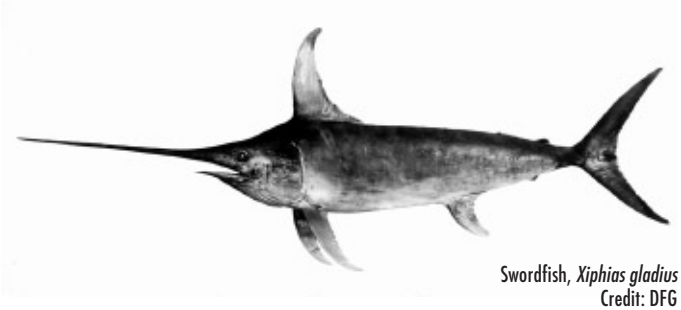
Swordfish

History of the Fishery

Swordfish (*Xiphias gladius)* is an important resource supporting major fisheries in all oceans of the world. The quality of swordfish flesh is excellent and is marketed both frozen and fresh. Major Pacific fishing areas include the waters off Japan, the North Pacific Transition Zone north of Hawaii, the west coasts of the U.S., Mexico, Ecuador, Peru, Chile, and off Australia and New Zealand. Much of the Pacific catch is taken incidentally in longline fisheries targeting tunas. Reported annual Pacific-wide landings averaged 26 million pounds per year between 1950 and 1986. Recent landings peaked in 1992 at 75 million pounds and now average around 65 million pounds annually. Japan, Taiwan and the U.S. account for about 70 percent of current reported production, with Mexico, Ecuador and Chile providing the remainder. In the eastern Pacific, swordfish are primarily harvested using longlines, drift nets and hand-held harpoons.

Early coastal and island middens of American Indians provide the first evidence of swordfish being utilized as a food source. The California harpoon fishery dates back to the early 1900s and the Tuna Club of Avalon reported the first record of a recreationally caught swordfish in 1909 that weighed 339 pounds. In 1931, the State Legislature required commercial fishing licenses and allowed only harpoons for the commercial take of swordfish. Recreational anglers were allowed to harpoon swordfish until 1935. Participation in the harpoon fishery peaked in 1978 with 309 vessels landing 2.6 million pounds before being largely displaced by the more efficient drift net fishery. A small number of harpoon vessels continue to fish swordfish off southern California from May to December. Primary fishing areas are from San Diego to Point Conception during the early season although these fishermen operate as far north as Oregon during periods of warm water. Harpooners require calm waters to see the swordfish finning, or basking, at the surface. When a finning swordfish is spotted, the fisherman guides his vessel over the fish and throws the harpoon from the bow plank extending far beyond the vessel bow. Harpooned fish are recovered using an attached line, buoys and marker flag. Use of spotter aircraft greatly improved catches by allowing takes of fish swimming just below the surface and not visible from the vessel. Most harpoon vessels sell their catch fresh daily and achieve a premium price above that for longline and drift net-caught fish.



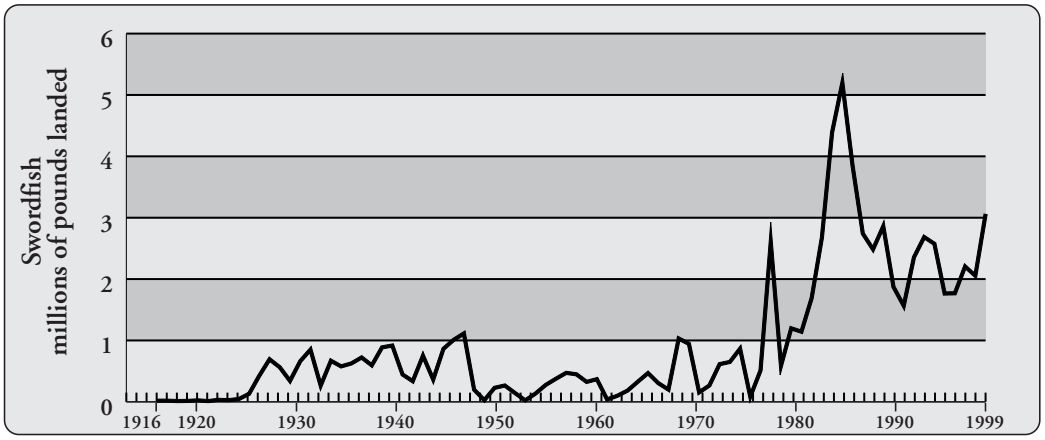
Swordfish, *Xiphias gladius*
Credit: DFG

The harpoon fishery remained the only legal gear until the late 1970s when a few drift gillnet vessels began targeting common thresher sharks. This rapidly developed into the successful drift net fishery for swordfish and thresher sharks, which proved more cost effective in terms of fuel economy and yielded greater catches than was possible with harpoon gear.

Annual landings of drift net caught swordfish increased rapidly peaking in 1984 at 5.2 million pounds valued at 10.3 million dollars. These vessels use nets up to 6,000 feet in length with mesh sizes ranging between 14 to 22 inches. The netting is attached to a floatline and a weighted leadline at the bottom allows the webbing to hang as a loose curtain in which the swordfish become entangled. Drift nets are set at sunset and hauled at sunrise. Regulations enacted in 1985 were designed to reduce fishing effort and landings, limit the number of permits to 150, restrict the season of operation and provide for several time-area closures aimed at reducing bycatch and interactions with recreational anglers. Drift net vessels, which numbered 220 in 1985, have decreased due to those regulations and now number about 120 vessels, of which only about 100 are fully active. These fishermen ply the waters from the Mexican border to Oregon and offshore to 200 miles. Approximately two-thirds of the landings and earnings occur in southern California, while one-third are landed in northern California, less than two percent of the landings occur in Oregon and Washington. This fishery is in a period of steady production with annual yields of 2.6 million pounds worth an estimated $5 million dollars. This level of production, along with imports from Mexico, has been known to saturate local markets, driving down ex-vessel prices.

Hawaii's longline fishery began targeting swordfish in 1988 and landings expanded to 13.2 million pounds worth 21 million dollars by 1998. These long-range vessels operate over a vast area of the north central Pacific accounting for as much a 36 percent of U.S. production in the Pacific. A small California-based, high seas longline fishery, operating beyond the EEZ, developed in 1991. These vessels were joined by other vessels from the Gulf Of Mexico in 1993 and numbered 31 by 1994. Most of these vessels returned home by 1995. Judicial ruling in Hawaii closed a vast area north of Hawaii to longline fishing in 2000. This resulted in nearly 20 longline vessels departing their Hawaiian base of operations to operate out of southern California ports.

In 1983, Mexico restricted the use of longlines along their coast by limiting the catch of billfish within 50 miles of



Commercial Landings 1916-1999, Swordfish
Data Source: DFG Catch Bulletins and commercial landing receipts.

their coast. A small fleet of drift net vessels, based in Ensenada began fishing swordfish in 1986. They operated from Ensenada moving south along the Baja peninsula and generally within 100 miles of the coast. They averaged nearly one million pounds of swordfish between 1986 and 1993. Concerns over bycatch of sport and protected species, prompted the Mexican government to issue permits in 2000 allowing these drift net vessels to convert to longline gear.

Status of Biological Knowledge

Broadbill swordfish, is the single species within its own family Xiphidae. It is characterized by a long, flat bill in contrast to the smooth, round bill of the marlins. Swordfish are elongate, round bodied, and lack teeth and scales as adults. They have a tall, non-retractable dorsal fin, and pelvic fins are lacking. They reach a maximum size of 14 feet and 1,190 pounds. The International Game Fish Association's all tackle angling record is for a 1,182-pound fish taken off Chile in 1953.

Swordfish are found in all tropical, subtropical, and temperate waters, sometimes entering sub-temperate water as well. In the western Pacific, it ranges from 50° N to 45° S whereas in the eastern Pacific, from 50° N to 35° S. Swordfish tend to concentrate where major ocean currents meet, and along temperature fronts. They are epi- and meso-pelagic, inhabiting the mixed surface waters where temperatures are greater than 55° F but also can move into water as cool as 41° F for short periods aided by specially adapted brain and eye heat exchange organs.

Areas of high apparent abundance in the North Pacific are north of Hawaii along the North Pacific transition zone, along the west coasts of the U.S. and Mexico and in the western Pacific, east of Japan. Migration patterns have not been described although tag release and recapture data indicate an eastward movement from the central Pacific north of Hawaii toward the U.S. West Coast. Catch records from Japanese longliners suggest greatest catches from Baja California, Mexico in the spring and summer, while catch data from the California drift net fishery show swordfish moving through coastal waters from August to January. Acoustic tracking indicates some diel movement from deeper depths during the daytime and moving into the mixed surface water at night. At times, they appear to follow the deep scattering layer, and small prey, as they undertake these vertical movements.

It is generally believed that females grow larger than males, as males over 300 pounds are rare. Females mature at four to five years of age in northwest Pacific and males mature first at about three to four years although there is some controversy as to size at first maturity in different areas. In the North Pacific, batch spawning occurs in water warmer than 75° F from March to July and year round in the equatorial Pacific. Reproductive material from nearly 500 female swordfish, of mature sizes, examined from the California drift net fishery contained no mature oocytes indicating swordfish were not reproductively active while vulnerable to that fishery.

Adult swordfish forage from surface waters to the bottom in coastal areas and are reported to 1,600 feet in the open ocean. Prey includes pelagic fish including small tuna, dorado, barracuda, flying fish, mackerel as well as benthic species of hake and rockfish. Squid are also important when available. Swordfish likely have few predators as adults although juveniles are vulnerable to predation by large pelagic fish.

Status of the Population

The condition of the swordfish stocks in the Pacific Ocean is unclear. Results of assessment studies so far have a large margin of uncertainty, owing in part to uncertainty in the stock structure of the population. Recent genetic studies suggest swordfish off the western coast of the Americas mix with swordfish from the central and western North Pacific. This result tends to support the hypothesis of a single stock in the Pacific with an uneven distribution that results in areas of high and low abundance. Studies of catch rates, on the other hand, suggest three or more stocks as demonstrated by high catch rates persisting in distinct areas that are separated by areas of low to zero catch rates in between. Also, genetic studies in the western Pacific found significant differences between southern and northern swordfish, indicating little mixing. Stock assessment studies using both hypotheses have concluded that the stocks appear to be in good condition and with exploitation at or below estimated MSY levels. These studies, however, have not included fishery statistics from recent years when some fisheries expanded significantly, nor have they taken into account the complex biology, such as sexual dimorphism and diurnal behavior, of swordfish indicating a need for more current stock assessment.

With recent expansion of the fisheries and indications that the expansion will continue, an up-to-date and accurate stock assessment is critically needed. Without such an assessment, it is difficult to rationally evaluate fishery management options for conservation and for implementing the precautionary approach.

In September 2000, major fishing nations in the Pacific agreed to an international convention on the Conservation and Management of Highly Migratory Fish Stocks of the western and central Pacific Ocean. This convention provides a mechanism for comprehensive monitoring and collection of data from swordfish fisheries, international cooperation in performing an up-to-date swordfish stock assessment, and implementation of conservation measures by all major fishing nations. In addition, swordfish will soon be covered in the fishery management plan for the West Coast highly migratory species being developed for the Pacific Fishery Management Council. Although swordfish is not a species of immediate concern to this convention, the convention provides a mechanism for comprehensive monitoring and collection of data from the swordfish fisheries, international cooperation in performing an up-to-date swordfish stock assessment, and implementation by all major fishing nations of conservation measures, including the use of the precautionary approach.

Management Considerations

See the Management Considerations Appendix A for further information.

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References

Coan, A.L., M. Vojkovich, and D. Prescott. 1998. The California harpoon fishery for swordfish, *Xiphias gladius*. Barrett, I., O. Sosa-Nishizaki, and N. Bartoo (eds) International Symposium of Pacific swordfish, Ensenada, Mexico, 11-14, December 1994. U.S Dep. Commer., NOAA Tech. Rep. NMFS 142. 276 pp.

Fulsom, W.B, D.M. Crory, and K. Brewster-Geisz. 1997. North America Swordfish Fishing. World Swordfish Fisheries: An analysis of swordfish fishing operations. Past-Present-Future. Vol. IV. Office of Science and Technology NMFS, NOAA, U.S. Dept. of Commerce, Silver Spring, MD, 1997.

Hanan, D.A., D.B. Holts and A.L. Coan. 1993. The California drift gillnet fishery for sharks and swordfish, 1981-82 through 1990-91. Fish Bulletin 175. 95 pp.

Holts, D.B. and O. Sosa-Nishizaki. 1998. Swordfish, *Xiphias gladius*, fisheries of the eastern North Pacific Ocean. Barrett, I., O. Sosa-Nishizaki, and N. Bartoo (eds) International Symposium of Pacific swordfish, Ensenada, Mexico, 11-14, December 1994. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 142. 276 pp.