

Sturgeon Facts

Green Sturgeon

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Adult Green Sturgeon. CDFW photo by Mike Healey.

- **Life History**

“Green Sturgeon are an anadromous fish with limited distribution in California. Historically the Klamath and Sacramento River systems had the greatest spawning populations of these fish. Today the Klamath River and its tributaries are home to the largest remaining spawning populations. The Eel River and South Fork Trinity had spawning populations at one time, though they are seemingly non-existent now. The lower reaches of the San Joaquin may have also had spawners at one time. Green Sturgeon have been observed as visitors in the Mad River, Smith River, and Salmon River.

Green Sturgeon are anadromous though they are considered the most marine of the sturgeon species and their life in freshwater may be relatively limited to spawning. Green Sturgeon hatch in freshwater and may leave as yearlings or stay in a river for up to 3 years. Most juveniles migrate downstream during the summer and fall of their second year. The juvenile fish usually remain in the estuary for a period before dispersing into the Pacific.

Green Sturgeon are benthic feeders that use their barbels and protruding ventral mouth to find prey. In the estuary sturgeon may feed on amphipods, opossum shrimp, clams, or anchovies. The diet of a sturgeon in the ocean may include sand lances and callinassid shrimp. Sturgeon also feed on other fish. They grow at a rate of approximately 7 cm per year until they reach maturity which is typically at an age of 15-20 years. Green Sturgeon spend 3-13 years in the ocean before returning to their natal streams. Males tend to spend less time at sea than females, and they mature earlier in life. Mature males do not become as large as mature females of the same age. Green Sturgeon of the Klamath River begin moving upstream in late February to late July and spawning takes place between March and July. Sturgeon spawning occurs above cobble in deep, fast water. Each female produces 60,000 to 140,000 eggs which presumably hatch after only 200 hours of incubation time. Green Sturgeon have been documented as living up to 42 years, though some fish biologists believe they may have a maximum life span of 60-70 years.” [Source](#)

- **Distribution**

“There are two genetically identifiable populations, or Distinct Population Segments (DPS), of Green Sturgeon recognized by the state and federal governments. The northern DPS is known to spawn in the Klamath River in California, as well as the Rogue River in Oregon. Northern DPS fish have also been observed in the Trinity and Eel rivers, as well as in the Umpqua River (OR), though it is not yet clear if they routinely spawn in those locations. Southern DPS Green Sturgeon are found in the Sacramento and San Joaquin rivers and Delta. They primarily spawn in the upper mainstem of the Sacramento River, although some spawning activity has recently been documented in the Feather and Yuba rivers. The extent to which the species uses the San Joaquin River is unclear at this time, although an adult fish was recently found in a major tributary, the Stanislaus River, indicating at least some use of that system. Green Sturgeon are one of the most marine-oriented sturgeon species, spending much of their life in coastal Pacific Ocean waters from Ensenada, Mexico, to the Bering Sea. The species frequently enters large coastal bays and estuaries, including the San Francisco Bay estuary, Columbia River estuary (WA), Willapa Bay (WA) during the summer to feed, with fish from both DPS’s mingling freely in those habitats.” [Source](#)

- **Threats**

“The primary spawning habitats of Green Sturgeon are confined to short reaches of a small number of rivers, so the species is vulnerable to habitat loss and climate change that might degrade or destroy those sites. In particular, most of the reproduction of the sDPS takes place in a small segment of the Sacramento River, which led to the DPS being listed as Threatened under the Federal Endangered Species Act. Temperature has a major impact on Green Sturgeon growth and development and early life stages are very sensitive to temperature, particularly eggs and larvae. These stages grow optimally at around 15°C and exhibiting reduced growth, deformities, or death at temperatures lower than 11°C and higher than 20°C. Other factors that threaten Green Sturgeon include entrainment of early life stages into water diversions, contaminants from pollution and terrestrial runoff, and poaching and illegal fishing.” [Source](#)

- **Conservation and management**

“Southern DPS Green Sturgeon are protected as a Threatened species under the Federal Endangered Species Act, so no take of any kind is permitted. Take is defined as “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.” CDFW regulations also prohibit take or possession Green Sturgeon anywhere in California, regardless of DPS, with the exception of a small, well-regulated, tribal fishery for northern DPS fish on the Klamath River. In all other cases, fish hooked accidentally may not be removed from the water and must be released unharmed immediately. Green Sturgeon captured accidentally in the White Sturgeon recreational fishery must be released and reported on the Sturgeon Fishing Report Card. All sturgeon fishing is prohibited in the Sacramento River from the Highway 162 bridge (Butte City) to Keswick Dam in order to protect Green Sturgeon at the primary spawning grounds.” [Source](#)

White Sturgeon



Adult White Sturgeon. CDFW photo by Mike Healey.

- **Life History**

“White Sturgeon are anadromous fish that spend most of their lives within an estuary, usually returning to freshwater only to spawn. White Sturgeon have been found in some cases to travel hundreds of kilometers to other estuaries and river systems. When Sturgeon larvae hatch in a stream they begin swimming around in a vertical position as they are suspended by a yolk sac, making them more susceptible to be carried down to the estuary in the current. After they consume the sac they begin swimming freely and feeding through their mouth. In general the distribution of sturgeon in an estuary is age dependent and a function of salinity tolerance. The younger fish are found on the upstream or freshwater end of an estuary whereas the older fish are found on the ocean side. Once White Sturgeon

have adapted to the changes in salinity they may move around a bay or estuary to find an optimal type of brackish water. They grow quickly in their first year, up to 30 cm FL in the San Francisco Bay estuary, and the growth rate generally decreases with age. The diet of young sturgeon consists primarily of different types of crustaceans, though they begin to increase the diversity with age. Most food is taken from the bottom of the estuary where the sturgeon may pick up clams, crabs, and shrimp. Larger sturgeon begin to feed on other fish such as anchovies, starry flounder, smelt and striped bass. The opportunism of the White Sturgeon can be seen in their documented consumption of crayfish, trout, frogs, salmon, crayfish and even one domestic cat. Male sturgeon reach sexual maturity before the females, though time of onset of maturity for both varies with photoperiod and temperature. Typically males are at least 10-12 years old and have a fork length of 75-105 cm. Females mature when they are 12-16 years old and have a fork length of 95-135 cm. White Sturgeon don't necessarily breed annually and only a small percentage of the adult population spawn in a given season. Males may spawn every 1-2 years and females every 2-4 years. The sturgeon begin migrating in streams during winter, with large peak flows triggering the spawning between February and early June. The optimal water temperature for spawning falls in the range of 8-19°C. Fish biologists believe the White Sturgeon pick deep swift water areas to spawn such as riffles or pools with rock and gravel substrate. Female sturgeon produce many eggs, with the Sacramento White Sturgeon producing an average of 5,648 eggs per kilogram of body weight. Male sturgeon fertilize the eggs, giving them a tacky property that allows the eggs to stick to the substrate till the larvae emerge 4-12 days later. White Sturgeons have a long life span that may have exceeded 100 years historically."

[Source](#)

"White Sturgeon in California are believed to occur in primarily estuarine and riverine habitats, and spend only a small proportion of their time moving outside the estuary to the open coast. However, within the estuary, certain components of the estuarine fish and invertebrate communities are strongly affected by climate driven ocean variability (i.e., currents and temperature), whereas others more strongly responded to land-based climate processes, such as precipitation and outflow (Cloern et al. 2010; Peterson and Vayssières 2010; Feyrer et al. 2015). Such mechanisms not only influence the estuarine environment, and thus the physiology of White Sturgeon, but also the abundance and distribution of organisms forming the food base for White Sturgeon." (Kimmerer 2002; Peterson and Vayssières 2010).

"White Sturgeon distribution is highly related to salinity patterns, with many fish inhabiting the brackish water of Suisun and San Pablo bays throughout the year (Kohlhorst et al. 1991). Further, these fish tend to move downstream in the winter when river flows tend to freshen Suisun Bay, and a portion move upstream into the Delta and lower Sacramento River beginning in fall and increasingly in winter, before presumably mature fish move farther into the Sacramento River in spring to spawn (Kohlhorst et al. 1991). In addition, abundance in the San Francisco Estuary is highly variable through time, and strong year-classes occur only in years when the Sacramento Valley Water Year index was rated "wet" and river flows were very high (Figure 1-3) (CDFG 2008). Changing ocean conditions will influence weather, precipitation and riverine flow and will likely affect sturgeon recruitment, particularly if years of high river runoff occur less frequently (Kohlhorst et al. 1991; Fish 2010). The frequency of wet years has declined across the decades from the 1980s through the present, leading to longer periods of little or no recruitment. This may have contributed to the declining adult abundances observed since that time." [Source](#)

- **Prey**

*"White Sturgeon are well adapted to preying on bottom-dwelling organisms, even in areas of high turbidity and low visibility. The species is able to use smell and electroreception, as well as taste and touch associated with the row of sensitive barbels on the underside of their rostrums. Once prey is detected, sturgeon swallow it whole using their sub-terminal mouth with long, extensible "lips". Young White Sturgeon feed on small crustaceans (e.g. amphipods and mysid shrimp) and aquatic insects (Radtke 1966). Their diet broadens as they grow to include a variety of bottom dwelling invertebrates, primarily clams, crabs and shrimps, but also fish and fish eggs in certain circumstances (Radtke 1966). After the invasion of the Over-bite Clam (*Potamocorbula amurensis*) in the 1980s, the clam itself and fish have become larger components of the White Sturgeon diet in the San Francisco Estuary." (Zeug et al. 2014).*

*"White Sturgeon eggs are vulnerable to benthic feeding organisms. Known predators of White Sturgeon eggs include Northern Pikeminnow (*Ptychocheilus oregonensis*), Largescale Sucker (*Catostomus macrocheilus*), Prickly Sculpin (*Cottus asper*) and Common Carp (*Cyprinus carpio*) (Miller and Beckman 1996). In lab experiments, Prickly Sculpin predation on White Sturgeon yolk sac larvae increased with reduced turbidity levels and significantly decreased at the lowest light levels with the presence of cover. This was especially true for small larvae that were best able to take advantage of the cover (Gadomski and Parsley 2005). In the San Francisco Estuary, young White Sturgeon are occasionally preyed upon by Striped Bass (Grossman 2016). While they have few predators as adults other than humans, they are occasionally preyed upon by large sharks, sea lions and other marine mammals." [Source](#)*

- **Age and Growth**

"Individual growth of marine species can be quite variable, not only among different species but also within the same species. Growth is often very rapid in young fish, but slows with maturity and again as adults approach their maximum size. The von Bertalanffy Growth Model has been used to model White Sturgeon growth (Kohlhorst et al. 1980; Blackburn 2018; Blackburn et al. 2019).

Juvenile White Sturgeon grow rapidly in culture at 16 °C (61 °F): body weights double every 2 to 3 weeks during their first 4 months of life (Brannon et al. 1984). Although they are likely to grow less rapidly in the wild, juvenile White Sturgeon in the Sacramento River reach 43 to 45 cm (17 to 18 in) TL at the end of their first year and then grow at a rate of 2.0 to 6.0 cm (0.8 to 2.4 in) per year after reaching 102 cm (40 in) TL (Brennan and Cailliet 1989; Hildebrand et al. 2016). Juveniles on average achieve 100 cm FL by age 9 and reach the 102 cm FL lower boundary of the harvestable slot limit that same age (Blackburn 2018; Blackburn et al. 2019). More specifically, a few juveniles enter the harvestable range (102 to 152 cm FL= 114 to 170 cm TL) by age 8 but virtually all have entered by age 13." (DuBois et al. 2010).

"White Sturgeon are late maturing, and both size and age at maturity vary across the species' range (see Hildebrand et al. 2016). In the Sacramento-San Joaquin river system, a small fraction of males sampled reached maturity between 100 and 105 cm (39 to 41 in) FL; and the first mature female observed was 104 (41 in) FL, but <10 percent of the females

observed were mature prior to 135 cm (53 in); beginning about 135 cm FL (≥ 53 in) the fraction of mature females increased to 20 percent and further increased with increasing length (Chapman et al. 1996). Males of 100 and 105 cm (39 to 41 in) FL would have averaged about 9 to 10 years of age, respectively; a female at 104 cm (41 in) would have been 9 to 10 years old as well and those at 135 cm (53 in) would have been about 14 years old based on back calculated length at age from Blackburn (2018). Blackburn (2018) estimated FL at age from recent sampling data (2014 to 2016) and provides evidence that White Sturgeon length at age is greater based on this recent data than for data from the 1970s. Age of maturity is much reduced in captivity, where males and females mature at an average age of 4 and 8 years, respectively (Doroshov et al. 1997).” [Source.](#)

- **Population Dynamics**

“Population estimates for White Sturgeon in the San Francisco Estuary have been conducted periodically and can fluctuate dramatically. Recent estimates suggest that the San Francisco Estuary population has declined in recent years. White Sturgeon are long-lived and exhibit highly variable recruitment. Most White Sturgeon in California recruit to the fishery at about 9 or 10 years old and mature around age 15. Their late maturity, combined with the fact that females spawn every 2 to 5 years, means that productivity is likely to be low. In addition, recruitment success is correlated to high Delta outflow, and thus large year-classes only occur in in wet years (Stevens and Miller 1970; Kohlhorst et al. 1991; CDFG 2008, Fish 2010), which have become more sporadic recently. Between 2000 and 2018, only three years have been classified as “wet” and produced White Sturgeon year-classes: 2006, 2011 and 2017, as compared to 1980 to 1989 when there were four wet years, and 1990 to 1999 which experienced five wet years (Figure 1.3). These factors combine to make White Sturgeon highly vulnerable to overfishing.” [Source](#)

- **Habitat**

“Reproductive White Sturgeon are believed to return to particular river reaches and then select specific areas for egg deposition based on water velocity, turbulence, depth, and bottom composition (Hildebrand et al. 2016). Spawning takes place in fast-flowing waters over coarse bottom materials (though occasionally finer particles such as sand or clay are present) located in main river channels and in some cases large side channels (Parsley et al. 1993; Schaffter 1997; Perrin et al. 2003). Fast, turbulent water disperses eggs across the bottom, possibly reducing density-dependent mortality (Hildebrand et al. 2016). Recently hatched embryos appear to have highest rates of survival in the interstitial spaces among coarse bottom particles.” (Hildebrand et al. 2016).

“Feeding larvae and early juveniles seek habitats with low water velocity in main channel reaches, side channels and sloughs. In the lower Fraser River, juveniles were most frequently caught during summer months in tidal sloughs or channels (currents varied in speed and direction), 5.0 m (16.4 ft) or deeper, water temperatures between 15 to 20 degree Celsius ($^{\circ}\text{C}$) (59 to 68 degrees Fahrenheit ($^{\circ}\text{F}$)), with mostly fine sediments and highly variable turbidities (1.5 to 86.0 Nephelometric Turbidity Unit).” (Bennett et al. 2005).

“In the San Francisco Estuary, older juveniles and adults inhabit estuarine habitats ranging from the Sacramento-San Joaquin Delta downstream into marine waters of central San

Francisco and south San Francisco bays, with the greatest numbers inhabiting Suisun and San Pablo bays (Kohlhorst et al. 1991; DuBois et al. 2010a).” [Source](#)

- **Fishery**

“The White Sturgeon fishery takes place in the San Francisco Estuary, but there has been no commercial fishery since 1917. A valuable recreational fishery began again in 1954 after a hiatus since 1917 to rebuild the stock. The recreational fishery supports a modest commercial passenger fishing vessel fleet, but most fishing occurs on private boats. The White Sturgeon recreational fishery focuses on the upper San Francisco Estuary (San Pablo and Suisun bays), the Sacramento-San Joaquin Delta and the Sacramento River. In the San Francisco Estuary over the period 2007 to 2018, White Sturgeon abundance appears generally low and possibly declining.” [Source](#)

- **Bycatch**

“FGC §90.5 defines bycatch as “fish or other marine life that are taken in a fishery but which are not the target of the fishery.” Bycatch includes “discards,” defined as “fish that are taken in a fishery but are not retained because they are of an undesirable species, size, sex, or quality, or because they are required by law not to be retained” (FGC §91). The term “bycatch” may include fish that, while not the target species, are desirable and are thus retained as incidental catch.

Limited information is available for bycatch during recreational angling for White Sturgeon. Many anglers catch and harvest additional species such as Striped Bass when targeting White Sturgeon, but there is no data available to quantify species composition or amount of bycatch caught. White Sturgeon not in the harvest slot limit are also frequent bycatch by anglers.

Data from the sturgeon report card program indicate that Green Sturgeon are also sometimes bycatch of the White Sturgeon fishery. In 2006, the National Marine Fisheries Service (NMFS) determined that the North American Green Sturgeon Southern Distinct Population Segment (DPS), which includes the populations originating from coastal watersheds south of the Eel River, is at risk of extinction in the foreseeable future throughout all or a significant portion of its range and listed the species as Threatened under the Federal Endangered Species Act (ESA). As a result, the Commission, upon a recommendation by the Department, closed the recreational fishery for Green Sturgeon in 2007 (§5.81, Title 14, CCR). In 2007, the Department began collecting data on angling effort and sturgeon catch via White Sturgeon report cards, which provide data on the number of Green Sturgeon caught in this fishery each year (Table 3-1). Anglers reported the catch and release of 230 Green Sturgeon in 2017, with an additional 27 sturgeon that could not be identified to species also released alive (DuBois and Danos 2018). There are a number of management measures in place to reduce the mortality of Green Sturgeon, including the use of barbless hooks, prohibitions on gaffing and snaring, and restrictions on removing Green Sturgeon from the water. While Green Sturgeon mortality after discard has not been formally studied, it is believed to be low.

The report card data also provides information on the number of released White Sturgeon, which has ranged from 1.5 to 6 times the number retained. It is unknown what proportion of

released fish were too small or too large relative to the slot limit. Hooking mortality for sturgeon is not well quantified, but is assumed to be minimal. One study simulated capture handling (e.g. air exposure and struggling) without hooks on White Sturgeon and found that while some physiological stress occurs, it is likely to be minimal and sublethal (McLean et al. 2016).

There are no known interactions between the White Sturgeon fishery and either seabirds or marine mammals. In the San Francisco Estuary, there have been rare observations of sea lions biting at White Sturgeon that have been netted or hooked, but these have not resulted in any injury to the sea lion (Jason DuBois pers. comm." [Source](#)

- **Management**

"The White Sturgeon sport fishery in California is managed to avoid over-harvest by establishment of minimum and maximum size limits (40 to 60 inches Fork Length may be retained) and bag limits of one fish per day and three fish per year, statewide. Anglers must report White Sturgeon catch and harvest, among other data, on their Sturgeon Fishing report card and return the card to the Department at the end of the year.

A commercial sturgeon fishery developed in the San Francisco Bay Estuary in the 1860s to supply the increasing demand for caviar and smoked sturgeon in the eastern United States. Records from the time do not differentiate between species, though the significant majority of the captured fish are believed to have been White Sturgeon as opposed to Green Sturgeon. The gear used in the commercial fishery included gill nets, long lines and snagging hooks. The commercial fishery peaked in 1885 when 1.65 million lbs were landed (Jordan and Gilbert 1887). Heavy commercial fishing led to serious resource depletion by 1900 and the fishery for sturgeon closed in 1901. The fishery reopened in 1909; however, small catches indicated that the population was still depressed. The commercial and recreational sturgeon fisheries closed in 1917, and the commercial fishery has remained closed. The recreational fishery for sturgeon (White and Green Sturgeon combined) was reestablished in 1954 with a 40 in (100 cm) TL minimum size limit, no seasonal closure, and a one fish per day bag limit." (Pycha 1956).

"A tagging study conducted in 1954 showed that the sturgeon fishery is dependent upon widely spaced strong year-classes. This tagging study resulted in a recommendation for a 50.0 in (130 cm) minimum size limit for both sturgeon species to provide a buffer stock of larger fish for anglers and to insure maintenance of an adequate spawning stock (Pycha 1956). The new size limit was implemented in 1956, the same year that snagging sturgeon became illegal. Subsequently, sturgeon could only be taken by angling, which is defined as the fish voluntarily taking bait or a lure in its mouth (§5.80, Title 14, CCR). The minimum size limit was returned to 40 in (100 cm) in 1964. Concern over potential depletion of the sturgeon resource in the late 1980s prompted regulation changes starting in 1990 with the implementation of a 72.0 in (180 cm) TL maximum size limit, creating the first slot size limit regulation for a marine species in California. The slot size limit protects smaller, non-reproductive, juvenile fish as well as larger fish with the highest reproductive capacity. In 1990, the minimum size limit was increased by 2.0 in (5.1 cm) each year until 1992 when a minimum size limit of 46.0 in (120 cm) was reached (§5.80, Title 14, CCR).

In 2007, several new recreational fishing regulations were implemented for the White Sturgeon fishery to assist enforcement, and to reduce the catch and the bycatch of Green Sturgeon, which was listed as threatened under the federal Endangered Species Act (ESA). The new regulations provided for an annual limit of three White Sturgeon and a reduction in the maximum size limit to 66.0 in (168 cm) TL, added a requirement to record all catch and harvest on a report card, and added a requirement to tag all retained White Sturgeon (§5.79; 5.80, Title 14, CCR) (Roberts and Gingras 2010).

Since 2007, regulations further changed the allowable White Sturgeon slot limit to 40.0 to 60.0 in (102 to 152 cm) FL. White Sturgeon that are 68 in (173 cm) FL or longer may not be removed from the water and shall be released immediately. The reduction in maximum length at the upper end of the slot limit and implementation of the 68 in (173 cm) water removal limit was intended to improve survival of larger fish that are important for reproduction and sustaining the fishery. The change to measuring FL instead of TL was implemented to combat poaching efforts in which some anglers would trim the outer end of a White Sturgeon's tail to make it fit within the designated slot limit. The use of snares and gaffs for landing White Sturgeon were banned in 1990 and 2013, respectively, to reduce discard mortality (§5.80, Title 14, CCR)." [Source](#)

- **The Sturgeon Study**

"Staff of the Sturgeon Study make estimates of sturgeon abundance, relative abundance, harvest rate, and survival rate by using data from Commercial Passenger Fishing Vessels (Party Boats; CPFV), various creel surveys, and a mark-recapture program. We monitor the relative abundance of sturgeon by calculating catch per unit effort (CPUE) from data submitted by Commercial Passenger Fishing Vessels. The Department's Marine Region compiles the data, we request the data at intervals, and we calculate CPUE. By applying tags to sturgeon and monitoring the subsequent ratio of tagged fish to untagged fish, we calculate sturgeon abundance, relative abundance, harvest rate, and survival rate. During August-October we use nets in San Pablo Bay and/or Suisun Bay to collect sturgeon, then we tag and release them on-site. Each tag includes our mailing address and a unique code, and some tags include a reward value. By posting "Tagged-fish Wanted" posters around the Estuary and making presentations, we encourage anglers to return tags to us. We also recover tags by talking with anglers during various creel surveys.

Sturgeon Fishing Report Cards (Cards) are an integral part of Department and legislative efforts to reduce the illegal commercialization of sturgeon. Cards provide critical data on catch and harvest that enable the Department to make informed fisheries management decisions surrounding White Sturgeon and federally threatened Green Sturgeon populations. While Card reporting is legally mandated for all anglers targeting White Sturgeon, it also serves as one of the most important actions anglers can take towards conserving these species. The California Department of Fish and Wildlife (CDFW) is currently evaluating White Sturgeon fishing regulations and would like your feedback. Responses from this questionnaire will be used to describe angler preferences for White Sturgeon and may be used to inform CDFW's management objectives for the fishery. The current harvest regulations for White Sturgeon caught in the sport fishery are: minimum length of 40 inches FL (fork length) and maximum length of 60 inches FL, one per day with

no more than one in possession, and a limit of three per year ([California Freshwater Sport Fishing Regulations](#)).” [Source](#)