EXHIBIT K-1

EVALUATION REPORT
WHITE AND GREEN STURGEON
(REVISED)

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INTRODUCTION

This memorandum provides supporting information on the effects of dredging and in-water disposal of dredge materials from the Corps of Engineers Channel Improvement Project on white sturgeon (*Acipenser transmontanus*) and green sturgeon (*A. medirostris*) in the lower Columbia River. The following is a summary of the research conducted by Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife on the distribution and abundance of sturgeon at three deep water sites in the project area as well as feeding habits at the site at RM 30. The final report from ODFW/WDW is attached. A progress report on the telemetry work on sturgeon behavior at RM 30 by the U.S. Geological Survey (USGS) is also attached. Although no green sturgeon were caught during the ODFW or USGS studies, green sturgeon have been observed in the study area. Because green sturgeon occupy similar habitat to white sturgeon, and because they are thought to behave similarly, the conclusions of these studies regarding the behavior of and potential effects on white sturgeon should apply equally to green sturgeon.

STUDIES

ODFW / WDFW Report

Introduction
Three sites within the lower Columbia River that are possible flowlane disposal sites were sampled by the ODFW in cooperation with the WDFW for the presence of sturgeon. The sites were sampled during summer, winter, and spring to determine if there are differences in sturgeon seasonal use of these areas. The objectives of this work were to: (1) further describe potential effects of flowlane disposal on sturgeon, and (2) provide, if necessary, recommendations to minimize the effects of flowlane disposal on sturgeon. Specific tasks include: (1) documenting the seasonal presence of sturgeon in the disposal areas, and (2) characterizing the diets of sturgeon collected in the disposal areas as compared to benthic invertebrate data collected.

The benthic invertebrate information was collected in 2001 by Marine Taxonomic Services Ltd. Two surveys of the benthic invertebrate population near the Three Tree Point site (CRM 30) on the lower Columbia River were done. One in the summer and one in the winter.

Results

A total of 1,022 white sturgeon were caught during the four sampling periods. Gill nets caught 410 sturgeon and 612 sturgeon were caught using setline gear. Gill nets were found to be more efficient in catching sturgeon then set line gear during all sampling periods. An examination of 34 white sturgeon stomachs was done.

White sturgeon were present in all three potential flowlane disposal sites sampled. Season appeared to influence the catch at all three sites with summer catches providing the greatest species diversity and winter the least. Diversity and abundance of sturgeon caught differed greatly among sampling periods. 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 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; North et al. 1993). Immature sturgeon were found to undertake an upriver migration in the fall of 1950, leading to a scarcity and even a 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) recorded an early fall migration 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 individuals than on feeding pressures. The belief that sturgeon seasonal movements are linked to water temperature was reiterated in Haynes and Gray (1981).

The Marine Taxonomic Services (2002) data showed that the Three Tree Point site is an area of clean, well-sorted sand with little or no fine sediment and low organic content. This type of dynamic habitat tends not to support quantities of larger benthic fauna. The low numbers of annelid worms found is indicative of a lack of prey items available for both the polychaetes and larger species that would prey on polychaetes. The polychaete, *Nereis vexillosa*, is an omnivore that may prey on Chironomid larvae and on mollusks when they are newly recruited into the habitat. The amphipod, *Corophium*, is probably too mobile to be a common prey item for polychaetes. The mollusk, *Corbicula fluminea*, is a filter feeder and as such tends not to be very mobile. The amphipod and Chironomid populations are significant by comparison to the other fauna and become prey items to juvenile salmonids and other small fish species.

White sturgeon stomach analysis indicated that of the 34 sampled only 4 were empty. It appeared that they were taking the most abundant prey items available *Corophium salmonis* and *Neomysis mercedis*. This contrasts with the results of McCabe et al. (1993) who found that although juvenile white sturgeon were preying heavily on *C. salmonis,* it was not one of the most abundant organisms in samples of benthic invertebrates taken at the same locations. The mollusk *Corbicula fluminea*, the polycheate worm *Nereis vexillosa*, and unidentified Chironomid individuals were all found in the benthos of Three Tree Point yet none of these invertebrates were found in the stomach samples taken from the same area. Without further research it is difficult to determine the cause of these results. McCabe et al. (1993) theorized that juvenile white sturgeon in their study were either (1) feeding on *C. salmonis* that were transported by the current drift, (2) feeding in other areas where *C. salmonis* was more abundant, or (3) feeding very efficiently on *C. salmonis*. The information gather does not conclusively indicate whether sturgeon are feeding in the deep water areas.

References: See attached report.

USGS REPORT

Introduction
Telemetry studies were initiated by USGS under contract to the Portland District to describe how juvenile and adult sturgeon use the aquatic habitat in an in-river flow lane disposal area near Three Tree Point (River Mile 30). The studies are intended to determine if home ranges of juvenile and adult sturgeon are restricted to deepwater areas that may be affected by dredge material disposal. Additionally, the studies were designed to describe juvenile and adult behavior before, during and immediately after dumping material from a hopper dredge.

Methodology
The study is using two types of acoustic telemetry receiver systems to monitor movements of sturgeon. The first includes three moored hydrophones, which monitor fish movements in real time, and provides information on the spatial location and depth of each fish. The second includes seven data-logging receivers surrounding the three moored hydrophones set up to monitor ingress and egress of tagged fish form the primary study area. All movements will be analyzed and displayed within a geographical information system.

Progress to Date
The researchers have secured equipment and supplies and run preliminary tests of the acoustic positioning system. Acoustic telemetry transmitters were surgically implanted in 19 white sturgeon during August 14-22; no green sturgeon were captured. Automated monitoring of sturgeon movements by the system has been ongoing since August 14. Several disruptions were experienced as detailed in the USGS progress report of November 22, 2002.

Findings from USGS Report

The two telemetry systems have enabled us to extensively monitor movements of individual tagged fish. It is not uncommon to obtain several hundred position fixes for an individual fish with the VRAP system on any given day. Precursory examinations of the depth profiles of fish show that the fish are using shallow water habitats as well as the deepest water available. Further analysis will be done to better understand depth use by fish.

Two transmitters (ID 008 and ID 014) have ceased moving within the detection range of the VRAP system, suggesting that the fish expelled the implanted tags or that the fish perished. Another possibility is that fisherman captured the fish and discarded the tags in the study area.

During September 19 to October 2, the Dredge Oregon conducted maintenance dredging adjacent to the VRAP system. This provided an opportunity to monitor sturgeon movements during pipeline dredging operations. The dredge cut began within 100 meters of a VRAP buoy and progressed away from the buoy array. The pipeline was routed between two buoys with the outlet located just upstream of the buoy array. The VRAP system appeared to function well during this activity, alleviating concerns that acoustic noise generated during dredging would hinder detection of the transmitters. During the three days prior to the dredging activity, ten of the tagged fish were using the area. Six of these fish remained in the area throughout the dredging operations. On the day that dredging commenced, two fish left the area and one fish entered the area from upstream. One of the fish that departed on the first day of dredging operations returned 10 days later but again departed within hours. One fish departed on the third day after dredging commenced, returned 5 days later, then departed again the next day. Another fish departed on the 7th day of the dredging operations. When dredging concluded, seven fish were still being monitored within the area.

The track histories of the fish during the dredging operations show that some fish were in close proximity to the Dredge Oregon on several occasions. Further analysis is needed to determine if fish showed altered movement patterns during the dredging operations.

CONCLUSIONS

Further evaluation of this years data and potentially additional research next year are needed to more fully assess potential impacts to sturgeon from dredging and disposal. This information is needed to develop measures to minimize impacts to sturgeon. WDFW has requested that, in order to evaluate the project before this additional information is available, the Corps develop a minimization plan for various outcomes of the research. The table below outlines the Corps' plan for potential outcomes.

Direct Mortality - Immediate mortality of significant numbers of fish due to burial - Delayed mortality of significant numbers of fish due to burial - Fish survive disposal action	• Do not dispose in area or modify / schedule disposal practices to minimize impact • Do not dispose in area or modify / schedule disposal practices to minimize impact • No mitigation action
Disturbance - Significant numbers of fish leave area permanently - Significant numbers of fish leave area temporarily - Fish do not leave area	• Do not use additional sites in the future or modify / schedule disposal practices to minimize impact • Schedule use of site to periods of low abundance • No mitigation action
Feeding - Sturgeon feed in site o Significant, long-term effects o Minor, short-term effects - Sturgeon not feeding in site	• Do not use additional sites in the future • No mitigation action • No mitigation action
Loss of Habitat - Do not use habitat after disposal - Return to area a short time after disposal - Return to area a long time after disposal	• Do not use additional sites in the future or modify / schedule disposal practices to minimize impact • No mitigation action • No mitigation action

SEASONAL PRESENCE AND DIET OF WHITE STURGEON IN THREE PROPOSED IN-RIVER, DEEP-WATER DREDGE SPOIL DISPOSAL SITES IN THE LOWER COLUMBIA RIVER

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ABSTRACT

Three proposed in-river, deep-water, dredge spoil disposal sites within the lower Columbia River were sampled to determine the seasonal presence and diet of white sturgeon *Acipenser transmontanus*. Each site was sampled during three seasons (summer, winter, and spring) with gill nets and setlines. Catches of white sturgeon were greatest during summer and least during winter. The diversity of species caught was also greatest during summer and least during winter. Catches of white sturgeon in spring were comparable to the summer for setline sampling and comparable to the winter for gill-net sampling. Gill-net sampling was more productive than setline sampling on a catch per unit effort basis. Setline catches yielded significantly larger fish than gill-net catches. Forty-one stomachs were collected from juvenile sturgeon (23 – 82 cm fork length) and the contents identified to the lowest appropriate taxonomic level. The amphipod *Corophium salmonis* was the most abundant food item identified. It occurred in 32 of the 42 stomachs and accounted for 88% of all prey items.

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.

The Columbia River is an important shipping channel that provides access to several commercial and recreational port cities, including Longview, Washington and Portland, Oregon. The U. S. Army Corps of Engineers (USACE) has proposed a channel-deepening project in the lower Columbia River to provide access to the commercial ports of Longview and Portland by deeper draft ships than are currently permitted. The proposed channel-deepening project would require the disposal of dredged materials. One possible location for disposal of dredged materials would be in-river, deep-water sites. Past research has shown that juvenile white sturgeon in the Columbia River may prefer deepwater habitats (McCabe and Hinton 1991; McCabe and Tracy 1994).

In documenting the seasonal presence of white sturgeon in proposed disposal areas our objective was to determine if sturgeon use of these areas varies seasonally. This information, along with information from other studies will enable the USACE to determine if seasonal schedules for possible channel-deepening operations are needed and if deep-water disposal of dredge spoil material would adversely affect white sturgeon. Although the results of our study 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 downstream of the confluence with the Kalama River (Figure 1). Sampling was restricted to three possible in-river, deep-water, dredge spoil 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 extends 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 Gear and Methods

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

We sampled for white sturgeon during three different seasons throughout the year to assess seasonal use of the study area. The summer 2000 setline sampling period commenced on 15 August and was completed on 17 August. Effort for this period was limited to Harrington Sump only. The summer 2000 gill-net sampling period began on 21 September and was completed on 24 September. Effort for this sampling period was limited to Harrington Sump and Three Tree Point.

The winter setline sampling period began on 2 January 2001. Harrington Sump and Three Tree Point were completed on 5 January 2001. Carrolls Channel was sampled between 30 January and 1 February 2001. The winter gill-net sampling period began on 9 January 2001 and was completed on 19 January 2001. All three sites were sampled.

The spring setline sampling period was conducted from 21 May to 31 May 2001. The spring gill-net sampling period was conducted from 25 April 2001 to 8 May 2001. All three sites were sampled.

We sampled again in summer 2001 to ensure that all three sites were sampled with both gears each season. The summer 2001 sampling period began on 6 August and was completed on 30 August. Setlines were fished at Three Tree Point and Harrington Sump between 6 August and 9 August. Setlines at Carrolls Channel were fished from 28 to 30 August. Gillnetting at Harrington Sump and Carrolls Channel was conducted from 15 to 16 August, and gillnetting was conducted on 27 August at Three Tree Point.

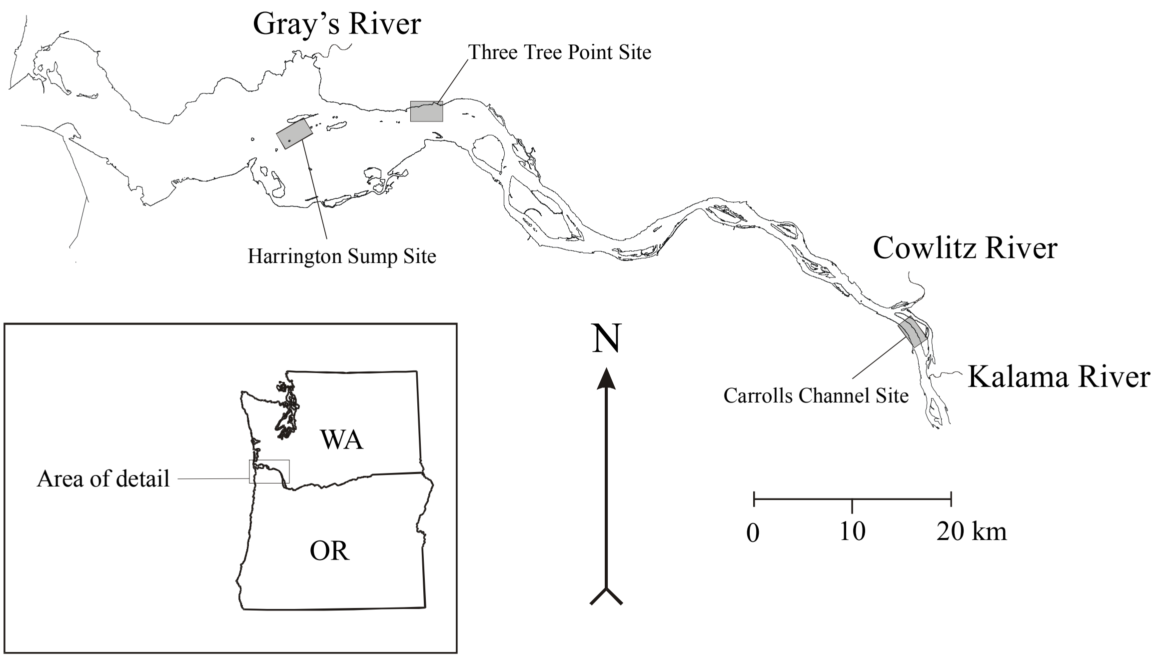

Figure 1. Location of proposed in-river, deep-water, dredge spoil disposal sites in the lower Columbia River that were sampled for white sturgeon.

Diet Analysis

To characterize the diet of white sturgeon inhabiting the study area, we euthanized 71 juvenile (23 – 82 cm fork length) white sturgeon in the field and collected their stomachs for later analysis in the lab. Stomachs were taken from fish caught in gill nets only and from winter, spring, and summer 2001 sampling periods only. All stomachs were preserved in the field in a 10%-formalin solution. Once in the lab, stomachs were emptied of their contents, which were then transferred to an ethyl alcohol solution. All prey items were identified to the most appropriate taxonomic level, counted and weighed (wet mass only).

Data Analysis

We summarized catch of white sturgeon by sampling season for each sampling location and gear. We also summarized catch of other fish species by sampling season for each sampling location and gear.

We used a Kruskal-Wallis one-way Analysis of Variance to compare differences in mean fork length of white sturgeon among sampling sites. If mean fork length differed among sites, we used Dunn's Multiple Comparison Procedure to isolate differences among individual sites. We used combined data from all four sampling periods for each test.
We also compared mean fork lengths between gears. We used a t-test to compare fork length between gears for all sampling periods combined. We also compared mean fork length between gears by sampling period. Results from all tests were considered significant when $P < 0.05$.

We determined the relative contribution of prey taxa to the diet by using a modification of the Index of Relative Importance (IRI; Pinkas et al. 1971; McCabe et al. 1993):

$$IRI = (N + W) \times F$$

Where

N = percent number of a prey item,
W = percent weight of a prey item, and
F = percent frequency of occurrence of a prey item.

We also represent IRI as percent of the summed IRI values for all prey items (%IRI):

RESULTS

Catch Comparisons

We caught 1,022 white sturgeon during the four sampling periods, with 410 white sturgeon caught in gill nets and 612 caught with setlines (Table 1). In general, catch rates were highest during summer. Despite receiving the least amount of total fishing effort, the summer 2000 sampling period was the most productive, with 419 fish caught and a catch per unit effort (CPUE) of 1.49 fish per hour (both gears combined). Catch rates for both gears were lowest in winter, when we failed to catch a white

Table 1. Summary of white sturgeon catch and effort at three proposed in-river, deep-water, dredge disposal sites in the lower Columbia River. Depth = mean depth of sets. HS = Harrington Sump, 3T = Three Tree Point, CC = Carrolls Channel.

	Setline			Gill net		
Season, location	Catch	Effort (h)	Depth (m)	Catch	Effort (h)	Depth (m)
Summer 2000						
HS	70	257.4	10.4	64	11.21	12.5
3T	--	--		285	11.97	23.2
Winter 2001						
HS	0	201.5	13.1	0	7.6	12.6
3T	1	198.3	24.2	8	7.2	22.9
CC	4	202.6	9.7	2	6.7	11.2
Spring 2001						
HS	65	191.6	12.1	3	6.6	13.0
3T	114	192.3	22.1	5	7.0	24.0
CC	92	203.9	9.5	0	7.2	9.8
Summer 2002						
HS	20	213.3	12.2	16	6.0	11.4
3T	82	212.4	17.8	20	6.3	22.7
CC	164	210.8	10.5	7	6.3	11.3

sturgeon with either gear at Harrington Sump. Catches in gill nets remained low in spring (zero at Carrolls Channel), whereas setline catch rates increased considerably. Unlike the other two areas, setline catch rate at Three Tree Point was highest during spring. Setline catch rates remained relatively high in summer 2001, and catch rates in gill nets increased, but not to levels observed in summer 2000.

Throughout the study, setline sampling resulted in very little bycatch. Of 613 fish caught with setlines all but one (a sculpin *Cottus* spp. at Harrington Sump in summer 2000) was a white sturgeon. A much greater variety of species were caught in gill nets. A total of 12 species were caught during the study (see Appendix A for more detail). In general, number of species collected and catch rates of the most abundant species were highest in summer and lowest in winter.

Mean fork length of white sturgeon differed among sampling sites ($P < 0.001$). Fish caught at Harrington Sump were significantly longer that fish caught at Three Tree Point ($P < 0.05$) and Carrolls Channel ($P < 0.005$). Additionally, fish caught at Three Tree Point were significantly longer than fish caught at Carrolls Channel ($P < 0.05$; Figure 2).

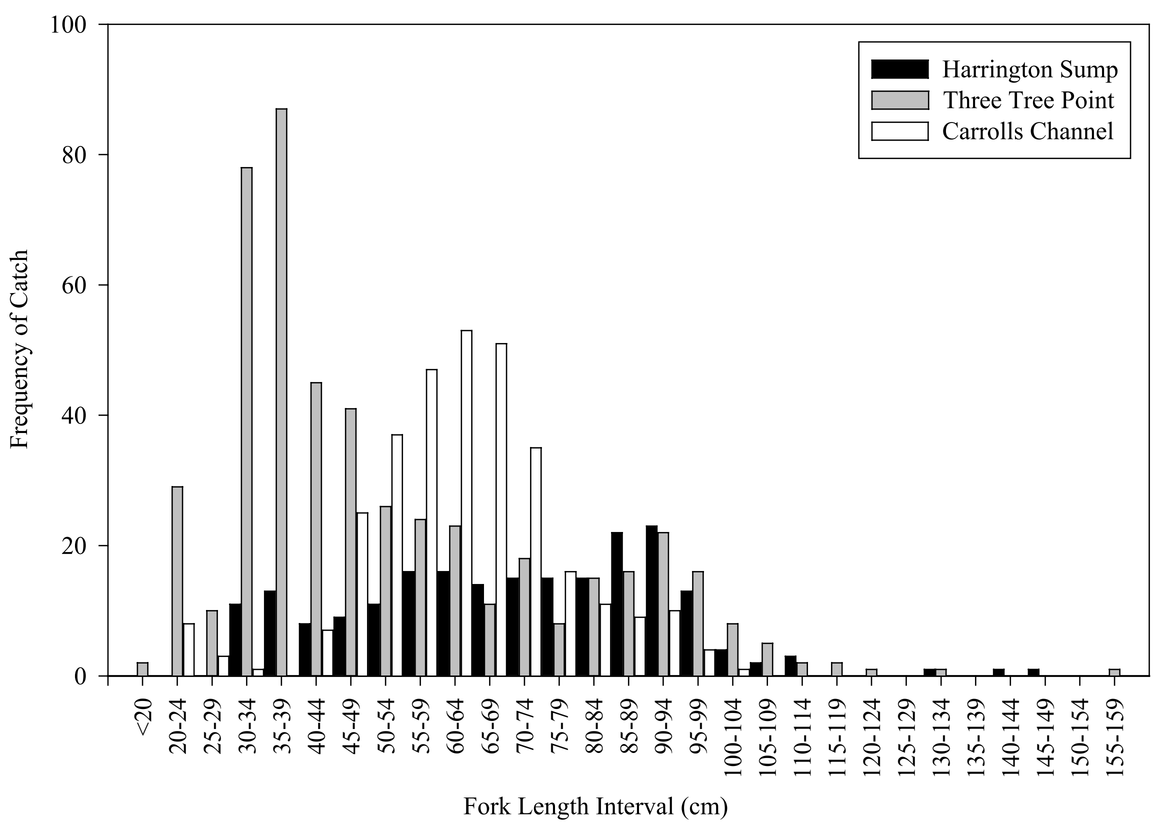

Figure 2. Fork length frequency distribution of white sturgeon caught at three proposed in-river, deep-water, dredge-spoil disposal sites in the lower Columbia River, all four sampling periods combined.

Gear Comparisons

Gill nets were more efficient than setlines 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 ($P < 0.001$) with setlines than with gill nets (Figure 3). The average fork length of white sturgeon caught with setlines was 71.8 cm (± 0.7 SE), whereas average fork length of white sturgeon caught with gill nets was 40.9 cm (± 0.7 SE). Differences in fork length between gears were consistent among seasons (Figures 4-7). Mean fork length of white sturgeon caught with setlines (84.4 cm ± 2.1 SE in summer 2000; 75.4 cm ± 2.7 SE in winter; 69.8 cm ± 1.0 SE in spring; 70.3 cm ± 1.1 SE in summer 2001) was always significantly greater ($P < 0.001$) than mean fork length of fish caught with gill nets (39.0 cm ± 0.6 SE in summer 2001; 26.0 cm ± 1.9 in winter; 45.4 cm ± 7.1 SE in spring; 59.2 ± 2.8 SE in summer 2001).

Diet Analysis

We analyzed 42 stomachs taken from white sturgeon during winter (N = 3), spring (N = 8) and summer 2001 (N = 31). All stomachs were collected from juvenile fish with fork lengths ranging from 22 cm to 82 cm (mean = 48 cm). The most abundant prey item recovered was the amphipod *Corophium salmonis,* which accounted for 3,394 of the 4,095 prey items identified (83%). *C. salmonis* was found in 32 of the 42 stomachs analyzed. *Neomysis mercedis* was the second most abundant prey item (8% of the total), accounting for 348 prey items and occurring in 18 stomach samples. This species is one of the few freshwater examples of the order Mysidacea. The amphipod *Ramellogammarus oregonensis* accounted for 3% of the total number of prey items identified; however, it occurred in only three stomachs (Table 2, Figure 8).

Although *C. salmonis* was the most abundant prey item found in stomach samples it only accounted for approximately 14% of the total wet mass of all prey items. The %IRI for *C. salmonis* in all samples was 88%. Sand, mixed with unidentifiable body parts of invertebrate prey items accounted for about 56% of the total wet mass. Fish accounted for 27% of the total wet mass of all prey items yet 10 other prey items were more abundant. The %IRI for fish in all samples was about 1%. Of the 42 stomachs analyzed only 3 fish were recovered from the samples and only two stomachs contained fish. Although *Neomysis mercedis* was the second most abundant prey item found in stomach samples this species only accounted for 8% of the total wet mass of all stomach contents. The %IRI for *N. mercedis* in all samples was 9%. Four of the stomachs analyzed in the study were completely empty. Two of the three stomachs collected in winter 2001 were empty (67%) the other contained unidentifiable parts. One of the eight stomachs collected in spring 2001 was empty (13%), and two other stomachs collected in the same sampling period contained a single *Corophium salmonis* each. One of the 30 stomachs collected in the summer of 2001 was empty (3%). One other stomach caontained primarily sand.

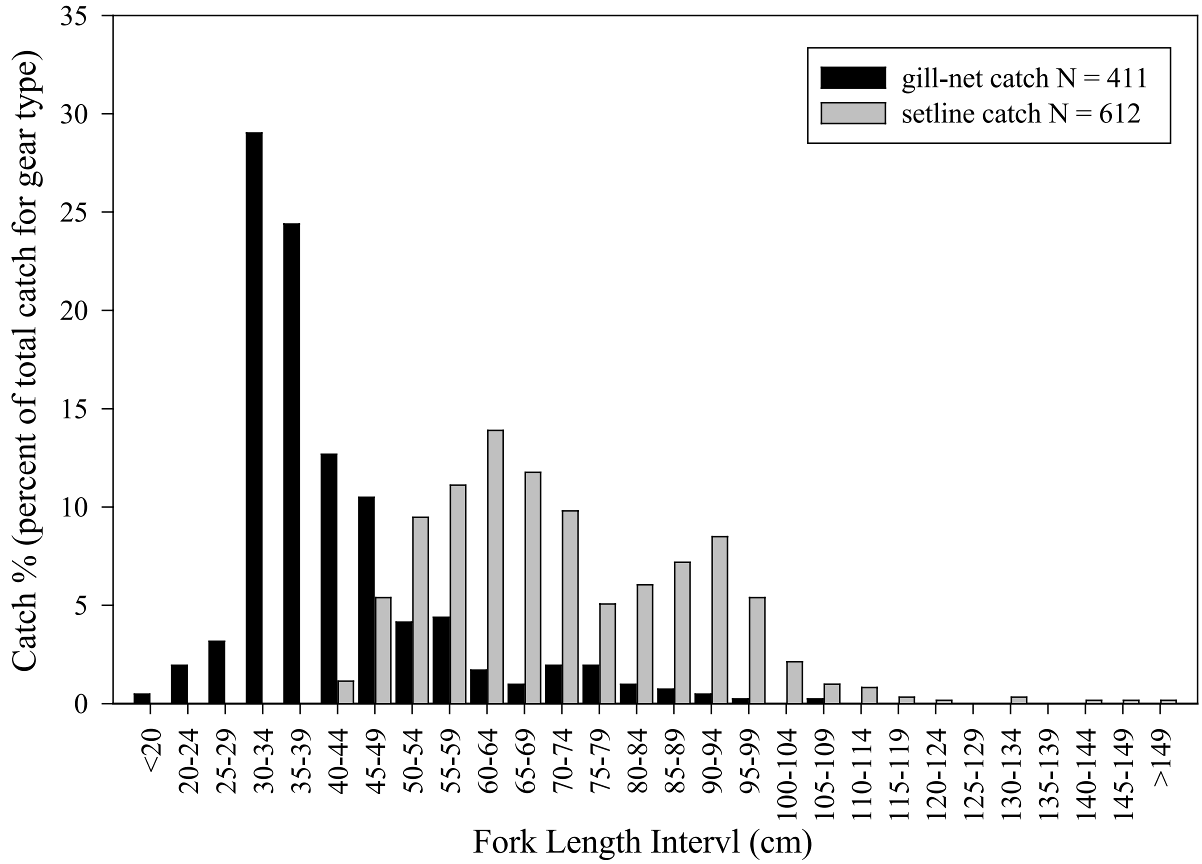

Figure 3. Fork length frequency distribution of white sturgeon as a percent of total catch for each gear type. Data from three proposed in-river, deep water, dredge spoil disposal sites within the lower Columbia River are combined.

DISCUSSION

Catch

White sturgeon were present in all three proposed in-river, deep-water dredge spoil disposal sites that we sampled. Season seemed to influence our catch at all three sites, as diversity and relative abundance of fish differed greatly among sampling periods. Catch and diversity were generally highest in summer, lowest in winter, and intermediate in spring.

Our finding that setlines catch significantly larger white sturgeon than small-meshed gill nets supports previous findings (Elliott and Beamesderfer 1990). A strong setline catch in spring combined with a weak gill-net catch therefore suggests that smaller white sturgeon may be rare in the study sites during spring. It is also possible that white sturgeon vulnerability to catch is related to season or water temperature (season or temperature may affect general fish activity

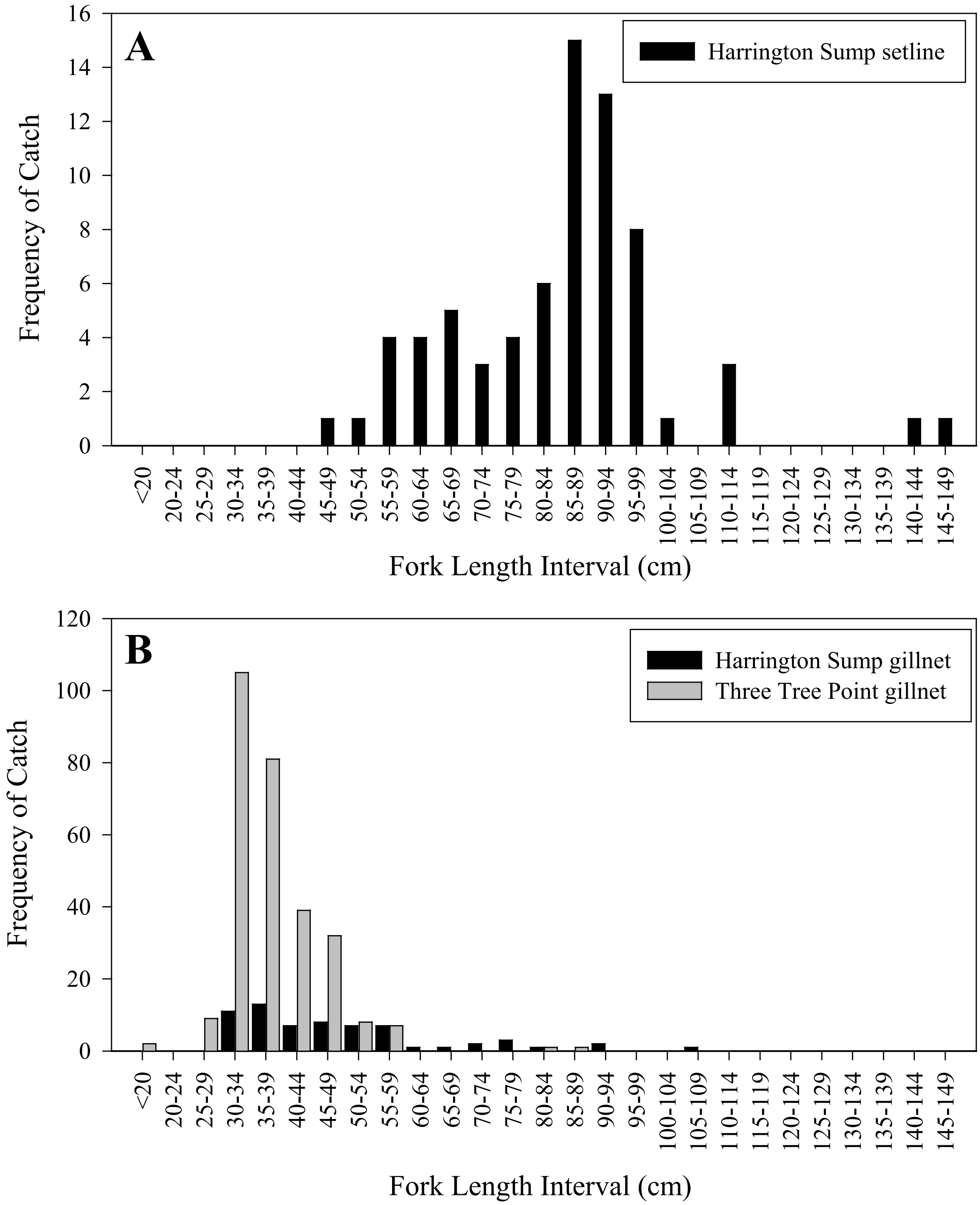

Figure 4. Fork length frequency distribution of white sturgeon caught with (A) setline gear or (B) gill-net gear, at two proposed in-river, deep-water, dredge spoil disposal sites in the lower Columbia River, summer 2000.

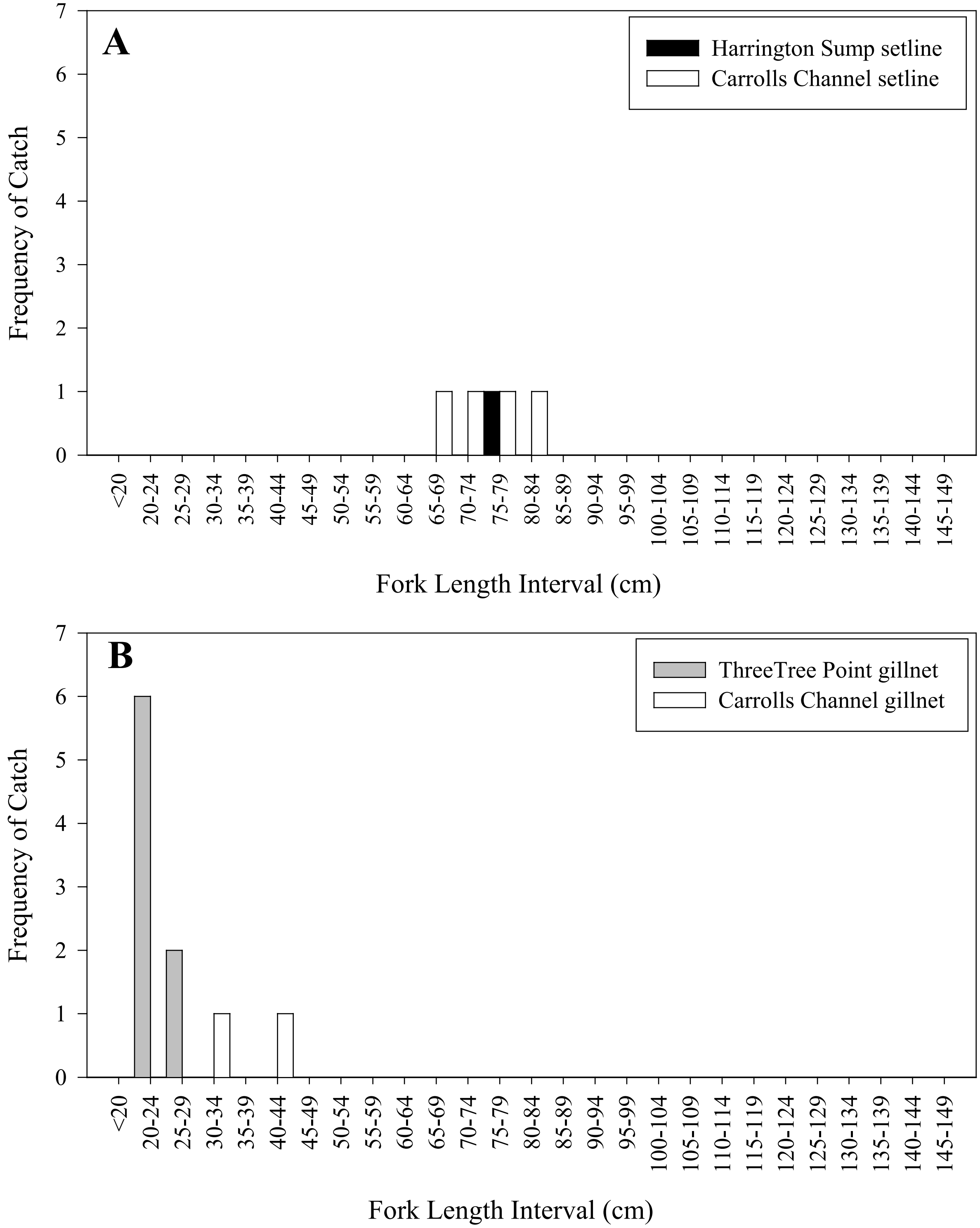

Figure 5. Fork length frequency distribution of white sturgeon caught with (A) setline gear or (B) gill-net gear, at three proposed deep water, in-river dredge spoil disposal sites in the lower Columbia River, winter 2001.

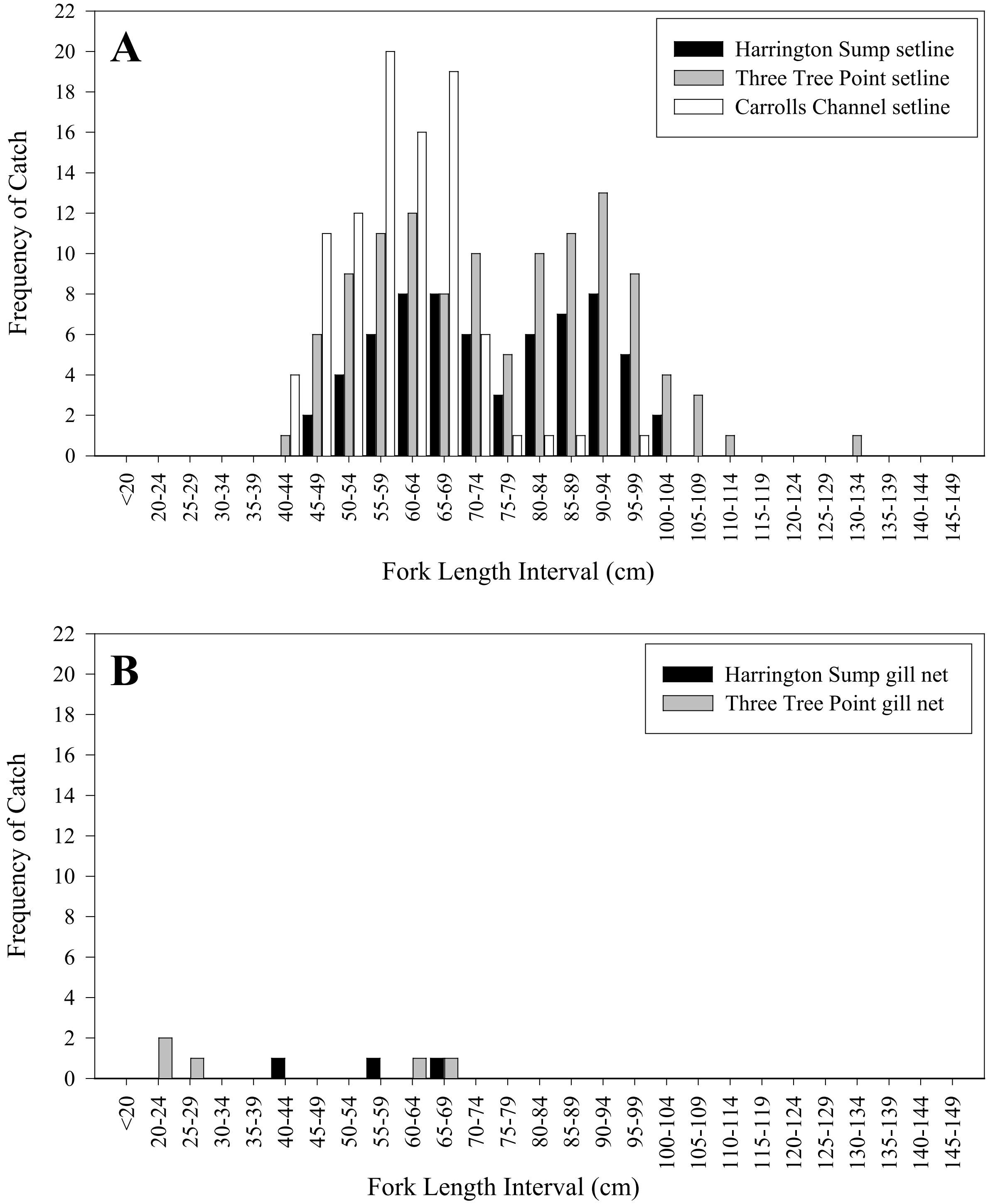

Figure 6. Fork length frequency distribution of white sturgeon caught with (A) setline gear or (B) gill-net gear, at three proposed in-river, deep-water, dredge spoil disposal sites in the lower Columbia River, spring 2001.

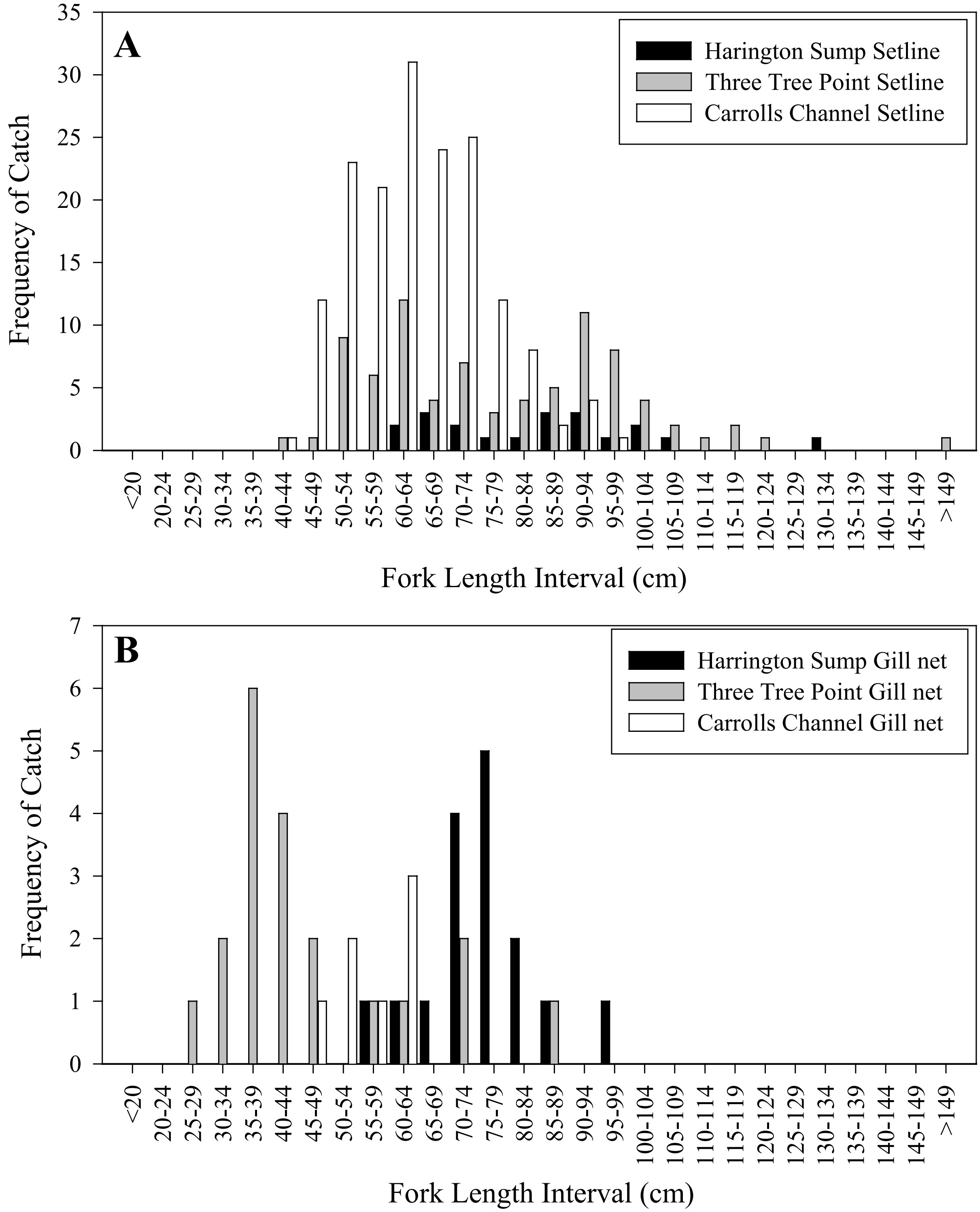

Figure 7. Fork length frequency distribution of white sturgeon caught with (A) setline gear or (B) gill-net gear, at three proposed in-river, deep-water, dredge spoil disposal sites in the lower Columbia River, summer 2001.

Table 2. Occurrence, count, wet weight, and Index of Relative Importance (IRI) for items found in stomachs of white sturgeon sturgeon captured from the Columbia River near Three Tree Point, Washington, August 2000 – January 2001.

	Stomachs		Organisms		Weight (g)		IRI = F*(N+W)	
Organism	Occurrence	Percent (F)	Count	Percent (N)	Sum	Percent (W)	Value	Percent
Turbellaria	2	4.76%	6	0.15%	0.00	0.00%	6.98E-05	0.01%
Nemertea	9	21.43%	57	1.39%	0.00	0.00%	2.98E-03	0.31%
Leech Sp.	2	4.76%	2	0.05%	0.00	0.00%	2.33E-05	0.00%
Gastropoda	1	2.38%	29	0.71%	0.14	0.23%	2.24E-04	0.02%
mollusk (clam)	4	9.52%	7	0.17%	0.00	0.00%	1.63E-04	0.02%
Crangon franciscorum	1	2.38%	31	0.76%	4.24	6.95%	1.84E-03	0.19%
Ceratopogonidae larvae	1	2.38%	1	0.02%	0.00	0.00%	5.82E-06	0.00%
Copepods	1	2.38%	82	2.00%	0.00	0.00%	4.77E-04	0.05%
Neomysis mercedis	18	42.86%	348	8.50%	7.59	12.45%	8.98E-02	9.46%
Shrimp sp.	1	2.38%	1	0.02%	0.00	0.00%	5.82E-06	0.00%
Isopoda	4	9.52%	7	0.17%	4.01	6.57%	6.42E-03	0.68%
Ramellogammarus oregonensis	3	7.14%	119	2.91%	0.80	1.32%	3.02E-03	0.32%
Corophium salmonis	32	76.19%	3,394	82.89%	16.17	26.50%	8.33E-01	87.78%
Northern Anchovy (*Engraulis mordax*)	1	2.38%	1.5	0.04%	14.70	24.11%	5.75E-03	0.61%
Eulachon (*Thaleicthys pacificus*)	1	2.38%	1	0.02%	12.55	20.57%	4.90E-03	0.52%
unidentified 6	1	2.38%	1	0.02%	0.00	0.00%	5.82E-06	0.00%
unidentified 8	1	2.38%	4	0.10%	0.79	1.30%	3.33E-04	0.04%
unidentified 11	1	2.38%	1	0.02%	0.00	0.00%	5.82E-06	0.00%
unidentified 13	1	2.38%	1	0.02%	0.00	0.00%	5.82E-06	0.00%
Parts [a]	34	80.95%	NA	NA	56.17 [a]	47.94% [a]	NA	NA
Empty	4	9.52%	NA	NA	0.00	0.00%	NA	NA
All	42	100%	4,094.5	100%	61.00 [a]	100% [a]	9.49E-01	100%

a. This material included sand and pieces of *Corophium salmonis* and *Neomysis mercedis*. Though "Parts" weighed 56.17 g, they were overwhelmingly comprised of inert material, therefore the weight was not included in totals or estimation of IRI.

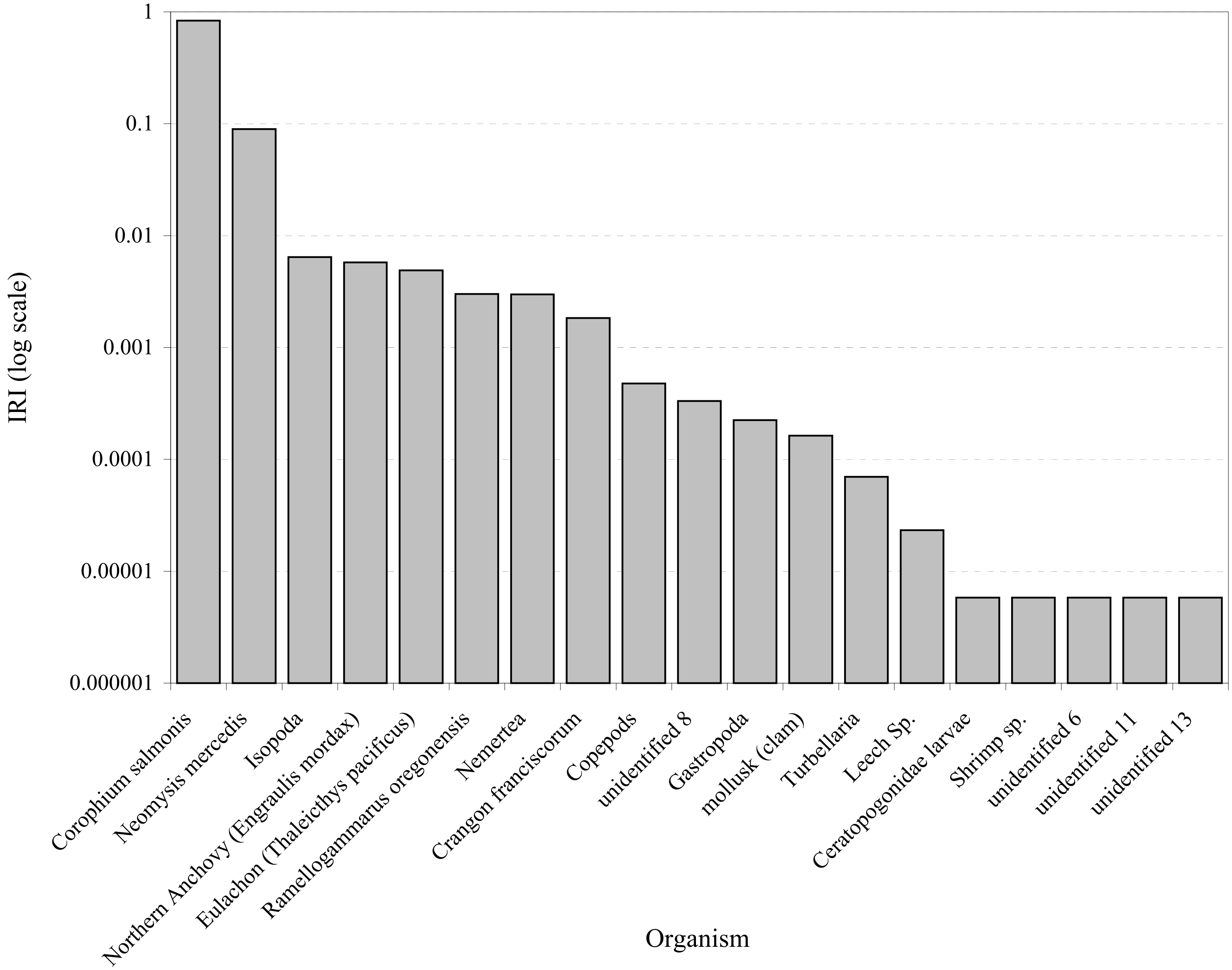

Figure 8. Index of Relative Importance (IRI) for prey items in stomachs of white sturgeon captured from the Columbia River near Three Tree Point,Washington, August 2000 – January 2001.

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; North et al. 1993). 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 late winter and early spring. Bajkov (1951) reported that these movements might 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. Haynes and Gray (1981) reiterated the belief that white sturgeon seasonal movements are linked to water temperature.

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 to fish the gear whereas our study based effort on the amount of time each gear type was actively fishing.

We found a great difference in the species caught by the two gears we used. Setlines caught practically all white sturgeon (with the exception of one cottid), whereas gill nets caught several other fish species. Elliott and Beamesderfer (1990) reported similar results. Although they were 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 summer 2000 at Three Tree Point. Bycatch of other fish species in gill nets 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 were greater than the spring sampling period, which in turn was greater than the winter sampling period.

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 clarkii* caught in a gill net at Carrolls Channel during spring. 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.

Diet Analysis

Our study agrees with the findings of both Muir et al. (1988) and McCabe et al. (1993) that *Corophium salmonis* is a common prey of juvenile white sturgeon in the lower Columbia River. Similar to our study, McCabe et al. (1993) also found that *C. salmonis* was the dominant prey in the diet of juvenile white sturgeon over more than one season.

C. salmonis is one of the most abundant invertebrate species at Three Tree Point according to surveys of benthic invertebrates performed by Marine Taxonomic Services Limited (MTS) during July and September 2001 (MTS 2002). Sediment samples in July 2001 contained an average of 452 *C. salmonis* individuals/m^2 sampled. The same samples contained an average of 328 unidentified Chironomid (midge) individuals/m^2 sampled (MTS 2002). Unidentified species of *Corophium* were the most abundant invertebrate in sediment samples collected at Three Tree Point in September 2001, with 873 individuals/m^2 sampled (MTS 2002). *C. salmonis* was also very abundant in September 2001 with 454 individuals/m^2 sampled.

White sturgeon captured in our study appeared to be taking one of the most abundant prey items available. This contrasts the results of McCabe et al. (1993) who found that although juvenile white sturgeon were preying heavily on *C. salmonis,* it was not one of the most abundant organisms in samples of benthic invertebrates taken at the same locations. The mollusk *Corbicula fluminea*, the polycheate worm *Nereis vexillosa*, and unidentified Chironomid individuals were all found in the benthos of Three Tree Point yet none of these invertebrates were found in the stomach samples taken from the same area. Without further research it is difficult to determine the cause of these results. McCabe et al. (1993) theorized that juvenile white sturgeon in their study were either (1) feeding on *C. salmonis* that were transported by the current drift, (2) feeding in other areas where *C. salmonis* was more abundant, or (3) feeding very efficiently on *C. salmonis*.

FUTURE WORK

Although 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. We have demonstrated some 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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REFERENCES

Bajkov, A. D. 1951. Migration of the white sturgeon (*Acipenser transmontanus*) in the Columbia River. Fish Commission of Oregon Research Briefs 3:8-21.

Elliott, J. C., and R. C. Beamesderfer. 1990. Comparison of efficiency and selectivity of three gears used to sample white sturgeon in a Columbia River reservoir. California Fish and Game 76:174-180.

Haynes, J. M., and R. H. Gray. 1981. Diel and seasonal movement of white sturgeon *Acipenser transmontanus*, in the mid-Columbia River. Fishery Bulletin 79:367-370.

Haynes, J. M., R. H. Gray, and J. C. Montgomery. 1978. Seasonal movements of white sturgeon (*Acipenser transmontanus*) in the mid-Columbia River. Transactions of the American Fisheries Society 107:275-280.

MTS (Marine Taxonomic Services, Ltd.). 2002. Benthic Survey at Three Tree Point on Columbia River (River Mile 30), Benthic infauna evaluation. Unpublished report for the U.S. Army Corps of Engineers, Portland District.

McCabe, G. T., Jr., R. L. Emmett, and S. A. Hinton. 1993. Feeding ecology of juvenile white sturgeon (*Acipenser transmontanus*) in the Lower Columbia River. Northwest Science 67:170-180.

McCabe, G. T., Jr., and S. A. Hinton. 1991. Report D *In* A. A. Nigro editor. Status and habitat requirements of the white sturgeon populations in the Columbia River downstream from McNary Dam. Annual Report to Bonneville Power Administration. (Project 86-50), Portland, Oregon.

McCabe, G. T., Jr., and C. A. Tracy. 1994. Spawning and early life history of white sturgeon, *Acipenser transmontanus*, in the lower Columbia River. Fishery Bulletin 92:760-772.

Muir, W. D., R. L. Emmett, and R. J. McConnell. 1988. Diet of juvenile and subadult white sturgeon in the lower Columbia River and its estuary. California Fish and Game 74:49-55.

North, J. A., R. C. Beamesderfer, and T. A. Rien. 1993. Distribution and movements of white sturgeon in three lower Columbia River reservoirs. Northwest Science 67:105-111.

Pinkas, L., M. S. Oliphant, and I. L. K. Iverson. 1971. Food habits of albacore, bluefin tuna, and bonito in California waters. California Department of Fish and Game, Fish Bulletin 152.

APPENDIX A

Fish Species Collected During Gill-Net Sampling

Appendix Table A-1. Catch of fish species other than white sturgeon during gill-net sampling at three proposed deep-water, in-river, dredge spoil disposal sites in the lower Columbia River, summer 2000 through summer 2001. HS = Harrington Sump, 3T = Three Tree Point, CC = Carrolls Channel.

		Summer 2000		Winter 2001			Spring 2001			Summer 2001		
Common name	Scientific name	HS	3T	HS	3T	CC	HS	3T	CC	HS	3T	CC
American shad	*Alosa sapidissma*	62	118	0	0	0	1	2	1	19	7	0
Cutthroat trout	*Oncorhynchus clarki*	0	0	0	0	0	0	0	1	0	0	0
Northern anchovy	*Engraulis mordax*	2	0	0	0	0	0	0	0	5	0	0
Eulachon	*Thaleyicthys pacificus*	0	0	0	1	0	0	0	0	0	0	0
Northern pikeminnow	*Ptychochelius oregonensis*	0	14	0	0	0	0	2	0	0	4	1
Peamouth	*Mylocheilus caurinus*	99	542	0	0	0	52	35	107	141	131	32
Largescale sucker	*Catostomus macrochelius*	1	41	0	0	0	0	0	2	0	0	0
Yellow perch	*Perca flavescens*	2	1	0	0	0	0	0	0	1	0	10
Pacific staghorn sculpin	*Leptocottus armatus*	0	0	0	0	0	2	0	0	0	0	0
Sculpin spp.	*Cottus* spp.	7	2	1	1	0	0	0	0	13	0	0
Starry flounder	*Platichthys stellatus*	58	13	4	3	0	18	0	4	21	1	2