

THE MARLIN CONUNDRUMS: TURNING THE TIDE FOR BY-CATCH SPECIES

D. G. Webster

ABSTRACT

The political economy of by-catch management is outlined with particular reference to the regulation of *Makaira nigricans* Lacépède, 1802 and *Tetrapturus albidus* Poey, 1860 in the Atlantic. As has happened in the US, national policy preferences can become more conservation-oriented as a result of lobbying by focused non-commercial interests, but these groups are most effective when bolstered by broad domestic institutions. Achieving legislation domestically prior to its introduction at the international level is important, because it gives national commercial fishing interests incentives to ensure that their competition from abroad is similarly regulated. Nevertheless, billfish management requires cooperation among decision-makers from many fishing countries, most of whom formulate policy under much different circumstances. Technological solutions that reduce the costs of avoiding by-catch are still the best option for sustainable billfish management.

From a political economy perspective, the effective management of istiophorid billfish stocks at maximum sustainable yield (MSY) is a particularly difficult problem because they tend to be highly migratory and are incidentally captured in valuable commercial fisheries (The MSY benchmark is used because it is the purported goal of most management institutions governing these fishes). As highly migratory species, billfishes can only be managed when fishing countries cooperate, usually via a multilateral institution. Measures to limit billfish by-catch mortality may be costly to commercial fishing interests without providing the benefits that accrue to direct users of the resource like recreational fishers. In these cases, both the barriers to management and the incentives to forgo action are substantial. Other highly migratory by-catch species such as turtles and dolphins have been managed with a fair amount of success, but only after widespread public protest and the development of technologies that minimize fishing mortality (De Sombre, 2000). Although iconic, billfishes do not seem to elicit the same breadth of response, so effective international management has been considered unlikely.

Nonetheless, one international fisheries organization (International Commission for the Conservation of Atlantic Tunas or ICCAT) has adopted rather extraordinary measures to reduce landings of Atlantic blue marlin, *Makaira nigricans* Lacépède, 1802, and Atlantic white marlin, *Tetrapturus albidus* Poey, 1860. By no means perfect—they fall short of the rebuilding plans that have been adopted by the same institution for commercially targeted stocks—the existence of these regulations is still a conundrum, since no measures would be expected given a purely commercial value set. Further scrutiny of the record of marlins in the Atlantic reveals that all of the actions to reduce by-catch of these species were instigated by one country, the United States. This is a second conundrum, since the US, like most ICCAT participants, has significant vested interests in commercial fisheries that capture marlins incidentally.

Although a complete answer to the problem of billfish management cannot be provided at this time, some illumination has been gained from exploring these two marlin conundrums:

- (1) In the absence of a widespread global outcry, why have costly management measures to reduce marlin by-catch been adopted by ICCAT?
- (2) Why has the US been the major force behind marlin measures at ICCAT, even though these regulations appear to be detrimental to commercial fishing interests?

In addressing these questions, this paper builds on and adds to a considerable literature on the politics and economics of international fisheries management. Most notably, Peterson (1995 and 2000), Young (1999), and De Sombre (1999 and 2005) tackled these fisheries from an international relations perspective, and Clark (1990), Kaitala and Munro (1993), Hannesson (1997), Bjorndal et al. (2000), and McKelvey, Sandal, and Steinshamn (2003) developed economic models of HMS management. My approach follows De Sombre (2000), who linked domestic US politics to international environmental policy and covered many HMS issues, including the conservation of other by-catch species like dolphins and sea turtles. To gain leverage on this linkage, I first present evidence regarding the international dynamics that led to relatively strong marlin measures in the Atlantic, providing a partial answer to conundrum 1. I then describe the domestic elements that shaped the US leadership in this area (conundrum 2) and consider the implications for a more generalized answer to both conundrums.

MARLIN CONUNDRUM #1: UNEXPECTED MEASURES IN THE ATLANTIC

Since no single country has jurisdiction over billfishes and other highly migratory species, international cooperation is required if these stocks are to be managed at all. Recognizing the need for cooperation, fishing countries have established multi-lateral bodies, known as regional fisheries organizations, to facilitate the negotiation and adoption of international regulations. Such international cooperation is difficult even when there are mutual gains from regulations, but management of many billfish stocks is further complicated because some have little commercial value and are by-catch in fisheries targeting tunas, swordfish, and other high-revenue fishes. Therefore, the commercial benefit to managing these species effectively is quite small relative to the potential cost of harvest forgone from by-catch avoidance. Any reductions to incidental mortality, beyond the release of live billfishes, require diminishing fishing effort on targeted stocks. Generally speaking, commercial fishers have incentives to prevent billfish management, rather than to encourage it.

This brings us to the major conundrum, and motivating question, of this paper: Why have costly management measures to reduce marlin by-catch been adopted by ICCAT in the absence of a widespread global outcry? In fact, why should fishing countries attempt to reduce billfish mortality at all? For commercially valuable stocks there can be economic incentives for cooperation and trade-based mechanisms to monitor and enforce compliance. When there is a widespread, global outcry, popular opinion can hold the recalcitrant in check. In a few cases the economic and political motivators combine, as when US consumers utilized their market power by choosing to boycott tuna until it became "dolphin safe" (De Sombre, 1999). These conditions do not exist for noncharismatic by-catch species like most billfishes.

In some cases, minimal or even non-existent management measures have been sufficient to maintain billfish stocks near full exploitation but, in other cases, fishing mortality has led to steady declines in abundance. For instance, striped marlin *Tetrapturus audax* (Philippi, 1887) in the eastern Pacific and the Pacific stock of blue marlin (*M. nigricans*) have been found to be stable at or around full exploitation (IATTC, 2003, 74, and 77). In contrast, according to official scientific reports of the Standing Committee on Research and Statistics (SCRS) of the International Commission for the Conservation of Atlantic Tunas (ICCAT), the biomass of *M. nigricans* was estimated at 40% of the level that would support maximum sustainable yield (B_{MSY}) in the Atlantic. An ASPIC model was used in the assessment, and bootstrap methods were used to calculate an 80% confidence interval from 25%–60% of B_{MSY} (ICCAT, 2004, 101). Similar methods were used to assess *T. albidus*; the 2001 biomass was estimated at only 12% of the B_{MSY} level with the confidence interval ranging from 6%–25% of B_{MSY} . Alternate models were also used, including a retrospective adjusted estimate ($B = 22\% B_{MSY}$). Sensitivity estimates of biomass ranged from 12%–176% of B_{MSY} , though the analyses were not chosen in a systematic way (ibid., 109).

These assessments suggest that ICCAT has fallen short of its purported goal: maintaining stocks of tunas and tuna-like species in its jurisdiction at levels that produce maximum sustainable yield. Considering the low commercial value of these stocks and their limited appeal to a global audience, this result is not surprising. Combined, all billfishes represent < 1% by volume of the stocks managed by ICCAT (ICCAT, 1988, 69). With relatively low prices—only skipjack is cheaper—the commercial value of billfishes, including *M. nigricans* and *T. albidus*, is miniscule compared to the millions of dollars generated by the exploitation of other highly migratory species in the Atlantic (FAO Commodities and Production 1976–2001 Database). Moreover, there has been no huge public response to such low biomass levels.

However, a closer look at the record on ICCAT management of Atlantic marlins reveals an unexpected exuberance in the regulatory activities associated with these stocks. Beyond requiring the release of all live billfish caught incidentally, which is common in other regional fisheries commissions, ICCAT has adopted binding resolutions requiring contracting parties to substantially reduce their billfish landings. Granted, the Commission has not adopted any of the international monitoring or enforcement measures for these by-catch stocks that it has for commercially valuable species such as *Xiphias gladius* Linnaeus, 1758, *Thunnus obesus* (Lowe, 1839), and *Thunnus thynnus thynnus* (Linnaeus, 1758). Nonetheless, by agreeing to binding recommendations, ICCAT members have made an official commitment to specific goals that can be independently analyzed.

Why would the members of ICCAT, all of which are countries with vested interests in commercial fishing, choose by consensus to adopt measures that could harm those economic interests, without strenuous pressure from an international environmental movement? I encountered this first marlin conundrum while testing a more general model, which posited that decision-makers, reified as states, formulate their policy preferences in order to protect their domestic fleets from escalating international competition. Because management measures were adopted for by-catch like Atlantic marlins, these cases, unlike the four others that were compiled for commercially tar-

geted stocks, invalidated the underlying assumption that all members of ICCAT are solely interested in protecting their commercial fleets. Nevertheless, the findings in that analysis do provide some preliminary answers to the questions at hand.

A PARTIAL ANSWER: SCIENCE AND NATIONAL POLICY

A careful comparison of scientific advice, national policy preferences, and actual management measures as they change over time offers two particular insights into marlin conundrum #1. First, improvements in scientific knowledge played an important role by clarifying the gravity of the situation for these stocks. Second, there is substantial evidence in the official record that a single, powerful member has consistently been the main proponent of billfish conservation over the years. At times, marlin protections have had support from a handful of other members, but it is safe to say that management of these stocks would look much different today if not for the activities of this one country [scientific advice was drawn from the annual reports of ICCAT's Standing Committee on Research and Statistics (SCRS)]. National policy preferences were derived from the statements and proposed management measures made by national delegations and recorded in the annual reports of the Commission itself. Actual management measures are also recorded in ICCAT's annual reports.)

In the mid-1970s, when concerns regarding billfish were first expressed at ICCAT, little was known regarding these fishes. In spite of repeated calls for better data and analysis from its SCRS, it took more than a decade for the Commission to approve remediation in the form of the Enhanced Research for Billfish Program (ERBP). Progress on the ERBP was slow at first, mainly because there was so much that needed to be done to improve databases and analytical techniques. Solid results were not available until the 1990s, when SCRS consistently reported that both *M. nigricans* and *T. albidus* were overfished (stock biomass was below the level that would support MSY), and that overfishing (fishing effort was above the level that would produce MSY) was still occurring for the species (ICCAT 1993, 164, and 165). In fact, SCRS started recommending the live release of both stocks in 1992 and has suggested that the Commission develop additional means of curbing fishing mortality every year for more than a decade.

Since the first full analysis by the SCRS in 1995, official estimates of biomass, fishing mortality, and maximum sustainable yield have presented a fairly clear, if somewhat varied picture of the state of these stocks. As Table 1 shows, several of the most important assessment indicators have fluctuated as databases and models have changed. Nevertheless, according to all of the most likely assessments, both Atlantic marlins are severely depleted. That condition is only likely to get worse unless fishing mortality can be reduced (ICCAT, 2001c, 2003b). By revealing the state of these stocks, SCRS assessments have been instrumental to the development of management measures. However, in this case, new science did not convince decision makers that have opposed stringent marlin management, many of whom still express skepticism regarding SCRS conclusions, so much as it amplified the concern of delegations that were already apprehensive about the welfare of these stocks.

One ICCAT member, or contracting party, in particular stands out in that regard. It was the US that initiated the push for billfish assessments in 1975, and the majority of the annual funding for the ERBP, which is still actively pursuing billfish research, has been raised from private sources within the US. In 1992, the SCRS recommend-

ed that the live release of incidental marlin catches could reduce fishing mortality by as much as 37%. That same year, the US put forth a proposal that would require all contracting parties to release whatever billfish they caught, dead or alive (ICCAT, 1993, 168, and 94). Thus, a dialog began, and the US continued to push for similar regulations, but no actions were taken until 1995, when the Commission adopted a non-binding resolution that established a 5-yr scientific program, during which contracting parties were encouraged to promote the live release and tagging of billfishes by both commercial and recreational fishers (ICCAT, 2005b, res. 95-12).

Due to opposition from several ICCAT members, the 1995 resolution was considerably less stringent than the original US proposal, which was a binding recommendation for a 12-yr mandatory live-release scientific study, rather than an optional program. Again, the US proved to be more adamant about adherence to scientific advice on billfishes in the Atlantic than other members of the Commission (ICCAT, 1996a, 166). In 1996, the US proposed a compulsory phase-in of monofilament lines in fishing gear, which might reduce mortality on billfishes, according to preliminary evidence from the Third ICCAT Workshop on Billfishes (ICCAT, 1997a, 88). Although one contracting party, Bermuda (represented as an overseas territory of the United Kingdom), vocally supported the US, reticence by others once more transformed the proposal into a non-binding resolution (ICCAT, 2005b, res. 96-9).

No new assessments were carried out for blue marlin or white marlin in 1997, but the USA proposed a prohibition on all landings of these stocks except for those caught in big game tournaments (ICCAT, 1998, 172). As in the past, most other members of ICCAT were less enthusiastic about the US plan, citing a need for fairness in application to all gear types and distaste for the waste created by discarding dead marlins. In the end, the Commission adopted a second proposal that had been developed in informal meetings between the USA, Japan, and other interested parties. Rather than a complete moratorium, the joint recommendation required a 25% reduction in landings of blue marlin and white marlin from 1996 levels by the end of 1999 (ICCAT, 2005b, rec. 97-9). This measure was kept in place until new assessments were conducted in 2000.

Although the 2000 estimates of biomass were somewhat more optimistic for blue marlin, the results for white marlin were much worse than previous assessments (see Table 1). In addition, SCRS recommended that the Commission look into ways of reducing fishing mortality on these stocks to supplement live-release requirements, including reducing fleet-wide effort, implementing time-area closures, and instituting an observer program (ICCAT, 2001b, 66, and 73). In response, the US presented a detailed proposal for a rebuilding plan that included release of all marlins caught incidentally and supported research into alternatives such as those recommended by the SCRS (ICCAT, 2001a, 242). After much discussion, ICCAT agreed that, over the next two years, all commercial fleets in the Atlantic Ocean would be required to further reduce their landings of blue marlin and white marlin to 50% and 33% of 1999 levels respectively. This is also the first year in which the United States agreed to limit its recreational fisheries. Combined landings of both stocks were restricted to a total of 250 fish, all of which would be taken in duly monitored tournaments. Other countries were required to establish size limits for both species in their recreational fisheries (ICCAT, 2005b, rec. 00-13).

This recommendation was scheduled for review after a new assessment and development of rebuilding plans in 2002. It was renewed at that time, but since then no

substantive new measures have been adopted for any of the billfish stocks in the Atlantic. At the instigation of Japan, the 2000 marlins recommendation was revised in 2001. The reference point for reduction of landings was changed to account for compliance, or lack thereof, with the 1997 recommendation to reduce catches of both species by 25%. As Japan pointed out, some countries had complied with the 1997 regulation, reducing their catches in 1999 while others had not. To make things more equitable, the rebuilding plan was modified so that nations could choose to reduce their landings of blue and white marlins relative to either 1999 or 1996 landings.

As the above narrative shows, the US consistently proposed, and pushed other nations to adopt, relatively strong management measures for both blue marlin and white marlin. Although one cannot say unequivocally that such strenuous measures would not have been undertaken in the absence of US influence, the reticence of other Commission members on this point does suggest that the US role was pivotal. Returning briefly to the evidence in ICCAT reports, the countries with the largest longline fleets in the Atlantic have shown decided preferences for minimal management measures on billfishes and expressed the most skepticism regarding SCRS assessments of blue marlin and white marlin. These include China, Japan, and Taiwan, which together harvest around 85% of the Atlantic bigeye tuna (*T. obesus*) that is captured via longline and the several members of the European Community, which land approximately 50% of longlined Atlantic swordfish (*X. gladius*) (ICCAT Landings 1950–2002 Database). As high value stocks, most incidental harvests of billfishes have been recorded in these fisheries so effective billfish management requires the cooperation of these four powerful and relatively independent members of ICCAT.

The above analysis provides us with a partial answer to the first marlin conundrum. ICCAT has adopted costly management measures to reduce marlin by-catch in the absence of a widespread global outcry because one powerful country expended concerted diplomatic effort to achieve consensus on those measures. Two things must be kept in mind here. First, in spite of its strength and dedication, the US has yet to fully overcome those objections, and marlin management remains weak in comparison with measures adopted to rebuild commercially targeted stocks. Second, US behavior itself must be explained, since it goes against the commonly held expectation that national policy preferences reflect domestic commercial fishing interests

MARLIN CONUNDRUM #2: UNDERSTANDING US INTEREST

Here, then is a second marlin conundrum. Why has the US been the major force behind marlin measures at ICCAT, even though these regulations appear to be detrimental to commercial fishing interests? For those who are familiar with this issue area, the most obvious answer would be the influence of noncommercial interests, who prize marlins and other billfishes for their recreational or existence value. Although less apparent, there are two other recent changes that have impacted US policy at ICCAT. On the one hand, there is the economic decline of US commercial longline fleets, those most involved in billfish by-catch and most harmed by mandatory landings reductions for marlins. On the other hand, there have also been several seminal laws passed in the US, largely due to pressures from broader conservation-based interest groups that have given commercial fishers reasons to desire marlin-specific regulations that would have comparable impacts at the international level.

The influence of noncommercial interests in US ICCAT policy development is difficult to measure, but a fair amount of circumstantial evidence exists. Organizations representing recreational fishers have been involved in the US decision-making process regarding ICCAT for decades, and at much deeper levels than can be observed for most other Atlantic fishing states. Conservation interests have also been active in this area, although to a lesser extent. At times, it may be difficult to distinguish these two types of interests, since they often share the same goals and the same constituencies. Nevertheless, there have been points of strong divergence between the two; most notably, the 2001 attempt by conservation organizations to have white marlin listed under the Endangered Species Act, which is described in greater detail below. This event created a large rift between recreational fishers, who wish to conserve marlin for their own enjoyment, and conservationists, who derive utility from the biological and existence values of these fish. Such potential for conflict makes finding a way to measure the impact of these noncommercial interests even more important. While by no means a majority, many of the members of past US delegations have been from the recreational fishing community and there are frequently a few representatives of the conservation community as well. Only a handful of other contracting parties like Venezuela and Cuba have ever had representatives of any noncommercial interest group on their delegations (ICCAT, 1996b, 46). This suggests that these groups are more important in the US than in other ICCAT member countries.

The most visible efforts of conservation organizations seemed to be aimed at a broader audience, such as the proposal to list white marlin as endangered or, though not directly aimed at marlin conservation, the "Give Swordfish a Break" campaign of the late 1990s and the Seafood Watch Program of the Monterey Bay Aquarium. As will be shown below, the latter maneuver was unsuccessful, although white marlin is now considered to be a species of concern and will be reevaluated for endangered status in 2007. Conservationists' public relations campaigns may have had some effect on consumption of certain commercially targeted species, like swordfish, but the magnitude of that impact on policy is difficult to assess. It is possible that these campaigns pushed events past some unobserved diplomatic tipping-point, but no visible evidence for this conclusion is available. What is quite obvious is that the public response to campaigns for the protection of almost any finfish, marlins included, has been much less passionate and pervasive than for marine mammals, sea turtles, and other more charismatic species.

By contrast, though they work to drum up support within their own ranks, evidence shows that the recreational community engages in more direct participation in the policy-making process. Recreational fishers have been a sizable faction on the US ICCAT Advisory Committee for many years. They have also engaged in scientific tag-and-release efforts since the mid-1970s, providing information that has helped shape stock assessments for marlins (ICCAT, 1978, 147). Moreover, US law mandates that, of the three US commissioners to ICCAT, one is always a representative of recreational fishers (a commercial fishing representative and a government employee each hold one of the other two seats) (US Congress, 1975, chap. 16A, sec. 971b, para. a1). In addition, US delegates have frequently referred to the importance of domestic recreational fisheries as a rationale for management measures when discussing proposals on billfish generally and marlins specifically.

There are several indications that the economic value of marlins and other billfishes targeted by recreational fishers from the US has significantly influenced policy.

Table 1. Highlights of reported results of Standing Committee on Research and Statistics (SCRS) stock assessments for blue marlin (*Makaira nigricans*) and white marlin (*Tetrapturus albidus*).

Year	<i>M. nigricans</i>			<i>T. albidus</i>		
	MSY (t)	B as %B _{MSY}	F as %F _{MSY}	MSY (t)	B as %B _{MSY}	F as %F _{MSY}
1995*	3,600	42%	?	1650	25%	?
1996**	4,461	24%	?	2,177 (2,102–2,228)	22.60%	?
2000**	2,000 (2,000–3,000)	40 (25–60)%	400 (250–600)%	1,300 (900–2,000)	12%	> 700%
2002**	No assessment			964 (849–1,070)	12 (6–25)%	828 (450–1,580)%

Sources: *M. nigricans*: ICCAT 1996b, 46; 1997b, 51; 2001b, 66; *T. albidus*: ICCAT 1996b, 53; 1997b, 58; 2001b, 73; 2003a, 77. MSY = maximum sustainable yield; B = biomass, BMSY = biomass that supports MSY; F = fishing mortality, FMSY = fishing mortality at MSY. * Estimates are of 1990 levels, ** numbers in parenthesis are 80% confidence intervals

Most telling are two official statements by US representatives at the negotiating table, which directly refer to the domestic economic importance of recreational fisheries as a reason to protect *M. nigricans* and *T. albidus*. During discussions of their 1995 live-release proposal, the US claimed that its recreational fisheries for billfish were worth more than \$15 billion (ICCAT, 1996a, 166). Five years later, when introducing their 2000 rebuilding plan, the US representative stated that, because of recreational fisheries, Atlantic marlins were as valuable to the United States as commercial fisheries targeting swordfish were to the European Community and bigeye tuna was to Japan (ICCAT, 2001a, 242).

Lastly, US recreational interests have directly impacted ICCAT management by funding science on Atlantic billfishes. Most of the money for the Enhanced Research for Billfish Program has come from groups of recreational fishers in the USA who have been dismayed at the decline in their catch per unit of effort since the early 1980s (ICCAT, 1988, 151). This includes the initial seed money of \$25,000, which supplemented the \$10,000 provided by ICCAT in the first year of the program (ICCAT, 1987, 126). By 1994, the ERBP was attracting as much as \$68,000 per year, mainly from US recreational fishers (ICCAT, 1994, 114–115). Though contributions are down, these groups continue to donate to the ERBP and others privately fund billfish science outside the Commission.

As important as recreational fisheries targeting billfishes might be in the US, domestic commercial fishers that incidentally harvest these species have also exercised considerable influence in the policy-making process. Of these, the most significant to billfish management is the US longline fleet, which has historically targeted mostly swordfish in the Atlantic (ICCAT Landings 1950–2002 Database). While a steep drop in participants and revenues has undermined the profitability of US commercial longlines targeting highly migratory species in the Atlantic, these fishers still maintained a considerable amount of political clout throughout the 1990s. This is the same time in which the US was pushing hardest at ICCAT for measures to reduce fishing mortality on *M. nigricans* and *T. albidus*. Although there certainly was not perfect accord between commercial and recreational fishing interests on the marlins issue during this period, a partial rapprochement did take place. The causes of this trend are complex, but one clear source of change can be found in the domestic legislation that presaged shifts in US policy at the Commission. By imposing the costs of by-catch reduction on US fishers, these laws strengthened US incentives to attain similar regulations at the international level.

For instance, the 1988 US Fisheries Management Plan for Billfishes (FMPB) prohibited commercial sale of either blue marlin or white marlin in the United States (NMFS, 1999). This would have imposed relatively small costs on US commercial fishers in the boom-time of the 1980s, but would have given their competitors from other countries an edge because they would still be able to supplement their revenues by selling any marlins they captured incidentally. As both prices and landings of targeted species plummeted in subsequent years, the marginal benefits of being able to retain billfishes for sale would have increased substantially. Aside from successfully altering this condition in the 1988 Management Plan, US fishers could have alleviated some economic pressures from abroad by ensuring that their competition was limited in the same way, as would have happened if any one of the US proposals made in 1992, 1995, 1997, or 2000 had been adopted without changes.

It is also interesting to note that the 1997 US push that finally resulted in a binding recommendation for some reduction of landings of Atlantic marlins was made one year after the passage of domestic legislation that could have potentially reduced US longline effort and effectiveness in order to protect those same stocks. Attained via pressure from a wider conservation movement, the Sustainable Fisheries Act of 1996 required that the US manage all fish stocks, commercial or otherwise, at an optimal yield that is less than or equal to maximum sustainable yield (Iudicello et al., 1999). Given the low biomass estimates that were generated in the 1995 assessments of Atlantic marlins, the possibility that more stringent measures might be undertaken domestically to protect these stocks provided additional cause for US commercial fishers to prefer international actions (ICCAT, 2004, 75).

In 1999, when NMFS began to implement the 1996 Sustainable Fisheries Act by proposing an amendment to the original 1988 FMPB, several time-area closures on commercial longlining were planned within the US Exclusive Economic Zone (NMFS, 2002). Scheduled to begin in 2001, this change in domestic policy directly preceded a similar alteration to the US policy stance at ICCAT. Additionally, the Endangered Species Act of 1990 caused US fishers to be more responsive to the 2000 SCRS advice in regards to white marlin in particular, because estimates of biomass were very low and, unlike blue marlin, white marlin is only found in the Atlantic Ocean. The listing of any billfish stock as an endangered species could potentially result in a complete closure of the US longline fishery in the Atlantic (ICCAT, 2001a, 219). In fact, a petition to list white marlin was filed by conservation interests in 2001, but the US National Marine Fisheries Service determined that such a listing was not warranted at that time. The species is scheduled for review in 2007 (NMFS, 2002).

In short, the answer to marlin conundrum #2 can be found in a confluence of influences that coalesced during the 1990s. Improvements in science clarified the biological situation, alarming recreational fishers and conservationists alike, causing them to increase their efforts to attain domestic and international protections for these stocks in the Atlantic. At the same time, increasingly vulnerable commercial fishers in the US began to favor international regulations that would impose restrictions on foreign fleets that were similar to those enacted in domestic legislation. Thus, the political will evinced by the United States as it negotiated for increasingly stringent international management measures on Atlantic marlins resulted more from a combination of domestic interests, as opposed to the dominance of one group or another. Similar dynamics have been observed in other by-catch cases (De Sombre, 2000), but this case differs in two ways: (1) the bifurcation of noncommercial interests between conservation and recreational groups, and (2) the size of the key groups, which is much smaller relative to the overall population.

Further research in this area could be quite useful, both within the United States and contrasting across many countries. Variations in the structure of US decision-making regarding marlins in different geographic locations could be exploited to derive insights into the relationship between domestic institutions and interest group influence. For instance, one could test the hypothesis that small interest groups are more powerful in the Atlantic because decision-making is centrally controlled by NMFS, but less powerful in the Pacific, where decision-making authority is still held by the respective Regional Fisheries Management Councils. Further comparisons could be made between the development of mainland policies for marlins, where

the majority of demand comes from recreational interests, and the Pacific Islands, where marlins are widely harvested for food. This analysis should be undertaken very carefully, since multiple, competing causal factors may play a role. As noted above, Atlantic marlins have been much more severely depleted than their Indo-Pacific counterparts, and such underlying details may be as instrumental in cross-sectional variations as institutions or interest groups.

At the international level, comparisons could be made between countries with different policy-making systems, combinations of interest groups, and levels of disposable income. In most other countries, recreational fishing and conservation interests that are specifically concerned with billfishes are not very active, nor do they command the financial resources available to these groups in the US. Also, many fishing countries rely heavily on production of highly migratory species so restrictions on commercial fishing effort to protect billfishes would create greater economic hardships than were experienced in the US. Similarly, labor unions and fishing cooperatives generally have more political clout in these countries as well, making it easier to drown out the concerns of noncommercial interest groups. Lastly, some countries may be reluctant to reduce landings of targeted species to protect by-catch because the former are consumed heavily in local markets. These observations suggest that noncommercial interests will be less influential in many fishing countries, but more data are needed to fully verify this prediction.

CONCLUSION: NO SIMPLE SOLUTION, YET

Returning to the original question, the above example shows that relatively small noncommercial interest groups can have an impact on the multilateral management of noncharismatic by-catch species, but that such influence is limited in scope. As instrumental as changes in US policy were to the development of international management measures for blue marlin and white marlin, ICCAT regulations have never been fully in line with the advice of the Commission's scientific committee. This is because the final regulatory outcome has always depended on consensus among all of ICCAT's contracting parties. Over the years, the US has had its allies on this issue, but there have been opponents as well. Building consensus requires concessions and side-payments, many of which undermined the rigor of the original proposals.

For several years, the Commission has postponed assessments for these stocks, so the full impact of the 2000 recommendation, which has been extended several times, has not yet been gauged. However, the average annual catch estimates for white marlin from 2001–2004 were about 1400 t above the estimated 1999 replacement yield (RY) of approximately 1200 t (ICCAT, 2005a, 54-55). The most recent assessment of white marlin was more contested, but estimated catches from 2001–2004 averaged about 430 t over the 222 t estimate of RY that was derived using the same methods as previous assessments and 50 t over even the highest estimate of replacement yield from the various sensitivity analyses (602 t; ICCAT, 2005a, 60-61).

Moreover, nonreporting and misclassification of blue marlin and white marlin in the Atlantic has increased since 1997, obscuring actual fishing mortality on the species. Information asymmetries are especially difficult to correct in by-catch fisheries and incentives to misreport tend to increase once management measures are in place. For example, in 1998, a year after the adoption of the first binding recommendation on these stocks, 34% of the states that had previously provided data on

landings of blue marlin reported nothing on the species and 12% stopped reporting data on white marlin (ICCAT, 1999, 69, and 76). More recently, large catches of unclassified billfishes have been reported, further obscuring actual catch rates. The SCRS annually reiterates that catches of Atlantic marlins are under-estimated (ICCAT, 2005a, 52, and 58).

In order for a more comprehensive management response to take place for species like billfishes, decision makers from a wide array of fishing countries would have to be convinced that the suggested measures are in their national interests. Usually, this larger transformation requires a broad popular base, but it is possible that concentrated interest groups could proliferate into many countries, shifting the balance of power at the international level. The case at hand revealed that conservation and recreational fishing organizations did help push US policy on billfishes toward conformity with official scientific advice. In fact, most of the countries that have spoken up in support of US proposals have referred to their interest in protecting or developing recreational fisheries targeting marlins. These have included Bermuda, Brazil, Cuba, Mexico, and Venezuela. Canada has also supported the US on billfish in recent years, citing purely conservationist concerns for these stocks.

On the other hand, the cases also indicated the importance of other factors. For instance, the 1990 Endangered Species Act and the 1996 Sustainable Fisheries Act are indicative of a more generic change in US politics in regards to renewable resources. Specific domestic legislation resulted from the combination of this larger political shift with the escalation of focused pressure from billfish-specific groups. In turn, these laws gave US commercial interests incentives to prefer similar regulations at the international level. Because of the economic importance and political power of commercial fishers in most countries that take part in international fisheries management, all three of these elements need to be present to engender policy shifts on noncharismatic by-catch species at the domestic level.

This is one potential path toward change, but, as noted above, many countries would find it to be a longer, more difficult road than it was in the US case. To be fair, many countries have ascribed their unwillingness to implement more costly measures for these stocks to uncertainties in SCRS assessments. Greater certainty, or more importantly, consensus among billfish scientists regarding the status of these stocks, could facilitate the adoption of effective management regimes. Uncertainty is endemic in many complex, large-scale environmental systems, but pressures from cohesive epistemic communities have been instrumental in overcoming uncertainty on other international issues (Haas and Haas, 1995). In the arena of international fisheries management, such cohesion is not yet evident and there are indications that uncertainty or even malleability in the assessment of some highly migratory stocks has been manipulated for political gains. Most notably, national science tends to be correlated with national political and economic interests, a parallel that was observed in the US case above, but is extant for other countries as well.

At the same time, most of the remedial measures available to reduce incidental mortality on Atlantic billfishes could create significant commercial losses for these countries. Even the requisite release of live by-catch can reduce revenues, but effort limitations or other regulations like time area closures can lower harvests of targeted species while increasing costs of production. Such changes impact consumers as well as producers, resulting in doubled hardships in some countries. For example, Japan is the world's largest consumer of *T. obesus* and the European Community is one of

the biggest consumers of *X. gladius*. For other countries, like Taiwan, which exports more than 75% of the bigeye tuna that is available on world markets, landings reductions would reduce the availability of foreign exchange along with revenues generally (FAO Commodities and Production 1976–2001 Database.). Foreign exchange is also important for China and many developing countries, as is the utilization of both targeted and incidental harvests to feed growing populations.

These are powerful and legitimate concerns that decision-makers from many fishing countries must contend with as they formulate national policy in regards to international fisheries. Furthermore, most decision makers are acutely aware of the global impacts that management of one stock can have on the regulation of others. Rules and norms have frequently spread from one regional fisheries organization to another as countries, many of which target highly migratory species in multiple oceans, contend with similar management problems. This increases incentives to forestall measures to protect by-catch species in one ocean, given the risk that the same regulations, and their concomitant costs, would quickly be adopted elsewhere. Similarly, a precedent in the regulation of one by-catch stock could be used as argument for the adoption of similar measures for other stocks, amplifying or dispersing the costs of adjustment.

All of these factors indicate that the management of marlins in the Atlantic, and of other billfishes around the world, is likely to remain relatively weak and ineffective. Nevertheless, the strides that have been made are vital. Growing scientific interest in these species has opened international discussions, increased our knowledge base, and stimulated the development of new methods for dealing with old uncertainties. Additionally, precedents have been set, and even if current regulations are not sufficient to rebuild Atlantic blue marlin and white marlin, international responsibility for these types of by-catches has been established. Perhaps most importantly, both commercial and noncommercial interest groups now have significant incentives to develop by-catch reduction technologies, which is the most effective long-run solution to the conundrums posed in this paper.

Such technologies have already made by-catch reduction more palpable in fisheries with incidental harvests of dolphins, sea turtles, or sea birds. For marlins, one possible technological solution could be the use of circle hooks, which have been shown to reduce post-release mortality (Horodysky and Graves, 2005). Nevertheless, more work is needed on this front. As history has shown, convincing fishers to switch to more by-catch-friendly gear can be as difficult as developing the modifications themselves. Here again, the size and diversity of fleets that incidentally harvest marlins in the Atlantic will be a formidable barrier to cooperation. Nonetheless, the progress made to date does indicate that improvements are possible. Politically, the key to rebuilding Atlantic marlin stocks is two sided; expanding the demand for conservation, while at the same time reducing the costs (or increasing the benefits) of management in commercial fisheries that incidentally harvest these species.

ACKNOWLEDGMENTS

I would like to thank the USC Wrigley Institute for Environmental Studies, the Offield Family Foundation, and the Rose Hills Foundation for funding this research. J. Graves, D. Kerstetter, and V. Restrepo were particularly helpful as I threaded my way through the labyrinth of Atlantic billfish management.

LITERATURE CITED

- Bjorndal, T., V. Kaitala, M. Lindros, and G. R. Munro. 2000. The management of high seas fisheries. *Ann. Operations Res.* 94: 183–196.
- Clark, C. W. 1990. *Mathematical bioeconomics*. 2nd ed., New York: John Wiley and Sons, Inc. 386 p.
- De Sombre, E. R. 1999. Tuna fishing and common pool resources. Pages 51–69 *in* J. S. Barkin and G. E. Shambaugh. 1999. *Anarchy and the environment*. New York: State University of New York Press.
- _____. 2000. *Domestic sources of international environmental policy*. Cambridge, MA: The MIT Press. 300 p.
- _____. 2005. Fishing under flags of convenience. *Global Environ. Polit.* 5: 73–94.
- FAO Commodities and production 1976–2001 database. Rome: FAO Fisheries Department, Fishery Information, Data, and Statistics Department, [online, for use with FishStat plus, universal software for fishery statistical time series. Version 2.3. 2000]; Available from: <http://www.fao.org/fi/statist/fisoft/FISHPLUS.asp> via the Internet. Accessed 8 December 2003.
- Haas, P. M. and E. B. Haas. 1995. Learning to learn: improving international governance. *Glob. Gov.* 1: 255–284.
- Hannesson, R. 1997. Fishing as supergame. *J. Environ. Econ. Manage.* 32: 309–322.
- Horodysky, A. Z. and J. E. Graves. 2005. Application of pop-up satellite archival tag technology to estimate postrelease survival of white marlin (*Tetrapturus albidus*) caught on circle and straight-shank (“J”) hooks in the western North Atlantic recreational fishery. *Fish. Bull.* 103: 84–96.
- IATTC. 2003. *Tunas and billfishes in the eastern Pacific Ocean in 2002*. La Jolla, CA: Inter-American Tropical Tuna Commission. 96 p.
- ICCAT. (1971–1994). *Annual Report*. Madrid: International Commission for the Conservation of Atlantic Tunas. Series.
- _____. (1995a–2005a). *Annual Report of the Commission*. Madrid: International Commission for the Conservation of Atlantic Tunas. Series.
- _____. (1995b–2005b). *Annual Report of the Standing Committee on Research and Statistics*. Madrid: International Commission for the Conservation of Atlantic Tunas. Series.
- _____. 2005c. *Compendium of management recommendations resolutions adopted by ICCAT for the conservation of Atlantic tunas and tuna-like species*. [online] Madrid: International Commission for the Conservation of Atlantic Tunas; Available from: <http://www.iccat.es/RecsRegs.asp> via the Internet. Accessed 13 July 2005.
- ICCAT Landings 1950–2002 Database. 2004. International Commission for the Conservation of Atlantic Tunas, <http://www.iccat.es/downloads.htm> [online, for use with FishStat Plus, Universal software for fishery statistical time series. Version 2.3. 2000; Accessed March 22, 2004]; Available from: <http://www.fao.org/fi/statist/fisoft/FISHPLUS.asp> via the Internet. Accessed 8 December 2003.
- Iudicello, S., M. Weber, and R. Wieland. 1999. *Fish, markets and fishermen*. Island Press. Washington, D.C., 192 p.
- Kaitala, V. and G. R. Munro. 1993. The management of high seas fisheries. *Mar. Resour. Econ.* 8: 313–329.
- McKelvey, R., L. Sandal, and S. Steinshamn. 2003. Regional fisheries management on the high seas. *Int. Game Theory Rev.* 5: 327–345.
- NMFS. 1999. Amendment 1 to the Atlantic Billfish Fishery Management Plan, chap 1. [online]. Silver Springs, MD.: National Marine Fisheries Service; Available from: <http://www.nmfs.noaa.gov/sfa/hms/FMP%20CHAPTER1.htm#1.1.1%20History%20of%20Atlantic%20Billfish%20Fishery%20Management> via the Internet. Accessed 1 January 2006.
- _____. 2002. Endangered and threatened wildlife and plants: 12-month finding on a petition to list the Atlantic white marlin as threatened or endangered. *Fed. Reg.* [serial online]; 67:

- 57204–57207. Available from: <http://www.epa.gov/EPA-SPECIES/2002/September/Day-09/e22805.htm> via the Internet. Accessed 1 January 2006.
- NMFS Annual Commercial Landings Statistics Database. 2005. Silver Spring, MD: National Marine Fisheries Service [online]; Available from: http://www.st.nmfs.gov/st1/commercial/landings/annual_landings.html via the Internet. Accessed 15 July 2005.
- Peterson, M. J. 1995. International fisheries management. Pages 249–305 in P. M. Haas, R. O. Keohane, and M. A. Levy, eds. 1995. *Institutions for the earth*. The MIT Press. Cambridge.
- _____. 2000. Implementation of environmental régimes. Pages 115–152 in O. Young, ed. 2000. *Global governance*, 2nd Printing. The MIT Press. Cambridge.
- U.S. Congress. 1975. Atlantic Tunas Convention Act of 1975. Public Law 94-70, US Code 16 [online]; Available from: http://www.access.gpo.gov/uscode/title16/chapter16a_.html via the Internet. Accessed 16 July 2005.
- Young, O. R. 1999. *The effectiveness of international environmental regimes*. The MIT Press. Cambridge. 326 p.

ADDRESS: *University of Southern California, Wrigley Institute for Environmental Studies, MC 0371, 3616 Trousdale Pkwy., Los Angeles, California 90089-0371.*



