Ad Hoc Committee Review of 2002-2003 U.S. Recreational Fishery Landings Estimates for White Marlin, Blue Marlin, and Bluefin Tuna

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Executive Summary

An *ad hoc* Committee was formed to review the 2002 estimates of U.S. recreational fishery landings of white marlin, blue marlin, and bluefin tuna reported by NOAA Fisheries to ICCAT. The Committee was charged with reviewing the data collection and estimation methods that were used to verify that the reported estimates were the most accurate that could be made with available 2002 data. The Committee was also charged with recommending methods to be used for the estimation of 2003 recreational fishery landings of marlins and bluefin tuna. The Committee was later charged with using the recommended methods to produce landings estimates from the available 2003 recreational fishery data.

NOAA Fisheries originally reported 2002 U.S. recreational fishery landings of 193 white marlin weighing 5.6 mt and 74 blue marlin weighing 14.9 mt. In addition, NOAA reported recreational fishery landings of 559 young school bluefin tuna weighing 2 mt; 13,245 school bluefin tuna weighing 168 mt; 10,225 large school bluefin tuna weighing 378 mt; and 1,927 small medium bluefin tuna weighing 122 mt in Virginia through Maine.

The monitoring programs that collect data on recreational fishery landings of these species include the Recreational Billfish Survey (RBS), the Large Pelagics Survey (LPS), the Marine Recreational Fishery Statistics Survey (MRFSS), the For-Hire Survey (FHS), the NOAA Fisheries mandatory Automated Landings Reporting System (ALRS) program, and the Catch Card Census (CCC) programs conducted in North Carolina and Maryland. The RBS provides near complete coverage of billfish landings by recreational fishing tournaments that target billfish; the LPS covers the landings of offshore recreational fishing trips that target tunas, billfish, swordfish, sharks, dolphin, wahoo, and amberjack in Virginia through Maine from June through October; the MRFSS covers all recreational fishery landings in Louisiana through Maine and Puerto Rico; the FHS now covers recreational fishery landings by charter boats in the Gulf of Mexico and by charter boats and headboats operating on the Atlantic Coast; the ALRS tracks reported recreational landings of bluefin tuna and billfish; and the CCC programs attempt to census landings of those species in Maryland and North Carolina.

Landings Estimates for Bluefin Tuna

The 2002 recreational fishery landings estimates reported for bluefin tuna were based on estimates produced by the 2002 LPS. Several improvements were made in the 2002 LPS that increased the efficiency and accuracy of both the telephone and intercept surveys. These improvements resulted in both higher contact rates and lower respondent burdens for the telephone surveys and higher numbers and more even geographic distributions of captain interviews obtained on the intercept survey. The 2002 LPS estimation procedures were consistent with methods advocated by NOAA Fisheries reviews in previous years. The Committee tested alternative estimation approaches that could potentially improve the precision and accuracy of estimates, but these had only very minor effects on the LPS point estimates of bluefin tuna landings in 2002. After identifying and resolving several problems with the raw data sets and two significant problems with the estimation programs used for the 2002 LPS estimates, the Committee generated revised estimates of 2002 recreational landings of bluefin tuna The revised estimates are as follows: 275 young school bluefin tuna weighing 1.2 mt; 10,363 school bluefin tuna weighing 150.9 mt; 8,693 large school bluefin tuna weighing 367.0 mt; and 1,557 small medium bluefin tuna weighing 113.1 mt. The North Carolina CCC program recorded an additional 113 large school and small medium bluefin tuna weighing a total of 9.4 mt, resulting in a total 2002 recreational landings estimate of 641.6 mt.

The revised 2002 LPS estimates of numbers of fish landed by size class are about 19.5% lower than the estimates previously reported to ICCAT, even though the North Carolina estimates were not included in the initial report. This change is largely attributed to the resolution of a software problem that caused an overestimation of mean catch rates in the 2002 LPS. However, the revised 2002 LPS estimate of the total weight of bluefin landed by rod and reel fishing is only about 6% lower than what was previously reported because the mean weights of landed fish by size class had been previously underestimated by about 17%. The Committee determined that mean weights had been underestimated because LPS length measurements had incorrectly been assumed to be curved lengths rather than straight lengths. These specific problems in the estimation of mean catch rates and mean weights were not found in the LPS estimation programs used in previous years.

In 2003, the LPS telephone survey of HMS charter/headboat permit holders was conducted as part of the new For-Hire Survey to minimize the reporting burdens of for-hire boat operators. This change made it necessary to modify the computer programs used for the LPS estimates to accommodate differences between the FHS and the traditional LPS databases in the way data was formatted and structured. Also, the Committee had to reconstruct the FHS/LPS telephone sampling frames to include the HMS charter/headboat permit numbers needed to identify boats intercepted by the LPS dockside survey that were also included in the telephone survey.

Using the revised estimation methods developed for the 2002 LPS estimates, the Committee produced 2003 LPS estimates of numbers and weight of bluefin tuna landed by recreational anglers in Virginia through Maine. The 2003 landings estimates are as follows: 73 young school fish weighing 0.3 mt; 7,598 school fish weighing 137.7 mt; 4,478 large school fish weighing 176.4 mt; and 1,393 small medium fish weighing 96.3 mt. The Committee used the same methods that were used for the 2002 LPS estimates to convert estimated numbers into total estimated weights. No landings of school and small medium bluefin occurred in North Carolina during the 2003 fishing year, and the total of the estimated landed weights of these size categories was 410.7 mt, which was about 35% lower than the total for 2002.

The Committee also post-stratified both 2002 and 2003 LPS estimates of total landings by size class so that separate estimates were produced for the Northern and Southern management areas. The boundary used for the purpose of generating these stratified estimates was the boundary between Ocean and Atlantic Counties in New Jersey. In 2002, an estimated 89.9 mt of bluefin tuna were landed in the Northern area and an estimated 542.3 mt were landed in the Southern area. In 2003, an estimated 127.7 mt were landed in the Northern area and an estimated 283.0 mt were landed in the Southern area.

The Committee evaluated the accuracy of the bluefin tuna landings reported to the Maryland CCC program and the NOAA Fisheries Automated Landings Reporting System (ALRS) by determining the proportions of landed bluefin tuna observed by the LPS that were also reported to those programs. These comparisons indicated that the Maryland CCC Program undercounted bluefin tuna landings by at least 14% in 2002 and 15% in 2003. The comparisons of LPS and ALRS data showed that the ALRS undercounted combined bluefin tuna landings in Virginia, Delaware, New Jersey, New York, Connecticut, Rhode Island, and Massachusetts by averages of 79% in 2002 and 82% in 2003.

The Committee began evaluating methods for characterizing uncertainty about the LPS estimates and provided preliminary multiplicative estimates of variances, percent standard errors, and 95% confidence limits for the 2002 and 2003 LPS landings estimates so that the uncertainty of those estimates could potentially be taken into consideration for compliance monitoring.

Landings Estimates for Marlins

This report provides a brief explanation of the logic behind the scalar expansion procedure used for white marlin landings estimates for calendar year 2002 (as well as years prior to 2002 as documented in SCARS/2000/57 and SCARS/2002/74). The scalar expansion method attempts to find a stable ratio of total recreational landings to total tournament landings that can be estimated with available data and used as a reliable expansion factor to convert annual tournament landings estimates into total landings estimates. The method uses the 1981-2002 MRFSS and RBS estimates for white marlin to estimate annual total/tournament landings ratios which were then averaged to provide an estimate of the necessary expansion factor. Statistical tests were unable to show any significant temporal trend in the annual MRFSS/RBS ratios, and the calculated expansion factor based on the average MRFSS/RBS ratio was 5.86. When the RBS tournament recorded landings of 951 kg of white marlin for calendar year 2002 was expanded by this factor a total white marlin landings estimate of 5.56 mt was obtained. This corresponds to an estimate of 193 fish landed in calendar year 2002.

When the scalar expansion method was attempted for blue marlin, the estimated ratios based on 1981-2002 MRFSS and RBS estimates proved to be temporally unstable. Consequently, the scalar expansion was not used and only the RBS recorded landings for blue marlin in calendar year 2002 were reported to ICCAT.

The Committee identified and attempted to evaluate the limiting assumptions of the scalar expansion method and considered the validity of the resulting estimates by making comparisons with alternative estimates that could be produced from other sources of information on recreational white marlin landings. The Committee recognized that it may not be valid to assume that the RBS estimates of tournament landings and the MRFSS estimates of total landings of white or blue marlin are unbiased. The RBS has not consistently provided complete coverage of all tournament landings of marlins. The MRFSS estimates could potentially be negatively biased because the intercept survey sampling of angler trips avoids sites with fishing tournaments. They could also be positively biased because sampling surveys tend to overestimate rare events, and marlin landings are rare in the MRFSS sampling. Comparison of the new 1998-2003 FHS estimates with the traditional MRFSS estimates for Gulf of Mexico charter boats suggests that the MRFSS estimates for offshore charter boat fishing effort and catch in the Gulf have been positively biased to some degree. The net effects of different potential positive and negative biases are hard to assess at this time for all coasts.

Several alternative estimators of total recreational fishery landings of white marlin were investigated. Alternative estimators of the MRFSS/RBS ratio were examined to determine if the estimator used by Goodyear *et al*. (2001) and Goodyear and Prince (2003) was the most appropriate to use for estimating marlin landings in 2002, 2003, and future years. The Committee found that MRFSS/RBS ratio estimates tended to decrease progressively as fewer recent years of estimates (1981-2002, 1982-2002, 1983-2002, ..., 1998-2002) were included in the calculations, but they also tended to become progressively less precise. The Committee also identified other possible estimators of mean MRFSS/RBS ratios that produce different results from the one that has been used. Simulation studies are needed to compare the performance of these alternative ratio estimators and determine which is the most robust. Therefore, the Committee cannot recommend superior methods to those employed for 2002 at this time.

Scalar expansion ratios derived from the LPS and RBS estimates for VA-ME were examined and compared with those based on MRFSS and RBS estimates. In general, the estimated LPS/RBS ratios were higher than the MRFSS/RBS ratios. In addition, LPS estimates for total white marlin landings in Virginia through Maine in 2002 and 2003 were compared with the estimates derived from expansions based on the estimated MRFSS/RBS ratios. Although the LPS estimates were higher than the ratio-expanded estimates in both years, the differences are not statistically significant because the expanded estimates were within the approximate 95% confidence regions around the LPS estimates.

The available data for blue marlin landings show that the estimate of recreational blue marlin landings reported to ICCAT for 2002 (and a number of prior years) was negatively biased because it did not account for any non-tournament landings. This is especially apparent because non-tournament landings of blue marlin have been intercepted by the MRFSS in Puerto Rico in each of the last four years. The 2000-2003 Puerto Rico landings estimates vary between 534 and 1,747 fish, but the estimates are imprecise due to low effective sample sizes. Nevertheless, the MRFSS suggests that blue marlin landings are much more common in Puerto Rico than in TX-ME. The Committee recommends that sufficient catch monitoring mechanisms be instituted to better assess the non-tournament landings of blue marlin by U.S. Caribbean recreational fishing to avoid what could be a significant undercounting of total U.S. recreational landings for this species.

Although the Committee agrees that the scalar expansion method or other ratio approaches are very reasonable to use for time periods when white and blue marlin landings were commonly observed by the MRFSS intercept survey sampling, such approaches will probably become less suitable as MRFSS observations of landings become more rare. The trend toward greater catch and release fishing for marlins suggests that MRFSS observations of U.S. continental marlin landings may continue to decrease over time unless increasingly higher dock-side sampling levels are instituted. Increasing sampling to achieve more precisely estimated landing levels for marlin is likely to be cost inefficient for the total recreational catch component. Therefore, the Committee recommends the development of an adequately enforced, specialized census approach similar to the Maryland and North Carolina CCC programs for future assessments of the total recreational fishery landings of marlins.

General sampling surveys of recreational fishing will probably be inadequate to provide the level of precision desired for monitoring of such small annual landings quotas for species targeted only by a small subset of the total recreational fishery. However, sampling surveys will still be necessary to provide useful catch-per-unit-effort and biological information for monitoring stock abundance, as well as a means of checking and measuring the level of non-compliance, hence the level of undercounting, of the CCC approach.

Introduction

On February 4, 2004, Dr. Michael Sissenwine assigned Dr. David Van Voorhees, Chief of the Office of Science and Technology's Division of Fisheries Statistics and Economics (F/ST1), to recruit and chair an *ad hoc* Committee to evaluate the methods that were used by NOAA Fisheries to generate the 2002 estimates reported to ICCAT for recreational fishery landings for white marlin, blue marlin, and bluefin tuna. Dr. Sissenwine charged the Committee to review the methods and verify that the 2002 estimates were the best that could be made with available data.

With the approval of Mr. Jack Dunnigan (Director of the Office of Sustainable Fisheries) , Dr. Nancy Thompson (Director of the Southeast Science Center), and Dr. John Boreman (Director of the Northeast Science Center), Dr. Van Voorhees recruited the following NOAA Fisheries scientists to participate in the evaluation:

Dr. Gerald Scott, Southeast Fisheries Science Center (F/SEC)
Dr. Christopher Rogers, Chief, Highly Migratory Species Division (F/SF1)

Dr. Mark Terceiro, Northeast Fisheries Science Center (F/NEC)
Dr. Craig Brown, Southeast Fisheries Science Center (F/SEC)
Dr. Eric Prince, Southeast Fisheries Science Center (F/SEC)
Dr. Joseph Desfosse, Highly Migratory Species Division (F/SF1)
Mr. William R. Andrews, Fisheries Statistics and Economics Division (F/ST1)

Dr. Phil Goodyear, a consultant for the Billfish Foundation, accepted an invitation to attend Committee meetings to explain the methods he developed for the marlin estimates and to respond to the Committee's questions about those methods. Ms. Arietta Venizelos and Dr. Joseph Serafy of the Southeast Fisheries Science Center also accepted invitations to attend one meeting and provide additional background information on the 2002 data collection and estimation methods for marlins.

The Committee held two conference call meetings in February and one face-to-face meeting on February 24-25 at the Southeast Fisheries Science Center in Miami to discuss and evaluate the methods. Following discussion of possible alternative approaches, Committee members conducted several analyses to evaluate the alternatives and reported their results for the Committee's evaluation. Subsequent conference call meetings were held and analytical work was conducted from late March through October to complete evaluations and develop consensus recommendations. The Committee's conclusions are summarized in this report.

Estimated 2002 Recreational Landings of Bluefin Tuna, White Marlin, and Blue Marlin

NMFS reported preliminary estimates of 2002 U.S. recreational fishery landings of school and medium size bluefin tuna to ICCAT as follows:

Bluefin Tuna - young school: 559 fish, 2 mt
Bluefin Tuna - school: 13,245 fish, 168 mt
Bluefin Tuna - large school: 10,225 fish, 378 mt
Bluefin Tuna - small medium: 1,927 fish, 122 mt
White marlin: 193 fish, 5.6 metric tons
Blue marlin: 74 fish, 14.9 metric tons

The Committee examined these estimates to determine if they were the most accurate measures of total U.S. recreational landings that could be made with available recreational fishery data.

Recreational Fishery Survey Methods

Data on recreational fishery landings of marlins are available from several NOAA Fisheries surveys, including the Recreational Billfish Survey (RBS), the Large Pelagics Survey (LPS), the Marine Recreational Fishery Statistics Survey (MRFSS), the NOAA Fisheries mandatory Automated Landings Reporting System (ALRS), and the current mandatory Catch Card Census (CCC) programs in Maryland and North Carolina.

Recreational Billfish Survey (RBS)

The primary purpose of the RBS has been to monitor fishing success rates (i.e., catch per unit effort, or CPUE) and average weights of billfish landed in the recreational fishery. It was designed to census a subset of recreational fishing tournaments that target billfish species. It was initiated in the Gulf of Mexico in 1971 and expanded in 1972 to include the U.S. East Coast (from Massachusetts through the Florida East Coast and Keys), and the U.S. Caribbean (i.e., Puerto Rico and the U.S. Virgin Islands). Data from Bahamian billfish tournaments are also collected by the RBS and reported to ICCAT as part of the U.S. Task I data because most of the participants are U.S. citizens fishing from U.S. flagged vessels. Because the RBS now covers almost all billfish tournaments, it is considered to provide a nearly complete census of the recreational tournament catches of blue marlin and white marlin. Prior to 1998, billfish tournament registration and reporting was not mandatory, hence the proportion of tournaments covered by the RBS was unknown and likely to be more variable. Although some CPUE information on non-tournament landings of billfish species has been obtained and reported along with RBS numbers in many years, this information was only collected for successful trips and cannot be used in any meaningful way to generate annual estimates of total non-tournament landings.

A billfish tournament is defined by the RBS as any organized fishing event for which there is a reward category for any billfish species. Rewards can be points, plaques, prizes, money or other awards. Federal regulations require that each billfish tournament director submit the following information to the RBS at least one month before the tournament takes place: 1) tournament name, 2) tournament location, 3) fishing dates and, 4) the name, telephone number and email address of the tournament director. Within one week after the event takes place, billfish tournament organizers are required to submit a summary of the tournament's fishing results. For each species caught, the tournament director of record must provide the RBS with, 1) the number of fish boated, 2) the number tagged and released, 3) the number released without a tag and, 4) the number released dead, such as undersized or otherwise disqualified fish that died during the capture process. Often these fish are disposed of offshore. Directors are required to include this information in their summary reports as documented billfish mortalities.

The RBS also conducts dockside sampling of landed fish at many of these billfish tournaments to collect representative biological information from the landings. This data collection effort provides a means for validating at least a sample of the landings reported by captains to tournament operators via radio reports while at sea.

Large Pelagics Survey (LPS)

The primary purpose of the LPS has been to estimate annual recreational catches of large pelagic species, especially school and medium size bluefin tuna, based on effort and catch-per-unit-effort (CPUE) data collected through random sampling surveys of offshore fishery participants along the northeastern U.S. Coast. The LPS has traditionally been conducted from June through

October in Virginia through Maine.

Telephone surveys of permit holders are used to collect the effort data needed to estimate the total number of large pelagic fishing trips made by permitted boats. The sampling frames used for the telephone surveys are developed from current lists of HMS Charter/Headboat, HMS Angling category, and Atlantic Tunas General category permits. Only boats with valid phone numbers are included in the frames. Separate telephone surveys are conducted for charter boats (Charter/Headboat category) and private boats (Angling and General category). The charter boat and private boat telephone surveys have traditionally been weekly sampling surveys, although the 2002 and 2003 private boat surveys were conducted biweekly. A random sample of boats is drawn each week and several attempts are made to contact and interview the operators of those boats to collect fishing effort data from the prior one-week, or two-week, period. Interviewed boat operators report the total number of fishing trips and the total number of offshore trips that were directed at tunas, billfishes, swordfish, sharks, dolphin, wahoo, or amberjack. Each trip is profiled to determine the state to which it returned and the date on which it occurred. The data are used to calculate the mean number of trips per boat, which is then expanded by the total number of boats in the frame from which the sample of boats were selected as follows:

total trips by in-frame boats = (mean number of trips per boat) X (number of boats in frame).

The telephone survey frames are stratified geographically such that independent charter and private boat surveys are conducted for different regions. Boats are assigned to geographic strata based on their principal port location. In 2002 and 2003, the primary geographic strata were as follows:

Virginia
Maryland/Delaware
New Jersey
New York
Connecticut/Rhode Island
Massachusetts
New Hampshire/Maine

Dockside intercept surveys of charter and private boats are used to collect catch data from representative samples of returning offshore boat trips that were directed at large pelagic species. The dockside surveys also determine whether or not the sampled trips were made by boats that were included in the sampling frames used for the telephone survey. Trips by boats included in the telephone frames are identified as "in-frame" trips. The ratio of total/in-frame boat trips is calculated and used to adjust the telephone survey estimate of effort upward to include an estimated number of trips by boats not covered by the telephone survey. This calculation is performed as follows:

total trips = total trips by in-frame boats X (total intercepted trips / intercepted in-frame trips).

The intercept survey catch data are used to estimate the mean numbers of fish caught, kept, and released per boat trip for different fish species.

Traditionally, weekly LPS trip estimates have been combined with weekly intercept survey estimates of catch per trip to generate weekly catch estimates for in-season monitoring of bluefin tuna catches. However, in 2002, monthly trip estimates were obtained by pooling or summing across the weekly or biweekly temporal strata for each geographic stratum, and those monthly effort estimates were combined with monthly intercept survey estimates to get monthly catch estimates. The effort estimates were combined with the mean catch-per-trip estimates to calculate total catch estimates as follows:

total catch = total trips X mean number of fish caught per trip.

Mean catch-per-trip estimates and catch estimates were calculated separately for catch that was landed and catch that was released. Total 2002 landings of different species and of different size categories of bluefin tuna were obtained by summing monthly landings estimates for each geographic stratum and then summing those annual totals across geographic strata.

Marine Recreational Fishery Statistics Survey (MRFSS)

The primary purpose of the MRFSS is to estimate annual marine recreational fishery catches of all fish species based on effort and CPUE data collected through random sampling surveys of participants. A coastal household telephone survey that is based on a random-digit-dialing method of sampling collects the data needed to estimate total saltwater fishing effort by residents of coastal zone households. Intercept surveys of shore, private/rental boat, and charter/headboat fishing assign trained interviewers to visit randomly selected fishing access sites on randomly selected days to intercept anglers and collect the data needed to estimate both the proportion of total marine recreational fishing trips made by non-residents of the coastal zone and the mean catch per angler trip for different fish species. The estimates from the two surveys are combined to generate estimates of total fishing effort and total catches of different fish species. The MRFSS has been conducted in Louisiana through Maine since 1981 and in Puerto Rico since 2001.

The coastal household telephone survey is conducted bimonthly and is stratified geographically such that an independent survey is conducted for each coastal state. The survey is restricted to the counties in each state that extend within 25-50 miles of the coastline. Telephone calls are made during a two-week period at the end of each two-month sampling wave to obtain a representative sample of residential households. Respondents are interviewed to determine if any permanent household residents fished in the prior two months, and attempts are made to interview each resident who fished and profile all of their trips by fishing mode, state, and county. These data are used to estimate the mean number of angler trips per household, which is expanded by the total number of households to estimate the total number of trips by coastal residents.

The intercept surveys are conducted continuously on randomly selected days at randomly assigned fishing access sites to collect catch information from anglers who have completed fishing for the day. The interviewed anglers are asked where they reside and whether they have a phone, so that their trips can be identified as either "in-frame", due to phone ownership and residence within the telephone survey costal zone, or "out-of-frame". These demographic data are used to estimate an adjustment factor that can be used to expand the telephone survey effort estimates to include unbiased accounting of the angler trips not covered by the telephone survey. The catch data are used to estimate mean angler catch per trip for different species, and the total catch is estimated as a product of the total estimated number of angler trips and the mean catch per angler trip. The variances of the point estimates are estimated to allow assessment of the relative uncertainty of resulting estimates in terms of standard errors and 95% confidence limits.

In general, the MRFSS coastwide estimates of catch for relatively common recreational fishing targets are rather precise, with percent standard errors of less than 10% for most federally managed species. However, the catch estimates are much less precise for large pelagic species, such as marlins or tunas, that are targeted by only a small subset of the total angler fishing trips.

For-Hire Survey (FHS)

The For-Hire Survey (FHS) provides more efficient coverage than the traditional MRFSS of the effort and catch of marine recreational anglers fishing on charter boats and headboats. The FHS has been conducted for Gulf of Mexico charter boats in Louisiana through Florida since 1998. It was implemented on the Atlantic Coast in June of 2003. The FHS design includes a boat directory telephone survey of fishing effort and an intercept survey that collects catch data from for-hire boat anglers as they return from completed fishing trips.

The FHS telephone survey is a weekly survey similar in design to the to the LPS telephone surveys. Lists of boats with telephone numbers and mailing addresses of boat operators are used as the sampling frames. A random sample of boats is selected each week and up to 10 attempts are made to contact the operator of each selected boat to conduct a telephone interview. The interviewed captains provide the number of trips, as well as the numbers of anglers who fished, the state of access, and the date for each trip, in the prior week. The data provided by respondents is used to estimate the mean number of angler trips per boat, and that mean is expanded by the total number of boats in the sampling frame to estimate the total number of angler trips for that week.

In 2003, the LPS telephone survey of effort on HMS Charter/Headboat category boats was combined with the Atlantic FHS telephone survey to avoid unnecessary overlap between the two surveys and minimize the reporting burdens of captains that would otherwise be asked to respond to two separate surveys. Interviewed operators of boats with the HMS Charter/Headboat permit were asked to report all offshore trips that targeted large pelagic species, including both for-hire trips (trips with paying passengers) and private trips (trips without paying passengers). The traditional LPS telephone survey questions were asked for all reported trips directed at large pelagic species.

The FHS intercept survey follows the same design as the traditional MRFSS intercept survey to collect catch data from a representative sample of completed angler fishing trips. Sampled trips by anglers who fished on boats not included in the FHS telephone sampling frame are identified as "out-of-frame" trips and an adjustment factor is calculated to expand FHS telephone survey estimates of effort to include an unbiased accounting of out-of-frame trips.

Automated Landings Report System

NOAA Fisheries established a mandatory requirement for call-in reporting of all recreational fishery landings of bluefin tuna along the Atlantic Coast. Holders of the HMS Charter/Headboat or Angling Category permits were informed that they must report any recreational fishery landings of bluefin tuna by calling a designated toll-free phone number or by entering the data on a designated internet website. In recent years, this Automated Landings Report System (ALRS) was expanded to require reporting of all recreational fishery landings of swordfish and billfish. Due to a significant amount of noncompliance, the total landings reported through this system for any of these species have usually been considered to be much lower than the total actual recreational fishery landings.

North Carolina and Maryland Catch Card Census (CCC) Programs

NOAA Fisheries has established pilot reporting programs with the States of North Carolina and Maryland to monitor recreational landings of bluefin tuna, swordfish and billfish. NOAA Fisheries provides funding for the pilot programs which is used by the States to hire seasonal biologists to distribute landings tags and collect catch recording cards. Tagging/reporting stations are sanctioned by the state level data collection program but consist mainly of private sector volunteers (e.g., bait and tackle shops). Anglers landing a fish (releases are not recorded in these programs) must complete an individual landing card with information on the angler, vessel permit, landing tag number and size of fish. Upon submitting the card, the angler receives a self-locking, numbered tail wrap tag that must be affixed to the fish before the fish can be removed from the vessel. Removing an untagged fish from the vessel constitutes both a state and federal violation. Landings cards are periodically collected from the reporting stations by state level personnel and forwarded to NOAA Fisheries. Because of these pilot landings card programs, anglers in NC and MD are not required to report landings via the ALRS. However, anglers or vessel operators may still be selected for voluntary LPS or MRFSS intercept or telephone surveys.

Trophy Fish Reporting

The regulations that implemented the management program for the recreational bluefin tuna fishery in 2002 and 2003 restricted landings to school, large school and small medium fish subject to a daily vessel limit. However, in response to requests from charter boat operators and private anglers, NMFS amended the regulations to allow vessel owners a single "trophy" bluefin tuna in each year. Operators landing trophy bluefin tuna in the large medium or large (giant) size categories (i.e., above 73 inches curved fork length) were required to report directly to NMFS. In Maryland and North Carolina, reports of trophy bluefin tuna landings could be made through the state-level CCC programs. In other states, reports of trophy bluefin tuna landings could be made through the Automated Landings Reporting System by touch tone phone or by internet.

2002 Estimation Methods for Bluefin Tuna

Improvements in 2002 LPS Data Collections

The 2002 estimates of recreational fishery landings of young school, school, large school, and small medium size categories of bluefin tuna were taken directly from the 2002 LPS. There were several improvements made in the way effort and catch data were collected for the 2002 LPS, and the Committee reviewed the estimation procedures that were used to be sure that they took full advantage of these improvements. In addition, the Committee reviewed the raw data files that were used for the estimates to be sure that any possible errors had been identified, checked, and appropriately resolved.

The 2002 LPS followed the same basic survey design that had been used in previous years (see general description above). Random sampling, boat directory telephone surveys based on lists of HMS and Atlantic Tunas permit holders were used to collect fishing effort data. Dockside intercept surveys were used to obtain catch data on representative samples of returning offshore boat trips that targeted large pelagic species.

A number of changes were made in 2002 to improve the sampling efficiency and response rates for the telephone and intercept surveys. The sampling procedures for the 1997-1998 LPS telephone surveys were reestablished in an attempt to lower the level of non-response and the magnitude of any potential non-response bias.

In 1999-2001, the LPS telephone survey contractor was required to meet weekly sampling quotas for each geographic stratum and this often resulted in both high levels of non-response and high levels of respondent burden for those captains that were easier to reach. The quota-based system allowed the contractor to replace any selected boats for a given week of sampling if a successful contact of the boat's operator could not be made in 5 attempts. In order to reach the sampling quotas established in the contract, hard-to-reach boats were often replaced. This often resulted in high non-contact rates and as much as a doubling of the total number of boats drawn by the end of each sampling week. In some states, this also led to repeated weekly contacts of many of the charter boat captains that were easy to contact. High levels of non-contact can be a serious problem if the captains that are harder to contact tend to take more, or fewer, trips than those that are easier to contact. Failure to represent these "non-contacted" captains in the telephone survey data could lead to a significant positive or negative bias in the estimate of mean effort that is used for the effort estimates.

In 2002, the contractor was instructed to draw a pre-determined number of boats each week and attempt to contact the operators of those boats through the end of the sampling period. No replacement of boats during the week was allowed, and a minimum of 10 contact attempts was required for each boat. The expectation was that this change would decrease the non-response rate, the potential for a significant non-response bias, and the level of reporting burden for easy-to-reach boat operators.

The efficiency of the LPS telephone surveys was also improved by collecting data on all large pelagic fishing trips by each sampled boat, including those that were taken outside of the boat's principal port state. In previous years, the LPS telephone survey only collected detailed information on in-state trips. Trips made in other states were recorded as out-of-state trips and were not used in the estimates of fishing effort. The collection of information on both in-state and out-of-state trips allowed for the estimation of more total trips directly from the telephone survey and provided the option to reduce reliance on an intercept survey adjustment factor to account for trips made in a given state by out-of-state boats. In geographic strata where the precision of the intercept survey adjustment factors is low, the adoption of such an approach could also potentially increase the precision of the resulting LPS effort and catch estimates.

The sampling efficiency for the 2002 LPS intercept survey was vastly improved by allowing interviewers to stay on site for more than 4 hours and to visit more than one fishing access site per assignment. In previous years, the interviewers were required to collect interviews during a specific 4-hour time window at one specified site. Consequently, if there were no offshore fishing trips returning to the assigned site, the interviewer would sit for 4 hours and collect no data. The low level of interviewing productivity associated with this approach was making it difficult to obtain the sample sizes needed to make reasonably reliable estimates of mean catch rates in many states. In 2002, the interviewers were not limited to 4 hours, In addition, they were assigned to a cluster of sites and allowed to move from one site to another within the cluster to intercept returning boats. This allowed NOAA Fisheries to establish interview quotas for each state, boat type (charter or private), and month. The contractor was expected to reach these quotas in order to receive full payment for their interviewing efforts. One outcome of this change was that the contractor collected more than 2 ½ times as many dockside interviews as had been collected in previous years for roughly the same price. Another important result was that the interviews were much more evenly distributed across states, boat types, and months.

The 2002 LPS catch estimates were stratified by month rather than by week, because there was no longer a need to produce weekly estimates for the purpose of in-season monitoring of bluefin tuna quotas. With the management change to making annual adjustments to catch limits commensurate with available quota, it is now possible to use a temporal stratification scheme which is much less prone to estimation errors caused by inadequate stratum level sample sizes. With the intended weekly stratification of previous years, the LPS often produced estimates of effort in strata with little or no sampled catch information. Consequently, estimates often had to be re-stratified at a biweekly or triweekly level to try to correct this problem. However the lack of sufficient intercept sample still often resulted in estimates of no catch (i.e., "false zeros") in some temporal strata when large pelagic fishing was active. With low levels of intercept survey sampling productivity, it was often extremely difficult to obtain the sampling levels required to support weekly, biweekly, or triweekly stratification schemes. With the change to a monthly stratification of estimates, the annual estimates should be more accurate because sample sizes would more likely be adequate to provide the effort and catch information needed for representative catch estimates at the lowest level of stratification.

2002 LPS Estimation Methods

The estimation methods used for the 2002 LPS were designed to match previously applied LPS estimation procedures with minor modifications to accommodate the monthly stratification of the effort and catch estimates. As described above, the switch to the monthly stratification allowed for larger sample sizes to be used for each stratum-level estimate and made more efficient use of the available effort and catch data. Only in-state trips reported on the telephone survey were used for telephone survey estimates of effort, and the traditional geographic strata for both sampling and estimation were maintained. This meant that all intercepted trips by boats with a principal port state different than the state of intercept were considered out-of-frame boat trips and included in the calculation of the intercept survey effort adjustment factor.

The estimation method used for the 2002 estimates pooled effort data across weekly or biweekly strata to obtain monthly estimates of effort. This pooling approach was used because telephone survey sample sizes for the for-hire boats were too small in certain geographic areas to support accurate estimates at the weekly or biweekly level. The Committee tested the alternative of producing the charter boat effort estimates at the weekly level and the private boat estimates at the biweekly level. The weekly or biweekly estimates were then summed to get monthly estimates of effort. This approach adhered more directly to the design of the actual stratification of the telephone survey sampling but ignored the possible problems with small sample sizes. The non-pooled estimates differed very little from the original pooled estimates, suggesting that the pooling may not have been necessary. Nevertheless, the Committee decided to proceed with the pooled approach for the 2002 and 2003 LPS estimates of effort in both the for-hire and private boat modes due to the sample size issues for the for-hire boats. The Committee's review of the pooled and unpooled approaches will continue to determine which approach would be most appropriate for the LPS estimates in 2004 and future years.

The Committee also tested the alternative approach of using both in-state and out-of-state trips in the telephone survey estimates of fishing effort. For each geographic area's boat frame, trips were estimated to all states based on the data reported in the telephone interviews. This resulted in a 7 x 10 matrix of effort estimates, where an effort estimate for each area frame (VA, MD/DE, NJ, NY, CT/RI, MA, and NH/ME) was produced for each state of fishing from Virginia through Maine. Effort estimates by state of fishing were summed across area frames to obtain the total trips made in each state by boats from all area frames. In this case, intercepted trips by out-of-state boats that were members of other state frames included in the telephone survey were not considered to be out-of frame boats for the purpose of calculating the intercept survey effort adjustment factor. The results of this new approach differed very little from the results of the previous approach, and estimates of the variances of the alternative estimators showed that there was only a very slight gain in precision obtained by using this new approach.

Because the original approach more closely matched the way effort estimates were produced in previous years and the differences between the alternative approaches were so minor, the Committee recommends acceptance of the previous out-of-frame adjustment approach for 2002 and 2003, but recommends continued comparison and evaluation of both approaches in 2004 and future years.

The Committee made some minor adjustments in the way intercepted boats were matched with the LPS telephone survey sampling frames. Priority was given to the use of permit numbers to match boats with their appropriate geographic area sampling frames. Boats without a permit, permitted boats in another boat type stratum, and permitted boats listed on the telephone sampling frame for another geographic area were identified as "out of frame". Since the accepted method only estimates effort by permitted boats in their own principal port state, the means of identifying trips made by out of frame boats is crucial for accurately estimating an adjustment that accounts for effort by non-permitted boats or permitted boats from other geographic areas.

<u>Resolution of 2002 LPS Data Issues</u>

The Committee's examination of the raw data files used for the 2002 LPS estimates revealed some necessary corrections that had a small impact on the estimated landings for bluefin tuna. The problems addressed included the following:

- elimination of some blank records in the telephone survey trip data files that were falsely identified as trip records by the estimation program;
- imputation of the trip data that was missed due to incomplete interviews
- elimination of a few missed duplicates in the boat sampling frames
- corrections of the principal port state identities of a few boats in the August sampling frames
- recovery of missing data set with the original geographic area sampling frames used for September-October telephone survey.

The biggest problem that the Committee identified was that one of the original data sets for the telephone survey sampling frames had been lost. This led to a successful effort to recover all of the original sampling frame data sets used by the contractor for the telephone survey sampling. After recovering the original frames, the original estimation program was re-run to produce revised estimates of recreational fishery landings of bluefin tuna by size category. The revised estimates are provided in the next section of this report.

Resolution of 2002 LPS Estimation Software Issues

The Committee discovered a problem in the way catch data was being handled by a software procedure used to calculate mean catch rates based on the modified 2002 LPS dockside intercept survey. The procedure did not count records for intercepted boats with no landings of large pelagic species, therefore mean catch rates for all large pelagic species were overestimated when applied to the successful and non-successful effort. The Committee resolved this problem by assigning "0" values to records for intercepted trips with no reported landings so that they would be included in the calculations of mean catch rates. This change reduced the estimated mean catch rates in numbers of fish by about 17% for school and small medium size bluefin tuna. The Committee checked and confirmed that this software issue only occurred in the computer program used for the 2002 LPS estimates and that it did not occur in programs used for prior year LPS estimates.

The Committee also discovered a problem in the way the mean measured lengths of landed bluefin sampled by the LPS were converted into mean weights for the purpose of estimating the total weights of 2002 recreational landings by size category. The program used for this conversion assumed that measured lengths were curved lengths rather than straight lengths, but the Committee confirmed that fish lengths were measured as straight lengths in the dockside intercept survey and modified the program to take that into account. This change resulted in about a 17% increase in the estimated mean weight of school and small medium bluefin tuna landed. The Committee checked and confirmed that the programs used for the LPS length-to-weight conversions in prior years correctly assumed that straight length measurements were obtained.

The net effect of the two programming corrections was that the revised 2002 LPS estimates of total weight landed in all bluefin tuna size categories associated with the recreational fishery (other than trophy fish) were about 6% lower than those originally reported to ICCAT.

Consideration of the Uncertainty of the LPS Estimates

Estimates of the variances of the 2002 LPS estimates had not been previously produced. The Committee will continue to investigate alternative methods that could be used to most accurately assess the level of uncertainty associated with the fishing effort and landings estimates. Although the comparison and evaluation of bootstrapping methods relative to the more traditional multiplicative methods used in survey sampling has not been completed, the Committee decided to use a multiplicative method to provide preliminary estimates of the variances and percent standard errors of the 2002 LPS estimates. The preliminary variance estimates can be used effectively for assessing differing levels of uncertainty in the LPS effort and harvest estimates for different geographic areas and time periods, and they can also be used to assess differences in the relative precision of harvest estimates for different large pelagic species and different size classes of bluefin tuna.

Using the preliminary variance estimates, the Committee also generated preliminary estimates of the upper and lower 95% confidence limits for the effort and landings estimates. The estimated variances, percent standard errors, and 95% confidence limits are shown with the point estimates of bluefin tuna harvest by size category in the following section. The Committee recommends that the estimated confidence limits be considered along with the point estimates in compliance monitoring.

Revised 2002 Estimates for Bluefin Tuna

The Committee recommends use of the following revised 2002 LPS estimates for bluefin tuna:

Bluefin Tuna - young school: 275 fish, 1.2 mt
Bluefin Tuna - school: 10,363 fish, 150.9 mt
Bluefin Tuna - large school: 8,693 fish, 367.0 mt
Bluefin Tuna - small medium: 1,557 fish, 112.9 mt

The total estimated landings are 20,888 fish weighing 632.2 mt. Table 1 shows the multiplicative estimates of the percent standard errors and 95% confidence limits for the estimated numbers.

Table 1. Large Pelagics Survey estimates of bluefin tuna landed by the recreational fishery during 2002 in Virginia through Maine. Estimates of percent standard error (PSE) and 95% confidence limits are included.

Size Category	Estimated Number of Fish Landed	Estimated Weight of Fish Landed	Estimated PSE of Number Landed	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Young School	275	1.2 mt	43.2 %	42	508
School	10,363	150.9 mt	11.2 %	8,092	12,633
Large School	8,693	367.0 mt	12.4 %	6,581	10,804
Small Medium	1,557	113.1 mt	23.8 %	831	2,282

2003 Estimation Methods for Bluefin Tuna

Improvements in 2003 LPS Data Collections

In 2003, the LPS telephone survey of HMS Charter/Headboat permit holders was conducted as an add-on to the new FHS telephone survey implemented on the Atlantic Coast with the cooperation of ACCSP and several state agencies. The two surveys were combined to avoid overlap and minimize the reporting burdens of for-hire boat operators that could otherwise be contacted by two separate sampling surveys. Also, it would have been redundant to collect data on for-hire boat fishing for large pelagic species in a separate survey because the FHS covers all for-hire boat fishing effort. All boats with HMS Charter/Headboat permits were included in the boat directories used to construct the Atlantic FHS telephone survey sampling frames in Virginia through Maine, and the traditional LPS telephone survey questions were added to the new FHS telephone interview questionnaire used in those states. As a result, telephone interviews with HMS permitted boat operators would collect required information on all fishing trips that were directed at large pelagic species. Although the FHS only collects data on fishing trips made with paying passengers, all respondents were asked to additionally report information on any private trips without paying passengers that targeted large pelagic species.

It was apparent from the data collected by the 2003 Atlantic FHS telephone survey that many of the boats with the HMS Charter/Headboat permit did not report any trips with paying passengers. However, many of these boats did report offshore private trips that targeted large pelagic species. This indicates that many boats purchasing this permit are actually being operated as private boats rather than as for-hire boats. The Committee recommends that such boats should be grouped with the “private” boats whose operators hold either an Atlantic Tunas General Category or an HMS Angling category permit. The inclusion of these “private only” boats in the FHS sampling frames greatly decreases the efficiency of sampling of for-hire fishing effort. It is also likely that the offshore fishing activity of these boats is more similar to the activity of the other private boats than to the activity of actual for-hire boats. If these boats were assigned to the LPS private boat stratum, then the stratification of sampling and estimates by boat type at current sampling levels would likely produce more precise effort estimates. However, transfer of these boats from the FHS sampling frames to the LPS private boat telephone survey frames will be difficult unless changes are made in the permit requirements for the charter/headboat category that would require actual evidence of for-hire fishing activity.

The 2003 LPS telephone survey of private boats and the 2003 LPS intercept surveys of both for-hire boats and private boats were conducted according to the same procedures that were used in 2002. Therefore, the improvements in telephone and intercept survey sampling efficiencies and the improvements in the geographic distribution of intercept survey sampling that are described above were carried forward into 2003.

2003 LPS Estimation Methods

The Committee applied the approved estimation methods for the 2002 LPS to the effort data collected by the LPS private boat telephone survey and the FHS telephone survey, and the catch per unit effort data collected by the LPS intercept survey in 2003. To obtain monthly effort estimates by boat type in different geographic areas, FHS large pelagics fishing effort data for Charter/Headboat Category boats were pooled across weekly sampling strata and LPS telephone survey effort data for general and angling category boats were pooled across biweekly sampling strata. The same approach was used to identify out of frame intercepted boats for the calculation of intercept survey effort adjustment ratios in each geographic area.

The Committee also applied the two new alternative estimation methods described above to the 2003 FHS and LPS data. This allowed further comparison and evaluation of these alternative approaches with the traditional approach. The effort and catch estimates generated for 2003 by the alternative approaches were again very similar to those produced by the approach accepted by the Committee for 2002.

Although the Committee again recommended use of the previously applied approach with the pooling of telephone data across temporal strata to get monthly estimates, the decision was made to continue to apply, compare, and evaluate the new alternative methods in 2004 and future years. The Committee recognizes that the alternative approaches may ultimately prove to be more efficient. They may also yield more accurate and precise estimates if they are supported with larger sample sizes at the weekly or biweekly stratum levels. The needs for telephone survey sample size increases at the temporal stratum level are greatest for the for-hire boats.

The increases in telephone survey sampling levels needed to support these new approaches could be obtained by either elevating the sampling rates overall or by collapsing the traditional geographic strata into larger strata at the current sampling levels. For example, Virginia, Maryland, and Delaware could be collapsed into one geographic stratum to get the larger sample sizes needed to support a weekly stratification of for-hire boat effort estimates for the larger area. The Committee plans to continue evaluation of the potential benefits of using larger geographic strata to support weekly stratification of for-hire boat effort estimates and biweekly stratification of private boat effort estimates. It is important to determine how best to balance the trade-off between finer temporal resolution and finer geographic resolution of the effort estimates. Providing a finer temporal resolution of the effort may prove to be more important for the accuracy and precision of the estimates than providing a finer geographic resolution. The pulse nature of the offshore large pelagic species fishery is likely to cause greater variation from week to week than from neighboring state to neighboring state within the same time period in effort and mean catch rates.

Resolution of 2003 FHS/LPS Data Issues

Due to the fact that the 2003 LPS telephone survey of HMS charter/headboat permit holders was conducted as part of the Atlantic FHS, the Committee had to make some changes in the way data was handled to produce the 2003 LPS effort estimates. The FHS Contractor delivered sampling frames that did not have the permit numbers for the boats with the HMS charter/headboat permits. Therefore, the Committee had to retrieve the original permit files that were used to develop the FHS sampling frames in order to match the appropriate permit numbers to the listed boats so the sampling frames would have all the data needed for the previously applied LPS for-hire boat estimates. This work was successful in retrieving and incorporating the permit numbers for 98% of the permitted boats listed in the FHS frame. The Committee decided to delete from the sampling frame the small number of permitted boats for which permit numbers could not be assigned and delete any data collected for those boats from the FHS data. The reasoning was that these boats would be counted as “out-of-frame” boats so their effort would be appropriately accounted for if they appeared in the intercept survey data. The Committee considered any potential impacts of the FHS frame reconstruction and the deletion of 2% of the boats to be of little consequence with regards to the accuracy of the 2003 effort estimates based on the FHS data, although no means exist to test this assumption.

Differences in the formatting and design of the new FHS and traditional LPS telephone survey databases complicated the preparation of the raw interview data for calculation of the mean and total offshore effort estimates for the for-hire boats. The Committee worked together to determine the best methods for converting the FHS data into the traditional LPS format, so that the same estimation methods used for the 2002 LPS could be appropriately applied to the available 2003 data for both for-hire and private boats. The new computer programs that were developed for this purpose were documented so that all changes from the 2002 LPS estimation program were trackable and transparent. The Committee recommends that the new programs be used to generate the alternative sets of 2004 LPS estimates to be compared and evaluated.

2003 Estimates for Bluefin Tuna

The Committee provides the following 2003 LPS estimates for recreational bluefin tuna landings from the LPS survey data:

Bluefin Tuna - young school: 73 fish, 0.3 mt
Bluefin Tuna - school: 7,598 fish, 137.7 mt
Bluefin Tuna - large school: 4,478 fish, 176.4 mt
Bluefin Tuna - small medium: 1,393 fish, 96.3 mt

The total estimated landings are 13,542 fish weighing 410.7 mt. These estimated landings are about 35% lower than those estimated for 2002. Table 2 provided the multiplicative estimates of the percent standard errors and 95% confidence limits for the estimated 2003 numbers of fish landed.

Table 2. Large Pelagics Survey estimates of bluefin tuna landed by the recreational fishery during 2003 in Virginia through Maine. Estimates of percent standard error (PSE) and 95% confidence limits are included.

Size Category	Estimated Number of Fish Landed	Estimated Weight of Fish Landed	Estimated PSE of Number Landed	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Young School	73	0.3 mt	55.6%	0	152
School	7,598	137.7 mt	10.8%	5,981	9,202
Large School	4,478	176.4 mt	16.3%	3,040	5,897
Small Medium	1,393	96.3 mt	28.9%	604	2,179

2002 and 2003 Bluefin Tuna Estimates by Management Area and Fishing Year

The 2002 and 2003 LPS estimates by northern and southern management areas are provided in Table 3. The Committee determined an appropriate method for producing separate LPS estimates for northern and southern areas of New Jersey. This approach allowed the combination

Table 3. Large Pelagics Survey estimates of school and small medium bluefin tuna landed by recreational anglers during calendar years 2002 and 2003 in southern and northern management areas. Estimates of percent standard error (PSE) in the estimated numbers are included.

Year	Size Category	Management Area	Estimated Number of Fish Landed	Estimated PSE of Landings Estimate	Estimated Weight of Fish Landed (mt)
2002	**Young School**	**North**	73	79.3 %	0.3 mt
		South	202	51.3 %	0.9 mt
	School	**North**	2,676	23.7 %	39.0 mt
		South	7,687	12.6 %	111.9 mt
	Large School	**North**	685	62.4 %	28.9 mt
		South	8,007	12.3 %	338.1 mt
	Small Medium	**North**	327	72.7 %	23.7 mt
		South	1,229	23.1 %	89.2 mt
	Total Young School - Small Medium	**North**	3,762		89.9 mt
		South	17,126		542.3 mt
2003	**Young School**	**North**	73	55.6 %	0.3 mt
		South	0		0 mt
	School	**North**	4,191	16.4 %	75.9 mt
		South	3,407	13.3 %	61.8 mt
	Large School	**North**	661	24.8 %	26.0 mt
		South	3,817	8.8 %	150.4 mt
	Small Medium	**North**	368	40.6 %	25.4 mt
		South	1,025	36.5 %	70.8 mt
	Total Young School - Small Medium	**North**	5,293		127.7 mt
		South	8,249		283.0 mt

of estimated southern New Jersey landings with those estimated for Delaware, Maryland, and Virginia, as well as the combination of estimated northern New Jersey landings with those estimated for New York, Connecticut, Rhode Island, and Massachusetts.

Two possible approaches were considered. One approach would identify northern and southern New Jersey sites so that the distributions of trips reported in the phone surveys and the distributions of trips intercepted by the dockside surveys could be determined prior to estimation of both trips and mean catch rates. This would allow the post-stratification of trips and mean catch rates by state subregion. The second approach would use only the distribution of intercepted trips to partition state effort estimates between state subregions. The partitioned effort estimates could then be applied to separately expand mean catch rates that were post-stratified by subregion.

The latter of the two approaches was used because the 2002 and 2003 LPS telephone surveys did not collect information on the specific site location of each reported trip. It was not possible to assign the phone-reported New Jersey trips to southern or northern areas. However, it was possible to assign NJ trips intercepted at dockside to a specific county.

The 2002 and 2003 LPS estimates were combined with landings counts obtained from the North Carolina CCC to provide estimates of total bluefin tuna landed by recreational fishers by size category and management area for the 2002 and 2003 fishing years. Those numbers are provided in Table 4. The fishing year runs from May through April of the following calendar year. Therefore, the North Carolina CCC counts for January-April of 2003 were added to the LPS estimates for 2002 to get 2002 fishing year estimates. The NC CCC counts for 2004 were added to the 2003 LPS estimates to get 2003 fishing year estimates.

Reported Trophy Fishery Landings of Large Medium and Large Bluefin Tuna

The trophy fishery landings of bluefin tuna in the large medium or giant categories that were reported via the ALRS in 2002 and 2003 are shown in Table 5. Because trophy landings are relatively rare and do occur in states not covered by the Large Pelagics Survey, tallies from direct angler reports are preferable to survey estimates. However, the Committee cautions that these landings may be under-represented because evidence indicates that there were significant levels of non-compliance with the mandatory ALRS in 2002 and 2003 (see next section).

Comparison of ALRS and LPS Data and Estimates for Bluefin Tuna

The Committee attempted to determine the relative accuracy of the landings reported in the NOAA Fisheries ALRS by comparing landings of bluefin tuna observed during dockside LPS interviews in 2002 and 2003 with the landings reported to the mandatory ALRS. States conducting catch card monitoring programs (Maryland and North Carolina) were not included in the comparison. LPS records of observed landed fish were matched with ALRS records. The proportion of LPS records that matched ALRS records was used as an estimate of the rate of

Table 4. Estimated recreational fishery landings of school and small medium bluefin tuna by management area and fishing year.

Fishing Year	Size Category	Management Area	LPS (VA-ME)		North Carolina CCC		Total (NC-ME)	
			Number	Weight (mt)	Number	Weight (mt)	Number	Weight (mt)
2002	Young School	North	73	0.3	-	-	73	0.3
		South	202	0.9	-	-	202	0.9
	School	North	2,676	39.0	-	-	2,676	39.0
		South	7,687	111.9	2	0.08	7,689	112.0
	Large School	North	685	28.9	-	-	685	28.9
		South	8,007	338.1	-	-	8,007	338.1
	Small Medium	North	327	23.7	-	-	327	23.7
		South	1,229	89.2	113	9.5	1,342	98.7
	Total Young School-Small Medium	North	3,762	89.9	-	-	3,762	89.9
		South	17,126	542.3	115	9.6	17,241	551.9
2003	Young School	North	73	0.3	-	-	73	0.3
		South	0	0	-	-	0	0
	School	North	4,191	75.9	-	-	4,191	75.9
		South	3,407	61.8	-	-	3,407	61.8
	Large School	North	661	26.0	-	-	661	26.0
		South	3,817	150.4	-	-	3,817	150.4
	Small Medium	North	368	25.4	-	-	368	25.4
		South	1,025	70.8	1	0.09	1,026	70.9
	Total Young School-Small Medium	North	5,293	127.7	-	-	5,293	127.7
		South	8,249	283.0	1	0.09	8,250	283.1

compliance with the ALRS. The percentage bias due to non-compliance was estimated as the percentage of unmatched LPS records. As shown in Tables 6 and 7, the mean annual compliance rate averaged about 20% or less on a coastwide basis. Individual state compliance ranged from 4.3 to 28.9% for states where the number of bluefin tuna observed by the LPS dockside survey was greater than 10 fish.

Table 5. Trophy fishery landings of large medium or large bluefin tuna reported to the mandatory Catch Card Census programs and Automated Landings Reporting System in fishing years 2002 and 2003.

Fishing Year	Size Category	Management Area	Catch Card Census Programs (MD, NC)		Automated Landings Reporting System (VA, DE-ME)		CCC and ALRS Totals	
			Numbers	Weight (mt)	Numbers	Weight (mt)	Numbers	Weight (mt)
2002	Large medium and Large	North	-	-	1	0.1	1	0.1
		South	66	8.3	6	1.2	72	9.5
2003	Large medium and Large	North	-	-	-	-	-	-
		South	-	-	8	0.9	8	0.9

Table 6. Comparison of 2002 ALRS bluefin tuna (BFT) landing reports with records of landed bluefin tuna observed during LPS dockside intercept sampling.

State	Number of BFT Reported in Call-in Reports (ALRS)	Number of BFT Observed in LPS Sample[1]	Number Observed in LPS and Reported to ALRS	Estimated Compliance Rate [2]	Estimated Bias Due to Non-Compliance
CT	12	9	0	0.0%	100.0%
DE	181	124	32	25.8%	74.2%
MA	212	20	2	10.0%	90.0%
NJ	214	92	11	12.0%	88.0%
NY	46	33	2	6.1%	93.9%
RI	46	37	6	16.2%	83.8%
VA	693	234	60	25.6%	74.4%
Total	1404	549	113	20.6%	79.4%

[1] Number of bluefin tuna directly observed during dockside intercept sampling

[2] Calculated by dividing number observed and reported by total number observed

Comparison of Maryland Catch Card and LPS Data and Estimates of Bluefin Tuna Landings

The Committee compared the 2002 and 2003 LPS landings estimates for bluefin tuna in Maryland with the numbers of landed fish recorded in the 2002 and 2003 Maryland Catch Card program (Tables 7 and 8). This required separation of the Delaware and Maryland telephone

Table 7. Comparison of 2003 ALRS bluefin tuna (BFT) landing reports with records of landed BFT observed during LPS dockside intercept sampling.

State	Number of BFT Reported in Call-in Reports (ALRS)	Number of BFT Observed in LPS Sample[1]	Number Observed in LPS and Reported to ALRS	Estimated Compliance Rate [2]	Estimated Bias Due to Non-Compliance
CT	36	5	3	60.0%	40.0%
DE	86	66	10	15.2%	84.8%
MA	98	22	7	31.8%	68.2%
NJ	146[3]	70	3	4.3%	95.7%
NY	66	77	6	7.8%	92.2%
RI	128	83	24	28.9%	71.1%
VA	116	58	15	25.9%	74.1%
Total	884	384	68	17.7%	82.3%

[1] Number of bluefin tuna directly observed during dockside intercept sampling
[2] Calculated by dividing number observed and reported by total number observed
[3] Total does not include 208 BFT caught by 3 headboats which are not sampled by LPS

Table 8. Comparison of observed 2002 bluefin tuna in LPS dockside sample and landings reported on Maryland catch cards.

2002 Comparison	**BFT Size Class**			
	School	**Large School**	**Small Medium**	**Total**
#Cards	903	1,171	202	2,329
#BFT observed (LPS)	86	87	22	195
#Observed w/cards	68	79	20	167
Estimated Bias (%)	20.9%	9.2%	9.1%	14.4%
Corrected #BFT	1,142	1,290	222	2,719

Total #cards includes 52 unknown size class and 1 large medium

survey data so that separate LPS estimates could be generated for Maryland. The 2002 Catch Card program recorded 903 school, 1,171 large school, and 202 small medium bluefin tuna. On the other hand, the LPS estimated 38 young school, 1,490 school, 1,429 large school, and 382 small medium. The total Catch Card count of 2,276 fish is about 32% lower than the total LPS estimate of 3,339 fish. Multiplicative estimates of the standard errors in the 2002 LPS estimates for MD indicate that the estimates for school and large school are relatively precise (percent stand error only slightly above 20%).

For 2003, the Maryland Catch Card program recorded 1,095 school, 875 large school, and 180 small medium bluefin tuna. The Large Pelagic Survey estimates for Maryland in 2003 were 1,470 school, 1,524 large school, and 94 small medium bluefin tuna. The total Catch Card count of 2,150 fish in this case was about 30% lower than the total LPS estimate of 3,088 fish. There are alternative explanations for the differences between the Catch Card and LPS numbers. The CCC may not have succeeded in recording all bluefin tuna landings, the LPS may have overestimated the landings, or both outcomes may have been possible.

Bluefin tuna landings observed through LPS dockside intercepts in 2002 and 2003 were compared to the total counts from catch cards submitted to the state of Maryland. Records of the fish observed in the LPS dockside sampling were matched to the catch card data where possible to get an estimate of the proportion of observed fish that were actually reported on catch cards. A correction based on the estimated bias due to non-reporting was applied to the number of landed fish reported by size class to calculate a less biased estimate of bluefin tuna landed in each year as follows:

Expanded #BFT = #cards + [(#BFT observed but unreported / #BFT observed) x #cards]

Applications of estimated corrections to the 2002 Catch Card numbers yielded estimates of 1,092 school, 1,279 large school, and 220 small medium bluefin tuna (see Table 8). The total corrected 2002 CCC estimates are about 22% lower than the LPS estimates for Maryland, but they are not significantly lower given that they are well within the 95% confidence intervals for the LPS estimates. Similar corrections of the 2003 Catch Card numbers provided estimates of 1,238 school, 999 large school, and 229 small medium fish (see Table 9). The total corrected 2003

Table 9. Comparison of observed 2003 bluefin tuna in LPS dockside sample and landings reported on Maryland catch cards.

2003 Comparison	**BFT Size Class**			
	School	**Large School**	**Small Medium**	**Total**
#Cards	1,095	875	180	2,245
#BFT observed (LPS)	107	127	26	260
#Observed w/cards	93	109	19	225
Estimated Bias (%)	13.1%	14.2%	26.9%	13.5%
Corrected #BFT	1,260	1019	246	2,594

Total #cards includes 94 unknown size class and 1 large medium; total observed w/cards includes 4 of unknown size class

Catch Card estimates are about 20% lower than the LPS estimates, but the difference is also not statistically significant.

The close correspondence of the corrected Catch Card estimates and the LPS estimates in both 2002 and 2003 suggests that the Catch Card approach would provide reasonably accurate estimates only if conducted in conjunction with a dockside sampling survey that estimates compliance rates and appropriate corrections for the negative biases caused by non-compliance. Coastwide application of a standardized Catch Card/dockside sampling approach would likely provide landings estimates comparable to the current LPS estimates that could potentially be much more precise, depending on sampling levels. However, the Committee recommends that the LPS estimates for Maryland should be used until such a coastwide Catch Card Census program with appropriate non-response corrections can be developed for both the Southern and Northern management areas. The Committee also recommends further pilot testing of the CCC program in Maryland to develop standard methods for measuring non-compliance biases and estimating necessary non-compliance corrections, as well as the relative precision of corrected catch card estimates.

2002 Estimation Methods for White Marlin

The Scalar Expansion Method for Estimating Tournament and Non-Tournament Landings

The 2002 estimates of recreational fishery white marlin landings were based on a "scalar expansion method" that has been documented to and accepted by ICCAT's SCRS (SCRS/2000/57 and SCRS/2002/74). This method produces an estimate of the total recreational fishery landings of white marlin that is based on (1) the 2002 RBS estimate of total billfish tournament landings and (2) an estimate of the 2002 ratio of total recreational fishery landings by weight (RLW) to total tournament landings by weight (TLW). This method was developed as a means of accounting for the non-tournament landings of marlin species by recreational anglers. If only tournament landings were used, the estimate of total white marlin landings are negatively biased. Therefore, if at all possible, some accounting must be made for the non-tournament landings. The method used for this accounting has been reviewed by the ICCAT Billfish Working Group and accepted by the ICCAT SCRS.

The reasoning behind the scaling method is straightforward. If both the total tournament landings and the ratio of total recreational landings (RL) to total tournament landings (TL) were known for a given species of marlin, then the total landings of the species could simply be calculated as the product of the total tournament landings and the known RL/TL ratio as follows:

total recreational landings = total tournament landings X (RL/TL).

This approach would be valid even if one does not know either the actual total landings or the total non-tournament landings, but it assumes that you actually do know that there is a predictable relationship between total landings and total tournament landings. If that is the case, then relationship (RL/TL) can be used as a "scaling factor" to adjust the tournament total up to an overall total that includes the non-tournament landings. For example, if it was known that 2 of every 12 white marlin landed by recreational anglers were landed by tournament participants, then the RL/TL ratio would be 12/2, or 6.0. If a total of 30 white marlin were landed by tournament anglers, then the total landings, including those by non-tournament anglers, could be simply calculated as follows:

total recreational landings = 30 fish X 6.0 = 180 fish. [This is only an example.]

This approach can be useful if it is easier to assess the relationship between total landings and total tournament landings than it is to assess total non-tournament landings in any given year.

This same approach could also be used to estimate total landings by weight if you knew the total tournament landings by weight and you also knew the relationship between the total recreational landings by weight (RLW) and the total tournament landings by weight (TLW). Suppose you knew that 1.2 metric tons of fish were landed in tournaments and that 1/5 of the total weight of recreational landings were landed in tournaments. In other words, for every 500 kg of total landings, 100 kg would be landed in tournaments. The known value of RLW/TLW would be 5/1, or 5.0, in this case. The total recreational landings by weight could be calculated as follows:

total recreational landings by weight = 1.2 mt X 5.0 = 6.0 mt. [This is only an example.]

The choice between the approaches shown in these two examples would depend on which relationship is better known – the one between numbers of landed fish (RL/TL) or the one between total weights of landed fish (RLW/TLW).

The scaling method used in 2002 for white marlin used the latter of the two possible approaches illustrated above, and attempted to estimate the relationship RLW/TLW. The method used the 2002 RBS landings total by weight (RBS-LW_{2002}) for white marlin in Louisiana through Maine (LA-ME) as an estimate of the total LA-ME tournament landings, and it used a long-term (1981-2002) average ratio of the MRFSS estimated LA-ME annual landings by weight and the RBS LA-ME annual landings by weight as an estimate of the 2002 RLW/TLW ratio for white marlin in LA-ME. The RBS reported 951 kg of landed white marlin in LA-ME tournaments, and the long-term average MRFSS-LW/RBS-LW ratio for LA-ME was calculated to be 5.85. The average ratio was calculated as the geometric mean of the estimated 1981-2002 annual ratios. The geometric mean was considered more appropriate than the arithmetic mean in this case because the annual MRFSS/RBS ratios tended to show a skewed distribution. The skew is largely due to the fact that the MRFSS estimated zero landings of white marlin in several recent years, producing annual ratios of "0".

The total recreational white marlin landings were estimated as follows:

$$\text{total white marlin landings by weight} = \text{RBS-LW}_{2002} \times (\text{MRFSS-LW/RBS-LW})_{(1981\text{-}2002)}$$

$= 951$ kg X 5.85
$= 5{,}563$ kg, rounded to 5.6 mt

The MRFSS landings estimates, rather than the LPS landings estimates, were used for estimation of the RLW/TLW ratio because the MRFSS has historically provided more complete coverage of the geographic range of non-tournament fishing for marlins. Both the LPS and the MRFSS cover both tournament and non-tournament recreational fishing effort, but only the MRFSS has provided nearly total year-round coverage of recreational fishing on the Gulf and Atlantic Coasts (Louisiana through Maine). The coverage of the LPS has been restricted to the June-October period in Virginia through Maine where it has been used mainly as a tool for monitoring recreational fishery landings of small and medium sized bluefin tuna.

Due to the general lack of weight information on landed marlins in the MRFSS intercept survey data, mean tournament landed weights from the RBS data from the same year were substituted to convert annual MRFSS estimates of the total number of fish landed into estimates of the total weight of landed fish. MRFSS intercept survey interviewers do not carry scales that can be used to weigh large fish such as marlins, and weight data on observed marlin is only entered when an acceptable scale is present at the fishing access site. Note that the substitution of RBS mean weights assumes that there is no difference between the mean sizes of fish landed by tournament and non-tournament anglers. It also means that the calculated annual MRFSS-LW/RBS-LW ratios are identical to calculated annual ratios of the MRFSS estimated number of fish landed (MRFSS-LN) to the RBS number of fish landed (RBS-LN).

Note that the scaling method does not simply use the MRFSS estimate of white marlin landings for 2002, because MRFSS annual estimates for this species and most other large pelagic species are generally very imprecise. Marlin catches are relatively rare in the annual MRFSS intercept survey samples of angler trips, hence the estimated standard errors for the annual landings estimates are quite large. Annual MRFSS estimates of white marlin landings vary greatly from year to year. Because the standard errors of the annual estimates are quite large, in some years the point estimate may be much higher than the actual landings and in others it may be much lower. The sampling levels for a general recreational fishery survey like the MRFSS would have to be extremely high to produce reasonably precise annual estimates of the total catches obtained by the small subset of recreational fishing trips that target marlins.

Although the annual MRFSS estimates for marlins are imprecise, the telephone and intercept survey components of the MRFSS are designed to provide unbiased estimators of total recreational fishing effort and total recreational catch by species. If the estimates are unbiased, then summing or averaging estimates over many years should provide reasonably precise estimates of total landings, or average annual landings, over those years. The precision of such multi-year estimates will improve as more annual estimates are included in the calculations. In other words, the MRFSS landings estimates for marlins in any one year are not very reliable, but when averaged over many years they may be used as a relatively reliable indicator of the multi-year average recreational landings.

Because the annual MRFSS estimates for marlins are so imprecise, the scaling approach used estimates produced by both the MRFSS and the RBS over the full time series and geographic extent of their overlap to calculate a more precise ratio which could potentially be used as an estimate of the RLW/TLW ratio for LA-ME in any given year. The lack of precision in the annual MRFSS estimates causes the MRFSS-LW/RBS-LW ratio in any given year to be very imprecise and potentially highly variable between years. However, the averaging of this ratio over many years produces a much more precise estimator of the average RLW/TLW for the total time period.

The multi-year average of the annual MRFSS-LW/RBS-LW ratios can only be considered a good estimator of the actual RLW/TLW relationship in 2002 if the RLW/TLW is likely to be constant over time. If the RLW/TLW ratio has actually decreased or increased over time, then using the multi-year average of the annual estimated ratios would likely result in an over- or under-estimation of the actual ratio in any specific year. Goodyear *et al*. (2001) attempted to test for a significant decreasing or increasing trend in the RLW/TLW ratio by performing a linear regression analysis on the annual estimated ratios and failed to find evidence of a significant temporal trend. Therefore, the multi-year average of the annual MRFSS-LW/RBS-LW ratios was used as an estimate of the RLW/TLW ratio for 2002.

2002 Estimation Method for Blue Marlin

The estimate of 2002 recreational fishery landings of blue marlin was based entirely on the RBS estimates of tournament landings. RBS tournament landings by weight were summed across geographic areas (Louisiana-Maine, Texas, Puerto Rico, U.S. Virgin Islands, and Bahamas) as follows:

$$\text{total recreational landings by weight} = RBS_{LA\text{-}ME} + RBS_{TX} + RBS_{PR} + RBS_{USVI} + RBS_{BA}.$$

Goodyear *et al*. (2001) attempted to apply the same scaling method that was used for white marlin, but concluded that the available data could not support that approach for this species. The use of a long-term average ratio of estimated MRFSS and RBS landings for LA-ME as an estimate of the RLW/TLW ratio for this species in the corresponding area of overlap was not considered to be appropriate because a linear regression analysis showed that the calculated MRFSS-LW/RBS-LW ratios for blue marlin exhibit a significant upward or downward trend over portions of the time series. The ratio increased significantly from 1981 to 1988 and decreased significantly from 1989 to 2002. The pattern appeared to depend greatly on the large upward shift in the weights of blue marlin in the MRFSS intercept data after 1986 to include large fish that were virtually absent in the earlier years of the survey. The Committee suggested that this apparent anomaly might be the result of some weights being erroneously recorded in pounds rather than kilograms. Inspection of the length-frequencies of the intercepted fish revealed that they show the same upward shift beginning in 1987. Also a scattergram of length-weight data does not appear to support the notion that there was a pattern shift that may have been a result of errors in the units recorded for length (inches instead of centimeters).

Because of the significant temporal pattern in the calculated ratios, the use of a 1981-2002 multi-year average MRFSS-LW/RBS-LW ratio was considered to be invalid. The possible restriction of such an approach to the data collected in only the more recent years was rejected largely because observed landings of blue marlin over recent years have gradually become so rare in the MRFSS intercept data that there is too little data upon which to base reasonable estimates of annual RLW/TLW ratios.

Examination of the Validity of the 2002 Estimation Methods for Marlins

The Committee examined the asserted, or implied, limiting assumptions of the methods used for the 2002 marlin estimates and attempted to find ways to test or qualify the potential validity of those assumptions with available data. The main assumptions examined were as follows:

- The RBS provides a complete census of the tournament landings of marlins.
- The MRFSS estimates of total recreational fishery landings of marlins are unbiased.
- The relationship between total recreational fishery landings and total tournament landings of white marlin has been relatively constant over time.
- The ratio of MRFSS estimated landings to RBS landings is an unbiased estimator of the ratio of total recreational fishery landings to tournament landings for marlins.
- Recreational fishery landings of blue marlin outside of tournaments are so rare that they can be ignored.

The Committee's consideration of these assumptions is summarized below in the same order as listed above.

<u>Does the RBS provide a complete census of tournament landings?</u>

The RBS does not cover all U.S. recreational fishing tournaments directed at billfish. The 2002 estimates for both white and blue marlin assume that the RBS counts of tournament landings represent a complete accounting of tournament landings for these species. The RBS was actually designed to census a subset of the recreational billfish tournaments, although its coverage of U.S. tournament landings is now considered to be close to complete. Over the years that the RBS has been conducted, it is believed that all major tournaments have usually been covered. In recent years, coverage has improved and the implementation of the Federal requirement for all tournament operators to report their landings has probably resulted in near complete coverage. Any unregistered tournaments that have been missed in 2002 are believed to be relatively minor in terms of participation and are believed to be primarily catch-and-release tournaments.

The Committee recognizes that the 2002 RBS totals for white and blue marlin are below the actual total of 2002 tournament landings for those species. The difference is likely to be small, considering that the RBS coverage is probably now close to complete and only 33 white marlin and 88 blue marlin were counted by the RBS. Nevertheless, a negative bias is likely. Given that there are no data available to evaluate this possible bias, the Committee agrees that no adjustment can be made at this time to account for it.

It is also possible that there are errors in the self-reported counts provided by tournament operators. The RBS conducts dockside sampling at a large number of the major billfish tournaments to collect biological data. That sampling provides a means of validating the landings data reported by the operators of those tournaments. However, it is possible that there are errors in the numbers reported for tournaments that were not visited for dockside sampling. Such errors could result in either over- or under-counting of landed fish, but there are no data available to evaluate potential biases resulting from such errors. The Committee considers the probability of reporting errors to be relatively low due to the dockside validation that is conducted at many major tournaments.

Are MRFSS estimates of recreational fishery landings of marlins unbiased?

The Committee identified and examined three different possible causes of bias in the MRFSS estimates of marlin landings. First of all, the exclusion of angler trips returning to tournament sites from the MRFSS intercept survey sampling is likely to cause a negative bias in MRFSS estimates of marlin landings. Secondly, the known tendency of sampling surveys to overestimate the occurrence of rare events could cause a positive bias in MRFSS estimates of marlin landings because marlin landings are relatively rare events in the general marine recreational fishery. Finally, the traditional MRFSS method for partitioning for-hire boat fishing effort between offshore and nearshore areas may have caused a positive bias in MRFSS estimates of landings for offshore targets like marlins. The following section of this report summarizes the Committee's examination of these three possible causes of bias.

MRFSS representation of tournament fishing

It is very likely that the MRFSS does not adequately represent the landings of anglers who participated in fishing tournaments. Although the MRFSS telephone survey of effort has always collected data on all recreational fishing trips, the intercept survey sampling has always specifically avoided fishing access sites where a tournament is in progress. Interviewers assigned to a given site on a given day are instructed to leave and go to an adjacent site if they discover a tournament is in progress at the originally assigned site. This procedure is intended to protect against the possibility of sampling relatively large clusters of angler trips that all targeted one or two species that are not commonly targeted by most recreational anglers. It is intended to increase the precision of catch per trip estimates, preventing possible extreme variations in the mean catch rates estimated for some species from one year to the next. However, this procedure can also cause a significant bias in the MRFSS estimates of mean catch rates for species like marlins that are more common targets for tournament angler trips than for non-tournament angler trips. The MRFSS design attempts to balance the trade-off between increased precision and reduced bias toward increased precision in this case, as measured by the mean square errors of the estimated mean catch rates for all species. In order to allow the tournament site sampling required to eliminate the potential biases for marlins and other common tournament targets, much higher levels of MRFSS intercept survey sampling would be needed to greatly reduce the potential negative precision effects.

The Committee agrees that the MRFSS intercept survey avoidance of tournament sites should result in negative bias in the MRFSS estimates of total recreational fishery landings for marlins. Estimation of that possible bias is difficult given that the MRFSS telephone and intercept surveys have not distinguished between tournament and non-tournament angler trips in recent years. In 1990-1992 the MRFSS made a distinction between tournament and non-tournament trips on both the telephone and intercept surveys. Only 0.8% of the intercept survey sample of private/rental boat angler trips on the East Coast of the U.S. in those years were tournament trips, but 1.24% of the private/rental boat angler trips reported in response to the telephone survey were tournament trips. Those numbers indicate that the MRFSS intercept survey sampling may have been under-representing tournament trips by as much as 35% in those years.

Unlike the MRFSS intercept survey, the LPS intercept survey has not avoided tournament sites. The Committee believes that some comparison of MRFSS and LPS intercept survey data might yield some information on the extent of the MRFSS under-representation of tournament angler trips (see discussion below). However, it will be difficult to determine a way to make a meaningful comparison because the MRFSS covers all trips and the LPS only covers offshore trips that target large pelagic species.

<u>MRFSS representation of rare event species</u>

It is well known in the survey statistics literature that sampling surveys have a tendency to over-estimate rare events. This is largely a result of an asymmetry in the potential occurrence of erroneous positive or negative records of rare events due to random classification, coding, or key–entry errors. Suppose you have only two possible species, A and B, that could show up in angler catches. Let's assume A is very common and B is rather rare. If the people classifying, coding or key-entering data are just as likely to accidentally cause an observation of "A" to be entered as "B" as they are to cause an observation of "B" to be entered as "A", then the same random error rate will result in more erroneous "B" records than erroneous "A" records because "A" is much more frequently observed. Therefore, one must be cautious in using sampling survey estimates of relatively rare events. It is possible that such estimates will be positively biased even if the survey design is unbiased.

Angler trips with landings of marlins are very rarely intercepted in the MRFSS intercept survey sampling. It is quite possible that random errors in the collection and entry of data for more common species could have resulted in occasional erroneous records of blue or white marlin that would cause a slight positive bias in the MRFSS catch estimates. Errors in the other direction (misclassification of marlins as other species) would probably be less likely. There is some suggestion that this may be a valid concern because a few marlin records included in the MRFSS data during the 1980's include weight and length measurements that appear to be unreasonable. The Committee acknowledges that a positive bias due to rareness may be likely, but also realizes that it would be difficult to assess the extent of such a bias even if it were present.

MRFSS representation of offshore fishing on for-hire boats

The traditional MRFSS estimates of offshore for-hire boat fishing effort appear to have been positively biased. The For-Hire Survey that was initiated in the Gulf of Mexico in 1998 has produced significantly lower estimates of offshore fishing effort than the traditional MRFSS. The average annual 1998-2003 FHS estimates of charter boat angler fishing trips in the EEZ are 45% lower than those generated by the traditional MRFSS. Although the difference between the FHS and MRFSS offshore effort estimates varies among states, it is substantial in all Gulf states. Preliminary results from the FHS started on the Atlantic Coast in 2003 indicate a similarly large difference between FHS and traditional MRFSS offshore for-hire boat effort estimates.

Since marlins are primarily caught on offshore fishing trips and they are frequently targeted by charter boats, the significant positive bias in the traditional MRFSS estimates for offshore charter boat fishing effort could have resulted in a fairly significant positive bias in the MRFSS estimates for white marlin and blue marlin. White marlin are much more commonly landed along the Atlantic Coast than along the Gulf Coast, so the known bias in the MRFSS estimates of offshore charter boat effort in the Gulf may have had little impact on the 2002 white marlin estimate. Because it is too early to draw strong conclusions regarding a possible positive bias in MRFSS estimates of Atlantic offshore charter boat effort, it would not be appropriate to make any corrective adjustments at this time. However, an adjustment may be needed once the apparent positive bias for the Atlantic Coast has been effectively measured.

Is the relationship between total landings and tournament landings constant over time?

The expansion method assumes the total/tournament ratio of retained fish was constant for the 1981-2002 period. MRFSS data suggest a decline in the MRFSS/RBS ratio of the numbers of fish kept in recent years. However, there has been a significant decline in retention rates in both the MRFSS and RBS data sets. For MRFSS, the retention rate has dropped from about 65% in the early 1980's (1981-1985) to less than 1% in the most recent 5 years of data (1998-2002). This trend makes the "rare event" problem more acute for fish retained in the most recent years of the MRFSS survey, leading to increased annual variability in the estimates of landed catch with a greater probability of zero estimates in years when the RBS actually recorded landings.

Moreover, the LPS encountered non-tournament landings of white marlin during the 2002 survey, suggesting that recreational anglers are continuing to retain white marlin. The LPS estimates lend some support to the use of a multi-year average MRFSS/RBS ratio in the estimation of total landings for 2002.

Not all of the tournament landings were included in the analysis leading to the 2002 white marlin estimates reported to ICCAT. This omission is expected to cause a negative bias in the overall white marlin estimates, and the extent of the bias is related to the proportion of the total tournament landings (not the number of tournaments) that were captured by RBS. This bias has not been estimated, but some information may be available to assess its importance in the future based on the distribution of landings among the tournaments in years where tournament reporting has been mandatory.

Given that the MRFSS cannot provide reasonably precise annual estimates of recreational marlin landings, the level of detail needed to accurately assess changes in the RL/TL ratio is unavailable at this time. Therefore, it is not clear whether or not the scaling method assumption of a temporally stable RL/TL ratio is reasonable for the most recent time. However, the alternative of excluding any accounting of non-tournament landings is much less desirable. Exclusion of the non-tournament landings would result in an estimate of total white marlin landings that would be extremely negatively biased.

The applicability of a MRFSS/RBS estimate of the RL/TL ratio appears to be more justifiable for the earlier years when observations of white marlin landings were much more common in the MRFSS sampling. It is probably safer to assume that the ratio is temporally stable during those years than during more recent years when the RBS recorded tournament landings and the MRFSS estimated no total landings. Given that the RL/TL ratios are difficult to estimate for those years without imputing MRFSS values, statistical tests of the stability of the RL/TL ratio are not likely to be powerful enough to show either an increasing or decreasing trend even if one were present. Therefore, the Committee advocates potential use of a scalar expansion method for earlier years, but cautions that it may not be suitable for compliance monitoring purposes in more recent years when catch and release fishing has become much more common and both tournament and non-tournament landings have reached much lower levels.

<u>Are MRFSS/RBS ratios for marlins unbiased estimators of the actual RL/TL ratios?</u>

For the reasons stated above, the MRFSS estimates of total recreational fishery marlin landings could be too high or too low, depending on the possible counteracting effects of the exclusion of tournament fishing in CPUE calculations (causing negative bias), the more likely occurrence of false records for rare species (causing positive bias), and the apparent overestimation of offshore charter boat effort in some geographic areas (possibly causing a positive bias) . In addition, the RBS counts of tournament landings in earlier years probably represent more negatively biased estimates of total tournament landings than the RBS counts in more recent years. With the data that is available for recreational fishery marlin landings, it is not possible to accurately assess the extent of possible positive or negative MRFSS biases caused by the factors identified in this report. However, if biases do exist and they have been relatively consistent over the years, then significant temporal trends in MRFSS estimates of total marlin landings are still likely to be representative. The Committee recognizes that the MRFSS/RBS landings ratio may actually be an unbiased estimator of the actual ratio of total landings to tournament landings, but decided to examine and compare other possible estimators of this ratio because there are enough unanswered questions about potential biases in both the MRFSS and RBS estimates for marlins and the constancy of RL/TL ratios.

Comparison of MRFSS/RBS and LPS/RBS scalar expansion ratios

In order to get another measure of the RL/TL ratio that could be compared with the ones estimated from by the alternative MRFSS/RBS ratio estimation methods, the Committee looked at the 1996-2002 LPS catch data. The LPS data and resulting estimates for white marlin should be less susceptible to the potential non-tournament, rare event, and offshore fishing effort biases identified above for the MRFSS data and estimates. White marlin is much more common in the LPS intercept data than it is in the MRFSS data for Virginia through Maine. Also, the LPS intercept sampling does not avoid tournament sites and should provide a better representation of the RL/TL ratio for white marlin in the states where it has been conducted. Finally, because the LPS only covers offshore fishing effort, it is less likely than the MRFSS to underestimate this effort for charter boats.

LPS and RBS numbers for 1996-2002 were combined to calculate a geometric mean annual LPS/RBS ratio as an estimator of the RL/TL ration for white marlin. This mean ratio was compared with the geometric mean MRFSS/RBS ratio(Table 10). Annual values of the LPS/RBS ratio were highly variable, ranging from 0.75 to 16.1, with the 2002 ratio at 6.61. The geometric mean of the LPS/RBS ratios over the most recent seven years (1996-2002) was found to be 3.79. This is considerably higher than the geometric mean of the MRFSS/RBS ratios (1.79) over the same seven years, suggesting that the geometric mean MRFSS/RBS ratio may be underestimating the true RL/TL ratio for white marlin.

Table 10. Estimated RL/TL ratios based on the geometric means of annual MRFSS/RBS or LPS/RBS ratios geometric mean of annual LPS/RBS ratios for the same multi-year periods.

Species	Year	Geometric Mean Ratio (1996-Present)	
		MRFSS/RBS	LPS/RBS
White Marlin	2002	1.35	3.79
	2003	1.35	4.70

Alternative methods for estimating means of skewed distributions

Goodyear *et al*. (2001) calculated a scalar expansion factor by taking the geometric mean of a time series of annual MRFSS/RBS ratios. The geometric mean was used instead of the arithmetic mean because the distribution of annual ratios tended to be very skewed, with unusually high ratios in some years and many lower ratios, including some zeros, in other years. The skew in the distribution of the annual ratios is largely attributed to a significant skew in the distribution of the annual MRFSS estimates. This skew is not surprising because marlin landings are relatively rare events in the MRFSS intercept survey sampling, and the frequencies of rare events in random samples of populations tend to be distributed in a skewed manner. In such cases, the arithmetic mean of the distribution may actually be a positively biased estimator of the true mean. The geometric mean is one possible alternative measure of central location that is likely to be less biased. Another possible alternative is the Poisson mean, which would be obtained by calculating the arithmetic mean of the square roots of the annual ratios and then squaring that value. Frequency distributions of rare events in random samples are known to approximate a Poisson distribution.

The Committee compared the results obtained by using either an arithmetic mean or a Poisson mean of annual MRFSS/RBS ratios with those obtained using the geometric mean. The alternative mean ratios are shown in Table 11. In general, the arithmetic mean ratios for white marlin were the highest, and the Poisson mean ratios were higher than the geometric mean ratios. The arithmetic mean ratios are more than twice as high as the geometric ratios for the same time periods, and the Poisson means ratios are 30-45% larger than the geometric mean ratios . It is apparent from this comparison that the choice of a mean estimator can have a significant effect on the size of the scalar expansion (MRFSS/RBS) ratio. It is not clear which mean estimator would be most appropriate as a measure of central tendency for the distribution of annual MRFSS/RBS ratios. Further study is needed to evaluate the robustness of these approaches to estimating non-tournament catch of white marlin.

Table 11. Multi-year MRFSS/RBS ratios based on the geometric mean, arithmetic mean, or Poisson mean of annual ratios of landings in numbers of fish.

Species	Year	Mean of Annual MRFSS/RBS Ratios (1981-present)		
		Geometric Mean	Poisson Mean	Arithmetic Mean
White Marlin	2002	5.05	7.33	12.88
	2003	4.60	6.71	12.32
Blue Marlin	2002	6.30	8.80	13.51
	2003	5.99	8.38	13.00

Alternative methods for estimating mean ratios

Goodyear *et al*. (2001) used the mean of the annual ratios, but the ratio of the multi-year means may actually be a more accurate estimator of the mean MRFSS/RBS ratio. The ratio of means is generally the preferred ratio estimator because it tends to have less bias than the mean of individual ratios (Cochrane, 1977:30). The Committee compared results obtained using the "ratio-of-means" approach with those obtained using a "mean-of-ratios" approach. In both cases the geometric mean was used as the measure of the true population mean. In general, the ratio-of-means approach gives much lower estimated ratios than the mean-of-ratios approach (Table 12).

Table 12. Multi-year MRFSS/RBS ratios based on either the geometric mean of annual ratios or the ratio of multi-year geometric means of landings in numbers of fish.

Species	Year	Geometric Mean Ratio MRFSS/RBS		Ratio of Geometric Means MRFSS/RBS	
		1981-Present	Most Recent 10 Years	1981-Present	Most Recent 10 Years
White Marlin	2002	5.05	1.69	2.16	0.32
	2003	4.60	1.69	1.83	0.38
Blue Marlin	2002	6.30	1.32	3.62	0.54
	2003	5.99	1.12	3.73	0.47

<u>Scalar expansion ratios calculated over fewer years</u>

To address the concern regarding the assumed temporal stability of the annual MRFSS/RBS ratio, the Committee examined alternative expansion ratios calculated over fewer years. It was apparent that both the geometric mean ratios and the ratios of Poisson means tended to get smaller as fewer recent years were included in the calculations. The geometric mean ratio of 5.05 over 22 years (1981-2002) reduces to 4.27 over the most recent 17 years (1986-2002), 1.99 over the most recent 12 years (1991-2002), and as low as 1.35 over the most recent 7 years (1996-2002). These reductions show that the estimated RL/TL ratio, as reflected by the annual MRFSS/RBS ratio, has been decreasing in recent years and that the use of all 22 years in the estimation of a representative mean ratio for 2002, or any later single year, is questionable. The degree to which this trend is leveraged by the last few years of data has not been fully evaluated.

It is difficult to determine the optimal number of recent years to include in the scalar expansion calculations to get a reasonably precise, accurate estimate of the RL/TL ratio in any given year. With perfect information, the fewer years included, the more likely that the calculated ratio would reflect the true ratio in the most recent year. However, the more years included, the more precise the estimator would be. Finding the number of years to include to achieve an optimum balance between bias and imprecision is not straightforward, and the Committee recommends evaluating alternatives.

Alternative MRFSS/RBS expansion ratios based on either the geometric mean of annual ratios or the ratio of geometric means for the most recent ten-year period are compared with those based on the full time series of overlap between the MRFSS and RBS in Table 12. Note that the ratio-of-means approach yields estimated MRFSS/RBS ratios less than 1 for both marlin species over the most recent ten year period. This seems unreasonable, suggesting that the use of geometric means in conjunction with the ratio-of means approach may be inappropriate. However, the use of another mean estimator, such as the Poisson mean, could produce reasonable ratio-of-means estimates for even the most recent ten years (see Table 13). It is not clear at this time which combination of mean and mean ratio estimators would be most accurate.

The Committee recommends further study to compare the various alternatives for mean and mean ratio estimation based on the annual MRFSS and RBS estimates. Only after simulation studies have been conducted to compare and evaluate the performance of the alternative estimators will it be possible to select one approach as the "best".

Table 13. Multi-year MRFSS/RBS ratios based on either the ratio of multi-year geometric means or the ratio of multi-year Poisson means.

Species	Year	Ratio of Geometric Means MRFSS/RBS		Ratio of Poisson Means MRFSS/RBS	
		1981-Present	Most Recent 10 Years	1981-Present	Most Recent 10 Years
White Marlin	2002	2.16	0.32	9.80	2.33
	2003	1.83	0.38	9.49	2.90
Blue Marlin	2002	3.62	0.54	12.75	1.35
	2003	3.73	0.47	0.32	1.05

Alternative Estimators of Total Marlin Landings

The scalar expansion method was originally applied to account for non-tournament landings and to stabilize estimates since sampling survey estimates have shown high interannual variability related to small sample size resulting in a high frequency of zero catch estimates when catch was known to occur. Estimates of total 2002 and 2003 landings based on this method are compared with LPS and MRFSS estimates for white marlin and blue marlin in Table 14. Because the Committee cannot determine the most appropriate scalar expansion ratio estimator at this time, it is not clear how the LPS and MRFSS estimates would compare with MRFSS/RBS scalar expansion estimates. Such comparisons will be more meaningful once simulations studies comparing alternative expansion ratio estimators have determined the most appropriate method.

Table 14. Alternative estimates of 2002 and 2003 marlin landings in numbers of fish based on the available RBS, MRFSS, and LPS data.

Species	Year	RBS	Expansion Based on Geometric Mean Ratio MRFSS/RBS 1981-Present	LPS (VA-ME) Estimate	MRFSS (LA-ME) Estimate
White Marlin	2002	33	167	218	0
	2003	20	92	365	0
Blue Marlin	2002	74	-	0	49
	2003	99	-	100	60

Combination of annual RBS and LPS estimates of marlin landings

The Committee also compared the scalar expansion estimate of total recreational fishery white marlin landings with the estimate generated by the LPS for Virginia through Maine in June-October of 2002. The LPS and MRFSS estimates for white marlin and blue marlin are shown above in Table 14. The revised LPS estimate of white marlin landed catch was 218 fish (approximately 6.28 mt, with an approximate PSE of 40%). As indicated, use of a single year survey data to estimate landed catch of marlins suffers from high inter-annual variability that is not well characterized and the Committee recommends use of inter-annual averaging techniques to dampen that inherent variability and to provide a consistent time-series of catch estimates.

Can non-tournament recreational fishery landings of marlins be considered insignificant?

The 2002 estimate of total recreational fishery landings of blue marlin must be considered to be negatively biased because it does not provide any accounting for non-tournament landings. Because the extent of this negative bias could be rather substantial, the Committee attempted to find data on non-tournament landings that may have been missed. Since the MRFSS was started in Puerto Rico in 2001, blue marlin landings have been recorded in the intercept survey data in each of the three years. The annual MRFSS landings estimates based on these data are very imprecise, and they vary between 534 and 1,747 fish. These data indicate that non-tournament landings of this species could be substantial in the Caribbean even if they are very low on the Gulf and Atlantic Coasts due to the apparent increase in catch-and-release fishing. The Committee concludes that some consideration must be made for the unmeasured, but potentially large, non-tournament landings of blue marlin in the Caribbean. The problem of determining a reliable unbiased estimator of the recreational catches of white and blue marlins in any given year should continue to be a research priority.

Even if MRFSS and LPS estimates of marlin landings were not used for compliance monitoring, a minimum accounting should at least include all landed fish that were directly observed by the MRFSS, LPS, and RBS. Table 15 provides the total unexpanded numbers of fish observed by the LPS, MRFSS, and ALRS that were not reported to the RBS. The totals of these direct observations could be used as absolute minimum counts of white marlin and blue marlin landed by recreational anglers. Although these counts would be more accurate than the RBS counts alone, they would not adequately account for all of the non-tournament landings that occurred in 2002 and 2003.

The Committee also looked to see if the call-in reporting program (ALRS) or the recent tagging programs in Maryland and North Carolina provided any useful data on landings of marlins. In 2002, there were no marlins reported by these programs, but in 2003 there was 1 white marlin landing reported**.**

Table 15. Total white and blue marlins directly observed and counted by the RBS, LPS, and MRFSS in 2002 and 2003.

Species	Year	RBS			LPS	MRFSS		ALRS and Catch Cards	Total
		LA-NC	VA-ME	Caribbean	VA-ME	LA-ME	Puerto Rico		
White Marlin	2002	0	33	0	8	0	0	0	41
	2003	1	19	0	12	0	0	1	32
Blue Marlin	2002	58	0	16	0	6	5	0	85
	2003	67	6	25	4	2	1	0	105

Consideration of the Uncertainty of the 2002-2003 Marlin Estimates

An important consideration in applying the current method for estimating the white marlin recreational landings for compliance monitoring is that the estimated values have statistical properties that differ in important ways from census methods. Specifically, the values are estimated with error, and the uncertainty in the point estimate is quantified by confidence intervals. A point estimate that suggests that a target limit has been exceeded may in fact have only a slightly greater than 50% chance that the true catch was greater than the catch limit. This is why such comparisons in scientific evaluations are generally judged using statistical tests often requiring a 95% certainty that two numbers differ before the difference is judged significant. Any particular scalar expansion of annual white or blue marlin landings would be estimated with error, and the uncertainty of that estimate would be bounded by lower and upper 95% confidence limits. The Committee recommends that the uncertainty of estimates be taken into account for compliance monitoring purposes.

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