State of Washington
DEPARTMENT OF FISHERIES

PROGRESS REPORT NO. 150

COLUMBIA RIVER STURGEON

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Nancy Burhart
State of Washington
Department of Fisheries
Room 115 General Administration Building
Olympia, Washington 98504

Dear Nancy:

While going through my Progress Report #150 on Columbia River sturgeon I encountered some errors. Would it be possible to attach an errata sheet on first page?

ERRATA

Page 6, paragraph 3, line 21: "then a steady .... indicated"
should read
"then a steady increment of 2.1 to 2.6 inches per year in Sacrameto River while sturgeon. Malm 1980, indicated a similar growth, etc."

Page 7, paragraph 2, line 8: "Most of the tag recoveries"
should read
"Peak recoveries"

Page 8, paragraph 3, line 14: "The nest"
should read
"The net"

PICKY!, PICKY!, PICKY!!!

Thank you,

Clint

Clint Stockley
Retired Biologist

copy: Austin

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INTRODUCTION

The purpose of this paper is to describe the life history of sturgeon of the Columbia River, present a review of landings, and describe investigations consisting of tagging and recoveries, migrations, spawning surveys, and effects of St. Helens eruption distribution, and to propose studies and regulations to protect sturgeon.

LIFE HISTORY

These ancient fish originated in the upper cretaceous period in the Mesozoic Era over 100 million years past. They are thought to have arisen from a salachians and saurians. The family Acipenseridae are characterized by five rows of bony plates, four subterminal sensory barbels, toothless jaws in adults, protractile mouth, no opercle bone, no mandible, upper lobe of caudal elongate (hecterocercal) and a cartilaginous skeleton.

White sturgeon (Acipenser transmontanus) have barbels nearer to tip of snout than mouth, they have 38-48 lateral scutes and are gray in color.

Green sturgeon (Acipenser mediostris) have barbels nearer to mouth than tip of snout, with only 23-30 lateral scutes and are green in color.

White sturgeon are more common than green and are found futher upstream, originally occupying nearly the entire watershed. The green is an anadromous fish spawning in upper estuaries, while the white is a freshwater fish and semi-anadromous. They are fast growing, but slow to mature. They have a long life span and grow very large. The largest white was 1,800 pounds, from the Fraser, and the largest green 350 pounds. Species from the Amur River grow to 2,500 pounds (Bajkov). The former record from the Caspian was 4,350 pounds (Doroshov). A modern day record was observed by John Pomeroy, Fisheries Patrol Officer, March 11, 1981 below Bonneville Dam at 11.5 feet.

Mike Kinsman of Vancouver, Washington claims to have hooked and beached a 13.5 foot sturgeon below Bonneville on April 14, 1981 on 50 pound test mono line. This giant was not witnessed, but if factual would have weighed 1,200 pounds, been 100-120 years old and have a fecundity potential of over 8.5 million eggs.

Female whites do not mature until 15 years of age at a length of 64 inches (165 cm) and a weight of 60-70 pounds. In colder water as in the Fraser River, they mature slower, taking 26 years. Eggs take more than a year to develop to maturity, so females do not spawn annually. Doroshov indicates spawning every three to five years. He also indicates that a female sturgeon with maturing ovaries, if subjected to stress, will voluntarily absorb her eggs and lose a spawning cycle. Spawning occurs in April-June (Bajkov). Eggs are 0.10 inch in diameter after release and fertilization and black in color. Upon release and fertilization eggs become adhesive, sinking to attach to substrate. They hatch after about seven days (Beer). Bajkov indicated that fry frequent shallows feeding on mollusks, crustaceans and insect larvae. I found yolk-sac fry in May 1979-80 and 1981, in from 30 to 65 fet of water, while drift trawling. Water fleas, tiny amphipods, and mayfly larvae and shad eggs and fry were common in plankton tows and would be easy prey to vigorous sturgeon larvae.

Figure 1 shows the fecundity of female sturgeon in millions of eggs compared to age and weight (Bajkov data). This demonstrates that the older, the larger, the more eggs. Consequently it is imperative that old brood stock be protected.

Figure 2 shows growth rate of white sturgeon in length, weight, and age (after Bajkov). Minimum sport legal size (36 inch), minimum commercial (48 inches) and maximum legal length (72 inches) are indicated.

Age has been determined from thin polished transverse base cross sections of the first bony ray of the pectoral fin, which can be projected to show annual growth rings (Figure 3). Recent aging of a pectoral fin ray section, from a 10 foot carcass, indicates that sturgeon may be growing faster below Bonneville as a result of better feeding conditions (Galbreath).

CATCH

Figure 4 shows the white sturgeon landings from Columbia River from 1889-1980. The explosive rise and sharp decline exemplifies unregulated exploitation to near extinction. Early deliveries ranged from 100-500 pounds per fish declining to 50 pounds or less in but a few seasons. Bajkov

had noted a similar pattern of landings in three other former sturgeon production areas (Chesapeake, Lake of the Woods, and Lake Michigan).

Abuse of small sturgeon by gillnetters, as they removed small unmarketable fish from their nets and struck their head on the gunwhale before discarding, had come to the attention of James Crawford, our first fish commissioner. He initiated legislation to protect small fish following decline in 1894 which resulted in protection of fish less than four feet in 1897 (Brannon). Finally in 1950 a six foot maximum was established to protect large female brood stock. In 1951 angler bag limits were reduced from five 30 inch minimum length to three 30 inch minimum per day. In 1958 anlger bag limits were altered to three fish not less than three feet or more than six feet.

CONDITION OF STOCKS

Recovery of the stocks in the lower river is illustrated in Figure 4. The sport catch since 1969 is shown on the right shaded area to demonstrate predominence of recreational catch to total landings. Table 1 lists the landings since 1889 with the sport numbers converted to poundage (17 lbs/fish).

Figure 5 shows histograms of sturgeon length frequencies caught in the spring chinook test fishery near Reed Island (RM 124) between 1977 and 1980. The net was a multi-walled trammel diver net that is presumed to be non-selective with catch representative of available population. From this it is apparent that the population is fully utilized, with about half protected for growth, and an average of some 44% available to sport fishery and only 4 or 5% available to commercial fishery, and, finally, about 1% of the large, over six feet, reserved for brood stock.

Length frequencies of sport catch below Bonneville from 1977-80, are illustrated in Figure 6 (King, 1981). They show a descending trend, from three feet to four feet and four feet to six feet, similar to the trends in size shown in histograms of Figure 5.

STURGEON TAGGING

Tags have been applied to incidentally caught sturgeon while spring chinook test fishing, monitoring sport and shad fisheries and by interested

anglers and sturgeon set line fishermen. A variety of tags have been used. Fish have been tagged in lower river, mid-river, and upper river below Bonneville Dam. This report will address tagging of fish between mouth of the Willamette River and Bonneville. Sturgeon have been tagged by Oregon Department of Fish and Wildlife and U.S. Fish and Wildlife Service above Bonneville Dam, however, there appears to be little interdam passage.

Oregon Game Commission biologist Bill Hosford first tagged sturgeon along the lower river with dangler tags from 1965 to 1969 recovering 53 out of 749 sturgeon tagged (7%).

Spaghetti

In 1969, Haxton of the Oregon Game Commission, began tagging with a labeled vinyl tube (spaghetti) along the lower river. Our sturgeon catch incidental to spring chinook test fishing increased so that we undertook tagging in 1970 near Reed Island. Numbered yellow vinyl tubing, with an Oregon Game Commission label, was first applied with a needle inserted transversely through the base of dorsal fin and then overhand knot tied in the double ends to fasten spaghetti tag to fish. Prior to release, the loop was tugged to assure a secure tie. Table 2 shows record of tags applied by type, year, and number. Recoveries are shown by year in number and percent. The spaghetti tag, longest used, has shown longest time of freedom in years out and best recovery rate at 13%.

Anchor

The nylon textile tag with color-coded vinyl label next came to our attention (Burton, 1976) and 138 tags were attached by insertion transversely at base of dorsal fin with Floy FDM 68 heavy duty tagging gun. The miniscule nylon "T" anchor did not appear to be adequate to hold in the soft sturgeon tissue, however, 3.6% of fish released with this tag were recovered (Table 2) and one fish so tagged in 1976 near Corbett, Oregon was later recovered from Mile 4 in the Willamette River (4/20/79), and released again to be recaptured 5/29/79, near Corbett, RM 127, where it had first been caught and tagged. Recoveries of anchor tagged fish continue. Insertion of tag through base of dorsal fin with "T" exterior to skin on far side of fish offers good tag security (McIntosh).

Disc Tag

In 1977, a tag shortage led us to apply a coded one-half inch disc attached to blank vinyl tube and inserted transversely through base of dorsal fin and knotted. Only 2.8% of the 281 disc tags applied 1977-79 were recovered (Table 2).

Dart

The concept of a trailing tube from the anchor type tag suggested use of a dart type inserted transversely through dorsal fin base between dorsal fin rays. Although the dart (1/16 inch in diameter by 9/16 inches long with a 5/8 inch barb) was much longer than the textile anchor, it often pulled out and was lost, resulting in only 2.6% recoveries from 305 tags applied (Table 2).

Double Tags

Combinations of double tags were applied 1976-1978.

Spaghetti and Anchor

In 1976, 330 spaghetti tags were attached through base of dorsal fin and knotted in place in combination with anchor tags inserted transversely into base of dorsal fin. A recovery period of five years has provided an overall 14% recovery with 11% retaining ththe anchor tag at recovery (Table 2).

Anchor and Disc

In 1979, a combination of 119 anchor tags inserted through first dorsal scute and disc tag attached with vinyl tube through dorsal fin base and knotted in place yielded an overall 10% recovery over four years of freedom, with a 9% anchor recovery and a 5% disc recovery, indicating a preference for the scute attached anchor over disc as applied (Table 2).

Anchor and Anchor

In 1977, a combination of 23 anchor dorsal fin base and anchor first dorsal scute produced a 13% overall recovery with 13% dorsal fin and 8.7% scute recoveries during the first and third years of freedom (Table 2).

Lock-On

From 1978 to 1980, 1,993 lock-on vinyl tube tags were inserted transversely through the base of dorsal by puncturing the base with an awl and inserting the tag through the hole and snapping the lock together (prior to release the loop should be firmly tugged to ascertain lock is snapped). After the first three seasons of freedom, this tag showed 97 recoveries (4.9%).

Dart and Lock-On

In 1978, a combination of 51 dorsal lock-on vinyl tubes and dart mounted spaghetti through first dorsal scute were applied. Recoveries occurred in second and third years of freedom with an overall 10% recovery, a 10% recovery of lock-on and a 6% recovery of scute mounted dart spaghetti, indicating a preference for the lock-on spaghetti tag (Table 2).

Continuing recoveries of the lock-on tag indicate it to be a superior type for duration of freedom and recovery.

TAG RECOVERIES

Growth Rate

Growth rate of sturgeon tagged, with recovery a year or more later, showed a wide range of growth per season, independent of size when tagged. Recovered fish ranged from 55-140 cm total length with a mean of 90 cm when tagged. Growth ranged from 1-29 cm with a mean of 10 cm (3.9") per year (Table 3). Pycha (1956) had reported rapid growth for first four years and then a steady indicated a similar growth rate for Bonneville pool. In contrast Coon, 1977, found sparsity of large sturgeon in the middle Snake River and a reduced growth rate since construction of Hells Canyon dams.

Recoveries by Month

Tag recoveries by month of year (Figure 7) show an upstream spring movement peaking in June, with a total 58% upstream, 25% downstream and 17% directionally unknown.

Duration of Freedom

Figure 8 shows the duration of freedom, in days and years, from tagging to recovery 1970-1980. The greatest number of recoveries occurred within the

year of release (51%), with half as many in second year out (26%), then half as many in third year of freedom (14%), then less than half in fourth year (5%), near half in fifth year (3%), and less than half in sixth year (1%).

Distance Traveled

Figure 9 is a bar chart showing distance traveled to recovery upstream, downstream and downstream and seaward from tagging location at ten mile intervals. The majority of recoveries (42%) were from 10-30 miles upstream, from the intensive fishery below Bonneville Dam. Most of the tag recoveries (35%) were from within ten miles of release. Recoveries downstream of tagging in mainstem amounted to 20%. Only 1% of total recoveries were from Willamette River. Only eight recoveries (2%) were made from downstream and seaward, with one Yaquina Bay, Oregon, four Willapa Bay, and one Naselle River and two Grays Harbor recoveries.

Recovery Location

The location of recoveries from tagging between Willamette River mouth and Bonneville Dam is shown in Figure 10. The majority of these (82%) were from above the Willamette mouth with 70% from above the main release point, only 1% from Willamette River and 15% from lower river, most of which were returned by sportsmen from Grays Point-Megler intensive fishing area. Only eight tagged fish were recovered from outside Columbia River through 1980.

While Figure 7 shows a spring upstream movement and summer downstream movement, both Figure 9 and 10 indicate a strong upstream movement from tagging to recapture.

Table 4 summarizes movement of tagged sturgeon from release to recovery between 1970 and 1980. It shows a strong upstream movement of both small (sublegal) fish and legal fish (3 to 6 feet). Small fish tended to not travel far, while larger fish showed a stronger tendency to range downstream and seaward.

SPAWNING

Bajkov had attempted to find sturgeon larvae by intensive plankton towing in the late 1940's.

Ivan Donaldson, retired U.S. Corps of Engineers biologist at Bonneville, had plankton netted extensively from Bonneville down to Beacon Rock (RM 141.7) without finding larvae. However, Donaldson had been presented with two fingerling sturgeon about 4 cm long which had been found tangled in commercial beach seine near Franz Lake outlet (RM 137.5), prior to construction of Bonneville Dam.

The annual congregation of brood size sturgeon below Bonneville and their inability to find fishways, prompted Donaldson to advocate a spawning sanctuary below Bonneville much as Bajkov urged. In hope of locating sturgeon larvae in Columbia River, I proceeded to obtain basic gear for drift sampling as described in Kohlhorst, 1976.

Materials

A sturgeon larval trawl net, 30 inches by 18 in half round, with one-half inch stainless frame, was obtained. The nest was 11.2 feet in length with 20 meshes per inch nylon marquisette web, and had a detachable collecting jar with 30 mesh per inch stainless screen. The anchor and trawl line were each 300 feet in length, of one-half inch soft laid braided nylon. Two ten pound troll weights were attached to bottom corners of net frame. Three six foot by 1/8 inch steel bridles were attached to a swivel, to which the trawl rope was attached. A ten foot chain was attached to patent anchor.

Methods

From May 11 to June 27, 1979 some 29 bottom trawls were made between River Mile 123 off Washougal and River Mile 140 near Dodson, Oregon. The majority of the trawls were of 30 minute duration. I made 17 static anchored sets and 12 tows. The combined time was 16 hours on the bottom. Mobile bottom trawls were often failures, as the net filled with sand, not being designed as a sled. Hauls were made in 15 to 70 feet of water with velocities from slow to swift.

Results

The catch consisted of eleven yolk sac fry and one fry with yolk sac absorbed. The fry appeared to be 5 to 7 day old since fertilization of egg, when compared to lake sturgeon (Harkness and Dymond). Later these fry were

said to be 2-3 days old (Ken Beer, 1981). Incidental catches of invertebrates were an insight to forage for young sturgeon. Microscopic cladoceron water fleas, small amphipod (Hyallella azteca), mayfly nymphs, large mysid shrimp "krill" tiny clams, many shad eggs and fry attest to great variety of food for sturgeon larvae.

In 1980, between April 29 and June 18, some 16 hours of net bottom time between Rm 118 and 144 produced five fry and many eggs. Fry were found between May 8 and June 18 between Washougal and Dodson, mainly river miles 137-138.

In 1981, some three hours trawling on May 14 in some areas, showed no fry. The wet cold spring probably delayed spawning. On May 20 and 21, some 4.5 hours netting yielded five sturgeon larvae from the same areas as previously found.

Gary Malm, U.S. Fish and Wildlife Service, Fisheries Assistance Program, tagged sturgeon in Bonneville and John Day pools. He found a large population of fish in Bonneville pool quite similar to our findings downstream, with a majority of juvenile fish. However, John Day reservoir showed but few large fish in their set line attempts. A brief larval search was made for evidence of spawning success in John Day pool. From June 16-18, Wayne Bowers, Oregon Department of Fish and Wildlife, and myself trawled on bottom for 12.5 hours below McNary in the Umatilla-Patterson area (RM 276-289) in a variety of depths and velocities. The high water resulting from heavy spring rains and snow melt produced high velocities, which should have attracted sturgeon to spawn in such an area. The time frame and temperature ranges (59-60°) was like that found below Bonneville when and where sturgeon larvae were found below Bonneville Dam. A senior resident angler from Plymouth told us that sturgeon angling was excellent below McNary before John Day was built (1968), but declined to unimportance a few years later.

Graduate students from Oregon State University have performed extensive netting in the John Day pool and backwaters finding no sturgeon fry and, but few larger juvenile sturgeon (Mundy). This indicates a loss of sturgeon habitat in this 76 mile lake and probable erratic spawning and limited reproduction. Studies of white sturgeon movements in McNary Dam-Hanford Reach (Haynes, 1978) indicated a preference for free-flowing habitat and that erection of extensive impoundments reducing habitat, could be detrimental to sturgeon survival.

ENVIRONMENTAL CONTAMINENTS

Cliff Bosley, U.S. Fish and Wildlife Service, Fisheries Assistance Program, Marrowstone, Washington has been investigating heavy chemical pesticide concentrations in sturgeon. He has found combinations of DDT, DDD, and DDE as high as 31.7 ppm in liver samples from McNary pool, which he considered dangerous to reenter food chain. He has found PCB as high as 5 ppm occasionally. He has found egg samples as high as 1.9 ppm in PCB, which exceeds levels that have sterilized eggs in salmon (Bosley). High concentrations of PCB in gonads of white sturgeon in San Francisco Bay could reduce survival of larval sturgeon (Kohlhorst, 1980).

A list of total lengths of sturgeon caught be Battelle Northwest Investigators, near Hanford above McNary pool between 1974 and 1977, was obtained (Dauble). The fish were caught in trammel nets with 1, 3 and 4 inch bars. I assumed gear to be non-selective and grouped data by 5 cm intervals. This indicated recruitment to area with 55% of fish less than three feet in length, 22% between three and four feet, 17% between four and six feet and 5% over six feet. Below Bonneville, in contrast, in 1976 and 1977 samples from test fishing ranged from 61-68% less than three feet, 30-26% between three and four feet and 2 to 3% between four and six feet.

STURGEON AND MT. ST. HELENS ERUPTION

Gill net test fishing was undertaken to investigate effects on sturgeon distribution in Columbia River by flood and siltation, resulting from the St. Helens eruption of May 18, 1980.

The 24' Coastal Laboratory gill net boat was readied for sturgeon test fishing with a 400 foot 8-3/4 inch mesh sturgeon set net. A base line catch from uneffected areas was established for comparison.

On June 27, a catch of six sturgeon in 1.8 (3.3 f/hour) was made near Mt. Pleasant (RM 129). A repeat drift in the same area yielded 1.1 fish/hour. Moving down to Corbett (RM 127) resulted in 13 sturgeon in 2.2 hours (5.8 fish/hour) in areas undisturbed by eruption.

On July 1, downstream at Grays Bay Light (RM 21) a 3.5 hour set produced 29 sturgeon (8.3 fish/hour). On July 2, a three hour set off Grays Point (RM 20), in 90 feet of water, yielded only eight sturgeon or 2.7 fish/hour.

Plankton net tows in this area yielded large number of mysid shrimp. A set net near Taylor Sands (RM 18), in 20 feet of water for 1.8 hours, yielded 13 sturgeon (7.2 fish/hour).

In contrast, on July 3 a 1.5 hour set net Walker Island (RM 60), eight miles downstream from the mouth of the Cowlitz River, in the flood devastated areas which were silt and debris laden, produced no sturgeon. Plankton net tows, in shallows along shores of island, yielded many invertebrate amphipods and mysid krill indicating recovery in lotic zones.

The gill net was towed between two boats near Tunnel Point (RM 59) for 2.5 hours in water 50 feet deep, in a formerly popular sport and commercial fishing area, yielding one sturgeon or 0.4 fish/hour.

Test fishing showed that sturgeon had been displaced from devastated area and was in agreement with angling reports. Later, many tag recoveries from Willapa Bay, Grays Harbor, Neah Bay, and even inner Puget Sound, indicated resident sturgeon in Columbia River below Cowlitz River mouth were forced seaward only returning to Columbia River on foraging sortees.

Purging of sturgeon from the river apparently contributed to heavy sturgeon landings by Makah Indian set nets near Neah Bay.

As food chain returned to normal in the lower river, angling improved in upper estuary to rise to new levels of success in the Grays Point-Astoria Bridge area.

Large incidental sturgeon catches near Mayger (RM 58), in autumn 1981 test fishery, indicated a recovery of sturgeon populations in the formerly flood devastated area.

Following eruption and massive siltation in the lower Cowlitz River and in spite of large scale dredging, sturgeon ascended the Cowlitz River to be caught by anglers from Oelqua Creek (RM 25) to barrier dam (RM 50). There was no record of previous sturgeon catches from Cowlitz River.

PROPOSALS

The lack of success in finding sturgeon larvae in John Day pool, in contrast to consistent netting of sturgeon fry below Bonneville, strongly suggests need for more formal investigation into spawning success in mainstem reservoirs. Populations could be so depressed and spawning habitat

so minimal, that transplant or hatcheries may be the only solution.

Spawning sanctuaries should be established below dams to provide an area where large sturgeon can congregate without being disturbed by anglers. This was advocated by Bajkov and Donaldson with no move for protection to date.

Currently U.S. Corps of Engineers maintains a no trespassing zone between Bonneville Dam and the lowermost powerline crossing. This deadline agrees with boat fishing and drone boat deadlines. This deadline should be maintained, for conservation needs, to protect brood stock sturgeon in a half mile reach below the dam.

ACKNOWLEDGMENT

The cooperation and assistance by James Galbreath and Wayne Bowers, of Oregon Department of Fish and Wildlife Service, made the sturgeon fry studies and effects of volcano upon sturgeon test fishing possible.

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Table 1. Columbia River joint Washington-Oregon white sturgeon landings in millions of pounds[1/].

Year	Millions of pounds	Year	Millions of pounds	Recreation below Bonneville[2/]	Gill Net below Bonneville	Set Line below Bonneville	Indian above Bonneville
1889	1.75	1950	.326				
1890	3.1	1951	.257				
1891	3.6	1952	.271				
1892	5.5	1953	.346				
1895	4.7	1954	.311				
1899	.073	1955	.223				
1904	.138	1956	.244				
1915	.135	1957	.312				
1923	.183	1958	.257				
1925	.231	1959	.203				
1926	.209	1960	.184				
1927	.212	1961	.183				
1928	.148	1962	.193				
1929	.160	1963	.212				
1930	.129	1964	.140				
1931	.113	1965	.158				
1932	.071	1966	.226				
1933	.084	1967	.160				
1934	.079	1968	.152				
1935	.073	1969	.404	0.094	.293		0.017
1936	.131	1970	.387	.122	.250		.015
1937	.127	1971	.359	.048	.280		.031
1938	.068	1972	.414	.085	.298		.031
1939	.074	1973	.599	.167	.390		.042
1940	.084	1974	.540	.168	.345		.027
1941	.085	1975	.667	.184	.324	.130	.029
1942	.095	1976	1.009	.252	.582	.151	.024
1943	.116	1977	.716	.379	.296	.025	.016
1944	.237	1978	.815	.505	260	.029	.021
1945	.266	1979	1.095	.522	.487	.047	.040
1946	.312	1980	.754	.439	.237	.025	.052
1947	.375						
1948	.575						
1949	.392						

1/ 1889-1949 data from F.C. Cleaver, O.F.C., 1951. Joint status report 1950-80.
2/ 1969-1980 data from S.D King ODF&W, 1980. Converted to pounds @ 17 lbs./fish.

Table 2. Tagged sturgeon recoveries by tag type and years out, of tags released between Willamette River mouth and Bonneville Dam.

Tag type	Years used	Number tags	Tags recovered by years out: First #	First %	Second #	Second %	Third #	Third %	Fourth #	Fourth %	Fifth #	Fifth %	Sixth #	Sixth %	Total #	Total %
Spaghetti	70-78	1,811	100	5.5	72	4.0	33	2.0	17	0.9	9	0.5	4	0.2	235	13.0
Anchor	76-78	138	1	1	0	0	2	1.4	2	1.4	-	-	-	-	5	3.6
Disc	77	281	5	1.8	2	0.7	1	0.4	-	-	-	-	-	-	8	2.8
Dart	78-79	305	7	2.3	1	0.3	-	-	-	-	-	-	-	-	8	2.6
Lock-on	78-80	1,993	62	3.1	32	1.6	3	0.2	-	-	-	-	-	-	97	4.9
Double tags																
Spaghetti and Anchor	76	330	12	3.6	12	3.6	9	2.7	9	2.7	4	1.2	-	-	46	14.0
w/spaghetti			9	2.7	12	3.6	8	2.4	8	2.4	2	0.6	-	-	39	11.0
w/anchor			11	3.3	7	2.1	6	1.8	3	0.9	4	1.2	-	-	31	9.0
Anchor and disc	77	119	6	-	3	-	2	-	1	-	-	-	-	-	12	10.0
w/anchor[1]			6	-	3	-	1	-	1	-	-	-	-	-	11	9.0
w/disc[2]			3	-	1	-	1	-	1	-	-	-	-	-	6	5.0
Anchor and anchor	77	23	2	-	-	-	1	-	-	-	-	-	-	-	3	13.0
Anchor dorsal			2	-	-	-	1	-	-	-	-	-	-	-	3	13.0
Anchor scute			2	-	-	-	0	-	-	-	-	-	-	-	2	8.7
Dart and Lock-on	78	51	-	-	4	-	1	-	-	-	-	-	-	-	5	10.0
w/lock			-	-	4	-	1	-	-	-	-	-	-	-	5	10.0
w/dart			-	-	3	-	0	-	-	-	-	-	-	-	3	6.0
Total		5,051	195	3.9	126	2.5	52	1.0	29	0.6	13	0.26	4	0.08	419	8.3

1/ Anchor at first scute.
2/ Base dorsal fin.

Table 3. Sturgeon growth in centimeters per year. Modal size of recoveries at tagging = (90 cm). Modal growth = 10 cm per year (3.9 inches).

		Centimeters growth per year																										
	Total	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
150	0																												
5	1													1															
140	1										1																		
5	-																												
130	1															1													
5	5										1	2		1		1													
120	4				1			2				1																	
5	6				1			1			2		1	1															
110	10			2		1		2		1	1	1		2															
5	9	2						1			1	2		1					2										
100	29			2		1			1		2	5	5	2	2	2	1		2			2	1			1			
5	21	2			1	3	2	1		1	1	2		2	2		2							1					1
90	37	2	-	1	2	5	2	4	4	1		3	4	2		2	1	1	1				1						1
5	35	2	2	3		3		4	3	3	1	4		2	1	2	2	2									1		
80	34	1	1	1	1	5	1	4	3	6	2	2	3		2		1		1										
5	16			1				1	2		2	1	1		3		1	2	1		1								
70	12				1	1	1		1	1	2				2	2		1											
5	3	1							1						1														
60	3				1					1													1						
5	4		1	1								2																	
50	0																												
5	0																												
40	2					1				1																			
5	0																												
30	0																												
Total		10	4	11	8	20	6	20	15	15	16	25	14	14	13	10	8	6	7	-	1	2	3	1	-	1	1	-	2
Total recoveries				233																									

Table 4. Movement summary of white sturgeon recovered from tagging in lower Columbia River between Willamette River mouth and Bonneville Dam 1970-1980.

Direction of movement	Number of fish	Miles traveled Mean	Miles traveled Range	Days of freedom Mean	Days of freedom Range
Sublegal fish - less than 3 feet (91 cm) total length when recovered					
Upstream	45	15	1-37	327	7-1,420
Local	34	-	1	117	2-1,070
Downstream	30	37	1-109	238	31-889
Willamette River	2	48	30-65	729	427-1,031
Seaward	2	222	195-249	316	123-508
Legal fish 3 to 6 feet (91-183 cm) total length					
Upstream	196	14	1-32	469	7-1,984
Local	19		1	358	2-1,164
Downstream	82	51	1-118	481	6-1,633
Willamette River	3	50	48-52	652	52-1,500
Seaward	6	183	170-201	503	68-1,120

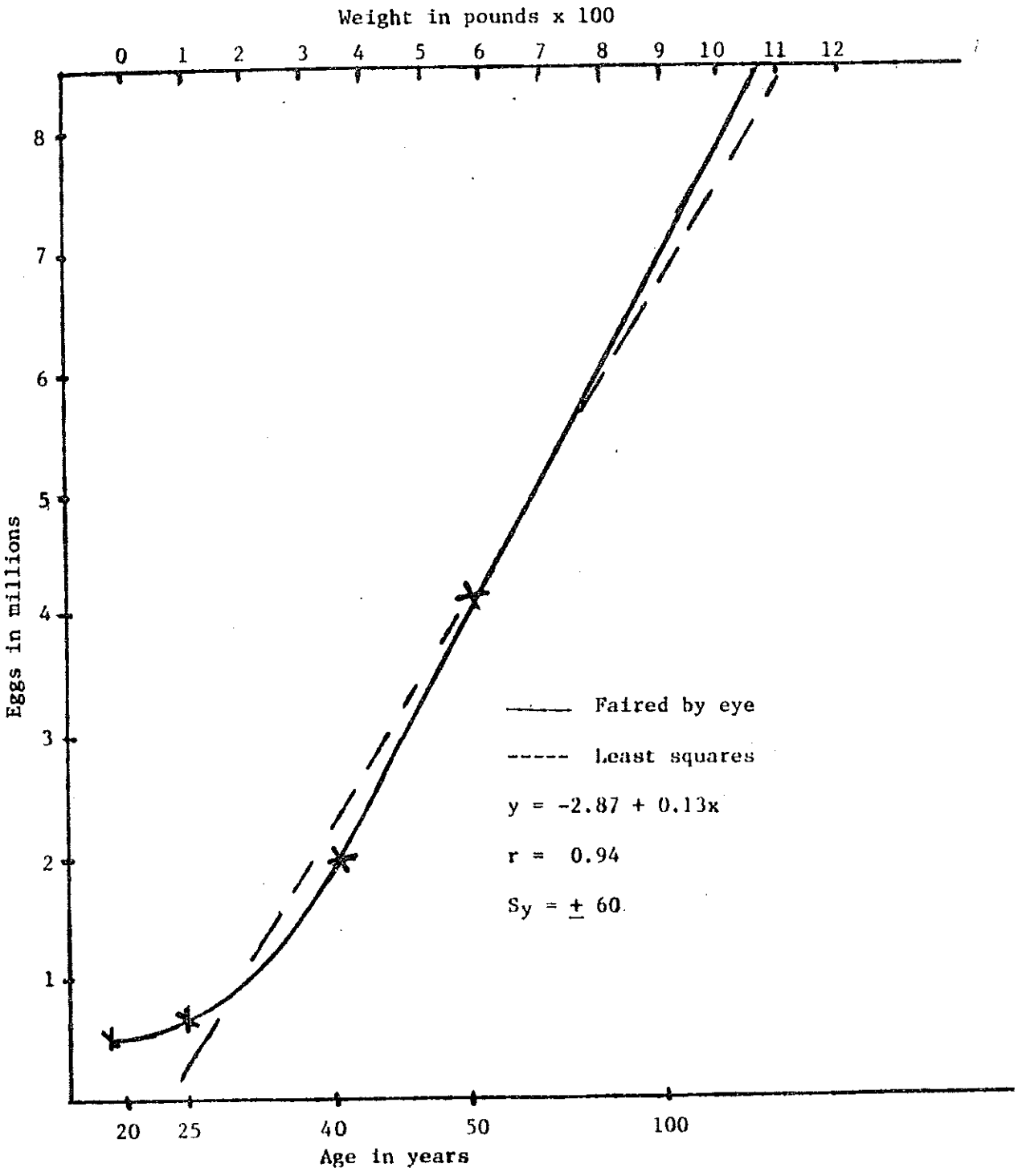


Figure 1. White sturgeon fecundity - age, weight and millions of eggs. (Data from Bajkov).

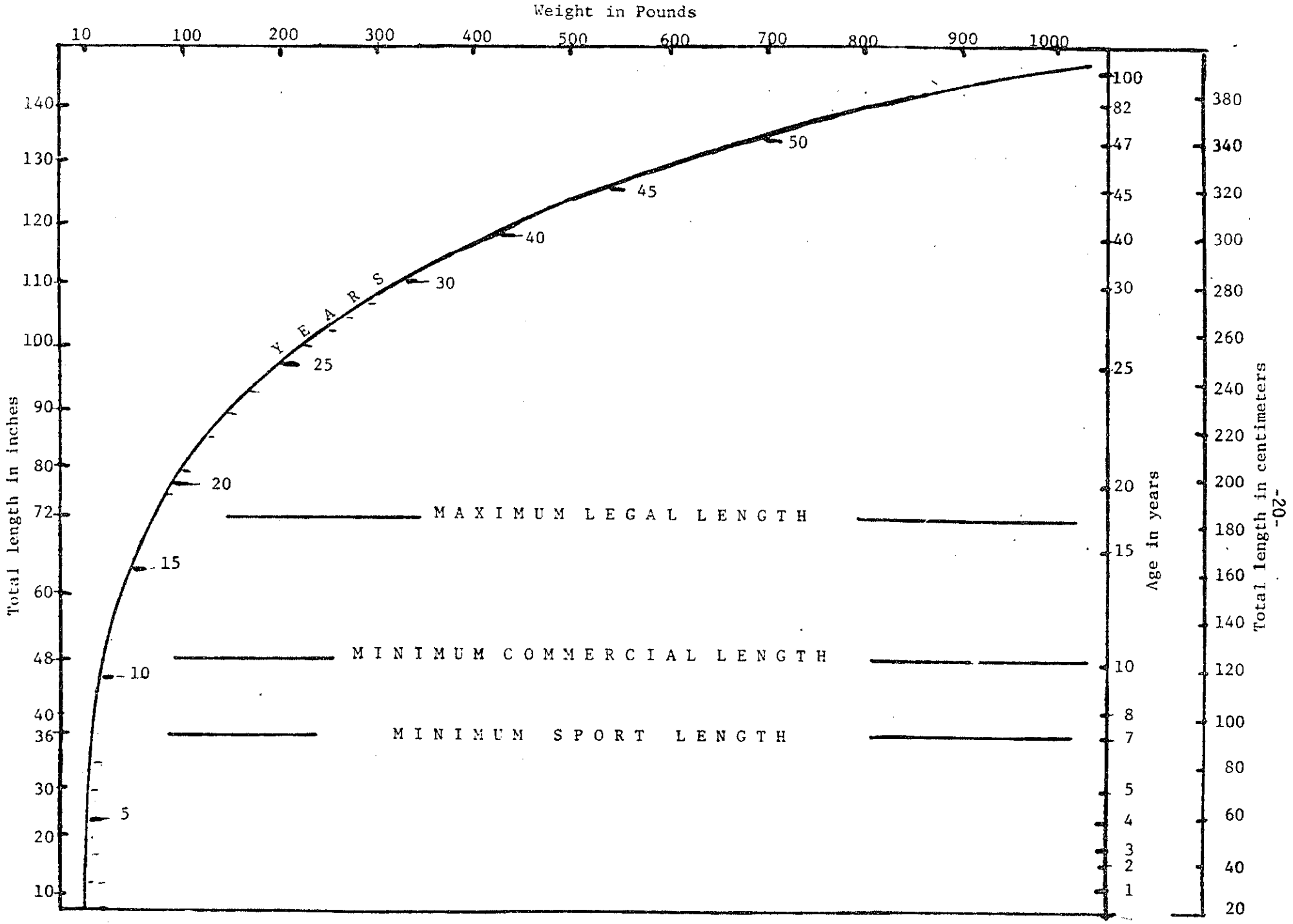


Figure 2. Columbia River white sturgeon - age length and weight.

Figure 3. Transverse base cross section of first bony ray of pectoral fin of white sturgeon showing annual growth rings.

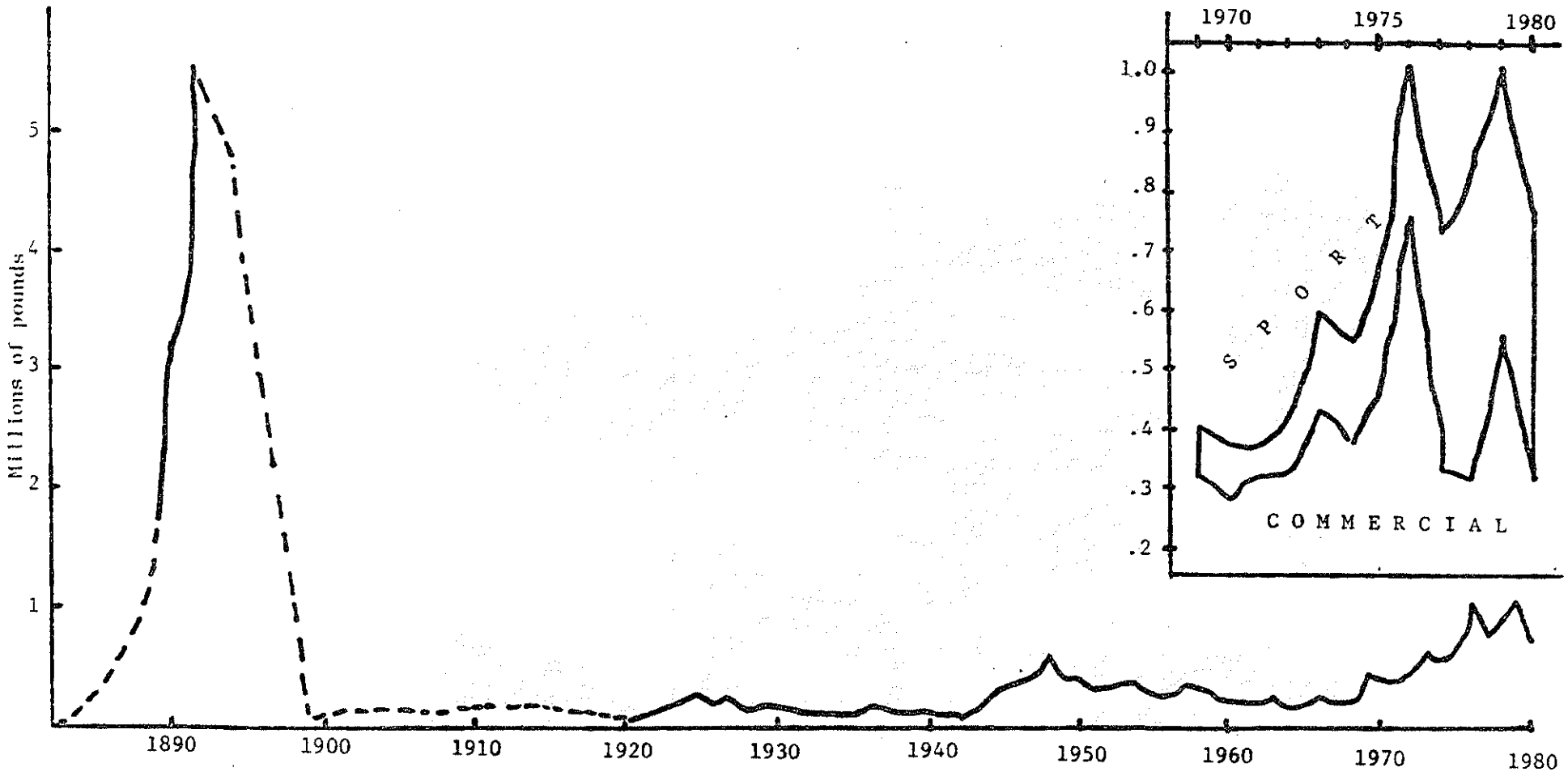


Figure 4. Columbia River Washington-Oregon joint white sturgeon landings in millions of pounds.

1889-1949 data from F. C. Cleaver.
1950-1968 data from Washington Department of Fisheries-Oregon Fish Commission status report.
1969-1980 from Steve King 1981.

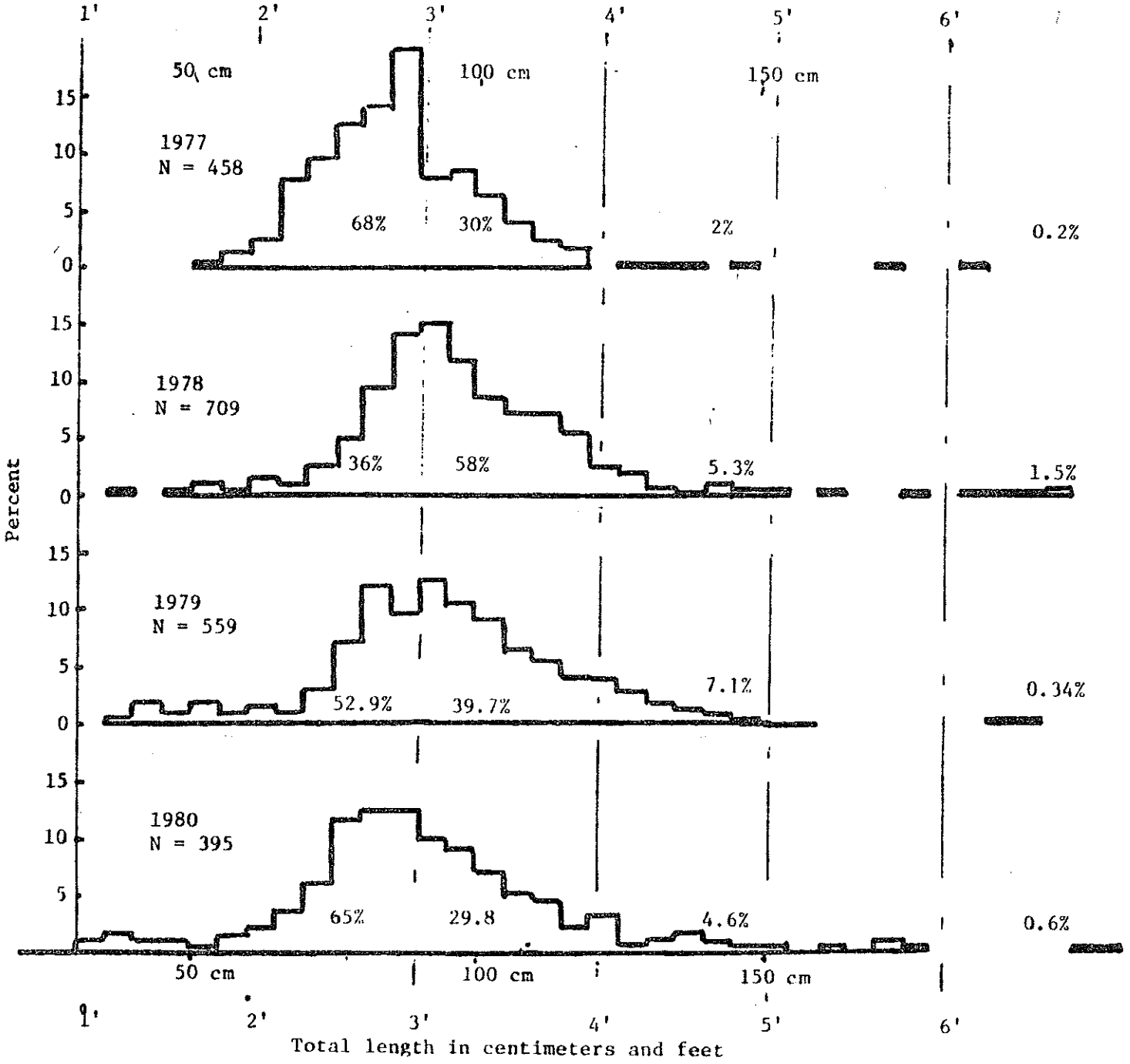


Figure 5. Histograms of sturgeon caught in April test fishing, total lengths in centimeters and feet.

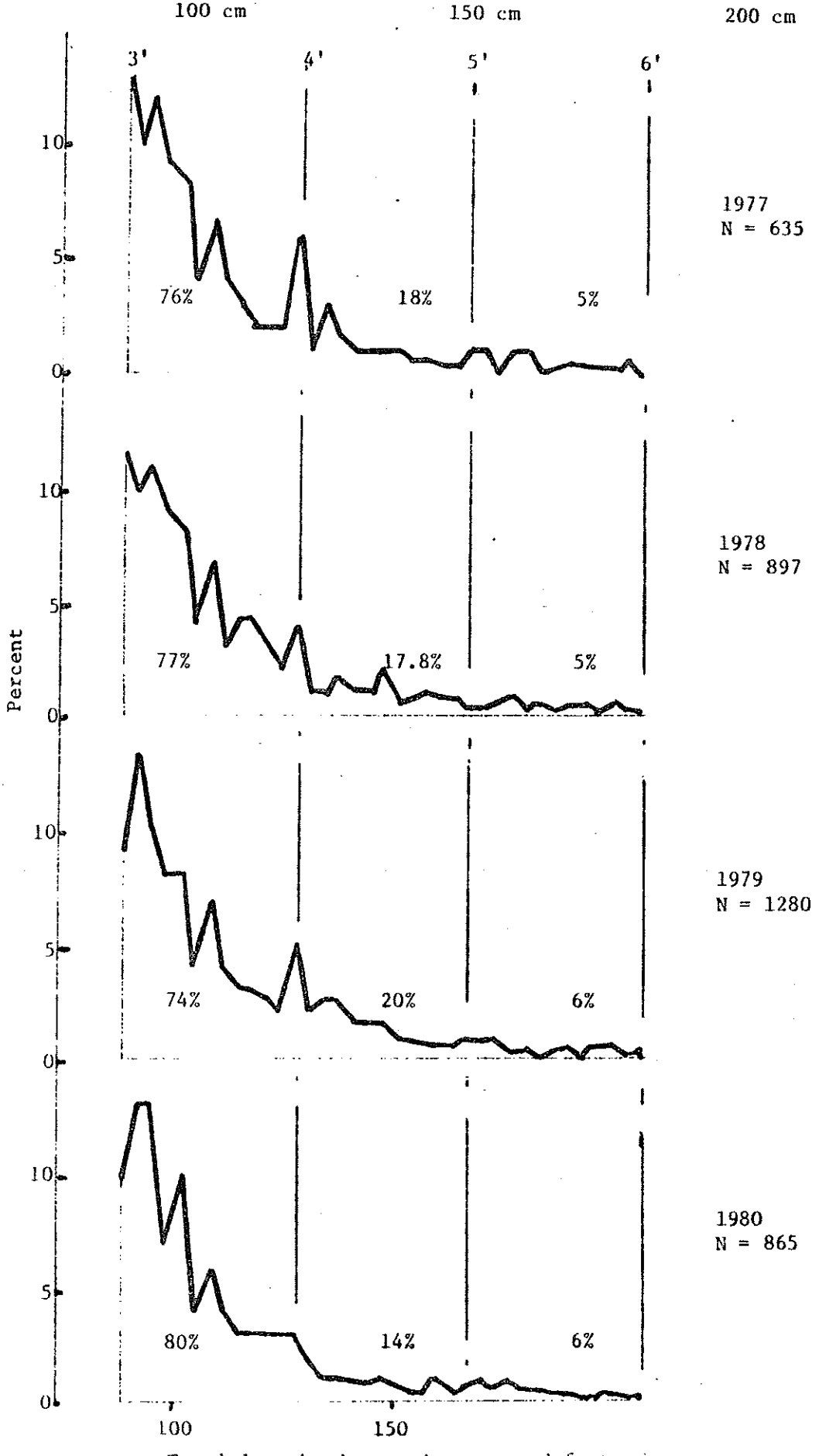


Figure 6. Length frequencies of sport catch below Bonneville Dam (King, 1981).

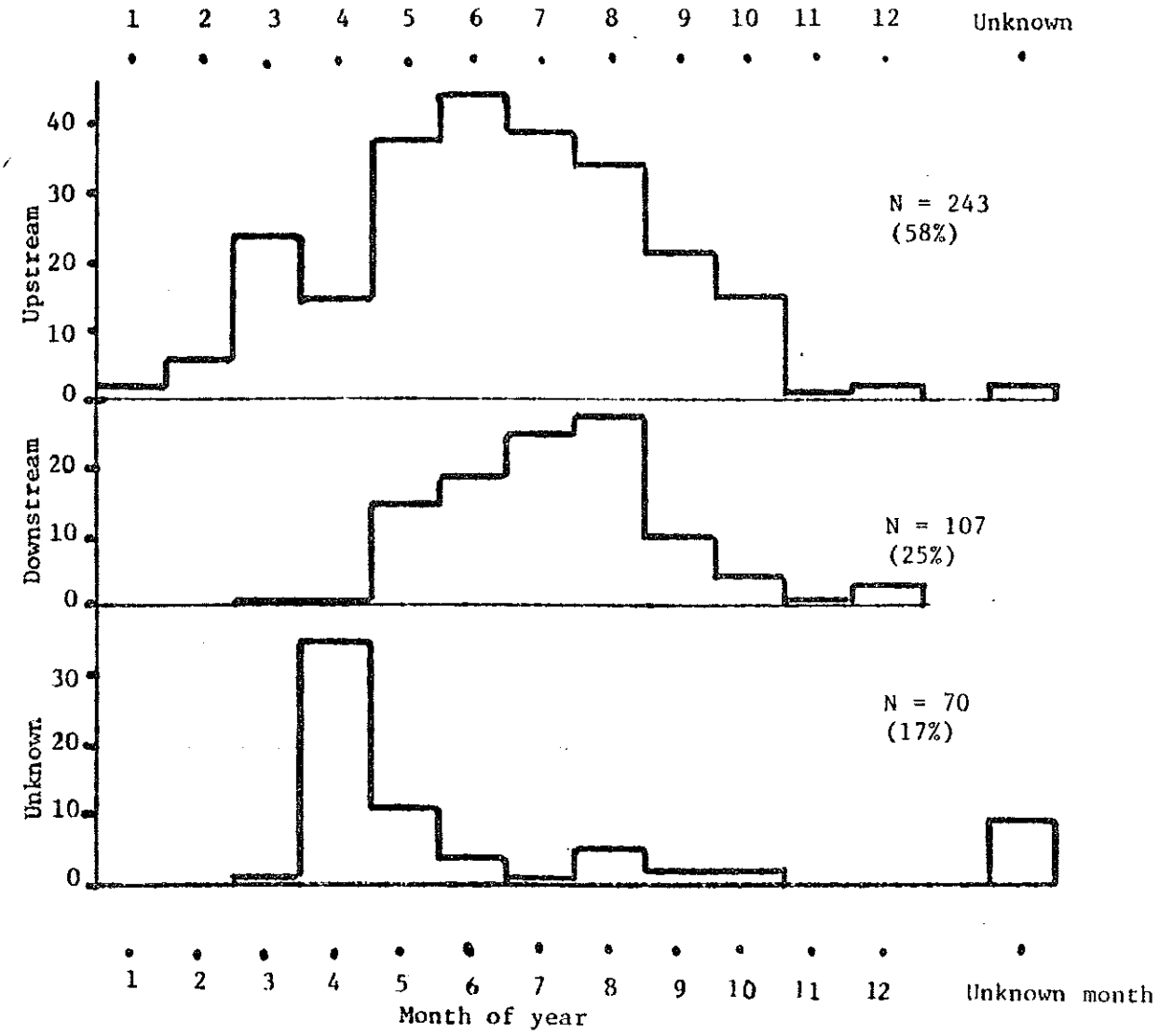


Figure 7. Sturgeon tag recoveries by month. Fish tagged and recovered 1970-1980.

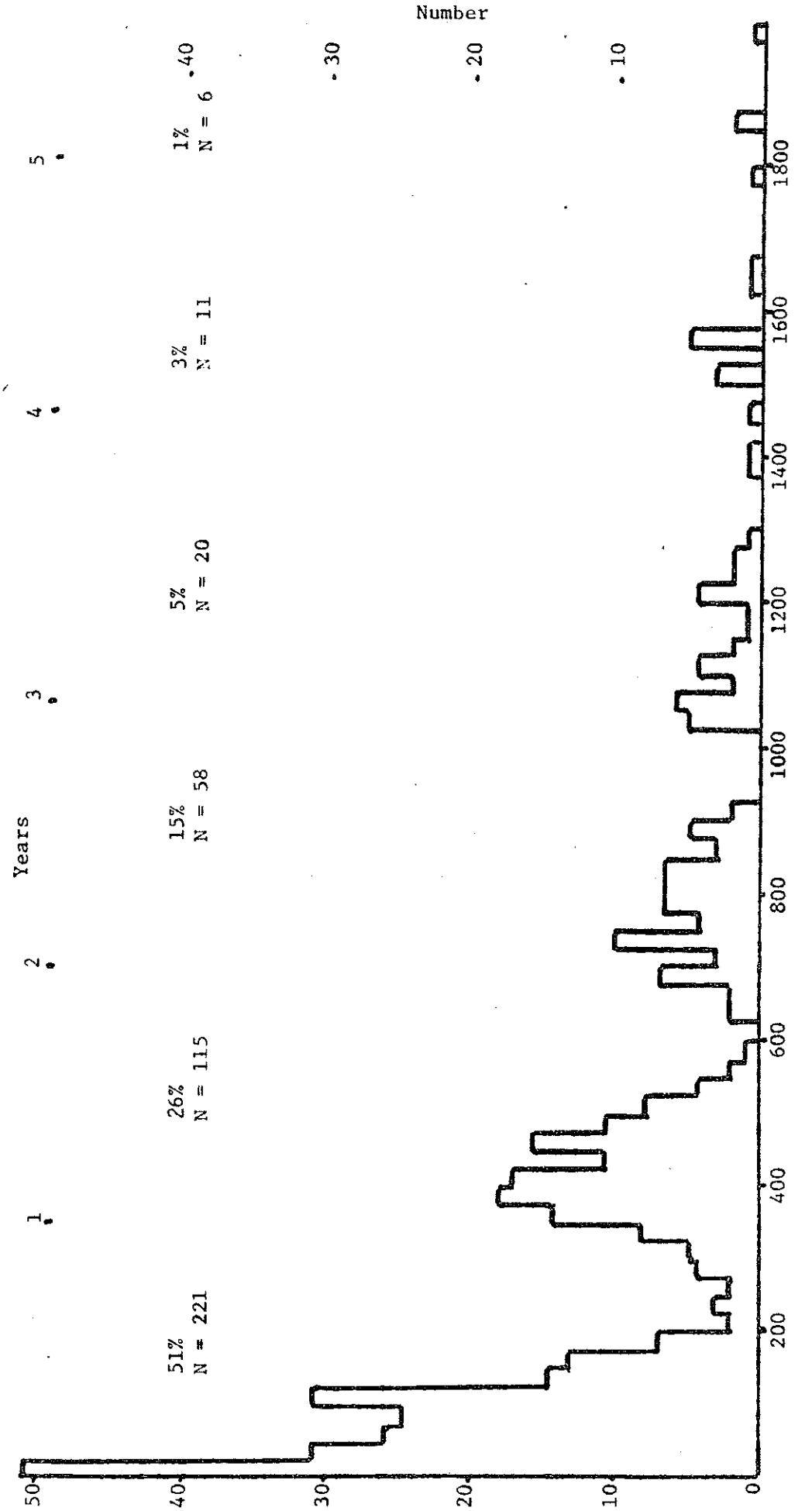


Figure 8. Sturgeon tags out in days and years from release to recovery between 1970-1980.

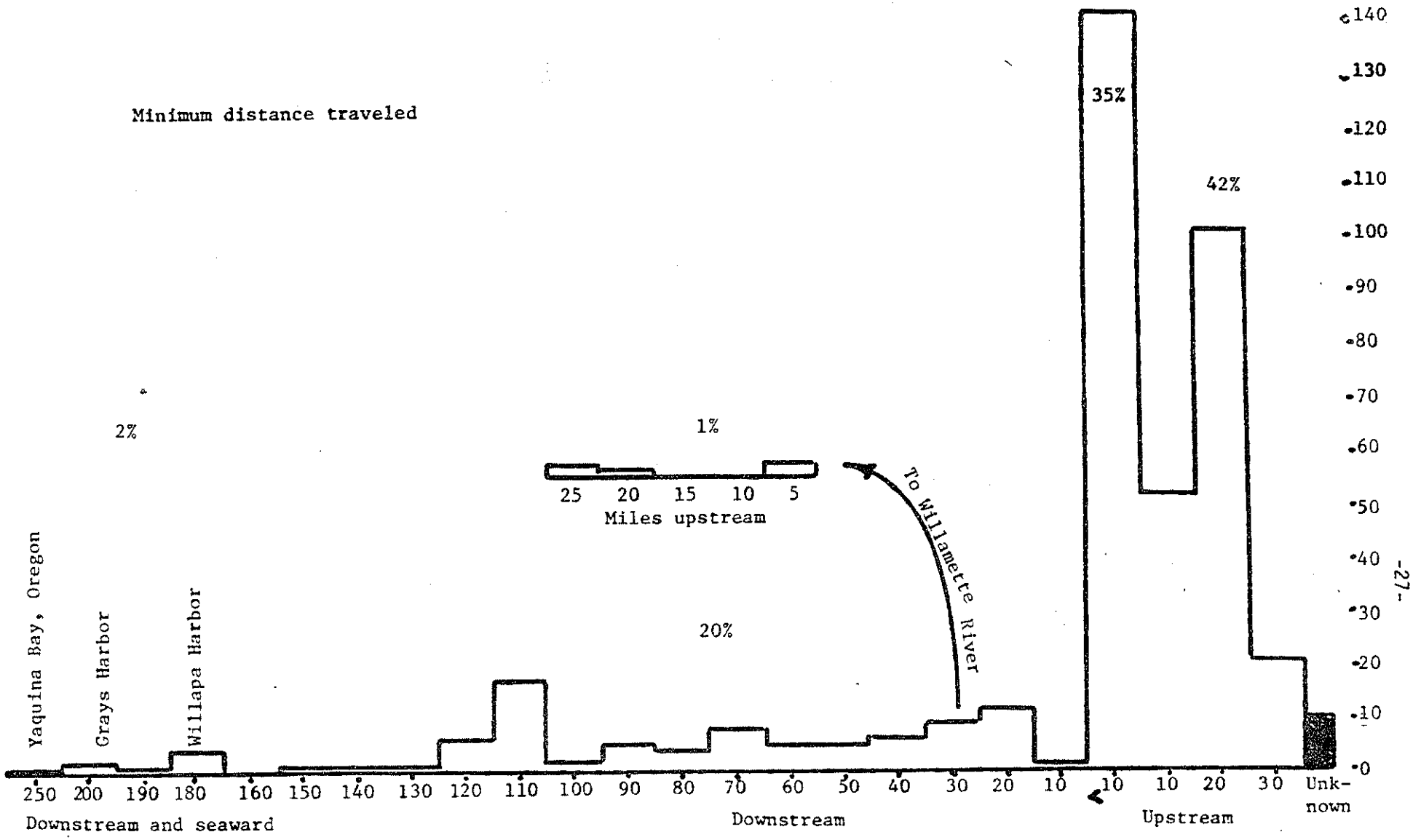
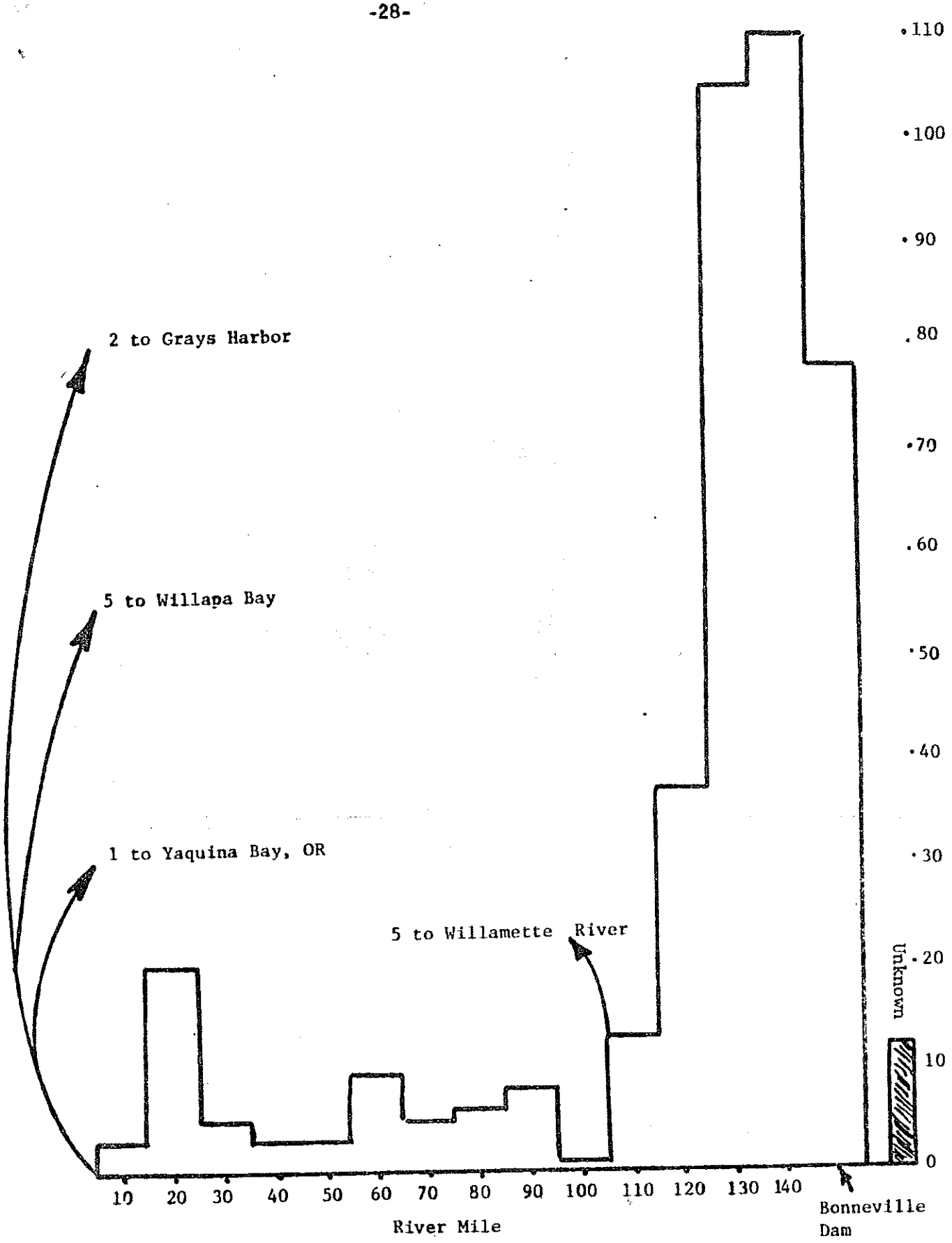


Figure 9. Sturgeon tag recoveries in miles traveled. Tagging from RM 100-145 between 1970-1980, recoveries through 1980.



10. Location of tag recoveries from releases above mouth of Willamette from 1970-1980.