

White Sturgeon

History of the Fishery

Historically, the white sturgeon (*Acipenser transmontanus*) resource has been very important to Californians. Sturgeon scutes and skull plates are found in Native American middens in the San Francisco Bay, Sacramento-San Joaquin delta, and Elkhorn Slough areas, indicating that these large fish were important sources of tribal nutrition. An early commercial fishery developed for white sturgeon between the 1860s and 1901, stimulated by a growing acceptance of smoked sturgeon and caviar on the East Coast of North America. The California harvest was concentrated in the San Francisco Bay and delta. Fishing gear included gillnets, longlines, and multiple unbaited hooks for snagging sturgeon. The commercial catch peaked at 1.65 million pounds in 1887, declined to 0.3 million pounds in 1895, and to 0.2 million pounds in 1901, when the commercial fishery was closed. Small commercial catches in a reopened fishery from 1909 to 1917 indicated that white sturgeon populations were still low, and commercial fishing ceased in 1917.

Sport fishing for white sturgeon was legalized in 1954, with a 40-inch total length minimum size limit and a one fish per day per person creel limit. In 1956, snagging for sturgeon was outlawed and the minimum size limit was raised to 50 inches through 1963. The small sport fishing catch increased dramatically in 1964 when the minimum size reverted to 40 inches and bay shrimp were discovered to be effective bait. By 1967, 2,258 sturgeon were landed by party boat anglers. Possibly due to reduced stocks of other estuarine and coastal marine species such as striped bass, angling for white sturgeon has become very popular. Although exact sport catch data are not available, the California Department of Fish and Game (DFG) estimates that the harvest rate during the 1980s was 40 percent greater than it was during the previous two decades. In 1990, a 72-inch maximum size limit became law and the minimum size limit was increased by two inches per year until a new minimum size of 46 inches was reached in 1992.

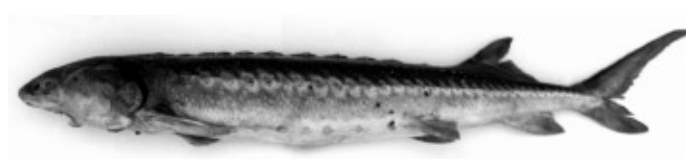
Status of Biological Knowledge

White sturgeon are generally found in estuaries, and their range extends along the Pacific Coast of North America from Ensenada, Mexico, to the Gulf of Alaska. However, spawning populations have been found only in large rivers from the Sacramento-San Joaquin system north. Indeed, most California white sturgeon are found in the San Francisco Bay estuary. Some white sturgeon move into the delta and lower Sacramento River during late-fall and winter. Some of these fish move up the Sacramento River to the Knights Landing-Hamilton City area to spawn.

Spawning may also occur in the Feather River, but has not yet been documented there. A small number move up the San Joaquin River. The Klamath River supports the other California subpopulation of white sturgeon. Although most recoveries from a tagging program in the San Francisco Bay estuary have come from the estuary and its tributaries, a few fish (less than one percent of total recoveries) have moved along the Pacific Coast and been recovered in Oregon and Washington.

California white sturgeon grow rapidly when young, reaching 12 inches fork length in one year. This rapid growth slows thereafter and they reach the present minimum legal size of 46 inches after nine to sixteen years. Subsequently, they grow one to 2.5 inches per year. Ages and growth rates of field-caught fish have been determined from the number and spacing of annular rings, visible in sections of first pectoral fin rays. Laboratory experiments have shown that young-of-the-year white sturgeon growth is affected by water temperature and dissolved oxygen concentration. They grow significantly faster at 68°F than at 59°F, but an increase to 77°F does not significantly increase growth rate. When dissolved oxygen concentrations drop to 56 percent of air saturation at any of these three temperatures, juvenile fish show a significant decrease in growth rate, presumably due to reduced food consumption. The white sturgeon's rapid growth rate has attracted the interest of some California aquaculturists, who grow sturgeon in freshwater tanks which have consistently moderate temperatures and high dissolved oxygen concentrations.

The largest sturgeon were caught before 1900 when size records were vague. However, the largest of these fish was probably more than 13 feet long and weighed more than 1,300 pounds, making white sturgeon the largest freshwater-inhabiting fish in North America. This fish may have been 100 years old. The largest white sturgeon captured in California waters during the past 40 years was a 468-pound fish caught by a sport angler in Carquinez Strait in 1983. This fish is the present world record sport-caught white sturgeon. In a University of California, Davis (UCD) study of white sturgeon during the 1980s, many fish were caught, measured, examined for sex and stage of maturity, and released. Median male size was 3.6 feet and median female size was 4.6 feet in San Francisco Bay.



White Sturgeon, *Acipenser transmontanus*
Credit: DFG

Compared with most freshwater or anadromous fishes, white sturgeon are quite old when they become sexually mature, but they evidence impressive fecundity at this large size. In the UCD study during the 1980s, sexually mature males were 3.6 to 6.0 feet long (nine to 25 years old), whereas mature females were generally 4.6 to 6.6 feet (14 to 30 years old). However, high natural variability in the size at sexual maturity was noted, especially among females. For example, the smallest pre-spawning female white sturgeon weighed only 25 pounds, whereas a 120-pound female was caught which, from gonadal analysis, was determined to have not yet spawned. Studies suggest that white sturgeon females do not spawn every year. Several years may lapse between successive spawnings in an individual female. In the study on San Francisco Bay fish, approximately 50 percent of the males captured were approaching spawning condition for that year, compared with only about 15 percent of the captured females. Fecundity varies with female size. Smaller females (under five feet) contain about 100,000 eggs, whereas a 9.2-foot, 460-pound female contained 4.7 million eggs.

Spawning occurs in the Sacramento River between mid-February and late May when water temperatures are 46° to 72°F. Little is known about spawning behavior. White sturgeon spawn their eggs onto deep gravel riffles or rocky holes in the Sacramento River. The fertilized eggs are very adhesive and hatch after four to 12 days on the bottom. Larvae stay close to the bottom and rear in both the river and the estuary downstream. Rearing location is at least partly determined by river flow; more larvae are washed into the estuary when freshwater flows are high. Young juvenile sturgeon become increasingly tolerant of brackish water as they grow and develop.

White sturgeon feed on a wide variety of bottom-dwelling animals. Sturgeon feed by suction with their ventral, protrusible mouths. Dense aggregations of taste buds on their four barbels presumably assist in identification of food on the bottom. When their mouths are blocked by food, white sturgeon can ventilate their gills by flushing water in via the dorsal part of the gill slit and out via the ventral part. Young sturgeon (eight inches) feed primarily on small crustaceans such as amphipods and opossum shrimp. As they develop, they take a wider variety of benthic invertebrates, including various species of clams, crabs, and shrimp. Larger white sturgeon diet includes fishes and, during winter in San Francisco Bay, herring roe.

Little is known about predators on white sturgeon. Smaller fish are undoubtedly taken by various fish and bird predators, although the five lines of bony scutes along their bodies probably make them less desirable prey than other estuarine species. Anglers undoubtedly mount the largest predatory effort on adult fish.

Status of the Population

The 19th century history of white sturgeon fishing in California waters shows this species' vulnerability to overfishing. Delayed sexual maturity and infrequent spawning by the females exacerbates this vulnerability compared to many other fishes. DFG tagging studies indicated that angler harvest was high during the 1980s and new size limits (including initiation of a first-ever maximum size limit in 1990) reflect DFG's management concerns. Annual harvest rate estimates indicate that the angling regulation changes begun in 1990 have had the desired effect: harvest rates have been reduced by at least half from the levels of the mid- to late 1980s.

Adult (at least 40 inches total length) white sturgeon abundance, as estimated from tagging studies, varied greatly between 1967 and 1998. The abundance estimate reached its highest level (142,000) in 1997. This abundance pattern is largely the result of irregular recruitment to the adult population by highly variable year classes. Strong year classes are produced in years with high spring freshwater outflows from the Sacramento-San Joaquin Delta, so much of the present high white sturgeon abundance is attributable to the very wet 1982-1983 period.

Unfortunately, the severe drought that gripped California from 1987 to 1992 will soon begin to affect the adult white sturgeon population, because reproductive success was low in most of those years. The strong year classes from the early 1980s were recruited starting in about 1994 and, by 1997 and 1998, few fish smaller than the minimum size limit of 46 inches were caught. Thus, the population should decline substantially as recruitment almost ceases and growth and mortality reduce the abundance of fish now in the fishable population. However, another cycle of strong recruitment can be expected when fish from a series of wet years starting in 1993 begin to enter the fishery late in the next decade.

The present low exploitation rates, past rapid recoveries from population lows in the mid-1970s and early 1990s, and current protection of the most fecund females by the 72-inch maximum size limit suggest that no further angling restrictions are needed at this time.

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Angler holding a white sturgeon
Credit: DFG