

## THE LIMITATIONS OF SHARK FISHERIES AND THE SHARK FISHERY OF THE SOUTHEASTERN UNITED STATES

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### The limitations of shark fisheries

Shark fisheries have emerged, proliferated, and expanded throughout the world during the last fifteen years because many nations have turned to sharks as a source of protein and profit. These fisheries have been engendered by two factors: First, declining catches and rising prices of traditional food fishes which have made shark an inexpensive source of protein. Second, the booming market on shark fins destined for the Chinese cookery in the Far East which has created a bonanza for fishermen and fin dealers. Dry fin prices of about \$60 USD provide a tremendous incentive for fishermen. Even when the meat is not utilized, the fins alone provide sufficient incentive to harvest sharks. In the last few years cartilage has emerged as another shark product.

Most of the shark fisheries of the past were localized fisheries that targeted individual species for specific products such as liver oil in the cases of the soupfin and basking sharks, and meat in the cases of the porbeagle and school shark. The new shark fisheries that have been emerging in the last fifteen years differ from previous fisheries in that they include nearly all large species of coastal and oceanic sharks and in that they encompass the entire world.

The rapid growth of shark fisheries throughout the world in the last decade, and the known vulnerability to overfishing of these fisheries have engendered worldwide concerns and attempts at management and conservation of sharks. Here I will review the limitations of shark fisheries from the biological and management view points, and will describe the shark fishery of the southeastern United States and its problems.

The history of the shark fisheries for which records are available suggests that they are not sustainable, and that initial exploitation is followed by, at best, a rapid decline in catch rates or, at worst, by a complete collapse of the fishery (Holden, 1974). Examples of shark fisheries that collapsed are the California soupfin shark fishery (Ripley 1946), the New England porbeagle fishery, the Australian school shark fishery (Olsen 1954), the basking shark fishery (Parker and Stott, 1965). There are several reasons why shark fisheries are ephemeral:

First, sharks have a very low reproductive potential. Sharks are usually slow growing, late maturing fishes. The spiny dogfish (*Squalus acanthias*) has been estimated by Jones and Geen (1977) to reach maturity at about 25 years. The sandbar shark (*Carcharhinus plumbeus*), the most economically important species along the eastern coast of the United States has been estimated to reach

maturity at about 30 years (Casey and Natanson, 1992).

Second, all sharks produce small numbers of large young that are born or hatch fully developed. Most species of sharks, at least most of the commercially important ones, are viviparous. The energy requirements of producing fully formed, large young result in reproductive cycles that are unusually long for fishes. In most species the reproductive cycle last one or two years. The reproductive cycle of sharks consists of the ovarian cycle and the gestation cycle. These last two cycles may run consecutively or concurrently, and their relationship determines how often the species can reproduce. For example, the spiny dogfish and other squaloids have ovarian and gestation cycles which run concurrently, both lasting two years. A dogfish giving birth in January of this year, will mate and get pregnant right after giving birth. It will then gestate for two years and give birth two years from this January. These sharks carry developing embryos at the same time they are preparing the next batch of eggs. Thus, these sharks reproduce biennially.

Most large carcharhinid sharks have long ovarian and gestation cycles that last one year each, but the cycles run consecutively instead of concurrently as in the dogfishes, thus they also reproduce biennially. For example, if we start with a female giving birth this spring, it will then start the ovarian cycle and ovulate and get pregnant the next spring, a year after having given birth. It will then gestate for one year, giving birth in the spring of the second year. Thus, these animals also produce a litter every two years.

In the hammerhead sharks (*Sphyrna*) and in the sharpnose shark (*Rhizoprionodon terraenovae*), the ovarian cycle and the gestation cycle last a year but they run concurrently. Thus, these animals reproduce annually. The lamnoid sharks, such as the sandtiger and the mako shark are believed to reproduce annually, but this has yet to be demonstrated or confirmed. Even longer cycles of three and four years have been proposed for other species without adducing any evidence.

Third, sharks generally produce very small broods, or litters. The number per brood usually ranges from two to few dozen. Most of the commercially important carcharhinid sharks usually produce less than a dozen young or pups per brood or litter. For example the sandbar shark averages 8 young per brood while the blacktip averages 5 per brood.

Fourth, most of the commercially important species, e.g., the genera *Carcharhinus*, *Sphyrna*, *Rhizoprionodon*, *Negaprion*, etc., have shallow water nurseries, where both gravid females and young are very vulnerable to fisheries. The mating grounds are also

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often close to the nurseries and thus adults of both sexes congregate close to shore in large numbers, where they are very vulnerable to fishing.

All these biological factors make sharks very vulnerable to modern fishing operations and they are easily overfished. In addition to these factors, we encounter other problems when we attempt to manage sharks: lack of biological data; lack of fisheries data; lack of suitable models for assessment; lack of validated ages at maturity; many species have very vast ranges and are migratory, often crossing many international boundaries in their migrations, etc. I have discussed these topics elsewhere and will not discuss them here because of lack of time.

#### The shark fishery of the southeastern United States

The commercial, directed shark fishery of the southeastern United States extends from North Carolina to Texas. It is by far the largest shark fishery in the nation. The fishery basically started in the early 1980's. Fishermen in this fishery use either longlines or gillnets. Longliners use modified swordfish boats and gear in coastal waters during a long season, often following stocks of sandbar or blacktip sharks as they move north and south along the Atlantic coast with the seasons. The primary species caught by longline fishermen are sandbar sharks (*Carcharhinus plumbeus*), blacktip (*C. limbatus*), dusky, (*C. obscurus*), bull (*C. leucas*), tiger (*Galeocerdo cuvieri*), sandtiger (*Odontaspis taurus*), spinner (*C. brevipinna*), scalloped hammerhead (*Sphyrna lewini*), and great hammerhead shark (*S. mokarran*).

Gillnet fisheries for sharks have existed in the southeastern United States. These fishermen operate small boats from May to November when sharks are in shallow estuarine waters 2-5 m deep. These shallow estuarine waters are nursery areas for many shark species and the catch often contains a high proportion of immature fish. Most of these fisheries are small and localized, but a few larger boats target migrating blacktip or finetooth sharks (*C. isodon*). Species caught in the gillnet fisheries include: Sandbar, blacktip, finetooth, blacknose (*C. acronotus*), bull, spinner, sandtiger, and sharpnose (*Rhizoprionon terraenovae*). Because most of these gillnet operations operate very close to shore, they are usually in state jurisdictions. Recent legislation in South Carolina, Georgia, and Florida has essentially terminated the use of gillnets in those states. This action has forced the gillnet fishermen in deeper waters where their gear is less effective.

In the southeastern United States alone the shark fishery grew from 135 mt in 1979 to 6452 mt in 1991. The rapid growth of this shark fishery and the known vulnerability of sharks to overfishing led to a fishery management plan in 1993 in an attempt to prevent overfishing and have a sustainable fishery for sharks. The shark catch in this fishery has been decreasing since 1989. The quota imposed by the management plan prevents the catches from reaching previous levels. However, effort data indicates that the stocks are much reduced. Examples of species that have been severely impacted are given below.

#### Sandtiger (*Carcharias taurus*)

The sandtiger is a large, sluggish shallow water predator found in temperate waters throughout the world. It has an extremely limited reproductive potential, producing only two young per litter. The reproductive cycle is probably annual but there is no data on this.

It is very vulnerable to fisheries because it congregates in large numbers, probably for mating, at particular spots at specific times of the year. These spots are known to commercial fishermen who can catch very large numbers of sandtigers with minimal effort, but with serious effects on the population. It was the first shark to receive fully protected status anywhere in the world, achieving that status in New South Wales, Australia, in 1984 out of concerns of severe population declines that started in the 1960's and 1970's. In the United States there has been a very severe population decline in the early 1990's, with sandtigers practically disappearing from North Carolina and Florida waters (Gilmore, pers. comm, attached). Musick et al. (1993) documented a decrease in CPUE of 1 shark per 100 hooks average in the 1974-1979 period to less than 0.2 sharks per 100 hooks in 1991.

#### Sandbar shark (*Carcharhinus plumbeus*)

The sandbar shark is the most important commercial species in the shark fishery of the southeastern United States. It is the preferred species in the area because of its size and yield, the quality of its flesh, and its large fins which are considered of the highest quality. Commercial longline fishermen pursue sandbar stocks in their north-south migrations along the coast, and their catches can be as much as 80-90% sandbar sharks in some areas. The sandbar is a very slow growing species, the latest estimate (Casey and Natanson, 1992) indicates that the species may take 29-30 years to reach maturity. Its fecundity is low; females produce 6-10 young after a one year gestation period, and have, at least, a one-year resting stage in the reproductive cycle (Musick et al. 1993). Hoff (1990) used an age at maturity of 15 years, a lifespan of 35 years, and two year reproductive cycle, to calculate that each female may reproduce only ten times. New maturity estimates and the increased mortality in the fishery may reduce that reproductive potential much further. Musick et al. (1993) have documented a severe decline in CPUE of the sandbar shark in the Chesapeake Bay area. A recent report by Ulrich (1996) showed a dramatic decline of sandbar sharks off South Carolina, catches decreasing from 4.73 sharks /100 hooks in 1983-84, to 0.41 sharks/100 hooks in 1993-94, to 0.39 sharks/100 hooks in 1994-95. It is remarkable that after a decade of intensive fishing in the southeastern United States, commercial fishermen are still producing large catches of sandbar sharks. This may be due to a very large initial population or to factors concentrating the remaining fish along the coast where they are fished (such as mating migrations or nurseries). Given known trends in shark fisheries, it is unlikely that sandbar shark catches will remain high for many more years.

#### Night shark (*Carcharhinus signatus*)

The night shark was abundant along the eastern coast of the United States before the development of the swordfish fishery. Berkeley and Campos (1988) stated that this species represented 26.1% of all sharks caught in swordfish fisheries studied by them along Florida's east coast from 1981 to 1983. Anecdotal evidence from commercial fishermen also indicates that, in the late 1970's, it was not unusual to have 50-80 dead night sharks, usually large gravid females, in every set from Florida to the Carolinas. During the 1970's sports fishermen in South Florida often resorted to

## LITERATURE CITED

catching night sharks when other more desirable species (marlins) were not biting. The photographic record of trophies landed shows that large night sharks were caught daily and landed at the Miami docks in the 1970's. The species is rare along the southeastern coast today. In a NOAA survey of sharks in 1991 (Delaware II cruise DE II 91-06) of 439 sharks caught only 2 were night sharks (0.005%). The NOAA observer program recorded only 1 night shark out of 362 sharks (0.28%) in 1993, and 10 night shark out of 295 shark sampled (3.39%) caught in commercial swordfish and tuna longline catches (Dennis Lee, SEFSC, pers. comm.).

**Dusky shark (*Carcharhinus obscurus*)**

The dusky shark is one of the preferred species in the southeastern commercial fishery of the United States. Its biology is poorly understood. It is a slow growing species that may not mature until about 17 years of age (Natanson et al. 1995). The oldest specimens aged by Natanson (1990) were 30-35 years old. Its reproductive cycle is also poorly understood. Clark and von Schmidt (1965) have suggested a 16 month gestation period, but this needs to be clarified. In a study of the lower Chesapeake Bay, Musick et al. (1993) found that this species constituted 10-20% of the total catch from 1974 to 1981, and declined to about 5% of the total catch during 1982-1989. According to Musick et al. (1993) the decline in CPUE for dusky sharks in the Chesapeake Bay started in the early 1980's prior to the escalation of the directed commercial shark fishery. These authors stated that the decline may have been associated with heavy recreational shark fishing that occurred along the east coast in the 1970's and to the bycatch of the swordfish and tuna fisheries of the 1970's and early 1980's. Large dusky sharks have also become a rarity in sports tournaments (Musick et al. 1993).

**Porbeagle (*Lamna nasus*)**

The porbeagle is lamnoid shark common in deep cold temperate zones. It is highly esteemed for its flesh. Very little is known about its reproductive potential. It is known to produce litters of 4-8 pups but the frequency of reproduction is not known. It probably reproduces annually, but there is no hard data on this. There have been fisheries for this species for many years. The only data available on the porbeagle fishery in North America dates back to the early 1960's. In the late 1950's and early 1960's, Norwegian fishermen came to the northeastern coast of North America to fish for porbeagle after they had exhausted the species in European waters. The fishery lasted for a few years and collapsed due to overfishing. It took nearly three decades for porbeagle to reappear in commercially important numbers in this area. The porbeagle is presently fished for throughout Europe and along the northeastern coast of North America.

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