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MIGRATION, FOOD HABITS, AND PREDATORS OF YEARLING COHO SALMON IN WHITEFISH RIVER AND LITTLE BAY DE NOC [1]

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Abstract

Migration of newly planted yearling coho salmon was monitored in the Whitefish River and Little Bay de Noc with trap nets and pound nets in April-June, 1968-69. Concurrently, coho and fish that were potential predators were stomach sampled. Yearling coho migrated out of the stream and through northern Little Bay de Noc within 2 months. They did not prey upon, or compete significantly for food with, native sport fishes, nor were they preyed upon extensively by the latter.

Introduction

The Michigan Department of Natural Resources has been stocking Great Lakes tributaries with large numbers of juvenile coho salmon (Oncorhynchus kisutch) since 1966. As some of these streams flow into productive bays that contain good endemic

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[1] Investigations conducted under Dingell-Johnson projects F-31-R.

populations of sport fishes, there has been concern about potential competitive relationships between the coho and resident species. Native fishes would be affected little if coho migrated rapidly downstream and through these bays into open waters of the Great Lakes. However, if substantial numbers of salmon remained in the streams and bays, they could prey upon, or compete with, resident fishes to a significant degree. On the other hand, planted coho could be preyed upon by resident fishes, perhaps resulting in serious decimation of their numbers. These possibilities led to an investigation of the early movements and interspecific relationships of newly planted yearling coho salmon in Little Bay de Noc, Lake Michigan and a tributary, the Whitefish River. My specific objectives were to determine (1) how long the coho remained in the river and bay, (2) their food habits, and (3) the extent of predation on coho by native fishes.

Materials and methods

My study was restricted to Little Bay de Noc north of Gladstone, and the Whitefish River estuary (Fig. 1). The maximum depth in this part of the bay is 51 feet, but about half is less than 12 feet. The Whitefish River has a base flow of about 50 cubic feet per second and is the largest tributary to the bay north of Gladstone. Fish populations in the bay and estuary consisted predominantly of endemic warm-water species, mainly yellow perch (Perca flavescens),

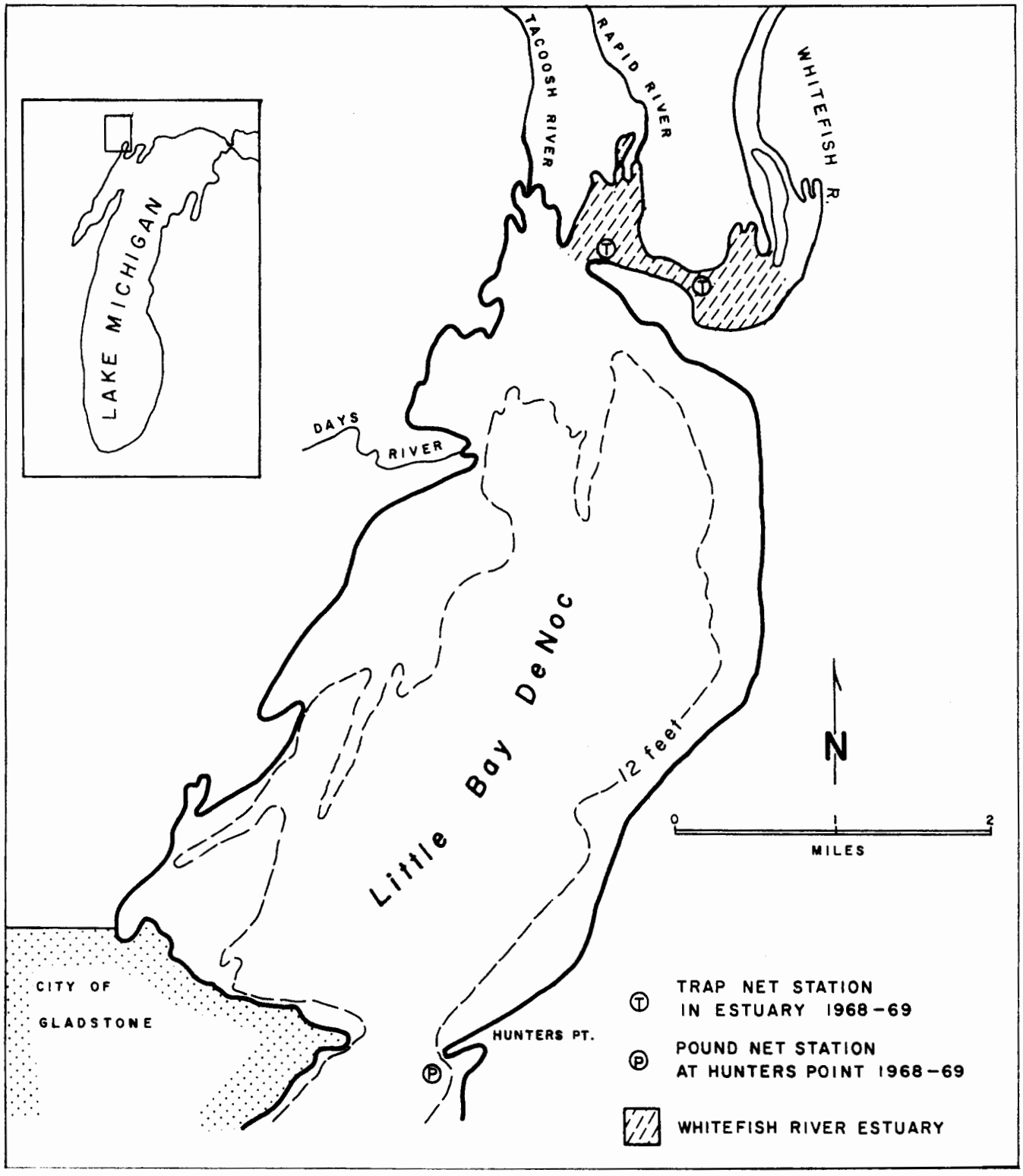

Figure 1.--Whitefish River estuary and northern Little Bay de Noc, Lake Michigan.

northern pike (Esox lucius), walleye (Stizostedion vitreum), smallmouth bass (Micropterus dolomieui), bullheads (Ictalurus spp.), spottail shiners (Notropis hudsonius), johnny darters (Etheostoma nigrum), and trout-perch (Percopsis omiscomaycus). Adult alewives (Alosa pseudoharengus) were abundant from June through August, and age-0 alewives from July into September (Wagner, 1970). Adult rainbow smelt (Osmerus mordax) were very abundant during the spawning season in April-May, and young smelt doubtlessly were even more abundant for sometime thereafter. Small populations of bowfin (Amia calva), burbot (Lota lota), rainbow trout (Salmo gairdneri), brown trout (Salmo trutta), and white bass (Morone chrysops) were also present in the bay. The physical characteristics and fish fauna of northern Little Bay de Noc are further described by Wagner (1970).

One hundred thousand 4- to 6-inch yearling coho were planted in Haymeadow Creek (T. 42 N., R. 20 W., Sec. 19), a tributary of Whitefish River, on 17 April in 1968 and 1969. The release location is some 6 miles above the river's mouth. An additional plant of 62,000 coho was made here on 19-20 May 1969. No attempt was made in the estuary to sample fish from this plant, although some may have been collected in the bay.

Sampling for yearling coho in the estuary (Fig. 1) began on 17 April both years. Collecting was accomplished mainly with a 2-foot trap net (1/2-inch stretch mesh; pot, 2 x 3 x 3 feet; wings, 10 feet long; lead, 30 feet long) and a 3-foot trap net (1-inch stretch

mesh; pot, 3 x 3 x 4 feet; wings, 20 feet long; no lead). The trap nets were set along shore with the open end facing upstream. Nets were fished continuously and checked in the morning (0600-0800) and evening (1800-2000). A few coho also were collected in multifilament nylon gill nets in 1968. These nets were 125 feet long by 6 feet deep and consisted of 25-foot panels of 3/4-, 1-, 1 1/4-, 1 1/2- and 1 3/4-inch stretch mesh. Gill nets were fished across current, day and night, with lifts made every 4 hours.

All but one yearling coho collected in the bay were captured in smelt pound nets. My pound net fishing consisted of one net at Hunters Point in 1968 and 1969 (Fig. 1). This net fished during most of May and was usually checked daily at 0600-0800. Most coho were taken in this net, but some were obtained during 28 April-2 May 1969 from smelt pound nets fished commercially just south of Gladstone. Pound nets consisted of a pot 30 feet square by 10 feet deep, 20- to 30-foot wings, and a 400- to 600-foot lead extending to shore. Mesh size in the pot, wings and lead was 1-inch stretch.

Surface water temperatures were taken with a pocket thermometer at net stations in the bay and estuary, usually when nets were checked.

Some of the gear used was unsuitable for collecting juvenile coho. Small-mesh gill nets (previously described) proved unsuitable in the estuary and bay. A few coho were captured with them in the estuary, but large numbers of smelt and yellow perch fouled the nets badly, and this required excessive effort for removal. In the bay, only one coho

was captured in 332 hours of gill net fishing between 1 May and 20 June 1968. Alewives fouled nets set during June. Gill net sets were of 8- to 12-hour duration and were made throughout the bay north of Gladstone. Most sets were overnight, but a few were made during daylight hours. No coho were captured in the two previously described trap nets fished 250 hours at Hunters Point during 3-21 June 1968. They were fished 3-4 days at a time and checked once a day. I believe that the trap nets and gill nets were too small to be effective in the bay. A pound net with dimensions similar to those of the smelt pound nets but with larger mesh (pot, 1 1/2-inch; wings and lead, 4-inch) was fished at Hunters Point during 17 May-21 June 1968. No coho were captured in this net, although it was fished longer (700 hours) than the smelt pound net (210 hours). While coho may have escaped through the 1 1/2-inch mesh of the pot, it is my opinion that they were not guided into the pot by the 4-inch mesh lead.

Concurrently with collection of juvenile salmon in the estuary and bay, fish thought capable of eating young coho were collected and stomach sampled. In the estuary and north end of the bay, large-mesh trap nets similar to those described by Crowe (1950), and a large-mesh gill net were used to collect predatory fish. In the bay proper, predatory fish were captured in the pound nets and a large-mesh floating gill net. The trap nets were checked in the morning and evening, and the pound net once daily. The gill nets were usually set in the evening and lifted the following morning.

All fish to be stomach sampled were measured to the nearest millimeter, total length. Stomach contents were initially preserved in 10% formalin. Those of juvenile coho were subsequently transferred to 70% isopropyl alcohol prior to identification and quantification. All food items except arachnids were identified at least to order. Insects in orders Hemiptera, Ephemeroptera and Diptera were identified to family. Food items in each coho stomach were counted. Food items (whole organisms and parts) from salmon caught in the same net on the same day were combined by taxonomic groups (class, order, or family). Each group was centrifuged to remove excess moisture, and weighed to the nearest 0.01 gram on a Cenco Model 158H6D direct-reading analytical balance. Stomachs of predatory fish were checked for the presence of salmon.

Results

Juvenile coho migration

The first yearling coho was captured in a gill net in the estuary on 19 April 1968, two days after planting. Gill nets and trap nets caught 126 coho between 19 April and 1 May 1968. No coho were taken during the next 7 days, so all nets were removed on 8 May. The downstream movement of coho through the estuary, as monitored by the trap nets, peaked sharply 25-28 April, when 101 were captured (Table 1).

Table 1.--Catch of yearling coho by 2-day periods in two trap nets in Whitefish River estuary, April-May, 1968-69

	April							May			
Year	17-18	19-20	21-22	23-24	25-26	27-28	29-30	1-2	3-4	5-6	7-8
1968	0	0	0	7	52	49	7	2	0	0	0
1969	0	19	41	12	37	26	135	5	1	0	1

In 1969, the first coho was again caught on 19 April, just 2 days after being planted. Coho were caught regularly in the estuary until 3 May. Only one was collected during the following 5 days, so the gear was removed on 8 May. Trap netting yielded 277 coho during the period 19 April-7 May, with large catches occurring 20-22 April, 25-26 April, and 29-30 April (Table 1).

To determine the time of day that most downstream movement occurred, Wilcoxon matched-pairs signed-ranks tests (Siegel, 1956) were applied to paired day and night catches of two trap nets fished in the estuary in 1969 (Table 2). No significant difference in catch per unit effort was found between day and night catches in either net.

Water temperatures were 40-50 F when coho were in the estuary in 1968 and 1969.

Table 2. --Catch per unit effort (fish per 12-hour set) of yearling coho in trap nets in Whitefish River estuary, April-May 1969

Gear and time of capture	Lift date												
	April												May
	19	20	21	22	23	24	25	26	27	28	29	30	1
2-foot trap net													
Day (0700-1700)	0	3	7	3	1	1	-	0	0	0	22	0	0
Night (1700-0700)	0	4	4	3	0	0	14	3	0	0	2	0	5
3-foot trap net													
Day (0700-1700)	1	3	7	14	0	0	1	0	0	8	94	2	0
Night (1700-0700)	1	7	1	2	10	0	17	2	8	10	8	6	0

Table 3. --Catch per unit effort (number per 24 hours) of yearling coho in the pound net at Hunters Point, Little Bay de Noc, 1968-69

1968		1969	
Lift date	Coho per 24 hours	Lift date	Coho per 24 hours
May 1	3	May 5	7
2	0	6	11
3	4	7	5
6	1	8	2
7	1	12	3
8	0	13	1
9	1	14	1
10	0	15	2
15	1	19	1
16	0	21	3
17	1	22	0
		23	0
		26	4
		27	2
		28	1
		June 4	<1

In 1968, 25 yearling coho were captured in the pound net at Hunters Point and one was collected in a gill net between 27 April-17 May. In 1969, 73 coho were collected in the Hunters Point pound net during 3 May-4 June, and 18 others were taken from four commercial pound nets monitored 28 April-2 May. Pound net catches in both years were largest during the first week of fishing, then declined irregularly until collecting ceased (Table 3). Surface water temperatures at the pound net were 40-60 F during May 1968 and 1969.

Juvenile coho food habits

I examined stomachs of 225 yearling coho from the estuary and 116 from the bay. At each location, 95% contained food. The kinds of food found are shown in Table 4.

More than 90% of the cohos had eaten insects. These were mainly aquatic species (adults, nymphs, and larvae). Aquatic insects that contributed the most weight to, and/or occurred most frequently in the diet of coho were mayflies (Ephemeroptera), water boatmen (Corixidae), and fly larvae (Diptera). Stoneflies (Plecoptera), and beetles (Coleoptera) were of lesser importance. Eight per cent of the yearling coho in the estuary and 32% in the bay had eaten terrestrial insects or aquatic species in the terrestrial stages of development. Most of the terrestrial forms were dipterans. Insects ranked first in percentage of the total weight of items eaten by yearling coho in the bay and estuary. Mayfly nymphs accounted for most of this weight at both locations.

Table 4.--Percentage of occurrence and (in parentheses) percentage of total weight of food in yearling coho salmon, Little Bay de Noc, April-June 1968-69

Food item	Location	
	Estuary	Bay
Oligochaeta	6 (9)	0 (0)
Crustacea	40 (13)	34 (8)
Cladocera		2 (tr)
Copepoda		2 (tr)
Isopoda	21 (10)	2 (1)
Amphipoda	27 (2)	33 (7)
Arachnoidea	2 (tr)	11 (tr)
Insecta	96 (76)	92 (48)
Ephemeroptera	77 (58)	42 (33)
Ephemeridae	20 (9)	23 (14)
Plecoptera	59 (10)	11 (1)
Hemiptera	43 (4)	55 (6)
Corixidae	43 (4)	55 (5)
Coleoptera	17 (1)	14 (tr)
Trichoptera	10 (tr)	8 (tr)
Diptera	43 (1)	50 (6)
Simulidae	9 (tr)	0 (0)
Tendipedidae	37 (tr)	35 (tr)
Miscellaneous adults	5 (tr)	27 (6)
Miscellaneous larvae [1]	7 (tr)	2 (tr)
Miscellaneous insects [2]	7 (1)	9 (1)
Fish	1 (2)	11 (44)

[1] Tipulidae, Dixidae, Ceratopogonidae, Tabanidae, Rhagionidae in the estuary; Ceratopogonidae in the bay.

[2] Collembola, Odonata, Neuroptera, Lepidoptera in the estuary; Homoptera, Neuroptera, Megaloptera in the bay.

Crustaceans followed insects in order of frequency, were the second most important item by weight in the estuary, and third in the bay. Crustaceans eaten by yearling coho in the estuary were amphipods and isopods. In the bay, coho ate mostly amphipods and a few isopods, copepods and cladocerans.

Fish were rarely eaten by yearling coho in the estuary, but 11% of the coho collected from the bay had eaten fish. Although few coho in the bay ate fish, the weight of this item ranked close behind insects and well ahead of crustaceans. All identifiable fish in coho stomachs were smelt, except for a spottail shiner and an unidentified centrarchid.

Six per cent of the coho from the estuary had eaten oligochaetes, which comprised 10% of the total weight of food. Oligochaetes were not eaten by coho sampled in the bay.

Predation on yearling coho

Only two coho were found in stomachs of the predatory fish listed in Table 5. One was eaten by a walleye captured in the estuary and the other by a northern pike captured in the open water of the bay. More than 90% of the fish eaten by predators examined were adult smelt.

Table 5.--Numbers and lengths of piscivorous fishes examined for presence of yearling coho, Little Bay de Noc, April-June, 1968-69

Species	Number sampled	Total length in inches	
		Average	Range
Northern pike	108	23	12-38
Burbot	46	24	16-28
Walleye	24	23	20-26
Brown trout	16	20	16-25
Bowfin	13	24	20-28
Yellow perch	6	13	12-14
Smallmouth bass	5	17	15-19
Rainbow trout	2	25	20-29
White bass	1	17	17

Discussion

Yearling coho planted in the Whitefish River system in 1968 and 1969 apparently migrated rapidly out of the river and through northern Little Bay de Noc. Some coho reached the estuary within 2 days after being planted, and evidently most of them were there within 10-14 days (Table 1). Movement through the bay appeared to be as fast. Best catches of coho at Hunters Point were made in the first few pound net lifts in 1968 and 1969 (Table 3). This indicates that a majority of coho planted on 17 April had reached Hunters Point within 20-25 days. The catch had declined considerably by the time the pound net was removed on 17 May in 1968 and on 4 June in 1969. No coho were reported caught in the bay by anglers during the summers of 1968 and 1969 (personal communication, Clifford F. Long, District 3 Fisheries Biologist). Most yearling coho evidently had left northern Little Bay de Noc by mid-June.

I do not know why coho left the bay so quickly. Water temperatures did not preclude them from residing there at least temporarily. While salmon were moving through the bay, surface water temperatures ranged from 40 to 60 F and certainly were within tolerance. Even summer water temperatures in Little Bay de Noc were tolerable for coho. Surface temperatures in the summers of 1966-68 never exceeded 73 F (Wagner, 1970), and water 60 F or colder was never more than 16 feet below the surface where bay

depth was 40 feet or deeper (unpublished data, Marquette Fisheries Research Station). Klein and Finnell (1969) collected juvenile coho salmon in shoal areas of Granby Reservoir, Colorado, when the water temperature was often higher than 75 F.

Juvenile coho fed actively after being planted, as 95% of those examined contained food. Their feeding habits were largely benthic, but many of them apparently took some food from the surface. They fed on a wide variety of organisms, from oligochaetes to fish.

Nymphs and larvae of aquatic insects and crustaceans were the most important food of yearling coho in the estuary. In the bay proper, nymphs and larvae of aquatic insects, fish, and crustaceans were the most important food items. The insect and crustacean diet of out-migrating juvenile coho placed them in direct food competition with resident species of similar diet such as yellow perch (Dodge, 1968), and spottail shiner (Basch, 1968). However, coho moved out so quickly that I doubt any competitive relationships had time to develop.

Coho were not preying on important game fish in the estuary and bay. Most of the recognizable fish in coho stomachs were age-I smelt. Smelt spawned in Little Bay de Noc tributaries, and age-I smelt apparently were abundant in the bay. Although spottail shiners and trout-perch were also abundant, only one individual, a spottail shiner, was found in coho stomachs. The small size of the coho would permit them to ingest only young-of-the-year game fish, but it is doubtful that many were available when most coho were migrating through the estuary and bay. Northern pike, walleye and yellow perch spawned shortly

before and during the coho migration. However, cold water temperature may have delayed hatching until after most coho had left. Average daily water temperatures were 40-45 F during April and 46-50 F during the first 2 weeks of May. Incubation time for northern pike eggs, as reported in Carlander (1969), is 23-29 days at 43 F and 16-19 days at 46 F. Incubation of walleye eggs in a hatchery required 29 days in 40-50 F water (Allbaugh and Manz, 1964). Harlan and Speaker (1956) report incubation time for yellow perch eggs as 12-21 days at 45-50 F. Yearling coho could be a serious predator on endemic game fishes only if the coho remained until the young-of-the year of other species were available, or until the coho grew large enough to eat older fish.

Other workers give conflicting reports regarding piscivorous feeding habits of juvenile coho salmon. Roos (1960) found that 30% of age-I and age-II coho salmon (2.4-6.1 inches, TL) sampled in Chignik Lake, Alaska, had eaten young-of-the-year sockeye salmon (Oncorhynchus nerka). However, Klein and Finnel (1969) report that 12-inch coho in Parvin Lake, Colorado, fed entirely on invertebrates, ignoring an abundant population of fathead minnows (Pimephales promelas). According to Shapovalov and Taft (1954) young coho in fresh water on the West Coast eat mainly aquatic and terrestrial insects; young in salt water depend on invertebrates; and adults in salt water are chiefly piscivorous.

Predation by inshore piscivorous fishes on yearling coho was insignificant in Little Bay de Noc. Coho moving through the bay were likely buffered by the numerous smelt present.

In summary, planted yearling coho salmon promptly migrated out of the Whitefish River and out of northern Little Bay de Noc. While there, they neither contributed to, nor were detrimental to, the welfare of resident fishes.

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