

14. LEOPARD SHARK

Review of the Fishery

The leopard shark, *Triakis semifasciata*, is targeted by recreational anglers, small-scale commercial fisheries, and marine aquaria collectors in ocean waters adjacent to California. Recreational anglers land the majority of the leopard shark catch, primarily using baited hooks. However, some are taken by divers using spears, and even bow and arrow.

Catch (number of fish) estimates for sport-caught leopard shark from 2004 to present were generated from the California Recreational Fishery Survey (CRFS). Prior to CRFS, catch and effort estimates for California were based on data from the Marine Recreational Fishery Statistics Survey (MRFSS). MRFSS data is available from 1980 through 2003, except for the years 1990 through 1992 when sampling was suspended due to lack of funding.

Although the catch estimates from the two surveys are not directly comparable, they do indicate that catches of sport-caught leopard shark have been relatively stable following the implementation of a three fish bag limit and 36-inch (0.9-meters) total length (TL) minimum size limit in 1992. Prior to 1992, the MRFSS data indicate the average annual catch was 450,000 pounds (204 metric tons) compared to 148,000 pounds (67 metric tons) after the 1992 regulations were implemented. From 2004 to 2006, the CRFS catch estimates indicate an average of 130,000 pounds (59 metric tons) was taken annually (Figure 14.1).

According to historical survey data, private boaters land the majority (55 percent) of leopard shark in the recreational fishery, followed by shore-based anglers (Man Made and Beach/Bank) (44 percent), and Commercial Passenger Fishing Vessels (CPFV) (1 percent). A tag and recapture study conducted on the central California coast during the 1980s also showed similar catch proportions by the different fishing modes. Survey statistics also indicate anglers fishing from San Francisco to Eureka catch the majority of leopard sharks in bays; whereas anglers fishing south of San Francisco catch leopard sharks primarily in nearshore coastal waters. Recent catch estimates indicate roughly half of the annual sport catch comes from within San Francisco Bay.

Beginning in 2005, recreational groundfish closures and depth restrictions were applied to all federally managed groundfish species in order to allow overfished stocks to rebuild. However, exceptions were incorporated into the regulations allowing the take of leopard shark during the groundfish closures within specified enclosed bays, including San Francisco Bay.

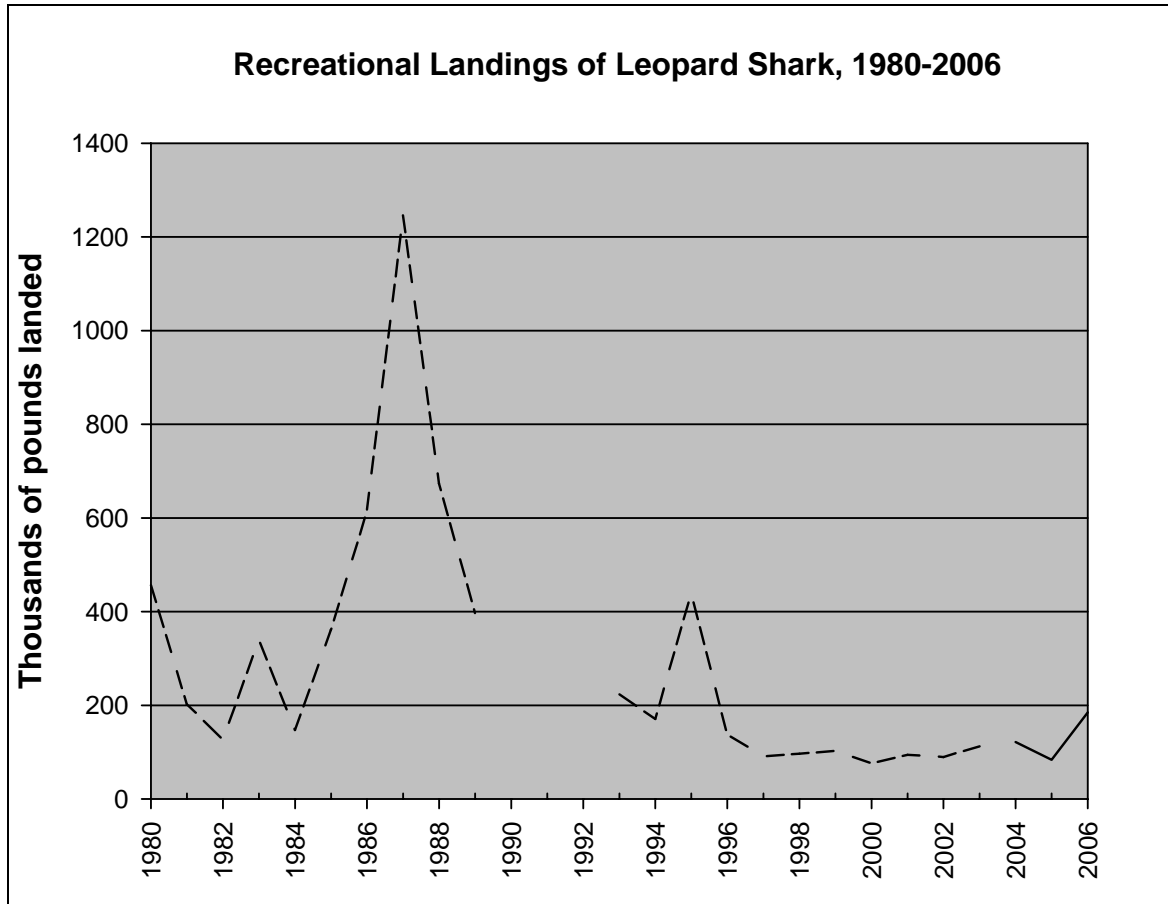


Figure 14.1. Catch estimates (thousands of pounds) for leopard shark from 1980-2006. Estimates derived from the MRFSS are a dashed line, and estimates derived from the CRFS are a solid line.

Documentation of commercial leopard shark landings began in 1977, and since that time California landings have ranged from a high of 103,000 pounds (47 metric tons) in 1983 to a low of 14,000 pounds (6 metric tons) in 1996 (Figure 14.2). These catch statistics indicate that commercial take is minor compared to the recreational fishery. However, it is important to note that leopard shark landings are subject to reporting bias since an unknown number are lumped with other shark species in the “shark unspecified” market category on commercial landing receipts.

Over the past 15 years, annual landings have averaged 26,000 pounds (12 metric tons). Most of the reported commercial leopard shark catch occurs incidentally in gillnet and trawl fisheries. However, a small hook-and-line fishery targets this species in San Francisco Bay. In 1994, the implementation of a minimum commercial size limit of 36-inches (0.9-meters) TL and the exclusion of gillnet gear in State waters south of Point Arguello resulted in a dramatic drop in landings. Landings have remained relatively stable since then (Figure 14.2). In 2002, the use of gillnet gear was also prohibited along the central California coast

in 360 feet (110 meters) or less from Point Reyes to Point Arguello, which appears to have further stabilized gillnet landings. Gillnets have been prohibited north of Point Reyes since 1987.

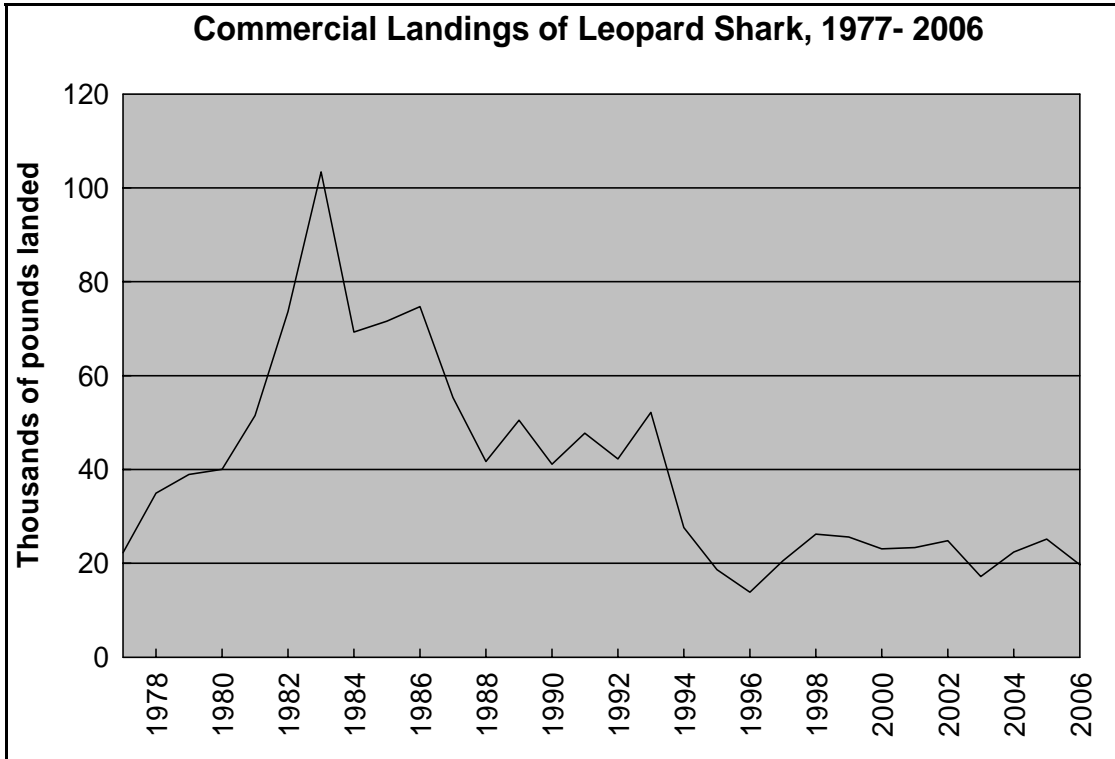


Figure 14.2. Commercial landings of leopard shark from 1977–2006. Data source: CDFG commercial landing receipt data.

Fishing revenue from the 2006 commercial harvest of leopard shark was about \$20,000 (ex-vessel 2006 dollars). The contribution to total business output, for the State, from this 2006 commercial harvest is estimated to be \$39,000. Likewise, total employment and wages from leopard shark is estimated to be the equivalent of 1 job and \$18,000 respectively.

Leopard shark pups have also been targeted by marine aquaria collectors due to their desirability as aquarium fish. Collecting pups for marine aquaria display became illegal in 1994 when the 36-inch (0.9-meters) TL commercial size limit went into effect. However, a black market for pups continues today.

In 2006, a three-year investigation involving the CDFG, NOAA Fisheries Service, and U.S. Fish and Wildlife Service, as well as investigators in the United Kingdom, Netherlands, and others resulted in the arrest and prosecution of several individuals charged with violating the Lacey Act. The Lacey Act is the Federal law which prohibits the possession, take, purchase, or sale of any wildlife

taken in violation of any state or federal regulation. Investigators estimated that from 1992 to 2004, 20,000 to 25,000 leopard shark pups were poached from San Francisco Bay, and 30,000 to 33,000 pups were poached from coastal waters off Los Angeles, Ventura, and Santa Barbara counties from 1992 to 2003. These estimates are significant when compared to recreational and commercial leopard shark landings. However, the recent convictions appear to have curtailed most of the illegal take of leopard shark pups at this time.

Status of Biological Knowledge

Leopard sharks are endemic to the Eastern North Pacific Ocean, ranging from Willapa Bay, Washington, to Mazatlan, Mexico, including the Gulf of California. This species is common in California waters, primarily in shallow water areas less than 60 feet (18 meters), although it has been found as deep as 273 feet (83 meters). These sharks are seasonally abundant in central and northern California bays and estuaries, but leave for the open coast in the winter months. South of central California, leopard sharks occur year-round along the open coast, particularly among kelp forests, rocky reefs, and sandy beach areas.

Nomadic, active swimmers, leopard sharks often form schools that are segregated by size and sex. Large groups may suddenly appear in an area and then quickly move on. They are also known to form aggregations with other elasmobranch species, such as bat rays, *Myliobatus californiaca*; smoothhound sharks, *Mustelis spp.*; and sevengill sharks, *Notorynchus cepedianus*. Studies in central and northern California bays and estuaries have shown that leopard shark movements are tidally influenced. They move into shallow mudflat areas to forage during high tides, and retreat to deeper water as the tide goes out. Studies also indicate that the seasonal abundance and movements of leopard sharks in bays and estuaries are likely influenced by prey availability as well as changes in salinity, temperature, and dissolved oxygen. Results from tag-recapture studies have demonstrated that the leopard sharks in San Francisco Bay are largely residential, although about 10 percent of the recaptured sharks made seasonal migrations out of the bay to the open ocean in fall and winter months.

Despite many tagging studies, little is known about the large-scale movements and population structure of leopard sharks. Tag-recapture studies have shown that this species can cover large distances. Leopard sharks tagged in Elkhorn Slough have been recaptured in San Francisco Bay, and vice versa. One shark tagged in San Francisco Bay was recaptured in Santa Monica Bay 10 years later. A leopard shark caught and tagged at Santa Catalina Island was recaptured in Carlsbad, indicating these sharks may be making offshore-onshore movements in southern California. However, recent genetic research on the structure of leopard shark populations indicates limited exchange occurs between regional stocks in California.

Leopard sharks are viviparous (live-bearing), with females giving birth to 7 to 36 young during the annual reproductive cycle. Gestation is estimated at 10 to

12 months, with pupping occurring March through July, peaking in April and May. Size at birth ranges from 7- to 8-inches (18- to 20-centimeters). Males mature at 27- to 47- inches (0.7- to 1.2-meters) (7 to 13 years) and females mature at 43- to 51-inches (0.7- to 1.3-meters) (10 to 15 years). Males live to at least 24 years of age, while females live to at least 20 years. The average annual growth rate for males is 0.75-inches (1.9-centimeters), and they reach a maximum length of 59-inches (1.5-meters). Females grow about 1-inch (2.5-centimeters) annually and reach a maximum length of at least 71-inches (1.8-meters). However, there is one record of a female measuring 83-inches (2.1-meters).

Little is known about the mating behavior of leopard sharks. In fact, there has been only one documented observation of mating activity in the wild, which took place off La Jolla, California, in August of 2003. Mating behavior was observed in a small aggregation of nine sharks, about 65 feet (19 meters) from shore in 3 to 10 feet (0.3 to 3 meters) of water. This observation supports the assumption that leopard shark mating takes place after spring parturition (giving birth), in the summer months.

Leopard sharks are opportunistic feeders, feeding on a wide variety of primarily benthic prey. Their diet is known to vary by location, season and shark size. Large adults are mostly piscivorous (fish eaters); eating anchovies, herring, sculpins, croakers, surfperch, rockfish, flatfish, and small elasmobranchs; while smaller adults and juveniles consume greater proportions of crustaceans, clam siphons; innkeeper worms, *Urechis caupo*, and fish eggs. Leopard sharks are preyed upon by other shark species such as sevengill sharks and white sharks, *Carcharodon carcharias*.



Leopard Shark, *Triakis semifasciata*. Photo credit: CDFG

Status of the Population

Leopard sharks are one of three shark species under the management authority of NOAA Fisheries through the Pacific Coast Groundfish Fishery Management Plan (Groundfish FMP). At this time, leopard shark stocks have not been assessed, and fall into the “Other Fish” management complex, which includes all Groundfish FMP species that are not rockfish or flatfish and have not had a stock assessment. A combined annual harvest guideline was established in 1983 for the “Other Fish” complex, which includes sharks, rays, ratfish, morids, grenadiers, and other groundfish species. Currently, the harvest guideline (optimum yield) for the “Other Fish” complex is set at 8,000 tons (7,264 metric tons) for West Coast fisheries.

Although the size of the California leopard shark population has not been estimated, recreational and commercial fishery catch statistics indicate that current management practices have been effective in protecting the resource. The curtailment of gillnet operations in nearshore waters, and the implementation of a recreational size and bag limit for leopard shark in the 1990s reduced and stabilized fishing mortality for this species.

Management Considerations

Current management measures appear to be effective in preventing over-harvest, and should remain in place. Nevertheless, increased outreach is needed to improve compliance with commercial landing receipt requirements for the marine aquaria trade and to eliminate illegal poaching of pups and the killing of gravid females to obtain live pups. Leopard sharks have a restricted geographic range, and genetic research suggests there is a limited exchange among regional populations. This species may therefore be vulnerable to overexploitation and habitat disturbance in areas with high human populations. Additionally, this species is slow growing, with a late maturity age, and long gestation period, suggesting it is vulnerable to overfishing. Future management should also take into account the potential impacts of poaching and other undocumented take, as well as the overall vulnerability of this species in shallow, nearshore habitats, especially areas thought to be important nursery grounds.

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Further Reading

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