Columbia River White Sturgeon Monitoring Study

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ABSTRACT

Three sites within the lower Columbia River that are possible deep-water, in-river, dredge spoil disposal sites for the U. S. Army Corps of Engineers proposed channel deepening project were sampled for the presence of white sturgeon *Acipenser transmontanus*. The sites were sampled during three seasons (summer, winter, and spring) to determine if there are differences in white sturgeon seasonal use of these areas. Catches of white sturgeon were greatest during the summer sampling period and least during the winter sampling period. Catches of white sturgeon in the spring sampling period were comparable to the summer for setline sampling and comparable to the winter sampling period for gill-net sampling. Gill-net sampling was more productive than setline sampling on a catch per hour basis. We caught significantly larger fish on setlines than we did with gill nets.

INTRODUCTION

This project is part of a larger effort to assess the effects of flowlane dredge disposal on white sturgeon *Acipenser transmontanus* that reside in the Lower Columbia River. Objectives of the overall effort are to: (1) describe potential effects of flowlane dredge disposal on sturgeon, and (2) provide, if necessary, recommendations to minimize the effects of flowlane dredge disposal on sturgeon. Tasks specific to this project include: (1) documenting the seasonal presence of sturgeon in disposal areas, and (2) characterizing the diets of sturgeon collected in disposal areas. This report presents the results on the first of these tasks. In documenting seasonal presence in disposal areas the goal is to determine if sturgeon use these areas throughout the year or if use of these areas is determined by season. This information will be used by the U. S. Army Corps of Engineers to determine seasonal schedules for possible channel-deepening operations. Although this sampling will be useful in documenting seasonal presence or absence of sturgeon in disposal areas, it is not designed to describe the effects of dredge disposal on sturgeon if they are present.

METHODS

Study Area

All work was conducted in the lower Columbia River, downriver of the mouth of the Kalama River (Figure 1). Sampling was restricted to three possible deep-water, in-river disposal sites. The Harrington Sump location extends from river kilometer (RK) 32.8 to RK 34.4, and is located just off Rice Island. The Three Tree Point location cov ers and area from RK 47.8 to RK 49.1, and is located to the west of Welch Island and immediately south of Three Tree Point. The Carrolls Channel location extends from RK 114.3 to RK 116.7. This area is located immediately south of Cottonwood Island, northwest of the upriver entrance to Carrolls Channel.

Sampling

Both setlines and gill nets were used to sample white sturgeon during this study. Both types of gear have been used successfully to capture sturgeon in the Columbia River (Elliot and Beamesderfer 1990). We used 183-m setlines and deployed them from a 7.5-m vessel operated by the Washington Department of Fish and Wildlife. Each line had 40 hooks (sizes 12/0, 14/0 and 16/0), which were baited with pickled squid. Each line was fished for a minimum of 18.5 h, with an average fishing time of 22.5 h. Gillnetting was performed using a contracted commercial fishing boat and captain. We used a 45-m long and 2.4-m deep gill net with 5-cm (stretched measure) monofilament nylon mesh. Gill nets were fished for much shorter periods of time to reduce the incidence of bycatch. Minimum fishing time for the gill nets was 0.88 h (50 minutes) and the average fishing time for gill nets was 1.1 h.

To assess seasonal use of the study area by white sturgeon we sampled at three different times throughout the year. The first setline sampling period commenced on 15 August 2000 and was completed 17 August 2000. The effort for this period was limited to the Harrington Sump site only. The first gill-net sampling period began on 21 September 2000 and was completed on 24 September 2000. The effort for this sampling period was limited to the Harrington Sump and Three Tree Point sites. The combined setline and gill-net sampling period from 15 August – 24 September 2000 will be referred to as summer 2000. The second setline-sampling period began on 2 January 2001. The Harrington Sump and Three Tree Point setline sites were completed on 5 January 2001. The Carrolls Channel setline site was sampled between 30 January and 1 February 2001. The second gill-net sampling period began on 9 January 2001 and was completed on 19 January 2001. The combined setline and gill-net sampling period from 2 January - 1 February 2001 will be referred to as winter 2001. All three sites were sampled in this effort. The third-gill net sampling period was conducted from 25 April 2001 to 8 May 2001. The third setline sampling period was conducted from 21 May to 31 May 2001. The combined setline and gill-net sampling period from 25 April – 31 May 2001 will be referred to as spring 2001.

Diet Analysis

In order to characterize the diet of white sturgeon inhabiting the study area, 42 sturgeons were euthanized in the field and their stomachs were collected for later analysis in the lab. Stomachs were taken from fish caught in gill nets only and from the winter, spring and summer 2001 sampling periods only. All stomachs were preserved in the field in a 10%-formalin solution. Once in the lab, the stomachs were emptied of their contents. All stomach contents were then transferred to an ethyl alcohol solution. Currently the contents of all of the stomachs are being quantified in the lab. All prey items within the stomach are being identified to the most appropriate taxonomic level and counted. The wet mass of all prey items is being taken as well.

Data Analysis

The fork length data from all white sturgeon caught were grouped by sample site and compared with a Kruskal-Wallis one-way Analysis of Variance. Comparisons among sites were made with Dunn's Multiple Comparison Procedure. The test for differences among sample sites was done using the combined data of all four sampling periods. All of the fork length data were grouped by gear type used to catch each fish, and compared with t-tests. We made a single comparison between gear types of fork length data for all sampling periods combined. We then compared fork-length data from each gear type, by sampling period. Results were considered significant when $P < 0.05$.

RESULTS

Catch Composition

Setline sampling resulted in very little bycatch. Of 613 fish caught using setlines during this study all but one were white sturgeon. The gill-net sampling caught a much greater variety of species. A total of 12 separate species were caught during the study (see Appendix 1 for more detail).

<u>Summer 2000 (15-17 Aug. and 21-24 Sep.)</u> – Gill-net sampling at the Harrington Sump and Three Tree Point sites yielded 9 different species of fish. At both sites peamouth chub

Mylochelius caurinus was the most abundant species caught during the sampling period (Table 1). In ten sets at Three Tree Point 542 peamouth chub were caught. While peamouth chub were still the most abundant species caught at Harrington Sump, only 99 individuals were caught in ten sets. White sturgeon were numerous and second only to the peamouth chub in total abundance at both sites. American shad *Alosa sapidissma* were the third most abundant fish species at both sites.

Setline sampling at Harrington Sump had little bycatch. Of 71 fish caught at this site, all but one were white sturgeon. The single fish was an unidentified cottid species.

Winter 2001 (2-5 Jan.; 9-19 Jan.; and 30 Jan. - 1 Feb.) – The winter sampling period had the lowest fish catch and the lowest species diversity among all sampling periods (Table 2). We caught only 20 fish in gill nets at the three sites combined. Starry flounder *Platichthys stellatus* were the most abundant at the Harrington Sump site, with five fish caught in six sets. White sturgeon were the most abundant fish caught at the Three Tree Point site and the Carrolls Channel site, although total fish caught at these sites was also very low.

There were no fish caught on setlines at Harrington Point for this sampling period. Setlines at both Three Tree Point and Carrolls Channel caught only white sturgeon (1 and 4 fish respectively; Table 2).

Spring 2001 (25 Apr. - 8 May; and 21-31 May) – Spring sampling saw greater diversity in species composition than the winter sampling period, yet diversity was not as high as the summer 2000 sampling period (Table 3). More total fish were caught during spring 2001 than in winter 2001, yet fewer fish were caught in spring 2001 than summer 2000. Peamouth chub was the most abundant species caught in gill nets for the spring 2001 sampling period at all three sites. The Carrolls Channel site had the greatest catch of peamouth chub (107) for the sampling period. Starry flounder was the second most abundant species at Harrington Sump and Carrolls Channel and white sturgeon was the second most abundant species at Three Tree Point.

Setline sampling for this period produced no bycatch. All fish caught on setlines during the spring 2001 sampling period were white sturgeon.

Summer 2001 (7-9, 15-16, 27, and 29-30 Aug.) – Eight different species of fish were caught during the summer 2001 sampling period. Only the Summer 2000 sampling period had a greater number of species caught. Additionally, only the summer 2000 sampling period had a greater total number of fish caught than the summer 2001 sampling period. White sturgeon was the most abundant fish caught in the sampling period for both types of gear combined, and peamouth chub were the most abundant fish caught using gill nets only (Table 4).

White Sturgeon Catch

A total of 1,022 white sturgeon were caught during the four sampling periods. 410 white sturgeon were caught in gill nets and 612 were caught using setline gear. The summer 2000 sampling period was the most productive, with 419 fish caught and a catch per unit effort (CPUE) of 1.49 fish caught per hour of effort (Figure 2; Table 1). The summer 2000 sampling period yielded the most white sturgeon of all of the sampling periods despite receiving the least amount of total fishing effort (280.6 h for summer 2000 compared to 623.9 h for winter 2001, 608.6 h for spring 2001, and 655.1 h for summer 2001).

There was a significant difference in the fork length of all fish caught at the three sampling sites (Kruskal-Wallis one-way ANOVA, $P<0.001$). Fish caught at the Harrington Sump location were significantly longer that fish caught at the Three Tree Point Site ($P<0.05$) and the Carrolls Channel Site ($P<0.005$). Additionally, fish caught at the Three Tree Point site were significantly longer than fish caught at the Carrolls Channel site ($P<0.05$; Figure 6).

Gear Comparison

Gill nets were more efficient in catching white sturgeon throughout the course of the study. We caught 410 white sturgeon with gill nets in 84.1 h of fishing effort for a CPUE of 4.9 white sturgeon/h. In contrast setlines caught 612 white sturgeon in 2,084.1 h of fishing effort for a CPUE of 0.29 white sturgeon/h. We caught larger fish using setline gear (Figure 7). The average fork length of white sturgeon caught using setlines was 71.8 cm (± 0.7 SE), whereas average fork length of white sturgeon caught using gill nets was 40.9 cm (± 0.7 SE). The difference between the two is significant (t-test statistic = 29.688, df = 1,021, $P < 0.001$). When compared on a seasonal basis the differences in fork length of the two types of gear employed remain. During summer 2000 the average fork length of white sturgeon caught using setlines (84.4 cm ± 2.1 SE) was significantly greater than those caught using gill nets (39.0 cm ± 0.6 SE; t-test statistic = 26.803; df 417; $P < 0.001$; Figure 2). Likewise, during the winter of 2001 sampling period sturgeon caught in setlines had an average fork length (75.4 cm ± 2.7 SE) that was significantly greater (T-test statistic= 15.0127, df = 13, $P < 0.001$) than white sturgeon caught with gill nets (26.0 cm ± 1.9 SE; Figure 3). Sturgeon caught with setlines during the spring 2001 period had a fork length (69.8 cm ± 1.0 SE), which was significantly greater (t-test statistic= 4.059, df = 277, $P < 0.001$) than those caught in gill nets (45.4 cm ± 7.1 SE; Figure 4). Finally, during summer 2001 the mean fork length of sturgeon caught using setlines (70.3 cm ± 1.1 SE) was significantly greater (T-test statistic= 3.901, df = 307, $P < 0.001$) than the mean fork length of fish caught in gill nets (59.2 ± 2.8 SE; Figure 5).

Diet Analysis

Stomach analysis is not complete. Prelin\minary examination of 34 white sturgeon stomachs revealed all but four contained prey items. The fork length of fish that stomachs were collected from ranged from 22 cm to 82 cm with an average of 48 cm. The most abundant prey items were *Corophium salmonis,* >3,000 individal prey items among 26 stomach samples, and *Neomysis mercedis,* >300 individal prey items among 16 stomach samples (Appendix 2).

DISCUSSION

White sturgeon were present in all three potential deep water, in-river dredge spoil disposal sites that we sampled. Season seemed to influence our catch at all three sites. Diversity and abundance of fish caught differed greatly among sampling periods. The catch for the summer 2000 sampling period had the greatest species diversity, total number of fish caught, and greatest CPUE of all four sampling periods. The summer 2001 sampling period was also characterized by high species diversity, the second greatest total number of fish caught of all of the periods, and very productive CPUE. The winter 2001 sampling period had the lowest diversity of species caught, the least total number of fish, and the least productive CPUE. The spring 2001 catch was intermediate between the high total numbers, diversity, and high CPUE of summer 2000, and 2001, and the low total numbers, diversity, and CPUE of winter 2001. The setline catch during the spring 2001 sampling period was comparable in number and CPUE to the setline catch of summer 2001. However the gill-net catch of the spring 2001 sampling period was comparable to the winter 2001 sampling period. Without more sampling it is difficult to say what is driving this result, but our sampling indicates smaller white sturgeon are rare in the study sites during the spring. Setlines have been shown to catch significantly larger white sturgeon than small-meshed gill nets (Elliott and Beamesderfer 1990, this study Figure 7). A paucity of smaller white sturgeon in the study area would explain why the setline catch in spring 2001 was strong while the gill-net catch was weak. It is possible that white sturgeon vulnerability to catch is related to season or water temperature (season or temperature may affect general fish activity levels or feeding activity.) This would mean that catch rate does not correlate directly with fish density throughout the year. Regardless of the cause, it seems clear that seasonality does play a role in white sturgeon use of the three study sites.

Long-distance seasonal movements of white sturgeon in the Columbia River have been previously documented (Bajkov 1951, Haynes et al. 1978, Haynes and Gray 1981 and, North et al. 1992). Immature white sturgeon were found to undertake an upriver migration in the fall of 1950, leading to a scarcity and even complete lack of small individuals in drift net catches in the lower part of the river (Bajkov 1951). A corresponding downriver migration occurred during the second part of winter and early spring. Bajkov (1951) reported that these movements may have been feeding migrations. Haynes et al. (1978) also recorded an early fall migration of white sturgeon in the free-flowing portion of the Mid-Columbia River, however the authors believe that these movements were dependent more on water temperature and size of the individuals than on feeding pressures. The belief that white sturgeon seasonal movements are linked to water temperature was reiterated in Haynes and Gray (1981).

There was a great difference in the species composition caught by the two types of gear we used. Setlines caught practically all white sturgeon (with the exception of one cottid), whereas gill nets caught a several other fish species (see Appendix 1 for more detail). Although caught only in gill nets, peamouth chub were the most abundant species of fish caught during the study. This was due primarily to a large catch of 542 peamouth chub during the summer 2000 sampling period at the Three Tree Point site. Bycatch of other fish species in the gill-net samples appeared to be affected by season in a pattern similar to the seasonal variation in the catch of white sturgeon. During both summer sampling periods the total abundance and CPUE of peamouth chub and American shad was greater than the spring sampling period, which in turn was greater than the winter sampling period.

We caught significantly larger fish using setline gear than using gill nets (Figure 6). This result is consistent with previous results comparing the two methods (Elliott and Beamesderfer 1990). Similar to the results of Elliott and Beamesderfer (1990) bycatch in this study was substantially greater in gill nets than on setlines. We found gill nets had higher average white sturgeon catches per set and per hour than setlines. Elliott and Beamesderfer (1990), had greater catch rates with setlines than with gill nets or angling. However, that study compared catch based on crew hours needed fish the gears. Bycatch of salmonids in gill nets was not a substantial problem in this study. The only salmonid caught was a single (presumed) sea-run cutthroat trout *Oncorhynchus clarki* was caught in a gill net at the Carrolls Channel site during the spring 2001 sampling period. The fish was caught by the mouth only, not the gills, and was released unharmed. This result was encouraging given that Elliott and Beamesderfer (1990) reported substantial bycatch and subsequent mortality of salmonids caught in gill nets in their study. Our use of smaller mesh (5 cm) gill nets is the likely reason for our lack of salmon bycatch.

FUTURE WORK

While we have established that white sturgeon are present in three potential dredge disposal areas in the lower Columbia River, the response of these fish to disposal activities is not known. Stomach contents samples collected during 2001 are currently being examined to describe prey species composition of the white sturgeon diet. These data, in concert with benthic invertebrate samples collected by the Marine Taxonomic Services will help to characterize the availability of prey in these areas and the likely use of these areas by white sturgeon. The response of white sturgeon to the disposal of dredged materials in these areas however will not be determined by these data. We have demonstrated seasonal variability in catch rates that are strong evidence of variable seasonal use. The short-term response of white sturgeon to dredge disposal activities will be clarified by telemetry work proposed by the U. S. Geological Survey. This added information will provide a more complete assessment of the affects potential loss of habitat (due to dredge-disposal activities) may have on white sturgeon.

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Table 1. Summary of catch and effort for summer 2000, at proposed deep-water, in-river, dredge spoil disposal sites in the lower Columbia River. Aug. 15-17; Sep. 21-24, 2000.

	Setline	Gill Net	
Common name	Harrington Sump	Harrington Sump	3 Tree Point
white sturgeon	70	64	285
American shad	0	62	118
cutthroat trout	0	0	0
northern anchovy	0	2	0
eulachon	0	0	0
northern pikeminnow	0	0	14
peamouth	0	99	542
largescale sucker	0	1	41
yellow perch	0	2	1
Pacific staghorn sculpin	0	0	0
sculpin spp.	1	7	2
starry flounder	0	58	13
Total Sets	12	10	10
Total Effort (h)	257.4	11.21	11.97
Mean Set Depth (m)	10.4	12.5	23.2
CPUE (strg/hour)	0.27	5.71	23.81
Catch/Set	5.83	6.40	28.50

Table 2. Summary of catch and effort for winter 2001 at three proposed deep-water, in-river, dredge spoil disposal sites in the lower Columbia River, Harrington Sump (HS), Three Tree Point (3T), and Carrolls Channel (CC). Jan. 2-5, Jan. 9-19, and Jan 30 to Feb 1, 2001.

	Setline			Gill Net		
Common name	HS	3T	CC	HS	3T	CC
white sturgeon	0	1	4	0	8	2
American shad	0	0	0	0	0	0
cutthroat trout	0	0	0	0	0	0
northern anchovy	0	0	0	0	0	0
eulachon	0	0	0	0	1	0
northern pikeminnow	0	0	0	0	0	0
peamouth	0	0	0	0	0	0
largescale sucker	0	0	0	0	0	0
yellow perch	0	0	0	0	0	0
Pacific staghorn sculpin	0	0	0	0	0	0
sculpin spp.	0	0	0	1	1	0
starry flounder	0	0	0	4	3	0
Total Sets	9	9	9	6	6	6
Total Effort (h)	201.52	198.29	202.56	7.63	7.16	6.74
Mean Set Depth (m)	13.1	24.2	9.7	12.6	22.9	11.2
CPUE (strg/hour)	0.00	0.01	0.02	0.00	1.12	0.30
Catch/Set	0.00	0.11	0.44	0.00	1.33	0.33

Table 3. Summary of catch and effort for spring 2001 at three proposed deep-water, in-river, dredge spoil disposal sites in the lower Columbia River, Harrington Sump (HS), Three Tree Point (3T), and Carrolls Channel (CC). Apr. 25 to May 8; May 21-31, 2001.

	Setline			Gill Net		
Common name	HS	3T	CC	HS	3T	CC
white sturgeon	65	114	92	3	5	0
American shad	0	0	0	1	2	1
cutthroat trout	0	0	0	0	0	1
northern anchovy	0	0	0	0	0	0
eulachon	0	0	0	0	0	0
northern pikeminnow	0	0	0	0	2	0
peamouth	0	0	0	52	35	107
largescale sucker	0	0	0	0	0	2
yellow perch	0	0	0	0	0	0
Pacific staghorn sculpin	0	0	0	2	0	0
sculpin spp.	0	0	0	0	0	0
starry flounder	0	0	0	18	0	4
Total Sets	9	9	9	6	6	6
Total Effort (h)	191.61	192.29	203.9	6.57	6.95	7.18
Mean Set Depth (m)	12.1	22.1	9.5	13.0	24.0	9.8
CPUE (strg/hour)	0.34	0.59	0.45	0.46	0.72	0.00
Catch/Set	7.22	12.67	10.22	0.50	0.83	0.00

Table 4. Summary of catch and effort for summer 2001 at three proposed deep-water, in-river, dredge spoil disposal sites in the lower Columbia River, Harrington Sump (HS), Three Tree Point (3T), and Carrolls Channel (CC). Aug. 7-9; Aug. 15-16; Aug. 27, 29-30, 2001.

	Setline			Gill Net		
Common name	HS	3T	CC	HS	3T	CC
white sturgeon	20	82	164	16	20	7
American shad	0	0	0	19	7	0
cutthroat trout	0	0	0	0	0	0
northern anchovy	0	0	0	5	0	0
eulachon	0	0	0	0	0	0
northern pikeminnow	0	0	0	0	4	1
peamouth	0	0	0	141	131	32
largescale sucker	0	0	0	0	0	0
yellow perch	0	0	0	1	0	10
Pacific staghorn sculpin	0	0	0	0	0	0
sculpin spp.	0	0	0	13	0	0
starry flounder	0	0	0	21	1	2
Total Sets	9	9	9	6	6	6
Total Effort (h)	213.28	212.44	210.76	5.98	6.26	6.35
Mean Set Depth (m)	12.2	17.8	10.5	11.4	22.7	11.3
CPUE (strg/hour)	0.09	0.39	0.78	2.68	3.19	1.10
Catch/Set	2.22	9.11	18.22	2.67	3.33	1.17

Appendix 1. List of fish taxa collected during gill net sampling at three proposed deep-water, in-river, dredge spoil disposal sites in the lower Columbia River, Harrington Sump (HS), Three Tree Point (3T), and Carrolls Channel (CC), September 2000 through August 2001. Codes: x = species present; xx = most abundant species.

		Sep-00		Jan-01			Apr/May-01			Aug-01		
Common Name	Scienctific Name	HS	3T	HS	3T	CC	HS	3T	CC	HS	3T	CC
white sturgeon	*Acipenser transmontanus*	x	x		xx	xx	x	x		x	x	x
American shad	*Alosa sapidissma*	x	x				x	x	x	x	x	
northern anchovy	*Engraulis mordax*	x								x		
peamouth	*Mylocheilus caurinus*	xx	xx				xx	xx	xx	xx	xx	xx
northern pikeminnow	Ptychochelius oregonensis		x					x			x	x
largescale sucker	*Catostomus macrochelius*	x	x						x			
eulachon	*Thaleyicthys pacificus*	x	x		x							
cutthroat trout	*Oncorhynchus clarki*											
Pacific staghorn sculpin	*Leptocottus armatus*						x					
sculpin spp.	*Cottus* spp.	x	x	x	x					x		
yellow perch	*Perca flavescens*	x	x									
starry flounder	*Platichthys stellatus*	x	x	xx	x		x		x	x	x	x

Appendix 2. White sturgeon stomach contents collected from three proposed deep-water, in-river, dredge spoil disposal sites in the lower Columbia River, Harrington Sump, Three Tree Point, and Carrolls Channel, Jannuary through August 2001.

		Count of individual food items by taxonomic group (continued on next page)										
Date	White Sturgeon FL (cm)	Ceratopogonidae larvae	Copepods	Corophium salmonis	Crangon franciscorum	Empty	fish *anchovy	fish *smelt	Gastropoda	Isopoda	mollusk (clam)	Nemertea
1/10/01	24					0						
1/19/01	32					0						
5/2/01	40			1								
	57			430								
	67					0						
5/3/01	22			125								
	23			126								
	25			54								8
	61			1								
5/8/01	68			6				1				2
8/15/01	29			41								
	33			401								
	36			4								
	38			176								26
	41			346								
	43			226								
	49		82	138								
	61			91								6
	64					0						
	68						2			4		
	73			52								
	82									1		1
8/16/01	36			146						1		
	37			31								
	40			433								12
	49			5								
	56			423							2	
	71				31					1		
8/27/01	49			12								
	53			22							1	
	58	1		47					29		3	
	61			56								1
	62										1	
	64			1								1
Total food items		1	82	3,394	31	0	2	1	29	7	7	57
Count of sturgeon		1	1	26	1	4	1	1	1	4	4	8

-- (Continued) --

Appendix 2 (continued). White sturgeon stomach contents collected from three proposed deep-water, in-river, dredge spoil disposal sites in the lower Columbia River, Harrington Sump, Three Tree Point, and Carrolls Channel, Jannuary through August 2001.

		Count of individual food items by taxonomic group (continued from previous page)										
Date	White Sturgeon FL (cm)	Neomysis mercedis	Neomysis mercedis (young)	Ramellogammarus oregonensis	Turbellaria	unidentified (shrimp)	unidentified 11	unidentified 13	unidentified 6	unidentified 8	unidentified leach	Total food items
1/10/01	24											0
1/19/01	32											0
5/2/01	40											1
	57											430
	67											0
5/3/01	22	1		14	4				1			145
	23											126
	25	15					1					78
	61											1
5/8/01	68	1										10
8/15/01	29											41
	33	14										415
	36											4
	38			3				1				206
	41	9										355
	43	1										227
	49											220
	61										1	98
	64											0
	68											6
	73										1	53
	82									4		6
8/16/01	36	1			2							150
	37	2										33
	40	21										466
	49	179				1						185
	56	6		102								533
	71											32
8/27/01	49	24										36
	53											23
	58	3										83
	61	66	1									124
	62	3										4
	64	2										4
Total food items		348	1	119	6	1	1	1	1	4	2	4,095
Count of sturgeon		16	1	3	2	1	1	1	1	1	2	34

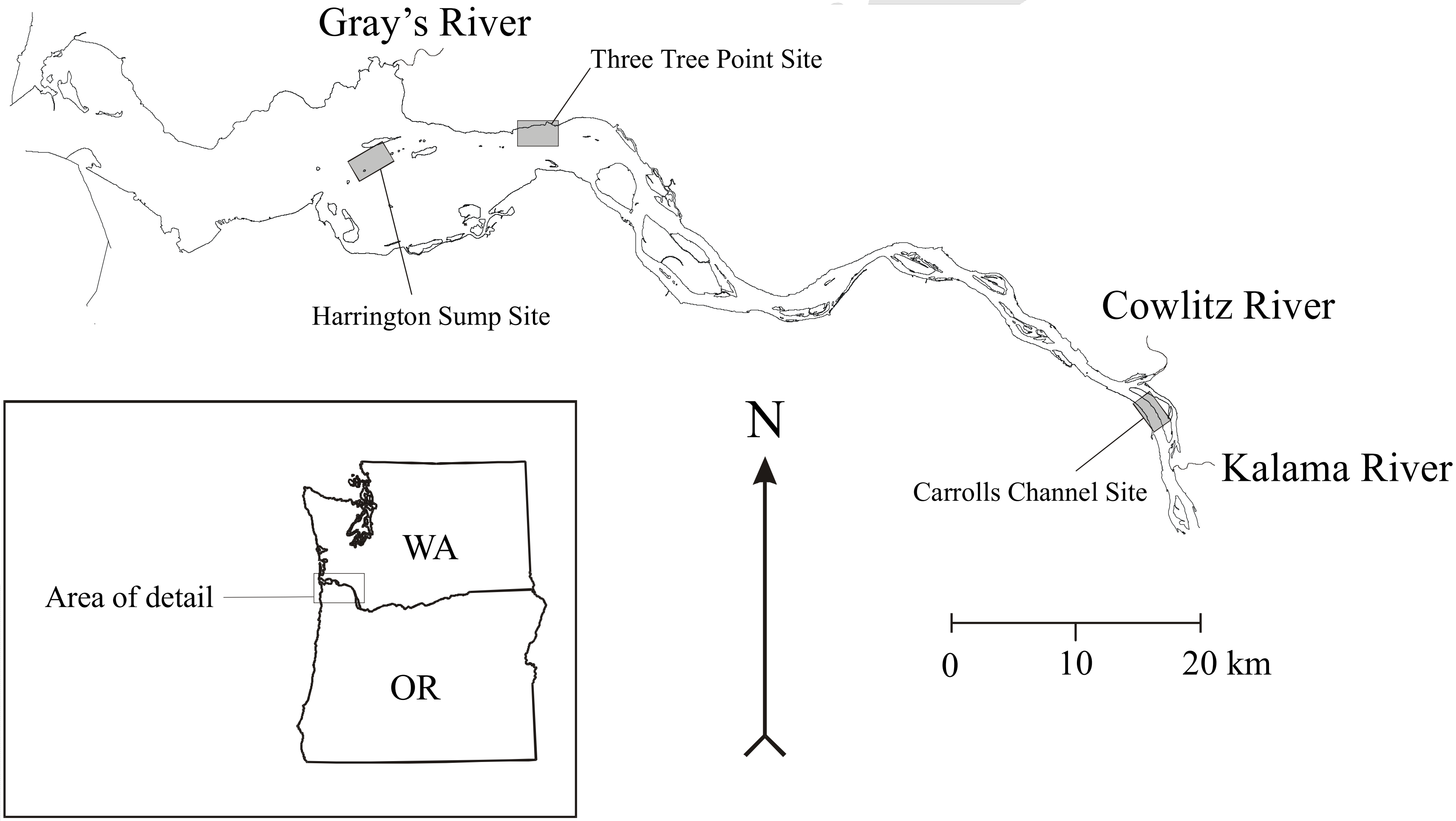


Figure 1. Location of proposed deep-water, in-river, dredge spoil disposal sites in the lower Columbia River, that were sampled for white sturgeon.

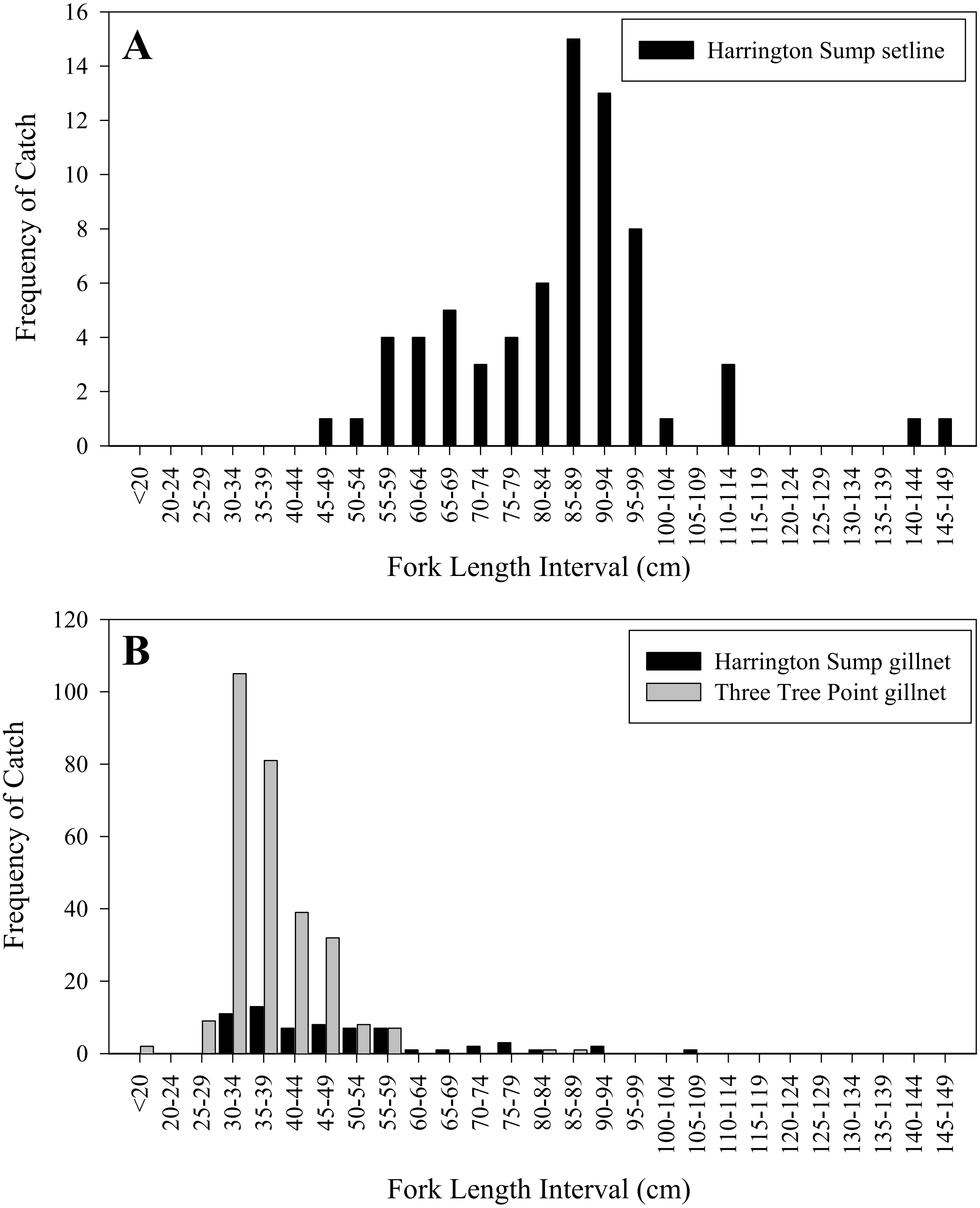


Figure 2. Summer 2000. Fork length frequency distribution of white sturgeon caught with (A) setline gear or (B) gillnet gear, at two proposed deep water, in-river, dredge spoil disposal sites in the lower Columbia River, (15-17 Aug. and 21-24 Sep.).

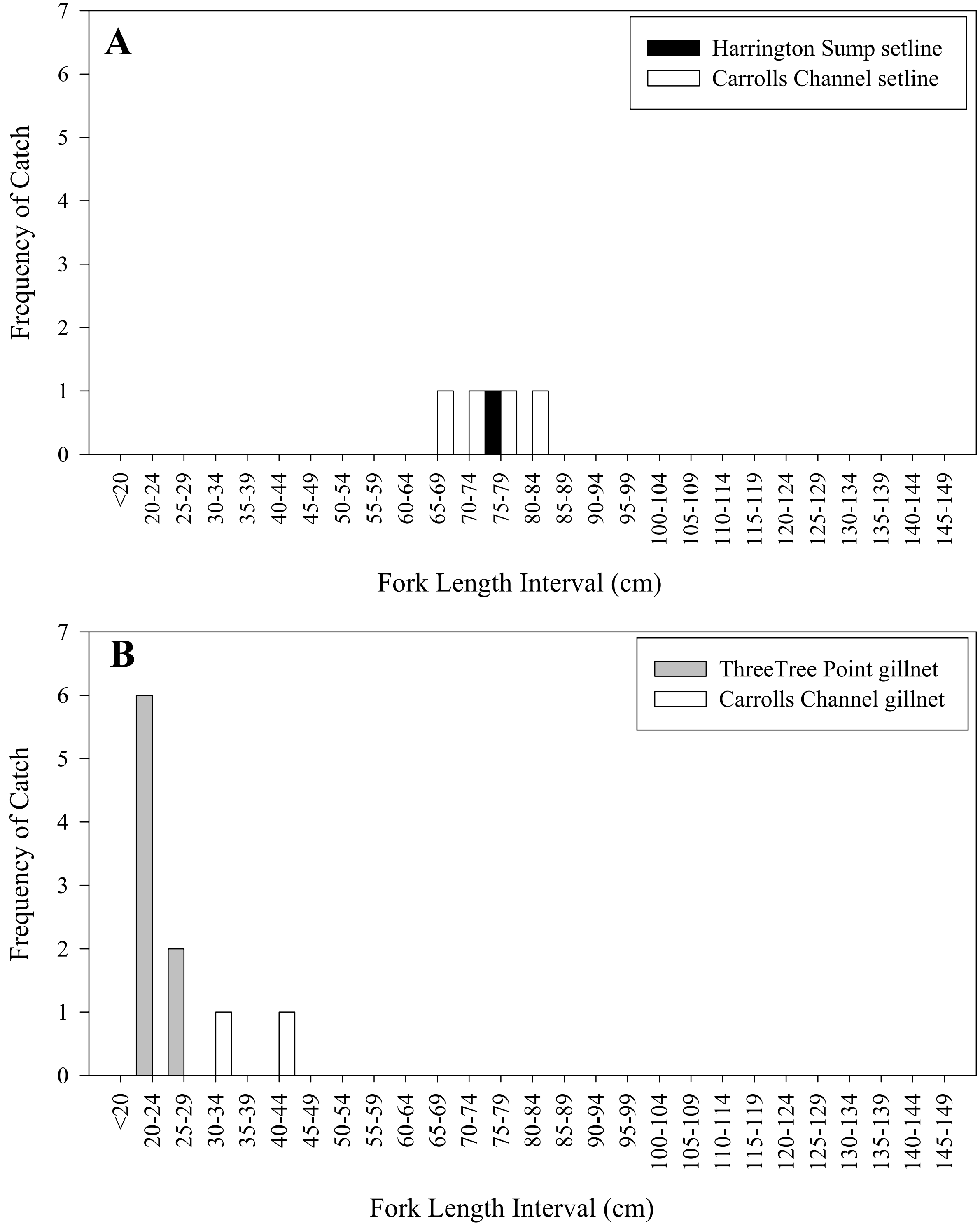
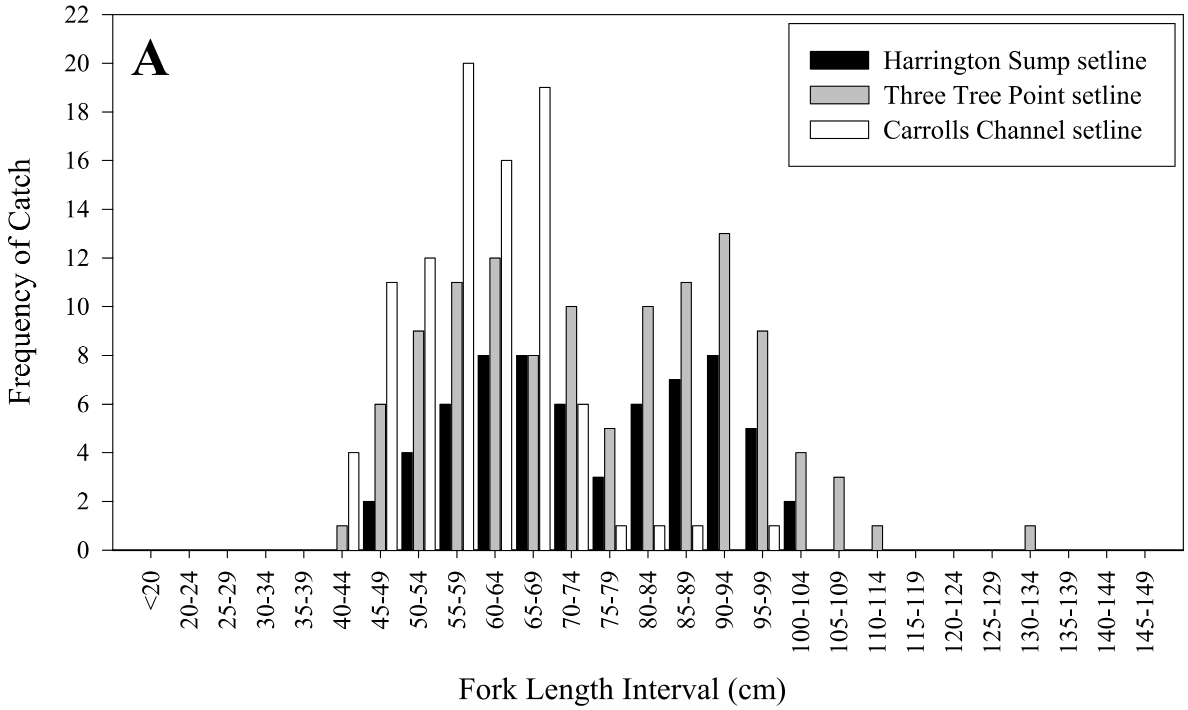


Figure 3. Winter 2001. Fork length frequency distribution of white sturgeon caught with (A) setline gear or (B) gillnet gear, at three proposed deep water, in-river dredge spoil disposal sites in the lower Columbia River (Jan.2-5; Jan. 9-19; Jan. 30 to Feb. 1).



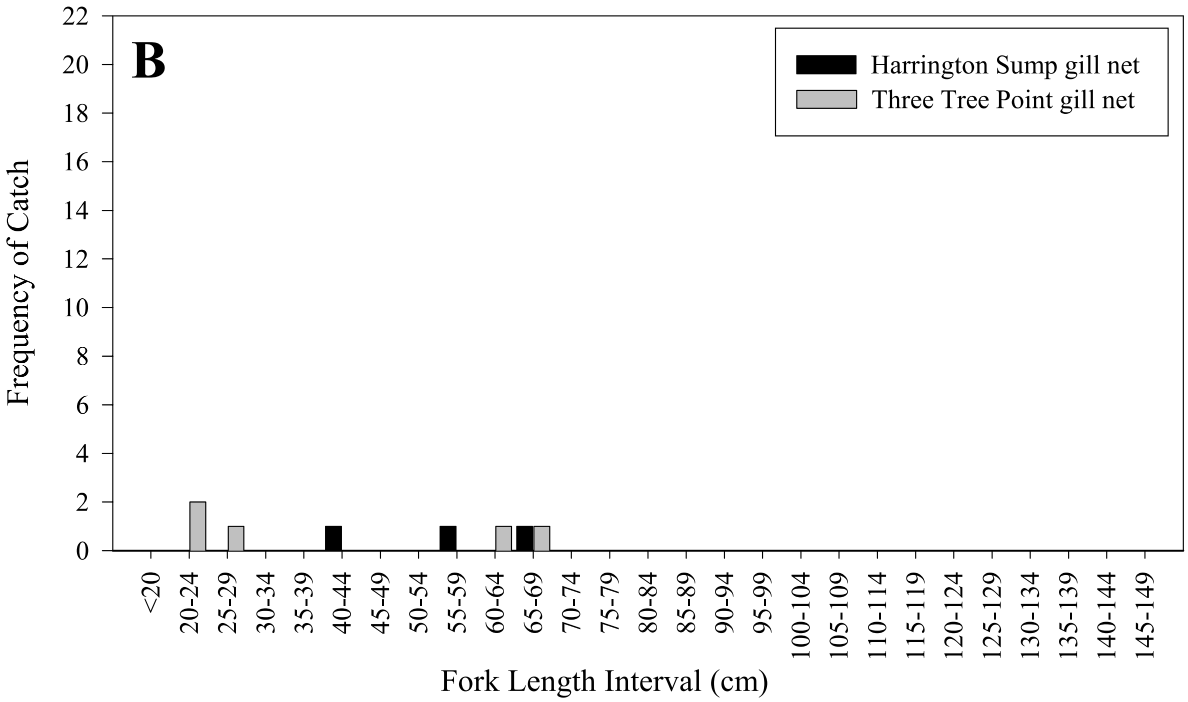


Figure 4. Spring 2001. Fork length frequency distribution of white sturgeon caught with (A) setline gear or (B) gillnet gear, at three proposed deep water, in-river, dredge spoil disposal sites in the lower Columbia River, (April 25 to May 8; May 21-31).

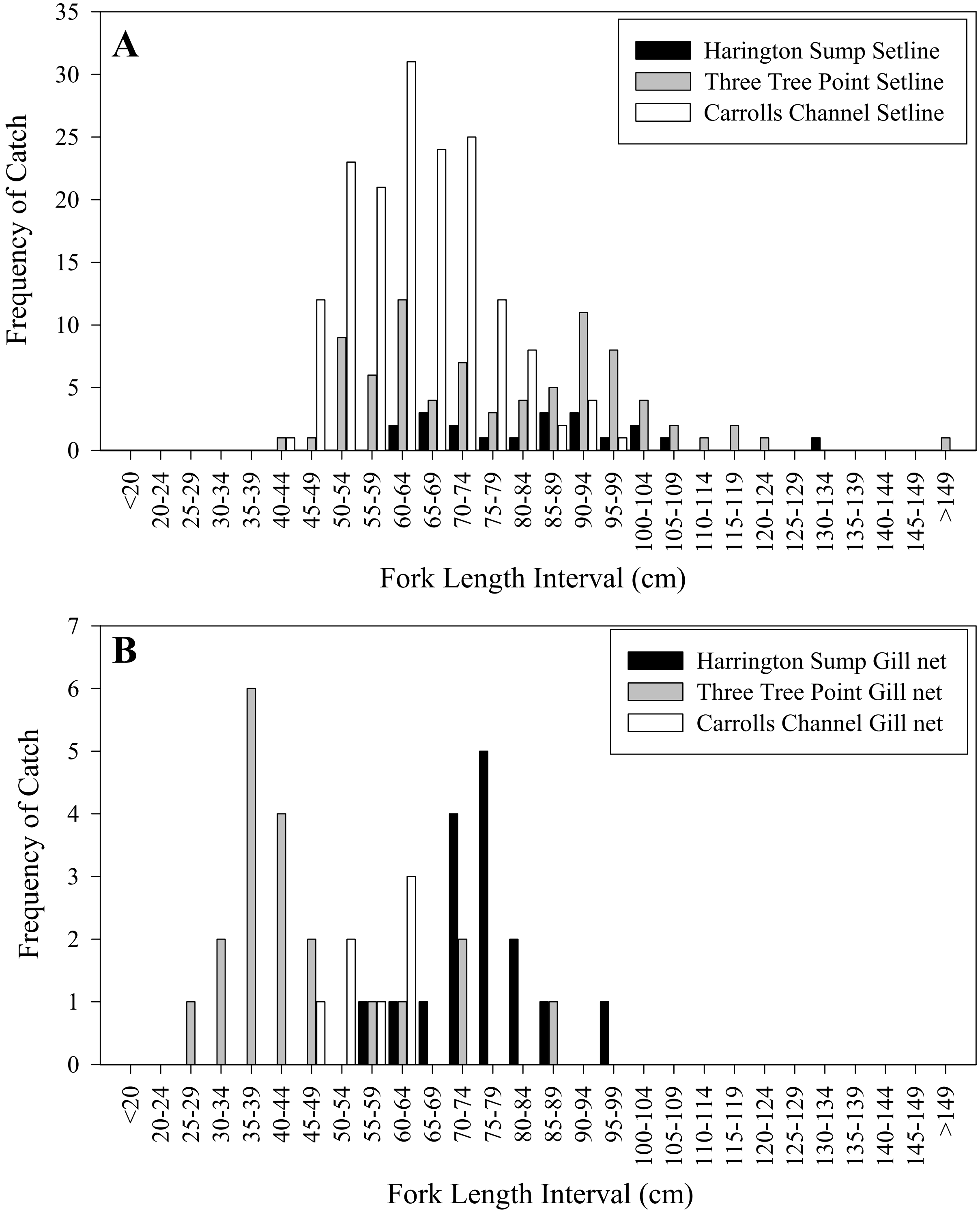


Figure 5. Summer 2001. Fork length frequency distribution of white sturgeon caught with (A) setline gear or (B) gillnet gear, at three proposed deep water, in-river, dredge spoil disposal sites in the lower Columbia River, Aug. 7-9; Aug. 15-16; Aug. 27; Aug. 29-30).

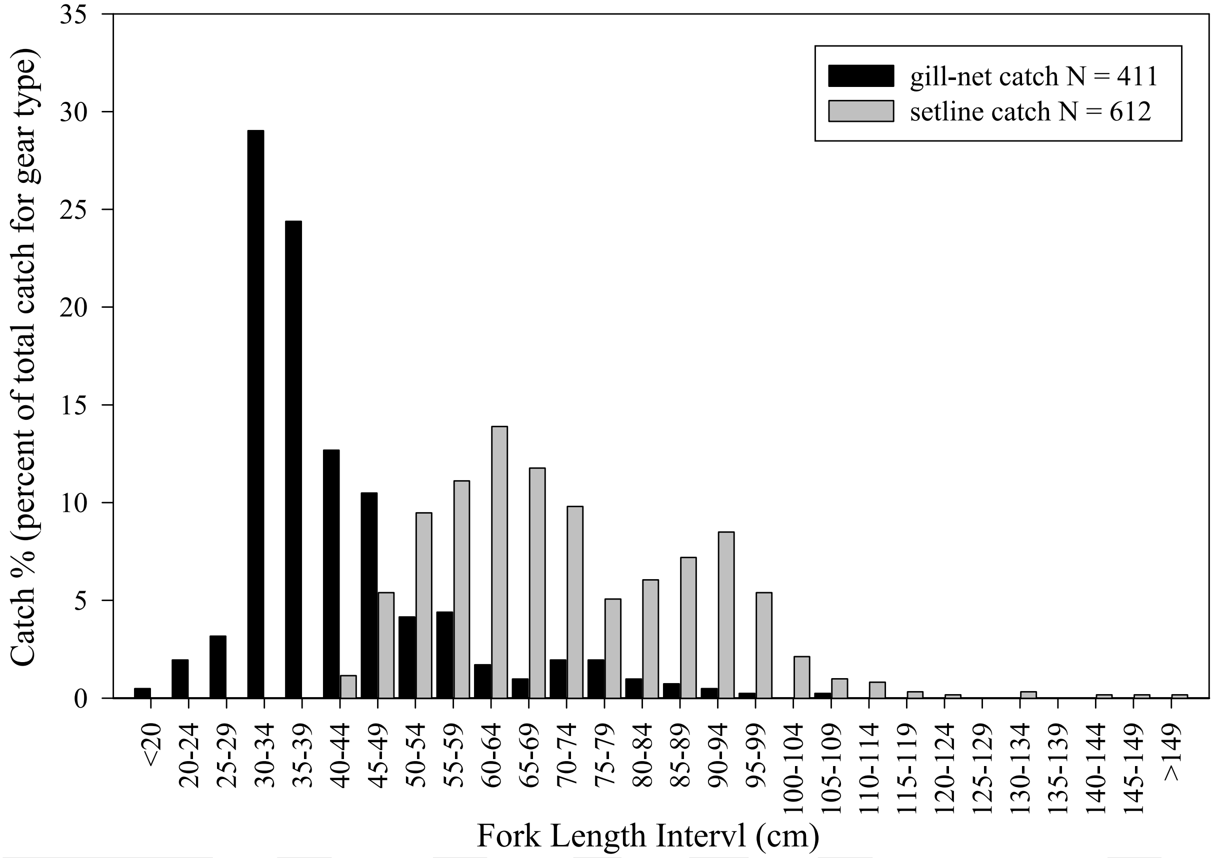


Figure 6. Fork length frequency distribution of white sturgeon as a percent of total catch for each gear type employed. Data from three proposed deep water, in-channel dredge spoil disposal sites within the lower Columbia River are combined.

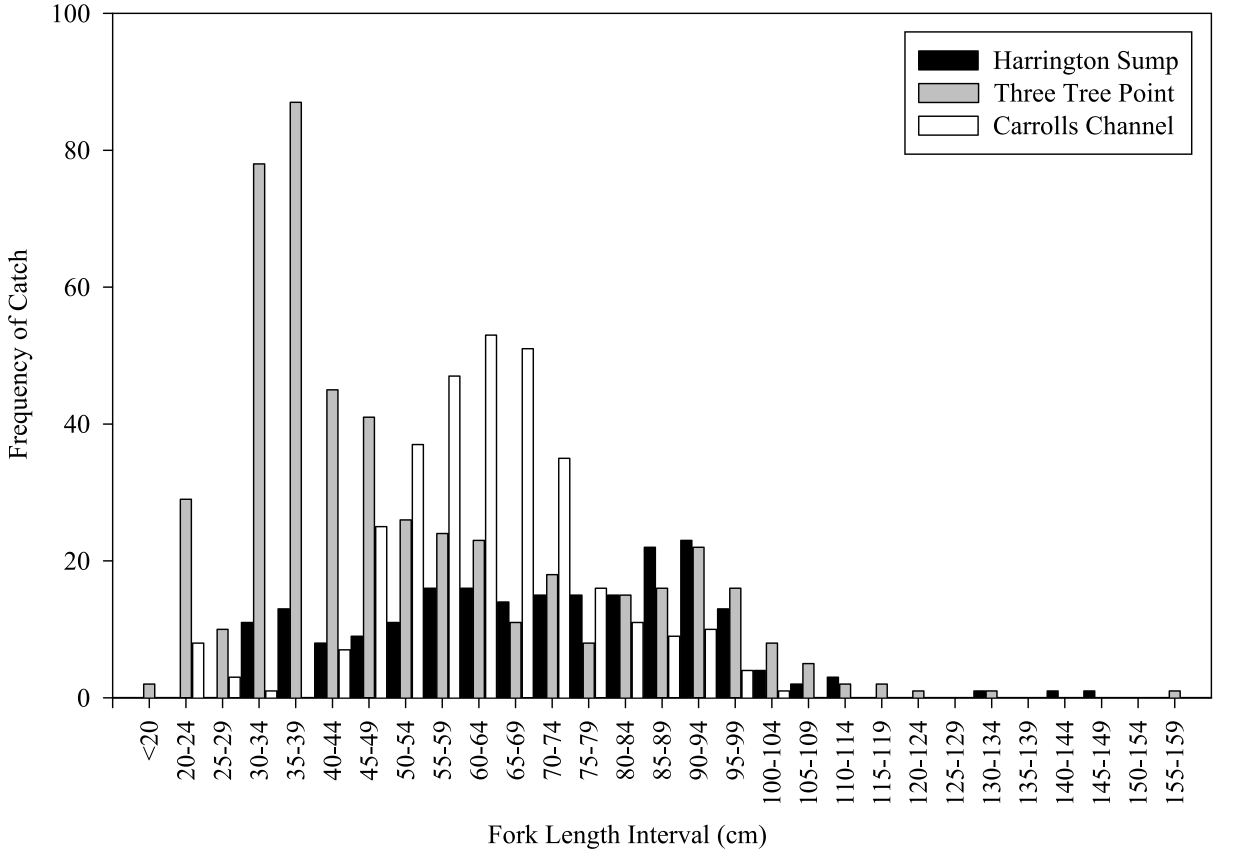


Figure 7. Fork length frequency distribution of white sturgeon caught at three different proposed deep water, in-river, dredge-spoil disposal sites in the lower Columbia River. Data for all four sample periods has been combined.