Leopard Shark

History of the Fishery

The leopard shark (*Triakis semifasciata*) is taken as both a food and game fish in California, and its distinctive markings and hardiness also make it desirable for public aquarium displays. Although some commercial landings may be lumped under a general "shark, unspecified" category, those reported as "leopard shark" have ranged from 9,270 pounds in 1958, to a high of 101,309 pounds in 1983. These landings, while not extensive, increased in the south and decreased in the north during the 1980s. Landings in southern California began increasing in 1981, and in 1985 surpassed landings in northern California for the first time since the collection of statistics began in the 1940s. Since 1991, landings have averaged about 31,000 pounds per year, with about 57 percent of the landings occurring south of Point Piedras Blancas. Legislative curtailment of inshore gillnetting in the San Francisco/Monterey Bay area undoubtedly contributed to much of the decline in northern California landings after 1986.

Judging from estimates made since 1980 by the National Marine Fisheries Service (NMFS) Marine Recreational Fisheries Statistics Survey, the recreational leopard shark catch appears to be greater than the commercial catch, although these estimates are subject to large sampling variability. According to the survey, sport catches in California between 1980 and 1988 averaged over 52,000 fish per year with a low of 33,000 fish taken in 1980 and a high of 59,000 fish taken in 1988. Since 1993, an estimated average of 45,000 leopard sharks have been taken by anglers, with a low of 34,000 taken in 1993 and again in 1994, and a high of 58,000 taken in 1997.

A variety of fishing methods and gear types are used in the fisheries for leopard sharks. Most of the recreational catch is taken angling with baited hooks with some spearfishing by divers. Analysis of tag-recaptures in the central California area in the 1980s suggests that most angler-caught leopard sharks are taken from private boats (55 percent), and from shore (41 percent), with a small percent landed by partyboats (four percent). The commercial catch, largely incidental in recent years, is taken mainly by set net (53 percent), hook-and-line (30 percent), and trawl (13 percent).

Leopard Shark, *Triakis semifasciata*
Credit: CA Sea Grant Extension Program

A 36-inch minimum size and a possession limit of three fish have been in effect for the sport fishery since 1991. This size limit was also extended to the commercial fishery in 1994, both for market and aquarium display. Additionally, the state has general restrictions on usage of certain types of commercial gear in the nearshore zone.

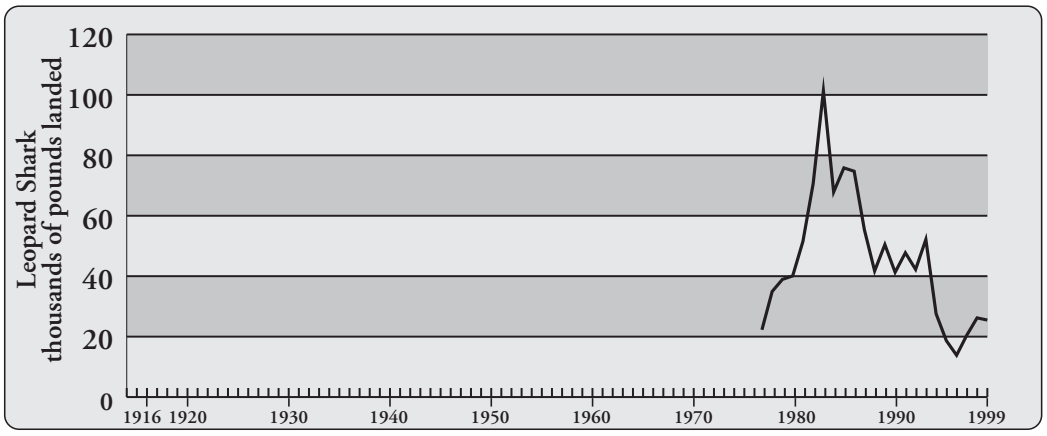
Status of Biological Knowledge

The leopard shark, also known as "tiger shark" and "cat shark," ranges from Mazatlan, Mexico, into the northern Gulf of California, and northward to Oregon. It is most common in shallow water from the intertidal down to 15 feet, less so down to 300 feet or deeper in ocean waters. Favoring muddy bays and sloughs, especially in northern California, it is known to move out and in with the tides to feed over shallow tidal mudflats. It also occurs along the open coast and around offshore islands off southern California, where it frequents kelp beds, sandy bottoms near rocky reefs, and the surf zone along sandy beaches.

The population structure throughout its range is not clearly understood, but is thought to consist of regional stocks among which there is relatively little exchange. Tagging studies in central California have shown there is at least some mixing between stocks in San Francisco Bay and those in central and southern California, but such exchange appears limited. The Gulf of California, Mexico, stock is presumed to be separate from the California stocks.

The maximum recorded and verified total length is about six feet long. The oldest validated age that has been determined by reading tetracycline-labeled rings on the vertebrae, is 26 years for a 49-inch female, an average of 1.8 inches per year. Size at birth is about eight to 10 inches in total length. Longevity is presumed to be around 30 years.

The live-bearing female leopard shark produces from seven to 36 offspring in an annual reproductive cycle. Males mature at seven years, and females at 10 years, when fish reach lengths between 40 and 42 inches total length. The gestation period is estimated at 10 to 12 months. Birth apparently takes place from March through July. The only known eye-witness account of leopard sharks giving birth in the wild is that of a fisherman who observed "pupping" activity at Santa Catalina Island in southern California in the 1940s. Dozens of large females,



Commercial Landings 1916-1999, Leopard Shark
Commercial landings for leopard shark were not reported prior to 1977. Data Source: DFG Catch Bulletins and commercial landing receipts.

with backs and dorsal fins breaking the surface of the water over a shallow mudflat in Catalina Harbor, were observed releasing their pups in the three to four-foot deep water; some of the pups were seen milling around in water only about a foot deep.

This shark is an opportunistic benthic feeder. Invertebrates taken include crabs, ghost shrimp, clam siphons and sometimes whole clam bodies, polychaete worms, fat innkeeper worms, and octopuses. Fishes in the diet include herring, anchovy, topsmelt, croakers, surfperches, gobies, rockfishes, midshipman, flatfishes, and small elasmobranchs such as smoothhounds, guitarfishes, and bat rays. Leopard sharks seasonally consume the eggs of herring, topsmelt, jacksmelt, and midshipman.

The leopard shark is preyed upon by the white shark and sevengill shark, and presumably other large sharks as well, which are known to enter bays. The phenomenon of young sharks being preyed on by larger sharks is not uncommon.

These nomadic sharks often occur in schools, sometimes with smoothhounds, which also belong to the houndshark family. Numbers of animals may suddenly appear in an area, then move on. Although generally timid and wary of divers, there is one record of an attack on a skin diver in 1955 in California.

Movements of this species have been studied in central California. Tagging in San Francisco Bay has revealed that this stock is mostly resident, although at least 10 percent of the population moves out of the bay into the ocean during fall and winter. One female at liberty for 20 years was recaptured in south San Francisco Bay less than five miles from where she was originally tagged. Of the longer distance migrants, one three-foot male tagged in San Francisco Bay was recaptured in Santa Monica Bay a decade later.

Status of the Population

The leopard shark is one of the many species considered, but not now actively regulated, under the Pacific Fishery Management Council's Groundfish Management Plan. Regulatory actions enacted by the State of California have contributed significantly toward protecting this species. Even though the commercial catch may be underestimated because of reporting problems, this species does not appear to be at risk, judging by the combined landings in relation to previously calculated estimates of fishing mortality and exploitation rates and current conservation measures which appear to have reduced these rates. The imposition of a sport and commercial fishing size limit and general curtailment of gillnetting within this species' nearshore range appear to have halted the increase if not reduced total fishing mortality over the past decade. Commercial sport fishing boat catches of leopard shark in California have dropped from an average of 6.8 fish per trip between 1980 and 1991 to an average of 4.0 fish after the size limit was imposed from 1992 to 1995, as more fish were released. Also encouraging is evidence that mortality from hooking injuries is quite low.

The size of the California leopard shark population has not been estimated, and the only information on relative changes in stock abundance is what can be inferred from catch statistics. Because of its rather limited geographical range with little exchange among regional stocks within this range, resident stocks near large population centers may be particularly vulnerable to heavy localized fishing pressure. A recent re-assessment of the leopard shark's intrinsic productivity and vulnerability to harvest revealed it to be even more susceptible to over-exploitation than previously reported. Its annual rate of increase under maximum sustainable yield exploitation has been calculated at only about two to three percent per year. And while the size limit protects juveniles, it does not protect

mature adults in their prime reproductive years in feeding and near shore pupping areas. Nonetheless, it appears that current conservation measures, as long as they are in place, appear to provide adequate protection for the sustainability of the California stock of this species at the present time. Possible future fishing mortality increases within regulatory constraints could be a concern if mature females become an increasingly important component of the catch, or if inshore fisheries develop that are efficient at targeting this species.

Susan E. Smith
National Marine Fisheries Service

References

Ackerman, J.T., M.C. Kondratieff, S.A. Matern, and J.J. Cech, Jr. 2000. Tidal influence on spacial dynmics of leopard sharks, *Triakis semifasciata*, in Tomales Bay, California. Environmental Biology of Fishes 58: 33-43.

Au, D. W. and S.E. Smith. 1997. A demographic method with population density compensation for estimating productivity and yield per recruit of the leopard shark, *Triakis semifaciata*. Canadian J. Fish. Aqua. Sci. 54, 415-20.

Cailliet, G.M. 1992. Demography of the central California population of the leopard shark (*Triakis semifasciata*). Austr. J. Mar. Freshwater Res. 43: 183-193.

Kusher, D.I., S.E. Smith, and G.M. Cailliet. 1992. Validated age and growth of the leopard shark, *Triakis semifasciata*, with comments on reproduction. Environmental Biology of Fishes 35, 187-203.

Russo, R.A. 1975. Observations on the food habits of leopard sharks (*Triakis semifasciata*) and brown smoothhounds (*Muselus henlei*). Calif. Fish Game 61:95-103.

Smith, S.E. and N. Abramson. 1990. Leopard shark *Triakis semifasciata* distribution, mortality rate, yield, and stock replenishment estimates based on a tagging study in San Francisco Bay. Fish. Bull., U.S. 88(2):371-381.