American Fisheries Society Symposium 73:75–93, 2011

FishSmart: Harnessing the Knowledge of Stakeholders to Enhance U.S. Marine Recreational Fisheries with Application to the Atlantic King Mackerel Fishery

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Abstract.—Despite widespread recognition of the importance of including stakeholders in management decisions for fisheries, an integrated process for broadening stakeholder involvement in the management of marine fisheries in the United States is lacking. Many marine recreational fishery stakeholders feel frustrated by a perceived lack of inclusion in the management process. Here, we describe a collaborative, integrated process between scientists and stakeholders, called "FishSmart," which complements current management by informing fishery managers of stakeholder preferences for alternative management strategies. Strategies were designed by the stakeholders to improve the status of the king mackerel *Scomberomorus cavalla* fishery off the southeastern coast of the United States, relative to their shared vision of an improved fishery. Over the course of four facilitated workshops, stakeholders explored and compared the consequences of voluntary and regulatory fishery management strategies, using a decision analysis model developed by project scientists. Goals identified by stakeholders included maintaining high and stable catches and retaining year-round access and the ability to catch large fish. Options modeled included both voluntary changes in fishing practices and mandatory regulations. Stakeholders agreed that status quo management options were not sufficient to ensure sustainability in the Atlantic king mackerel fishery and developed a suite of 18 consensus recommendations of how to best meet their shared vision of a quality fishery.

Introduction

Recent work has recognized that numerous benefits accrue from including stakeholders in the management of marine fisheries. For example, Johnson and van Densen (2007) argue that stakeholder involvement leads to improvements in the spatial and temporal resolution of data available and in our understanding of the movement and behavior of exploited fish populations. Ultimately, such improvements should lead to a reduction in the uncertainties associated with stock assessments (NRC 2006; Johnson and van Densen 2007). The incorporation of stakeholders more directly in the management process has the additional benefit of improving stakeholders' understanding of the assessment and management processes (Miller et al. 2010). Schratwieser (2006) suggested that this, in turn, will lead to improvements in stakeholder buy-in and compliance with management decisions, which could result in improved working relationships among stakeholders, managers, and scientists.

Stakeholder collaboration in marine recreational fisheries seems especially desirable because of the diversity of this fishing sector, its potential for impacting the resource, its monetary value, and because data for many aspects of these fisheries are lacking. The goals and characteristics of the recreational sector are diverse (McFadden 1969; Pereira and Hansen 2003; Schramm and Gerard 2004; NRC 2006). Populations of recreational species may be simultaneously targeted by independent anglers, for-hire anglers and their clients, tournament anglers, and commercial fishermen. Significant

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mortality can be generated by marine recreational fisheries (Schroeder and Love 2002; NRC 2006), and on occasions, this mortality can be greater than commercial fishing mortality (Coleman et al. 2004; Cooke and Cowx 2004). The relative importance of the recreational sector in terms of proportion of the overall landings has been increasing for many marine species (Ihde et al., in press), Moreover, once established, recreational fisheries can be less sensitive to overall fish abundance because anglers are able to change fishing locations and species relatively easily (Post et al. 2002). Recreational fisheries can generate substantial economic revenue, often in excess of the commercial sector (De Sylva 1969; Post et al. 2002). Yet, monitoring of the biological and economic impacts of recreational fishing has been less rigorous for this sector than for the commercial sector (NRC 2006). Consequently, it appears that there is much to be gained if managers, scientists, and stakeholders work together to share knowledge and ideas about ensuring the sustainability of these resources.

Currently, fisheries management seeks to achieve maximum or optimum sustainable yield (Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006; Brodziak et al. 2008) with the ultimate goal of sustaining fisheries resources. Maximum sustainable yield (MSY) or optimal yield (OY) may be appropriate goals for fisheries dominated by the commercial sector, but neither is likely an appropriate foundation for recreational fisheries (Larkin 1977). Commercial fisheries typically seek to harvest the portion of the stock that will either optimize profit or yield in weight. However, in recreational fisheries, the experience may be as important as the actual catch (McFadden 1969; Hudgins 1984; Schramm and Gerard 2004), and maximizing catch rate or recreational opportunities themselves are likely more important objectives than maximizing yield (Larkin 1977). If fishery removals are sufficiently high, fishing will ultimately result in a population with a modified size and age structure, and harvests will consist of relatively small, young fish. However, the recreational sector may simultaneously value both smaller fish for food and larger and older "trophy-sized" fish in the catch (Pereira and Hansen 2003). As a result, efforts to apply MSY and OY concepts to management of marine recreational fisheries have not been successful (Tuomi 1977; Malvestuto and Hudgins 1996; Pereira and Hansen 2003).

Commercial harvesters and recreational anglers are not the only stakeholders in fisheries management, and goals of other stakeholder groups may differ markedly from those of both fishing sectors. Depending on the fishery, other groups of stakeholders might include the environmental nongovernment organizations (ENGOs), tackle shop owners, boat and tackle manufacturers, the tourism industry, consumers, and property owners. A central motivation for involving stakeholders is that disputes over management goals and actions should be reduced if they are included in the management process from the very beginning—when a management body becomes concerned about the status of a stock and begins to consider measures that might be useful to improve stock status. However, the current federal regional management council process, under which fisheries are managed in U.S. federal waters, does not provide such an opportunity for many stakeholder groups (Okey 2003). Our experience suggests that even the groups that are involved are often frustrated and frequently feel their ideas and opinions are not fully considered in management decisions (Miller et al. 2010). If a stakeholder group is not represented on a particular council or advisory panel, their opportunity for input is limited to contributing a statement at public meetings, often *after* management options are already formulated by the management council and its scientific and statistical committee (SSC). As a result, a range of stakeholders in several prominent U.S. fisheries have been frustrated by a perceived lack of inclusion of their views in fishery management decisions. This dissatisfaction has led to numerous lawsuits against national and regional management agencies in attempts to block or force a range of management decisions, including allocations, rebuilding plans, access, or area closures (e.g., see Brodziak et al. 2008).

Leaders in the recreational sector proposed a collaborative effort between stakeholders and fisheries scientists to determine best fishing practices and management strategies. Here, we describe a collaborative process, called "FishSmart," that resulted from this effort. FishSmart is designed to incorporate stakeholder knowledge of the fishery resource into the management process by proactively informing fishery managers of stakeholder-preferred management strategies, thereby improving stakeholder satisfaction in their level of participation and buy-in for management decisions. FishSmart presents stakeholders with a unique opportunity to objectively evaluate their ideas of best fishing practices, improve their knowledge of the biology of a species about which they care, learn the science behind stock assessment, and work closely with other stakeholders in the fishery, thereby building new relationships and trust. Participation in the FishSmart process allows stakeholders to improve their chances of getting the outcomes they want while empowering them to reduce their impact on the resource and promote sustainability.

The process includes rigorous evaluation of the likely effects of alternative management strategies through simulations with a forecasting model (the decision analysis tool). This is similar to the method described by de la Mare (1996) and similar in concept to "management strategy evaluations" (MSE; Punt et al. 2002a, 2002b, 2002c; Cox and Kronlund 2008; Mapstone et al. 2008) or, alternatively, the "management procedure" approach (Butterworth 2007). However, the FishSmart process was not as extensive as MSE in that we only evaluated alternative management strategies. FishSmart also differs from many comanagement efforts and modeling approaches in that we made an effort to involve all stakeholder groups throughout our process, and management strategies modeled were determined by the stakeholders themselves.

Methods

In an effort to test the ability of such a collaborative process to improve participation and satisfaction of marine recreational anglers in the management process, we adopted a case study approach. After an extensive review of U.S. fisheries, and of the literature and data available for each fishery, with input from a steering committee (composed of high-level professionals with a national fisheries perspective from a wide variety of government, ENGO, recreational fishing, and industry organizations), we selected a case study species from potential candidate fisheries. Candidate fisheries were based on the following criteria: (1) the recreational fishery comprised the largest portion of the landings, (2) there was some conservation concern for this fishery but not so much so that stakeholder views had become entrenched, (3) the stock had sufficient data available such that an assessment was possible, (4) management action was likely in the near future, and (5) management and stakeholders welcomed our involvement. Following this review, we selected the fishery for the Atlantic migratory group of king mackerel *Scomberomorus cavalla* as a case study. Additionally, stakeholder recommendations for this stock could be made to managers within a time frame to influence management (Figure 1) since the stock assessment was taking place concurrently with FishSmart.

The King Mackerel and Its Fisheries in the Atlantic

King mackerel is a coastal pelagic piscivore whose range extends from the northeastern United States to as far south as Brazil (Collette and Russo 1984; Godcharles and Murphy 1986). Collette and Russo (1984) and Godcharles and Murphy (1986) provide a general description of the biology of king mackerel. Within U.S. waters, spawning occurs from April to October (Finucane et al. 1986). Growth is rapid (DeVries and Grimes 1997; Shepard et al. 2008), with most females reaching maturity by age 4 (Finucane et al. 1986). Maximum weight is reported to be approximately 45 kg.

The U.S. king mackerel fishery is managed as two stocks: one centered in the Gulf of Mexico managed by the Gulf of Mexico Fishery Management Council (GMFMC), and a second distributed along the southeastern U.S. Atlantic coast from Florida to North Carolina, which is managed by the South Atlantic Fishery Management Council (SAFMC; Figure 2). For our work, we considered the Atlantic migratory group only. Only limited exchange is assumed between these two stocks (Gold et al. 1997, 2002), but a study using DNA microsatellites suggests that gene exchange between areas may be more substantial (Broughton et al. 2002). The two stocks are thought to co-occur in the area off southern Florida (mixing zone; Figure 2) from October to March, which complicated modeling and data analysis.

The Atlantic migratory group is fished by both recreational anglers and commercial

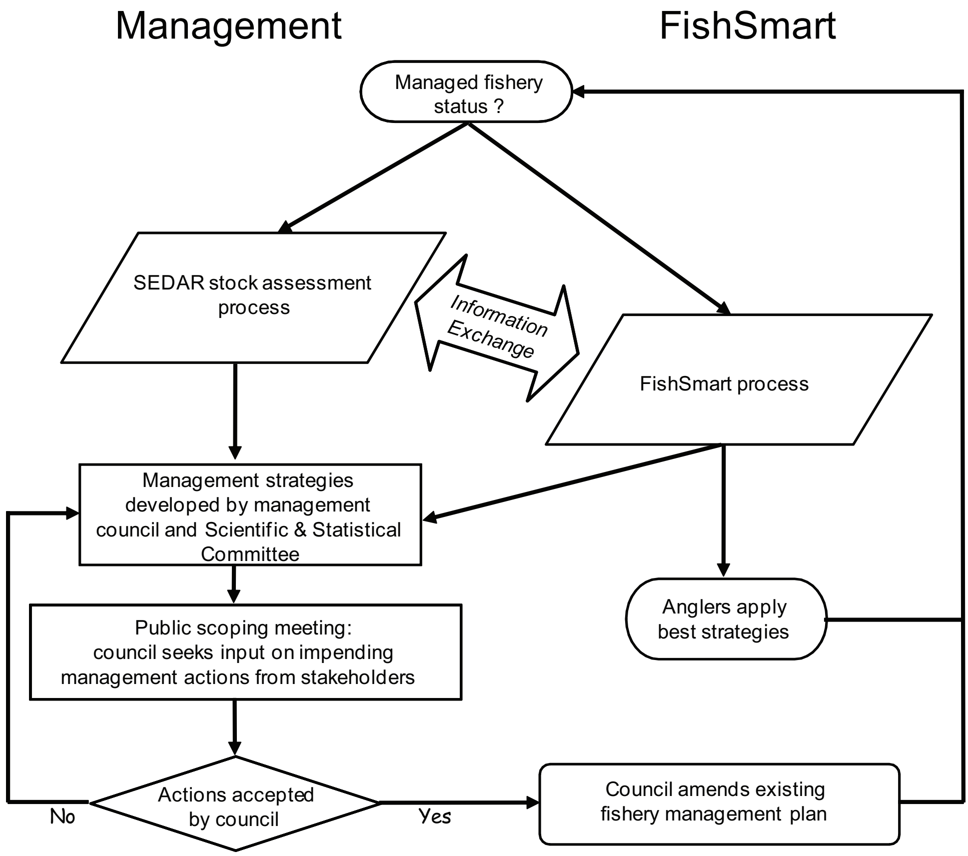

Figure 1.—The FishSmart process parallels and complements the existing fishery management process. Shown on the left is the Southeast Data Assessment and Review management process currently employed by the South Atlantic Fishery Management Council. On the right is the FishSmart process, which both informs anglers of best practices (in terms of achieving the shared vision of the stakeholder workgroup) and feeds model-informed workgroup recommendations to fishery managers before new management measures are developed.

harvesters. The recreational sector includes a for-hire component composed mainly of charter vessels, private anglers that fish both from boats and from shore, and a tournament fishery. The commercial sector is currently limited to a hook-and-line fishery. In the past, the commercial sector also included a modified run-around gill-net gear with a purse line on the lead line (also called "roller-rig" gear). This gear was extremely effective in depleting the resource and the Atlantic migratory group was considered to be overfished in the late 1980s (SAFMC 1986). As a result, substantial changes in regulations were enacted to reduce fishing mortality rates, including gear restrictions for commercial harvesters (roller-rigs were prohibited in the Atlantic), increased size limits, and reduced bag limits for recreational fisheries. Harvests are managed by quotas, with 62.9% of total landings allocated to the recreational sector. During the past decade, the fishery landings have been relatively steady with total landings between 3,846 and 5,795 metric tons (between 8,478,891 and 12,775,657 lbs; SEDAR 2008; Figure 3). Because recreational fisheries have not achieved their portion of the quota, recreational landings are only approximately 60% of the total landings. This is an important species for tournaments throughout the southeastern United States. Many of these tournaments provide substantial prize money for the largest fish brought to the weighing station. However, tournament

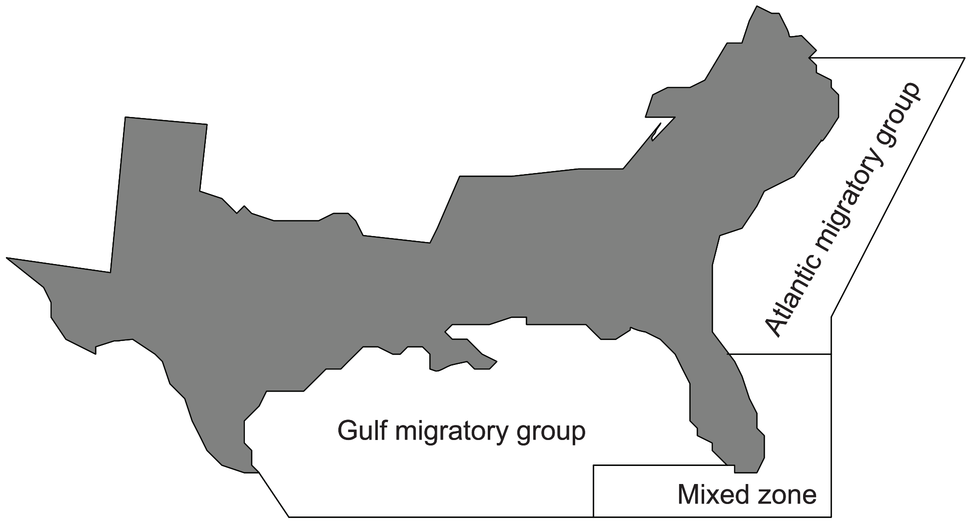

Figure 2.—Definitions of king mackerel migratory groups in the United States.

harvest is poorly represented in data collection programs and stock assessments.

The FishSmart Process

We developed an iterative process that enabled stakeholders to define shared objectives for the fishery, design different management and voluntary options to achieve their objectives, and then evaluate the effectiveness of these options in achieving their objectives for the king mackerel fishery. With key stakeholder involvement, we (a research team of fisheries scientists with expertise in modeling and fisheries biology) developed a stochastic simulation model over the course of a series of professionally facilitated workshops. An experienced, professional facilitation team ensured that the goals of each of the workshops were met and that all stakeholders were able to express their views and fully contribute to the process (Figure 4). The early workshops sought to develop a vision (i.e., objectives) for the future fishery that was shared by all stakeholders, as well as recom-

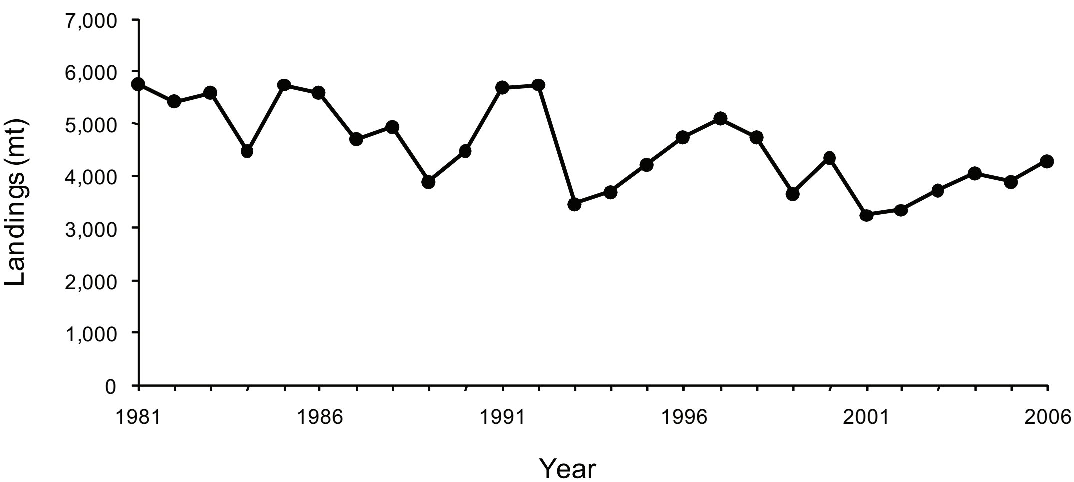

Figure 3.—Landings of king mackerel in metric tons (mt) from the Atlantic migratory group from 1981 to 2006.

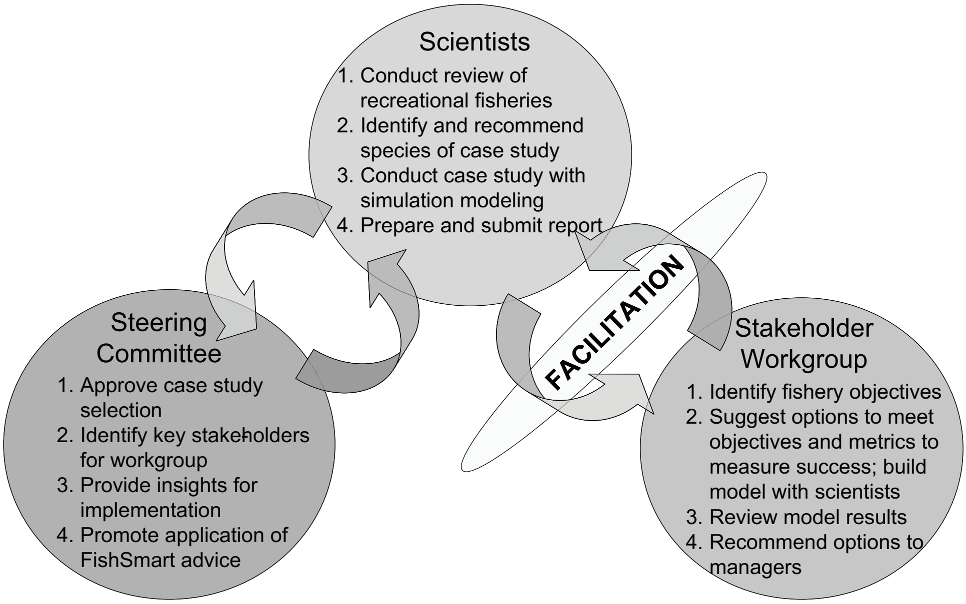

Figure 4.—Interaction of interest groups involved in the FishSmart process for Atlantic king mackerel.

mendations for options to achieve that vision. Subsequent workshops focused on identifying options and performance measures that stakeholders believed important to achieving the objectives. We defined options as voluntary behaviors or management strategies that could be used to achieve the objectives of the group; performance measures were defined as metrics that could be used to gauge which options achieved the shared objectives. The simulation model described the dynamics of the fishery over a 50-year period for each of the options that the stakeholders wanted to evaluate. The performance measures also provided a basis for ranking the outcome of different options. Upon completion of the option evaluation process, the workgroup recommended a package of preferred options to the SAFMC (Figure 1).

The application of the FishSmart process to king mackerel involved establishing a workgroup of representatives of the key stakeholder groups in the king mackerel fishery. The workgroup worked closely over a period of 8 months to develop a suite of recommendations for management approaches that they believed would lead to an improved king mackerel fishery and would also satisfy legal requirements under federal law. Workgroup members selected to participate were knowledgeable and influential stakeholders of the king mackerel fishery. Members were initially identified with recommendations from management council staff, angler organizations, sports writers, the FishSmart steering committee, nongovernmental organizations, and state and federal agencies. Potential members were subsequently interviewed to evaluate their background and interest in participating. Because the workgroup had to be limited in size to remain effective and constituent groups of stakeholders had to be represented effectively, members were chosen carefully to be recognized as leaders within their groups. Each stakeholder group is a relatively close-knit community; thus, leaders could easily be recognized because the same individuals were recommended by multiple sources. An additional and important requirement for members was that they had to commit to attending all of the workshops because the workshops built upon one another, and educating new members partway through the process would have severely diminished the rate of progress that could be achieved. Further, continuity was viewed as important to maximize the development of positive working relationships between stakeholder groups. Participation of individuals in the process was voluntary, so members had to be satisfied that the process would be a valuable use of their time.

Four stakeholder workshops were held in Jacksonville, Florida between April and November, 2008. A primary goal of the first workshop was to introduce the workgroup members to the process, to one another, and to considerations required for model development. Structured discussions of the state of the resource, concerns of the stakeholders, and ways the workgroup believed progress could be made to improve the fishery all occurred at this first meeting. The workgroup also developed an initial shared vision for a more ideal Atlantic king mackerel fishery (objectives), voluntary or management options that might achieve that vision, and performance measures that estimate how well objectives are achieved under the different options modeled.

Having workgroup members develop options and performance measures early on was a critical part of the process. These considerations helped define the structure and complexity of the simulation model that would be used to compare the performance of the suggested options. For example, workgroup participants were very interested in not only total catch and landings, but also the sizes of fish caught. Therefore, it was necessary to incorporate sizes of fish caught into the model. Many stakeholder concerns were not amenable to model evaluation, but they allowed the workgroup to make additional recommendations, such as educational programs for anglers to improve handling practices and decrease bycatch mortality, and general principles that could enhance effective management for this species.

Based on input from stakeholders during the first meeting regarding the spatial and temporal resolution likely required, the research team developed an age-, size-, and sex-structured stochastic simulation model with four intra-annual periods, two areas, and three fisheries. The four intra-annual periods allowed for the seasonal migrations of the stock that are thought to occur along the Atlantic coast. Two areas were included to accommodate an area where mixing with the Gulf of Mexico stock is believed to occur (Florida) and a second area where stock mixing is not believed to occur (North Carolina, South Carolina, and Georgia; Figure 2). The two areas were also helpful for including current management regulations in the model because recreational bag limits differ in the two areas. The model contained three fishery sectors to reflect stakeholder input and the main sources of mortality on this stock: recreational (including both private anglers and the for-hire industry), tournament, and commercial.

Many sources of information were used to develop parameter estimates and functional relationships for the model. Parameter estimates and uncertainty in these estimates were taken from the most current stock assessment for the species (Southeast Data Assessment and Review [SEDAR] 16, SEDAR 2008), from separate data sources, or were developed with the input of the FishSmart workgroup. The stock assessment was not completed when the FishSmart process began; nonetheless, we incorporated some of the information produced from the SEDAR 16 process (Ortiz et al. 2008; SEDAR 2008) into the model. In some cases, we began with information from SEDAR 16 and then modified assumptions in the model based on consensus recommendations of the workgroup (e.g., catch-and-release mortality). Other model inputs were entirely based on information gathered from our workgroup participants or from other data sources. For example, because the steepness of the stock–recruitment relationship was not well defined for the Atlantic migratory group of king mackerel, the parameters of the stock–recruitment relationship were estimated from a meta-analysis of other mackerel stocks. The model included parameter uncertainty, within-simulation uncertainty, and implementation uncertainty (i.e., uncertainty in how the fishery will respond to changes in the population and regulations). For full model documentation, see Wilberg et al. (2009).

Inclusion of uncertainty is a critical part of the modeling process, but explicit inclusion of some factors identified by the workgroup was impractical or the assumptions of their inclusion seemed unreasonable. Such factors were examined with sensitivity analyses. Members off the workgroup worked closely with the research team to design the simulation model, and they identified critical areas that required sensitivity analyses. For example, workgroup members had long discussions about future trends in recreational fishing effort based on the effects of increasing fuel prices, changes in management of other fisheries, and an overall decline in participation rates in U.S. recreational fisheries. We sought to include the range of these views by conducting simulations in which effort increased linearly by 0.5%/year, remained constant or decreased linearly by 0.5%/year. A wide range of uncertainties and research needs that could potentially improve the knowledge and management of the fishery that were discussed by the workgroup but not amenable to the modeling exercise are listed in Table 1.

The second workshop served to update the workgroup on progress of model development and provided a forum for the workgroup to review modeling decisions and further develop the options and performance measures. We again reviewed king mackerel population dynamics and the simulation model. During these discussions, workgroup members suggested alternative values for model parameters and assumptions that they did not believe were reasonable. This workshop included ideas to improve scientific understanding underlying the population and simulation models and continued discussions on options and performance measures. The third workshop reviewed an updated set of model results that built upon progress from the first two workshops. It provided workgroup members an opportunity to discuss insights gained from model results as to how well the various options they suggested were likely to achieve their shared vision for the fishery. Workgroup members were then able to suggest new options and alternative performance measures that might better determine how well objectives were achieved. Workgroup members were also encouraged to discuss which objectives they considered to have the highest priority and whether there were specific minimum thresholds for some performance measures that would need to be met for an option to be successful in their mind. The workgroup was not asked to define a specific utility function, which means that each member of the workgroup was free to weigh performance measures differently when evaluating the options. During this workshop, the workgroup decided that they wanted to see short-term as well as long-term performance measures. During the fourth workshop, predictions of the final model were reviewed and consensus recommendations made to be presented to the regional management council. To make their recommendations, the workgroup used both the results of the model and their discussions of critical areas for improvement for the fishery that were not amenable to the modeling exercise.

Throughout the FishSmart process, the workgroup made all decisions through an interactive consensus procedure, defined as ≥75% agreement by those members present. Workgroup voting was made with a show of hands. Miller et al. (2010) provides for complete documentation of the decision-making process. Support for the decisions made by the workgroup reflected the expertise of the individual members and the collective judgment of the workgroup and did not necessarily reflect

Table 1.—Stakeholder-identified critical uncertainties and research priorities for the south Atlantic king mackerel fishery.

Uncertainties
- Future effort trends
- Global warming effects
- Forage fish (prey) abundance

Funding priorities for research (not ranked by workgroup)
- Quantify forage fish abundance and dynamics
- Updated biological information: age, growth, and reproduction for current population
- Migratory behavior for the population
- Stock definition and mixing rates
- Economic impact of changes in fishery
- Angler education
- Improve data quality for recreational fisheries

the position of the organizations to which individual members belonged.

Results

The final workgroup was composed of 13 members. Stakeholder groups that were represented included (number of representatives in parentheses) independent recreational anglers (2), angling organizations (2), charter captains (1), the tournament sector (2), commercial fishers (1), tackle shop owners (1), ENGOs (2), state biologists (1), and managers (1). Group members included the sitting chairperson, the past chairperson, and two other members of the SAFMC Mackerel Advisory Panel and the managing partner of the Southern Kingfish Association, the largest U.S. tournament circuit for king mackerel.

The workgroup developed and unanimously adopted (by the end of the four workshops) a shared vision for an improved Atlantic king mackerel fishery for all stakeholders:

> A sustainable Atlantic king mackerel fishery should be managed to prevent overfishing from occurring, prevent the species from being overfished, to ensure optimum yield is not exceeded while maintaining the genetic diversity of fish and providing acceptable levels of access and allocation for all sectors while conserving biological and ecological functions.

Workgroup members filled data gaps in some instances by making their best estimates as a group and in others by providing their own data. An important outcome of the first workshop was that tournament organizers have now compiled and contributed estimates of tournament catches and the characteristics of these catches. These catches represent approximately 3% of the annual estimate of recreational harvest in numbers (about 9% by weight) from the Marine Recreational Fisheries Statistics Survey, which is comparable to the harvest taken by the head boat fishery (also known as "party boats"—for-hire vessels that carry a relatively large number of anglers). Previously, these data had not been available for inclusion in council assessments.

Over the course of the workgroup meetings, relationships among the stakeholders improved. This manifested itself through stakeholder identification of new opportunities for collaborative research and data sharing and also in the desire of stakeholders to collaborate in the management process. One of our workgroup members reported that he applied for membership on two of the SAFMC's advisory panels as a direct result of his participation in our workshops. However, we believe that the most important accomplishment of the workgroup is that members representing stakeholder groups with substantially different interests have been able to work together to develop consensus recommendations to improve the king mackerel fishery.

Development of Objectives, Options, and Performance Measures

Objectives identified by stakeholders included a wide range of goals. Specific objectives for the fishery included (1) promote sustainability for the population, the fishery, and the ecosystem while maximizing access for anglers (i.e., maintaining an open fishery year-round); (2) reduce and simplify regulations; (3) improve stakeholder interactions with management and with each other; and (4) improve stakeholder education. Thus, the objectives proposed and considered by the workgroup ranged far wider than current objectives used to manage the fishery, where management goals continue to focus on achieving MSY (Brodziak et al. 2008).

The workgroup discussed a wide assortment of options that could potentially help to achieve their vision of an improved king mackerel fishery (Table 2). These options included outreach and educational activities (e.g., outreach to prevent misidentification between juvenile king and Spanish mackerel *Scomberomorus maculatus* as an option to improve compliance with regulations and improve catch and release), voluntary changes in fishing practices and behaviors (e.g., adoption of techniques that reduce catch and release mortality), and mandatory regulations. Additionally, changes in allocation between commercial and recreational sectors were discussed, as well as dividing allocation among groups within a sector (e.g., private recreational, for hire, and tournament), but such allocation changes were not considered by the group in the final stages of options evaluation.

Performance measures (Table 3) were developed to assess how well objectives were met on average and how often the fishery would be

Table 2.—Stakeholder-identified options evaluated for the South Atlantic king mackerel fishery.

Options	Current regulations "status quo" options	Options evaluated
A. Management		
Size limits	24″	Incorporate higher release mortality of 20% with increased size limits
		28″, 32″
		24–36″ slot limit
Bag/creel limits	2 fish (FL), 3 fish (NC)	2 fish, 1 fish (all areas)
Season limits	None for recreational	Maintain none for recreational above all else
Constant quota control rule	10 M (million pounds)	4 M, 6 M, 7.1 M, 8 M
Area closures	None	Maintain none
Combinations:		
Quota/bag limit/size limit	as above for status quo	7.5 M/2 fish/28″
		8 M/2 fish
		8 M/1 fish
		8 M/2 fish/28″
		8 M/status quo/28″
		8 M/status quo/32″
		8 M/status quo/24–36″ slot
B. Voluntary		
Increased minimum size for tournaments	24″ (approx. 4 lbs)	15 lbs
Increased catch-and-release fishing (CR)	26%	30%, 50%, 80% (overall sizes)
		Release all fish > 20 lbs
Reduction of catch-and-release mortality (RM) (by half)	12.5%	6.25%
Combinations:		
Quota decrease/increase tournament minimum size	As above for status quo	8M/15-lb tournament minimum size
Increase CR/reduce RM/ increase minimum size		50% CR/6.25% RM/28″
Quota decrease/increase CR		8 M/50% CR
		8 M/50% CR of >20 lbs

in "poor" condition, relative to the objectives. "Poor" conditions were when the population exhibited levels of the key performance measures that stakeholders perceived to be undesirable and that should be avoided. Aside from biomass and exploitation (which are relative to an absolute standard as defined by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006), actual values of "poor" or "good" conditions were subject to modification by the stakeholders throughout the iterative process as different trade-offs were considered and discussed. Performance measures that were suggested were diverse, but generally related to a healthy population (spawning stock biomass, diversity of sizes and ages, multiple opportunities for most females to spawn, etc.), relatively high levels of catch with fish of preferred sizes (catch, harvest, landings, and harvest within preferred size categories), and access to the fishery (amount of the year open to fishing).

The effects of options suggested by the workgroup were initially summarized as aver-

Table 3.—Stakeholder-identified performance measures for the south Atlantic king mackerel fishery.

Performance measures
Population
Abundance (numbers)
Spawning stock biomass (SSB; biomass of mature females)
Average weight of spawners
Proportion of the population ≥ 15 years old
Fishing mortality and SSB relative to threshold reference points
Fishery
Recreational harvest (numbers)
Recreational catch—all fish caught (numbers)
Tournament harvest (numbers)
Commercial harvest (weight, numbers)
Recreational harvest of fish larger than 20 lbs (recreational target)
Tournament harvest of fish larger than 50 lbs (tournament target)
Commercial harvest of fish between 10 and 12 lbs (commercial target)
Average weight in recreational harvest
Average weight in tournament harvest
Average weight in commercial harvest
Number of days in the recreational fishing season (before quota is reached)
Number of days in the commercial fishing season (before quota is reached)
Proportion of years that recreational quota is reached or exceeded
Proportion of years that commercial quota is reached or exceeded
Number of dead fish due to release mortality

ages over the 50-year time horizon of the model and as changes between the first year and year 5. However, stakeholders based final recommendations on a 15-year time horizon.

Recommendations

During the last meeting, the workgroup made 18 consensus recommendations for actions that they believe would improve the quality and sustainability of the king mackerel fisheries in the Atlantic. Critical uncertainties and data gaps (i.e., priorities for research) were also identified by stakeholders (Table 1). Recommendations of the stakeholder workgroup were directed to both managers and stakeholders. Recommendations to the SAFMC included specific regulatory changes and management principles for the fishery. Recommendations for stakeholders included behavioral changes for anglers and educational initiatives.

1. Regulatory recommendations.—The workgroup recommendations to the SAFMC for regulatory change were determined by stakeholder concerns to meet the following three minimum criteria: (1) the recommended options should maintain the Atlantic king mackerel stock above the overfished and below overfishing thresholds (based on the current stock assessment) on average over a period of at least 15 years, (2) the recommended options should result in the least impact to both recreational and commercial sectors, and (3) the recommended options should avoid season and area closures. After stakeholders reviewed all model predictions for their chosen options (including the current "status quo" regulations as one set of options), they agreed that status quo regulations were not sufficient to limit fishing mortality on the king mackerel resource in the Atlantic. Subsequently, three consensus recommendations were made by the workgroup to the SAFMC:

- 8-million-lb annual total allowable catch, and a two fish per angler daily bag limit for the recreational fishery (minimum size limit unchanged);

- 8-million-lb annual total allowable catch, two fish per angler daily bag limit, and a 28″ minimum size limit for the recreational fishery;
- 8-million-lb annual total allowable catch and a 32″ minimum size limit for the recreational fishery (daily bag limits unchanged).

Although each of the options met the criteria the workgroup selected for inclusion, modeling results and analysis suggested that they performed differently relative to their overall effects on the recreational and commercial fisheries, on increasing spawning stock biomass, and on fishing mortality (Figure 5). The FishSmart workgroup decided to recommend consideration and evaluation of all of these management options by the council. However, the workgroup did not establish a priority order for these options because the group agreed that the adoption of any one of them would be likely to satisfy their shared vision for the fishery and they wanted to provide a set of possible options to the SAFMC.

Interestingly, two additional voluntary options that also performed well according to the stakeholders three minimum criteria were not forwarded as recommendations to the management council by the workgroup. The workgroup chose not to recommend voluntary options to the council because workgroup members perceived that the council cannot use management options that cannot be enforced (i.e., options whose suc-

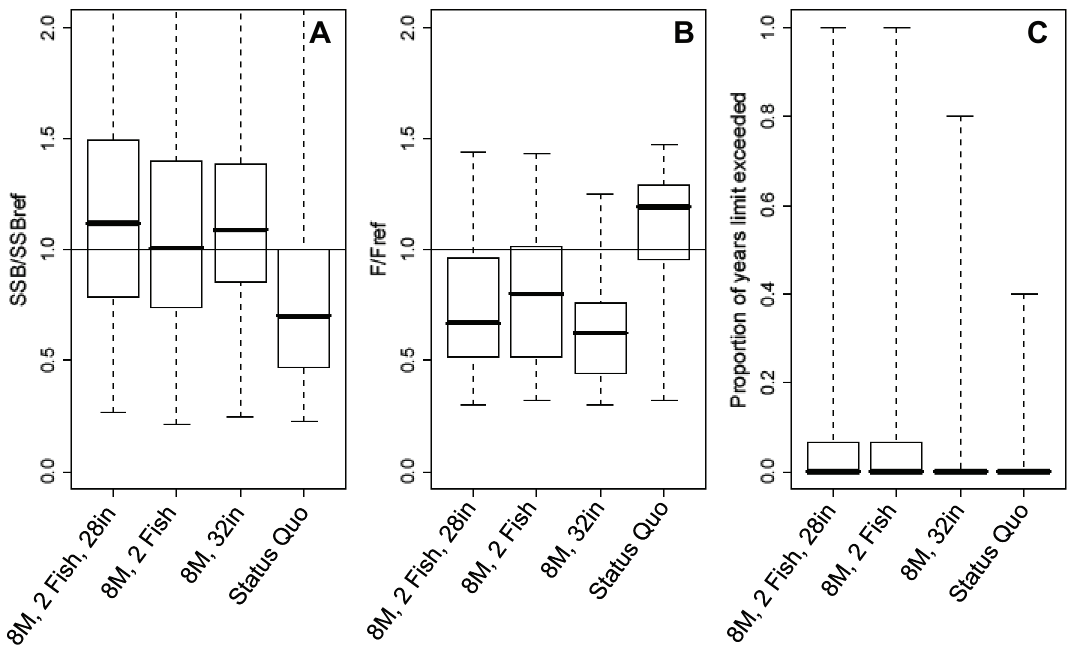

Figure 5.—Performance of the three management options, 8,000,000-lb quota with a two fish per angler bag limit and a 28-in minimum size limit (8M, 2 Fish, 28 in), 8,000,000-lb quota with a two fish per angler bag limit (8M, 2 Fish), and 8,000,000-lb quota with a 32-in minimum size limit (8M, 32 in), recommended by the stakeholder workgroup to the management council (see text for details) compared to the performance of the current regulations ("Status Quo"). Panel A shows results of average spawning stock biomass (SSB) over the first 15 years of the simulation divided by the reference point of SSB at F_{30}% from the stock assessment (SEDAR 2008), panel B shows the average fishing mortality rate (F) divided by the $F_{30\%}$ reference point from the stock assessment, and panel C shows the proportion of the first 15 years in which the recreational quota is reached. Box plots summarize 300 simulations for each option. Boxes indicate the interquartile range, and the heavy line in each box indicates the median. Whiskers indicate the minimum and maximum.

cess depends on uncertain compliance). Other concerns voiced by stakeholders in their selection of the three recommended options included ease of implementation, enforceability, perceived reception by fishing community, fairness of the regulations (i.e., concern that new measures do not impact any one stakeholder group more than the others), and the simplification and unification of regulations.

2. Stakeholder action and behavioral recommendations.—The workgroup recommended the following additional actions be continued or undertaken by the recreational sector, or be established by management regulation:

- Mandatory Web-based trip and catch reporting for head boats;
- Mandatory Web-based trip and catch reporting for charter boats;
- Encourage voluntary reporting by recreational anglers of catch and effort on a Web-based system;
- Mandatory reporting of catch for all tournaments;
- Fishing tournaments that include king mackerel should only allow the weigh in of one fish per boat, with the exception of youth, seniors, and ladies categories.

3. Management principles recommendations.—The FishSmart workgroup developed consensus recommendations on principles that should be incorporated in future management. The workgroup believed that adoption of these principles by the relevant management councils will lead to fishery policies that meet their minimum criteria (described above), as well as broad acceptance of these policies by an educated and informed stakeholder community. The workgroup made the following recommendations for the king mackerel fishery:

- The SAFMC and GMFMC should consider the effects of fishing on the stock in Mexican waters in their future stock assessments.
- The SAFMC should consider the Gulf of Mexico king mackerel stock as well as the Atlantic stock before any adjustments are made to the Atlantic king mackerel stock quota. Mixing zone allocation decisions should be informed by a stakeholder process and based on a comprehensive analysis of the underlying biology of the two fisheries.
- Decisions affecting the Atlantic king mackerel fishery should be considered in conjunction with the Gulf king mackerel fish ery before changes in management are made.
- The SAFMC should focus on management of Atlantic king mackerel in the context of an ecosystem-based approach.
- Artificial habitats and their effects on the king mackerel fishery population and migration patterns should be studied and, as appropriate, considered in management decisions.

The workgroup recommended changes for the management process as well. These were

- An increased and ongoing collaboration among all fishery stakeholders, managers, scientists, and regulators will result in
  —Quality input that will be key to achieving a more sustainable fishery;
  —A fair allocation among stakeholders;
  —Maximum access to the Atlantic king mackerel fishery;
  —An effective management process.
- A commitment to the best available science conveyed to the stakeholders in a transparent, consistent, and understandable for mat should lead to effective management;
- That the council's stakeholder process should be expanded to include a more di rect and interactive stakeholder-driven process that seeks to improve input in de veloping scientifically based management advice and exploring potential consequenc es of alternative management actions, such as the FishSmart process, to guide the council's management decisions.

4. Education initiatives recommendations.—The FishSmart workgroup recognized the importance of educational and outreach activities for ensuring compliance with fishery management policies and promoting use of best practices for handling fish. They considered an educated stakeholder to be the strongest proponent of sound and sustainable stewardship of the resource. Accordingly, the workgroup made the following recommendations:

- Stakeholders and managers should support the development of a consistent message developed by stakeholder perspectives, which will result in increased angler recruitment and a broader understanding of both benefits and challenges for the fishery.
- Simplifying, and unifying where possible, the enforceable regulatory structure designed with educated user input will result in greater compliance and lead to a more sustainable fishery.

The full suite of stakeholder recommendations was made to the SAFMC on December 7, 2008. The presentation was made jointly by two elected representatives of the stakeholder workgroup and T. J. Miller. The SAFMC subsequently voted to send the FishSmart workgroup recommendations out for public comment alongside those developed by the SAFMC and its advisory panel.

Discussion

The FishSmart process was successful in opening channels of communication among stakeholders in the king mackerel fishery and in developing a suite of specific recommendations for management. The FishSmart workgroup effectively and efficiently worked together. In so doing, stakeholders improved their relations with one another and became empowered to function as partners in the management process. For example, stakeholders became aware of other stakeholder positions and some level of improved understanding was developed. The improvement in stakeholder relations was evident during discussions of potential future collaborative research to fill data gaps identified and by the contribution of tournament data for our analysis. Stakeholders successfully developed a shared vision of an improved king mackerel fishery that satisfied all workgroup members. They identified both voluntary and regulatory options to achieve their shared vision as well as performance measures, and stakeholders chose their recommended options according to their value in achieving stated objectives. Stakeholders also identified critical research needs for the council to improve future assessment efforts for this species. Key to the success of the process was that workgroup recommendations of management options were shared directly with the SAFMC and its SSC *as* council strategies were developed, so that the stakeholder preferences could be incorporated in the development of new management strategies. Importantly, stakeholder recommendations resulting from the FishSmart process appeared to carry more weight with the council than those given in the general public comment because they were based on a scientific evaluation of options.

Lessons Learned

Communication.—Effective communication and setting of expectations was extremely important to the success of this project. This was true for all parties involved throughout the process.

Establishing trust and respect among the stakeholders and between the stakeholders and the modeling team was essential. Our impression, given discussions with stakeholders at the beginning of the process, suggests that having the modeling team come from an institution independent of the regional management process made it easier to build trust more quickly because we did not have any direct interest in defending previous management decisions or in pursuing specific management recommendations. The research team had an important role in engaging stakeholders by acknowledging their contributions to the process and then by using the input they provided as appropriate. If stakeholders provide data, the onus is on the analysts to give the information careful consideration for its use in the model.

Communication with the stock assessment team and the management council was important as well. Frequent exchange of information with the stock assessment analysts assured that we stayed abreast of the most current knowledge of the fishery and of its assessed status throughout the parallel processes (Figure 1). It was also important to communicate to these groups that the FishSmart process was not a competing stock assessment and that the main purpose of this process was to provide stakeholders with a decision analysis tool (the simulation model) to empower them to determine preferred fishing practices and then knowledgeably inform managers of their preferences for management options. We made a concerted effort to answer questions stakeholders had about assumptions made in both the stock assessment and the FishSmart model and, in so doing, helped stakeholders to better understand and appreciate the difficulties posed by the realities of imperfect data. As a result, we believe that there was improved buy-in of the current assessment process by stakeholders. This was evidenced by the group's acceptance of estimates of fishing mortality and current abundance from the stock assessment as the "best available" knowledge of the fishery with which to begin our model simulations, whereas at the beginning of this process, many of these stakeholders were not willing to accept anything from the assessment or management processes as reasonable. Clear and repeated communication with the managers and the council staff in regard to these efforts helped prepare the council to consider the workgroup recommendations when formulating new management strategies for this fishery.

An important benefit from the FishSmart process is the empowerment of stakeholders to work as partners with management to share their knowledge and concerns about the fishery. However, without some commitment of managers to consider workgroup recommendations, there is a danger of exacerbating tensions between stakeholders and management. If stakeholder recommendations are not taken seriously after the workgroup has worked hard to develop them, stakeholders will likely be further alienated from management. Thus, to avoid this, clear communication with the council was essential.

Representation.—The selection of key stakeholders was critical to the success of our process. Workgroup members had to be fully engaged and committed to participate through the entire process, leaders among their groups, and carefully chosen to provide a balanced representation of the fishery.

The work required of the stakeholders was not trivial. To participate fully, stakeholders had to work closely with other stakeholders that potentially hold different and sometimes opposing views, interests, and goals for the fishery. They also had to familiarize themselves with available data, deficiencies in the data, assumptions of the model, and issues related to model structure. They learned to interpret a wide variety of displays of model output, and they had to work through long meetings with few breaks for days at a time. Though some members participated as part of their professional positions, most were in attendance voluntarily and some sacrificed income in order to attend workgroup meetings.

In this case study, conservation concerns or impending management action appeared to engage stakeholder interest. Though it seemed likely that king mackerel quota might be reduced before our process began (SAFMC 2007), we had some attrition of member attendance after our first workgroup meeting. However, when preliminary results of the SEDAR 16 assessment suggested that fishing mortality was at the overfishing threshold, group attendance improved and workgroup members became much more engaged in investigating alternative management strategies to possibly mitigate new management restrictions on the fisheries. If the process was strictly proactive (i.e., conducted before the rise of a conservation concern and without the threat of impending management restrictions), it appears unlikely that regular attendance at the workgroup meetings would have been maintained.

Other concerns, like the inclusion of leaders and balanced representation of stakeholder groups also must be considered when forming a workgroup. Members must be leaders of their constituent stakeholder groups if the consensus recommendations of the workgroup are to become adopted by the community at large. A balance of key stakeholders, in our perception, was important to defeat the ability of a particular group to undermine results of the process if some constituents find results unpalatable. It would be difficult for a group to complain about a recommendation that one of their leaders participated in making. Likewise, if a group had been invited but chose not to participate, there would be little ground for complaint that their opinions were not heard in the process.

Of course, it is possible that the leaders and opinion makers who we included in the workgroup may not be able to convince their constituent groups of the validity of the workgroup's conclusions, especially if those conclusions differ substantially from the uninformed beliefs of a majority of that group. It is too early to tell how successfully the recommendations of the FishSmart workgroup for king mackerel will be spread to the constituent groups of our participants. It seems likely that buy-in to the results of the process by the larger group will depend not only on the individual leaders who participated in the process, but also on the size of the constituent group, their geographical range, and how closely knit they are as a community. However, it similarly seems unlikely that the frustration many of our stakeholders expressed at the beginning of our process regarding the current management system could be maintained if FishSmart-type processes were to become commonplace and stakeholders knew that the knowledge and views of their peers were being taken seriously by managers.

Other challenges.—At first, stakeholders had difficulty envisioning an improved status for the fishery because many were currently satisfied with the status of the fishery. The "shifting baseline" described by Pauly (1995) for fisheries also proved to be a vexing problem for stakeholders attempting to envision the real potential of a fully recovered stock. This seems likely to be a difficulty for many fisheries like king mackerel, in which recovery from a state of depressed stock abundance has taken place over a long time period, and when the current status is relatively better than it has been for a long time. A discussion of the characteristics of an undesirable fishery was useful to both envision possible improvements and to develop performance measures that were thresholds that stakeholders did not want to exceed (e.g., overfishing status).

The number of workshops and length of time of the process depends on the level of conflict in the fishery and the degree to which the position of different stakeholders have become entrenched. Part of the reason we chose to work on the king mackerel fishery was because the level of conflict among stakeholder groups was relatively low. Therefore, we believed we could complete the process during an ambitious 6–9-month time frame. This schedule worked out for this fishery, but in more contentious fisheries, much longer time frames may be necessary for stakeholders to develop positive working relationships. Ideally, a FishSmart process should be initiated long before a high level of conflict has arisen.

The importance of improving communication and cooperative work between marine recreational anglers, scientists, and managers has long been recognized. De Sylva (1969) predicted that advisory groups like FishSmart would play an increasingly important role in marine sport fishing. Though extensive cooperative work has been accomplished since then (see Read and Hartley 2006 for review), it seems somewhat surprising that, four decades later, a process like FishSmart has not yet been established as an integral part of the management process for marine fisheries in the United States.

We consistently heard the same complaints from stakeholders of the Atlantic, Gulf of Mexico, and Pacific coasts from a variety of fisheries during the course of extensive interviews conducted while selecting a focal fishery for FishSmart: management agencies are not listening to stakeholders, and when stakeholders are allowed time to voice their opinions, it is too late in the process because management decisions have already been made. There appears to be a real need in the current management process for an additional process like FishSmart that proactively incorporates stakeholder preferences and promotes buy-in among stakeholders for management decisions.

Conclusion

The FishSmart process is based on the fundamental belief that when stakeholders are truly involved in the process, they take ownership of the results, which lends credibility to the results (Walters 1986; Lee 1993). We believe that widespread adoption of this approach, and consequently the inclusion of a wider range of stakeholders and their views, should produce better decisions and will both decrease the conflicts among user groups that have characterized the management of marine recreational fisheries and quell the anger commonly expressed by fishery stakeholders. The collaborative process involves substantially more education of stakeholders about the science on which decisions are made and develops a deeper understanding of the available data, its potential problems, and the assumptions used to make decisions. Our experience suggests that processes similar to FishSmart could be used effectively to try to set up rules and guidance for management before problems become too contentious and before views of some groups become irrevocably entrenched. Such a process is likely to improve stakeholder buy-in of management practices, as long as stakeholder recommendations are not ignored.

Acknowledgments

Support for this research was provided by the Gordon and Betty Moore Foundation and the University of Maryland Center for Environmental Science Chesapeake Biological Laboratory. We thank Mike Nussman and the American Sportfishing Association for conceiving FishSmart. We particularly appreciate the invaluable participation and input of the stakeholders in the workgroup process and the efforts of the Steering Committee in helping design and conduct the process. The Florida Conflict Resolution Consortium assisted greatly by facilitating the workgroup meetings. Additionally, we thank the king mackerel stock assessment team and the Marine Recreational Information Program (MRIP) for providing assessment results and data. We also thank Nadine Marshall and an anonymous reviewer whose thoughtful suggestions have improved this manuscript, as well as Dave Loewensteiner, who provided assistance with data summarization and Tina Stockton, who provided invaluable logistical support for stakeholder meetings. This is contribution number 4378 of the University of Maryland Center for Environmental Science Chesapeake Biological Laboratory.

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