CSIRO PUBLISHING

www.publish.csiro.au/journals/mfr *Marine and Freshwater Research*, 2003, **54**, 567–573

Use of minimum size regulations to achieve reduction targets for marlin landings in the Atlantic Ocean

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Abstract. Trends in US recreational catch and effort data for Atlantic blue marlin and white marlin from 1972 to 2000 are examined. A method for predicting and setting minimum size regulations for this fishery is described. Additionally, this paper re-examines the impact of the most recent minimum size increases on the US recreational fishery for Atlantic marlin. The effectiveness of setting minimum size limits as a primary management approach is discussed, as is the increase in catch and release fishing in the US recreational marlin fishery.

Extra keywords: catch rates, landing size, recreational billfish survey.

Introduction

In 1988, the Atlantic Billfish Fishery Management Plan (FMP) required commercial fishing vessels within the US Exclusive Economic Zone to release all Atlantic billfish, whether alive or dead. The FMP allowed recreational landings of billfish within US waters to continue, but minimum size restrictions for blue marlin (*Makaira nigricans*), white marlin (*Tetrapturus albidus*) and sailfish (*Istiophorus playpterus*) were established for the first time. Despite these measures several population indices for Atlantic marlin suggested that stock numbers were continuing to decline (Anon 2001). This led the International Commission for the Conservation of Atlantic Tunas (ICCAT) to recommend, in 1997, that all member nations reduce landings of both blue marlin and white marlin by at least 25% from 1996 landings. In response, in 1998 the National Marine Fisheries Service (NMFS) implemented rulings that increased the minimum size limit for landing Atlantic marlin. For blue marlin, the minimum landing size was increased from 86″ to 96″ (218 cm–244 cm) lower-jaw-fork-length (LJFL), and then further increased to 99″ LJFL (251 cm) six months later. For white marlin, the minimum size limit was increased from 62″ to 66″ (157 cm–168 cm) LJFL. These rulings expired the following year, briefly returning the size restrictions to earlier levels; however, in June 1999, the 99″ and 66″ minimum size limits for blue marlin and white marlin were made permanent.

Limiting the minimum length that a fish can be legally landed is a tool commonly used by fishery managers to protect a stock from overfishing (Nowlis 2000; Ward *et al.* 2000). Fishery constituents generally accept size limits as being a reasonable management approach that allows continued use of the resource (Renyard and Hilborn 1986; Hill 1990; Fisher and Ditton 1992). Size restrictions are particularly effective in the rod-and-reel fishery for marlin, where fish are handled individually and typically brought to the boat in good condition.

Assigning size limits for the recreational Atlantic marlin fishery presented a unique challenge. Although per-recruit models are often used to determine optimum size limits for other species (Waters and Huntsman 1986; Die *et al.* 1988), such analyses have not been performed on marlin due to limitations surrounding existing studies on age, growth and natural mortality rates of these species. Instead, US fishery managers used catch statistics from organized fishing events to determine the minimum size limits that would achieve target reductions in marlin landings (Anon 1999).

Most recreational fishing effort for north Atlantic billfish is concentrated at tournaments that take place off the US Atlantic coast, in the Gulf of Mexico, and in the Caribbean Sea. The NMFS has been collecting data from recreational billfish tournaments since 1972 through the Recreational Billfish Survey (RBS). Data reporting was voluntary in the early years of the program, but since 1998, all tournaments with a reward category for Atlantic billfish were required to register and report fishing results to the NMFS as a mechanism for estimating total catch and effort from this component of the rod-and-reel fishery. Although the RBS covers only the tournament portion of the recreational fishery, it provides the best available estimate of trends in US recreational marlin landings and fishing effort in US waters.

 10.1071/MF02001 1323-1650/03/040567

This paper examines trends in RBS catch and effort for Atlantic blue marlin and white marlin from 1972 to 2000. It also reviews methods used for setting size limits for billfish in the US. Size distributions of billfish landed at tournaments were used to evaluate size limit alternatives. Although tournament data are available from 1972, only measurements from recent years were used to ensure that size distributions reflect the current size structure of the population. Additionally, this paper re-examines the impact of the most recent minimum size increases on the US recreational fishery for Atlantic marlin. Because the 2000 calendar year was the first time the new regulations were in effect for an entire year, data for 2000 were compared with earlier years. Data from 1999 are also presented to evaluate, as far as possible, transitional effects of regulatory actions.

Materials and methods

Data for the RBS are collected from organized recreational fishing tournaments that have a reward category for billfish and take place along the US Atlantic and Gulf of Mexico coasts, from US territories in the Caribbean (US Virgin Islands and Puerto Rico), or in the Bahamas. Data from the Bahamas are included in the RBS because most of the participants in Bahamian billfish tournaments are US citizens using US flagged boats. Few data from non-tournament sources are included in the RBS, although some non-tournament data are normally incorporated each year. In 2000, for example, out of a total of 120 recorded blue marlin landings, three were caught recreationally by non-tournament fishers and documented by port samplers. These were added to the total recreational catch, but with no associated measures of effort. Tournament data include at least: numbers of boats fishing in the tournament; dates of fishing; hours of fishing; and the numbers and sizes of blue marlin, white marlin, and sailfish that were boated and released. Fishing effort was calculated as the number of boats fishing × fishing hours per day.

Two indices of fishing success for blue marlin and white marlin were examined in this study: catch-per-unit effort (CPUE) and boated-per-unit effort (BPUE). 'Catch' is defined here as the number of fish hooked, lost, caught and released, or boated. The CPUE values for 1973–1999 were then standardized as described in Ortiz and Farber (2000). 'Boated' fish are those that are landed (killed). Both CPUE and BPUE were plotted against year and the means were calculated for the entire time series. Both indices were then restricted to the period when management measures were in place (1988–2000) and standardized relative to their means. The annual trend in the ratio of marlin released to boated was also examined.

In order to estimate the increases in size limits that were necessary to achieve at least 25% reductions in landings of marlin, the NMFS evaluated size distributions from Atlantic billfish landed in tournaments from 1995 to 1997 (Anon 1999). Data for blue marlin and white marlin from the RBS for 1999 and 2000 were evaluated and compared with those of 1995–1997[1]. Individual fish data were compiled in order of decreasing length for all blue marlin and white marlin boated. When only one measurement was recorded for an individual fish (length or weight), the length-weight relationships of Prager *et al.* (1995) were used to estimate the missing measurement. Landed fish that had no measurements recorded were assumed to be undersized fish that were disqualified under tournament rules. All such fish were assigned missing measurements at 1″ under the minimum size regulation in effect at the time of landing.

To examine relationships between minimum size and landings, plots were generated with a range of minimum size lengths on the x-axis, and with the cumulative numbers and weights of fish that would have been retained with each hypothetical minimum length increment on the y-axis. Arranged in this manner, the slopes of linear trend lines fitted to these data correspond to the reduction in landings per 1″ increase in minimum length. This value was then used to yield landings reduction predictions that we compared with actual landings in 1999 and 2000, after minimum size increases were implemented.

Results

Incremental analysis indicated that the 99″ minimum size limit imposed on the recreational fishery for blue marlin would reduce landings by an estimated 97 fish or 15.6 Mt (Tables 1 and 2). The actual reductions in the 2000 calendar year approached or exceeded those levels, depending on the year the landings were compared with. Target reductions from 1996 levels, as mandated by ICCAT, were exceeded. In numbers of fish, there was a 42% reduction in blue marlin landings in 2000 as compared with 1996. In weight, a 27% reduction also met the ICCAT recommended reduction of 25%.

For white marlin, landings in 2000 were down over 80% in both numbers of fish and weight as compared with levels in 1995 through 1997 (Tables 3 and 4). These reductions greatly exceeded those projected by the analysis.

Recreational fishing effort recorded by the RBS rose from 14 582 h in 1972 to 146 655 h in 2000 (Fig. 1). Catch rates increased sharply and then fluctuated throughout the 1980s and most of the 1990s, followed by sharp declines from 1999 onward (Fig. 2). Catch per-unit-effort indices demonstrate a downward trend since 1980, particularly for white marlin (Figs 3*a* and 4*a*). A sharp decline in the number of fish boated per-unit-effort since the 1980s is also evident for both species (Figs 3*b* and 4*b*). The BPUE and CPUE diverge sharply after 1988, when minimum size limits were imposed on the fishery for the first time (Figs 3*c* and 4*c*). The increase in the number of marlin caught and released is shown for both species in Fig. 5. A shift to catch and release fishing is evident after 1988, when the first minimum size limits went into effect, and then again in 1999, when large increases in minimum sizes were implemented. At that time, the ratio of released to boated marlin rose sharply, particularly for white marlin.

Discussion

Trends in catch and effort

Recreational fishing effort recorded by the RBS has increased five-fold since 1973 (Fig. 1). It is possible that technological advances in navigational equipment and fishing gear, coupled with a prospering economy, contributed to increased interest and investment in big game fishing activity. By the early 1980s, a substantial increase in the number of marlin landed in the US recreational fishery was documented by the RBS (Figs 3*b* and 4*b*). This period of high catch rates and landings

[1] Tournament data are continually amended with new information. We substituted the updated data sets for this evaluation resulting in some values being different than those in previously published reports.

Table 1. Reductions in blue marlin RBS landings per 1″ increase in the minimum size limit (MSL)
Predictions from tournament data from 1995–1997 are compared with actual results from 1999 and 2000. Reductions are displayed in terms of numbers of fish, with cumulative percentages in parentheses

Year	Predicted reduction in landings per 1″ increment	Predicted reduction in total landings with 99″ MSL	Actual reduction in landings in 1999	Actual reduction in landings in 2000
1995	6.78 (3.2%)	89 (43%)	32 (15%)	89 (43%)
1996	6.92 (3.3%)	90 (43%)	31 (15%)	88 (42%)
1997	8.62 (3.3%)	112 (43%)	83 (32%)	140 (54%)
3-year average	7.44	97	–	–

Table 2. Reductions in weight of blue marlin RBS landings per 1″ increase in the minimum size limit (MSL)
Projections from tournament data from 1995–1997 are compared with actual results from 1999 and 2000. Reductions are displayed in terms of fish biomass (Mt), with cumulative percentages in parentheses

Year	Projected reduction in weight of landings per 1″ increment (Mt)	Projected reduction in total weight of landings with 99″ MSL (Mt)	Actual reduction in total weight of landings in 1999 (Mt)	Actual reduction in total weight of landings in 2000 (Mt)
1995	1.0 (3%)	13 (39%)	0.8 (2%)	10 (30%)
1996	1.2 (3.5%)	15.6 (46%)	−0.4 (−1%)	8.8 (27%)
1997	1.4 (0.8%)	18.2 (10.4%)	9.8 (23%)	19 (45%)
3-year average	1.2	15.6	–	–

Table 3. Reductions in white marlin RBS landings per 1″ increase in the minimum size limit (MSL)
Projections from tournament data from 1995–1997 are compared with actual results from 1999 and 2000. Reductions are displayed in terms of numbers of fish, with cumulative percentages in parentheses

Year	Projected reduction in landings per 1″ increment	Projected reduction in total landings with 66″ MSL	Actual reduction in landings in 1999	Actual reduction in landings in 2000
1995	6.4 (10.9%)	26 (44%)	23 (39%)	51 (86%)
1996	4.2 (6.1%)	17 (24%)	38 (51%)	64 (89%)
1997	4.8 (7.2%)	19 (29%)	34 (49%)	62 (89%)
3-year average	5.1	21	–	–

Table 4. Reductions in weight of white marlin RBS landings per one-inch increase in the minimum size limit (MSL)
Projections from tournament data from 1995–1997 are compared with actual results from 1999 and 2000. Reductions are displayed in terms of fish biomass (Mt), with cumulative percentages in parentheses

Year	Projected reduction in weight of landings per 1″ increment (Mt)	Projected reduction in total weight of landings with 66″ MSL (Mt)	Actual reduction in total weight of landings in1999 (Mt)	Actual reduction in total weight of landings in 2000 (Mt)
1995	0.16 (10.8%)	0.64 (43%)	0.53 (36%)	1.25 (84%)
1996	0.11 (5.6%)	0.44 (22%)	0.95 (50%)	1.67 (88%)
1997	0.12 (7%)	0.48 (28%)	0.75 (44%)	1.47 (86%)
3-year average	0.13	0.52	–	–

was followed by sharp declines within the same decade, with the downward trend continuing to the present.

Indices of abundance (CPUE) from the US recreational fishery indicate that declines in the relative abundance of Atlantic blue and white marlin have occurred over the last three decades, particularly between 1980 and 1988 (Figs 3*a* and 4*a*). Whereas the CPUE index is derived from the number of fish hooked (boated, released, and hooked but lost), BPUE is a subset of that data based solely on the number of fish boated. Thus, the latter index reflects the effects of management measures and fishing practices on the marlin fishery (Figs 3*b* and 4*b*). In order to examine the effects of minimum size limits, the trend line for both indices was restricted to the period since minimum size regulations were first imposed

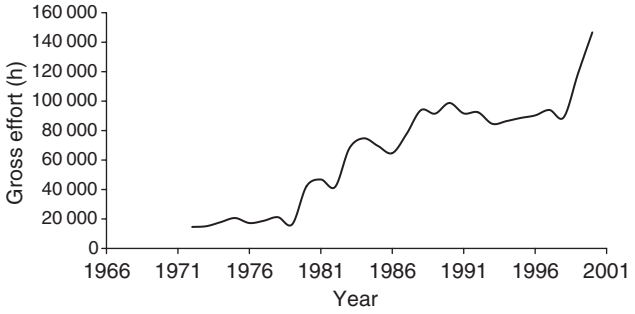

Fig. 1. Gross fishing effort from 1972 to 2000 recorded by the Recreational Billfish Survey from the US recreational tournament fishery for blue marlin and white marlin.

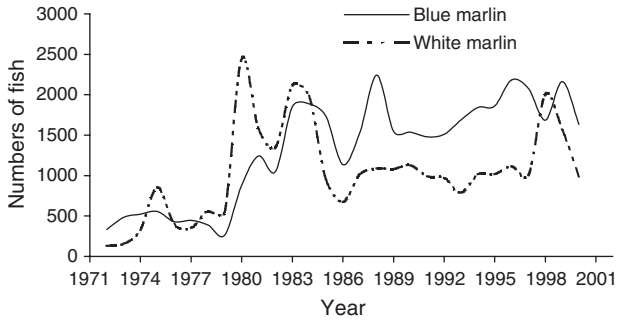

Fig. 2. Total catch from 1972 to 2000 recorded by the Recreational Billfish Survey from the US recreational tournament fishery for blue marlin and white marlin. Catch is defined as the number of fish hooked, lost, caught and release, and boated.

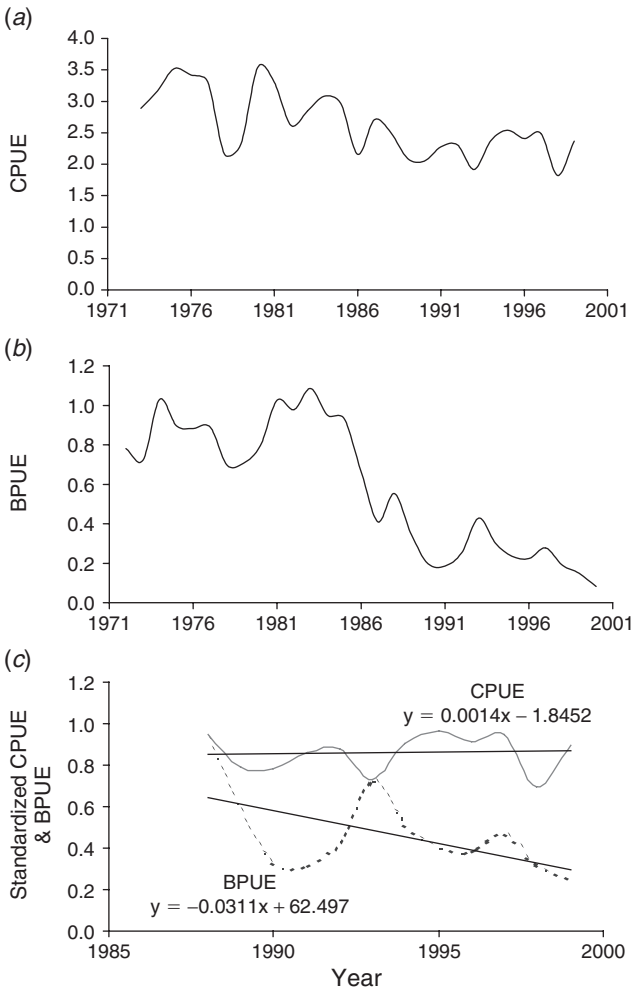

Fig. 3. (*a*) Catch-per-unit effort per 100 h (CPUE) and (*b*) boated-per-unit effort per 100 h (BPUE) for blue marlin from the Recreational Billfish Survey, 1972–2000. For CPUE, catch included the number of fish hooked and lost, caught and released, and boated. For BPUE, only the number of fish boated was used. (*c*) Standardized CPUE and BPUE for blue marlin for the period when minimum size limits were in effect, 1988–2000.

on the recreational fishery (Figs 3*c* and 4*c*). For blue marlin, differences in the trends shown by the two indices since the late 1980s reveal that the rate of decline in the number of blue marlin boated is greater than the rate of change in abundance alone (Fig. 3*c*). For white marlin, the difference in the rate of decline in BPUE compared with CPUE is even more evident than for blue marlin (Fig. 4*c*). These figures capture the impact of minimum size limits, and catch and release fishing, on recreational marlin landings.

The increase in catch and release fishing during this period was an important factor in the reduction of recreational marlin landings (Fig. 5). Anglers in the US were voluntarily reducing landings of Atlantic billfish even before the first minimum size limits were established (Jones *et al.* 1996; Anon 1999). However, many billfish tournaments, particularly marlin events, did not adopt rules to reward release fishing until after 1988, suggesting that the implementation of size restrictions was responsible for much of the shift to catch and release fishing.

It is unlikely that the US minimum size limits had a measurable impact on Atlantic marlin population levels. United States landings account for about 1% of blue marlin and less than 1% of white marlin landings reported for the Atlantic Ocean (Anon 2001). Nonetheless, with other measures already in place, increases in the legal lengths of recreational landings was a logical management response for achieving further landings reductions.

Setting minimum size limits

The 1997 ICCAT recommendation identified 1996 as the landmark year for calculating reductions in marlin landings. To determine the level at which to set the new size limits, the NMFS evaluated size distributions from Atlantic billfish landed in tournaments from 1995 to 1997 (Anon 1999). Using tournament data for the same years, we compared reductions predicted by the data with actual tournament results from 1999 and 2000 (Tables 1–4).

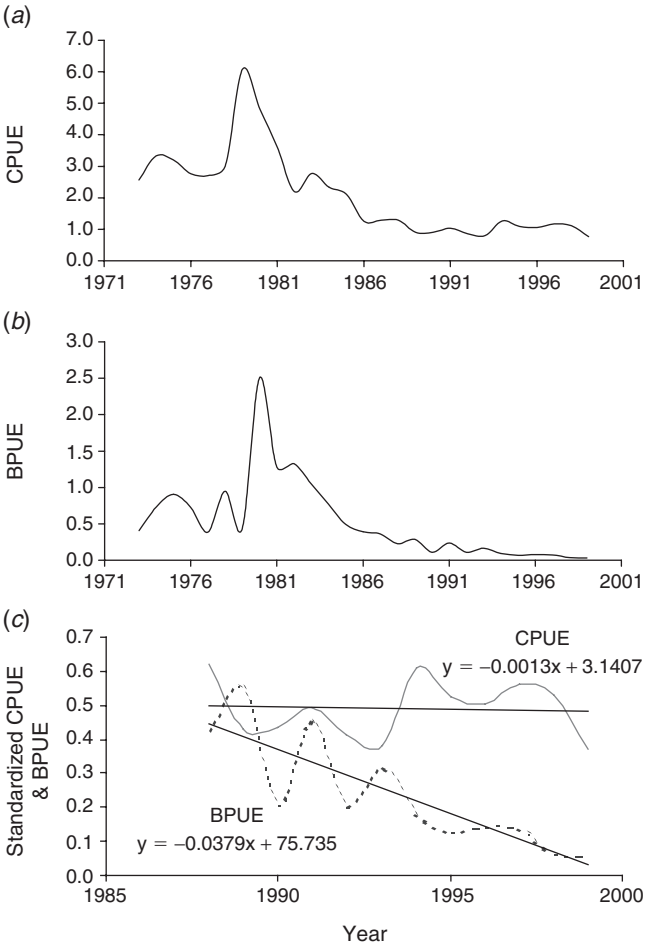

Fig. 4. (*a*) Catch-per-unit effort per 100 h (CPUE) and (*b*) boated-per-unit effort per 100 h (BPUE) for white marlin from the Recreational Billfish Survey, 1972–2000. For CPUE, catch included the number of fish hooked and lost, caught and released, and boated. For BPUE, only the number of fish boated was used. (*c*) Standardized CPUE and BPUE for white marlin for the period when minimum size limits were in effect, 1988–2000.

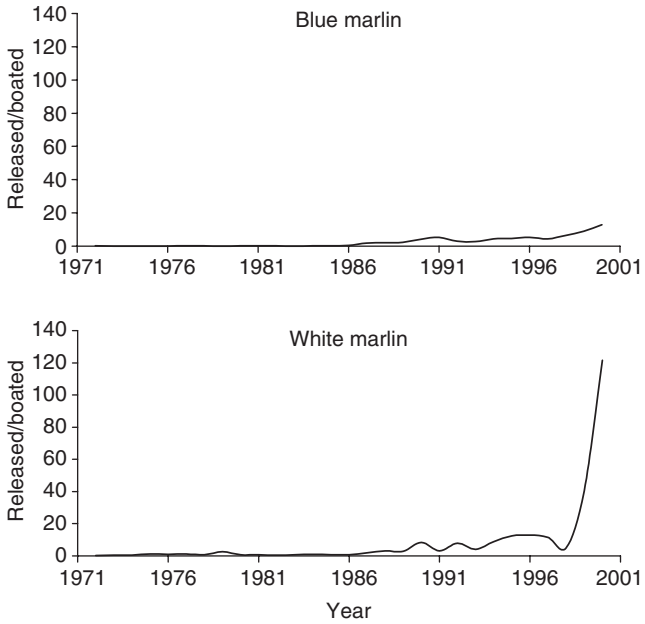

Fig. 5. The ratio of released to boated blue marlin and white marlin during recreational tournaments 1972–2000.

Blue marlin

Numbers of blue marlin recorded landed through the RBS were 209 in 1995,208 in 1996, and 260 in 1997. Estimated reductions in the number of blue marlin landed, per 1″ increase in the minimum size, ranged from 6.78 to 8.62 (all r^2 values > 0.98, Table 1). Using the average of the slopes for the 3-year period, a decrease in landings of 7.4 blue marlin was predicted for every 1″ increase in the minimum size limit. Therefore, a 13″ increase in the minimum size limit (86″ to 99″ LJFL) corresponds to a projected reduction of 96 fish, under steady-state assumptions. The actual decrement in 2000 was 88 fish (from 208 to 120 fish): this equates to a 42% reduction from 1996 landings.

In biomass, the reduction projected for blue marlin from the 3-year average was 16.25 Mt from 1996 to 2000, whereas the actual reduction was only 8.8 Mt (Table 2). This overestimation is due to the fact that, although minimum size limits do reduce the number of fish landed, they also raise the mean size of landings. A 99″ LJFL blue marlin is estimated to weigh 317 lbs (Prager *et al.* 1995). The previous legal size for landing a blue marlin was 96″ LJFL, estimated to be a 286 lb fish (Prager *et al.* 1995). Landings are now restricted to fish weighing at least 30 lbs more than pre-1999 landings. In addition, inter-annual fluctuations in the size structure and condition of the population will affect total biomass of the catch.

Catch and size frequency data from the RBS were previously used to evaluate the effects of the recent increases in US minimum size regulations one year after they were implemented (Farber and Venizelos 1999, 2000). Both the number and weight of marlin landed during Atlantic billfish tournaments in 1999 were examined. For blue marlin, there was a 15% reduction in the absolute number of tournament-captured fish boated in 1999, compared with 1996. Despite this reduction, there was a slight increase in the estimated weight of landings. This may be partly attributed to the 25% increase in tournament monitoring in 1999, when billfish tournament reporting became mandatory. However, the next year, a 27% reduction in biomass of landings of tournament-caught fish was achieved, compared with 1996, despite an additional 19% increase in gross effort.

An important consideration in evaluating minimum size regulations is the transitional effect of new management measures. The new minimum sizes did not go into effect until June of 1999. The 2000 calendar year was the first year the new regulations were in effect for the entire year and the first year

that target reductions in marlin landings were achieved. It is reasonable to expect that changes in fishing behaviour require a transitional period for constituents to learn about and adjust to new regulations.

White marlin

Numbers of white marlin recorded landed through the RBS were 59 in 1995, 69 in 1996, and 67 in 1997. Estimated reductions in the number of white marlin landed, per 1″ increase in the minimum size, ranged from 4.2 to 6.4 ($r^2 > 0.98$, Table 3). Using the average of the slopes for the 3-year period, a decrease in landings of 5.1 white marlin would be predicted for every 1″ increase in the minimum size limit. Therefore, a 4″ increase in the minimum size limit (62″ to 66″ LJFL) corresponds to a projected reduction of 20.4 fish, under steady-state assumptions. The actual decrement in 2000 was 61 fish (from 69 to 8 fish): this equates to an 89% reduction from 1996 landings.

The extreme accuracy of the predictive equations for reductions in blue marlin landings suggests that the underestimation of reductions in white marlin landings most likely resulted from differences in fishing methods, or in fish behaviour and abundance, between 1996 and 2000. In 2000, 988 white marlin were caught in the tournament fishery, yet only 8 were landed (0.8%). In 1999, 1566 white marlin were reported caught, with 36 landed (2%). In 1996, 68 of the 1117 white marlin caught were landed (6%). For comparison, from a total of 2184 blue marlin caught in the tournament fishery in 1996, 203 were reported landed (9%) whereas in 2000, 120 of 1634 blue marlin caught were reported as landed (7%). Although Atlantic-wide abundance levels have declined for both species (Anon 2001), Fig. 4 shows strong differences in the amount of catch and release fishing practiced for each marlin species. The unexpectedly large reduction in the number of white marlin landed in 2000 corresponds to a sharp increase in catch and release fishing activity for this species and would have the effect of underestimating the predictive equations for landings reductions.

Likewise, the reduction in the weight of white marlin landings that was projected from the 3-year average was 0.13 Mt from 1996 to 2000, whereas the actual reduction was 1.67 Mt (Table 4). In biomass, there was a reduction of about 50% in the estimated weight of landings of white marlin in 1999 compared with 1996, exceeding the ICCAT recommended reduction of 25%.

Conclusions

Our results reveal CPUE declined for both blue marlin and white marlin and these declines were consistent with those in other data sets (Anon 2001). Despite this effect, the imposition of minimum size limits on the US recreational fishery has had an effect on the number and biomass of marlin landed by this fishery.

Although increases in the minimum size limits were implemented at the end of 1998, the effects of the new regulations were not fully realized until the 2000 calendar year. Target reductions (recommended by ICCAT) were not achieved in 1999 due to the confusion among fishery constituents created by the recent implementation of the new restrictions, which led to a reversion of the regulations to earlier levels for several months during the 1999 marlin fishing season. However, by increasing the minimum allowable length for landing marlin, US fishery managers achieved and exceeded the ICCAT recommended reductions in marlin landings after the length regulations had been in place for an entire calendar year.

Application of the method described in this paper provided estimates of reductions in marlin landings that resulted from US fisheries restrictions. Though there was no specificity in the ICCAT recommendation as to whether landings reductions were to be achieved in numbers or weight, both were evaluated. For blue marlin, minimum size limits were found to have a greater effect on the number of fish landed than on weight. Although a 42% reduction in the number of blue marlin landed in 2000 was achieved, this level was necessary in order to meet target reductions in weight. For white marlin, reductions in landings greatly exceeded reductions projected to occur both in the number of fish landed and in weight. The increased popularity of catch and release fishing is likely responsible for much of the decrease in landings for this species.

References

Anonymous (1999). 'Amendment 1 to the Atlantic Billfish Fishery Management Plan.' (US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service: Washington, DC.)

Anonymous (2001). Report of the Fourth ICCAT Billfish Workshop held in Miami, Fl. July 2000. *International Commission for the Conservation of Atlantic Tunas*, *Collective Volume of Scientific Papers*, Madrid, Spain **53**, 1–130.

Die, D. J., Restrepo, V. R., and Hoenig, J. M. (1988). Utility-per-recruit modelling: a neglected concept. *Transactions of the American Fisheries Society* **117**, 274–281.

Farber, M. I., and Venizelos, A. (1999). A preliminary evaluation of US billfish landings in 1998 relative to 1996. *International Commission for the Conservation of Atlantic Tunas, Collective Volume of Scientific Papers* SCRS/99/99.

Farber, M. I., and Venizelos, A. (2000). An evaluation of US billfish landings in 1999 relative to 1996. *International Commission for the Conservation of Atlantic Tunas*, *Collective Volume of Scientific Papers*, Fourth International Billfish Workshop, Miami, FL, July 2000. SCRS/00/55.

Fisher, M. R., and Ditton, R. B. (1992). Characteristics of billfish anglers in the U.S. Atlantic Ocean. *Marine Fisheries Review* **54**, 1–6.

Hill, B. J. (1990). Minimum legal sizes and their use in management of Australian fisheries. In 'Proceedings of the Australian Society for Fish Biology Workshop, Lorne, Victoria, 1990'. (Australian Government Publishing Services: Canberra.)

Jones, C. D., Rosenthal, D. S., Jackson, T. L., Judge, M. T., and Prince, E. D. (1996). Cooperative Tagging Center Annual Newsletter: 1996.

National Oceanic and Atmospheric Administration Technical Memorandum **391**, 1–24.

Nowlis, J. S. (2000). Short- and long-term impacts of three fishery-management tools on depleted fisheries. *Bulletin of Marine Science* **66**, 651–62.

Ortiz, M., and Farber, M. I. (2000). Standardized catch rates for blue marlin (*Makaira nigricans*) and white marlin (*Tetrapturus albidus*) from the US recreational tournaments fishery in the northwest Atlantic and the Gulf of Mexico. In 'Proceedings from the 4th International Billfish Workshop, International Commission for the Conservation of Atlantic Tunas, Miami, Florida'.

Prager, M. H., Prince, E. D., and Lee, D. W. (1995). Empirical length and weight conversion equations for blue marlin, white marlin, and sailfish from the North Atlantic Ocean. *Bulletin of Marine Science* **56,** 201–210.

Renyard, T. S., and Hilborn, R. (1986). Sports angler preferences for alternative regulatory methods. *Canadian Journal of Fisheries and Aquatic Sciences* **423**, 240–42.

Ward, P., Porter, J. M., and Elscot, S. (2000). Broadbill swordfish: status of established fisheries and lessons from developing fisheries. *Fish and Fisheries* **1**, 317–36.

Waters, J. R., and Huntsman, G. R. (1986). Incorporating mortality from catch and release into yield-per-recruit analyses of minimum size limits. *North American Journal of Fisheries Management* **6**, 463–71.

Manuscript received 2 January 2002; revised and accepted 11 January 2003.