Atlantic White Marlin Status Review Document

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<u>White Marlin Status Review Team</u>

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Executive Summary

The National Marine Fisheries Service (NMFS) received a petition from the Biodiversity Legal Foundation and James R. Chambers requesting NMFS to list the Atlantic white marlin (*Tetrapturus albidus*) as a threatened or endangered species under the Endangered Species Act (ESA). NMFS convened a status review team (SRT) of experts in pelagic fish biology, fisheries management, and fisheries stock assessment, charged with conducting the status review for Atlantic white marlin. The SRT was asked to assess the species status and the degree of threat to the species with regard to the listing criteria provided in the ESA.

White marlin are managed by the member nations of the International Commission for the Conservation of Atlantic Tunas (ICCAT). By consensus, this group adopts binding recommendations to manage for maximum sustainable catch of the fish stocks under its purview. The U.S. participates in ICCAT-supported stock assessments for white marlin that utilize data from multiple fishing nations. These assessments are conducted by the Standing Committee for Research and Statistics (SCRS), a group of scientists from ICCAT member nations.

The status of the Atlantic white marlin resource has been the subject of a number of quantitative assessments. The most recent assessments were conducted in 2000 and again in May 2002. Basic information available for conducting stock assessments includes time series of fishery landings and discards (for some fleet sectors, over varying periods of years) and trends in commercial and recreational catch per unit of effort (CPUE) as relative indices of stock abundance. Production models are the primary method used in the stock assessments to estimate population size, fishing mortality, and biological reference points.

Atlantic billfish, including white marlin, have historically been landed as the incidental catch of foreign and domestic commercial pelagic longline and purse seine vessels, and in directed recreational and artisanal fisheries. The majority of billfish fishing mortality in the Atlantic Ocean results from pelagic longline fisheries. Total reported landings in the Atlantic for white marlin peaked in 1965 at 4,911 mt. Since the 1970s catches have averaged 1500 mt without trend, while fishing effort has increased substantially. U.S commercial and recreational reported catches (landings plus dead discards) were 63 mt and 42 mt during 1999 and 2000, representing 5 and 4%, respectively, of the total reported Atlantic catch.

Current stock size of Atlantic white marlin is probably 5-15% of carrying capacity (K); biomass is in long-term decline; and fishing mortality rates (F) substantially exceed the level associated with maximum sustainable yield (F_{MSY}). The existing analyses are consistent with recent population sizes of about 200,000 individuals in the size range vulnerable to the fishery. The SRT does not consider the estimates of population decline or current stock size to be consistent with imminent risk of extinction.

To evaluate the possible future condition of the stock, the SRT reviewed model results that provide projections of stock status under varying policy choices regarding F and catch. The most problematic scenario would be status quo or declining recruitment combined with increasing F. The SRT decided that a stock size below 1% of the current estimate of K would warrant ESA protection. Projection results suggest a relatively low probability of the stock declining to 1% of K or lower in the next 10 years, except when scenarios with constant catch, F_{2000} (which does not incorporate any reduction in F as a result of ICCAT recommendation 00-13 requiring each party to reduce white marlin landings by 67%), or higher F values are used. Under the continued F_{2000} scenario, there is less than a 10% chance in 5 years, and about a 20% chance in 10 years, that the stock will reach 1% of K. If recruitment declines or F increases, the likelihood of the stock approaching 1% of K increases.

The SRT recognizes that management measures implemented by the U.S. alone will have a negligible impact on the Atlantic-wide stock. Current measures by ICCAT are not sufficient to prevent continued overfishing. Even with assumptions of full compliance with management measures, no post-release mortality, and no unreported fishing, the stock likely will continue to decline, but not necessarily to high-risk levels. These assumptions are unrealistic as post-release mortality, non-compliance, and illegal, unreported and unregulated fishing occur. ICCAT is currently the only forum in which effective cooperative management action could be taken to reverse this decline. The SRT, however, is concerned about ICCAT's resolve to adopt further, effective management measures for white marlin – a bycatch species – in the immediate future.

The SRT examined the five statutory ESA listing factors relative to white marlin: (1) the present or threatened destruction, modification, or curtailment of its habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) the inadequacy of existing regulatory mechanisms; and (5) other natural or manmade factors affecting its continued existence. The two ESA listing factors of concern for white marlin are overutilization and the inadequacy of existing regulatory mechanisms. White marlin are overfished, and overfishing continues to occur. The SRT does not believe the stock has declined to levels at which it is now in danger of extinction; however, unless fishing mortality is reduced significantly and relatively quickly, the stock could decline to a level that would warrant ESA protection.

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I. Introduction

A. Petition for Endangered Species Act Listing

On September 4, 2001, the National Marine Fisheries Service (NMFS) received a petition from the Biodiversity Legal Foundation and James R. Chambers requesting NMFS to list the Atlantic white marlin (*Tetrapturus albidus*) as a threatened or endangered species, under the Endangered Species Act of 1973 (ESA), throughout its range. The petition also requested that NMFS designate critical habitat for white marlin. The petition contained a detailed description of the species, including the present legal status; taxonomy and physical appearance; ecological and fisheries importance; distribution; physical and biological characteristics of its habitat and ecosystem relationships; population status and trends; and factors contributing to the population's decline. Potential threats identified in the petition included: (1) overutilization for commercial purposes; (2) inadequacy of existing regulatory mechanisms; (3) predation; and (4) other natural or man-made factors affecting the species' continued existence.

On December 20, 2001, NMFS published its determination (66 F.R. 65676) that the petition to list Atlantic white marlin presented substantial scientific or commercial information to indicate that the petitioned action may be warranted and announced the initiation of a formal white marlin status review, as required by section 4(b)(3)(A) of the ESA. At the same time, NMFS requested public comment and solicited additional information that might be useful in conducting the status review. Although the ESA does not provide a petition mechanism to designate critical habitat, NMFS also requested information on areas that may qualify as critical habitat for Atlantic white marlin. The public comment period ran through February 19, 2002.

B. ESA Listing Criteria and Process

The ESA defines an "endangered species" as "any species which is in danger of extinction throughout all or a significant portion of its range." A "threatened species" is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." Section 4(a)(1) of the ESA states that a species is threatened or endangered if any one or more of the following factors causes it to be, or be likely to become, in danger of extinction throughout all or a significant portion of its range: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence.

Having found that listing white marlin *may be* warranted, NMFS is required to make a finding within 12 months (i.e., by September 3, 2002) on whether listing white marlin as endangered or threatened *is* warranted. Section 4(b)(1)(A) of the ESA requires that NMFS make listing determinations based solely on the basis of the best scientific and commercial data available, after conducting a review of the status of the species and after taking into account those efforts, if any, being made by any state or foreign nation to protect the species, whether by predator control, protection of habitat and food supply, or other conservation practices, within any area under its jurisdiction, or on the high seas. If listing as threatened or endangered is found to be warranted, NMFS would be required to publish a proposed regulation to implement the listing.

C. Status Review Team

In order to conduct a comprehensive review, the Southeast Regional Administrator of NMFS, who is charged with conducting the status review for Atlantic white marlin, convened a status review team (SRT) of experts in pelagic fish biology, fisheries management, and fisheries stock assessment. The SRT was asked to assess the species status and the degree of threat to the species with regard to the listing criteria provided by the ESA. This status review document is a summary of the information assembled by the SRT for this status review and incorporates the best available scientific, commercial, and recreational data on Atlantic white marlin. This document addresses the status of the species, the five ESA threatening factors, and the effect of efforts underway to protect the species. The SRT intends that this summary of information and analysis will be useful to NMFS in reaching its finding on whether listing Atlantic white marlin under the ESA is warranted.

The SRT consists of

Dr. Roy E. Crabtree	Florida Fish and Wildlife Conservation Commission, Division of Marine Fisheries, Tallahassee, Fla.
Dr. John E. Graves	Virginia Institute of Marine Science, Gloucester Point, Va.
Dr. Steve Murawski	NMFS, Northeast Fisheries Science Center, Woods Hole, Mass.
Dr. Scott Nichols	NMFS, Southeast Fisheries Science Center, Pascagoula, Miss.
Mr. Gregory Skomal	Massachusetts Division of Marine Fisheries, Oak Bluffs, Mass.
Ms. Jill T. Stevenson	Maryland Department of Natural Resources–Fisheries Service, Annapolis, Md.

Dr. Gerry Scott of the NMFS, Southeast Fisheries Science Center, provided the SRT with invaluable scientific support, particularly with his extensive knowledge of the NMFS and ICCAT data sets and stock assessment approaches. The SRT's work was facilitated and coordinated by Ms. Jennifer Lee and Mr. David Bernhart, NMFS Southeast Regional Office.

The SRT would like to acknowledge the assistance of several scientists who provided information to the team on approaches to evaluating extinction risk in marine species and on population modeling of Atlantic white marlin: Dr. Beth Babcock, Dr. David Die, Mr. John Field, Dr. Phil Goodyear, and Dr. John Musick. The SRT would also like to acknowledge the hundreds of concerned citizens who attended and provided input at the scoping meetings held by NMFS staff to gather additional input and data for this status review.

D. Approach

This Status Review Document begins with a summary of white marlin biology (Section II) and a description of the fisheries and the fishery management and conservation mechanisms affecting white marlin (Section III). Section IV assesses data on the status of the stock and reviews existing analyses of white marlin population dynamics: mostly based on ICCAT stock assessment documents and on papers prepared by U.S. scientists in support of ICCAT. Section V examines the literature of extinction risk criteria and then develops a list of factors that the SRT deemed specifically appropriate for white marlin. Section VI assesses the threats to white marlin under each of the five ESA listing factors. The SRT's analysis of listing factors focuses on the threat of Overutilization, which is assessed against the extinction risk parameters identified by the SRT, and on the threat of Inadequacy of Regulatory Mechanisms, which particularly examines the prospects for effectiveness of ICCAT management and includes population projections to illustrate possible future stock outcomes, based on various management scenarios. The analysis of the effect of conservation efforts for white marlin is included in the discussion of the effectiveness of regulatory mechanisms. Section VII provides a summary and a simplified, tabular description of alternative future conditions which could have the greatest impact on Atlantic white marlin's future status.

II. Natural History of White Marlin

A. Description of the Species

1. Taxonomy (Nakamura, 1985)

Family: Istiophoridae
Order: Perciformes
Class: Actinopterygii

Species: *Tetrapturus albidus* Poey, 1860

Synonymy: *Tetrapturus lessonae* Canestrini, 1861; *Makaira lessonae* Jordan and Evermann, 1926; *Makaira albida* Jordan and Evermann, 1926; *Lamontella albida* Smith, 1956.

2. Physical Appearance (excerpted from Nakamura, 1985)

Diagnostic Features: Body elongate and fairly compressed. Bill stout and long, round in cross section; nape fairly elevated; right and left branchiostegal membranes completely united to each other, but free from isthmus; no gillrakers; both jaws and palatines with small, file-like teeth. Two dorsal fins, the first with 38-46 rays, usually with a rounded anterior lobe, higher than body depth anteriorly, then abruptly decreasing in height to about the 12th dorsal fin ray and gently decreasing further backward; first dorsal fin base long, extending from posterior margin of preopercle to near second dorsal fin origin; second dorsal fin with 5-6 rays, its position slightly backward with respect to the second anal fin; two anal fins, the first with 12-17 rays, the second with 5-6 rays and very similar in size and shape to the second dorsal; pectoral fins long and wide, round-tipped, adpressible against sides of body with 18-21 rays; pelvic fins slender and almost equal to or slightly shorter than the pectorals. Caudal peduncle well compressed (laterally) and slightly depressed (dorsoventrally), with strong double keels on each side and a shallow notch on both the dorsal and ventral surfaces; anus situated just in front of first anal fin origin. Lateral line single and obvious, curving above base of first pectoral fin and then continuing in a straight line above the caudal fin base. Body densely covered with elongate bony scales, each with 1-2 posterior points. Vertebrae 24 (12 precaudal, 12 caudal). Color: Body blue-black dorsally, silvery white splattered with brown laterally, and silvery white ventrally; usually no marks or blotches on body, but sometimes more than 15 rows of obscure whitish stripes. First dorsal fin dark blue with many black dots; second dorsal fin dark blue; pectorals blackish brown, sometimes tinged with silvery white; pelvic fins blue-black with a black fin membrane; caudal fin blackish brown. Maximum size: 280.0 cm TL and 82 kg.

B. Distribution and Habitat

White marlin are found throughout tropical and temperate waters of the Atlantic Ocean and adjacent seas. Unlike blue marlin (*Makaira nigricans*) and sailfish (*Istiophorus platypterus*), white marlin occur only in the Atlantic Ocean. As a pelagic species in the tropics, white marlin usually occur above the thermocline in deep waters (greater than 100m) with surface temperatures above 22° C and salinities of 35 to 37 ppt. However, vertical distribution of white marlin may not be solely a function of temperature (Goodyear et al., 2002). Pop-up archival tags indicate white marlin undertake daily excursions in excess of 150 m (J. Graves, pers. comm.) Although generally considered to be a rare and solitary species relative to the schooling scombrids (tunas), white marlin are known to occur in small groups consisting of several individuals (SCRS, 2001). The longest distance traveled by a tagged and recaptured white marlin (at large for 1.64 years) was 3,150 nautical miles (SCRS, 2000).

Details of habitat types and distributions are found in Amendment 1 to the Billfish Fishery Management Plan, Chapter 4 and are not repeated in this document. Marlin are often associated with rip currents and weed lines, and with steep bottom features such as submarine canyons and shoals (NMFS, 1999). Densities of billfish in the open ocean are likely naturally very low, compared to schooling species (Goodyear et al., 2002).

C. Biological Characteristics

Little is known about the age, growth and reproductive biology of white marlin and, with few exceptions, no quantitative estimates of population parameters for this species exist that can be used in stock assessments (SCRS, 2001). White marlin spawn in tropical and subtropical waters in mid- to late spring, and enter colder temperate waters during the summer (SCRS, 2001). They are considered to be very fast growing, and have a lifespan of at least 17 to 18 years. Female white marlin grow faster and reach a larger maximum size than males. Sexual maturity of females is reached at about 20 kg. Mature females probably spawn more than once a year, likely from March through June in the Northern Hemisphere (NMFS, 1999).

White marlin are generally considered piscivorous, but also have been known to consume squid. The most important items of prey of adult white marlin are squid, herring, dolphinfish (*Coryphaena*), and hardtail jacks (*Caranx crysos*), at least in the Gulf of Mexico and U.S. Atlantic coast (Nakamura, 1985). Likely predators of adults of this species are sharks and killer whales (Mather et al., 1975).

D. Definition of the Stock/Stock Structure

Over the past ten years the Standing Committee for Research and Statistics (SCRS) of the International Commission for the Conservation of Atlantic Tunas (ICCAT) has considered two stock models for white marlin: a two-stock model with distinct North Atlantic and South Atlantic stocks separated at 5º N, and a one-stock or total Atlantic stock model. In 1992 and 1996 the SCRS assessed white marlin as both separate North and South Atlantic stocks, and as a single, total Atlantic stock. It was noted in the report of the 1996 assessment that the working group felt the existing data were consistent with the one-stock hypothesis, but an assessment based on two stocks was conducted as a precautionary approach to management of the species. Based on a consensus of the workshop participants, the SCRS assessments of white marlin in 2000 and 2002 only considered the total Atlantic stock hypothesis. It should be noted that in 1992 and 1996, when both stock models were considered, the relative biomass of the North Atlantic stock was higher than that of the total Atlantic stock.

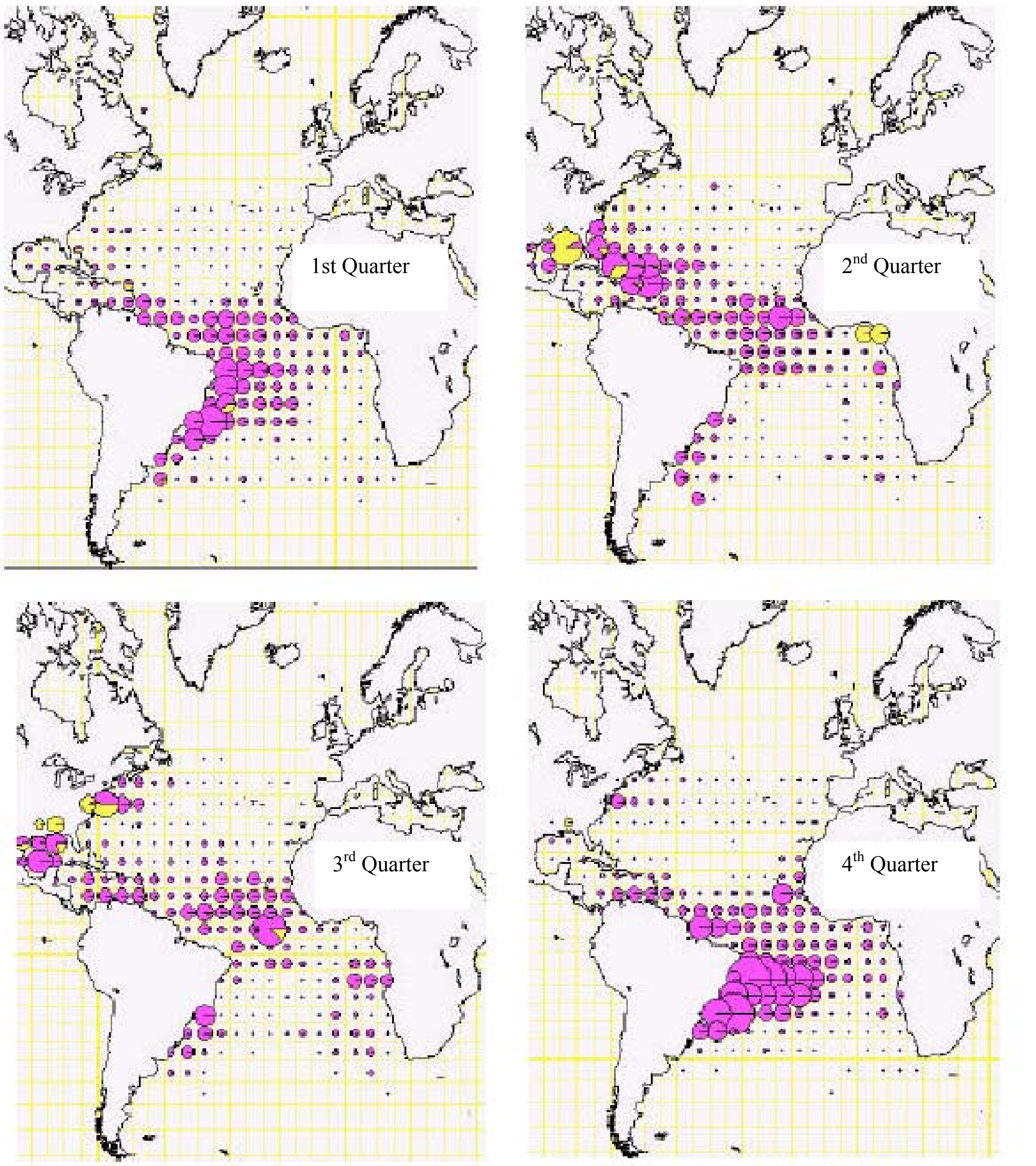
The original evidence supporting the existence of separate North and South Atlantic stocks of white marlin was based on the distribution of catches, information on the location and timing of spawning, and tag/recapture data. The stock boundary of 5º N was chosen primarily because it coincided with ICCAT statistical areas. During the 1970s, much of the international pelagic longline effort in the Atlantic was directed north and south of 5º N (Uozumi and Nakano, 1994), and catches were conveniently allocated into the existing ICCAT statistical areas. Analysis of adult gonadal condition and sporadic catches of putative white marlin larvae indicated that spawning occurred in the North and South Atlantic in each hemisphere's respective spring and summer, and it was considered unlikely that an individual would spawn in both areas. The relative independence of the two putative stocks was supported by preliminary results of tag/recapture studies that provided no evidence of movements of tagged white marlin across 5º N or the equator.

More recently, several lines of evidence have been cited to support the existence of a single, total Atlantic stock of white marlin. An increase in the distribution of longline fishing effort throughout the Atlantic has documented the presence of white marlin across 5º N during all four quarters of the year (Figure 1) (SCRS 2001), and analyses of white marlin CPUE values from the Japanese longline fishery do not reveal a major break between hemispheres (Uozumi and Nakano, 1994). Furthermore, an increase in the number of tag recoveries has demonstrated several trans-Atlantic movements of white marlin, as well as movement across 5º N (Prince et al., in press). While the long distance movements account for a relatively small fraction of reported recoveries, the number of white marlin undertaking such movements may be considerably larger since the likelihood of receiving a tag recovered in a distant water fishery is low. In all, the tagging data suggest a substantial connectivity between white marlin in the North and South Atlantic.

Recent, detailed genetic analysis of white marlin stock structure has provided no evidence to support the existence of distinct North and South Atlantic stocks. Restriction fragment length polymorphism (RFLP) analysis of mitochondrial DNA and analysis of hypervariable nuclear microsatellite DNA loci revealed considerable genetic variation within relatively large samples of white marlin from geographically distant collection locations throughout the Atlantic, but no significant heterogeneity in the distribution of allele frequencies was found between North and South Atlantic samples (Graves and McDowell, 2001). An analysis of molecular variance (AMOVA) demonstrated that essentially all of the variance was due to differences among individuals within a collection. There was no significant difference in allele frequencies among collections taken in the same location in different years, among collections within an ocean basin, or between collections from the North and South Atlantic. This contrasts sharply with significant spatial heterogeneity of allele frequencies observed between geographically distant collections of the closely related striped marlin (*Tetrapturus audax*; Graves and McDowell, 2001).

Evidence for a high degree of connectivity among white marlin throughout the Atlantic is also provided by the impact of U.S. fishery management actions. For more than ten years U.S. pelagic longline fishermen have been required to release all billfish. Since a portion are alive at the time of haulback (44-69%; Jackson and Farber, 1998; NMFS, 1999), this requirement would substantially reduce fishing mortality if, as preliminary evidence suggests, a large fraction of released fish survive (Kerstetter et al., in press). During this same period there has been a move to catch and release fishing of white marlin in the recreational community, with a current release rate in excess of 90% (Goodyear and Prince, 2002). Although there is post-release mortality associated with catch and release recreational fishing, a large fraction of the recreationally-released fish survive (Graves et al., 2002; Domeir and Dewar, in press). Together, one would expect the reduction in fishery mortality of the U.S. commercial and recreational fisheries to result in a local increase in abundance if there were high site fidelity. U.S. CPUE indices for the rod and reel and longline fisheries reveal no such trend. This result is consistent with a lack of stock structure and considerable movement of individual fish.

Figure 1 Geographical distribution of reported catches of white marlin by quarter, combined for all years from 1950 to 1997. (Heavy-shaded areas represent longline catches and light-shaded areas represent gears other than longline.) [reproduced from SCRS, 2001, Figure WHM-1]



The ICCAT SCRS has only considered a single Atlantic-wide stock of white marlin in the two most recent assessments – 2000 and 2002 – citing the continuous distribution of white marlin across 5º N latitude, the results of tag/recapture studies, and the apparent genetic homogeneity of samples from the North and South Atlantic. A single stock hypothesis is most consistent with the existing data. The SRT accepts the single stock hypothesis and uses it for the remainder of this evaluation.

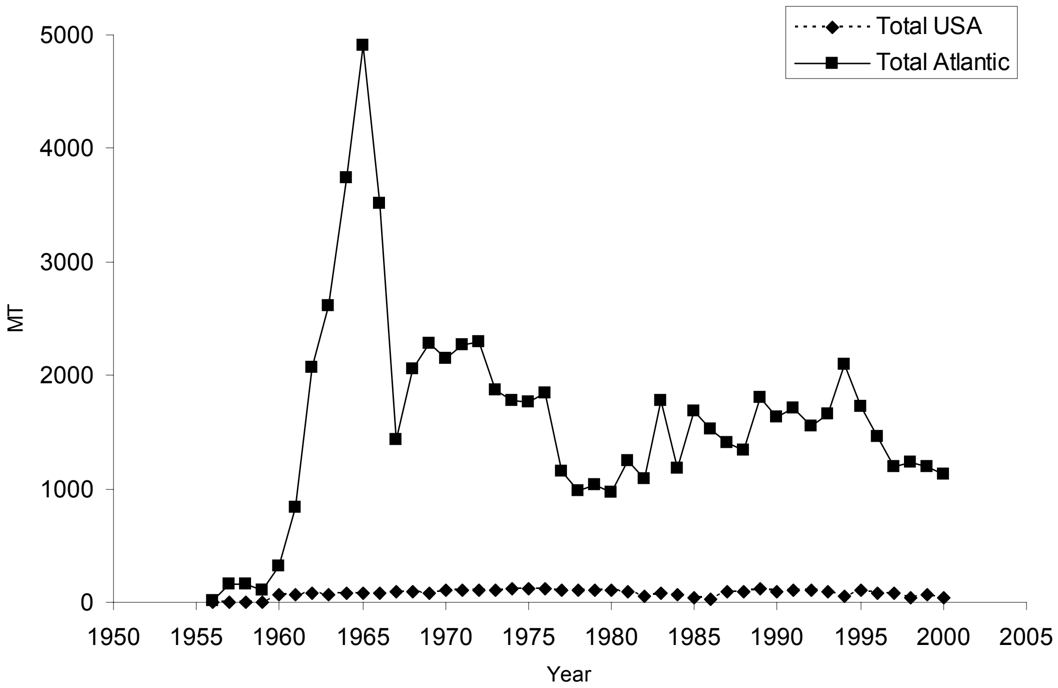
III. Fisheries and Fishery Management and Conservation Mechanisms Affecting White Marlin

A. Description of the Fisheries

1. Overall Fishery and Its International Nature

Atlantic billfish, including the white marlin, have historically been landed as the incidental catch of foreign and domestic commercial pelagic longline vessels, or in directed recreational and artisanal fisheries. Since the majority of billfish fishing mortality in the Atlantic Ocean is part of international commercial pelagic fisheries, billfish catch estimates have risen and fallen with the overall catch estimates for pelagic fisheries (NMFS 1999). White marlin landings in the Atlantic (Figure 2) have followed a fluctuating pattern similar to blue marlin landings (ICCAT 2002). Total reported landings for white marlin peaked in 1965 at 4,911 metric tons (mt), declining to 969 mt by 1980. Over the past 20 years, the landings numbers have fluctuated between 1,130-2,100 mt. In 1999 and 2000, 1,200 and 1,130 mt of white marlin were landed Atlantic-wide, respectively. By comparison, the reported U.S. catch (landings plus dead discards) was 63 mt and 42 mt during 1999 and 2000, representing 5 and 4%, respectively, of the total reported Atlantic catch.

Figure 2. White Marlin Catches (source: ICCAT, 2002)



Atlantic blue marlin, white marlin and sailfish are highly-prized recreational species in the U.S., Venezuela, Bahamas, Brazil and many countries in the Caribbean Sea and west coast of Africa. Several countries also land them for consumption from incidental catches to directed commercial longline fisheries (NMFS, 1999). The directed effort is principally targeted toward tuna species and swordfish. However, billfish occur in the same area as these other pelagic species, making them susceptible to this gear. Billfish tend to be associated more with tuna catches than swordfish because they are largely daylight feeders (NMFS, 1999).

<u>International Catch</u>

White marlin catches have been reported by 27 countries in the Atlantic since 1956 (ICCAT, 2002). Traditionally, ICCAT has collected data by ocean area because of differing exploitation patterns in the North (north of 5° N. lat.) and South Atlantic Oceans. The combined reported catches of white marlin from the Atlantic are shown in Figure 1. It is important to note that, with the exception of those from the U.S., current ICCAT landings estimates do not include dead discards. As is the case for blue marlin, Japan was responsible for nearly 95% of all white marlin caught in the Atlantic Ocean during the 1960s, with a peak white marlin catch of 4,631 mt in 1965 (1,913 mt in the North Atlantic and 2,718 mt in the South Atlantic). In the North Atlantic, 18 countries have reported catches of white marlin, with Chinese Taipei, Japan, Cuba, Venezuela, Korea and the U.S. reporting the highest catches during the 1970s and 1980s. In the 1990s, Chinese Taipei, Venezuela, Spain, Japan, Barbados, and the U.S. provided the greatest catch of white marlin in the North Atlantic. In 2000, EC-Spain (23%), Chinese Taipei (15%), Japan (14%), Venezuela (12%), and the U.S. (8%) reported the highest catches of white marlin in the North Atlantic.

In the South Atlantic, Japan, Korea, Chinese Taipei, Brazil, and Cuba were the most frequent countries of the 20 reporting catches of white marlin in the South Atlantic during the 1970s and 1980s. After Japan reduced catches of white marlin in the South Atlantic in 1973, Korea, Chinese Taipei and Cuba were responsible for nearly 90% of the reported landings. In the 1990s, Brazil, Chinese Taipei, Japan, Korea, and the EC-France/Spain accounted for most white marlin landings in the South Atlantic. In 2000, Chinese Taipei (58%), EC-Spain (11%), Brazil (10%), and EC-France/Spain (9%) landed the most white marlin in the South Atlantic.

In 2000, total Atlantic catches of white marlin were highest for Chinese Taipei (36%), followed by EC-Spain (17%), Japan (8%), EC-France/Spain (8%), Venezuela (6%), Brazil (5%), and the U.S. (4% including commercial discards). Over the period from 1956-2000, U.S. catches were 5% of the total; during 1990-2000 the U.S. contribution to total white marlin catches was similarly 5% (Figure 2).

2. U.S. Commercial Fisheries

Since the early 1900s, the traditional use of Atlantic billfish resources in the waters off the continental U.S. has been in recreational fisheries, with a significant increase in participation after World War II (NMFS, 1999). Until the early 1950s, the fishery was concentrated in only a few areas along the Atlantic and Gulf Coasts. Fisheries in waters off Puerto Rico traditionally included a small-scale, handline subsistence fishery, in addition to a recreational fishery. There have been no directed commercial activities for white marlin, with the exception of a small harpoon fishery that once existed in the waters off southern New England. However, white marlin and other billfishes caught incidentally in commercial fisheries were marketed prior to the late 1980s, and were usually processed and sold as smoked fish product.

In 1988, the South Atlantic Fishery Management Council, in cooperation with the Caribbean, Mid-Atlantic, New England, and Gulf of Mexico Fishery Management Councils, prepared a Fishery Management Plan (FMP) for Atlantic billfish, that prohibited retention, landing, or sale of billfish (including white marlin) caught by commercial fishing vessels in U.S. waters, thereby reserving this resource for recreational anglers. The 1988 FMP required that all Atlantic billfish caught on commercial gear shoreward of the outer boundary of the EEZ must be released "in a manner that will ensure maximum probability of survival," by cutting the line near the hook without removing the fish from the water. These measures are currently in effect under a Secretarial FMP.

<u>Pelagic Longlines</u> (NMFS, 1999)
The U.S. pelagic longline fishery for Atlantic highly migratory species (HMS) primarily targets swordfish, yellowfin tuna, or bigeye tuna in various areas and seasons. Secondary target species include dolphin, albacore tuna, and pelagic sharks including mako and thresher sharks and porbeagle, as well as several species of large coastal sharks. Although this gear can be modified (i.e., depth of set, hook type, etc.) to target either swordfish or tunas, like other hook and line fisheries, it is a multi-species fishery. These fisheries are opportunistic, switching gear style and making subtle changes to target the best available economic opportunity of each individual trip. Longline gear may attract and hook non-target finfish with no commercial value, as well as species that may not be retained by commercial fishermen, such as billfish. Pelagic longlines may also interact with protected species such as marine mammals, sea turtles and sea birds, and have thus been classified as a Category I fishery with respect to the Marine Mammal Protection Act. Any species (or undersized animal of permitted species) that cannot be landed due to fishery regulations is required to be released, whether dead or alive.

Pelagic longline gear is composed of several parts. The primary fishing line, or mainline, can vary from five to 40 miles in length, with approximately 20 to 30 hooks per mile. The depth of the mainline is determined by ocean currents and the length of the floatline, which connects the mainline to several buoys and periodic markers with radar reflectors and radio beacons. Each individual hook is connected by a leader to the mainline. Lightsticks, which contain chemicals that emit a glowing light, are often used. When attached to the hook and suspended at a certain depth, they attract baitfish, which may, in turn, attract pelagic predators. When targeting swordfish, the lines generally are deployed at sunset and hauled in at sunrise to take advantage of the nocturnal near-surface feeding habits of the large pelagic species (Berkeley et al., 1981). In general, longlines targeting tunas are set in the morning, deeper in the water column, and hauled in the evening. Except for vessels of the distant water fleet, which undertake extended trips, fishing vessels preferentially target swordfish during periods when the moon is full to take advantage of increased densities of pelagic species near the surface. A much smaller number of sets target dolphinfish; those sets are made in the daytime near the surface, with shorter longlines and shorter soak time.

Secondary hook and line gear is permitted onboard pelagic longline vessels. Using a technique known as "green sticking," fishermen may use a long pole to extend several longline leaders and hooks behind the vessel. Typically, this line is trolled while hauling the primary gear or while the vessel is moving on the fishing grounds. Many pelagic longliners troll regular rod and reel gear while drifting to determine what species are available in the area they are passing through.

Reported effort, in terms of number of vessels fishing, has fluctuated in recent years but has not shown obvious trends in the distant water, southeast coastal, and northeast coastal areas. However, there appears to be a trend toward decreasing numbers of vessels fishing in the Caribbean and the Gulf of Mexico. In all areas, the reported number of hooks per set has increased. Although swordfish appear to have remained the primary target species in the Caribbean, distant water, and southeast coastal fishery areas, the proportion of swordfish in the reported landed catch has decreased in both the distant water and southeast coastal areas. In the case of the distant water fishery, an increasing proportion of the reported landings consists of yellowfin, albacore, bigeye and/or skipjack tunas. Coastal shark and reported dolphin landings have increased in the southeast coastal area. The largest decreases in targeting and landing of swordfish were in the northeast coastal area (Cramer and Adams, 1998). The Gulf of Mexico, which has historically been primarily a yellowfin tuna fishery, has had an increase in reported targeting and landing of swordfish in recent years (Cramer and Scott, 1998).

The pelagic longline fishery sector is comprised of five relatively distinct segments with different fishing practices and strategies, including: the Gulf of Mexico yellowfin tuna fishery, the south Atlantic-Florida east coast to Cape Hatteras Swordfish fishery, the mid-Atlantic and New England swordfish and bigeye tuna fishery, the U.S. distant water swordfish fishery, and the Caribbean Islands tuna and swordfish fishery. Because of restrictive measures implemented in the U.S. pelagic longline fishery in the last several years, these fleets have somewhat evolved to stay in business and maximize market opportunities. The following descriptions (based on NMFS, 1999) may be somewhat outdated but provide the most comprehensive published description of the fishery to date. Each vessel type has different range capabilities due to fuel capacity, hold capacity, size, and construction. In addition to geographical area, segments differ by percentage of various target and non-target species, gear characteristics, bait, and deployment techniques. Some vessels fish in more than one fishery segment during the course of the year.

<u>The Gulf of Mexico Yellowfin Tuna Fishery</u>
These vessels primarily target yellowfin tuna year-round. However, each port has one to three vessels that direct on swordfish either seasonally or year-round. Longline fishing vessels that target yellowfin tuna in the Gulf of Mexico also catch and sell dolphin, swordfish, and other tunas and sharks. During yellowfin tuna fishing, few swordfish are captured incidentally. Many of these vessels participate in other Gulf of Mexico fisheries (targeting shrimp, shark, and snapper/grouper) during allowed seasons. Major homeports for this fishery include Panama City, Florida; Destin, Florida; Dulac, Louisiana; and Venice, Louisiana.

<u>The South Atlantic - Florida East Coast to Cape Hatteras Swordfish Fishery</u>
These pelagic longline vessels primarily target swordfish year-round. Yellowfin tuna and dolphin are other important marketable components of the catch. Until the area was closed to longlining, smaller vessels fished shorter trips from the Florida Straits north to the bend in the Gulf Stream off Charleston, South Carolina (Charleston Bump). Mid-sized and larger vessels migrate seasonally on longer trips from the Yucatan Peninsula throughout the West Indies and Caribbean Sea and some trips range as far north as the mid-Atlantic coast of the U.S. to target bigeye tuna and swordfish during the late summer and fall. Fishing trips in this fishery average nine sets over 12 days. Major homeports (including seasonal ports) for this fishery include Georgetown, South Carolina; Cherry Point, South Carolina; Charleston, South Carolina; Fort Pierce, Florida; Pompano Beach, Florida; Dania, Florida; and Key West, Florida. This sector of the fishery consists of small to mid-size vessels that typically sell fresh swordfish to local high-quality markets.

<u>The Mid-Atlantic and New England Swordfish and Bigeye Tuna Fishery</u>
This fishery has evolved during recent years to become an almost year-round fishery based on directed tuna trips, with substantial numbers of swordfish trips as well. Some vessels participate in the directed bigeye/ yellowfin tuna fishery during the summer and fall months and then switch to bottom longline fisheries and/or shark fishing during the winter when the shark season is open. Fishing trips in this fishery sector average 12

sets over 18 days. During the season, vessels primarily offload in the major ports of Fairhaven, Massachusetts; Montauk, New York; Barnegat Light, New Jersey; Ocean City, Maryland; and Wanchese, North Carolina. Some of these vessels follow the swordfish along the mid-Atlantic coast, then fish off the coast of the southeast U.S. during the winter months.

The U.S. Atlantic Distant Water Swordfish Fishery

This fleet's fishing grounds range virtually the entire span of the western North Atlantic to the Azores and the mid-Atlantic Ridge. About ten larger vessels operate out of mid-Atlantic and New England ports during the summer and fall months, and move to Caribbean ports during the winter and spring months. Many of the current distant water operations were among the early participants in the U.S. directed Atlantic commercial swordfish fishery. These larger vessels, with greater ranges and capacities than the coastal fishing vessels, enabled the U.S. to become a significant player in the North Atlantic fishery. They also fish for swordfish in the South Atlantic. The New England longline vessels traditionally have been larger than their Florida counterparts because of the distances required to travel to the fishing grounds. The larger sized vessels allow more time at sea. A typical New England longline vessel generally ranges from 60 to 80 feet in length, and fishes off New England in the summer and fall. As winter approaches, these vessels work southward. Fishing trips in this fishery tend to be longer than in other fisheries, averaging 30 days and 16 sets. Principal ports for this fishery range from San Juan, Puerto Rico through Portland, Maine, and include Fairhaven, Massachusetts and Barnegat Light, New Jersey. There have been approximately ten to fifteen distant water vessels in recent years, reduced from a peak of 60 to 70 vessels in the late 1980s and early 1990s. Some large vessels have moved to other oceans to fish for HMS or have re-flagged.

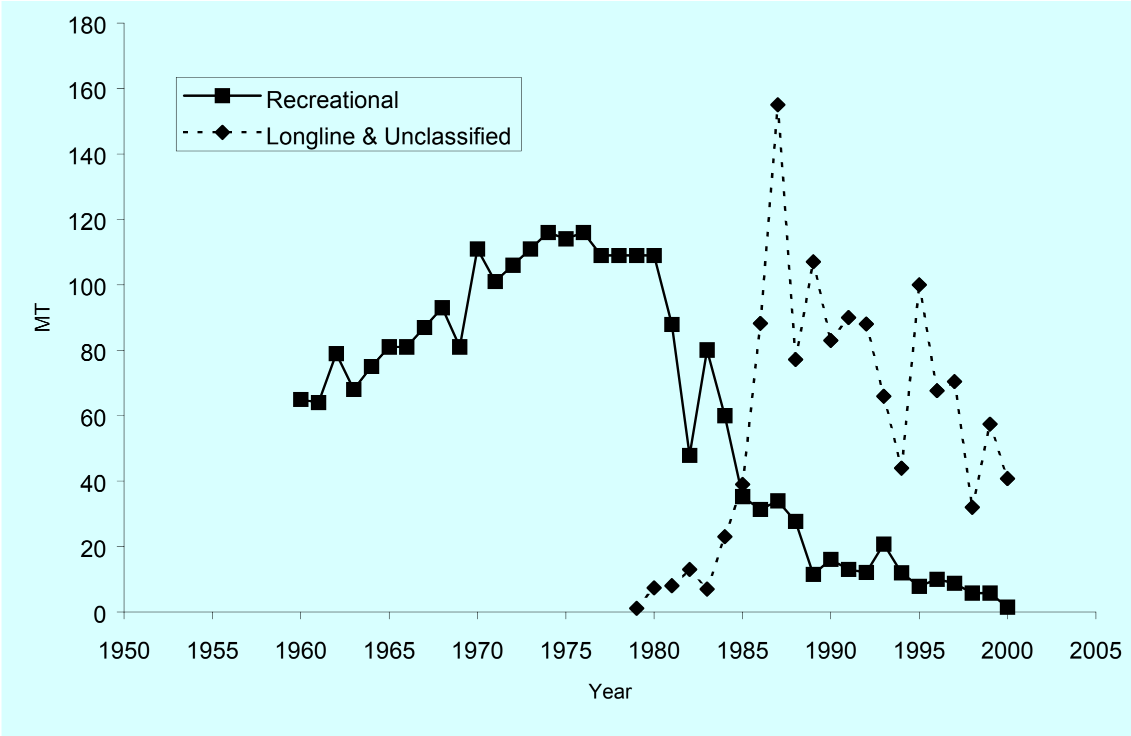
The Caribbean Tuna and Swordfish Fishery

This fleet is similar to the southeast coastal fishing fleet in that both are comprised primarily of smaller vessels that make short trips relatively near-shore, producing very high quality fresh product. Both fleets also encounter relatively high numbers of undersized swordfish at certain times of the year. Longline vessels targeting HMS in the Caribbean set fewer hooks per set, on average, fishing deeper in the water column than the distant water fleet off New England, the northeast coastal fleet, and the Gulf of Mexico yellowfin tuna fleet. This fishery is typical of most pelagic fisheries, being truly a multi-species fishery, with swordfish as a substantial portion of the total catch. Yellowfin tuna, dolphin and, to a lesser extent, bigeye tuna, are other important components of the landed catch. Principal ports are St. Croix, U.S. Virgin Islands and San Juan, Puerto Rico. Many of these high quality fresh fish are sold to local markets to support the tourist trade in the Caribbean.

Commercial Catch and Landings

The billfish FMP management measures have resulted in regulatory dead discards of white marlin in the pelagic longline fishery since 1988. Billfish bycatch in the U.S. longline fleet has been estimated using data from mandatory pelagic logbooks. Observer data are used to scale logbook-reported encounters to provide a more accurate assessment of billfish bycatch. Estimates of white marlin dead discards in the U.S. commercial longline fishery peaked in 1989 and 1995 at 107 mt and 100 mt, respectively, but were 57 mt in 1999 and 41 mt in 2000 (Figure 3). Total Atlantic white marlin catch is compared to the U.S. landings estimates in Figure 2. The U.S. contribution to total white marlin fishing mortality has ranged 3-7% since the FMP. In 1999 and 2000, the U.S. proportion of the catch was 5% and 4%, respectively.

Figure 3. U.S. commercial and recreational catch of white marlin. Commercial possession of marlin has been prohibited since 1988, so commercial data represent landings and discards, prior to 1988, and dead discards from 1988 on.



3. U.S. Recreational Fisheries (NMFS, 1999)

Billfish angling has a long history in the U.S., and the first reported marlin was landed in 1903 (Gillis and Ditton, 1998). Billfish anglers are a small constituency compared to other marine or freshwater angler groups (Ditton and Stoll, 1998). Ditton (1996) described typical participants in billfish angling as white males in their forties, highly educated, with high annual household incomes; billfish anglers tend to fish twice as frequently as those targeting other saltwater species. These results are similar to those found by Maiolo (1990) from a survey of U.S. billfish anglers participating in tournaments along the east coast, Gulf of Mexico and Caribbean (Puerto Rico and Bahamas). Most recreational anglers consider themselves to be strong advocates for conservation of Atlantic billfish resources.

Conservation of Atlantic billfish resources was a primary objective of the 1988 Atlantic Billfish FMP in order to maintain the highest availability of billfish to the U.S. recreational fishery. The FMP set minimum size limits for the recreational retention of Atlantic billfish species including a 62 inches lower jaw fork length (LJFL) for white marlin. A March 24, 1998 (63 FR 14030) interim rule increased the minimum sizes for billfish, including an increase to 66 inches LJFL for white marlin. The interim rule was extended September 29, 1998, (63 FR 51859). Complete current billfish regulations may be found at 50 CFR 635. There are currently no bag limits for white marlin in the recreational fishery. The recreational fishing community has actively encouraged its members to release their live billfish catches to better conserve the resource for future anglers. Goodyear and Prince (2002) estimated that 99% of all white marlin caught by U.S. anglers in 2000 were released.

In the U.S., Atlantic blue marlin, white marlin, west Atlantic sailfish, and longbill spearfish can be landed only by recreational fishermen fishing from either private or charterboats. Ditton and Stoll (1998) reported, based on a 1991 survey, that 230,000 anglers in the U.S. spent 2,136,899 days fishing for various billfish species. They noted that the ten states with the highest number of billfish anglers were: 1. Florida (159,575); 2. California (31,162); 3. North Carolina (30,071); 4. Hawaii (26,588); 5. Texas (23,714); 6. New Jersey (17,687); 7. New York (12,671); 8. South Carolina (N/A); 9. Maryland (9,959); and 10. Delaware (8,666).

<u>Recreational Fishing Gear (NMFS, 1999)</u>
Sport fishing for Atlantic billfish on private recreational and charterboats is done with rod and reel, often with multiple rigs trolled simultaneously. The sportfishing gear used for billfishes is generally more expensive than

that used for other recreational marine species. Atlantic white marlin are often caught using multiple hook artificial lures that are trolled at high speeds relative to other pelagic fisheries. In the northern part of its range (southern New England), white marlin may be baited (with live or dead bait) while swimming at the surface. Atlantic billfish caught with high-speed lures are generally hooked around the mouth/bill area, which enhances the release survival rate. Natural baits are generally pulled at a slower speed or cast and can be swallowed by billfish, resulting in a gut-hooked fish. The white marlin fishing season generally begins in May, although tournaments in warmer-water areas (e.g., Bahamas) will start in March. Marlins move up along the coast of the U.S. as waters warm during the summer, with relatively more white marlin traveling farther north to be caught off mid-Atlantic and southern New England during July to September. The Atlantic marlin season generally ends by October for the continental U.S., but fish are still caught in the warm Caribbean waters off Puerto Rico and the U.S. Virgin Islands.

The 1988 Atlantic Billfish FMP noted that boats used in the U.S. sport fishery for billfishes range from 16 feet to more than 65 feet in length, powered with outboard engines to large diesels. Lucy et al. (1990), describing the fleet characteristics in Virginia's recreational marlin-tuna fishery, found that boats averaged 28 feet in length, with charter vessels averaging 37 feet, and private boats averaging 26 feet in length. Fishing for blue marlin and white marlin generally requires a larger vessel with inboard engines because of the distance needed to travel to reach the fishing grounds. Trips in excess of 100 miles from the shore may be required to reach primary fishing areas. In some geographical areas, where deep waters are closer to shore, vessels of all sizes targeting white marlin can be found. This is particularly evident off the southeast coast of Florida, northern Gulf of Mexico, and the Caribbean (Puerto Rico and U.S. Virgin Islands). The development of more reliable engines, electronic devices (e.g., GPS, cellular phones, and satellite-based communications), and new vessel designs has made offshore fishing grounds accessible to more anglers in a greater variety of vessel sizes.

Recreational angling for Atlantic billfish can be sub-divided into tournament and non-tournament trips. The number of vessels ranges from 5 to 150 per tournament, with the number of anglers ranging from 10 to 1,000 per tournament. Fisher and Ditton (1992) completed an extensive mail survey of 1,984 billfish tournament anglers, and estimated that there were 7,915 U.S. tournament billfish anglers in the western Atlantic Ocean during 1989. The participants in the billfish fishery from their study were generally college-educated males, with a mean age of 46, median household income of $115,000 and more than 11 years of experience fishing for billfish.

There are approximately 300-400 billfish tournaments per year along the U.S. Atlantic coast (including the Gulf of Mexico and Caribbean). Offshore fishing tournaments target blue marlin, with other categories for white marlin, sailfish, tuna (generally yellowfin tuna), dolphinfish, and wahoo (*Acanthocybium equiselis*), generally by high-speed trolling. Billfish tournaments may range from small club series tournaments to high profile tournament events that are characterized by large vessels and big prizes. Tournament entry fees range from $20 to $8,000, with the high-profile events being the most expensive. Fisher and Ditton (1992) found the average tournament fee in 1989 was $546. Additional estimated expenditures of $1,600 per angler per tournament, included loading, boat operation, food, bait and tackle, transportation, and captain/charter fees. Cash prizes range from $20 to more than $100,000. Other prizes may include Rolex watches, fishing equipment, and boats. Tournaments can also involve a calcutta, which generally consists of pool contributions from a group of tournament participants. The calcutta is subsequently won by a member of the group who catches-and-releases or lands the largest or most fish.

Sport fishing for white marlin and other billfishes on private recreational and chartered vessels is conducted in nearly all warm water ocean areas, generally in relatively deeper waters of tropical and subtropical areas. The recreational U.S. Atlantic billfish fishery is concentrated from Massachusetts to North Carolina, southeast Florida, the northern Gulf of Mexico and the Caribbean (including Puerto Rico and the U.S. Virgin Islands), depending upon the species and season. White marlin are available to the recreational sport fisheries in the Gulf of Mexico from June into October, with peak abundance in the northern Gulf in July and August (Browder and Prince, 1990). The northeastern limit of the summer coastal occurrence of white marlin is off Nantucket and Martha's Vineyard Islands, south of Cape Cod, MA. Spring is the peak season for sport fishing for white marlin in the Straits of Florida, Bahamas, Puerto Rico and the Virgin Islands. Most of the recreational fishing effort for billfish along the U.S. Atlantic coast, Gulf of Mexico, and in the Caribbean Sea is concentrated either around key ports, fishing centers, or billfish tournaments (Prince et al., 1990), in relatively deep waters from 120 ft to 6,000 ft (Lucy et al., 1990).

Recreational Catches and Landings

There is currently no individual or vessel permit requirement for U.S. recreational boats that target Atlantic billfish, except for those required by states. NMFS recently proposed a permit requirement for all recreational fishermen fishing for any Atlantic highly migratory species (67 FR 20176, April 26, 2002).

Recreational catches (fish hooked and either released or retained) and landings (fish killed and brought back to shore) of billfish from private and charterboats are difficult to accurately assess because billfish are relatively rare in comparison with other species targeted by marine anglers, and because there are relatively few billfish fishermen relative to the vast number of marine recreational anglers (NMFS, 1999). These characteristics challenge the use of traditional recreational angler surveys for monitoring billfish catches. Recreational landings of billfish by U.S. billfish anglers are estimated by a combination of billfish tournament intercepts, mandatory reporting by tournaments selected by NMFS, the Large Pelagic Survey, and the Marine Recreational Fishery Statistics Survey (MRFSS). The total reported recreational landings for white marlin are summarized in Figure 3. Recreational landings of white marlin peaked in the mid 1970's at 116 mt, then declined through the next two decades to a low of 2 mt in 2000 (Goodyear and Prince, 2002).

Fisher and Ditton (1992) estimated that there were 7,915 U.S. tournament billfish anglers in the western Atlantic Ocean during 1989, making a total of 102,895 billfish fishing trips (90% confidence interval = 6,512), including tournament and non-tournament participation. In 1989, these trips resulted in an estimated 42,301 billfish caught, consisting of 38% sailfish, 33% blue marlin, 29% white marlin, and less than 1% spearfish. They estimated that 5,541 billfish were landed (90% confidence interval = 715); of billfish landed, 59% were blue marlin, 24% were white marlin, 15% were sailfish, and approximately 2% were spearfish. In their survey targeting anglers who participate in billfish tournaments, Fisher and Ditton reported that anglers make an average of 13 billfish trips per year. The number of trips over the survey year varied by region, with the maximum number taken in the Caribbean (17.3 per year), and the least in the Gulf of Mexico (8.7 trips per year). Billfish trips averaged 2.6 days, with each angler, on average, landing less than one billfish each year. The success rate also varied among regions. The highest number of successful trips taken during the year of the survey, relative to the total number of trips taken, was in the mid-Atlantic region (45% of trips resulting in the catch of a billfish). Recreational billfish trips in the Gulf of Mexico were the least successful, with approximately 28% of trips resulting in the catch of a billfish. A total of 71% of the 1,171 anglers responding in the Fisher and Ditton study indicated that they did not land a billfish during the year of the survey, therefore 29% of anglers accounted for all angler-induced mortality. During 1989, it took an average of 6.3 days of fishing to boat a billfish. Mid-Atlantic anglers caught the most billfish per angler, and had the highest release rate (95%) and lowest retention rate per angler. Gulf of Mexico anglers caught the fewest billfish per angler (0.83). Caribbean anglers had the highest retention rate per angler.

Goodyear and Prince (2002) present MRFSS estimates for white marlin for the period of 1981-2001. Annual recreational white marlin catch (including releases) for this period ranged from 249 to 39163 animals and the proportion released ranged 0-100%. In 1999 and 2000, the survey estimated that 3,650 and 7,748 white marlin were caught by recreational anglers with 98 and 99% released, respectively.

4. Post-Release Mortality

NMFS regulations implementing the Atlantic billfish FMP require the release of all white marlin and other billfishes by commercial fishermen. In addition, minimum sizes and have been imposed on the recreational fishing community, which is estimated to release over 90% of the white marlin caught in recent years. These regulations coupled with a strong conservation ethic result in the release of thousands of white marlin annually by domestic fisheries. Moreover, recent ICCAT resolutions and recommendations call for the reduction of white marlin landings and the release of live white marlin by Contracting Parties (ICCAT 96-9, 97-9, 98-10, 00-13). If compliance is attained, these measures will result in high numbers of white marlin being released by international fisheries as well.

Little is known of the post-release mortality associated with the capture of highly migratory species. Evidence from NMFS Cooperative Tagging Programs shows a higher recapture rate for sharks (4%) (N.E. Kohler, NEFSC, NMFS, pers. comm.) than billfish (2%) (Prince et al., 2002). Although tag shedding, emigration, stock size, reporting failure, and natural mortality can contribute to low recapture rates, mortality associated with capture stress (physical and physiological) cannot be discounted.

Post-release mortality can dramatically affect landings estimates. For example, Goodyear and Prince (2002) present the MRFSS estimate of 7,723 white marlin released in 2000 by the U.S. recreational sector. Using a mean weight of 28.74 kg (Goodyear and Prince, 2002), a hypothetical 15% mortality rate would translate to 33 mt in post-release mortality for the recreational fishery, a significant increase from the 2 mt in landings currently reported to ICCAT. Similarly, a proportion of white marlin released alive by the U.S. commercial longline industry does not survive. Estimates from U.S. observer data and the Venezuelan longline fishery indicate that 69% and 44% of marlin caught, respectively, were released alive (NMFS, 1999; Jackson and Farber, 1998), but U.S. commercial catch reports to ICCAT do not include estimates of the live-released white marlin that subsequently die. Moreover, post-release mortality estimates must be realized for the total Atlantic, but the number of white marlin released by international commercial and recreational fisheries is presently unknown. It is important to note that estimates of white marlin post-release mortality have not been incorporated into ICCAT landings estimates to date.

The magnitude of post-release mortality in terms of dead fish depends on the mortality rates associated with each fishery. Unfortunately, statistically sound estimates of post-release mortality rates are lacking for the white marlin. Survivorship and post-release recovery of pelagic fishes has been directly observed with acoustic telemetry, which may provide preliminary estimates. However, acoustic tracking studies are generally designed to investigate behavior in a species and not to evaluate or quantify post-release mortality. Therefore, these studies may not reflect valid estimates of post-release mortality because of low sample size, short tracks, and the selective use of healthy fish. An analysis of published acoustic tracking data yields estimates ranging 0-50% for the blue marlin, depending on the study (Yuen et al., 1974; Holland et al., 1990; Block et al., 1992; Edwards, 1995). When the tracks are pooled (n=23), this results in a mortality rate of 13-26% for blue marlin taken on recreational fishing gear. Holts (1990) found no mortality in 12 striped marlin taken on recreational fishing gear and tracked off the coast of California. Jolley and Irby (1979) had a single mortality during eight acoustic tracks of Atlantic sailfish, resulting in a mortality rate of 12.5%. Pepperell and Davis (1999) also experienced a single mortality while tracking six black marlin (*Makaira indica*) taken on sportfishing tackle, resulting in a 17% mortality estimate. The only study to acoustically track a billfish species captured on commercial longline gear was conducted by Brill et al. (1993) on striped marlin. During this study, six fish were tracked and one died, resulting in a 17% mortality rate. Billfish mortality in all the aforementioned studies was largely attributed to sharks.

Only a single acoustic tracking study has been conducted on white marlin. Skomal and Chase (2002) conducted a study to quantify the physiological effects of recreational angling on post-release survivorship in a number of highly migratory species, including the white marlin. The results of this study indicate that white marlin that had longer than average fight times experienced significant physiological perturbations, yet survived short-term acoustic tracks. However, the low sample size (five fish total and two acoustic tracks) limits the utility of this study.

New developments in high-tech archival tagging may provide future estimates of post-release survivorship for highly migratory species. Recently, pop-up satellite archival tags (PSATs) have been employed to evaluate the behavior of billfishes after capture, and these studies provide rough estimates of post-release mortality. Graves et al. (2002) deployed PSATs on 9 blue marlin captured in the recreational fishery off Bermuda. The tags recorded water temperature and tag inclination, and were programmed to release from the fish after a period of 5 days. Eight of the 9 tags reported, and based on net displacement, water temperature, and inclinometer data, it was inferred that those 8 fish survived for at least 5 days after release. If one assumes that the non-reporting tag was due to mortality rather than a tag failure, the data indicate a post-release mortality of 11% for blue marlin in the Bermuda recreational fishery. The same technology was employed by Kerstetter et al. (in press) to evaluate post-release behavior of blue marlin released from the pelagic longline fishery. Seven tags with release times of 5 days, and 2 tags with release times of 30 days were deployed. Five of the seven 5-day tags reported, as did both 30-day tags. The net displacement, water temperature, and inclinometer data were consistent with survival of the 7 individuals for periods of 5-30 days. If one conservatively attributes the non-reporting tags to mortality rather than tag failure, post-release mortality of blue marlin released from pelagic longline gear was 22%.

Domeir and Dewar (in press) have attached PSATs to striped marlin, a species closely related to white marlin. Striped marlin were caught on recreational gear using live baits off Baja California, Mexico. Forty animals were tagged in each of two years. A relatively high number of mortalities was observed, although almost all of the tags were released prematurely. Post-release mortality estimates of 16-31% were noted over the two years of the study.

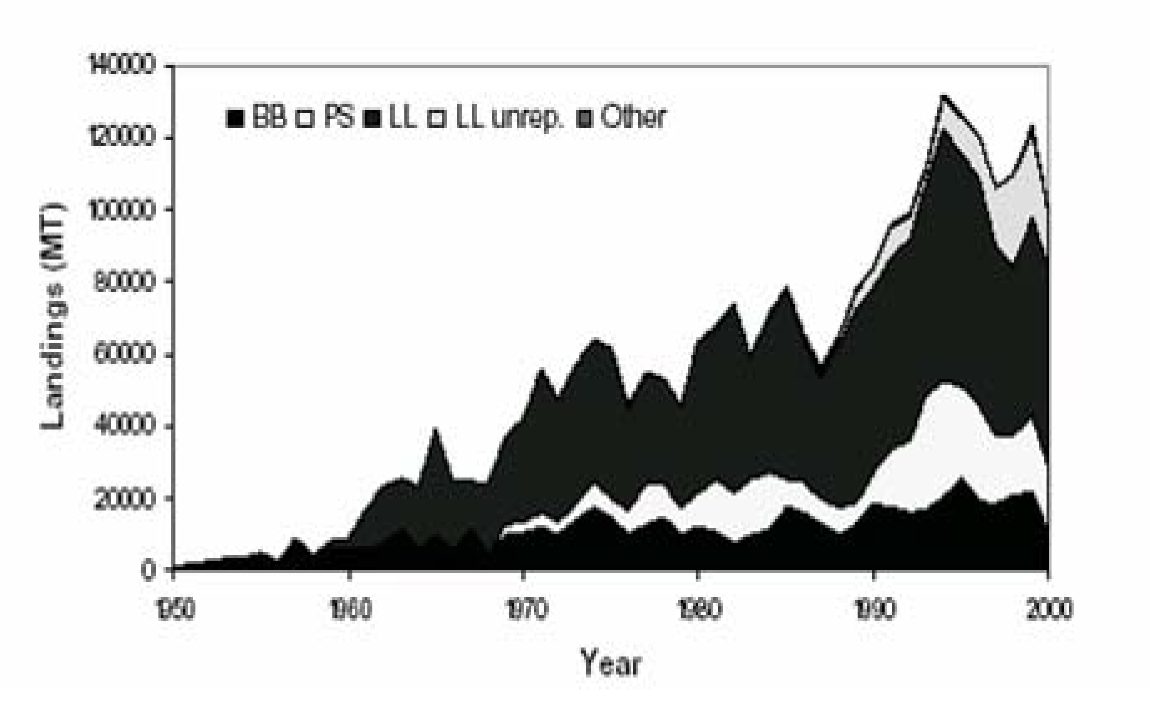
Graves et al. (unpublished data) deployed 5 PSATs on white marlin taken on recreational gear off the Dominican Republic in May of 2002. Fight times for most individuals were much longer than normal as it was difficult to position the animals close to the vessel to attach the tags. Two of the 5 tags, which were programmed to release after 5 days, detached 2 days early (one after 2.5 days, one after 4 days), but activity patterns were consistent with survival of both individuals. One mortality was evident among the 3 individuals who retained tags for the 5-day duration: a fish that was fought for more than an hour and 15 minutes on light tackle before release. Six white marlin were tagged with PSATs and released from pelagic longline gear in June and July 2002. Two PSATs programmed to pop-off after 5 days transmitted, and the net displacement, temperature, and inclination data were consistent with survival for those 2 fish. Two of 3 tags set to pop-off after 30 days have transmitted and the data are consistent with survival (Graves, unpublished data).

Goodyear (1999) provided an analysis of the use of satellite tagging technology to estimate post-release mortality. He states that "each experiment will only estimate the release mortality rate for the species and gear and fishing method employed in the fishery studied" and that "individual experiments should employ a minimum of 100 tags." Therefore, additional studies are needed to derive valid estimates of post-release mortality rates in billfishes, but existing data are consistent with relatively low levels of post-release mortality.

5. Unreported Fishing

Illegal, unreported, and unregulated (IUU) fishing activities affecting tunas and tuna-like fishes, including marlins, in the ICCAT convention area have been a source of concern within ICCAT for many years. The Commission has adopted several Recommendations to attempt to combat this activity and continues to seek ways to eliminate this fishing. Although direct estimates of IUU catches are seldom available, monitoring of import and export statistics has been used to identify IUU catches for certain species of Atlantic tunas. As an example, estimated catches of Atlantic bigeye tuna that have been attributed to IUU fishing based on Japanese market statistics have been increasing substantially in recent times, as ICCAT adopts regulations intended to reduce catch levels and promote rebuilding of the bigeye resource (Figure 4, reproducing bigeye tuna figure BET-3 from SCRS [2001]). This estimated volume of IUU fishing now represents up to about one-quarter of the total estimated removals of bigeye tuna from the Atlantic. As species such as white marlin are taken as bycatch in fisheries harvesting bigeye, there are likely IUU catches of white marlin (and other species).

Figure 4. Landings of bigeye tuna in the Atlantic by gear categories: baitboat (BB), purse seine (PS), other, longline (LL), and unreported longline (LL unrep.).



B. Existing Fishery Management and Regulatory Authorities

1. International Authorities

a. ICCAT

White marlin are managed in the Atlantic Ocean by the member nations of the International Commission for the Conservation of Atlantic Tunas (ICCAT). By consensus, this group adopts binding recommendations to manage for maximum sustainable catch of the fish populations under its purview. The conservation and management recommendations of ICCAT include, but are not limited to, total allowable catches, sharing arrangements for member countries, minimum size limits, effort controls, time/area closures, trade measures, and monitoring and inspection programs. Meetings are held annually and the U.S. negotiating platform is developed by NMFS and the State Department, in conjunction with ICCAT Commissioners that represent recreational and commercial industries. In addition, the ICCAT Advisory Committee, comprised of interested U.S. citizens, provides advice to NMFS on matters regarding international management of these species. The U.S. platform at ICCAT is finally established through discussions between NMFS, U.S. Dept of State, and the ICCAT Commissioners and does not include public input at that stage. As with all foreign policy negotiating, U.S. negotiators have the latitude to identify priorities among species while still pursuing U.S. conservation goals.

b. United Nations Convention on the Law of the Sea (UNCLOS)

On December 4, 1995, the U.S. signed the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea (U.N. Agreement) relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks. The U.N. Agreement has its origins in Agenda 21, the detailed plan of action adopted by the 1992 U.N. Conference on Environment and Development. It builds upon certain fisheries-related provisions of the 1982 U.N. Convention on the Law of the Sea, and reaffirms the central role of the Convention as the accepted foundation and framework for this critical body of international law. While all States have the right to engage in fishing on the high seas, the Convention qualifies this right with the duty to conserve high seas resources and to cooperate with other States in conservation efforts. In fulfillment of these obligations, multilateral fishery agreements and organizations such as ICCAT have been established to conserve and manage high seas fisheries.

The U.N. Agreement is designed to strengthen and make more specific the provisions of the Convention, and back the provisions with effective enforcement techniques and compulsory dispute settlement. This should give the international community mechanisms to reverse overfishing trends and create an opportunity to ensure sustainable marine fisheries. The U.N. Agreement sets forth general principles for fishery conservation and management, including obligations to ensure the long-term sustainability of these stocks; take measures that are based on the best scientific information available; assess relevant environmental impacts; adopt conservation and management measures for other stocks belonging to the same ecosystem; minimize catch of non-target species; and take measures to prevent or eliminate overfishing and excess fishing capacity. UNCLOS does not have specific authority for technical species-specific management but rather defers to regional fishery management organizations.

2. Domestic Authorities

U. S. vessels fishing for or encountering Atlantic HMS are managed by NMFS, acting for the Secretary of Commerce, under the dual authority of the Atlantic Tunas Convention Act (ATCA) and the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act).

a. Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Act establishes the authority and responsibility of the Secretary of Commerce to develop fishery management plans and subsequent amendments for Atlantic HMS. The Magnuson-Stevens Act requires NMFS to allocate both overfishing restrictions and recovery benefits fairly and equitably among sectors of the fishery. Fisheries managed under an international agreement, such as HMS, must reflect traditional participation in the fishery, relative to other nations, by fishermen of the U.S. The Magnuson-Stevens Act specifies that NMFS must provide fishing vessels of the U.S. with a reasonable opportunity to harvest any allocation or quota of an ICCAT species to which the U.S. has agreed. The FMP or amendment to such a plan must specify a time period for ending overfishing and rebuilding the fishery that shall be as short as possible, taking into account the status and biology of the stock of fish, the needs of fishing communities, recommendations by international organizations in which the U.S. participates, and the interaction of the overfished stock within the marine ecosystem. The rebuilding plan cannot exceed ten years, except in cases where the biology of the stock of fish, other environmental conditions, or management measures under an international agreement in which the U.S. participates dictate otherwise.

In preparing Amendment 1 to the Billfish FMP (NMFS, 1999) and the HMS FMP (NMFS, 1999a), NMFS evaluated the likely effects of conservation and management measures on participants in the affected fisheries, and attempted to minimize, to the extent practicable, any disadvantage to U.S. fishermen in relation to foreign competitors.

i. Amendment 1 to the Billfish FMP

Amendment 1 to the Billfish FMP was completed in April 1999. This document amends the original FMP that was developed in 1988. The primary purpose of the original FMP was to reduce gear conflicts between the U.S. recreational fishery and foreign longline fisheries. The FMP established a prohibition on U.S. commercial possession of billfish species. Among other objectives, Amendment 1 focuses on the objectives of ending overfishing of these species and rebuilding the stocks. In addition, it seeks to coordinate domestic regulations with ICCAT recommendations for controlling stock-wide fishing mortality. One of the final actions of the Amendment is to "Establish a foundation for negotiation with ICCAT for a ten-year rebuilding plan."

Amendment 1 includes an introduction that provides background information on the history of Atlantic billfish management, issues and problems, objectives, summary of management measures of the final FMP amendment, research needs, and association with other laws, international agreements and FMPs. Subsequent chapters include information on the status of the stocks, description of the fisheries and permitting and reporting requirements, and other management measures designed to rebuild overfished stocks and maintain the stocks that are rebuilt. The FMP also includes Atlantic billfish essential fishery habitat information, including information on habitat, Atlantic billfish life histories, threats to essential fishery habitat, and research needs (see section below for summary). Information related to minimizing bycatch of billfish is contained in the Fishery Management Plan for Atlantic Tunas, Swordfish, and Sharks (HMS FMP), which includes measures to manage the Atlantic pelagic longline fishery. Specific management measures contained in the amendment include size limits, tournament registration and reporting, a ban on the import of Atlantic billfish, regardless of its country of origin, and a documentation requirement to certify that imported billfish is not from the Atlantic management unit.

ii. Fishery Management Plan for Atlantic Tunas, Swordfish, and Sharks (HMS FMP)

The HMS FMP was developed in conjunction with Amendment 1 to the Billfish FMP to manage, among other fisheries, the Atlantic pelagic longline fishery, which is a significant source of billfish bycatch mortality in the U.S. Therefore, the HMS FMP and a subsequent regulatory amendment that was later published contain measures that affect billfish, specifically bycatch reduction measures such as gear modifications and time/area closures.

NMFS implemented several management measures that affect white marlin under the authority of the HMS FMP. Specifically, NMFS closed areas of U.S. waters to longlining, which may benefit white marlin, depending on the levels of re-distribution of longline effort. In addition, NMFS implemented a live bait prohibition in the Gulf of Mexico that is likely to reduce interactions with marlin and to increase survival of released white marlin. Several groups are disputing the consistency of these measures with the Magnuson-Stevens Act and have filed suit in U.S. District Court (National Coalition for Marine Conservation v. Daley, Civ. No. 1:99CV01692; A Fishermen's Best, Inc. v. Mineta, Civ. No. 00-CV-3096; The Billfish Foundation v. Mineta, Civ. No. 1:00CV02086). Ultimately, a judge will determine if the measures address the requirements of the Magnuson-Stevens Act. If they are deemed not to comply with Magnuson-Stevens Act requirements, NMFS will be forced to take additional action to protect billfish in U.S. waters.

b. Atlantic Tunas Convention Act (ATCA)

The Atlantic Tunas Convention Act of 1975 authorizes the Secretary of Commerce to administer and enforce all provisions of the International Convention for the Conservation of Atlantic Tunas. Pursuant to this goal, the Secretary cooperates with the duly authorized officials of the government of any party to the Convention as well as any other Federal department or agency or any State.

The Secretary of Commerce is authorized to issue regulations deemed necessary to implement the Convention. ATCA authorizes the Secretary to use the personnel, services, and facilities of any agency of any party to the Convention, any other Federal department or agency, or any agency of any State. ATCA also charges the Secretary with issuing regulations for the advancement of any recommendation from ICCAT. However, regulations promulgated under ATCA are, to the extent practicable, to be consistent with fishery management plans prepared and implemented under the Magnuson-Stevens Act.

ATCA authorizes the Secretary of Commerce to prohibit the entry into the U.S. of any species subject to regulations recommended by ICCAT and taken from the Convention area in a manner that would diminish the effectiveness of ICCAT's conservation efforts. The Secretary may also prohibit the importation of any fish regulated by the Convention from a country whose fishing vessels are harvesting in the Convention area in a manner which would diminish the effectiveness of ICCAT's recommendations.

All domestic management measures for white marlin are implemented under the dual authority of the Magnuson-Stevens Act and ATCA.

c. National Environmental Policy Act (NEPA)

NEPA requires NMFS to evaluate the ecological, economic, and social impacts on marlin and the fishermen who interact with them, prior to implementing fishery management regulations. It also requires Federal agencies to include in every major Federal action significantly affecting the quality of the human environment a detailed statement on: a) the environmental impact of the proposed action; b) any adverse environmental effects which cannot be avoided should the proposal be implemented; c) alternatives to the proposed action; d) the relationship between local short-term uses and enhancement of long-term productivity; and e) any irreversible and irretrievable commitments of resources involved in the proposed action. The agencies use the results of this analysis in decision-making and alternatives analysis. NMFS plays a significant role in the implementation of NEPA through its consultative functions relating to conservation of marine resource habitats.

3. State Authorities

State fishery management agencies have authority for managing fishing activity in state waters only (0-3 miles in most cases; 0-9 miles off Texas and the Gulf coast of Florida). Considering that white marlin do not frequently enter the waters of most states, state authority is limited. Some states have implemented regulations to protect marlin caught in Federal waters, however, through implementation of possession prohibitions. For example, the state of Georgia has established a catch-and-release fishery for both blue and white marlins, with no possession of marlins allowed, regardless of where they were caught. Most states that have implemented regulations have copied Federal regulations for white marlin (Table 1).

Table 1. State fishery management regulations for white marlin

State	**Management Measures**
Massachusetts	Minimum size Bag limit Gear restrictions No sale
Rhode Island	None
Connecticut	None
New York	None
New Jersey	None
Delaware	None
Maryland	Emergency regulations in progress requiring tagging of all landed billfish
Virginia	None
North Carolina	Bag limit (1blue or white marlin) Minimum size No sale
South Carolina	No sale Gear restrictions Minimum size
Georgia	No possession or landing of white marlin
Florida	Minimum size Bag limit Gear restrictions No sale

Alabama	None
Mississippi	None
Louisiana	Minimum size
Texas	Minimum size

C. Non-Regulatory Conservation Efforts

Current conservation efforts include not only domestic and international conservation and management measures, but also non-regulatory conservation efforts. These non-regulatory programs are generally long-term programs, although some programs of shorter duration that have specific targets may be as or more effective at raising awareness and contributing to conservation.

Spreading a catch-and-release ethic among recreational fishermen perhaps has been the most effective non-regulatory conservation effort in the U.S. billfish fishery to date. The Billfish Foundation has developed a release certificate program to reward release fishing. For each billfish released, anglers receive from the Foundation a certificate of congratulations. Annual Release Awards are given to captains, anglers and clubs worldwide. U.S. anglers have established a strong ethic that has achieved a white marlin release rate of over 98% since 1998 (Goodyear and Prince, 2002), and the ethic has been "exported" throughout the Caribbean although it remains strongest in U.S. fisheries.

The Billfish Foundation continues a "No Marlin on the Menu" education campaign; the intent of which is to discourage Americans from eating marlin and increase support for the fishery's recreational status. Whenever Foundation staff receive information about an establishment selling imported marlin, they contact the establishment and explain the conservation implications. A copy of that correspondence is sent to a local reporter. A follow up letter is sent later. Establishments that agree to discontinue sales of marlin are sent a certificate that can be framed and a thank-you letter. This program has been in place for years and likely serves to increase awareness of white marlin.

U.S. anglers have also promoted and developed recreational fishing in other parts of the world. Because billfish anglers expect high catch rates and pursue larger fish, expanded international recreational fishing may provide economic incentives for other countries to conserve white marlin. These promotional activities have indeed led to increased involvement in the fishery management process and stewardship of the resource. For example, the Bahamian government prohibits the use of longline gear in state waters largely to protect the economically more valuable recreational fishing industry (predominantly billfish tournaments and trips).

Finally, recreational anglers have worked through the Billfish Foundation and the NMFS Cooperative Tagging Center to tag marlin. This program has been ongoing for years and has provided data regarding migrations of marlin. While tagging data has limited use in age and growth studies, it has provided information regarding migrations of Atlantic white marlin (Prince et al., in press).

IV. Status of the Stock

The U.S. participates in ICCAT-supported stock assessments for white marlin that utilize data from multiple fishing nations. These assessments are conducted by the Standing Committee for Research and Statistics (SCRS), a group of scientists from ICCAT member nations. The U.S. does not conduct stock assessments for U.S. waters only; the results would not be meaningful, given the range of the white marlin stock.

The status of the Atlantic white marlin resource has been the subject of a number of quantitative assessments conducted under the auspices of ICCAT. The most recent assessment meetings were conducted in 2000 and again in May 2002. Results of the assessment for 2002 have not yet been adopted by the SCRS and ICCAT, nor have summary documents been released. Therefore, the SRT based its review on both the 2000 ICCAT assessment, and our review of results already available from the 2002 assessment meeting. The 2002 SCRS assessment and supporting documents submitted to SCRS by individual scientists are currently considered to be in draft form as of August 2002, and will be finalized only upon adoption by the SCRS and ICCAT. Therefore, the SRT reviewed data inputs, model formulation, assessment results, and sources of uncertainty from both 2000 and 2002 papers and analyses as they now stand, and the SRT drew its own conclusions about the status of the stock relevant to extinction risk.

A. Underlying Data Available, and General Assessment Structure

Basic information available for conducting white marlin stock assessments includes time series of fishery catches, and trends in commercial and recreational catch per unit of effort (CPUE) as relative indices of stock abundance. Variants on production models are the primary methods considered for providing stock assessment calculations. (Data available are minimal at best for stage-based modeling, although Porch (2002) did attempt a stage-based approach in 2002 for exploratory purposes.) A single pan-Atlantic stock is assumed (see Section II).

Fishery catch data are now available for the time period 1956-2000 (Figure 1). The SRT has used the ICCAT historical catch data, as modified by the ICCAT SCRS scientists to reflect the most likely estimates of fishery landings and dead discards by nation, gear type, and fishing area. The SRT accepts the SCRS workshops' decisions about catches as the best available at the time of each assessment.

CPUE data for white marlin are available from multiple time series from commercial and recreational fisheries. These data represent longline, purse seine, recreational, and artisanal fisheries. For the U.S. alone, there are a number of time series available, including the commercial longline series (1986-2000), and data from various recreational sources, including tournaments and the NMFS Large Pelagic Fishery Survey (Ortiz, 2002; Ortiz and Scott, 2002; Goodyear and Prince, 2002). A selection of available CPUE series has been chosen by the ICCAT workshops for inclusion in CPUE standardization and production model analyses. The SRT accepts the choices of the ICCAT workshops for the inclusion of indices.

There are no data available from fishery-independent sampling programs with which to characterize the abundance or population demography of the species.

There are two problems to be addressed with use of the available CPUE data in the stock assessments. First, no single series covers all the relevant years. Second, various components of the fishery have increased or decreased over the years with the spatial distribution of effort and specific fishing techniques changing over time. In recent years, regulations (e.g., landings and bycatch quotas) likely have affected CPUE. The ICCAT assessments used two approaches to reduce or remove these limitations: 1) CPUE indices are combined via General Linear Models (GLMs) to produce a single composite index over all years; 2) Population models are structured to accept multiple CPUE indices, with independent expectations of the relationship between CPUE and population size. The GLM technique may be a bit more powerful, in that the models used can also develop a 'standardization' of CPUE to account for variations in effectiveness within individual fisheries. Multiple index models are not usually structured to include variations in effectiveness within individual fisheries (referred to as 'constant q,' where q is the coefficient of proportionality between fishing effort and fishing mortality rate (F); q is also sometimes called the effectiveness of the fishery or the catchability of the species). In the SCRS workshops, some models were restructured to allow within-fishery variations in q.

The ICCAT SCRS scientists did not reach consensus on the best CPUE standardization technique (GLM model) in the 2002 assessment workshop. The specific methods of CPUE standardization remain a significant issue of scientific debate within ICCAT. This debate generally focuses on methods to standardize for changes in the spatial extent of fishing effort (i.e., marlin are not primarily the object of directed fisheries but are incidentally caught in fisheries directed primarily for tunas). Target species for longline fisheries have changed over time, and fisheries effort has expanded, and thus it is important to consider these factors in selecting a robust standardization technique.

The standardization approach currently accepted by the U.S. scientists participating in the 2002 assessment produced results very similar to the 2000 results. The SRT accepted the CPUE index developed by the U.S. scientists for the 2002 workshop as the primary basis for our evaluation.

Because of the lack of time series data on catch by life stage (age and/or length), the viable options for applying quantitative models to estimate absolute biomass and fishing mortality rate trends are the use of production models. The most common form of the production model is the Schaefer (logistic) formulation:

$$dB/dt = rB\,(1-B/K)-C$$

where K is carrying capacity, r is the intrinsic rate of population growth, C is catch, and B is stock biomass. This form is generalized by allowing non-symmetric production functions and non-equilibrium structure. For white marlin, a series of production models was fit, including the Schaefer, Fox, generalized, and a “model-free” simulation approach. Various combinations of model runs included alternative model forms, differing combinations of CPUE indices (e.g., use of combined or individual CPUE series, various standardization factors, and, in the case of Bayesian models, the use of prior information to constrain the model search for important parameters including r and K).

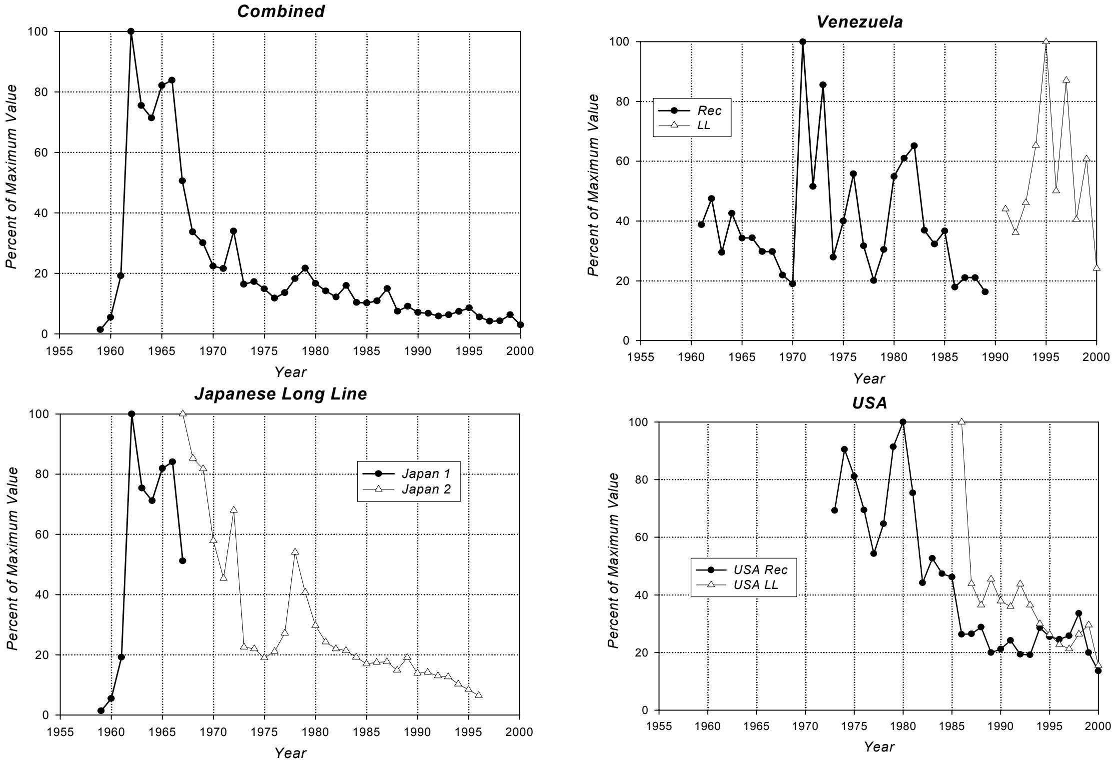
The white marlin and other similar stocks present a difficult problem in estimating parameters of the production function (r, K) because of the so called “one-way trip” of near continuous decline throughout the time series. In these circumstances, it is difficult to discern the parameters of the model, since they tend to be inversely correlated. Applications where the stock has stabilized or undergone a number of decreases and increases offer the best situation for estimating the model with a high degree of certainty.

B. SRT Examination of Catch and CPUE Trends

The composite CPUE index reported in the ICCAT 2000 assessment is reproduced in Figure 5. Qualitatively, there is evidence of a few early years of either incomplete reporting or increasing catchability, followed by a decade or more of high and declining CPUEs consistent with mining a lightly exploited stock of its older fish. This period is followed by another decade and a half of fairly steady decline, likely consistent with an increasing F. A sharp downturn in the CPUE index during the 1990s is not evident.

The catch data (Figure 1) also show a pattern of high initial removals, but have since fluctuated without major trend, averaging about 1500 mt per year from the early 1980s through 1996. Total reported catch dropped after 1996, coincident with management recommendations to reduce white marlin catch.

Figure 5. Selected indices of relative abundance used to measure white marlin stock abundance, based on commercial and recreational CPUE



Examining several of the CPUE indices in Figure 5 individually, some clear patterns in catch rates by major fishery sectors are apparent. CPUE series are presented for the combined index from all sectors and six of the indices available from Japan, Venezuela and the U.S. (the most consistent long-term data series). Trends are plotted as a percentage of the maximum annual catch rate in each individual series. During the period 1990-2000 the combined CPUE index averaged only 6% of the maximum value (1962), and in 2000 only 3% of the maximum. The combined CPUE series is driven primarily by the Japanese longline fishery data, since this is the only such series that extends back to the beginning of the commercial longline fishery. Other series show similar declines in abundance – but over a shorter period of time. For example, the U.S. recreational index (a composite of various U.S. indices) is currently at about 14% of its maximum value (1980). However, this series began in 1973. Based on Japanese longline data (and the combined CPUE series), the white marlin abundance had dropped by about 80% from the early 1960s to 1973. Thus, the trends in shorter series are consistent with large reductions in CPUE since the early 1960s, and this conclusion is robust to the various issues surrounding CPUE standardization. It is clear that the white marlin CPUE has declined to 10% or less of the levels that occurred in the early 1960s.

C. 2000 ICCAT Stock Assessment Model Results

Two production-modeling approaches (FISHLAB and ASPIC) were used in the 2000 ICCAT assessment, and information from both of them contributed to the 2000 SCRS advice to ICCAT (SCRS, 2000). Results were qualitatively similar. The ICCAT 2000 white marlin assessment concluded that the stock was significantly overfished (Table 2). The SRT concurs with the ICCAT finding of significant overfishing, and believes the magnitude of overall reduction in stock size reported for many of the model cases is realistic, given the underlying declines in CPUE. The SRT is less certain about the absolute magnitude of F and the conclusion that F in 1999 was several multiples of F_{MSY}, as these results are uncertain, and sensitive to real variation in q. One indication of the uncertainty in model results is that the calculated MSY values between the ASPIC and FISLAB models varies by a factor of four (305 mt vs. 1276 mt). However, with the catches above both MSY values since about 1985, a finding of overexploitation seems inescapable.

Table 2. Summary of white marlin non-equilibrium production model results. Run 1 corresponds to the base assessment evaluation. Five additional sensitivity evaluations were conducted. (Reproduced from SCRS, 2000, Table 28)

Run	Index	Dynamics Model	Constraints	Comments	F/Fmsy	B/Bmsy	MSY
FL 1	Combined, equal wt	Logistic	B1=K	Base Fishlab	7.64	0.13	1276
Run 1	Combined equal wt	Logistic	None	Base ASPIC, terminal with least mean squares	>10	0.11	305
FL 0	Nine indices	Logistic	B1=K	Fishlab	4.95	0.22	854
Sens 1 FL	Combined equal wt	Logistic	None	Use 1986-99 data only	0.69	0.95	1384
Sens 2 FL	Combined equal wt	Logistic	B1=K	Assume 2 series split 1973/74	5.43	0.20	845
Sens 3	JLL, SCRS/00/81	Logistic	B1=K	Alternative catch rates	>10	<0.10	2009

Both models show major declines in biomass (Figures 6 and 7) and increases in fishing mortality (Figure 8), accelerating in recent years for some of the model cases. If F has accelerated, there should be independent corroboration in effective fishing effort, or some other mechanism (such as refocusing of the fishery in marlin concentrations), which would act to increase fishery catchability (q). The SRT obtained statistics of nominal longline effort (available from ICCAT, but not included in the assessment reports). The nominal longline effort data are plotted in Figure 9, along with standardized effort from the 2002 assessment, calculated as catch divided by the composite CPUE index. The nominal effort appears to be incompletely reported since about 1997, and we discounted the last 3 years in our evaluation. The change in standardized fishing effort since 1990 (Figure 9) does not appear to correspond fully with the calculated fishing mortality on white marlin, which increased by a factor of about 3 (Figure 8).

Figure 6. Fit of the biomass dynamic model to the combined CPUE index for Atlantic white marlin.

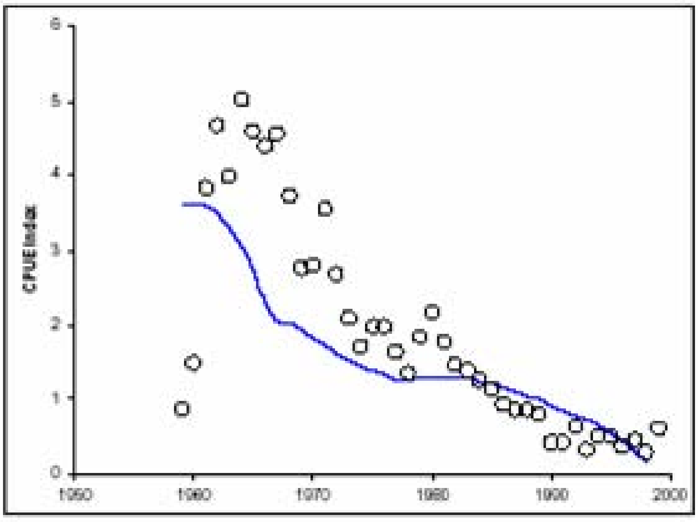


Figure 7. Estimated biomass trajectory for white marlin using a single combined index of abundance.

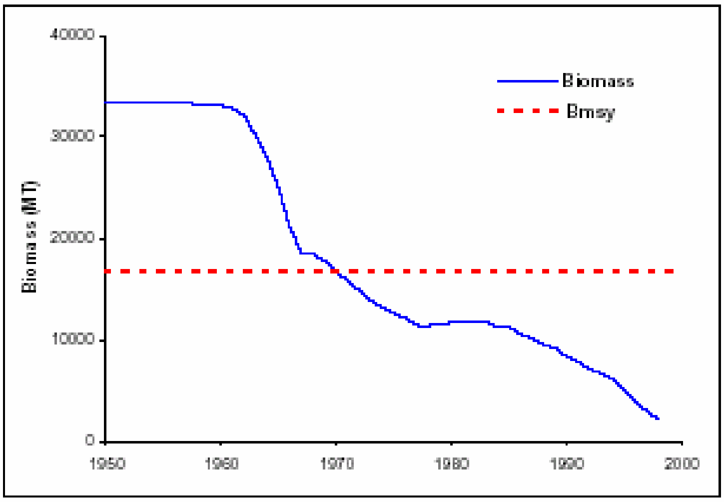


Figure 8. Relative fishing mortality trajectory for white marlin estimated with a logistic production model applied to catch and composite CPUE series

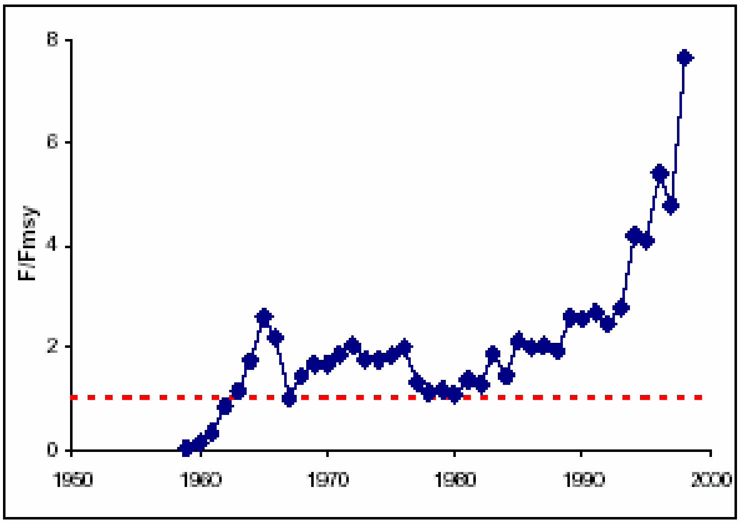
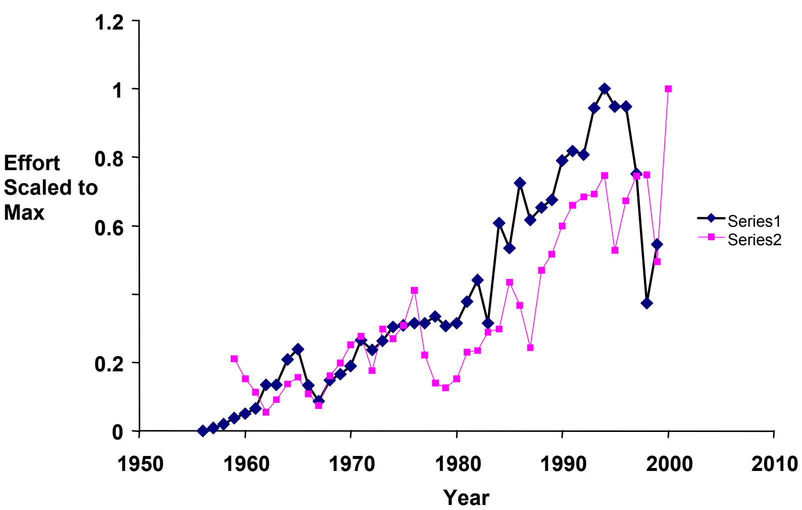


Figure 9. Nominal (Series 1) and standardized (Series 2) longline effort over time



D. Papers by U.S. Authors Submitted for the ICCAT 2002 Assessment Workshop

The SRT evaluated the papers submitted for the 2002 ICCAT assessment, plus subsequent analyses, for evidence to confirm or reject our evaluation of the 2000 assessment results. Three papers submitted for consideration at the 2002 ICCAT assessment are particularly relevant to evaluation of extinction risk.

Babcock and McAllister (2002) provide strong evidence that r is on the order of 0.1 for white marlin, which is low compared to other fish species. Their analysis was based on a Bayesian production model, with priors on r based on the compilation by Myers et al. (1999). The data caused the posterior on r to move well to the low end of the prior distribution, with considerable reduction in the width of the distribution. Even with the narrow distribution on r, the r and K estimates remained highly (negatively) correlated.

Goodyear (2002) simulated the properties of CPUE as an indicator of B/ B_{MSY} over a wide variety of vital rates, and concluded that the ratio of recent CPUE to CPUE under lightly fished situation could provide an adequate estimator of the B/B_{MSY} benchmark. He provided a point estimate and confidence intervals of B_{recent}/ B_{MSY} without relying on production models. This bypassed the residuals problem of the 2000 production models, and produced estimates of B_{recent} / B_{MSY} of 17.5%, with 95% confidence intervals of 12.7 to 22.3%.

Porch (2002) provided a first cut at age structured modeling for white marlin. He identified several fitting problems requiring either highly informative priors (or additional information) to avoid parameter estimates at or near the boundaries. His analysis paralleled the production model cases of composite and fleet specific CPUEs. The composite case was generally more optimistic than the base production model results, in the sense that F_{recent}/ F_{MSY} was on the order of 2-3, but suggested a lower absolute population (broad range around 4000 mt), and higher absolute F than the fleet specific case. The fleet specific case suggested a several fold excess in recent F over F_{MSY}, but this coincided with an absolute stock size in the 9000-14000 mt range. His model allowing variable q in particular eliminated some of the anomalous residuals and trends of the 2000 assessment, and suggested F peaked in the mid-1990s at about 2 times F_{MSY}. All his cases show a drop in F in the late 1990s. Porch later provided estimates of recruitment variation from his results to this SRT (plotted in Figure 10), which suggest a major reduction in recruitment success has occurred. The stock recruitment estimates were also plotted as recruits/spawners vs. spawners (Figure 11) to look for evidence of depensation.

Figure 10. Spawning biomass-recruit relationship for white marlin

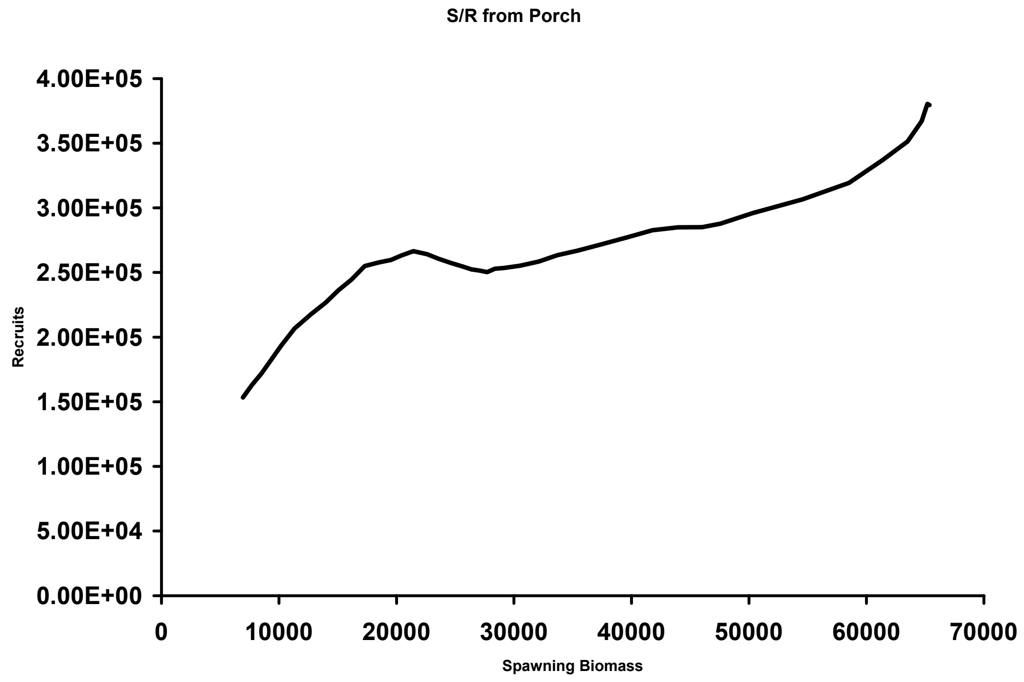
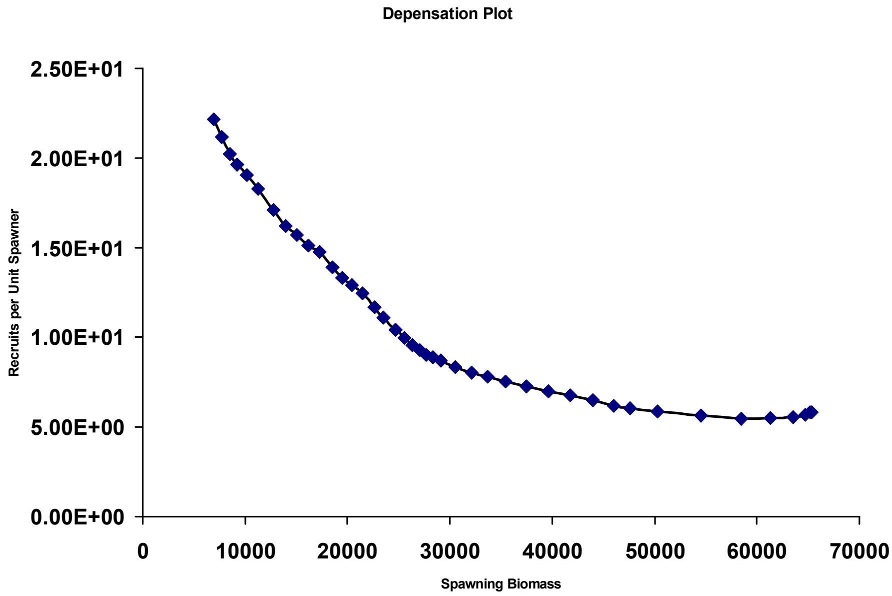


Figure 11. Spawning biomass-recruits per unit spawning biomass relationship for white marlin



E. Analyses from the ICCAT 2002 Assessment Workshop

The ICCAT 2002 working group fit a total of 36 alternative model/data combinations. Results of these models are briefly summarized in Figure 12. This figure summarizes the ratio of the biomass determined in 2000 to the carrying capacity of the stock (K) from the various model runs. It should be stressed that these model results do not necessarily represent an unbiased set of likely model configurations (e.g., some very unlikely model/data combinations were tried to explore the effects of various particular schemes for model and data handling). Nevertheless, there is a clear central tendency in these model results – the median of these model outcomes indicates that 2000 biomass is about 14% of K.

Figure 12. Ratios of biomass in 2000 to K in 33 alternative formulations of production models used for white marlin in the 2002 SCRS stock assessment. Note that the model runs did not provide an unbiased set of model simulations with respect to likely B_{2000}/K ratios. Rather, these results document the range of model outcomes examined and the frequency of occurrence of particular outcomes.

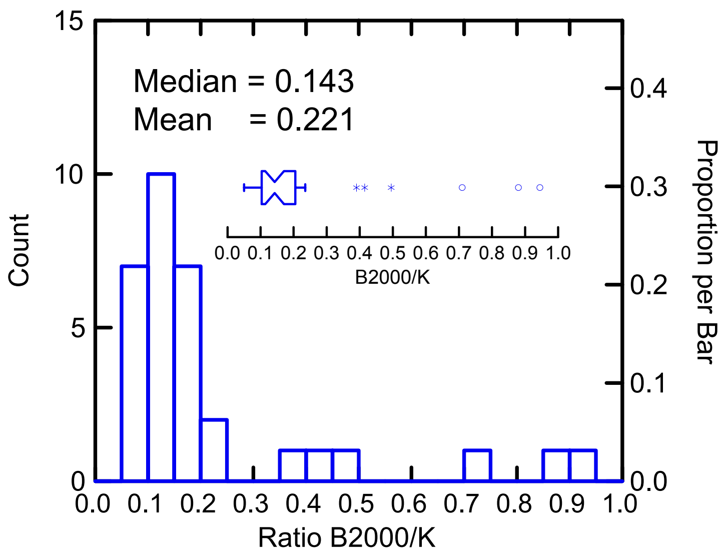


Table 3 summarizes results of the 2002 ICCAT stock assessment. The data used in the base case estimate are not sufficiently informative to choose a "best case." For consistency, the base case presented here is based on data and assumptions that closely resemble the analyses made in 2000. Confidence limits from bootstrapping are conditional on this model-data set and thus may underestimate the real uncertainty.

Table 3. Atlantic White Marlin Status Summary – Reproduced from 2002 ICCAT draft stock assessment (Yield figures in mt)

	Likely Value	Base case estimate (80% conf. limit)	Range of Sensitivity [1] estimates
Maximum Sustainable Yield	Below 2000 Yield	964 (849-1070)	323-1320
2000 Yield [2]	1,126	--	--
2001 Yield	Unknown	--	--
2001 Replacement Yield	Below 2000 Yield	222 (101-416)	102-602
Relative Biomass (B_{2001}/B_{MSY})	<1 (Overfished)	0.12 (0.06-0.25)	0.12-1.76
Relative Fishing Mortality (F_{2000}/F_{MSY})	>1 (Overfishing)	8.28 (4.5-15.8)	0.80-10.30
Management measures in effect	- In 2001 and 2002, PS and LL fisheries limit landings to 33% of max(1996,1999) level. [00-13] and [01-10]		

[1] The sensitivity analyses made were not chosen in a systematic way; the range is presented only for qualitative guidance.
[2] Estimated yield including that carried over from previous years

Because of various uncertainties in interpreting CPUE series and appropriate model forms, the ICCAT working group did not endorse any single model formulation as the "key" run. Rather, the ICCAT advice is formulated on a range of model results thought to represent the likely model and data combinations. This advice indicates that the stock is well below K and B_{MSY}, and F is currently several times the sustainable level.

F. Other Available Information on Population Status

Goodyear (2002a) provided a document directly to the SRT to offer his interpretation of the population trends for white marlin. He noted that there has been a surprisingly steady decline in CPUE that could be well described by a single exponential parameter for over 35 years. The fit is purely empirical – there is no particular reason to expect such a simple relationship, and thus no reason to expect that particular trend to continue indefinitely, but the results can provide a sense of scale. The SRT notes that, with the exponential structure, the predicted population cannot reach zero in a finite time, so Goodyear's results should not be interpreted as a prediction of extinction risk.

Babcock provided the SRT with additional runs with new results relevant to the current status of the population, and these were the basis of population projections presented in section VI.D.3.b. The changes from Babcock and McAllister's draft SCRS report include addition of the most recent catches and CPUE data, and a switch to the composite CPUE index. Of particular interest to the SRT, results from the newest runs raised the point estimate of r from 0.1 to 0.15, indicating that the stock may be more productive than previously thought. The most likely values of r were distributed between 0.1 and 0.2.

V. Approaches to Evaluating Danger of Extinction

The Endangered Species Act does not give quantitative criteria for determining whether a species is in danger of extinction. At present, there are no comprehensive NMFS guidelines either, and it is likely that no single set of criteria will fit all circumstances. No rigorous guidelines exist in the general scientific literature either, but there has been considerable discussion of possible criteria. The SRT examined this literature, and invited presentations from experts (American Fisheries Society and U.S. Fish and Wildlife Service) on criteria for status evaluation, with the intent of extracting extinction risk considerations specifically for white marlin.

Section 4(a)(1) of the ESA states that a species is threatened or endangered if any one or more of the following factors causes it to be, or be likely to become, in danger of extinction throughout all or a significant portion of its range: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence. There are no quantified guidelines in the ESA, however, associating these factors with an evaluation of extinction risk. Therefore, the SRT considered the interplay of the ESA factors with the extinction risk considerations that the SRT identified specifically for white marlin.

This section discusses the SRT's review of existing literature and its development of specific white marlin extinction risk considerations. The following section evaluates the five ESA listing factors and their interaction with the extinction risk considerations.

A. Criteria Recommendations in the Literature

This sub-section summarizes several of the approaches proposed by other organizations, along with general remarks about relevance to white marlin as judged by this SRT.

1. World Conservation Union (IUCN)

The IUCN was founded in 1948 and comprises States, government agencies, and a diverse range of non-governmental organizations. The IUCN produces a Red List of Threatened Species. The threatened species categories have been in place, with some modification, for almost 30 years. The most recent revision of listing criteria (Version 3.1) was approved at the 51st meeting of the IUCN Council on February 9, 2000. The red list categories of relevance to the SRT in the context of ESA listing are: critically endangered, endangered, and vulnerable. The distinctions among these categories are largely determined by the extent and rate of population decline, geographic range, estimated population size, and analyses of the probability of future extinction. Species may also be categorized as lower risk, meaning that the species does not satisfy the criteria for the above categories. For example, a species may be listed as conservation dependent if it is the focus of a continuing conservation program, the cessation of which would result in the species qualifying for one of the threatened categories above within five years.

Criteria based on reductions in population size to meet the critically endangered category include a population size reduction of at least 90% over the last 10 years or three generations, whichever is longest, where the causes of the reduction are clearly reversible, understood, and ceased. If the causes of reduction are not understood, not reversible, or have not ceased, a population reduction of at least 80% over the last ten years or three generations, whichever is longest, or a projected reduction of at least 80%, to be met within the next ten years or three generations, whichever is longest, would apply. In the case of white marlin, the available scientific information suggests that the cause of population reduction is fishing mortality. Fishing mortality is reversible, but the fishing mortality rates remain high and one could not claim that the cause of population decline has ceased; thus, the 80% standard would apply. To be classified as endangered a reduction of 70% when the causes are known and ceased would apply and a reduction of 50% when the causes are unknown or not ceased would apply. The vulnerable standard is based on a reduction of 50% when the causes are known and ceased, and 30% when the causes are unknown or not ceased.

IUCN criteria based on geographic limits seem to offer little guidance with respect to white marlin. The standards for classification as vulnerable are a geographic range estimated to be less than 20,000 km^2 or an area of occupancy estimated to be less than 2,000 km^2, severely fragmented populations with limited ranges, or a decreasing trend in range or extreme fluctuation in range. The geographic range of white marlin is over two orders of magnitude greater than the 20,000 km^2 criterion adopted by IUCN which would thus not seem to apply in this case.

Criteria based on population size are also proposed by IUCN. To be considered vulnerable a population size of fewer than 10,000 mature individuals and an estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer. A very small population size of fewer than 1,000 mature individuals would also justify this classification.

Finally, species may be classified based on quantitative analyses showing the probability of future extinction. The standard for critically endangered is a probability of 50% within 10 years or three generations, whichever is longest, for endangered the probability standard is 20% within 20 years or five generations, whichever is longest. For vulnerable the standard is 10% within 100 years.

The IUCN decline criteria do not appear useful in the context of evaluating extinction risk of exploited marine fishes such as white marlin. Marine fish stocks managed to achieve maximum sustainable yield would be expected to persist at biomass levels of about 50% of carrying capacity, and might not even be considered to be overfished unless population biomass declined to levels as low as, say, 35% of carrying capacity. For white marlin, the Atlantic Billfish FMP sets the overfishing stock size threshold at 43% of carrying capacity (NMFS, 1999). Thus, the population reduction standards used by IUCN are inappropriate for exploited fish stocks.

2. American Fisheries Society (AFS)

AFS modified the IUCN criteria to better reflect the population dynamics of exploited fish stocks and suggested four categories be used to evaluate risk:

1. Rarity
2. Small Range and Endemics
3. Specialized Habitat Requirements
4. Population Decline

AFS proposed a two-tier system that first assesses the productivity of the stock and then provides standards regarding levels of decline of stocks based on productivity. Stock productivity is assigned to one of 4 levels: high, medium, low, or very low. Productivity is assessed based on the intrinsic rate of increase ‘r’, the K parameter from the von Bertalanffy growth equation, fecundity, age at sexual maturity, and longevity. Of these criteria, population decline is most relevant to our consideration of white marlin. Stocks with declines exceeding threshold decline levels for their productivity class would then be classified as vulnerable, and would warrant close scrutiny. The AFS intent with a ‘vulnerable’ classification is twofold: to inspire more detailed evaluation to determine if extinction were a foreseeable threat and to provide early enough warning such that corrective management action might be taken before a serious extinction risk developed. The other 3 AFS criteria are based on qualitative factors such as rarity, specialization in habitat requirements, and small range; but these clearly will not come into play for white marlin.

3. Convention on International Trade in Endangered Species of Wild Fauna and Flora

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement between governments that regulates international trade in wild animals and plants. CITES was drafted as a result of a resolution adopted in 1963 at a meeting of members of The World Conservation Union (IUCN). CITES works by regulating aspects of international trade in selected species.

The species covered by CITES are listed in appendices according to the degree of endangerment and the level of protection provided. Appendix I includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances. Appendix II includes species not necessarily threatened with extinction, but for which trade must be controlled to avoid exploitation rates incompatible with species survival. Appendix III contains species that are protected in at least one country, which has asked other CITES Parties for assistance in controlling the trade.

CITES criteria for identifying a species as threatened with extinction include measures of population size, geographic range, and rate of decline. Guidelines are provided through examples as to what constitutes a small wild population in terms of absolute numbers. Examples such as <5,000 for a population or <500 for a subpopulation are given but CITES recognizes that these may not be applicable to all species. Geographic range is evaluated in terms of defining the smallest area essential for the survival of a species. As examples, figures of <10,000 km^2 for a population and <500km^2 for subpopulations are given; however, these are given only as examples recognizing that it is impossible to give a figure applicable to all taxa.

CITES gives guidance to assist in identifying rates of decline in wild populations that should trigger concern. Examples are given of >50% in 5 years or 2 generations; or for a small population >20% in 10 years or 3 generations. Again these numbers are offered only as guidelines recognizing that they will not be applicable to all species.

CITES also encourages a proactive approach and suggests listing in Appendix I species that if not protected, would be likely to meet the above criteria within 5 years. Criteria for listing in Appendix II basically address the likelihood of a species meeting Appendix I criteria in the near future, unsustainable levels of exploitation, whether harvest for international trade has or will reduce the population to a level where it is threatened by other factors, and the issue of species that resemble another species that qualifies biologically, and must be listed for enforcement reasons.

B. Population Dynamics Considerations in Evaluating the Risk of Extinction

After consideration of the literature and presentations, the SRT arrived at a list of factors to be considered in evaluating whether white marlin are at risk of extinction:

1. Decline in population
2. Absolute population size
3. Recruitment: trends and variability
4. Spatial focusing
5. Depensation considerations
6. Formal modeling of probability of extinction

The SRT did not employ a scoring system among these factors, nor did it formally prioritize among them. However, a case could be made that factors 1 and 2 should be at the core of any extinction risk recommendation, and that the other factors serve more to modify conclusions based on 1 and 2, should there be issues suggesting an elevated risk beyond that indicated by 1 and 2 alone. This section expands discussion on each of these factors, to explain what we will be looking for in evaluation of the risk to white marlin.

1. Decline in Population

The SRT accepts the guidelines of AFS criterion 4 (population decline) as the most reasonable available for evaluating the extent of decline in marine finfish species. The SRT considers the IUCN decline guideline not to be realistic for most marine fish species, as there are many examples of species sustaining production after declines in excess of the IUCN guidelines. IUCN criteria might be appropriate for extremely low productivity species (e.g., some sharks), but the AFS guidelines also appear to address these adequately. The AFS approach of 'looking further' if a 'vulnerable' threshold is crossed seems reasonable, with the caveat that estimates of decline well past the threshold levels might by themselves justify a finding of significant risk.

The SRT accepts the AFS recommendation that r is in theory the best criterion for assigning a level of productivity to a species, but notes that in practice, a formal estimate of r may be very indirect, and thus potentially less reliable, than some of the other AFS productivity indicators. The SRT intends to consider all available indicators of productivity for white marlin. The SRT believes that the extent of decline is more important than the rate of decline in evaluating risk, recognizing that one might have more concern about ability to control a rapid decline compared to a slow decline.

2. Absolute Population Size

Thompson (1991) has reviewed the literature on absolute population size from a fisheries perspective. Absolute population size criteria have often been associated with the concept of Minimum Viable Population (MVP), and there has been considerable criticism about a number of 'rules of thumb' approaches to designating MVP. We consider many of the criticisms valid, but they must be considered along with a sense of scale. Many of the MVP ideas originated in considering extremely rare species, with population sizes on the order of a few tens to a few hundreds of individuals, and it would be difficult to put much credence in a rule of thumb that suggested 550 was viable, whereas 450 was not. But in our context, we consider population size (in numbers) over several powers of ten. Thus, we would be highly alarmed by population size estimates of about 1,000 for a large, wide-ranging marine fish species, unless there was evidence that the species had always been that rare, and that human impingements were negligible. We would be unlikely to be concerned about imminent extinction for populations over 100,000. For population estimates on the order of 10,000, we would be concerned about imminent extinction risk, and would then take special note of exploitation history and possible focusing mechanisms that might put the species at risk in excess of what one might expect for a conceptually 'average' marine fish species.

We note that our evaluation of risk at these 3 powers of ten is similar to that advanced by IUCN. Our criterion may be a bit more risk-averse than IUCN, in that we have not linked decline considerations directly to the population size factor. We prefer to look at the two factors separately.

3. Recruitment: Trends and Variability

In marine finfish species, quantifying and predicting decline in recruitment has become the key to evaluating possible compromise of a stock's productivity due to overfishing. That task may be difficult. Biomass may decline considerably before recruitment is noticeably impacted. Natural, real variability in recruitment can be very high (5x to 20x or more). In our context, declining recruitment may be indicative of serious overexploitation, but is not necessarily an indicator of extinction risk. For evaluating extinction risk, we are more likely to be interested in reductions exceeding expectations given the exploitation history, or marked changes in the pattern of variability. We are also particularly interested in comparing the steepness of the slope of fitted stock recruitment curves with the slope of the replacement curve on a common scale.

4. Spatial Focusing

Spatial focusing may apply to the fish, to the fishery, or both. For the fish, the concern is primarily for behavioral mechanism concentrating much of the stock over small spatial areas (e.g., spawning aggregations), to the extent that effectiveness of a unit of fishing effort might be greatly enhanced. For a fishery, the concern would be intense 'hunting' of a species, such that available effort statistics might not be proportional to F. In our context, we are also particularly interested in evidence for range contraction, such as CPUEs at the extremes of the range showing far higher percent declines than values in the center of the range, or in more optimal habitats. In that situation, it could be difficult to develop a standardization that resulted in a constant q (proportionality between CPUE and stock size). Presence of spatial focusing mechanisms per se is not evidence of significant extinction risk. Focusing mechanisms are present to some extent in almost all populations. We are interested in whether spatial focusing could be of sufficient magnitude to increase risk significantly beyond that indicated by other criteria, and also whether spatial focusing could be causing a substantial bias in population assessments.

5. Depensation Considerations

Depensation is frequently raised as an issue in extinction risk discussion, yet there is rarely evidence to suggest its occurrence in marine fishes (Myers et al., 1995). (Liermann and Hilborn [1997], however, question the ability of the Myers et al. approach to detect depensation.) For our purposes, we would be concerned by evidence of a population not recovering after a reduction in F, by a series of near zero recruitments, by an S shape in a stock recruitment relationship, or by a stock/recruitment relationship that tended toward zero recruitment at parent stocks well removed from the origin.

6. Formal Modeling of Probability of Extinction

Estimates of probability of extinction have been most closely associated with a class of models usually referred to as Population Viability Analysis (PVA). In many contexts, PVA referred to models that considered the effects of real but stochastic variation in vital rates, addressing cases where the stochastic variation itself might doom a population to extinction, whereas average rates would predict indefinite persistence. That usage has been expanded over the years, such that PVA now may refer to any population model making a statement in the form of calculating a probability of extinction (e.g. Morris et al., 2002).

Several of the population modeling techniques commonly used for stock assessment can be recast as PVAs under the more general definition. Such models can also serve as vehicles for projecting future population trends under different management scenarios. However, by expanding the uncertainty considered in future fishing mortality, most approaches would ultimately produce significant estimates of extinction probability even for lightly exploited stocks. With this in mind, the SRT took no position on specific recommendations of threshold probabilities, such as those put forth in the IUCN criteria, instead believing that these probabilities must be considered in the context of any particular models used. For our purposes, we would be most concerned about results that predicted significant probability of extinction at plausible levels of F, including special attention to prospects for spatial focusing that might cause high F's to be more plausible than one might accept initially.

VI. Analysis of Listing Factors

A species may be listed under the ESA if it is threatened or endangered because of any of the following five factors: present or threatened destruction, modification, or curtailment of its habitat or range; overutilization for commercial, recreational, scientific, or educational purposes; disease or predation; inadequacy of existing regulatory mechanisms; and other natural or manmade factors affecting its continued existence.

A. Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

1. Range Contraction

a. Ocean Scale

Annual ICCAT white marlin catch distributions (1950s-1990s) show no evidence of range contraction (Figure 13). This is further substantiated by the historical distribution of ICCAT longline fishing effort resulting in the catch of white marlin (Figure 14).

Figure 13. Average annual catch distributions of white marlin by 5° by 5° block, by decade

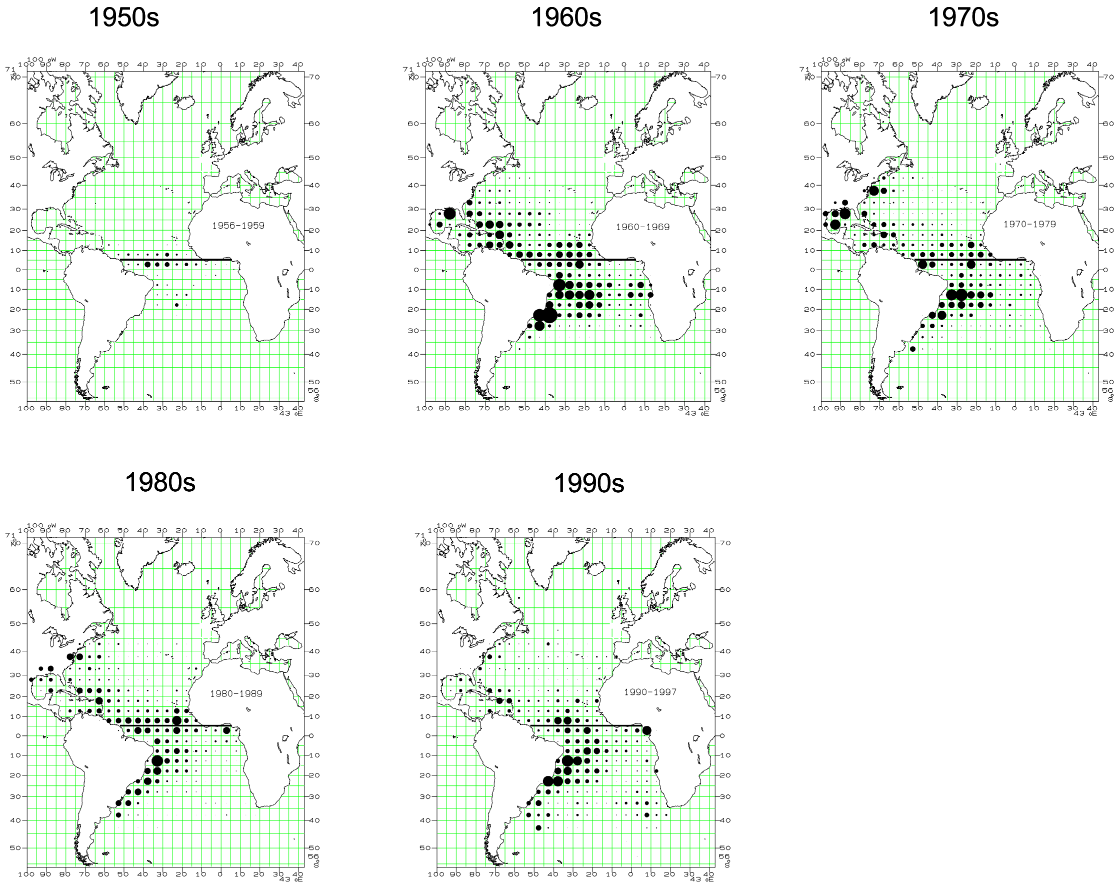
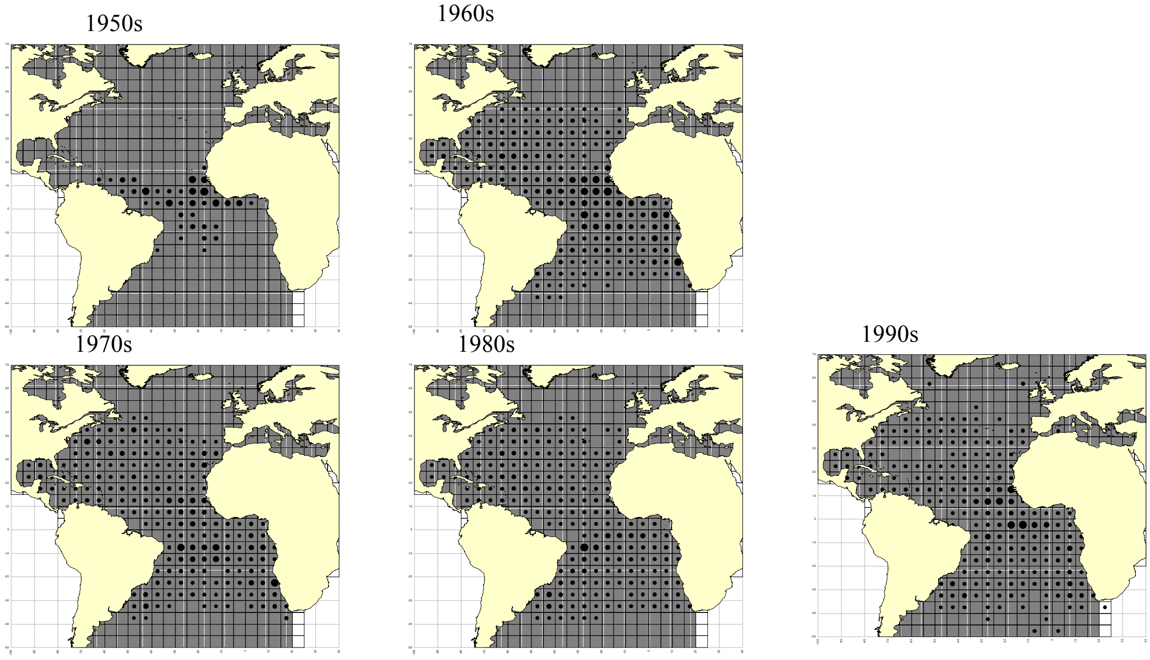


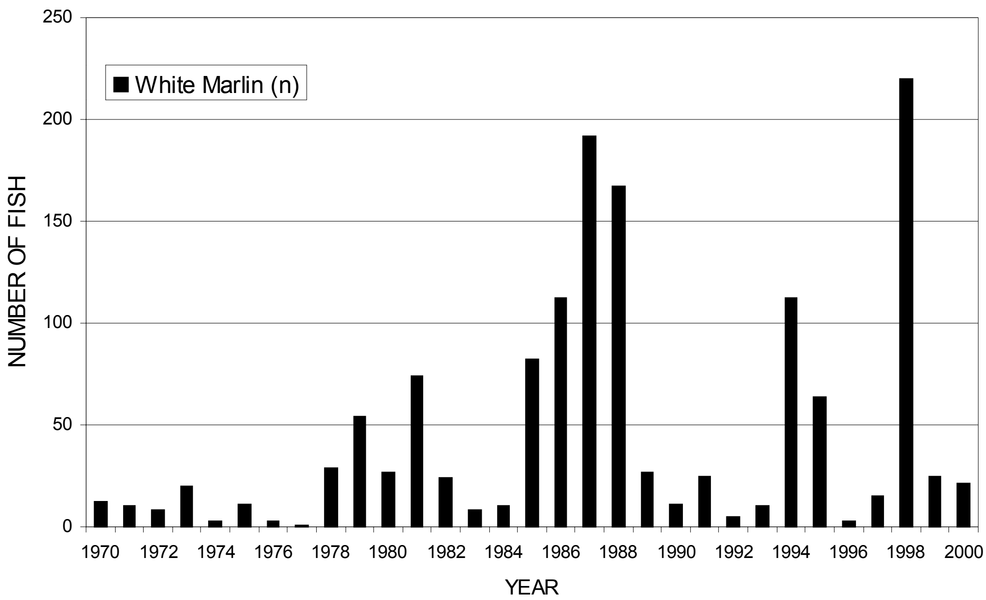
Figure 14. Distribution, by 5° by 5° block, of longline fishing effort that resulted in white marlin catch by decade



b. Local Scale

Southern New England represents the northern limit of the U.S. recreational fishery for white marlin. The Massachusetts Division of Marine Fisheries (MDMF) has collected catch and effort information at all recreational fishing tournaments that target highly migratory species. Figure 15 shows the number of white marlin caught by recreational tournament fishermen in the waters off southern New England from 1970 to 2000 (G. Skomal, MDMF, pers. comm.). Interannual fluctuations in white marlin abundance are likely related to environmental, biological, and ecological factors in this region. There is no evidence of range contraction for the white marlin in these data. This conclusion was substantiated by considerable testimony received by NMFS at public scoping meetings held to address this topic (see Appendix 1 for summary of scoping meetings).

Figure 15. Annual catch of white marlin during southern New England fishing tournaments



2. Destruction or Modification of Habitat

Amendment 1 to the Atlantic Billfish Fishery Management Plan (NMFS, 1999) describes and delineates essential fish habitat for white marlin and discusses fishing and non-fishing activities that may adversely affect that habitat. The Amendment concludes that no "Habitat Areas of Special Concern" should be identified and lists research and information needs. Based on an initial assessment, NMFS indicates that no evidence exists to indicate that fishing methods for billfish have any impact on billfish habitat. It is unlikely that other fishing activities affect marlin habitat but there are no data to indicate such.

Water quality degradation is possible as a result of mining and offshore oil and gas operations in the Gulf of Mexico, as well as industrial coastal development. Billfish are known to congregate over submarine canyons whose features may provide for redistribution of contaminants from nearshore areas to offshore habitats (NMFS, 1999). We have found no data, however, to indicate what effects offshore activities may have on the continued decline of this species.

The SRT concludes that there is no evidence of range curtailment or habitat degradation to suggest that white marlin are at risk of extinction.

B. Overutilization

In this section, the SRT evaluated the results from the ICCAT assessments and subsequent analyses, stepping through the SRT's list of population factors for evaluating danger of extinction for white marlin. See earlier sections for details on fishing activities and their impacts on the population (stock status). For the first two criteria (decline in population and absolute abundance), some results are summarized in Table 4. Here and through the remainder of the document, the SRT has chosen to express population decline as the ratio of current biomass to unfished biomass (B/K), rather than B/B_{MSY} which is the usual benchmark in fishery stock assessments, since the extinction risk literature focuses on reductions from unexploited levels.

Table 4. Summary of population estimates from various sources for white marlin decline in population and absolute population size.

Source	Stock Size as % of K	Absolute Abundance
2000 ICCAT Assessment	6-11%	100,000-300,000
Babcock & McAllister (2002)	6-12%	200,000
Goodyear (2002)	6-11%	N/A
Porch (2002)	8-18%	200,000-700,000
2002 ICCAT draft Assessment	3-12%	100,000-300,000

All ranges are based on the central tendencies from the cases presented by the authors as the primary cases. They do not include analyses added later for more specialized sensitivity considerations, nor (except for Goodyear), development of confidence intervals. For those production model-based papers reporting recent biomass as a fraction of B_{MSY}, B_{MSY} was assumed to be $0.5*B_{unfished}$. (Results for the Porch paper were estimated off graphs.) The population sizes were based on the papers' estimates of recent biomass, assuming an average weight of 20 kg per fish, and rounded to one significant digit. Goodyear specifies recent biomasses as starting point cases in his analysis, and his work does not contain estimated recent population sizes.

1. Decline in Population

The declines estimated are generally consistent with 'vulnerable' status under AFS criteria if white marlin are taken to have low productivity, and 'not at risk' if white marlin are taken to have medium productivity. The limited age and growth information for white marlin makes the assessment of white marlin productivity difficult: white marlin would probably be characterized as low productivity by maximum age based on tag-recapture (Prince et al., in press) and probably as medium or high productivity, based on growth rate of blue marlin (Prince et al., 1991). Estimates of r from production models range from low to high productivity. The most reliable range of r ranges between 0.1 and 0.2 (Babcock and McAllister, 2002 and Babcock, pers. comm.). The most recent estimates straddled the border between low and medium productivity using AFS standards. There is no evidence supporting classification of white marlin as having 'extremely low productivity' by AFS standards. Our interpretation: white marlin declines are on the borderline between 'vulnerable' and 'not at risk' status under AFS criterion 4. This borderline situation certainly justifies this further look at white marlin's status, but does not in itself argue strongly for significant danger of extinction.

2. Absolute Population Size

The existing analyses are consistent with recent population sizes of about 200,000 individuals in the size range vulnerable to the fishery. This value is not consistent with imminent extinction.

3. Recruitment: Trends and Variability

Evidence specific to recruitment is very sparse. None of the CPUE time series could be identified as specific to newly recruited fish. Small fish appear intermittently in some of the CPUE series (Goodyear et al., 2002), but that result can at present be interpreted as chance encounter with small fish as readily as with evidence for stronger year classes. Porch's model allows estimation of recruitment and its trends, which he provided to the SRT separate from his ICCAT paper (results plotted in this document for one case as Figure 10), but the data limitations lead to very smoothed estimates of recruitment. A decline was evident, but the magnitude was not out of line with what could be expected based on declines of biomass evident in the less structured production models. Porch reported that the data did not allow reliable estimation of a stock recruitment steepness parameter; we agree with his evaluation.

4. Spatial Focusing

Maps of catch (Figures 12 and 13) indicate a broad geographic range for white marlin, persisting throughout the history of significant fishing. The longline fisheries may have become more tropical in recent years, but given the white marlin distribution, there is little likelihood that a unit of effort has become or is becoming far more effective, beyond that already accounted for in the CPUE standardization analyses. Further, since white marlin are a bycatch species, one would not expect that fishing effort would become more efficient at targeting them. White marlin are, however, co-distributed with target fishery species (i.e., tunas) that are receiving increasing fishing effort. Large aggregations of white marlin have not been reported. Spawning appears to occur throughout much of the range. In short, there is no evidence to suggest special vulnerability of white marlin to spatial focusing of fishing effort.

5. Depensation Considerations

Nothing in the biological knowledge base for white marlin suggests special vulnerability to depensatory effects. There are no signals in the population models or their underlying data to suggest that depensatory effects are beginning. The population size estimates on the order of 200,000 suggest that white marlin are not in and are not about to be in a range where one should expect depensatory effects. The very limited information on recruitment is not consistent with depensatory patterns (Figures 10 and 11).

6. Formal Modeling of Probability of Extinction

No formal PVA models for white marlin are available from outside sources. Because the past declines and absolute population level are not consistent with risk of imminent extinction, the SRT decided not to attempt formal PVA analysis. Population projections were made, however, to assess the chances of the stock dropping to levels where ESA protection would be warranted in the future. These results are presented in section VI. D. 3. b. below, as the projections evaluate the population response to various management scenarios.

7. Uncertainty about Risk Factor Findings

In rough terms, within the population models the CPUE data drive the findings about population decline, and the catch data scale the results to absolute population. It is hard to conceive of revisions to the catch data sufficient to change our general conclusions about absolute population size. The CPUE signal is very strong, and is derived from multiple sources. The estimates of extent of decline do not vary greatly among the analyses currently accepted by the U.S. scientific delegation to ICCAT. The only competing analyses on the table (from Japan) argue for less decline than this SRT is accepting. Within the base cases, the range of uncertainty for population decline is largely driven by how the model fits the early CPUE data. The optimistic results tend to be associated with fits that leave large residuals in the early years, essentially suggesting that over the short term in the 1960s, the fishery was operating with a higher q than in later years than accounted for by CPUE standardization. The more pessimistic results tend to have early 1960s CPUEs track the population size more closely. We believe that little should be inferred from the details of fluctuations in the 1990s in the population model results, but point out that our conclusions about population decline and absolute abundance are unaffected by this interpretation. The remaining factors tend to be more qualitative, and operate more as modifiers to conclusions based on the decline and absolute population size factors. For some of these (particularly recruitment and depensation), there is to some extent an 'absence of evidence' situation, but in general we believe that if situations existed under these factors serious enough to question the implications of the primary factors, those situations would have been evident in the information available.

While overutilization is occurring and the white marlin population is declining, the stock is not in danger of imminent extinction.

C. Competition, Predation, and Disease

1. Competition

The ESA requires an evaluation of competition, predation, and disease factors as they affect white marlin. It is not likely that under "balanced" circumstances white marlin lose in the competition for food because they are piscivorous and cover large areas of ocean when foraging (NMFS, 1999). In the most recent Report to Congress on the 2001 Status of Fisheries, NOAA indicated that certain species known to be prey of white marlin in U.S. waters were considered overfished. It is clear that levels of some prey species have declined due to fishing and other factors; however, no information exists to indicate that depressed populations of some bait species are negatively affecting white marlin in the Atlantic Ocean.

2. Predation

Not much is known regarding predation of white marlin. This species is a part of a productive pelagic ecosystem and as such, white marlin experience high levels of mortality from a wide range of predators. The most significant predator on white marlin is likely to be humans. Other species pursue marlin, including sharks (Pepperell and Davis 1999; Block et al. 1992) and possibly killer whales (Mather et al., 1975), and young white marlin are likely eaten by a broad range of other species, including adult white marlins. Killer and pilot whales are known to prey upon marlin hooked on longlines (D. Kerstetter, pers. comm.).

3. Disease

We have found no information to indicate that disease is a factor in white marlin abundance. These animals likely carry a range of parasites that do not have any known population effects (Barse and Hocutt 1990).

The SRT concludes that there is no evidence that competition, predation, or disease are affecting the white marlin population in ways that would contribute to risk of extinction.

D. Evaluation of Adequacy of Existing Measures and Authorities

The SRT evaluated the risk of extinction and then evaluated the adequacy of management measures and authorities that could prevent further decline in biomass of the white marlin population.

1. Magnuson-Stevens Act and ATCA Measures and State Authorities

Domestic management measures implemented under the Magnuson-Stevens Act, ATCA, or state legislation are not adequate to protect white marlin from continued decline, given that U.S. fishing mortality is such a small proportion of the total mortality. In any case, most states' regulations and Federal regulations implement minimum sizes to comply with an ICCAT recommendation; these minimum sizes (as implemented in Federal waters) were not designed to protect a certain portion of the population but were rather designed to maintain landings below a certain level.

NMFS implemented a live bait prohibition on longlines operating in the Gulf of Mexico. This measure is predicted to reduce numbers of marlin caught on U.S. longlines by 326-2400 (NMFS, 2000).

Time/area closures are expected to reduce U.S. longline billfish catch by 12% if there is no re-distribution of effort and could increase discards of white marlin by 11%, if all effort is re-distributed to other areas (NMFS, 2000). It is likely that some re-distribution had occurred but data are not yet available to evaluate the effectiveness of these closures. Additional time/area closures were implemented in 2001 to reduce bycatch of sea turtles in the longline fishery. Interestingly, this U.S. closure affects only U.S. longline vessels and it occurs outside of U.S. waters, where vessels from other nations may continue to fish. Such a closure is not likely to have a significant positive impact on marlin bycatch given the location as well as the ability of other nation's vessels to fill the "void" created by the closure to U.S. vessels.

These measures alone, implemented under the Magnuson-Stevens Act and the ATCA are not adequate to protect white marlin. There may be some limited benefits, however, resulting from implementation of domestic management measures such as time/area closures in U.S. waters, particularly such measures that reduce overall fishing effort on white marlin. Longline closures in any area of high billfish bycatch could provide additional incremental protection that would complement international efforts.

2. Evaluation of Adequacy of ESA Measures and Authority

The U.S. currently accounts for approximately 5% of the total, reported catch of white marlin. It is realized that reporting of white marlin catches from some countries' artisanal and industrial fisheries is lacking, and as a result, the U.S.' actual share of the total fishing mortality on the Atlantic-wide stock of white marlin may be substantially less than 5%. If white marlin are listed as endangered, every effort would be made to minimize domestic interactions with the species, and in theory, there would be minimal U.S. fishing mortality. This would decrease total fishing mortality on the Atlantic-wide stock by a maximum of 5% (Figure 2).

In reality, it is likely that a closure of the U.S. pelagic longline and recreational fisheries would not result in a 5% reduction of fishing mortality on white marlin. The loss of target catch (tunas and swordfish) from the domestic pelagic longline fishery would be offset with increased imports from other nations. This demand would translate to increased fishing effort by other nations, and a resultant increase in the incidental catch of white marlin. Similarly, it is likely that some U.S. offshore anglers would opt to fish for white marlin on foreign flagged vessels stationed in other countries. The language of the ESA is quite broad regarding the activities of U.S. citizens away from U.S. waters; however, an ESA listing could increase recreational fishing effort in those countries. In some areas where white marlin are considered a valuable food source, it is likely that there would be less of a tendency for catch and release fishing, further increasing fishing mortality on the species.

3. Evaluation of Adequacy of International Measures and Authorities

Most white marlin are taken as incidental catch on pelagic longline gear, and traditionally, white marlin and other incidental or bycatch species have not received much attention by ICCAT. The ICCAT SCRS has assessed white marlin four times in recent years (1992, 1996, 2000 and 2002), and in each of these assessments the stock was determined to be overfished. Despite these findings, there have been relatively few management actions taken by ICCAT on billfishes until the past few years.

a. Adequacy of Current ICCAT Measures

In 1995, ICCAT adopted a non-binding resolution (95-12) that encouraged member nations to improve billfish research, update historical catch and effort data, increase participation in tag and release programs, and promote voluntary release of live billfish. The following year ICCAT adopted another resolution (96-9) that encouraged member nations to promote the use of monofilament leaders (gangions) to reduce billfish mortality, and to report on the costs and benefits of the use of monofilament leaders. The resolution also encouraged member nations to improve catch statistics and investigate the post-release mortality of billfish released live from commercial and recreational gears, information necessary to develop a recovery plan for billfish stocks.

ICCAT adopted its first binding recommendation for billfish at the 1997 Commission meeting (97-9). The recommendation required all member nations and cooperating parties to reduce landings of white marlin and blue marlin by 25% from landings reported in 1996 starting in 1998 with the full reduction to be accomplished by the end of 1999. The recommendation also encouraged parties to promote voluntary release of live billfish, and mandated the SCRS to conduct stock assessments in 1999. The following year, Recommendation 98-10 postponed the SCRS assessments to 2000 and extended the 25% landings reduction through the year 2000.

Considering reported catches of all nations in aggregate, the goals of Recommendation 97-9 appear to be met, although not all countries complied. Some countries exceeded the recommended catch reductions, thus compensating for any overages. Reported landings for the total Atlantic (excluding exempted small-scale artisanal fisheries) were 1231 mt in 1996 and the target reduction to be achieved by the end of 1999 was 923 mt. Reported and estimated landings of white marlin available at the 2002 SCRS assessment meeting (excluding exempted small-scale artisanal fisheries) were 1025 mt in 1998, 951 mt in 1999, and 790 mt in 2000. Reductions were evident in the landings reported by most nations with the exception of Brazil and the EC-Spain. ICCAT's Compliance Committee will consider the data and make official determinations of non-compliance.

The results of the 2000 billfish assessments indicated a continued reduction in white marlin biomass, and the Commission adopted another binding recommendation to establish a rebuilding plan for blue marlin and white marlin at the 2000 meeting (00-13). The recommendation provides for a two-phase program to rebuild overfished billfish stocks. In Phase 1, Contracting Parties were to reduce landings of blue marlin by 50% from 1999 levels, and landings of white marlin by 67% from 1999 levels. (Observer estimates of the percentage of white marlin alive at the time of longline gear retrieval range from 44% [Jackson and Farber, 1998] to 69% [NMFS, 1999].) Animals alive at the time of capture in the pelagic longline and purse seine fisheries were to be released in a manner to maximize survival. There were also provisions in Phase 1 to record catch composition and the number of live and dead releases, to improve catch and catch-at-size reporting, to improve observer coverage, and to adopt minimum sizes in recreational fisheries. The U.S. was required to have scientific observer coverage of at least 10% at recreational tournaments by 2002, and to limit to 250 the number of recreationally-caught blue and white marlin combined. In Phase 2, the SCRS was mandated to conduct assessments of blue marlin and white marlin in 2002, and to present an evaluation of specific stock recovery scenarios. The Commission would consider the SCRS advice at the 2002 meeting and develop and adopt programs to rebuild Atlantic stock of blue marlin and white marlin to levels that would support MSY. Based on a suggestion from the SCRS at the 2001 Commission meeting, a recommendation was adopted (01-10) that postponed the assessment of blue marlin until 2003, but continued the conservation measures specified in Phase 1 of Recommendation 00-13.

At the 2002 assessment of white marlin, 2001 landings data were not available from several parties. Therefore it was not possible to evaluate compliance with the mandated 67% reduction in white marlin landings implemented in 2001. Furthermore, assessment of compliance with live releases can only be determined through observer coverage. Most countries have limited or no observer coverage.

Several other ICCAT Recommendations limiting effort or catch for various target species also provide benefits to white marlin. Country-specific quotas are in place for North Atlantic swordfish, western Atlantic bluefin tuna, and North Atlantic albacore. Catch and effort limitations exist for South Atlantic albacore, bigeye tuna, and yellowfin tuna. In addition, a seasonal closure on fish-aggregating-device (FAD) fishing in the Gulf of Guinea could reduce fishing pressure on white marlin.

The final consideration regarding adequacy of international management measures relates to illegal, unreported, and unregulated (IUU) fishing that occurs in the Atlantic Ocean. IUU fishing activities have continued and increased in the Atlantic Ocean and are diminishing the effectiveness of ICCAT conservation and management measures (SCRS, 2001). There is evidence to indicate that vessel owners have re-flagged to avoid ICCAT management measures (ICCAT Resolution 99-11). At its 1998 meeting, ICCAT adopted a resolution (98-18) to address IUU fishing by large-scale longline vessels, considering that mortality of certain species, including white marlin, could be considerably higher than current data reflect. The non-binding resolution requested that all countries that imported ICCAT species provide ICCAT with detailed information about the vessels landing those species. ICCAT would then utilize this data to recommend non-discriminatory trade restrictions on any country whose vessels may be conducting IUU fishing. The resolution also requested countries to revoke licenses of vessels that may be fishing in such a manner that diminishes the effectiveness of ICCAT measures.

In 1999, ICCAT adopted another resolution (99-11) that urged countries to, among other things, take every possible action to urge their importers and other businesses to refrain from engaging in any transaction concerning ICCAT species that were caught by IUU vessels. Since adoption of the 1998 resolution, ICCAT has taken measures to implement trade restrictions on several countries whose vessels are fishing in an IUU fashion. In 2000, ICCAT adopted yet another resolution (00-19) to address IUU fishing by urging Japan and Chinese Taipei to complete the scrapping of Japanese-built IUU longline vessels. This resolution further intensifies actions recommended in the 1999 resolution. It is clear that ICCAT members have committed to addressing IUU activity, although it is difficult to evaluate whether their efforts will ultimately be successful. If IUU fishing mortality on white marlin is substantial, ICCAT management measures alone may not be sufficient to protect the species in the long-term. These efforts are supported by long-term efforts made by the Food and Agriculture Organization.

b. Population Projections

To predict effectiveness of current ICCAT recommendations, the SRT reviewed population projections of white marlin under various management/compliance scenarios.

Population projections are an integral part of stock assessment and, in this case, are important for determining the likely fate of stocks under consideration for ESA listings. Projection methodology for white marlin is limited because of the lack of age or size-based information on stock demographics. There are two viable choices for population projections in this case: (1) empirical projections based on trends in population sizes or indices, and (2) use of projection formulations consistent with production models used in stock assessment.

Empirical projections have been conducted for white marlin (Goodyear, 2002a) based on an exponential decline model, predicting an approximate 6% decline per year. Obviously, an exponential model will never lead to true population extinction, since the projected abundance will converge to, but not reach zero, as the time dimension approaches infinity. In this case, however, the exponential model predicts that, all things being equal, the decline will be to 18% of the 2000 abundance level by 2025. Thus, if the current abundance is 12% of B_{MSY} then the exponential model predicts it will be about 2% of B_{MSY} (1% of K) by 2025. A linear decline model (attempted by the SRT) provided even more pessimistic results, but the residuals were sufficiently patterned to reject a linear trend.

Population projections from production model results need to be interpreted with extreme caution. The models have most utility in tactical fisheries management for making short-term projections (1-2 years ahead). Because recruitment and growth dynamics are incorporated into a single term, ‘r’, however, long-term projections can only describe average conditions and will not, therefore, be sensitive to dynamics that may either rapidly rebuild a depleted stock (e.g., recruitment events), or that may constrain such stocks below average trajectories (e.g., depensatory processes). Mindful of these caveats, the SRT evaluated a series of population projections based on the Bayesian surplus production model of Babcock & McAllister (kindly provided on request by Dr. Beth Babcock). Several statistics can be computed from these projections, including the expected value of the final (year N) biomass in relation to K, and the probabilities that the biomass in year N exceeds various biomass benchmarks. The SRT decided to examine the probability that stock size falls below 0.01K under several future harvest scenarios. For a large pelagic species like white marlin, with virgin stock size estimated to be on the order of 2-3 million individuals, the SRT agreed that 0.01K would indicate a population with an ESA-level problem, without concluding at this time whether the 0.01K level would be most consistent with a vulnerable, threatened, or endangered level of risk. The 0.01K level is also consistent with the SRT’s evaluation of risk, based on absolute abundance.

The effects of 7 constant fishing mortality rate (F) and 4 constant Total Allowable Catch (TAC) based policies on white marlin biomass were evaluated with 2002 as the starting year for projections. Projections were provided for 5-year, 10-year, 20-year and 30-year horizons. The SRT focused on the 10 year projection in discussion, but all results are given in Figures 16 and 17. The following harvest policies were considered:

F=0 (cessation of all fishing mortality)
F=0.07 (100% compliance with ICCAT recommendation goals)
F=0.16 (highest value without appreciable chance of reaching 0.01K)
F=0.24 (approximately 75% of F_{2000})
F=0.30 (F_{2000} minus the U.S. mortality [i.e., no F generated by U.S. fisheries])
F=0.32 (F_{2000})
F at MSY

Catch=TAC of 300 mt
Catch=TAC of 599 mt (100% compliance with ICCAT goals)
Catch=TAC of 1,082 mt (2000 catch minus U.S. catch)
Catch=TAC of 1,130 mt (2000 catch).

Results are presented separately for the F-based and TAC-based policies. For F<0.15 there is no significant probability that the biomass in any of the time periods will go below 1% of carrying capacity. Above F=0.15, the probabilities increase with fishing mortality and time.

Constant TAC policies are much more risk-prone, initial probabilities (e.g., in 5 years) of the stock declining below 0.01K are greater than those associated with constant F policies, and these probabilities increase over time. Attaining constant catch with a decreasing population requires an increase in F, which may make some of the higher constant catch scenarios increasingly unlikely if the stock drops.

Figure 16. Calculated probabilities of white marlin biomass declining below 1% of carrying capacity (K) over time, based on the results of stochastic population projections from a Bayesian Schaefer production model. Probabilities are evaluated for 5 F-based policies.

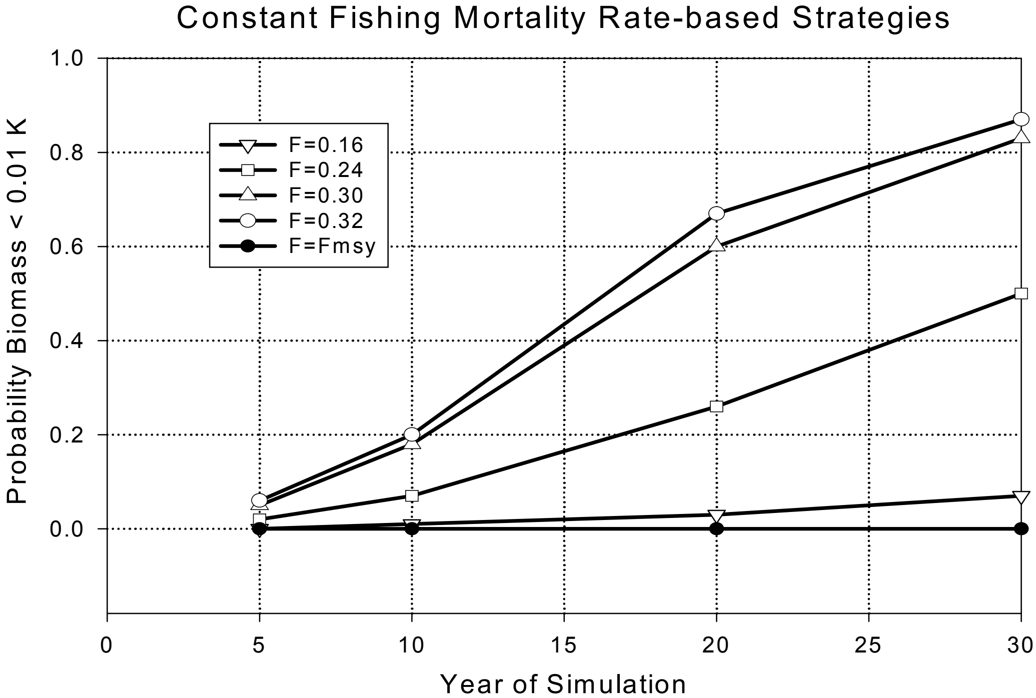
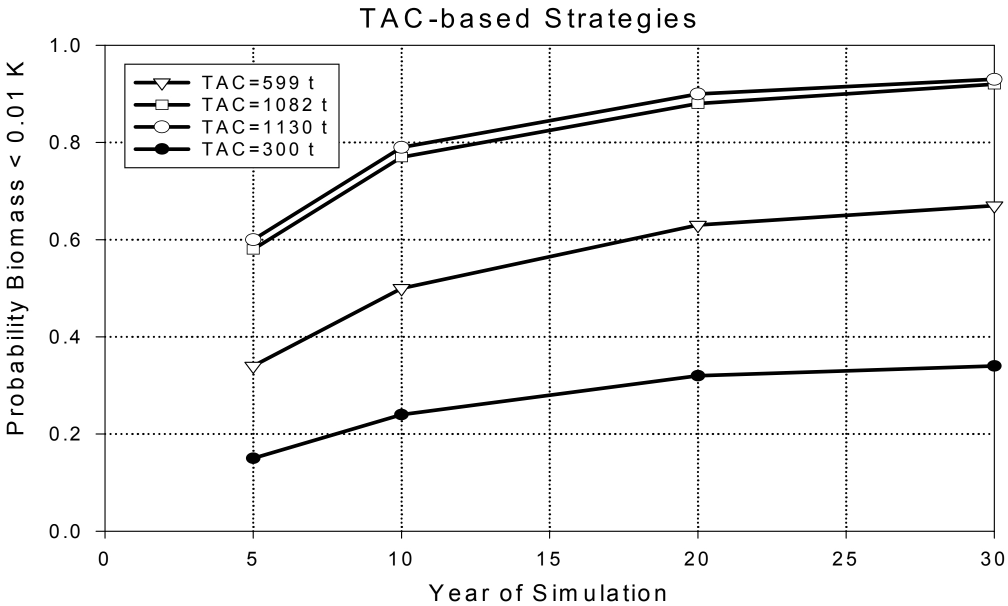


Figure 17. Calculated probabilities of white marlin biomass declining below 1% of carrying capacity (K) over time, based on the results of stochastic population projections from a Bayesian Schaefer production model. Probabilities are evaluated for 4 TAC-based policies.



Projection results from the Babcock and McAllister model indicate a relatively low probability of the stock declining to 1% of K or lower in the next 10 years, except in the circumstances when constant catch, status quo F (F_{2000}, which does not include any effect of the 2000 ICCAT Recommendation to reduce white marlin landings by 67%), or higher F scenarios are used. Under almost all model formulations, the stock is not now at or below 1% of carrying capacity (Figure 12 and Table 3). How likely is it that the stock will reach this condition within 10 years? Under status quo fishing mortality rates, there is about a 20% chance that the stock will reach 1% of K in 10 years. This conclusion is based on recent production parameters remaining constant. If stock productivity declines or F increases, the likelihood of the stock declining to 1% K increases.

c. Potential for Future ICCAT Measures

Above, we discussed existing ICCAT management measures for white marlin, general compliance with binding recommendations, and population projections. What is the possibility of future ICCAT management measures to protect white marlin? First, one must consider the likelihood that the U.S. ICCAT Commissioners would urge ICCAT members to adopt additional protective measures for white marlin in 2002. In certain recent years, the U.S. ICCAT Commissioners have pushed for strong conservation measures to protect marlins. There is no mandate, however, that any particular species should be a priority for the U.S. at any given ICCAT meeting. During 2002, the SCRS will assess western and eastern Atlantic bluefin tuna, North and South Atlantic swordfish, bigeye tuna, and white marlin. Based on the results of these assessments, the U.S. may wish to push for conservation measures on all of these stocks, but in reality, progress will be made for only one or two. Given the competing interests and the latitude U.S. negotiators have in directing the focus of U.S. efforts at ICCAT, Congressman Gilchrest introduced a resolution in Congress urging that white marlin be a top priority at ICCAT in 2002. This, in addition to a previous recommendation requiring ICCAT to adopt a rebuilding program may result in increased attention for white marlin by the U.S. at ICCAT.

Regardless of the potential U.S. effort to seek additional protective measures for white marlin at ICCAT in 2002, it is unknown if ICCAT parties would adopt additional measures to reduce overall fishing effort in order to protect white marlin or if compliance is likely to improve. Obtaining consensus on previous billfish recommendations was extremely difficult. One additional management measure to reduce fishing effort on white marlin would be to develop international time/area closures for longline and purse seine vessels. To consider the likelihood of ICCAT implementing such closed areas for white marlin, we can consider their progress in closing areas to protect juvenile swordfish. Swordfish are a target of many of the longline fleets and a species that is subject to an ICCAT rebuilding program. ICCAT adopted a non-binding resolution in 1999 (99-04) that tasked the SCRS with analyzing data and identifying areas for possible closure that would contribute to the protection of undersized swordfish. The SCRS has undertaken such a study and will likely present ICCAT with potential options at the 2002 meeting. Whether any of these options would be adopted by ICCAT is unknown, although there appears to be support for the idea among ICCAT members due to concern for the swordfish population. Billfish, however, are bycatch species, and there may not be support for a reduction in fishing effort on target species to protect white marlin.

For example, Japan appears to be committed to ICCAT measures currently in place regarding white marlin. The Japanese government has implemented regulations to require release of all live billfish and vessels appear to be complying (R. Husted, pers. comm.). However, it should be noted that Japan has expressed serious concern about the SCRS white marlin stock assessment (ICCAT, 2000). In 2000, Japan indicated in a position paper at the outset of the ICCAT meeting that there was no need to take drastic management measures, but Japan ultimately supported the consensus recommendation from that meeting to reduce white marlin landings by 67%. Japanese scientists participated in the 2002 white marlin assessment, but some Japanese scientists have expressed concern for what they perceive to be bias in the assessment results. Given that Japan will find fault with the SCRS assessment results for white marlin, it is not likely that they would support further conservation measures to protect this species in 2002, nor would they encourage other Contracting Parties to do so.

Finally, one must also evaluate whether such measures, if implemented, would be effective given past lapses in compliance. In 1999, NMFS indicated concern regarding international compliance in Amendment 1 to the Billfish FMP (NMFS, 1999). Lack of compliance can not only diminish the effectiveness of ICCAT's measures but also impede the progress of any domestic or international rebuilding plan for white marlin. While closed area(s) would likely be the most effective of all the options, they would require significant enforcement resources on the high seas. Vessel monitoring systems (VMS) would be an effective way to monitor closed areas; however, despite ICCAT's adoption of a limited pilot program for VMS (Rec. 97-12), member nations have not pursued such a program fleet-wide. Therefore, compliance would be dependent on the resources each member country would devote. In 1998, ICCAT implemented a closed area/season for the use of FADs to protect juvenile tunas. While this closure is not a direct parallel to a potential longline closure due to the difference in the fisheries, its success can be evaluated to determine generally, if time/area closures on the high seas could be adequately enforced. The closure was adopted as a binding recommendation by ICCAT in 1998; the following year ICCAT extended that measure (98-1, 99-1). Early data indicated the closed area had a strong effect on fishing patterns (SCRS, 1999). In 1998, the closure was enforced by three tuna boat owners' associations and observer coverage of the purse seine fleet was close to 95% (SCRS, 1999). The purse seine fishery continued to comply with the closed area in 2000 (SCRS, 2001). Voluntary compliance is only likely if Contracting Parties perceive a benefit to their fisheries.

d. UNCLOS

Because ICCAT exists as a regional fishery management body, the UNCLOS depends on ICCAT to protect white marlin. As a stand-alone instrument, the UNCLOS Straddling Stocks agreement is not adequate to protect white marlin. As of January 2001, only 27 countries had ratified the agreement. The agreement entered into force in 2001, after 30 countries had ratified it. There is no effective enforcement tool. While the Agreement recognizes that most of the actual conservation and management work for highly migratory fish stocks must be carried out through ICCAT or other regional fishery management organizations, it recommends some specific measures to strengthen the operations of such organizations. For example, one Article requires any State whose fishermen wish to harvest a stock that is governed by such an organization either to join or to agree to apply the conservation and management measures established by the organization. Many countries fishing in the Atlantic are not members of ICCAT, and IUU fishing continues to exist.

4. Evaluation of Non-Regulatory Measures

The effectiveness of the non-regulatory measures largely implemented by the recreational fishing community is difficult to evaluate. The catch-and-release ethic practiced in the U.S. has had an important impact on recreational landings, although post-release mortality still accounts for some unknown level of mortality in this fishery. This ethic has probably been important in gaining the respect of the international community, which was not familiar with the value of recreational fishing or the public interest in catch-and release fishing in general. Many countries view fishing as a means to land seafood. There has been some concern by the international community about the impact of the recreational fishery, given the gaps in data collection from this fishery in the past. It is likely that the catch-and-release nature of the fishery minimizes the concerns of the foreign fishing nations regarding the U.S. recreational fishery.

Despite the "No Marlin on the Menu" campaign, marlin continues to be widely offered by grocery store chains and in restaurants, thereby undermining the educational nature of the campaign. It is not likely that this campaign has boosted conservation of the species, but it may have enhanced enforcement of the ban on sale of Atlantic marlin.

Promoting recreational marlin fishing opportunities in other parts of the world could have a substantial impact on how small island nations, in particular, view commercial fishing. For example, a nation that realizes the value of marlin fishing and the related tourism benefits may be likely to favor the recreational take of marlin over commercial landings. Any nation that has an economic incentive to protect marlin is more likely to cooperate with restrictive measures recommended by ICCAT.

Recreational and commercial participation in billfish tagging programs has produced a substantial amount of data related to marlin biology and ecology. Although this information has not led to any specific conservation measures being adopted by ICCAT (e.g., time/area closures), it may contribute to the determination of essential habitat for this species.

5. Summary of Adequacy of Measures and Authorities

In conclusion, the SRT recognizes that domestic measures by the U.S. alone will have a negligible impact on the stock status of white marlin. Current measures by ICCAT are not sufficient to prevent continued overfishing. Even in the "best case" scenarios (that 67% of white marlin survive on the longline or in the purse seine to be released alive, full compliance by all parties, no post-release mortality, and no IUU fishing), population projections resulted in a reduction in the rate of stock decline, with a very small probability of a slight rebuilding. Considering that 67% of white marlin may not survive to be released alive, that there is post-release mortality, non-compliance with ICCAT recommendations, and a significant level of IUU fishing, current ICCAT management measures are not sufficient to stop the decline in abundance of white marlin.

While it is impossible to predict future ICCAT actions, the SRT believes that additional, meaningful management measures for white marlin are unlikely to be adopted by the Commission in the near future. Already, scientists of certain parties are working to undermine the results of the 2002 white marlin stock assessment. In past years such "doubts" regarding assessments have been used to prevent or delay the adoption of management measures, and it is unlikely that the Commission will reduce effort on valuable target species simply to protect bycatch species. Although white marlin will likely benefit from future management measures to reduce effort on overfished target species and curb IUU fishing, it is likely that such measures will not be sufficient to reverse the current stock decline.

The SRT concludes that the Magnuson-Stevens Act, ATCA, the ESA (if white marlin were listed), UNCLOS, and current non-regulatory conservation measures are not adequate to affect extinction risk for white marlin, and ICCAT is currently the only forum in which effective cooperative management action could be taken to reverse the white marlin's population decline. Current ICCAT management measures are not sufficient to prevent stock decline, and the SRT is concerned about ICCAT's resolve to adopt further, effective management measures to protect white marlin - to ICCAT, a bycatch species - in the immediate future.

E. Other Natural or Manmade Factors Affecting White Marlin's Continued Existence

The petitioner raised concerns in the petition and in a subsequent April 4, 2002 letter to NMFS about an additional potential threat to white marlin: the U.S. Navy's proposed use of the Surface Towed Array Sensor System Low Frequency Active (LFA) sonar. The LFA sonar is a low-frequency, extremely high energy active sound transmission to detect acoustically quiet targets over long distances. The Navy may begin operational use of LFA sonar by one vessel in the Atlantic Ocean. The petitioner raised concerns that exposure to this high decibel sound source may injure or kill white marlin and other marine life. The Navy has prepared a final environmental impact statement (FEIS) on LFA sonar and has applied for and received from NMFS a small take authorization under the Marine Mammal Protection Act for the effects of the system on marine mammals (67 F.R. 46712, July 16, 2002). NMFS, in issuing the small take authorization, determined that LFA sonar would have a negligible effect on stocks of acoustically-sensitive marine mammals. The Navy, in their FEIS, concluded that LFA sonar's effects on stocks of marine fish – which are generally much less acoustically dependent than marine mammals – would be negligible. As part of the mitigations to avoid effects to marine mammals, the Navy will use, in conjunction with the LFA, a high-frequency, lower energy fish-finder type sonar to detect dolphin-sized (and greater) marine mammals and cease LFA transmissions if animals are tracked that may enter the region of potential injury to marine mammals (U.S. Navy, 2001). White marlin, due to their size, are likely detectable by this system and may thus avoid ensonification at high levels. **Operation of LFA sonar is not a threat that may cause the white marlin population to become endangered.**

The SRT did not identify any other natural or manmade factors affecting white marlin's continued existence not already discussed above.

VII. Summary – Conditions Under Which ESA Action Would Be Warranted

The two statutory ESA listing factors of primary concern for white marlin are overutilization and the inadequacy of existing measures to end overfishing and recover the population. While the SRT does not believe the stock has declined to levels consistent with imminent risk of extinction, unless fishing mortality is reduced significantly or recruitment prospects for the stock measurably improve, there are several scenarios under which stock declines to below 1% of carrying capacity within 10 years are probable. At this 1% of carrying capacity level, the SRT believes that the stock would warrant ESA protection. The table below lists some of the potential scenarios of fishing mortality (decreasing, unchanged, increasing), and stock productivity (recruitment to the population) that would potentially lead to the 1% K condition. The most problematic scenarios represent status quo or declining recruitment combined with status quo or increasing fishing mortality. Fishery and population mechanisms associated with each of the nine possible combinations of recruitment and fishing mortality scenarios are given in appropriate table columns**.** Each column of the table is independent. Given each future recruitment and mortality situation of the first two rows, the likelihood of the population decreasing to levels warranting ESA concern is offered in the third row. The SRT did not consider the relative likelihood of the outcomes described in the separate columns. Considering these potential outcomes, though, there is risk that the population could eventually fall below 1% of carrying capacity unless fishing mortality is decreased substantially in the short- to medium-term.

White Marlin Scenario Table – Likelihood of Reaching 1% of Carrying Capacity by 2010

IF Future Recruitment	Increases			Does Not Change			Decreases		
AND Future Mortality	Decreases	Does Not Change	Increases	Decreases	Does Not Change	Increases	Decreases	Does Not Change	Increases
THEN Likelihood of B2010<.01K is	**Very Unlikely**	**Unlikely**	**Unlikely**	**Unlikely**	**Possible**	**Possible**	**Possible**	**Probable**	**Probable**
Fishery Mechanisms Associated with this Scenario	- effective reduction in fishing mortality due to measures	-cap on effective fishing effort -no spatial focusing --catch remains high despite quota decrease	-increased effective effort -spatial focusing of fishery on marlin -high discard mortality	- effective reduction in fishing mortality due to measures	-cap on effective fishing effort -no spatial focusing -catch remains high despite quota decrease	-increased effective effort -spatial focusing of fishery on marlin -high discard mortality	- effective reduction in fishing mortality due to measures	-cap on effective fishing effort -no spatial focusing -catch remains high despite quota decrease	-increased effective effort -spatial focusing of fishery on marlin -high discard mortality
Population Mechanisms Associated with this Scenario	-improved recruitment due to increased SSB -Compensation (improved recruitment at low stock sizes)	-improved recruitment due to increased SSB -Compensation (improved recruitment at low stock sizes)	depensation (increased natural mortality at low stock sizes) -improved recruitment due to increased SSB -Compensation (improved recruitment at low stock sizes)	Compensation (improved recruitment at low stock sizes)	-Compensation (improved recruitment at low stock sizes)	-depensation (increased natural mortality at low stock sizes or decreased recruitment to the stock)	-population already below depensatory threshold (so recruitment does not improve even when F reduced)	-depensation (increased natural mortality at low stock sizes or decreased recruitment to the stock)	-depensation (increased natural mortality at low stock sizes or decreased recruitment to the stock)

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Appendix 1.

Atlantic White Marlin Status Review
Summary of Comments from Scoping Meetings

Staff from the Southeast Regional Office, Protected Resources Division, and the Office of Protected Resources, Endangered Species Division, held 11 public scoping meetings on the Endangered Species Act (ESA) status review for Atlantic white marlin. The meetings' purpose was to inform the public on the status review and listing process and to solicit information from the public that may be useful to the status review and the National Marine Fisheries Service's (NMFS) listing determination for white marlin.

<u>Public Scoping Meeting Locations and Dates</u>
Silver Spring, Md., June 11
Miami, Fla., June 17
New Orleans, La., June 18
Panama City Beach, Fla., June 19
Orange Beach, Ala., June 20
St. Thomas, USVI, June 24
Atlantic Beach, N.C., June 24
Manteo, N.C., June 25
Fairhaven, Mass., June 27
Atlantic City, N.J., June 27
Ocean City, Md., June 28

<u>Additional Meetings</u>
ICCAT Advisory Committee, June 11
SAFMC, June 18
MAFMC, August 9

The scoping meetings generated a lot of public participation. Many participants expressed their appreciation of NMFS for coming out to explain the petition and listing process, as well as providing an opportunity for public input. The level of participation varied by location. Two sites had low (<= 6) attendance: Fairhaven and St. Thomas. Five sites had medium attendance (10-40): Miami, Panama City Beach, Atlantic Beach, and Atlantic City. Four sites had high attendance (60-100+): New Orleans, Orange Beach, Manteo, and Ocean City. The attendees were almost entirely recreational fishermen or associated with sportfishing-related concerns. A few speakers were state fisheries managers and elected officials or their representatives.

The comments at the meetings were highly similar, regardless of location. Below is a summary of the comments. The commenters were asked specifically to focus their comments on information on the biology and status of white marlin and on the applicability of the ESA's five listing factors to white marlin. We received oral statements at each meeting, recorded by a court reporter, and a number of written statements and letters. Many of the speakers were recreational fishermen who gave anecdotal accounts of fishing experiences; an attempt has been made to consolidate those accounts. A number of participants have submitted written records of marlin catches during tournaments or other targeted marlin fishing trips, subsequent to the meetings. Those records are being forwarded to the Southeast Fishery Science Center for evaluation for scientific utility; because of the limited time to complete the status review, it is unlikely that those records can be compiled and used explicitly for this status review. Without exception, the commenters expressed opposition to ESA listing for white marlin.

<u>Public Comments</u>
Status of the Stock
White marlin have always been rare.

White marlin are in trouble.

Recreational catches along the U.S. coast have always been highly variable from year-to-year. The variability is attributed to oceanographic conditions in and along the continental shelf.

Catch has decreased compared to previous years.

Catch has declined compared to the 50s, 60s, and 70s, but has leveled off.

A trend in catch cannot be seen because of the high interannual variability. Periodic big years indicate that the stock is OK.

White marlin have been steadily increasing off North Carolina in the past 10 years.

Not a lot of white marlin are caught in St. Thomas.

White marlin are not "in extremis," which should be the standard for ESA listing.

White marlin have declined greatly and are continuing to decline, but the population is large enough now to sustain the impact, while we wait for management measures to be implemented.

Threat from Overfishing
White marlin are being overfished, but by international longliners, not U.S. fishermen.

It's a big ocean out there, and it's impossible to catch the last fish. That is, overfishing alone cannot result in extinction.

White marlin are in similar or better shape to species that have responded positively to management after having declined to very low levels.

No highly migratory species has ever been considered for ESA listing before. There is no precedent, and it is hard to believe that a fish occupying such a large habitat can actually be endangered.

Impact of Recreational Fishing on White Marlin
The overall impact of U.S. sportfishing on white marlin is minimal.

Most marlin tournaments do not focus on white marlin, because blue marlins have the greater weights. Some tournaments in the Gulf do not even give white marlin catch and release points.

White marlin are always, or nearly always, released by sport fishermen as an ethical issue. Many commenters said they could live with a 100% catch and release requirement.

Some post-release mortality for sport-caught marlin is acknowledged, but the increasing trend to use circle hooks is reducing the injury and therefore the post-release mortality.

Impact of International Fisheries on White Marlin
Foreign longliners are the real problem, so international (rather than domestic) management/ restrictions should occur. (** Probably the number 1 comment.**)

The U.S. should make billfish conservation a top priority at ICCAT negotiations, perhaps giving concessions in other (commercial) interests to gain negotiating strength.

Foreign longliners have come into U.S. waters in the Caribbean.

Adequacy of Data
NMFS and ICCAT were criticized for not undertaking research to develop basic life history parameters for white marlin. NMFS and ICCAT should make white marlin research a high priority.

The absence of basic life history data limits the models that can be used and/or compromises the effectiveness of the models.

It would be a shame if American fishermen were restricted on the basis of poor data or poor data models.

Some ICCAT members do not collect or submit quality data on billfish. The U.S. should insist on better reporting performance from other countries.

Billfishermen have not been reporting all their catches to NMFS. They now realize this was a mistake and urged other fishermen to accurately report their catches.

Better information on the distribution and reproductive behavior of white marlin could suggest alternative (time-area based) management measures.

Adequacy of Management
Mechanisms ARE in place to adequately manage white marlin. Reasonable conservation measures that do not unfairly burden U.S. fishermen would be supported.

We need to put more teeth in ICCAT so there are consequences for overages.

We need to enforce the provisions we have. There is no enforcement presence in the U.S. EEZ in the Caribbean. Who is enforcing ICCAT recommendations on other nations' vessels on the high seas?

We need to evaluate the effectiveness of current U.S. management and ICCAT recommendations before applying additional restrictions.

Effectiveness of ESA Listing
ESA listing would be ineffective or even counter-productive:

- By listing white marlin, the U.S. would lose credibility and negotiating position at ICCAT, especially for efforts to protect white marlin.
- An ESA recovery plan would do little other than repeat a fishery management plan, which is already in place.
- The ESA has not been effective for many species. For example, leatherback turtles are declining because of egg poaching and longline interactions, but the ESA hasn't controlled the decline.
- ESA listing would reduce cooperation from commercial and recreational fishermen in conserving white marlin.

Eliminating U.S. catches of white marlin entirely (by shutting down recreational and/or commercial fishing) would have a negligible effect on the stock, since the U.S. contribution to mortality is so low.

Eliminating U.S. recreational fishing would reduce white marlin stocks, since dolphinfish would flourish and consume young marlin.

White marlin are in trouble and need conservation, but the ESA is the wrong way to do it: use existing fishery management mechanisms and techniques.

Effects of Listing on Recreational Fisheries
Recreational fishing and boating would be "devastated." The economic cost of listing "could run hundreds of millions of dollars and cost tens of thousands of jobs in the recreational fishing sector.

The impact to the boat-building industry has to be considered also since many luxury sportfishing boats are built explicitly for marlin fishing.

If there will be significant impacts to the recreational fishing sector, there should be some type of compensation to recreational fishermen, similar to that discussed in commercial "buy-out" schemes.

Other Threats
It is assumed that the population decline is the result of overfishing, but we haven't assessed whether a regime shift in Atlantic Ocean climate has affected white marlin reproduction and catch rates.

Prey competition is not a threatening factor for white marlin: they eat a wide variety of fish and the continental shelf and ocean stocks of those prey fish are not overfished.

Alternative Protection Measures NMFS Should Take to Listing

Wait and See: The Billfish FMP and ICCAT measures have been put into effect only recently, and sufficient time has not passed to adequately judge the effectiveness of the measures. Therefore, it is premature to determine that the existing regulatory mechanisms are ineffective.

Push hard at ICCAT for compliance with billfish recommendations and even seek greater reductions of billfish landings.

Make all white marlin sportfishing catch and release only (no-kill).

Require circle hooks for U.S. recreational billfishing.

Make billfish tagging mandatory.

Close additional areas to U.S. longliners.

Impose gear restrictions on U.S. longliners to protect white marlin.

Provide additional observer coverage on the longline fishery to evaluate the effectiveness of gear restrictions and area closures.

Provide more enforcement effort towards domestic and international billfish management measures.

Miscellaneous
Who is on this status review team? Participants were always satisfied when told, with the exception of one gentleman who felt that John Hoey should have been on the team.

Listing white marlin sets a dangerous precedent in fisheries management. There are other fish species at similar or lower levels of biomass.

The ESA should be changed to prevent NMFS from even considering ridiculous proposals like listing white marlin.

There were expressions of anger that the petition was accepted and the listing process begun.

Many criticisms were made of the petition and particularly the petitioner.

There were calls to action to the other participants: call your Congressman to express his concern about listing white marlin to NMFS and the State Department (to impress the importance of billfish at ICCAT negotiations).

NMFS will be sued by one side or the other, regardless of its decision to list or not to list.