A WINTER SURVEY OF FISHES IN THE VICINITY OF THE WLSSD SEWAGE TREATMENT PLANT: NOVEMBER, 1991 - APRIL, 1992

A Report Submitted to: Western Lake Superior Sanitary District

by

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INTRODUCTION

The Western Lake Superior Sanitation District's (WLSSD) waste treatment facility on the shore of the St. Louis River estuary contributes a large volume of warm effluent to the St. Louis River on a continuous basis. The effluent mixes with the river in a relatively shallow embayment adjacent to the treatment facility and forms an area approximately 0.5 kilometer in diameter in which water temperatures and conductivities may be considerably different than surrounding river waters. This mixing zone can also have chemical characteristics that contrast significantly with unmixed river water. During winter conditions, elevated temperatures within the mixing zone may provide a potential refuge for fish species that are unable to exist in the cold waters of the river, and, some native species may seek warmer temperatures during winter when they are available. Alternatively, fish species may avoid the elevated temperatures or water chemistry characteristics of the mixing zone. Either of these situations could result in altered fish community characteristics during winter months.

The purpose of this study was to provide preliminary data on the types and relative abundances of fish that inhabit the mixing zone during several winter months. Surveys were only conducted within 0.3 km of the outfall pipe; results were compared to other winter fish abundance data from the St. Louis River estuary.

METHODS AND MATERIALS

Our investigation of fishes in the St. Louis River estuary in the vicinity of the outfall was conducted four times during the winter and early spring: late November, early

January, early February, and mid April. We chose three locations for sampling within the mixing zone: 1) within 40 m of the effluent pipe, an area that ranged in depth from approximately 1.8 m to less than 0.5 m, this area typically had highest temperatures however even at this location strong river currents frequently caused the outfall plume to miss trap sites; 2) an area 50 to 200 m from the effluent pipe in which the effluent mixed with river water and temperatures were generally lower, this area included much of the embayment near the plant and included water up to 1.8 m in depth as well as shoreline habitat; 3) areas with minimal mixing with the effluent plume; these areas were similar in temperature to the rest of the harbor during winter conditions, depths ranged from 1 to 2 m and also included some shoreline habitat. Because of the frequently changing condition of the ice, we were not always able to set nets in "cold" water, or were forced to move them slightly (ie. move from site 2 to 4 in January/February). In April, we expanded our sampling in the cold bay to the east of the outfall so that preliminary comparisons between the two bays could be made.

Surveys employed three types of gear: gill nets, trap nets, and seines. A fourth method, trawling, was initially proposed, but dropped due to the early freeze up in November and the numerous snags in the bays near the plant. Gill nets were set in areas that were 1.5 to 2 m in depth. The gill nets were 125' in length, 6' in depth, and consisted of five 25' panels (bar measure; 3/4", 1", 1 1/4", 1 1/2", 2"). Trap nets were of similar size and construction to those used in lake surveys by Minnesota DNR (1" mesh, 3' by 6', rectangular opening, 40' lead, 3/4" bar measure netting). Trap nets were employed in areas that were 0.8 to 1.5 m deep. Both gill nets and trap nets were set for approximately 24 hrs. Survey locations are shown on the map (Figure 1).

Seining was conducted during daylight hours except in April, when additional samples were collected in the evening. We used a 25' bag seine approximately 4' high with 1/8" mesh. Sampling consisted of a series of 30 m hauls along portions of the warm (west) side of the outfall pier. A set of hauls were also conducted on the cold (east) side of the pier in April for comparison between the two bays.

Captured fishes were identified on site and measured to the nearest mm (total length-TL). Notes were taken on any unusual marks or lesions which appeared unrelated to the collection methods. All fish captured in trap nets were fin clipped to determine repeat captures. Clips represented the sampling period in which they were taken (left pelvic-Nov; right pelvic-Jan; Anal-Feb).

Temperature, dissolved oxygen, and conductivity were determined with YSI meters at the outfall, several netting locations, and elsewhere within and outside the mixing zone. Temperatures at the netting locations were determined using a max/min thermometer set overnight with each of the nets. This allowed us to determine extent of temperature variation that occurred at a site during the set period.

RESULTS AND DISCUSSION

Twenty species of fish out of approximately 48 species that inhabit the St. Louis River estuary (Anonymous 1988, Anonymous 1982, Devore 1978, Kucera 1980) were captured in the WLSSD mixing zone. Eleven of these were found in gill nets (Table 1) and 14 were found in trap nets (Table 2). Ten species were found in seines (Table 3). The most abundant fishes were northern pike, black bullhead, white sucker, and the

European ruffe. Carp, yellow perch, smallmouth bass, and black crappies also made up significant portions of the overall catch.

Max/min thermometers indicated that considerable variation in temperatures occurred during the 24 hr sets (Tables 1 and 2). Even at the sites closest to the outfall, temperatures fluctuated by up to 19^{0}C. The highest temperature recorded was 23^{0}C in November.

Patterns in our gill net catches suggest that abundance and species richness tend to be higher near the WLSSD outfall (Table 1). During three of the four surveys, the total catch was greatest in the net set closest to the outfall. Catch size here was 150-300% of those in cooler waters within or near the receiving bay. Similarly, the total number of species was greatest at the net closest to the outfall except in April when the total number of species at this site was equal to other sites in the WLSSD embayment.

Some distinct seasonal trends were noted in species composition. White suckers were the most abundant fish in November. These fish apparently moved out of the area during January and February and began to return by the April survey. Northern pike were relatively abundant during all surveys, although they were most abundant in April. Ruffe were also collected during all sampling periods, however only a few were caught in each net except in April when the catch of ruffe increased substantially. The remaining species were less abundant and were caught sporadically during the surveys.

Results from the trap nets (Table 2) generally concur with gill net catches. The greatest number of fish and the greatest number of species were found in traps closest to the outfall during all surveys. Strongest seasonal differences were observed with northern pike which were much more abundant in the April survey. As with gill nets, most

other species were present sporadically in much smaller numbers. Only pumpkinseed, brown bullheads, carp, and tiger musky were caught in trap nets and not in gill nets.

Very few fish were captured along shorelines with the bag seine (Table 3). Due to the large amount of woody debris and trash along shorelines, only a small portion of shoreline could be seined. However, three species (spottail shiners, emerald shiners, and sticklebacks) were not captured with other sampling gear. No fish were captured in December and the most fish were captured in April. More fish and more fish species were found on the warm side of the pier in April. Similar surveys could not be made in the other months.

Cumulative plots of the lengths of northern pike indicated that fish captured in winter were evenly distributed over a wide range of larger size classes (Figure 2). In April, however, the catch not only increased, but also shifted to a stronger representation by the 400-500 mm TL size range and included some fish shorter than 390 mm for the first time in our survey. Similarly, the catch of smaller pike (<500 mm) which were marked with colored floy tags rose from none in December, to 22% in January, 27% in February, and finally to 34% in April.

The mean size of northern pike among survey sites was compared with ANOVA by pooling all size data from the four survey periods. A significant difference existed among the sites ($F=4.42$, $df=3,60$, $p<0.01$). Northern pike were somewhat larger at the two sites closest (site 1 and 3) to the outfall than sites further away (sites 2 and 5) although this difference was only 10 cm (Figure 3). Such comparisons were not possible with other species due to low sample sizes.

Catches of black bullheads and white suckers were dominated by adults (Figure 4). Although, several younger white suckers were collected during the April survey. No YOY bullheads were observed during the study.

Four species of fish showed lesions unrelated to capture. These included swollen, fungal infested areas, eroding fins, and large ulcerations. One of three pumpkinseeds (33%) had a severe fungal infection. Five of forty-one black bullheads (12.2%) and six of sixty-three white suckers (9.6%) showed lesions, most of which were fungal infections or bleeding ulcerations. Only five of 221 northern pike had eroded fin lesions (2.3%).

Of the fish marked after trap net capture in November/December, one of eight carp (12.5%), one of one yellow perch (100%), one of fourteen black bullheads (7.1%) were recaptured during this same trapping period. In January one of one northern pike (100%) was recaptured once. No other recaptures occurred within or between the other trapping surveys.

Comparisons with other winter surveys

There are few winter fish surveys from the lower St. Louis River system from which to make direct comparisons with our data. No other winter surveys are known from the WLSSD embayment. However, Balcer (1989) conducted gill net surveys in Bunge Slip and Interstate Hole across the river from the WLSSD embayment from December through February, 1988-1989. Trout-perch, black bullhead, white sucker, and yellow perch were the most numerous species at these locations. Schramm (1978) conducted gill net surveys at the Reiss Coal Docks, Connor's Point, Barker's Island, and Bunge Dock during February and March, 1978. Northern pike, yellow perch, walleye, and spottail shiners

were the most abundant species. Schram (1978) captured only 7 species under the ice in 1978, and Balcer (1989) found 7 near Interstate Island and 14 species near Bunge Slip in winter 1988 (Table 4). The relatively high total number of species captured in the mixing zone during our study was high primarily due to the occasional capture of rarer and exotic species (longnose sucker, stickleback, shiners, sunfishes, tiger musky, chinook salmon, atlantic salmon, rainbow trout). Some of these were lake run fish, however, walleyes, burbot, lake trout, and other lake run suckers observed by Balcer near Bunge Slip (1989) were not observed near the mixing zone. Nonetheless, the number of species caught in the mixing zone was comparable to those observed across the bay (Table 4).

In general the major differences between fish communities in the mixing zone and those reported form other winter surveys were in relation to: 1) the relatively low number of forage fishes present, 2) the presence of relatively large numbers of ruffe, and 3) the relatively high catches of northern pike. The first two of these differences are in general agreement with recent observations of fish communities in the estuary by the US Fish and Wildlife Service (J. Selgeby, personnel communication, Ashland, WI). They have found that several forage species have declined significantly in abundance over the last few years as ruffe populations increased dramatically. Ruffe have become one of the most abundant fish in the lower river. In addition, our smallest mesh size (3/4") may not have been small enough to capture several forage species. Balcer (1989) noted much higher catches of forage species in mesh sizes less that 3/4".

The catch rate of northern pike in the present study were several times higher than those observed in other studies (Table 4). The Minnesota DNR stocked large numbers of northern pike in the lower river over the last few years in an attempt to control ruffe

populations, consequently, northern pike populations may be considerably greater than those that were present during previous surveys. However, even if our northern pike catch rate was reduced by 34% (the proportion with DNR tags), catch rates would still be much higher than previously reported rates.

CONCLUSIONS

The mixing zone in the embayment receiving warm effluent from the WLSSD treatment facility contains a relatively high number of fish species during winter months. The number of species is as high or higher than those reported in other winter surveys in the lower St. Louis River. Locations closest to the outfall pipe had a greater number of species and a greater catch rate than locations on the edge of the mixing zone.

Northern pike and ruffe were among the most abundant fish in the embayment. Ruffe are abundant throughout the lower river but comparative winter survey information on relative abundance in other embayments is nonexistent due to the relatively short time they have been present in the harbor. High catch rates of northern pike indicate that this species may preferentially choose the mixing zone environment since catch rates appear much higher than those reported in other studies. This study was not designed to determine the length of residence of pike and other species in the mixing zone. Consequently, it is not possible to identify whether the mixing zone acts as a winter refuge for these species or whether high catches represent greater transient activity through the warmer mixing zone.

LITERATURE CITED

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FIGURE TITLES

Figure 1. Fish sampling locations near the WLSSD discharge, November, 1991 - April, 1992. Numbers indicate locations of gill net sets and letters indicate trap and seine net locations.

Figure 2. Size frequency distribution of cumulative observations of pike sampled at the WLSSD discharge, winter of 1991-1992.

Figure 3. Mean length (TL) of pike sampled at four stations near the WLSSD discharge, April, 1992. Error bars represent the 95% confidence interval around the means, and letters above the bars denote significant differences between the means as shown by the least significant difference (LSD) test.

Figure 4. Size frequency distribution of cumulative observations of Black Bullhead and White Sucker sampled near the WLSSD discharge, winter of 1991-1992.

Figure 1

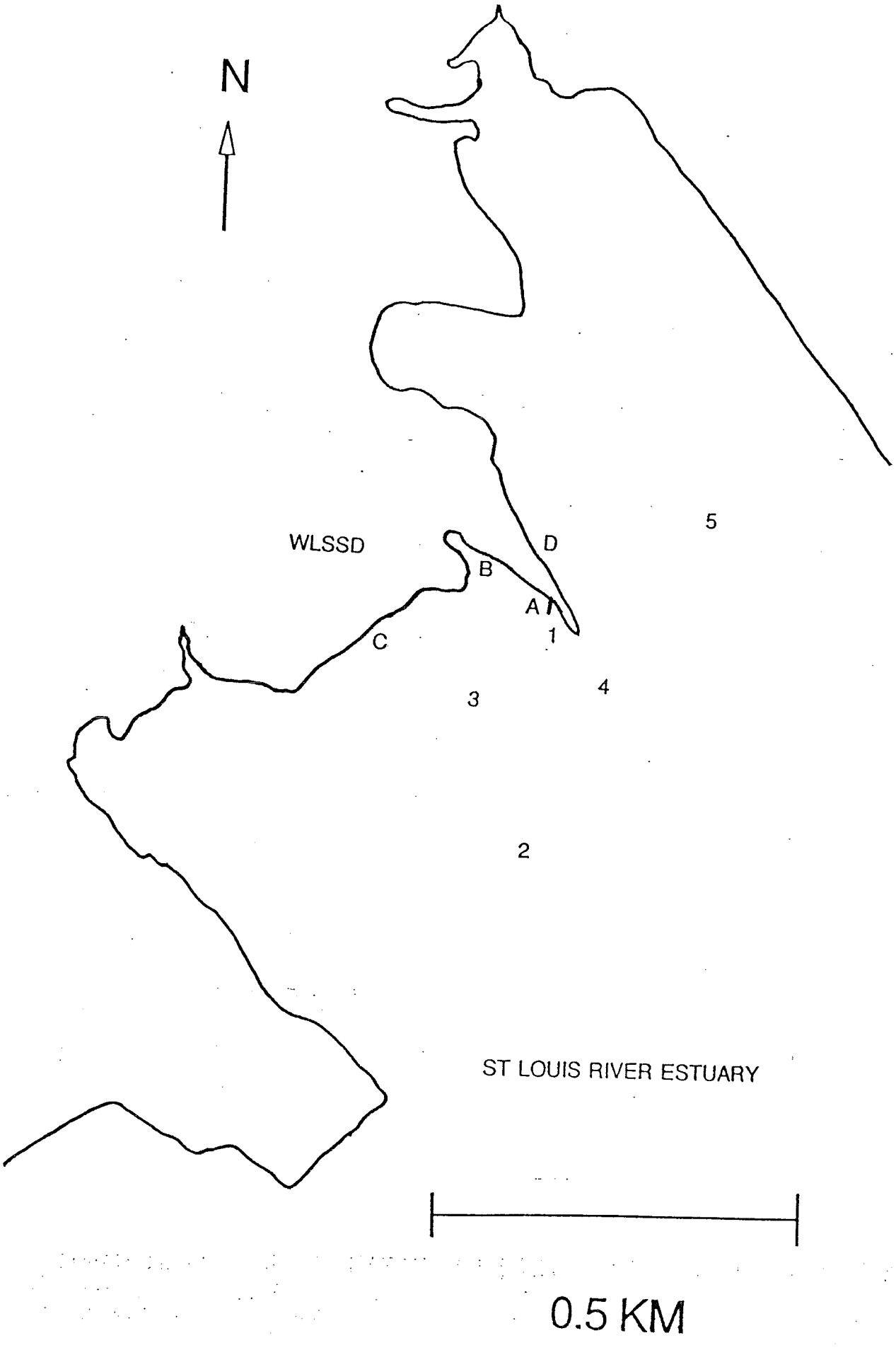
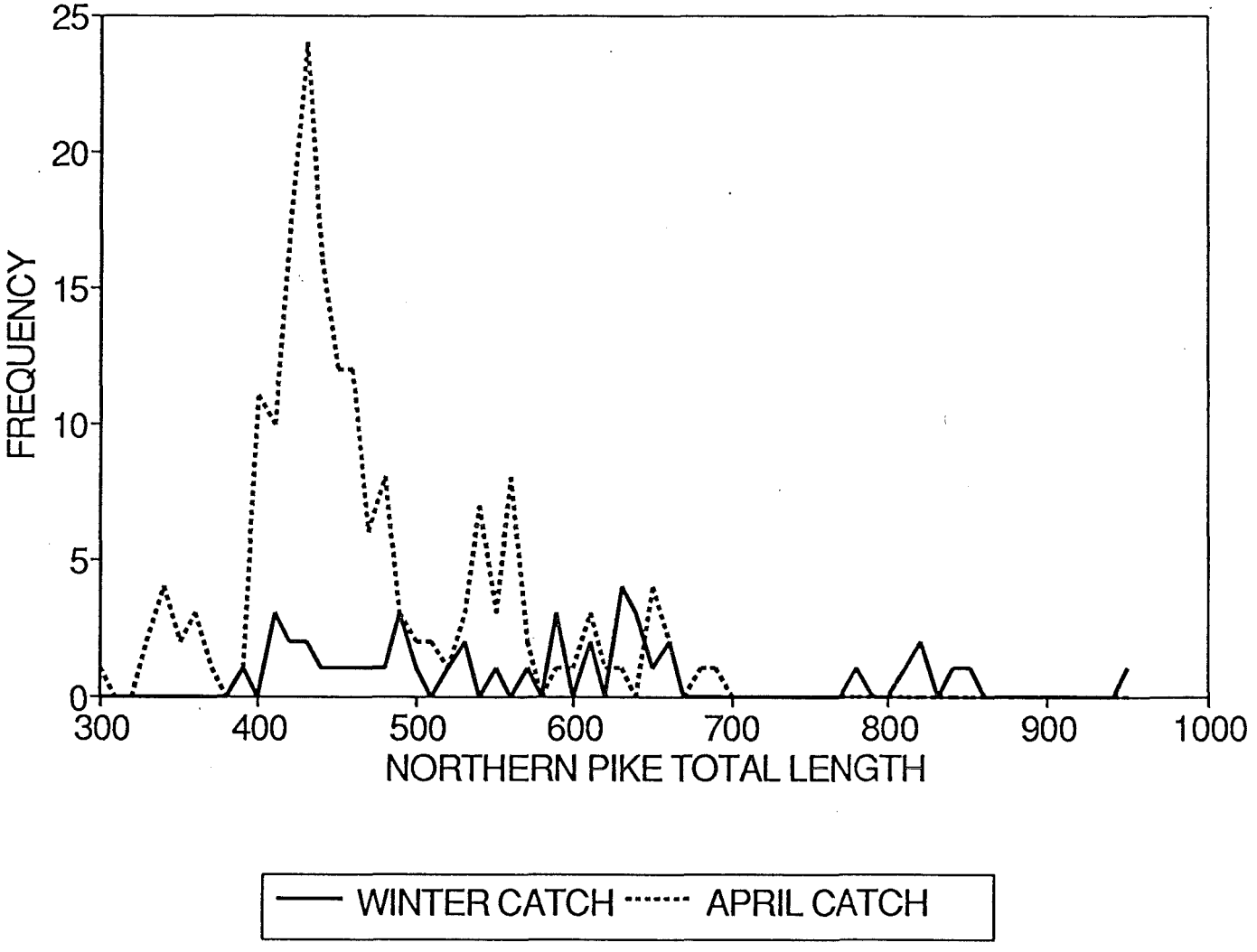


Figure 2


25
20
15
10
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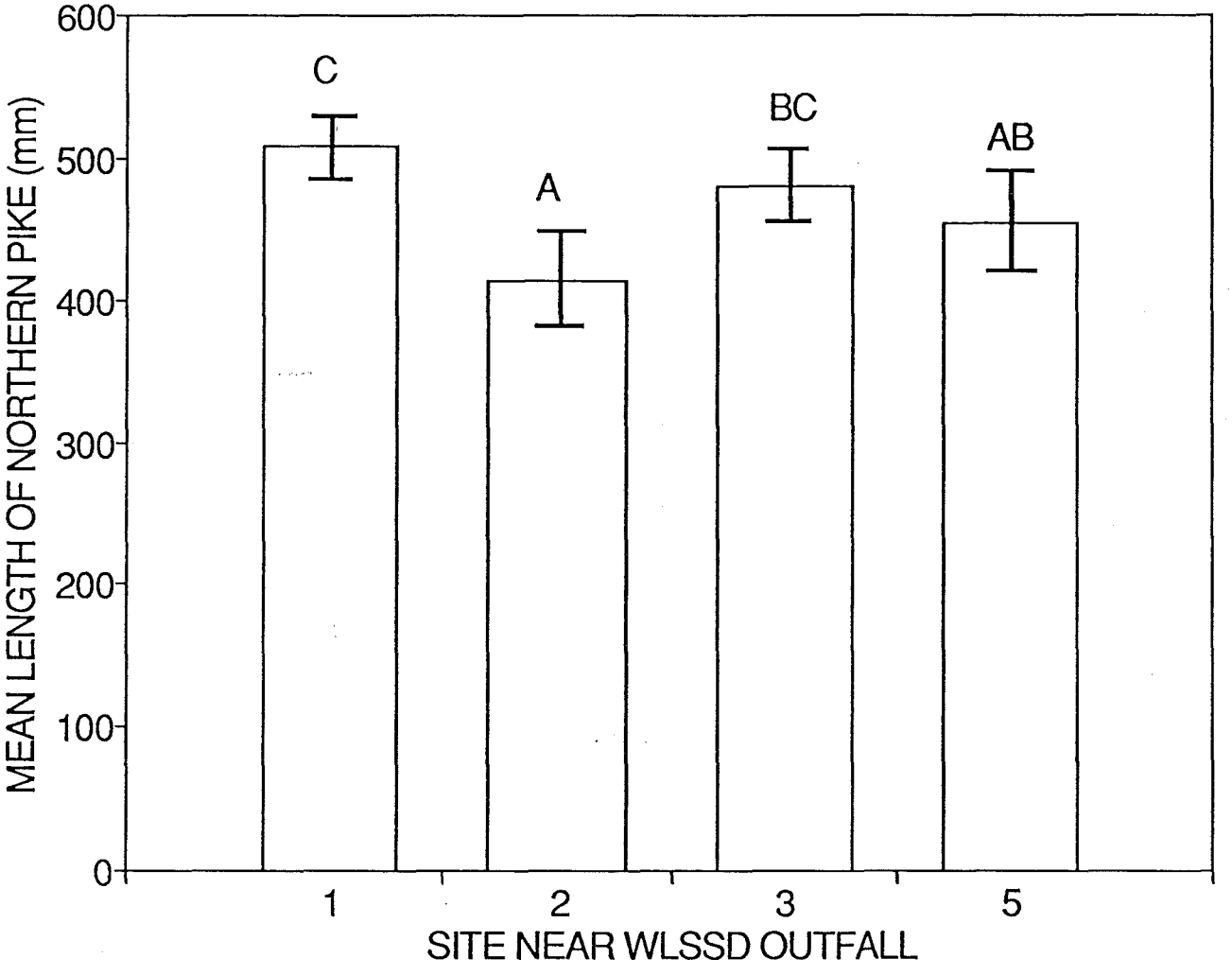
0
FREQUENCY
300
400
500
600
700
800
900
1000
NORTHERN PIKE TOTAL LENGTH
WINTER CATCH
APRIL CATCH

Figure 3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MEAN LENGTH OF NORTHERN PIKE (mm)
C
A
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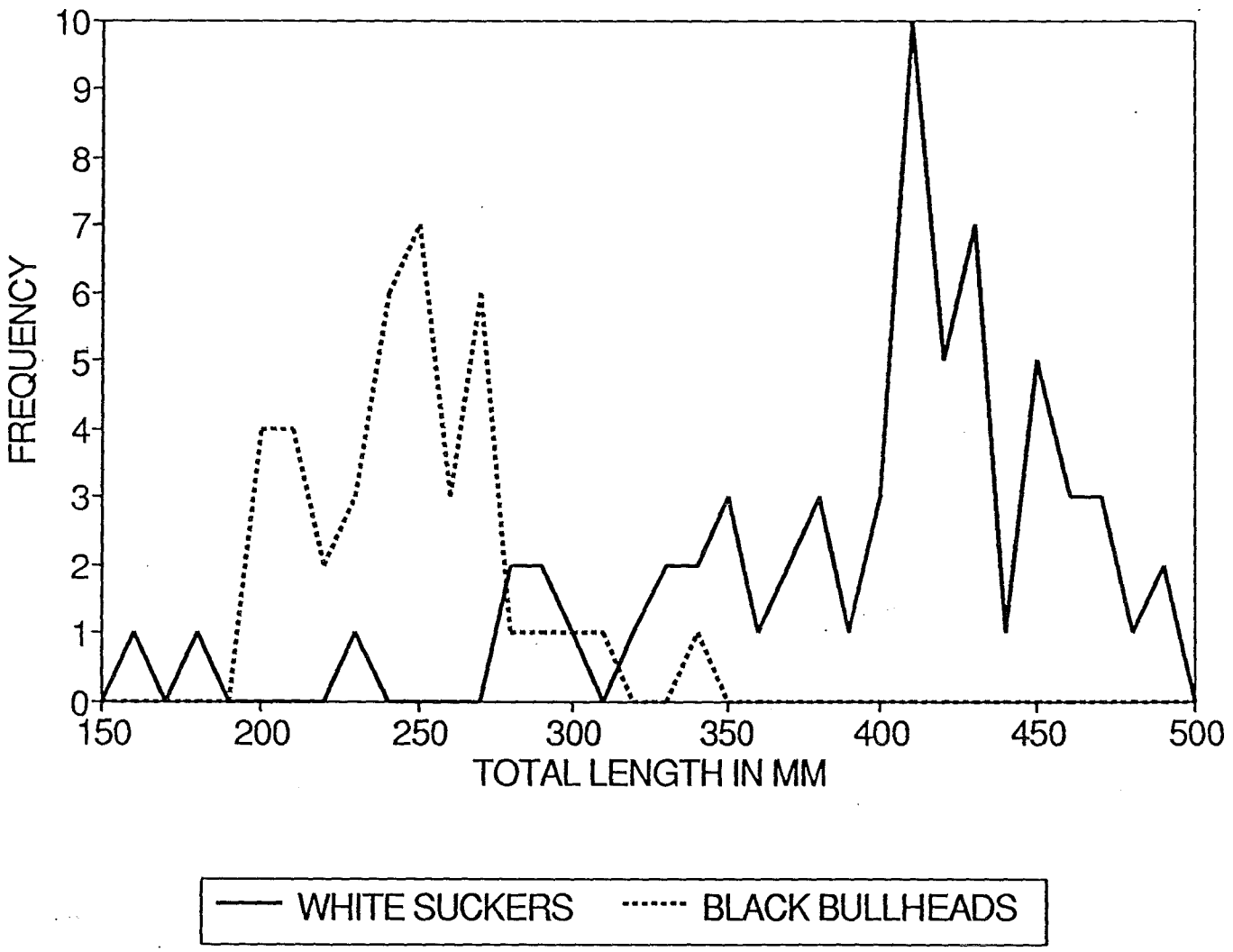
AB
1
2
3
5
SITE NEAR WLSSD OUTFALL

Figure 4


FREQUENCY
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7
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150
200
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TOTAL LENGTH IN MM
WHITE SUCKERS
BLACK BULLHEADS

Table 1. Percent composition of gillnet catches near the WLSSD outfall: November, 1991 to April, 1992.

PERIOD	LATE NOVEMBER			EARLY JANUARY			EARLY FEBRUARY			MID APRIL				
SITE	1	2	3	1	4	3	1	4	3	1	2	3	5	
HIGH TEMP (CENTIGRADE)	15	1		12	1	12	16	13	13	17	9	17	2	AVERAGE
LOW TEMP (CENTIGRADE)		1	1	1	1	1	1	1	1	4	2	2	2	COMPOSITION
TOTAL CATCH	24	16	10	10	4	11	8	3	4	42	28	29	14	15.6
SPECIES RICHNESS	7	6	5	6	1	4	4	2	3	5	5	5	3	4.3
ESOX LUCIUS (NORTHERN PIKE)	12.5	31.3	20.0	40.0	100.0	72.7	50.0	66.7	50.0	69.0	35.7	48.3	78.6	51.9
E. LUCIUS X MASQUINONGY (TIGER MUSKY)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CATOSTOMUS COMMERSONI (WHITE SUCKER)	54.2	43.8	20.0	0.0	0.0	0.0	0.0	0.0	25.0	7.1	10.7	17.2	0.0	13.7
C. CATOSTOMUS (LONGNOSE SUCKER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.3
ICTALURUS MELAS (BLACK BULLHEAD)	4.2	6.3	40.0	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0	3.4	0.0	4.8
I. NEBULOSUS (BROWN BULLHEAD)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ONCORHYNCHUS MYKISS (RAINBOW TROUT)	8.3	0.0	10.0	10.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	3.1
O. TSHAWYTSCHA (CHINOOK SALMON)	0.0	6.3	10.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
SALMO SALAR (ATLANTIC SALMON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	3.4	7.1	1.2
GYMNOCEPHALUS CERNUUS (RIVER RUFFE)	8.3	6.3	0.0	20.0	0.0	9.1	25.0	33.3	25.0	14.3	46.4	27.6	14.3	17.7
PERCA FLAVESCENS (YELLOW PERCH)	8.3	6.3	0.0	10.0	0.0	9.1	12.5	0.0	0.0	0.0	3.6	0.0	0.0	3.8
MICROPTERUS DOLOMIEUI (SMALLMOUTH BASS)	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
POMOXIS NIGROMACULATUS (BLACK CRAPPIE)	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	1.1
LEPOMIS MACROCHIRUS (BLUEGILL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LEPOMIS GIBBOSUS (PUMPKINSEED)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AMBLOPLITES RUPESTRIS (ROCK BASS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CULEA INCONSTANS (BROOK STICKLEBACK)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CYPRINUS CARPIO (CARP)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOTROPIS HUDSONIUS (SPOTTAIL SHINER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOTROPIS ATHERINOIDES (EMERALD SHINER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 2. Percent composition of trapnet catches near the WLSSD outfall: November, 1991 to April, 1992.
SGL = single net opening away from shore, DBL = two nets with tied leads and facing openings set perpendicular to shore.

PERIOD	LATE NOVEMBER						EARLY JANUARY				EARLY FEBRUARY			MID APRIL					
SITE	A	B	D	A	A	A	A	A	B	C	A	A	B	A	A	B	C	D	
GEAR	SGL	SGL	SGL	DBL	DBL	DBL	DBL	DBL	DBL	DBL	DBL	DBL	DBL	DBL	DBL	DBL	DBL	DBL	
HIGH TEMP (CENTIGRADE)	15.2	11		26	18	17	23	22	16	3	21	16	16	22	21	17	13	3	AVERAGE
LOW TEMP (CENTIGRADE)			0.5	9	1	1	10	3	1	1	4	1	1	11	9	11	9	3	COMPOSITION
TOTAL CATCH	6	1	1	12	9	15	4	3	1	2	6	5	4	29	52	43	7	39	13.3
SPECIES RICHNESS	4	1	1	5	5	4	4	3	1	1	4	3	3	7	7	8	5	4	3.9
ESOX LUCIUS (NORTHERN PIKE)	0.0	0.0	0.0	0.0	22.2	0.0	25.0	33.3	0.0	0.0	16.7	0.0	50.0	58.6	69.2	69.8	42.9	71.8	25.5
E. LUCIUS X MASQUINONGY (TIGER MUSKY)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	2.3	0.0	0.0	1.5
CATOSTOMUS COMMERSONI (WHITE SUCKER)	0.0	0.0	100.0	33.3	0.0	0.0	25.0	33.3	100.0	100.0	0.0	0.0	0.0	17.2	1.9	11.6	14.3	17.9	25.3
C. CATOSTOMUS (LONGNOSE SUCKER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.4
ICTALURUS MELAS (BLACK BULLHEAD)	16.7	100.0	0.0	41.7	11.1	60.0	25.0	0.0	0.0	0.0	50.0	60.0	0.0	3.4	7.7	7.0	0.0	0.0	21.3
I. NEBULOSUS (BROWN BULLHEAD)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.2
ONCORHYNCHUS MYKISS (RAINBOW TROUT)	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
O. TSHAWYTSCHA (CHINOOK SALMON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SALMO SALAR (ATLANTIC SALMON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.8
GYMNOCEPHALUS CERNUUS (RIVER RUFFE)	16.7	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	16.7	20.0	0.0	6.9	3.8	0.0	14.3	0.0	4.7
PERCA FLAVESCENS (YELLOW PERCH)	0.0	0.0	0.0	8.3	11.1	6.7	0.0	33.3	0.0	0.0	0.0	0.0	25.0	0.0	0.0	2.3	0.0	0.0	4.8
MICROPTERUS DOLOMIEUI (SMALLMOUTH BASS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.9	3.8	0.0	14.3	0.0	1.4
POMOXIS NIGROMACULATUS (BLACK CRAPPIE)	50.0	0.0	0.0	0.0	11.1	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	3.4	9.6	2.3	0.0	0.0	5.2
LEPOMIS MACROCHIRUS (BLUEGILL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LEPOMIS GIBBOSUS (PUMPKINSEED)	16.7	0.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	2.5
AMBLOPLITES RUPESTRIS (ROCK BASS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.1
CULEA INCONSTANS (BROOK STICKLEBACK)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CYPRINUS CARPIO (CARP)	0.0	0.0	0.0	8.3	44.4	26.7	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	3.8	2.3	0.0	0.0	5.9
NOTROPIS HUDSONIUS (SPOTTAIL SHINER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOTROPIS ATHERINOIDES (EMERALD SHINER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 3. Percent composition of seine catches near the WLSSD outfall: November, 1991 to April, 1992. Hauls were approximately 30 m along the shoreline; DY = day, EV = evening sampling.

DATE	5 DEC	10 JAN	10 FEB	9 APR EV	9 APR EV	13 APR DY	13 APR DY	
SITE	A-B	A-B	A-B	A-B	D	A-B	D	
# OF HAULS	4	4	4	4	2	4	2	AVERAGE COMPOSITION
TOTAL CATCH	0	3	3	16	2	5	0	4.1
SPECIES RICHNESS	0	2	3	5	1	3	0	2.0
ESOX LUCIUS (NORTHERN PIKE)	0.0	33.3	0.0	0.0	0.0	20.0	0.0	7.6
E. LUCIUS X MASQUINONGY (TIGER MUSKY)	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.9
CATOSTOMUS COMMERSONI (WHITE SUCKER)	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.9
C. CATOSTOMUS (LONGNOSE SUCKER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ICTALURUS MELAS (BLACK BULLHEAD)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I. NEBULOSUS (BROWN BULLHEAD)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ONCORHYNCHUS MYKISS (RAINBOW TROUT)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O. TSHAWYTSCHA (CHINOOK SALMON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SALMO SALAR (ATLANTIC SALMON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GYMNOCEPHALUS CERNUUS (RIVER RUFFE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERCA FLAVESCENS (YELLOW PERCH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MICROPTERUS DOLOMIEUI (SMALLMOUTH BA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
POMOXIS NIGROMACULATUS (BLACK CRAPPIE	0.0	0.0	0.0	37.5	0.0	20.0	0.0	8.2
LEPOMIS MACROCHIRUS (BLUEGILL)	0.0	0.0	33.3	0.0	0.0	0.0	0.0	4.8
LEPOMIS GIBBOSUS (PUMPKINSEED)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AMBLOPLITES RUPESTRIS (ROCK BASS)	0.0	0.0	33.3	0.0	0.0	0.0	0.0	4.8
CULEA INCONSTANS (BROOK STICKLEBACK)	0.0	0.0	33.3	0.0	0.0	0.0	0.0	4.8
CYPRINUS CARPIO (CARP)	0.0	66.7	0.0	0.0	0.0	0.0	0.0	9.5
NOTROPIS HUDSONIUS (SPOTTAIL SHINER)	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.9
NOTROPIS ATHERINOIDES (EMERALD SHINER)	0.0	0.0	0.0	43.8	100.0	60.0	0.0	29.1

TABLE 4. Means and standard deviations for recent and recorded winter gillnet catches within the St. Louis River Estuary. Species Richness is the number of species reported from the site during the entire winter survey period. Other means reflect actual catch data from 24 hour sets using 125 foot (38.1 m) gillnets, or data transformed to reflect estimated catches with nets of this length.

SITE	DEPTH	SPECIES RICHNESS	# OF SPECIES PER SET	TOTAL CATCH PER SET	# OF PIKE PER SET
OUTFALL[1]	1-2 m	10	5.5 (1.12)	21 (13.7)	10.0 (11.0)
COLD BAY[1]	1.5-2 m	7	3.5 (2.06)	12.8 (10.2)	5.25 (2.95)
INTERSTATE HOLE[2]	7.4-8.5 m	8	1.7 (1.18)	7.1 (14.4)	0 (0)
BUNGE SLIP[2]	6.1-7.7 m	14	4.55 (1.34)	33.4 (26.4)	0.67 (0.67)
REISS DOCKS[3]	1.2-3 m	6		2.95	1.25
CONNOR'S POINT[3]	2.4-8.2 m	5		0.95	0
BARKER'S ISLAND[3]	1.2-4.5 m	5		3.75	2.5
BUNGE DOCK[3]	1-8.2 m	7		2.03	0.38

[1]The outfall is site 1 and the cold bay is site 2 from this survey; four sets pr site. [2]Sites surveyed by Balcer (1989) using single sets of a 175 foot net for 24 hours. There were 8 sets at Interstate Hole and 9 sets at Bunge Slip during the 11/15/88 to 4/24/89 period. [3]Sites surveyed by Schram (1978) during February and March of 1978. Since this author used a variety of net lengths and numbers of sets, the means shown here are his reported numbers per foot*day multiplied by 125. No other statistics could be calculated.

Table 5. Summary of depth and chemical measurements taken at sites near the WLSSD outfall: November, 1991 to April, 1992. Reported chemical determinations are surface readings; depth fluctuated up to 0.3 m depending on the weather.

SITE	PIPE	1	2	3	4	5	A	B	C	D
DEPTH	1.2	1.8	1.8	1.8	1.8	1.8	.5-1.5	.5-1.5	1.3-2	1-1.3
DISSOLVED OXYGEN (ppm)										
NOVEMBER	5.4						9	9.2		12.8
FEBRUARY							6.5	9		11.8
APRIL		9.8	12.6	10.8		12.4			10.9	
CONDUCTIVITY (umhos)										
NOVEMBER		650	110	120			790	68		
FEBRUARY							820	510		85
APRIL	1150	490	110	350		140			280	