2. STOCK ASSESSMENT UPDATES

With the exception of Atlantic sharks, stock assessments for Atlantic HMS are conducted by ICCAT and the SCRS. In 2002, the SCRS conducted stock assessments for Atlantic white marlin, North and South Atlantic swordfish, bigeye tuna, and bluefin tuna. Also in 2002, the United States conducted stock assessments for the Atlantic large and small coastal shark complexes. For 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) falls below the minimum stock size threshold (MSST) and overfishing occurs when the maximum fishing mortality threshold (MFMT) exceeds the fishing mortality rate (F).

Table 2.1 Stock Assessment Summary Table (stock assessment summary for Atlantic sharks can be found in section 2.5)

Species	Current Relative Biomass Level	Minimum Stock Size Threshold	Current Fishing Mortality Rate	Maximum Fishing Mortality Threshold	
North Atlantic Swordfish	B_{02}/B_{MSY} = 0.94 (0.75-1.24)	*$0.8B_{MSY}$*	F_{01}/F_{MSY} = 0.75 (0.54-1.06)	F_{year}/F_{MSY} = 1.00	Overfished; overfishing is not occurring, stock is in recovery
South Atlantic Swordfish	*Not estimated*	*$0.8B_{MSY}$*	*Not estimated*	F_{year}/F_{MSY} = 1.00	Fully fished; Overfishing may be occurring.*
West Atlantic Bluefin Tuna	SSB_{01}/SSB_{MSY}= 0.31 (low recruitment); 0.06 (high recruitment) SSB_{01}/SSB_{75} = 0.13 (low recruitment); 0.13 (high recruitment)	*$0.86SSB_{MSY}$*	F_{01}/F_{MSY} = 2.35 (low recruitment scenario) F_{01}/F_{MSY} = 4.64 (high recruitment scenario)	F_{year}/F_{MSY} = 1.00	Overfished; overfishing is occurring.
East Atlantic Bluefin Tuna	SSB_{00}/SSB_{70} = 0.80	*Not estimated*	F_{00}/F_{max} = 2.4	*Not estimated*	Overfished; overfishing is occurring.*

Species	Current Relative Biomass Level	Minimum Stock Size Threshold	Current Fishing Mortality Rate	Maximum Fishing Mortality Threshold	Outlook
Atlantic Bigeye Tuna	B_{02}/B_{MSY} = 0.81-0.91	*$0.6B_{MSY}$ (age 2+)*	F_{01}/F_{MSY} = 1.15	F_{year}/F_{MSY} = 1.00	May be overfished; overfishing is occurring.
Atlantic Yellowfin Tuna	B_{99}/B_{MSY} = 1.03	*$0.5B_{MSY}$ (age 2+)*	F_{99}/F_{MSY} = .88-1.16	F_{year}/F_{MSY} = 1.00	Not overfished; overfishing may be occurring.
North Atlantic Albacore Tuna	B_{99}/B_{MSY} = 0.68 (0.52-0.86)	*$0.7B_{MSY}$*	$F_{99}F_{MSY}$ = 1.10 (0.99 - 1.30)	F_{year}/F_{MSY} = 1.00	Overfished; overfishing is occurring.
South Atlantic Albacore Tuna	B_{99}/B_{MSY} = 1.60 (0.01-1.98)	*Not estimated*	F_{99}/F_{MSY} = 0.57 (0.34-556)	*Not estimated*	Not overfished; overfishing not occurring.*
West Atlantic Skipjack Tuna	*Unknown*	*Unknown*	*Unknown*	F_{year}/F_{MSY} = 1.00	Unknown
Atlantic Blue Marlin	B_{00}/B_{MSY} = 0.4 (0.25 - 0.6)	*$0.9B_{MSY}$*	F_{99}/F_{MSY} = 4.0 (2.5 - 6.0)	F_{year}/F_{MSY} = 1.00	Overfished; overfishing is occurring.
Atlantic White Marlin	B_{01}/B_{MSY} = 0.12 (0.06-0.25)	*$0.85B_{MSY}$*	F_{00}/F_{MSY} =8.28 (4.5-15.8)	F_{year}/F_{MSY} = 1.00	Overfished; overfishing is occurring.
West Atlantic Sailfish	*Not estimated*	*$0.75B_{MSY}$*	*Not estimated*	F_{year}/F_{MSY} = 1.00	Overfished; overfishing is occurring.

* South Atlantic swordfish, South Atlantic albacore and East Atlantic bluefin tuna are not found in the U.S. EEZ and, therefore, not managed under the Magnuson-Stevens Act.

2.1 Stock Assessment Update: ATLANTIC SWORDFISH

2.1.1 Life History/Species Biology Information

This section is taken primarily from the 2002 SCRS Report which summarizes all recent data on Atlantic swordfish.

Swordfish are widely distributed in the Atlantic Ocean and Mediterranean Sea. They range from Canada to Argentina in the western Atlantic, and from Norway to South Africa in the eastern Atlantic. The management units for assessment purposes are a separate Mediterranean group, and North and South Atlantic groups separated at 5°N. This stock separation is supported by recent genetic analyses. However, the precise boundaries between stocks are uncertain, and mixing is believed to be highest in the boundary areas. As a result, there is uncertainty as to whether the management units used correspond exactly to the biological stock units.

These large pelagic fishes feed throughout the water column on a wide variety of prey including groundfish, pelagics, deep-water fish, and invertebrate. Swordfish show extensive diel migrations and are typically caught on pelagic longlines at night when they feed in surface waters. They are found in the colder northern waters during summer months and all year in the subtropical and tropical areas.

Swordfish are characterized by having dimorphic growth, where females show faster growth rates and attain larger sizes than males. Young swordfish grow very rapidly, reaching about 130 cm lower jaw-fork length (LJFL) by age two. Swordfish are difficult to age, but 53% of females are considered mature by age five, at a length of about 180 cm. Known spawning areas are located in the warm tropical and subtropical waters, where swordfish spawn throughout the year in different localized areas displaying a regular seasonal pattern.

2.1.2 Recent Stock Assessment Results

A new assessment of North and South Atlantic swordfish stocks was conducted in 2002, during which updated catch per unit of effort (CPUE) and catch data were examined. Sex and age-specific catch rates for the North Atlantic, as well as biomass standardized catch rates for both the North and South Atlantic were updated from various fleets.

North Atlantic Swordfish

The SCRS noted that there has been high recruitment since 1997. The updated North Atlantic CPUE data show similar trends to previous years, and also show signs of improvement in stock status since 1998. The high recruitment in combination with other factors has resulted in an increase in the North Atlantic stock size. The biomass at the beginning of 2002 was estimated to be at 94% (range: 75 to 124%) of the biomass needed to produce MSY. The 2001 fishing mortality rate was estimated to be 0.75 times the fishing mortality rate at MSY (range: 0.54 to 1.06). The replacement yield for the year 2003 was estimated to be about the MSY level.

South Atlantic Swordfish

The CPUE data in the South Atlantic show contradictory patterns by fleet. Lack of important CPUE information from some fleets fishing in the South Atlantic prevented SCRS from reconciling the conflicts. As a result of inconsistencies in the available CPUE trends, reliable stock assessments could not be obtained.

2.1.3 SCRS Advice and Current Management Measures

North Atlantic Swordfish

The SCRS warned against large catch increases over the 2002 TAC for North Atlantic Swordfish, and stated that moderate catch increases (e.g. to levels below the estimated MSY) would guard against potential biases in the assessment and provide stability for the stock and fisheries. The SCRS noted that if the Commission desired to rebuild the stock to biomass levels that would support MSY by the close of 2009 with a probability of greater than 50%, then the catch could be maintained at 14,000 mt for 2003-2009. The SCRS further noted that positive signs in recent recruitment may be due, in part, to environmental factors, and it is unknown if these factors will be positive or negative in the future.

In 2000, Japan reported that it had significantly exceeded its North Atlantic swordfish quota for the last few years despite some actions taken to address this compliance problem. Because of concerns for the integrity of the 10 year swordfish rebuilding program adopted by ICCAT in 1999 and given the recent under-harvest by the United States of its North Atlantic swordfish quota, the United States, with the full support of the U.S. longline industry, agreed to assist Japan in addressing its swordfish over-harvest. Specifically, a measure was adopted that, among other things, allowed Japan access to as much as 400 mt of unused U.S. quota for 2001 only. Of this, 215 mt will be transferred to Japan to address that nation's over-harvest. The remainder will be rolled back into the U.S. quota allocation. ICCAT also continued its efforts to control illegal, unregulated, and unreported fishing activities by moving forward with implementation of an agreement to develop a statistical document program for swordfish. This program will monitor landings and trade, and assist in the collection of data. Together, these steps are designed to prevent total catches from exceeding the TAC established by the 1999 rebuilding program.

The SCRS noted that time and area closures implemented in the North Atlantic by the United States to protect small swordfish and other species caught incidentally by pelagic longline have reduced the catches attributed to the United States, and may have contributed to redistribution of the fleet. Analyses conducted to examine the impact of the area closures on CPUE did not reveal a measurable impact on catch rates in 2001.

South Atlantic

The SCRS recommended that catch should remain at about the same level of the past few years (14-15,000 MT). SCRS is concerned about the lack of availability and inconsistency of scientific data on catches, sizes, and CPUE indices in the South Atlantic and the impact of these data limitations on future assessments.

Table 2.1.1 **Summary Table for the Status of Atlantic Swordfish Stocks**. Source: SCRS, 2002, unless otherwise indicated.

Stock (2 stocks; divided at 5°N. Lat.)	**North Atlantic**	**South Atlantic**
Age/size at Maturity	Females: 53% are mature ~ 180 cm lower jaw fork length (LJFL) (5 years) Males: 50% are mature ~ 129 cm LJFL (Arocha, 1997)	
Spawning Sites	Warm tropical and sub-tropical waters (throughout the year)	
Current Relative Biomass Level (B_{2001}/B_{MSY}) *Minimum Stock Size Threshold*	0.94 (0.75-1.24) $0.8B_{MSY}$	*Not estimated* $0.8B_{MSY}$
Current Fishing Mortality Rate F_{2001}/F_{MSY} *Maximum Fishing Mortality Threshold*	0.75 (0.54-1.06) $F_{1998}/F_{MSY} = 1.00$	*Not estimated* $F_{1998}/F_{MSY} = 1.00$
Maximum Sustainable Yield	14,340 mt (11,580-15,530)	*Not estimated*
Current (2001) Yield[1]	9,797 mt	14,251 mt
Current (2002) Replacement Yield	~MSY	*Not estimated*
Outlook	Overfished; Overfishing is not occurring, stock is in recovery	Fully fished*; Overfishing probably continues to occur

[1] Includes an estimate of unreported catches.
* 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.

2.1.4 Evaluation of Current Management Measures

Catch limits: The North Atlantic swordfish catch limit (stock-wide) for 2001 was 10,500 mt (10,200 mt landed and 300 mt discarded dead). The reported landings were 8,605 mt and the estimated dead discards were 828 mt. Total catch was probably under-reported for 2001 due to partial compliance with ICCAT reporting obligations. The target total allowable catch in the South Atlantic for 2001 was 14,620 mt. The reported landings were 13,379 mt and reported discards were less than 1 mt.

In 2001, U.S. fishermen were limited to a 2,951 mt catch limit (including a 280 mt dead discard allowance) for North Atlantic swordfish and a self-imposed catch limit of 384 mt for South Atlantic swordfish. In the North Atlantic fishery, the estimated total swordfish catch of U.S. fishermen decreased by 913 mt in 2001 to 2,568 mt, including 293 mt of dead discards. This catch level resulted in an under-harvest of 383 mt for the year, but an overharvest in the dead discard allowance of 53 mt. Reported landings from U.S. fishermen in the South Atlantic fishery were 43 mt, resulting in a 340 mt under-harvest.

Minimum size limit: There are two minimum size options that are applied to the entire Atlantic: 125 cm LJFL with a 15% tolerance, or 119 cm LJFL with zero tolerance and evaluation of discards. United States' fishermen must abide by the 119 cm LJFL size limit. In 2000, the percentage of swordfish reported landed (throughout the Atlantic) less than 125 cm LJFL was about 21% (in number) overall for all nations fishing in the Atlantic. If this calculation is made using reported landings plus estimated discards, then the percentage of swordfish landed that were less than 125 cm LJFL would be approximately 25%. In the absence of size data, these calculations could not be updated or examined for 2001.

The Swordfish Certificate of Eligibility program was continued in 2002 to support enforcement of the U.S. minimum size requirement. This program requires that all imported swordfish be accompanied by a document stating that the fish meets the minimum size requirement, or that if it doesn't meet minimum size requirements, that it was harvested from other than the Atlantic Ocean. Importers must submit copies of all COEs on a bi-weekly basis which are then compared to dealer reports on purchased fish, and U.S. Customs data. This program is being amended to comply with the ICCAT swordfish statistical document requirements. Table 7.5 summarizes the bi-weekly dealer report and the COE data for the 2001 calendar year.

Stock structure: NOAA Fisheries is concerned about the uncertainties in the stock structure of Atlantic swordfish and its management implications, reinforcing the importance of effective management measures throughout the Atlantic and Mediterranean.

Time/area closures/Live bait prohibition: *Please refer to Chapter 8 "Bycatch" for evaluation of these measures.*

Reporting Requirements: Evaluation of international management measures on a stock-wide basis can only occur based on *reported* landings and discards. A significant problem exists internationally with the under-reporting of fishing activities. Therefore, on an Atlantic-wide basis catch, landings, discard, and fishing mortality rate figures are likely to be underestimates.

2.2 Stock Assessment Update: ATLANTIC BLUEFIN TUNA

2.2.1 Life History/Species Biology Information

Basic 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). There are numerous research projects underway regarding the life history of West Atlantic bluefin tuna. Much of the information below is taken from the 2002 U.S. National Report to ICCAT.

As part of its commitment to ICCAT's Bluefin Year Program (BYP), research supported by the United States has concentrated on ichthyoplankton sampling, reproductive biology, methods to evaluate hypotheses about movement patterns, spawning area fidelity and stock structure investigations. Ichthyoplankton surveys in the Gulf of Mexico during the bluefin spawning season were continued in 2001 and 2002. Data resulting from these surveys which began in 1977 are used to develop a fishery-independent abundance index of spawning West Atlantic bluefin tuna. This index has continued to provide one measure of bluefin abundance that is used in SCRS assessments of the status of the resource (SCRS/02/91).

Efforts are underway to identify bluefin larvae for possible use in genetic analyses. Ichthyoplankton surveys in the Gulf of Mexico during the bluefin spawning season deploy two types of gear (bongo and nueston); the bongo samples have been used for the bluefin larval index. For about a decade two neuston nets have been fished at each station and the samples from one net have been preserved in ethanol. During 2001 and 2002 neuston samples which were preserved only in ethanol and collected throughout the 1990s have been sent for sorting. Those sent in 2001 were from 1995-2000 and have been sorted, but the identifications have not yet been verified. Samples sent for sorting in 2002 were from 1992-1994 and 2001. These samples in addition to samples already made available from 1994 when the joint cruise with the Japanese occurred, may be useful in stock discrimination analyses.

Studies related to genetic evaluations of the number of fishery management units of Atlantic bluefin are being conducted at several laboratories in the United States. The NOAA laboratory in Charleston, SC is acting as a sample archive center and has tissues from all bluefin collected for stock structure research by the NOAA Fisheries since 1996 and some or all samples collected by researchers from various institutions including the University of South Carolina, the Virginia Institute of Marine Science, the University of Maryland and the Massachusetts Division of Marine Fisheries.

Scientists at Virginia Institute of Marine Science and Texas A&M University continue to search for heterogeneous micro-satellite loci. In addition they have begun screening adult bluefin from the eastern and western management areas for micro-satellite frequencies. Regional and temporal heterogeneity of allele frequencies have been found for several loci, but consistent differences between adults captured in the eastern and western Atlantic have not been found.

Research on the feasibility of using otolith chemistry to discriminate bluefin stock continues at Texas A&M University and the University of Maryland. Current research is focused on preconcentration procedures to eliminate chemical interferences and increase sample classification accuracy. Additionally stable isotopes (d13C and d18O) have been used as recorders of environmental conditions and are being investigated for possible use in determining stock structure. Preliminary results for one isotope (d18O) for 1 year old bluefin from the

Mediterranean and the West Atlantic were markedly different with cross-validated classification success of 100%, indicating that nursery area could be accurately predicted.

Research on bluefin tuna movement patterns using electronic tags and on the associated methodology was continued in 2001 and 2002. Tagging activities continued off North Carolina (scientists from Stanford University, Monterey Bay Aquarium and NOAA Fisheries) and off northeast North America (by scientists from (1) New England Aquarium, Massachusetts Division of Marine Fisheries. and D.F.O. from Canada and (2) Stanford University and the Monterey Bay Aquarium). Report SCRS/02/92 reviewed the most recent results obtained from electronic tagging of > 500 fish by the Stanford University Team. Additionally, researchers from Stanford University and the Monterey Bay Aquarium continued studying the feasibility of tagging bluefin tuna in the Gulf of Mexico, successfully releasing 4 bluefin with electronic tags in 1999, about 10 fish in 2000, 5 fish in 2001, and 8 in 2002.

Scientists from the New England Aquarium conducted studies on a variety of topics related to bluefin tuna in addition to the tagging activities mentioned above and extensive participation in the exploratory research in the central Atlantic. Data from pop-up satellite tags is being studied to determine the reliability of the geographic information for understanding bluefin movement and behavior. Studies of the relationship between bluefin schools and surface water temperatures has been conducted. Additionally research on the bluefin movement patterns and their relationship to the environment have been investigated with respect to the utility of spotter aircraft observations for indicators of abundance. Research is also continuing on bluefin energetics, reproduction and predator prey relations.

Several documents considered the implications of mixing between eastern and western stocks. SCRS/02/93 examines recapture rates of tagged fish in three areas: 1) West Atlantic, 2) Northeast Central Atlantic, and 3) East Atlantic and Mediterranean. The use of the ICCAT tagging data for identifying stock mixing in the Northeast Central area is discussed, as is the possibility of differing reporting rates between areas. SCRS/02/87 assumed a six strata spatial structure (as identified at the September 2001 ICCAT workshop on bluefin mixing) and applied a simple age-aggregated (production) model approach with inter-stratum mixing. The results suggest that, with or without mixing, the 1997 catch levels of bluefin in the western Atlantic are sustainable; however, those in the east for 1997 are well above sustainable levels and need substantial reduction. Across a wide range of model input parameter values, even at relatively modest levels of mixing the fishery in the West is predicted to be adversely affected unless reduction in the east takes place. In SCRS/02/88, a multi-area, fleet-disaggregated, age-structured population dynamics model is used to evaluate the effectiveness of existing and alternative management measures under different mixing scenarios. The model simulates the dynamics of the two bluefin tuna stocks in the North Atlantic and of the fisheries that target them Results indicate that assessment results can be affected considerably by the level of mixing, age-specific movement patterns and gear selectivities.

SCRS/02/86 identified some improvements for the ADAPT VPA assessment and projection computations carried out at the 2000 assessment, related to plus-group mass and how this was taken into account in MSY computations. Abundance indices were developed using Canadian fishery data (SCRS/02/81), U.S. longline data (SCRS/02/90) and U.S. rod and reel data (SCRS/02/89) for a range of size classes of bluefin tuna.

2.2.2 Recent Stock Assessment Results

The two management units for Atlantic bluefin tuna 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. A new stock assessment was conducted for both Atlantic bluefin tuna management units (East and West) in 2002. The West Atlantic stock assessment included projections for two scenarios about future recruitment (Table 2.2.1). One scenario assumed that future recruitment will approximate the average estimated recruitment since 1976, unless spawning stock size declines to low levels. The second scenario anticipated an increase in recruitment corresponding to an increase in spawning stock size up to a maximum level no greater than the average recruitment for 1970 - 1974. These scenarios were referred to as the low recruitment and high recruitment scenarios, respectively.

The results of projections based on the low recruitment scenario (Table 2.2.2) for the Atlantic stock indicated that a constant catch of 2,500 mt per year has a 97 percent probability of allowing rebuilding to the associated B_{MSY} level by 2018. A constant catch of 2,500 mt per year has about a 35 percent probability of allowing rebuilding to the 1975 stock size by 2018. The SCRS notes that, arguably SSB75 is appropriate as a target level for interpreting the implications of projections based on the high recruitment scenario. Under the high recruitment scenario, a constant catch of about 2,500 mt has about a 60 percent probability of allowing rebuilding to the 1975 stock size; a catch of 2,700 has about a 52 percent chance of reaching this stock size. The SCRS cautioned that these conclusions do not capture the full degree of uncertainty in the assessments and projections. The immediate rapid projected increases in stock size are strongly dependent on estimates of high levels of recent recruitment, which are the most uncertain part of the assessment. The implications of stock mixing between the east and West Atlantic add to the uncertainty.

The SCRS noted again, as it has in the past, that mixing of East and West management unit fish could have important implications for both resources. It stressed the potential adverse effect that the eastern stock fishery cold have on the western stock, and noted that significant improvements to the biological knowledge of bluefin tuna are required before an improved assessment of West Atlantic bluefin can be achieved. Based on these concerns and the mounting evidence of inter-stock mixing, in 2002, ICCAT established a working group to evaluate the issues of stock structure and mixing and charged them with developing operational management options for review in 2004.

The SCRS updated the assessment for the east Atlantic and Mediterranean stock in 2002, but noted that it lacked confidence in the analysis due to increased under-reporting and a lack of CPUE and size data. The 1998 projections (Table 2.2.3) show that current catch levels are not sustainable. Results for the 2002 analysis were similar to 1998's assessment in terms of trends but more optimistic in terms of current depletion. The SSB in 2000 was estimated to be about 86% of the 1970 level, up from the SSB_{97}/SSB_{70} of 47%. Fishing mortality has increased, especially for older fish since 1993, which is of grave concern; F_{00} was almost 2.5 times higher than that which maximizes yield per recruit (YPR). Substantial reductions in F could support future yields at current or even higher (perhaps > 50 mt greater) levels. The SCRS expressed continued concern about the intensity of fishing pressure on small fish. This contributes substantially to growth over-fishing, and seriously reduces the long-term potential yield from the resource.

2.2.3 SCRS Advice and Current Management Measures

The SCRS' recommendation for the West Atlantic stock is based on ICCAT's 1998 Rebuilding Program, which aspires to rebuild with 50% probability to SSB_{MSY} by 2018. The SCRS concluded that in light of uncertainty in the assessment including recruitment estimates, stock mixing, and rebuilding targets, the total allowable catch (TAC) should not be changed from the current level of 2,500 mt. Based on similar advice in 2001, ICCAT did not adopt any changes to the 20 year rebuilding program at its 2001 meeting. However, in 2002 ICCAT chose to increase the TAC to 2,700 mt for the 2003 fishery.

Despite SCRS advice that current catch levels in the East Atlantic and Mediterranean are unsustainable, the total allowable catch was not reduced at the 2002 ICCAT meeting. However, ICCAT did include virtually all entities of concern in its allocation scheme which caps TAC at 32,000 mt per year through 2005, and requires a management program re-evaluation in 2005 before rollover underages may be applied. ICCAT also addressed the high fishing mortality on juvenile fish by reducing tolerances for small fish harvest and increasing the Mediterranean's minimum size from 3.2 kg to 4.8 kg. Parties are also required to develop plans to reduce catches of Mediterranean juveniles to at least reach the recommended tolerance levels.

Table 2.2.1 Summary Table for the Status of West Atlantic Bluefin Tuna

Age/size at Maturity	Age 8/~ 200 cm fork length
Spawning Sites	Primarily Gulf of Mexico and Florida Straits
Current Relative Biomass Level *Minimum Stock Size Threshold*	SSB_{01}/SSB_{75} (low recruitment) = .13 (.07-.20) SSB_{01}/SSB_{75} (high recruitment) = .13 (.07-.20) SSB_{01}/SSB_{msy} (low recruitment) = .31 (.20-.47) SSB_{01}/SSB_{msy} (high recruitment) = .06 (.03-.10) *$0.86B_{MSY}$*
Current Relative Fishing Mortality Rate *Maximum Fishing Mortality Threshold*	F_{01}/F_{MSY} (low recruitment) = 2.35 (1.72-3.24) F_{01}/F_{MSY} (high recruitment) = 4.64 (3.63-6.00) *F/F_{MSY}* = 1.00
Maximum Sustainable Yield	Low recruitment scenario: 3,500 mt (3,300-3,700) High recruitment scenario: 7,200 mt (5,900-9,500)
Current (2001) Yield	2,646 mt

Short Term Sustainable Yield	Probably > 3,000 mt
Outlook	Overfished; overfishing continues to occur

Table 2.2.2 Probability of western Atlantic bluefin tuna achieving rebuilding target by 2018. From SCRS 2002.

Catch (mt)	Low Recruitment Scenario		High Recruitment Scenario	
	SSB_{1975}	SSB_{MSY}	SSB_{1975}	SSB_{MSY}
500	95 %	100 %	98 %	73 %
1,000	89 %	100 %	96 %	62 %
1,500	77 %	100 %	87 %	47 %
2,000	60 %	99 %	75 %	30 %
2,300	45 %	98 %	66 %	24 %
2,500	35 %	97 %	60 %	20 %
2,700	26 %	95 %	52 %	17 %
3,000	14 %	83 %	38 %	11 %
5,000	0%	1%	2%	0%

Table 2.2.3 Summary Table for the Status of East Atlantic Bluefin Tuna

Age/size at Maturity	Age 4-5
Spawning Sites	Mediterranean Sea
Current Relative Biomass Level	SSB_{00}/SSB_{1970} = .80
Current Relative Fishing Mortality Rate	F_{00}/F_{MAX} = 2.4
Maximum Sustainable Yield	Not estimated
Current (2000) Yield	33,754 mt
Sustainable Yield (1997)	about 25,000 mt
Outlook	Overfished; overfishing continues to occur.

2.3 Stock Assessment Update: BAYS TUNAS

2.3.1 ATLANTIC BIGEYE TUNA

2.3.1.1 Life History/Species Biology Information

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). In 1999, ICCAT began its Bigeye Tuna Year Program (BETYP) with an ambitious research agenda including conventional and pop-tagging, improvement of catch statistics, studies on genetics, growth, and natural mortality, and the development of an integrated stock assessment program. During 2001 and 2002, conventional tagging occurred in the Gulf of Guinea and Canary Islands and pop-up tagging was conducted in the Azores. Fishery statistics were improved in Ghana, and genetic, hard part, and modeling projects continued. The BETYP is scheduled to wrap-up in the near future, and the final symposium to review research findings will occur in March 2004.

2.3.1.2 Recent Stock Assessment Results

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 2002). The latest stock assessment of Atlantic bigeye tuna was conducted in October 2002. The assessment was hampered by a paucity of information about illegal, unregulated, or unreported (IUU) catches, limited Ghanian fishery statistics, and the lack of a reliable index of abundance for small bigeye tuna. An estimate of natural mortality for juvenile fish was computed, which will help reduce uncertainty in future assessments.

Various production models were used which estimated that the total catch was larger than the upper limit of MSY estimates for the years between 1993 and 1999, causing the stock to decline considerably (SCRS 2002). This period was followed by a leveling off of biomass in recent years as total catches decreased. These results indicate that the current biomass is about 10-20% below the biomass corresponding to MSY and that current fishing mortality is about 15% higher than the rate that would achieve MSY. In addition to the estimates from production models, yield-per-recruit (YPR) analyses and other models support the production model results indicating that the stock is being over-fished. Further YPR analysis indicates that YPR can be increased with a reduction of fishing effort in small-fish fisheries. Increases in biomass are expected with catches below 95,000 mt, and further biomass declines are expected with catches of 105,000 mt or greater.

2.3.1.3 SCRS Advice and Management Measures

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 estimated at up to 59 percent by number of all bigeye tuna harvested. At its 2000 meeting, ICCAT adopted a recommendation that established the first-ever catch limits for bigeye tuna, which went into effect in 2001. These measures were continued for 2002 and 2003. While these measures will not be sufficient to rebuild the stock, bigeye tuna catches in 2000 (100,413 mt) and 2001 (96,482 mt) were down significantly from the 1999 level of 120,883 mt - first steps toward rebuilding.

The SCRS also expressed gratitude to the Commission for implementation of the bigeye tuna statistical document program. With this data collection tool in place, future assessments should be improved.

Table 2.3.1 Summary Table for the Status of 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*	B_{02}/B_{MSY} = 0.81 - 0.91 $0.6B_{MSY}$ (age 2+)
Current Relative Fishing Mortality Rate *Maximum Fishing Mortality Threshold*	F_{01}/F_{MSY} = 1.15 F_{year}/F_{MSY} = 1.00
Maximum Sustainable Yield	79,000 - 105,000 mt
Current (2001) Yield	96,482 mt
Current (2002) Replacement Yield	102,200 mt
Outlook	May be overfished; overfishing is occurring

2.3.2 ATLANTIC YELLOWFIN TUNA

2.3.2.1 Life History/Species Biology Information

The HMS FMP (Sections 2.2.1 and 6.3.1.5) includes summary information on the life history of yellowfin tuna. In 2002, several collaborative studies were conducted by U.S. scientists in cooperation with scientists from other countries. Cooperative research by the NOAA Fisheries and the Instituto Nacional de la Pesca (INP) in Mexico continued. Cooperative research plans include further development of abundance indices for sharks and other tunas, as well as the refinement of the yellowfin tuna indices as additional data become available. Cooperative research on yellowfin tuna abundance indices, catch at age, and life-history studies is also continuing with Venezuelan scientists.

2.3.2.2 Recent Stock Assessment Results

Based on movement patterns, as well as other information (e.g., time-area size frequency distributions and locations of fishing grounds), ICCAT manages Atlantic yellowfin tuna based on an Atlantic-wide single stock hypothesis. The latest stock assessment for Atlantic yellowfin tuna was conducted in 2000, but the input data were updated for this year's report. The assessment incorporated various age-structure and production models, and both equilibrium and non-equilibrium production models were examined. The data used for the equilibrium models assumed a fixed increase in fishing power of 3% per year. In contrast, the non-equilibrium model estimated changes in fishing power trends internally by fleet.

The production model analyses imply that 2001 catches were above the range of MSY levels, and that effort may be either above or below the MSY level, depending on assumptions about changes in fishing power. Consistent with these results, yield-per-recruit analyses also indicate that current fishing mortality rates could either be above, or about at, levels that could produce MSY. In summary, reported yellowfin tuna landings appear to be close to the MSY level and fishing effort and fishing mortality may be in excess of the levels associated with MSY.

2.3.2.3 SCRS Advice and Management Measures

The SCRS continues to recommend that fishing mortality on small yellowfin tuna should be reduced. Based on the results of the 2000 assessment, the SCRS reaffirmed its support for the Commission's 1993 recommendation that there be no increase in the level of effective fishing effort exerted on Atlantic yellowfin tuna over the level observed in 1992.

A number of management measures have been implemented in the United States, consistent with this advice, to prevent overfishing. In 1999, NOAA Fisheries implemented limited access in the pelagic longline fishery for Atlantic tunas, as well as a recreational retention limit for yellowfin tuna. The United States has also implemented a larger minimum size than that required by ICCAT. This species has not been listed as overfished, thus no rebuilding program has been adopted at this time.

Table 2.3.2 Summary Table for the Status of 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*	B_{99}/B_{MSY} = 1.03 $0.5B_{MSY}$ (age 2+)

Current Relative Fishing Mortality Rate *Maximum Fishing Mortality Threshold*	F_{99}/F_{MSY} = 0.88 - 1.16 F_{year}/F_{MSY} = 1.00
Maximum Sustainable Yield	144,600 - 152,200 mt
Current (2001) Yield	157,000 mt
Current (2001) Replacement Yield	May be somewhat below the current yield
Outlook	Stock not overfished, overfishing may be occurring

2.3.3 ATLANTIC ALBACORE TUNA

2.3.3.1 Life History/Species Biology Information

The HMS FMP (Sections 2.2.1 and 6.3.1.4) includes summary information on the life history of Atlantic albacore tuna. The cooperative research initiated by the United States (NOAA Fisheries) and the Instituto Espanol de Oceanografia (IEO) of Spain in 1993 continued. In 1999, the effort was extended to analyze the catch per unit effort data for the Spanish troll and baitboat fisheries using the general linear modeling approach. Further training sessions on this topic also took place in late 2000 and was extended to standardization of eastern Atlantic bluefin tuna catch rate time series in early 2001. A U.S. scientist also provided training to Spanish IEO and other ICCAT country scientists in mid-2001.

2.3.3.2 Recent Stock Assessment Results

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. U.S. fishermen caught relatively small amounts of albacore from the North Atlantic stock/management unit (322 mt in 2001), and had minor catches of South Atlantic albacore (2 mt in 2001).

The latest stock assessment for Atlantic albacore tuna was conducted in 2000. Results of the North Atlantic assessment were consistent with previous findings. Equilibrium yield analyses indicated that current spawning stock biomass is about 30% below that associated with MSY. However, there are considerable uncertainties associated with the estimates of current biomass relative to the biomass associated with MSY (B_{MSY}), due to difficulty in estimating how recruitment might decline below historical levels of stock biomass.

The South Atlantic albacore spawning stock biomass appears to have declined substantially relative to the late 1980s, but the decline may have leveled off in recent years. After the 2000 assessment, the SCRS concluded that the recent level of South Atlantic albacore landings can probably be maintained into the near future without causing a substantial decline in spawning stock biomass. However, a dramatic increase in the 2001 estimated catch and potential future repercussions of continued high catch were of great concern to the SCRS this year.

2.3.3.3 SCRS Advice and Management Actions

The 2002 SCRS repeated its advice from the previous year for the northern stock, which was that catch should not exceed the current catch level (34,500 mt) over the next year to maintain a stable spawning stock biomass for the near future. In order to begin increasing biomass towards the level estimated to support MSY, catches of North Atlantic albacore would need to be reduced to less than 31,000 mt. In 1998, parties agreed to limit the number of vessels fishing for northern albacore to the average number in the period 1993-95. At a later date, the SCRS determined that effort limitations were likely to be ineffective for this stock, and recommended a 34,500 mt catch limit for 2000 and 2001. In 2000, ICCAT set a total allowable catch of 34,500 mt for the year 2001, which was renewed in 2002 and again in 2003. The 2003 quota for the United States was established at 607 mt.

For the southern stock, the SCRS recommended that catch should not exceed the estimated replacement yield of 29,200 mt for 2003. The 2001 catch exceeded both the replacement yield and MSY, and the SCRS expressed concern about the current management framework. In response, ICCAT recommended a catch limit of 29,200 mt and improved communication among parties actively fishing for southern albacore. The United States continues to have a bycatch TAC of 100 mt.

Table 2.3.3 Summary Table for the Status of 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_{99}/B_{MSY} = 0.68 (0.52 - 0.86) $0.7B_{MSY}$
Current Relative Fishing Mortality Rate *Maximum Fishing Mortality Threshold*	F_{99}/F_{MSY} = 1.10 (0.99 - 1.30) F_{year}/F_{MSY} = 1.00
Maximum Sustainable Yield	32,600 mt [32,400 - 33,100 mt][1]
Current (2001) Yield	24,955 mt (25,052[1])
Current Replacement Yield	not estimated
Outlook	Overfished; overfishing is occurring

Table 2.3.4 Summary Table for the Status of South Atlantic Albacore Tuna

Age/size at Maturity	Age 5/~90 cm curved fork length
Spawning Sites	Subtropical western waters of the southern Hemisphere
Current Relative Biomass Level	B_{99}/B_{MSY} = 1.60 (0.01 - 1.98)
Current Relative Fishing Mortality Rate	F_{99}/F_{MSY} = 0.57 (0.34 - 556)
Maximum Sustainable Yield	30,200 mt (50 - 31,400)
Current (2001) Yield	34,616 mt (35,731[1])
Current Replacement Yield (2000)	29,200 mt (12,100 - 31,400)

Outlook	Not overfished; overfishing is not occurring

[1]This figure includes reported catch, provisional catch reported to the SCRS, and carry-overs

2.3.4 WEST ATLANTIC SKIPJACK TUNA

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 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.

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, the SCRS has not conducted a stock assessment for Atlantic (West or East) skipjack tuna since 1999, and few definitive conclusions on the status of the stocks can be made. Standardized abundance indices from the Brazilian baitboat fishery and Venezuelan purse seine fishery both indicated a stable status for the western stock. The SCRS did not propose any management recommendations.

Table 2.3.5 Summary Table for the Status of 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* $F_{year}/F_{MSY} = 1.00$
Maximum Sustainable Yield	*Not Estimated*

Current (2001) Yield	33,320 mt
Current Replacement Yield	*Not Estimated*
Outlook	*Unknown*

2.4 Stock Assessment Update: ATLANTIC BILLFISH

2.4.1 Life History/Species Biology Information

This section was taken primarily from the 2002 SCRS Report which summarizes all recent data on Atlantic billfish

Blue and White Marlin

Blue and white marlin are found throughout tropical and temperate waters of the Atlantic ocean and adjacent seas. They range from Canada to Argentina in the western Atlantic, and from the Azores to South Africa in the eastern Atlantic. Blue marlin are large apex predators with an average weight of 100 - 175 kg. The average size of white marlin is 20 - 30 kg. Blue marlin have an extensive geographical range, migratory patterns that include trans-Atlantic as well as trans-equatorial movements, and are generally considered to be a rare and solitary species relative to the schooling scombrids. Although white marlin are generally considered to be a rare and solitary species, they are known to occur in small groups consisting of several individuals. Blue marlin are considered sexually mature by ages 2 - 4, spawn in tropical and subtropical waters in the summer and fall, and are found in the colder temperate waters during the summer. Young blue marlin are one of the fastest, if not the fastest growing of all teleosts, reaching from 30 - 45 kg by age 1. Female white and blue marlin grow faster and reach a much larger maximum size than males. Very little is known about the age and growth of white marlin, although they are considered to be very fast growing, as are all the Istiophoridae.

Blue and white marlin feed on a wide variety of fish and squid. They are found predominately in the open ocean near the upper reaches of the water column and are caught most frequently as a bycatch in the offshore longline fisheries which target tropical or temperate tunas using gear intended to fish near-surface waters. However, significant bycatch landings are also made by offshore longline fisheries that target swordfish and bigeye tuna using gear intended to fish deeper in the water column. White and blue marlin are both managed using the single Atlantic stock hypothesis.

Sailfish/Spearfish

Sailfish and spearfish have a pan-tropical distribution. Although sailfish have highest concentrations in coastal waters (more than any other Istiophorid), they are still found in oceanic waters. Spearfish are most abundant in offshore temperate waters. No trans-Atlantic movements have been recorded, suggesting a lack of mixing between east and west. Although sailfish and spearfish are generally considered to be rare and solitary species relative to the schooling Scombrids, sailfish are known to occur along tropical coastal waters in small groups consisting of at least a dozen individuals. Sailfish are the most common Atlantic Istiophorid and spearfish are generally the rarest Atlantic Istiophorid.

Sailfish and spearfish are generally considered piscivorous, but have also been known to consume squid. They are found predominantly in the upper reaches of the water column and are caught as a bycatch in the offshore longline fisheries and as a directed catch in coastal fisheries. In coastal waters, artisanal fisheries use many types of shallow water gear to target sailfish.

Sailfish spawn in tropical and subtropical waters in the spring and throughout the summer. Little is known about spearfish life history due to their relatively rare abundance in offshore waters. Both sailfish and spearfish are considered to be fast growing species compared to other teleosts. Female sailfish grow faster and reach a larger maximum size than males.

Historically, ICCAT has considered Atlantic sailfish/spearfish as separate eastern and western management units. The separation of sailfish into two management units was based on the coastal orientation of the species, tag release/recapture data that suggest a lack of mixing, and morphological data. The Committee re-evaluated the stock structure of Atlantic sailfish based on the results of a genetic investigation submitted to the 2001 SCRS. The study failed to find differences, but this did not necessarily mean a lack of structure, as a very small exchange rate between east and west could produce these results. Therefore, the Committee determined that there was no basis for changing the current stock boundary at this time. However, this issue should be reviewed as more data becomes available. As a result, sailfish are currently managed under a two-stock hypothesis. NOAA Fisheries manages only the West Atlantic sailfish stock.

2.4.2 Recent Stock Assessment Results

Blue and White Marlin

The last stock assessment for Atlantic blue marlin was conducted in 2000. An assessment of Atlantic white marlin was conducted in May 2002. The SCRS suggested that substantial investments in research on the habitat requirements of marlins, as well as the verification of historical catch data, are needed to reduce uncertainties in these assessments.

The latest assessment for blue marlin is slightly more optimistic than the 1998 assessment, however, productivity is lower than previously estimated. The total Atlantic stock is approximately 40% of B_{msy}, the current fishing mortality rate is approximately four times higher than F_{msy}, and overfishing has taken place in the last 10-15 years. Blue marlin landings declined in 1999 by 14% from the 1996 level. The 2000 assessment estimated that overfishing was still occurring and that productivity (MSY and stock's capacity to replenish) was lower than previously estimated. The SCRS recommended that ICCAT take additional steps to reduce the catch of blue marlin as much as possible.

The previous two white marlin assessments, made in 1996 and 2000, indicated that the biomass of white marlin has been below B_{msy} for more than two decades. Thus, white marlin has been overfished for many years. The 2002 assessment results suggest that the total Atlantic stock in 2000 remains overfished and overfishing is continuing to occur. Given that the stock is severely depressed, the SCRS concluded that ICCAT should take steps to reduce the catch of white marlin as much as possible. Results from the 2002 assessment indicate a MSY of 964 mt (849-1070 mt), a relative biomass (B_{2001}/B_{msy}) of 0.12 (0.06 - 0.25) and a relative fishing mortality rate (F_{2000}/F_{msy}) of 8.28 (4.5 - 15.8).

On September 4, 2001, the Biodiversity Legal Foundation and James R. Chambers petitioned the NOAA Fisheries to list the Atlantic white marlin as endangered or threatened throughout its range, and to designate critical habitat under the Endangered Species Act (ESA). On December 19, 2001, NOAA Fisheries found that the Atlantic white marlin petition presented substantial information indicating that a listing of Atlantic white marlin may be warranted and initiated a comprehensive review of the status of the species. On December 20, 2001, NOAA Fisheries published a 90-day finding (66 FR 65676) announcing this determination and the initiation of a formal Atlantic white marlin status review, as required by section 4(b)(3)(A) of the ESA. At the same time, NOAA Fisheries requested public comment and solicited additional information that might be useful in conducting the status review. The public comment period extended through February 19, 2002.

In order to conduct a comprehensive review, NOAA Fisheries convened a status review team (SRT) of experts in pelagic fish biology, fisheries management, and fisheries stock assessment. The SRT was requested to assess the species status and the degree of threat to the species in the context of the listing criteria provided by the ESA. The SRT summarized all available biological information on white marlin and conducted analyses to predict population trends under various scenarios. The status review document prepared by the SRT contains a summary of the information they assembled and constitutes the best available scientific, commercial, and recreational data on Atlantic white marlin. The document addresses the status of the species, the five ESA listing factors, and the effect of efforts underway to protect the species. NOAA Fisheries also conducted a number of public meetings to solicit information from the public about the status of white marlin during the status review process.

After reviewing the best scientific and commercial information available and the effects of current conservation efforts, on September 3, 2002, NOAA Fisheries determined that listing Atlantic white marlin as either threatened or endangered under the ESA is not warranted at this time. The best available information indicates that the Atlantic white marlin population has declined greatly, but is not at levels that merit ESA protection. NOAA Fisheries added Atlantic white marlin to the “species of concern” list and will reevaluate the need for ESA protection of Atlantic white marlin in 2007.

Sailfish/Spearfish

Longbill spearfish and sailfish landings have historically been reported together in annual ICCAT landings statistics. An assessment was conducted in 2001 for the western Atlantic sailfish stock based on sailfish/spearfish composite catches and sailfish “only” catches. The assessment tried to address the shortcomings of the previous assessments by improving the list of abundance indices and by separating the catch of sailfish from that of spearfish in the off-shore longline fleets.

Considerable progress was made on obtaining new, more reliable abundance indices. The new separation of sailfish/spearfish allowed assessments to be attempted on sailfish “only” data. Results from the 2001 sailfish “only” assessment indicate a recent yield (2000) of 506 mt and a 2000 replacement yield of ~ 600 mt. However, considerable uncertainties remain relating to both catches and catch rates that can only be addressed by substantial research investment in historical data validation and in investigations of the habitat requirements of sailfish.

For the western Atlantic stock, recent catch levels for sailfish/spearfish combined seem sustainable as both CPUE and catch have remained relatively constant over the last two decades. For the combined sailfish/spearfish western Atlantic stock, it is not known whether the current catch level is below or at maximum sustainable yield. For this same stock, tentative catches of sailfish “only” have averaged about 700 MT over the past two decades and the abundance indices have remained relatively stable for the same period. New analyses do not provide any information on the MSY or other stock benchmarks for the western Atlantic composite or sailfish “only” stock.

2.4.3. SCRS Advice and Management Measures

Management recommendations from SCRS during 2002 were the same as those made in 2001. SCRS (2001) stated that blue and white marlin stocks are unlikely to recover if the landings associated with the 1996 ICCAT recommendation continue into the future. Time area closures, reductions in fleet-wide effort, release of live fish, a better estimation of dead discards, and scientific observer sampling could be considered as techniques to reduce interactions/ mortality and improve the quality of assessments.

In 1997, ICCAT made several recommendations to recover billfish resources throughout the Atlantic Ocean, including a reduction of Atlantic blue and white marlin landings by at least 25 percent from 1996 levels; the promotion of the voluntary release of live Atlantic blue marlin and white marlin; and an improvement of current monitoring, data collection and reporting in all Atlantic billfish fisheries. A 1998 ICCAT recommendation required a reduced level of marlin landings through 2000. Because commercial landings of Atlantic billfish by U.S.-flagged vessels were already prohibited by the 1988 Atlantic Billfish FMP, the 25 percent reduction in blue and white marlin landings affected only recreational anglers in the United States.

In November, 2000, ICCAT made a third recommendation for Atlantic blue and white marlin by developing a two-phase rebuilding program effective in mid-2001. In November, 2002, ICCAT recommended the continuation of phase one through 2005, with re-evaluation and adjustment in 2005. During phase one, the annual amount of blue marlin that can be harvested

Table 2.4.1 Summary Table for the Status of 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_{2000}/B_{MSY} = 0.4 (0.25-0.6) *$0.9B_{MSY}$*	B_{2001}/B_{MSY} = 0.12 (0.06-0.25)[2] *$0.85B_{MSY}$*	$B_{92\text{-}96}/B_{MSY}$ = 0.62 *$0.75B_{MSY}$*
Current Relative Fishing Mortality Rate *Maximum Fishing Mortality Threshold*	F_{99}/F_{MSY} = 4.0 (2.5 - 6.0) F_{1995}/F_{MSY} = 1.00	F_{2000}/F_{MSY} =8.28 (4.5-15.8)[2] F_{1995}/F_{MSY} = 1.00	$F_{91\text{-}95}/F_{MSY}$ = 1.4 $F_{91\text{-}95}/F_{MSY}$ = 1.00
Maximum Sustainable Yield	2,000 mt (2000-3000 mt)	964 mt (849-1070 mt)[2]	*Not estimated*
Recent (2000) Yield[1]	3,394 mt	(information is incomplete)	506 mt
Current Replacement Yield	~1,200 mt (840 - 1600 mt)	222 mt (101-416 mt)[2]	~600 mt
Outlook	Overfished; overfishing is occurring	Overfished; overfishing is occurring	Overfished; overfishing is occurring

[1] Estimated yield including that carried over from previous years
[2] The data used were not sufficiently informative to choose a "best case". For consistency, the data presented in this table reflects the "continuity case" which was based on data and assumptions that closely resemble the analyses made in 2000.
* 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.

and retained for landing by pelagic longline and purse seine vessels must be no more than 50% of the 1996 or 1999 landing levels, whichever is greater. For white marlin, the annual amount of white marlin that can be harvested by pelagic longline and purse seine vessels and retained for landing must be no more than 33% of the 1996 or 1999 landing levels, whichever is greater. All blue and white marlin captured by pelagic longline and purse seine vessels alive shall be released in a manner that maximizes their survival. These provisions do not apply to marlin that are dead when brought alongside of a vessel and that are not sold or entered into commerce. The United States is to monitor the landings of billfish tournaments to ensure at least 5% scientific observer coverage and to endeavor to attain 10% scientific observer coverage on billfish tournament landings by the end of 2002. The United States will also limit its landings of recreationally-caught Atlantic blue and white marlin to 250 fish in aggregate.

As recommended by the SCRS, in 2002, ICCAT also stated that during Phase One, Contracting Parties, Cooperating non-Contracting Parties, Entities or Fishing Entities (as these terms are defined by ICCAT) are encouraged to conduct research on blue marlin and white marlin, including, but not limited to: habitat requirements of white marlin, studies on post release survival rates of released fish, further verification of historical fishery data and validation, life history characteristics of marlin, and development of models for abundance estimation and stock assessment. A workshop will be held in 2003 to discuss a program to improve catch data for blue and white marlin. This program may include a statistical document program where appropriate and feasible.

During the second phase of the rebuilding program, the SCRS will conduct stock assessments of Atlantic blue and white marlin in 2005, and present its evaluation of specific stock recovery scenarios. Based on SCRS advice, at its 2005 meeting the Commission will, if necessary, develop and adopt programs to rebuild Atlantic stocks of blue and white marlin to levels that would support MSY.

2.4.4 Evaluation of Current Management Measures

Catch Limits: While some countries have already implemented the recommended 2000 ICCAT billfish catch limits, information is not yet available to evaluate the effects. The United States has limited its recreational landings of Atlantic blue and white marlin combined to 250 fish per year and has prohibited the possession of spearfish.

Minimum size limits: Amendment 1 to the Atlantic Billfish Fishery Management Plan implemented minimum size limits for Atlantic blue marlin at 99 inches (251 cm) LJFL, Atlantic white marlin at 66 inches (168 cm) LJFL, and west Atlantic sailfish at 63 inches (160 cm) LJFL. These minimum sizes are intended to provide an increase in reproductive potential, which would lead to a long-term benefit for the Atlantic-wide stock (U.S. DOC, 1999).

Prohibition on Sale: The NOAA Office for Law Enforcement has continued to expend resources responding to reports of illegal sale of Atlantic billfish. The prohibition on sale precludes the possession of Atlantic billfish by commercial fishermen, seafood dealers, and restaurants with the intent to sell. While billfish are still caught incidental to commercial fishing operations, this management measure has precluded any directed fishing effort on these species which supports rebuilding.

Time/area closures/Live bait prohibition: *Please refer to Chapter 8 "Bycatch" for evaluation of these measures.*

2.5 Stock Assessment Update: ATLANTIC SHARKS

2.5.1 Life History/Species Biology Information

A general discussion of shark characteristics can be found in the HMS FMP (2.4.1). Additional information on shark nursery ground and essential fish habitat (EFH) research reported in 2001 can be found in section 3.1 of this report.

Ongoing Research

The Northeast Fishery Science Center (NEFSC) is involved in a number of shark studies including life history, species biology, stock assessment, tagging, and migration studies which are described briefly below.

Fishery Independent Survey: The NEFSC conducts a bi-annual fishery-independent survey of Atlantic large and small coastal sharks in U.S. waters from Florida to Delaware to: 1) monitor the species composition, distribution, and abundance of sharks in the coastal Atlantic; 2) tag sharks for migration studies; 3) collect biological samples for age and growth, feeding ecology, and reproductive studies; 4) tag sharks whenever feasible for age validation studies; and 5) collect morphometric data for other studies. The time series of abundance indices (CPUE) from this survey are critical to the evaluation of coastal Atlantic shark species. This survey will be conducted in 2003.

Age and Growth of Pelagic Sharks: Re-examination of the age and growth of the shortfin mako, *Isurus oxyrinchus*, and preliminary studies on age and growth of the thresher shark, *Alopias vulpinus*, and white shark, *Carcharodon carcharias*, are being conducted. Vertebrae, length-frequency data, and tag/recapture data collected between 1962 and 2001 are being analyzed on each of these species to obtain von Bertalanffy growth function parameters. Methodology and the problems associated with validation and verification of age estimates of highly migratory species are being addressed.

Biology of the Porbeagle Shark: Life history studies of the porbeagle shark, *Lamna nasus*, continued under a cooperative United States/Canada research program and a paper on the validated age and growth of the porbeagle shark in the western North Atlantic Ocean was published in 2002. Two other manuscripts on the population dynamics and the reproduction of the porbeagle are in press, and information on their feeding ecology was summarized for an International Council for Exploration of the Sea (ICES) document. In addition, a preliminary analysis of porbeagle tagging and recapture data was begun using information from U.S., Canadian, and Norwegian sources.

Predator-Prey Interactions Between Shortfin Mako and Bluefish: The objective of this research is to quantify whether the level of dependence of shortfin mako and other shark species on bluefish, *Pomatomus saltatrix*, has changed from historic levels. Analyses will determine the relationship between bluefish distribution and abundance and the distribution and abundance of species of sharks that prey on, or compete with, bluefish for food.

Atlantic Blue Shark Life History and Assessment Studies: A collaborative program to examine the biology and population dynamics of the blue shark, *Prionace glauca*, in the North Atlantic is ongoing. An age and growth study conducted cooperatively with Massachusetts Division of Marine Fisheries staff has been completed and a manuscript is in press. Research on the food and feeding ecology of the blue shark is being conducted cooperatively with University of Rhode Island staff with a manuscript under revision. Recent focus is on the population dynamics in the North Atlantic with the objectives of constructing a time series of blue shark catch rates (CPUE) from research surveys, estimation of blue shark migration and survival rates, and the development of an integrated tagging and population dynamics model for the North Atlantic for use in stock assessment. This research is a collaboration between NOAA Fisheries scientists in the NEFSC, Apex Predators Program, Narragansett, RI, the NOAA Fisheries, Fisheries Statistics Division, Silver Spring, MD, and scientists at the School of Aquatic and Fishery Sciences, University of Washington. Progress to date includes the preliminary recovery of historical research survey catch data, size composition, and biological sampling data on pelagic sharks and two manuscripts describing Atlantic-wide movements and migrations and stock structure based on tag and release data from the NOAA Fisheries Cooperative Shark Tagging Program (CSTP). Preparation of standardized catch rate and size composition data compatible with pelagic longline observer data is the next step in this data recovery process. As part of this comprehensive program, cooperative research is underway with the Irish Marine Institute and Central Fisheries Board on mark-recapture databases including coordination of formats and programs with the NOAA Fisheries CSTP for joint data analyses.

Blacktip Shark Migrations: Movements of the blacktip shark, *Carcharhinus limbatus*, in the western North Atlantic and Gulf of Mexico based on release and recapture data were analyzed and utilized at the 2002 Shark Evaluation Workshop with general migration patterns and exchange between and within regions of U.S. and Mexican waters discussed.

Cooperative Atlantic States Shark Pupping and Nursery Survey (COASTSPAN): NEFSC, Apex Predators Program staff manage and coordinate this project that uses researchers in each major coastal Atlantic state from Florida to Delaware to conduct a cooperative, comprehensive, and standardized investigation of valuable shark nursery areas. This research identifies which shark species utilize coastal zones as pupping and nursery grounds, gauges the relative importance of these areas, and determines migration and distribution patterns of neonate and juvenile sharks.

Monitoring and assessment of Delaware Bay Sandbar Shark: NEFSC staff conduct this part of the COASTSPAN monitoring and assessment project for the juvenile sandbar shark, *Carcharhinus plumbeus,* population in the Delaware Bay nursery grounds using monthly longline surveys from June to September each year. A random stratified sampling plan based on depth and geographic location is ongoing to assess and monitor the juvenile sandbar shark population during the nursery season. In addition, the tagging and recapture data from this project are being used to examine the temporal and spatial relative abundance and distribution of sandbar sharks in Delaware Bay.

Habitat Utilization and Monitoring of Delaware Bay Sandbar Shark: This research is a study of the movements of juvenile sandbar sharks in Delaware Bay, a known nursery area, to quantify their habitat use and activity patterns using acoustic techniques. Acquired data allows quantification of home range (minimum area required) and, when coupled with environmental data, information on preferred habitat. This information is an important contribution towards understanding essential fish habitat and provides information necessary for nursery ground management and rebuilding of depleted shark populations.

Investigations into Nurse Shark Mating and Nursery Grounds in the Florida Keys: An analysis of the reproductive biology and habits of the nurse shark, *Ginglymostoma cirratum*, is ongoing in the Dry Tortugas, FL to understand its life history and ecology. Information from this research will be utilized to define essential fish habitat and manage this coastal shark species.

Overview of Gulf and Atlantic Shark Nurseries: Due to the requirement for a better understanding of shark nursery habitat in U.S. coastal waters, NEFSC, Apex Predators Program staff co-convened a symposium at the 2002 American Fisheries Society Annual Meeting in Baltimore, MD, titled "Shark Essential Fish Habitat: Towards Ecosystem Management" and are editing a report describing Atlantic and Gulf of Mexico coastal shark nursery ground and habitat studies.

Post-release Recovery and Survivorship Studies in Sharks: Physiological Effects of Capture Stress: This research is directed towards the sandbar shark, *Carcharhinus plumbeus*, and is being conducted cooperatively with Massachusetts Division of Marine Fisheries biologists. The study utilizes blood and muscle sampling methods in addition to acoustic tracking to obtain physiological profiles of individual sharks to characterize stamina and to determine ultimate post release survival. To investigate post-release survivorship, a two-phase study was undertaken utilizing sharks made available by the COASTSPAN Delaware Bay sampling program (Spargo *et al*., 2001). The first phase involved a field study that would mimic the natural conditions facing sandbar sharks when subjected to angling and would quantify the effects of exhaustive exercise. The second phase, with the sharks in captivity, experimentally reproduced the recovery phase that would naturally occur after exposure to exhaustive exercise. The purpose of this study was to quantify physiological changes in blood chemistry that occur during catch and release angling in sandbar sharks and to assess recovery and survivorship. This study attempted to assess blood parameters associated with stress and the effect of independent environmental variables on the stress reaction. Overall, this study was able to quantify the physiological changes that occurred in sandbar sharks during exhaustive exercise and follow the sharks through their metabolic recovery. Most metabolites returned to normal within 6-10 hours, indicating that sandbar sharks are able to physiologically recover after the exhaustive exercise associated with rod and reel angling. Therefore, catch and release fishing may not severely impact neonatal and juvenile sandbar sharks in important nursery areas (Spargo *et al*., 2001). This work will provide an important benchmark to evaluate the effects of capture and release on similar wild sharks, and hopefully aid fisheries managers in determining catch and release management strategies.

Natanson *et al*., (2001) estimated porbeagle shark maturation, age and growth, and longevity parameters in a cooperative study with Canada. The study is the first to use validated vertebral band pair counts in conjunction with length-frequency and tag-recapture analyses to provide consistent and accurate age estimates for porbeagle sharks. Results have shown that male porbeagles mature at about 174 cm (8 years) and females at 218 cm (13 years). Males and females grew at similar rates until the size of male maturity, after which the relative growth of the males declined. The growth rate of females declined in a similar manner at the onset of maturity. Maximum age, based on vertebral band pair counts, was 25 and 24 years for males and females, respectively. Longevity calculations, however, indicated a maximum age of 45 to 46 years in an unfished population.

Skomal and Natanson (2001) derived age and growth estimates for the blue shark. Males and females were aged to 16 and 13 years, respectively. Both sexes grew similarly to age seven when growth rates decreased in males and remained constant in females. Growth rates from tag-recaptures agreed with those derived from vertebral annuli for smaller sharks but appeared overestimated for larger sharks. The species was found to grow faster and have a shorter life span than previously reported for the North Atlantic Ocean.

Natanson (2001) reports on re-examination of the age and growth of the shortfin mako shark and preliminary studies on the age and growth of thresher and white sharks. Vertebrae, length-frequency, and tag-recapture data collected between 1962 and 2001 are being analyzed on each of these species to obtain von Bertalanffy growth function parameters. Preliminary results indicate that the vertebral centra are appropriate structures to use for aging these species.

Tagging Studies

The Cooperative Shark Tagging Program involving over 6,500 volunteer recreational and commercial fishermen, scientists and fisheries observers conducted since 1962, continued to tag large coastal and pelagic sharks and provide information to define essential fish habitat for shark species in U.S. Atlantic and Gulf of Mexican waters. In 2001, nearly 6000 sharks were tagged and 510 were recaptured. Between 1962 and 2001, more than 165,700 sharks of 40 species have been tagged and 9,500 sharks of 32 species have been recaptured, as a result of the CSTP

(Hueter, 2003). Eighty-seven percent of the tags are represented by eight species: blue shark, sandbar shark, tiger shark, dusky shark, shortfin mako, blacktip shark, Atlantic sharpnose shark, and scalloped hammerhead. The number of sharks tagged varies from two for the smalleye hammerhead to 93,489 for the blue shark. Numbers of recaptures by species range from one for the Greenland shark to 5,760 for the blue shark. Eighty-eight percent of the recaptures are made up of seven species: blue shark, sandbar shark, shortfin mako, tiger shark, lemon shark, blacktip shark, and dusky shark.

To date, the Mote Marine Laboratory Center for Shark Research (CSR) has tagged 9,741 sharks of 16 species and has received data on 355 recaptures (3.6 percent). Of these recaptures, the maximum distance traveled was 280 nm (by a blacktip shark) and the longest time at large was 2,461 days (by an Atlantic sharpnose shark). A trend of philopatric behavior, possibly resulting in natal homing, has emerged from these data. Tagged sharks of several species, in particular blacknose, bonnethead, and blacktip, have been recaptured in essentially the same location after significant periods at large and on annual cycles, i.e. approximately 1.0, 2.0, 3.0, etc. years later. In some cases, sharks have been recaptured on the same grassflat where they were originally tagged after being at large for five or more years. Current research utilizing both genetic analysis and acoustic tagging technology is testing the philopatry hypothesis with respect to the blacktip shark. To date, three 1 year-old juvenile blacktip sharks and two 2 year-olds have returned to their natal nursery on annual cycles, as detected using acoustic telemetry.

Two fishery independent bottom longline surveys were conducted by NOAA Fisheries in 2001. In April and May, the Apex Predators Program shark survey was conducted from Key West, Florida, to the Maryland/Delaware border. The majority of sets were made in the 11-20 fathom depth zone. Standard gear used was a Florida commercial-style bottom longline with a 940 lb test monofilament mainline, 12 foot gangions of 730 lb test monofilament, 300 3/0 hooks baited with spiny dogfish chunks, 5-7 lb weights attached to the mainline every 15 hooks, and a bullet float and 15 lb weight attached every 50 hooks. The gear was fished for 3 hours after completion of setting with an average of 6 hours from start of setting to completion of haulback. A total of 668 fish (652 sharks), representing 26 species (13 shark species) were caught on 85 sets. One leatherback turtle was entangled around the neck and flipper and was dead upon retrieval; resuscitation attempts were unsuccessful. Sharks represented 98 percent of the total catch, with sandbar sharks the most common (n=309), followed by tiger (n=136) and dusky sharks (n=71). The catch per unit effort for sharks was 2.6/100 hooks with a mean catch of sharks of 45.2/10,000 hook hours.

In June, the MEXUS-Gulf coastal shark survey was staged from Veracruz, Mexico on the R/V ONJUKU, and was conducted in the Gulf of Mexico along the Yucatan peninsula coast of the Bay of Compeche, Mexico. Gear included a one nautical mile monofilament mainline (940 lb test), 12 foot gangions of 730 lb test monofilament, #15/0 circle hooks baited with Atlantic bonito, and 11 lb weights at the start, mid, and end of the mainline. Bottom longline effort was 100 hooks fished for one hour (time from the last radar buoy being deployed to the first radar bouy being retrieved). The survey produced 37 sharks represented by 3 species caught in 38 sets. The most frequently captured shark was the Atlantic sharpnose shark (n=30), followed by the blacknose shark (n=4), and bonnethead (n=3). All viable live sharks were tagged and released (n=33). Seventeen species of incidental catch (n=117) were recorded including red drum (n=23), hardhead catfish (n=23), red snapper (n=4), and southern stingray (n=16).

Kohler *et al.*, (2001), summarized tag and recapture data from the Cooperative Shark Tagging Program for blue, shortfin mako, and porbeagle sharks from 1962-2000. For blue sharks, tag and catch data suggest that there are distinct seasonal abundances and latitudinal migrations in discrete parts of the population although blue sharks of the North Atlantic constitute a single stock. Trans-Atlantic movements are frequent between the western and eastern regions, utilizing the major North Atlantic current systems. Four tag returns indicate some partial exchange between the North and South Atlantic Oceans.

For the shortfin mako, tag and catch data indicate that, with the exception of the Grand Banks area, all other areas had the complete size range with larger mean lengths found off the Southeastern United States and Gulf of Mexico (Kohler *et al.*, 2001). In the Grand Banks, shortfin makos as small or smaller than reported at birth were tagged and released. The sex ratio changed with increasing size with a preponderance of females above 240 cm fork length. Kohler *et al.*, (2001), report on a seasonal cycle of abundance off the Northeastern United States with shortfin makos common along the western margin of the Gulf Stream and off Cape Hatteras in January. Beginning in April and May, makos move northward onto the continental shelf between Cape Hatteras and the southern part of Georges Bank. Makos are frequently caught off southern New Jersey in early June and off New York and southern New England by late June. From June through October, they are caught between Cape Hatteras and Cape Cod on the continental shelf and between the continental shelf and the Gulf Stream from Cape Hatteras and the southern tip of the Grand Banks. During November and December, shortfin makos move to offshore wintering grounds in the Gulf Stream and the Sargasso Sea (*Kohler* et al., 2001). Tagging results also support frequent exchange between the western and Central North Atlantic, however, there is not enough evidence at this time to support or reject the existence of one stock for the shortfin mako in the North Atlantic.

For the porbeagle, tagging was concentrated in the western North Atlantic and eastern North Atlantic Ocean. In the western North Atlantic, the overall sex ratio was 1:1 whereas in the eastern North Atlantic the sex ratio favored males (1:0.25); the size ranges were similar in both areas *(*Kohler *et al.,* 2001). Over 90 percent of the porbeagles traveled less than 500 nautical miles from the original tagging location and no movements between areas occurred. Tagging and catch data from the entire Atlantic give clear evidence that the eastern and western Atlantic stocks of porbeagles are distinct (Kohler *et al.*, 2001).

The CSR has also conducted tagging studies with the cooperation of the Instituto Nacional de la Pesca (INP) in Mexico. In the six field trips to date (1995, 1996, 1997, 1998, 2000, 2001), a total of 390 gillnet sets have been made resulting in the capture and tagging of 1,160 juvenile blacktip sharks with Spanish/English dart tags. In addition to blacktip sharks, several other shark species have been documented inside the lagoon including the bonnethead, lemon shark, nurse shark and Atlantic sharpnose shark.

To date, 22.3 percent of tagged blacktip sharks have been recaptured and reported, mostly by Mexican commercial fishermen. This is a very high recapture rate as compared with the CSR's U.S. tagging program, which yields only about 4-5 percent recaptures of tagged sharks. The longest time at liberty for these recaptures was 793 days; the longest distance traveled was 362 km for a blacktip tagged in central Yalahau and recaptured west of Celestun after being at large for 168 days. All 134 recaptures have been reported from Mexican coastal waters of the Yucatan peninsula, both east and west of Isla Holbox and inside the lagoon.

The high recapture rate indicates that fishing pressure on the blacktip juveniles is significant, which may or may not be a concern for the stock depending on the total number of pups produced in the lagoon, their natural mortality, demographic parameters and other factors. Estimates using a Peterson mark-recapture technique concluded that approximately 1,000-1,500 blacktip pups utilize Yalahau lagoon annually. The limited migratory data suggest that these juvenile sharks spend at least the first year or two along the Mexican Yucatan coast without venturing into deeper water or territorial waters of other nations.

In the western Gulf of Mexico, preliminary NOAA Fisheries tag-recapture data has indicated a north-south migration of juvenile sharks between U.S. and Mexican waters. These data indicate that blacktip sharks born in Texas/Louisiana nurseries in the spring are encountered in the Mexican artisanal fishery during their fall (southward) migrations. Likewise, it appears that sharks inhabiting Mexican coastal waters of the southwestern Gulf of Mexico may be returning to U.S. territorial waters during their spring (northward) migrations. To gain a better understanding of these movements of sharks between Mexico and U.S. Gulf states, directed CSR tagging efforts have concentrated along the Gulf coasts of Texas in the United States and Tamaulipas in Mexico. This work focuses on the blacktip shark and utilizes the skills of artisanal fishermen in Mexico and recreational fishermen in the United States to locate and catch the sharks for tagging. A total of 450 sharks of 10 species have been tagged and released with 14 recaptures, including four recovered in Mexico that were tagged in Texas. The longest distance traveled was 330 nm for a finetooth shark tagged in Corpus Christi, Texas and recaptured in Pueblo Viejo, Veracruz.

2.5.2 Most Recent Stock Assessment Data

Large Coastal Sharks

The 2002 large coastal sharks (LCS) stock assessment included additional catch estimates, new biological data, and a number of fishery-independent and fishery-dependent catch rate series. Additionally, the 2002 LCS stock assessment used several stock assessment models, including the model used in the 1992 LCS stock assessment, to estimate the status of LCS stocks and project their future abundance under a variety of future catch levels in waters off the U.S. Atlantic and Gulf of Mexico coasts. The 2002 LCS stock assessment concluded that:

1. The LCS complex as a whole is overfished and overfishing is occurring;
2. Sandbar sharks are no longer overfished although biomass levels have not reached optimum yield (the point at which they would be considered healthy) and that overfishing is occurring; and,
3. Blacktip shark populations are healthy and overfishing is not occurring.

Tables 2.5.1 and 2.5.2 provide the biomass and fishing mortality estimates used to make these determinations. Because of the large number of models and sensitivity runs presented in the LCS stock assessment, only a few of the models and sensitivity runs are summarized in tables 2.5.1 and 2.5.2. The particular models shown were chosen to be consistent with the phase plots presented in figures 71, 73, and 76 of the 2002 LCS stock assessment.

Directed commercial longline fishing vessels currently catch primarily sandbar and blacktip sharks. Sandbar and blacktip sharks make up approximately 60 to 75 percent of the commercial catch (GSAFDF, 1996). In 2000 and 2001, sandbar and blacktip sharks made up approximately 84 and 71 percent of the landings, respectively (Cortes and Neer, 2002, Table 2.5.1). In 2000 and 2001, approximately 3 and 21 percent of the landings were reported as unclassified sharks, respectively (Cortes and Neer, 2002). The remainder of the catch is comprised mostly of dusky, bull, bignose, tiger, sand tiger, lemon, spinner, scalloped hammerhead and great hammerhead sharks, with catch composition varying by region (GSAFDF, 1996). These species are less marketable and are often released, so they are reflected in the overall catch but not the landings. Approximately 84 to 91 percent of LCS came from the Southeast region, mainly Louisiana, Florida, and North Carolina, although Texas and South Carolina had a large percentage in 2001 (Cortes and Neer, 2002). Observer data indicates that LCS discarded from the fishery accounts for approximately 5.7 percent of the total LCS mortality (Cortes and Neer, 2002).

Small Coastal Sharks

In 2002, NOAA Fisheries conducted the first small coastal shark (SCS) stock assessment since 1992. This stock assessment used additional biological data, improved fisheries statistics, and bycatch estimates from the shrimp trawl fishery. Additionally, the stock assessment used new or extended fishery-dependent and independent catch rate series and several stock assessment models. The stock assessment determined that the SCS complex as a whole, Atlantic sharpnose, bonnethead, and blacknose sharks are not overfished and that overfishing is not occurring (Tables 2.5.3 and 2.5.4). The stock assessment also concluded that finetooth sharks are not overfished, but that overfishing is occurring (Tables 2.5.3 and 2.5.4). Thus, NOAA Fisheries has one year to design a rebuilding plan for finetooth sharks.

Also, in 2002, the Mote Marine Laboratory and the University of Florida conducted a stock assessment for SCS using similar data, but different models. The results were similar in that current biomass levels for Atlantic sharpnose, bonnethead, and blacknose were at least 69 percent of the biomass in 1972 while the current biomass level for finetooth sharks was only 9 percent the level in 1972. Both stock assessments note that the data used for finetooth sharks is not as high a quality as the data used for Atlantic sharpnose due to shorter catch per unit effort (CPUE) and catch series, lack of bycatch estimates, and no catches reported in some years.

Small coastal sharks are targeted in localized fisheries in the southern United States, caught incidentally in other commercial fisheries, and are commonly used for bait. The majority of commercial harvest occurs in the South Atlantic region (57 percent) with gillnets. Finetooth, Atlantic sharpnose, and blacknose sharks comprise most of the commercial landings (34, 24, and 30 percent in 2000, respectively; 42, 27, and 22 percent in 2001, respectively) with bonnethead shark landings less than 12 percent in both 2000 and 2001.

Dusky Shark Status Review

The dusky shark was listed on the Endangered Species Act (ESA) Candidate Species List in 1997 due to its depleted stock status and concern for further stock declines. Inclusion on the Candidate Species List does not have any regulatory impact; it is meant to highlight concern for the species and to encourage proactive conservation measures. In 1999, regulations implementing the HMS FMP added the dusky shark to the prohibited species management group and prohibited possession of the dusky shark in commercial and recreational fisheries; however, a court injunction prevented implementation of the prohibition in commercial fisheries until June 2000. In order for a species to be considered for a proposal for listing as threatened or endangered under ESA, a review of the population status and sources of mortality must be conducted. NOAA Fisheries solicited this status review for dusky sharks, which was completed in 2001.

Data collected by the Florida Museum of Natural History, Commercial Shark Fishery Observer Program (CSFOP) from 1994-2000 in the South Atlantic and off Florida (Atlantic and Gulf regions) were analyzed for catch rates, length frequencies, mortality estimates, and life history parameters. Data collected by a fishery-independent shark monitoring program at the Virginia Institute of Marine Science (VIMS) from 1973-1999 were also analyzed for catch rates, relative abundance, and reproductive parameters.

Length frequency analyses of CSFOP data indicate a distinct shift in catch composition from a widely scattered size distribution in 1994 to catches comprised primarily of sharks less than 110 cm FL (0-2 age classes) in 1999 (Romine *et al*., 2001). VIMS data show a decrease in relative abundance from 1980 to 1992, however recent years (1997 to 2000), have shown an increase in relative abundance. CSFOP catch rate data show an increase from 1974 to 1999, particularly for dusky sharks less than 110 cm FL, although catch rates of sharks greater than 170 cm FL declined over the period. The decrease in catch rates of older mature animals was also seen in the VIMS data. The increase in catch rates of small sharks does not appear to be caused by a shift of the fishery to inshore waters where small sharks are more abundant because depth of set locations increased for the time period (Romine *et al*., 2001).

Hooking mortality increased as shark size decreased with mature dusky sharks (> 230 cm FL) experiencing 37 percent mortality and immature sharks < 110 cm FL experiencing 79 percent mortality. Reproductive data suggest a gestation period of approximately 20-22 months and at least a one-year resting period such that the total reproductive cycle of this species is 3 years (Romine *et al*., 2001).

Canadian Assessment of Porbeagles

An analytical assessment of the porbeagle population in the Northwest Atlantic, with estimates of long-term sustainable yield, was conducted by the Canadian Science Advisory Secretariat in 2001. After an intensive fishery with catch levels of about 4500 tons that collapsed in the 1960s, the fishery appeared sustainable during the 1970s and 1980s when annual landings averaged about 350 tons and the population slowly recovered. Catches of 1000-2000 tons throughout the 1990s appear to have once again reduced population abundance, resulting in very low catch rates and numbers of females. In 1998, an intensive research program was initiated with the support and funding of the shark fishing industry and in collaboration with the Apex Predator Investigation of NOAA Fisheries. Research to date has led to the development of a confirmed growth model, established the presence of a single stock in the Northwest Atlantic, suggested size- and sex-specific migration patterns, determined fecundity and maturity ogives by length and age, revealed highly specific temperature and depth associations, determined diet, and resulted in estimates for a natural mortality rate of 0.10, which increase after sexual maturity (0.20 in females) (Campana *et al.,* 2001).

The current assessment confirms the unsustainability of fishing at $F_{0.1}$ for porbeagles and indicates that a fishing mortality above 0.08 will cause the population to decline. A fishing mortality of 0.04-0.05 is required if the population is to recover. Independent estimates of recent fishing mortality based on Petersen analysis of tag recaptures, Paloheimo Zs, and an age- and sex-structured population model all suggest that F is now about 0.20. A standardized catch rate analysis indicated that the relative abundance of young porbeagle sharks in 2000 was 30 percent of its 1991 level, while the standardized catch rate of mature porbeagles decline to 10 percent of its 1992 level. Current population size appears to be at 10-20 percent of virgin levels. An annual catch of 200-250 tons would correspond to fishing at MSY and would allow population recovery. Annual catches of 400 tons would not allow any population growth, nor room for error in the estimates. The 850 ton catch level of the past two years is close to the MSY of a healthy population. However, the current population is seriously depleted and will require a greatly reduced fishing mortality if recovery is to occur (Campana et al. 2001).

Table 2.5.1 Summary table of the status of the biomass of large coastal sharks. Sources: 2002 LCS stock assessment; E. Cortes, personal communication; L. Brooks, personal communication.

Species	**Current Biomass N_{2001}**	**N_{MSY}**	**Current Relative Biomass Level N_{2001}/N_{MSY}**	**Biomass Target B_{OY} = 125%B_{MSY}**	**Outlook**
Large Coastal Complex	2,940 - 10,156	4,469 - 8,371	0.46 - 1.18	5,586 - 10,464	STOCK IS OVERFISHED. B_{2001}<B_{OY} The majority of the models, including the models not summarized here, indicate that the resource is overfished. Even in the models where the resource is not overfished, the rebuilding target (B_{OY}) has not been met.
Sandbar	1,027 - 4.86 E8	786 - 1.50 E12	3.25 E-4 - 2.22	983 - 1.88 E12	STOCK IS NOT OVERFISHED; REBUILDING IS STILL NEEDED. B_{2001}<B_{OY} The models have conflicting results. These conflicts are due, in part, to the sensitivity of certain models to catch or CPUE series. The Bayesian SPM models and SSLRSG models appear to correspond with each other, have good convergence[2], and fit well with CPUE data. These models generally indicate that the biomass is at or above B_{MSY} levels and below B_{OY} levels.
Blacktip	5,587 - 3.16 E7	3,43 - 1.90 E7	0.79 - 1.66	4,288 - 2.38 E7	STOCK IS NOT OVERFISHED AND IS REBUILT. B_{2001}>B_{OY} The majority of the models indicate that biomass levels exceed B_{MSY} and B_{OY}. Some of the models that were very optimistic had difficulty converging. The other models were sensitive to the catch series.

1 MSC for age structures models is in biomass, not numbers.
2. Convergence indicates that the algorithm has become stable and come to an optimal solution.

Table 2.5.2 Summary table of the status of the fishing mortality on large coastal sharks. Sources: 2002 LCS stock assessment; E. Cortes, personal communication.

Species	**Current F** F_{2001}	**Maximum Fishing Mortality Threshold** MFFT = F_{MSY}	**Current Relative Fishing Mortality Rate** F_{2001}/F_{MSY}	**Fishing Mortality Target** $F_{OY} = 0.75F_{MSY}$	**Outlook**
Large Coastal Complex	0.07 - 0.21	0.05 - 0.10	0.89 - 4.48	0.05 - 0.08	OVERFISHING $F_{2001}>F_{OY}$ The majority of the models indicate that current F levels exceed F_{MSY}.
Sandbar	0.0001 - 0.70	0.05 - 0.46	0.00156 - 2.45	0.03 - 0.34	OVERFISHING $F_{2001}>F_{OY}$ The majority of the models indicate the overfishing is occurring. Most of the models that indicate overfishing also indicated that biomass levels are at or above MSY.
Blacktip	0.01 - 0.21	0.06 - 0.18	0.13 - 1.72	0.04 - 0.14	NOT OVERFISHING $F_{2001}<F_{OY}$ The majority of the models indicate that current fishing rates are below F_{OY}. Most of these models are the same models that indicate biomass levels are above B_{MSY}.

Table 2.5.3 Summary table of the status of the biomass of small coastal sharks. Sources: 2002 SCS stock assessment; E. Cortes, personal communication.

Species	**Current Biomass B_{2001}**	**B_{MSY}**	**Current Relative Biomass Level** **B_{2001}/B_{MSY}**	**Minimum Stock Size Threshold** **MSST = (1-M)B_{MSY} if M<0.5** **MSST = 0.5 B_{MSY} if M>=0.5**	**Minimum Biomass Flag** **Bflag = (1-M)B_{OY}**	**Biomass Target** **B_{OY} = 125%B_{MSY}**	**MSY**	**Outlook**
Sharpnose	72.7 - 73.2	23 - 43.3	1.69 - 3.16	11.5 - 33.4	9.0 - 41.8	28.75 - 54.12	7.8 mill lb dw to 1.9 mill lb dw	Stock not overfished $B_{2001} > B_{OY}$
Bonnethead	12.8 - 13.4	4.6 - 9.2	1.46 - 2.78	2.3 - 7.3	0.8 - 9.2	5.75 - 11.50	1.8 mill lb dw to 0.5 mill lb dw	Stock not overfished $B_{2001} > B_{OY}$
Blacknose	10.4	3.3 - 5.4	1.92 - 3.15	1.6 - 4.5	2.0 - 5.6	4.12 - 6.75	0.8 mill lb dw to 0.2 mill lb dw	Stock not overfished $B_{2001} > B_{OY}$
Finetooth	1.9 - 2.3	0.8 - 1.65	1.39 - 2.37	0.4 - 1.4	0.5 - 1.7	1.00 - 2.06	0.26 mill lb dw to 0.05 mill lb dw	Stock not overfished $B_{2001} > B_{OY}$
SCS aggregate	77.1 - 83.8	32.3 - 60.75	1.38 - 2.39	16.2 - 50.2	12.4 - 62.7	40.38 - 75.94	7.0 mill lb dw to 2.2 mill lb dw	Stock not overfished $B_{20010} > B_{OY}$

Table 2.5.4 Summary table of the status of the biomass of small coastal sharks. Sources: 2002 SCS stock assessment; E. Cortes, personal communication.

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Species	Current F F_{2000}	Maximum Fishing Mortality Threshold MFFT = F_{MSY}	Current Relative fishing Mortality Rate F_{2000}/F_{MSY}	Fishing Mortality Target $F_{OY} = 0.75F_{MSY}$	Outlook
Sharpnose	0.02 - 0.06	0.04 - 0.42	0.14 - 0.42	0.03 - 0.31	Not overfishing
Bonnethead	0.03 - 0.18	0.05 - 0.53	0.35 - 0.56	0.04 - 0.40	Not overfishing
Blacknose	0.02 - 0.19	0.03 - 0.32	0.61 - 0.65	0.02 - 0.24	Not overfishing
Finetooth	0.13 - 1.50	0.03 - 0.44	3.42 - 4.13	0.02 - 0.33	OVERFISHING
SCS aggregate	0.03 - 0.24	0.04 - 0.28	0.24 - 0.78	0.03 - 0.21	Not overfishing but $F_{2000} >= F_{OY}$

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