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Review

Social and economic perspective on recreational billfish fisheries

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Abstract. At the Second International Billfish Symposium in Kona, it was reported that little was known about the social and economic aspects of recreational billfish fisheries. There was plenty of background, some good questions, but few answers. There had been little history of social science involvement in fisheries management at the time and even less in billfish fisheries. Whether authorized or not, fishery management decisions worldwide are going to be made on the basis of 'best available' social and economic understanding. Unfortunately, the values held by many in the billfish angler community are not likely to be well represented in the mix for various reasons. Research in the USA and in Latin America over the past 13 years has provided an understanding of the billfish angler constituency, its commitment to catch and release and support for resource conservation, its local and regional impacts on tourism economies, and its willingness-to-pay above and beyond trip costs (a measure of user value) in the US Atlantic, Puerto Rico, Costa Rica and Mexico Pacific. Although knowledge of the recreational billfish fishery has improved, comparatively little is known about the social and economic benefits associated with commercial (direct and bycatch) billfish fisheries. With little more than dockside prices available in many localities, it is difficult to know their value in comparison with recreational fisheries and the possible trade-offs associated with various management measures. In addition to describing what is still not known, this paper will identify a future research agenda in this area.

Extra keywords: social science, human dimensions.

Introduction

The 1988 International Billfish Symposium was a watershed event in that it helped set the stage for the need for a more integrated understanding of billfish fisheries and their management. Rockland (1989) carefully differentiated economic valuation from economic impact concerns to guide future data collection and decision-making efforts. There is still a lot of confusion out there on how these two concepts are used today. Orbach (1990) provided a policy analysis to enhance understanding of regional differences in billfish management and the Fishery Management Plan for Atlantic Billfishes that was about to be approved by the US Secretary of Commerce at the time. Regional differences remain in how people in various parts of the world value billfish. Some value billfish intrinsically as a quarry to be caught and carefully released. Some see billfish as the foundation for their fishing tourism economy, whereas others value them as food or a commodity for sale to others as food. There are differences even in the recreational community. Fedler and Ditton (1990) reviewed previous social and economic research on the recreational billfish fishery, detailed what little was available, and concentrated their efforts on developing a human dimensions research agenda for billfish fisheries.

The lack of social and economic information on recreational billfish fisheries was attributed to four factors (Fedler and Ditton 1990). First, billfish anglers are a small constituency compared with the other angler groups or anglers overall. The number of billfish anglers may be disproportionately large at particular fishing destinations but overall they are a small angler group. Second, the usual motivation for social and economic research, namely, highly publicized resource allocation battles, was missing prior to 1988. This is no longer the case, with issues involving directed and bycatch commercial billfish fisheries worldwide. Third, integrated fisheries management is still a new concept and thus social and economic concerns and research support continue to trail traditional biological and ecological concerns. Good management, it can be argued, is only likely to occur as a result of our overall understanding of billfish fisheries. Fourth, data collection from billfish anglers is difficult because anglers are widely dispersed and not easily identifiable for survey research purposes. Thus, efforts to collect

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data from the population of billfish anglers in the US suffer from the lack of a sampling frame. This is because no specific license is required for billfish angling (nor is one being advocated here). This is a problem in other nations as well. As a result, nearly all previous efforts have focused on identifiable subsets of billfish anglers, for example billfish tournament anglers, billfish anglers using charter boats, members of billfish conservation organizations and *Marlin Magazine* readers. Questions remain regarding the generalizability of results from these subpopulation groups to the population level, but they are nevertheless useful to promote understanding at the subpopulation level.

Fedler and Ditton (1990) not only called for a programme of research to help clarify the social and economic importance of billfish angling, but also argued it should have priority over more traditional biological and ecological research efforts. The line of thinking was that once the billfish angling community and the general public understood the social and economic significance of billfish and related tourism activity and educated their government representatives accordingly, there would be increases in public and private funding levels for biological and ecological research on billfish not seen previously. Although there has been increased funding support for biological and ecological billfish research, it is not clear if this has been the result of more widespread understanding of the social and economic importance of billfish populations. In fact, for this to be the case, much would depend on non-governmental organizations and agencies making effective use of social science results. Most of our efforts in this regard have focused on getting our own research peer reviewed and published in order to share results and conclusions with other social scientists and fishery managers. If our results have not been used to the fullest to secure greater attention to billfish species and their management, then may be this presentation will reinvigorate these efforts.

In this paper, we summarize the social and economic research on billfish angling completed over the past 13 years, and provide a synthesis of recent human dimensions understandings. We conclude with a new research agenda and some observations and recommendations to guide future efforts.

Demographic characteristics

Based on secondary analysis of data from the 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (US Fish and Wildlife Service 1993), the American Sportfishing Association (1995) projected that 230 000 anglers in the USA spent 2 136 899 days fishing for various billfish species in 1991. Nationally, this works out to 3.6% of all saltwater anglers over 16 years of age and an average of 6.6 days of fishing per billfish angler. The five states with the highest number of billfish anglers are as follows: Florida (159 575), California (31 162), North Carolina (30 071), Hawaii (26 588), and Texas (23 714). A demographic profile of the national population of billfish anglers residing in the USA is as follows: most live in small cities and towns (45%), followed by big cities and urban areas (28%); most are male (72%); most are married (64%); most are between 25 and 44 years of age (64%); most have household incomes of between US$30 000 and US$74 999 (54%), with only 13% at US$75 000 or more; and 50% have a high school education or less (American Sportfishing Association 1995).

Four billfish angler studies completed in the US Atlantic, Puerto Rico, Costa Rica Pacific and Mexico Pacific (Ditton and Fisher 1990; Ditton and Clark 1994; Ditton and Grimes 1995; Ditton *et al*. 1996), focused on various subpopulation groups of billfish anglers, providing different demographic profiles. Tournament and charter boat billfish anglers, for example, are typically white males in their forties (46–50 years), highly educated (college graduates and above), and have high annual household incomes (US$70 000–179 000). Differences from population level data may best be explained by their participation in tournaments, use of charter boats, and extensive participation in billfish angling far above the mean days indicated rather than as an artefact of targeting of billfish species. When these groups of billfish anglers are compared with the general population of licensed anglers in general, the former groups are even more distinctive. For example, white males, 30–49 years of age, dominate the community of licensed anglers in Texas, with about 20% female anglers (Ditton and Hunt 1996). About 45% of licensed anglers in Texas have annual household incomes below US$40 000 (median income category US$40 000–49 000), most were white/Anglo (89%; Ditton and Hunt 1996), and only 27% of anglers, 16 years of age and above, had 4 or more years of college (US Fish and Wildlife Service 1993).

Commitment to fishing

In terms of years of previous fishing experience and annual fishing frequency, billfish anglers studied previously by Ditton and his associates exhibit a high level of commitment to their fishing activity. The mean number of years fishing in saltwater (19 and 26 years of experience for tournament billfish anglers in Puerto Rico and the US Atlantic respectively) exceeds the mean number of years fishing for billfish (10 and 16 years respectively); this suggests that most began billfish fishing after 9 and 10 years of saltwater fishing experience respectively (Fisher and Ditton 1992; Ditton *et al.* 1999). Furthermore, billfish anglers studied in the US Atlantic, Puerto Rico and Costa Rica fished between 39 and 43 days, which is more than twice as frequently as the statewide population of licensed saltwater anglers in Texas (17 days) for example (Ditton and Hunt 1996).

When asked how their fishing ability compared with other anglers in general, over 33% of the anglers who participated in billfish tournaments in the US Atlantic, those who

participated in tournaments in Puerto Rico (residents only), and those who used charter boats in Costa Rica, indicated they were more skilled. Only 19% of the billfish charter-boat anglers in the southern Baja felt they were more skilled than other anglers. Again, results for billfish anglers contrast with those for saltwater anglers in Texas, for example, where only 11% felt they were more skilled than other anglers (Ditton and Hunt 1996).

Commitment to catch and release and conservation

There is increasing commitment to catch and release as a social norm within the billfish angler community. Ideally, the rationale for anglers to practice catch and release fishing is that high stock abundance is more likely to mean quality fishing and impact local and national economies at the same time. There has been a change even in billfish tournaments that have emphasized extrinsic rewards (i.e. money and prizes) for the largest billfish landed. Many billfish tournaments are now encouraging catch and release in support of billfish conservation. As an indicator of this, billfish tournament anglers in the US Atlantic (including the US Caribbean) indicated a self-reported billfish release rate of 89% (Ditton and Fisher 1990). In this fishery, each angler kept one billfish per year on average. Actually, 29% of this group of tournament anglers accounted for 100% of the billfish brought to the dock. Among tournament anglers in Puerto Rico, release rates were lower but still 72% and 87% for resident and non-resident billfish anglers respectively (Ditton and Clark 1994; Ditton *et al.* 1999). Currently, there is pressure for the billfish community to do even better in this regard. Some argue that increasing stock abundance in US waters is the sole responsibility of the recreational billfish community since they alone can land billfish in the US Atlantic and often cite their high levels of commitment to the resource as support for why this should not be a problem. The National Marine Fisheries Service (NMFS) is seeking to use various means to decrease even further the number of billfish currently landed by recreational anglers. Non-governmental organizations argue that efforts to reduce harvest need to be shouldered by all stakeholders on an equal basis and not the recreational billfish fishery alone because most anglers support rules and regulations that promote conservation.

Generally, there is consistency between billfish anglers' self-reports of high billfish release rates and their management preferences. Most anglers in the US Atlantic supported increased minimum sizes, increased minimum sizes for tournaments, mandatory 'no-kill' tournaments, one billfish per angler per day, and a zero bag limit; most opposed decreasing minimum sizes, not having minimum sizes for tournaments, not having minimum sizes for fish that will be mounted, and recreational handlining and harpooning of billfish (Ditton and Fisher 1990). There is a diversity of thought on these matters within the billfish angler community. For example, most non-resident tournament billfish anglers in Puerto Rico supported increasing the minimum sizes for blue marlin, mandatory 'no-kill' tournaments, catch and release only (zero bag limit), no stainless steel hooks, and they were opposed to recreational handlining and harpooning of billfish (Ditton and Clark 1994). Most resident tournament billfish anglers in Puerto Rico, however, did not support these same management options, with the exception of being opposed to recreational handlining and harpooning. There were numerous other differences between these two angler groups in demographic characteristics, fishing motivations, and orientation towards catch. Graefe *et al.* (2003) attributed these differences to cultural differences between groups. They suggested that management agencies need to be aware of cultural differences within the recreational fishing community if their efforts are to be effective and understood by the angling community.

Graefe and Ditton (1997) investigated the predictors of the decision to release all billfish caught annually by tournament anglers in the US Atlantic (Ditton and Fisher 1992) and Puerto Rico (Ditton and Clark 1994). They found the best predictors of releasing all fish caught were the number of trips targeting billfish and the number of tournaments entered (the more trips and tournaments, the more likely one was to keep at least one billfish), geography (anglers in Puerto Rico tournaments were more likely to keep billfish), and income (the greater the income, the less likely to keep billfish). Level of formal education was not a significant predictor, whereas members of fishing conservation organizations were significantly more likely to release all billfish caught. Sutton (2001) recently examined the influence of several dimensions of specialization (experience, centrality of lifestyle, and the importance placed on four catch-related aspects of the fishing experience) on the relative frequency with which Pacific billfish anglers (Costa Rica and Mexico) practiced catch and release over a 12-month period. Results indicated that anglers for whom fishing is a more central part of their lifestyle and those who place low importance on keeping fish are more likely to practice catch and release. A lack of significant relationship between catch and release behaviour and experience, importance placed on catching 'something', number of fish caught, and catching trophy fish was consistent with previous findings for bluefin tuna anglers in Hatteras, NC, USA (Sutton and Ditton 2001). Sutton (2001) suggests these findings are not as expected because of the common belief that all big game anglers are high specialization anglers (Ditton *et al.* 1992); standard deviations for study variables indicate a wide range of experience and avidity among billfish anglers.

Angler expenditures

Billfish anglers spend a great deal of money to go fishing, more than many other anglers and much more than tourists in general. Anglers reported spending an average of US$3766

on their most recent trip to Costa Rica (Table 1). This is nearly double the trip cost in the US Atlantic and Mexico Baja. Major local expenditures incurred by over half of all anglers included boat operation costs, food and drink expenditure, and bait and tackle (Table 2). There were notable differences between studies in terms of major expenditure categories depending on whether air transportation, charter boat and tournament fee costs were involved.

Table 1. Total trip cost for a 'typical' billfish angler by study location

Includes all billfish anglers reporting expenditures in one or more categories listed. Expense categories in which no expenditures were reported were set to zero to allow for calculation of 'typical' total trip expenditures

Study region	Mean expenditure in US$ (95% CI)
US Atlantic (1990)	2105 (1583–2627)
Puerto Rico (1994)	1052 (886–1218)
Costa Rica (1995)	3766 (3502–4029)
Mexico (1996)	2041 (1824–2257)
All anglers	2132 (1907–2357)

Table 2. Trip expenditures for selected items by billfish anglers making that type of expenditure

Data are only for billfish anglers reporting expenditures within each category

	% Making expenditure	All anglers (mean US$)
Auto transport	67	80
Charter and guide fees	39	1003
Tournament fees	2	821
Lodging	42	561
Food, drink etc.	84	218
Tips	25	173
Boat rental	6	1528
Boat operation	53	603
Bait and tackle	50	131
Entrance fees	16	407
Billfish fishing package	14	2055
Anything else/billfish trip	17	582
Total trip cost		1950

Expenditure for travel to a fishing destination and for billfish fishing packages is likely to be made outside the country of destination and thus have little impact on the destination country. These two types of expenditures have been deleted from the numbers reported in Table 3. To the extent these expenditures are made in the destination country, the subsequent impact estimates reported here are conservative. Billfish fishing trip expenditures by study region range from an average of roughly US$1000 for Puerto Rico to US$2000 for Costa Rica, with an overall average of US$1600 per trip (Table 3).

Indirect (multiplier) impacts

Expenditure made within a country is income for the businesses that operate there. This income is then spent for purchase of inputs to produce the product sold by the business or distributed as income to the owner(s) of the business. As recipients of this secondary expenditure continue to spend further for other inputs or use their receipts as income, expenditure circulates and multiplies throughout the regional economy. The indirect impacts resulting from billfish anglers will be larger to the extent that there are minimal leakages from the economy where they are spent. That is, if additional expenditures are not spent for goods and services produced outside the region of concern, there will be few leakages from this multiplier effect. However, if there are major purchases of items from outside the region, the indirect impact of billfish angler expenditures will be reduced.

In Table 3, mean expenses are reported for each study and for the pooled analysis of all respondents. Focusing on the pooled analysis, mean expenditures are approximately US$1600. The 95% confidence interval for this estimate is from US$1388 to US$1815 per trip. This is an estimate of the direct impact of the 'typical' billfish angler's billfish trip. An economic impact multiplier must be used to estimate the total impact of this trip. Such multipliers are used to incorporate the circulation of expenditures through the economy as described previously. When a multiplier of 1.5 is used with the 'typical' billfish angler's trip, the total impact is estimated to be about US$2400, with low and high estimates ranging from

Table 3. Annual direct and indirect impact of typical trip expenditures by study location

Total trip expenditures omit airfare and billfish fishing package costs since most of these expenditures are made outside the destination region

Study region	Direct expenditures per trip (Mean) (US$)	Total impact per trip (Middle) (US$)		Aggregate impact (millions) trips (Middle) (US$)	
		Assuming a multiplier of 1.5	Assuming a multiplier of 2.5	Assuming a multiplier of 1.5	Assuming a multiplier of 2.5
US Atlantic	1911	2867	4778	22.69	37.82
Puerto Rico	980	1471	2452	48.60	81.01
Costa Rica	1971	2957	4929	46.30	77.17
Mexico	1387	2081	3468	58.86	98.10
Combined studies	1601	2402	4004	203.95	339.91

US$2082 to US$2723 (using the upper and lower bounds of the direct expenditure confidence interval and multiplying by 1.5) (Table 3). Aggregating the middle estimate (US$2400) across the estimated annual number of billfish trips for the pooled studies yields an aggregate annual impact of US$204 million (direct and indirect). Similar procedures were performed using low and high estimates for individual country studies to yield estimates of aggregate annual billfish fishing impacts (only middle estimates are shown in Table 3). It is important to note these are annual estimates. Since the billfish population undergoes net annual recruitment (which may be positive or negative depending on a number of factors, such as oceanographic and ecological factors as well as level of fishing effort), it supports billfish angling over time. To arrive at a measure of total impacts, it is necessary to consider this as well. Only then can appropriate comparisons be made with alternative uses of the natural resource base and their respective values. For sake of illustration, if we were to assume that the interest rate for discounting is 10%, then the US$204 million measure of annual impact would have a discounted value of US$2.04 billion (assuming stewardship of resources capable of supporting the existing level of billfish angling).

Choice of multipliers for measuring total impacts is not without controversy. Clearly, choosing a total effects multiplier of 1.0 would indicate there are no indirect impacts from the direct expenditures made for billfish angling. This seems unlikely. Equally unlikely is a total effects multiplier as high as 4.0, which would imply that each US$1 of direct expenditure generates an additional US$3 of indirect expenditures in the regional economy. One way to handle the problem of choosing an appropriate multiplier is to select several alternatives and demonstrate the consequences of each (sensitivity analysis). Here, we have chosen a conservative multiplier of 1.5 and a slightly less conservative 2.5, neither believed to be totally unrealistic. Results using these two choices are shown in Table 3. For the analysis from the pooled studies, aggregate economic impacts are shown to increase from US$204 million (multiplier = 1.5) to US$340 million (multiplier = 2.5). Similar results are shown for each study location as well.

Recreational fisheries development

The term 'fisheries development' is usually associated with commercial fisheries; however, it can apply as well to rational decisions by public sector decision-makers to promote particular recreational fisheries. Travel agencies are already promoting billfish fisheries throughout the world because of US angler demand. Some nations' tourism offices work in consultation with their fishery agency counterparts to ensure their fishing destinations remain competitive and vital from an economic development sense. They are interested in attracting additional foreign currency to their national economies because of the indirect and induced economic impacts involved. Other nations are not interested in promoting recreational fishing as a means of economic development. Some do not have the ingredients to compete successfully with the major billfish destinations in the region, or cannot get all of the constituent parts of the tourism system to work together to be a major fishing destination. Some try to promote both recreational and commercial fisheries without concern for the special requirements of the recreational fishery. Other nations are committed to traditions of harvest and sale of billfish resources (direct or bycatch) as food over appreciative non-consumptive uses. This decision is usually portrayed as one of necessity, but nevertheless it is an uninformed commitment of fishery resources and may not be the wisest choice on closer inspection.

Development of recreational billfish fisheries need not lead to overfishing, or result in the problems typically associated with fisheries development. As suggested by Holland *et al.* (1998), the development of billfish fisheries, if done well, can be viewed from an ecotourism perspective, a connotation usually reserved for birding and other non-consumptive wildlife-associated forms of outdoor recreation. The authors constructed a template of ecotourism criteria from previous literature and evaluated billfish fisheries according to these established criteria. They concluded that billfish angling can be a form of ecotourism if it meets the criteria of: (*i*) a unique natural resource; (*ii*) a unique clientele; (*iii*) an activity of environmental resource responsibility; (*iv*) an activity with economic support for resource conservation; (*v*) an activity that provides an economic advantage for appreciative use; and (*vi*) an activity with direct economic assistance to the local economy. The authors argue that it is not the type of activity *per se* that qualifies it as ecotourism, but the specific nature of the human behaviours involved, the distribution of economic benefits, and the associated social and economic impacts. Holland *et al.* (1998) make the case that billfish angling in the US Atlantic and in Puerto Rico qualifies in some ways as ecotourism; an even stronger case was made for the recreational billfish fishery in Costa Rica.

Although there may be many other localities or situations where billfish angling would not meet the various criteria for ecotourism, there is increasing peer pressure within the angler community to minimize negative impacts and to enhance its positive impacts. The Presidential Challenge of Central America tournament series is an example of such an effort. It was originally conceived as a means of encouraging billfish fisheries development from Mexico through Panama through increased governmental awareness of sustainable recreational fisheries and their benefits. The tournament series is catch and release only, uses fish-friendly circle hooks, employs locals only, depends on locally produced goods and services, uses profits to support conservation through grants to local fisheries conservation organizations, and seeks to enhance economic development but without negative social and economic impacts (J. Vernon, personal communication). They have co-sponsored two Central American Conferences for the

Conservation of Sport Fishing in Panama City and Guatemala City. The goal of the meetings was to make participants more aware of the economics of recreational fisheries and the ecotourism approach to recreational fisheries development.

Economic value of billfish fisheries

In keeping with their stewardship responsibilities, fisheries management agencies make allocation decisions on a regular basis. First, they must decide how they will use their funds to carry out their management responsibilities. Second, they must decide whether they will have mixed commercial and recreational fisheries (not to mention small-scale subsistence fisheries) for a particular species and to what extent. Many agencies are guided by tradition in these determinations; others are charged with making decisions that are in the national interest. The US Fishery Management Plan for Atlantic Billfishes, for example, reserved the billfish resource for its traditional use, which is almost entirely a recreational fishery. They believed they were optimizing 'the social and economic benefits to the nation'; the US Secretary of Commerce agreed and approved the plan. This was a political decision based on 'best available social and economic scientific data'. At the time, this included mainly data on billfish angler expenditures and indirect economic impacts on the local communities and regions. No effort was made to calculate changes in economic benefits (net economic value) owing to this allocation decision as per established NMFS economic valuation procedures (Huppert 1983). Ditton and Fisher (1990) completed the first economic valuation study of the US Atlantic billfish fishery but only after the billfish Fishery Management Plan had been approved.

Whereas economic impact understandings are derived from the expenditures made by billfish anglers (the cost of going fishing), economic value addresses how much resource users (in this case, billfish anglers) value the opportunity to use billfish resources. The extent to which anglers value their billfish fishing opportunity is partially expressed by their fishing expenditures, but this partial measure of total value excludes an additional value they would pay in a market situation before foregoing the opportunity to fish for billfish (this is commonly referred to as consumer's surplus or net economic value, e.g. see Mitchell and Carson 1989; Loomis and Walsh 1997). Measures of willingness-to-pay in excess of trip expenditures can be used to estimate the value of these additional benefits to the individual (Huppert 1983; Edwards 1990; Waddington *et al.* 1994). The contingent valuation method was used to estimate the net economic value (consumer's surplus) of billfish fishing in the US Atlantic, Puerto Rico, Costa Rica and in the southern Baja, Mexico. In each case, the net economic value of the billfish fishing experience was the difference between the total benefits received (aggregate economic value) by anglers and the expenditures they incurred to go billfish angling.

A logistical regression model of yes/no responses to a question on willingness-to-pay into a management fund yielded annual willingness-to-pay estimates for billfish angling while maintaining current billfish populations for each of the study areas (Table 4). Estimates of consumer's surplus or net economic benefits ranged from a high of US$497 in the US Atlantic billfish fishery to a low of US$292 in the Mexican Baja (Table 4), or US$422 across all billfish anglers studied. Aggregate willingness-to-pay was calculated by multiplying the mean annual per person willingness-to-pay times the annual number of billfish anglers in each study location. The task of identifying the annual number of billfish anglers fishing in Costa Rica and Mexico was problematic in that we were dependent on effort data provided by charter boat operators or port authority counts, and we believe these were low for various reasons. With this caveat in mind, estimates of aggregate willingness-to-pay for these two locations are extremely conservative. The aggregate economic value of billfish angling is calculated by summing the aggregate willingness-to-pay and aggregate direct economic impact of billfish angling (angler expenditures) for each study area and for all anglers. In all cases, it is assumed that current billfish populations are maintained. The aggregate economic value of billfish angler fishing activity was the highest in the Mexican Baja (US$44.07 million), reportedly the largest sport fishing fleet in the Pacific and the lowest in the US Atlantic (US$19.06 million) (Table 4).

Just what do these numbers mean? An example might clarify their usefulness and meaning. When one purchases fish in the marketplace (dockside), there is a price paid by the consumer. The price includes the cost of inputs used to harvest the fish and a profit margin for the producer over and above costs. In purely competitive markets, the profit margin for the marginal producer would be a normal rate of return for this type of activity, whereas in less competitive markets, there is some return in excess of a normal rate owing to an inability of others to enter the market to compete with existing producers. There may also be a return to non-marginal producers in excess of the normal return, possibly owing to scarcity of unique factors of production such as the best fishing locations. This latter return is often called scarcity rent or producer's surplus. Thus, the price of fish includes the cost of inputs and a normal rate of return for the marginal producer ('the last guy on the block' who goes fishing with less favourable resources and skills but yet is able to sell a desired product to the consumer). Some producers earn an additional return (infra-marginal) because of the uniqueness of the inputs and skills they possess; this is referred to as the producers' surplus. Fish prices, in a well-functioning market, capture economic opportunity costs for the marginal producer and, for non-marginal producers (all those other than the 'last guy in'), it captures a producer's surplus as well. In a situation where markets do not exist, such as billfishing angling experiences, individuals pay a price by purchasing services from

Table 4. Estimates of economic value of current billfish population for billfish anglers by study location
Estimates for each area were calculated by numerical approximation from the estimated logistic regression model. Variables (other than the offer amount, which is the subject of the numerical approximation of the integral) were set equal to their mean values. Individual country estimates were obtained by using the mean for the pooled sample data while setting the individual country dummy variables to 1 or 0 in order to force the estimate for the country under the assumption that all other angler characteristics in the model are identical for each country

Scenario	US Atlantic (US$)	Puerto Rico (US$)	Costa Rica (US$)	Mexico (US$)	All anglers (US$)
Mean annual willingness-to-pay (net economic value or consumer surplus/current billfish population)	497	480	312	292	422
Annual number of billfish anglers	7915	1627	2899	16 542	28 983
Aggregate willingness-to-pay for maintaining current billfish population	3.93 million	0.78 million	0.90 million	4.83 million	12.24 million
Aggregate direct impact of billfish expenditures/current billfish population	15.13 million	32.40 million	30.87 million	39.24 million	135.97 million
Aggregate economic value of billfish angler fishing (net economic value + direct impact)	19.06 million	33.18 million	31.77 million	44.07 million	148.21 million

others (e.g. charter operators, tour agencies, hotels, restaurants) who cover their own expenses and earn a normal return and possibly a producer's surplus as well. Thus, it is possible to compare angler expenditures for billfish fishing with dockside fish prices.

What about consumer's surplus? In the case of dockside fish sales, the consumer receives a residual value above the price paid, which is termed consumer's surplus. Similarly, so too does the billfish angler. What happens when the fishery resource or, more specifically, the billfish resource is reduced in quantity (or, comparably, quality)? In each case, the consumer would lose the consumer's surplus unless an alternative source of supply can be found at the same price. If the resource is non-unique, it will be available from other suppliers and possibly at the same price. If fish can be purchased elsewhere for the same price, there is no loss of consumer's surplus. If at a higher price, a portion of the consumer's surplus will be lost. Those supplying the resource will be different and who receives the producer's surplus will thus be altered, but provided it is of the same or comparable magnitude, this may be largely self-cancelling from a national or international perspective. If the billfish resource is unique and not available elsewhere, its loss will result in alteration of both consumer and producer surpluses. Lessened quality or quantity will impact the valuation of experiences. Such changes imply a higher cost of producing a comparable billfish angling experience to that received in the past, meaning that the consumer's surplus (residual above cost) is reduced, a direct welfare loss to consumers (billfish anglers). If resources are paid their opportunity costs in the marketplace, the producers will receive a normal rate of return for the inputs they sell (e.g. travel), but fewer billfish trips consumed will imply lessened aggregate producer's surplus as well.

Thus, the net value of billfish fishing is the summation of consumer and producer surplus associated with the activity, just as it is for fish production. However, more importantly, since the billfish fishery constitutes a unique resource, reductions in billfish populations are largely irreplaceable. Thus, reductions (or increases) in billfish populations result in both producer and consumer surplus changes unlike those experienced in some other market good contexts. The loss to society from declining billfish population levels is the change in producer and consumer surplus (net valuation), while the expenditure to engage in billfish angling provides a measure of the direct economic impact on regional economies and the ultimate indirect impacts linked to those expenditures as measured by economic multipliers (for a somewhat comparable discussion, see Stoll *et al*. 1987).

Economic valuation results are useful in various ways. First, they provide a baseline for future comparisons. As more anglers are attracted to these fishing destinations and if fishing quality and conditions remain the same or improve, billfish angling will have even higher social values than reported here. This implies an important role for understanding the current baseline from which policy changes and their impacts must be compared. Second, with changes in fish abundance or management policies, it will be possible to measure and understand resultant changes in economic value with follow-up billfish angler studies. Growth in billfish populations will likely not lower commercial billfish prices nearly as much as it will increase the quality of billfish angling experiences. Furthermore, the expectation is that future growth in the demand for billfish angling will be greater than the growth in demand for billfish (which has substitutes) as a food resource. Third, given the shift toward catch and release billfish fisheries, much of the social value of billfish angling reported here does not result in harvest and thus, with careful attention to release mortality, an allocation of billfish to the recreational sector is likely to result in much higher values than might be the case in the commercial sector. Unfortunately, since comparable net economic benefits (producer's and consumer's surplus) associated with directed commercial fisheries are not

known, efforts to optimize fisheries management decision-making will continue to be difficult. There seems little reason to expect producer's surpluses from commercial fishing activities or from the suppliers of inputs selling services to recreational fishers to be vastly different. However, it is quite likely that the consumer's surpluses associated with billfish angling will be larger than that associated with consumption of commercial billfish catch, which is but one of a variety of other seafood and non-seafood nutritional sources. That is because there are fewer substitutes for billfish angling experience than there are for billfish as a nutritional source.

Future research and action agenda

There is still much social science research and application needed in support of billfish conservation and management. The following are high priority items in our opinion. First, and perhaps most importantly, there is a need to recognize the difference between the economic impact of billfish angling and its economic value in allocation decision-making. Fallacious arguments relying on angler expenditures and their local and regional economic impacts continue to be made by recreational fisheries representatives and advocates (e.g. see Edwards 1991 for a critical review and analysis of these arguments), despite established economic valuation protocols. Not surprisingly, resource economists working for fishery management agencies quickly dismiss these arguments. Current understandings of net economic benefits associated with recreational billfish fisheries need to be used in accordance with established agency protocols. This will require recreational fishery non-governmental organizations to employ economists capable of articulating effective arguments. Recreational fishery non-governmental organizations may also have to fund the acquisition of consumer and producer surplus data for commercial billfish fisheries, since none is currently available. This lack of valuation data for commercial (direct and bycatch) fisheries is a major impediment to understanding the trade-offs associated with making billfish allocation decisions. Some questions to be answered are as follows. To what extent would curtailment of billfish bycatch increase or decrease overall benefits associated with the US Atlantic billfish fishery? Similarly, to what extent would mandatory catch and release regulations increase overall economic benefits in this fishery?

Economic valuation research needs to go beyond willingness-to-pay for the current billfish angling experience to examine the willingness-to-pay or net economic benefits under various management conditions. We used this methodology recently to understand differential willingness-to-pay in fewer than three different catch scenarios in the Cape Hatteras bluefin tuna fishery, including total catch and release (Ditton *et al.* 1998). Results showed that net economic benefits associated with the most restrictive management regime (total catch and release) were as expected less than the least restrictive management regime (one fish retained/person), but differences were not great.

There is a need to understand the extent to which the public values current billfish resources. The extent to which billfish are valued by the public, and not just billfish anglers, is important. This involves having the option to see or fish for billfish at some later date (option value), having the option for your children to see or fish for billfish (bequest value), or valuing them as a part of the marine ecosystem (existence value). This type of research has been completed previously for whooping cranes in Texas (Stoll and Johnson 1984; Bowker and Stoll 1988) and for birds and fish along the southern coast of Lake Michigan (J. Brammeier, personal communication). Whereas non-use values would be expected to be less than use values, the number of people holding them may be much greater than the number of billfish anglers. The availability of this information would help broaden billfish conservation and management beyond the community of billfish anglers.

Most of the available social science on billfish fisheries focuses on US anglers regardless of the study location. Whereas US anglers constitute the major market in countries such as Mexico and Costa Rica, we need to better understand non-US billfish anglers in these and other locations, their characteristics, benefits sought, attitudes regarding management, and willingness-to-pay above trip costs (consumer's surplus). Another reason for more work focusing on non-US anglers is to avoid the assumption that all billfish anglers are alike. It would be a mistake to assume homogeneity and generalize results from US billfish anglers to those from other nations.

We need to know much more about why some anglers choose to practice catch and release and others do not. This will involve better understanding of the range of attitudes, beliefs, norms, motivations, and expectations that determine an angler's choice to release a caught billfish and how these factors are in turn influenced by situational factors (Sutton 2001). Also, we need to know more about how billfish anglers are socialized into the practice of catch and release. What is the process by which they come to learn the requisite attitudes, norms and skills appropriate for participation in catch and release fishing. These insights should be fundamental to efforts underway to promote catch and release.

There is the matter of resource substitution. If billfish anglers are constrained by various factors where they currently fish, the question is where are they likely to go fishing and receive the same level of satisfaction enjoyed previously at the original fishing location? When billfish anglers in Costa Rica were given a scenario that described a change in fishing outcomes (reduced billfish populations, which reduced their chances of a successful fishing trip by 25%) and asked how their travel plans would change as a result, most responded that they would travel to an alternate location to fish for billfish (Ditton and Grimes 1995). This is useful feedback to nations whose leaders think they can retain anglers (and their

expenditures) without a commitment to billfish conservation and efforts to maintain high billfish abundance. We also need to better understand which areas will be the most likely substitutes and the predictors for those making substitution decisions. This will be important for predicting the extent of additional stress placed on these alternative destinations in the future.

Billfish angler preferences for various management measures need to be better understood in terms of the trade-offs made. Previously, common practice was to ask anglers to rate a series of single management options in terms of their support or opposition; options were separate from each other and usually did not approximate the complexity of final choices made by decision-makers. In the future, more attention needs to go to stated preference analyses because these techniques allow respondents to 'evaluate technologically new or otherwise radically different … management concepts' (Louviere and Timmermans 1990). Conjoint and discrete choice measurement, for example, can be used to identify the most desirable combination of features for management measures from an angler perspective. A metric conjoint technique was used by Gillis (2003) to estimate preference functions and describe how billfish anglers (in this case, members of The Billfish Foundation) combined their preferences for various choice options to form an overall opinion of (or preference for) particular management options under consideration by the NMFS in the fall of 1998. Under intense political pressure, the NMFS backed away from focusing on options involving only the recreational billfish community. The trade-offs billfish anglers made among various management measures should prove to be useful information at some later date.

Finally, there are education and outreach needs. Communication within the scientific community will not educate decision-makers at the local, regional, national and international levels. Available social and economic research on the recreational billfish fishery needs to be summarized and made available for widespread consumption by all stake-holder groups: anglers, commercial fishermen, politicians, fishery managers, community leaders, the recreational fishing industry and, most importantly, the public. Also, this information needs to be used more extensively in the public policy-making arena. It is likely to resonate well with politicians involved with fishery management decision-making; commercial fishing interests know how to make social and economic arguments in support of their interests. Recreational fishery interests need to be more effective at bringing their social and economic 'facts' to bear on the decision-making process as well.

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