conservation **perspective**

Is the collapse of shark populations in the Northwest Atlantic Ocean and Gulf of Mexico real?

ABSTRACT

Increasing fishing pressure on sharks stocks over recent decades has resulted in declines of many populations and led to increasing concerns for their conservation. The extent of these declines, however, has been highly variable—the result of the level of fishing, ocean conditions, and the life history of individual species. Two recent articles have described the collapse and possible extirpation of shark populations in the northwest Atlantic Ocean and Gulf of Mexico. Herein, we examine the results of these two papers commenting on the data sets used, comparing them to other available data sets, and critically evaluating the analyses and conclusions. We argue that these conclusions have been overstated because: (1) the analyses were based on a limited number of data sets, (2) the data sets themselves are inadequate to describe the status of all shark populations in the northwest Atlantic Ocean and Gulf of Mexico reported in these studies, (3) available data sets that could produce different conclusions were not utilized, (4) some factors were not taken into account that could have biased the results, (5) there were no alternate hypotheses presented evaluating other causes of the perceived decline, and (6) the authors did not consider any current stock assessments, which in several cases report the status of sharks to be considerably healthier than asserted.

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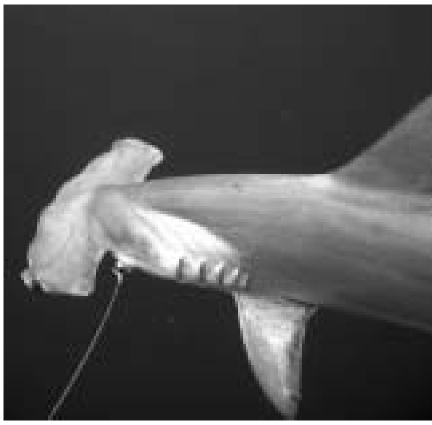

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Introduction

Sharks are generally regarded to exhibit slow growth, late maturity, and low reproductive output, making them particularly vulnerable to exploitation (Musick et al. 2000a). Although our knowledge of the demography and population dynamics of sharks has been slow to develop when compared to teleosts and other vertebrates, considerable progress has been made in recent years in the study of demographic rates and population modeling of sharks, which have provided a more accurate picture of the status of some populations (Cortés 2004). For example, Smith et al. (1998) and Cortés (2002a) reported on intrinsic rates of increase using two demographic modeling approaches for 26 and 38 species of sharks, respectively. Age- and sex-structured population dynamics models with probabilistic risk analysis under various harvesting strategies were developed to assess the status of school (*Galeorhinus galeus*) and whiskery (*Furgaleus macki*) sharks off southern Australia (Punt and Walker 1998; Simpfendorfer et al. 2000, respectively). Apostolaki et al. (2002) and Cortés et al. (2002) applied fleet-disaggregated, fully explicit age- and sex-structured population dynamics models to the blacktip shark (*Carcharhinus limbatus*) in the northwestern Atlantic Ocean. These studies have illustrated that the productivity of sharks varies widely, declines in shark populations are not consistent for all species, and in some cases sharks can be sustainably harvested.

In two recent papers, Baum et al. (2003) and Baum and Myers (2004) described the collapse of shark populations in the northwest Atlantic Ocean and Gulf of Mexico, respectively. Baum et al. (2003) concluded that scalloped hammerhead (*Sphyrna lewini*), white (*Carcharodon carcharias*), and thresher (*Alopias* spp.) sharks have declined by over 75%, and tiger sharks (*Galeocerdo cuvier*) and a coastal species group (*Carcharhinus* spp.) have declined by over 60% in the past 15 years in the northwest Atlantic Ocean. Further, Baum and Myers (2004) concluded that oceanic whitetip (*Carcharhinus longimanus*) and silky (*Carcharhinus falciformis*) sharks have declined by over 99%

and 90%, respectively, in the Gulf of Mexico since the 1950s. These papers may have had a substantial influence in a number of recent conservation decisions regarding the listing of species under the Convention on International Trade in Endangered Species (CITES) and the World Conservation Union (IUCN) Red List of Endangered Species. For example, the white shark was recently proposed and listed under Appendix II of CITES (CoP13 Doc. 32 Rev1) . One of the factors in the decision to list the white shark was the purported decline in abundance of over 75% in the northwest Atlantic Ocean reported by Baum et al. (2003). Moreover, in June 2004 the oceanic whitetip shark was proposed as "Critically Endangered" under the IUCN Red List of threatened species based primarily on the study of Baum and Myers (2004) in the Gulf of Mexico (R. Cavanagh, World Conservation Union, pers. comm.). We believe Baum et al. (2003) and Baum and Myers (2004) made inferences based on limited data sets that are inappropriate for estimating abundance of many shark species, thus making their conclusions overly pessimistic. These conclusions have alarmed the conservation and scientific community in general, and the public at large, on the status of shark populations. Herein, we identify several potential flaws and omissions in these studies which should have been taken into account in the analyses or discussed as alternate hypotheses.

Estimated population status can be dependent on the data source

In Baum et al. (2003), the analyses and conclusions were based on detailed examination of only one gear type (pelagic longline, which does not adequately sample coastal shark species) out of the more than 20 data sets available for coastal and pelagic sharks (Table 1). The Pelagic Logbook Data Set has advantages in that it has a wide geographic coverage, is a long time series, and has over 200,000 samples. However, sharks constitute bycatch in the pelagic longline fishery, and there are major caveats associated with utilization of the pelagic logbook data. The results for oceanic shark species such as the blue shark (*Prionace glauca*) or shortfin mako (*Isurus oxyrinchus*) may be more credible than those for coastal species, but the results should still be considered preliminary without the full benefit of data from multiple international sources and a complete stock assessment.

One of the major caveats associated with this data set is the occurrence of under-reporting and over-reporting of some shark species, and misidentification of species by commercial fishers. Vietnamese-Americans make up a substantial amount (up to 50%) of the pelagic longline fishing effort, particularly in the Gulf of Mexico. The potential among these fishers to misidentify and misuse generic words such as "white shark" is very high (S. Allen, fisheries observer with the Pelagic Observer Program, National Marine Fisheries Service, Southeast Fisheries Science Center, pers. comm.). For example,

Table 1. A summary of catch series available from previous shark stock assessments. DNR = Department of Natural Resources, NMFS = National Marine Fisheries Service, UF = University of Florida, VIMS = Virginia Institute of Marine Science. Years refers to the time period of the data set, beginning with the oldest. A year followed by a dash denotes an ongoing survey or program. Type refers to whether the index is from a commercial or recreational source, or is fishery independent from a scientific survey. Area indicates the area covered by the survey or fishery. NE = northeast, NW = northwest, SE = southeast, SW = southwest.

Data Set	Years	Type	Area
NMFS SE Bottom Trawl Survey	1972–	Scientific Survey	Gulf of Mexico
NMFS NE Bottom Trawl Survey	1972–	Scientific Survey	NW Atlantic Ocean
VIMS Longline Survey	1974–	Scientific Survey	Mid-NW Atlantic Ocean
JAX (Florida Shark Club)	1974, 1989, 1990	Recreational	East Florida
Crooke Longline	1975–1989	Commercial	NW Florida
Point Salerno	1976–1990	Recreational	East Florida
Japanese Longline Observer Program	1978–1988	Commercial	NW Atlantic Ocean, Gulf of Mexico
Marine Recreational Fisheries Statistics Survey (Early)	1981–1993	Recreational	NW Atlantic Ocean, Gulf of Mexico
South Carolina DNR Longline Survey (Early)	1983, 1994	Scientific Survey	South Carolina
Tampa Bay	1985–1990	Recreational	West Florida
Hudson	1985–1991	Recreational	West Florida
Large Pelagic Survey	1986–	Recreational	Mid-NW Atlantic Ocean
Pelagic Logbook Program	1986–	Commercial	NW Atlantic Ocean, Gulf of Mexico
Brannon	1986–1991	Commercial	Alabama, North Carolina
NC#	1988–1989	Commercial	North Carolina
NMFS NE Longline (Early)	1989, 1991	Scientific Survey	NW Atlantic Ocean
Charterboat Logbook Program	1989–1995	Recreational	North Gulf of Mexico
NMFS Pelagic Observer Program	1992–	Commercial	NW Atlantic Ocean, Gulf of Mexico
NMFS Gillnet Observer Program	1993–1995, 1998-	Commercial	NW Atlantic Ocean
NMFS Panama City Longline Survey	1993–2000	Scientific Survey	NE Gulf of Mexico
UF Commercial Shark Fishery Observer Program	1994–	Commercial	NW Atlantic Ocean, Gulf of Mexico
Marine Recreational Fisheries Statistics Survey (Late)	1994–	Recreational	NW Atlantic Ocean, Gulf of Mexico
South Carolina DNR Longline Survey (Late)	1995–	Scientific Survey	South Carolina
NMFS SE Bottom Longline Survey	1995–	Scientific Survey	NW Atlantic Ocean, Gulf of Mexico
Mote Marine Laboratory Gillnet Survey	1995–	Scientific Survey	East Gulf of Mexico
NMFS Panama City Gillnet Survey	1996–	Scientific Survey	NE Gulf of Mexico
Bottom Longline Logbook Program	1996–	Commercial	NW Atlantic Ocean, Gulf of Mexico
NMFS NE Longline Recent Survey	1996, 1998, 2001	Scientific Survey	NW Atlantic Ocean

Vietnamese-American fishers often call oceanic whitetip shark "white sharks" and they tend to translate the English literally, thus "white shark" may not mean "*Carcharodon carcharias*" to them. Rather, "white shark" means any shark that has large patches of white or is just lighter in color than sharks they more commonly see. In addition, shortfin makos are sometimes called "blue sharks" and any large, brown colored shark is generally a "tiger shark."

While Baum et al. (2003) recognized under-reporting, they should have cross-checked individual observations and trends in species composition over time from the Pelagic Logbook Data Set with the corresponding observations also available through the National Marine Fisheries Service Pelagic Observer Program, which samples the same fishery and randomly selects vessels for observer coverage throughout the year from the same universe of boats that is required to report catch in pelagic logbooks (Cramer et al. 1993). Baum et al. (2003) cited limited comparisons of the two data sets for two years, but provide no supporting documentation in their article or in the supporting material online. In addition, analyses of the observer data to check the reliability of the logbooks would be preferred for all available years as captains in the fleet change and incentives to provide accurate reports also change from year to year. Although coverage represents 3–5% of the total pelagic sets, Baum et al. (2003) should have been alerted by the fact that while 6,087 white sharks were reported in pelagic logbook data, onboard observers did not record a single white shark after 1992 (Beerkircher et al. 2004). In addition, most of the white shark records in the logbook data set were from the tropical Caribbean where the species is known to be rare (Compagno 1984). Conversely, there are no records from northern areas off Nova Scotia and Newfoundland where white sharks are regularly reported from the continental shelf (Compagno 1984). These facts suggest that many, if not most, records of white sharks in the pelagic logbook data set are based on misidentifications and thus this data set cannot provide information on population trends in the species. Lastly, although there was a declining pattern in the "white shark" analyzed by Baum et al. (2003) data, the confidence intervals overlapped among most years thus lessening the strength of their conclusion.

Information within the pelagic logbook data also represents two different time series with a breakpoint around 1993–1994, signaling a change in management practices. The U.S. Atlantic Shark Management Plan (NMFS 1993), came into effect in 1993 and contained new reporting requirements (Karyl Brewster-Geisz, National Marine Fisheries Service, pers. comm.). Prior to 1993, fishers in the directed shark fishery, as well as other longline fishers who targeted tunas (*Thunnus* spp.) or swordfish (*Xiphias gladius*) and took sharks as bycatch, could report shark landings in the pelagic longline logbook. Subsequent to 1993, many fishers switched and began reporting shark catches in the directed shark fishery in a new logbook designed specifically for sharks, and they no longer used the pelagic longline logbook. Some fishers continued to use the pelagic longline logbook but those fishers were not targeting sharks. This change in reporting practices alone could have led to substantial reductions in the estimates of catch rates derived from the pelagic longline logbooks because fishers in the directed shark fishery are more likely to record shark catches than fishers who target swordfish or tunas and therefore consider sharks to be unwanted bycatch (Karyl Brewster-Geisz, pers. comm.).

Many species of sharks, such as sandbar (*Carcharhinus plumbeus*) and blacktip are coastal and thus do not occur with a high frequency in the pelagic environment (Compagno 1984) and therefore in this data set. As acknowledged by Baum et al. (2003; supporting online material), coastal sharks were recorded in between <1% and 5.9% of the positive catches of sharks. Thus, the pelagic longline logbook data alone should not be expected to predict the status of coastal shark populations (e.g., sandbar or blacktip) because this data set does not fully sample those populations.

Using indices of relative abundance from a single data series to report percentage declines for a variety of species and species aggregates to infer stock collapse is simplistic, and can be potentially misleading. The absolute numbers of sharks remaining may still be very large if total virgin biomass was very high and because the extent of depletion at the starting point of the time series is unknown. In contrast, recent stock assessments on coastal shark populations from the northwest Atlantic Ocean and Gulf of Mexico conducted by the National Marine Fisheries Service (Cortés 2002b; Cortés et al. 2002) utilized multiple catch-per-unit-effort (CPUE) time series (most of those cited in Table 1, including the pelagic logbook data) and catches (landings and discards) to predict population status. The reliability of each CPUE time series depends on the type (e.g., commercial, recreational, scientific), the generalized linear model and error structure assumed and applied to those data (e.g., Punt et al. 2000), and the relative weight assigned to each series. When incorporating these trends and others into an assessment, several weighting schemes (e.g., the inverse of the coefficient of variation) are considered. Further, all stock assessments for sharks are subjected to sensitivity analyses which examine the implications of considering different data sets, weighting schemes, and other aspects of the assessment.

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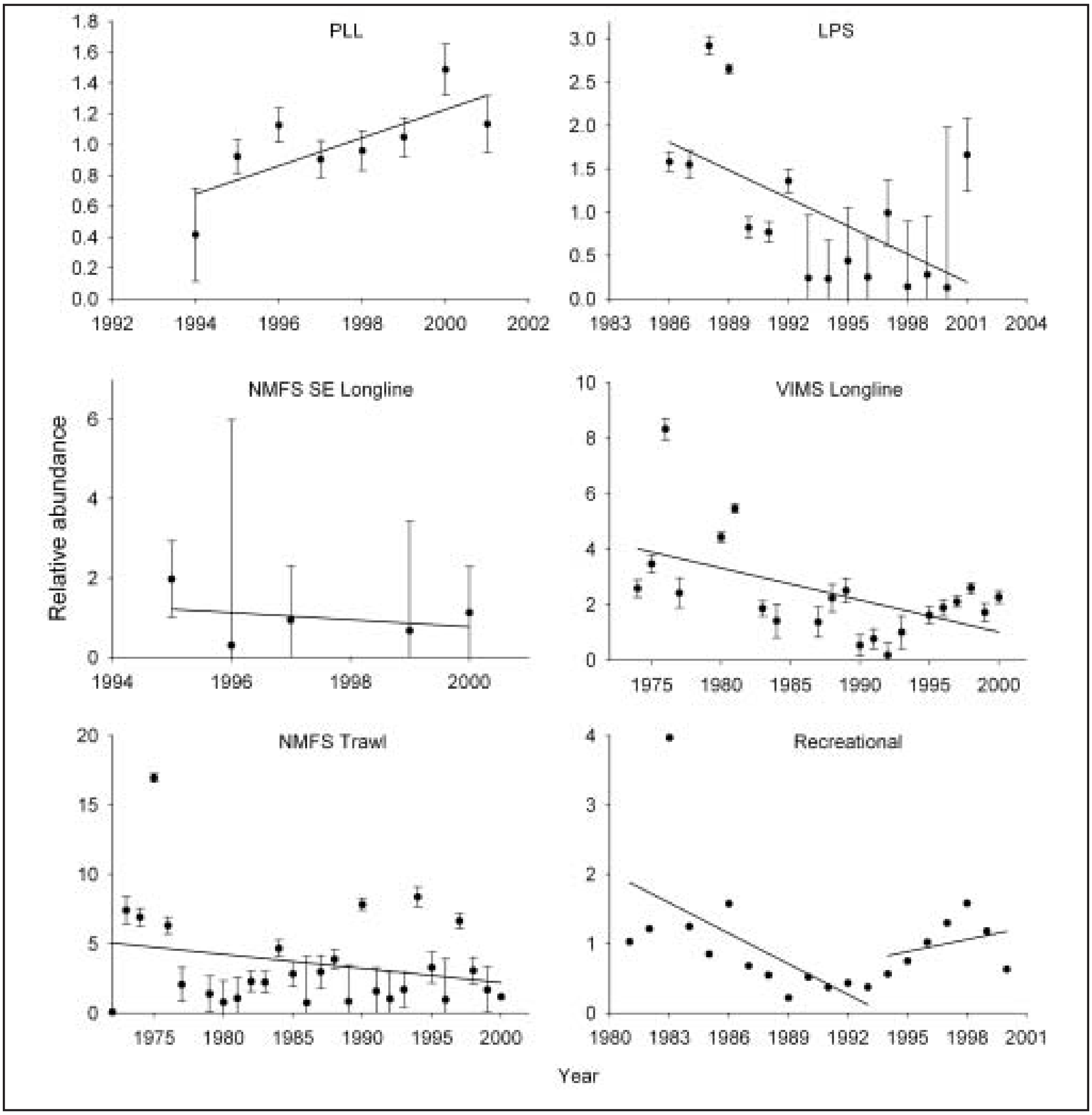
Different data sets can result in different trends of abundance. As an illustrative example, Figure 1 presents catch rate indices from commercial, recreational, and scientific surveys for the sandbar shark, a species not reported by Baum et al. (2003). Some of these series were previously standardized through a generalized linear model (GLM) approach by various authors (see Brown 2002; Brown and Cramer 2002; Cortés 2002c for details). Although the length of the time series varies, we attempt here to illustrate data series that sample over the entire or large portions of the

Figure 1. Catch rates of sandbar sharks from several sources. Vertical bars represent 95% confidence intervals. PLL= National Marine Fisheries Service (NMFS) Pelagic Logbook data; LPS=Large Pelagic Survey; NMFS SE Longline= NMFS Southeast Fishery—Independent Longline Survey; VIMS Longline= Virginia Institute for Marine Science Fishery-Independent Longline Survey; NMFS Trawl= NMFS Northeast Bottom Trawl Survey; Recreational= Marine Recreational Fisheries Statistics Survey. Data sources are referenced in Table 2.



range of this species. We avoid reporting percentage changes in population abundance from relative time series (as was done in Baum et al. 2003), but a linear regression of each CPUE series (natural-logarithm transformed) on year shows that of the seven series illustrated, five had negative slopes, of which three were significant, and two had positive slopes, one of which was significant (Table 2). As earlier stated, we contend that no single series should be expected to predict the status of the population when more series are available from multiple sources.

Disregarding factors that may affect catch rates

Baum et al. (2003) relied solely on self-reported data from commercial pelagic longliners. Baum and Myers (2004) compared data collected from a fishery-independent survey in the 1950s with on-board observer data collected on pelagic longline fishing vessels targeting tuna in the 1990s. Although both studies used a variant of the generalized linear model approach (see review in Maunder and Punt 2004) in an attempt to correct for factors unrelated to abundance such as gear changes, time of year, and area, they did not account for other factors such as regime shifts related to oceanographic conditions (i.e., Klyashtorin 2001), fishing behavior due to tuna and swordfish market conditions, or regulations which may strongly affect shark bycatch patterns (Hilborn and Walters 1992).

As pointed out earlier, pelagic longline fisheries are multi-specific and sharks are rarely targeted. The development of modern pelagic gear and the deployment strategies of fishermen are driven not only by a desire to increase target catches, but also to decrease bycatch, particularly bycatch like sharks that tend to damage the longline gear. Moreover, fishers will compensate for declines in abundance of target species or changes in market through technological improvements, increased knowledge, and rapid shifts into other fishing areas. As pointed out by Hilborn and Walters (1992) and Walters (2004), catch rates can also initially decline much more rapidly than stock abundance due to the behavior of the stock, changes in the size/age of the target species, and by assuming that fishing behavior is similar over all areas and strata sampled.

In particular, the change from wire to monofilament leaders in the Japanese longline fishery in the Gulf of Mexico likely influenced catch rates more than Baum and Myers (2004) acknowledged. Fishers switched from steel leaders in the 1950s to monofilament leaders in the 1980s primarily to increase catch rates of target species (e.g., tuna) and reduce the catch of large sharks through bite-offs of the monofilament leader. Beverly et al. (2003) state that "Using monofilament leaders (not steel) directly onto the hook will allow sharks to bite off the hooks and escape." A bite-off rate for monofilament leaders (6.7 bite-offs per 100 hooks) 5 times higher than for steel leaders (1.4 bite-offs per 100 hooks) has also been noted (Grubbs, personal observation). Despite this information, leader type was not included as a factor in the Baum and Myers (2004) GLM model, but instead they referenced Berkeley and Campos (1988) and Branstetter and Musick (1993) as support for no or little effect of change in leader type on catch rates, when in fact these studies were not conclusive or actually showed the opposite.

Berkeley and Campos (1988) used only 21% steel leaders in 13 of 111 sets and stated that the restricted extent of the study area, limited numbers of sets, and low catch rates typical of pelagic longlining limited statistical precision and restricted their ability to confidently generalize from the results of their study. They also reported many bite-offs with monofilament leaders suggesting that larger sharks may escape. Differential catchability as a result of leader strength was also recently postulated by Beerkircher et al. (2003) for silky sharks caught on monofilament pelagic longline gear.

Branstetter and Musick (1993) also found that in the offshore sampling stratum (>100 m), shark catch was higher on steel leaders than on monofilament, and when the data were pooled into "offshore species" (shortfin makos, and silky, blue, bigeye thresher *Alopias superciliosus*, and bignose sharks *Carcharhinus altimus*) across depth strata, more sharks were caught on steel gear than on monofilament gear by a factor of 2:1. These studies do not provide much evidence of catches being as high or higher with monofilament than with steel leaders for offshore shark species in general, and oceanic whitetip and silky sharks in particular. In fact, they suggest just the opposite. Thus the change from steel gangions used in the 1950s to monofilament gangions used in the 1990s could explain a significant part of the decline reported by Baum and Myers (2004).

Table 2. Slope of the logarithm of abundance indices for sandbar shark by year. NMFS = National Marine Fisheries Service, VIMS = Virginia Institute of Marine Science. Years refers to the time period of the data set, beginning with the oldest. Slopes significantly different from zero are indicated by an asterisk (alpha = 0.05). Type refers to whether the index is from a commercial or recreational source, or is fishery independent from a scientific survey. Area indicates the area covered by the survey or fishery.NW = northwest. GLM standardization indicates whether the index was standardized through a generalized linear model procedure. The details for each survey and GLM procedure can be found in the source.

Data Set	Years	Slope	Area	GLM Standardized	Source
NMFS NE Bottom Trawl Survey	1972–2000	-0.101	NW Atlantic Ocean	Yes	Cortés 2002c
VIMS Longline Survey	1974–2000	-0.115*	Mid-NW Atlantic Ocean	No	Musick et al. 1993; Musick and Conrath 2002
Marine Recreational Fisheries Statistics Survey (Early)	1981–1993	-0.147*	NW Atlantic Ocean, Gulf of Mexico	No	Cortés et al. 2002
Marine Recreational Fisheries Statistics Survey (Late)	1994–2000	0.05	NW Atlantic Ocean, Gulf of Mexico	No	Cortés et al. 2002
Large Pelagic Survey	1986–2001	-0.135*	Mid-NW Atlantic Ocean	Yes	Brown 2002
Pelagic Logbook Program	1994–2001	0.110*	NW Atlantic Ocean, Gulf of Mexico	Yes	Brown and Cramer 2002
NMFS Bottom Longline Survey	1995–2000	-0.089	NW Atlantic Ocean, Gulf of Mexico	Yes	Grace and Henwood 1998; NMFS 2002

Baum and Myers (2004) also dismissed hook size and type as influential factors in their analysis. Hook type and size changed dramatically from a 9/0 J-hook in the 1950s to several types of hooks ranging from circle hooks to J-hooks in sizes 7/0, 8/0, 15/0, and 16/0 in the 1990s. Unfortunately, few controlled experimental studies are available on how variation in hook type in pelagic longline fisheries affects catches of large pelagic species, particularly sharks. Grubbs (unpublished data) performed 9/0 J-hook and 14/0 circle hook comparisons in waters around Chesapeake Bay, Virginia. Based on about 7,000 hooks, catch rates of juvenile sharks were much higher with circle hooks (18.1 to 7.1 sharks per 100 hooks) than with J-hooks. However, for sharks over 100 cm TL (which are primarily caught in the pelagic fishery), the catch rate was 38% higher for J-hooks (3.7 to 2.6 sharks per 100 hooks for sets including at least one shark >100cm). Some preliminary conclusions of experiments (n = 687 sets) conducted in 2001-2002 to reduce sea turtle interactions in pelagic longlines fishing in the Northeast Distant Zone (NED) of the United States suggest that even relatively subtle gear changes can have statistically significant changes in both target catch (swordfish and bigeye tuna *Thunnus obesus*) and bycatch (blue shark and species of sea turtles; Watson et al. 2003). For example, 18/0 circle hooks caught 33% fewer swordfish by weight than a 9/0 J hook.

Although Baum and Myers (2004) considered hook depth in their analysis using estimates from Myers and Ward (unpublished work at http://fish.dal.ca), they did not account for the habitat utilization patterns of the oceanic whitetip and silky shark, two species that showed huge declines in abundance. Most GLM models are designed to statistically remove the spatial and temporal variations in the data set, but generally do not take into account the preferred habitat of the species modeled. However, Hinton and Nakano (1996) applied a habitat-standardized model to blue marlin (*Maikara nigricans*) to incorporate known habitat utilization information into the standardization procedure. Further, Goodyear (2003) created a simulation of longline catch-effort data for blue marlin, varying depth distribution of sets, the propensity of blue marlin to bite moving baits, and the assumed habitat preference of blue marlin, to test the robustness of the habitat model. He concluded that habitat standardizations proved accurate but only when the assumptions regarding habitat choice were correct. Recent data from oceanic whitetip (n = 6, 774 days in aggregate) and silky sharks (n = 4, 409 days in aggregate) equipped with pop-off satellite tags (PSAT) deployed offshore around the Hawaiian Islands indicate that both oceanic whitetip and silky sharks inhabit shallow waters less than 100 meters deep (Musyl, unpublished data). Thus, the shift in average gear depth from 72 m in the 1950s to 110 m in the 1990s in the Baum and Myers (2004) data sets could have significantly impacted the catch rate of oceanic whitetip sharks and silky sharks. For example, the oceanic whitetip sharks tracked in Hawaii spent approximately 40% of their time deeper than the minimum and 20% of their time deeper than the average hook depths in the 1950s data set, respectively. In contrast, oceanic whitetip sharks only spent 2% and 13% of their time deeper than the minimum and average hook depths in the 1990s data set, respectively. Similarly, the silky sharks in Hawaii spent 68% of their time below the minimum and 81% below the average hook depths in the 1950s data set, but only 31% below the minimum and 55% below the average hook depths in the 1990s data set. In light of the information on different gangion material, hook type, and fishing time and depth and their effect on shark CPUE, the declines reported by Baum and Myers (2004) are based on a potentially flawed analysis and are probably exaggerated.

Inconsistent conclusions based on small sample size

The strength of the conclusions drawn in Baum and Myers (2004) is disproportionate to the sample size on which they based them. A total of 170 longline sets in the 1950s was compared with 275 sets made in the 1990s. Of those 275 sets observed from 1995 to 1999, 196 sharks (62 unidentified) were recorded. At those low sample sizes, misidentification problems could have occurred that would only amplify the magnitude of the decreases or increases in each species population status. For example, misidentification is common even among trained scientists, especially for blacktip vs. spinner (*Carcharhinus brevipinna*) shark (Branstetter 1982), and for ridgeback species like silky and dusky (*Carcharhinus obscurus*) sharks (Grace 2001). Dusky sharks often are also misidentified as sandbar sharks (Huish and Benedict 1977). This could account for the increase from 0 to 16 sandbar sharks reported in Baum and Myers (2004).

Baum and Myers (2004) were also inconsistent in the reasoning that led to their conclusions. While they concluded that oceanic whitetip and silky sharks have declined by >90%, they did not suggest population increases in species when catch rates had increased. The authors attempted to rationalize that "catches of new shark species," such as sandbar shark increasing from 0 to 16 sharks, were an "artifact of the increased sample size or depth of sets (e.g., sandbar sharks), although it is also possible that their niche distribution may have expanded offshore to occupy niches left by pelagic sharks that have declined." (Baum and Myers 2004:142). Had they followed the same logic they applied for explaining declines, an increase of sandbar sharks from 0 to 16 would indicate a huge increase in that species' abundance. Further, Baum and Myers (2004) reported a decline in blacktip sharks based on only 6 animals in the 1950s decreasing to zero during 1995–1999. Using several stock assessment methods, Cortés et al. (2002) estimated that the recent biomass of blacktip sharks in the U.S. Atlantic Ocean and Gulf of Mexico was likely to have been reduced by less than a third with respect to virgin levels and no overfishing was occurring.

Discussion

While we certainly acknowledge that there have been declines in the populations of some species of sharks (Musick et al. 2000a, 2000b; Cortés et al. 2002), we disagree with the magnitude of the changes reported by Baum et al. (2003) and Baum and Myers (2004) and contend that some of their results were based on inadequate data sources and incomplete analyses. For example, in 2002 it was estimated (Cortés et al. 2002) that the status of the large coastal shark complex (i.e., blacktip, sandbar, and hammerhead sharks among others) had improved since the last assessment conducted in 1998 (NMFS 1998). Examination of some of the results of the surplus production models from Cortés et al. (2002) indicates relative CPUE declined by about 58% from 1974 to 2001, 39% from 1986 to 2001, and 19% from 1992 to 2001. In contrast, Baum et al. (2003) reported that abundance of their coastal species group had declined by 61% from 1992 to 2000. For sandbar shark, which they did not examine, resource status has also improved since 1998 and the resource may be near maximum sustainable yield with some overfishing still occurring (Cortés et al. 2002).

For pelagic sharks, Baum et al. (2003) estimated a 60% decline in abundance of blue sharks and a moderate decline in shortfin makos. Simpfendorfer et al. (2002) also found an 80% decline in male blue shark abundance from the northwest Atlantic Ocean from 1977 to 1994, but no significant change in abundance for female sharks. However, Campana et al. (2004) noted that it was difficult to reconcile a net decline of only 9.6% during 1986–2000 for the Atlantic Canada area with the very different overall trend for blue sharks reported in Baum et al. (2003), considering that Atlantic Canada was the area with the greatest number of sharks. Further, the International Committee for the Conservation of Atlantic Tunas (ICCAT) Sub-Committee on Bycatches recently conducted a stock assessment of these two species, and preliminary results for blue sharks indicate that current biomass in both the North and South Atlantic Ocean appears to be above the biomass that can support maximum sustainable yield (Anonymous 2005). Current shortfin mako biomass may be below that producing maximum sustainable yield in the North Atlantic and above maximum sustainable yield in the South Atlantic, but results—especially for this species—were highly conditional on the assumptions made and data available (Anonymous 2005). In addition, the small coastal shark group (i.e., Atlantic sharpnose shark (*Rhizoprionodon terraenovae*), bonnethead (*Sphyrna tiburo*), blacknose shark (*Carcharhinus acronotus*), and finetooth shark (*Carcharhinus isodon*) not examined by Baum et al. (2003), was recently assessed using several stock assessment models and generally found to be healthy (Cortés 2002b; Simpfendorfer and Burgess 2002).

In summary, we believe that many of the conclusions of Baum et al. (2003) and Baum and Myers (2004) and subsequent conclusions drawn by the conservation community are exaggerated based on analysis of limited data sets that do not capture the complete picture of all shark populations documented. The authors did not reference any of the stock assessments conducted for sharks in the northwest Atlantic Ocean and Gulf of Mexico (e.g., Cortés 2002b; Cortés et al. 2002; Simpfendorfer and Burgess 2002), which in several cases reported the status of shark populations to be well above those stated by Baum et al. (2003) and Baum and Myers (2004). By stating that many populations have collapsed and are "at risk of large-scale extirpation" (Baum and Myers 2004:390) these authors have misled the public and scientific community concerning the impacts of longline fisheries and the status of shark populations in the Northwest Atlantic and the Gulf of Mexico. We agree with Baum and Myers (2004) and Baum et al. (2003) that populations of some species of sharks in the northwestern Atlantic and Gulf of Mexico have declined, but we disagree with the magnitude of decline they estimated and with their dire prediction of imminent extinction of some species.

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References

Anonymous. 2005. Report of the 2004 intersessional meeting of the ICCAT subcommittee on bycatches: shark stock assessment. SCRS/2004/014. Collective Volume of Scientific Papers 58(3):799-890.

Apostolaki, P., M. K. McAllister, E. A. Babcock, and **R. Bonfil.** 2002. Use of a generalized stage-based, age-, and sex-structured model for shark stock assessment. International Commission for the Conservation of Atlantic Tunas Collective Volume of Scientific Papers 54:1182-1198.

Baum, J. K., R. A. Myers, D. G. Kehler, B. Worm, S. J. Harley, and **P. A. Doherty.** 2003. Collapse and conservation of shark populations in the northwest Atlantic. Science 299:389-392.

Baum, J. K., and **R. A. Myers.** 2004. Shifting baselines and the decline of pelagic sharks in the Gulf of Mexico. Ecology Letters 7:135-145.

Beerkircher, L. R., C. J. Brown, D. L. Abercrombie, and **D. W. Lee.** 2004. SEFSC pelagic observer program data summary for 1992-2002. NOAA Technical Memorandum NMFS-SEFSC-522.

Beerkircher, L., M. Shivji, and **E. Cortés.** 2003. A Monte Carlo demographic analysis of silky shark (*Carcharhinus falciformis*):

implications of gear selectivity. Fishery Bulletin 101:168-174.

Berkeley, S. A., and **W. L. Campos.** 1988. Relative abundance and fishery potential of pelagic sharks along Florida's east coast. Marine Fisheries Review 50:9-16.

Beverly, S., L. Chapman, and **W. Sokimi.** 2003. Horizontal longline fishing methods and techniques—A manual for fishermen. Secretariat of the Pacific Community, Noumea, New Caledonia.

Branstetter, S. 1982. Problems associated with the identification and separation of the spinner shark, *Carcharhinus brevipinna*, and the blacktip shark, *Carcharhinus limbatus*. Copeia 1982:461-465.

Branstetter, S., and **J. A. Musick.** 1993. Comparisons of shark catch rates on longlines using rope/steel (Yankee) and monofilament gangions. Marine Fisheries Review 55:4-9.

Brown, C. A. 2002. Updated standardized catch rates of four species of sharks in the Virginia-Massassachusetts (U.S.) rod and reel fishery. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Sustainable Fisheries Division Contribution SFD-01/02-163.

Brown, C. A. and **J. Cramer.** 2002. Large pelagic logbook catch rates for large coastal sharks. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Sustainable Fisheries Division Contribution SFD-01/02-166.

Campana, S. E., L. Marks, W. Joyce, and **N. Kohler.** 2004. Catch, bycatch, and indices of population status of blue shark (*Prionace glauca*) in the Canadian Atlantic. International Commission for the Conservation of Atlantic Tunas Collective Volume of Scientific Papers 80.

Cortés, E. 2002a. Incorporating uncertainty into demographic modeling: application to shark populations and their conservation. Conservation Biology 16:1-15.

_____. 2002b. Stock assessment of small coastal sharks in the U.S. Atlantic and Gulf of Mexico. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Sustainable Fisheries Division Contribution SFD-01/02-152.

_____. 2002c. Catch rates of large coastal sharks. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, 2002 Shark Evaluation Workshop Document SB-02-12.

_____. 2004. Life history patterns, demography, and population dynamics. Pages 449-470 *in* J.C. Carrier, J.A. Musick, and H.R. Heithaus, eds. Biology of sharks and their relatives. CRC Press, Boca Raton, FL.

Cortés, E., L. Brooks, and **G. Scott.** 2002. Stock assessment of large coastal sharks in the U.S. Atlantic and Gulf of Mexico. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Sustainable Fisheries Division Contribution SFD-2/03-177.

Compagno, L. J. V. 1984. FAO species catalogue: sharks of the world. An annotated and illustrated catalogue of shark species known to date. FAO Fisheries Synopsis (125), vol. 4, part 1: Hexanchiformes to Lamniformes. FAO, Rome.

Cramer, J. C., D. W. Lee, and **G. P. Scott.** 1993. Vessel-trip sampling plan for U.S. longline vessels operating in the Atlantic. International Commission for the Conservation of Atlantic Tunas Collective Volume of Scientific Papers 40 (2):492-497.

Goodyear, C. P. 2003. Tests of the robustness of habitat-standardized abundance indices using simulated blue marlin catch-effort data. Marine and Freshwater Research 54:369-381.

Grace, M. 2001. Field guide to requiem sharks (Elasmobranchiomorphi: Carcharhinidae) of the western north Atlantic. NOAA Technical Report NMFS 153.

Grace, M., and **T. Henwood.** 1997. Assessment of the distribution and abundance of coastal sharks in the U.S. Gulf of Mexico and eastern seaboard, 1995 and 1996. Marine Fisheries Review 59:23-32.

Hinton, M. G., and **H. Nakano.** 1996. Standardizing catch and effort statistics using physiological, ecological, or behavioral constraints and environmental data, with an application to blue marlin (*Maikara nigricans*) catch and effort data from Japanese longline fisheries in the Pacific. Inter-American Tropical Tuna Commission Bulletin 21:171-200.

Hilborn, R., and **C. J. Walters.** 1992. Quantitative fisheries stock assessments: choice, dynamics, and uncertainty. Chapman and Hall, New York.

Huish, M. T., and C. Benedict. 1977. Sonic tracking of dusky sharks in the Cape Fear River, North Carolina. Journal of the Elisha Mitchell Scientific Society 93(1):21-26.

Klyashtorin, L. B. 2001. Climate change and long-term fluctuations of commercial catches: the possibility of forecasting. FAO Fisheries Technical Paper 410, Rome.

Maunder, M.N., and **A.E. Punt.** 2004. Standardizing catch and effort data: a review of recent approaches. Fisheries Research 70:141-159.

Musick, J. A., S. Branstetter, and **J. A. Colvocoresses.** 1993. Trend in shark abundance from 1974-1991 for the Chesapeake Bight region of the U.S. mid-Atlantic coast. Pages 1-18 *in* S. Branstetter, ed. Conservation biology of elasmobranches. NOAA Technical Report NMFS 115.

Musick, J. A. and **C. L. Conrath.** 2002. A delineation of shark nursery grounds in Chesapeake Bay and an assessment of abundance of shark stocks (2001-2003). National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, 2002 Shark Evaluation Workshop Document SB-02-28.

Musick, J. A., G. H. Burgess, M. Camhi, G. Cailliet, and **S. Fordham.** 2000a. Management of sharks and their relatives (*Elasmobranchii*). Fisheries 25(3):9-13.

Musick, J. A., and **17 coauthors.** 2000b. Marine, estuarine, and diadromous fish stocks at risk of extinction in North America (exclusive of Pacific salmonids). Fisheries 25(11):6-30.

NMFS (National Marine Fisheries Service). 1993. Fishery management plan for sharks of the Atlantic Ocean. U.S. Department of Commerce, Washington, D.C. National Oceanic and Atmospheric Administration, Silver Spring, MD.

_____. 1998. 1998 Report of the shark evaluation workshop. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City, FL.

_____. 2002. Final meeting report of the 2002 shark evaluation workshop. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City, FL.

Punt, A. E., and **T. I. Walker.** 1998. Stock assessment and risk analysis for the school shark *Galeorhinus galeus* (Linnaeus) off southern Australia. Marine and Freshwater Research 49:719-731.

Punt, A. E., T. I. Walker, B. L. Taylor, and F. Pribac. 2000. Standardization of catch and effort data in a spatially-structured shark fishery. Fisheries Research 45:129-145.

Simpfendorfer, C. A., and **G. H. Burgess.** 2002. Assessment of the status of the Atlantic sharpnose shark (*Rhizoprionodon terraenovae*) using an age-structured population model. Northwest Atlantic Fisheries Organization SCR Doc. 02/116.

Simpfendorfer, C. A., K. Donohue, and N. G. Hall. 2000. Stock assessment and risk analysis for the whiskery shark (*Furgaleus macki* [Whitley]) in southwestern Australia. Fisheries Research 47:1-17.

Simpfendorfer, C. A., R. E. Hueter, U. Bergman, and **S. M. H. Connett.** 2002. Results of a fishery-independent survey for pelagic sharks in the western North Atlantic, 1977-1994. Fisheries Research 55:175-192.

Smith, S. E., D. W. Au, and **C. Show.** 1998. Intrinsic rebound potentials of 26 species of Pacific sharks. Marine and Freshwater Research 49:663-678.

Walters, C. 2004. Folly and fantasy in the analysis of spatial catch rate data. Canadian Journal of Fisheries and Aquatic Science 60:1433-1436.

Watson, J. W., D. G. Foster, S. Epperly, and **A. Shah.** 2003. Experiments in the western Atlantic north east distant waters to evaluate sea turtle mitigation measure in the pelagic longline fishery. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Pascagoula, MS.