Enhancing sustainability in marine recreational fisheries: a stakeholder-driven process for evaluating angling practices and management options for king mackerel in the U.S.

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Abstract: Despite increasing importance of marine recreational fisheries, management goals and objectives have not changed from a focus on managing for commercially important objectives such as maximum or optimum sustainable yield. Additionally, recreational fishery stakeholders in several prominent U.S. fisheries have been frustrated by a perceived lack of inclusion of recreational views in fishery management decisions. Our objective was to provide a forum for representatives of stakeholder groups to explore consequences of policy alternatives, which could then be used in the management of recreational fisheries. We developed a stakeholder-driven process that allowed stakeholders to evaluate how well alternative options could achieve their goals through development of a simulation model over the course of four workshops. The first application of this collaborative process was to the king mackerel (*Scomberomorus cavalla*) fishery off the southeastern coast of the U.S. The workshops centered around developing objectives for the fishery, performance measures to gage whether objectives were reached, and options that could be used to reach the objectives. Goals identified by stakeholders included traditional and non-traditional goals such as maintaining high and stable catches and retaining the ability to catch large fish, and options included both voluntary changes in fishing practices (e.g., adoption of techniques that reduce catch and release mortality) and mandatory regulations (e.g., size limits or bag limits). Through an iterative process, stakeholders assisted in developing a model to allow them to compare how well the options they wanted to consider met their vision for a quality fishery.

Keywords: decision analysis, *Scomberomorus cavalla*, recreational fisheries management, stakeholder participation

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Introduction

Despite importance of marine recreational fisheries for many U.S. stocks (Coleman et al. 2004), management of these fisheries is still largely dominated by goals and objectives of maximum or optimum sustainable yield, which may be more appropriate for commercial fisheries. Additionally, recreational fishery 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 lead to numerous law suits against national and regional management agencies in attempts to block a range of management decisions including allocations, rebuilding plans, and access. Paralleling the increase in prominence of marine recreational fisheries has been an increasing focus on marine issues by a diverse array of environmental, non-governmental organizations (NGOs) such as the Nature Conservancy, the Blue Ocean Institute, and the Cousteau Society. These organizations seek to encourage the stewardship and conservation of the marine ecosystem. Sometimes the interests of recreational organizations and environmental NGOs make them effective partners; in other instances their interests diverge. Clearly, disputes over management goals and actions will be reduced if all potential stakeholders are included in the management process from the very beginning. However, the current federal regional management Council process under which fisheries are managed in US federal waters does not full provide such an opportunity. Our goal was to develop a process that would improve the level of stakeholder input into the management process and thus improve the relationship between stakeholders and managers. The process involved a focused workgroup designed to define objectives for the long term future of the fishery in fishery activity, ecological function, and economic considerations. The workgroup then evaluated how well alternative fishing practices, both voluntary or changes in regulations, achieved the objectives by comparing the output of a simulation model with regard to specific performance measures. Finally, the workgroup will recommend a package of preferred options to the management council.

Our approach to achieve our desired outcome was to combine an analysis of mortality resulting from both fisheries and natural sources with an assessment of how alternative fishing practices affected the pattern of mortality, which we have termed FishSmart. The process is a collaborative effort involving anglers, commercial fishermen, environmental organizations, tackle shop owners, managers, and scientists, which seeks to identify changes in angling practice and management that could lead to increased sustainability and to improve relations among stakeholder groups. The process is centered on developing a simulation model to explore how changes in the fishery affect the ability to achieve stakeholder objectives over a series of several workshops. We postulated that this process would contribute to the development of trust and a renewed positive working relationship among the stakeholders as well as demonstrate a new approach to managing marine recreational fishery resources to ensure their sustainability.

Focal Fishery

We reviewed a wide range of potential candidate fisheries in which to apply the FishSmart approach, including fisheries on the Pacific, Gulf and Atlantic coasts of the U.S. We chose the fishery for the Atlantic migratory group of the U.S. king mackerel (*Scomberomorus cavalla*) as the first case study of our process because it had several desirable components: 1) the recreational fishery comprises the largest portion of the landings, 2) the stock was being assessed during 2008 and management changes were likely to be made, 3) a substantial reduction in the quota had already been suggested prior to the assessment, 4) other external factors may lead to increased recreational fishing effort for king mackerel, such as restrictions for recreational fisheries for snappers (Lutjanidae) and groupers (Serranidae), and 5) management and stakeholders were welcoming of our involvement. Additionally, the king mackerel fishery is one of the largest marine recreational fisheries in the U.S. and has an important tournament component, which could help disseminate recommendations of the workgroup.

King mackerel is a coastal pelagic piscivore with a range extending from the northeastern U.S. 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 (von Bertalanffy K between 0.094-0.409; DeVries and Grimes 1997; Shepard et al. 2008), with most females reaching maturity by age 4 (Finucane et al. 1996). Maximum size is reported to be approximately 45 kg. Clupeids are the most important forage item for king mackerel, but shrimp and squid species are also common in the diets in U.S. waters (Beaumariage 1973, Naughton and Salomon 1981). 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, 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 (Fig. 1). For our work we only considered the south Atlantic migratory group. There is believed to be only limited exchange 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 populations are thought to occur in the same area (mixing zone) from October to March which complicates modeling and data analysis.

The Atlantic migratory group of king mackerel was considered to be overfished in the late 1980s (SAFMC 1989). As a result, substantial changes in regulations were enacted to reduce fishing mortality rates, such as gear restrictions for commercial fisheries and increased size limits and reduced bag limits for commercial fisheries. Harvests are managed by quotas, with 70% of total landings allocated to the recreational sector. During the last decade, the fishery landings have been relatively steady with total landings of approximately 400 metric tons (MT – Fig. 2). Because recreational fisheries have not achieved their portion of the quota, recreational landings are only approximately 60% of the total landings. Additionally, this is an important species for tournaments throughout the southeastern U.S. Many of these tournaments are organized by the Southern Kingfish Association (http://www.fishska.com/) and provide substantial prize money for the largest fish brought to the weighing station. However, catches due to tournaments are poorly represented in current data collection programs and stock assessments.

Methods

Stakeholder workshops

Our goal was to help recreational anglers, managers, and other interested stakeholders evaluate alternative scenarios for angling practices and fisheries management. An additional goal was to develop methods that could reduce recreational fishing mortality while maintaining or increasing the amount of recreational fishing effort. In conjunction with stakeholders, we developed a computer simulation model as the primary tool to evaluate alternatives, but other non-modeled options were also discussed. Our objectives were to provide a forum for representatives of stakeholder groups to explore consequences of policy alternatives, which could then be used in the prosecution and management of this fishery. The process centered on the development of a decision analysis model that would estimate the ability of options to meet stakeholder objectives.

We developed a stakeholder-driven process that allowed stakeholders to evaluate how well alternative options were likely to achieve their objectives through development of a simulation model over the course of four workshops. The workshops centered around developing objectives for the fishery, performance measures to gage whether objectives were reached, and options that could be used to reach the objectives. Through an iterative process, stakeholders assisted in developing a stochastic simulation model of the fishery for and dynamics of Atlantic migratory group of the U.S. king mackerel fishery to allow them to compare how well the options they wanted to consider met their vision for a quality fishery. The purpose of model development in the process is to ensure that all stakeholders are aware of the information and assumptions that go into predicting expected benefits.

The process involved defining objectives and options for the fishery, determining how well alternative options achieved the objectives, and developing recommendations for changes of fishery practices and management over the course of several workshops. A group of key stakeholders (the workgroup) that were broadly representative of the different stakeholder groups involved in the fishery was assembled to participate in the process. For this application, the workgroup included representatives from recreational anglers and angler clubs, commercial fishermen, environmentalists, tackle shop owners, managers, and scientists. The workshops were organized in a manner to structure discussions on the topic of needing to make decisions given the best available current information. The process was originally designed to use a series of three workshops, but we expanded it to include a fourth workshop to allow workgroup members to further synthesize the results to make recommendations. All of the workshops were professionally facilitated to ensure the goals of each of the workshops were met and to ensure that all workgroup participants had their views heard and contributed to the process. By having an open process, we anticipated that participants would champion the results of the exercise or, at least, attest to their objectivity.

A primary goal of the first workshop was to introduce the workgroup to the process (including the use of modeling to help make decisions), and to one another. The workshop also covered considerations for model development, such as possible management and conservation actions (options), objectives, and metrics to measure how well options achieve the objectives (performance measures). The workshop began with introductions to the project and 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. Then, the workshop focused on objectives of the fishery and variables that could be used as performance measures and options available to change management or fishing practices. Having workgroup members develop options and performance measures is a critical part of the process because these considerations help define the necessary model complexity. 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. Additionally, the discussions during the first workshop were much wider ranging than just the parts necessary for model development. This was both necessary and desired because many of the concerns that stakeholders had about the management of the resource were not amenable to a harvest policy evaluation, but the workgroup was able to agree on specific recommendations that would lead to best practices, such as ways to increase communication among stakeholder groups.

The second workshop served to update the workgroup on progress of model development, provide a forum for the workgroup to review modeling decisions, to further develop the performance measures and options, and to continue involvement and participation of the workgroup. The first part of this workshop was largely an update of work that the modeling team had conducted up to that point. This included a review of the science on king mackerel population dynamics and ways these could be included in a simulation model. During these discussions, workgroup members suggested alternatives for assumptions they did not believe were reasonable. Workgroup members had fruitful discussions on how some of the information needed to understand the population dynamics could be collected in collaborative research projects. This workshop also included extended discussions on options to consider in the model and alternative performance measures to those that were suggested in the first workshop.

The goal of the third workshop was to review the model results and to discuss how well alternative options were likely to achieve the objects in the model. At this workshop, we showed results of the final version of the model and allowed the workgroup to suggest alternative model runs from those already completed and to suggest alternative performance measures that could be used to determine how well objectives were achieved. We also encouraged workgroup members 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. Unlike some other decision analysis projects, we did not try to make the workgroup define a specific utility function, which means that each member of the workgroup is free to weight performance measures differently when evaluating the options.

The goal of the fourth workshop will be to craft a set of recommendations that can be presented to the management council. The workgroup will use both the results of the model and discussion of topics that were not amenable to the modeling exercise to make recommendations for improving management of the fishery, propose collaborative research, and design ways for stakeholders to communicate more effectively with one another. The results of this meeting will be presented to the management council upon completions.

Selection of workgroup participants

The selection of workgroup participants is critical to the success of this process because the results of the process will only be respected if the people involved in the process are seen to be leaders of the groups they represent and are respected within their communities; they must also be interested in working as part of the workgroup. Each of these workshops involved a diversity of stakeholders with the goal of having a process where the participants believe their goals and beliefs have been treated fairly. We invited the participants representing each group by deciding which groups would be important and looking for representatives for each group. Many people who were identified as important and respected in the fishery were interviewed prior to being invited to join the workgroup process both to determine who should be invited to participate in the process and whether they would be constructive members in the process. In most cases, participation of individuals in the process was voluntary, so it was important to convince some members that the process would be a valuable use of their time. Another important consideration was that all members had to agree that they would attend all of the workshops. This was an important criterion for workgroup membership because the workshops build upon one another and educating new members partway through the process would have severely diminished the rate of progress we could expect to achieve.

Development of the model

An age-, size-, and sex-structured stochastic simulation model with four intra-annual periods and two areas was developed. The model contained three fishery sectors: recreational, tournament, and commercial. Parameter values and their uncertainty were largely taken from the most recent stock assessment estimates (Ortiz et al. 2008). One notable exception to this was the parameters of the stock-recruitment relationship. The steepness of the stock-recruitment estimates was not well defined because of a lack of contrast in the estimates of stock and recruitment. Therefore, we used a meta-analysis of other mackerel stocks and species with similar life histories to estimate the steepness of the stock-recruitment relationship. Much of the data were taken from Ransom Myers's stock-recruitment database of stock-recruitment data sets (http://www.marinebiodiversity.ca/RAMlegacy/srdb). The model also included assessments with realistic amounts of assessment error and management based on the assessment (Fig. 3).

Uncertainty is included in the model through parameter uncertainty, within simulation uncertainty, and uncertainty in how the fishery will respond to changes in the population and regulations. Inclusion of uncertainty is a critical part of the modeling process, but explicit inclusion of some factors was very difficult. For example, workgroup members had long discussions about future trends in recreational fishing effort and effects of increasing fuel prices, changes in management of other fisheries, and overall declining participation rates in U.S. recreational fisheries. We were unable to include these considerations in the model explicitly. However, we conducted sensitivity analyses to evaluate how future effort patters could affect the efficacy of different options. Other major uncertainties included effects of global warming, economic impacts of changes in the fishery, and uncertainty about migration patterns and timing of migration.

Results

Overall outcomes

Although the process is not yet complete, we can comment on some of the progress that has been made up to this point. The workgroup has come together as a group more quickly than we expected. The workgroup has developed concrete, constructive recommendations to improve the king mackerel fishery. Relationships among some of the stakeholders have improved and this has manifested itself in a desire to collaborate in the management process. Also, the process has identified new opportunities for collaborative research, data sharing, and collection of new information. For example, as a result of the FishSmart process, tournament organizers have now compiled and contributed estimates of tournament catches and the characteristics of these catches. These data have not been made available before. However, we believe that, in the long term, the most important part is that workgroup members representing stakeholder groups with substantially different interests have been able to develop consensus recommendations to improve the king mackerel fishery.

Development of objectives, performance measures, and options

Objectives identified by stakeholders included traditional and non-traditional goals such as maintaining high and stable catches and retaining the ability to catch large fish. The objectives proposed and considered by the workgroup ranged far wider than current objectives used to manage the fishery. A wide range of ideas that would improve the fishery that were not included in the model were also discussed.

Performance measures covered a wide range of objectives, but generally related to a healthy population (spawning stock biomass, diversity of sizes and ages, 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) (Table 1). Performance measures were developed to assess how well objectives were met on average and how often the fishery would be in "poor" condition.

A wide range of options was discussed by stakeholders including some that we did not incorporate into the model such as simplification of regulations (Table 2). Options included both voluntary changes in fishing practices (e.g., adoption of techniques that reduce catch and release mortality), and mandatory regulations (e.g., changes in quota, size limits or bag limits). Additionally, changes in allocation between commercial and recreational sectors was discussed as well as dividing allocation among groups within a sector (e.g., private recreational, for hire, and tournament).

Development of the model

An age-, size-, and sex-structured stochastic simulation model with four intra-annual periods and two areas was developed. The model contained three fishery sectors: recreational, tournament, and commercial. Parameter values and their uncertainty were largely taken from the stock assessment model. One notable exception to this was the stock recruitment parameters. The steepness of the stock-recruitment estimates was not well defined because of a lack of contrast in the estimates of stock and recruitment. Therefore, we used a meta-analysis of other mackerel stocks and species with similar life histories to estimate the steepness of the stock-recruitment relationship. Uncertainty is included in the model through parameter uncertainty, within simulation uncertainty, and uncertainty in how the fishery will respond to changes in the population and regulations. Inclusion of uncertainty is a critical part of the modeling process, but explicit inclusion of some factors was very difficult. For example, workgroup members had long discussions about future trends in recreational fishing effort and effects of increasing fuel prices, changes in management of other fisheries, and overall declining participation rates in U.S. recreational fisheries. We were unable to include these considerations in the model explicitly. However, we conducted sensitivity analyses to evaluate how future effort patters could affect the efficacy of different options. Other major uncertainties included effects of global warming, economic impacts of changes in the fishery, and uncertainty about migration patterns and timing of migration.

Discussion

The FishSmart process is based on the fundamental idea 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 will decrease conflicts among user groups and stakeholders that have characterized management of marine recreational fisheries. One simple reason for this belief is that 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, potential problems with the data, and assumptions used to make decisions. Inclusion of the views of a wider range of stakeholders and their views should produce better decisions and reduce conflict. This has been seen in many systems that have adopted co-management approaches (Hilborn 2007). Processes similar to the one we employed for king mackerel can be used to try to set up rules and guidance for management before problems becomes too contentious and views of some groups become irrevocably entrenched.

Effective communication and setting of expectations is extremely important to the success of this kind of project. Establishing trust and respect among the stakeholders and between the stakeholders and the modeling team is an important part of the success of a project like this. It is important to avoid jargon and use language that is understandable, but not pandering. It is also likely that having the modeling team come from an institution independent of the regional management process probably makes it easier to build trust more quickly because the analysts do not have any direct interest in defending previous management decisions or in pursuing specific management recommendations. The modeling team has an important role to engage stakeholders by acknowledging their contributions to the process and to use the input they provide. If stakeholders provide data, the onus is on the analysts to use data in some way.

Challenges

Sometimes ideas brought up by stakeholders fall outside the scope of the modeling process. This can occur because data are lacking to parameterize a model, the process is too complex and not well enough understood to adequately model, or because the concern is not amenable to modeling (e.g., effects of prey dynamics on the stock or species of interest, angler responses to changes in fuel prices, or effects of increased collaboration among stakeholders, management, and scientists). Some concerns that involve lack of data can be addressed using sensitivity analyses where results of alternative models are compared with the original model (e.g., Wilberg et al. 2008). Concerns that are outside the realm of modeling, such as views of fairness and equitability, can be discussed within the framework of this process, but the model will not directly provide measures to compare potential effectiveness of different choices. However, the process set up by building the model may bring about enough trust among stakeholders that these kinds of issues can be fruitfully discussed.

The number of workshops and length of time of the process probably 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 thought we would be able to have a successful process during an ambitious time frame of only six to nine months. This time frame seems to have worked out for this fishery, but other applications of similar methods should allow for longer periods of time, ideally at least one year. In very contentious fisheries even longer times may be necessary for stakeholders to develop positive working relationships. Ideally of course, a FishSmart process should be initiated long before conflict has arisen.

We have learned that recruiting the appropriate stakeholders and maintaining their involvement in the workgroup process is a critical component of success. Stakeholders need to be respected within their own community and the involvement of appropriate stakeholders lends credibility to the process. Because the workshops build on one another, it is optimal for the same workgroup members participate in all of the work groups. Despite the critical role of stakeholder participation in the process, encouraging and maintaining participation is difficult. Many of the stakeholders in our process have to take time away from their normal jobs to participate. Providing a stipend for stakeholder participation may make it easier for stakeholders to commit to a several workshop long process. Also, there is currently no official way for a process such as the one we designed to directly affect management. If management committed to use this information in the beginning of the process, it would probably encourage participation.

It is also clear that the process needs to be conducted in a way that minimizes the ability of stakeholders to sabotage it. One way of doing this is to ensure decisions are made even if some stakeholder groups choose not to participate in the process. Another mechanism we employed was to have a professional facilitation team run the workshops so that individuals were not able to completely dominate the process to the detriment of other stakeholder groups.

This is an expensive process because of the need to cover travel costs to reduce barriers for stakeholders' participation. It is made even more so when a fishery covers a large geographic area and workgroup members need to travel long distances to attend meetings. Options to reduce costs, such as having fewer meetings would likely result in a less effective process, so they would not be optimal.

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Table 1. Stakeholder-identified performance measures for the south Atlantic king mackerel fishery.

Performance measures
Population
Abundance (numbers)
Spawning stock biomass (biomass of mature females)
Proportion of the population older than 15 years
Sex ratio
Average age of spawners
Fishery
Total harvest (numbers)
Total yield (lbs)
Recreational harvest (numbers)
Tournament harvest (numbers)
Commercial yield (lbs)
Recreational harvest of fish larger than 20 lbs
Tournament harvest of fish larger than 50 lbs
Commercial harvest of fish between 10 and 12 lbs
Average weight in recreational harvest
Average weight in tournament harvest
Average weight in commercial harvest
Proportion of year fishery is closed
Frequency and duration of years with low harvest and catch rates
Ratio of average age in the fishery to average age at maturity
Number of dead fish due to release mortality

Table 2. Stakeholder-identified options for the south Atlantic king mackerel fishery.

Options
Management
Size limits
Bag/creel limits
Season limits
Constant quota control rule
Area closures
Voluntary
Increased catch and release fishing
Reduction of catch and release mortality

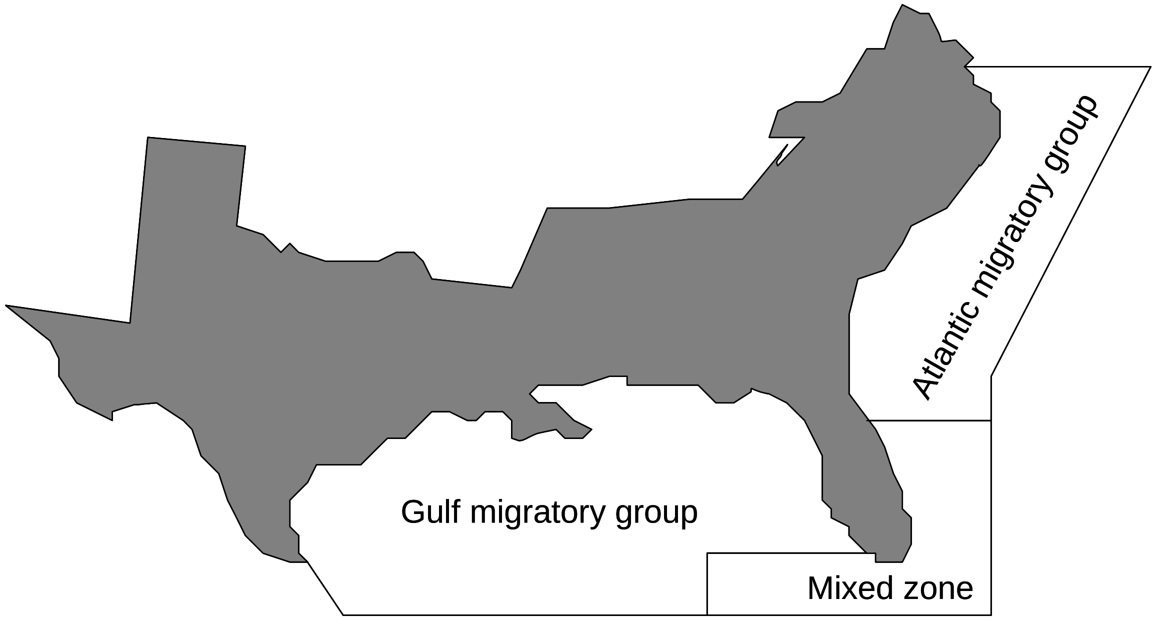

Fig. 1. U.S. definitions of king mackerel migratory groups.

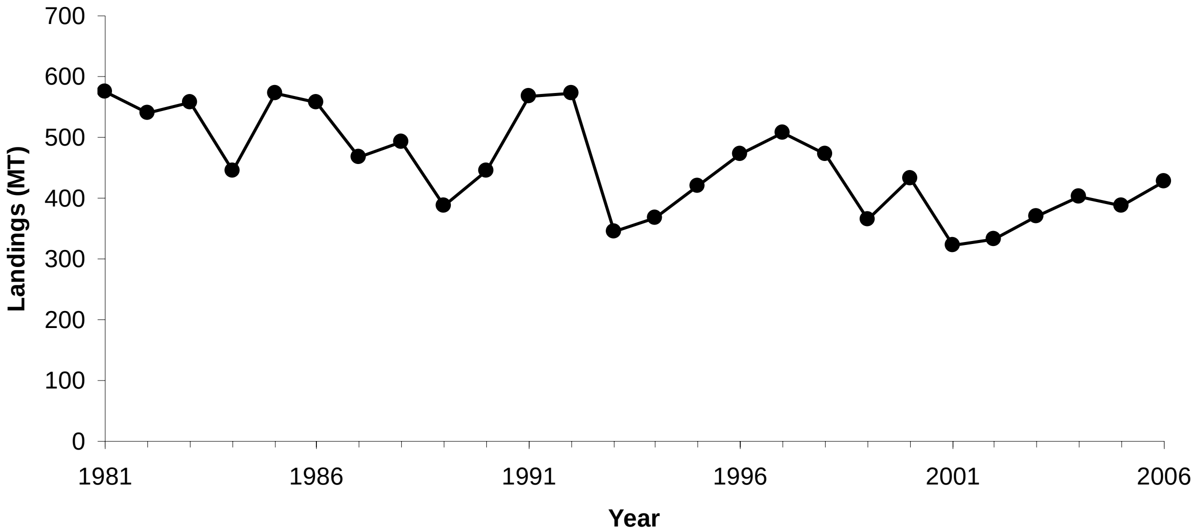

Fig. 2. Landings of king mackerel in metric tons (MT) from the Atlantic migratory group from 1981 to 2006.

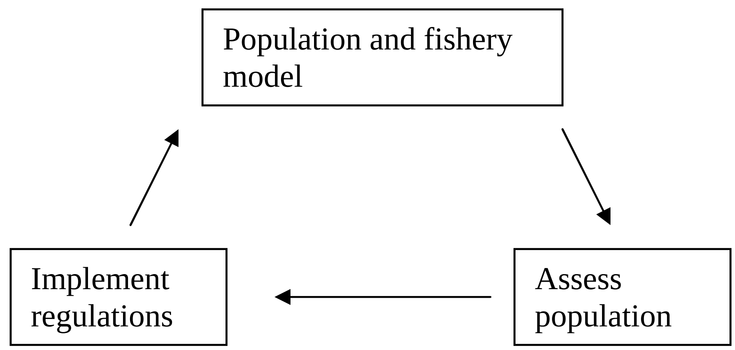

Fig. 3. Flow chart of the simulation model including the population dynamics, fisheries, and management process.