Status, life history, and management of Columbia River white sturgeon, *Acipenser transmontanus*

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Synopsis

Exploitation of Columbia River sturgeon in the 1860–1890s caused severe depletion of the stocks. Stringent fishery regulations were promulgated to protect the resources, including minimum-maximum size limits of 91–183 cm TL for sport and 122–183 cm TL for commercial. Regulations, increased food supplies, and shortened salmon gill-net seasons are primary reasons for a healthy stock in the Columbia River below Bonneville Dam. The recent 10 year catch levels are the highest of the century with average annual harvest of near 40 000 fish, with a 2–3:1 ratio of sport to commercial landings. White sturgeon below Bonneville Dam grow at an annual mean rate of 6.6 cm with a range of 2.1–14.0 cm between ages 1–21 years. A current tagging program suggests that lower Columbia River sturgeon between 70 and 130 cm TL grow an average of about 10 cm per year. White sturgeon enter the sport fishery at a minimum length of 91 cm and a mean age of 9 years, the commercial fishery at a minimum length of 122 cm and a mean age of 12 years, and leave both fisheries at a maximum length of 183 cm and a mean age of 20 years. Males mature at 12 years and females 15–20 years. White sturgeon above Bonneville Dam are essentially landlocked within each successive pool. Stock size and recruitment appear satisfactory in some areas, but decrease is evident in others.

Introduction

White sturgeon, *Acipenser transmontanus,* and green sturgeon, *A. medirostris* are found in the Columbia River. White sturgeon are found throughout the Columbia River with the greatest numbers below Bonneville Dam. They have high flesh quality and are a very desirable sport and commercial fish. In contrast green sturgeon are primarily estuarine, and because of inferior flesh quality and low catchability, are of minor importance to the commercial and sport fisheries. On rare occasions green sturgeon are found as far upstream as Bonneville Dam, particularly during low flow years when saltwater intrusion is greatest.

Commercial sturgeon fisheries are managed jointly by the Washington Department of Fisheries (WDF) and the Oregon Department of Fish and Wildlife (ODFW) under authority of the Columbia River Compact established in 1918. The states manage the sport fishery separately. The primary management activities are monitoring fisheries, sampling catches and larvae, and a tagging program. There has not been a large-scale research project on Columbia River sturgeon since the late 1940s and early 1950s (Bajkov 1949, 1951). However, with the salmonid problems in the Columbia River and Pacific Ocean and the increasing importance of sturgeon as a food and game fish, more interest is now shown in sturgeon research.

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Background

Sturgeon were dominant when the first salmon gill-net fisheries began on the Columbia River in 1860. At that time sturgeon were routinely killed and discarded in an attempt to eradicate them. However, by 1880 an important industry on the Columbia River had begun, with 85 m tons of salted and pickled sturgeon used locally, and the first railroad car of frozen sturgeon shipped to the East Coast and San Francisco (Craig & Hacker 1940).

Several types of gear were used to catch sturgeon including fish wheels, traps, gill nets, baited setlines and Chinese gang lines. By 1892 a peak production of 2500 tons was reached. The average weight of sturgeon was about 68 kg, but by 1895 had dropped to 25 kg. The fishery collapsed in the late 1890s due to overfishing, particularly on the large female brood stock, and landings had dropped to 33 100 kg (Fig. 1).

Sturgeon catches from the 1900s through the 1960s were small and incidental to salmon gill-net fishing and a further restriction on the fishery became necessary. As a result of extensive research by Oregon Fish Commission (OFC) biologists, the most important protective regulation was enacted in 1950, a maximum size limit of 183 cm to protect the female brood stock.

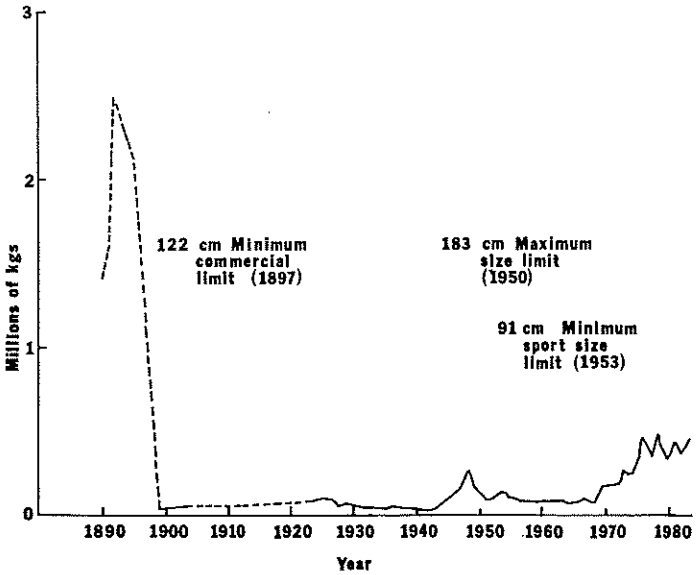

Fig. 1. Columbia River commercial white sturgeon landings, 1898–1983.

Also in 1950, a minimum size limit of 76 cm and a five fish per day bag limit for sturgeon anglers was adopted. In 1951 the bag limit was reduced to three fish per day. In 1958 the minimum length was increased to 91 cm. With the minimum and maximum size limits, reduced salmon gill-net seasons, food supplies, and pollution cleanup, the sturgeon stock below Bonneville flourished. Commercial sturgeon landings almost doubled in the early 1970s, nearly doubled again in the late 1970s, and have remained at a reduced level in the early 1980s (Table 1).

In terms of numbers of fish, the recent peak catch of 1983 was greater than the historical peak catch of 1892. However, the average weight now is 14–16 kg in the commercial fishery and about 8 kg in the sport fishery.

Fisheries below Bonneville

The majority of the commercial catch of sturgeon is incidental during salmon gill-net seasons. However, some fishermen target on sturgeon with large-mesh nets in areas of known abundance.

Landings of sturgeon during salmon gill-net fisheries in the main-stem Columbia River below Bonneville Dam during 1975–1983 varied with sturgeon abundance and salmon fishery duration. Salmon gill-net fishing averaged 80 days annually from 1960–1974. The average decreased to 48 days in the period 1975–1979. Reduced commercial sturgeon landings in the 1980s are probably a result of shortened salmon seasons, which have averaged 27 days.

Because of declining salmon stocks and commercial gill-net fishing opportunity, experimental setlining for sturgeon was conducted in January-March 1975. Subsequently, a 1-month season in May 1975 was established to allow harvest of sturgeon without an impact on salmonids. Setline seasons expanded each year, reached a peak of 9 months in 1982, and were reduced to 7 months in 1983. The months of May-July have been closed to protect spawning sturgeon.

In recent years management and social problems have developed in the setline fishery. Lines are not

Table 1. Commercial and recreational landings of white sturgeon in the Columbia River (1000's of fish), 1970–1983.

Year	Below Bonneville Dam					Above Bonneville Dam					Total Columbia River
	Commercial			Recreational[1]	Total	Commercial			Recreational	Total	
	Gillnet	Setline	Total			Setnet	Setline	Total			
1970	6.3	–	6.3	7.2	13.5	0.4	–	0.4	–	0.4	13.9
1971	7.2	–	7.2	2.8	10.0	0.7	–	0.7	–	0.7	10.7
1972	7.6	–	7.6	5.0	12.6	0.7	–	0.7	–	0.7	13.3
1973	10.7	–	10.7	9.8	20.5	1.1	–	1.1	–	1.1	21.6
1974	10.7	–	10.7	9.9	20.6	0.5	–	0.5	–	0.5	21.1
1975	13.0	1.0	14.0	10.8	24.8	0.6	–	0.6	–	0.6	25.4
1976	18.1	4.7	22.8	15.0	37.8	0.4	0.2	0.6	–	0.8	38.4
1977	8.9	0.8	9.7	22.3	32.0	0.3	0.3	0.7	–	0.7	32.6
1978	8.8	1.0	9.8	29.7	39.5	0.4	0.3	0.7	–	0.7	40.2
1979	18.5	2.0	20.5	30.7	51.2	0.6	0.7	1.3	–	1.3	52.5
1980	6.8	2.6	9.4	25.8	35.2	0.4	1.4	1.8	–	1.8	37.0
1981	10.8	4.1	14.9	25.7	40.6	0.3	1.8	2.1	1.2[2]	3.3	43.9
1982	7.0	4.6	11.6	23.2	34.8	0.2	1.1	1.3	–	1.3	36.1
1983	9.5	2.9	12.4	33.7	46.1	0.3	1.1	1.4	1.8[3]	3.2	49.3

[1] Estimated catches for: 1970–74 March-September, 1975 February-March, May-September, 1976 March, May-October, 1977 March-October, 1978-79 February-November, 1980-83 February-October

[2] Represents estimated catch for June-July only in the area from Bonneville Dam to McNary Dam.

[3] Represents estimated catch for May 25-September 6 only in John Day and McNary Dam tailrace areas only.

checked in a timely manner and some sublegal mortality is caused by snagging. There are general gear problems (loss, theft, vandalism), sport-commercial conflicts (91–122 cm sublegals kept as sport fish, 122–183 cm sport-caught fish sold as commercially caught, and entanglement of sport gear and gill nets with setlines), low return on investment, unrestricted effort, and enforcement problems. It is also difficult to sample a lengthy, low-volume catch season such as the setline fishery. Biologists requested the setline season be reduced to 4 months in 1983, down from 9 months in 1981–1982. However, a 7 month season was set with some tightening of certain regulations to avoid problems. If these problems are not solved, we may be looking at complete closure of the setline fishery in the future.

In May 1982 a test fishery using large, 23 cm minimum mesh gill nets was evaluated as a potential commercial management tool to harvest sturgeon without impacting salmonids. Subsequently, a 5 day season was conducted from January 25–29, 1983, a time frame when salmonids are relatively scarce.

Results from the actual fishery paralleled that of the test fishery, with 40% legal, 60% sublegal, and <1% oversize fish taken. The large-mesh fishery appears to be a viable method for commercial harvest.

Prior to 1975 anglers on the lower Columbia River were mainly interested in salmon (*Oncorhynchus* spp.) and steelhead (*Salmo gairdneri*). Beginning in 1975, with extended salmon and steelhead angling closures, sturgeon angler trips and catches began to climb dramatically. Angler trip totals have established new record highs each year since 1976, numbering 136 000 in 1983. The catch climbed from a low of 2800 fish in 1971 to a peak of 33 700 in 1983 and has averaged nearly 30 000 fish the last 3 years (King 1983b).

Research

Some studies are being conducted to update information gathered during earlier studies. White sturgeon have a relatively long life span, grow very large (579 kg and 675 kg in the Columbia and Snake

rivers, respectively [Galbreath 1979]), and are slow to mature. Males mature at about 12 years of age at a length of about 122 cm and females at 15–20 years and 168–183 cm. Of course, older females spawn less frequently with varying intervals between spawning. At least 99.5% of the females taken commercially in the Columbia River are immature and only small amounts of caviar are available. This valuable caviar in oversize fish is quite an inducement for illegal marketing.

Researchers in the past have had little success locating white sturgeon eggs and larvae. We know spawning white sturgeon need water temperatures around 9–15° C. Water temperatures in May are in the middle of the range.

Biologists from Washington and Oregon used an ichthyoplankton net in an attempt to capture white sturgeon eggs and larvae (Stockley 1981). The following results were obtained with net tows in Columbia River flows of 55 000–102 000 cubic meters per second, 12–18° C water temperature, and 3–21 m depth: (1) May–June 1979 – 29 tows yielded 12, 2–3 day-old larvae; (2) April–mid June 1980 – five larvae and several eggs; (3) May 1981 – five larvae.

Extensive sampling conducted in 1983 by WDF during late April–mid June at flows of 76 000–123 500 $m^3 s^{-1}$, 12–17° C water temperature, and 2–15 depth yielded 183 white sturgeon larvae and 48 eggs (Kreitman personal communication).

Over 1300 white sturgeon fin rays were collected from 1980–1983 for age determination. Sturgeon grew at an annual mean rate of 6.6 cm, with a range of 2.1–14.0 cm between the ages of 1–21 years. White sturgeon enter the sport fishery at a minimum of 91 cm and a mean age of 9 years and the commercial fishery at 122 cm and mean age of 12 years. Fish leave both fisheries at a maximum length of 183 cm and a mean age of 20 years (Fig. 2). Comparisons with a similar study (Bajkov 1951) indicated that sturgeon are slightly slower growing now with considerably more age range for each length. This slower growth could be related to a larger stock density with less available food supply, which may be limiting growth (Hess 1984).

A tagging study was conducted by OFC during the late 1940s and early 1950s. A new tagging study was begun in 1965 and has continued with small

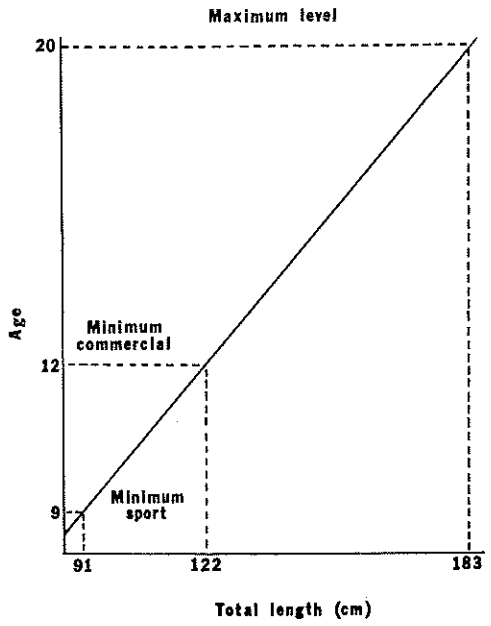

Fig. 2. Length-age relationship of white sturgeon from the lower Columbia River.

numbers of fish tagged each year. Since 1976 more than 1000 white sturgeon have been tagged each year. Through 1983 we have tagged 11 519 white sturgeon in the lower Columbia and have 1141 recoveries (10.1%).

Our purpose in tagging is to determine growth rates and define migrational patterns. Growth data from tag recoveries indicate that sturgeon between 70 and 130 cm TL grow an average of 10 cm per year. To date we cannot define a set migrational pattern. Movement based on tag recoveries appears to be random. Food availability is important, particularly in the winter and early spring when many sturgeon follow the smelt run upriver from the ocean, and in the fall when anchovies are in the estuary. However, this may not be as important as previously thought, as many sturgeon do not exhibit migratory behavior.

Tagging demonstrated that the May 18, 1980, eruption of Mt. St. Helens had a definite effect on sturgeon. The eruption caused a number of sturgeon to leave the Columbia River, particularly on the Washington side. Prior to May 18, 1980, we had 526 tag recoveries of which only 4 (1%) were from river systems other than the Columbia (such as the Oregon's Yaquina River and Washington's Neah Bay in Puget Sound). From May 18, 1980,

through 1981, 174 tag recoveries were made with 25 (14%) from other systems. The out-of-system movement was not as pronounced for 1982 with 218 recoveries made; 11 (5%) from outside the Columbia.

Some of the most interesting recoveries were: the fastest growing sturgeon grew 27.9 cm per year; the fastest moving sturgeon went 37 km in 3 days; the farthest recovery was a sturgeon traveling to Puget Sound, WA (a distance of 608 km in 459 days); the longest time out was 8.1 years with a growth of 70 cm, and movement of 35.4 km upstream; and the oddest recovery was from a crab fisherman that found a dead 122 cm sturgeon in a crab pot off the mouth of the Columbia (King in 1983 speech at American Fisheries Society Chapter meeting in Corvallis, OR).

We have problems keeping tags on sturgeon. Nets knock them off or pull them out. We have had the best success with a spaghetti loop tag (overhand knot) inserted at the base of the dorsal fin. The return is about 11%. With other types of tags we have had only a 6% or less return. We also have problems getting some commercial fishermen to report tags. We believe that a high percentage (80%) of tagged fish handled by the commercial fishery may go unreported. Another problem is getting anglers to report tagged sublegals. In 1982, using tagged-untagged ratios, we determined that 81% of the tagged sublegal 20% of the tagged legal fish were going unreported in the sport fishery (King 1983).

Future

What does the future hold for white sturgeon stocks and fisheries below Bonneville? The key to maximum sturgeon production is proper spawning escapement. While measures of spawning escapement are sketchy at this time, we believe the sturgeon stock on the lower Columbia is healthy. The recent 10 year catch level is the highest in this century, suggesting a large stock. Key juvenile indicators are also currently positive, i.e., larval sampling, and the number of sublegal fish handled by the sport and commercial fisheries. However, we are getting some indications that the white sturgeon population may be stabilizing after rapidly increasing in the 1970s. The commercial and sport catches have leveled off in the last several years and the stock may be near a maximum sustainable yield level (Fig. 3).

Table 2 lists the relative catch by size group and indicates stable recruitment in the 152–183 cm length category, implying stable recruitment into the spawning escapement. Commercial fisheries commonly handle oversize sturgeon, and the sport fishery was estimated to have handled 600 and 2200 oversize white sturgeon in 1982 and 1983.

It appears the sport fishery, as it now exists, cannot deplete the sturgeon resource. The sport fishery allows sufficient sturgeon in the 92–122 cm length category to reach the 123–152 cm category, allowing a productive commercial fishery (King personal communication).

Table 2. Estimated landings of white sturgeon (1000's of fish) in legal centimeter-length groups in lower Columbia River commercial and recreational fisheries, 1977–1983.

	91–122 cm	123–152 cm			153–183 cm			Grand total
	Sport	Sport	Comm.	Total	Sport	Comm.	Total	
1977	17.4	3.8	9.1	12.9	1.1	0.6	1.7	32.0
1978	22.6	5.5	9.2	14.7	1.6	0.6	2.2	39.5
1979	23.0	6.0	19.2	25.2	1.7	1.3	3.0	51.2
1980	20.4	3.9	9.1	13.0	1.5	0.3	1.8	35.2
1981	20.2	4.2	14.2	18.2	1.3	0.7	2.0	40.6
1982	18.2	4.0	10.8	14.8	1.0	0.8	1.8	34.8
1983	24.6	6.7	11.2	17.9	2.4	1.2	3.6	46.1
1977–83 Avg	20.9	4.9	11.8	16.7	1.5	0.8	2.3	39.9

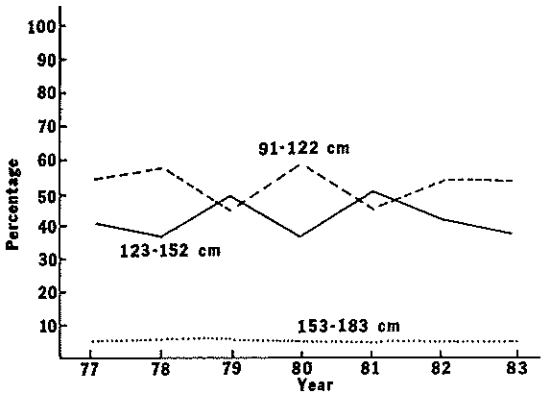

Fig. 3. Relative catch proportion of white sturgeon in centimeter-length groups from sport and commercial fisheries of the lower Columbia River, 1977–1983.

The current commercial fishery is capable of harvesting a good percentage of legal-size fish, but with regulations established to protect the brood stock, we should not see the overexploitation experienced in the 1890s. We will continue to monitor the sturgeon fisheries of the Columbia River. The time frame necessary to recover from a management mistake, such as overfishing, is much longer for sturgeon than for other fish.

Fisheries above Bonneville Dam

The treaty Indian set-net fishery does not catch many sturgeon. Setline landings, although on the increase, do not approach the magnitude of landings by the below-Bonneville Dam fisheries (Table 1). Although sturgeon are found throughout the reservoirs, the non-Indian sport fishery is more concentrated at the bases of various dams. Attempts are now being made to estimate this sport catch.

Research

In 1974, 195 sturgeon were tagged in the Bonneville and John Day pools. To date we have had a 5% recovery rate. This was not a funded project. An Indian sturgeon fishermen employed by ODFW was allowed to keep and sell the legal-size sturgeon (122–183 cm) caught in his setlines and nets. Obviously, we could not attempt a stock estimate. As this was a treaty Indian fishing area and Indians wished to take oversize sturgeon, federal funds were made available for a 3 year study conducted by the U. S. Fish and Wildlife Service (USFWS). Malm (1980) published results of tagging in the Bonneville Pool and Tom Macy (USFWS) intends to publish soon on the John Day pool. The Dalles pool remains to be studied. Funding was not continued as hoped and Malm was unable to delve into the early life history of sturgeon above Bonneville. ODFW and WDF biologists have not been successful in their attempts to find eggs or larvae. Proposals have been prepared to obtain funding for early life history studies. There is little passage from pool to pool over fish ladders and stocks are essentially landlocked. There is some passage through navigation locks and fish were elevated over Bonneville Dam in earlier years (Donaldson 1948).

Malm (1980) tagged 2405 sturgeon and recaptured 161, for a 6% recovery. Abundance was estimated at 31 691 fish using Schnabel's formula with Chapman's modification. The 95% confidence limits were 25 981 and 40 494. This estimate was based upon fish captured during the study which ranged in size from 30.5 cm to 245.1 cm. The catch consisted of 98% sub-legal sport fish (<91 cm TL), 17% legal sport (91–183 cm TL), and 5% oversize (<183 cm. TL).

Average growth was 3.4 cm per year from age 3–12 years, was relatively constant at 16.9 cm per year from age 12–18 years, and was 8.1 cm per year from age 19–28 years. Growth pattern comparisons made with lower Columbia River, Snake River (Idaho), Fraser River (BC), and San Pablo Bay (CA) stocks indicated that sturgeon having free access to ocean and estuary environments grew at a constant rate compared to those landlocked by dams. Malm also stated that a life history management data base (life history data from fish <3 years and >28 years, maturation, timing, and spawning and rearing locations) must be obtained.

We also need to determine the extent of egg resorption in female white sturgeon in the reservoirs, determine the effect of polychlorinated biphenyls (PCBs) on eggs, and answer the question as to whether we have too many large, unproductive white sturgeon for the available food supply.

Conclusions

The catch level of white sturgeon since 1973 remains the highest of the century, with the 1983 catch well over the recent 10 year average. Catches by size group for each fishery indicate stable recruitment in the 168–183 cm category, implying stable recruitment into the spawning escapement. Creel census interviews in 1983 indicated about 2200 oversize white sturgeon were handled compared to 650 in 1982. The recreational catch, angler trips, and average total length of legal size sturgeon were all record highs in 1983. The white sturgeon catch per angler trip in 1983 was greater than 1981 and 1982 (ODFW-WDF reports 1983).

Research conducted in 1983 on spawning characteristics of white sturgeon again documented successful spawning below Bonneville. The number of 1 to 4 year old white sturgeon observed in the commercial shad fishery increased again in 1983. This information suggests the white sturgeon stocks of the lower Columbia River below Bonneville Dam are healthy at the present time. The primary emphasis on problem solving research should be directed above Bonneville Dam.

Acknowledgments

I appreciate the opportunity provided by this symposium to aid in gathering together some of the widely scattered information on sturgeon. Special thanks are due the Oregon Department of Fish and Wildlife for sending me to this symposium and to departmental employees, Steve King for editorial comments, Joanne Hirose for typing and format, and Shirley McKinney for constructing the figures.

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