CONTRASTING SOCIOECONOMIC INDICATORS FOR TWO FISHERIES THAT TARGET ATLANTIC BILLFISH: SOUTHEAST FLORIDA RECREATIONAL CHARTER BOATS AND VENEZUELAN ARTISANAL GILL-NETTERS

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ABSTRACT

Developing and implementing effective management measures is critical for the sustainability of billfish (sailfish, *Istiophorus platypterus* (Shaw in Shaw and Nodder, 1792); blue marlin, *Makaira nigricans* Lacépède, 1803; and white marlin, *Tetrapturus albidus* Poey, 1860) populations and pelagic ecosystems. Typically managers use biological performance indicators to evaluate stock status and ultimately determine management measures. Social and economic performance indicators for resource users should be better studied to determine the impact of management strategies on affected communities. These indicators can be linked to each management objective, whether the objective is biological, social or economic, and used to evaluate the performance of management strategies. In this study, we collected data in the United States and Venezuela and developed four performance indicators: gross revenue, net revenue, financial profit, and economic profit. Here we show that socio-economic indicators can be developed for vastly different fisheries and can be used to describe and quantify the socioeconomic impacts of alternative management measures. The indicators are useful tools to highlight the impacts that certain management measures may have on various stakeholder groups.

Management of marine fishery resources attempts to achieve conflicting objectives, e.g., increase yields, maximize resource rent, rebuild overfished stocks, or maintain biodiversity. Governments increasingly demand that managers associate each objective to measurable performance indicators supported by scientific data in order to evaluate the success of management strategies and objectives (Cochrane, 2002). In theory, fishery management plans should clearly identify the process and performance indicators that are to be used in the evaluation (FAO, 1997; Smith et al., 1999; Die, 2002) and ideally these indicators need to explicitly incorporate uncertainty (Stokes et al., 1999).

Defining the process to be followed when evaluating management strategies can be complicated. The process varies depending on the type of fishery but typically is dictated by governmental policies at each level: local, state, national, or international. Such policies rarely prescribe the specific quantitative models or methods that are to be used to develop each performance index. More commonly, detailed operational definitions are presented in other documents and are intended to reflect technical standards. Some examples of these are the social (ICGP, 1994) and biological (Restrepo et al., 1998) guidelines for federal fisheries in the United States and the general standards for international fisheries (FAO, 1997). Ultimately, the evaluation of management success is a process in which the relative importance of meeting conflicting objectives is evaluated through the political process. Moreover, actual management is often driven by objectives that are neither spelled out, nor as lofty as the government policy; thus, day to day management reflects the risk-averse nature of most managers (Walters, 1986).
The open access nature of most marine resources poses an additional problem because there are few incentives for individual users to invest in fisheries conservation. In addition, open access allows users that often do not share the same management objectives to exploit the same fishery resources. Differing objectives tend to influence the relative weight given by various users to the evaluation of management performance. Commercial fishers place more weight on performance measures that relate to yield and profits; sport fishers judge the likelihood of encountering fish, especially prize-size fish; subsistence fishermen seek to harvest enough protein; non-consumptive users want to ensure exclusive access to specific sites; while, conservationists want to enhance the “intrinsic value” of a site or the conservation value of a species or stock.

Typically managers utilize the results of biological and ecological studies to implement management measures for billfishes because initially most managers were trained as ecologists (Walters, 1986). This paradigm persisted because both government and fishing interest groups agreed to work under the paradigm that “if the biology is taken care of” management will succeed, or as Walters (1986) expressed “... with the implicit assumption that regulation and enhancement of biological harvests will also lead to economic well being”. Such management led to the development of biological indicators that were stock related (e.g., maximum sustainable yield, overfishing, and overfished criteria) and tied to management actions through explicit formulae (Punt, 1992; Butterworth and Bergh, 1993; McDonald and Smith, 1997; Restrepo et al., 1998; Butterworth and Punt, 1999; Geromont et al., 1999; Sainsbury et al., 2000). Partially due to our naïve view of the ocean as an inexhaustible source of fish, more and more resources reached unsafe biological limits and remedial action was sought through biological regulations. However, any management measure restricts human use or access in order to ensure species’ sustainability.

Examination of the current literature (FAO, 1997; Restrepo et al., 1998) that presents guidelines on quantitative measures used in the evaluation of fishery management strategies reveals that there are many accepted measures to quantify and evaluate the biological consequences of management actions on the target stock. There is, however, much less agreement on how to quantify the economic, social, and ecological consequences of management strategies. We contend that this is not necessarily due to the lack of methods to obtain such quantitative measures, but rather the unwillingness of the fishery management process to accept simple indicators to measure the socioeconomic consequences. There is a need to complete social and economic studies of the users of billfish resources. These studies can produce data that can be linked to each management objective, whether the objective is biological, social or economic, and used to evaluate the performance of management strategies. This sort of evaluation would undoubtedly make the management process more transparent and responsive to the needs of all stakeholders. Moreover, it is well accepted that increased recognition of stakeholder needs improves the effectiveness of fisheries management. With a strong sense of ownership in the management decisions, stakeholders are more likely to support the implementation of management measures.

Effective management is necessary for the continued sustainability of billfish (including sailfish, *Istiophorus platypterus* (Shaw in Shaw and Nodder, 1792); blue marlin, *Makaira nigricans* Lacépède, 1802; and white marlin, *Tetrapturus albidus* Poey, 1860) populations and pelagic ecosystems. Atlantic Billfish management is compli-
cated by all of the problems presented earlier: multiple levels of institutional control, competing users' objectives, the tendency to use biological indicators to determine management measures, and the unwillingness of managers to accept socioeconomic indicators. Our study addresses the latter issue with the objective of providing a baseline characterization of the financial and economic performance of two fisheries that target Atlantic billfish: the artisanal fishery of Playa Verde, Venezuela and the south Florida charter fishery.

The Venezuelan artisanal fishery is a commercial and subsistence fishery; some of the catch is sold to local consumers and the remainder is for the crew’s consumption. The operations target billfish, but will land whatever by-catch species are caught. The Playa Verde fleet is limited to 35 vessels which cannot be replaced nor modified. The artisanal port is located along the Venezuelan central coast about 10–15 mi north of the port of La Guaira (Marcano et al., 2001). The south Florida charter fishery includes charter boat operations that specifically target billfish from Miami to Stuart, Florida. This fishery is a mixed recreational and commercial fishery (some of the vessels sell their non-billfish catch when they return to the dock). The two study sites were chosen because each country (United States and Venezuela) is a contracting member of the International Commission for the Conservation of Atlantic Tunas, (ICCAT). Each nation provides catch and effort data to ICCAT.

Performance Indicators

The study collected data that can be used to develop performance indicators for the fisheries that target billfish. These performance indicators can in turn be used to evaluate the efficiency of billfish fisheries. Four performance indicators were used in this study: gross revenue, net revenue, financial profit, and economic profit (Fig. 1). These performance indicators are not to be used to estimate the total value of billfish, but to characterize and contrast the performance of the producers: fishers that target billfish.

The first performance indicator is annual gross revenue, $GR$, the total amount of income generated from fish sales or fishing rentals. In charter fisheries, additional revenue may be generated by referrals to the taxidermist. Gross revenue is the revenue accruing to the owner before accounting for any costs. Net revenue, $NR$, is the difference between gross revenue and running or variable costs. Running costs are costs that change with the number of trips a vessel takes. Running costs include the cost of bait, fuel, and groceries. Net revenue is the short term revenue for the producer: the artisanal vessel owner or the charter boat owner.

Financial profit is the third performance indicator and it measures the amount of cash coming in and out of an industry (Hundloe, 2000). This financial performance indicator considers the viability of an industry in terms of its commercial profitability (Pascoe et al., 1996). Positive financial profits indicate that the revenue exceeds the owner’s cash investment (Pascoe et al., 1996; Whitmarsh et al., 2000; J. Agar, NOAA, unpubl. data).

Financial profit is the difference between gross revenue and all costs (running costs, fixed costs, crew payments, and interest payments). Fixed costs include insurance, advertising fees, dock fees, office space, licenses, and repair/maintenance of the vessel, motor, gear, and equipment. In contrast to running costs, fixed costs do not change with the number of trips taken in a year. The crew payment includes any
direct payment to crew members and interest payments are loan repayment schemes for vessels.

In contrast to financial profit, economic profit is the value of fishing to society in terms of the resource costs of that activity (Pascoe et al., 1996). Economic profit is an indicator that measures the efficiency of a producer in society’s view. This performance indicator measures the real costs of inputs in comparison to the value of output, or revenue (Pascoe et al., 1996; Whitmarsh et al., 2000).

Economic profit is calculated by deducting running costs, fixed costs, the opportunity cost of labor, the opportunity cost of capital goods (including economic depreciation) from gross revenue. The opportunity cost of an item is defined as the value of the next best alternative (Allen et al., 2002). We assumed that the opportunity cost of labor is equal to the current wage for persons employed in manufacturing jobs. Many times it is impossible to know the value of the capital item in the next best alternative (opportunity cost of capital goods). Instead, the rental price of the capital good is used as the opportunity cost of that capital good. We assumed that depreciation followed a linear relationship; therefore, the rental price was the value of the capital good multiplied by the sum of interest and depreciation.

The four performance measures account for costs in different manners. Financial profit calculations simply view the industry in terms of its profitability to the business owner; whereas, economic profit calculations allocate resources in the most efficient manner for society as a whole. If financial profit is positive, the industry is profitable for the owner. If economic profit is positive, then the industry is efficient and profitable for society. If economic profit is negative, then the true cost of factors of production exceed the revenue generated by the industry. If performance indicators for financial profit and economic profit conflict, this is due to the treatment of costs. Only economic performance indicators account for the opportunity cost of labor and capital. If results show positive financial profit and negative economic profit, the fishery may be commercially viable in the short term, but the fishery is not operating optimally (long-term analysis) based upon society’s view of allocating resources in the most efficient manner (Pascoe et al., 1996; Hundloe, 2000; Whitmarsh et al., 2000).
Methods

Surveys were developed following Armstrong et al. (1992) to obtain data on the fishery. Four types of information were collected from the surveys: a description of fishery operations, socioeconomic operator data, demographic, and perceptions of fishery management objectives. The questionnaire included both quantitative and open-ended questions, with the latter providing an opportunity for comment on contentious and complicated issues. After some adjustments, the final survey instrument was adopted and administered in the two study areas: south Florida, United States, and Playa Verde, Venezuela. The survey instrument in Venezuela included questions related to social livelihood of the fishermen and their families and the instrument was administered in Spanish.

Both countries provide detailed catch and effort data that are used by ICCAT in their species’ assessments. Billfish are directly targeted by both fleets and are important for the survival of these fishermen, while other species are secondary targets. The south Florida fleet has 117 working vessels and the Playa Verde fleet has 22 working vessels. Typical catches in the south Florida fleet include dolphin, wahoo, and cobia. In Venezuela, any species that is caught by the gill net is sold at the dock.

Charterboat operators/captains in Martin, Palm Beach, Broward, and Miami-Dade Counties were identified through a variety of sources: internet websites, yellow pages, and personal referral. In Venezuela, vessel owners and fishers were contacted through the Playa Verde Fishermen’s Association; the Association functions as a cooperative and includes all licensed gillnet fishermen in the fishery. Standard techniques were utilized to contact and conduct personal interviews with the respondents (Dillman, 2000; Fowler, 2002). A member of the research team called a potential respondent or visited their dock space, explained the purpose of the survey, and attempted to establish a meeting time to interview the captain or owner. The research team then administered the 40-question on-site personal interview. Interviews were typically conducted at the marina or in the case of Venezuela, the artisanal port of Playa Verde.

Occasionally, surveys were conducted at the operator’s home or another designated meeting place. All efforts were made to minimize the amount of time taken from the operators’ schedule. Interviews were conducted from September 2002–June 2003 in south Florida; Playa Verde interviews were conducted in June and July of 2003.

Results

In each of the study areas, all of the fishermen were contacted for participation. The results represent the responses of all of those who chose to participate in the study. Fishermen primarily refused participation due to lack of time and/or unwillingness to reveal information about their operations. Data were obtained from 87% of the Playa Verde fishing fleet. Responses from 75% of the south Florida charter boat fleet were collected; the response rates for the included counties were: Miami-Dade (80%), Palm Beach (85%), Martin (90%), and Broward (60%). In Venezuela, all of the active fishermen were adults, with an average age above 30 yrs. Ninety-eight percent were Venezuelan, having an average of 15 yrs experience in fishing; 11 yrs on average were spent at Playa Verde alone. In south Florida, fishermen had the same level of fidelity to their sites. They worked in the charter boat industry for a median of 18 yrs and 9 yrs on the same operation.

In Venezuela, fishing is carried out at night about 16 d per month and depends on the weather and phases of the moon. Fishing takes place only during the new moon, early crescent, and late waning phases. Venezuelan fishermen took about 192 trips per vessel per year. Charter fishermen took close to 15,000 trips in 2003, or 177 trips
per vessel per year. They rely upon a clientele that is comprised of repeat (repeat: 53%, mixed first-time and repeat: 28%, first-time: 19%) out-of-state customers (out-of-state: 60% and Floridians: 25%). The majority of operations offer half-day trips, but full-day and 6-hr trips are also available.

Due to the economic disparity between the two study nations, the Venezuelan component included the collection of additional information about the family life. Of those interviewed, 13% could not read, 14% could not write, and just 26% had completed the fifth grade. The results found illiteracy among the families of captains or mates, but there was no instance of illiteracy among families of boat owners. Fishermen’s family groups included 197 persons, of whom only 19% reported contributing to the family income and by an average of $87.16 per month.

The median gross revenue for an individual vessel in the Venezuelan artisanal fleet and south Florida charter fleet was estimated to be $19,701.50 (Table 1) and $357,600.00 (Table 2), respectively. Gross revenue for the Venezuelan fleet was estimated as the sum of all fish sales in 1 yr. Gross revenue for the south Florida fleet was estimated to be the sum of the cost of fishing charters, plus the referral rate to the taxidermist (for vessels that landed billfish only).

In Venezuela, the median vessel earned a net revenue of $13,362.38, including running costs (bait, fuel, and groceries) estimated to be $6320 (Table 1). The typical

Table 1. Gross revenue, net revenue, and financial profit for the Venezuelan artisanal fishery.

<table>
<thead>
<tr>
<th></th>
<th>Median</th>
<th>No. obs</th>
<th>Min</th>
<th>Mean</th>
<th>Max</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross revenue(^1)</td>
<td>19,701.50</td>
<td>19</td>
<td>3,068.00</td>
<td>19,269.85</td>
<td>36,219.00</td>
<td>7,888.60</td>
</tr>
<tr>
<td>Running costs(^2)</td>
<td>6,320.00</td>
<td>19</td>
<td>4,148.00</td>
<td>7,427.69</td>
<td>26,325.00</td>
<td>4,800.97</td>
</tr>
<tr>
<td>Net revenue</td>
<td>13,362.38</td>
<td>19</td>
<td>-16,005.00</td>
<td>12,383.44</td>
<td>29,367.00</td>
<td>9,832.80</td>
</tr>
<tr>
<td>Fixed costs(^3)</td>
<td>2,904.69</td>
<td>19</td>
<td>1,762.50</td>
<td>3,402.89</td>
<td>6,325.00</td>
<td>1,386.68</td>
</tr>
<tr>
<td>Crew payments</td>
<td>7,388.06</td>
<td>19</td>
<td>1,151.00</td>
<td>7,226.19</td>
<td>13,582.00</td>
<td>2,958.23</td>
</tr>
<tr>
<td>Interest payments(^4)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Financial profit</td>
<td>1,295.82</td>
<td>19</td>
<td>-22,290.00</td>
<td>1,213.07</td>
<td>12,198.00</td>
<td>7,681.02</td>
</tr>
</tbody>
</table>

\(^1\)The exchange rate used for these calculations was Bs1,600 = US$1
\(^2\)Includes revenue from fish sales.
\(^3\)Running costs include the cost of bait, fuel, and groceries.
\(^4\)Fixed costs include the cost of insurance, advertising fees, dock fees, office space, licenses, repair/maintenance of vessel, motor, gear, and equipment.

Table 2. Gross revenue, net revenue, and financial profit for the south Florida charter fishery.

<table>
<thead>
<tr>
<th></th>
<th>Median</th>
<th>No. obs</th>
<th>Min</th>
<th>Mean</th>
<th>Max</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross revenue(^1)</td>
<td>357,600.00</td>
<td>84</td>
<td>22,380.00</td>
<td>418,030.89</td>
<td>1,525,500.00</td>
<td>279,896.11</td>
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<tr>
<td>Running costs(^2)</td>
<td>23,531.00</td>
<td>84</td>
<td>0.00</td>
<td>28,049.35</td>
<td>189,840.00</td>
<td>28,043.06</td>
</tr>
<tr>
<td>Net revenue</td>
<td>329,293.45</td>
<td>84</td>
<td>4,500.00</td>
<td>389,621.55</td>
<td>1,514,746.80</td>
<td>272,155.35</td>
</tr>
<tr>
<td>Fixed costs(^3)</td>
<td>26,825.00</td>
<td>84</td>
<td>2,410.00</td>
<td>32,983.22</td>
<td>131,760.00</td>
<td>24,008.72</td>
</tr>
<tr>
<td>Crew payments(^4)</td>
<td>0.00</td>
<td>84</td>
<td>0.00</td>
<td>13,995.83</td>
<td>180,000.00</td>
<td>32,460.17</td>
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<tr>
<td>Interest payments(^5)</td>
<td>0.00</td>
<td>72</td>
<td>0.00</td>
<td>4090.88</td>
<td>27,600.00</td>
<td>7,507.68</td>
</tr>
<tr>
<td>Financial profit</td>
<td>277,077.34</td>
<td>72</td>
<td>-149,126.00</td>
<td>330,328.56</td>
<td>1,451,746.80</td>
<td>272,891.45</td>
</tr>
</tbody>
</table>

\(^1\)Includes revenue from fishing charters and mounting referral fees.
\(^2\)Running costs include the cost of bait, fuel, and groceries.
\(^3\)Fixed costs include the cost of insurance, advertising fees, dock fees, office space, licenses, repair/maintenance of vessel, motor, gear, and equipment.
\(^4\)The median value for crew payments in the south Florida charter fleet was $0. On 79% (n = 66) of the operations, the crew did not receive a salary; instead they worked for tips from customers.
vessel in south Florida had net revenue of $329,293.45, when accounting for running costs, $23,531.00 (Table 2).

Financial profit, or the value of the enterprise to the individual owner, accounts for running costs, fixed costs, direct payments to the crew, and any interest payments on the capital goods (vessel, gear, etc). In Venezuela, the median vessel’s financial profit was $1296.82 (Table 1) whereas in south Florida, the typical vessel’s financial profit was $277,077.34 (Table 2). The median value for crew payments in the south Florida charter fleet was $0. On 79% (n = 66) of the operations, the crew did not receive a salary; but instead worked for tips from customers. Economic profit, or the value of the enterprise to society as a whole, was $1210.00 (Table 3) for the median Venezuelan vessel, $1210.00 (Table 3) and $198,272.30 in south Florida (Table 4).

More than one-third (39%) of the fishermen surveyed in Venezuela perceived that the billfish catch rates have remained the same since they began fishing in the area (Fig. 2). In contrast, close to one-half (45%) of the south Florida fishermen surveyed perceived that the billfish catch rates are higher. In both study areas, fishermen did not perceive a change in the size classes of billfish species.

In both Venezuela and south Florida, fishermen were committed to their respective fisheries. Only one-in five Venezuelan fishermen reported that they would abandon the fleet if the billfish catch decreased by 50%. The same trend was apparent in Table 4. Economic profit for the South Florida charter fishery.

| Table 3. Economic profit for the Venezuelan artisanal fishery. |
|---------------------------|---------|----------------|----------------|----------------|----------------|
|                           | Median  | No. obs | Min          | Mean           | Max            |
| Running costs¹            | 6,320.00| 19      | 4,148.00     | 7,427.69       | 26,325.00      |
| Fixed costs¹              | 2,904.69| 19      | 1,762.50     | 3,402.89       | 6,325.00       |
| Labor opportunity cost¹   | 2,001.50| 19      | 2,001.50     | 2,001.54       | 2,001.50       |
| Capital items opportunity cost¹ | 2,503.40| 19  | 1,312.50     | 2,571.85       | 3,675.00       |
| Depreciation              | 2,937.50| 19      | 1,762.50     | 3,493.22       | 7,050.00       |
| Economic profit           | 1,210.00| 19      | −29,972.00   | 372.64         | 18,673.00      |

¹The exchange rate used for these calculations was Bs1,600 = $US1.
²Running costs include the cost of bait, fuel, and groceries.
³Fixed costs include the cost of insurance, advertising fees, dock fees, office space, licenses, repair/maintenance of vessel, motor, gear, and equipment.
⁵The opportunity cost of capital items, m, is assumed to be equal to the rental price of goods; where m = Capital item * (interest + depreciation).

| Table 4. Economic profit for the South Florida charter fishery. |
|---------------------------|---------|----------------|----------------|----------------|----------------|
|                           | Median  | No. obs | Min          | Mean           | Max            |
| Running costs¹            | 23,531.00| 84    | 0.00         | 28,049.35       | 189,840.00     |
| Fixed costs²              | 26,825.00| 84    | 2,410.00     | 32,983.22       | 131,760.00     |
| Labor opportunity cost¹   | 57,782.00| 84    | 57,782.00    | 57,782.00       | 57,782.00      |
| Capital items opportunity cost¹ | 29,365.00| 84  | 3,962.00     | 47,998.63       | 426,300.00     |
| Depreciation              | 9,400.00| 84    | 0.00         | 17,441.10       | 117,500.00     |
| Economic profit           | 198,272.30| 84  | −338,687.40  | 233,416.20      | 1,358,064.40   |

¹Running costs include the cost of bait, fuel, and groceries.
²Fixed costs include the cost of insurance, advertising fees, dock fees, office space, licenses, repair/maintenance of vessel, motor, gear, and equipment.
⁴The opportunity cost of capital items, m, is assumed to be equal to the rental price of goods; where, m = Capital item * (interest + depreciation).
south Florida; less than one in ten Florida fishermen reported that they would leave the fishery if catch rates were to decrease by such a level.

Fishermen in Playa Verde believed that less than half (44%) of the billfish released by recreational fishermen actually survive. In fact, many (71%) of these artisanal fishermen perceived that recreational fishing drives away billfish. South Florida charter fishermen have a different perception of their impact on billfish populations in south Florida. Charter fishermen (84%) rate the status of sailfish in the south Florida region as either good or excellent. Close to three-fourths (74%) of the fishermen interviewed practice total catch and release for all billfish species. South Florida charter fishermen believe that sailfish have high rates (85%) of post release survival. Despite this perceived high rate of sailfish post-release survival, 50% are using J-hooks, 24% are using both J-hooks and circle hooks, and 19% are solely using circle hooks to target sailfish.

Although charter fishermen are making a financial profit (Table 2, $277,077.34), fishermen rely on other means to supplement their income. They either have other occupations (40%) or sell their catch at the docks (46%). Charter owners who have a saltwater products license are able to sell other species that are caught while targeting billfish (the sale of Atlantic billfish is illegal). Those with other occupations usually worked in another sector of the fishing industry (44%). The entire Venezuelan artisanal fleet is dependent upon fish sales at the dock for economic survival. Close to half (43%) of artisanal fishers have another occupation to supplement their income. In both Venezuela and south Florida, participation with fishing organizations is important. The majority (65%) of the charter boat fleet belong to some sort of fishing organization. One-third (38%) participate in a local angler’s association and another 36% belong to the International Game Fish Association. In Venezuela, 98% belong to the Playa Verde Fishermen’s Association.
Discussion

Fisheries indicators measure the state of the fishery and can represent critical situations. In theory, indicators will help determine the biological, social, and economic effects of management strategies (Seijo and Caddy, 2000). Indicators that are linked to each other are effective tools to (1) identify where more resources are needed, (2) monitor whether resources are being used effectively, and (3) evaluate the success of management objectives (Seijo and Caddy, 2000). Biological indicators in fishery systems have been collected for many years to monitor trends in stocks; e.g., biomass, total catch, effort, spawning stock biomass, etc. The importance of maintaining similar socioeconomic performance indicator databases is recognized by many, but yet a major problem exists. There are few long-term datasets that compile social and economic information for fishery systems. This partially reflects the fact that investment in the science required to support fishery management is largely biased towards biological information on target species.

This lack of information on socioeconomic indicators is a general phenomenon across world fisheries. For instance during 1997–2000 the European Community Fisheries Directorate invested 78% of its research budget into biological studies, 11% on studies related to regulation and harvesting, and only 2% on socioeconomic studies (European Commission, 2004). ICES, the International Council of Exploration of the Sea, the main scientific body advising European countries on fisheries matters has an almost exclusive biological focus (ICES, 1964). ICES summarizes stock status on the basis of two precautionary reference points. The first indicator measures whether the spawning stock is inside or outside safe biological limits; the second measures whether the stock is being harvested sustainably (ICES, 2002a; ICES, 2002b). These two measures are analogous concepts to the overfished and overfishing criteria established by the National Oceanic and Atmospheric Administration (NOAA) who manages United States stocks (Restrepo et al., 1998). Similarly ICCAT interpretation of the precautionary approach only refers to estimations of the biological status of stocks and the safe harvest levels that could maintain such status. There are no statements suggesting the inclusion of socioeconomic or ecosystem issues in these considerations (ICCAT, 1999). An analysis of the ICCAT database of scientific papers presented at ICCAT meetings reveals that most of the technical work conducted through ICCAT focuses on biological issues pertaining to target stocks. Out of a total of 2844 papers presented at ICCAT meetings only 11 papers focused on economic issues and 74 focused on environmental issues. Slightly more attention is focused on issues related to the environment, but most of the 74 papers focused on environmental issues related to oceanographic processes and only five of these focused on ecosystem issues.

The present study shows that socioeconomic indicators can be developed for vastly different fisheries and to describe and quantify the impacts of alternative management measures. The indicators are ideal tools to highlight the various impacts that certain management measures may have on different fleets. For instance, perception of stock status and commitment to the fishery were rather similar among the two fleets studied; however, economic performance and income dependency from billfish fishing were not similar.

Developing and collecting information on socioeconomic indicators will integrate and improve the evaluation of management measures, because biological and eco-
logical impacts can be evaluated alongside socioeconomic costs and benefits within a single mathematical framework. We recommend that social and economic indicators such as those used in this study be considered by both scientists and managers as alternatives for the quantitative evaluation of management performance for highly migratory fisheries.

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