2. STOCK ASSESSMENT UPDATES

Stock assessments are periodically conducted to determine status relative to both international and domestic management criteria. Assessments for tunas, swordfish, and billfishes are conducted by The International Commission for the Conservation of Atlantic Tunas (ICCAT) and their Standing Committee on Research and Statistics (SCRS). Assessments for Atlantic sharks are conducted by NMFS. North and South Atlantic swordfish and Atlantic bigeye tuna assessments, as well as an attempt to assess West Atlantic skipjack tuna were conducted in 1999. Results are detailed in Sections 2.1, 2.3.1, and 2.3.4 respectively. For the other HMS stocks, a brief review of the most recent assessment information and any new species-specific (primarily biological) studies with management implications are discussed. As established in the HMS FMP, a stock is considered overfished when the biomass level (B) is less than the minimum stock size threshold (MSST) and overfishing is occurring when the fishing mortality rate (F) exceeds the maximum fishing mortality threshold (MFMT). A summary of status (using HMS criteria) is provided in Table 2.1.

Table 2.1 HMS Status Summary Table*

Species	Current Relative Biomass Level	Minimum Stock Size Threshold	Current Fishing Mortality Rate	Maximum Fishing Mortality Threshold	Outlook
Atlantic Swordfish: North Atlantic Stock	B_{99}/B_{MSY} = 0.65 (0.51 -1.05)	$0.8B_{MSY}$	F_{98}/F_{MSY} = 1.34 (0.84-2.05)	F_{MSY}	Overfished; overfishing continues to occur
Atlantic Swordfish: South Atlantic Stock**	B_{99}/B_{MSY} = 1.10 (0.84-1.40)	$0.8B_{MSY}$	F_{98}/F_{MSY} = 0.81 (0.47-2.54)	F_{MSY}	Fully fished; Overfishing probably continues to occur
West Atlantic Bluefin Tuna	SSB_{97}/SSB_{MSY} (two-line) = 0.48 SSB_{97}/SSB_{MSY} (Beverton-Holt) = 0.071 SSB_{97}/SSB_{75} = 0.14-0.17	$0.86B_{MSY}$	F_{97}/F_{MSY} (two-line)= 1.73 F_{97}/F_{MSY} (Beverton-Holt) = 4.10	F_{MSY}	Overfished; overfishing continues to occur

Species	Current Relative Biomass Level	Minimum Stock Size Threshold	Current Fishing Mortality Rate	Maximum Fishing Mortality Threshold	Outlook
Atlantic Bigeye Tuna* **	SSB_{98}/SSB_{MSY} = 0.57-0.63	*$0.6B_{MSY}$ (age 2+)*	F_{98}/F_{MSY} = 1.50-1.82	F_{MSY}	Overfished; overfishing is occurring
Atlantic Yellowfin Tuna** **	unknown	*$0.5B_{MSY}$ (age 2+)*	F_{97}/F_{MSY} = 0.92-1.35	F_{MSY}	Stock not overfished; overfishing may be occurring
North Atlantic Albacore Tuna*** **	B_{97}/B_{MSY} = 0.47 (0.34-0.63) B_{90-94}/B_{75-80} = 0.72	*$0.7B_{MSY}$*	F_{97}/F_{MSY} = 1.39 (uncertain) F_{97}/F_{MAX} = 0.91 $F_{97}/F_{0.1}$ = 1.60	F_{MSY}	Overfished; overfishing is occurring; SCRS notes that stock is at, or above, full exploitation
West Atlantic Skipjack Tuna	unknown	unknown	unknown	F_{MSY}	unknown
Atlantic Blue Marlin	B_{96}/B_{MSY} = 0.24	*$0.9B_{MSY}$*	F_{95}/F_{MSY} = 2.87 (1.45-3.41)	F_{MSY}	Overfished; overfishing is occurring
Atlantic White Marlin	B_{96}/B_{MSY} = 0.23	*$0.85B_{MSY}$*	F_{95}/F_{MSY} = 1.96 (1.33-2.91)	F_{MSY}	Overfished; overfishing is occurring
Atlantic Sailfish	B_{92-96}/B_{MSY} = 0.62	*$0.75B_{MSY}$*	F_{91-95}/F_{MSY} = 1.40	F_{MSY}	Overfished; overfishing is occurring
Blacktip Shark	N_{98}/N_{MSY}=0.50 (baseline) N_{98}/N_{MSY}=0.48 (alternative)	*$0.9B_{MSY}$*	F_{97}/F_{MSY} = 3.52 (baseline) F_{97}/F_{MSY} = 3.74 (alternative)	F_{MSY}	Overfished; overfishing is occurring
Sandbar Shark	N_{98}/N_{MSY}=0.58 (baseline) N_{98}/N_{MSY}=0.70 (alternative)	*$0.9B_{MSY}$*	F_{97}/F_{MSY} = 2.70 (baseline) F_{97}/F_{MSY} = 1.62 (alternative)	F_{MSY}	Overfished; overfishing is occurring

Species	Current Relative Biomass Level	Minimum Stock Size Threshold	Current Fishing Mortality Rate	Maximum Fishing Mortality Threshold	Outlook
Large Coastal Sharks (all species)	N_{98}/N_{MSY}=0.30 (baseline) N_{98}/N_{MSY}=0.36 (alternative)	$0.9B_{MSY}$	F_{97}/F_{MSY} = 6.34 (baseline) F_{97}/F_{MSY} = 6.03 (alternative)	F_{MSY}	Overfished; overfishing is occurring
Small Coastal Sharks	B_{91}/B_{MSY} = 1.12	$0.9B_{MSY}$	$F_{86\text{-}91}/F_{MSY}$ = 0.89	F_{MSY}	Stock not overfished; overfishing is not occurring
Pelagic Sharks	unknown	unknown	unknown	unknown	unknown

*Current Relative Biomass Levels and Current Fishing Mortality Rates are established by the SCRS for tunas, swordfish, and billfish, and by NMFS for sharks. Minimum Stock Size Threshold and Maximum Fishing Mortality Threshold are levels set by NMFS in accordance with the provisions of the Magnuson-Stevens Act. These distinctions apply wherever these terms are found throughout the document.
**South Atlantic swordfish are not found in the U.S. EEZ and, therefore, not managed under the Magnuson-Stevens Act. The classification of the stock as fully fished is based on the definitions established in the HMS FMP and is for descriptive purposes only.
***B/B_{MSY} and F/F_{MSY} ranges for bigeye tuna are ranges of estimates from different model formulations rather than confidence intervals around an estimate.
****F/F_{MSY} ranges for yellowfin tuna are ranges of estimates from different model formulations rather than confidence intervals around an estimate.
*****Due to the uncertainty of F/F_{MSY} for North Atlantic albacore tuna, three equations are presented for Current Fishing Mortality Rate.

2.1 Stock Assessment Update: NORTH AND SOUTH ATLANTIC SWORDFISH

The SCRS completed a stock assessment of North and South Atlantic swordfish in October 1999. The assessment utilized landings and discard data as well as fishing effort information submitted by ICCAT member and non-member nations. These data provide minimum estimates due to unreported landings from vessels flying flags of convenience and other unreported sources of mortality from both member and non-member nations (SCRS, 1999a). This section provides a summary interpretation of the stock assessment results.

2.1.1 Life History/Species Biology Information

North and South Atlantic swordfish are currently managed as two separate stocks of fish. The stocks are divided by a line designated for management purposes at 5 degrees north latitude. In 1999, two new genetic studies were presented to the SCRS concerning swordfish. Both studies found significant differences between Northwest Atlantic, South Atlantic, Mediterranean, and Indo-Pacific swordfish. It is important to note that management measures are necessary in both the North and South Atlantic in light of the uncertainty associated with the stock structure assumption.

Considerable effort was expended to incorporate new sex-specific catch-at-age data into the assessments. Results were corroborative of other modeling approaches and provided further support for management advice.

2.1.2 Most Recent Stock Assessment Data

Table 2.1.1 **Summary Table for North and South Atlantic Swordfish**. Source: SCRS, 1999, unless otherwise indicated.

Stock (2 stocks; divided at 5°N. Lat.)	**North Atlantic**	**South Atlantic**
Age/size at Maturity	Females: 50% are mature at 179 cm lower jaw fork length (LJFL) (5 years) Males: 50% are mature at 129 cm LJFL (Arocha, 1997)	
Spawning Sites	Warm tropical and sub-tropical waters (throughout the year)	
Current Relative Biomass Level (B_{1999}/B_{MSY}) *Minimum Stock Size Threshold*	0.65 (0.51-1.05) $0.8B_{MSY}$	1.10 (0.84-1.40) $0.8B_{MSY}$
Current Fishing Mortality Rate F_{1998}/F_{MSY} *Maximum Fishing Mortality Threshold*	1.34 (0.84-2.05) F_{MSY}	0.81 (0.47-2.54) F_{MSY}
Outlook	Overfished; overfishing continues to occur	Fully fished*; Overfishing maybe occurring
Management Measures in Place	Reduced stock-wide total allowable catch (TAC) Include dead discards in TAC Time/area closures in U.S.	N/A

*South Atlantic swordfish are not found in the U.S. EEZ and, therefore, not managed under the Magnuson-Stevens Act. The classification of the stock as fully fished is based on the definitions established in the HMS FMP and is for descriptive purposes only.

Stock Assessment Methods

SCRS used a surplus production model that is commonly applied to HMS assessments. It is a dynamic model (non-equilibrium) that incorporates the catch per unit effort (CPUE) biomass index and estimated dead discards. The model also accounts for two different types of longline fisheries; those that target swordfish and those that target other species. The advantage of this model is that it estimates parameters based on simple abundance statistics. However, this model uses few parameters and does not employ age- or size-specific information available for the swordfish fishery.

The surplus production model was fit to the data using two different fitting approaches: 1) using maximum likelihood fitting of predicted versus observed data (ASPIC), and 2) a Bayesian framework. The Bayesian framework was only used in the North Atlantic stock assessment. The

Bayesian approach incorporates the prior possibility of unobserved parameters such as the intrinsic rate of increase given the probability of the observed data. Both fitting approaches provided similar management advice.

The third model used in the North Atlantic swordfish stock assessment was the virtual population analysis (VPA). This model is a retrospective analysis of a time series of age-specific data in which abundance estimates are updated each year. The age data were estimated from catch at size data and growth equations for males and females. The North Atlantic assessment incorporated both a sex-specific and non sex-specific model. Results for the final years in the time series (i.e., the recent past) can vary widely as data are updated annually. In these models, historic data are more stable and generate more reliable results.

SCRS also conducted yield per recruit and spawners per recruit models for female data alone and for the combined sexes. Spawning biomass per recruit information was based only on the female spawning stock under the hypothesis that males were not limiting to swordfish reproductive success. These can be age-structured models and make optimal use of the available swordfish data.

Catch Rates and Stock Assessment Implications

Some fleets are moving away from targeting swordfish in favor of a multi-species approach (Spain) while other nations are changing target species to swordfish (Brazil). These changes may affect the estimated CPUE time series used by SCRS in the stock assessment models for North and South Atlantic swordfish. This is a particular problem in non-swordfish targeting fisheries where zero catch records of swordfish are not related to abundance, but rather a lack of swordfish availability to the fishing gear. Total catch levels reported to ICCAT reflected a sharp drop-off in 1998 versus previous years" data. 1998 catch levels were estimated at 12,175 metric tons (mt) in the North Atlantic, 13,468 mt in the South Atlantic, and 5,458 mt in the Mediterranean. 1997 reported catches were 12,931 mt, 18,494 mt, and 14,669 mt respectively.

All of the following stock assessment results are based on total mortality estimates. To maintain accuracy, all sources of mortality (i.e., dead discards and landings) should be included when reporting swordfish catch. A discussion of the plan and the implications for U.S. fisherman can be found in Section 4.

North Atlantic Swordfish Stock Assessment Results

Most of the model runs for North Atlantic swordfish estimate that the current biomass is below the MSY level, and that the fishing mortality rate is above F_{MSY}. Projections for stock recovery were done with a wide variety of models and several options for rebuilding were investigated.

The surplus production model, ASPIC, indicates that rebuilding (with 50 percent probability) of North Atlantic swordfish to B_{MSY} can occur in 10 years (by 2009) if there is a

decrease in catch to 10,000 MT (TAC of 9,090 MT plus expected overages).

The Bayesian results indicate that rebuilding (with 48 percent probability) can occur in 10 years at status quo catch levels. A number of sensitivity analyses were conducted using alternative production model formulations and inputs. Two of seven sets of runs indicated a greater than 50 percent chance of rebuilding to B_{MSY} within 10 years at the current (1998) catch levels while six When input parameters are slightly modified, existing catch levels produce a 31 percent chance of rebuilding in 10 years. In the second and third of the Bayesian models, 6,000 mt or below or 10,000 mt (depending on input parameters) are required in order to have a 50 percent chance of rebuilding within 10 years.

The VPA indicates that catch would have to be less than 9,000 mt to reach the target spawning stock level within 10 years.

Summary of North Atlantic Results

Total swordfish biomass corresponding to MSY levels is not likely to be achieved with status quo catch levels. All models indicate that reductions in catch would allow for the population to have a greater than 50 percent chance of recovery in 5, 10, or 15 years.

Summary of South Atlantic Results

The SCRS noted quite a bit of uncertainty in the South Atlantic swordfish models. Continued harvest at current quota levels in the South Atlantic will result in a continued gradual reduction in biomass; the expected levels of decline and the associated timing vary between models. Fishing mortality is likely to continue to increase gradually and reach F_{MSY} in 2006. Reducing the catch will assist in supporting a healthy South Atlantic stock. The confidence intervals obtained in the projections for the rebuilding cases spanned a broad range and cast some doubt on the accuracy of the results. In addition, there is a good deal of uncertainty surrounding the projection results themselves due to ambiguity in the CPUE trend for the non-target fisheries.

2.1.3 Minimum Stock Size Threshold

In the HMS FMP, NMFS determined the MSST for North and South Atlantic swordfish to be $0.8B_{MSY}$, based on estimates of natural mortality. The North Atlantic stock is **below** the minimum stock size threshold ($0.65B_{MSY}$). This stock is overfished and NMFS seeks to rebuild it, with international cooperation, within ten years.

The South Atlantic stock is estimated to be **above** the minimum stock size threshold ($1.10B_{MSY}$) but the range is very broad ($.84\text{-}1.40B_{MSY}$). The South Atlantic stock assessment has considerable uncertainty associated with it due to a limited data set, lack of age and growth data, and a lack of reporting by some nations.

2.1.4 Maximum Fishing Mortality Threshold

In the HMS FMP, NMFS also set the maximum level of fishing mortality on these stocks. Overfishing is occurring if F exceeds F_{MSY}. The FMP also notes, however, that ICCAT generally adopts constant quota recommendations, and that ICCAT treats F_{MSY} as a target, not a limit. NMFS set a target of 0.75 F_{MSY} for healthy stocks to reduce the probability that the maximum fishing mortality threshold would be exceeded. Mortality on the North Atlantic stock **exceeds** the maximum fishing mortality threshold and the stock is being overfished. In 1998, the fishing mortality rate was too high to promote rebuilding ($F_{1998}/F_{MSY} = 1.34$). Mortality on the South Atlantic swordfish stock is **below** the threshold , however, there is more uncertainty associated with the models for this stock and the range varies widely (0.47-2.54). For these reasons, NMFS encourages the use of the precautionary approach when managing the South Atlantic stock. Data collection is difficult due to the number of countries fishing on this stock and the potential mixing of the North and South Atlantic stocks.

2.2 Stock Assessment Update: WEST ATLANTIC BLUEFIN TUNA

The SCRS did not conduct a new stock assessment for Atlantic (west or east) bluefin tuna in 1999. The latest stock assessment was conducted in 1998, and the next assessment is scheduled for September 2000. The HMS FMP includes a summary of the 1998 Atlantic bluefin tuna stock assessment (Section 2.2.1).

2.2.1 Life History/Species Biology Information

There are several research projects underway regarding the life history of west Atlantic bluefin tuna. Topics of investigation include stock structure, migration patterns, and reproduction. These studies are described in the Comprehensive Research and Monitoring Plan for Atlantic Highly Migratory Species (Appendix I). Additional information on the life history of west Atlantic bluefin tuna can be found in the HMS FMP (Sections 2.2.1 and 6.3.1.3).

2.2.2 Most Recent Stock Assessment Data

ICCAT currently manages Atlantic bluefin tuna based on a two-stock hypothesis. The two management units are separated at 45° W above 10° N and at 25° W below the equator, with an eastward shift in the boundary between those parallels. U.S. vessels fish on west Atlantic bluefin tuna.

The total reported catch of Atlantic bluefin tuna (both east and west) reached a historical high in 1996 at 54,723 mt. Total catch in 1998 has been estimated at 44,700 mt (1998 reported catch is only an estimate as catch reports were missing from some nations) (SCRS, 1999b). There has been a dramatic increase in total Atlantic bluefin tuna catches since 1994 due to increased catches in the east Atlantic and Mediterranean. The west Atlantic catch has been limited between 2,000 and 2,700 mt through a quota since 1982. In 1998 ICCAT adopted measures designed to rebuild west Atlantic bluefin tuna to F_{MSY} within 20 years.

Information on the stock status of west Atlantic bluefin tuna as of 1998 is presented in Table 2.2.1. East Atlantic bluefin spawn in the Mediterranean Sea, and are thought to spawn at a younger age (age 5) than west Atlantic bluefin. Bluefin catch in the east was approximately 42,000 mt in 1998 with the current sustainable yield estimated at 25,000 mt. West Atlantic 1998 catch was 2,643 mt (including discards) and sustainable yield (1997) was estimated between 2,000 and 2,500 mt. The SCRS projections indicate that current catch levels of bluefin tuna in the east Atlantic and Mediterranean are not sustainable, and that the condition of the east Atlantic stock and fishery may adversely affect recovery of the bluefin tuna stock in the west Atlantic.

Table 2.2.1 Summary Table for West Atlantic Bluefin Tuna

Age/size at Maturity	Age 8/~ 200 cm fork length
Spawning Sites	Gulf of Mexico and Florida Straits
Current Relative Biomass Level *Minimum Stock Size Threshold*	SSB_{97}/SSB_{MSY} (two-line) = 0.48 SSB_{97}/SSB_{MSY} (Beverton-Holt) = 0.071 SSB_{97}/SSB_{75} = 0.14 - 0.17 $0.86B_{MSY}$
Current Relative Fishing Mortality Rate F_{1997}/F_{MSY} *Maximum Fishing Mortality Threshold*	F_{97}/F_{MSY} (two-line)= 1.73 F_{97}/F_{MSY} (Beverton-Holt) = 4.10 F_{MSY}
Outlook	Overfished; overfishing continues to occur
Management Measures in Place	20-Year ICCAT Rebuilding Program; TAC including dead discards; minimum sizes.

2.3 Stock Assessment Update: BAYS TUNAS

2.3.1 ATLANTIC BIGEYE TUNA

The SCRS completed a stock assessment of Atlantic bigeye tuna in October 1999. The assessment utilized catch and effort information submitted by ICCAT member and non-member nations. This section provides a summary interpretation of the stock assessment results.

The 1999 SCRS report/stock assessment for bigeye tuna indicates (as have previous SCRS reports) that the catch of undersized fish remains a major problem in the Atlantic bigeye tuna fishery. The share of bigeye tuna less than the ICCAT minimum size (3.2 kg) is approximately 55 percent, by number, of all bigeye tuna harvested. This number has stabilized since with the time/area closure for purse seining in the eastern tropical Atlantic area (detailed in Section 4.2.3), but still remains a concern (SCRS 1999b).

In 1997, SCRS recommended a reduction of overall catch of bigeye tuna to at least the 1992 level (approximately 85,000 mt in the 1997 estimate, but revised to 97,000 mt in 1999). The 1998 catch was 95,000 mt, slightly less than 1992 levels, but still higher than the sustainable catch level. The results of the latest stock assessment indicate an MSY between 79,000 and 94,000 mt. One important component of the 1999 bigeye tuna assessment was the incorporation of revised data from previous years. This resulted in the addition of some 20,000 mt of previously unreported catch. SCRS recommended a reduction of catch to approximately 80,000 mt to reduce the probability of further decline of the stock, although an additional reduction of catch would be required to rebuild the stock to MSY levels. The SCRS was unable to provide recovery projections in 1999 due to lack of data.

2.3.1.1 Life History/Species Biology Information

Compared to other tuna and tuna-like species, less research has been conducted on bigeye tuna. The lack of reasonable estimates of some biological parameters considerably hinders the stock assessment process. The Bigeye Tuna Year Program, which calls for extensive research on bigeye tuna, was adopted in 1996 and began its operation in 1999 as funds became available. Additional information on the life history of Atlantic bigeye tuna can be found in the HMS FMP (Sections 2.2.1 and 6.3.1.2).

2.3.1.2 Most Recent Stock Assessment Data

ICCAT currently manages Atlantic bigeye tuna based on an Atlantic-wide single stock hypothesis. However, the possibility of other scenarios, including north and south stocks, does exist, and should not be disregarded (SCRS 1999b)

Table 2.3.1 Summary Table for Atlantic Bigeye Tuna

Age/size at Maturity	Age 3/~100 cm curved fork length
Spawning Sites	Tropical waters
Current Relative Biomass Level* *Minimum Stock Size Threshold*	SSB_{98}/SSB_{MSY} = 0.57 - 0.63 $0.6B_{MSY}$ (age 2+)
Current Relative Fishing Mortality Rate* F_{1998}/F_{MSY} *Maximum Fishing Mortality Threshold*	F_{98}/F_{MSY} = 1.50 - 1.82 F_{MSY}
Outlook	Overfished; overfishing is occurring
Management Measures in Place	Minimum sizes; time/area closures for fish aggregating device (FAD) fishing; limit on number of vessels > 24 m length overall (LOA) (not applicable to countries catching less than 2000 mt/year); catch and vessel limit for Chinese Taipei. No specific rebuilding program is in place.

*B/B_{MSY} and F/F_{MSY} ranges are ranges of estimates from different model formulations rather than confidence intervals around an estimate.

2.3.2 ATLANTIC YELLOWFIN TUNA

The SCRS did not conduct a new stock assessment for Atlantic yellowfin tuna in 1999. The most recent stock assessment was conducted in 1998 and a summary of the status of Atlantic yellowfin tuna can be found in the HMS FMP (Section 2.2.1). The next assessment is scheduled for July 2000.

2.3.2.1 Life History/Species Biology Information

No new life history information is available regarding Atlantic yellowfin tuna, although research on the life history of yellowfin and other Atlantic tunas is currently being conducted and/or funded by NMFS. The HMS FMP (Sections 2.2.1 and 6.3.1.5) includes summary information on the life history of yellowfin tuna.

2.3.2.2 Most Recent Stock Assessment Data

Based on migration patterns, as well as other information (e.g., time-area size frequency distributions and locations of fishing ground), ICCAT currently manages Atlantic yellowfin tuna based on an Atlantic-wide single stock hypothesis.

Table 2.3.2 Summary Table for Atlantic Yellowfin Tuna

Age/size at Maturity	Age 3/~110 cm curved fork length
Spawning Sites	Tropical waters
Current Relative Biomass Level *Minimum Stock Size Threshold*	unknown $0.5B_{MSY}$ (age 2+)
Current Relative Fishing Mortality Rate F_{1997}/F_{MSY} *Maximum Fishing Mortality Threshold*	F_{97}/F_{MSY} = 0.97-1.35 F_{MSY}
Outlook	Stock not overfished, overfishing may be occurring
Management Measures in Place	Minimum sizes; ICCAT recommendation for effective fishing effort not to exceed 1992 levels; recreational retention limit in the United States.

2.3.3 NORTH ATLANTIC ALBACORE TUNA

The SCRS did not conduct a new stock assessment for Atlantic (northern, southern, or Mediterranean) albacore tuna in 1999. The latest stock assessment was conducted in 1998. The HMS FMP includes a summary of the status of the stock of northern Atlantic albacore tuna (Section 2.2.1). The next assessment for both North Atlantic and South Atlantic albacore tuna is scheduled for October 2000.

2.3.3.1 Life History/Species Biology Information

No new life history information is available regarding Atlantic albacore tuna. Please refer to the HMS FMP (Sections 2.2.1 and 6.3.1.4) for more information on the life history of albacore tuna.

2.3.3.2 Most Recent Stock Assessment Data

On the basis of the available biological information, the existence of three stocks of albacore tuna is assumed for assessment and management purposes; northern and southern Atlantic stocks (separated at 5° N) and a Mediterranean stock. The United States primarily fishes on the north Atlantic stock/management unit, with very minor catches (~ 1 mt) of south Atlantic albacore.

Table 2.3.3 Summary Table for the North Atlantic Albacore Tuna

Age/size at Maturity	Age 5/~90 cm curved fork length
Spawning Sites	Subtropical western waters of the Northern Hemisphere
Current Relative Biomass Level *Minimum Stock Size Threshold*	B_{97}/B_{MSY} = 0.47 (0.34 - 0.63) $B_{90\text{-}94}/B_{75\text{-}80}$ = 0.72 $0.7B_{MSY}$
Current Relative Fishing Mortality Rate F_{1997}/F_{MSY} *Maximum Fishing Mortality Threshold*	F_{97}/F_{MSY} = 1.39 (uncertain) F_{97}/F_{MAX} = 0.91 $F_{97}/F_{0.1}$ = 1.60 F_{MSY}
Outlook	Overfished; overfishing is occurring
Management Measures in Place	Limit number of vessels to average number 1993-1995

2.3.4 WEST ATLANTIC SKIPJACK TUNA

The characteristics of Atlantic skipjack tuna stocks and fisheries make it extremely difficult to conduct stock assessments using current models. Continuous recruitment occurring throughout the year, but heterogeneous in time and area, makes it impossible to identify and monitor individual cohorts. Apparent variable growth between areas makes it difficult to interpret size distributions and their conversion to ages. For these reasons, SCRS did not conduct a stock assessment for Atlantic (west or east) skipjack tuna in 1999, although some estimates were made (SCRS 1999b).

2.3.4.1 Life History/Species Biology Information

No new life history information is available regarding Atlantic skipjack tuna. Please refer to the HMS FMP (Sections 2.2.1 and 6.3.1.4) for more information on the life history of skipjack tuna.

2.3.4.2 Most Recent Stock Assessment Data

The stock structure of Atlantic skipjack tuna is not well known, and two management units (east and west) have been established due to the development of fisheries on both sides of the Atlantic and the lack of transatlantic recoveries of tagged skipjack tuna. U.S. vessels fish on the west Atlantic stock/management unit.

Table 2.3.4 Summary Table for West Atlantic Skipjack Tuna

Age/size at Maturity	Age 1 to 2/~50 cm curved fork length
Spawning Sites	Opportunistically in tropical and subtropical waters
Current Relative Biomass Level *Minimum Stock Size Threshold*	unknown unknown
Current Relative Fishing Mortality Rate F_{1998}/F_{MSY} *Maximum Fishing Mortality Threshold*	unknown F_{MSY}
Outlook	unknown

2.4 Stock Assessment Update: ATLANTIC BILLFISH

2.4.1 Life History/Species Biology Information

A summary of life history information is provided in the Billfish Amendment in Section 3.1.1 and Chapter 4. New information with potential management implications is described below in the following subsections.

The effect of fishing mortality on a particular resource depends in part on the population structure of the species. If localized populations exist, high mortality in one area could lead to a regional collapse. On the other hand, if there is sufficient exchange between geographically distant areas, efforts to restore a stock in one area could be undermined by continued high levels of fishing pressure in another. In work funded by a NMFS grant, the Virginia Institute of Marine Science (VIMS) is nearing completion of a molecular genetic analysis of blue marlin stock structure within the Atlantic Ocean. Between May 1, 1998 and July 31,1999, researchers collected billfish samples from the United States, Brazil, Jamaica, and Ghana and screened them for potentially informative mitochondrial and nuclear DNA markers.

In September, 1999, under a separate NMFS grant, Dr. John Graves of VIMS initiated a new study to examine the genetic relationship between Atlantic and Indo-Pacific sailfish using a suite of high resolution molecular markers. The intent of the study was to document a molecular marker that can be used to discriminate between Atlantic and Indo-Pacific populations. DNA isolated from ten Atlantic and ten Indo-Pacific sailfish are to be analyzed with the following techniques: RFLP or sequence analysis of a region, the mtDNA D-loop, RFLP analysis of at least two nuclear intron loci, and/or analysis of two or more variable microsatellite loci. An identifiable marker provides the ability to distinguish Atlantic istiophorids from conspecific or closely related istiophorids from the Indian and Pacific Oceans, and can be used to aid enforcement of the no-sale provision in the United States for Atlantic billfishes.

2.4.2 Most Recent Stock Assessment Data

No new stock assessments for Atlantic blue marlin, Atlantic white marlin, or west Atlantic sailfish were conducted for the 1999 SCRS report. At the 1998 meeting, ICCAT decided that in order to allow analysis of the 1997 ICCAT recommendation to reduce Atlantic blue and white marlin landings by 25 percent from 1996 levels (to be fully implemented by the end of 1999), the next assessment update should be conducted in 2000 when 1999 data are fully available. In light of this, the SCRS postponed the assessments of Atlantic blue marlin and Atlantic white marlin originally scheduled to be conducted in 1999 until the year 2000. The next stock assessment for west Atlantic sailfish is scheduled for the year 2001. However, at the 1999 meeting, ICCAT expressed concern regarding the incomplete reporting of Atlantic marlin and sailfish landings, particularly for the last two years. The Commission recommended that all countries with blue marlin landings or dead discards report these data to the ICCAT Secretariat so planned assessments can proceed.

Longbill spearfish and sailfish landings have historically been reported together in annual ICCAT landings statistics. The majority of these landings were most likely sailfish; for 1998 the SCRS reported a 2182 mt catch of sailfish/spearfish, only 17 mt of which was identified as spearfish. The SCRS has not completed an assessment of longbill spearfish in the Atlantic due to the lack of data. Therefore, relative biomass and fishing mortality levels are unavailable. The Billfish Amendment details the final action prohibiting the retention of longbill spearfish in Section 3.4.2. This measure was selected as a result of the paucity of biological data, the rarity of a recreational angler encounter with spearfish, and adherence to a precautionary management strategy.

The most recent ICCAT stock assessments for Atlantic blue and white marlin were conducted in Miami, Florida in July 1996, and included data through 1995. The last assessment for West Atlantic sailfish/spearfish was submitted to the SCRS in 1993 and was based on data collected through 1991. Stock abundance estimates for Atlantic billfish were based on non-equilibrium production models using catch per unit of effort data. Section 2.1.1 of the Billfish Amendment describes the status of the stocks based on those assessments. A summary is also provided in Table 2.4.1.

ICCAT recommended in 1997 that additional detailed analyses of the available blue and white marlin data be conducted and that alternative assessment methodologies be explored in order to improve the 1996 assessments. A document presented at the 1997 International Symposium on Fishery Stock Assessment Models for the 21st Century provided a case history of stock production models of blue marlin and white marlin in the Atlantic, along with approaches that enabled specific problems to be addressed when applying the production model (Jones *et al.*, 1998).

Table 2.4.1 Summary Table for Atlantic Billfish*

	Atlantic Blue Marlin	**Atlantic White Marlin**	**West Atlantic Sailfish**
Age/size at Maturity	2-4 years Females: 193 cm Males: 175 cm	Unknown Females: 155 cm Males: 140 cm	3 years Females: 157 cm Males: 122 cm
Spawning Sites	Tropical and subtropical waters in the summer and fall	Tropical and subtropical waters in the mid- to late spring	Tropical and subtropical waters in the spring through summer
Current Relative Biomass Level *Minimum Stock Size Threshold*	B_{96}/B_{MSY} = 0.24 *$0.9B_{MSY}$*	B_{96}/B_{MSY} = 0.23 *$0.85B_{MSY}$*	$B_{92\text{-}96}/B_{MSY}$ = 0.62 *$0.75B_{MSY}$*
Current Relative Fishing Mortality Rate F_{1997}/F_{MSY} *Maximum Fishing Mortality Threshold*	F_{95}/F_{MSY} = 2.87 (1.45-3.41) *F_{MSY}*	F_{95}/F_{MSY} = 1.96 (1.33-2.91) *F_{MSY}*	$F_{91\text{-}95}/F_{MSY}$ = 1.4 *F_{MSY}*
Outlook	Overfished; overfishing is occurring	Overfished; overfishing is occurring	Overfished; overfishing is occurring
Management Measures in Place	Reduce landings by 25 percent from 1996 levels; No specific rebuilding program.	Reduce landings by 25 percent from 1996 levels; No specific rebuilding program.	None at present

*Longbill spearfish are considered Atlantic billfish, but are not included in this table due to the lack of data. The SCRS has yet to complete an assessment of longbill spearfish in the Atlantic and relative biomass and fishing mortality levels are unavailable.

2.5 Stock Assessment Update: ATLANTIC SHARKS

2.5.1 Life History/Species Biology Information

There are several research projects underway regarding Atlantic sharks detailed in the Comprehensive Research and Monitoring Plan for Atlantic Highly Migratory Species (Appendix I). A general discussion of shark characteristics can be found in the HMS FMP (2.4.1). Previously released life history information concerning the thirty-three shark species recently added to the shark management unit can be found in the Essential Fish Habitat section of this report (3.1).

2.5.2 Most Recent Stock Assessment Data

No new stock assessments were conducted for Atlantic sharks this year. The stock assessment information used in the HMS FMP came primarily from the 1998 Shark Evaluation Workshop. Detailed information can be found in Section 2.4 of the HMS FMP. In general, there remains a good deal of uncertainty regarding shark stocks and mortality. Due to most shark species' inability to withstand intense exploitation, precautionary approaches were used in adherence with Magnuson-Stevens guidelines.

The SCRS Subcommittee on Bycatch met in Messina, Italy, from May 11-14, 1999. The meeting was attended by scientists representing Brazil, Spain, Italy, Portugal, France, Japan, the United Kingdom, the United States, and the ICCAT Secretariat. There were 12 working papers presented (6 of which were submitted by the U.S. delegation) and 7 reference papers presented on various aspects of shark (or other) species bycatch in the Atlantic and Mediterranean (or associated) tuna fleets.

The focus of the meeting was to discuss progress made by ICCAT on data collection for sharks from the Atlantic tuna or tuna-like fisheries. Thus far, only 19 of the more than 80 nations, entities, and fishing entities have reported any catch and effort data on sharks to ICCAT and few have reported any size frequency data. The Subcommittee continues to observe that the shark data reporting response level by member and non-member countries is poor and may reflect the relatively low priority various nations, entities, and fishing entities place on monitoring the catches and by-catches of these species. The statistical data on sharks available through ICCAT is not sufficient to conduct stock assessments through normally applied methods which relate catch and effort patterns. It is unlikely that sufficient catch and effort data for more traditional stock assessments will in fact exist through the present ICCAT data collection scheme, even if complete reporting by the member and non-member nations comes about. The ICCAT data collection scheme is generally limited to sharks taken as bycatch in the Atlantic and Mediterranean tuna fleets which likely represents only a small fraction of the total fisheries removals for all but a few of these species.

The Sub-Committee concluded that if the Commission wishes that SCRS conduct stock assessments and provide fishery management advice for sharks, the Commission needs to make

this clear by changing the mandate of ICCAT relative to this issue. This will likely require modification in the level and amount of ICCAT Secretariat staff for data collection, since if the Commission considers stock assessments for sharks necessary, changes in the levels and amounts of data collection by ICCAT will be required. The Subcommittee also concluded that the Food and Agriculture Organization of the United Nations' (FAO) International Plan of Action for Sharks does not require any modifications to functions of ICCAT. FAO is still considered by the Sub-Committee to be the focal point for total shark catch statistics compilations and the ICCAT mandate is still limited to statistics related to sharks caught by the Atlantic and Mediterranean tuna fleets (either as by-catches or sometimes even as target species).

The most recent stock assessment for small coastal sharks was conducted in 1993. A small coastal shark survey may be funded outside of NMFS to assess current stock size, fishing mortality rates, and recent life history information. The grant has been applied for and has been recommended for funding, subject to sufficient funds being available.

Table 2.5.1 Summary Table for Atlantic Sharks

	Blacktip Sharks	**Sandbar Sharks**	**Large Coastal Sharks (all species)**	**Small Coastal Sharks**	**Pelagic Sharks**
Current Relative Biomass Level	N_{98}/N_{MSY}=0.50 (baseline) N_{98}/N_{MSY}=0.48 (alternative)	N_{98}/N_{MSY}=0.58 (baseline) N_{98}/N_{MSY}=0.70 (alternative)	N_{98}/N_{MSY}=0.30 (baseline) N_{98}/N_{MSY}=0.36 (alternative)	B_{91}/B_{MSY} = 1.12	unknown
Minimum Stock Size Threshold	$0.9B_{MSY}$	$0.9B_{MSY}$	$0.9B_{MSY}$	$0.9B_{MSY}$	unknown
Current Relative Fishing Mortality Rate F_{1998}/F_{MSY}	F_{97}/F_{MSY} = 3.52 (baseline) F_{97}/F_{MSY} = 3.74 (alternative)	F_{97}/F_{MSY} = 2.70 (baseline) F_{97}/F_{MSY} = 1.62 (alternative)	F_{97}/F_{MSY} = 6.34 (baseline) F_{97}/F_{MSY} = 6.03 (alternative)	$F_{86\text{-}91}/F_{MSY}$ = 0.89	unknown
Maximum Fishing Mortality Threshold	F_{MSY}	F_{MSY}	F_{MSY}	F_{MSY}	unknown
Outlook	Overfished; overfishing is occurring	Overfished; overfishing is occurring	Overfished; overfishing is occurring	Stock not overfished; overfishing is not occurring	unknown
Management Measures in Place	Quotas, trip limits, minimum sizes, prohibited species, bag limits.				

Section 2 References:

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SCRS. 1999c. 1999 Detailed Report for Atlantic Blue Marlin, White Marlin, and Sailfish , ICCAT.

VIMS (Grant #NA86FM0379). Molecular Genetic Analysis of Blue Marlin Stock Structure within the Atlantic Ocean.

VIMS (Grant #NA96FM0496). Development of a Molecular Marker to Discriminate between Atlantic and Indo-Pacific Sailfish.