LEOPARD SHARK

History of the Fishery

The leopard shark (*Triakis semifasciata*) is valued as both a food and game fish in California; it is not uncommon in fresh fish markets and has a firm, mild-tasting flesh. The distinctive markings and hardiness of this fish also make it desirable for aquarium displays.

The scope of the fisheries for leopard shark is difficult to estimate for two reasons: an unknown portion of the commercial catch may be landed under the general category "shark, unspecified"; and statistics on leopard sharks caught by recreational anglers have been inadequate until the beginning of the last decade.

Total commercial landings for California reported under the "leopard shark" category have ranged from 9,270 pounds in 1958 to 101,309 pounds in 1983. The value to fishermen averaged around $37,000 per year in the 1980's. These landings, while not extensive, have increased in the south and decreased in the north over the past decade. 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 1940's. Legislative curtailment of inshore gillnetting in the San Francisco/Monterey Bay area probably 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, although these estimates are subject to large sampling variability. According to the survey, sport landings in California between 1980 and 1987 averaged over 270,000 pounds per year and were estimated at 719,608 pounds in 1987.

The importance of recreational anglers as users of the resource in central California was confirmed by analysis of recovery patterns of 948 tagged fish released in the San Francisco Bay area in 1979 by the NMFS. About 82 percent of the 108 recoveries were returned by sport anglers, while only 12 percent were returned by commercial fishermen. Of the recreationally caught returns, 54.5 percent came from skiff/private boat anglers, 40.9 percent came from shore anglers, and only 4.5 percent came from partyboat anglers. Leopard sharks are commonly taken from piers and jetties, and are known to congregate around the warm water outfalls of power plants.

A variety of fishing methods and gear types are used in the fisheries for leopard sharks: angling with baited hooks, spearfishing by divers, gillnetting along the coast, and some commercial longlining. Recreational spearing reportedly occurs in Humboldt Bay in shallow water. Gillnet catches will probably continue to decline with increasing legislation restricting use of these nets in coastal waters. Some leopard sharks are also taken incidentally in ocean bottom trawl catches.

Because of its slow growth rate, late sexual maturity, low fecundity, and easy accessibility to fishermen, this species is considered susceptible to fishing pressure. Fishing mortality rates and life history parameters indicate that with the current amount of fishing pressure, some measure of protection would be necessary to assure population replenishment.

Leopard shark, *Triakis semifasciata*.

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 north to Oregon. Abundant in cool to warm temperate zones, it is most common in shallow water from the intertidal down to 15 feet and less so in deeper water down to 300 feet. This species seems to favor enclosed muddy bays and sloughs, especially in northern California, although it is not unusual to find it along the open coast and around islands off southern California, where it frequents kelp beds and sandy bottoms near rocky reefs.

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. Nevertheless, tagging studies in central California have shown that there is some mixing between stocks in San Francisco Bay and Elkhorn Slough in Monterey County. There is no information on exchange among other regional stocks, but such exchange is presumed to be limited.

By examining calcified growth zones in vertebral centra, age and growth of leopard sharks from central California have been determined. Growth rate is generally slow (averaging less than one inch per year), with considerable individual variation. The maximum recorded and verified length is about six feet; however, most adults are smaller than that. The maximum age is presumed to be around 30 years; the oldest ages that have been determined by reading calcified rings on vertebrae, are 24 years for a 53-inch male, and 20 years for a 51-inch female. The

largest female aged so far (a 55-inch specimen) was estimated at 19 years. Size at birth is about eight to 10 inches in total length.

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 10-12 months. Birth apparently takes place in the spring 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 Catalina Island in southern California in the 1940's. Dozens of large females, 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 octopi. Fishes in the diet include herring, anchovy, topsmelt, croakers, surfperches, gobies, rockfishes, midshipman, flatfishes, and small elasmobranchs such as smoothhounds, guitarfish, and bat ray. Leopard sharks seasonally consume the eggs of herring, topsmelt, jacksmelt, and midshipman.

Predators of the leopard shark are not known, but young or smaller individuals may be preyed upon by larger sharks such as the sevengill and sixgill sharks, which are known to enter bays. The phenomenon of young sharks being preyed on by larger sharks is not uncommon.

These strong swimming, nomadic sharks often occur in schools, sometimes with smooth-hounds, 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. Pectoral fin nipping of smaller individuals by larger ones has been observed in fish held in captivity. Evidence attests to the hardiness of these fish, both in their ability to thrive in captivity, and in their capacity to recover from the trauma of hooking injuries.

Migrations of this species have been studied in central California. Results of the San Francisco Bay tagging project revealed that at least 10 percent of the resident population moves out of the bay into the ocean during fall and winter. A fish tagged in San Francisco Bay was recaptured in Elkhorn Slough and vice versa, indicating some exchange between these stocks.

Status of Population

The size of the California leopard shark population has not been estimated, and the only information on relative changes in stock abundance is that which can be inferred from catch statistics. There is evidence, however, that fluctuation in catches may not be a reliable indicator of changes in stock abundance, as environmental conditions may also affect patterns of availability or vulnerability of leopard sharks to capture. Increased commercial and recreational catches have been observed in the San Francisco area in heavy delta outflow years, increases that tagging results indicate do not appear related to immigration of sharks from other areas.

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