

THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF FISH AND GAME
WATER PROJECTS BRANCH

An Historical Review of the
**FISH AND WILDLIFE RESOURCES
OF THE
SAN FRANCISCO BAY AREA**

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STURGEON

Two species of sturgeon are common in San Francisco Bay; the white (*Acipenser transmontanus*) and the green (*Acipenser medirostris*). Little has been recorded about the early history of the green sturgeon except that it was considered definitely inferior to the white and was actually claimed by some to be poisonous. Most early accounts refer to white sturgeon, which incidentally, also was considered a nuisance by commercial fishermen who destroyed them at every opportunity because they inflicted heavy damage to their nets. Until 1870 or thereabouts only the Chinese, who extricated the gelatinous notochord from the backbone, found them of value. Up to that time white sturgeon were abundant.

The westward movement brought Easterners with appetites for sturgeon and caviar to the Pacific Coast. About the same time sturgeon were becoming scarce on the Atlantic seaboard. These factors served to bring about a complete reversal in demand for the species and by 1901 when the legislature temporarily abolished the fishery, white sturgeon were claimed to be on the verge of extinction.

Commercial Fishery

Relatively speaking, the commercial sturgeon fishery was short-lived. Fishing was principally by "Chinese" trawl lines, long lines suspended several feet above the bottom from which large barbless hooks were "dropped". Gill and trammel nets were also successful gear for capturing them; but such catches, more often than not, were made incidental to fishing for other species.

The earliest records concerning the catch date from about 1875. Catch data are almost exclusively from the annual reports of the U. S. Commissioner of Fisheries. Unfortunately, the statistics for one year often contradicted those of preceding years, making a definitive determination virtually impossible. Nevertheless, statistics for those years for which catch data are available are given in Appendix B-4. Where contradictory data were encountered, the latest was used on the assumption that such data were based on more complete and detailed reports.

Jordan (1887) reported a catch of 1,658,000 pounds for the year 1885, the largest catch on record. The annual catch from 1875-1892 apparently averaged just under 500,000 pounds, while those between 1892 and 1901 were on the order of 100,000 to 200,000 pounds. The fishery was abolished between 1901 and 1910, reopened for two years and then closed until 1916. In 1917 the fishery was again abolished by the legislature and the taking or possession of sturgeon was completely prohibited until 1954.

Sport Fishery

Sturgeon made an encouraging recovery under their 35 years of complete protection, and Department research personnel working on the Bay fisheries in 1953 advocated the opening of a year-round angling season for them. The Fish and Game Commission subsequently adopted an open season in April, 1954. At the outset a considerable amount of effort was expended for sturgeon, judging from party boat records, the numerous inquiries received by the Department of Fish and Game, and the extensive newspaper coverage in 1954 and 1955.

Angling is centered in San Pablo Bay, which supports the largest sturgeon population in the State. During the first year of the open season many were taken by the party boat fleet and occasional catches were made by individual anglers. It was charged that party boat anglers were "snagging" most of the sturgeon they took, and as a result this method was declared illegal.

Anglers have not yet found a successful method of taking sturgeon by hook and line other than snagging. It is hoped that eventually a specific bait or method will be developed. Today most catches are made incidental to striped bass angling.

In order to keep watch on the fishery, the Department initiated a tagging program to measure the catch (Pycha 1956). In this study 994 white sturgeon and 25 green sturgeon were tagged in San Pablo Bay between August and December 1954. Some idea of the numbers taken by sportsmen can be obtained from Table 28 which contains data on recaptured tagged fish. Anglers returned tags from two percent of 888 legal-size tagged white sturgeon (over 40 inches) within the first year after tagging. The combined catch of anglers and commercial gill net fishermen (who caught the sturgeon incidental to other fish) was 5.3 percent; however, since sturgeon could not be possessed legally by commercial fishermen, it is not possible to assess the significance of the commercial returns. As Table 29 indicates, the sturgeon catch from party boats dropped rapidly after adoption of the anti-snagging regulation.

Chadwick (1959), estimates that the actual harvest by anglers in the first year after tagging was two to ten percent.

Sturgeon Life History Notes

Sturgeon are the largest of all freshwater fishes. The white sturgeon, common to the Sacramento and Columbia River drainages of the Pacific Coast, are the largest in North America and are exceeded in size only by those of the genus *Huso* of Eurasia.

The weight of an individual white sturgeon taken from the Columbia River, Oregon, was reported to

be in excess of 1800 pounds. Here in California specimens of three hundred pounds and over were common before 1900, but when they came under severe exploitation the average size decreased rapidly. Under periodic protection from 1900 to 1917 and then complete protection until 1954 they made a surprising recovery. In August of 1955 a 462 pound female was found enmeshed in a Department salmon trap in the Sacramento River near Fremont Weir, and one weighing 277 pounds was taken by an angler in Suisun Bay.

TABLE 28
RECAPTURES OF TAGGED STURGEON

	By Anglers	By Commercial Fishermen	Totals
0-365 days at large	19	33	52
366-730 days at large	6	2	8
Over 730 days at large	2	0	2
Totals	27	35	62

TABLE 29
STURGEON REPORTED CAUGHT BY PARTY BOATS
1954-1957

April 1, 1954-March 31, 1955 (40 inch size limit)	191
April 1, 1955-March 31, 1956 (40 inch size limit)	70
April 1, 1956-March 31, 1957 (50 inch size limit)	12
April 1, 1957-October 1, 1957 (50 inch size limit)	2
Total	275

Green sturgeon rarely exceed 350 pounds and in the Bay Area the average weight is probably less than 100 pounds.

White sturgeon are an anadromous species, ascending the larger rivers north of Monterey to spawn in freshwater. Green sturgeon on the other hand apparently prefer salt or brackish water. The writer, while engaged in a study of sturgeon and striped bass observed numerous white sturgeon above the confluence of the Sacramento and San Joaquin Rivers. They are especially plentiful above that point in the winter.

During an investigation of the gill net fishery (1954-57), many green sturgeon were caught in the nets in Suisun Bay and Carquinez Strait. The general upstream limit of this species was observed to be at about the Middle Grounds in Suisun Bay. However, two green sturgeon were taken by departmental personnel at Collinsville, some 15 miles above the Middle Grounds. Both species appear to be most abundant in San Pablo Bay during the fall.

Concentrations of white sturgeon can easily be located by observing the fish jump out of the water. They rise out in a forward leap and come down in a resounding splash. No explanation has been given for this peculiar behavior but it may be associated with

feeding. Herring and anchovies enter the Bay in the fall and sturgeon might be feeding on schools of these fish at the surface.

White sturgeon appear to make a general migration out of the Bay into the upstream waters in the spring but data are lacking to support this point. Spawning is said to occur in May and June, although this has not been demonstrated in California. Bajkov (1954) and Dr. Vadim Vladykov (personal communication) of Canada believe that spawning occurs on rocky bottom in deep holes supplied with swift currents. This agrees with reports on the spawning of rock sturgeon (*Acipenser fulvescens*), in Southern Michigan streams. Adult sturgeon are known to have occurred in the Pit River in the Sacramento system and were observed at the face of Mendota Dam on the San Joaquin River in 1947.

White sturgeon are extremely prolific. The number of eggs is correlated with size. Individual females may contain as many as 5 million eggs. The 462 pound female taken in the Sacramento River in August 1955 was estimated by the author to contain 4,700,000 ripe eggs. Bajkov (1949) states that a closely related species in Russia contained 665,000 at 25 years, 1,978,000 at 40 years, and 4,100,000 at 50 years. The eggs are adhesive and attach to the substrate in the area where spawning occurs.

Nothing is known of the embryology of white sturgeon to this writer's knowledge. The Russians, however, have done extensive work in this field, and have published on the embryology of several closely related species.

The adults do not die after spawning and research has thus far failed to reveal whether individuals spawn annually or at longer intervals. The latter seems most probable. Three distinct phases of ova formation were observed by the writer in the 462 pound female noted above. Ripe, loose, black eggs constituted the bulk. In addition, cream colored eggs somewhat less than half the size of the ripe ones in an intermediate stage of development were still firmly attached to the ovarian tissue. These eggs appeared to be a year or so from maturity. The third size appeared as minute follicles imbedded in the walls of the ovaries.

The youngest individuals taken in the Sacramento-San Joaquin system have been recovered at the Tracy Pumping Plant of the Central Valley Project and at the Pacific Gas and Electric Company's Contra Costa Steam Plant. Individuals as small as 5 and 6 inches have occurred at these installations. They are thought to be downstream migrants which were spawned farther up in the river systems.

Fish between 18 and 30 inches are common in the Delta and Bay Area. Those under 18 inches are perhaps most numerous in the Delta. No information is available to indicate the age at which they first move into the ocean.

Pycha (1956), estimated the adult population (over 40 inches) in the Bay to number about 11,000 fish. In the gill net investigation mentioned previously an estimated 17,900 sturgeons, chiefly under 36 inches, were caught by commercial fishermen in Carquinez Strait and Suisun Bay between September 1955 and June 1956.

White sturgeon live for many years. The oldest encountered in the present investigation was the 462-pound female trapped near Fremont Weir; its age was determined at 45 to 47 years by examination of the annuli in a pectoral fin ray. Since this species is known to attain a much larger size, the age attained also must be proportionately greater. Individuals aged 100 years or more probably existed before development of the fishery. Canadian authorities have placed the age of a sturgeon from Ontario (a different species) at 152 years.

The age at which white sturgeon attain sexual maturity is not definitely known, but it is tentatively believed to be between 15 and 20 years for females. At that time they are about 40 to 60 inches in length. Males mature somewhat earlier.

Sturgeon are bottom feeders primarily. Their mouth is ventrally located and the fish moves along the bottom sucking up mud and debris, sifting out the organisms upon which it feeds. They are therefore largely dependent upon the bottom fauna. Known items in the diet (observed by the writer) include small shore crabs, immature market crabs, clams, bay shrimp, and neomysid shrimp. Sturgeon over 20 inches definitely eat other fish. Several specimens caught in the Sacramento River were gorged with smelt (*Sprinichus thaleichthys*) and (*Hypomesus olidus*). A 19 inch carp was removed from the stomach of one large adult. Concentrations of anchovies and herring during the fall and winter in the Bay are thought to provide excellent forage, but this has not yet been proven.

From the 1954 tagging study some useful data are available concerning their migrations. Most of the tagged fish caught by anglers were taken in San Pablo Bay, the tagging site. A small number of returns came from fish caught during the winter and spring upstream from the tagging site. However, rather than indicating a definite movement in that direction, those returns are thought to be a reflection of angling effort.

One tagged white sturgeon was recaptured at the mouth of the Columbia River on August 26, 1955. This migration represents a minimum distance of 600 miles in 294 days. Three tagged green sturgeon have also been taken off the Oregon Coast, two at the mouth of the Columbia River; one on December 4, 1955 and the other on August 20, 1958. The third was caught in Winchester Bay on September 1, 1957. These returns strongly suggest an interchange of both species between the Columbia and Sacramento River systems.

AMERICAN SHAD

The American shad (*Alosa sapidissima*) appears to have been the first exotic species introduced into this State. They were first stocked in the Sacramento River near Tehama, California on June 27, 1871 by Mr. Seth Green, famous fish culturist of the U. S. Fish Commission. There were about 10,000 fry in the first stocking. Livingston Stone in 1873 brought out another 35,000 and between 1876 and 1881 several subsequent plants totaling 784,000 fry were made by the U. S. Fish Commission (Table 30).

TABLE 30

AMERICAN SHAD INTRODUCTIONS INTO CALIFORNIA

Year	Number	Source	Location Stocked
1871 ¹	10,000	Albany, N. Y.	Sacramento R., Tehama, Teh. Co.
1873 ²	35,000	—	Sacramento R., Tehama, Teh. Co.
1876	99,000	—	Sacramento R., Tehama, Teh. Co.
1877	110,000	—	Sacramento R., Tehama, Teh. Co.
1878	115,000	—	Sacramento R., Tehama, Teh. Co.
1880	240,000	—	Sacramento R., Tehama, Teh. Co.
1881	220,000	—	Sacramento R., Tehama, Teh. Co.

Total 834,000

¹ Introduced by Seth Green on June 27, 1871. Out of 15,000 at start of trip, an estimated 10,000 survived.

² Introduced by Livingston Stone on July 2, 1873.

After the original introduction, shad appeared at various points along the coast from San Diego to Alaska. The only stable populations in California, however, have been those in the Salinas and Russian Rivers and, of course, the Bay and Delta. In Oregon they have been taken in substantial numbers in the Umpqua and Coos rivers. Records have been maintained for the Umpqua River fishery since 1923 and show the catch to average about 400,000 pounds annually.

Commercial Fishery

Nidever (1916) reported that shad first appeared in numbers in the San Francisco markets in 1879. In 1886 the State Board of Fish Commissioners estimated a million mature fish were taken. Shortly after their introduction curious customers paid \$10.00 to \$15.00 per fish and many brought \$1.00 to \$1.50 per pound. By 1880 the price was down to 20 to 25 cents and still later (1888) only 5 cents per pound was obtainable during the height of the run. In 1894 the price declined to 2 cents per pound. This condition prevailed until at least 1916. Even at this price many fish could not be disposed of.

Between 1870 and 1915 data are limited, but apparently the catch rarely exceeded a million pounds before 1900 (Appendix B-4). After 1900 the catch regularly ran over a million pounds. The all-time record catch of 5,675,509 pounds was made in 1917. Landings

APPENDIX B-4

LANDINGS OF SELECTED COMMERCIAL SPECIES PRIOR TO 1918

	Salmon	Striped Bass	Shad	Sturgeon	Oysters	Clams and Mussels	Bay Shrimp	Crab	Abalones
1864	96,000+	----	----	----	----	----	----	----	----
1865	96,000+	----	----	----	----	----	----	----	----
1869	----	----	----	----	----	----	----	----	----
1870	----	----	----	----	Eastern oyster introduced 1869	Soft-shell Clam intro. 1869?	----	----	----
1871	----	----	Introduced 1871	----	----	----	----	----	----
1872	----	----	----	----	----	----	----	----	----
1873	----	----	----	----	----	----	----	----	----
1874 ¹	4,079,025	----	16±	----	----	----	----	----	----
1875 ¹	5,095,781	----	----	118,350	----	----	----	----	----
1876 ¹	5,331,423	----	----	274,375	----	----	----	----	----
1877 ¹	6,493,563	----	----	295,650	----	----	----	----	----
1878 ¹	6,520,768	----	----	334,500	----	----	----	----	----
1879 ¹	4,432,250	Introduced 1879	3,000±	607,800	----	----	250,000	----	787,600
1880 ¹	10,837,400	----	600+	----	750,000	----	-2,500,000-	----	----
1881	9,605,000	----	----	291,050	----	----	----	----	----
1882	9,605,280	----	----	251,700	----	2,880,000	5,313,345	2,862,320	----
1883 ²	9,585,672	----	3,620+	125,850	----	----	----	----	----
1884	3,909,600	----	----	----	----	----	----	----	----
1885	4,320,000	----	----	----	----	----	----	----	----
1886	1,886,400	----	5,152+	----	----	185,104 gal.	----	----	----
1887	3,640,000	----	75,000	1,658,000	----	4,000,000±	300,000	190,000±	2,600,000
1888	6,622,978	----	90,871	460,000	8,190,000 ⁴	2,294,415	4,902,360	1,867,200 ⁵	1,862,000 ⁶
1889 ³	6,471,095	1,000+	----	495,000	12,369,000 ⁴	1,295,000 ⁵	5,000,000±	1,920,000 ⁶	70,000 ⁷
1890	2,970,111	5,000	300,000	587,625	12,829,500	1,750,000 ⁵	5,000,000±	2,160,000 ⁶	60,000 ⁷
1891	1,957,354	25,000	600,000	715,795	13,387,800	2,100,000 ⁵	5,000,000±	2,640,000 ⁶	75,000 ⁷
1892	3,435,710	56,209	526,494	765,297	15,098,700	2,654,800	5,315,075±	----	----
1893	3,950,373	79,738	405,391	----	----	----	----	----	----
1894	4,494,618	144,754	269,379	----	----	----	----	----	----
1895 ²	4,350,375	252,452	146,399	299,729	14,975,682	2,070,954	5,425,000	2,565,000	302,292
1896 ⁸	3,276,587	60,628+	68,742+	175,675	----	----	----	----	----
1897 ⁸	3,979,397	358,194+	111,137+	190,445	----	----	----	----	----
1898 ⁸	4,079,397	43,857+	107,744+	----	----	----	----	----	----
1899	6,458,959	1,234,320	1,137,801	205,659	2,940,000	2,535,010	4,047,186	3,676,680	369,411
1900	1,886,592	1,251,202	620,891	----	----	----	----	----	----
1901	2,414,592	----	----	Prohibited 1901	----	----	----	----	----
1902	2,312,256	----	----	----	----	----	----	----	----
1903	3,092,640	2,000,000	----	----	----	----	----	----	----
1904	8,233,148	1,570,404	----	----	1,320,000	----	----	----	----
1905	2,472,480	----	----	----	----	----	----	----	----
1906	2,585,952	----	----	----	----	----	----	----	----
1907	9,111,200	----	----	----	----	----	----	----	----
1908 ²	8,001,750	1,776,000	1,169,000	----	729,000	----	979,000	----	----
1909 ²	11,211,400	----	----	----	----	----	----	----	----
1910	10,256,000	----	----	----	----	----	----	----	----
1911	----	----	----	----	----	----	----	----	----
1912	----	----	----	----	----	----	----	----	----
1913	45,600	----	----	----	----	----	----	----	----
1914	831,120	----	----	----	----	----	----	----	----
1915	3,471,624	1,784,448	3,111,448	----	----	----	----	----	----
1916	3,450,786	----	----	15,178	----	----	----	----	----
1917	3,975,486	----	----	9,822	----	----	----	----	----

¹ Season: August 1 to August 1.² Salmon figures for 1883, 1895, 1908 and 1909 are from U. S. Bureau Commercial Fisheries and State Fish Commission records and differ from those reported by Clark (1929) and Appendix C-2.³ Not a full year report in 1889.⁴ Poundage estimated from bushels reported on basis of 70 lbs./bu. (910,000 pounds native oysters shown in Table 33, excluded.)⁵ Poundage estimated from boxes reported on basis of 70 lbs./box.⁶ Poundage estimated from dozens reported on basis of 24 lbs./dozen.⁷ Poundage estimated from dozens reported on basis of 50 lbs./dozen.⁸ Statistics for striped bass and shad based on market sales in San Francisco only.

APPENDIX C

ANADROMOUS FISH AND FISHERIES

APPENDIX C-1

SELECTED ANADROMOUS FISHES OF THE SAN FRANCISCO BAY AREA

Common Name	Scientific Name	Common Name	Scientific Name
Pacific lamprey	<i>Entosphenus tridentatus</i>	Pink salmon (rare)	<i>Oncorhynchus gorbuscha</i>
White sturgeon	<i>Acipenser transmontanus</i>	Chum salmon (rare)	<i>Oncorhynchus keta</i>
Green sturgeon	<i>Acipenser medirostris</i> ¹	Red salmon (rare)	<i>Oncorhynchus nerka</i>
American shad	<i>Alosa sapidissima</i>	Steelhead rainbow trout	<i>Salmo gairdnerii gairdnerii</i>
King (Chinook) Salmon	<i>Oncorhynchus tshawytscha</i>	Striped bass	<i>Morone saxatilis</i>
Silver (Coho) salmon	<i>Oncorhynchus kisutch</i>		

¹ Green Sturgeon apparently are not a truly anadromous species in that their migrations are between ocean and estuarine habitat rather than ascending and spawning in freshwater streams.

APPENDIX C-2

SACRAMENTO-SAN JOAQUIN RIVER COMMERCIAL SALMON CATCH 1864-1957¹

Year	Catch in Pounds	Year	Catch in Pounds	Year	Catch in Pounds	Value
1864	96,000	1901 ³	2,414,592	1930	1,213,698	-----
1865	96,000	1902 ³	2,312,256	1931	941,605	-----
1874	4,079,025	1903 ³	3,092,640	1932	1,264,987	-----
1875	5,095,781	1904	8,233,148	1933	454,253	-----
1876	5,311,423	1905 ³	2,472,480	1934	397,572	-----
1877	6,493,563	1906 ³	2,585,952	1935	888,868	-----
1878	6,520,768	1907	9,111,200	1936	949,179	-----
1879	4,432,250	1908	7,292,000	1937	974,871	-----
1880	10,837,400	1909	8,796,828	1938	1,668,376	-----
1881	9,605,000	1910	10,256,000	1939	496,933	\$57,024
1882	9,605,280	1911	-----	1940	1,515,588	120,094
1883	9,000,000	1912	-----	1941	844,963	64,514
1884 ³	3,909,600	1913 ³	45,600	1942	2,552,944	300,138
1885 ³	4,320,000	1914 ³	831,120	1943	1,295,424	202,140
1886 ³	1,886,400	1915	3,471,624	1944	3,265,143	415,974
1887	3,640,000	1916	3,450,786	1945	5,467,960	782,578
1888	6,622,978	1917	3,975,486	1946	6,463,245	921,304
1889	6,471,095	1918	5,938,029	1947	3,380,484	586,054
1890	2,970,111	1919	4,529,222	1948	1,939,801	467,686
1891	1,957,354	1920	3,860,312	1949	899,090	220,098
1892	3,435,710	1921	2,511,127	1950	1,211,513	292,703
1893	3,950,373	1922	1,765,066	1951	1,343,171	301,677
1894	4,494,618	1923	2,243,945	1952	738,171	164,907
1895	3,581,244	1924	2,640,110	1953	869,696	177,938
1896	3,276,587	1925	2,778,846	1954	900,961	262,270
1897	3,979,397	1926	1,261,776	1955	2,320,746	600,841
1898	4,079,397	1927	917,525	1956	1,139,585	361,933
1899	6,458,959	1928	553,777	1957	321,824	99,121
1900 ²	1,886,592	1929	581,497	1958 ²	-----	-----

¹ Partly after Clark (1929).

² Gill net fishery discontinued by legislative action in 1957.

³ Poundage based on recorded pack of canned salmon only.