Status Review of King Mackerel in the Gulf of Mexico

Feature Article 3

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INTRODUCTION

This feature reviews the biology of king mackerel, the history and management of the fisheries for it in the Gulf of Mexico, and the issues of concern as the resource is recovered from being overfished. This review is based on the most recent stock assessment which was carried out in the spring of 1998. The status of king mackerel and other coastal migratory pelagics is described in Unit 7.

The king mackerel is a migratory coastal pelagic species found in the western Atlantic Ocean from New England to Brazil and in the Gulf of Mexico. Two groups are currently recognized in U.S. waters for management purposes: the Atlantic group and the Gulf of Mexico group. Both groups undergo long-distance migrations each year from the northern part of their range in the summer, where they spawn, to the southern part of their range in the winter, where they feed on large schools of baitfish. The Gulf of Mexico group splits during the winter migration with some fish going to Mexican waters and others going to southern Florida waters where they intermingle with the Atlantic group. Genetic studies have found some differences between the Atlantic and Gulf groups, but they have concluded that there is some gene flow between the two groups. Similar genetic studies within the Gulf of Mexico have found much smaller differences between king mackerel in the eastern and western Gulf.

Based on mark-recapture studies conducted during 1975–79, the boundary between the Atlantic and Gulf of Mexico groups was set at Florida's Volusia-Flagler County border in winter (1 November–31 March) and the Monroe-Collier County border in summer (1 April–31 October). The area between these two boundaries, the southeast coast of Florida, is known as the mixing zone with fish from both groups present in the winter, although for management purposes all the fish caught in this area in the winter are assigned to the Gulf of Mexico group.

King mackerel are relatively fast growing fish that form large schools and eat voraciously. They reach maturity quickly, as early as 2 years, and can live up to 20 years, although the majority of catches are younger than 6 years old. Their large size (up to 40+ kg for females), appealing taste, and strong fighting ability when hooked make them a target for both commercial and recreational fishermen. Landings from the commercial sector alone have been valued at approximately $6,000,000 on average over the past few years.

HISTORY

Large-scale exploitation of king mackerel began in Florida in the early 1900's. Sailing skiff operators, using hook-and-line, processed the fish for both local consumption and for sale as a dried and salted product. The introduction of ice houses in the area led to an increase in fishing pressure because the fish could now be shipped frozen, commanding a higher price. Total commercial catches averaged approximately 1,814 metric tons (t) annually during the 1920's and 1930's. These catches decreased in the early 1950's to about 1,134 t and then increased to about 3,629 t in the 1970's.

Recreational fishing for king mackerel in the Gulf of Mexico became important starting in the 1950's and 1960's as boats and technology for offshore fishing became available to large numbers of people. The increasing number of recreational anglers, combined with advances in technology such as larger and more powerful boats, the global positioning system (GPS), and gear improvements, has increased considerably the recreational fishing pressure on the king mackerel. King mackerel have traditionally been an important component of the charterboat fishery in the Gulf of Mexico, and large numbers are taken from private and rental boats. Size and bag-limit regulations were begun in 1986 in an attempt to reduce the fishing pressure from the recreational sector.

CURRENT FISHERIES

Recreational

The recreational fishing sector targeting the Gulf of Mexico group is currently allocated 68% of the total acceptable catch (TAC), making it the largest component of the Gulf king mackerel fishery. Hook-and-line gear is employed in this sector from private and rental boats, chartered fishing trips, and headboats. The fishery is concentrated in Florida, which accounts for about 80% of the recreational landings. Current management regulations in this fishery are a 20-inch (~50 cm) fork length minimum size and a daily bag limit of two king mackerel. Fish caught under the recreational bag limit are occasionally sold, particularly by the captain and crew in the charter boat fleet. These sales are especially important and contentious when the commercial fishery has been closed due to filling its quota. In general, the recreational sector seeks the largest king mackerel while the commercial sector seeks the highest density of fish. Thus, on average the recreational sector catches bigger and older king mackerel than does the commercial sector.

Commercial

The commercial fishing sector targeting the Gulf of Mexico group is currently allocated 32% of the TAC which is further subdivided between the eastern and western sections of the Gulf. The eastern Gulf (east of the Florida-Alabama border) is allocated 69% of the total commercial quota (22% of the TAC) with the western Gulf allowed to catch the remaining 31% of the commercial quota. The fleet is mainly hook-and-line with some gillnetting done in Federal waters. The ban on entangling nets in Florida state waters enacted in 1994 was not as important in this fishery as it was in the Spanish mackerel fishery where commercial catches were reduced approximately 70%. The king mackerel gillnet fleet consists of larger boats (that fish further offshore in the U.S. Exclusive Economic Zone) than the Spanish mackerel gillnet fleet. The fish caught by the commercial sector are mainly sold whole and iced to wholesalers, who may produce fillets or steaks before they reach the market, or directly to restaurants straight from the boats.

Bycatch in Shrimp Trawls

An additional source of king mackerel mortality in the Gulf of Mexico is the catch of juveniles by the shrimp trawl fleet. Although the capture of a king mackerel in a shrimp trawl is relatively rare (<5% of tows), there are hundreds of thousands of days spent trawling by the fleet each year, resulting in annual bycatch estimates ranging from 300,000 to 1,300,000 fish. The estimated catches of king mackerel in the shrimp trawl fishery have been higher in recent years than prior to the start of king mackerel fishery management. Implementation of bycatch reduction devices in the shrimp trawl nets is expected to reduce this large bycatch, but the amount of reduction in terms of fishing mortality that will result is not known.

Management

Large catches by both commercial and recreational fishermen in the late 1970's and early 1980's, associated with perceived declines in catch rates, were the impetus for the inclusion of king mackerel Coastal Migratory Pelagic Resources

Fishery Management Plan in 1985. The goal of management is to achieve maximum sustainable yield (MSY), the largest catch which can consistently be taken from the population while preventing the stock from collapsing. The Gulf of Mexico Fishery Management Council sets the TAC for the Gulf of Mexico group of king mackerel as well as determines the allocations amongst user groups and specific regulations such as minimum size and bag limits. The TAC is based upon a specific fishing mortality rate criteria chosen by the Council. The Stock Assessment Panel provides the scientific advice on the catches that will achieve the target fishing mortality rate in the form of a range of acceptable biological catches reflecting uncertainty in the level of catch that will achieve the target fishing mortality rate. The range of acceptable biological catch is determined by a population analysis using a mixed Monte Carlo/bootstrap[1] algorithm that incorporates uncertainty about a number of important life-history parameters and catch statistics (Legault et al., 1998). The Stock Assessment Panel recommends a specific level of catch from within this range, traditionally the risk-neutral median of the range. The Council also incorporates recommendations from the Socioeconomic Panel and angler anecdotes when setting the TAC. For management purposes, the fishing year for the TAC is defined as beginning on 1 July and ending on 30 June of the following calendar year.

Originally, the TAC was set according to an $F_{0.1}$[2] strategy to achieve the goal of MSY. Implementation of the 602 Guidelines (§50 CFR Part 602 guidelines for the preparation of fishery management plans) in 1991 required a definition of the act of overfishing and a measure of overfished status. The spawning potential ratio (SPR), the ratio between the number of progeny that would be produced under current fishing levels to that which would have occurred in a virgin population, was chosen as this measure. The manner in which the spawning potential ratio has been calculated, as well as a number of important life history parameters, such as the natural mortality rate, have changed over time. The model-tuning indices used in the assessments have changed over time as well. However, king mackerel of the Gulf of Mexico Group have generally remained classified as overfished, but improving, since 1991. Currently, an unweighted SPR of 30% is both the target of management and the threshold for overfishing, a conflict which should be resolved due to the implementation of new Federal guidelines on definitions of overfishing.

Management of the directed fisheries for king mackerel in the Gulf of Mexico has been successful in reducing the average fishing mortality rate and increasing the biomass (Figures 1 and 2) (MSAP, 1998). These changes have occurred even with a general increasing trend in catch and acceptable biological catch since 1987. Thus, management has improved the biomass level while also increasing the fishery yield. This has been possible due to regulations on minimum size of fish allowed to be kept, gear types, and closed fishing seasons, as well as some years of increased recruitment. However, the goal of recovering the stock from an overfished condition has not yet been accomplished.

The Council has always been risk-prone in its TAC selection, choosing from the upper end of the range of acceptable biological catch provided by the Stock Assessment Panel. Furthermore, the TAC allocations have been overrun every year, slowing the recovery from an overfished condition. These allocation overruns have occurred in both the recreational and commercial fisheries, but have been larger both in percentage and amount of fish in the recreational fishery. The commercial fishery is monitored closely during the fishing season through a trip ticket reporting system, and each portion of the commercial fishery is closed once its quota is filled. The recreational fishery is monitored through the Marine Recreational Fisheries Scientific Survey (MRFSS[3]), which provides

[1]Monte Carlo and bootstrap are two resampling schemes used to estimate uncertainty in the results. The resampling is done from an assumed distribution (Monte Carlo) or from the original data (bootstrap).

[2]At $F_{0.1}$, only a 10% increase in yield per recruit occurs following an additional unit of fishing effort (See Appendix 4).

[3]NMFS Fisheries Statistics and Economics Division, Office of Science and Technology, Silver Spring, MD 20910.

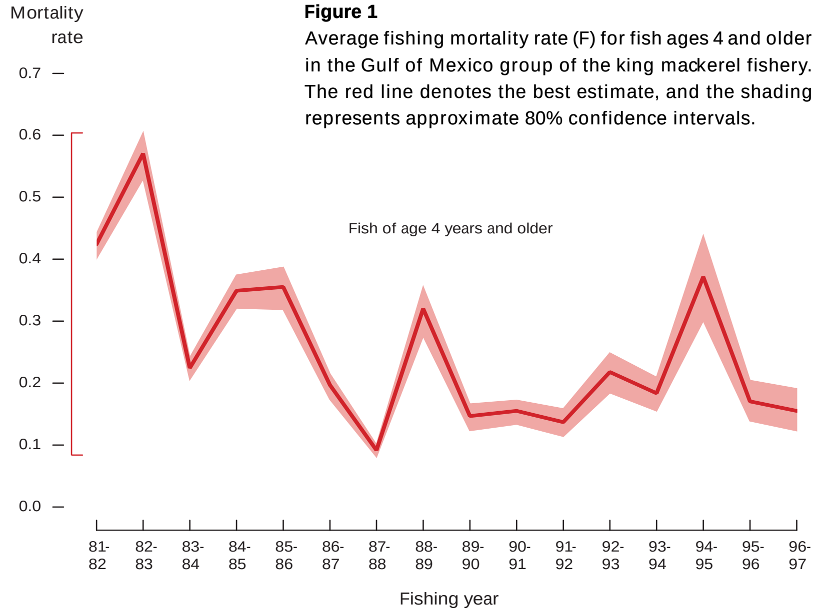

Figure 1
Average fishing mortality rate (F) for fish ages 4 and older in the Gulf of Mexico group of the king mackerel fishery. The red line denotes the best estimate, and the shading represents approximate 80% confidence intervals.

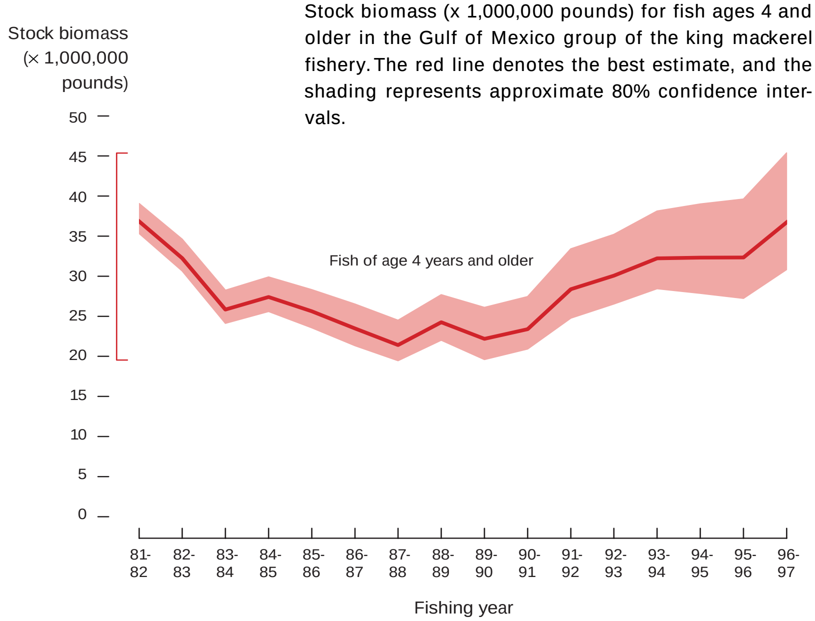

Figure 2
Stock biomass (x 1,000,000 pounds) for fish ages 4 and older in the Gulf of Mexico group of the king mackerel fishery. The red line denotes the best estimate, and the shading represents approximate 80% confidence intervals.

estimates of recreational catches in 2-month blocks. Bag limits and minimum size regulations are used in an attempt to limit the amount of catch due to the recreational sector, thus the fishery is no longer closed during a fishing season, although it has been in the past. These regulations have not been successful, resulting in annual overruns of the recreational allocation of 41% on average (1986–96).

ISSUES OF CONCERN

Stock Definition

As more information becomes available, particularly a recent otolith-shape analysis, it is becoming apparent that the king mackerel caught in the mixing zone in the winter are more likely to be from the Atlantic group than from the Gulf of Mexico group. The repercussions of changing the group designation for these fish are not trivial. Preliminary calculations suggest that classifying these fish as of the Atlantic group increases the total acceptable catch and SPR in the Atlantic and decreases the total acceptable catch and SPR in the Gulf of Mexico. These TAC changes are slightly greater than the amount of fish caught within the mixing zone, and thus it could potentially be a net benefit to the fishermen in the Atlantic and a net loss to fishermen in the Gulf of Mexico.

Additionally, Mexico's king mackerel catches are currently not included in stock assessments. The level of catch is not well known but thought to be large, especially relative to the catches from the western Gulf of Mexico. It has been hypothesized that there are two stocks of king mackerel within the Gulf of Mexico, eastern and western, which mix in the summer in the northern Gulf of Mexico. If this hypothesis is correct, the Mexican catches are most likely the largest source of mortality for the western Gulf stock, and cooperative management between the United States and Mexico will have to be undertaken to successfully evaluate and regulate this fishery.

Allocation

The subdivision of the TAC is a contentious issue due to its zero-sum nature; for one sector to increase its portion, at least one other must decrease. This is especially important during the recovery phase when catches should be reduced relative to the status quo. Once the fishery has recovered, the TAC should increase and reduce this source of conflict.

Of special note in the context of allocation is the fact that reductions in the TAC impact mainly the commercial fishery due to its stringent monitoring and the ability to close the fishing season, while the recreational sector is allowed to continue to fish throughout the year. This disparity in impact of smaller TAC's could be reduced by lowering the recreational bag limit or closing parts of the fishing season or specific areas for recreational fishing (SEP, 1998).

Total Acceptable Catch Overruns

A related point is the consistent overruns of the TAC allocations by both the recreational and commercial sectors every year since management began. These overruns significantly reduce the ability of king mackerel to recover from an overfished state, especially when the TAC set is risk-prone from the start. These overruns are expected to continue in the recreational sector due to human population increases and increases in fishing power, for example, through bigger boats, better location devices (GPS), and improved gear, and as accumulated information regarding when, where, and how to fish spreads rapidly through the sportfishing media. As king mackerel recover, more fish will become available, and thus a constant bag limit will allow more fish to be caught, thereby increasing the probability of recreational fishery allocation overruns. Thus, recreational anglers may be faced with the counterintuitive situation of reduced bag limits as the fish become more abundant, at least until full recovery is achieved (SEP, 1998).

Recovery Times

The Gulf of Mexico group of king mackerel was supposed to have been recovered to a level of 30% SPR by the 1997–98 fishing season, based on the Coastal Migratory Pelagic Resources Fishery Management Plan begun in 1985, the implementation of the 602 Guidelines in 1991, and a 12-year generation time. The generation time is a measure of how quickly a fish is able to replace itself in the stock, on average, under conditions of no fishing. This recovery plan has not been met. The redefinition of overfishing guidelines which are in review in 1999 will most likely increase the recovery SPR goal. It is unclear whether a new 12-year period will be allowed for recovery to this level or if a shorter recovery time will be required.

What Could Have Happened

The king mackerel group in the Gulf of Mexico could have been recovered already to levels approximating maximum sustainable yield (40% SPR) if the midpoint of the acceptable biological catch range provided by the Stock Assessment Panel had been caught (Figure 3) (see Powers, 1996). Additionally, if the TAC had been caught without overruns, the stock would currently be defined as not overfished (Figure 3). Of course, these gains in spawning potential ratio would have come at the expense of catches during this time period (Figure 4). It should be noted that the methods used to estimate the acceptable biological catch ranges, as well as important parameter values such as natural mortality and tuning indices, have changed during this time period. Thus, these scenarios do not accurately reflect upon the management of the fishery; rather, they provide a demonstration of what could have happened. These "what if" scenarios were generated by starting at the estimated 1986–87 fishing season, projecting the population forward under a modified catch using the same estimated historical selectivity pattern and recruitment values. This was repeated 400 times incorporating uncertainty in the inputs.

If the current methods, parameter values, and risk-neutral TAC's associated with a 30% SPR fishing mortality rate ($F_{30\%}$[4]) had been applied, the trajectory of SPR would have been a gentle increase to the recovery level during the recovery period, as expected (Figure 3). Comparing the catches from the $F_{30\%}$ trajectory with those from the actual TAC and ABC midpoint trajectories, it is seen that the TAC's chosen would in fact be risk-averse relative to the $F_{30\%}$ values, at least initially, and thus allow a faster recovery. Had risk-prone

[4]The spawning potential ratio is the amount of reproductive output for one recruit relative to the amount expected under no fishing (see Appendix 4). $F_{30\%}$ and $F_{40\%}$ are the fishing mortality rates expected to produce 30% SPR and 40% SPR, respectively.

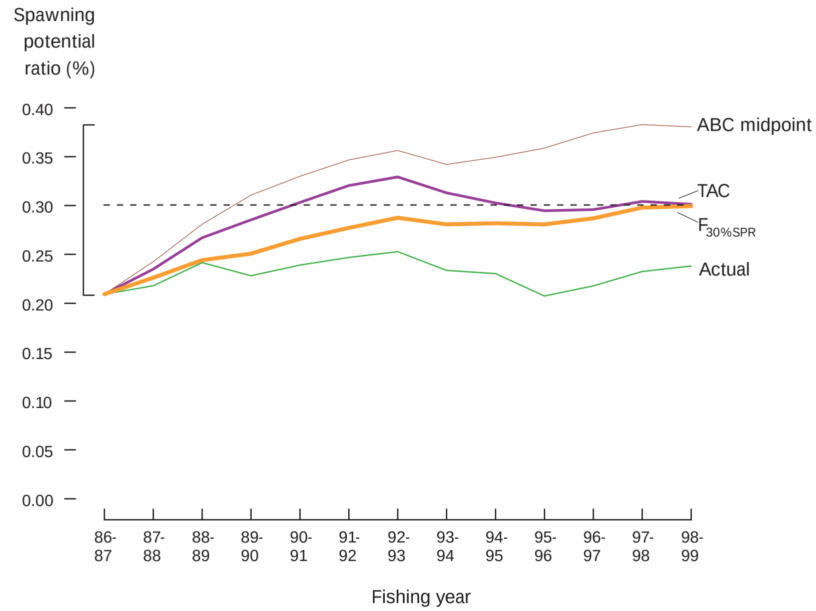

Figure 3
Spawning potential ratio, a measure of stock health where bigger values are better, under three scenarios of what could have happened and what actually happened. The three scenarios are: 1) the midpoint of the acceptable biological catch (ABC) range provided by the Stock Assessment Panel had been caught, 2) the TAC chosen by the Council had been caught without overruns, and 3) the current methods and parameter values had been used to set a risk-neutral TAC, which was then caught without overruns.

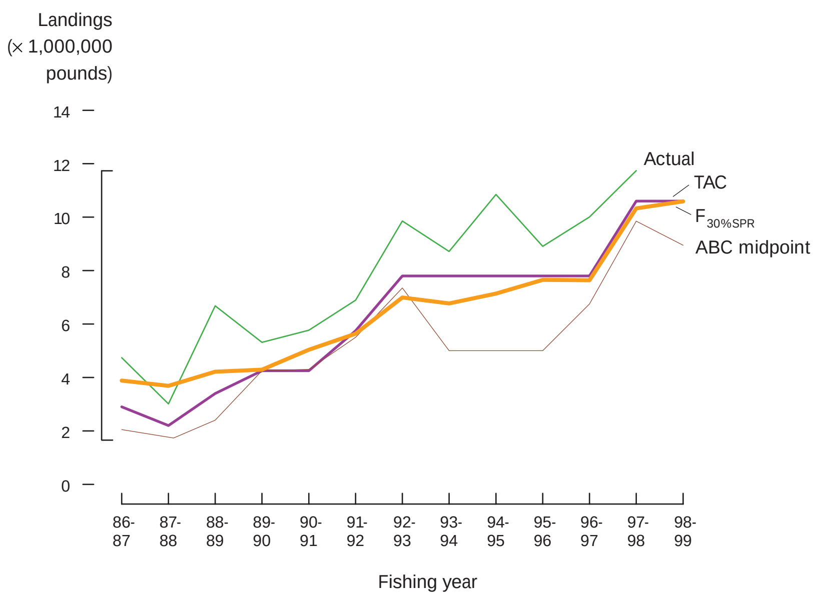

Figure 4
Total catch (x 1,000,000 pounds) that actually occurred in the fishery compared to the three scenarios described in Figure 3.

TAC's been set each year, that is TAC's larger than those corresponding to the $F_{30\%}$ trajectory, the king mackerel would not have recovered to levels of 30% SPR during this time period. In fact, these "what if" scenarios are conservative in that they assume the same recruitment occurred. If recruitment had further increased with the increase in biomass (it appears there is a relationship in this stock), then this would accentuate the differences between the scenarios.

DISCUSSION

The Gulf of Mexico king mackerel fishery is an example of how catches can increase while fishing mortality rate(s) decreases, and biomass increases, a win-win situation for the fishery and the fish stock. All that is left is to take the final step to full recovery of the species, which will require a reduction in catches and/or further improvement in recruitment. Although it is a complex fishery consisting of migratory groups which overlap in distribution and are exploited mainly by recreational anglers whose total catch cannot be easily measured, the potential exists to fully recover the stocks while providing food, employment, and social benefits to the Nation for generations to come. This recovery will require not just the setting of risk-neutral TAC's, but also a recovery trajectory and a plan to compensate when the TAC allocations are not filled exactly, thereby moving away from the recovery trajectory (Powers, 1996). The seemingly random nature of recruitment levels and possible influence of environmental conditions means there will always be imperfect implementation of a recovery trajectory. The ability to compensate for falling behind the planned trajectory or to take advantage of improved conditions would significantly increase the probability of achieving stock recovery while maintaining viable fisheries.

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