Recreational fishery. It has been estimated that there are between 17,373 and 21,980 boats in the billfish fishery. Assuming an average of three to four anglers per boat, there are from 50,000 to 85,000 participants in the billfish fishery. This is the population of anglers that have the necessary equipment for offshore swordfishing but only a very small number actively engage in this nighttime sport. Swordfishing grounds are 112.6 to 160.9 km (70 - 100 mi) offshore along much of the Atlantic Coast, making the costs for swordfishing higher than for most other species.

Economic Dependence on Commercial or Marine Recreational Fishery and Related Activities. It is estimated that there are at least 340 commercial swordfish vessels. There are approximately 312-315 longline vessels and between 25 and 28 harpoon vessels and approximately 22 spotter airplanes. It is estimated that approximately 1,400 fishermen (based on an average crew size of 4) derive a majority of their income from swordfishing. Many combination fishermen report that swordfish accounts for a major part of their total revenues.

9.0 CAPACITY DESCRIPTORS

9.1 Yield-per-recruit analysis

Since 1981 the development of this FMP has relied on a yield-per-recruit analysis on fish from the Straits of Florida as a baseline for the status of the stock. General conclusions were that females were exploited near maximum yield-per-recruit (YPR) and that males were exploited below maximum YPR. This meant that increasing fishing on females would decrease total landings by weight and average size harvested. Increasing fishing on males could slightly increase landings by weight but would also decrease the average size harvested. There is no way to selectively harvest fish by sex, therefore any increase in fishing would have the net effect of not significantly increasing (or possibly decreasing) total landings by weight (males and females) and would reduce the size of fish harvested (males and females).

9.2 Estimate of Maximum Sustainable Yield

Maximum sustainable yield is theoretically the maximum harvest in pounds that can be sustained. Its actual estimation is normally based on a

series of catch and effort trends over a long time period. These trends have not been documented for swordfish. The best estimate is likely near the actual landings in 1980 when females were estimated to be near maximum yield-per-recruit. Recorded landings in 1980 were approximately 8.4 million pounds. Recorded landings decreased slightly in 1981 and then gradually increased to approximately 9.3 million pounds in 1983. Actual landings may be considerably larger than recorded landings due to under-reporting. However, the trend indicating the fishery is near the range of maximum production is probably accurate.

The only way landings can significantly increase above recent (1980-83) catch levels is by increasing the age at entry into the fishery (size first liable to capture). The goals of maintaining maximum landings consistent with having those landings embodied in larger fish are the biological and economic objectives of the plan. The yield-per-recruit analysis showed that the most effective way to maximize yield and maintain large fish was to increase the age at entry into the fishery (size first liable to capture). This amounts to controlling fishing on smaller fish (both sexes). Another way is to control fishing on all sizes. This latter strategy was chosen during plan development from 1980-82. The strategy was to use time and area closures to control total landings. There was no known way to selectively control fishing on smaller fish until size frequency data for all areas became available in 1983. These new size frequency data, voluntarily provided to the Councils by fishermen and dealers, showed a monthly trend in the size of fish caught in all areas. It became apparent that if fishing was controlled during months of high concentrations of small fish in all areas that this would better serve the biological and economic objectives of the plan.

9.3 Recent Commercial Size Frequency

Size frequency data for all areas were provided to the Councils by fishermen and dealers subsequent to public hearings held in 1983. It had always been recognized that a major limitation of the only available yield-per-recruit analyses for this five Council management plan is that the analyses were based on fish exclusively from the Straits of Florida. There

were no data to verify if the size frequency observed in Florida in 1979-80 was representative of the entire western North Atlantic fishery (management unit).

New South Carolina data. From 1978-83 South Carolina recorded the carcass weight of 40,366 swordfish landed in South Carolina. Unfortunately, there is no way to identify the sexes of the carcasses; therefore a valid yield-per-recruit analysis could not be done. However, the South Carolina data for the sexes combined (1980-83) showed two things. First, since 1980 the size frequency of the catch landed in South Carolina has shifted considerably (average size declined from 73 to 66 pounds dressed weight). Second, since 1979 the age liable to capture (age or size at entry to the fishery) has decreased from the 40-50 to 20-30 pound dressed weight class as indicated by the mode in the size frequency distributions. When this was combined with an increasing total catch it meant substantially more small fish (under 50 pounds dressed weight) were being caught. This re-emphasized the importance of finding a strategy to control fishing on small fish as compared to a strategy to control fishing on all size fish.

New data from Florida, Gulf of Mexico, and North Carolina northwards. The South Carolina data were presented at meetings with fishermen and dealers and at public hearings (March-April, 1984). People from areas other than South Carolina reported different size frequencies. Many fishermen were dissatisfied with the strategy to use time and area closures to control total landings. A better alternative was to use closures to control the catch of small fish. They had data to show the months with concentrations of small fish. Since then they have provided the Councils with their confidential size frequency data for all areas. Annual comparisons for 1980 and 1983 are shown in Figure 3 and Table 8. The total catch (by number) of small fish depends on the levels of total landings as well as the percent of small fish in the catch.

Monthly landings patterns. The increasing catch of small fish is a trend the plan will reverse through closures during months with high concentrations of small fish (Tables 11-14, Section 10). Size frequency analyses which show both the annual and the monthly trends were derived from data voluntarily provided to the Councils by fishermen and dealers.

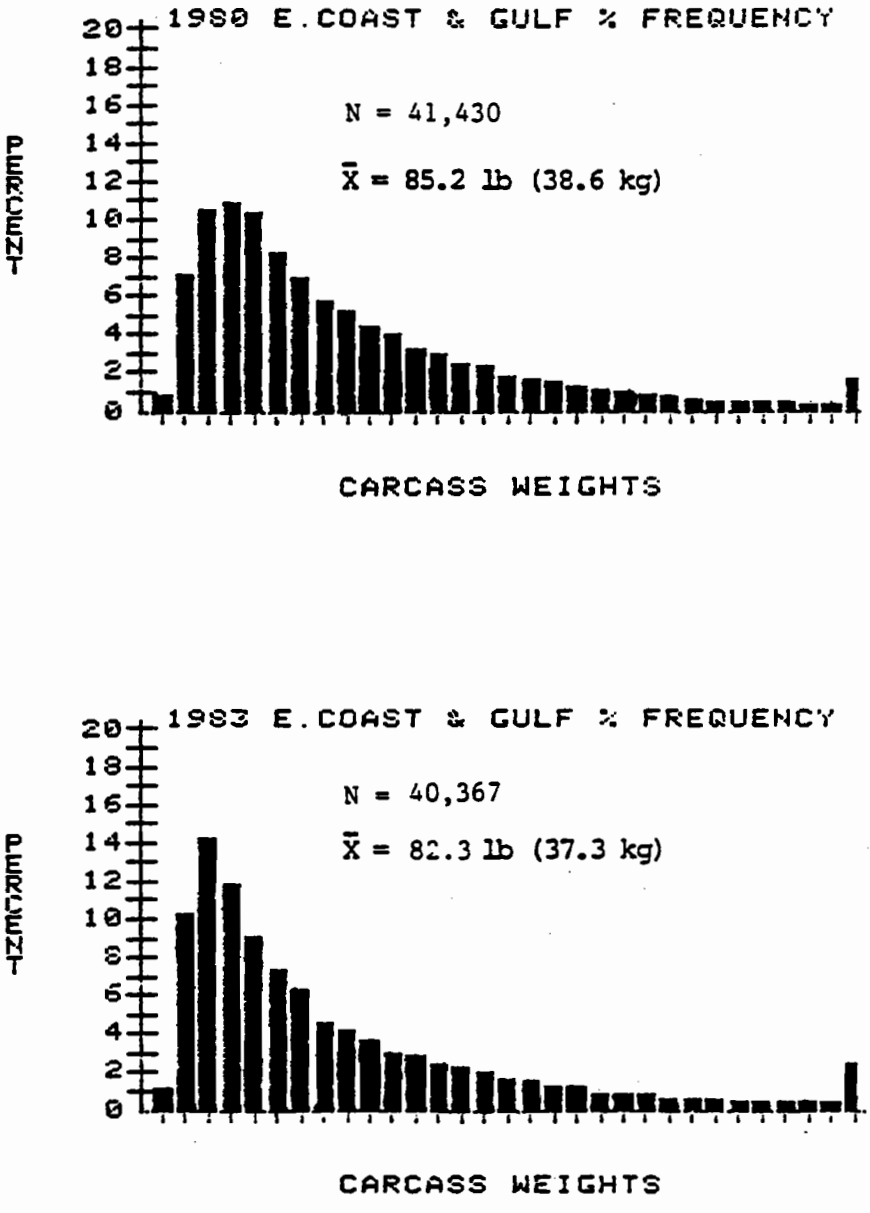

Figure 3. Composite size frequency histograms for 1980 and 1983.

Table 8. Change in swordfish sizes from 1980-83.

	1980			1983		
AREA	Average size	% under 50 lb	Number under 50 lb	Average size	% under 50 lb	Number under 50 lb
NE&MA[1]	89.7	34.57	10,281	96.2	30.86	10,942
SA[2]	73.4	48.36	4,176	66.1	64.79	8,683
FL-EC[3]	97.5	32.44	5,759	89.0	41.05	9,893
GM[4]	58.0	60.64	13,534	41.5	78.75	10,200
All Areas Total			33,750			39,718

17.68% Increase from 1980 to 1983 in the number under 50 lb

1. Atlantic North of Cape Hatteras
2. Atlantic South of Cape Hatteras to Florida/Georgia
3. Florida/Georgia to Dry Tortugas (Straits of Florida)
4. Dry Tortugas to Texas/Mexico (Gulf of Mexico)

Ramifications of the 1980-83 size frequencies. The size frequency data and reported landings support two important theoretical predictions of the yield-per-recruit models. In the flat-topped range of yield-per-recruit, where the fishery is presumably operating, both total landings and average size are not very sensitive indicators.

Also, the economic loss associated with catching small fish is not accurately reflected by either total landings or average size. At this time the most important management conclusions that can be drawn from the size frequency data have to do with the estimated increase in the catch (total number) of small fish and the resulting economic benefits that would occur if these small fish were not harvested until they were larger. The size frequency data focus the plan on the objective of controlling the harvest of small fish.

9.4 OPTIMUM YIELD

It is not possible to specify optimum yield in terms of standard measures of stock condition for the same reasons that it is not possible to specify quantitative estimates of maximum sustainable yield or maximum yield-per-recruit. Optimum yield is therefore specified in terms of reversing the documented 1980-83 trend in the increasing harvest of smaller swordfish (under 50 pounds dressed weight).

Recommended optimum yield. Optimum yield is defined as the harvest that results when no more than the optimum number of fish under 50 pounds dressed weight are harvested. This number is 33,750 fish , the number of fish less than 50 lbs harvested in 1980. Optimum yield is tied to the resulting number of small fish to provide a numerical estimate for monitoring purposes. The resulting harvest cannot be accurately measured because historically swordfish landings have been under-reported to avoid problems with the mercury issue. Additionally, the actual harvest may increase or decrease as long as the optimum number of fish under 50 pounds dressed weight is not exceeded. The optimum number or weight criteria (for 1985 fish under 50 pounds dressed weight) may be changed by regulatory amendment if it is justified by the procedures described in the plan.

Rationale for the optimum yield. Any reversal in the trend of catching a larger number of small fish or increasing the size at entry is

consistent with the economic and biological objectives of this plan. Smaller fish will have an opportunity to gain weight and will be more valuable per pound. At the same time, this delay in harvest will offer a buffer against recruitment overfishing because a larger number of fish will survive to reproductive maturity.

The theoretically optimum reduction in the catch of small fish (based on growth, mortality, and market preferences) has not been determined. The decision to reduce the catch of small fish to the 1980 level is based primarily on the fact that these are the only years for which the increasing trend in the catch of smaller fish has been documented. Also, the only published yield-per-recruit by sex indicates that females were near or at maximum yield-per-recruit in 1980. As better data and analyses become available as a result of this plan, the optimum number of small fish (males, females, or sexes combined) and the specified size criteria may be altered.

9.5 Optimum Yields Considered and Rejected

Optimum yields that were rejected fall into two categories: first, those that would result in conditions that are incompatible with the goals of this plan (optimum sizes to reduce mercury concentration); second, specifications of optimum yield in conventional stock assessment terms (sustainable yield or yield-per-recruit) because there are insufficient data for the required analyses. This second category (determining sustainable yield and yield-per-recruit) is actually a long term research objective of this plan. The intent of the plan is to eventually collect the data necessary to better evaluate the economic and biological goals of the plan using established stock assessment parameters.

Quota on total landings that would accomplish FDA goals. The present FDA action level of 1.0 ppm for mercury is based on U.S. consumption patterns of swordfish that occurred with reported landings of approximately four million pounds. The extent to which increased landings increase individual consumer risk depends on the extent to which higher landings are dispersed in the market. The councils considered a quota low enough to eliminate the need for FDA action. No quota is sufficiently low because even at very low landings some people eat enough swordfish to exceed the FDA guidelines.

Encourage growth overfishing that would reduce the average size of fish to a size that would accomplish FDA goals. Increasing fishing effort would reduce the average size of fish landed; smaller fish have lower mercury concentration. In order to sufficiently reduce mercury concentration, severe growth overfishing of females is required which may cause recruitment failure. Fishing down the stock to meet this objective would cause a severe loss of industry revenue because larger fish are preferred in the market. This would also place domestic production at a disadvantage with imported larger swordfish. It is doubtful that economic returns would allow the fishery to expand sufficiently to achieve this objective. Fishing effort would have to increase while both total landings and value per pound would be reduced. This could only be achieved by subsidizing the fleet.

Total landings that result in theoretical maximum yield. In the context of the yield-per-recruit analysis this would be landings that maximize the yield-per-recruit for each sex. There is no fishing gear that can selectively harvest by sex. Minimum size limits are not possible because the majority of swordfish are landed dead. This alternative is consistent with the biological objective to provide a buffer against recruitment overfishing, but it is not consistent with the economic objective defined in terms of the market preference for larger fish. The economic objective (market preference for larger fish) will likely call for greater restriction on the catch of small fish than the biological objective.

Close fishing areas to influence the size or sex of fish caught by longlines. There is not sufficient information to close fishing areas based on the expected size and sex composition of fish encountered in different areas. Even if this were possible, small gains in potential landings (by weight) would be at the expense of eliminating fishing opportunities for whole regions.

Maximize yield-per-recruit for female swordfish. A strategy during plan development was to maximize the YPR for females. This amounts to focusing on the size frequency of females and treating the catch of males as a bycatch. Regulating the catch of females at maximum YPR would then automatically result in the regulation of males at something less than maximum YPR unless fishing could target swordfish by sex.

This strategy was superseded by the strategy to reduce the catch of small fish (both sexes) when the new size frequency data from all areas

became available. Controlling fishing on all size females would produce more pounds and bigger fish than controlling fishing on all size males, but controlling fishing on smaller fish of both sexes produces the largest potential increase in landings by weight and larger fish.

9.6 Domestic Annual Harvest (DAH)

From 1980-83 reported domestic landings reached and stabilized at around 9 million pounds. Any significant increase in landings is unlikely and if an increase occurred it would be at the expense of producing more smaller fish. Therefore DAH, measured by weight landed, is approximately 9 million pounds whole weight. DAH is also defined in terms of the number of small fish. In 1983 approximately 39,718 fish under 50 pounds dressed weight were harvested.

9.7 Expected Domestic Annual Processing (DAP)

Swordfish are sold as carcasses, either fresh or frozen. They are dressed at sea by the crew. Landside processing entails only refrigeration and transportation. Therefore, domestic annual processing capacity tracks harvesting capacity.

Domestic harvest currently exceeds the OY level, therefore no surplus is available for joint venture. Consequently, the amount of swordfish available for JVP is zero.

9.8 Total Allowable Level of Foreign Fishing (TALFF)

There is no TALFF. Total allowable level of foreign fishing is OY (33,750 fish under 50 pounds dressed weight) minus the domestic annual harvest (estimated to have been 39,718 fish under 50 pounds dressed weight in 1983). There are likely to be restrictions placed on domestic fishermen (variable season closure) to decrease the domestic annual harvest (measured in terms of number of fish under 50 pounds caught in 1983) to the optimum level (measured as the number of fish under 50 pounds caught in 1980). This precludes the possibility of a TALFF.

10.0 ALTERNATIVE DOMESTIC FISHERY MANAGEMENT MEASURES AND REGULATORY IMPACT REVIEW

Executive Order 12291. "Federal Regulation" established guidelines for promulgating new regulations and reviewing existing regulations. Under these guidelines each agency, to the extent permitted by law, is