771	197.1277040
0.2200000	0.2771868	32.1635625	1.2599399	146.1980113	116.0356984	196.5516799
0.2300000	0.2823823	32.4597987	1.2277490	141.1295596	114.9498461	195.9975981
0.2400000	0.2873154	32.7282526	1.1971473	136.3677190	113.9105551	195.4643509
0.2500000	0.2920056	32.9718730	1.1680222	131.8874921	112.9152228	194.9508889
0.2600000	0.2964705	33.1932510	1.1402711	127.6663502	111.9614028	194.4562187
0.2700000	0.3007261	33.3946679	1.1138003	123.6839552	111.0467970	193.9794014
0.2800000	0.3047868	33.5781365	1.0885244	119.9219160	110.1692483	193.5195503
0.2900000	0.3086659	33.7454365	1.0643652	116.3635743	109.3267334	193.0758281
0.3000000	0.3123753	33.8981451	1.0412511	112.9938169	108.5173547	192.6474452
0.3100000	0.3159261	34.0376621	1.0191163	109.7989101	107.7393331	192.2336569
0.3200000	0.3193281	34.1652334	0.9979003	106.7663543	106.9910010	191.8337611
0.3300000	0.3225907	34.2819690	0.9775475	103.8847546	106.2707950	191.4470957
0.3400000	0.3257223	34.3888608	0.9580067	101.1437083	105.5772495	191.0730368
0.3500000	0.3287306	34.4867961	0.9392303	98.5337031	104.9089903	190.7109962
0.3600000	0.3316229	34.5765703	0.9211747	96.0460287	104.2647285	190.3604190
0.3700000	0.3344057	34.6588980	0.9037993	93.6726973	103.6432551	190.0207821
0.3800000	0.3370852	34.7344219	0.8870664	91.4063736	103.0434352	189.6915919
0.3900000	0.3396671	34.8037215	0.8709413	89.2403114	102.4642036	189.3723828
0.4000000	0.3421566	34.8673195	0.8553915	87.1682988	101.9045596	189.0627148

AGE LIABLE TO CAPTURE (5.2000000)

0.1500000	0.2276152	28.8820737	1.5174350	192.5471580	126.8898885	202.1142736
0.1600000	0.2352938	29.5051434	1.4705866	184.4071466	125.3970029	201.3884623
0.1700000	0.2425012	30.0636352	1.4264779	176.8449128	123.9731195	200.6920671
0.1800000	0.2492792	30.5652407	1.3848846	169.8068929	122.6144726	200.0236572
0.1900000	0.2556649	31.0166220	1.3456049	163.2453789	121.3174684	199.3818546
0.2000000	0.2616914	31.4235608	1.3084570	157.1178039	120.0786883	198.7653371
0.2100000	0.2673882	31.7910857	1.2732770	151.3861223	118.8948892	198.1728404
0.2200000	0.2727816	32.1235795	1.2399163	146.0162705	117.7630018	197.6031585
0.2300000	0.2778954	32.4248702	1.2082409	140.9776967	116.6801266	197.0551442
0.2400000	0.2827509	32.6983085	1.1781286	136.2429522	115.6435300	196.5277077
0.2500000	0.2873672	32.9468335	1.1494688	131.7873340	114.6506372	196.0198159
0.2600000	0.2917618	33.1730288	1.1221606	127.5885721	113.6990268	195.5304909
0.2700000	0.2959503	33.3791702	1.0961120	123.6265564	112.7864230	195.0588075
0.2800000	0.2999469	33.5672671	1.0712390	119.8830967	111.9106890	194.6038918
0.2900000	0.3037648	33.7390967	1.0474647	116.3417127	111.0698191	194.1649185
0.3000000	0.3074156	33.8962346	1.0247186	112.9874488	110.2619317	193.7411088
0.3100000	0.3109102	34.0400805	1.0029360	109.8067113	109.4852621	193.3317280
0.3200000	0.3142584	34.1718800	0.9820575	106.7871250	108.7381553	192.9360832
0.3300000	0.3174694	34.2927441	0.9620284	103.9174064	108.0190596	192.5535212
0.3400000	0.3205514	34.4036656	0.9427982	101.1872517	107.3265196	192.1834257
0.3500000	0.3235121	34.5055331	0.9243203	98.5872375	106.6591702	191.8252158
0.3600000	0.3263586	34.5991440	0.9065516	96.1087333	106.0157311	191.4783438
0.3700000	0.3290973	34.6852144	0.8894523	93.7438227	105.3950005	191.1422926
0.3800000	0.3317344	34.7643892	0.8729853	91.4852347	104.7958505	190.8165748
0.3900000	0.3342754	34.8372498	0.8571163	89.3262814	104.2172218	190.5007299
0.4000000	0.3367254	34.9043212	0.8418135	87.2608030	103.6581193	190.1943235

AGE LIABLE TO CAPTURE (5.3000000)

0.1500000	0.2239871	28.8014005	1.4932475	192.0093368	128.5850721	203.1037869
0.1600000	0.2315457	29.4290986	1.4471609	183.9318660	127.0984218	202.3863600
0.1700000	0.2386404	29.9923728	1.4037673	176.4257226	125.6801759	201.6979335
0.1800000	0.2453124	30.4988597	1.3628465	169.4381093	124.3266280	201.0371054
0.1900000	0.2515981	30.9551766	1.3242004	162.9219820	123.0342380	200.4025243
0.2000000	0.2575301	31.3670701	1.2876504	156.8353504	121.7996355	199.7928929
0.2100000	0.2631375	31.7395408	1.2530355	151.1406704	120.6196210	199.2069695
0.2200000	0.2684462	32.0769494	1.2202100	145.8043153	119.4911643	198.6435692
0.2300000	0.2734796	32.3831065	1.1890419	140.7961154	118.4114011	198.1015639
0.2400000	0.2782587	32.6613496	1.1594114	136.0889565	117.3776291	197.5798817
0.2500000	0.2828024	32.9146072	1.1312096	131.6584289	116.3873019	197.0775060
0.2600000	0.2871277	33.1454553	1.1043374	127.4825205	115.4380231	196.5934738
0.2700000	0.2912502	33.3561641	1.0787043	123.5413486	114.5275394	196.1268738
0.2800000	0.2951838	33.5487386	1.0542278	119.8169237	113.6537343	195.6768447
0.2900000	0.2989413	33.7249535	1.0308322	116.2929431	112.8146199	195.2425731
0.3000000	0.3025345	33.8863826	1.0084483	112.9546087	112.0083311	194.8232908
0.3100000	0.3059738	34.0344247	0.9870124	109.7884667	111.2331174	194.4182733
0.3200000	0.3092692	34.1703253	0.9664661	106.7822665	110.4873368	194.0268368
0.3300000	0.3124293	34.2951958	0.9467556	103.9248356	109.7694492	193.6483365
0.3400000	0.3154626	34.4100297	0.9278311	101.2059697	109.0780097	193.2821641
0.3500000	0.3183764	34.5157170	0.9096469	98.6163342	108.4116626	192.9277461
0.3600000	0.3211778	34.6130562	0.8921606	96.1473783	107.7691359	192.5845413
0.3700000	0.3238732	34.7027653	0.8753330	93.7912576	107.1492355	192.2520392
0.3800000	0.3264685	34.7854909	0.8591276	91.5407655	106.5508403	191.9297579
0.3900000	0.3289692	34.8618162	0.8435107	89.3892723	105.9728973	191.6172428
0.4000000	0.3313804	34.9322683	0.8284509	87.3306708	105.4144168	191.3140642

AGE LIABLE TO CAPTURE (5.4000000)

0.1500000	0.2204164	28.7157897	1.4694424	191.4385981	130.2797589	204.0828262
0.1600000	0.2278569	29.3478588	1.4241057	183.4241177	128.7995094	203.3737055
0.1700000	0.2348407	29.9156702	1.3814160	175.9745306	127.3870616	202.6931733
0.1800000	0.2414083	30.4268041	1.3411572	169.0378003	126.0387685	202.0398560
0.1900000	0.2475956	30.8878330	1.3031347	162.5675421	124.7511433	201.4124286
0.2000000	0.2534347	31.3044677	1.2671733	156.5223387	123.5208643	200.8096181
0.2100000	0.2589541	31.6816804	1.2331147	150.8651446	122.3447756	200.2302056
0.2200000	0.2641795	32.0238089	1.2008159	145.5627679	121.2198861	199.6730268
0.2300000	0.2691338	32.3346464	1.1701472	140.5854193	120.1433670	199.1369728
0.2400000	0.2738378	32.6175162	1.1409908	135.9063176	119.1125473	198.6209895
0.2500000	0.2783099	32.8753363	1.1132398	131.5013452	118.1249090	198.1240763
0.2600000	0.2825671	33.1106744	1.0867967	127.3487475	117.1780810	197.6452851
0.2700000	0.2866246	33.3257944	1.0615726	123.4288683	116.2698331	197.1837185
0.2800000	0.2904962	33.5226972	1.0374863	119.7239185	115.3980686	196.7385278
0.2900000	0.2941944	33.7031541	1.0144635	116.2177727	114.5608182	196.3089111
0.3000000	0.2977308	33.8687370	0.9924361	112.8957901	113.7562328	195.8941112
0.3100000	0.3011158	34.0208435	0.9713414	109.7446566	112.9825767	195.4934132
0.3200000	0.3043591	34.1607188	0.9511220	106.7522462	112.2382211	195.1061426
0.3300000	0.3074692	34.2894742	0.9317250	103.9074977	111.5216375	194.7316630
0.3400000	0.3104545	34.4081040	0.9131015	101.2003058	110.8313916	194.3693740
0.3500000	0.3133222	34.5174989	0.8952063	98.6214254	110.1661371	194.0187092
0.3600000	0.3160793	34.6184588	0.8779980	96.1623854	109.5246107	193.6791343
0.3700000	0.3187320	34.7117029	0.8614377	93.8154132	108.9056260	193.3501449
0.3800000	0.3212861	34.7978795	0.8454898	91.5733670	108.3080688	193.0312650
0.3900000	0.3237472	34.8775735	0.8301210	89.4296756	107.7308923	192.7220453
0.4000000	0.3261202	34.9513138	0.8153004	87.3782845	107.1731128	192.4220612

APPENDIX B

MONTHLY LANDINGS INDEXES

Table 1. Comparison of monthly landings index (MLI) as calculated by pounds (lb) vs numbers (num) and NMFS vs volunteered data.

NEW ENGLAND AND MID-ATLANTIC AREA

	NMFS		VOLUNTEERED	
	MLI LB		MLI LB	MLI NUM
	1980-83	1983	1983	1983
JANUARY	0.00	0.00	0.00	0.00
FEBRUARY	0.00	0.00	0.00	0.00
MARCH	0.00	0.00	0.00	0.00
APRIL	0.29	0.03	0.38	0.49
MAY	2.05	1.11	2.24	2.35
JUNE	9.93	12.76	9.02	7.64
JULY	19.45	19.18	14.97	11.86
AUGUST	24.15	23.64	23.94	26.47
SEPTEMBER	18.63	18.63	23.53	22.33
OCTOBER	18.09	17.71	15.81	15.93
NOVEMBER	5.78	5.99	8.85	11.57
DECEMBER	1.63	0.92	1.27	1.35

Table 2. Comparison of monthly landings index (MLI) as calculated by pounds (lb) vs numbers (num) and NMFS vs volunteered data.

SOUTH ATLANTIC AREA

	NMFS		VOLUNTEERED	
	MLI LB		MLI LB	MLI NUM
	1980-83	1983	1983	1983
JANUARY	0.04	0.14	0.17	0.25
FEBRUARY	0.34	0.00	0.00	0.00
MARCH	0.38	0.78	0.94	0.61
APRIL	4.27	8.47	6.43	5.97
MAY	11.81	21.56	16.90	17.29
JUNE	11.91	14.55	16.21	13.51
JULY	17.19	8.84	10.02	8.82
AUGUST	19.71	10.88	12.10	13.97
SEPTEMBER	16.10	10.80	11.96	13.80
OCTOBER	12.64	16.95	18.82	19.40
NOVEMBER	5.06	6.72	6.05	5.82
DECEMBER	0.57	0.32	0.39	0.59

Table 3. Comparison of monthly landings index (MLI) as calculated by pounds (lb) vs numbers (num) and NMFS vs volunteered data.

FLORIDA EAST COAST AREA

	NMFS		VOLUNTEERED	
	MLI LB		MLI LB	MLI NUM
	1980-83	1983	1983	1983
JANUARY	4.81	6.57	7.20	8.32
FEBRUARY	4.60	4.65	7.61	7.73
MARCH	7.09	2.52	9.91	9.14
APRIL	13.35 •	20.53	22.70	17.73
MAY	16.61	19.61	19.56	16.48
JUNE	12.84	16.56	12.76	11.98
JULY	11.67	9.17	3.68	4.35
AUGUST	6.40	4.27	2.84	4.36
SEPTEMBER	6.73	3.69	2.91	3.54
OCTOBER	6.07	4.09	3.42	5.34
NOVEMBER	5.26	4.49	4.41	6.41
DECEMBER	4.59	3.86	3.01	4.62

Table 4. Comparison of monthly landings index (MLI) as calculated by pounds (lb) vs numbers (num) and NMFS vs volunteered data.

GULF OF MEXICO AREA

	NMFS		VOLUNTEERED	
	MLI LB		MLI LB	MLI NUM
	1980-83	1983	1983	1983
JANUARY	13.83	23.39	14.49	14.32
FEBRUARY	22.04	29.47	20.97	20.10
MARCH	18.02	17.62	8.73	9.19
APRIL	13.34	8.41	0.00	0.00
MAY	6.34	5.30	0.00	0.00
JUNE	4.16	1.12	0.00	0.00
JULY	3.03	0.46	0.00	0.00
AUGUST	1.69	0.46	0.00	0.00
SEPTEMBER	1.84	0.42	0.00	0.00
OCTOBER	1.86	0.33	0.00	0.00
NOVEMBER	4.46	4.99	5.90	6.10
DECEMBER	9.41	8.05	49.92	50.28

Table 5. Comparison of monthly landings index (MLI) as calculated by pounds (lb) and small fish index* (MLI*MSFI).

NEW ENGLAND & MID-ATLANTIC AREA

	NMFS	1983 VOLUNTEERED DATA SMALL FISH INDEX		
	1980-83 MLI LB	≤ 70 lb MLI*MSFI	≤ 50 lb MLI*MSFI	≤ 25 lb MLI*MSFI
JANUARY	0.00	0.00	0.00	0.00
FEBRUARY	0.00	0.00	0.00	0.00
MARCH	0.00	0.00	0.00	0.00
APRIL	0.29	0.35	0.32	0.03
MAY	2.05	1.22	0.87	0.15
JUNE	9.93	2.68	1.90	0.38
JULY	19.45	3.31	2.09	0.38
AUGUST	24.15	11.96	7.53	1.65
SEPTEMBER	18.63	8.48	5.60	1.86
OCTOBER	18.09	6.68	4.94	2.17
NOVEMBER	5.78	7.87	6.91	3.45
DECEMBER	1.63	0.81	0.70	1.27
TOTAL		43.36	30.86	10.34

*SMALL FISH INDEX = MLI*MSFI = DISTRIBUTION OF SMALL FISH CATCH OVER THE YEAR.

Table 6. Comparison of monthly landings index (MLI) as calculated by pounds (lb) and small fish index* (MLI*MSFI).

SOUTH ATLANTIC AREA

	NMFS	1983 VOLUNTEERED DATA SMALL FISH INDEX		
	1980-83 MLI LB	≤ 70 lb MLI*MSFI	≤ 50 lb MLI*MSFI	≤ 25 lb MLI*MSFI
JANUARY	0.04	0.22	0.17	0.07
FEBRUARY	0.34	0.00	0.00	0.00
MARCH	0.38	0.41	0.33	0.07
APRIL	4.27	4.26	3.49	0.82
MAY	11.81	13.21	11.09	2.56
JUNE	11.91	9.13	7.16	1.51
JULY	17.19	6.07	4.90	1.18
AUGUST	19.71	11.27	9.83	3.43
SEPTEMBER	16.10	11.30	10.04	4.52
OCTOBER	12.64	15.02	13.50	6.82
NOVEMBER	5.06	4.32	3.84	1.44
DECEMBER	0.57	0.50	0.44	0.19
TOTAL		75.71	64.79	22.61

*SMALL FISH INDEX = MLI*MSFI = DISTRIBUTION OF SMALL FISH CATCH OVER THE YEAR.

Table 7. Comparison of monthly landings index (MLI) as calculated by pounds (lb) and small fish index* (MLI*MSFI).

FLORIDA EAST COAST AREA

	NMFS	1983 VOLUNTEERED DATA SMALL FISH INDEX		
	1980-83 MLI LB	≤ 70 lb MLI*MSFI	≤ 50 lb MLI*MSFI	≤ 25 lb MLI*MSFI
JANUARY	4.81	5.56	4.61	1.83
FEBRUARY	4.60	4.52	3.52	1.37
MARCH	7.09	4.78	2.98	0.84
APRIL	13.35	7.63	3.83	0.79
MAY	16.61	7.88	4.11	0.87
JUNE	12.84	6.28	4.09	0.84
JULY	11.67	2.81	2.03	0.59
AUGUST	6.40	3.34	2.87	1.17
SEPTEMBER	6.73	2.28	1.89	0.68
OCTOBER	6.07	4.25	3.76	2.22
NOVEMBER	5.26	4.84	4.22	2.21
DECEMBER	4.59	3.56	3.14	1.62
TOTAL		57.73	41.05	15.03

*SMALL FISH INDEX = MLI*MSFI = DISTRIBUTION OF SMALL FISH CATCH OVER THE YEAR.

Table 8. Comparison of monthly landings index (MLI) as calculated by pounds (lb) and small fish index* (MLI*MSFI).

GULF OF MEXICO AREA

	NMFS	1983 VOLUNTEERED DATA SMALL FISH INDEX		
	1980-83 MLI LB	≤ 70 lb MLI*MSFI	≤ 50 lb MLI*MSFI	≤ 25 lb MLI*MSFI
JANUARY	13.83	12.37	10.66	5.94
FEBRUARY	22.04	16.44	15.46	10.90
MARCH	18.02	7.56	7.32	5.29
APRIL	13.34	0.00	0.00	0.00
MAY	6.34	0.00	0.00	0.00
JUNE	4.16	0.00	0.00	0.00
JULY	3.03	0.00	0.00	0.00
AUGUST	1.69	0.00	0.00	0.00
SEPTEMBER	1.84	0.00	0.00	0.00
OCTOBER	1.86	0.00	0.00	0.00
NOVEMBER	4.46	5.53	5.12	3.50
DECEMBER	9.41	44.02	40.19	20.67
TOTAL		85.92	78.75	46.30

*SMALL FISH INDEX = MLI*MSFI - DISTRIBUTION OF SMALL FISH CATCH OVER THE YEAR.

Table 9. Swordfish catch size composition by area.

	≤ 70 lb		≤ 50 lb		≤ 25 lb	
	1980	1983	1980	1983	1980	1983
NE & MA	49.79	43.36	34.57	30.86	10.44	10.34
SA	66.62	75.71	48.36	64.79	9.98	22.61
FL-EC	48.98	57.73	32.44	41.05	7.84	15.03
GM	72.02	85.92	60.64	78.75	28.41	46.30

Table 10. Percent increase in numbers of small fish.

	1980			1983		
AREA	% ≤ 50 lb	L/$\bar{X}$	N*	% ≤ 50 lb	L/$\bar{X}$	N
NE&MA	34.57	$\frac{2,667,667}{89.7}$	10,281	30.86	$\frac{3,411,018}{96.2}$	10,942
SA	48.36	$\frac{633,823}{73.4}$	4,176	64.79	$\frac{885,858}{66.1}$	8,683
FL-EC	32.44	$\frac{1,731,032}{97.5}$	5,759	41.05	$\frac{2,113,487}{87.7}$	9,893
GM	60.64	$\frac{1,294,481}{58.0}$	13,534	78.75	$\frac{537,548}{41.5}$	10,200
		N =	33,750	N =		39,718

17.68 % INCREASE

FROM 1980 to 1983

*Numbers (N) less than or equal to 50 lb carcass weight = landings (carcass weight+) in pounds divided by the average carcass weight in pounds times the percentage of carcasses equal to or less than 50 lb carcass weight.

+Carcass weight = 0.75 times round weight.

Table 11. Percent reduction using the small fish index.

AREA	% ≤ 50 LB	% INCREASE FROM 1980-1983	% REDUCTION
NE & MA	30.86		5.46
SA	64.79		11.45
FL-EC	41.05	17.68	7.26
GM	78.75		13.92

Table 12. Swordfish calendar based on the small fish index for fish ≤ 50 lb carcass weight.

	NE & MA 1983 VOLUNTEERED NUM ≤ 50 LB		SA 1983 VOLUNTEERED NUM ≤ 50 lb		FL-EC 1983 VOLUNTEERED NUM ≤ 50 lb		GM 1983 VOLUNTEERED NUM ≤ 50 lb	
	5.46%	% DECREASED BASED ON MLI LB	11.45%	% DECREASED BASED ON MLI LB	7.26%	% DECREASED BASED ON MLI LB	13.92%	% DECREASED BASED ON MLI LB
APRIL	123		52	13	56	27	251	
MAY	94		33	13	54	26	221	26
JUNE	67		57	27	73	27	190	19
JULY	45	30	52	31	96	26	160	15
AUGUST	22	17	36	22	82	17	129	12
SEPTEMBER	29	18	33	17	72	15	98	10
OCTOBER	33	18	26	11	56	10	68	8
NOVEMBER	24	5	190*	*	60	10	37	7
DECEMBER	237		171		59	9	11	3

*SA COULD CLOSE 30 DAYS IN NOVEMBER AND 17 DAYS IN OCTOBER TO REDUCE THE PERCENTAGE OF FISH ≤ 50 LB BY 11.45%. THIS WOULD REPRESENT A 12% REDUCTION BASED ON MLI LB.

Table 13. Common starting date of October 15.

AREA	% REDUCTION BASED ON VOLUNTEERED NUMBER ≤ 50 LB	DAYS CLOSED BEGINNING ON OCTOBER 15	% REDUCTION BASED ON NMFS MLI LB
NE & MA	5.46	29	12
SA	11.45	47	12
FL-EC	7.26	57	10
GM	13.92	54	8

Table 14. MONTHLY LANDINGS INDEX VALUES BY AREA AND YEAR.

	GULF OF MEXICO					FLORIDA EAST COAST					SOUTH ATLANTIC					MID-ATLANTIC				
YEAR	1980	1981	1982	1983	AVERAGE	1980	1981	1982	1983	AVERAGE	1980	1981	1982	1983	AVERAGE	1980	1981	1982	1983	AVERAGE
JANUARY	10.27	13.99	7.65	23.39	13.83	4.81	4.71	3.15	6.57	4.81	0.00	0.00	0.00	0.14	0.04	0.00	0.00	0.00	0.00	0.00
FEBRUARY	19.26	24.63	14.79	29.47	22.04	4.47	3.79	5.50	4.65	4.60	0.00	1.36	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.00
MARCH	15.83	15.35	23.27	17.62	18.02	7.89	10.06	7.90	2.52	7.09	0.00	0.00	0.73	0.78	0.38	0.00	0.00	0.00	0.00	0.00
APRIL	15.22	14.86	14.88	8.41	13.34	7.15	14.87	10.85	20.53	13.35	0.19	0.23	8.18	8.47	4.27	0.00	0.00	0.69	0.04	0.18
MAY	3.71	9.27	7.07	5.30	6.34	11.71	17.03	18.08	19.61	16.61	5.06	6.48	14.15	21.56	11.81	0.00	0.71	1.38	0.85	0.74
JUNE	2.80	7.60	5.13	1.12	4.16	7.19	11.84	15.76	16.56	12.84	14.26	10.97	7.87	14.55	11.91	2.86	3.60	6.27	6.54	4.82
JULY	2.76	2.65	6.24	0.46	3.03	16.06	9.28	12.17	9.17	11.67	17.22	26.72	15.96	8.84	17.19	30.83	24.77	13.24	18.14	21.75
AUGUST	2.55	0.25	3.50	0.46	1.69	13.21	4.09	4.02	4.27	6.40	25.67	21.98	20.30	10.88	19.71	26.10	14.27	12.63	19.59	18.15
SEPTEMBER	5.01	0.36	1.56	0.42	1.84	12.15	5.38	5.70	3.69	6.73	25.33	18.81	9.45	10.80	16.10	8.79	27.84	21.32	17.97	18.98
OCTOBER	4.72	1.73	0.66	0.33	1.86	7.27	7.51	5.39	4.09	6.07	8.99	11.35	13.25	16.95	12.64	20.35	13.58	26.67	23.11	20.93
NOVEMBER	5.93	2.88	4.03	4.99	4.46	4.70	6.73	5.11	4.49	5.26	3.27	1.37	8.89	6.72	5.06	11.07	15.15	13.88	11.54	12.91
DECEMBER	11.94	6.44	11.21	8.05	9.41	3.40	4.71	6.38	3.86	4.59	0.00	0.74	1.23	0.32	0.57	0.00	0.07	3.93	2.22	1.56

Table 14. (continued)

	NEW ENGLAND					MID-ATLANTIC & NEW ENGLAND					SOUTH ATLANTIC, MID-ATLANTIC & NEW ENGLAND				
YEAR	1980	1981	1982	1983	AVERAGE	1980	1981	1982	1983	AVERAGE	1980	1981	1982	1983	AVERAGE
JANUARY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01
FEBRUARY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.08
MARCH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.18	0.10
APRIL	0.60	0.00	0.00	0.02	0.16	0.49	0.00	0.65	0.03	0.29	0.57	0.06	2.71	2.01	1.34
MAY	0.72	0.71	3.97	1.25	1.66	0.59	3.31	3.19	1.11	2.05	0.89	4.08	6.18	5.91	4.27
JUNE	7.44	3.60	11.76	15.87	9.67	6.60	10.10	10.26	12.76	9.93	7.62	10.31	9.61	13.18	10.18
JULY	16.02	24.77	22.96	19.70	20.86	18.71	23.33	16.59	19.18	19.45	16.38	24.16	16.42	16.75	18.43
AUGUST	25.07	14.27	28.26	25.68	23.32	25.26	25.41	22.28	23.65	24.15	25.12	24.57	21.74	20.65	23.02
SEPTEMBER	24.01	27.84	16.61	18.96	21.86	21.24	18.90	15.75	18.63	18.63	23.75	18.88	14.03	16.79	18.36
OCTOBER	16.58	13.58	13.55	15.02	14.68	17.27	13.56	23.80	17.71	18.09	16.35	13.02	20.91	17.53	16.95
NOVEMBER	4.84	15.15	2.88	3.22	6.52	5.97	5.39	5.75	5.99	5.78	4.91	4.41	6.61	6.16	5.52
DECEMBER	4.72	0.07	0.00	0.28	1.27	3.86	0.01	1.73	0.92	1.63	4.43	0.19	1.59	0.78	1.75

APPENDIX C

SWORDFISH PERMIT INFORMATION

Table 1. Number of swordfish vessels by size by ability to carry an observer. (Source: Councils' Request to the Secretary of Commerce under Section 303(e). Data input and analysis by NMFS SEFC.)

LENGTH	CARRY OBSERVER YES	CARRY OBSERVER NO	NO ANSWER	TOTAL
1-10	0	0	0	0
11-20	0	1	0	1
21-30	8	21	7	36
31-40	14	45	12	71
41-50	25	40	10	75
51-60	24	21	7	52
61-70	22	23	6	51
71-80	13	18	5	36
81-90	12	4	0	16
91-100	2	0	0	2
TOTALS	120	173	47	340

Table 2. Total number of vessels by month, by gear and by area for a yes response to carrying an observer. (Source: Councils' Request to the Secretary of Commerce under Section 303(e). Data input and analysis by NMFS SEFC.)

	LONGLINE	HARPOON	GILLNET	OTHER	COMBINATION
JANUARY					
Gulf of Mexico	44	1	0	0	3
Florida East Coast	28	1	0	0	5
Jacksonville, FL to Cape Hatteras	0	0	0	0	4
Hatteras through New York	3	0	0	0	3
North of New York	1	2	0	0	1
Caribbean	1	0	0	0	1
TOTALS	77	4	0	0	17
FEBRUARY					
Gulf of Mexico	45	1	0	0	3
Florida East Coast	29	1	0	0	4
Jacksonville, FL to Cape Hatteras	0	0	0	0	4
Hatteras through New York	3	0	0	0	3
North of New York	1	2	0	0	1
Caribbean	1	0	0	0	1
TOTALS	79	4	0	0	16
MARCH					
Gulf of Mexico	33	1	0	0	2
Florida East Coast	37	1	0	0	5
Jacksonville, FL to Cape Hatteras	0	1	0	0	4
Hatteras through New York	3	0	0	0	4
North of New York	2	2	0	0	2
Caribbean	1	0	0	0	2
TOTALS	76	5	0	0	19
APRIL					
Gulf of Mexico	13	1	0	0	2
Florida East Coast	41	1	0	0	5
Jacksonville, FL to Cape Hatteras	3	1	0	0	4
Hatteras through New York	4	0	0	0	4
North of New York	4	2	1	0	3
Caribbean	1	0	0	0	2
TOTALS	66	5	1	0	20

Table 2. Continued

	LONGLINE	HARPOON	GILLNET	OTHER	COMBINATION
MAY					
Gulf of Mexico	9	1	0	0	2
Florida East Coast	39	1	0	0	5
Jacksonville, FL to Cape Hatteras	7	1	0	0	4
Hatteras through New York	5	1	0	0	6
North of New York	10	9	1	0	5
Caribbean	1	0	0	0	2
TOTALS	71	13	1	0	24
JUNE					
Gulf of Mexico	1	0	0	0	1
Florida East Coast	33	0	0	0	0
Jacksonville, FL to Cape Hatteras	19	0	1	0	0
Hatteras through New York	20	0	1	0	5
North of New York	15	31	0	0	14
Caribbean	1	0	0	0	0
TOTALS	89	31	2	0	20
JULY					
Gulf of Mexico	1	0	0	0	0
Florida East Coast	30	0	0	0	0
Jacksonville, FL to Cape Hatteras	18	0	1	0	0
Hatteras through New York	20	0	1	0	5
North of New York	20	30	0	0	15
Caribbean	1	0	0	0	0
TOTALS	90	30	2	0	20
AUGUST					
Gulf of Mexico	2	0	0	0	1
Florida East Coast	24	0	0	0	1
Jacksonville, FL to Cape Hatteras	19	0	0	0	1
Hatteras through New York	20	0	1	0	5
North of New York	22	30	0	0	16
Caribbean	1	0	0	0	0
TOTALS	88	30	1	0	24

Table 2. Continued

	LONGLINE	HARPOON	GILLNET	OTHER	COMBINATION
SEPTEMBER					
Gulf of Mexico	4	0	0	0	1
Florida East Coast	24	0	0	0	2
Jacksonville, FL to Cape Hatteras	18	0	0	0	1
Hatteras through New York	25	0	1	0	5
North of New York	19	29	0	0	16
Caribbean	1	0	0	0	1
TOTALS	91	29	1	0	26
OCTOBER					
Gulf of Mexico	8	0	0	0	1
Florida East Coast	27	0	0	0	2
Jacksonville, FL to Cape Hatteras	19	0	0	0	2
Hatteras through New York	25	0	0	0	6
North of New York	14	13	0	0	13
Caribbean	1	0	0	0	1
TOTALS	94	13	0	0	25
NOVEMBER					
Gulf of Mexico	27	0	0	0	1
Florida East Coast	27	1	0	0	2
Jacksonville, FL to Cape Hatteras	7	0	0	0	2
Hatteras through New York	6	0	0	0	6
North of New York	12	5	0	0	10
Caribbean	1	0	0	0	1
TOTALS	80	6	0	0	22
DECEMBER					
Gulf of Mexico	38	0	0	0	1
Florida East Coast	33	1	0	0	3
Jacksonville, FL to Cape Hatteras	1	0	0	0	4
Hatteras through New York	5	0	0	0	5
North of New York	6	3	0	0	4
Caribbean	1	0	0	0	1
TOTALS	84	4	0	0	18

Table 3. Number of swordfish vessel-months* by gear and by area for a yes response to carrying an observer. (Source: Councils' Request to the Secretary of Commerce under Section 303(e). Data input and analysis by NMFS SEFC.)

	LONGLINE	HARPOON	GILLNET	OTHER	COMBINATION
Gulf of Mexico	225	5	0	0	18
Florida East Coast	372	7	0	0	34
Jacksonville, FL to Cape Hatteras	111	3	2	0	30
Hatteras through New York	139	1	4	0	57
North of New York	126	158	2	0	100
Caribbean	12	0	0	0	12
TOTALS	985	174	8	0	251

*This table is a summation of the monthly information shown in Table 2. Vessel-month refers to a vessel fishing in a particular area in a particular month. The numbers shown here in Table 3 are not numbers of vessels; the total number of vessels as of October 29, 1984 was 340.

Table 4. Number of swordfish vessels by month, by gear and by area. (Source: Councils' Request to the Secretary of Commerce under Section 303(e). Data input and analysis by NMFS SEFC.)

	LONGLINE	HARPOON	GILLNET	OTHER	COMBINATION
JANUARY					
Gulf of Mexico	98	2	0	0	4
Florida East Coast	57	3	0	0	6
Jacksonville, FL to Cape Hatteras	2	0	0	0	4
Hatteras through New York	11	1	0	0	5
North of New York	7	4	0	0	1
Caribbean	2	0	0	0	1
TOTALS	177	10	0	0	21
FEBRUARY					
Gulf of Mexico	97	2	0	0	4
Florida East Coast	60	3	0	0	5
Jacksonville, FL to Cape Hatteras	2	0	0	0	4
Hatteras through New York	11	1	0	0	5
North of New York	6	4	0	0	1
Caribbean	1	0	0	0	2
TOTALS	177	10	0	0	21
MARCH					
Gulf of Mexico	66	2	0	0	2
Florida East Coast	81	3	0	0	8
Jacksonville, FL to Cape Hatteras	3	1	0	0	4
Hatteras through New York	14	0	0	0	6
North of New York	6	5	0	1	5
Caribbean	2	0	0	0	2
TOTALS	172	11	0	1	27
APRIL					
Gulf of Mexico	35	2	0	0	2
Florida East Coast	93	3	0	0	7
Jacksonville, FL to Cape Hatteras	8	1	0	0	4
Hatteras through New York	18	1	0	0	6
North of New York	11	6	1	1	5
Caribbean	2	0	0	0	2
TOTALS	167	13	1	1	26

Table 4. Continued

	LONGLINE	HARPOON	GILLNET	OTHER	COMBINATION
MAY					
Gulf of Mexico	24	2	0	0	2
Florida East Coast	87	3	0	1	7
Jacksonville, FL to Cape Hatteras	15	1	0	0	4
Hatteras through New York	20	2	0	0	10
North of New York	18	16	1	1	9
Caribbean	1	0	0	0	2
TOTALS	165	24	1	2	34
JUNE					
Gulf of Mexico	9	1	0	0	2
Florida East Coast	68	2	0	1	4
Jacksonville, FL to Cape Hatteras	28	0	1	0	1
Hatteras through New York	41	5	1	0	12
North of New York	40	79	0	0	34
Caribbean	3	0	0	0	1
TOTALS	189	87	2	1	54
JULY					
Gulf of Mexico	6	1	0	0	0
Florida East Coast	55	1	0	1	1
Jacksonville, FL to Cape Hatteras	29	1	1	0	0
Hatteras through New York	41	5	1	0	10
North of New York	49	88	0	0	38
Caribbean	2	0	0	0	1
TOTALS	182	96	2	1	50
AUGUST					
Gulf of Mexico	7	1	0	0	1
Florida East Coast	48	1	0	1	2
Jacksonville, FL to Cape Hatteras	29	0	0	0	1
Hatteras through New York	45	5	1	0	12
North of New York	53	90	0	0	39
Caribbean	2	0	0	0	1
TOTALS	184	97	1	1	56

Table 4. Continued

	LONGLINE	HARPOON	GILLNET	OTHER	COMBINATION
SEPTEMBER					
Gulf of Mexico	10	2	0	0	1
Florida East Coast	50	1	0	1	3
Jacksonville, FL to Cape Hatteras	27	0	0	0	1
Hatteras through New York	54	5	1	0	11
North of New York	49	84	0	0	39
Caribbean	1	0	0	0	3
TOTALS	191	92	1	1	58
OCTOBER					
Gulf of Mexico	22	1	0	0	2
Florida East Coast	58	1	0	0	3
Jacksonville, FL to Cape Hatteras	29	1	0	0	2
Hatteras through New York	54	1	0	0	11
North of New York	38	26	0	0	27
Caribbean	1	0	0	0	3
TOTALS	202	30	0	0	48
NOVEMBER					
Gulf of Mexico	54	2	0	0	2
Florida East Coast	55	2	0	0	3
Jacksonville, FL to Cape Hatteras	12	0	0	0	2
Hatteras through New York	31	1	0	0	11
North of New York	29	9	0	1	15
Caribbean	3	0	0	0	2
TOTALS	184	14	0	1	35
DECEMBER					
Gulf of Mexico	75	2	0	0	2
Florida East Coast	60	2	0	0	4
Jacksonville, FL to Cape Hatteras	6	0	0	0	4
Hatteras through New York	19	1	0	0	8
North of New York	15	6	0	1	5
Caribbean	3	0	0	0	1
TOTALS	178	11	0	1	24

Table 5. Number of swordfish vessel-months* by gear and by area. (Source: Councils' Request to the Secretary of Commerce under Section 303(e). Data input and analysis by NMFS SEFC.)

	LONGLINE	HARPOON	GILLNET	OTHER	COMBINATION
Gulf of Mexico	503	20	0	0	24
Florida East Coast	772	25	0	5	53
Jacksonville, FL to Cape Hatteras	190	5	2	0	31
Hatteras through New York	359	28	4	0	107
North of New York	321	417	2	5	218
Caribbean	23	0	0	0	21
TOTALS	2,168	495	8	10	454

*This table is a summation of the monthly information shown in Table 4. Vessel-month refers to a vessel fishing in a particular area in a particular month. The numbers shown here in Table 5 are not numbers of vessels; the total number of vessels as of October 29, 1984 was 340.

Table 6. Average trip length in days by month and by area. (Source: Councils' Request to the Secretary of Commerce under Section 303(e). Data input and anlysis by NMFS SEFC.)

	MEAN	STANDARD DEVIATION	NUMBER VESSELS	TOTAL DAYS
JANUARY				
Gulf of Mexico	9.90	5.37	72	713
Florida East Coast	7.13	5.40	52	371
Jacksonville, FL to Cape Hatteras	15.33	8.60	6	92
Hatteras through New York	11.89	7.16	9	107
North of New York	17.00	12.03	3	51
Caribbean	22.00	8.00	2	44
TOTALS	9.57	6.51	144	1,378
FEBRUARY				
Gulf of Mexico	9.73	5.33	73	710
Florida East Coast	7.30	5.33	53	387
Jacksonville, FL to Cape Hatteras	15.33	8.60	6	92
Hatteras through New York	11.89	7.16	9	107
North of New York	17.00	12.03	3	51
Caribbean	22.00	8.00	2	44
TOTALS	9.53	6.43	146	1,391
MARCH				
Gulf of Mexico	10.38	5.47	53	550
Florida East Coast	7.55	5.21	71	536
Jacksonville, FL to Cape Hatteras	13.29	9.41	7	93
Hatteras through New York	11.85	6.25	13	154
North of New York	8.86	10.48	7	62
Caribbean	21.33	5.19	3	64
TOTALS	9.47	6.44	154	1,459
APRIL				
Gulf of Mexico	11.71	6.33	28	328
Florida East Coast	7.68	4.94	82	630
Jacksonville, FL to Cape Hatteras	13.00	8.37	9	117
Hatteras through New York	13.67	11.09	15	205
North of New York	10.25	9.71	12	123
Caribbean	21.33	5.19	3	64
TOTALS	9.85	7.33	149	1,467

Table 6. Continued.

	MEAN	STANDARD DEVIATION	NUMBER VESSELS	TOTAL DAYS
MAY				
Gulf of Mexico	11.44	7.35	18	206
Florida East Coast	7.58	5.01	79	599
Jacksonville, FL to Cape Hatteras	12.47	6.58	19	237
Hatteras through New York	13.74	12.76	19	261
North of New York	9.58	8.04	24	230
Caribbean	25.00	0.00	2	50
TOTALS	9.83	7.78	161	1,583
JUNE				
Gulf of Mexico	7.60	4.84	5	38
Florida East Coast	5.69	2.65	58	330
Jacksonville, FL to Cape Hatteras	8.17	3.75	24	196
Hatteras through New York	8.24	4.17	41	338
North of New York	8.08	7.50	95	768
Caribbean	14.00	0.00	1	14
TOTALS	7.52	5.67	224	1,684
JULY				
Gulf of Mexico	9.25	3.96	4	37
Florida East Coast	5.40	2.55	45	243
Jacksonville, FL to Cape Hatteras	6.62	2.34	26	172
Hatteras through New York	8.44	5.25	39	329
North of New York	8.19	7.58	116	950
Caribbean	14.00	0.00	1	14
TOTALS	7.55	6.10	231	1,745
AUGUST				
Gulf of Mexico	14.50	8.10	6	87
Florida East Coast	5.80	3.93	41	238
Jacksonville, FL to Cape Hatteras	7.26	4.27	27	196
Hatteras through New York	9.18	9.19	45	413
North of New York	8.07	7.71	118	952
Caribbean	14.00	0.00	1	14
TOTALS	7.98	7.36	238	1,900

Table 6. Continued.

	MEAN	STANDARD DEVIATION	NUMBER VESSELS	TOTAL DAYS
SEPTEMBER				
Gulf of Mexico	12.33	7.47	9	111
Florida East Coast	6.70	5.29	44	295
Jacksonville, FL to Cape Hatteras	7.84	5.27	25	196
Hatteras through New York	8.94	10.43	52	465
North of New York	8.03	7.75	108	867
Caribbean	30.00	0.00	2	60
TOTALS	8.31	8.12	240	1,994
OCTOBER				
Gulf of Mexico	13.11	6.81	18	236
Florida East Coast	6.22	4.51	50	311
Jacksonville, FL to Cape Hatteras	8.74	5.45	27	236
Hatteras through New York	9.91	10.92	46	456
North of New York	10.66	8.08	53	565
Caribbean	30.00	0.00	2	60
TOTALS	9.51	8.24	196	1,864
NOVEMBER				
Gulf of Mexico	10.72	5.61	43	461
Florida East Coast	6.10	4.70	48	293
Jacksonville, FL to Cape Hatteras	11.83	6.50	12	142
Hatteras through New York	12.59	13.77	27	340
North of New York	13.43	9.58	28	376
Caribbean	25.00	5.00	2	50
TOTALS	10.39	8.80	160	1,662
DECEMBER				
Gulf of Mexico	10.47	5.41	60	628
Florida East Coast	6.06	4.90	47	285
Jacksonville, FL to Cape Hatteras	14.00	8.60	7	98
Hatteras through New York	10.00	6.90	17	170
North of New York	9.56	10.07	9	86
Caribbean	22.00	8.00	2	44
TOTALS	9.23	6.67	142	1,311

Table 7. Average trip length in days by area - grand totals for 1983. (Source: Councils' Request to the Secretary of Commerce under Section 303(e). Data input and anlysis by NMFS SEFC.)

	MEAN	STANDARD DEVIATION	NUMBER VESSELS	TOTAL DAYS
Gulf of Mexico	10.55	5.84	389	4,105
Florida East Coast	6.74	4.75	670	4,518
Jacksonville, FL to Cape Hatteras	9.57	6.38	195	1,867
Hatteras through New York	10.08	9.52	332	3,345
North of New York	8.82	8.15	576	5,081
Caribbean	22.70	6.82	23	522
TOTALS	8.90	7.25	2,185	19,438

Table 8. Average number of hooks per set times the average trip length in days by month and by area. (Source: Councils' Request to the Secretary of Commerce under Section 303(e). Data input and analysis by NMFS SEFC.)

	MEAN	STANDARD DEVIATION	NUMBER VESSELS	TOTAL DAYS TIMES HOOKS/SET
JANUARY				
Gulf of Mexico	3,900.74	5,298.53	58	226,243
Florida East Coast	2,904.52	5,573.28	42	121,990
Jacksonville, FL to Cape Hatteras	25,000.00	0.00	2	50,000
Hatteras through New York	6,637.14	9,650.00	7	46,460
North of New York	15,125.00	14,875.00	2	30,250
Caribbean	17,800.00	12,200.00	2	35,600
TOTALS	4,518.08	7,228.69	113	510,543
FEBRUARY				
Gulf of Mexico	3,865.83	5,305.44	58	224,218
Florida East Coast	2,994.40	5,657.34	42	125,765
Jacksonville, FL to Cape Hatteras	25,000.00	0.00	2	50,000
Hatteras through New York	6,637.14	9,650.00	7	46,460
North of New York	15,125.00	14,875.00	2	30,250
Caribbean	17,800.00	12,200.00	2	35,600
TOTALS	4,533.57	7,249.84	113	512,293
MARCH				
Gulf of Mexico	4,479.65	5,970.02	43	192,625
Florida East Coast	2,483.79	4,472.94	57	141,576
Jacksonville, FL to Cape Hatteras	25,000.00	0.00	2	50,000
Hatteras through New York	7,153.00	9,075.08	10	71,530
North of New York	16,750.00	11,667.26	3	50,250
Caribbean	18,533.33	9,145.25	3	55,600
TOTALS	4,759.16	7,325.08	118	561,581
APRIL				
Gulf of Mexico	7,140.79	8,097.56	19	135,675
Florida East Coast	2,508.02	4,223.99	65	163,021
Jacksonville, FL to Cape Hatteras	14,150.00	10,868.65	4	56,600
Hatteras through New York	6,590.83	8,494.73	12	79,090
North of New York	11,714.29	10,006.77	7	82,000
Caribbean	18,533.33	9,145.25	3	55,600
TOTALS	5,199.87	6,635.13	110	571,986

Table 8. Continued.

	MEAN	STANDARD DEVIATION	NUMBER VESSELS	TOTAL DAYS TIMES HOOKS/SET
MAY				
Gulf of Mexico	6,111.67	7,799.05	15	91,675
Florida East Coast	2,448.75	4,375.87	59	144,476
Jacksonville, FL to Cape Hatteras	10,780.00	9,475.21	10	107,800
Hatteras through New York	7,299.23	8,282.19	13	94,890
North of New York	9,254.55	8,929.13	11	101,800
Caribbean	25,000.00	0.00	2	50,000
TOTALS	5,369.46	7,685.96	110	590,641
JUNE				
Gulf of Mexico	1,033.67	857.24	3	3,101
Florida East Coast	1,264.31	745.42	49	61,951
Jacksonville, FL to Cape Hatteras	1,822.11	812.21	19	34,620
Hatteras through New York	2,773.08	3,267.97	26	72,100
North of New York	7,909.26	7,559.82	27	213,550
Caribbean	0.00	0.00	0	0
TOTALS	3,107.44	4,665.35	124	385,322
JULY				
Gulf of Mexico	1,550.00	550.00	2	3,100
Florida East Coast	1,146.51	593.45	37	42,421
Jacksonville, FL to Cape Hatteras	1,460.00	528.64	23	33,580
Hatteras through New York	3,210.42	5,673.99	24	77,050
North of New York	7,362.61	8,418.98	38	279,779
Caribbean	0.00	0.00	0	0
TOTALS	3,515.56	5,931.96	124	435,930
AUGUST				
Gulf of Mexico	13,275.00	11,731.45	4	53,100
Florida East Coast	1,871.85	4,131.60	33	61,771
Jacksonville, FL to Cape Hatteras	2,816.52	5,069.56	23	64,780
Hatteras through New York	3,004.69	5,119.02	32	96,150
North of New York	7,059.97	8,256.21	38	268,279
Caribbean	0.00	0.00	0	0
TOTALS	4,185.23	6,817.72	130	544,080

Table 8. Continued.

	MEAN	STANDARD DEVIATION	NUMBER VESSELS	TOTAL DAYS TIMES HOOKS/SET
SEPTEMBER				
Gulf of Mexico	9,933.33	10,728.73	6	59,600
Florida East Coast	2,977.81	6,047.35	36	107,201
Jacksonville, FL to Cape Hatteras	3,615.91	6,775.56	22	79,550
Hatteras through New York	2,772.63	4,841.35	38	105,360
North of New York	7,715.27	8,687.04	33	254,604
Caribbean	30,000.00	0.00	1	30,000
TOTALS	4,678.79	7,561.68	136	636,315
OCTOBER				
Gulf of Mexico	8,679.55	9,041.86	11	95,475
Florida East Coast	2,309.91	5,050.99	43	99,326
Jacksonville, FL to Cape Hatteras	3,861.25	6,510.50	24	92,670
Hatteras through New York	3,292.16	5,463.77	37	121,810
North of New York	8,040.00	8,525.81	25	201,000
Caribbean	30,000.00	0.00	1	30,000
TOTALS	4,541.00	7,225.30	141	640,281
NOVEMBER				
Gulf of Mexico	5,067.42	6,493.91	33	167,225
Florida East Coast	2,309.17	5,171.84	41	94,676
Jacksonville, FL to Cape Hatteras	6,987.00	9,051.54	10	69,870
Hatteras through New York	5,513.00	7,609.90	20	110,260
North of New York	8,351.76	8,341.33	17	141,980
Caribbean	30,000.00	0.00	1	30,000
TOTALS	5,032.88	7,469.20	122	614,011
DECEMBER				
Gulf of Mexico	4,354.59	5,633.04	49	213,375
Florida East Coast	2,323.05	5,377.94	38	88,276
Jacksonville, FL to Cape Hatteras	13,144.00	10,369.94	5	65,720
Hatteras through New York	5,179.17	8,312.68	12	62,150
North of New York	8,427.50	12,522.69	4	33,710
Caribbean	30,000.00	0.00	1	30,000
TOTALS	4,525.06	7,369.76	109	493,231

Table 9. Average number of hooks per set times the average trip length in days by area - grand totals for 1983. (Source: Councils' Request to the Secretary of Commerce under Section 303(e). Data input and anlysis by NMFS SEFC.)

	MEAN	STANDARD DEVIATION	NUMBER VESSELS	TOTAL DAYS TIMES HOOKS/SET
Gulf of Mexico	4,868.48	6,561.38	301	1,465,412
Florida East Coast	2,310.79	4,597.76	542	1,252,450
Jacksonville, FL to Cape Hatteras	5,172.53	8,050.94	146	755,190
Hatteras through New York	4,131.55	6,608.89	238	983,310
North of New York	8,151.94	8,904.34	207	1,687,452
Caribbean	22,025.00	9,726.99	16	352,400
TOTALS	4,480.15	7,076.52	1,450	6,496,214

APPENDIX D

COUNCIL STAFF DRIFT NET OBSERVATIONS

Table 1. Longline (L/L) and drift entanglement net (NET) observations by Bruce Austin (SAFMC Staff) aboard fishing vessel number one (FV#1). Radio reports from FV#2, September 20-26, 1984.

	FISHING VESSEL NUMBER 1		FISHING VESSEL NUMBER 2	
	L/L	NET	L/L	NET
9/20	X		X	
9/21	X		X	
9/22		X		X
9/23	X	X		X
9/24		X		X
9/25	X	X		X

Table 2. Catch composition from longline and net gear sets between September 21 and September 26.

DATE	GEAR	SWORDFISH	BILLFISH	TUNAS	BLUE SHARKS	OTHER SHARKS	RAYS	TURTLES	MAMMALS	OTHER
September 21	L/L	1			12	1	Many	1		
September 22	L/L				35					
	L/L	1	1	4				1		
September 23	NET			16	2	4				
	NET	1		25	8	5				
September 24	NET			7		2				
	NET	2		57	20	20				1 (Sunfish)
	L/L	1			40					
September 25	NET	1		26		8				
	NET	1		9		4				
September 26	NET	2		20	4	5				
	NET	2		20		2				
	L/L	1		3	Many		1			

Table 3. Species composition of catches of tunas and sharks.

Date	Gear	TUNAS			SHARKS			
		Skipjack	Albacore	Yellowfin	Blue	Mako	Hammerhead	Mackerel
September 21	L/L				12	1		
September 22	L/L				35			
	L/L			4				
September 23	NET	10		6	2	3	1	
	NET	12	8	5	8	2	3	
September 24	NET	7				2		
	NET	50		7	20		10	10
	L/L				40			
September 25	NET	20		6		1	7	
	NET			9		1	3	
September 26	NET	12		8	4	3	2	
	NET	7	8	5				2
	L/L			3	Many			

PART II

SOURCE DOCUMENT
FOR THE
SWORDFISH
FISHERY MANAGEMENT PLAN

MAY 1982

Prepared By The
South Atlantic Fishery Management Council
In Cooperation With

Caribbean Fishery Management Council

Gulf of Mexico Fishery Management Council

Mid-Atlantic Fishery Management Council

New England Fishery Management Council

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This source document was prepared by the South Atlantic Fishery Management Council staff. Personnel involved were:

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INTRODUCTION

The Magnuson Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.) gives responsibility to the Regional Fishery Management Councils to prepare and submit fishery management plans for fisheries within their geographical area. The South Atlantic, New England, Mid-Atlantic, Gulf of Mexico and Caribbean Fishery Management Councils, in accordance with their legislative mandate, are preparing a joint plan for the swordfish fishery.

This source document contains the detailed scientific, technical and other supportive documentation on which the Fishery Management Plan for Swordfish is based. The source document is available for review at the following locations:

New England Fishery Management Council
Suntaug Office Park, 5 Broadway (Route 1)
Saugus, Massachusetts 01906

Mid-Atlantic Fishery Management Council
Federal Building, Room 2115
North and New Streets
Dover, Delaware 19901

South Atlantic Fishery Management Council
Southpark Building, Suite 306
1 Southpark Circle
Charleston, South Carolina 29407-4699

Gulf of Mexico Fishery Management Council
Lincoln Center, Suite 881
5401 West Kennedy Boulevard
Tampa, Florida 33609

Caribbean Fishery Management Council
Suite 1108, Banco de Ponce Building
Hato Ray, Puerto Rico 00918

National Marine Fisheries Service
Northeast Regional Office
14 Elm Street
Gloucester, Massachusetts 01930

National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole, Massachusetts 02543

National Marine Fisheries Service
Southeast Regional Office
Duval Building
9450 Koger Boulevard
St. Petersburg, Florida 33702

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

National Marine Fisheries Service
Washington, D.C. 20235

Definitions of terms used in this document:

Age At Entry: Age at which swordfish are first vulnerable to the predominant fishing gear (longlines) which is age two weighing 20 kg whole weight.

CPUE: Catch per unit of effort, the total number or weight of fish harvested by a defined unit of fishing effort in a given time period.

DAH: Domestic annual harvest. For swordfish DAH (1980) was 7.5 million lb.

DEIS: A Draft Environmental Impact Statement is required by the National Environmental Policy Act of 1969 whenever major Federal actions may significantly affect the quality of the environment, including the human environment.

Dressed weight: .75 of whole weight after fish are gutted and head and fin ae removed.

E.O. 12291: Executive Order 12291 establishes guidelines for developing new regulations and reviewing existing regulations to ensure that they are necessary, appropriate, and cost effective.

F: Instantaneous rate of fishing mortality calculated in yield-per-recruit analysis is that portion of total mortality attributable to fishing. It is equal to total mortality (Z) minus natural mortality (M). For swordfish, F=0.17 for males and F=0.19 for females.

FCZ: Fishery Conservation Zone established by the Magnuson Fishery Conservation and Management Act that extends 200 nautical miles seaward of the states' territorial seas.

FDA: Food and Drug Administration.

FDA Action Level: Maximum allowable mercury concentration in seafood measured in parts per million (ppm) (1971-78=.05 ppm; 1978-present=1.0 ppm).

F_{max}: Instantaneous rate of fishing mortality that maximizes yield-per-recruit.

FMP: Fishery Management Plan prepared by a fishery management council to aid in managing a particular fishery, as directed by the MFCMA.

Growth overfishing: Fishing effort beyond that which maximizes yield-per-recruit (MSY for a given gear assuming constant recruitment).

ICCAT: International Commission for the Conservation of Atlantic Tunas.

ICES: International Commission for the Exploration of the Seas.

Incidental Catch: Catch other than the target species; also called bycatch. Incidental species taken with swordfish longlines include marlin, sailfish and sharks. Swordfish is an incidental catch of foreign longline fishing for tuna and foreign squid trawling.

M: Instantaneous rate of natural mortality calculated in yield-per-recruit analysis is equal to total mortality (Z) minus fishing mortality (F) or that portion of total mortality attributable to all causes except fishing for fish above the size at recruitment. For swordfish, M=0.27 for males and M=0.14 for females.

Maximum YPR: Maximum yield-per-recruit which is comparable to MSY if there is constant recruitment.

MFCMA: Magnuson Fishery Conservation and Management Act (P.L. 94-265) established the FCZ and eight Regional Fishery Management Councils to prepare, monitor, and revise fishery management plans.

MSY: Maximum sustainable yield is the largest quantity of fish that can be harvested continually from a stock.

NMFS: National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Department of Commerce, responsible for conservation and management of fisheries.

Overfishing: Fishing effort above the level which will produce MSY, resulting in catches less than MSY.

OY: Optimum Yield is the amount of fish (1) which will provide the greatest overall benefit to the Nation and (2) is defined as maximum sustainable yield modified by relevant economic, social, or ecological factors. For swordfish, OY is equal to the maximum level of harvest that will not exceed maximum yield-per-recruit for female swordfish.

PMP: Preliminary Management Plan prepared by the Secretary of Commerce to manage the harvest by foreign fishermen in the FCZ until a FMP has been prepared by a regional fishery management council.

Recruitment: Number of fish growing into the smallest harvestable size category each year.

Recruitment overfishing: Harvesting to the point that reproduction by the remaining brood stock is inadequate to produce as many recruits as the habitat can support.

RIR: Regulatory Impact Review is an assessment of the economic impacts of proposed government regulations.

Secretary: Secretary of Commerce.

Stock: A group of fish manageable as a unit. For swordfish, the stock consists of swordfish in the western North Atlantic within the five Council FCZ.

TALFF: Total Allowable Level of Foreign Fishing which is OY minus DAH. For swordfish, the TALFF is zero because the fishery is fully exploited by U.S. fishermen.

Territorial Seas: The seas under the jurisdiction of a state.

VSC: Variable season closure.

YPR: Yield-per-recruit is a theoretical calculation based on known growth rates and natural mortality rates that allows an estimate of relative yield from a fishery without knowing landings. It does not permit a calculation of total landings but it is possible to calculate the relative amount of fishing effort and landings (in percents) compared to maximum yield-per-recruit which is comparable to MSY given constant recruitment.

Z: Instantaneous rate of mortality calculated in yield-per-recruit analysis is equal to the sum of natural mortality (M) and fishing mortality (F). Z represents the total instantaneous mortality from both natural causes and fishing. For swordfish, Z = 0.44 for males and Z = 0.33 for females.

5.0 THE FISHERY MANAGEMENT UNIT

5.1 Description of the Species

The swordfish, Xiphias gladius (Linnaeus, 1758), has a stout body with the greatest depth just behind the head, large mouth with the upper jaw greatly prolonged into a sword which is wider than deep, large eyes and only possesses teeth in the jaws when young (Leim and Scott, 1966). The color is a dark metallic-purplish above, dusky below, and the sword is virtually black above and lighter below; swordfish can be recognized easily by the greatly prolonged upper jaw, large pectoral fins, lack of scales in the adult, and lack of pelvic fins (Leim and Scott, 1966).

5.2 Range of the Fishery

The swordfish (Robins et al., 1980) is considered to be a single species, Xiphias gladius, over its worldwide distribution in temperate and tropical zones. In the western Atlantic Ocean, swordfish occur from Newfoundland to Argentina, including the Gulf of Mexico and Caribbean Sea (Goode, 1882, 1883; Bigelow and Schroeder, 1953). Commercial catches of swordfish have been taken primarily in temperate zones in the summer and secondarily in subtropical and tropical zones in winter (Cavaliere, 1963; Ueyanagi et al., 1970; Guitart-Manday, 1975).

There are four primary fishing areas in U.S. waters. The first is the California harpoon, rod and reel, and more recently drift gill net fisheries. The second is the south Florida area where a longline and rod and reel fishery recently developed. The third fishing area is the traditional New England fishery where four types of gear are used: rod and reel, longline, harpoon, and, more recently, drift gill nets. The final fishing area is the Gulf of Mexico where longline gear predominates. In addition, a fishery is being developed within the waters of Puerto Rico and the U.S. Virgin Islands. This management plan addresses the fishing areas in the New England, Mid-Atlantic, South Atlantic, Gulf of Mexico and Caribbean waters.

5.3 Management Unit

The fishery management unit for the swordfish, Xiphias gladius, consists of that portion of the resource that lies within the FCZ in the jurisdiction of the New England, Mid-Atlantic, South Atlantic, Gulf of Mexico and Caribbean Fishery Management Councils.

5.4 Rationale for Choosing This Unit

This unit was chosen because the swordfish is considered to be a single species with a world-wide distribution in temperate and tropical zones and similar harvesting and marketing methods throughout the range of the fishery. For more detailed discussions, refer to Sections 8.1.4 and 8.4.4.3.

The large degree of similarity among the different geographical fishing areas facilitates management of the swordfish fishery under the jurisdiction of a joint plan. This reduces the cost of plan preparation; reduces the likelihood of redundant and/or conflicting research, regulations or management solutions; eases the burden of compliance by fishermen through one comprehensive plan; and allows enforcement agencies to cooperate under one set of regulations, thereby maximizing enforcement efficiency while minimizing cost.

6.0 PROBLEMS AND ISSUES

See FMP document, Section 6.0.

7.0 OBJECTIVES

See FMP document, Section 7.0.

8.0 DESCRIPTION OF THE FISHERY

8.1 Description of Stocks

8.1.1 Species and Its Distribution

The swordfish, Xiphias gladius, is considered to be a single species over its worldwide distribution from about 45° N to 45° S in all tropical, subtropical and temperate seas (Palko et al., 1979).

8.1.2 Life History

8.1.2.1 Reproduction

Swordfish are heterosexual; however, there are no known external characteristics to separate males from females although several authors indicate that larger swordfish are usually females (Palko et al., 1979).

Age at first spawning was reported to be five or six years (Yabe et al., 1959), which is at an orbit-fork length of approximately 160 to 185 cm (64 to 74 in). This is equivalent to a lower jaw-fork length of 219 to 245 cm (86 to 97 in) calculated as follows (S. Berkeley, Research Associate, Univ. Miami, Miami, FL; pers. comm.): lower jaw-fork length = 13.39 + 1.053 (orbit-fork length). Estimates of sexual maturity off the southeast coast of the U.S. are 21 kg (49.3 lb) for males and 74 kg (163.1 lb) for females (Berkeley, 1981).

Fecundity estimates range from 3 million to 16 million eggs produced per spawning (Fish, 1926; Yabe et al., 1959; Uchiyama and Shomura, 1974). Recent estimates of fecundity, defined as the number of ova in the most advanced mode within the ovary, for south Florida waters ranged from 1.41 to 4.20 million (Berkeley, 1981). Further, fecundity is related to weight by the following linear relationship:

$$F = 0.77 + 0.0144 W$$

where:

F = fecundity in millions of ova

W = whole weight of female in kg

Mean relative fecundity, defined as ova per gram body weight, was 17.8 (Bekeley, 1981).

In comparison, a 33 kg (72.8 lb) sailfish was estimated to release up to 4.8 million ova per season (Jolley, 1977). Jolley (1977) also observed that fecundity increased with fish size. Fecundity estimates for white marlin between 26.8 and 37.2 kg (59 and 82 lb) ranged from 3.8 to 10.5 million eggs (Baglin, 1979).

Historical evidence exists to classify swordfish as single, multiple or partial spawners (Yabe et al., 1959; Cavaliere, 1963; Uchiyama and Shomura, 1974). However, recent data from south Florida waters indicate that they are multiple spawners and that fecundity estimates will need to be modified to include less developed ova for a final estimate that will significantly increase initial estimates (Berkeley, 1981) which included only more developed ova (S. Berkeley, Research Associate, Univ. Miami, Miami, FL; pers. comm.).

Fertilization is external (Palko et al., 1979). The peak spawning period in the western North Atlantic Ocean occurs during late fall and winter months (Arata, 1954; Taning, 1955; Tibbo and Lauzier, 1969; Markle, 1974; Fahay, 1975; Grall et al., 1981); however, larvae have been collected in the northwest Atlantic in all months which suggests a longer spawning period. Three main spawning areas were reported by Grall et al. (1981): (1) Straits of Yucatan, (2) Straits of Florida, and (3) near the Lesser Antilles.

8.1.2.2 Age and Growth

Adult swordfish lack scales which makes scale-reading for age assessment impossible. However, Artuz (1963) reported rings on the dorsal fin spines of Sea of Marmara swordfish which he thought to be annual marks. More recently Berkeley and Houde (1980, 1981) have used anal fin spines to age swordfish. They found a good linear relationship between fork length and fin spine radius of 439 swordfish (1981 paper):

$$L = 58.50 + 23.90\,S \qquad r = .94$$

where:

L = lower jaw-fork length (cm)

S = anal fin spine radius (mm)

r = correlation coefficient

There was no difference by sex reported. Berkeley and Houde (1981) then used the relationship and the measured radii to each presumed annulus to back calculate mean lengths at each annulus. They then converted lengths to weight (from their length-weight relationship) in order to estimate mean weights at different ages:

	Males		Females		Both Sexes	
Age*	Whole weight (kg)+	Dressed weight** (kg)	Whole weight (kg)	Dressed weight** (kg)	Whole weight (kg)	Dressed weight** (kg)
I	12.0	9.0	9.8	7.4	10.9	8.2
II	21.6	16.2	19.6	14.7	20.6	15.5
III	31.7	23.8	33.3	25.0	32.5	24.4
IV	41.8	31.4	49.2	36.9	45.5	34.1
V	54.4	40.8	67.2	50.4	60.8	45.6
VI	66.7	50.0	85.3	64.0	76.0	57.0
VII	75.8	56.9	109.1	81.8	92.4	69.3
VIII	82.0	61.5	135.9	101.9	109.0	81.8

* Older fish (XI+) have been aged but due to small sample sizes they were excluded from this analysis.
** Dressed wt = 0.75 whole weight
\+ 1 kg = 2.2046 lb

Beckett (1974) estimated a faster growth rate using modal size frequencies and tagging data from the Canadian fishery. Females grow faster than males after age II and attain a larger size (Berkeley and Houde, 1980, 1981). The largest female aged in Florida weighed more than 300 kg (661.4 lb; 11 years old) while the largest males were less than 140 kg (308.6 lb).

Berkeley and Houde (1981) fitted the von Bertalanffy growth model to their fork length at age data for males, females and sexes combined; the result is shown in Figure 8-1. The equations, population parameter estimates, back-calculated lengths at age, as well as predicted lengths at age are presented in Table 8-1.

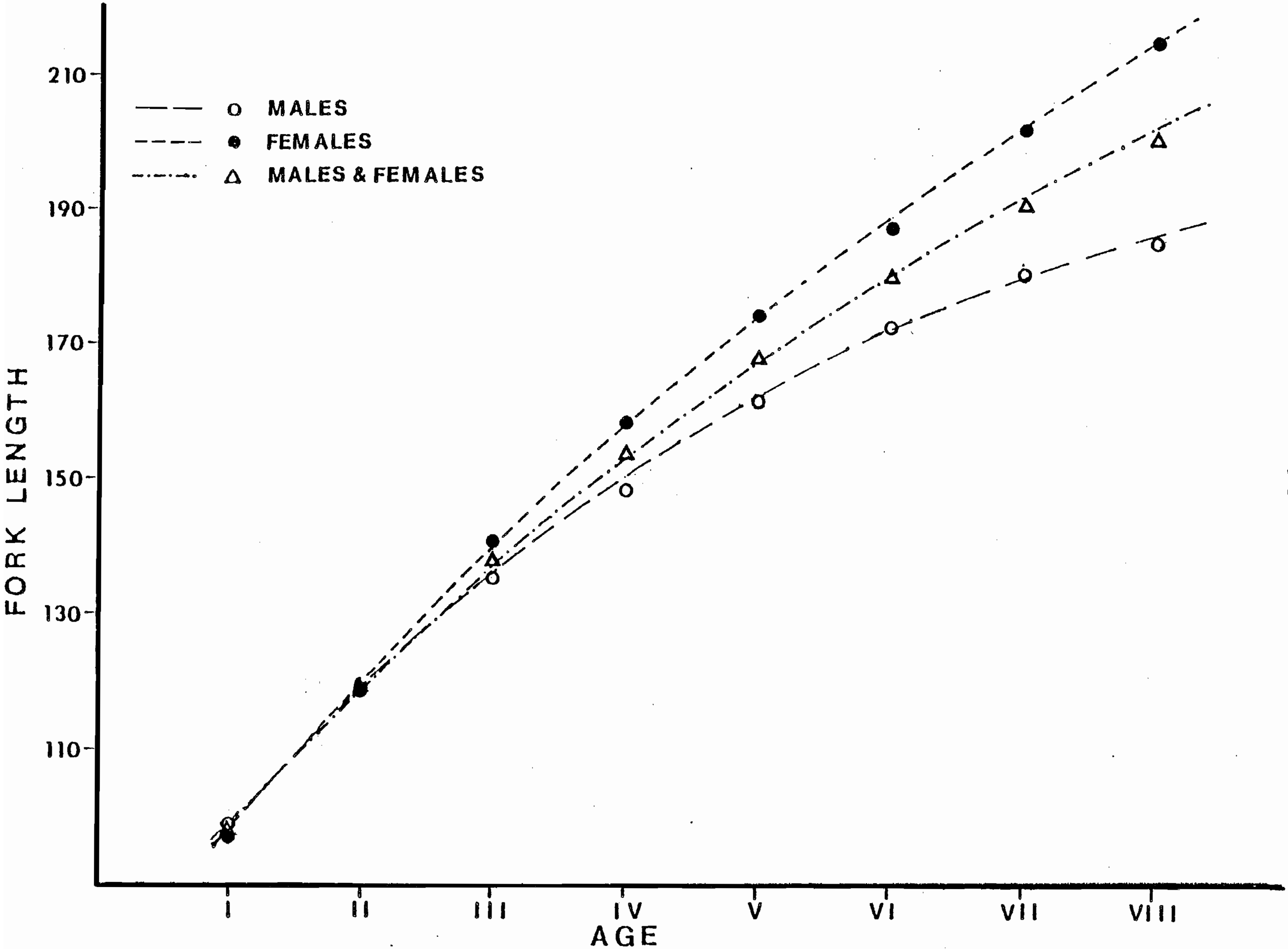

Figure 8-1. The relationship between fork length (cm) and age (yr) for swordfish landed in south Florida. The data points are back-calculated lengths at annuli for males, females and both sexes combined. Curves are based on the von Bertalanffy models fitted to these data. (Source: Berkeley and Houde, 1981).

Table 8-1. Mean back-calculated lengths at age and those predicted by the von Bertalanffy model for swordfish landed in south Florida. Equations and parameter estimates are also given. (Source: Berkeley and Houde, 1981)

Age	Males and Females Fork length (cm)		Males Fork length (cm)		Females Fork length (cm)	
	Back-calculated	Predicted from von Bertalanffy growth equation	Back-calculated	Predicted from von Bertalanffy growth equation	Back-calculated	Predicted from von Bertalanffy growth equation
1	98.02	99.46	98.86	97.24	97.17	97.99
2	119.55	119.23	119.27	118.50	119.83	119.85
3	138.16	137.02	135.41	136.00	140.90	139.73
4	153.59	153.03	148.54	150.40	158.63	157.82
5	168.01	167.45	161.55	162.25	174.46	174.28
6	180.20	180.42	172.79	172.01	187.60	189.25
7	191.29	192.09	180.38	180.03	202.19	202.87
8	200.67	202.59	185.12	186.64	216.22	215.25
	$L_t = 297.10(1-e^{-0.1054(t + 2.8672)})$		$L_t = 217.36(1-e^{-0.1948(t + 2.0444)})$		$L_t = 340.04(1-e^{-0.09465(t + 2.5912)})$	
	$L_{oo} = 297.10$		$L_{oo} = 217.36$		$L_{oo} = 340.04$	
	$K = 0.1054$		$K = 0.1948$		$K = 0.09465$	
	$t_o = -2.8672$		$t_o = -2.0444$		$t_o = -2.5912$	

The differential growth rates of the sexes is clearly shown by growth coefficients of 0.1948 and 0.09465 for males and females respectively. In addition, the sexes do not occur in equal proportions in the Florida fishery where males predominate by a ratio of 1.7:1 (Berkeley and Houde, 1981). They further report that the sex ratio changes with age:

Age	I	II	III	IV	V	VI	VII	VIII
Males:Females	2.1:1	1.5:1	3.6:1	2.6:1	1.9:1	1.2:1	1.1:1	0.4:1

Note that, after age 8, females represent virtually 100 percent of the catch. Due to the unequal sex ratios, Berkeley and Houde (1981) averaged estimates of length and weight at age for males and females to give the combined estimates.

Beardsley (1978) summarized Caddy's (1977) estimated parameters of the von Bertalanffy growth equation based upon swordfish taken by Canadian fishermen in the northwest Atlantic. These are:

L_{∞} = 144 in (365 cm)

K = 0.230

Calculated ages at size from Caddy (1976):

Age (years)	Fork Length[1]		Round Weight	
	in	cm	lb	kg
1	19.7-35.4	50-90	3.1-19.4	1.4-8.8
2	39.4-43.3	100-110	26.9-36.1	12.2-16.4
3	47.2-59.0	120-150	47.3-94.4	21.4-42.9
4	63.0-70.9	160-180	115.3-166.1	52.2-75.3
5	74.8-86.6	190-220	196.4-309.2	89.1-140.3
6+	90.6+	230+	354.9+	160.9+

1. Tip of lower jaw to caudal fork.

In 1977 and 1978, Beardsley et al. (1978) sampled 168 swordfish caught at night by recreational fishermen using rod and reel which ranged in size from 3.5 kg (7.72 lb) to 268.0 kg (590.83 lb). They reported the following length-weight relationship:

$$Y = -5.5669 + 3.2994\,L \qquad \text{std. error} = .0370$$
$$N = 166$$

where:

$Y = \log_{10}$ weight

$L = \log_{10}$ lower jaw - fork length

Berkeley and Houde (1981) observed fish in age classes 0 to XI in south Florida longline catches; however, more than 50 percent of the catch was composed of ages 1-4 (Figure 8-2). It is important to note that while landings are dominated by catches of relatively small swordfish (mostly males), the fishery depends to a large extent on the relatively infrequent catches of large, older and mostly female fish, which contributed greater than 30 percent of the landings by weight in the Florida Strait's fishery (Berkeley and Houde, 1980) and bring a higher price per pound than smaller fish.

8.1.2.3 Mortality

Total mortality rates were estimated by Berkeley and Houde (1981) using several methods.* The maximum likelihood estimate (Robson and Chapman, 1961) of the instantaneous mortality coefficients with .95 confidence limits for males, females and both sexes combined are:

Males	Females	Both Sexes
$Z = 0.44 \pm 0.07$	$Z = 0.33 \pm 0.06$	$Z = 0.40 \pm 0.05$
N = 245	N = 139	N = 391

A second estimate based on the expected relationship between growth and annual mortality rate (Beverton and Holt, 1956) was obtained from:

$$Z = \frac{K(L_{oo} - \bar{l})}{\bar{l} - l'}$$

where: l' = length of smallest fish fully represented in the sample

$\bar{l}$ = average length of all fish above l'

*Portions are taken directly from Berkeley and Houde (1981).

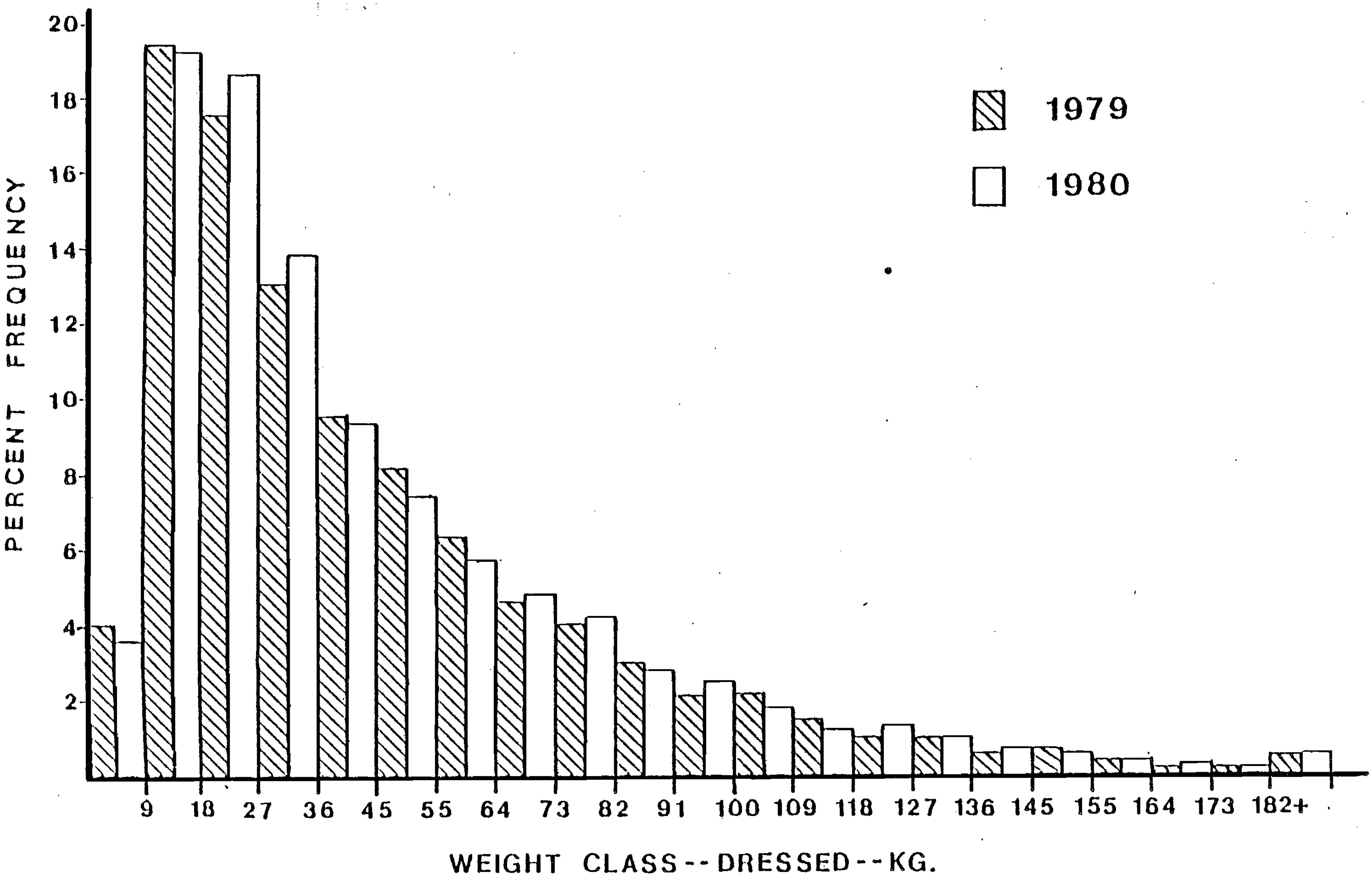

Figure 8-2. The weight-frequency distribution for 7,985 swordfish landed by longline in Florida in 1979 and 14,837 swordfish landed in 1980. Dressed weight equals whole weight X 0.75. (Source: Berkeley and Houde, 1981).

The results are:

Males		Females		Both Sexes	
Z	= 0.36	Z	= 0.26	Z	= 0.35
1'	= 127 cm	1'	= 130 cm	1'	= 130 cm
$\bar{1}$	= 158.7 cm	$\bar{1}$	= 185.6 cm	$\bar{1}$	= 168.6 cm
L_{oo}	= 217.4 cm	L_{oo}	= 340.0 cm	L_{oo}	= 297.1 cm
K	= 0.1948	K	= 0.0946	K	= 0.1054

A third estimate was obtained from (Ssentongo and Larkin, 1973):

$$Z = K\left(\frac{n}{n+1}\right)\left(\frac{1}{\bar{y} - y_c}\right)$$

where:

n = sample size

$$\bar{y} = -\ln\left(1 - \frac{\bar{1}}{L_{oo}}\right)$$

$$y_c = -\ln\left(1 - \frac{1'}{L_{oo}}\right)$$

Using the above values for L_{oo}, 1', $\bar{1}$, and K, the results are:

Males		Females		Both Sexes	
Z	= 0.45	Z	= 0.30	Z	= 0.40
n	= 190	n	= 98	n	= 291

Natural mortality rates were estimated from the equation relating natural mortality, growth parameters and mean environmental temperature determined empirically by Pauly (1980):

$$\log M = 0.1228 - 0.1912 \log L_{oo} + 0.7485 \log K + 0.2391 \log T$$

Assuming a mean environmental temperature of 15°C (59° F) and using the previously determined growth parameters the estimates are:

Males		Females		Both Sexes	
M	= 0.27	M	= 0.14	M	= 0.16

Caddy (1977), using the Beverton and Holt (1956) method, reported that total mortality was in the range of 0.12 to 0.65 for the Canadian harpoon fishery and 0.16 to 0.58 for the Canadian longline fishery.

Using Berkeley and Houde's (1981) mortality data, the estimated fishing mortality coefficient (F) was in the range 0.10-0.24 for males, 0.13-0.25 for females and 0.19-0.29 for both sexes.

8.1.3 Ecological Relationships

8.1.3.1 Larval Ecology

Swordfish larvae can be recognized by their long snouts, prominent supraorbital crest, heavily pigmented, elongate bodies. When longer than 8.0 mm (0.32 in) they possess one or more rows of spinous scales on each side of the dorsal and anal fins, with those along the anal fins continuing forward to the level of the pectoral fin (Matsumoto and Kazama, 1974; Palko et al., 1979).

Swordfish larvae occur at or near the surface during all times of the day and thus do not exhibit negative phototrophism (Arata, 1954; Taning, 1955; Tibbo and Lauzier, 1969; Markle, 1974). Larvae feed on fish larvae and copepod crustaceans. The juveniles and adults of tunas, dolphins, mackerels, snake mackerels, flying fish and billfish are predators of swordfish during their early life. Cannibalism may result in scattered distribution of swordfish larvae (Arata, 1954). Larval growth rates range from 0.6 to 2.0 mm (0.02-0.08 in) per day (Arata, 1954; Taning, 1955; Yabe et al., 1959; Tibbo and Lauzier, 1969; Uchiyama and Shomura, 1974).

Berkeley and Houde (1980) recently completed a search of published and unpublished data to examine areas of occurrence of larval swordfish and to relate their occurrence to spawning distributions and abundances of adults. Their conclusions were as follows:

"Larval swordfish have been collected in every month of the year from the western North Atlantic Ocean. Of 545 larval observations, 207 (38 percent) were from the Gulf of Mexico and 64 (11.7 percent) were from the Caribbean Sea. The majority of larvae (75.1 percent) were collected when surface temperature ranged from 25^{o}-30^{o}C. Most Gulf of Mexico swordfish larvae (76.8 percent) were collected when surface temperatures exceeded 27^{o}C, indicating that a spawning population is present in the Gulf throughout the summer months. In the Caribbean Sea most swordfish larvae have been collected from November to February, when surface temperature was less than 27^{o}C, indicating a possible distributional shift toward the tropics by adults during the winter months. In areas other than the Gulf or Caribbean most larvae (75.8 percent) were collected from May to November. For the entire western North Atlantic, 22.5 percent of larvae were collected from January to April, 48.7 percent from May to August and 28.8 percent from September to December. Concentrations of larval occurrences were noted in the east-central Gulf of Mexico, Straits of Florida and eastern Caribbean Sea. Because sampling effort among areas is not known, we cannot be certain that those areas are the most important spawning sites, but they are areas where significant spawning occurs in the western North Atlantic."

Grall et al. (1981) studied the distribution and seasonality of a collection of 961 larval swordfish from the Atlantic, Pacific and Indian Oceans. In the western North Atlantic larvae were most abundant in the Straits of Florida, Straits of Yucatan and the Lesser Antilles. They appeared most numerous during the fall and winter (September-February) but were found year round. Also, most were collected in the open ocean greater than 200 m (656.2 ft).

8.1.3.2 Food-Chain Relationships

Swordfish are opportunistic feeders that feed on fish and squid from the surface to about 914.4 m (3,000 ft) In adults, the vertical distribution (see Section 8.1.3.4.1) of these upper trophic level predators is believed to be linked to the diurnal movements of their prey, and the species composition of prey found in the stomach of swordfish varies with the geographical area, depth and concentration of forage (Bigelow and Schroeder, 1953; Yabe et al., 1959; Tibbo et al., 1961; Squire, 1962; Cavaliere, 1963; Guitart-Manday, 1964; Scott and Tibbo, 1968; Maksimov, 1969; Ovchinnikov, 1970; Torin 1971; Beckett, 1974.)

Stomach contents from 65 swordfish caught in the Florida Straits were analyzed (Toll and Hess, 1981) and results indicated that cephalopods account for over 90 percent of total weight of contents in 69 percent of the stomachs. Of these, squid (Illex) were the most important prey items. The diversity of prey found in this study confirms the postulated opportunistic feeding strategy of swordfish. "Analysis of the vertical distribution of cephalopod prey indicated that swordfish feeding is most concentrated in epipelagic and upper mesopelagic waters" (Toll and Hess, 1981). The following fish were found in the stomachs: (1) scads

(Trachurus spp.); (2) round herring (Etrumeus teres); (3) scombrids; (4) various pelagic midwater species; and (5) demersal parrotfishes (family Scaridae). Berkeley (1981) noted that prey such as parrotfishes implies that swordfish must make feeding forays onto reef areas of relatively shallow depth.

In temperate waters of the Atlantic, swordfish have been seen basking on the surface; this is thought to facilitate digestion (Palko et al., 1979). There is evidence from stomach contents (Tibbo et al., 1961) and the long dorso-ventrally compressed sword (Scott and Tibbo, 1968) that indicate swordfish may use their sword to kill prey. Swordfish have been observed stunning small fish in a school and later swallowing these fish (Goode, 1883). Scott and Tibbo (1968) found fish in swordfish stomachs that may have been cut with the sword, damaging the muscle and vertebral column. The use of their sword to kill prey was verified by Toll and Hess (1981).

8.1.3.3 Predator-Prey Relationships

The intraspecific and interspecific relationships of swordfish are not well understood (Parin, 1967, 1968; Ovchinnikov, 1970). Swordfish do not school like tunas and are generally classified as solitary fish. Tibbo et al. (1961) and Ovchinnikov (1970) reported that nonspawning swordfish are commonly separated by a distance of about 9.1 to 91.4 m (30 to 300 ft). However, catch rates at depth (i.e., where several fish are hooked in a particular location during a short period of time) suggest that swordfish may aggregate to some degree.

Swordfish are hydrodynamically adapted for swift swimming (Ovchinnikov, 1968; Aleev, 1971; Kozlov, 1973; Magnuson, 1973). It is speed that contributes both to protection from predators and to their own predatory habits. Adult swordfish are often found with tunas, dolphins (coryphaena), sharks, and other billfishes seeking similar food. The effect this competition for similar food has on survival is probably minimal since swordfish can feed on a variety of foods from the surface to the ocean floor, can travel between tropical and temperate waters, and are opportunistic predators (Palko et al., 1979).

The competing species are predatory upon larval and juvenile swordfish. Dolphin frequently contain juvenile swordfish in their stomachs. In addition, larval and juvenile swordfish are cannibalistic. Swordfish compete with sharks (Parin, 1967) for food, and are preyed on by sharks (Tibbo et al., 1961; Parin, 1970), sperm and killer whales (Tibbo et al., 1961). Swordfish attacks on sharks have been documented (Maksimov, 1968).

Although sea lampreys (Petromyzon marinus) have been reported by Tibbo et al. (1961) and Guitart-Manday (1964) to attack migrating swordfish, leaving open wounds, it is probably the cookie-cutter shark (Isistius) that causes these nonserious wounds (Jones, 1971; Amorim et al., 1979).

The following parasites were found in swordfish off Cuba (Guitart-Manday, 1964): Ascaris incurva in virtually all stomachs, unidentified Hirudinea in the stomach, unidentified cestoda attached to the outer walls of the stomach, and an unidentified ectoparasitic Pennella deep in the subcutaneous muscular tissue. Many nematodes are found in the stomachs and two kinds of cestodes are found in the intestinal tract (Artuz, 1963). Palko et al. (1979) reported that swordfish in the Sea of Marmara frequently have a parasitic copepod (Pennellidae) attached.

8.1.3.4 Movement Patterns

8.1.3.4.1 Horizontal and Vertical Movements

Sonic tagging experiments in the eastern Pacific and western Atlantic Oceans (Carey and Robison, 1977) showed the following movement. During the day swordfish generally stayed inshore and at dusk headed seaward moving up and down through large depth ranges. They fed offshore near the surface (1.8-12.8 m; 1-7 fm) after sunset and returned inshore but at a greater depth, 91.4-128.0 m (50-70 fm), at sunrise. Larger swordfish did not move inshore; instead, they set up a meandering course seaward.

Movements of swordfish were studied using acoustic telemetry to record water temperature and depth of swordfish in the Pacific and Atlantic by Carey and Robison (1980, 1981). Swordfish seem to follow a diel cycle of movement between an inshore bank during the day and deep water offshore at night. Swordfish showed definite vertical movement in response to light, moving down in the water column during daylight hours and moving up near the surface at night. The maximum depth in their experiments was 617 m (2,024.4 ft); however, Church (1968) sighted a swordfish at 654 m (2,145.8 ft) from a submarine and another submarine (Alvin) was attacked by a swordfish while on the bottom at 610 m (Zarudski, 1967).

The fact that longline vessels fish a narrow range along the edge of the continental shelf is well known and supported by numerous advisory panel representatives. This was further confirmed by Berkeley (1981) where aerial overflights by Florida's Department of Natural Resources indicated an average density of 0.11 boats per nautical mile. These flights were conducted along the shelf edge and support a narrow horizontal distribution for swordfish.

8.1.3.4.2. Migrations

It is generally believed that swordfish migrate from subtropical western North Atlantic Ocean waters to temperate waters along the edge of the continental shelf during spring, after spawning, and then return south in late autumn and winter to complete the cycle (Tibbo et al., 1961; Guitart-Manday, 1964; Ovchinnikov, 1969, 1970; Beckett, 1971, 1974; Caddy, 1976). These contentions are supported in part by a long-range (3,057.1 km; 1,900 mi) tag return from the Gulf of Mexico to Georges Bank and two tag returns from Georges Bank to Florida (over 1,000 mi). Seasonal north-south migration patterns of swordfish are reported for the eastern North Atlantic Ocean and Black Sea and in the Pacific Ocean (Nakamura et al., 1951; Yabe et al., 1959; Svetovidov, 1964; Ovchinnikov, 1970; Ueyanagi et al., 1970). This is further supported by researchers that report a seasonal aggregation along the edge of the continental shelf and on offshore banks in higher latitudes (Rich, 1947; Wise and Davis, 1973). Ovchinnikov (1969) considers it possible for swordfish and other billfishes to migrate between the North Atlantic Ocean and the Indian Ocean past the Cape of Good Hope. It is not known if all life history stages of swordfish migrate or if migration occurs across the North Atlantic or from the southern Caribbean Sea or South Atlantic Ocean north into regional waters.

8.1.4 Stock Definition

There are no reports in the scientific literature which define the stock structure for swordfish in the Atlantic Ocean. However, investigators have commented on stock structure which may be pertinent to this description of the fishery. Beardsley (1978) reported that the catch-per-unit of effort (CPUE) from the Japanese longline fishery in the Atlantic

Ocean shows three seasonal concentrations of broadbills: (1) northwest coast of Africa, just outside the Mediterranean Sea, in November and December; (2) northwest Atlantic Ocean in July and again in September through October; (3) South Atlantic, off the coasts of Uruguay and Argentina, from April through October. The swordfish fisheries off the northwest coast of Africa (and Mediterranean Sea) are discussed by Cordiero (1958), Artuz (1963), Amorim et al. (1979), and Rey and Gonzales-Garces (1979), while those from the southwest Atlantic are reported on by Amorim et al. (1979). The fisheries of the northwest Atlantic are discussed by Goode (1883, 1884), Rich (1947), Tibbo et al. (1961), Torin and Volkov (1971), and Caddy (1976).

Although Beardsley (1978) reported that the existence of three fairly distinct concentrations located thousands of miles apart suggests that there are three populations of swordfish in the Atlantic, Japanese CPUE data provide inconclusive evidence for the purposes of defining unit stocks, because considerable intermixing is possible among the three areas. In addition, the Japanese longline fishery targets tunas, not swordfish; thus the CPUE could be misleading. It should be cautioned that swordfish are taken in almost all areas of the Atlantic Ocean and there does not appear to be a clear-cut dividing line between the groups. However, the Japanese longline catch data presented by Wise and Davis (1973) seem to reveal a general drift of North Atlantic swordfish from the equatorial region to northern waters in the northern summer, and a corresponding drift of South Atlantic swordfish toward the south during the southern summer. Wise and Davis (1973) pointed out, however, that Japanese CPUE data for swordfish stock definition may yield invalid interpretations because swordfish harvested* by Japanese longlines were caught in a fishery which is primarily a daytime fishery although fishing activities extend into nighttime hours, whereas the U.S. fishery is primarily a nighttime fishery.

*The Japanese CPUE data discussed in Beardsley (1978), were derived from catch data before the Preliminary Management Plan for billfishes (Federal Register January 27, 1978) was effected.

In the New England Region, commercial catches of swordfish are taken from June to December in continental shelf and slope waters, primarily from Georges and Grand Banks to offshore Gulf Stream waters (Tibbo et al., 1961; Wilson and Bartlett, 1967; Wise and Davis, 1973; Beckett, 1974; Caddy, 1976). Originally, the fishery from Cape Hatteras north had been a year-round fishery (M. R. Bartlett, Advisory Panel, pers. comm.). It is generally believed that each year swordfish migrate south along the continental shelf edge from New England in late autumn, to spawn in tropical waters and then return north in the spring. A swordfish tagged in the Gulf of Mexico was recovered in New England and two swordfish tagged on Georges Bank were recovered in Florida. In regard to stock definition, Beckett (1974) and Caddy (1976) suggest that two races exist within the seasonal northwest Atlantic fishery. However, Beckett (pers. comm.) reported that the data needed for conclusive stock identification were lacking.

In the South Atlantic and Gulf of Mexico regions, swordfish are caught in continental shelf and slope waters of all states (North Carolina to South Florida, including the Florida Keys, and from the west coast of Florida to Texas). It is generally believed that the maximum number of swordfish in Cuba occur during the winter and early spring (during spawning), while a minimum number occur in summer and fall (Guitart-Manday, 1964).

There are no means to clearly separate stocks based on life histories, distributions, morphological characteristics, catch and effort records, parasites or diseases, and biochemical characteristics, as has been done in the past on other species (Lackey and Herbert, 1977). However, data which are available concerning the incidence of infection of swordfish from various parts of the Atlantic with specific parasite species is of interest in analyzing the stock structure question. The copepod Pennella filosa was reported by Tibbo et al. (1961), Guitart-Manday (1964) and Amorim et al. (1979) to occur on swordfish in New England, Cuban and Spanish waters, respectively, whereas P. filosa, P. instructa and P. orthagorisci were reported by Amorim et al. (1979) to occur in Brazilian waters.

The Task Force for Reevaluation and Analysis of Available Data Concerning Billfishes and Sharks chose to consider two different swordfish stock possibilities in their preliminary assessment of the status of western North Atlantic billfish and shark stocks. They were (1) a "North Atlantic" stock with removals from FAO statistical areas 21, 27, 31 and 34, (Figure 8-3) and (2) a "Western North Atlantic" stock with removals coming from FAO statistical areas 21 and 31 (Figure 8-3).

Since swordfish are among the most widely distributed species and apparently have a very complex migratory pattern, a completely definitive answer on the problem of stock structure will not be forthcoming. However, there appears to be sufficient information to adequately assess stock structure for management purposes. The weight of circumstantial evidence presently available strongly suggests separate northeastern and northwestern Atlantic stocks of swordfish:*

1. At least 40-50 swordfish tagged in the western North Atlantic have been recaptured.+ Most recaptures have been within a relatively short distance from the point of release. There has been at least one swordfish tagged in the Gulf of Mexico and recaptured in waters off New England. One fish tagged off Norfolk Canyon was recaptured off Cape Canaveral, Florida. There have been no swordfish tagged in the western North Pacific recaptured in the eastern Atlantic despite an intensive fishery there.

2. Japanese swordfish catches incidental to their directed high seas tuna longline fishery show no particular trend relative to changes in catches or effort in the Canadian or U.S. swordfish fishery. After a few years of intensive swordfish longlining, the Canadians experienced a dramatic decline in CPUE and mean size. This was not reflected in the Japanese swordfish incidental catch.

3. Swordfish landings in the northeast Atlantic and Mediterranean do not appear to have fluctuated with major changes in landings in the northwest Atlantic. Within a few years after the swordfish fishery began its rapid expansion in Florida and the Gulf of Mexico, there was a decline

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*Source: S. Berkeley, Research Associate, Univ. Miami, Miami, FL; pers. comm.)
+The shark tagger annual summaries. Various years. NOAA, NMFS.

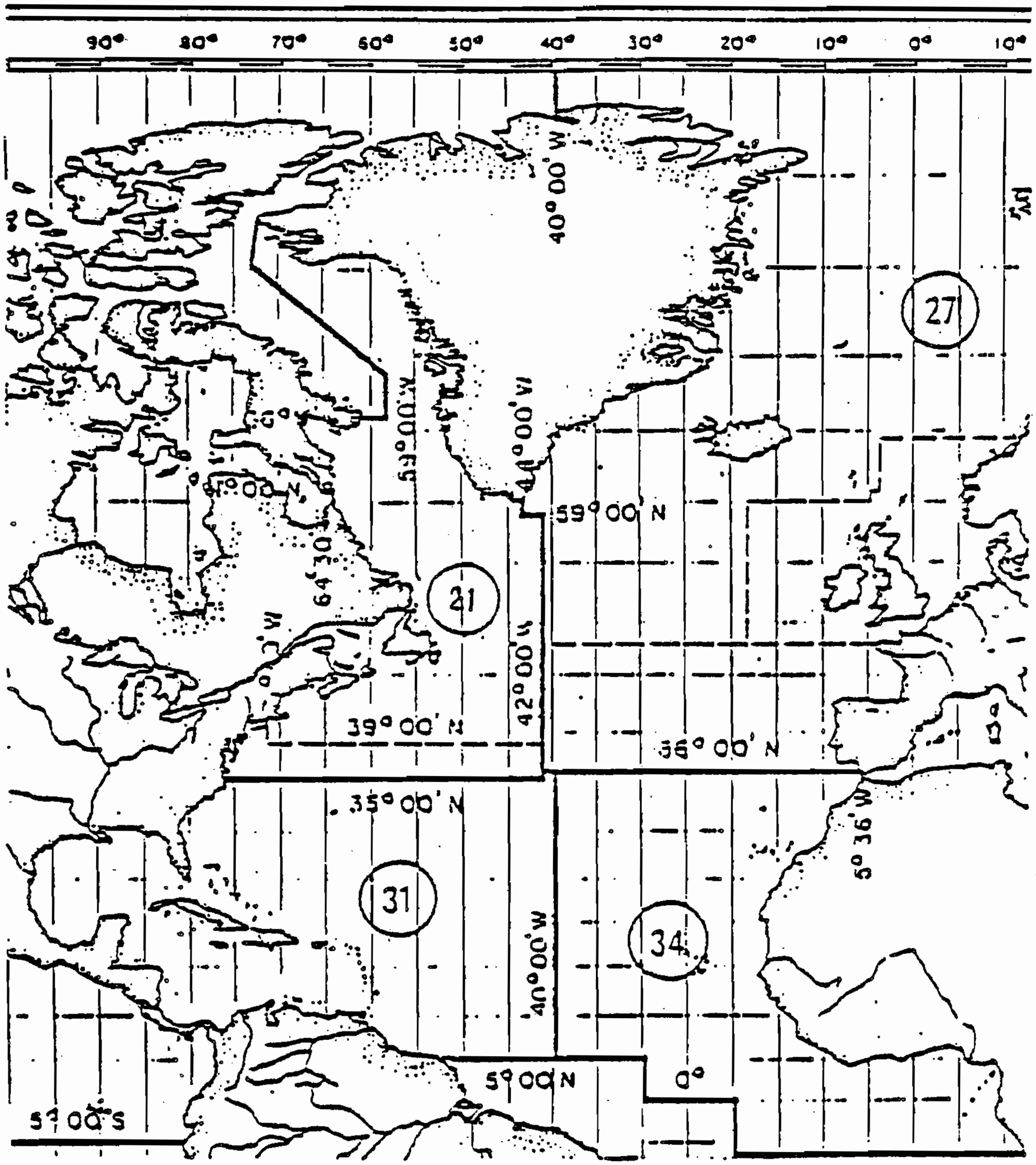


Figure 8-3. FAO statistical reporting areas (21 = NWAtl.; 27 = NE Atl.; 31 = WC Atl.; 34 = EC Atl.; Western NAtl=21,31; Eastern NAtl=27,34; Source: FAO Yearbook of Fishery Statistics)

in CPUE in the New England area suggesting that the two areas may be fishing the same stock. However, a concurrent decline in catch or CPUE did not occur in the Mediterranean or eastern Atlantic suggesting that these fish constitute a separate stock. Figure 8-4 shows the reported swordfish landings for the eastern and western Atlantic between 1960 and 1979. In 1963, the Canadian and American swordfish fisheries changed from a harpoon fishery to a primarily longline fishery. Reported landings which had previously fluctuated around 2,500 MT (5.5 million lb) increased to 8,500 MT (18.7 million lb) and then stabilized at around 5,000 MT (11.0 million lb) until 1970. In the eastern Atlantic, during this period, reported landings increased steadily from approximately 2,000 MT (4.4 million lb) to over 7,000 MT (15.4 million lb). In 1971, the mercury issue caused the fishery in Canada and the U.S. to collapse. Although reported landings are known to underestimate actual landings after 1971, there certainly was a substantial reduction in catches and effort during this time. Between 1971 and 1978, the allowable level of mercury remained at 0.5 ppm and effort remained relatively low. Reported landings during this period remained at less than 2,000 MT (4.4 million lb). In the eastern Atlantic, reported landings fluctuated between 7,000 and 9,000 MT (15.4-19.9 million lb). In 1975, the swordfish fishery began expanding in the western North Atlantic, primarily in Florida, South Carolina and the Gulf of Mexico. In addition, the raising of the allowable mercury concentration from 0.5 to 1.0 ppm in 1978 encouraged additional effort in the fishery and landings in the western North Atlantic began increasing. During this time period, landings in the eastern North Atlantic continued to fluctuate between 7,500 and 9,000 MT (16.5-19.9 million lb).

Although these data give no indication of change in landings relative to effort, they do indicate that changes in landings in one area are independent of changes in the other area, thus suggesting separate stocks.

4. Spawning information compiled by Beardsley (1977) indicates that ripe females and larvae occur in the Straits of Messina in the Mediterranean from April through September, and in the Caribbean and throughout the Florida Straits from January through October. Although larvae have been found over a wide area in the tropical and sub-tropical Atlantic, concentrated spawning activity in these widely divergent areas suggests two separate spawning stocks.

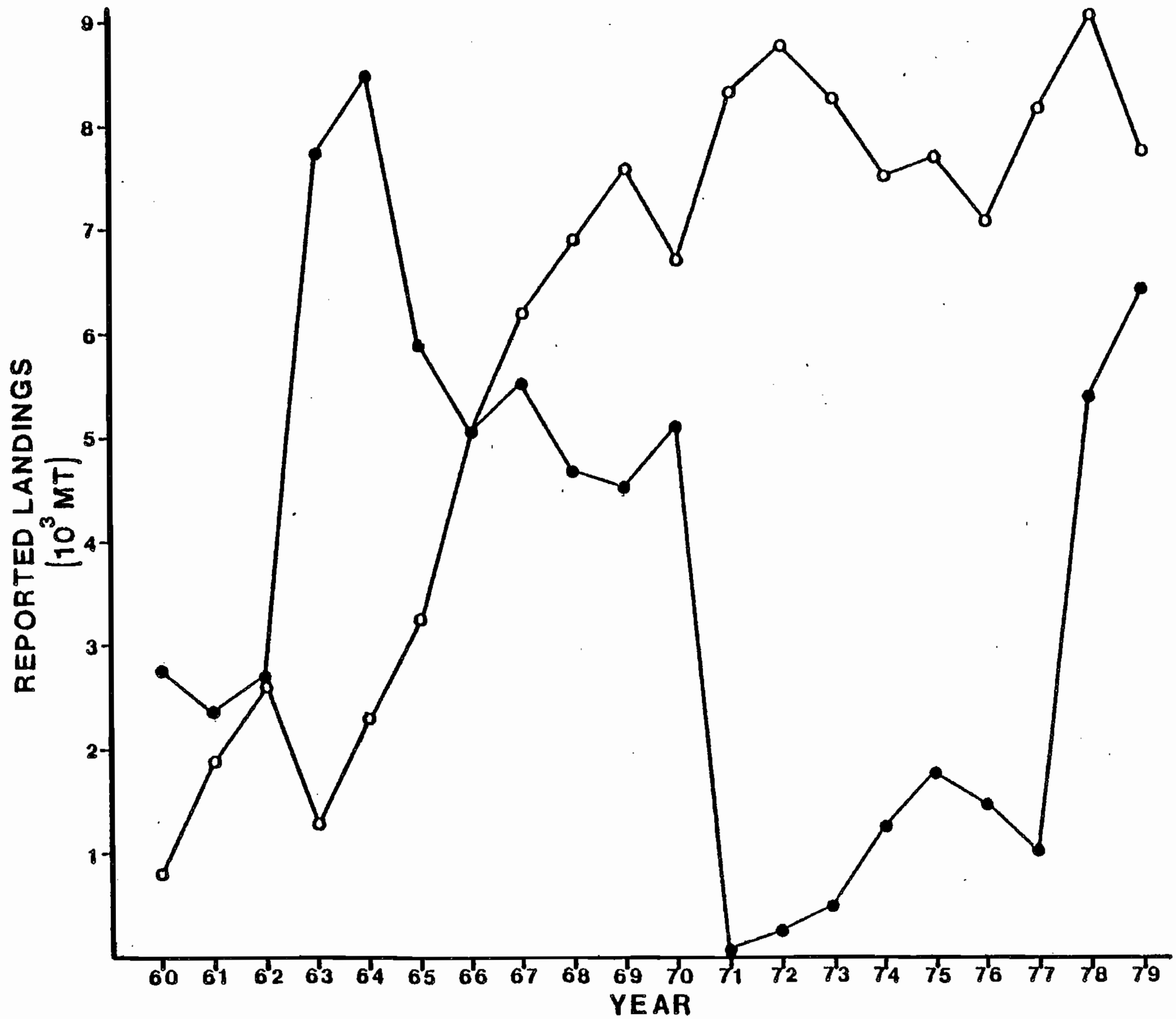


Figure 8-4. Reported swordfish landings from the western North Atlantic (●——●) and eastern North Atlantic (including the Mediterranean Sea) (O——O), 1960-1979. (Source: S. A. Berkeley, Research Associate, Univ. Miami, Miami, FL; pers. comm.)

Although some mixing between the eastern and western Atlantic is not only possible but almost certainly does occur, it appears that this exchange is insignificant from the standpoint of management. With over 40 tag recaptures, some out as long as nine years, if there were a significant amount of interchange between the eastern and western Atlantic, we would expect at least a small number of tag returns from the eastern Atlantic.

Landings in the U.S. and Canadian fisheries in the western North Atlantic and landings in the eastern North Atlantic and Mediterranean appear to fluctuate independently. The occurrence of spawning adults and larvae at the same time of year in very widely separated areas also suggests separate stocks. Although not definitive, the evidence to date supports the two stock hypothesis in the North Atlantic.

8.1.5 Abundance, Historical Fluctuations, and Present Condition

Appendix A contains the historical (1960-1976) U.S. swordfish catch and effort data by Council area. The swordfish catch by distance caught off U.S. shores is shown in Table 8-2. During 1976 (the most recent data) 68.6 percent of the catch originated in the FCZ, 30.9 percent from international waters and only 0.5 percent from State territorial seas.

During the first few years of longlining, total U.S. and Canadian catches increased dramatically (Figure 8-5). Combined landings reached a high of over 8,000 metric tons (MT) (17.6 million lb) round weight in 1963 and then dropped off and stabilized at between 4,500 and 5,000 MT (9.9 and 11.0 million lb) round weight on an annual basis up until 1970 (Caddy, 1976). The Canadian fishery accounted for 80 to 95 percent of the total catch during this period.

Catches by the Canadian fleet after 1962 included many more small fish (Beckett, 1971). This trend toward the landing of smaller fish continued until the Canadian fishery closed in 1971 and is illustrated by a comparison of the size distribution of Canadian landed fish in 1963 and in 1970, as shown in Figure 8-6. The average dressed weight of fish landed each year prior to 1963 was approximately 90.7 kg (200 lb); in 1970, it was approximately 45.4 kg (100 lb) (Beckett, 1971). This change in size composition of the catch has been partially attributed by Beckett (1971) and Caddy (1976) to a change to longline gear (harpoon gear is selective for

Table 8-2. Swordfish catch by distance caught off U.S. shores. (Source: Fish. Stat. of the U.S., 1960-76.)

	Distance Caught off U. S. Shores				International Waters (Includes Catch off Foreign Coasts)		TOTAL	
	0 - 3 miles		3 - 200 miles					
	'000 lb	'000 $	'000 lb	'000 $	'000 lb	'000 $	'000 lb	'000 $
1960	-	-	-	-	-	-	-	-
1961	400				(1)			
1962	900				(1)			
1963	2,000				300			
1964	1,400				100			
1965	732				56			
1966	817				38			
1967	0				0			
1968	373				16			
1969	0				0			
1970	0				0			
1971	0				0			
1972	0				0			
1973	0				0			
1974 (2)	-	-	-	-	-	-	-	-
1975	174	279	3,588	5,043	1,697	1,909	5,459	7,231
1976	20	48	2,974	4,452	1,341	1,809	4,335	6,309

(1) Less than 50

(2) First year landings were divided as indicated in heading. For years 1960-1973 the headings were "Waters off U.S. Coasts" and "High Seas off Foreign Coasts"; values were not recorded prior to 1974.

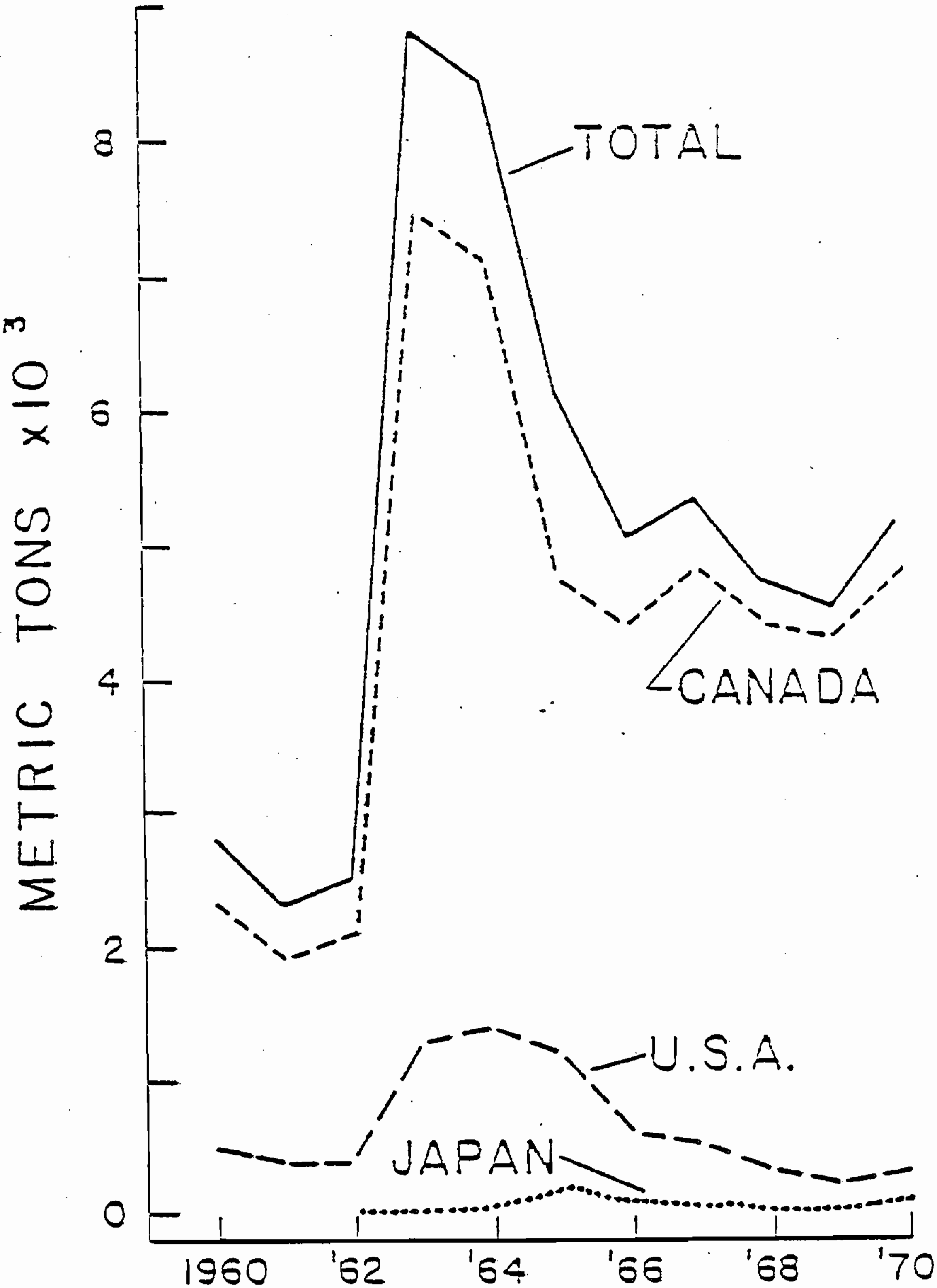


Figure 8-5. Annual landings of swordfish in the western North Atlantic by Canada, the U.S. and Japan north of 25°N and West of 50°W. (Source: Caddy, 1976). (Note: Catches from the western and eastern North Atlantic for the years 1970-1979 are shown in Tables 8-28 and 8-29.)

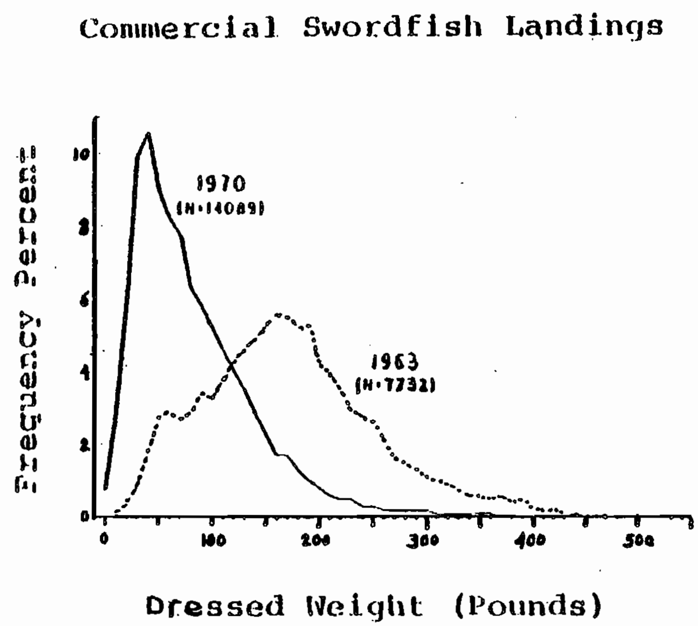


Figure 8-6. Size distribution of swordfish landed in Canada in 1963 and 1970. (Source: Beckett, 1974).

large, female fish), as well as to the expansion of the fishing grounds into warmer waters where more small fish are taken, and to the extension of the season.

Caddy (1976) has reported that, from 1962 to 1970, harpoon landings in the Canadian fishery decreased in response to a decrease in effort. Longline landings, however, rose to 5,218 MT (11.5 million lb) dressed weight (6,888 MT or 15.2 million lb round weight) in 1964, at an effort level of somewhat less than 6 million hooks, and then fell to a fairly constant level of around 3,500 MT (7.7 million lb) dressed weight (4,600 MT or 10.1 million lb round weight), although fishing effort had increased to between 6 million and 7 million hooks (Caddy, 1976). The data from Caddy (1976), shown in Table 8-3, demonstrate that catch per unit effort expressed in terms of metric tons per thousand hooks decreased between 1962 and 1970. Data on the Canadian swordfish longline fishery, reported by Beckett (1971) and presented in Table 8-4, showed that catch-per-unit effort expressed as number of fish caught per 100 hooks decreased slightly from 1964 to 1969, and average fish weight decreased. Caddy (1976) notes that Canadian longline landings were maintained at a level of around 4,500 MT (9.9 million lb) round weight annually from 1965 to 1970 only by increased fishing effort and continual expansion into new fishing areas.

In 1970, the size of the Canadian longline fleet was estimated at 58 to 67 vessels, with an annual effort of 6 million to 7 million hooks (Caddy, 1976). In 1971, however, the commercial Canadian swordfish fishery collapsed as a result of mercury restrictions (Beckett, 1971). In 1979, Canada reopened its swordfish fishery with a quota of 3,000 MT (6.6 million lb).

A Japanese pelagic longline fishery targeting tuna has existed in the Atlantic since 1956 (Fox, 1971). During the period from 1966 to 1971, Japan reported annual landings of swordfish (as an incidental catch) from this fishery of around 1,800 MT (4.0 million lb) (ICCAT). In contrast to the Canadian and U.S. longline fishery, which were mostly night fisheries, the Japanese fishery was predominantly a daytime longline fishery, with lines being set before dawn and taken in after dark.

Table 8-3. Catch and effort statistics for the Canadian harpoon and longline fisheries, 1950-1970. (Source: Caddy, 1976)

Year	Landings Dressed Weight (Metric Tons) Harp.	LL	Total	Effort: Days Fished Harp.	Days Fished LL	Estimated Effort Thousand Hooks LL	Catch-per-unit effort (metric tons): Catch Per Days Fished Harp.	Catch Per Days Fished LL	Catch Per Thousand Hooks LL
1950	978	-	978	3,195	-	-	0.31	-	-
1951	1,154	-	1,154	3,773	-	-	0.31	-	-
1952	1,432	-	1,432	4,614	-	-	0.31	-	-
1953	1,508	-	1,508	5,186	-	-	0.29	-	-
1954	1,952	-	1,952	6,122	-	-	0.32	-	-
1955	2,062	-	2,062	4,841	-	-	0.43	-	-
1956	2,092	-	2,092	4,760	-	-	0.44	-	-
1957	2,350	-	2,350	5,345	-	-	0.44	-	-
1958	2,439	-	2,439	7,112	-	-	0.34	-	-
1959	3,040	-	3,040	6,204	-	-	0.49	-	-
1960	1,764	-	1,764	5,260	-	-	0.34	-	-
1961	1,450	-	1,450	4,756	-	-	0.30	-	-
1962	1,349	236	1,585	4,424	325	114	0.30	0.73	2.07
1963	606	5,062	5,668	1,260	3,807	2,323	0.48	1.33	2.18
1964	160	5,218	5,378	572	6,653	5,786	0.28	0.78	0.90
1965	393	3,148	3,541	945	4,707	5,335	0.42	0.67	0.59
1966	532	2,826	3,358	1,249	4,325	4,740	0.43	0.65	0.60
1967	197	3,435	3,632	700	4,102	4,930	0.28	0.84	0.70
1968	39	3,289	3,328	186	5,261	6,735	0.21	0.63	0.49
1969	82	3,143	3,225	225	4,971	6,769	0.36	0.63	0.46
1970	83	3,553	3,636	218	4,263	6,216	0.38	0.83	0.57

Note: Harp. = harpoon
LL = Longline

Table 8-4. Average fish size and catch-per-unit effort for the Canadian swordfish longline fishery 1963-1969. (Source: Beckett,1971.)

Year	Log Coverage[a] %	Number of Fish[a]	Hooks[a] (thousands)	Catch per 100 Hooks	Average Weight
1963	41	74,911	2,117	2.88	168.1
1964	39	79,604	5,225	1.36	148.9
1965	58	54,882	4,746	0.98	142.24
1966	57	54,323	4,646	1.00	136.3
1967	57	70,245	4,770	1.36	114.0
1968	58	70,588	6,739	1.03	104.0
1969	58	71,350	6,735	1.03	99.9

a. Estimated on ratio of landings covered by log books to total landings.

8.1.5.1 Swordfish Fishery Under Mercury Restrictions of 0.5 PPM (1971-1978)

In 1971, the swordfish fishery suffered a severe setback when the FDA issued interim guidelines limiting the permissible amount of mercury in swordfish to 0.5 ppm. The FDA guideline of 0.5 ppm was based on the following assumptions:

1. Daily mercury intake of 300 mcg/day is the threshold level at which clinical effects are observed in humans
2. 10 fold safety factor sets the threshold at 30 mcg/day
3. All mercury consumed is through seafood
4. All mercury consumed is methyl mercury
5. Average consumption of seafood is 60 g/day

Therefore, mercury consumption in all seafood cannot exceed 0.5 ppm to ensure mercury consumption is not above 30 mcg/day.

Few swordfish pass the 0.5 ppm criteria. Based on a regression of mercury concentration by size fish (381 Canadian samples from the Consumer Risk Simulation Model, NOAA, NMFS-SEFC-18) the following are predicted mercury concentrations by size fish:

AVERAGE SIZE (POUNDS WHOLE WEIGHT)	MERCURY CONCENTRATION (PPM)
66.65	0.6676
133.30	1.0190
199.95	1.3049
266.00	1.5552
333.25	1.7819
399.90	1.9916
466.55	2.1882

Some U.S. fishermen continued to fish for swordfish during the 0.5 ppm mercury restrictions. The clandestine operation of this fishery was fostered by the fishermen's fear that they would suffer economic loss if their catches were impounded by the FDA for sampling and testing. Commercial catch statistics after 1970 are inaccurate since landings went unreported for the most part. Because of the secrecy surrounding the fishery during this time, there is very little known about the extent of U.S. involvement and actual amounts of catches.

Caddy (1976) reported that there is some evidence from Canadian research cruises conducted in 1975 that average fish size and CPUE have increased in Northwestern Atlantic waters since 1970. He attributed this finding to diminished Canadian fishing effort in that area. A comparison of CPUE and dressed weight of swordfish landed in 1970 and 1975, from Caddy (1976), is given in Table 8-5.

In 1976 Cuban Americans began a localized longline fishery for swordfish off the coast of Florida. This was primarily a small boat, one-night trip type of operation. In a report of the Swordfish Workshop held in Miami in 1977 and summarized by Beardsley (1977), fleet size of the Cuban American fishery was estimated at about 35 boats concentrated mainly between Miami and Key West. Techniques used by the Cuban Americans were adopted by Florida fishermen, with the result that a local fishery for swordfish began to spring up in this area. By 1978, at least 100 vessels were estimated by Florida officials to be involved in the local fishery. Following reports of successful fishing by Miami fishermen, swordfishing activity began along the western Florida coast.* A very rapid increase occurred between 1978 and 1980. The principal fishing ports were Madeira Beach, Ft. Myers, and Panama City. In 1979, shrimp vessels along the Texas coast began entering the swordfish fishery. Most of these vessels have since returned to shrimp fishing. The number of swordfish vessels based in Gulf ports as of 1981 is unknown, but is believed to be between 50 and 100. Most of these are based along the central western coast of Florida.

With the expansion of the fishery to new geographic areas, landings from the South Atlantic region have assumed increasing importance. The percentage of landings by region before 1976 and in 1978 are shown in Figure 8-7.

*Information on the Gulf fishery is provided by C. Davis (Fishery Biologist, Gulf of Mexico Fishery Management Council; pers. comm.).

Table 8-5. Comparison of catch-per-unit of effort and dressed weight of Canadian swordfish landed in 1970 and 1975. (Source: Caddy 1976.)

	Catch/100 Hooks				Average Weight (lbs)			
Unit Area	1970	No. of Fish	1975	No. of Fish	1970	No. of Fish	1975	No. of Fish
4165	-	-	1.35	16	-	-	100.7	16
4166	-	-	1.61	56	-	-	90.1	50
4261	-	-	1.50	9	-	-	100.9	9
4262	0.83	140	2.55	68	88.5	140	111.0	43
4263	0.95	23	1.27	57	98.1	23	88.1	13
4264	1.12	300	0.47	3	82.9	300	-	-
4265	1.06	92	3.33	163	92.6	92	107.0	161
4361	0.69	29	1.25	53	114.8	29	155.3	25
Totals and weighted averages	1.01	584	2.31	425	87.9	584	107.4	317

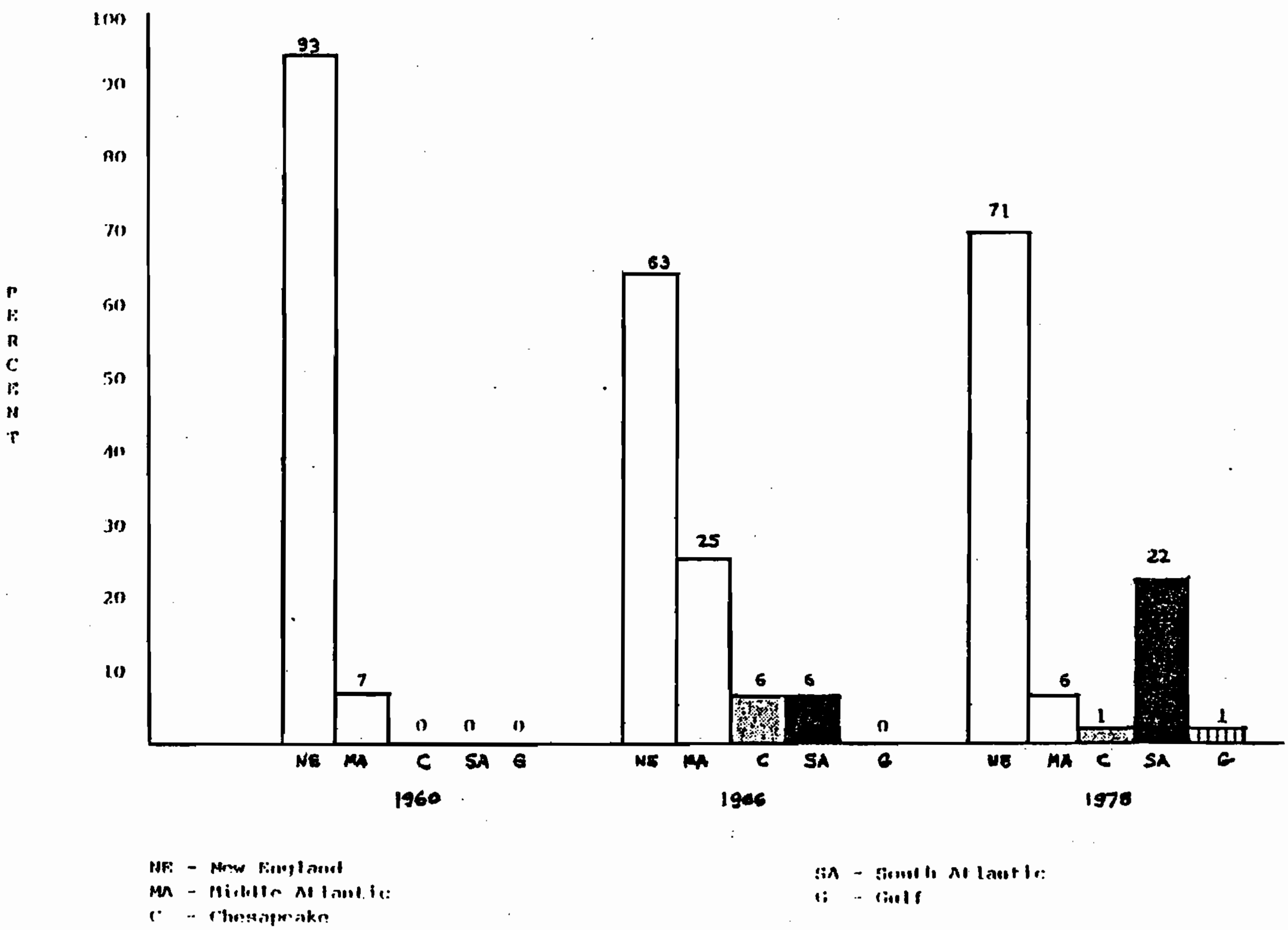


Figure 8-7. Percentage of landings by region, 1960, 1966 and 1978 (Booz et al., 1980).

8.1.5.2 Swordfish Fishery After 1978 (Mercury Restriction of 1.0 PPM)

The FDA 0.5 ppm action level was challenged in 1978 (Anderson Seafood vs. Joseph Califano, Secretary, HEW). Partially based on a more detailed analysis of seafood consumption patterns developed by NMFS (Model for the estimation of the consumption of contaminants from aquatic foods, MFCCA model) the action level was raised to 1.0 ppm. The most recent version of this technique is the Consumer Risk Simulation Model (NOAA Technical Memorandum NMFS-SEFC-18). It is likely that this form of consumer risk modelling will be the technical basis for future court challenges to increase or decrease the FDA action level. (See: Officer and Ryther 1981; Cordle, 1981, for recent discussions on mercury in swordfish.)

Recent data from southern Florida (Berkeley and Houde, 1980) provide a comparison among kinds of swordfishermen and show some trends in the fishery (Table 8-6). Initially recreational tournament fishermen had the highest catch per 100 hooks (10.86) but by 1980 their catch rate (3.14) had fallen below that of Florida longlines (3.38). The lowest mean catch per 100 hooks (1.10) was for the New England longlines.

The mean weight (dressed) of landed swordfish (Table 8-6) ranged from 39.6 to 40.9 kg (87.2 - 90.2 lb) since 1978 for Florida longlines. Initially, recreationally caught fish weighed more but recent catches seem to be similar in weight to the longline catches (Berkeley and Houde, 1980).

The longline fishery for swordfish in the Northwest Atlantic has grown rapidly in recent years. Despite this considerable increase in effort, mean size and size composition of the catch from the Straits of Florida have remained constant. Dressed weight-frequency distributions for 1979 and 1980 are almost identical (Figure 8-2, p. 8-8). The ratio of increase in catches between 1980 and 1979 was 1.44. Mean weights were 44.2 kg (97.4 lb) in 1979 (N = 7985) and 44.1 kg (97.2 lb) in 1980 (N = 14,837). Total reported landings increased from 632.3 mt in 1979 to 910.9 mt in 1980, an increase of 44 percent. Although these figures are known to considerably underestimate actual landings, they may be a valid indication of relative change.

Catch-per-unit effort was calculated by month for 1979 and 1980 (Tables 8-7). CPUE is expressed both as numbers and dressed weight per 100 hooks. Mean CPUE was calculated as the average of ratios CPUE

Table 8-6. Catch and effort of three kinds of swordfish fishermen in southeast Florida. (Source: Berkeley and Houde, 1980)

Boat Type	Dates	Number of Sets	Mean Number of Hooks per Set	Mean Number of Fish per Set	Mean Weight of Fish per Set (dressed) (lbs)**	Mean Weight of Fish (dressed) lbs)**	Mean Catch per 100 Hooks
New England	Jan-Jul 1975-78	141	571	6.28	414.0	73.0	1.10
Florida	Mar-Apr 1978	11	320	6.64	578.7	87.2	2.07
Florida	Feb-Dec 1979	920	219	6.80	675.6	90.2	3.10
Florida	Jan-Mar 1980	109	209	7.05	719.4	87.6	3.38
Recreational	Apr-Sep 1977-78	626*	3.5	0.38	-	127.3	10.86
Recreational	Jun-Jul 1979	121*	3.5	0.14	-	83.0	4.01
Recreational	Jun 1980	73*	3.5	0.11	-	115.0	3.14

* Represents boat-trips.
** Dressed weight = whole weight x 0.75.

Table 8-7. Mean catch per 100 hooks and mean weight by month for swordfish caught in the south Florida longline fishery, 1979 and 1980.

Year/Month	Number of boat trips sampled	Number of fish per 100 hooks	Dressed Weight of fish per 100 hooks* (kg)	Mean Dressed weight* (kg)
1979				
February	11	2.92	116.2	40.2
March	41	3.88	147.6	39.5
April	55	4.98	209.8	42.1
May	112	4.19	219.6	52.7
June	109	4.52	236.0	51.5
July	81	3.95	183.3	44.8
August	90	4.20	166.2	39.0
September	35	3.35	131.8	40.7
October	74	4.35	157.1	35.5
November	46	4.63	204.5	40.1
December	44	4.50	191.4	41.9
Mean 1979	699	4.26	190.5	44.2
1980				
January	49	2.52	104.2	36.1
February	55	2.93	138.2	43.3
March	71	3.05	141.4	49.4
April	62	3.55	158.2	47.2
May	83	3.47	170.4	48.6
June	104	3.37	182.6	49.1
July	49	2.95	147.0	47.1
August	62	2.79	121.7	41.8
September	41	2.40	87.5	37.2
October	32	2.46	87.6	35.8
November	13	2.80	108.6	37.4
December	13	2.52	106.7	38.8
Mean 1980	634	3.03	141.4	44.1

*Dressed weight = whole weight x 0.75

statistic (Rothschild and Yong, 1970). CPUE declined in 1980 in all months except February, April, October and November. The yearly mean catch in numbers per 100 hooks in 1980 was 28.9 percent less than in 1979. The decline by weight was 25.8 percent. Assuming the increase in reported landings is proportional to the increase in actual landings then effort in 1980 increased approximately 94 percent over 1979.

The presence of swordfish in the Caribbean Fishery Management Council area has been known from the Japanese longline incidental catch and the occasional landing of swordfish in the recreational rod and reel fishery and in the commercial fishery. However, the landing of swordfish is such a rare event that they are grouped in the "other fish" category. Weiler and Suarez-Caabro (1980) present an overview of Puerto Rico's small-scale fisheries statistics 1972-1978 and do not report any swordfish landings.

In 1980, the Department of Marine Sciences of the University of Puerto Rico conducted an exploratory swordfish project supported by Sea Grant, Dr. Douglas Y. Shapiro, Project Leader.* A converted Thompson trawler was outfitted with 3.2 km (2 mi) of longline and fished near the edge of the shelf 3.2-4.8 km (2-3 mi) offshore in a depth of 27.4-54.9 m (90-180 ft). A total of 18 trips was made between April 21, 1980 and January 17, 1981 with 1,096 hooks fished. An average of 59 hooks was fished per trip and the CPUE was 0.0055 fish per hook. A total of 6 swordfish was caught, with a mean weight of 30.75 kg (67.8 lb) and an average overall length of 2.2 m (7.22 ft).

Since this exploratory work, two local fishing boats made several trips with longline gear and caught four or five swordfish (exact weights and measurements are not available but one was much larger than those caught in the exploratory fishing.)

In addition, Capt. Luis Mendoza is presently attempting to develop a fishery for swordfish in the Mayaguez area. Fishing from a 45 foot steel

*The information on the exploratory fishing was originally provided by Dr. Shapiro to Mr. Miguel A. Rolon, the Puerto Rican Government representative to the CFMC. Mr. Rolon, in turn, supplied the information to the CFMC and the Council, in a letter from Mr. Omar Munoz-Roure dated April 2, 1981, kindly authorized that it be made available for use in this profile document.

vessel, equipped with a hydraulic longline reel he has experimented with a line similar to the Japanese tuna longline. Cyalume lights are too expensive and there is a problem with fish breaking the lines. However, the major problem is lack of a market; the local price is only $.80 per lb, much below the mainland price.

According to Dr. Shapiro, "Swordfish are in Puerto Rican waters in sufficient numbers to make additional efforts to discover the best fishing sites, depths, and type of gear warranted. I feel that the low yield for our efforts was due to not knowing precisely where and how best to fish. The fact that several local fishing boats have obtained longline gear and have begun their own exploratory trips is a good indication that this exploratory swordfish project was successful at demonstrating the existence of swordfish in local waters and that they can be caught."

8.1.5.3 Drift Gill Net Fishery

Recently a new gear has been introduced in the Northwest Atlantic swordfish fishery. Drift gill net gear presently in use is patterned after the thresher shark gill net fishery in California. The following accounts are condensed from conversations with Ron Tegland (owner of two boats fishing in the northwest Atlantic), Jim Squires (NMFS, California; billfish and swordfish research) and Dennis Bedford (California Fish and Game; Project Leader, Drift Gill Net Study).

Two boats, 21.3 m (70 ft) in length fished drift gill net gear for swordfish during 1980. The net was 47.5 cm (18 in) stretch mesh, 23.8 m (78 ft) deep, 0.81 to 1.01 km (1/2 to 5/8 mi) in length and fished on a longline/net combo drum. The net was fished approximately 5.5 m (18 ft) below the surface and remained attached to the boat at one end. Radar reflectors allowed the crew to monitor the net and if the current started to tangle the gear, one end was let go and the other end pulled tight to prevent entanglement. One net broke free and monitoring on the radar showed that within one hour the net had become an entangled ball of net, rendering it unable to fish.

The net is set at dusk and pulled at approximately 1:00 a.m. The time required to haul the gear varies from 30 minutes, if empty, to 1-1/2 to 2 hours if fish are present. No chemical lights are used in conjunction with the nets. These vessels harpoon during the day and gill net at night.

Twenty sets were made during 1980 in the vicinity of Georges Bank and the only billfish caught were swordfish. It is important to note that other billfish are scarce in this area. The average catch was 2.5 swordfish per set with a mean weight of 129.7 kg (286 lb). In comparison, the mean weight of swordfish harpooned during the day was 117.0 kg (258 lb). The incidental catch in this drift gill net did not include any billfish other than swordfish and did not include any small fish. A pilot whale became caught in the net but was quickly released.

The following discussion of the west coast drift gill net fishery is taken from the Draft Fishery Management Plan for Pacific Coast Billfish and Oceanic Shark Fisheries (Pacific Fishery Management Council; September, 1981).

> A number of gill net fisheries (e.g., gill net, trammel net; inshore, offshore; drift, set) operate off southern California. Of these, the offshore drift gill net fishery is directed at oceanic sharks and swordfish.
>
> Mako shark is caught from Monterey to San Diego generally less than ten miles from shore. Common thresher is caught from Monterey to San Diego. The few blue shark marketed are caught in southern California waters. There is no high seas fishery for oceanic sharks off the coast of California, yet from limited exploratory fishing a high catch rate can be obtained for blue sharks. The drift gill net fishery for thesher shark is expanding. Larger mesh nets are increasingly used to reduce the take of less valuable blue sharks.
>
> Historically, both gill net fisheries have taken incidental catches of swordfish. During 1977 and 1978, it was found that drift gill nets set primarily for thresher shark would take swordfish. Fishing operations were modified where possible to take, along with the thresher, mako, and blue shark, the relatively more valuable swordfish. The fisheries occasionally take incidental numbers of a variety of fishes and some marine mammals.
>
> The gill net fishery landed 1,261 swordfish (150 mt) in 1979, an estimated 30-40 percent of total California landings of this species.
>
> Fishing log data for six drift gill net vessels operating 468 nights in 1979 suggest that the catch of swordfish in this fishery is incidental (approximately 7 percent of the catch of all species) (Table 8-8). There is an even smaller incidental catch of striped marlin.

Table 8-8. Composition of the annual catch of six drift gill net vessels in California in 1979.

Species	Catch		Percent by	
	Numbers	Weight (lbs)	Numbers	Weight* (lbs)
Blue Shark	4,507	202,815	42.0	18.0
Thresher shark	4,556	820,000	43.0	73.0
Mako shark	920	16,560	9.0	1.0
Soupfin shark	176	3,520	2.0	0.3
Swordfish	413	82,500	4.0	7.0
Striped Marlin	18	2,556	0.2	0.2

*Catch (weight) = catch (numbers) x average weight

Observer data through August 1981, tend to confirm the incidental nature of billfish in annual catches of this fishery (Table 8-9).

In 1979, the California Fish and Game Commission authorized the sale of swordfish taken incidentally in the drift gill net fishery. In 1980, legislation authorized the use of gill nets to take sharks and swordfish. The legislation specified entry criteria, mesh size and catch limits. To qualify for a drift gill net permit an applicant must provide evidence (landing receipt) of prior participation in the fishery (1978 or 1979) or provide evidence of serious intent to engage in the fishery (significant investment prior to May 20, 1980). The gill net catch of swordfish is limited to 25 percent of the catch by the harpoon fishery; the catch of striped marlin to 10 percent of that by the recreation rod and reel fishery.

In 1979, an estimated 20-40 drift gill net vessels fished for shark and swordfish. In 1980, 165 boats were licensed for the fishery and 105 boats reported actually fishing. Of the 165 boats having licenses, 94 were registered as dual gear, harpoon and drift gill net.

Several features make the drift gill net an attractive gear to catch swordfish. The gear is set at dusk and retrieved at dawn and is physically non-conflicting with commercial harpoon and recreational rod and reel fisheries. Gill net gear is fuel efficient gear. Fishermen report that the night gill net operation requires about 70 percent less fuel than the day harpoon operation. If both night gill net and day harpoon are fished, the fuel saving approximates 50 percent compared to day harpoon fishing only. Finally, comparison of catches by harpoon and drift gill net gear in 1979 and 1981 indicate that the gear may be more efficient at producing swordfish than is the harpoon fishery, especially during seasons of poor surface availability.

Additional evidence of the efficiency of gill net gear is provided by its extensive use in the Western Pacific to catch swordfish, striped marlin and several species of tuna. Since 1972, drift gill net gear has been rapidly replacing harpoon gear in the Japanese billfish fisheries.

Table 8-9. Observed composition of the catches of 12 drift gill net vessels during 88 nights (1981 season through August). (Source: PFMC, 1981)

Species	Catch (Numbers)	Percent (Numbers)
Blue Shark	281	21.0
Thresher shark	580	43.0
Mako shark	278	21.0
Soupfin shark	14	1.0
Swordfish	5	.3
Striped marlin	0	-
Sea lions	43	3.0
Other (17)	147	10.7

In California, the Legislature can delegate authority to manage specific fisheries to the Commission and this was the case with swordfish. When drift gill nets were initially introduced in California the Commission prohibited their use; however, in September 1980 the Legislature reviewed the situation and lifted the restriction on landing swordfish caught by drift gill nets with two restrictions: the swordfish landed from drift gill nets cannot exceed 25 percent of the cumulative catch of harpoon caught swordfish and the incidental catch of striped marlin cannot exceed 10 percent of the striped marlin caught by the recreational rod and reel fishery.

The drift gill net fishery in California targets thresher sharks and has a very valuable incidental catch of swordfish. Other species caught include blue sharks, makos and a very few striped marlin. Nets are 20.3-40.6 cm (8-16 in) and more recently up to 50.8 cm (20 in) stretch mesh, 1.61 km (1 mi) in length, and 20.1 m (66 ft) deep. They are fished 2.7-3.7 m (9-12 ft) below the surface and flotation is maintained with approximately 100 buoys. The boats involved harpoon during the day and drift gill net from dusk to dawn. Prior to September 15, 1980, the harpoon permit was free and there were 979 permits. After September 15, the cost of a permit was $150, which reduced the number of permits to 408. Of the 408 harpoon permits, 94 were issued to boats with gill net permits. The total number of gill net permits is 165, which includes the 94 dual (harpoon/gill net) boats. Approximately 15 percent of the boats land 90 percent of the catch; the remainder have permits for tax and recreational fishing benefits.

West coast workers conclude that the drift gill net gear is no more efficient than harpoon gear but that the gill net gear extends the fishing season for approximately 2 months longer than the harpoon season because while fish are not "finning" at the surface they are in the area. The gill net gear also increases the effective fishing season of a boat by allowing it to fish at night. Fish caught average 90.7 kg (200 lb) and sell for approximately $3 per pound. While the numbers of fish caught by the drift gill net gear are not large, the value is very important, making up, in many cases, 50 percent of a vessel's gross income.

The California Fish and Game has a program with 12 observers in an attempt to study the drift gill net gear. Based on 76 observer days, only 1 marlin was observed as an incidental catch. Observers report that fish are both gilled and tangled in the nets.

West Coast researchers indicated that there was no danger to the billfish stocks (including swordfish) from the drift gill net gear; the situation is viewed as purely competition between different gear user groups with no biological basis for concern.

8.1.5.4 Recreational Catch and Effort

Results of recreational angling effort, 1977-1980, in the Florida Straits is summarized in Table 8-10. There has been a rather steady decline in the number of fish caught per boat per night from 0.44 in June 1977 to 0.11 in June 1980. Members of the Stuart Sailfish Club fished 11 boat nights during 1981 and caught 4 swordfish (0.36 per boat) with an average weight of 56.02 kg (123.5 lb) (B. Pelosi, South Atlantic Council Advisory Panel Chairman; pers. comm.).

8.1.5.5 Commercial Catch and Effort

Summarized data from the logs of a New England longliner from sets made in the Gulf of Mexico, Florida Straits, and New England area are included as Appendix B. The mean weight (pounds dressed weight) and percent in each size category for the years 1974-78 in the GMFMC, SAFMC and NEFMC areas are given in Table 8-11. It can be seen that the mean weight is lowest in the Gulf of Mexico (28.12 kg; 62.0 lb), increases to between 31.53 and 33.11 kg (69.5 - 73.0 lb) in the Mid and South Atlantic, and is highest in New England (39.46 kg; 87.0 lb) and the Florida Straits (40.37 kg; 89.0 lb). CPUE and weight by area were also calculated from the data in Appendix B (Table 8-12). CPUE (mean catch per 100 hooks) decreased from 1.73 in 1974 to 1.13 in 1976, then increased to 1.98 in 1978. The most recent data available are from Florida (Berkeley and Houde, 1980) and indicate a catch rate of 3.39 in 1979 and 3.55 for the first three months of 1980.

The seasonal peak in effort by southeast Florida longliners occurs in spring-summer (Table 8-13). The highest catch rates were observed during April and October through December 1979, and February and March 1980. Larger fish were caught during May through July 1979, when a greater

Table 8-10. Results of recreational angling for swordfish, 1977-1980, in the Florida Straits. (Source: Berkeley, 1979; Berkeley and Houde, 1980)

Source	Date	Number of Fish	Boat Nights	Number of Fish/Boat/Night	Total Weight (lbs)	Mean Whole Weight (lbs)
Miami Tournament	June 1977	60	135	0.44	11,268.0	187.8
Stuart Sailfish Club	Apr-Sep 1977	74	164	0.45	7,207.5*	171.6
Duck Key Tournament	May 1978	8	15	0.53	1,123.0	140.4
Ft. Lauderdale Tournament	June 1978	30	64	0.47	4,765.0	158.8
Miami Tournament	June 1978	48	172	0.28	7,243.0	150.9
Stuart Sailfish** Club	Apri-Sep 1978	21	78	0.27	4,849.5	230.9
Duck Key Tournament	May 1979	1	12	0.08	294.0	294.0
Ft. Lauderdale Tournament	June 1979	4	33	0.12	405.0	101.3
Miami Tournament	July 1979	13	88	0.15	1,476.0	113.6
Ft. Lauderdale Tournament	June 1980	8	73	0.11	1,227.0	153.4
TOTALS		267	834	0.32	39,858	169.6

*Only 42 fish weighed.
**Records from Stuart Sailfish Club

Table 8-11. Mean weight (pounds dressed weight) and percent in each size category for the years 1974-1978 in the Gulf of Mexico, Florida Straits and New England areas. (From Appendix B.)

AREA	MEAN WEIGHT	PERCENT IN EACH SIZE CATEGORY* %LG	%MED	%SM	%VSM
G.Mex	62.0	19.4	32.1	24.7	23.8
Fla.EastCoast	73.0	23.1	37.9	28.6	10.4
M-A	69.5	17.5	34.9	37.0	10.5
NorthEast	87.0	31.4	42.6	19.6	6.5

* LG over 100 lb. dressed weight
MED 50-99 lb dressed weight
SM 25-49 lb dressed weight
VSM under 25 lb dressed weight

Table 8-12. Catch-per-unit effort (CPUE) and weight by area for the years 1974-1978 in the Gulf of Mexico, Florida Straits and New England areas. (From Appendix B)

		CPUE				WEIGHT					
AREA	YEAR	$\bar{X}$	S_x	$S_{\bar{x}}$	n	$\bar{X}$	n	%LG	%MED	%SM	%VSM
Gulf of Mexico	1974	.0237	.0002	.0140	4	59.1	381	18.1	31.2	24.2	26.5
	1975	.0082	.0000	.0030	4	64.2	141	19.2	31.2	27.0	22.7
	1976	.0058	.0000	.0006	2	78.1	47	21.3	55.3	19.2	4.3
	1977	.0078	.0000	.0050	2	59.9	53	20.8	22.6	30.2	26.4
	1978	.0074	-	-	1	82.0	22	36.4	27.3	18.2	18.2
Fla.EastCoast	1974	-			0		-				
	1975	.0188	.0000	.0033	2	67.2	152	17.8	44.1	25.7	10.5
	1976	.0099	.0000	.0047	5	55.5	283	11.3	38.9	28.3	12.7
	1977	.0111	.0000	.0028	8	74.0	369	29.0	29.0	26.0	7.6
	1978	.0071	.0000	.0030	4	63.4	81	23.5	23.5	17.3	3.7
Mid-Atlantic	1974	.0029	-	-	1	-	8	-	-	-	-
	1975	.0163	.0002	.0149	2	50.5	94	6.4	30.9	35.1	21.3
	1976	.0135	.0002	.0124	3	59.3	131	15.3	22.1	39.7	12.2
	1977	.0492	.0004	.0187	5	69.1	378	18.0	36.0	36.0	8.7
	1978	.0140	.0001	.0103	2	88.7	78	26.9	44.9	28.2	0
Northeast	1974	.0182	.0001	.0068	10	81.1	53	81.1	18.9	0	0
	1975	.0157	.0001	.0107	8	87.6	371	33.2	40.7	17.5	8.6
	1976	.0139	.0001	.0095	7	73.5	332	23.2	36.2	34.6	6.0
	1977	.0271	.0002	.0149	2	70.8	150	14.7	61.3	20.7	3.3
	1978	.0345	.0006	.0238	9	91.3	570	34.7	44.7	13.7	6.8

Table 8-13. Catch-per-unit effort and mean weights by month for swordfish caught by south Florida longliners, 1979 and 1980. (Source: Berkeley and Houde, 1980).

Year and Month	Number of Boat Trips	Number of Fish per 100 Hooks	Dressed Weight of Fish per 100 Hooks (lbs)**	Mean Dressed Weight (lbs)**
1979				
February	11	2.69	245.6	90.1
March	40	3.77	313.6	86.9
April	55	4.75	436.1	92.5
May	148	3.08	358.3	116.0
June	181	2.70	309.6	113.3
July	132	2.35	240.4	98.5
August	131	2.89	247.4	85.5
September	36	3.04	262.3	89.5
October	76	3.95	313.8	78.2
November	54	4.08	390.6	87.5
December	56	3.97	372.8	92.7
1980				
January	48	2.69	260.5	80.0
February	52*	4.00	433.0	92.9
March	9	3.97	342.2	89.7

*Incomplete data.
**Dressed weight = whole weight x 0.75.

number of large females were caught (Berkeley and Houde, 1980). Preliminary aerial overflights estimated approximately 0.11 boats per nautical mile (based on 15 flights, each covering between 72 and 127 miles of coastline) (Berkeley, 1981).

In the Gulf, the principal fishing areas are around the mouth of the Mississippi river and west northwest of Key West, Florida (C. Davis, Fishery Biologist, GMFMC; pers. comm.). The best fishing occurs in late winter and early spring, a few months earlier than along the southeast coast.

8.1.5.6 Abundance and Present Condition

Beardsley (1977) reports that the general trend of the Japanese data "leads to the conclusion that the abundance of swordfish stocks in the entire Atlantic, in general, has not been significantly reduced and is still capable of supporting some increase in fishing effort." Trends in CPUE in the North Atlantic from Japanese tuna longline data from 1957 through 1976 are presented in Figure 8-8. CPUE in the North Atlantic during this time has fluctuated in the range of 2.0 to 7.0 fish per 10,000 hooks (0.02 to 0.07 fish per 100 hooks) with an overall upward trend. Any conclusions derived from the Japanese longline fishery "must be interpreted with considerable caution" (Wise and Davis, 1973), because Japanese longline efforts have been historically directed primarily toward tuna, with activities occurring for the most part during the daytime although setting and hauling of the line extends into nighttime hours. Yearly increases in CPUE may also reflect the increasing expansion of longline vessels into geographic regions in which swordfish have previously been unexploited.

Some evidence of stock reduction (marked decrease in average size and CPUE was reported for the Canadian longline fishery in the northwest Atlantic during the 1960's at an effort level of around six to seven million hooks (Beckett, 1975; Caddy, 1976). However, part of the decrease in size was attributed to the catch of swordfish in warmer offshore waters where small swordfish comprise a large proportion of the catch.

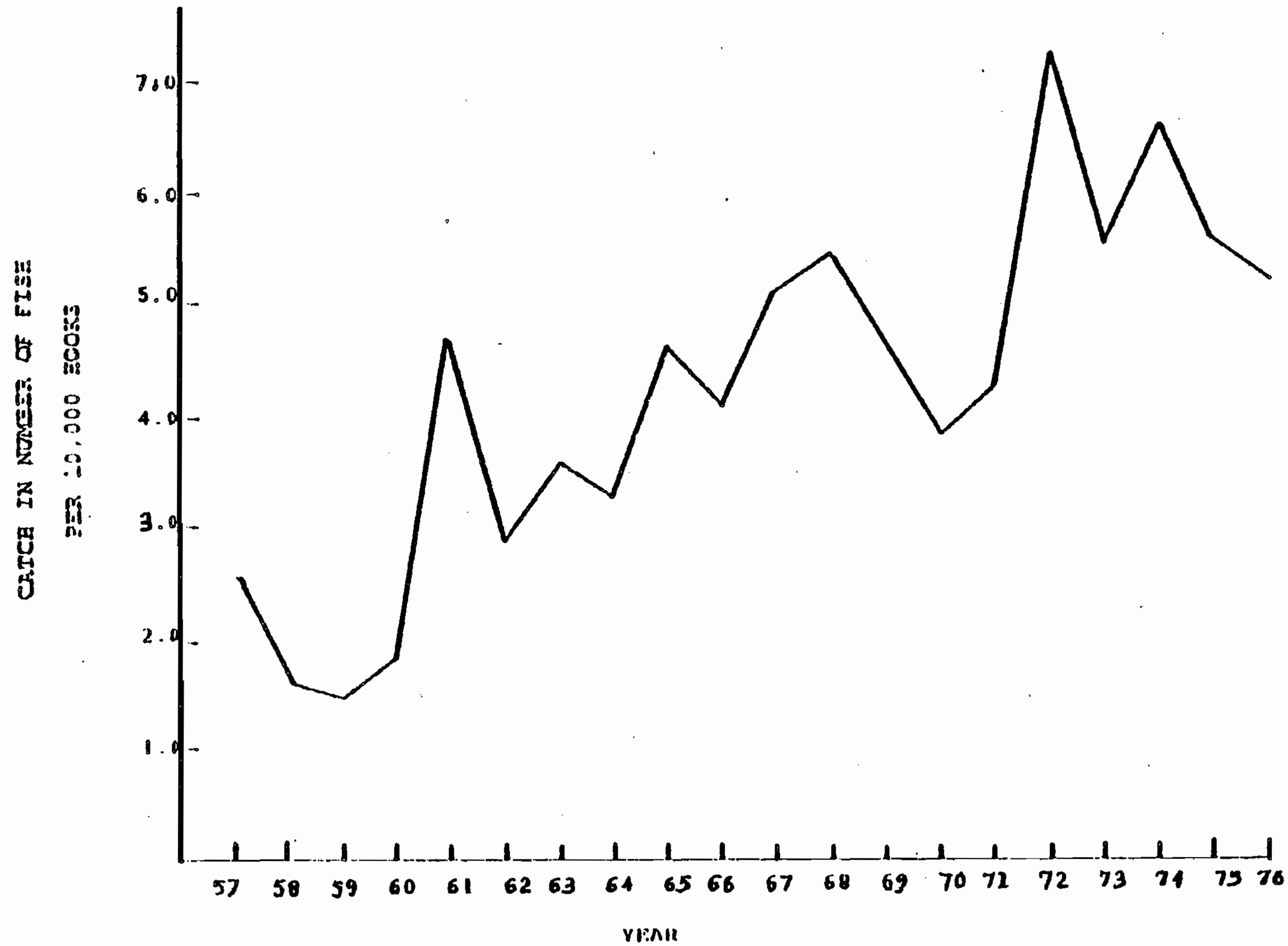


Figure 8-8. Catch-per-unit of effort in the North Atlantic Ocean 1957-1976. (Source: Japanese Longline Data.)

Historical landings and value data presented in Table 8-14 illustrate the fluctuations in swordfish landings over the period 1960-76. There were lower landings in 1961-62 and 1968-73, and higher landings in the years 1960, 1963-67 and 1974-76. A portion of the decrease in the 1968-73 time frame was due to poor reporting associated with the mercury restrictions. More recently reported landings have increased even further to a peak of 7.5 million lb in 1980 (Table 8-15).

Preliminary information from South Carolina (E. Joseph, Director, South Carolina Marine Resources Center, Charleston, S.C.; pers. comm.) documents a decreasing average size for swordfish landed in South Carolina: (1) 1978 mean dressed weight = 40.92 kg (90.2 lb); (2) 1979 mean dressed weight = 37.01 kg (81.6 lb); and (3) 1980 mean dressed weight = 33.75 kg (74.4 lb). Mean dressed weights from south Florida (Berkeley and Houde, 1980, 1981) during the same time period were as follows: (1) 1978 = 39.46 kg (87.0 lb); (2) 1979 = 44.2 kg (97.9 lb); and (3) 1980 = 44.1 kg (97.2 lb). The South Carolina data indicate a decline from 1978 to 1979 and 1980 and the Florida data indicate no significant change from 1979 to 1980. However, both data sets have a smooth distribution when weight is plotted against frequency. This indicates that the age structure contains significant numbers of older, mature fish and does not imply any recruitment problem to date.

8.1.6 <u>Probable Future Condition</u>

Yield-per-recruit (YPR) analysis (Berkeley and Houde, 1981) indicates that, for females, fishing effort is at the level that would maximize yield-per-recruit; however for males, present effort is well below the maximum level. Any additional increase in fishing effort would result in growth overfishing of the female portion of the stock. In addition, it is not known to what extent recruitment may be influenced by reducing spawning potential.

8.1.7 <u>Interdependence on Other Species</u>

8.1.7.1 <u>Incidental Species</u>

Sharks, tunas and other billfish species are caught incidentally in the domestic directed longline swordfish fishery. The problems associated with tunas and other billfish are discussed in Section 8.4.6. Sharks are presently

Table 8-14. Historical swordfish landings and value data by Council area (Source: Appendix A)

YEAR	NEFMC		MAFMC		SAFMC		GMFMC		TOTAL ALL AREAS	
	'000 lb	'000 $	'000 lb	'000 $	'000 lb	'000 $	'000 lb	'000 $	'000 lb	'000 $
1960	942	380	69	37	-	-	-	-	1,011	417
1961	829	320	72	34	-	-	-	-	901	354
1962	867	377	67	38	-	-	-	-	934	415
1963	2,331	577	423	186	1	1	-	-	2,755	764
1964	1,456	431	1,113	379	483	233	-	-	3,052	1,043
1965	788	305	1,391	580	524	283	-	-	2,703	1,168
1966	855	346	425	196	77	38	-	-	1,357	580
1967	641	250	404	159	-	-	-	-	1,045	409
1968	389	193	216	106	-	-	-	-	605	299
1969	336	163	40	18	-	-	2	1	378	182
1970	268	163	18	10	-	-	346	249	632	422
1971	73	71	4	2	-	-	1	(1)	78	73
1972	541	756	-	-	-	-	-	-	541	756
1973	873	1,249	7	10	-	-	14	14	894	1,273
1974	3,353	3,280	76	107	-	-	86	149	3,515	3,536
1975	4,294	5,315	149	262	-	-	149	256	4,592	5,833
1976	3,408	4,604	187	302	262	355	391	816	4,248	6,077

Table 8-15. Recent landings (round weight) and value data for the swordfish fishery. (Source: Preliminary Data - NMFS).

	NEW ENGLAND & MID-ATLANTIC FMC AREAS (ME,NH,MA,RI,CT,NY,NJ)		(DE,MD,VA)		SOUTH ATLANTIC FMC AREAS[2] NC		SC		FL.E.COAST		GULF OF MEXICO FMC AREAS[3] FL.W.COAST		TX[4]		TOTALS	
	lb	$	lb	$	lb	$	lb	$	lb	$	lb	$	lb	$	lb	$
1977	1,272,343	N/A[1]	6,018	9,663	120,000	210,000	0	0	113,000	172,000	2,321	2,308	0	0	1,513,682	2,442,443
1978	5,512,971	7,192,149	47,768	72,206	439,306	668,688	581,542	817,573	536,000	941,000	52,708	93,907	0	0	7,172,917	9,790,767
1979	4,683,412	7,256,837	N/A		170,436	253,585	822,711	1,009,341	1,391,000	2,893,000	318,000	579,000	60,000	N/A[5]	7,445,559	12,100,963
1980	2,751,524	4,918,704	N/A		316,576	455,243	845,097	1,154,746	2,004,000	3,004,000	630,000	1,624,000	966,000	N/A[6]	7,513,197	13,648,973

1. 1.61
2. GA landed 2,622 lb worth $5,244 in 1978.
3. AL, MS and LA reported no landings.
4. During 1979 landings were by out-of-state boats, landing in Galveston. The initial success stimulated the development of a fishery by state boats landing at Aransas Pass in 1980. All landings are shipped out-of-state and the price per lb follows Florida's price.
5. 1.82
6. 2.58

covered under the Preliminary Management Plan (PMP) of January 1978 for Sharks and Billfish. However, a PMP applies only to foreign fishermen and as such would not impose any restrictions on the domestic swordfish fishery. When a shark FMP is prepared, management measures could potentially impose restrictions on the swordfish industry.

Table B-4 in Appendix B shows the number and percent of total billfishes caught incidental to swordfish for the years 1974 to 1978 for one domestic longline vessel. Total billfish caught for this 5 year period were: sailfish -13, white marlin - 42, and blue marlin - 3. During the same period 3,837 swordfish were caught.

8.1.7.2 Marine Mammal/Endangered Species Interactions

Marine mammals and sea turtles are caught very infrequently in the longline fishery. Catches from observer data indicate that in the Japanese tuna longline fishery 12 turtles and no marine mammals were caught in 199 sets (451,902 hooks) during 1979 in the Gulf of Mexico (Table 8-16). The percent mortality ranged from 10-50 percent. During 1979, in the Atlantic in 295 sets (663,551 hooks) 17 turtles and 5 marine mammals were caught (Table 8-17). The percent mortality for turtles was 37.5 percent and for marine mammals it ranged from 0 percent for porpoise up to 50 percent for one of the two false killer whales.

The incidental turtle catch by Council area is given in Table 8-18. During 1979, the catch ranged from a high of 12 in the GMFMC area to 2 in the SAFMC area. There were no incidental catches reported for the NEFMC area. In 1980, catches varied from 9 in the MAFMC area to 1 in the SAFMC area.

The recent introduction of drift gill net gear into the NEFMC area may impact turtles and marine mammals. Section 8.1.5.3 discusses this fishery and Tables 8-8 and 8-9 contain information on the incidental catch in drift gill net gear.

8.1.8 Estimate of MSY

MSY cannot be estimated from a surplus production model because accurate catch and effort data are not available for the swordfish fishery. The Japanese CPUE data have some serious drawbacks: (1) the fishery targets tuna, not swordfish; (2) the tuna fishery is primarily a daytime fishery; and (3) tuna fishing strategy minimizes the incidental catch of billfish and swordfish.

Table 8-16. Observed catches of sea turtles and marine mammals in the Gulf of Mexico for 1979 from observer data. (Source: Thompson, in press)

Species	No. Caught	Mean Catch/100 Hooks	Standard Deviation	95% Confidence Limits Lower	Upper	Mortality(%)
Turtle Unidentified	10	0.0022	0.0105	0.0007	0.0036	10.0
Leatherback	2	0.0004	0.0043	-0.0002	0.0010	50.0
Loggerhead	0	-	-	-	-	-
Porpoise Unidentified	0	-	-	-	-	-
Bottlenose	0	-	-	-	-	-
False Killer Whale	0	-	-	-	-	-
No. of Sets	199.0					
No. Hooks	451902.0					

Table 8-17. Observed catches of sea turtles and marine mammals in the Atlantic for 1979 from observer data. (Source: Thompson, in press)

Species	No. Caught	Mean Catch/100 Hooks	Standard Deviation	95% Confidence Limits Lower	95% Confidence Limits Upper	Mortality(%)
Turtle Unidentified	8	0.0011	0.0069	0.0004	0.0019	37.5
Leatherback	0	-	-	-	-	-
Loggerhead	9	0.0013	0.0089	0.0003	0.0023	00.0
Porpoise Unidentified	2	0.0004	0.0044	-0.0001	0.0009	00.0
Bottlenose	1	0.0001	0.0021	-0.0001	0.0004	00.0
False Killer Whale	2	0.0003	0.0055	-0.0003	0.0010	50.0
No. of Sets	295.0					
No. Hooks	663551.0					

Table 8-18. Turtle incidental catch in the Japanese tuna fishery as reported by observers. (Source: S. Drummond, Chief, Branch of Fishing Survey, Pascagoula Lab., SEFC)

	1979				1980			
MONTH	GMFMC	SAFMC	MAFMC	NEFMC	GMFMC	SAFMC	MAFMC	NEFMC
Jan			1					
Feb	5				7			
Mar	4				1			
Apr	3						3	
May								
Jun								
Jul								
Aug			1					
Sep		1					3	
Oct		1				1	3	
Nov			7					
Dec								
TOTALS	12	2	9		8	1	9	

In contrast, estimates of growth and mortality for swordfish were recently published. These estimates were used to calculate yield-per-recruit (YPR). The published data are from Florida but for management purposes the stock covers the entire western North Atlantic and the Florida estimates are expected to be representative of the stock.

8.1.8.1 Yield-per-Recruit Analysis *

Based on the best point estimates of the growth and mortality parameters, a yield-per-recruit (YPR) analysis was carried out using the Beverton and Holt (1966) yield tables. Separate analyses were done for males and females because of their widely divergent parameter estimates.

The estimated mean length at entry into the Florida longline fishery (L_c) is 119 cm (46.9 in) fork length, which corresponds to the estimated mean length at age II when whole weight is approximately 20 kg (9.1 lb). This L_c was used for both males and females as there is no apparent difference in length at recruitment by sex. Figure 8-9 gives the relationship between yield-per-recruit (in kg) and fishing mortality rate (F) for males and females using the following parameters:

Males	Females
L_{oo} = 217.4 cm	L_{oo} = 340.0 cm
K = 0.1948	K = 0.0946
M = 0.27	M = 0.14
M/K = 1.37	M/K = 1.50
C = 0.55	C = 0.35

where $C = L_c/L_{oo}$

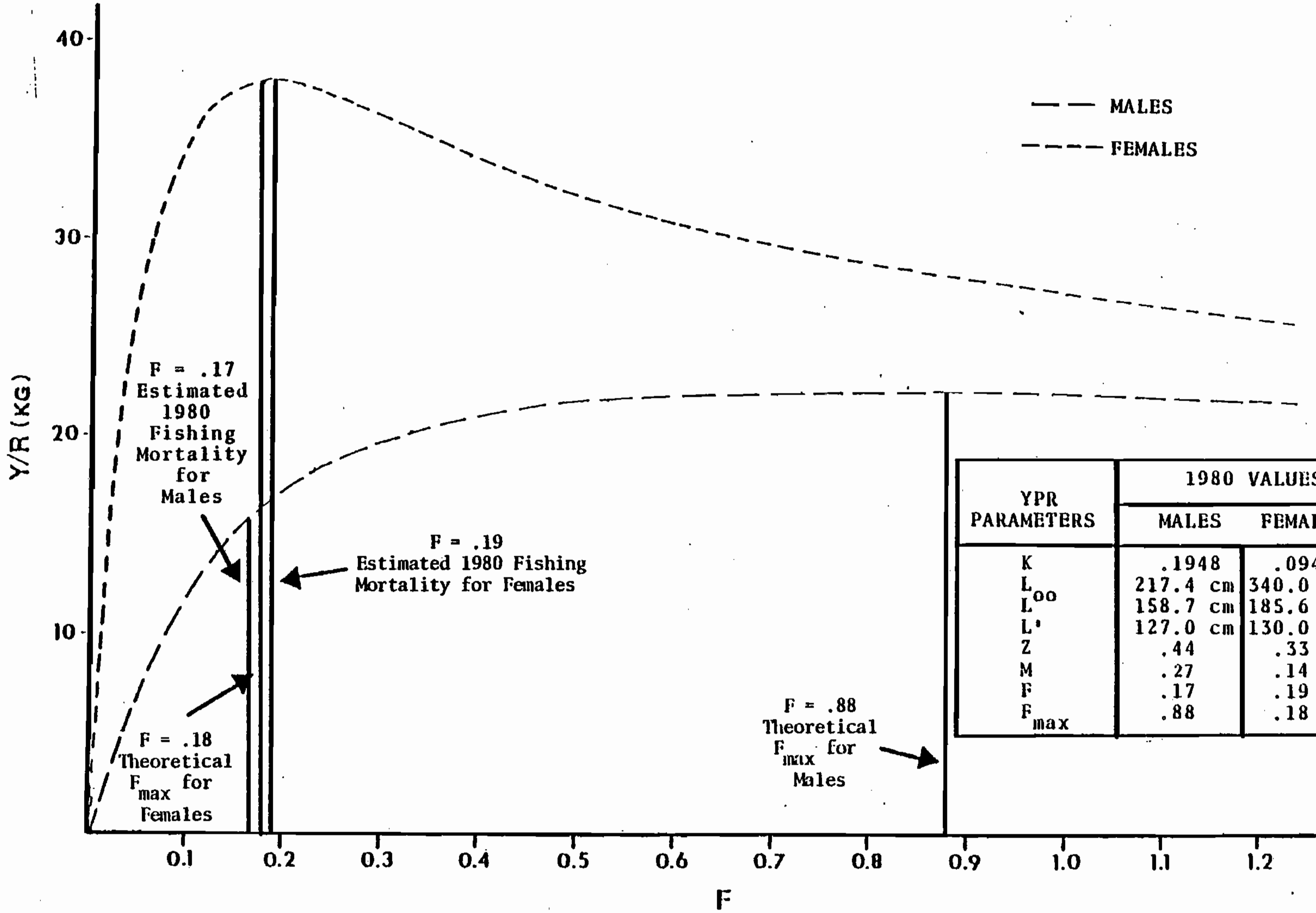
Assuming that the best estimates of Z are those given by the maximum likelihood method then estimates of the present levels of fishing mortality are:

Males	Females
F = 0.17	F = 0.19

Under present circumstances the fishing mortality coefficients that would maximize yield-per-recruit (F_{max}) are:

Males	Females
F_{max} = 0.88	F_{max} = 0.18

* Taken from Berkeley and Houde (1981).



YPR PARAMETERS	1980 VALUES MALES	1980 VALUES FEMALES
K	.1948	.0946
L_{oo}	217.4 cm	340.0 cm
L	158.7 cm	185.6 cm
L'	127.0 cm	130.0 cm
Z	.44	.33
M	.27	.14
F	.17	.19
F_{max}	.88	.18

Figure 8-9. Yield curves for Florida swordfish. Yield-per-recruit (YPR) is given in relation to the fishing mortality coefficient (F) for males and females. (Source: Modified from Berkeley and Houde, 1981).

These results indicate that female swordfish are presently being fished at F_{max} while the exploitation rate for males is well below F_{max}. An increase in YPR of 6.0 kg (13.2 lb) might be realized by increasing effort on males to F = 0.88.

8.2 Description of Habitat

8.2.1 Condition of Habitat*

The hydrographic habitat of swordfish in or near U.S. management jurisdiction is the Gulf Stream system, including the Loop and Florida currents and waters inshore, and the Caribbean Sea in the vicinity of Puerto Rico and the Virgin Islands. The western "edge," "wall" or "front" of the Gulf Stream is characterized by having a greater temperature contrast to the slope water than the eastern front has, and the temperature contrast is used by fishermen to determine the edge. The western front is also often identified by a color boundary, a current change, as well as by long thick lines of Sargassum weed or other flotsam on the surface.

The Gulf Stream from Florida to Cape Hatteras is often coincident to the 600 foot (approximately 200 meter) isobath (or bottom curve). The position of the Gulf Stream varies in wavelike patterns, which are known as meanders. The amplitudes of the meanders are greater north of Cape Hatteras than south of Cape Hatteras to the Tortugas. This is particularly important because, in the process of meandering, the Gulf Stream may be outside the FCZ.

The circulation in the eastern Gulf of Mexico (east of the Mississippi River) is dominated by the Loop Current, which enters the Gulf through the Yucatan Straits and exits through the Straits of Florida. The path of the Loop Current varies considerably with time and although the Loop Current does not directly flow over the continental shelf, eddies that detach from the current, similar to Gulf Stream eddies, drift on to the shelf carrying warm, saline Caribbean waters.

The Caribbean Sea is connected to the Atlantic by Mona Passage to the west of Puerto Rico and Anegada Passage to the east of the Virgin Islands. Surface currents in the vicinity of Puerto Rico and the Virgin Islands include the Caribbean and Antilles Currents which result from the convergence of the North Equatorial Current with the Guiana Current. The Caribbean Current flows through the Caribbean Sea while the Antilles Current flows to the north of the islands.

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*Booz et al., 1980

Based on food habits in the northwest Atlantic and in south Florida, swordfish appear to spend at least a part of their time on or near the bottom feeding on organisms which live just off the bottom.

8.2.2 Habitat Areas of Particular Concern

The swordfish is a pelagic species which is widely distributed in oceanic and coastal waters. However, it is also found near the bottom along the continental shelf, and thus apparently must utilize this region as a habitat.

Swordfish spawning grounds (Section 8.1.2.1) are evidently at or near the surface of oceanic waters, relatively far from coastal sources of pollution. However, offshore oil spills and the possible impact of tar and tar balls in the open ocean (Horn et al., 1970; Burns and Teal, 1973) may be deleterious to the young stages because components of tar which may be carcinogenic (Kraybill et al., 1977) can enter into the food chain of pelagic ecosystems (Evans and Rice, 1974). No quantitative data are available on the relationship between the distribution of swordfish larvae and oceanic pollutants, such as tar and tar balls.

Adults living at the surface can be expected to be affected by oil spills and tar balls for the reasons stated above. Those living in subsurface waters could receive pollutants, such as heavy metals, pesticides and radionuclides, via the food chain which cycles from neritic waters to the epipelagic and to the mesopelagic, which is the important, deep-water habitat of oceanic swordfish (Chipman, 1966; Walsh, 1972; Harvey, 1974; Windom and Duce, 1977).

Swordfish living on or near canyons of the continental shelf could be affected by pollutants carried through direct ocean dumping, as is common in the FCZ (Kullenberg, 1975) or through transfer from the neritic zone to the bottom waters overlying the continental shelf. Pollutants thus could be taken up directly by swordfish or more likely, through their food which had acquired them from surface or neritic waters (Leatherland et al., 1973). Squid, for example, have rather high concentrations of heavy metals (Martin and Flegal, 1975) but the degree to which this results from man-made pollutants as compared to natural sources, and how these affect swordfish is unknown. Thus, while the swordfish is an offshore, pelagic fish, man-made activities may affect it or its habitat.

8.3 Fishery Management Jurisdiction, Laws and Policies

8.3.1 Management Institutions

The U.S. Department of Commerce, acting through the five eastern regional councils—New England, Mid-Atlantic, South Atlantic, Gulf of Mexico, and Caribbean—pursuant to the Magnuson Fishery Conservation and Management Act (MFCMA) (P.L. 94-265), has authority to manage swordfish stocks throughout the U.S. Fishery Conservation Zone (FCZ) in the Northwest Atlantic, the Gulf of Mexico, and the Caribbean Sea.

8.3.2 Treaties and International Agreements

Foreign fishing for swordfish in U.S. waters is regulated solely through the Magnuson Act. The United States is a member of the International Commission for the Conservation of Atlantic Tunas (ICCAT). Because swordfish are caught by foreign participants in the Atlantic tuna longline fishery, statistics on the catch are maintained by this commission; however, no plans currently exist to manage or regulate the swordfish fishery through international commissions. The U.S. longline fishery catches tunas as an incidental catch (S. Berkeley, Research Associate, University of Miami, Miami, FL; pers. comm.).

The Canadian government barred U.S. fishermen from the Canadian fisheries zone in June 1978 and the United States took similar action against Canadian fishermen shortly thereafter. By de facto agreement the two nations have maintained flag state enforcement within the region claimed by both: The U.S. exercises jurisdiction over U.S. ships and Canada has jurisdiction over ships flying the Canadian flag, each state reserving the right of enforcement against any third state.

8.3.3 Federal Laws, Regulations and Agreements

The only federal law that relates to the management of the Atlantic, Gulf and Caribbean swordfish fisheries is MFCMA. Until a Fishery Management Plan for this species is approved by the Secretary of Commerce, this fishery will be managed through the Preliminary Fishery Management Plan (CFR 50§ 611.60), prepared by the Department of Commerce (U.S. Department of Commerce, 1978). Briefly stated, these regulations require that foreign longline fishermen release billfishes (of which swordfish are included) and maintain catch records.

In December 1970, the swordfish fishery went into a decline, as a result of the FDA mercury restriction of 0.5 ppm. The enforcement of the 0.5 ppm mercury level amounted to a ban on swordfish. Importation from Canada dropped below 50,000 pounds per year, and domestic commercial harvesting continued at a reduced rate.

On June 27, 1978, essentially as a response to the ruling of the U.S. District Court for the North District of Florida in two cases (Anderson Seafoods vs. FDA and FDA vs. Anderson Seafoods), the FDA issued an administrative guideline (FDA, 1978) instructing its inspectors to take enforcement action only against fish with mercury levels in the edible parts exceeding 1.0 ppm. The decision of the Florida court was appealed by those seeking to have the acceptable level of mercury in swordfish raised. The decision on the appeal was not to alter the level from 1.0 ppm. The American Swordfish Association, relying on the toxicological findings of the Florida court and on new consumption evidence prepared by the National Marine Fisheries Service, attacked the 1.0 ppm action level for mercury and asserted that only an action level of 4.0 ppm is required (Anon, 1979a). However, the FDA is maintaining the 1.0 ppm action level. In denying petitions of the National Food Processors Association and AMR Biological Research, FDA stated that the agency had reviewed the new data on fish consumption and determined that the action level of 1.0 ppm is appropriate to regulate unavoidable residues of mercury in fish (Anon, 1979b).

Not all swordfish meet the 1.0 ppm limit for mercury. The difficulty for the fishermen and processors is not only in meeting the limit, but in the loss involved if fish is impounded for testing, which takes five to six days. Imports must meet the lower of either the U.S. standard or the standard in the country of origin.

8.3.4 State Laws, Regulations and Policies

Massachusetts limits the catch of sport swordfish by noncommercial fishermen to one fish per angler per day. Although Massachusetts does not require a license for recreational fishing, the commonwealth prefers that boats landing fish in the commonwealth have a Massachusetts boat license.

Only two states, Delaware and Florida, have laws regulating the utilization or taking of billfishes, which are taken as an incidental catch in the U.S. longline fishery. The text of these regulations follow.

Delaware - Statute § 1310

Illegal Possession of Atlantic sailfish, blue marlin, white marlin and striped marlin; penalties

"(a) No person shall sell, possess for sale, offer for sale, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport or cause to be transported, carry or cause to be carried, by any means whatever, for the purpose of sale, or barter, the carcass, processed byproduct, or any portion thereof of any Atlantic sailfish (Istiophorus americanus), blue marlin (Makaira nigricans ampla), white marlin (Makaira albida) or striped marlin (Makaira mitsukurii).

(b) This section shall not apply to Atlantic sailfish, blue marlin, white marlin or striped marlin, whole, packed or processed in transportation in unbroken packages and coming from any other state or country, but such packages shall be clearly marked by stencil, tag, or otherwise, showing the true origin of the shipment and its destination beyond the limits of this State.

(c) Any person who violates any provision of this section shall be fined not more than $1,000 for each offense, or be imprisoned for not more than 30 days for each offense.

(d) The Superior Court shall have jurisdiction of offenses under this section."

Florida - Statute 370.11

Regulation; Fish; Sailfish; Penalty

"5. No person may sell, offer for sale, barter, exchange for merchandise, transport for sale, either within or without the state, offer to purchase or purchase any species of fish known as sailfish; provided, however, any one person may carry out of the state as personal baggage or transport within or out of the state not more than two sailfish if they are not being transported for sale. The possession of more than two sailfish by any one person is unlawful; provided, however, any person may catch an unlimited number of sailfish if they are immediately returned uninjured to the water and released where the same are caught. No common carrier in the state shall knowingly receive for transportation or transport, within or without the state, from any one person for shipment more than two sailfish except as hereinafter provided. It is expressly provided that any lawful established taxidermist in the conduct of taxidermy, may be permitted to move or transport any reasonable number of sailfish at any time and in any manner he may desire, as specimens for mounting; provided, however, satisfactory individual ownership of the fish so moved or transported can be established by such taxidermist at any time upon demand. Common carriers shall accept for shipment sailfish from a taxidermist when statement of individual ownershp involved accompanies bill of lading or other papers controlling the shipment.

6. SAILFISH TRANSPORTING - Sailfish being transported shall be kept intact and flesh shall not be removed from the skeleton; provided, however, sailfish after having been delivered to a bona fide taxidermist or smoking establishment, may be dismembered."

8.3.5 Local and Other Applicable Laws, Regulations and Policies

No local or other laws, regulations or policies are known to exist relative to the swordfish fishery.

8.4 Description of Fishery Activity

8.4.1 History of Exploitation

8.4.1.1 Recreational

A sport fishery for swordfish has existed since around the 1920's. Rich (1947) notes that "in former times", i.e., prior to around 1930, small-boat men caught swordfish off Martha's Vineyard and Nantucket by "trailing" a hook baited with some silvery fish such as herring. Few swordfish were taken with rod and reel. Moss (1967) estimated that in an average season only about 50 swordfish would be caught by rod and reel in about 1,000 attempts, in the area stretching from Massachusetts to Long Island. The main technique used was to locate a fish which was on the surface and then attempt to entice it to strike a nearby bait (Wilcoxson, 1975). This method was seldom successful. Harpooning of swordfish has also been practiced occasionally by sport fishermen.

The U.S. recreational swordfish fishery has grown considerably during the 1970s. Since 1976, a substantial rod and reel fishery for swordfish has grown up in Florida. In the new methods developed in Florida, fishing is done at night and the bait is drifted below the surface utilizing techniques copied from the Cubans. These new techniques have proven to be much more successful than traditional daytime trolling techniques for swordfish and have been key factors in opening up new sport fisheries for swordfish in areas where none previously existed. Consequently, the number of participants in the recreational sector of this fishery has increased significantly in recent years.

8.4.1.2 Commercial

Longline gear was introduced to Canadians by Norwegian shark fishermen who caught substantial numbers of swordfish as an incidental catch (Mr. R. Bartlett, Advisory Panel member; pers. comm.). Further, after the first summer season, the Norwegians hung up their gear and a winter fishery for swordfish was developed by Canadian fishermen.

An accurate, concise overview of the swordfish fishery is given by Berkeley and Houde (1980):

> "Swordfish have been fished commercially in the northwest Atlantic since the 19th century. Until 1962 virtually all swordfish

were harpooned and fishing was confined to waters between New York and Canada during summer. In 1960 the estimated total catch of swordfish in the northwest Atlantic was 2800 metric tons (Caddy, 1976). In the early 1960's longline gear was introduced into the fishery, mostly by Canadian fishermen. In 1963 the estimated total catch had increased to 8800 m.t. It declined the next year and stabilized at about 5000 m.t. until 1971. With the introduction of longlining the range of the fishery expanded. By the middle 1960's it extended from Canada to the Gulf of Mexico and operated year round. In 1971, as a result of United States Food and Drug Administration guidelines that prohibited sale of swordfish with more than 0.5 ppm tissue mercury content, the swordfish fishery collapsed (Caddy, 1976). Some Canadian and United States boats continued fishing clandestinely although total effort was greatly reduced. Reported total catches from the western North Atlantic (Zones 21 and 31) declined to 800 m.t. in 1971 (FAO, 1976). In 1978, the permissible level of mercury was raised to 1.0 ppm. This resulted in rejuvenation of both the Canadian and the United States fisheries. FAO (1979) reported 7077 metric tons landed from the western North Atlantic (Zones 21 and 31) in 1978. The catches almost certainly have increased in 1979 and 1980, but good landings data are not presently available. The reported catch from Florida in 1979 was at least 777 m.t., which is probably a gross underestimate of actual landings."

The first cooperative longline catch of swordfish was made in the Gulf of Mexico in 1969, and the first commercial catch in 1970 (M. R. Bartlett, Advisory Panel Member; pers. comm.).

8.4.2 Domestic Recreational and Commercial Fishery Activities

8.4.2.1 Participating User Groups

The problem of clear definition between recreational and commercial fishing activities in the swordfish fishery is a major one since:

Most fish caught are too large for consumption by an individual sport fisherman; thus, many recreational fishermen resort to selling the product.

The value of swordfish is high, making it highly lucrative to sell the catch.

The costs involved in sports fishing for swordfish are high; thus, many sports fishermen regard the sale of the catch as a method for defraying these costs.

8.4.2.1.1 Recreational

Prior to 1976, very few swordfish were caught by rod and reel. Wilcoxson (1975) reported that in all probability less than 2,000 swordfish had been caught in the history of sport fishing.

Swordfish have been sought by marine anglers from Nantucket, Massachusetts, to Shinnecock, Long Island, during summer months ever since 1926, when the first swordfish was caught by rod and reel in this part of the Atlantic (Freeman and Walford, 1974). Swordfish were also occasionally, but infrequently taken by billfish anglers in the Middle Atlantic Bight (de Sylva, 1974). Annual tournaments have been held in New York, Massachusetts, and Rhode Island for a number of years. Prior to 1976, the usual method of angling for swordfish was to attempt to entice a basking swordfish to strike at a baited hook placed within 30 feet of its mouth (Freeman and Walford, 1974; Wilcoxson, 1975). This was rarely successful, since swordfish do not customarily feed while at the surface.

In 1976, rod and reel fishermen in south Florida began to experiment with night fishing techniques adopted from Cuban American longliners. These efforts were more successful than previous methods. In a report of the Swordfish Workshop held in Miami in 1977, summarized by Beardsley (1977), it was estimated that in 1976 approximately 25 to 30 swordfish were landed by rod and reel in Florida; in 1977 landings were expected to exceed 400 to 500 fish. The sport fishery for swordfish using the new techniques has rapidly expanded along the Atlantic Coast from south Florida to Cape Cod and to the Gulf of Mexico (International Marine Angler, 1978). Swordfish tournaments were initiated in Florida in 1977. In 1978, swordfish tournaments were held in South Carolina and New Jersey, the first ever to be held in these states (International Marine Angler, 1978).

Berkeley and Houde (1980) reported a decrease in recreational effort in Florida during 1978 and 1979 and expect a further decrease in tournament effort in 1980. Their reasons include loss of interest on the part of anglers and relatively poor success in 1979 tournament fishing.

8.4.2.1.2 Commercial

There are three types of commercial effort directed at swordfish in southern Florida (Berkeley and Houde, 1980): 1) a mobile New England fleet of vessels larger than 50 ft which fishes the Florida Straits primarily in winter and spring, usually north of Ft. Pierce; 2) Florida longline vessels, approximately 35-50 ft long, mostly based in the Miami-Cape Canaveral areas; and 3) Cuban-American type longline vessels, usually 25-40 ft long and which mostly fish between Key West and Miami. A substantial number of the Florida longline vessels are based along the Florida west coast (C. Davis, Fishery Biologist, GMFMC; pers. comm.).

A surface harpoon fishery for swordfish is centered in New England off Montauk, Long Island*. Estimates of the harpoon fleet in New England range from 25 to 28 vessels on an annual basis with approximately 22 airplanes. The harpoon fishery is confined to northern waters and is a seasonal fishery which takes place during the summer months (May through October). Traditionally, the harpoon season is over when the first significant storm occurs in the fall. Because of the seasonal nature of the harpoon fishery, many of the harpooners are active in diversified fisheries such as herring, flounder, squid, lobster and scup at other seasons of the year. The main activity is offshore dragging.

8.4.3 Vessels and Fishing Gear

8.4.3.1 Recreational

Rod and reel fishing for swordfish requires heavy tackle similar to that used for tuna and other large billfish. Rods are rated at 50, 80 and 130 pounds; reels are rated similarly. Leaders, which typically are 15 to 30 feet long, are rated at 150 to 300 pounds, and hooks are the 12/0 to 14/0 size. Fishing line and other ancillary equipment is also heavy duty. Line is typically 50 to 80 pound test.

Vessels used for rod and reel swordfish fishing are similar to those used for tuna and other billfish and have been described by de Sylva (1974). Boats used range from 6.1 to 15.2 m (20 to 50 ft) depending on location. These may be either privately owned or chartered. Such vessels fish by drifting in Florida or, in the northeast, occasionally by trolling after a

*Much of the information on the harpoon fishery is from discussions with Everett Mills and Forrest Hoxsie of the New England Advisory Panel.

swordfish has been seen. Baits are placed deeper than for other billfishes. A typical charter vessel for swordfish angling carries four to six fishermen, plus a captain and a mate (D. de Sylva, Professor, University of Miami, Miami, FL; pers. comm.).

In Florida waters, because of the proximity of the Gulf Stream, smaller boats can be used for swordfishing by rod and reel. Vessels as small as 5.5 m (18 ft) are occasionally reported to be rod and reel fishing in these waters.

8.4.3.2 Commercial

Three principal types of commercial effort are present in the Florida fishery (Table 8-19). The New England longline vessels fish the eastern coast from the New England states to Florida. Fishing effort directed at swordfish would fall within one of the vessel types described in Table 8-19.

Characteristics of longline gear used by the New England type vessel have been described by Rhule (1969). Florida's commercial longline gear and methods have been described by Berkeley et al. (1981) and are shown in Figure 8-10. Construction and operation of longline gear for artisanal fishermen suitable for use in the developing swordfish fishery in the Caribbean area are discussed by Berkeley (in press). Boston mackerel, Western mackerel, squid and mullet are some commonly used baits for longlining. Chemical lights are often attached to the line just above the bait as a means of attracting swordfish to the bait. Sharks and billfishes are caught by swordfish longline gear as an incidental catch.

Harpooning is carried out in the daytime during calm weather when swordfish are found at the surface. Typical harpoon gear is shown in Figure 8-11. Harpoon vessels typically range from 18.3 to 25.9 m (60 to 85 ft) in length although there are a few vessels of 12.2 to 13.7 m (40 to 45 ft) which make day trips only. Vessels designed for harpooning are equipped with spotting towers and crows nests, from which crew members can survey the surrounding waters (Anon, 1978). Most harpooners use spotter planes to locate fish. The following account of the use of airplanes is from Cornell (1981):

Table 8-19. Characteristics of the three principal types of commercial effort presently fishing in Florida waters. (Source: Berkeley and Houde; pers. comm.)

Vessel Type	Boat Length	Miles of Longline	Hooks Fished Per Night	Nights Fished Per Trip	Days at Sea	Area Fished	Number Vessels Fishing in Florida	Disposal of Catch
New England Longline Vessels	60'-80'	15-40 mi	400-2000	7-15	10-21	New England states during summer & fall. Move south as winter approaches. Gulf of Mexico or Florida east coast during winter.	Approximately 25 fished during 1979/80.	Most of the swordfish landed is off-loaded directly into trucks and driven or air freighted to the New York or Boston markets. These fish do not show up in Florida landings because they were not sold through local dealers.
Florida Longline Vessels	35'-50'	5-20 mi	100-400	1-2	2-3	Most are based in the Miami to Cape Canaveral areas and usually depart and return to the same port each trip.	Number increased from approximately 50 in 1978 to perhaps 200 at present. Some of these only fish swordfish during spring and summer, while many fish year round.	Sold through local dealers.
Cuban-American Type Longline Vessels	25'-40'	1-5 mi	75-150	1	1	Mostly between Miami and Key West	These vessels established the Florida swordfish fishery and numbered approximately 30 in 1977. However, there are few if any active in the fishery at the present time. Some gave up swordfishing and others switched to the Florida type gear.	Sold through local dealers.

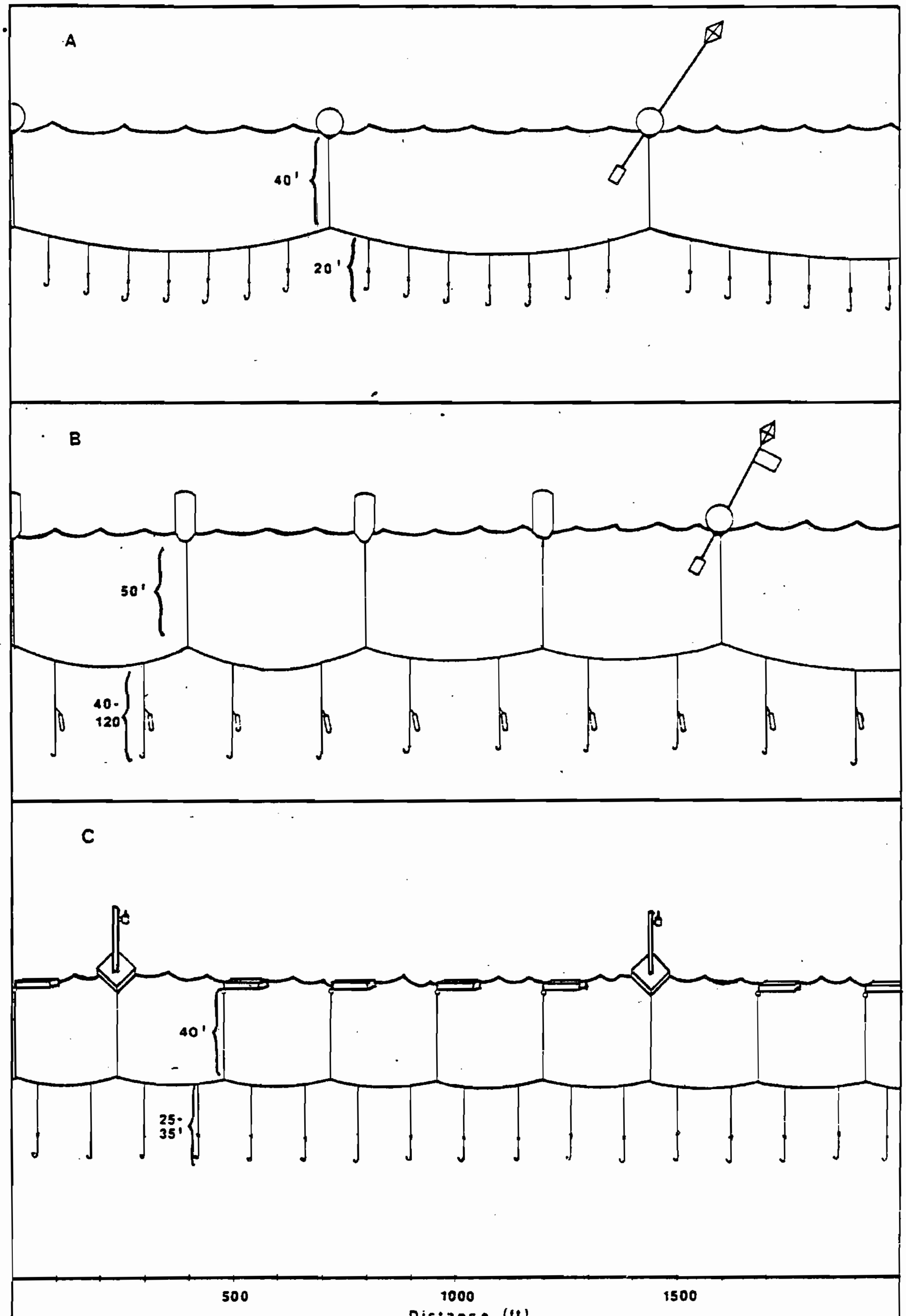

Figure 8-10. A) Typical New England swordfish longline; B) Typical Florida longline; C) Typical Cuban longline. (Source: Berkeley et al., 1981)

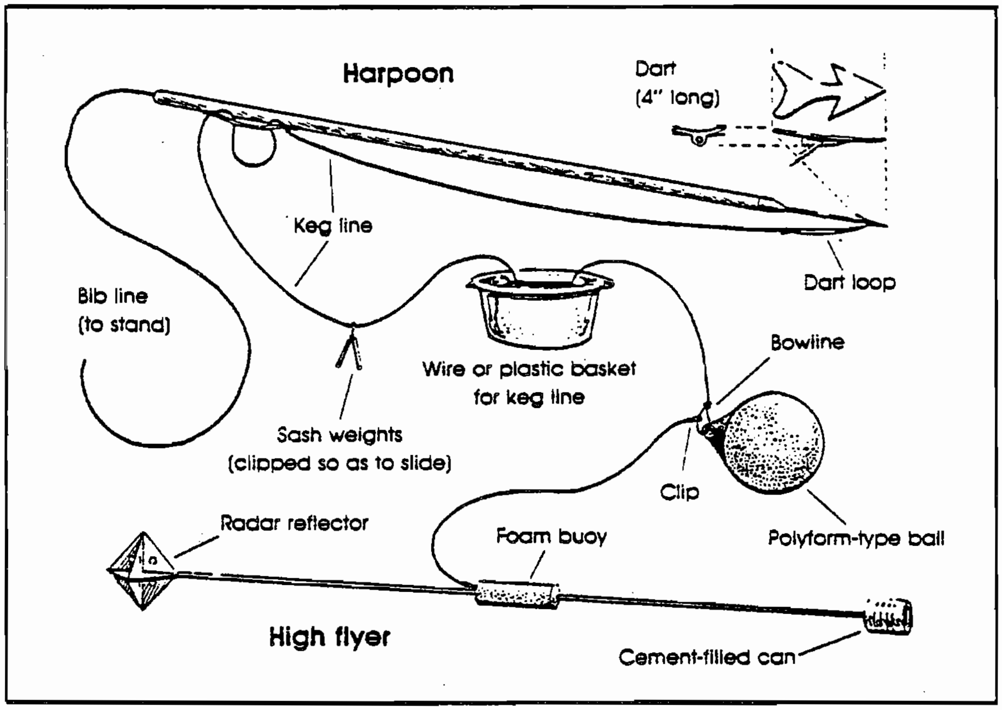

Figure 8-11. Basic harpoon gear used in the Georges Bank swordfish fishery. (Source: Cornell, 1981)

> "The use of aircraft to spot swordfish is an integral - and critical - part of the harpoon fishery on the East Coast. (By contrast, their use is prohibited by state law in the waters of California where the West Coast's swordfish fleet operates). The planes used are invariably either Citabrias or Super Cubs, and all are equipped with extra-large wing tanks and substantial belly tanks, enabling them to stay in the air for some 14 hours.
>
> Guided to their boats by loran bearings given over the VHF (each plane also carried its own loran set), these aircraft fly a random search pattern in the vicinity of the boats, with their altitude varying from about 200' to 800' off the water, depending on the conditions. When the pilot spots a fish, he drops a dye marker near it and banks the plane into a turn, "holding the circle" and "talking" his boat to the fish using the clock system for direction and boat lengths for distance."

The planes fly about 400 hours per year over approximately 35-36 fishing/flying days. Harpooning takes place from an extended bow pulpit using hand-held harpoons. Harpooned fish may be marked with buoys and reflectors and hauled on board after all harpooning within the area is completed.

The harpoon and longline segments of the commercial fishery exploit different weight classes of fish. Swordfish taken by harpoon gear are generally females averaging over 90.7 kg (200 lb). Swordfish taken by longline gear are much smaller on the average, i.e., average weight less than 90.7 kg and range less than 4.5 to over 136.1 kg (10-300 lb), and consist of both males and females.

8.4.4 Foreign Fishing Activities

8.4.4.1 Foreign Fishing Within the FCZ

There is no foreign fishing activity that targets swordfish; however, swordfish are caught as an incidental catch in the foreign longline tuna fishery and the foreign squid trawl fishery.

Historically, only Japanese longliners have fished for tuna within the U.S. FCZ. The resulting billfish incidental catch has been regulated since January of 1978 by a Preliminary Management Plan (PMP). A PMP applies only to foreign fishermen and is prepared by the Secretary of Commerce prior to the development of a fishery management plan by a Fishery Management Council. The PMP for Atlantic Billfishes and Sharks requires that any billfish by-catch be released without being removed from the water.

The total incidental swordfish catch for the Japanese tuna longline fishery for the years 1978 through 1980 is shown in Table 8-20. The estimated observer catch is consistently greater than the Japanese reported catch. This could reflect different fishing strategies. The 1980 incidental swordfish catch by area (Table 8-21) indicates that the Gulf and Mid-Atlantic catches are approximately equal and account for all but 558 swordfish caught in the South Atlantic out of a total catch of 4,911 swordfish.

Swordfish make up approximately 50 percent of the incidental 1980 billfish catch in the Gulf and Mid-Atlantic and only about 10 percent in the South Atlantic (Table 8-22). This trend seems to have occurred for the past three years. Also, note that there is close agreement between the observer extrapolated data and the Japanese reported data on a percentage basis (Table 8-22) but not on a numerical swordfish basis (Table 8-21).

A very important factor in the release of the swordfish incidental catch is the mortality rate. Discounting long term mortality, the initial mortality averaged over the years 1978 through 1980 was 66 percent as reported by the Japanese and 76 percent as estimated from the observer data (Table 8-23). This means that approximately 66-76 percent of the swordfish incidental catch that is released is subjected to initial mortality.

A more detailed analysis of the 1978 foreign fishery in the Gulf of Mexico is given in Table 8-24. The percent swordfish in the catch varied from a high of 12.86 percent in March to a low of 1.96 percent during July 1-17. The CPUE was highest in March, dropped to its lowest level in April and increased steadily through July. The percent mortality is high, ranging from 63-77 percent.

The available monthly observer data for 1979 and 1980 is shown in Table 8-25. During 1979, the catch varied from 185 in the SAFMC area to 377 in the GMFMC area; the total catch for 1979 was 796 swordfish. In 1980, the catch ranged from 172 in the SAFMC area up to 601 in the MAFMC area; the total 1980 catch was 1,362 swordfish, a 71 percent increase over 1979.

Table 8-20. Total incidental swordfish catch (number of fish) extrapolated from observer data and data reported by the Japanese. (Source: NMFS Observer Program Data)

	YEAR		
	1978	1979	1980
Japanese Data	4,992	3,797	4,911
Observer Data	6,626	4,425	8,075

Table 8-21. Longline incidental swordfish catch (number of fish) by area as reported by the Japanese for the years 1978-1980. (Source: NMFS Observer Program Data)

AREA	YEAR 1978	1979	1980
Gulf	770	2,450	2,068
South Atlantic	828	394	558
Mid-Atlantic	3,382	953	2,285
Total	4,992	3,797	4,911

Table 8-22. Percent swordfish in incidental billfish catch by region for the years 1978-1980. (Source: NMFS Observer Program Data)

	Japanese Data			Observer Data		
YEAR	GULF	SATL	MIDATL	GULF	SATL	MIDATL
1978	15.4	16.6	67.8	14.9	16.7	68.4
1979	64.5	10.4	25.1	54.8	11.9	33.3
1980	42.1	11.4	46.5	54.7	6.5	38.8

Table 8-23. Number and percentage of swordfish that are dead when released for the Gulf and Atlantic areas. (Source: NMFS Observer Program Data)

	Japanese Data				Observer Data			
Year	Gulf	%	Atl	%	Gulf	%	Atl	%
1978	512	66.5	2,285	54.3	714	72.3	3,563	63.2
1979	1,624	66.3	874	64.9	1,781	73.4	1,492	74.6
1980	1,355	65.5	1,503	52.9	3,640	82.5	2,319	63.4

Table 8-24. Swordfish incidental catch by month as recorded by U.S. observers aboard Japanese longline vessels in the Gulf of Mexico in 1978.* (Source: Lopez et al., 1979)

	Sets	Hooks	Number Swordfish	% Total Catch	Number Live	Number Dead	Percent Mortality	Number Turtles
March	13	27,162	22	12.86	8	14	64%	
April	18	40,096	13	3.24	3	10	77%	
May	40	77,070	30	4.09	11	19	63%	
June	46	101,600	59	2.42	14	45	76%	2
July 1-17	50	119,550	88	1.96	21	67	76%	4
Total	167	365,478	212	2.57	57	155	73%	6

* The target species from 1 March to 1 June was bluefin tuna; yellowfin tuna was the target species from 1 June to 17 July. These data do not represent the total catch by Japanese longline vessels in the Gulf of Mexico in 1978; they represent observer data based on 21 boardings during which 167 fishing days were monitored.

Table 8-25. Swordfish incidental catch in the Japanese tuna fishery as reported by observers. (Source: S. Drummond, Chief, Branch of Fishing Survey, Pascagoula Lab., SEFC; pers. comm.)

	1979				1980			
MONTH	GMFMC	SAFMC	MAFMC	NEFMC	GMFMC	SAFMC	MAFMC	NEFMC
Jan		74	13		21			
Feb	219				180		35	
Mar	82				370			
Apr	76				18		8	
May								
Jun							8	
Jul			31				52	
Aug		6	9			8	18	
Sep		25	3			3	54	
Oct		29	5			137	198	
Nov		51	160			14	146	
Dec			13			10	82	
TOTALS	377	185	234		589	172	601	
1979 TOTAL	796							
1980 TOTAL					1,362			

The historical swordfish incidental catch from the Caribbean area is shown in Table 8-26. The swordfish catch ranged from a low of 0 during 1958-61 to a high of 367 in 1963. If only the years when swordfish were caught (1962-1977*) are considered, the catch per 100,000 hooks varied from 3 in 1969 to 68 in 1974. The catch in 1974 is important because so few hooks (13,312) were fished. The mean catch per 100,000 hooks for the years 1962-1977 was 16.

The incidental swordfish catch in the foreign squid trawl fishery is shown in Table 8-27. Based on a 20 percent observer coverage, the observed swordfish catch for 1978 was 18.6 MT (41.1 thousand lb). If this figure is expanded to the fleet of 60 vessels engaged in the squid fishery the total 1978 swordfish incidental catch was approximately 93 MT (205.5 thousand lb). In 1979, 62.8 MT (138.4 thousand lb) were caught, and 115.7 MT (255.2 thousand lb) in 1980, an increase of 24.4 percent from 1978.

8.4.4.2 Foreign Swordfish Fishery in the North Atlantic

Nations which reported catches of swordfish from the North Atlantic to FAO in 1979 included Canada, Cuba, Japan, Korea Republic, and Venezuela.

Canada officially reopened its swordfish fishery in 1979 and has set a quota of 3,000 MT (6.6 million lb). The Canadian fishery for swordfish is a mixed gear fishery consisting of longliners and harpooners; fleet size is around 50 to 60 vessels. Characteristics of vessels and gear are similar to the U.S. fishery. Cuba and Spain both have directed longline fisheries for swordfish.

Japan catches swordfish in its daytime, longline, tuna-directed fishery. Japanese vessels are normally larger than American vessels with an average length of 184 feet (49.8 meters) (Southeast Foreign Fishery Observer Project, NMFS). A typical longline is about 40 to 70 miles long with about 2,000 hooks. Setting the longline begins and is usually completed before sunrise. The line is left out for 2 to 3 hours. Hauling the longline takes from 12 to 16 hours. The average time per set is around 20 to 22 hours (Southeast Foreign Fisheries Observer Project, NMFS). Korea and Taiwan also longline for tuna in the Atlantic and catch swordfish as a by-catch. Vessels and gear are similar to the Japanese.

Swordfish are also caught in the squid fishery by vessels utilizing bottom and mid-water trawl gear.

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*There has been no longline fishing effort by the Japanese in this area since 1977.

Table 8-26. Swordfish and other billfish incidental catch from the Japanese longline fishery in areas 4-1565 and 2065 (two 5^{o} squares from 15^{o}N to 25^{o}N and 65^{o}W to 70^{o}W). (Source: T. Chenning, pers. comm.)

YEAR	NUMBER HOOKS[1]	SWORDFISH		WHITE MARLIN		BLUE MARLIN		SAILFISH		BLACK MARLIN	
		C	CPUE[2]	C	CPUE	C	CPUE	C	CPUE	C	CPUE
1958	37,440					64	171				
1959	112,437			1	1	224	199	26	23		
1961	2,806					12	428				
1962	1,830,572	246	13	2,279	124	18,514	1,011	413	23		
1963	1,896,493	367	19	5,985	316	9,267	489	430	23		
1964	2,124,433	220	10	5,155	243	3,167	149	377	18	32	2
1965	1,020,820	59	6	2,242	220	1,873	183	899	88		
1966	1,368,524	205	15	3,466	253	1,418	104	1,011	74	81	6
1967	202,221	13	6	1,365	675	320	158	80	40		
1968	170,205	12	7	1,502	882	243	143	31	18	3	2
1969	91,377	3	3	140	153	163	178	15	16		
1970	567,846	53	9	1,455	256	1,437	253	123	22		
1971	526,473	66	13	905	172	791	150	140	27		
1972	-										
1973	31,680	6	19	42	133	73	230				
1974	13,312	9	68	3	23	15	113	66	496		
1976	10,660	3	28	2	19	2	19				
1977	2,423	1	41								
TOTAL	10,011,562	1,263	16	24,542	245	37,583	375	3,611	36	116	1

1. Number of records = 12,034
2. CPUE = catch-per-unit effort = catch per 100,000 hooks.

Table 8-27. Observed incidental catch of swordfish in the squid trawl fishery during 1978,* based on 20 percent observer coverage. (Source: William Stevenson, NMFS, St. Petersburg, FL.; pers. comm.)

Northwest Atlantic Area	Observer Trips	Swordfish Observations	Total Amount Swordfish** MT	'000 lb
1	20	18	5.2	11.5
2	76	41	7.7	17.0
3	46	16	4.7	10.4
4	56	6	.9	2.0
5	23	2	.1	0.2
TOTAL	221		18.6	41.1

YEAR	Number Swordfish	Total Amount Swordfish+ MT	'000 lb
1979	1,153	62.8	138.4
1980	2,126	115.7	255.2

*In 1978, there were 250 foreign vessels permitted to fish in the Northwest Atlantic; of these, only about 110 actually fished. Of these 110 vessels, about 60 engaged in the squid fishery.

**These totals are for the observed boats. The expanded figure for the fleet of 60 vessels is 93 mt.

+These totals are for the entire fleet.

Stock removals of swordfish from the North Atlantic by country are shown in Figure 8-12 and Table 8-28. Canada fishes for swordfish in the Northwest Atlantic with stock removals from FAO Statistical reporting area 21. Cuba catches swordfish in areas 31 and 34. Spain's fishing areas in the North Atlantic are in FAO area 27. Stock removals by Venezuela occur in FAO areas 31 and 34. Korea reports stock removals from areas 21, 31 and 34. Foreign nations do not currently land swordfish caught outside the FCZ in U.S. ports.

8.4.4.3 Foreign swordfish fishery in the western North Atlantic

Nations which reported catches of swordfish from the western North Atlantic to FAO in 1979 included Canada, Cuba, Japan, Republic of Korea, USA and Venezuela. The total 1979 harvest was 4,371 MT (9.6 million lb) (Table 8-29). The 1979 U.S. harvest accounted for 76 percent of the total western North Atlantic reported landings.

The best available data support a western North Atlantic swordfish stock hypothesis. Given that this is the case, management of the U.S. domestic fleet will have a significant beneficial effect on the swordfish stock. In addition, by reducing the foreign longline and trawl incidental swordfish catches (principally Japan and Spain) management will further benefit the stock.

8.4.4.4 Landings and Value as Distributed Among the Stock Comprising the Management Unit

Landings of swordfish from the western North Atlantic as reported to FAO are presented in Table 8-29. If we assume a 1980 take of approximately 10 million lb (1979 = 4,371 MT = 9,638,492 lb), the major countries and gear involved are as follows.

The 1980 Japanese incidental catch in the FCZ was 4,911 swordfish* (589,320 lb) as reported by the Japanese and 8,075 swordfish (969,000 lb) as extrapolated from observer data. Observer data reported an initial mortality rate of 76 percent, which implies an initial loss of between 3,732 and 6,137 swordfish (447,840-736,440 lb). Using the 1980 ex-vessel price of $1.91 per lb across all sizes of fish (Table 8-31), the 1980 value was between $0.9 and $1.4 million.

The Japanese Fishery Association has recently proposed to turn over dead swordfish resulting from Japanese tuna longlining activities in the FCZ to an American sponsored group. This offer is currently receiving attention in various quarters.

*Average weight = 120 lb

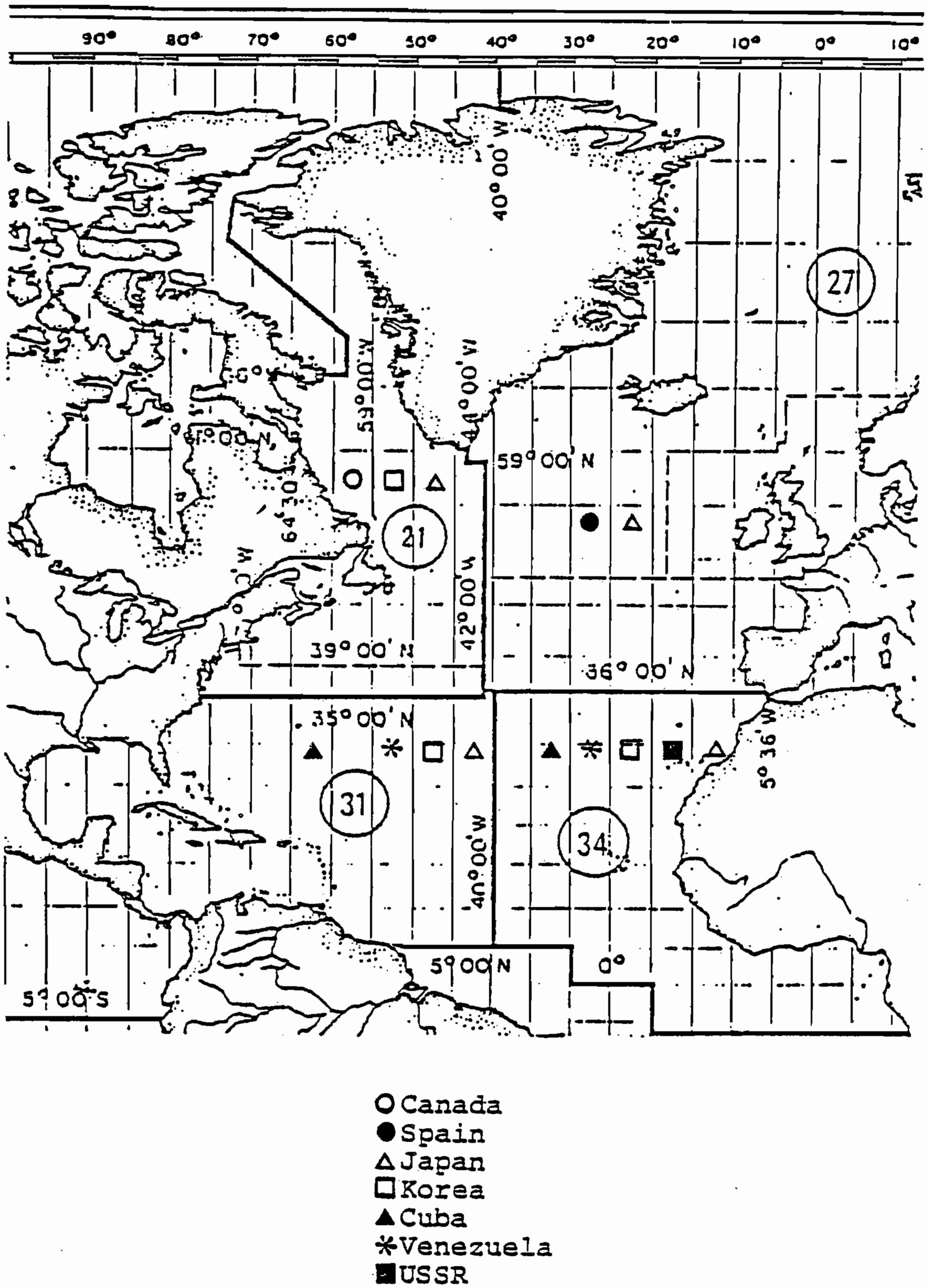

Figure 8-12. Stock removals of swordfish in the North Atlantic. (Source: FAO, Yearbook of Fishery Statistics.)

Table 8-28. Swordfish catches [1] (MT) from the North Atlantic. [2] (Source: FAO, Yearbook of Fishery Statistics.)

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Canada	4,800	a	100	a	2	21	60	117	3,053	50
Cuba	a	a	a	a	a	a	600	700	600	400
Ireland	a	a	a	a	a	3	1	a	a	a
Japan	400	900	900	600	1,170	1,032	717	272	514	574
Korea Republic	a	a	a	a	a	38	a	1	1,000	436
Morocco	200	400	300	200	208	133	199	150	179	208
Norway	400	200	a	a	a	a	a	a	a	a
Poland	a	a	a	100	a	a	a	a	a	a
Spain	2,200	2,200	1,000	7,300	2,178	3,836	2,101	4,531	2,369	999
Togo[3]	a	a	a	a	2	3	200	421	NL	NL
USA	300	a	300	a	1,367	2,019	1,632	910	3,232	3,321
USSR	200	200	200	200	1,400	263	157	87	146	58
Venezuela	-	100	a	a	43	65	43	29	90	90
Ghana[3]									1.998[b]	a
Other	200	300	400	400	400	400	200	264	320	a
Total	8,700	4,300	3,200	8,800	6,770	7,813	5,910	7,482	13,456	6,696

1 FAO statistical reporting areas 21, 27, 31 and 34. (Figure 8-3)
2 Live weight equivalent
3 Togo became Ghana from 1978 onwards.
a None reported
b FAO estimate
NL Not listed

Table 8-29. Swordfish catches [1] (MT) from the western North Atlantic. [2] (Source: FAO, Yearbook of Fishery Statistics)

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Canada	4,800	a	100	a	2	21	15	110	3,053	50
China	0.0[b]	0.1[b]	NL	NL	NL	NL	NL	NL	NL	NL
Cuba	a	a	a	a	a	a	400	400	400	100
Ireland	a	a	a	a	a	3	1	a	a	a
Japan	100	600	300	300	406	290	416	364	269	267
Korea Republic	a	a	a	a	a	38	142	42	11	263
Mexico	a	a	a	a	a	NL	NL	NL	NL	NL
Morocco	a	a	a	a	a	a	a	a	a	a
Norway	a	a	a	a	a	a	a	a	a	a
Poland	a	a	a	100	a	a	a	a	6	a
Spain	a	a	a	a	a	a	a	a	a	a
Togo[3]	a	a	a	a	a	a	a	a	NL	NL
USA	300	a	300	400	1,158	1,924	1,927	910	3,232	3,321
USSR	a	a	a	a	a	a	a	a	a	a
Venezuela	a	100	a	a	43	65	43	29	90	90
Ghana[3]	NL	NL	NL	NL	NL	NL	NL	NL	a	a
Other[b]	a	100	200	200	200	200	150	170	160	280
Total	5,200	800	900	1,000	1,809	2,541	3,094	2,025	7,221	4,371

1 FAO statistical reporting areas 21 and 31. (Figure 8-3)
2 Live weight equivalent
3 Togo became Ghana from 1978 onwards.
a None reported
b FAO estimate
NL Not listed

Estimated catches of swordfish by foreign vessels participating in the squid trawl fishery in the FCZ was approximately 115.7 MT (255.2 thousand lb) for 1980, as extrapolated from observer data. Assuming virtually a 100 percent mortality rate and a value of $1.91 per lb, the 1980 value of this catch was approximately $487,000. This catch occurred in the area from Cape Cod to Cape Hatteras.

8.4.5 Conflicts Between Domestic and Foreign Fishing

There are basically two types of interactions between domestic and foreign fishermen: (1) foreign longline vessels - domestic longline vessels, and (2) foreign longline vessels - domestic recreational rod and reel vessels.

The domestic longline fleet has undergone rapid expansion during the last two years resulting in more direct gear conflict in the Gulf of Mexico and Atlantic waters.

There are numerous areas along the Atlantic and Gulf* coasts of the United States where U.S. sport fishermen come into direct contact with Japanese longliners. Some of these are in the Gulf of Mexico off Port Aransas, Texas and the Mississippi Delta; off Cape Hatteras, North Carolina; and off New Jersey and Maryland.

The various foreign participants in this fishery have manifested some negative interactions.

Japan: U. S. swordfishermen report the sighting of dead and mutilated swordfish where Japanese tuna longlines have been fishing. They are concerned about the loss of swordfish to the domestic fishery as a result of Japanese tuna longlining activities in the FCZ. They also report gear conflicts arising from failure of the Japanese to mark their longline with radar reflectors so that it can be seen at night. Consequently, gear tangles occur often resulting in loss of portions of the line. In addition, recent reports of extreme congestion on the fishing grounds, as well as direct damage to domestic gear by foreign vessels have been received by the Councils. Sports fishermen are also affected by the Japanese activities, and those fishing in the northern Gulf of Mexico report a decline in billfish catches which they link to the Japanese longlining fishing activities.

*Japan has agreed not to fish in the Gulf of Mexico during 1982 and 1983.

Canada: The Canadian fishery for swordfish officially reopened in 1979 under a quota system. At present Canadian swordfishing vessels do not have access to the U.S. FCZ. Canada plans to issue licenses to foreign vessels wishing to enter Canadian waters to purchase swordfish. Purchased Canadian swordfish will compete directly on the market with domestically caught fish. Prior to the official reopening of the Canadian fishery for swordfish in 1979, some Canadian vessels fished for swordfish without the sanction of the Canadian government and sold the catch to American vessels at sea. The Canadian catch was then landed at American ports as U.S. caught fish. Many fishermen report that the Canadian fish entering the U.S. under these conditions is of substandard quality and they feel that this adversely affects the market for their own fish.

- Other Countries: Fishermen report that activities of Spanish, Korean and Taiwanese vessels affect their catch and their freedom of swordfish fishing.

Fishing activities by foreign participants sometimes exert positive effects. These may manifest themselves in various forms. In the case of swordfish, Canadian fishing activities, prior to 1971, have resulted in the generation of data which are now being used in the understanding of this fishery. The Canadian fishing activities have also resulted in the sponsoring of many research activities including cooperative programs with U.S. research personnel. Furthermore, the Japanese longliners have provided considerable catch and effort data.

8.4.6 Interactions With Other Fisheries

The swordfish fishery interacts with foreign trawling for squid (Section 8.4.4), foreign longlining for tuna (Section 8.4.4), domestic longlining for tuna and the domestic recreational billfish fishery. The domestic longline fishery has recently begun to target tuna when the catches of swordfish are low and/or during high abundance of tuna (S. Berkeley, Research Associate, University of Miami, Miami, FL; pers. comm.).

By far, the most important interaction will be with the Atlantic billfishes. The five council billfish FMP defines OY as follows (Draft Fishery Management Plan and Regulatory Impact Review, February, 1982): "Optimum yield for billfishes is the amount of fish caught by the domestic fisheries in the FCZ and territorial sea pursuant to the provisions of the management plan."

8.5 Description of Economic Characteristics of the Fishery*

8.5.1 Domestic Harvesting and Processing Sector

8.5.1.1 Harvesting

The following tables (Tables 8-30 and 8-31) indicate ex-vessel prices as calculated from NMFS data 1960-80. Note that price had the most significant increase in 1972 after the FDA mercury concentration criteria virtually eliminated imports.

Ex-vessel prices vary considerably over the years. They are lowest in the summer with the increase in domestic production from New England landings. Prices also vary by size fish because there is a market preference for larger "steaks." Size classes and average range in price per pound for each weight class in 1978 are shown in Table 8-32. Prices generally increase approximately 25 cents per pound by each size classification (small, medium, large). Prices reported in Florida in 1979 were $1.52/pound for small, $1.82/pound for medium, and $2.08/pound for large (Cato and Lawlor, 1981). "Chunks" of partial swordfish (e.g., after shark attack) sell for negotiated prices normally below the small fish price.

Monthly swordfish ex-vessel price per pound dressed weight for the Florida East Coast is shown in Table 8-33. The mean prices were $2.30 per lb for 100+, $2.05 for 50-99 lb, $1.80 for 25-49 lb, and $1.55 for under 25 lb. Prices for 1981 followed the same general seasonal trend but averaged $1.00 per lb more for each size category (S.A. Berkeley, Research Associate, Univ. of Miami, Miami, FL; pers. comm.).

Harpooned fish command a higher price than longlined fish. Data gathered by NMFS on average value of harpooned versus longlined swordfish landed in New Bedford are shown in Table 8-34. The price differential shown by the data reflects both the higher value placed on harpooned fish as well as the fact that harpooned fish are larger on the average than longlined fish. During 1981, harpooned swordfish received a premium of $.25-$.75 per lb over the general swordfish price of $3.12-$4.00 per lb (E. Mills and F. Hoxsie, New England Advisory Panel; pers. comm.).

In northern waters, large swordfish represent a larger percentage of the catch. In the Gulf of Mexico, swordfish are expected to have a smaller size distribution or contain a larger percentage of smaller fish. The effect this has on percent of revenue (by size fish) for a Florida boat is shown in Table 8-35.

*See Holt (1978) for a socio-economic discussion of the California harpoon fishery.

Table 8-30. Historical swordfish prices by council area by gear type. (Source: Calculated from landings data in Appendix A.)

	NEFMC							MAFMC							SAFMC		GMFMC		ALL AREAS
	H	LL	TROLL LINE	FLOATING TRAP	HAND LINE	FISH TRAWL	AVG	H	LL	OTTER TRAWL	FISH TRAWL	HAND LINE	LOBSTER TRAWL	AVG	LL	AVG	LL	AVG	AVG PRICE
1960	0.40		0.36				0.38		0.54					0.54					0.46
1961	0.39		0.43	0.10			0.31	0.46		0.44				0.45					0.38
1962	0.44	0.42					0.43	0.54	0.61					0.58					0.51
1963	0.24	0.25					0.25	0.38	0.44	0.32				0.38	0.54	0.54			0.39
1964	0.24	0.30					0.27	0.33	0.34		0.27			0.31	0.48	0.48			0.35
1965	0.41	0.38					0.40	0.34	0.42		0.32			0.36	0.54	0.54			0.43
1966	0.45	0.39					0.42	0.43	0.46					0.45	0.50	0.50			0.46
1967	0.42	0.37					0.40		0.39					0.39					0.40
1968	0.53	0.45					0.49		0.49			0.46		0.48					0.49
1969	0.60	0.37	0.75				0.57	0.44	0.45			0.37		0.42			0.90	0.90	0.63
1970	0.62	0.52	0.86		0.76		0.69		0.55			0.55		0.55			0.72	0.72	0.65
1971	0.97						0.97	0.50					0.38	0.44			0.40	0.40	0.60
1972	1.41	1.34					1.38												1.38
1973	1.73	1.23				1.13	1.36	0.84	1.68					1.26			1.00	1.00	1.21
1974	1.22	0.87					1.05		1.40					1.40			1.73	1.73	1.39
1975	1.27	1.23					1.25		1.76					1.76			1.72	1.72	1.58
1976	1.60	1.31					1.46		1.61					1.61					

Table 8-31. Swordfish prices by council area for the years 1977-1980. (Source: NMFS, prelim. data.)

	NEFMC & MAFMC			SAFMC					GMFMC						ALL AREAS
	ME-NJ	DE,MD,VA	AVG	NC	SC	GA	FL.E. COAST	AVG	FL.W. COAST	AL	MS	LA	TX	AVG	AVG
1977	N/A	1.61	1.61	1.75	-	-	1.52	1.64	0.99	-	-	-	-	0.99	1.41
1978	1.30	1.51	1.41	1.52	1.41	2.00	1.76	1.64	1.78	-	-	-	-	1.78	1.61
1979	1.55	N/A	1.55	1.49	1.23	-	2.08	1.60	1.82	-	-	-	N/A	1.82	1.66
1980	1.79	N/A	1.79	1.44	1.37	-	1.50	1.44	2.50	-	-	-	N/A	2.50	1.91

Table 8-32. Ex-vessel price ranges for the various swordfish weight classes in 1978. (Source: American Swordfish Association as given in Booz et al., 1980)

Swordfish Size (lb)	Price Range ($)
0-25	0.90-2.40
26-49	1.10-2.60
50-99	1.30-2.80
100+	1.50-3.00

Table 8-33. Approximate ex-vessel price per pound dressed weight of swordfish by size and month on the Florida East Coast, 1980. (Source: S.A. Berkeley, Research Associate, Univ. Miami, Miami, FL; pers. comm.).

MONTH	WEIGHT CLASS (lb)			
	100+	50-99	25-49	Under 25
Jan	3.20	2.95	2.70	2.45
Feb	2.90	2.65	2.40	2.15
Mar	2.70	2.45	2.20	1.95
Apr	2.50	2.25	2.00	1.75
May	2.20	1.95	1.70	1.45
June	2.10	1.85	1.60	1.35
July	1.90	1.65	1.40	1.15
Aug	1.80	1.55	1.30	1.05
Sept	1.70	1.45	1.20	0.95
Oct	1.60	1.35	1.10	0.85
Nov	2.20	1.95	1.70	1.45
Dec	2.80	2.55	2.30	2.05
Mean	$2.30	$2.05	$1.80	$1.55
Standard Deviation	0.52	0.52	0.52	0.52

Table 8-34. Ex-vessel price for harpooned versus longlined swordfish from 1974 to 1978, New Bedford, Massachusetts, swordfish summary. (Source: NMFS)

	Harpooners				Longliners			
	Trips	Pounds	Value ($)	Average Price[a] ($/lb)	Trips	Pounds	Value ($)	Average Price ($/lb)
1978 (Jan.-July)	24	213,952	424,618	1.98	5	110,518	183,150	1.66
1977	60	249,013	423,355	1.70	16	397,403	593,641	1.49
1976	50	203,866	393,830	1.93	48	815,900	1,378,156	1.69
1975	39	244,195	380,418	1.56	54	836,353	1,231,190	1.47
1974	32	267,588	351,742	1.31	18	453,837	479,373	1.06

a. Average price differential favoring harpooners primarily reflects larger size and secondarily reflects premium for harpooned fish.

Table 8-35. Revenue by size fish from a 36-foot swordfish vessel using a 10 mile longline on the South Florida Atlantic Coast, 1979. (Source: Cato and Lawlor, 1981)

	$/lb	Total pounds (lb)	Total revenue ($)	Percent of Revenue
Large Swordfish	2.08	45,834	95,308	69
Medium Swordfish	1.82	16,161	29,485	21
Small Swordfish	1.52	8,631	13,112	10
TOTALS		70,626	137,905	

Share systems are the common method of payment for commercial fishermen. In New England, these share systems are formally written in the contracts for the unionized fishermen but similar share systems are in use for nonunionized fishermen. Smith and Peterson (1977) have provided a description of conventional share systems in use in New England. The share system specifies which costs are to be taken out of the gross revenues, subtracts them and then divides the remainder between the boat owner and the crew according to a predetermined ratio. A number of expenses are subtracted from the crew share before it is divided. A typical system is the 50/50 split. In this system, operating expenses for fuel, ice, food, etc., are subtracted from gross revenues. The captain receives 10 percent of the amount remaining after expenses have been subtracted. Half of the remainder goes to the boat owner, and the other half is divided among the crew. Share systems are the typical method of payment for the large swordfish vessels. Small vessels, with only one or two crew members, may be paid by other methods, such as a flat fee or a percentage of total earnings.

The typical method of crew share in the small boat longline fishery on Florida's East Coast is as follows (Cato and Lawlor, 1981): "...trip expenses for bait, lights, ice, fuel, batteries, groceries and miscellaneous costs to be deducted from total revenues with the remainder divided among the boat (40 percent) and the captain and crew (60 percent). The 60 percent is then divided by the captain (35 percent), first mate (15 percent) and crewman (10 percent)."

Share systems associated with shrimp vessels converting to swordfish longlining for a portion of the year are discussed in Section 8.5.1.3.

During 1979, the necessary investment capital to enter the small-boat swordfish longline fishery on the South Florida Atlantic Coast was approximately $77,000 (Table 8-36). A sample costs and return budget for a boat of this size using a 10-mile longline is shown in Table 8-37.

The 36 foot Florida swordfish boat earned $142,327 in 1979. Fixed costs were $16,255, variable costs $70,259 (including crew share) (Table 8-37). Net revenue to owner/captain was $55,813 of which $39,044 was captain's share and $16,769 was a 22 percent return on a total investment of $76,855 (Table 8-37).

Table 8-36. Estimated value of a 36-foot swordfish vessel using a 10-mile longline on the South Florida Atlantic Coast, 1979 (Source: Cato and Lawlor, 1981).

Item		1979 Value[c]		19__ Value[b]
		——Dollars——		
Hull		47,250		____
Engine		11,000		____
Electronics[a]				
fathometer (2 @ 500)	1,000		____	
radar	5,000		____	
loran	2,000		____	
VHF	500		____	
single side band	500		____	
CB	100			
		9,100		____
Longline				
reel and leader cart	3,500		____	
hiflyers (.8 per mile) including strobe, rod, radar reflector, buoy	1,200		____	
tarred main line - 53,300 feet (5,330 per mile)	2,239		____	
100-foot drops, 250 feet apart, from buoys and hiflyers - 21,200-foot line	742		____	
bullet buoys, 203 (20.3 per mile)	609		____	
gangions, 200, 150 feet each monofilament (20 per mile)	700		____	
snaps, 409 (40.9 per mile)	385		____	
hooks, 200 (20 per mile)	130			
		9,505		____
Total investment		76,855		

[a]Some boats do not use this full array of electronic equipment and thus costs may vary slightly among boats.

[b]This column can be used to estimate cost in a future year.

[c]These values represent used values of the vessel and equipment except for the longline. Replacement values would be higher.

Table 8-37. Costs and returns budget for a 36-foot swordfish vessel using a 10-mile longline on the South Florida Atlantic Coast, 1979. (Source: Cato and Lawlor, 1981).

		1979						19 Budget[c]				
	Price per Pound (Dollars)	Number of fish		Pounds or Units		Dollars		Units or Pounds per Trip x	Number of trips x	Price or Cost per Pound or Unit =	Total Revenue or Cost	Revenue or Cost per Trip
		Total	Per Trip[a]	Total	Per Trip[a]	Total	Per Trip[a]					
										Dollars		
Revenue												
Large swordfish	2.08	257	2.9	45,834	533	95,308	1,108					
Medium swordfish	1.82	224	2.6	16,161	188	29,485	343					
Small swordfish	1.52	260	3.0	8,631	100	13,112	152					
Total		741	8.6	70,626	821	137,905	1,603					
Swordfish chunks	1.50	26	.3	1,331	15	1,998	23					
Tuna	.82	34	.4	2,142	25	1,751	20					
Other	.89	—	—	759	9	673	8					
Total		801	9.3	74,858	870	142,327	1,654					
Expenses:												
Variable												
Bait (pounds)				11,024	128	6,134	71					
Cyalume lights (number)				12,900	150	10,191	119					
Ice (pounds)				28,566	332	592	7					
Fuel (gallons)				10,320	120	8,978	104					
Batteries (number)				1,290	15	889	10					
Groceries				—	—	3,440	40					
Misc. (gloves, saws, etc.)						550	6					
Crewshare						27,888[d]	324					
Longline repairs and maintenance												
mainline reel (feet)				7,980	93	336	4					
gangions				43	1	2,408	28					
Bullet buoys (number)				30	(b)	90	1					
hooks (number)				2,580	30	1,548	18					
strobes (number)				860	10	99	1					
Hiflyers (number)				2	(b)	360	4					
snaps (number)				860	10	808	9					

Continued

Table 8-37. (continued)

	Price per Pound (Dollars)	1979 Number of fish Total	Number of fish Per Trip[a]	Pounds or Units Total	Pounds or Units Per Trip[a]	Dollars Total	Dollars Per Trip[a]	19 Budget[c] Units or Pounds per Trip x	Number of trips x	Price or Cost per Pound or Unit =	Total Revenue or Cost	Revenue or Cost per Trip
									———Dollars———			
buoys drops (feet)				2,120	25	74	1	____	____	____	____	____
miscellaneous						300	3	____	____	____	____	____
Vessel repair and maintenance												
hull						2,362	27		____	____	____	____
engine						1,100	13		____	____	____	____
electronics						2,112	25	____	____	____	____	____
Total variable costs						70,259	817					
Fixed												
Depreciation												
longline						3,168	37				____	____
hull						3,225	38				____	____
engine						1,143	13				____	____
electronics						2,916	34				____	____
Insurance						2,660	31				____	____
Interest						2,659	31				____	____
Dockage						432	5				____	____
Vessel registration						52	1			____	____	____
Total fixed costs						16,255	189				____	____
Total Costs						86,514	1,006				____	____
Net Revenue to owner/captain's crewshare, management and capital						55,813	649				____	____

[a] Totals may not add due to rounding. Average number of trips was 86.

[b] Less than one half.

[c] This column can be used in a future year.

[d] Does not include captain's share of $39,044. This is included in the net revenue to owner/captain of $55,813.

8.5.1.2 Processing

Swordfish are normally dressed at sea by the fisherman who removes the head and tail, guts the fish and scrubs out the body cavity. The only additional processing required before the fish reaches the consumer is the removal of the center bone and cutting into steaks. Waste is only 10 percent to 20 percent of the dressed weight of the fish. Steaks which are not to be sold fresh chilled are frozen.

Only eight processors of swordfish, all located in New England, are listed in "Processors of Fishery Products in United States," 1976, published by the National Marine Fisheries Service, Washington, D.C. Many other fish processors handle swordfish but have been reluctant to admit it. Thus, actual numbers of processors and wholesalers of swordfish are not known at this time.

A total of 1,196 fish processing establishments operated on the Atlantic and Gulf coasts in 1979 (U.S. Department of Commerce, Fisheries of the U.S., 1980). Plants involved in processing fish fillets and steaks numbered 127 in 1977, 146 in 1978, 158 in 1979, and 167 in 1980. Smith and Peterson (1977) report that a substantial number of the fish processing plants in New England have underutilized capacity.

8.5.1.3 Probability of Increasing Fishing Effort

Business decisions to convert existing fishing vessels to longline swordfishing are based on the relative attractiveness of swordfishing compared to alternative fisheries. In the South, the poor economic condition in the shrimp fishery offers the largest number of potential immediate conversions. Many shrimpers in the Gulf of Mexico have attempted swordfish longlining. However, because of travel distance, weather conditions, and other factors, most of the Gulf shrimpers are now finding more success with closer inshore bottom longlining for snapper amd grouper. Commercial snapper/grouper landings compared to swordfish landings in Texas reflect this trend (Orman Farley, NMFS; pers. comm.).

It has been estimated that small boat longlining on the East Coast of Florida can be more profitable than mackerel fishing for an equivalent boat (James Cato, Associate Professor, Univ. FL, Gainesville, FL; pers. comm.). However, it is also recognized that the fishing conditions are quite different. Longlining is further offshore, requiring multiple days of night fishing; considerably more stress is placed on the crew and boat than most other types of commercial fishing.

Mackerel Boat-Type Conversions

Cato and Lawlor (1981) report that "boats used in the King and Spanish mackerel fishery and the spiny lobster fishery could be converted to swordfishing with minimal physical changes." As an example, estimated costs and returns for a large Lower Florida Atlantic Coast mackerel net boat were given (Table 8-38). They analyzed the changes as follows:

Increased Costs		Decreased Costs	
Bait	$ 6,134	Fuel (12,211 - 8,978) =	$ 3,233
Cyalume lights	10,191	Crewshare (51,324 - 27,888) =	23,436
Batteries	889	Spotter plane	7,852
Groceries	3,440	Ice (2,536 - 592) =	1,944
Longline r & m	6,023	Gear (1,443 - 550) =	893
Longline depreciation	3,168	Net r & m	1,784
		Net depreciation	7,094
Decreased Income		**Increased Income**	
	0	Fish sales	
		(142,327 - 130,870) =	$11,457
Loss effect	$29,845	Gain effect	$57,693

Gain effect	$57,693
Loss effect	-29,845
Profit from change	$27,848

Table 8-38. Estimated costs and returns for large lower Florida Atlantic Coast mackerel net boats, 1979. (Source: Cato and Lawlor, 1981)

Item		Dollars
Revenue		
king mackerel		25,760
Spanish mackerel		59,764
other fish		45,346
Total		130,870
Variable Costs		82,352
fuel and oil	12,211	
crewshare and picking labor	51,324	
spotter plane	7,852	
ice	2,536	
raingear and gloves	1,443	
hull and engine repair and maintenance	4,888	
net repair and maintenance	1,784	
electronics repair and maintenance	314	
Fixed Costs		18,407
hull and engine depreciation	6,269	
electronics depreciation	363	
net depreciation	7,094	
insurance, interest, registration, dockage	4,681	
Total Costs		100,759
Net returns to owner's labor, management and investment		30,111

"By changing to swordfishing, the former mackerel fisherman realizes an additional $11,457 in income. Decreased costs resulted from using less fuel, ice and gear, paying a smaller crewshare, not requiring a spotter plane, and not having expenses for net repair and maintenance and net depreciation. Increased costs resulted from bait, cyalume lights, batteries and groceries. Costs will also be incurred from longline repair and maintenance and from depreciating the newly acquired longline and reel. The net effect of switching is then $27,848. This analysis means the mackerel fisherman will make an additional $27,848 by making the switch for a total income of $57,959. This result is slightly higher than that earned from the 36 foot swordfish boat. The larger vessel will consume more fuel than the smaller vessel. However, this difference was not calculated for this partial budget analysis."

Shrimper-Type Conversions

The only published information available on this type of conversion is from the Gulf of Mexico in a study by Nichols et al. (1980). The following tables and much of the discussion is taken directly from this work. For further information please see the original article (reference contained in Section 9.0).

The initial total investment expenditure for equipping a 75 foot shrimp vessel with 19 miles of longline gear ranged from $26,105 without radio beacons to $31,105 with radio beacons (Table 8-39).

Nichols et al. (1980) assumed a basic operating concept as follows: (1) a seasonal fishing activity with the summer months devoted entirely to shrimping and winter months entirely to swordfish longlining; (2) in some years the cash flow to shrimping can be quite high through November and December, but these are also important months for swordfishing; (3) for this analysis the shrimping season extends from May through October and swordfishing begins in November and runs through April; (4) once the swordfish activity leaves the Gulf after April, the fishing activity of the fishermen is again directed toward shrimp; (5) using available shrimp historical monthly cash flow data it was found that roughly 39 percent of the revenue was earned by the shrimper during the November-April period

Table 8-39. Initial investment expenditure for equipping a 75 foot shrimp vessel with 19 miles of longline gear, Spring 1980. (Source: Nichols et al., 1980)

	Cost/Unit	Amount	Value
1. Fishing Gear			
Line	$ .04 per ft	115,000 ft	$ 4,600
Monofilament	8.00 per lb	80 lbs	640
Hooks	.50 ea.	1,500	750
Snaps	.91 ea.	1,100	1,001
Floats			
30 inch	7.00 ea	200	1,400
50 inch	25.00 ea.	20	500
Hiflier poles	24.00 ea.	20	480
Radar reflectors	12.00 ea.	20	240
Strobe lights	50.00 ea.	10	500
Chemical light stocks	.90 ea.	3,000	2,700
Knives	7.00 ea.	4	28
Batteries for Strobe lights	1.00 ea.	36	36
Rubber bands			6
Lead Ballast	.50 per lb	100 lbs	50
Subtotal, Fishing gear (19 miles)			$12,920
Radio beacons (optional)	$5,000.00 per set	1 set	5,000
Subtotal, Fishing gear with radio beacons (19 miles)			$17,920
2. Deck or Dry Equipment			
Winch installation			
winch	$6,500.00 ea.	1	$ 6,500
parts and labor	$1,500.00		1,500
Subtotal, winch installation			$ 8,000
Fairlead blocks	30.00 ea.	2	60
Gangion spools	60.00 ea.	7	420
Gaffs	30.00 ea.	2	60
Baiting table	75.00 ea.	1	75
Buoy racks or cages	400.00 ea.	1	400
Subtotal, Deck Equipment			$ 9,015

Table 8-39. (continued)

	Cost/Unit	Amount	Value
3. Electronic Equipment			
Water temperature gauge	$ 350.00 ea.	1	$ 350
Subtotal, Electronic Equipment			$ 350
4. Structural Modifications			
Cutting bulwarks			$ 50
Enlarging crew quarters			1,700
Installing steering station			2,000
Sectioning boat			70
Subtotal, Structural Modifications			$ 3,820
Total investment expenditure (without radio beacons)			$26,105
Total investment expenditure (with radio beacons)			$31,105

while approximately 41 percent of the costs were accrued during this time. The budget shown in Table 8-40 reflects these costs and returns divided seasonally; (6) landings reflected for the May-October period is 61 percent; and (7) the crew share allowed some of the variable costs to be assumed by the crew. Under this arrangement the cost of ice and packing are deducted from the total revenue figure. Then the remaining revenue is divided such that the crew receives 40 percent and the owner receives 60 percent. The crew is responsible for groceries, any personal expenses, and also, 20 percent of the fuel costs.

The budget shown in Table 8-40 shows a positive return above variable costs for both seasons but a loss of $32,503 for the year when all fixed costs are included. It is important to note that the November-April period results in a positive return above variable costs of $3,806 and any alternative activity such as swordfishing should yield at least this much as a contribution towards fixed costs.

These partial budgets were developed by Nichols et al. (1980) because the costs incurred by the owner, crew and captain are different.

For the swordfish analyses it was assumed that (Nichols et al., 1980) (1) the average catch was 600 lb per day; (2) the average size during the spring of 1980 in the Gulf was estimated to be 65-70 lb; (3) the average ex-vessel price for this size swordfish was $2.60 per lb; (4) the vessel had already been purchased and used as a shrimp boat; (5) all depreciation and interest on the vessel itself were charged against the shrimping side of the operation; and (6) there were no changes in the rates of depreciation as a result of the longlining. In addition, under the crew share arrangement most prevalent among Texas longliners in early 1980, the captain received five percent of the catch as a bonus. Then the remainder of the catch was divided such that the boat got 40 percent of the remaining 95 percent or 38 percent of the total catch; the crew got 60 percent of the remainder or 57 percent of the total catch. The crew is responsible for the bait, ice, fuel, replacement of damaged or lost line, groceries, light sticks, and their share (57 percent) of the freight and handling on the fish. This crew share arrangement shifts the risk of the trip from the owner of the boat to the crew. For this reason, there has been experimentation with alternative share arrangements. One alternative is a 50-50 split between boat and crew.

Table 8-40. Estimated average cost and returns by seasons for the owner of a 75 ft Gulf shrimp vessel, 1979-80[1/] (Source: Nichols et al., 1980)

Revenue and Cost Items	November-April	May-October	Total
1. Gross receipts (shrimp)			
30,500 @ 3.00		$91,500	
19,500 @ 3.00	$58,500		
Total			$150,000
2. Variable Costs			
Ice	1,120	1,612	
Fuel	15,773	23,861	
Nets and supplies	6,516	10,191	
Repair and maintenance	6,715	9,663	
Crew share	23,400	36,600	
Packing	1,170	1,830	
Total	54,694	83,757	138,451
3. Return above variable cost	3,806	7,743	11,549
4. Fixed Costs			
Insurance			7,073
Depreciation			10,833
Overhead			5,896
Interest			20,250
Total Fixed Costs			44,052
5. Total Costs			182,503
6. Return to owner's equity and management			-32,503

1/ Share arrangement as follows: ice and packing are taken off the top (shared proportionally); remaining revenue is shared, with owner receiving 60 percent and crew 40 percent; crew pays for groceries, personal expenses and 20 percent of fuel.

Estimated costs and returns for the owner, crew and captain are shown in Tables 8-41, 8-42 and 8-43 respectively. The return to the owner was $46,786, $33,611 to a crew of five and a bonus of $13,622 to the captain.

Budgets for a joint shrimp/swordfish season are shown for owner and crew in Tables 8-44 and 8-45; both reflect positive returns, $10,477 to the owner and $58,742 to the crew.

Finally, a breakeven analysis was performed by Nichols et al. (1980) to calculate either the price or the quantity necessary for the operation to exactly cover all costs or to just "breakeven." Separate analyses were made for the owner and crew because both pay part of the expenses under the assumed swordfishing share system. (See Nichols et al., 1980 for the basic formula used in calculating the breakeven price and quantity.) Estimated breakeven prices for swordfish at alternative levels of landings, for owner and crew and with a 60/40 share arrangement indicated a price of between $0.64 - $2.14 assuming a catch of 600 lb per night (Table 8-46). Estimated breakeven landings assuming an average price of $2.60 per lb ranged from 10,473 - 46,504 lb in the six month season (Table 8-47). The combined relationship of price and quantity is shown graphically in Figure 8-13.

As mentioned previously, the 50/50 share arrangement is gaining popularity and estimated breakeven prices assuming an average landing of 57,600 lb during the six month season ranged between $1.06 and $2.01 per lb (Table 8-48). A graphical presentation of the price/quantity relationship is shown in Figure 8-14.

In conclusion, estimates for 1980 (Nichols et al., 1980) indicated that swordfish longlining could be sufficiently profitable to turn a negative cash flow from shrimping into a positive annual cash flow (shrimping and swordfishing). However, available data indicate swordfish longlining in 1981 did not produce sufficient profits to result in a positive annual cash flow (J. P. Nichols, Professor, Texas A&M Univ., College Station, TX; pers. comm.).

Table 8-41. Estimated average 1980 cost and returns for the owner of a 75 ft Gulf vessel engaged in swordfish longlining for a six month period. (Source: Nichols et al., 1980)

Revenue and Cost Items	Value	Total
1. Gross receipts from operation		
Swordfish—57,600 lb @ $2.60	$149,760	
Total returns		$149,760
2. Share accruing to owner (38%)		
Swordfish—21,888 lb @ $2.60	56,909	56,909
3. Variable Costs		
Freight & handling		
Swordfish—21,888 lb @ $.20	4,378	
Winch and electronic maintenance	600	
Equipment expense	1,015	
Total variable costs		5,993
4. Returns above variable costs		50,916
5. Fixed Costs[1]		
Depreciation	1,604	
Interest	2,520	
License	6	
Total Fixed Costs		4,130
6. Total Costs		$ 10,123
7. Returns to Boat's fixed costs, owner's equity and management		$ 46,786

1 This includes only fixed costs directly associated with longlining enterprise.

Table 8-42. Estimated average 1980 cost and returns for the crew of a 75 ft Gulf vessel engaged in swordfish longlining for a six month period. (Source: Nichols et al., 1980)

Revenue and Cost Item	Value	Subtotal	Total
1. Gross receipts from operation			
Swordfish—57,600 lb @ $2.60	$149,760		
Total returns			$149,760
2. Share accruing to crew (57%)	85,363		85,363
3. Variable Costs			
Ice - 960 bars @ $4.00	3,840		
Fuel - 12,000 gal @ $.90	10,800		
Groceries - 8 trips @ $600	4,800		
Bait - 40,000 lb @ $.36	14,400		
Light sticks - 11,136 sticks @ $.90	10,022		
Subtotal, Variable		$43,862	
Replacements			
Line - 10,032 ft @ $.04	401		
Monofilament - 8 lb @ $8.00	64		
Hooks - 150 @ $.50 ea.	75		
Snaps - 110 @ $1.01 ea.	111		
Bar buoys - 2 @ $36.50 ea.	73		
Net buoys - 24 @ $7.00 ea.	168		
Strobe lights - 1 @ $50.00 ea.	50		
Hiflier poles - 2 @ $25.00 ea.	50		
Radar reflectors - 2 @ $15.00 ea.	30		
Batteries, knives, weights, and rubber bands	302		
Subtotal, Replacement		$ 1,324	
Freight & handling - 32,832 lb @ $.20		$ 6,566	
Total Variable Costs			$ 51,752
4. Return to Crew (5 members)			$ 33,611
Return to individual members of the crew			$ 6,722

Table 8-43. Estimated average 1980 costs and returns for a captain of a 75 ft Gulf vessel engaged in swordfish longlining for a six month period. (Source: Nichols et al., 1980)

Revenue and Cost Items	Value	Total
1. Gross receipts from operation		
Swordfish - 57,600 lbs. @ $2.60	$149,760	
Total returns		$149,760
2. Share accruing to captain (5%)		
Swordfish - 2,880 lbs. @ $2.60	7,488	
Return to captain as a crew member	6,710	
Total returns to captain		14,198
3. Variable costs		
Freight & handling swordfish - 2,880 lbs. @ $.20	576	
Total variable costs		576
4. Net returns to captain		$ 13,622

Table 8-44. Estimated average 1980 annual costs and returns for the owner of a 75 ft Gulf vessel engaged in six months of shrimping and six months of longlining.[1/] (Source: Nichols et al., 1980)

Revenue and Cost Items	Value	Total
1. Gross receipts from operation		
Shrimp (owner's share)—		
18,300 lbs. @ $3.00	$54,900	
Swordfish (owner's share)—		
21,888 lbs. @ $2.60	56,909	
Total Returns to Owner		$111,809
2. Variable Costs		
Ice—403 bars @ $4.00	1,612	
Fuel—26,512 gals @ $.90	23,861	
Nets & Supplies	10,191	
Repair & maintenance	10,263	
Packing, freight & handling	6,208	
Equipment expense	1,015	
Total Variable Costs		$ 53,150
3. Returns to Owner above variable costs		$ 58,659
4. Fixed Costs		
Fishing license	6	
Depreciation	12,437	
Insurance	7,073	
Interest	22,770	
Overhead	5,896	
Total Fixed Costs		$ 48,182
5. Total Costs		$101,332
6. Returns to Fixed Cost, Owner's Equity & Management		$ 10,477

1/ Calculated from Tables 8-40 and 8-41.

Table 8-45. Estimated average 1980 annual costs and returns for the crew of a 75 ft Gulf vessel engaged in six months of shrimping and six months of swordfish longlining.[1] (Source: Nichols et al., 1980)

Revenue and Cost Items	Value	Total
1. Gross receipts from operation		
Shrimp (Crew's share)— 12,200 lb @ $3.00	$36,600	
Swordfish (Crew's share)— 32,832 lb @ $2.60	85,363	
Total returns to crew		$121,963
2. Variable Costs		
Bait—40,000 lb @ $.36	14,400	
Fuel—18,628 gal @ $.90	16,765	
Ice—1,229 bars @ $4.00	4,916	
Groceries	7,950	
Light sticks— 116/day or 11,136 @ $.90	10,022	
Replacement	1,382	
Packing, freight & handling		
Shrimp—12,200 lb @ $.10	1,220	
Swordfish—32,832 lb @ $.20	6,566	
Total variable costs		$ 63,221
3. Returns to crew		$ 58,742

[1] Calculated from Tables 8-40 and 8-42.

Table 8-46. Estimated breakeven prices for swordfish at alternative levels of landings, owners and crew with 60/40 share arrangement, Texas, 1980. (Source: Nichols et al., 1980)

Quantity		Breakeven price per pound			
		Requirements for Vessel Owner		Requirements For Crew	
Per Night	Per Season[1]	Returns to Shrimping Alternative	Including one-half vessel fixed costs	Without opportunity cost	With opportunity cost
pounds		dollars			
100	9,600	2.81	7.81	8.46	11.83
200	19,200	1.51	4.00	4.33	6.01
400	38,400	.85	2.10	2.26	3.10
600[2]	57,600	.64	1.47	1.57	2.14
800	76,800	.53	1.15	1.23	1.65
1000	96,000	.46	.96	1.03	1.36
1200	115,200	.42	.83	.89	1.17
1400	134,400	.39	.74	.79	1.03

1 Season is assumed to consist of 8 trips averaging 12 days of fishing each over a six month season.

2 Corresponds with estimated "typical" landings used in preparing cost and returns budgets shown in Tables 8-41 and 8-42.

Table 8-47. Estimated breakeven landings for swordfish at alternative prices, owner and crew, Texas, 1980. (Source: Nichols et al., 1980)

	Breakeven quantity per season [1]			
	Requirements for Vessel Owner		Requirements For Crew	
Price per Pound	Returns to Shrimping Alternative	Including one-half vessel fixed costs	Without opportun-ity cost	With opportunity cost
dollars		pounds		
1.50	19,344	56,215	60,980	85,854
2.00	13,963	40,599	44,041	62,006
2.20	12,567	36,539	39,637	55,805
2.40	11,425	33,218	36,033	50,732
2.60[2]	10,473	30,450	33,031	46,504
2.80	9,667	28,107	30,490	42,927
3.00	8,976	26,100	28,312	39,861
3.20	8,378	24,360	26,425	37,204
3.40	7,854	22,837	24,773	34,878

1 A season is assumed to consist of 96 fishing days (8 trips average 12 fishing days each) over a six month season.

2 Corresponds with estimated price received for "typical" vessel as used in cost and returns budgets, Tables 8-41 and 8-42.

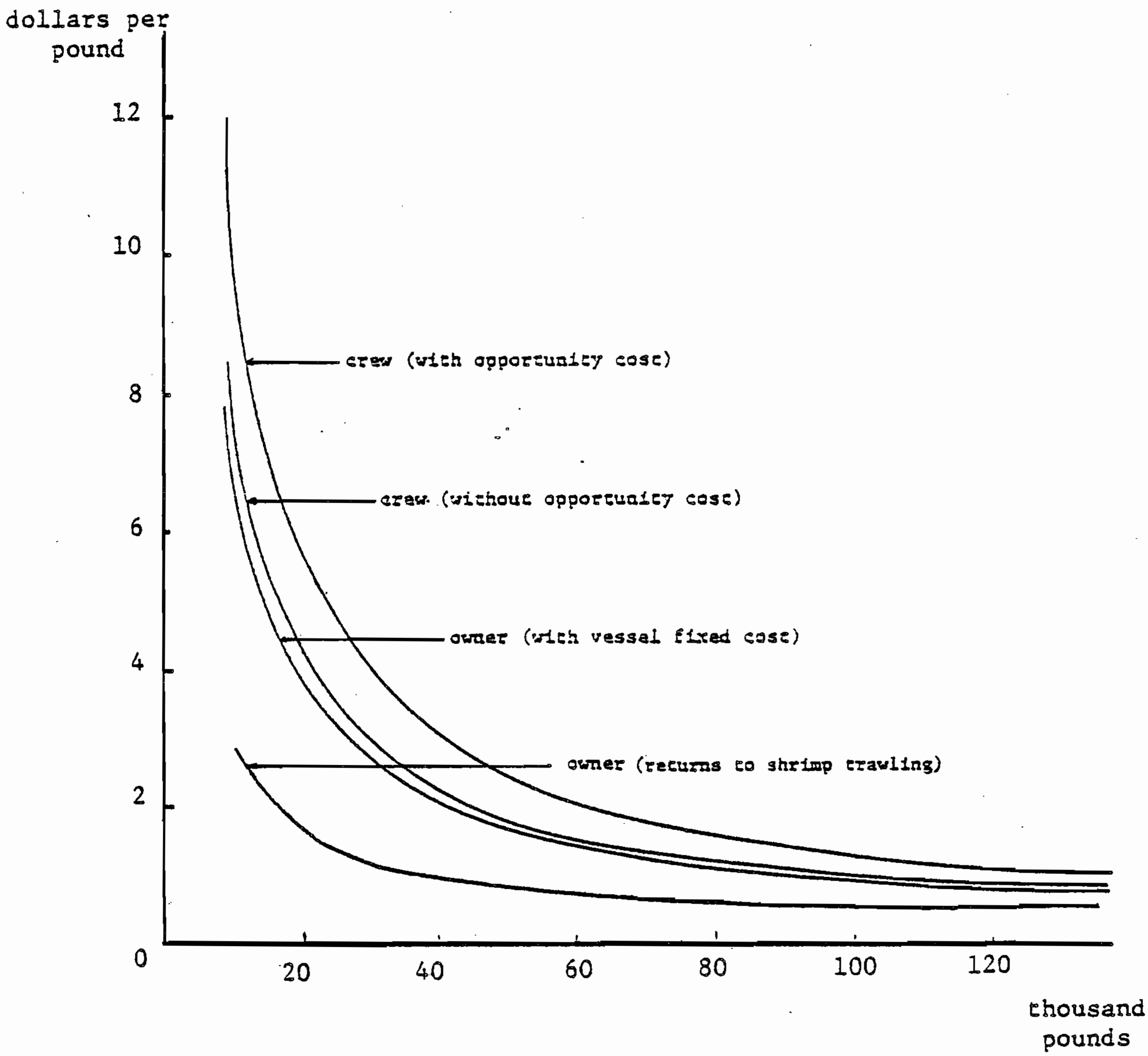

Figure 8-13. Estimated breakeven prices and landings for swordfish longlining with 60-40 crew/owner share system; six months combined with shrimp trawling, Gulf of Mexico, 1980. (Source: Nichols et al., 1980)

Table 8-48. Estimated breakeven prices for swordfish at alternative levels of landings, owners and crew with 50/50 share arrangement, Texas, 1980. (Source: Nichols et al., 1980)

	Breakeven price per pound [1]			
	Requirements for Vessel Owner		Requirements For Crew	
Quantity per Season[1]	Returns to Shrimping Alternative	Including one-half vessel fixed costs	Without opportunity cost	With opportunity cost
pounds	dollars			
9,600	7.07	11.07	5.33	9.37
19,200	3.63	5.63	2.77	4.79
38,400	1.91	2.92	1.48	2.49
57,600[2]	1.35	2.01	1.06	1.73
76,800	1.06	1.56	.84	1.35
96,000	.89	1.29	.71	1.12
115,200	.77	1.11	.63	.96
134,400	.69	.98	.57	.85

1 Season is assumed to consist of 8 trips averaging 12 days of fishing each over a six month season.

2 Corresponds to estimated "typical" landings used in preparing cost and returns budgets shown in Tables 8-41 and 8-42.

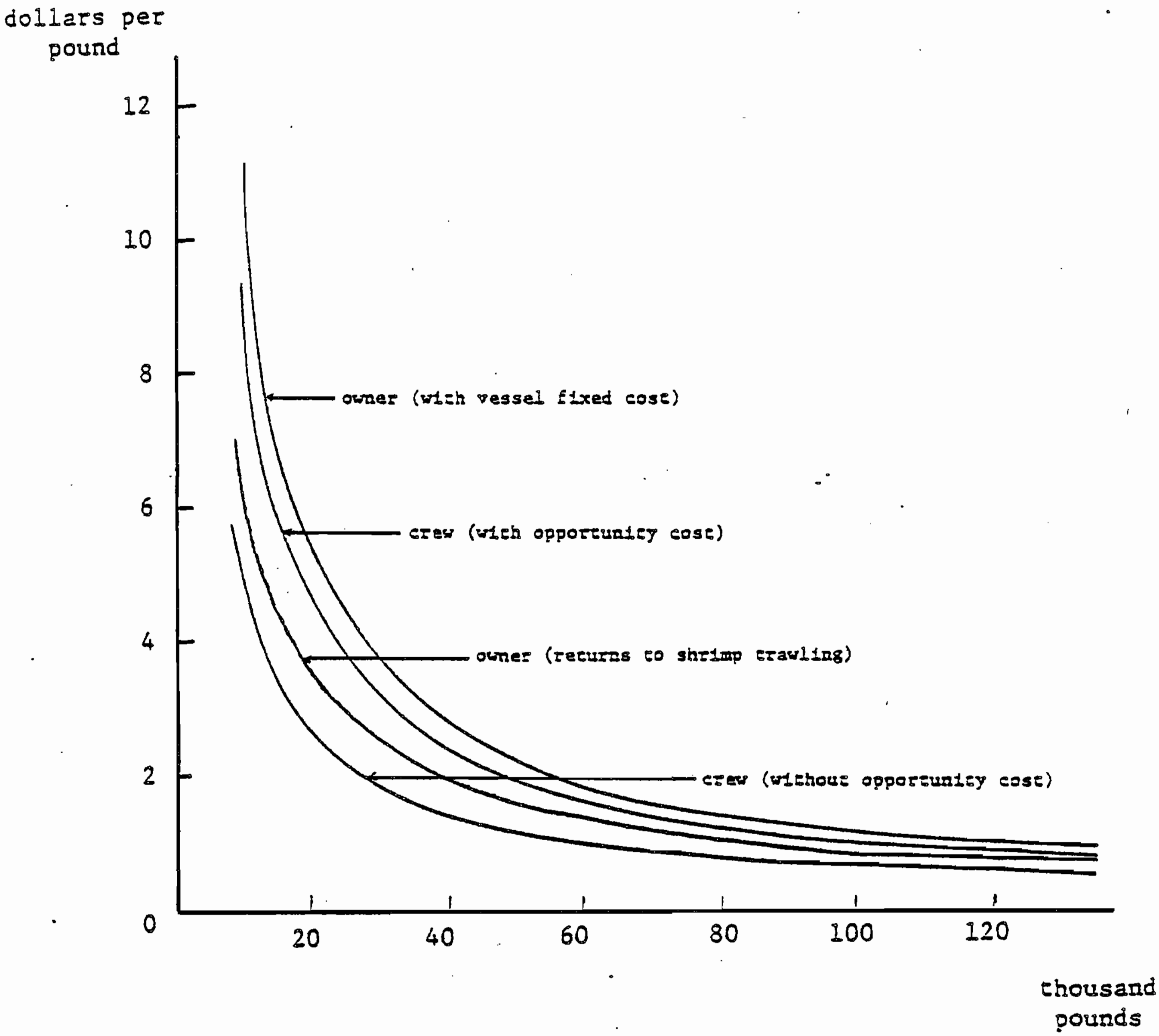

Figure 8-14. Estimated breakeven prices and landings for swordfish longlining with 50-50 crew/owner share system; six months combined with shrimp trawling, Gulf of Mexico, 1980. (Source: Nichols et al., 1980).

Swordfish advisory panel members unanimously agree that profits are declining and that the swordfish fishery is no longer expanding as rapidly. The yield-per-recruit (YPR) model developed by Berkeley and Houde (1980, 1981) also supports decreasing economic returns. Table 8-49 is calculated from the yield-per-recruit model (both sexes). It indicates predicted percent changes in landings with percent increases in fishing effort (as estimated by F level). Expanding effort will not only decrease landings but the resulting smaller average size fish will bring lower dollar value per pound.

When value by size fish is incorporated, total revenue to the industry will decrease with any increasing effort on females or males (Table 8-50).

8.5.1.4 International Trade

From 1960 to 1970, imports accounted for a large portion of total domestic consumption (Table 8-51). After 1970 imports were severely restricted by FDA requirements on mercury content. Restricted imports resulted in a substantial price increase for domestic swordfish.

Although few swordfish are currently being imported or exported, it is recognized that swordfish caught by Canadian boats are being sold to American fishermen at sea, who then land them in the United States (National Fisherman, March 1979). Prices paid to the Canadians for their swordfish are about half the ex-vessel market price in the United States. Some U.S. fishermen express concern over this situation, since they feel that swordfish brought in under these conditions are of inferior quality and tend to drive down prices for their own catches.

Table 8-49. Change in landings and average size with changing fishing effort based on yield-per-recruit model.*

Fishing Mortality (Theoretical F)	Cumulative % Change in F from three base levels			Yield-Per-Recruit Kilos	Yield-Per-Recruit Pounds	Cumulative % change in Landings from three base levels			Average Size Kilos	Average Size Pounds
.01	- 93.8			3.97	8.75	-83.3			79.40	175.05
.06	- 62.5			15.98	35.23	-32.7			66.58	146.78
.11	- 31.3			21.01	46.32	-11.5			56.78	125.18
.16	Existing			23.75	52.36	Existing			51.63	113.82
.21	+ 31.3	Existing		24.72	54.50	+ 4.1	Existing		46.64	102.82
.26	+ 62.5	+23.8	Existing	25.34	55.87	+ 6.7	+2.50	Existing	43.69	96.32
.31	+ 93.8	+47.6	+19.2	25.42	56.04	+ 7.0	+2.80	+0.01	41.00	90.39
.41	+156.3	+95.2	+57.7	25.16	55.47	+ 5.9	+1.80	-0.01	37.00	81.57
.51	+218.8	+142.8	+96.1	24.63	54.30	+ 3.7	-0.01	-0.03	33.74	74.38
.61	+281.3	+190.4	+134.6	24.36	53.70	+ 2.6	-0.02	-0.04	32.05	70.66
.71	+343.8	+238.1	+173.1	23.75	52.36	0	-0.04	-0.06	30.06	66.27

*Based on yield-per-recruit estimates of Berkeley and Houde (1981) for both sexes combined.

M = .19
K = .0949
L_c = 118 cm (age II, 18.6 kg)
F = .16-.21
F_{max} = .35

Table 8-50. Industry revenue adjusted for value by size fish in the market.

MARKET CATEGORY (dressed weight)	MEAN 1980 Ex-vessel price/lb (Florida)	AGE OF FISH (YR)	
		FEMALES	MALES
PUPS Less than 25 lb	1.55	0.0-1.6	0.0-1.3
SMALL 25-49 lb	1.80	1.6-2.7	1.3-2.8
MEDIUM 50-99 lb	2.05	2.7-4.6	2.8-5.5
LARGE Over 100 lb	2.30	4.6+	5.5+

FISHING EFFORT (F LEVEL)	PERCENT OF FEMALES IN EACH MARKET CATEGORY*				INDEX OF TOTAL REVENUE**	PERCENT CHANGE
	PUPS	SMALL	MEDIUM	LARGE		
0.18	-	20.69	37.93	41.38	12,132	-31.11
0.28	-	31.58	59.21	9.21	8,359	

FISHING EFFORT (F LEVEL)	PERCENT OF MALES IN EACH MARKET CATEGORY*				INDEX OF TOTAL REVENUE**	PERCENT CHANGE
	PUPS	SMALL	MEDIUM	LARGE		
0.17	-	22.76	49.59	27.64	10,614	-17.57
0.88	-	37.04	48.15	14.82	8,749	

*Calculated from survival rates estimated from the YPR parameters (Survival = $(1 - F/Z(1-e^{-Z}))$ integrated over the ages in each market category) times the average weight in each size category: small = 49 lb, medium = 75 lb, large = 149 lb.

**Calculated by multiplying a price index for each market category times the percent of landings in that market category. The price indexes are:

Pups:	\$1.55/\$1.80 = 0.8611
Small:	\$1.80/\$1.80 = 1 (numeraire)
Medium:	\$2.05/\$1.80 = 1.1389
Large:	\$2.30/\$1.80 = 1.2778

Table 8-51 . Percent of total U.S. swordfish consumption from imported swordfish. (Source: U.S. Department of Commerce, Fishery Statistics of the U.S.)

	Quantity (million pounds)	Value (million dollars)	Percent of Total U.S. Swordfish Consumption (lb) (Remainder is domestic production)
1960	7.3	3.0	88.0
1965	7.2	3.8	73.0
1968	7.3	4.7	92.0
1969	7.4	5.0	95.0
1970	8.8	5.0	94.0
1971	0.2	0.9	67.0
1972	0.1	0.1	17.0
1973	0.4	0.3	31.0
	(thousand pounds)	(thousand dollars)	
1974	88	37	2.0
1975	26	17	1.0
1976	72	56	2.0
1977			
1978			
1979*	347	492	
1980*	478	632	

*From: Imports and Exports of Fishery Products, Annual Summary 1980, NMFS, NOAA.

In July 1979, Canada reopened the fishery for swordfish. The Canadian swordfishery is currently operating under a quota of 3,000 MT. Canada has a very limited domestic market for swordfish and traditionally the major amount of Canadian caught swordfish has found its way to the U.S. market. Canada plans to issue licenses to foreign vessels to enter Canadian waters to purchase swordfish.

During 1979, Canadian officials met with the U.S. Food and Drug Administration to discuss a proposed program to certify lots of swordfish as to their mercury content for entry into the United States. The certification program was expected to proceed under an interim agreement for purposes of testing the concept with the understanding that a more formal source country certification program could be adopted after more data were accumulated (Food Chemical News, 1979).

8.5.2 Recreational and Subsistence Fisheries

Although detailed economic data on investments, revenues and tourism associated with the recreational sector of the swordfishery are not presently available, there is some information on expenses associated with recreational swordfish activities. Individuals involved in the recreational sector estimate that direct expenses for an overnight swordfishing trip in a private vessel are approximately $200 to $800 depending on geographic area and proximity to fishing grounds. These estimates include expendable gear, bait, gas and food. The price of a chartered swordfishing trip is usually about $750 to $1,000; rod and reel setups, suitable for swordfish, cost from $400 to $450 (J. M. Dorn, John's Rod and Reel, Charleston, S.C.; pers. comm.).

8.6 Description of Businesses, Markets and Organizations Associated with the Fishery

8.6.1 Relationship Among Harvesting, Brokering and Processor Sections

Swordfish catches are sold primarily to brokers, often according to an informal verbal agreement. The fish are dressed on board the fishing vessel, scrubbed down and stored in ice. The dressed weight is about 75 percent* of the total weight (S. Berkeley, Research Associate, University of Miami, Miami, FL; pers. comm.). The dressed fish are unloaded from the fishing vessel and transferred to the broker at the dock. The price per pound, paid by the broker, is calculated for each individual fish and varies with size; larger fish command higher per pound prices. (See Table 8-32 for a description of class sizes.)

A large portion of the swordfish bought by brokers is shipped to the principal fish markets in Boston and New Bedford, Massachusetts; Philadelphia, Pennsylvania; Baltimore, Maryland; and to the Fulton Fish Market in New York City for processing and distribution. The major wholesale markets supply the product to buyers nationwide. The product may be distributed either fresh or frozen.

Some swordfish is sold locally by the brokers to other wholesalers, retail fish markets, supermarkets and restaurants. Some fishermen also sell their swordfish catches directly to the same types of customers.

The following summary of marketing areas resulted from interviews with industry representatives during April 1980 (McAvoy, 1980):

Boston

Boston is the major swordfish distribution center by a wide margin, handling over 4 million lb on an annual basis and more or less sets the market price throughout the country. Swordfish from Florida arrive by truck and air (air shipments arrive in 3,000 lb LD3 refrigerated containers). Southern shipments of swordfish allow wholesalers an opportunity to market swordfish more months of the year. This market buys outright, and not on consignment.

*Dressed weight = 0.75 total weight
Edible weight = 0.8-0.9 (dressed weight)
= 0.60-0.68 (total weight)

Product form on the Boston market is whole fish, head, tail and fins removed and eviscerated. Wholesale price by size class was: (a) 100 lb + = \$3.30 - \$3.40 per lb; (2) 50-100 lb = \$3.10 per lb; 25-50 lb = approximately \$2.90 - \$3.00 per lb; and (3) less than 25 lb, not very acceptable on the market. The premium size range is 90-200 lb. Market price is usually at a low in the summer and during 1979 the low was \$1.50 -\$1.80 per lb.

New York Fulton Fish Market

This market moved approximately 1.1 million lb of fresh swordfish in 1979 (NMFS Market News Office, NY). Florida accounted for 75 percent (850,000 lb), Massachusetts 20 percent (231,000 lb) and NC, ME, RI, VA, and NJ each accounting for a few thousand lb. Only negligible amounts of foreign swordfish have been sold over the Fulton Market since the height of the mercury controversy. In addition, price and quantity information is difficult to ascertain due to the mercury problem.

Product form is the same as that in the Boston Market but with the following size categories: (1) large = 100 lb +; (2) medium = 80-100 lb and (3) small = 50-75 lb. Wholesale prices are vague but the following are estimates: (1) large = \$3.30 - \$3.40 per lb; (2) medium = \$3.15 - \$3.25 per lb; and (3) small = \$2.75 per lb. Pups (less than 50 lb) are hard to move and the dealers require a good size mix.

Atlanta

No fresh, whole, swordfish are being shipped into the Atlanta market.

Chicago

Swordfish is not a major market item in Chicago, perhaps 1,000 lb per week. Most is sold to restaurants with very little going to supermarkets. Product form is the same, whole, head, tail and fins removed and eviscerated.

San Diego

Approximately 250,000-300,000 lb of swordfish move through the market on an annual basis with local fishermen supplying about 90 percent. Companies buy outright, not on consignment. In addition, some companies import directly and also buy through brokers. Some Florida swordfish supply this market.

The bulk of sales are to restaurants and supermarkets in the metro-San Diego area; some fish are sold to Los Angeles distributors and directly to hotels and restaurants in Las Vegas and Phoenix. Local fishermen many times sell directly to these markets in Las Vegas and Phoenix and often land their catches in Los Angeles.

Local catches are greatest during July-October and taper off sharply after November 1. Mexican, Hawaiian and Florida fish make it possible to market swordfish in the spring, fall and early winter months. There is a real or perceived problem with the quality of Florida and Gulf of Mexico fish. Problems cited included soft, discolored and poorly cleaned fish from Florida and improper icing by Gulf fishermen. The result is a shorter storage life for Florida fish and on occasions in the past, Florida fish have sold at a discount. This view was opposed by a Florida broker who regularly ships fish to the West Coast; however, it was agreed that some fishermen must increase their at-sea handling practices during the hot summer months.

TWA, Eastern, Delta and National will ship Florida swordfish to the West Coast in 3,000 lb LD3 refrigerated containers. Market form is the same with the following size categories: (1) 200 lb +; (2) 100-200 lb; and (3) under 100 lb. Very small fish are sharply discounted due to their low yield. Price is the same for medium and large fish, while small fish bring about 10-15¢ less per lb. The current price is between $3.00 and $3.25 per lb; the high price in 1979 was $4.00 per lb, a low of $1.90 per lb and an average of $3.00 - $3.25 per lb.

Los Angeles-San Pedro

In a normal year, about 1 million lb move through this market. Local harpooners are the main source, although increasing amounts are being shipped in from Texas and Florida. Local quality is reported to be greater than shipped-in product due to improper icing and handling.

Several dealers could handle several LD3 container loads per week. Dealers want fish over 100 lb and pay one price (about $3.25-$3.50 per lb) for the mixed bag; however, if too many small fish are in the shipment the entire shipment could be rejected. The low price in 1979 was $1.80-$1.90 per lb.

San Francisco

A conservative estimate of the annual product moved through the market is 300,000 lb. Local catches are very small and as a result most comes from southern California and other parts of the country including Florida.

TWA, Delta, EAL and National will ship Florida fish in LD3 containers. Prices are roughly the same as Boston prices and dealers buy outright.

Seattle

Swordfish is not an important market item.

8.6.2 Fishery Cooperatives or Associations

8.6.2.1 Associations and Organizations

The American Swordfish Association, founded in 1976, is composed of commercial dealers, processors and fishermen on the Eastern and Gulf coasts. The Association is concerned with legal issues as they affect the swordfish industry, and is actively involved in focusing the attention of legislators on problems and issues which affect commercial fishermen. The American Swordfish Association raised money from its members to pay the legal fees incurred in the Anderson Seafoods, Inc. vs. FDA and FDA vs. Anderson Seafoods cases which resulted in raising the action level of mercury in swordfish.

Organized Fishermen of Florida (OFF) was formed in 1967 as a statewide nonprofit trade association devoted to promoting and protecting the interests of Florida fishermen. OFF is made up of individual fresh and salt water chapters. The organization works with the Florida legislature to promote enactment of laws to protect the fishing resources of Florida for both commercial and sports interests, promotes industrywide research on problems facing the industry, provides publicity and public relations programs, and promotes sales and marketing programs.

The National Fisheries Institute founded in 1945 is a trade association with approximately 950 member companies including producers, distributors, wholesalers, importers and canners of fish and shellfish. The Institute disseminates statistics and information of interest to the seafood industry and sponsors market extension and promotion programs on fish and seafood products.

The Southeastern Fisheries Assocation, located in Tallahassee, Florida consists of producers, distributors and suppliers of seafood in the South Atlantic and Gulf of Mexico area.

The Sport Fishing Institute, located in Washington, D.C., promotes the conservation of sport fish and is supported by manufacturers of fishing tackle, outboard motors, boats, sporting goods, petroleum and other related products. The Institute provides research grants, publishes reviews of sport fish conservation activities and conducts educational and informational programs on fisheries science and sport fisheries management.

The Sport Fishery Research Foundation, located in Washington, D.C., has the objective of financially supporting research in the sport fishery resources field.

The International Game Fish Association in Fort Lauderdale, Florida, has more than 10,000 members. The Association supports programs to encourage and further the study of marine game fish angling; analyzes the impact of sports fishing and commercial fishing upon various game fish species; develops and supports game fish tagging and other efforts to collect scientific data; and compiles a worldwide history of marine game fishing. Bimonthly, the Association publishes The International Marine Angler, which disseminates information concerning scientific research on commercial and game fish and reports on angling activities of interest to its members. As of late 1979, the Association is conducting a worldwide survey to tabulate the total amount of swordfish taken on rod and reel prior to initiation of night fishing techniques.

National Coalition for Marine Conservation has as its goals the protection of the marine environment and the development of effective management programs for fishery resources, which enable both commercial and recreational groups to make the best use of marine resources.

There are a number of active sport fishing clubs along the Atlantic and Gulf coasts, the members of which participate in the sport fishery for swordfish and other billfishes. These clubs promote sport fishing in their area, and several sponsor billfish tournaments. In addition, many clubs sponsor tag and release programs and the furtherance of scientific research of big game sport species, through both tournament and regular fishing activities.

Scientists were present at the First, Second, and Third Annual Miami Swordfish Tournaments; First and Second Ft. Lauderdale International Swordfish Tournaments; First, Second and Third Duck Key Tournaments; First, Second and Third Ft. Lauderdale Swordfish Tournaments; and the First and only Stuart Swordfish Release Tournament, to examine the catches. These and other tournaments have provided the scientific community with valuable information regarding the biology of swordfish.

8.6.2.2 Fishery Cooperatives

In 1977, there were 44 fishery cooperatives on the Atlantic Coast and Gulf of Mexico (NMFS). At least a few of these cooperatives, those located mainly in New England and in Florida, have members who fish for swordfish. Cooperatives engaged in swordfishing activities during 1978 and 1979 include the Point Judith Cooperative in Point Judith, Rhode Island; the Provincetown Fisherman's Cooperative in Provincetown, Massachusetts; and the Fort Pierce Cooperative in Florida.

Napoli (1973), in a report on the Workshop on Fisheries Cooperatives held in Galilee, Rhode Island, in 1972, discussed the formation and operation of fishery cooperatives. One of the oldest of the cooperatives is the Point Judith Fishermen's Cooperative Association founded in 1947. The Point Judith Cooperative, because of its early beginnings, has served as an organizational model for the establishment of other fishery cooperatives. The cooperatives generally perform a number of functions for their members, including marketing, supply, production and bargaining. Some, but not all, cooperatives hold marketing agreements with their members which provide for compulsory delivery to the cooperative of all fish caught by the co-op members. Profits earned by the cooperative are distributed to the members on the basis of gross landings of each member in proportion to total landings (Napoli, 1973).

8.6.3 Labor Organizations

Most employees engaged in the commercial fishing industry are covered by the Fair Labor Standards Act, which provides for minimum wages and maximum hours (University of Mississippi Law Center, 1976). However, employees are exempt from these provisions when they are engaged in certain types of offshore fishing activities, namely, during the catching or taking of aquatic forms of animal life; in the first processing when done while at sea; and during the loading and unloading of the aquatic life so taken and processed. The exemption from the Act also applies to employees whose activities are essential to any of the aforementioned activities.

Fishermen in certain New England ports are represented by labor unions, although not all the fishermen in union ports belong to the unions. The use of union crews tends to be more common on company-owned fishing boats. Most swordfishing is done by independently owned or family-owned boats, and it is estimated that only a few, if any, swordfish boats carry union crews. Table 8-52 lists the labor characteristics of the major New England ports with a swordfishing industry. Fishermen in Boston, New Bedford and Gloucester, Massachusetts, are represented by the Atlantic Fisherman's Union and the New Bedford Fishermen's Union, locals of the Seafarers International Union of North America, Atlantic, Gulf, Lakes and Inland Waters District, AFL-CIO. The Unions represent the captain, cook, and deck hands in all negotiations with boat owners. The contracts state conditions under which the men will work, duties, benefits and method of pay. Outside of New England, there is very little union activity.

Workers in seafood processing plants in Boston and New Bedford belong to the Seafood Workers Union, ILA, AFL-CIO (Smith and Peterson, 1977). As a result, wages for these employees have been standardized in these ports.

8.6.4 Foreign Investment

No information is available on foreign investments. However, Booz et al. (1980) conducted interviews and reported that no significant foreign investment is involved in this fishery.

Table 8-52. Labor representation of offshore fishermen in New England ports. (Source: Smith and Peterson, 1977.)

Ports	Labor Representation
Massachusetts	
Boston	Union & nonunion
Gloucester	Union & nonunion
Menemsha	No union or co-op
New Bedford	Union
Provincetown	Co-op & nonunion
Rhode Island	
Newport	Union & nonunion
Point Judith	Co-op
Maine	
Portland	No union or co-op
Rockland	No union or co-op

8.7 Description of Social and Cultural Framework of Domestic Fishermen and Their Communities*

8.7.1 Ethnic Character, Family Structure, Community Organization, Age and Education of Fishermen

There are no data available on ethnic character, family structure and community organization of swordfish fishermen as a separate group. However, Smith and Peterson (1977) have compiled data on labor characteristics of offshore fishermen in major New England fishing ports. Ethnic background and approximate age of offshore fishermen in New England ports with a swordfish fishery as shown by Smith and Peterson are given in Table 8-53. Ethnic characteristics of fishermen vary widely from port to port probably reflecting the ethnic makeup of the overall population in each area. Evidence from interviews indicates that fishermen who participate in the swordfish fishery are not distinctly different from other types of fishermen. Therefore, it can be expected that ethnic character, family structure, community organization, age and education profiles of swordfish fishermen will vary according to area and will reflect characteristics of the general fishing population in each particular area.

8.7.2 Recreational Fishery

From the survey of the recreational billfish and shark fisheries, May 1, 1977 to April 30, 1978, National Marine Fisheries Service estimated that there are from 17,373 to 21,980 boats in the billfish fishery. Based on these data and assuming an average of 3 to 4 anglers per boat for estimation purposes, there may be from around 50,000 to 85,000 participants in the billfish fishery. The proportion of this population that engages in swordfish sport fishing activities cannot, however, be estimated.

There are no data currently available which describe characteristics of participants in the billfish or sport swordfish fisheries. However, information about socio-economic characteristics of the general marine recreational fishing population is available on a state-by-state basis from the 1975 U.S. Fish and Wildlife Survey (Table 8-54). On the Eastern seaboard, saltwater fishing is an activity dominated by males in their middle years with incomes in the $7,500 to $35,000 range.

*See Holt (1978) for a socio-economic discussion of the California swordfish harpoon fishery.

Table 8-53. Labor force characteristics of offshore fishermen in New England ports with a swordfish fishery. (Source: Smith and Peterson, 1977.)

PORTS	NUMBER OF FULL-TIME FISHERMEN	AVERAGE AGE	MAJOR ETHNIC GROUPS
MASSACHUSETTS			
Boston	100	55	Yankee, Portuguese
Chatham	60-80	45	Yankee
Gloucester	500	45	Italian, Yankee
Menemsha	30	40	Yankee
New Bedford	400	43	Yankee, Norwegian Canadian, Portuguese
Provincetown	150-200	40	Yankee
RHODE ISLAND			
Newport	80	45	Yankee, Portuguese Italian
Pt. Judith	120	40	Yankee, Norwegian
MAINE			
Portland	150	40	Yankee
Rockland	80	40	Yankee

Table 8-54. Socio-economic characteristics of saltwater recreational participants by state of residence, 1975. (Source: U.S. Department of the Interior, 1977.)

	State of Residence															
	AL	FL	GA	LA	MS	NC	SC	TX	DE	ME	MD	MA	NH	NJ	NY	RI
Number of Participants (000)	239	1740	471	575	192	865	311	2010	114	98	509	601	66	889	1212	100
Age	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
9-17	19	18	32	21	23	15	15	22	25	26	15	19	10	29	13	26
18-24	25	11	18	12	10	12	23	10	12	13	14	17	14	11	11	16
25-34	17	28	13	26	22	30	30	23	23	22	13	27	36	20	25	18
35-44	19	13	11	11	25	14	14	8	13	10	25	10	10	12	16	15
45-54	3	8	16	18	8	20	12	18	13	15	17	17	14	16	20	9
55-64	12	13	9	12	5	5	4	8	10	12	11	8	9	3	3	10
65 or older	5	9	1	-	7	4	2	8	4	2	5	1	5	3	7	6
Sex																
Male	66	73	74	70	70	72	73	73	72	69	80	86	78	81	81	86
Female	34	27	26	30	30	28	27	27	28	31	20	14	22	19	19	14
Income																
Under $2,000	15	7	14	16	19	11	7	8	12	15	11	9	8	13	16	10
$2,000 - $4,999	7	6	4	3	2	6	8	9	*	3	*	8	5	8	3	7
$5,000 - $7,499	7	5	3	3	4	8	3	7	7	10	4	9	8	7	3	5
$7,500 - $9,999	6	21	5	5	10	16	8	15	6	18	*	5	11	8	5	11
$10,000-$14,999	18	22	13	17	17	21	32	12	30	28	29	33	29	22	16	25
$15,000-$24,999	38	26	31	35	22	26	29	21	34	22	37	27	26	32	38	31
$25,000-$34,999	9	12	9	8	19	9	5	23	8	2	12	9	11	6	8	6
$35,000-$49,000	-	1	15	4	2	1	6	2	2	*	2	*	4	2	7	2
$50,000 or more	*	*	6	9	5	2	2	3	*	*	*	*	2	3	2	1

*Less than one percent

Since swordfishing grounds are 70 to 100 miles offshore along a good deal of the Atlantic Coast, the costs for swordfishing tend to be greater than for many other species. Thus, it can be expected that income levels of sport swordfishermen may in general be somewhat higher than the average for all marine fishing participants.

Social benefits of recreational fishing have been reported to include "escape" from the pressures of modern civilization, the chance to be outdoors, to be with friends or family and to have fun (Martin, 1976). In a study of charter boat fishermen in Texas, Ditton et al. (1978) identified fishing motives and ranked them in relative order of importance using mean factor importance scores rated on a six point scale from 1 = not at all important, to 6 = extremely important. Some findings from their study are given in Table 8-55. Having fun, escaping normal routines, adventure, being with others and learning about nature were ranked high. Ditton et al. (1978) reported that the quality aspects of catch, i.e., excitement, unique experience, challenge and adventure, were considered more important than just the quantity of fish caught.

8.7.3 Economic Dependence on Commercial or Marine Recreational Fishery and Related Activities

There are no data currently available concerning economic dependence on commercial or marine recreational fishing and related activities for the swordfish fishery. However, it is known that a number of vessels are involved in the year-round fishery for swordfish. These include a number of vessels from the mobile northern longline fleet as well as vessels in the local southeastern Florida fishery. It is estimated that there are approximately 50 mobile longline vessels which fish up and down the Atlantic Coast and in the Gulf of Mexico, fishing in the warmer waters during winter months, and northern waters in summer months. There are approximately 25-28 northern harpoon vessels and approximately 22 spotter airplanes. There are also approximately 150-200 full-time vessels in the fixed base Florida fishery and 50-100 boats in the expanding Gulf of Mexico fleet. Thus it can be expected that there are approximately 1,000* fishermen who derive most if not all their income from swordfishing activities. In addition, some fishermen who fish for swordfish during only part of the year report that because of the high economic value of swordfish, swordfishing activities account for a major part of their total fishing revenues.

*Based on a crew of at least 3 in Florida longline boats, 4-5 in New England longline and harpoon boats and 22 pilots flying spotter airplanes.

Table 8-55. Motivational factors in recreational fishing. (Source: Ditton et al., 1978)

Motive	Mean Factor Importance [a]
Have fun	5.14
Escape	3.75
Adventure experience	3.54
Affiliation	3.42
Learn about nature	3.34
Catch fish	3.29
Outdoor coastal experience	3.21
Fishing challenge	3.17
Convenience in fishing	3.12
To eat fish	2.81
Personal achievement	2.11
Establish and maintain business relationships	2.09
Status achievement	1.68

a. Derived on a six point rating scale from 1 = not at all important, to 6 = extremely important.

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APPENDIX A

HISTORICAL SWORDFISH CATCH AND EFFORT DATA.

These data are from Fishery Statistics of the U.S., NOAA/NMFS, years 1960-1976 (the most recent issue). States were grouped as follows: New England Fisheries -ME, NH, MA, RI, CT; Middle Atlantic Fisheries - NY, NJ, DE; Chesapeake Fisheries - MD, VA; South Atlantic Fisheries -NC, SC, GA, FL E. Coast; Gulf Fisheries - FL W. Coast, AL, MS, LA, TX; Puerto Rico Fisheries. Landings were then grouped according to Council area: NEFMC - ME, NH, MA, RI, CT; MAFMC - NY, NJ, DE, MD, VA; SAFMC - NC, SC, GA, FL E. Coast; GMFMC - FL. W. Coast, AL, MS, LA, TX; CFMC - PR, U. S. VI.

Table A-1. NEW ENGLAND FISHERY MANAGEMENT COUNCIL AREA - New England Fisheries

	MAINE						NEW HAMPSHIRE					
	TOTAL LANDINGS		HARPOON		LONGLINE		TOTAL LANDINGS		HARPOON		LONGLINE	
YEAR	'000 lb	'000 $	lb	$	lb	$	'000 lb	'000 $	lb	$	lb	$
1960	1	(1)	1,000	411	0	0	-	-	-	-	-	-
1961	6	2	5,900	2,073	0	0	-	-	-	-	-	-
1962	52	21	9,000	4,047	43,400	17,222	-	-	-	-	-	-
1963	445	101	0	0	445,200	101,291	-	-	-	-	-	-
1964	241	84	40,100	2,766	241,100	83,838	-	-	-	-	-	-
1965	210	82	0	0	209,500	82,106	-	-	-	-	-	-
1966	171	73	0	0	170,700	72,877	-	-	-	-	-	-
1967	88	30	0	0	88,200	30,270	-	-	-	-	-	-
1968	89	39	0	0	89,400	38,758	-	-	-	-	-	-
1969	109	46	0	0	108,600	45,720	-	-	-	-	-	-
1970	53	28	0	0	52,900	27,500	-	-	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-	-	-	-	-	-
1973	(1)	1	0	0	400[5]	525[5]	-	-	-	-	-	-
1974	119	118	6,000	7,902	113,000	109,781	-	-	-	-	-	-
1975	146	198	3,900	4,805	142,200	193,545	-	-	-	-	-	-
1976	611	825	0	0	610,500	824,524	-	-	-	-	-	-

Table A-1. Continued

YEAR	MASSACHUSETTS TOTAL LANDINGS '000 lb	'000 $	HARPOON lb	$	LONGLINE lb	$	RHODE ISLAND TOTAL LANDINGS '000 lb	'000 $	HARPOON lb	$	LONGLINE lb	$
1960	713	289	712,600	288,527	0	0	211	84	210,700	83,621	700 [2]	251 [2]
1961	694	268	693,700	267,640	0	0	128	49	127,100	48,745	300 [2]	128 [2]
											600 [3]	58 [3]
1962	703	307	632,600	275,519	70,600	31,445	109	48	93,500	42,432	15,700	5,336
1963	1,717	431	343,600	82,122	1,373,300	349,069	169	45	55,800	13,252	113,500	31,870
1964	1,149	326	175,700	46,671	973,600	279,102	65	21	35,200	11,134	29,900	9,795
1965	550	210	156,400	63,698	393,600	146,476	28	13	28,300	12,828	0	0
1966	683	272	160,600	71,430	522,500	200,765	1	1	800	458	0	0
1967	514	205	255,800	108,751	257,900	96,302	39	15	38,800	14,658	0	0
1968	263	134	186,000	98,216	77,500	35,308	37	20	20,500	11,218	16,000	8,637
1969	208	108	165,200	98,421	43,000	9,476	18	8	4,700	2,718	12,800	5,423
1970	209	131	207,800	129,379	1,500 [4]	1,145 [4]	6	4	5,800	3,870	300 [2]	258 [2]
1971	73	71	73,200	70,815	0	0	-	-	-	-	-	-
1972	417	604	350,800	515,332	66,300	89,033	124	152	123,600	152,060	0	0
1973	811	1,148	303,000	528,335	30,200 [5]	34,155 [5]	62	100	54,000	89,568	7,600	10,675
					477,600	585,230						
1974	2,898	2,682	716,100	799,727	2,181,700	1,882,237	336	480	319,100	462,058	16,900	17,550
1975	3,389	4,169	552,100	688,507	2,837,200	3,480,759	754	942	245,000	324,388	509,300	617,381
1976	2,458	3,268	355,200	552,559	2,103,300	2,714,886	338	510	92,500	161,527	244,600	347,868

Table A-1. Continued

	CONNECTICUT					
	TOTAL LANDINGS		HARPOON		LONGLINE	
YEAR	'000 lb	'000 $	lb	$	lb	$
1960	17	7	17,200	6,827	0	0
1961	1	1	1,000	597	-	-
1962	3	1	2,600	1,117	0	0
1963	-	-	-	-	-	-
1964	1	(1)	600	319	0	0
1965	(1)	(1)	300	186	0	0
1966	-	-	-	-	-	-
1967	-	-	-	-	-	-
1968	-	-	-	-	-	-
1969	1	1	-	-	1,000 [2]	750 [2]
1970	-	-	-	-	-	-
1971	-	-	-	-	-	-
1972	-	-	-	-	-	-
1973	-	-	-	-	-	-
1974	-	-	-	-	-	-
1975	5	6	4,800	6,500	0	0
1976	1	1	800	1,500	0	0

(1) Less than 500 lb or $500
2. Troll line
3. Floating trap
4. Hand line
5. Fish trawl
6. Otter trawl
7. Lobster trawl

Table A-2. MIDDLE-ATLANTIC FISHERY MANAGEMENT COUNCIL AREA

Middle Atlantic Fisheries

YEAR	NEW YORK						NEW JERSEY					
	TOTAL LANDINGS		HARPOON		LONGLINE		TOTAL LANDINGS		HARPOON		LONGLINE	
	'000 lb	'000 $	lb	$	lb	$	'000 lb	'000 $	lb	$	lb	$
1960	49	28	49,300	27,502	0	0	20	9	19,600	9,410	0	0
1961	49	22	48,900	21,466	100[6]	44[6]	23	12	23,100	11,557	0	0
1962	41	22	41,000	21,620	0	0	26	16	12,300	7,419	13,900	8,419
1963	47	17	29,100	10,813	17,700	6,583	193	90	6,300	2,648	100[6] 186,500	32[6] 86,872
1964	171	58	16,200	5,438	154,700	52,205	307	103	4,100	1,248	100[5] 302,700	27[5] 102,063
1965	88	30	39,800	13,504	47,900	16,227	1,001	438	1,600	670	100[5] 998,900	32[5] 437,293
1966	83	35	15,900	6,757	67,200	28,443	253	120	900	436	252,400	119,561
1967	2	1	0	0	2,200	698	257	86	0	0	256,600	86,412
1968	57	27	0	0	700[4] 55,800	323[4] 26,505	73	29	0	0	73,100	29,255
1969	2	1	0	0	300[4] 2,200	110[4] 800	31	13	700	308	29,800	13,070
1970	18	10	0	0	300[4] 17,400	165[4] 9,570	-	-	-	-	-	-
1971	4	2	0	0	4,000	2,000	.5	.5	0	0	200[7]	75[7]
1972	-	-	-	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	5	5	2,800	2,355	300[5] 1,700	437[5] 2,304
1974	1	2	0	0	1,200	1,469	7	12	0	0	7,100	12,196
1975	-	-	-	-	-	-	122	225	0	0	122,000	224,908
1976	-	-	-	-	-	-	162	268	0	0	162,500	267,574

Table A-2. Continued

Middle Atlantic Fisheries

	Delaware					
	TOTAL LANDINGS		HARPOON		LONGLINE	
YEAR	'000 lb	'000 $	lb	$	lb	$
1960	-	-				
1961	-	-				
1962	-	-				
1963	-	-				
1964	-	-				
1965	-	-				
1966	-	-				
1967	-	-				
1968	-	-				
1969	-	-				
1970	-	-				
1971	-	-				
1972	-	-				
1973	-	-				
1974	-	-				
1975	-	-				
1976	-	-				

Table A-2. Continued

Chesapeake Fisheries

YEAR	VIRGINIA TOTAL LANDINGS '000 lb	VIRGINIA TOTAL LANDINGS '000 $	VIRGINIA HARPOON lb	VIRGINIA HARPOON $	VIRGINIA LONGLINE lb	VIRGINIA LONGLINE $	MARYLAND TOTAL LANDINGS '000 lb	MARYLAND TOTAL LANDINGS '000 $	MARYLAND HARPOON lb	MARYLAND HARPOON $	MARYLAND LONGLINE lb	MARYLAND LONGLINE $
1960	-	-	-	-	-	-		-	-			
1961	-	-	-	-	-	-	-	-				
1962	-	-	-	-	-	-	-	-				
1963	183	79	0	0	183,200	78,740	-	-				
1964	635	218	0	0	635,400	217,946	-	-				
1965	302	112	0	0	302,400	112,183	-	-				
1966	89	41	0	0	88,500	40,793	-	-				
1967	145	72	0	0	145,200	72,175	-	-				
1968	86	50	0	0	86,000	49,666	-	-				
1969	7	4	0	0	6,900	3,559	-	-				
1970	-	-	-	-	-	-	-	-				
1971	-	-	-	-	-	-	-	-				
1972	-	-	-	-	-	-	-	-				
1973	2	5	0	0	2,400	4,565	-	-				
1974	68	93	0	0	68,300	93,427	-	-				
1975	27	37	0	0	27,300	37,285	-	-				
1976	25	34	0	0	24,900	34,001	-	-				

(1) Less than 500 lb or $500
2. Troll lines
3. Floating trap
4. Hand line
5. Fish trawl
6. Otter trawl
7. Lobster trawl

Table A-3. SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL AREA -- South Atlantic Fisheries

	NORTH CAROLINA						SOUTH CAROLINA					
	TOTAL LANDINGS		HARPOON		LONGLINE		TOTAL LANDINGS		HARPOON		LONGLINE	
YEAR	'000 lb	'000 $	lb	$	lb	$	'000 lb	'000 $	lb	$	lb	$
1960	-	-	-	-	-	-	-	-	-	-	-	-
1961	-	-	-	-	-	-	-	-	-	-	-	-
1962	-	-	-	-	-	-	-	-	-	-	-	-
1963	1	1	0	0	1,200	648	-	-	-	-	-	-
1964	483	233	0	0	482,800	232,790	-	-	-	-	-	-
1965	524	283	0	0	524,000	283,320	-	-	-	-	-	-
1966	77	38	0	0	76,900	38,353	-	-	-	-	-	-
1967	-	-	-	-	-	-	-	-	-	-	-	-
1968	-	-	-	-	-	-	-	-	-	-	-	-
1969	-	-	-	-	-	-	-	-	-	-	-	-
1970	-	-	-	-	-	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-	-	-	-

Table A-3. Continued

	GEORGIA						FLORIDA EAST COAST					
	TOTAL LANDINGS		HARPOON		LONGLINE		TOTAL LANDINGS		HARPOON		LONGLINE	
1960	-	-	-	-	-	-	-	-	-	-	-	-
1961	-	-	-	-	-	-	-	-	-	-	-	-
1962	-	-	-	-	-	-	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-	-	-	-	-
1964	-	-	-	-	-	-	-	-	-	-	-	-
1965	-	-	-	-	-	-	-	-	-	-	-	-
1966	-	-	-	-	-	-	-	-	-	-	-	-
1967	-	-	-	-	-	-	-	-	-	-	-	-
1968	-	-	-	-	-	-	-	-	-	-	-	-
1969	-	-	-	-	-	-	-	-	-	-	-	-
1970	-	-	-	-	-	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	262	355	-	-	262,200	355,281

Table A-4. GULF OF MEXICO FISHERY MANAGEMENT COUNCIL AREA - Gulf of Mexico Fisheries

YEAR	FLORIDA WEST COAST TOTAL LANDINGS '000 lb	FLORIDA WEST COAST TOTAL LANDINGS '000 $	FLORIDA WEST COAST HARPOON lb	FLORIDA WEST COAST HARPOON $	FLORIDA WEST COAST LONGLINE lb	FLORIDA WEST COAST LONGLINE $	ALABAMA TOTAL LANDINGS '000 lb	ALABAMA TOTAL LANDINGS '000 $	ALABAMA HARPOON lb	ALABAMA HARPOON $	ALABAMA LONGLINE lb	ALABAMA LONGLINE $
1960	-	-	-	-	-	-	-	-	-	-	-	-
1961	-	-	-	-	-	-	-	-	-	-	-	-
1962	-	-	-	-	-	-	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-	-	-	-	-
1964	-	-	-	-	-	-	-	-	-	-	-	-
1965	-	-	-	-	-	-	-	-	-	-	-	-
1966	-	-	-	-	-	-	-	-	-	-	-	-
1967	-	-	-	-	-	-	-	-	-	-	-	-
1968	-	-	-	-	-	-	-	-	-	-	-	-
1969	-	-	-	-	-	-	-	-	-	-	-	-
1970	56	23	0	0	55,700	22,831	3	3	0	0	3,000	2,480
1971	1	(1)	0	0	1,200	474	-	-	-	-	-	-
1972	-	-	-	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-	-	-	-
1974	50	86	-	-	49,900	85,860	36	63	-	-	36,400	63,336
1975	131	226	-	-	131,000	226,320	18	30	-	-	18,300	30,195
1976	391	816	30,400 [2]	39,530 [2]	1,600 [4]	3,092 [4]	-	-	-	-	-	-
					359,400	773,227						

Table A-4. Continued

	MISSISSIPPI						LOUISIANA					
	TOTAL LANDINGS		HARPOON		LONGLINE		TOTAL LANDINGS		HARPOON		LONGLINE	
YEAR	'000 lb	'000 $	lb	$	lb	$	'000 lb	'000 $	lb	$	lb	$
1960	-	-	-	-	-	-	-	-	-	-	-	-
1961	-	-	-	-	-	-	-	-	-	-	-	-
1962	-	-	-	-	-	-	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-	-	-	-	-
1964	-	-	-	-	-	-	-	-	-	-	-	-
1965	-	-	-	-	-	-	-	-	-	-	-	-
1966	-	-	-	-	-	-	-	-	-	-	-	-
1967	-	-	-	-	-	-	-	-	-	-	-	-
1968	-	-	-	-	-	-	-	-	-	-	-	-
1969	2	1	0	0	1,600	1,446	-	-	-	-	-	-
1970	287	223	0	0	286,500	223,056	-	-	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	14	14	0	0	14,400	14,400
1974	-	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-	-	-	-

Table A-4 Continued

	TEXAS					
	TOTAL LANDINGS		HARPOON		LONGLINE	
YEAR	'000 lb	'000 $	lb	$	lb	$
1960	-	-				
1961	-	-				
1962	-	-				
1963	-	-				
1964	-	-				
1965	-	-				
1966	-	-				
1967	-	-				
1968	-	-				
1969	-	-				
1970	-	-				
1971	-	-				
1972	-	-				
1973	-	-				
1974	-	-				
1975	-	-				
1976	-	-				

(1) Less than 500 lb or $500
2. Troll line
3. Floating trap
4. Hand line
5. Fish trawl
6. Otter trawl
7. Lobster trawl

Table A-5. CARIBBEAN FISHERY MANAGEMENT COUNCIL AREA

	PUERTO RICO[1]						U.S. VIRGIN ISLANDS[2]					
	TOTAL LANDINGS		HARPOON		LONGLINE		TOTAL LANDINGS		HARPOON		LONGLINE	
YEAR	'000 lb	'000 $	lb	$	lb	$	'000 lb	'000 $	lb	$	lb	$
1960												
1961												
1962												
1963	-	-	-	-	-	-						
1964	-	-	-	-	-	-						
1965	-	-	-	-	-	-						
1966	-	-	-	-	-	-						
1967	-	-	-	-	-	-						
1968	-	-	-	-	-	-						
1969	-	-	-	-	-	-						
1970	-	-	-	-	-	-						
1971	-	-	-	-	-	-						
1972	-	-	-	-	-	-						
1973	-	-	-	-	-	-						
1974	-	-	-	-	-	-						
1975	-	-	-	-	-	-						
1976	-	-	-	-	-	-						

1. Landing data for Puerto Rico was first published in Fishery Statistics of the U.S. in 1963. Historical catches were given.
2. No landing data was published for the U.S. Virgin Islands through 1976.

Table A-6. Summary of operating units by Council area (#H = number swordfish harpoons; #LL = number longlines or number set with hooks).

	NEFMC		MAFMC				SAFMC		GMFMC		CFMC	
	(ME, NH, MA, RI, CT)		Mid Atlantic (NY, NJ, DE)		Chesapeake (MD, VA)		(NC, SC, GA, FL E. Coast)		(FL. W. Coast, AL, MS, LA, TX)		(PR, VI)	
	# H	# LL	# H	# LL	# H	# LL	# H	# LL	# H	# LL	# H	# LL
1960	195 [1]	138	38 [1]	168	0	92	0	1,136	0	1,119		
1961	99	194	10 [1]	169	0	141	0	1,198	0	1,633		
1962	103	199	10 [1]	159	0	88	0	1,201	0	1,835		
1963	68	185	12 [1]	150	0	80	0	1,102	0	2,097	-	-
1964	38	171	8 [1]	108	0	88	0	1,040	0	1,830	-	-
1965	27	222	3 [1]	91	0	83	0	1,256	0	1,921	-	-
1966	23	155	3 [1]	48	0	60	0	1,013	0	1,684	-	-
1967	24	162	0	28	0	329	0	901	0	1,709	-	-
1968	21	118	0	45	0	60	0	916	0	1,576	-	-
1969	15	139	2	34	0	54	0	1,588	0	1,687	-	-
1970	21	144	0	42	0	38	0	1,181	0	1,712	-	-
1971	17	199	0	24	0	45	0	1,233	0	1,317	-	-
1972	20	207	0	49	0	46	0	1,330	0	1,248	-	-
1973	23	232	1	28	0	19	0	1,900	0	1,331	-	-
1974	43	231	0	36	0	204	0	1,769	0	144,575 [2]	0	0
1975	38	179	0	64	0	251	0	1,423	0	1,535	0	0
1976	28	294	0	170	0	322	0	1,312	0	1,497	0	0

1. Not specified as swordfish harpoons.
2. 141,464 from Louisiana.

APPENDIX B

SUMMARIZED DATA FROM THE LOGS OF A NEW ENGLAND LONGLINER FROM SETS MADE IN THE GULF OF MEXICO, FLORIDA STRAITS AND NEW ENGLAND AREA

Table B-1. Summarized catch and effort data of a New England longliner from sets made 1974-78 in the Gulf of Mexico, Florida Straits, and New England area.

	1974	1975	1976	1977	1978
Total number of fish	1,042	903	840	965	777
Total number of hooks	60,250	74,096	74,576	53,456	39,273
Mean dressed weight (lbs)	72.3	75.5	68.4	73.6	90.9
Mean catch per 100 hooks	1.73	1.22	1.13	1.81	1.98
Number of sets in Florida Straits	0	12	42	56	31
% of total sets made in Fla. Straits	0	11.7%	38.2%	51.4%	29.5%

Table B-2. Catch per hook set (CPUE), and mean, standard deviation and standard error by fishing area.

GULF OF MEXICO

TRIP	CPUE
1	
2	
3	.0116
4	.0436
5	.0169
6	.0226
18	.0101
19	.0108
20	.0078
21	.0041
36	.0054
37	.0062
52	.0113
53	.0043
69	.0074
MEAN =	.0125
S =	.0107
$S_{\bar{x}}$ =	.0030
n =	13

FLA. EAST COAST

TRIP	CPUE
22	.0165
23	.0211
34	.0052
35	.0053
38	.0115
39	.0162
40	.0112
54	.0073
55	.0134
56	.0115
57	.0155
58	.0120
59	.0119
60	.0074
68	.0097
70	.0085
71	.0092
72	.0080
73	.0027
MEAN =	.0107
S =	.0045
$S_{\bar{x}}$ =	.0010
n =	19

mean CPUE Fla. east coast

1975	.0188
1976	.0099
1977	.0111
1978	.0071

MIDDLE ATLANTIC

TRIP	CPUE
17	.0029
24	.0057
33	.0268
41	.0100
50	.0272
51	.0032
61	.0220
64	.0531
65	.0630
66	.0683
67	.0396
74	.0212
75	.0067
MEAN =	.0269
S =	0.227
$S_{\bar{x}}$ =	.0063
n =	13

NORTH EAST

TRIP	CPUE
7	.0142
8	.0188
9	.0183
10	.0287
11	.0244
12	.0191
13	.0262
14	.0144
15	.0090
16	.0091
25	.0049
26	.0123
27	.0063
28	.0127
29	.0207
30	.0132
31	.0166
32	.0390
43	.0036
44	.0066
45	.0081
46	.0149
47	.0318
48	.0132
49	.0190
62	.0376
63	.0165
76	.0161
77	.0201
78	.0352
79	.0233
80	.0180
81	.0747
82	.0758
83	.0288
84	.0188

Mean =	.0214
S_x =	.0159
$S_{\bar{x}}$ =	.0027
n =	.6

Table B-3. Catch (number of swordfish) and effort (number of hooks) by trip and mean, standard deviation, and standard error for each year (CPUE = number swordfish per hook).

TRIP	TOTAL HOOKS SET	CPUE			TRIP	TOTAL HOOKS SET	CPUE		
1	?	-			34	4778	.0052		
2	?	-			35	6788	.0053		
3	3876	.0116			36	3156	.0054		
4	2796	.0436			37	5364	.0062		
5	4730	.0169			38	6684	.0115		
6	4332	.0226			39	3648	.0162		
7	2808	.0142			40	7708	.0112		
8	3981	.0188			41	1608	.0100		
9	4584	.0183			43	2796	.0036		
10	3312	.0287	MEAN	= .0187	44	5328	.0066	MEAN	= .0117
11	3156	.0244	S_x	= .0098	45	3960	.0081	S_x	= .0082
12	4021	.0191	$S_{\bar{x}}$	= .0025	46	5496	.0149	$S_{\bar{x}}$	= .0020
13	3048	.0262	n	= 15	47	2952	.0318	n	= 17
14	3948	.0144			48	3708	.0132		
15	2770?	.0090			49	3888	.0190		
16	3070	.0091			50	3894	.0272		
17	2730	.0029	1974		51	2820	.0032	1976	
18	4274	.0101			52	3000	.0113		
19	5267	.0108			53	5328	.0043		
20	5253	.0078			54	4272	.0073		
21	4416	.0041			55	4323	.0134		
22	3828	.0165			56	5240	.0115		
23	4212	.0211			57	4910	.0155		
24	2616	.0057			58	4160	.0120		
25	4884	.0049			59	4810	.0119		
26	6964	.0123	MEAN	= .0143	60	1890	.0074	MEAN	= .0238
27	6864	.0063	S_x	= .0092	61	2275	.0220	S_x	= .0206
28	5034	.0127	$S_{\bar{x}}$	= .0023	62	3540	.0376	$S_{\bar{x}}$	= .0050
29	5256	.0207	n	= 16	63	1698	.0165	n	= 17
30	6384	.0132			64	1656	.0531		
31	5664	.0166			65	762	.0630		
32	564	.0390			66	1860	.0683		
33	2616	.0268	1975		67	1566	.0396		
					68	2166	.0097	1977	

Table B-3. Continued

TRIP	TOTAL HOOKS SET	CPUE		
69	2968	.0074		
70	2352	.0085		
71	3043	.0092		
72	3125	.0080		
73	2595	.0027		
74	2594	.0212		
75	3596	.0067		
76	1488	.0161		
77	2978	.0201	MEAN	= .0234
78	2416	.0352	S_x	= .0220
79	1928	.0233	$S_{\bar{x}}$	= .0055
80	3057	.0180	n	= 16
81	1232	.0747		
82	1939	.0758		
83	1355	.0288		
84	2607	.0188	1978	

Table B-4. Number and percent of total billfishes caught incidental to swordfish by year.*

YEAR	NO. HOOKS	SWORDFISH		SAILFISH		WHITE MARLIN		BLUE MARLIN	
		NO. OF	%	NO. OF	%	NO. OF	%	NO. OF	%
1974	22,743	352	99.72	0	0	1	0.28	0	0
1975	74,096	903	99.12	0	0	8	0.88	0	0
1976	74,576	840	98.59	4	0.47	7	0.82	1	0.12
1977	53,456	965	98.97	5	0.51	4	0.41	0	0
1978	39,273	777	96.52	4	0.50	22	2.73	2	0.25
TOTALS	264,144	3,837	98.51	13	0.33	42	1.08	3	0.08

*Includes only those sets for which associated species were recorded in logs.

Table B-5. Size frequency distributions by year (dressed weight).*

WEIGHT	1974		1975		1976		1977		1978	
CLASS	NO.	PERCENT	NO.	PERCENT	NO.	PERCENT	NO.	PERCENT	NO.	PERCENT
0-20	47	10.83	47	5.87	21	2.75	32	3.98	23	3.10
21-40	126	29.03	168	20.97	207	27.13	187	23.23	102	13.73
41-60	54	12.44	144	17.98	182	23.85	183	22.73	118	15.88
61-80	50	11.52	119	14.86	136	17.82	144	17.89	139	18.71
81-100	55	12.67	103	12.86	78	10.22	81	10.06	118	15.88
101-120	32	7.37	61	7.62	49	6.42	59	7.33	75	10.09
121-140	20	4.61	46	5.74	30	3.93	46	5.71	58	7.81
141-160	14	3.23	30	3.75	21	2.75	24	2.98	32	4.31
161-180	6	1.38	26	3.25	15	1.97	20	2.48	24	3.23
181-200	9	2.07	17	2.12	10	1.31	13	1.61	20	2.69
201-220	9	2.07	15	1.87	3	0.39	3	0.37	11	1.48
221-240	5	1.15	10	1.25	4	0.52	6	0.75	6	0.81
241+	7	1.61	15	1.87	7	0.92	7	0.87	17	2.29
	434		801		763		805		743	

*only includes trips for which a weigh-out sheet exists.

Table B-6. Percent and number swordfish caught by size category for the Gulf of Mexico.

TRIP	TOTAL NO. HOOKS	NO. OF SETS	TOTAL NO. FISH	TOTAL WT.*		MEAN WT.	PERCENT AND NUMBER IN EACH SIZE CATEGORY**							
							%LG	(NO.)	%MED	(NO.)	%SM	(NO.)	%V.SM	(NO.)
1	?	6	34	1176	(33)	35.6	3.0	(1)	18.2	(6)	24.2	(8)	54.6	(18)
2	?	6	18	1152	(18)	64.0	16.7	(3)	33.3	(6)	22.2	(4)	27.8	(5)
3	3876	6	45	3344	(45)	74.3	28.9	(13)	46.7	(21)	4.4	(2)	20.0	(9)
4	2796	4	122	7097	(122)	58.2	16.4	(20)	34.4	(42)	23.8	(29)	25.4	(31)
5	4730	6	80	5123	(75)	68.3	26.7	(20)	29.3	(22)	22.7	(17)	21.3	(16)
6	4332	6	98	4611	(88)	52.4	13.6	(12)	25.0	(22)	36.4	(32)	25.0	(22)
18	4274	6	43	2354	(43)	54.7	14.0	(6)	23.	(10)	20.9	(9)	41.9	(18)
19	5267	6	57	3719	(57)	65.2	22.8	(13)	29.8	(17)	31.6	(18)	15.8	(9)
20	5253	7	41	2979	(41)	72.6	19.5	(8)	41.5	(17)	26.8	(11)	12.2	(5)
21	4416	6	18	-	-									
36	3156	4	17	1201	(17)	70.6	11.8	(2)	52.9	(9)	29.4	(5)	5.9	(1)
37	5364	8	33	2469	(30)	82.3	26.7	(8)	56.7	(17)	13.3	(4)	3.3	(1)
52	3000	5	34	1751	(32)	54.7	15.6	(5)	18.8	(6)	31.3	(10)	34.4	(11)
53	5328	11	23	1423	(21)	67.8	28.6	(6)	28.6	(6)	28.6	(6)	14.3	(3)
69	2968	7	22	1506	(22)	82.0	36.4	(8)	27.3	(6)	18.2	(4)	18.2	(4)
TOTAL	54,760	94	685	39,905		(644)								
MEAN	4,212	6.3	45.7	2,850.4		62.0	19.4	(125)	32.1	(207)	24.7	(159)	23.8	(153)

* Based on number of fish in parentheses - not all fish weights were recorded.

**LG - over 100 lbs dressed weight
MED - 50-99 lbs dressed weight
SM - 25-49 lbs dressed weight
V.SM - under 25 lbs dressed weight

Table B-7. Percent and number swordfish caught by size category for the Florida east coast.[1] (*, **, See Table B-6).

TRIP	TOTAL NO. HOOKS	NO. OF SETS	TOTAL NO. FISH	TOTAL WT.*		MEAN WT.	PERCENT AND NUMBER IN EACH SIZE CATEGORY** %LG (NO.)		%MED (NO.)		%SM (NO.)		%V.SM (NO.)	
22	3828	6	63	3799	(61)	62.3	11.5	(7)	47.5	(29)	26.2	(16)	14.8	(9)
23	4212	6	89	6412	(88)	72.9	22.7	(20)	43.2	(38)	26.1	(23)	8.0	(7)
34	4778	6	25	1898	(25)	75.9	24.0	(6)	48.0	(12)	20.0	(5)	8.0	(2)
35	6788	11	36	1462	(34)	43.0	2.9	(1)	26.5	(9)	44.1	(15)	26.5	(9)
38	6684	10	77	4213	(73)	57.7	11.0	(8)	42.5	(31)	27.4	(20)	19.2	(14)
39	3648	6	59	3906	(55)	71.0	14.6	(8)	50.9	(28)	27.3	(15)	7.3	(4)
40	7708	9	86	4238	(71)	59.7	12.7	(9)	42.3	(30)	35.2	(25)	9.9	(7)
54	4272	8	31	1506	(22)	68.5	18.2	(4)	45.5	(10)	22.7	(5)	13.6	(3)
55	4323	6	58	3981	(57)	69.8	24.6	(14)	31.6	(18)	31.6	(18)	12.3	(7)
56	5240	9	60	6077	(59)	103.0	45.8	(27)	35.6	(21)	13.6	(8)	5.1	(3)
57	4910	8	76	3857	(70)	55.1	14.3	(10)	20.0	(14)	50.0	(35)	15.7	(11)
58	4160	8	50	3613	(44)	82.1	31.8	(14)	45.5	(20)	20.5	(9)	2.3	(1)
59	4810	8	57	5055	(53)	95.4	45.3	(24)	28.3	(15)	24.5	(13)	1.9	(1)
60	1890	4	16	1793	(12)	149.4	66.7	(8)	33.3	(4)	0		0	
68	2166	5	21	1422	(21)	67.7	28.6	(6)	23.8	(5)	38.1	(8)	9.5	(2)
70	2352	6	20	2405	(20)	120.3	50.0	(10)	30.0	(6)	20.0	(4)	0	
71	3043	7	28	2033	(27)	75.3	25.9	(7)	37.0	(10)	25.9	(7)	11.1	(3)
72	3125	9	25	-										
73	2595	9	8	698	(8)	87.3	25.0	(2)	37.5	(3)	37.5	(3)	0	
TOTAL	80,532	141	885	58,368	(800)									
MEAN	4,238.5	7.4	46.6	3,242.7		72.96	23.1	(185)	37.9	(303)	28.6	(229)	10.4	(83)

1. Includes sets from Dry Tortugas to Cape Canaveral, including the Bahamas.

Table B-8. Percent and number swordfish caught by size category for the Mid-Atlantic Area.[1/] (*, **; See Table B-6).

							PERCENT AND NUMBER IN EACH SIZE CATEGORY**							
TRIP	TOTAL NO. HOOKS	NO. OF SETS	TOTAL NO. FISH	TOTAL WT.*		MEAN W.T	%LG	(NO.)	%MED	(NO.)	%SM	(NO.)	%V.SM	(NO.)
17	2730	3	8	-	-	-	-	-	-					
24	2616	4	24	1439	(24)	60.0	4.2	(1)	54.2	(13)	33.3	(8)	8.3	(2)
33	2616	4	70	3309	(64)	51.7	7.8	(5)	25.0	(16)	39.1	(25)	28.1	(18)
41	1608	4	16	1420	(16)	88.8	25.0	(4)	31.3	(5)	43.8	(7)	0	
50	3894	6	106	6350	(101)	62.9	15.8	(16)	23.8	(24)	44.6	(45)	15.8	(16)
51	2820	5	9	-		-								
61	2275	7	50	4127	(49)	84.2	22.5	(11)	46.9	(23)	26.5	(13)	4.0	(2)
64	1656	4	90	6318	(90)	70.2	21.1	(19)	40.0	(36)	27.8	(25)	11.1	(10)
65	762	2	48	4024	(48)	83.8	20.8	(10)	25.0	(12)	45.8	(22)	8.3	(4)
66	1860	4	127	7143	(124)	57.6	9.7	(12)	36.3	(45)	45.2	(56)	8.9	(11)
67	1566	4	63	4522	(62)	72.9	25.8	(16)	32.3	(20)	32.3	(20)	9.7	(6)
74	2594	7	54	4297	(52)	82.6	25.0	(13)	46.2	(24)	28.9	(15)	0	
75	3596	9	24	2618	(26)	100.7	30.8	(8)	42.3	(11)	26.9	(7)	0	
TOTAL	30,593	63	689	45,567	(656)									
MEAN	2,353	4.8	53	4,142.5		69.5	17.5	(115)	34.9	(229)	37.0	(243)	10.5	(69)

[1/] Includes all sets north of Florida and south of Woods Hole.

Table B-9. Percent and number swordfish caught by size category for the north-east Area.[1] (*, **; See Table B-6).

TRIP	TOTAL NO. HOOKS	NO. OF SETS	TOTAL NO. FISH	TOTAL WT.*		MEAN WT.	PERCENT AND NUMBER IN EACH SIZE CATEGORY** %LG (NO.)		%MED (NO.)		%SM (NO.)		%V.SM (NO.)	
7	2808	4	40	-		-								
8	3981	5	75	-		-								
9	4584	5	84	-		-								
10	3312	4	94	-		-								
11	3156	4	77	-		-								
12	4021	5	77	-		-								
13	3048	4	80	-		-								
14	3948	5	57	8888	(53)	167.7	81.1	(43)	18.9	(10)	0		0	
15	2770	6	25	-	-	-	-							
16	3070	5	28	-	-	-	-							
25	4884	8	24	3210	(23)	139.6	78.3	(18)	17.4	(4)	4.4	(1)	0	
26	6964	9	60	7095	(58)	122.3	58.6	(34)	37.9	(22)	3.5	(2)	0	
27	6864	9	43	3318	(41)	80.9	29.3	(12)	53.7	(22)	14.6	(6)	2.4	(1)
28	5034	7	64	4702	(61)	77.1	24.6	(15)	45.9	(28)	23.0	(14)	6.6	(4)
29	5256	7	109	-	-									
30	6384	8	82	7365	(80)	92.1	35.0	(28)	41.3	(33)	16.3	(13)	7.5	(6)
31	5664	9	94	5511	(86)	64.1	16.3	(14)	38.4	(33)	26.7	(23)	18.6	(16)
32	564	1	22	1300	(22)	59.1	9.1	(2)	40.9	(9)	27.3	(6)	22.7	(5)
43	2796	6	10	773	(7)	104.7	57.1	(4)	28.6	(2)	14.3	(1)	0	
44	5328	7	35	2466	(29)	85.0	31.0	(9)	44.8	(13)	24.1	(7)	0	
45	3960	5	32	2349	(26)	90.3	26.9	(7)	34.6	(9)	30.8	(8)	7.7	(2)
46	5496	8	82	6079	(81)	75.0	25.9	(21)	39.5	(32)	30.9	(25)	3.7	(3)
47	2952	4	94	7022	(88)	79.8	29.6	(26)	33.0	(29)	28.4	(25)	9.1	(8)
48	3708	6	49	2544	(44)	57.8	9.1	(4)	43.2	(19)	43.2	(19)	4.6	(2)
49	3888	5	74	3193	(57)	56.0	10.5	(6)	28.1	(16)	52.6	(30)	8.8	(5)
62	3540	10	133	8813	(124)	71.1	14.5	(18)	63.7	(79)	19.4	(24)	2.4	(3)
63	1698	6	28	1809	(26)	69.6	15.4	(4)	50.0	(13)	26.9	(7)	7.7	(2)
76	1488	6	24	2377	(25)	95.1	20.0	(5)	68.0	(17)	8.0	(2)	4.0	(1)
77	2978	6	60	5999	(60)	100.0	43.3	(26)	50.0	(30)	6.7	(4)	0	
78	2416	4	85	6925	(82)	84.5	23.2	(19)	65.9	(54)	7.3	(6)	3.7	(3)
79	1928	6	45	3799	(36)	105.5	55.6	(20)	36.1	(13)	5.6	(2)	2.8	(1)
80	3057	8	55	5119	(51)	100.4	43.1	(22)	29.4	(15)	19.6	(10)	7.8	(4)
81	1232	3	92	9513	(87)	109.3	47.1	(41)	41.4	(36)	10.3	(9)	1.2	(1)
82	1939	5	147	11426	(147)	77.7	27.2	(40)	41.5	(61)	19.1	(28)	12.2	(18)
83	1355	4	39	3559	(37)	96.2	40.5	(15)	32.4	(12)	13.5	(5)	13.5	(5)
84	2607	6	49	3341	(45)	74.2	22.2	(10)	37.8	(17)	26.7	(12)	13.3	(6)
TOTAL	128,678	210	2,268	128,455	(1476									
MEAN	3,574	5.8	63.0	4,940.6		87.0	31.4	(463)	42.6	(628)	19.6	(289)	6.5	(96)

1. Trips out of Woods Hole, including trips to various canyons.

Table B-10. Percent and number swordfish caught by size category for all areas, by season, 1974 (*, **; See Table B-6).

MONTH	TRIP NO.	TOTAL NO. HOOKS	NO. SETS	NO. FISH	TOTAL WT.*		MEAN WT.	PERCENT AND NUMBER IN EACH SIZE CATEGORY** %LG	(NO.)	%MED	(NO.)	%SM	(NO.)	%V.SM	(NO.)
Mar	1	3544	6	34	1176	(33)	35.6	3.0	(1)	18.2	(6)	24.2	(8)	54.6	(18)
Mar-Apr	2	3544	6	18	1152	(18)	64.0	16.7	(3)	33.3	(6)	22.2	(4)	27.8	(5)
Apr	3	3876	6	45	3344	(45)	74.3	28.9	(13)	46.7	(21)	4.4	(2)	20.0	(9)
Apr-May	4	2796	4	122	7097	(122)	58.2	16.4	(20)	34.4	(42)	23.8	(29)	25.4	(31)
May	5	4730	6	80	5123	(75)	68.3	26.7	(20)	29.3	(22)	22.7	(17)	21.3	(16)
May	6	4332	6	98	4611	(88)	52.4	13.6	(12)	25.0	(22)	36.4	(32)	25.0	(22)
July	7	2808	4	40	-	-									
July	8	3981	5	75	-	-									
July-Aug	9	4584	5	84	-	-									
Aug	10	3312	4	94	-	-									
Aug	11	3156	4	77	-	-									
Sept	12	4021	5	77	-	-									
Oct	13	3048	4	80	-	-									
Oct	14	3948	5	57	8888	(53)	167.7	81.1	(43)	18.9	(10)	0	0		
Nov	15	2770	6	25	-	-									
Nov-Dec	16	3070	5	28	-	-									
Dec	17	2730	3	8	-	-									
TOTAL		60,250	84	1,042	31,391	(434)	-	-	-	-	-				
MEAN		3,544	4.9	61.3	4,484.4		72.3	25.8	(112)	29.7	(129)	21.2	(92)	23.3	(101)

Table B-11. Percent and number swordfish caught by size category for all areas, by season, 1975 (*, **; See Table B-6).

MONTH	TRIP NO.	TOTAL NO. HOOKS	NO. SETS	NO. FISH	TOTAL WT*		MEAN WT	PERCENT AND NUMBER IN EACH SIZE CATEGORY** %LG (NO.)		%MED (NO.)		%SM (NO.)		%V.SM (NO.)	
Jan	18	4274	6	43	2354	(43)	54.7	14.0	(6)	23.3	(10)	20.9	(9)	41.9	(18)
Feb	19	5267	6	57	3719	(57)	65.2	22.8	(13)	29.8	(17)	31.6	(18)	15.8	(4)
Feb-Mar	20	5253	7	41	2979	(41)	72.6	19.5	(8)	41.5	(17)	26.8	(11)	12.2	(5)
Mar	21	4416	6	18	-		-	22.2	(4)	50.0	(9)	27.8	(5)		
Apr	22	3828	6	63	3799	(61)	62.3	11.5	(7)	47.5	(29)	26.2	(16)	14.8	(9)
Apr-May	23	4212	6	89	6412	(88)	72.9	22.7	(20)	43.2	(38)	26.1	(23)	8.0	(7)
June	24	2616	4	24	1439	(24)	60.0	4.2	(1)	54.2	(13)	33.3	(8)	8.3	(2)
June	25	4884	8	24	3210	(23)	139.6	78.3	(18)	17.4	(4)	4.4	(1)	0	
July	26	6964	9	60	7095	(58)	122.3	58.6	(34)	37.9	(22)	3.5	(2)	0	
July-Aug	27	6864	9	43	3318	(41)	80.9	29.3	(12)	53.7	(22)	14.6	(6)	2.4	(1)
Aug	28	5034	7	64	4702	(61)	77.1	24.6	(15)	45.9	(28)	23.0	(14)	6.6	(4)
Sept	29	5256	7	109	-	-	-	-	-	-					
Sept-Oct	30	6384	8	82	7365	(80)	92.1	35.0	(28)	41.3	(33)	16.3	(13)	7.5	(6)
Oct-Nov	31	5664	9	94	5511	(86)	64.1	16.3	(14)	38.4	(33)	26.7	(23)	18.6	(16)
Nov	32	564	1	22	1300	(22)	59.1	9.1	(2)	40.9	(9)	27.3	(6)	22.7	(5)
Dec	33	2616	4	70	3309	(64)	51.7	7.8	(5)	25.0	(16)	39.1	(25)	28.1	(18)
TOTAL		74,096	103	903	56,512	(749)									
MEAN		4,631	6.4	56.4	4,036.6		75.5	24.4	(183)	38.9	(291)	23.4	(175)	13.4	(100)

Table B-12. Percent and number swordfish caught by size category for all areas, by season, 1976 (*, **; See Table B-6).

MONTH	TRIP NO.	TOTAL NO. HOOKS	NO. SETS	NO. FISH	TOTAL WT*		MEAN WT	PERCENT AND NUMBER IN EACH SIZE CATEGORY** %LG (NO.)		%MED (NO.)		%SM (NO.)		%V.SM (NO.)	
Jan	34	4778	6	25	1898	(25)	75.9	24.0	(6)	48.0	(12)	20.0	(5)	8.0	(2)
Jan-Feb	35	6788	11	36	1462	(34)	43.0	2.9	(1)	26.5	(9)	44.1	(15)	26.5	(9)
Feb	36	3156	4	17	1201	(17)	70.6	11.8	(2)	52.9	(9)	29.4	(5)	5.9	(1)
Mar	37	5364	8	33	2469	(30)	82.3	26.7	(8)	56.7	(17)	13.3	(4)	3.3	(1)
Mar-Apr	38	6684	10	77	4213	(73)	57.7	11.0	(8)	42.5	(31)	27.4	(20)	19.2	(14)
Apr	39	3648	6	59	3906	(55)	71.0	14.6	(8)	50.9	(28)	27.3	(15)	7.3	(4)
May	40	7708	9	86	4238	(71)	59.7	12.7	(9)	42.3	(30)	35.2	(25)	9.9	(7)
June	41	1608	4	16	1420	(16)	88.8	25.0	(4)	31.3	(5)	43.8	(7)	0	
Jun-Jul	43	2796	6	10	733	(7)	104.7	57.1	(4)	28.6	(2)	14.3	(1)	0	
July	44	5328	7	35	2466	(29)	85.0	31.0	(9)	44.8	(13)	24.1	(7)	0	
Aug	45	3960	5	32	2349	(26)	90.3	26.9	(7)	34.6	(9)	30.8	(8)	7.7	(2)
Aug-Sep	46	5496	8	82	6079	(81)	75.0	25.9	(21)	39.5	(32)	30.9	(25)	3.7	(3)
Sept	47	2952	4	94	7022	(88)	79.8	29.6	(26)	33.0	(29)	28.4	(25)	9.1	(8)
Sep-Oct	48	3708	6	49	2544	(44)	57.8	9.1	(4)	43.2	(19)	43.2	(19)	4.6	(2)
Oct	49	3888	5	74	3193	(57)	56.0	10.5	(6)	28.1	(11)	52.6	(30)	8.8	(5)
Nov	50	3894	6	106	6350	(101)	62.9	15.8	(16)	23.8	(24)	44.6	(45)	15.8	(16)
Dec	51	2820	5	9	-	-	-	-	-	-					
TOTAL		74,576	110	840	51,543	(754)	-	-	-	-	-				
MEAN		4,387	6.5	49.4	3,221.4		68.4	18.4	(139)	37.8	(285)	34.0	(256)	9.8	(74)

Table B-13. Percent and number swordfish caught by size category for all areas, by season, 1977 (*, **; See Table B-6).

MONTH	TRIP NO.	TOTAL NO. HOOKS	NO. SETS	NO. FISH	TOTAL WT*		MEAN WT	PERCENT AND NUMBER IN EACH SIZE CATEGORY** %LG (NO.)		%MED (NO.)		%SM (NO.)		%V.SM (NO.)	
Jan-Feb	52	3000	5	34	1751	(32)	54.7	15.6	(5)	18.8	(6)	31.3	(10)	34.4	(11)
Feb-Mar	53	5328	11	23	1423	(21)	67.8	28.6	(6)	28.6	(6)	28.6	(6)	14.3	(3)
Mar	54	4272	8	31	1506	(22)	68.5	18.2	(4)	45.5	(10)	22.7	(5)	13.6	(3)
Apr	55	4323	6	58	3981	(57)	69.8	24.6	(14)	31.6	(18)	31.6	(18)	12.3	(7)
Apr-May	56	5240	9	60	6077	(59)	103.0	45.8	(27)	35.6	(21)	13.6	(8)	5.1	(3)
May	57	4910	8	76	3857	(70)	55.1	14.3	(10)	20.0	(14)	50.0	(35)	15.7	(11)
Jun	58	4160	8	50	3613	(44)	82.1	31.8	(14)	45.5	(20)	20.5	(9)	2.3	(1)
Jun-Jul	59	4810	8	57	5066	(53)	95.4	45.3	(24)	28.3	(15)	24.5	(13)	1.9	(1)
Jul	60	1890	4	16	1793	(12)	149.4	66.7	(8)	33.3	(4)	0		0	
Aug	61	2275	7	50	4127	(49)	84.2	22.5	(11)	46.9	(23)	26.5	(13)	4.1	(2)
Aug-Sep	62	3540	10	133	8813	(124)	71.1	14.5	(18)	63.7	(79)	19.4	(24)	2.4	(3)
Sep	63	1698	6	28	1809	(26)	69.6	15.4	(4)	50.0	(13)	26.9	(7)	7.7	(2)
Oct	64	1656	4	90	6318	(90)	70.2	21.1	(19)	40.0	(36)	27.8	(25)	11.1	(10)
Nov	65	762	2	48	4024	(48)	83.8	20.8	(10)	25.0	(12)	45.8	(22)	8.3	(4)
Nov	66	1860	4	127	7143	(124)	57.6	9.7	(12)	36.3	(45)	45.2	(56)	8.9	(11)
Nov	67	1566	4	63	4522	(62)	72.9	25.8	(16)	32.3	(20)	32.3	(20)	9.7	(6)
Dec	68	2166	5	21	1422	(21)	67.7	28.6	(6)	23.8	(5)	38.1	(8)	9.5	(2)
TOTAL		53,456	109	965	67,234	(914)									
MEAN		3,144	6.4	56.8	3,954.9		73.6	22.8	(208)	38.0	(347)	30.5	(279)	8.8	(80)

Table B-14. Percent and number swordfish caught by size category for all areas, by season, 1978 (*, **' See Table B-6).

MONTH	TRIP NO.	TOTAL NO. HOOKS	NO. SETS	NO. FISH	TOTAL WT*		MEAN WT	PERCENT AND NUMBER IN EACH SIZE CATEGORY** %LG (NO.)		%MED (NO.)		%SM (NO.)		%V.SM (NO.)	
Jan-Feb	69	2968	7	22	1506	(22)	82.0	36.4	(8)	27.3	(6)	18.2	(4)	18.2	(4)
Feb-Mar	70	2352	6	20	2405	(20)	120.3	50.0	(10)	30.0	(6)	20.4	(4)	0	
Mar	71	3043	7	28	2033	(27)	75.3	25.9	(7)	37.0	(10)	25.9	(7)	11.1	(3)
Apr	72	3125	9	25	-	-	-								
Apr-May	73	2595	9	8	698	(8)	87.3	25.0	(2)	37.5	(3)	37.5	(3)	0	
May	74	2594	7	54	4297	(52)	82.6	25.0	(13)	46.2	(24)	28.9	(15)	0	
June	75	3596	9	24	2618	(26)	100.7	30.8	(8)	42.3	(11)	26.9	(7)	0	
Jun-Jul	76	1488	6	24	2377	(25)	95.1	20.0	(5)	68.0	(17)	8.0	(2)	4.0	(1)
Jul	77	2978	6	60	5999	(60)	100.0	43.3	(26)	50.0	(30)	6.7	(4)	0	
Aug	78	2416	4	85	6925	(82)	84.5	23.2	(19)	65.9	(54)	7.3	(6)	3.7	(3)
Aug	79	1928	6	45	3799	(36)	105.5	55.6	(20)	36.1	(13)	5.6	(2)	2.8	(1)
Aug-Sep	80	3057	8	55	5119	(51)	100.4	43.1	(22)	29.4	(15)	19.6	(10)	7.8	(4)
Sep	81	1232	3	92	9513	(87)	109.3	47.1	(41)	41.4	(36)	10.3	(9)	1.2	(1)
Oct	82	1939	5	147	11426	(147)	77.7	27.2	(40)	41.5	(61)	19.1	(28)	12.2	(18)
Oct	83	1355	4	39	3559	(37)	96.2	40.5	(15)	32.4	(12)	13.5	(5)	13.5	(5)
Nov	84	2607	6	49	3341	(45)	74.2	22.2	(10)	37.8	(17)	26.7	(12)	13.3	(6)
TOTAL		39,263	102	777	65,615	(725)	-								
MEAN		2,454	6.4	48.6	4,374.3		90.5	33.9	(246)	43.4	(315)	16.3	(118)	6.3	(46)

APPENDIX C

CLOSED FISHING DAYS BY REGION TO CAP SWORDFISH FISHING EFFORT AT THE 1980 LEVEL

CLOSED FISHING DAYS BY REGION TO CAP SWORDFISH FISHING EFFORT AT THE 1980 LEVEL

Prepared for

SWORDFISH INTER-COUNCIL STEERING COMMITTEE MEETING
ATLANTA, GEORGIA
December 1-3, 1981

Prepared by:

C. Bruce Austin
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Reationale:

Yield-per-recruit (YPR) analysis (Berkeley and Houde, 1981)* indicates that female swordfish are presently harvested (1980) at a level that maximizes YPR. Anticipated increasing fishing effort over the entire Atlantic FCZ range will result in growth overfishing if fishing effort is not restrained to its present level.

Equity Considerations:

Restricting fishing effort to its present level over the entire Atlantic FCZ range is complicated by the equity implications of one region's landings being able to expand only by reductions in landings elsewhere. The initial premise of this approach to closed fishing days by region is the proposition that expansion of one region and the necessary contraction of other regions should be determined by competitive free market forces. Closed fishing days should restrain only total fishing effort and landings, while permitting complete freedom of competition between regions.

Calculation of closed standard and calendar days:

Total reported landings by area by month for the domestic and foreign catches are shown in Appendix C-1. These landings were then grouped into the zones indicated in Table 1 of this text, and represent the percent of landings in each area by month for the domestic fishery. The percent of landings by area and month for the foreign incidental fishery are presented in Table 2. Figures 1-8 (Appendix C-2) are graphical presentations of Tables 1 and 2.

*See Section 9.0.

Standard fishing days for the domestic fishery are shown in Table 3. The number of standard days in each month (for each region) is the percent of that region's annual catch in that month (Table 1) times the number of days in a calendar year (364). The interpretation of standard fishing days is that they are days for comparing the reglative importance of a given month to a given region.

At the bottom of Table 3 is the number of calendar days associated with a percent reduction in available days in the year. For example, five percent of 364 days is 18 days. If five percent of total fishing days for all regions (18 days) had to be closed to swordfishing to maintain landings at their 1980 level, then this would be accomplished by removing 18 standard days from each region. The number of calendar days a region would have to close depends on when the closure occurs during the year. For example, closing 18 standard days in Florida in September would require closing four tenths of the month, which is 12 calendar days (See Table 3):

$$\frac{\text{18 standard days closed in FL}}{\text{44 standard days available in Florida in September}} = 0.41$$

$$\text{(0.41)(30 September calendar days)} = \text{12 calendar days}$$

For the Gulf of Mexico, the closure would be for the entire month of September (30 calendar days, see Table 3). However, 18 standard days for the Gulf of Mexico in April would be only 10 calendar days:

$$\frac{\text{18 standard days closed in GM}}{\text{55 standard days available in GM in April}} = 0.33$$

$$\text{(0.33)(30 April calendar days)} = \text{10 calendar days}$$

The number of calendar days that must be closed in each area to achieve a given percentage reduction in total effort were calculated and are shown in Appendix C-3.

Free choice of closed days:

Each region can choose to close whatever days during the year they desire. They could decide what is to their advantage based on the seasonal patterns of their own boats as well as the expected mobility of vessels into or out of their region. The only constraint for practical purposes is that if and when additional closed days are required in the future, that the additional closed days are contiguous with the already existing closed days.

Iterative adjustments of closed calendar days for all regions (annually):

If estimates of total (all regions) effort and landings have increased in a previous year over the estimated 1980 level, then a larger percent of calendar days for all areas will be removed. This could occur because (1) existing boats intensified their fishing during the open season in a region to compensate for the closed days, (2) the number of boats swordfishing continue to increase, or (3) technological innovations increase effective effort even with fewer available fishing days. These occurrences are nothing new with techniques to control fishing effort by closed seasons. What's important is that while any of these three factors may dampen the effort reducing effectiveness of closed days, unless (1), (2), and (3) change dramatically, effort can be effectively restrained with closed days.*

For example, moving from five percent to ten percent is from 18 to 36 calendar days (bottom of Table 3). Then each region would be required to remove 36 standard days from their fishing season by closing whatever calendar days correspond to 36 standard days. As an example, 36 standard days in New England could be 19 calendar days in July (Calculate from Table 3 or see appropriate table in Appendix C-3):

$$\frac{\text{36 standard days closed in New Eng}}{\text{58 standard days available in New Eng in July}} = 0.62$$

$$\text{(0.62)(30 July calendar days)} = \text{19 calendar days}$$

*The arithmetic of the situation illustrates the point. Fishing effort (E) is a composite index of the multiplicative factors of the number of boats (B) times the number of days they fish (D) times their fishing power or harvesting technology (T):

$$E = BDT$$

Therefore, percent change in effort (E) is always equal to the percent change in number of boats (B), plus the percent change in number of fishing days (D), plus the percent change in technology (T). That means that if the number of boats increases by 10 percent, then a 10 percent reduction in available fishing days (D) will stabilize effort (offset increase in B). While we cannot precisely anticipate increases in the number of boats or technology we do not expect them to exhibit percentage increases that cannot be compensated for by reasonable decreases in the number of fishing days (e.g. 20-50 percent).

Opinion of the inter-council advisory panel:

On November 9-10, 1981, in Atlanta, the Inter-Council AP reviewed the proposed management measure to phase-out the Japanese incidental catch of swordfish according to the formula in the American Fisheries Promotion Act and cap domestic fishing effort and landings at the 1980 level.

The phase-out was wholly agreeable to the AP. They recommended the fastest posssible phase-out and that during the phase-out, the Japanese be allowed to keep the number of swordfish that are permitted by the phase-out formula but they strongly emphasized that 100 percent observer coverage would be necessary to accomplish the phase-out.

The AP also approved the variable season closure (VSC) method as presented. They believe that all area closures should have overlapping closed days to minimize the relative advantages to larger mobile vs. smaller fixed port vessels. The initial choice was to begin all region closures in November. This would mean that the number of calendar days closed in the northern and central areas would be greater than the number of calendar days closed in the southern and Gulf areas to achieve comparable reductions. The nothern closures would not affect the harpoon fishery.

Another recommendation suggested that all region closures begin in August, but there was concern over the effect on the northern harpoon fishery which has a very short season. Staff (Austin/Waugh) is calculating variable season closure tables only for the northern harpoon fishery which will specify their closures which will differ from the northern longline figures. It was also suggested that since the northern harpoon fishery represents such a small portion of total landings and the season and area is so limited that the closed days only apply to longline gear.

Table 1. Monthly landings index* by area expressed as a percentage of annual landings using 1980 monthly data as a base year. (GM = Gulf of Mexico; FL-EC = Florida East Coast; S-ATL = NC, SC & GA; MID-ATL = NY, NJ, MD, VA; NEW ENG = RI, MA, ME).

	GM	FL-EC	S-ATL	MID-ATL	NEW ENG	S-ATL MID-ATL NEW ENG
JANUARY	10.27	4.81	0.00	0.00	0.00	0.00
FEBRUARY	19.26	4.47	0.00	0.00	0.00	0.00
MARCH	15.83	7.89	0.00	0.00	0.00	0.00
APRIL	15.22	7.15	0.19	0.00	0.60	0.57
MAY	3.71	11.71	5.06	0.00	0.72	0.89
JUNE	2.80	7.19	14.26	2.86	7.44	7.62
JULY	2.76	16.06	17.22	30.83	16.02	16.38
AUGUST	2.55	13.21	25.67	26.10	25.07	25.12
SEPTEMBER	5.01	12.15	25.33	8.79	24.01	23.75
OCTOBER	4.72	7.27	8.99	20.35	16.58	16.35
NOVEMBER	5.93	4.70	3.27	11.07	4.84	4.91
DECEMBER	11.94	3.40	0.00	0.00	4.72	4.43

*Monthly Landings Index (MLI) = $\frac{\text{Landings in a month}}{\text{Annual Landings}}$

Table 2. Monthly landings index* by area expressed as a percentage of total swordfish incidental catch extrapolated from 1980 observer data and 1980 data reported by the Japanese. (Source: NMFS Observer Program, unpublished data)

	GULF		SATL/MATL/NEW ENG	
	OBSERVER DATA	JAPANESE DATA	OBSERVER DATA	JAPANESE DATA
JANUARY	2.29	3.87	0.00	5.45
FEBRUARY	24.76	27.13	3.80	3.83
MARCH	71.64	67.31		
APRIL	1.31	1.69	0.11	0.25
MAY				
JUNE			0.22	0.28
JULY			4.07	4.75
AUGUST			4.07	2.99
SEPTEMBER			14.56	15.09
OCTOBER			26.37	21.21
NOVEMBER			22.71	18.75
DECEMBER			24.10	27.40

*Monthly Landings Index (MLI) = $\frac{\text{Landings in a month}}{\text{Annual Landings}}$

Table 3. Standard fishing day (measure of importance of that month to that region) by month and area.

	GM	FL-EC	S-ATL	MID-ATL	NEW ENG	S-ATL MID-ATL NEW ENG
JANUARY	37	18	-	-	-	-
FEBRUARY	70	16	-	-	-	-
MARCH	58	29	-	-	-	-
APRIL	55	26	1	-	2	2
MAY	14	43	18	-	3	3
JUNE	10	26	52	10	27	28
JULY	10	59	63	112	58	60
AUGUST	9	48	93	95	91	91
SEPTEMBER	18	44	92	32	87	87
OCTOBER	17	27	33	74	60	60
NOVEMBER	22	17	12	40	18	18
DECEMBER	44	12	-	-	17	16
TOTALS	364	365	364	363	363	365

PERCENT REDUCTION IN EFFORT	NUMBER OF CALENDAR DAYS
5	18
10	36
15	55
20	73
25	91
30	109

APPENDIX C-1

MONTHLY CATCH DATA FOR THE DOMESTIC FISHERY FOR THE YEARS 1977-1980(81) AND 1980 MONTHLY FOREIGN CATCH DATA BOTH AS REPORTED BY THE JAPANESE AND EXTRAPOLATED FROM OBSERVER DATA

Table 1. Monthly swordfish landings data for Texas. (Source: Ormon Farley, NMFS; pers. comm.)

	1977	1978	1979*	1980+	1981
JANUARY			44,300	95,200	103,200
FEBRUARY			26,600	206,500	179,700
MARCH			86,100	191,300	102,700
APRIL			23,700	215,700	39,000
MAY				43,100	-
JUNE				6,800	300
JULY				5,500	
AUGUST				-	
SEPTEMBER				7,700	
OCTOBER				6,100	
NOVEMBER				21,500	
DECEMBER				166,100	
TOTAL			180,700	965,500	

*During 1979, 4 out-of-state longline boats fished four months; no Texas vessels fished.

+During 1980, 42 converted shrimp trawlers fished for swordfish.

Table 2. Monthly swordfish landings data for Florida West Coast. (Source: Ernie Snell, NMFS; pers. comm.)

	1977	1978	1979	1980
JANUARY	-	-	4,025	82,092
FEBRUARY	-	198	3,949	125,916
MARCH	-	75	3,033	81,911
APRIL	-	3,868	18,539	47,044
MAY	99	22,613	74,871	20,858
JUNE	1,358	4,681	28,676	41,451
JULY	864	1,662	28,181	42,174
AUGUST	-	276	36,518	44,078
SEPTEMBER	-	2,649	14,730	78,740
OCTOBER	-	72	30,248	75,308
NOVEMBER	-	12,534	75,166	80,887
DECEMBER	-	4,080	116,376	40,016
TOTALS	2,321	52,708	434,312	760,475

Table 3. Monthly swordfish landings data for Florida East Coast. (Source: Ernie Snell, NMFS; pers. comm.)

	1977	1978	1979	1980
JANUARY	-	-	14,353	111,006
FEBRUARY	-	-	29,473	103,068
MARCH	-	21,420	120,064	182,202
APRIL	7,957	66,685	226,434	165,033
MAY	29,737	94,419	305,241	270,276
JUNE	16,600	137,539	307,559	165,854
JULY	26,570	75,510	235,155	370,593
AUGUST	16,823	44,012	121,475	304,972
SEPTEMBER	12,685	58,526	55,148	280,344
OCTOBER	2,046	23,095	162,564	167,736
NOVEMBER	967	8,756	141,169	108,386
DECEMBER	-	6,331	135,303	78,572
TOTALS	113,385	536,293	1,853,938	2,308,042

Table 4. Monthly swordfish landings data for North and South Carolina. (Source: Ken Harris, NMFS; pers. comm.)

	1977	1978	1979	1980
JANUARY		124	121	-
FEBRUARY		-	-	-
MARCH		-	-	-
APRIL		-	18,879	2,245
MAY		283,153	235,567	58,832
JUNE		161,226	149,128	165,705
JULY		89,700	185,324	200,043
AUGUST		122,816	310,116	298,195
SEPTEMBER		134,468	69,939	294,236
OCTOBER		192,591	17,713	104,432
NOVEMBER		18,718	6,360	37,986
DECEMBER		18,052	-	-
TOTALS		1,020,848	993,147	1,161,673

Table 5. Monthly swordfish landings data for Georgia. (Source: Ken Harris, NMFS; pers. comm.)

	1977	1978	1979	1980
JANUARY		-		
FEBRUARY		-		
MARCH		-		
APRIL		-		
MAY		-		
JUNE		2,622*		
JULY		-		
AUGUST		-		
SEPTEMBER		-		
OCTOBER		-		
NOVEMBER		-		
DECEMBER		-		
TOTAL		2,622		

*Worth $5,244.

Table 6. Monthly swordfish landings data for New York, New Jersey, Maryland and Virginia. (Source: Bill Kelly, NMFS; pers. comm.)

	1977	1978	1979	1980
JANUARY	-	-	-	-
FEBRUARY	-	-	7,400	-
MARCH	-	-	-	-
APRIL	-	-	-	-
MAY	-	11,972	7,741	-
JUNE	-	7,327	21,182	16,840
JULY	22,092	56,248	127,585	181,661
AUGUST	-	150,140	72,376	153,831
SEPTEMBER	64,750	72,275	82,920	51,819
OCTOBER	134,305	182,496	8,212	119,943
NOVEMBER	486	29,343	-	65,219
DECEMBER	645	230	16,138	-
TOTALS	222,278	510,031	343,554	589,313

Table 7. Monthly swordfish landings data for Rhode Island*. (Source: Ronnie Schultz, NMFS; pers. comm.)

	1977	1978	1979	1980
JANUARY	-	-	-	-
FEBRUARY	-	-	-	-
MARCH	-	-	-	-
APRIL	-	-	-	-
MAY	23,000	-	-	2,000
JUNE	6,000	50,000	17,000	42,000
JULY	9,000	264,000	195,000	136,000
AUGUST	10,000	239,000	124,000	162,000
SEPTEMBER	33,000	80,000	175,000	38,000
OCTOBER	-	15,000	-	74,000
NOVEMBER	-	20,000	-	-
DECEMBER	-	-	-	-
TOTALS	81,000	668,000	511,000	454,000

*Landings data reported rounded to thousand pounds live weight.

Table 8. Monthly swordfish landings data for Massachusetts.* (Source: Ronnie Schultz, NMFS, pers. comm.)

	1977	1978	1979	1980
JANUARY	-	-	-	-
FEBRUARY	-	-	-	-
MARCH	-	-	-	-
APRIL	-	-	100,000	16,000
MAY	-	28,000	177,000	18,000
JUNE	34,000	389,000	409,000	94,000
JULY	267,000	900,000	843,000	241,000
AUGUST	275,000	1,138,000	912,000	225,000
SEPTEMBER	196,000	797,000	669,000	598,000
OCTOBER	73,000	409,000	388,000	174,000
NOVEMBER	-	324,000	11,000	96,000
DECEMBER	-	-	-	125,000
TOTALS	845,000	3,985,000	3,509,000	1,587,000

*Landings data reported rounded to thousand pounds live weight.

Table 9. Monthly swordfish landings data for Maine*. (Source: Ronnie Schultz, NMFS; pers. comm.)

	1977	1978	1979	1980
JANUARY	-	-	-	-
FEBRUARY	-	-	-	-
MARCH	-	-	-	-
APRIL	-	-	-	-
MAY	-	9,000	-	-
JUNE	7,000	14,000	27,000	61,000
JULY	111,000	124,000	82,000	47,000
AUGUST	154,000	70,000	66,000	277,000
SEPTEMBER	40,000	118,000	115,000	-
OCTOBER	68,000	13,000	102,000	192,000
NOVEMBER	-	21,000	-	33,000
DECEMBER	-	-	-	-
TOTALS	380,000	369,000	392,000	610,000

*Landings data reported rounded to thousand pounds live weight.

Table 10. Estimated monthly Japanese swordfish catch extrapolated from 1980 observer data and 1980 data reported by the Japanese. (Source: NMFS Observer Program, unpublished data)

	GULF		SATL/MATL/NEW ENG	
	OBSERVER DATA	JAPANESE DATA	OBSERVER DATA	JAPANESE DATA
JANUARY	101	80	-	155
FEBRUARY	1,093	561	139	109
MARCH	3,163	1,392	-	-
APRIL	58	35	4	7
MAY	-	-	-	-
JUNE	-	-	8	8
JULY	-	-	149	135
AUGUST	-	-	149	85
SEPTEMBER	-	-	533	80
OCTOBER	-	-	965	603
NOVEMBER	-	-	831	533
DECEMBER	-	-	882	779
TOTALS	4,415	2,068	3,660	2,494

APPENDIX C-2

GRAPHIC ILLUSTRATIONS OF SEASONAL LANDINGS INDEX FOR THE DOMESTIC AND FOREIGN SWORDFISH 1980 CATCH DATA

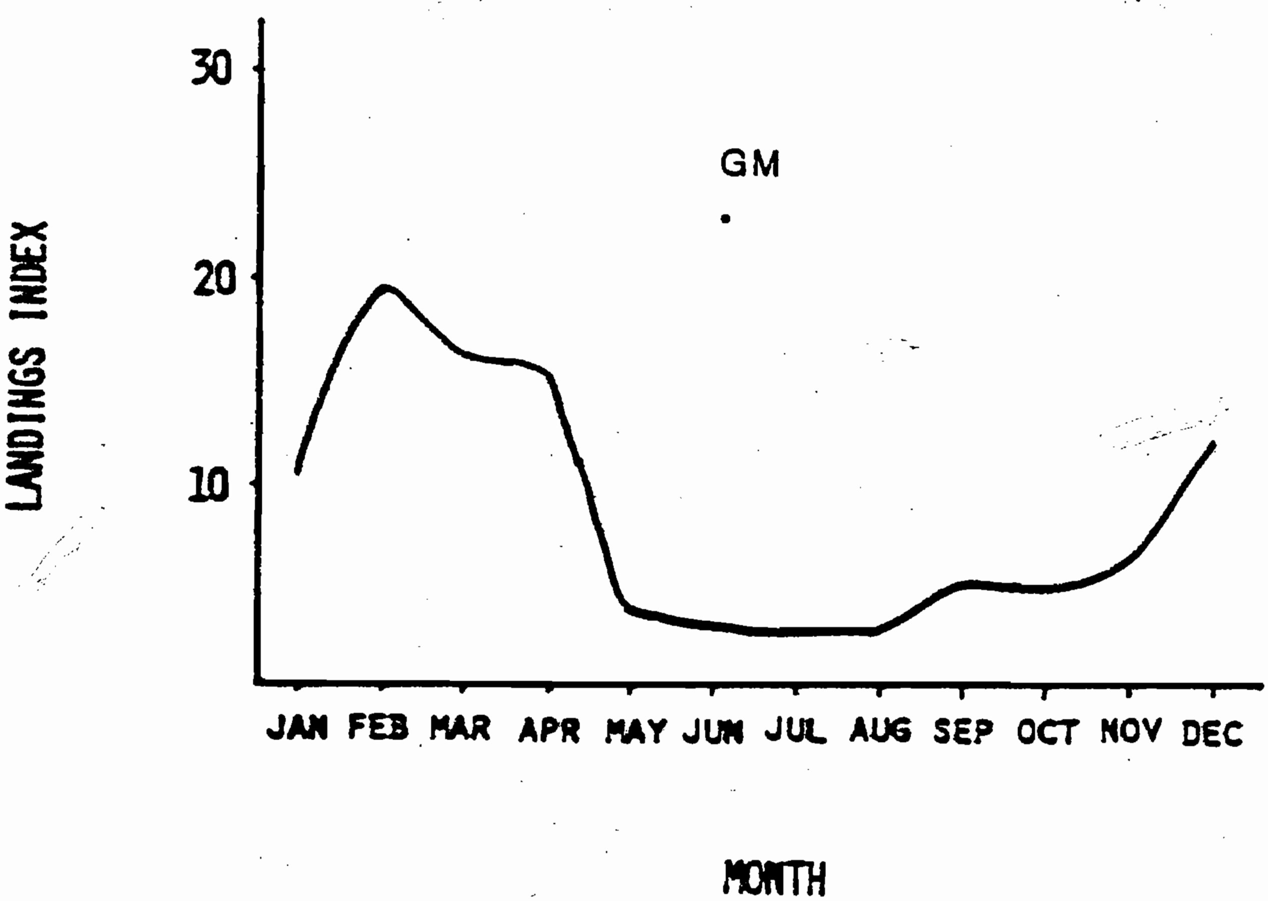

Figure 1. Seasonal domestic 1980 landings index (percent of landings in each area by month; measures importance of that month to that area) for the Gulf of Mexico (GM) area.

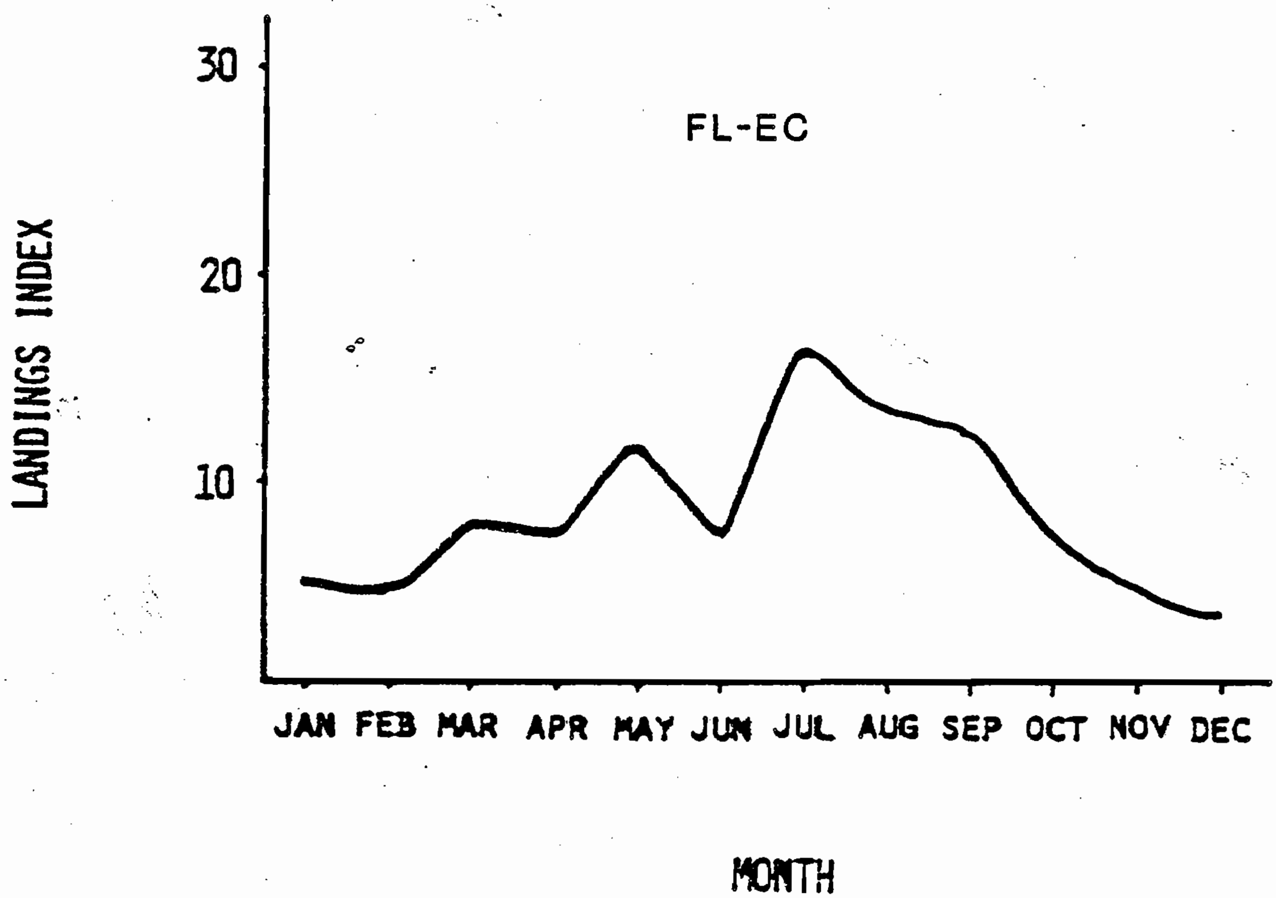

Figure 2. Seasonal domestic 1980 landings index (percent of landings in each area by month; measures importance of that month to that area) for the Florida East Coast (FL-EC) area.

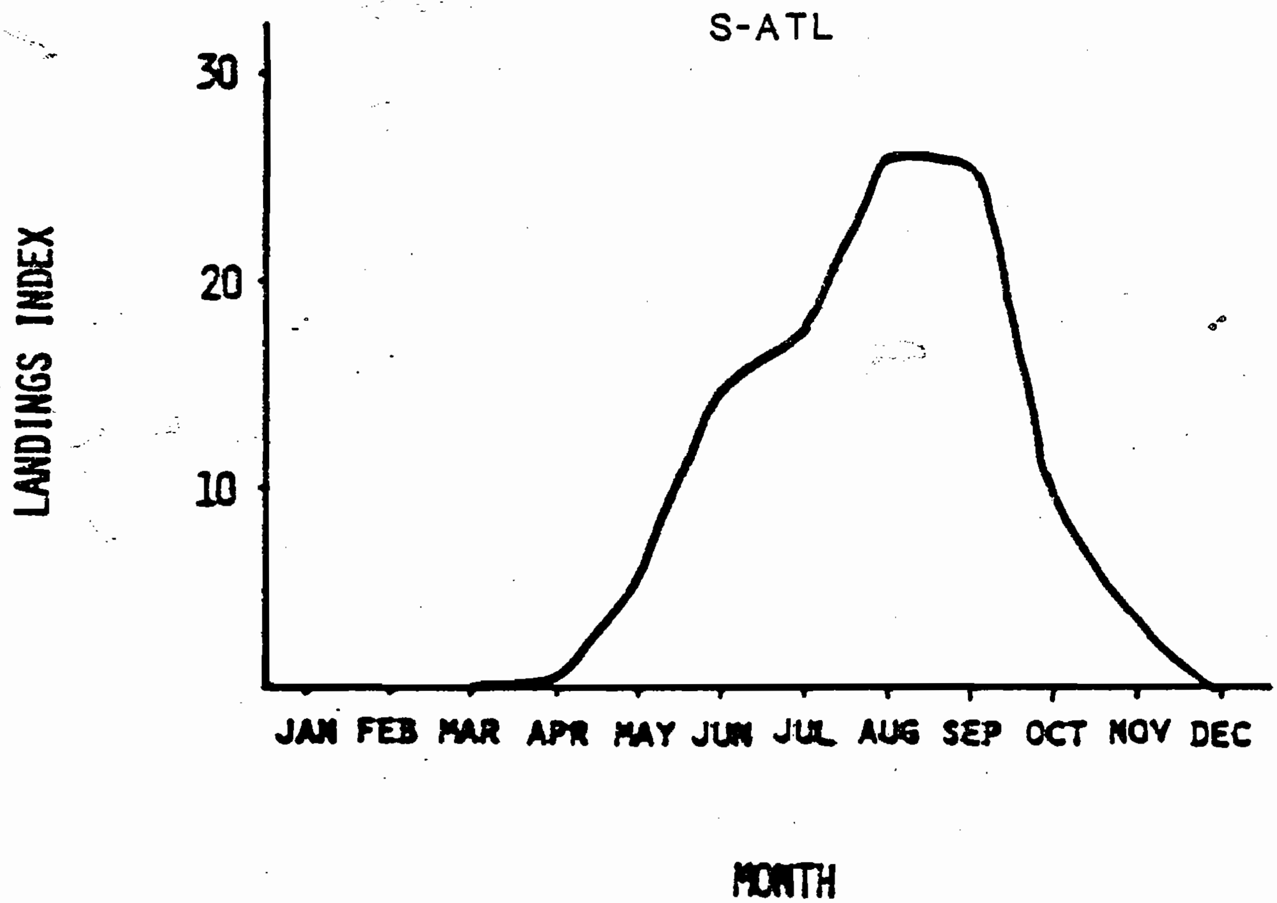

Figure 3. Seasonal domestic 1980 landings index (percent of landings in each area by month; measures importance of that month to that area) for the South Atlantic (S-ATL) area.

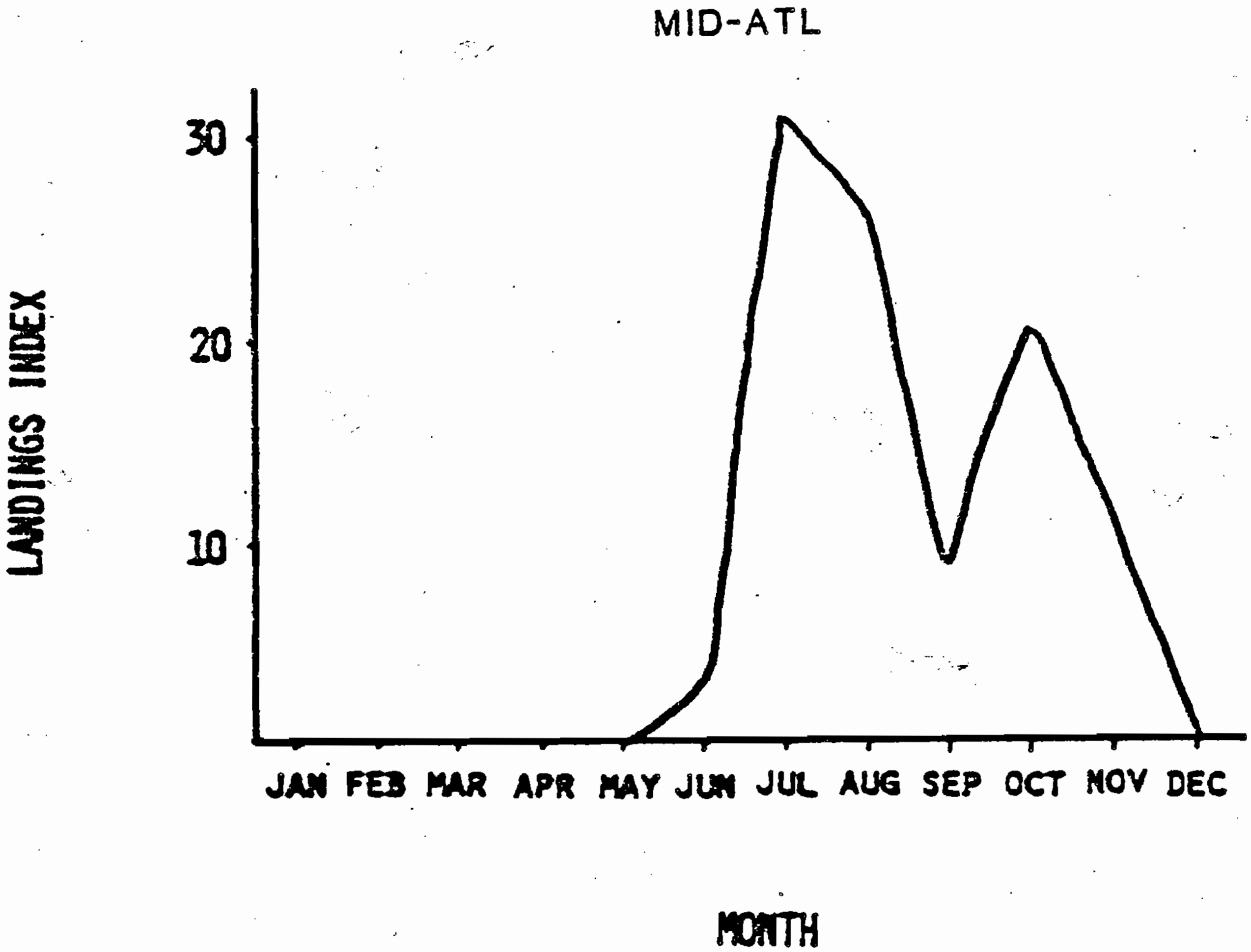

Figure 4. Seasonal domestic 1980 landings index (percent of landings in each area by month; measures importance of that month to that area) for the Mid-Atlantic (MID-ATL) area.

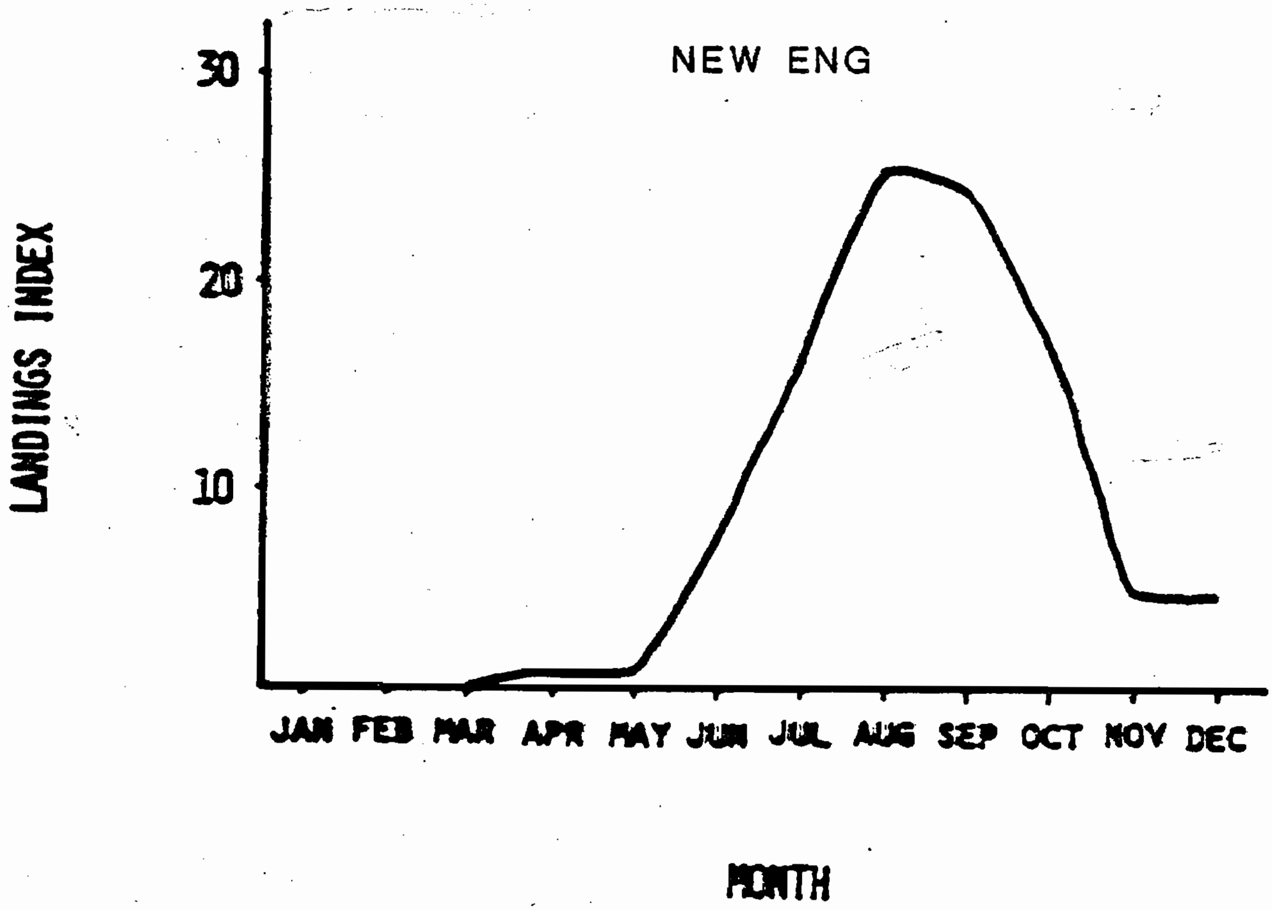

Figure 5. Seasonal domestic 1980 landings index (percent of landings in each area by month; measures importance of that month to that area) for the New England (NEW ENG) area.

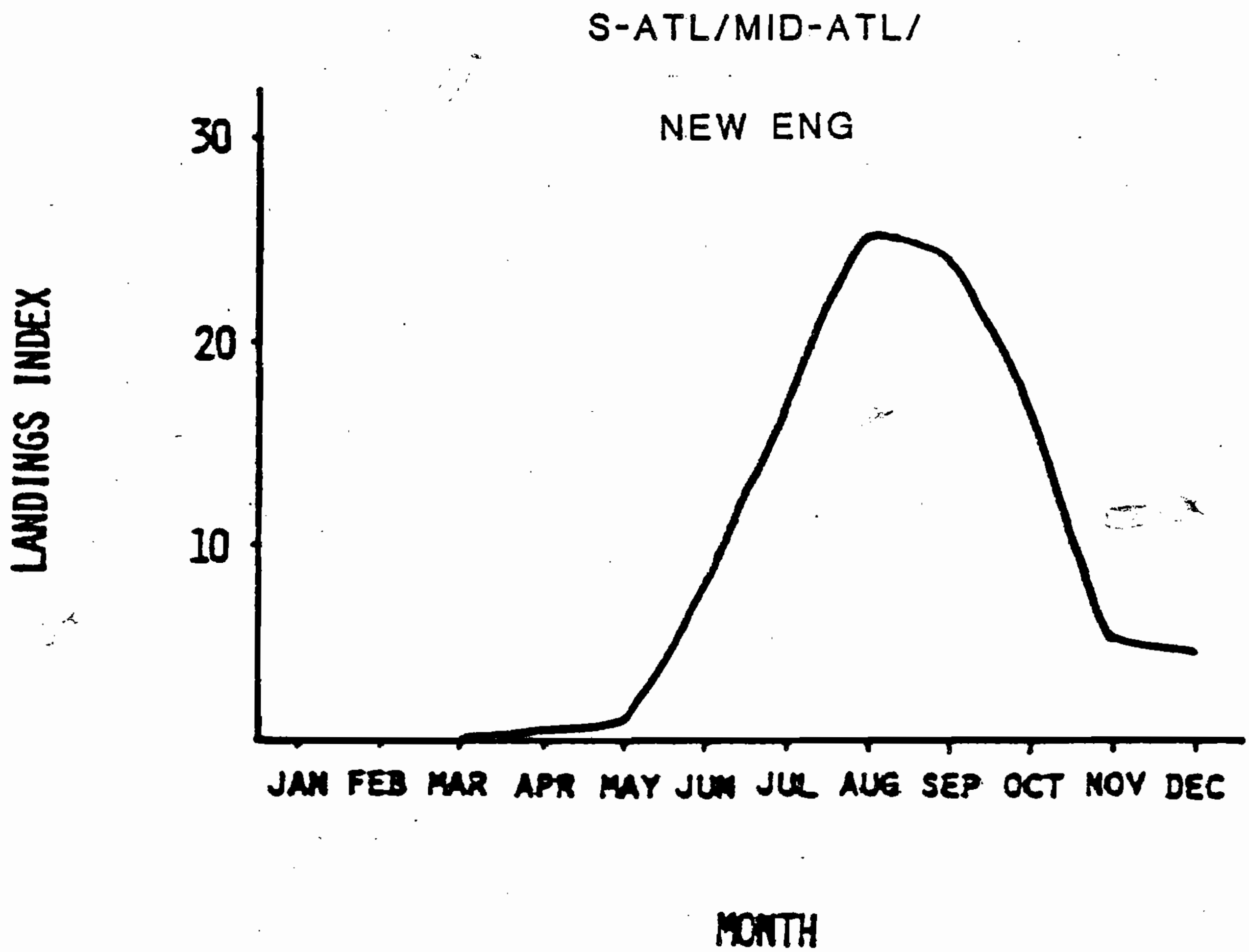

Figure 6. Seasonal domestic 1980 landings index (percent of landings in each area by month; measures importance of that month to that area) for the South Atlantic/Mid-Atlantic/New England (S-ATL/MID-ATL/NEW ENG) area.

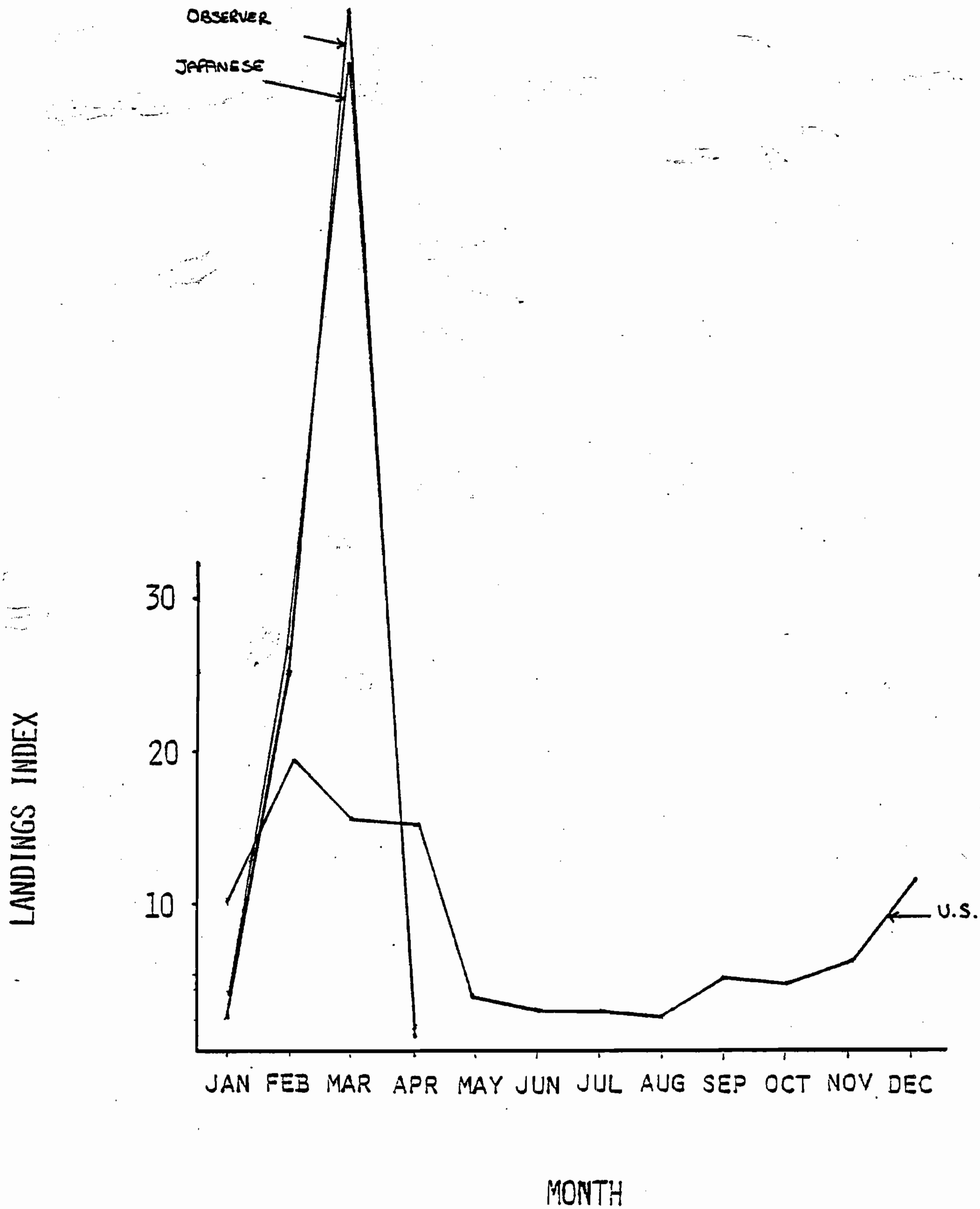

Figure 7. Seasonal 1980 landings index (percent of landings in each area by month; measures importance of that month to that area) for the Gulf of Mexico showing U.S. domestic catch distribution, Japanese reported catch distribution and the Japanese catch distribution as extrapolated from observer data.

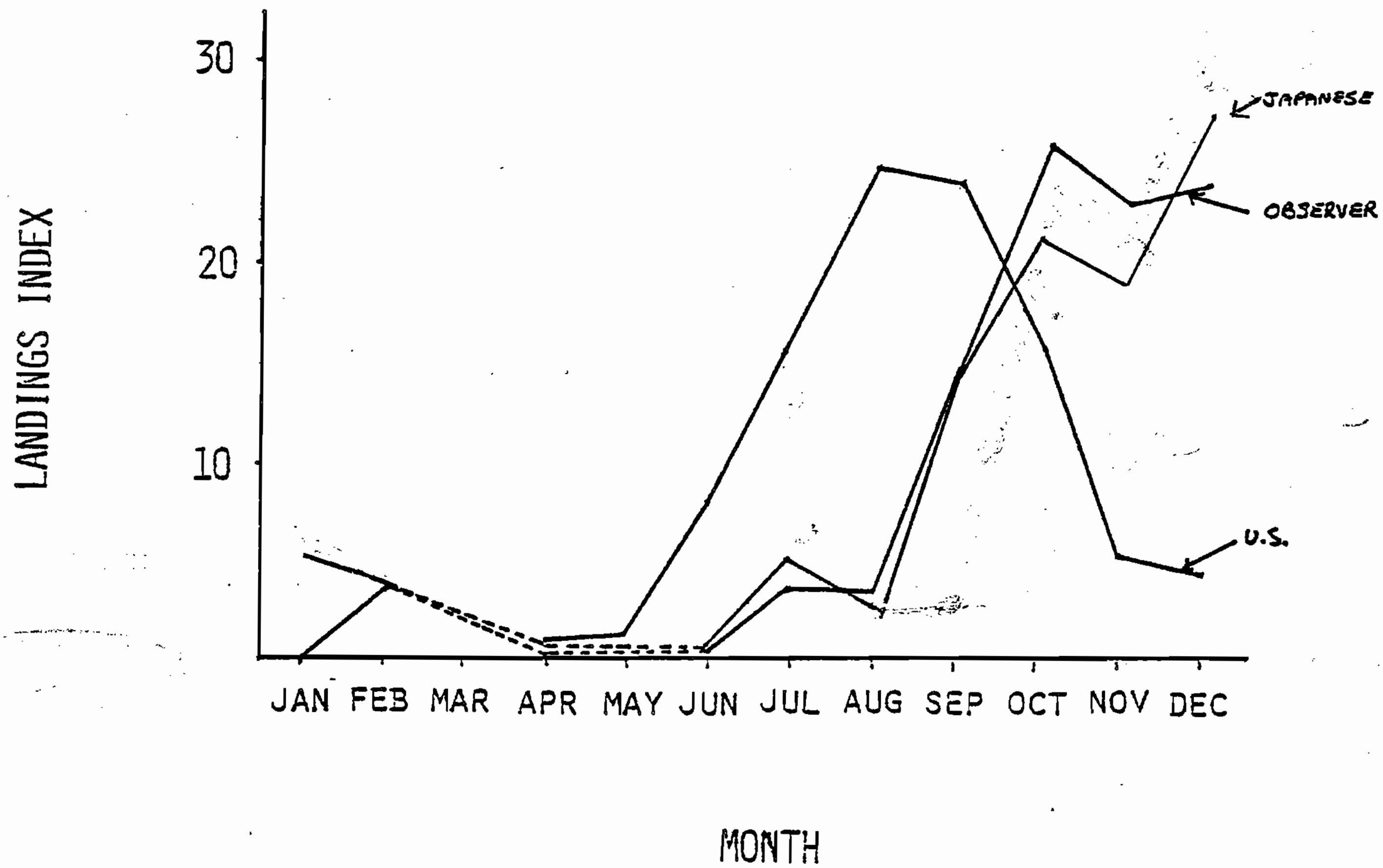

Figure 8. Seasonal 1980 landings index (percent of landings in each area by month; measures importance of that month to that area) for the S-ATL/MID-ATL/NEW ENG area showing the U.S. domestic catch distribution, Japanese reported catch distribution and the Japanese catch distribution as extrapolated from observer data.

APPENDIX C-3

NUMBER OF DAYS THAT MUST BE CLOSED IN EACH AREA (GM, FL-EC, S-ATL, MID-ATL, NEW ENG) TO ACHIEVE SPECIFIED REDUCTIONS IN FISHING EFFORT (5%, 10%, 15%, 20%, 25%)

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = GULF OF MEXICO

% REDUCTION = 5%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	15											
FEB		7										
MAR			10									
APR				10								
MAY					31	12						
JUN						30	25					
JUL							31	28				
AUG								31	15			
SEP									30			
OCT										31	1	
NOV											25	
DEC												13

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = GULF OF MEXICO

% REDUCTION = 10%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	30											
FEB		14										
MAR			19									
APR				20								
MAY					31	30	31	7				
JUN						30	31	31	12			
JUL							31	31	28			
AUG								31	30	16		
SEP									30	31	1	
OCT										31	26	
NOV											30	10
DEC												25

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = GULF OF MEXICO

% REDUCTION = 15%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	7										
FEB		22										
MAR			29									
APR				30								
MAY					31	30	31	31	20			
JUN						30	31	31	15			
JUL							31	31	30	31	1	
AUG								31	30	31	15	
SEP									30	31	27	
OCT										31	30	11
NOV											30	23
DEC	9											31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = GULF OF MEXICO

% REDUCTION = 20%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	14										
FEB		28	2									
MAR			31	8								
APR				30	31	12						
MAY					31	30	31	31	30	22		
JUN						30	31	31	30	31	12	
JUL							31	31	30	31	26	
AUG								31	30	31	30	5
SEP									30	31	30	11
OCT										31	30	24
NOV	6										30	31
DEC	24											31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = GULF OF MEXICO

% REDUCTION = 25%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	22										
FEB		28	11									
MAR			31	18								
APR				30	31	30	31	7				
MAY					31	30	31	31	30	31	18	
JUN						30	31	31	30	31	30	4
JUL							31	31	30	31	30	11
AUG								31	30	31	30	18
SEP									30	31	30	24
OCT	7									31	30	31
NOV	21										30	31
DEC	31	4										31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = FLORIDA EAST COAST

% REDUCTION = 5%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31											
FEB		28	2									
MAR			19									
APR				21								
MAY					13							
JUN						21						
JUL							10					
AUG								12				
SEP									12			
OCT										21		
NOV											30	3
DEC	10											31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = FLORIDA EAST COAST

% REDUCTION = 10%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	2									
FEB		28	21									
MAR			31	8								
APR				30	7							
MAY					26							
JUN						30	5					
JUL							19					
AUG								23				
SEP									25			
OCT										31	16	
NOV	12										30	31
DEC	31	11										31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = FLORIDA EAST COAST

% REDUCTION = 15%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	23									
FEB		28	31	12								
MAR			31	30								
APR				30	21							
MAY					31	14						
JUN						30	15					
JUL							29					
AUG								31	5			
SEP									30	13		
OCT										31	30	28
NOV	31	14									30	31
DEC	31	28	10									31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = FLORIDA EAST COAST

% REDUCTION = 20%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	12								
FEB		28	31	30	1							
MAR			31	30	13							
APR				30	31	5						
MAY					31	30	2					
JUN						30	25					
JUL							31	9				
AUG								31	17			
SEP									30	31	4	
OCT	29									31	30	31
NOV	31	28	11								30	31
DEC	31	28	29									31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = FLORIDA EAST COAST

% REDUCTION = 25%

MONTH	MONTHS AND/OR DAYS CLOSED											
BEGIN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	1							
FEB		28	31	30	14							
MAR			31	30	26							
APR				30	31	25						
MAY					31	30	12					
JUN						30	31	4				
JUL							31	21				
AUG								31	29			
SEP									30	31	30	8
OCT	31	28	1							31	30	31
NOV	31	28	30								30	31
DEC	31	28	30	19								31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = SOUTH ATLANTIC

% REDUCTION = 5%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	29							
FEB		28	31	30	29							
MAR			31	30	29							
APR				30	29							
MAY					31							
JUN						10						
JUL							9					
AUG								6				
SEP									6			
OCT										17		
NOV	31	28	31	30	9						30	31
DEC	31	28	31	30	29							31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = SOUTH ATLANTIC

% REDUCTION = 10%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	31	10						
FEB		28	31	30	31	10						
MAR			31	30	31	10						
APR				30	31	10						
MAY					31	10						
JUN						21						
JUL							18					
AUG								12				
SEP									12			
OCT										31	8	
NOV	31	28	31	30	31	3					30	31
DEC	31	28	31	30	31	10						31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = SOUTH ATLANTIC

% REDUCTION = 15%

MONTH	MONTHS AND/OR DAYS CLOSED											
BEGIN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	31	21						
FEB		28	31	30	31	21						
MAR			31	30	31	21						
APR				30	31	21						
MAY					31	21						
JUN						30	2					
JUL							27					
AUG								18				
SEP									18			
OCT	31	28	31	30	16					31	30	31
NOV	31	28	31	30	31	14					30	31
DEC	31	28	31	30	31	21						31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = SOUTH ATLANTIC

% REDUCTION = 20%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	31	30	1					
FEB		28	31	30	31	30	1					
MAR			31	30	31	30	1					
APR				30	31	30	1					
MAY					31	30	2					
JUN						30	10					
JUL							31	3				
AUG								24				
SEP									24			
OCT	31	28	31	30	31	5				31	30	31
NOV	31	28	31	30	31	24					30	31
DEC	31	28	31	30	31	30	1					31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = SOUTH ATLANTIC

% REDUCTION = 25%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	31	30	10					
FEB		28	31	30	31	30	10					
MAR			31	30	31	30	10					
APR				30	31	30	10					
MAY					31	30	10					
JUN						30	19					
JUL							31	9				
AUG								30				
SEP									30			
OCT	31	28	31	30	31	16				31	30	31
NOV	31	28	31	30	31	30	4				30	31
DEC	31	28	31	30	31	30	10					31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = MID-ATLANTIC

% REDUCTION = 5%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	31	30	2					
FEB		28	31	30	31	30	2					
MAR			31	30	31	30	2					
APR				30	31	30	2					
MAY					31	30	2					
JUN						30	2					
JUL							5					
AUG								6				
SEP									17			
OCT										8		
NOV											14	
DEC	31	28	31	30	31	30	2					31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = MID-ATLANTIC

% REDUCTION = 10%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	31	30	7					
FEB		28	31	30	31	30	7					
MAR			31	30	31	30	7					
APR				30	31	30	7					
MAY					31	30	7					
JUN						30	7					
JUL							10					
AUG								12				
SEP									30	2		
OCT										15		
NOV											27	
DEC	31	28	31	30	31	30	7					31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = MID-ATLANTIC

% REDUCTION = 15%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	31	30	13					
FEB		28	31	30	31	30	13					
MAR			31	30	31	30	13					
APR				30	31	30	13					
MAY					31	30	13					
JUN						30	13					
JUL							15					
AUG								18				
SEP									30	10		
OCT										23		
NOV	31	28	31	30	31	30	1				30	31
DEC	31	28	31	30	31	30	13					31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = MID-ATLANTIC

% REDUCTION = 20%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	31	30	17					
FEB		28	31	30	31	30	17					
MAR			31	30	31	30	17					
APR				30	31	30	17					
MAY					31	30	17					
JUN						30	17					
JUL							20					
AUG								24				
SEP									30	17		
OCT										31		
NOV	31	28	31	30	31	30	6				30	31
DEC	31	28	31	30	31	30	17					31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = MID-ATLANTIC

% REDUCTION = 25%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	31	30	22					
FEB		28	31	30	31	30	22					
MAR			31	30	31	30	22					
APR				30	31	30	22					
MAY					31	30	22					
JUN						30	22					
JUL							25					
AUG								30				
SEP									30	25		
OCT										31	13	
NOV	31	28	31	30	31	30	11				30	31
DEC	31	28	31	30	31	30	22					31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = NEW ENGLAND

% REDUCTION = 5%

MONTH	MONTHS AND/OR DAYS CLOSED											
BEGIN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	31	14						
FEB		28	31	30	31	14						
MAR			31	30	31	14						
APR				30	31	14						
MAY					31	17						
JUN						20						
JUL							10					
AUG								6				
SEP									6			
OCT										9		
NOV											30	
DEC	30	28	31	15								31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = NEW ENGLAND

% REDUCTION = 10%

MONTH	MONTHS AND/OR DAYS CLOSED											
BEGIN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	31	30	2					
FEB		28	31	30	31	30	2					
MAR			31	30	31	30	2					
APR				30	31	30	2					
MAY					31	30	3					
JUN						30	5					
JUL							19					
AUG								12				
SEP									12			
OCT										19		
NOV	31	28	31	15							30	31
DEC	31	28	31	30	31	16						31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = NEW ENGLAND

% REDUCTION = 15%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	31	30	12					
FEB		28	31	30	31	30	12					
MAR			31	30	31	30	12					
APR				30	31	30	12					
MAY					31	30	13					
JUN						30	15					
JUL							29					
AUG								19				
SEP									19			
OCT										28		
NOV	31	28	31	30	31	17					30	31
DEC	31	28	31	30	31	30	3					31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = NEW ENGLAND

% REDUCTION = 20%

MONTH BEGIN	MONTHS AND/OR DAYS CLOSED											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	31	30	22					
FEB		28	31	30	31	30	22					
MAR			31	30	31	30	22					
APR				30	31	30	22					
MAY					31	30	23					
JUN						30	25					
JUL							31	5				
AUG								25				
SEP									25			
OCT										31	22	
NOV	31	28	31	30	31	30	3				30	31
DEC	31	28	31	30	31	30	13					31

CLOSED FISHING DAYS BY REGION GIVEN % REDUCTION

AREA = NEW ENGLAND

% REDUCTION = 25%

MONTH	MONTHS AND/OR DAYS CLOSED											
BEGIN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
JAN	31	28	31	30	31	30	31					
FEB		28	31	30	31	30	31					
MAR			31	30	31	30	31					
APR				30	31	30	31					
MAY					31	30	31	1				
JUN						30	31	2				
JUL							31	11				
AUG								31				
SEP									30	2		
OCT										31	30	24
NOV	31	28	31	30	31	30	13				30	31
DEC	31	28	31	30	31	30	23					31