Case study of the impact of recent management measures on overall fishing capacity and fishing effort of the United States North Atlantic Ocean longline fleet

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ABSTRACT

A brief case study of recent management actions taken regarding the United States Atlantic pelagic longline fleet and their combined effect on several indicators of fleet effort and capacity for harvesting swordfish is presented. This fishery began during the 1960s, targeting primarily swordfish, and has since diversified to its present form, targeting different species, depending on the abundance of desirable species regularly taken by the gear in the area-time strata in which the vessels are able to fish. North Atlantic-wide, the amount of catch taken and the longline fishing effort expended evolved quickly, especially after mercury level restrictions for swordfish marketed in the United States were loosened in the late 1970s. Resource status evaluations of North Atlantic swordfish indicated a pattern of rapid increase in fishing mortality, leading to a period of overexploitation, followed by a period of rebuilding after management actions were adopted by the International Commission for the Conservation of Atlantic Tunas (ICCAT). There has been a measurable decline in various measures of United States Atlantic pelagic longline fishing effort and fishing capacity, which correlates with the suite of management measures taken by the United States to limit its harvest of swordfish to levels agreed by ICCAT. Over the past few years, the catches of United States vessels have been less than their total allowable catches (TACs), even though their catch rates have increased as the swordfish population has rebuilt. Fishery participants attribute the recent low harvest levels to reduced access and lower participation levels in the fishery. From the information available, there appears to be potential to improve average per hook efficiency and, by doing so, improve fleet-wide capacity to a level more appropriate for achieving the United States TACs.

1. INTRODUCTION

Upon declaration of an Exclusive Economic Zone (EEZ) in 1976, the United States established a policy promoting growth in domestic fishing capacity. By the early 1990s, this policy had resulted in the phase-out of foreign operations within its EEZ and significant increases in domestic fishing effort and catches. The programs designed to promote development of the United States fishing industry resulted in growth in domestic fishing capacities that exceeded the levels needed to extract optimal harvests from several of the nation's marine fisheries resources, and also in needs for management actions to limit harvests and fishing capacities (Hogarth, 2001)[1].

This paper provides a brief case study of recent management actions taken regarding the United States Atlantic pelagic longline fleet and their combined effect on several indicators of fleet effort and capacity for harvesting swordfish, *Xiphias gladius*. A detailed description of the management history for this fishery may be found in Amendment 1 to the US Fishery Management Plan for Atlantic Tunas, Swordfish and Sharks, available at http://www.nmfs.noaa.gov/sfa/hms/Amendment1/Final_EIS_Chapters/Chapter01.pdf. The United States Atlantic pelagic longline fishery started during the 1960s, targeting primarily swordfish, but has since diversified to its present form, targeting different species, depending on times and areas of greatest abundance of the desirable species regularly taken by the gear (Hoey and Moore 1999). After its start, the range of the longline fishery quickly expanded, and became the dominant United States gear for harvesting North Atlantic swordfish by the mid-1960s (Figure 1).

FIGURE 1

Catches of swordfish by United States vessels in the North Atlantic Ocean (open squares), proportions of the catches made by longline gear (closed circles) and five-year running averages of the latter (solid line)

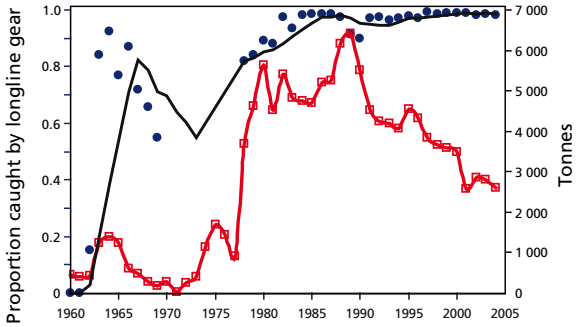
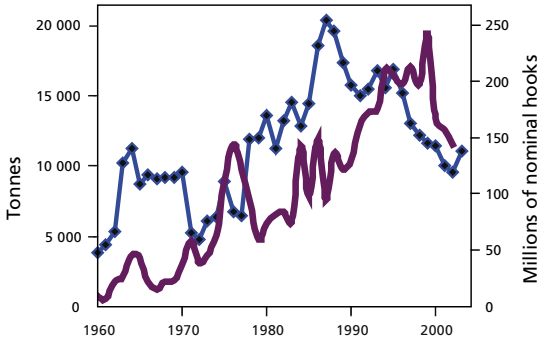


FIGURE 2

Catches of swordfish by longline vessels of all nations in the North Atlantic Ocean (diamonds) and reported numbers of hooks fished (solid line)

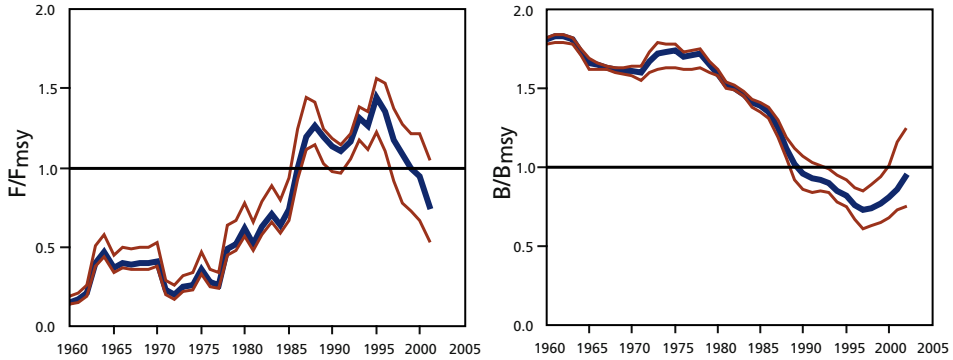


Restrictions on mercury content in the tissues of swordfish sold in the United States were established in 1971, leading to decreased landings of swordfish worldwide. In 1978, however, the maximum permissible level was raised, which revitalized the United States fishery. At the same time, the longline fleet became more efficient through changes in gear, fishing strategies and selection of areas and times for concentrating fishing effort.

Longline fishing effort and catches by longline gear expanded all over the North Atlantic Ocean (Figure 2), following a pattern similar to that for the United States fleet. Assessments of North Atlantic swordfish, carried out by the Standing

[1] Programs that fostered this growth in harvesting capacity included those that encouraged engagement in fisheries previously dominated by foreign vessels, including species that were "underutilized" in United States markets; tax credits, tax deferrals, loans and loan guarantees, which stimulated spending on new vessel construction through the mid-1980s, and also stimulated purchase, repair and refitting of fishing vessels; direct grant programs, which provided support for new product development and other projects and allocations; and trade policies designed to promote foreign market opportunities for United States producers.

FIGURE 3
Estimates of fishing mortality rate (left panel) and exploitable biomass (right panel) of North Atlantic swordfish relative to MSY benchmarks from the 2002 SCRS swordfish stock assessment



The heavy lines represent median trajectories and the thin lines the 90-percent bootstrap confidence limits.
Source: SCRS, 2003.

Committee on Research and Statistics (SCRS) of the International Commission for the Conservation of Atlantic Tunas (ICCAT) indicated a rapid increase in fishing mortality, leading to a period of overexploitation, followed by a period of rebuilding after management actions were adopted by ICCAT (Figure 3). The pattern of effort directed at swordfish is somewhat different from the nominal pattern, as not all of the effort is directed at swordfish, but the two patterns are similar.

2. MANAGEMENT MEASURES

During the mid-1980s the United States implemented a permit system, which led to limiting access to the pelagic longline fishery catching swordfish as a step toward managing capacity and fishing effort within the fleet.

ICCAT first agreed to conservation measures for Atlantic swordfish in 1990, after receiving scientific advice from the SCRS regarding measures to reduce fishing mortality. Among the measures agreed upon was an Atlantic-wide minimum size of 25 kg live weight (corresponding to a length of 125 cm from the tip of the lower jaw to the fork of the tail), with a limit of 15 percent of the number of fish landed for each trip of each boat that could be undersized. In 1991, the United States instituted minimum size restrictions in conformity with ICCAT agreements.

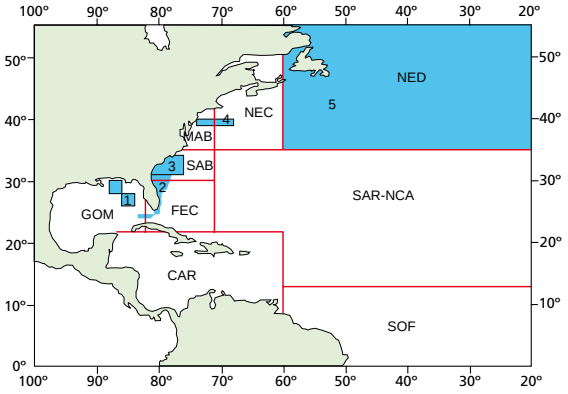
At ICCAT's 1994 meeting, following additional stock assessments, the SCRS advised that additional management measures would be needed to stop the decline in North Atlantic swordfish and to rebuild the stock to a level that could produce the maximum sustainable yield (MSY). As a result, ICCAT first established total allowable catch (TAC) levels for the nations fishing for North Atlantic swordfish in 1997. These were reduced during some of the subsequent years. In 2003, however, after the SCRS advised that there had been a measurable improvement in stock status, ICCAT increased the overall TAC to about the MSY level.

In 1999, several additional controls were imposed by the United States , including regulations to aid in tracking swordfish trade and a prohibition on importing swordfish less than the minimum size.

Additionally, ICCAT encouraged the Contracting Parties to take other appropriate measures within their national jurisdictions to protect small swordfish, including, but not limited to, the establishment of time and area closures. The minimum size regulations placed on the United States fishery had resulted in amounts of discarded fish greater than the 15-perecent limit adopted by ICCAT. The total United States catches

FIGURE 4A

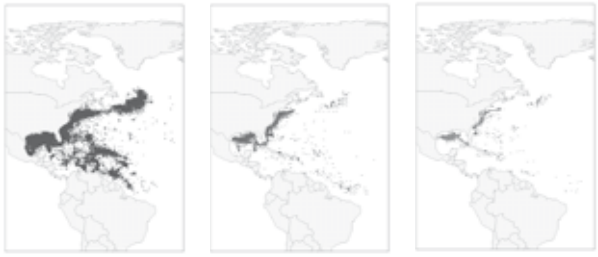
Area classification for the North Atlantic Ocean: Caribbean (CAR), Gulf of Mexico (GOM), Florida East Coast (FEC), South Atlantic Bight (SAB), Mid-Atlantic Bight (MAB), Northeast Coastal Waters (NEC), Northeast Distant Waters (NED), Sargasso-North Central Atlantic (SAR-NCA) and Southern Offshore area (SOF)



The blue areas correspond to time-area restrictions for United States longline vessels adopted for management of the harvest level of swordfish and associated incidentally-caught species: (1) Desoto Canyon, (2) Florida East Coast, (3) Charleston Bump, (4) bluefin tuna protection area, (5) Northeast Distant Waters.

FIGURE 4B

Distributions of pre- and post-closure United States longline effort (positions of first set of trip) for the periods of 1987-1996 (left), 1997-1999 (center) and 2003-2005 (right)



during 1997, 1998, 1999 and 2000 exceeded the TACs for those years (although the amounts of fish landed were less than the TACs), so seasonal closures of the directed fishery were imposed when the directed in-season catches were expected to exceed the TACs. Beginning in 2001, in order to further protect juvenile swordfish and to avoid unwanted bycatches of billfish and other species, longline fishing by United States vessels was prohibited or restricted in the areas shown in Figure 4. Closures were fully implemented for all five areas by 2002. The three southernmost areas, (Charleston Bump, Florida East Coast and Desoto Canyon), were selected, at least in part, to reduce the catches of swordfish less than 125 cm in lengths and of other species. A bluefin tuna (*Thunnus thynnus*) area (Area 4 in Figure 4) was closed primarily to reduce the catches of bluefin less than the size permitted for sale by United States fishers. Longline vessels were allowed to fish in the Northeast Distant area (NED, Figure 4) if they participated in a turtle bycatch study and were accompanied by observers. In 2002, the NED was closed throughout the year to vessels not participating in the turtle study. This area has subsequently been re-opened to United States longline fishing vessels that carry observers and have agreed to utilize fishing methods designed to reduce interaction rates with and serious injuries to sea turtles. (Additional information on the program to reduce the effect of the longline fishery on sea turtles is given by Watson *et al.* (2005) and Scott *et al.* (this volume).)

3. CHANGES IN FISHING CAPACITY, EFFORT AND PERFORMANCE

Since the mid-1990s, there have been declines in various measures of capacity of the United States longline fleet that fishes in the North Atlantic Ocean and the fishing effort exerted by that fleet (Table 1), which correlates with the management measures described above. The landings of swordfish by United States vessels have been less than the TACs, but considerable amounts of fish, most of which were undersized, have been discarded at sea, so the catches exceeded the TACs during 1997-2000.

The numbers of United States longline vessels targeting and catching swordfish have declined steadily since the mid-1990s (Table 1, Figure 5). The first imposition of a TAC correlates with the decline in fishing capacity and fishing effort that has carried through to the 2001/2002-2004 period, during which closed areas and seasons were also implemented. While the imposition of closed areas has had an additional effect on catch and effort (Figure 6) it is not possible to separate the effects of the minimum size limits and time-area closures to the overall reductions in catch of

TABLE 1
Measures of fishing capacity and fishing effort by United States longline vessels that fished in the Atlantic Ocean obtained from logbook data

Year	Vessels that fished	Vessels that caught swordfish	Vessels that caught swordfish in five months	Hooks reported	Year	Vessels that fished	Vessels that caught swordfish	Vessels that caught swordfish in five months	Hooks reported
1987	297	273	180	6 558 426	1996	367	275	191	10 944 660
1988	388	338	210	7 009 358	1997	352	265	167	10 213 780
1989	456	415	251	7 927 401	1998	288	233	139	8 120 273
1990	419	363	209	7 500 095	1999	226	200	143	7 996 685
1991	342	308	176	7 754 127	2000	206	185	135	8 158 390
1992	340	304	184	9 076 717	2001	185	168	114	7 897 037
1993	435	306	177	9 735 806	2002	149	140	107	7 107 958
1994	501	306	176	10 351 805	2003	123	119	94	6 862 091
1995	489	314	198	11 270 539	2004	117	114	96	7 345 048

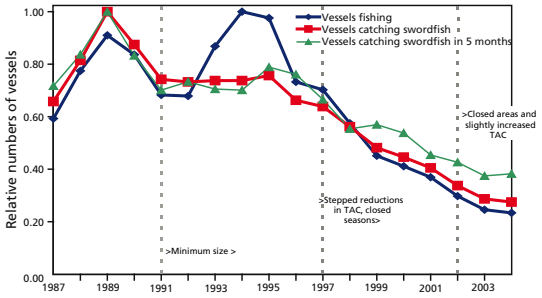
undersized fishes nor in fishing effort, since the regulations acted in combination. There was some reduction in hooks fished during 2001/2002-2004, the period in which specific areas were closed to fishing. Some of the effort previously reported from within the now closed area along the east coast of Florida (FEC, Figure 4) was redistributed to the Gulf of Mexico (GOM) and further to the north along the United States east coast (see Figure 4 for particulars). Although the estimated amounts of swordfish less than 125 cm in length caught increased in some areas, notably the Caribbean Sea and the Gulf of Mexico, relative to the 1997-1999 average, the overall result was a reduction of approximately 50 percent in the catches of undersized fish after the implementation of the area closures, but an overall reduction in effort (in numbers of hooks) of about 10 percent relative to the average for 1998-2000, the 3-year period prior to the area closures.

The primary factors influencing the effort and catch are undoubtedly the costs of fishing and the value of the catch. During the 1987-2004 period the inflation-adjusted prices paid for swordfish have declined, while the inflation-adjusted prices of fuel have increased (Figure 7), which has led to diversification of effort toward other species of tunas or related species.

4. COULD FLEET-WIDE EFFICIENCY BE INCREASED?

Analysis of individual vessel performance in terms of per hook productivity indicates a relatively wide range of variability within the fleet owing to a variety of factors, including the fishing methods employed by the vessel,

FIGURE 5A
Numbers of United States vessels participating in the longline fishery in the North Atlantic Ocean



The values are shown on scales relative to the maxima.

FIGURE 5A
Nominal and standardized numbers of hooks employed by United States vessels in the North Atlantic Ocean, relative to the numbers of hooks employed during 2003

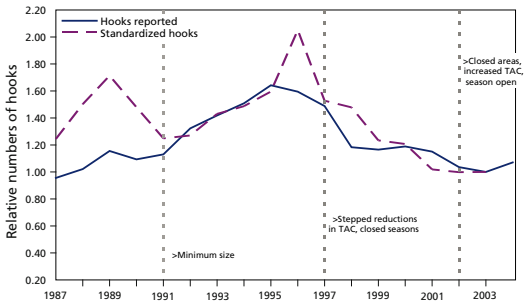


FIGURE 5C
Landed and discarded catches of swordfish by United States vessels in the North Atlantic Ocean and TACs (total allowable catches) for those longline vessels

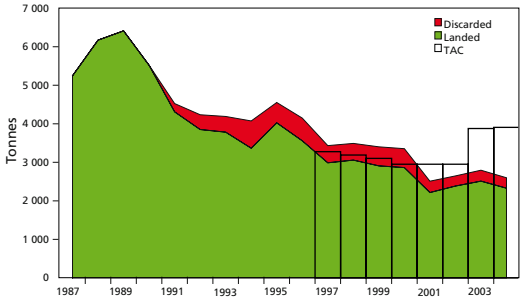
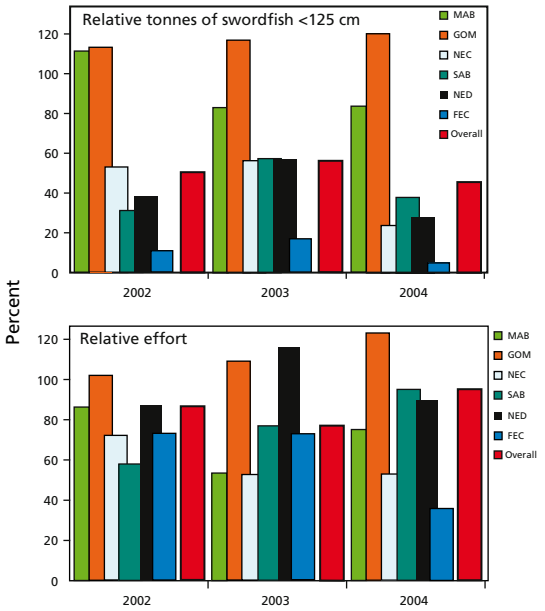


FIGURE 6

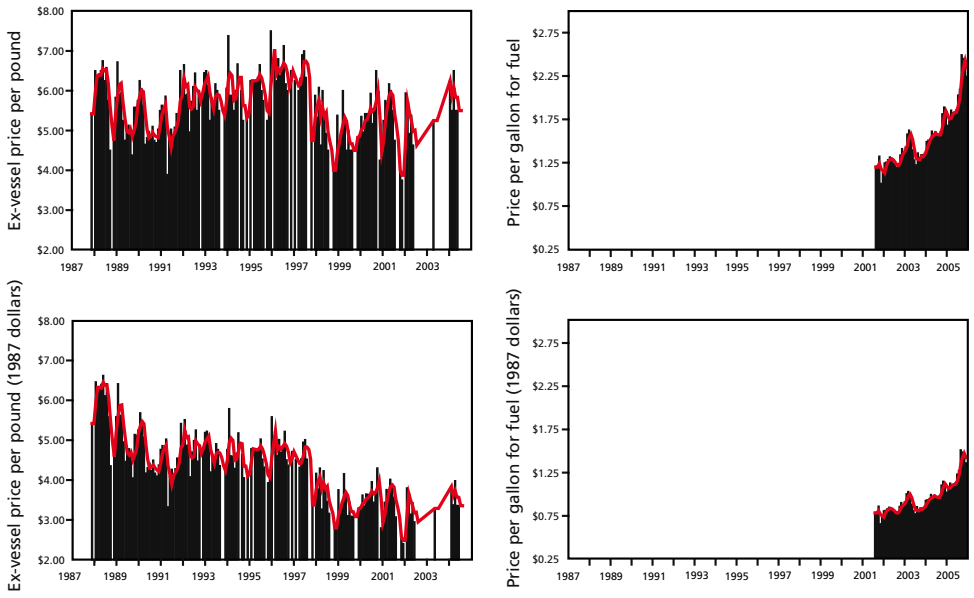
Amounts of undersized swordfish caught in various areas during 2002-2004 relative to the amounts caught during 1997-1999 in those areas (upper panel) and amounts of effort expended in those areas during 2002-2004 relative to the amounts expended in those areas during 1997-1999 (lower panel). The areas are shown in Figure 4A.



the particular area fished, the degree of targeting for swordfish and the size of the set made. Methods applied to "standardize" the effort to remove the effects of factors independent of stock abundance, such as area, season and vessel and gear characteristics (*e.g.* Ortiz and Scott 2003) provide a basis for estimating the potential performance of the fleet if it were possible to increase the average per hook productivity to the levels of the most efficient fishing strategies. Given the most recent estimate of stock status, the current (2003) biomass is at approximately the level corresponding to the MSY. With the effort (in number of hooks) exerted in 2004, the catch per hook would have had to approximately double to achieve a catch equal to the MSY From the analysis of Ortiz and Scott (2003), it appears to be possible to increase the average catch per hook by 50 percent or more if the fleet were to fish in more efficiently (Figure 8). The degree to which this potential could be realized is unknown. Over time, estimates of relative fishing capacity and fleet capacity utilization (the proportion of the fleet employing the most efficient fishing strategy) have

FIGURE 7

Left: Ex-vessel prices for swordfish of 100 pounds (45.4 kg) or more from Florida at the Fulton fish market in New York City.
Right: Prices per gallon (3.79 litres) paid by United States longline vessels for fuel



The amounts in the upper left panel are not adjusted for inflation, and those in the lower left are adjusted to 1987 dollars. The lines are 3-month moving averages.

decreased, but the capacity utilization ratios suggest the that it is possible to achieve greater catches per hook. (In 2004 capacity utilization is estimated to have been about 65 percent (Figure 9).)

5. REFERENCES

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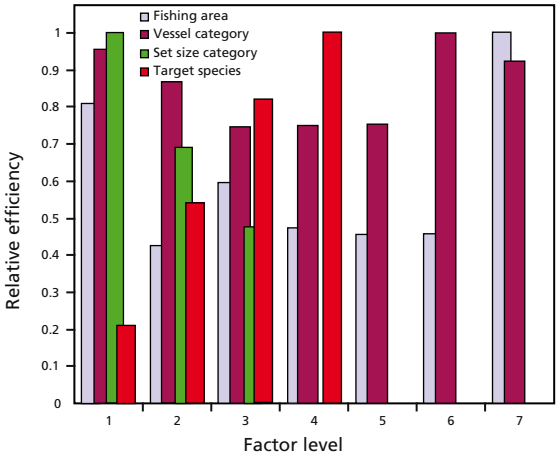
FIGURE 8

Estimates of the relative efficiencies of factors, other than abundance, important in explaining the variability in the catch rates of swordfish by United States longline vessels



A value of 1 corresponds to the greatest average level estimated for the vessel trips that were categorized (see Ortiz and Scott, 2003).

FIGURE 9

Estimates of capacity (circles) expressed relative to the time-series maximum estimated from the general linear modeling factor loadings for the most efficient fishing strategies of Ortiz and Scott (2003) and estimates of annual fleet capacity utilization (diamonds) based on logbook performance reports