ENVIRONMENTAL ASSESSMENT OF THE FY 1979 WINTER NAVIGATION DEMONSTRATION ON THE ST. LAWRENCE RIVER

TECHNICAL REPORT B

BENTHIC SAMPLING AND SUBSTRATE ANALYSIS AT ICE BOOM SITES I. BENTHIC INVERTEBRATE POPULATIONS

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This study was conducted as part of Project Number 210-6141 of the Research Foundation of State University of New York created as a result of Cooperative Agreement Number 14-16-0005-9001 between Fish and Wildlife Service, U.S. Department of Interior, and the Research Foundation for and in conjunction with the State University of New York College of Environmental Science and Forestry and in cooperation with the New York State Department of Environmental Conservation.

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Published by
State University College of Environmental Science and Forestry
Institute of Environmental Program Affairs
Syracuse, New York 13210
June, 1978

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PREFACE

The FY 1979 Winter Navigation Demonstration Program is part of an ongoing investigation to demonstrate the practicability of certain enabling measures for extending the commercial navigation season on the Great Lakes-St. Lawrence River System. As part of that program, the St. Lawrence Seaway Development Corporation proposes to modify existing ice booms at Ogdensburg-Prescott and Galop Island in the St. Lawrence River and conduct a limited number of vessel transits in a Demonstration Corridor. The Demonstration Corridor includes the ice boom sites and extends upstream and downstream in the channel for a total length of approximately 20 miles.

In anticipation of that proposal, the Winter Navigation Program allocated funds for the project "Environmental Assessment to Precede Execution of Winter Navigation Demonstration on the St. Lawrence River, FY 1978." These funds were transferred through the Detroit Engineering District of the U.S. Army Corps of Engineers to the North East Region of the Fish and Wildlife Service. They were provided to the Research Foundation of the State University of New York for and in conjunction with the State University College of Environmental Science and Forestry through a Cooperative Agreement with Fish and Wildlife. The benthic invertebrate population studies reported here for sediments collected at ice boom sites in the river were designed as a component of that Environmental Assessment project. These studies were conducted under a contract between the Research Foundation and Cornell University.

Sample locations and field procedures described in this report also pertain to a companion report, "Benthic Sampling and Substrate Analysis at Ice Boom Sites II. Heavy Metal and Contaminant Content." When taken together with that report, a comprehensive profile of the physical, chemical, and biological characteristics of selected boom site sediments emerges.

EXECUTIVE SUMMARY

Sediment samples were collected through a stable ice cover at 26 stations along the St. Lawrence River shoreline above and below ice boom sites near Ogdensburg-Prescott and Galop Island. A wide variety of benthic invertebrates were present in the samples, with oligochaetes, chironomids, amphipods, and molluscs representing the most abundant forms. Benthic invertebrate biomass was dominated by molluscs.

The abundance of benthic populations in similar substrates was quite variable. Fewer taxa of benthic forms were collected upstream from the Oswegatchie River than downstream from the point where it enters the St. Lawrence. Causal factors affecting this distribution are likely the character of bottom sediments and the presence of organic wastes. Excessive numbers of oligochaetes and chironomids were observed below Dupont of Canada and are indicative of enriched conditions. The abundance of oligochaetes, chironomids, and nematodes appears to be associated with enriched conditions below sewer outfalls at Prescott elevator, Chimney Bay, Dupont of Canada, and Ogdensburg Harbor.

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LIST OF ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

cm	centimeters
g	grams
m	meters
no.	number

SYMBOLS

<	less than
>	greater than
%	percent

ACKNOWLEDGEMENTS

The authors wish to recognize the assistance of Mr. William C. Aikens and Mr. Anthony M. Menkel of Chippewa Bay, New York for their assistance with sample collection.

INTRODUCTION

Benthic invertebrates are an important link in the food chain as well as an essential component for the decomposition process. Also, many invertebrates serve as indicator organisms of clean or polluted waters. Ferrell (1931) reported an abundance of crustaceans and molluscs as well as a few caddis worms in a cross section of the St. Lawrence River near Ogdensburg. Other studies of the St. Lawrence River benthos are rare. However, benthos studies in Lake Ontario are more common (Johnson and Brinkhurst 1971a, 1971b, Brinkhurst et al. 1968, Hiltunen 1967).

As the benthos are associated with the sediment/water interface, disturbances due to environmental modifications should be carefully evaluated. The primary objective of this portion of this study is to characterize the benthos populations at ice boom sites near Ogdensburg-Prescott and Galop Island. Baseline information in the Demonstration area of benthic communities collected during this study will provide a reference to compare with proposed future activities in the St. Lawrence River as well as to suggest the pollutional status of river sediments.

MATERIALS AND METHODS

Sampling sites were selected along transects parallel to and perpendicular with the shoreline in the ice boom area near Ogdensburg-Prescott and Galop Island. Bottom sediments were collected through a stable ice cover from January 24 to February 1, 1978 using a ponar dredge (495 cm^2), except where substrates were too hard. A modified soil bucket auger (71 cm^2) was employed for benthos sampling in the clay and gravel substrates. This sampler was used at depths less than 10 meters since the river current and other factors restricted its use in deeper waters. The ponar dredge was the preferred of the two devices since the area sampled was greater than the corer auger. The locations of sampling stations are given in Table 1 and illustrated in Appendix Figures A1 to A4.

Total substrate samples were preserved immediately in 10-30% formaldehyde and returned to the laboratory for separation. Samples were sieved through No. 60 (235 mesh) screen and preserved in formaldehyde with phloxine B stain for ease of separating organisms from the retained substrate materials. Sucrose floatation and water sorting were used in these separations. Benthic invertebrates were identified to major taxonomic groups (Edmundson 1959; Pennack 1953; Parrish 1968) and enumerated. Biomass for each group was determined by oven drying organisms at 60°C for 24 hours and weighing with a Cahn electrobalance. Many studies delete the contribution of the molluscan component to benthic community biomass or use a corrected value of mollusc biomass without the shell. Since energy is assimilated for the production of the molluscan shell, the shell weight is here included with molluscan biomass (recommended by Dr. Willard Harmon of SUNY College at Oneonta). The dry weight of Mollusca without shell was determined to be 16.6% of Mollusca total biomass.

Table 1. Locations of Benthic Sampling Stations in the St. Lawrence River

Sample Number	UTM Coordinates	Depth Meters	USGS QUAD.
1	0455-2, 4943-9	2.5	Ogdensburg West
2	0454-8, 4943-6	3.0	Ogdensburg West
3	0455-8, 4944-5	4.25	Ogdensburg West
4	0453-7, 4944-5	2.5	Ogdensburg West
5	0454-7, 4945-7	3.0	Ogdensburg West
6	0455-3, 4946-5	1.0	Ogdensburg West
7	0455-9, 4947-0	8.0	Ogdensburg West
8	0460-8, 4949-8	7.5	Ogdensburg East
8A	0460-7, 4949-9	2.0	Ogdensburg East
9	0460-8, 4950-2	2.0	Ogdensburg East
10	0461-2, 4950-6	5.0	Ogdensburg East
11	0460-6, 4950-5	2.0	Ogdensburg East
12	0460-2, 4950-1	1.0	Ogdensburg West
13	0460-2, 4949-5	8.0	Ogdensburg West
14	0459-5, 4948-6	5.0	Ogdensburg West
15	0459-4, 4948-8	13.0	Ogdensburg West
16*	0459-0, 4947-7	1.25	Ogdensburg West
17	0459-8, 4949-0	1.25	Ogdensburg West
18	0463-0, 4950-7	2.0	Ogdensburg East
19	0462-9, 4951-2	4.0	Ogdensburg East
20	0462-9, 4951-6	10.0	Ogdensburg East
21	0462-4, 4952-7	1.5	Ogdensburg East
22	0465-6, 4953-0	1.5	Ogdensburg East
23	0465-2, 4953-2	10.0	Ogdensburg East
24	0465-2, 4954-0	5.5	Ogdensburg East
25*	0464-8, 4954-7	7.0	Ogdensburg East
26*	0465-3, 4954-6	3.0	Ogdensburg East
27	0463-9, 4954-4	3.0	Ogdensburg East
28	0464-6, 4955-1	1.5	Red Mills
29*	0456-5, 4945-3	2.0	Ogdensburg West
30*	0457-4, 4946-3	4.5	Ogdensburg West
31**	0465-0, 4954-3	---	Ogdensburg East

* Sample not taken; substrate too rocky or hard

** Sample not taken; current too swift

Table 2. Benthic Invertebrate Abundance, Dry Weight Biomass, and Percent Composition in the Ice Boom Area of the St. Lawrence River, January 24 to February 1, 1978. Data Combined from 26 Individual Samples

Taxa	Shallow < 5 m (16 sites)					Deep > 5 m (10 sites)				
	Abundance		Biomass			Abundance		Biomass		
	No/m^2	%	g/m^2	%	% excluding mollusca	No/m^2	%	g/m^2	%	% excluding mollusca
Annelida										
Oligochaeta	4020	34.4	.518	0.4	40.6	6502	77.8	.908	0.1	75.8
Polychaeta	0	0	0	0	0	1	@	+	@	@
Hirundinea	14	0.1	.120	0.1	9.4	4	@	.002	@	0.2
Coelenterata										
Hydra	7	@	.0002	@	@	0	0	0	0	0
Theca *	84	0.7	.027	@	2.1	194	2.3	.034	@	2.8
Nematoda	932	8.0	.062	@	4.9	280	3.3	.011	@	0.9
Crustacea										
Ostracoda	46	0.4	.004	@	0.3	6	0.1	+	@	@
Isopoda	28	0.2	+	@	@	2	@	+	@	@
Amphipoda	488	4.2	.254	0.2	19.9	592	7.1	.077	@	6.4
Hydracarina	22	0.2	.002	@	0.2	2	@	+	@	@
Insecta										
Haliplidae	4	@	.0005	@	@	8	0.1	.003	@	@
Chironomidae	4304	36.9	.284	0.2	22.2	312	3.7	.122	@	10.2
Tanypodinae	22	0.2	+	@	@	46	0.6	+	@	@
Ceratopodinidae	4	@	.001	@	0.1	5	@	+	@	@
Ephemeroptera	0	0	0	0	0	4	@	.034	@	2.8
Lepidoptera	18	0.2	.003	@	0.2	5	@	.006	@	0.5
Trichoptera	14	0.1	+	@	@	2	@	+	@	@
Total w/o Mollusca	10007	85.7	1.276	1.1		7965	95.3	1.197	0.1	

Continued

Table 2 (Concluded)

Taxa	Shallow < 5 m (16 sites)					Deep > 5 m (10 sites)				
	Abundance		Biomass			Abundance		Biomass		
	No/m^2	%	g/m^2	%	% excluding mollusca	No/m^2	%	g/m^2	%	% excluding mollusca
Mollusca										
Ancylidae	39	0.3	.029	@		1	@	+	@	
Physidae	20	0.2	.180	0.2		4	@	.015	@	
Valvatidae	380	3.2	16.442	14.1		90	1.1	.356	@	
Hydrobiidae	854	7.3	62.587	53.6		111	1.3	2.970	0.3	
Sphaeriidae	371	3.2	36.246	27.6		166	2.0	.11	@	
Unionidae						22	0.3	1141.3	99.6	
Total	11671		116.760			8359		1145.948		

@ less than 0.1%

+ dry weights of benthic invertebrates could not be determined due to presence as body parts. Invertebrate body parts were used to estimate abundance.

* overwintering cyst.

Table 3. Benthic Invertebrate Abundance, Dry Weight Biomass, and Percent Composition Upstream from Oswegatchie River in the St. Lawrence River, January 24 to February 1, 1978. Data Combined from 10 Individual Samples.

	Shallow < 5 m (6 sites)					Deep > 5 m (4 sites)				
	Abundance		Biomass			Abundance		Biomass		
Taxa	No/m^2	%	g/m^2	%	% excluding mollusca	No/m^2	%	g/m^2	%	% excluding mollusca
Annelida										
Oligochaeta	2971	21.6	.428	0.2	40.1	11188	91.0	1.593	0.1	89.1
Polychaeta	0	0	0	0	0	0	0	0	0	0
Hirundinea	0	0	0	0	0	5	@	.003	@	0.2
Coelenterata										
Hydra	0	0	0	0	0	0	0	0	0	0
Theca*	141	1.0	.045	@	4.2	0	0	0	0	0
Nematoda	355	2.6	.039	@	3.6	418	3.4	.010	@	0.5
Crestacea										
Ostracoda	47	0.3	.001	@	0.1	0	0	0	0	0
Isopoda	42	0.3	.021	@	2.0	0	0	0	0	0
Amphipoda	608	4.4	.278	0.1	26.0	35	0.3	.008	@	0.4
Hydracarina	37	0.3	.003	@	0.3	0	0	0	0	0
Insecta										
Haliplidae	0	0	0	0	0	0	0	0	0	0
Chironominae	6915	50.3	.253	0.1	23.7	282	2.3	.162	@	9.1
Tanypodinae	3	@	+	@	@	70	0.6	0	0	0
Ceratopodonidae	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	0	0	0	0	0	0	0	0	0	0
Lepidooptera	0	0	0	0	0	5	@	.011	@	0.6
Trichoptera	0	0	0	0	0	0	0	0	0	0
Total w/o Mollusca	11119	80.9	1.068	0.5		12003	97.6	1.787	0.1	

Continued

Table 3 (Concluded)

Taxa	Shallow < 5 m (6 sites)					Deep > 5 m (4 sites)				
	Abundance		Biomass			Abundance		Biomass		
	No/m^2	%	g/m^2	%	% excluding mollusca	No/m^2	%	g/m^2	%	% excluding mollusca
Mollusca										
Ancylidae	0	0	0	0		0	0	0	0	
Physidae	12	0.1	.072	@		0	0	0	0	
Valvatidae	682	5.0	32.614	14.2		76	0.6	.345	@	
Hydrobiidae	1379	10.0	124.241	53.9		70	0.6	4.844	0.3	
Shpaeriidae	551	4.0	72.334	31.4		110	0.8	.076	@	
Unionidae	0	0	0	0		35	0.3	1842.6	99.6	
Total	13473		2302.29			12294		1849.6		

@ less than 0.1%

+ dry weights of benthic invertebrates could not be determined due to presence as body parts. Invertebrate body parts were used to estimate abundance.

* overwintering cyst

Table 4. Benthic Invertebrate Abundance, Dry Weight Biomass, and Percent Composition Downstream from Oswegetchie River in the St. Lawrence River, January 24 to February 1, 1978. Data Combined from 16 Individual Samples.

	Shallow < 5 m (10 sites)					Deep > 5 m (6 sites)				
	Abundance		Biomass			Abundance		Biomass		
Taxa	No/m^2	%	g/m^2	%	% excluding mollusca	No/m^2	%	g/m^2	%	%excluding mollusca
Annelida										
Oligochaeta	5070	52.8	.608	20.1	40.4	1815	41.0	.223	@	36.8
Polychaeta	0	0	0	0	0	2	@	.0003	@	@
Hirundinea	28	0.3	.240	7.9	16.0	2	@	.001	@	0.2
Coelenterata										
Hydra	14	0.1	.0004	@	@	0	0	0	0	0
Theca*	28	0.3	.009	0.3	0.6	388	8.8	.067	@	11.0
Nematoda	1509	15.7	.086	2.8	5.7	143	3.2	.012	@	2.0
Crustacea										
Ostracoda	44	0.5	.006	0.2	0.4	12	0.3	.001	@	0.2
Isopoda	14	0.1	+	@	@	3	0.1	.0003	@	@
Amphipoda	369	3.8	.229	7.6	15.2	1149	26.0	.146	@	24.1
Hydracarina	7	0.1	.001	@	@	5	0.1	.0003	@	@
Insecta										
Haliplidae	7	0.1	.001	@	@	17	0.4	.006	@	1.0
Chironominae	1693	17.6	.315	10.4	21.0	343	7.8	.081	@	13.4
Tanypodinae	42	0.4	+	@	@	22	0.5	+	@	@
Ceratopodonidae	9	0.1	.002	@	@	10	0.2	.0003	@	@
Ephemeroptera	0	0	0	0	0	8	0.2	.067	@	11.0
Lepidoptera	35	0.4	.006	0.2	0.4	5	0.1	.0007	@	0.1
Trichoptera	28	0.3	+	@	@	3	0.1	+	@	@
Total w/o Mollusca	8897	92.7	1.503	49.6		3927	88.8	.606		

Continued

Table 4 (Concluded)

Taxa	Shallow < 5 m (10 sites)					Deep > 5 m (6 sites)				
	Abundance		Biomass			Abundance		Biomass		
	No/m^2	%	g/m^2	%	% excluding mollusca	No/m^2	%	g/m^2	%	% excluding mollusca
Mollusca										
Anyclidae	78	0.3	.058	1.9		2	@	.0007	@	
Physidae	28	0.3	.108	3.6		7	0.2	.031	@	
Valvatidae	77	0.8	.270	8.9		105	2.4	.368	@	
Hydrobiidae	328	3.4	.933	30.8		152	3.4	1.096	0.2	
Sphaeriidae	191	2.0	.158	5.2		222	5.0	.144	@	
Unionidae						8	0.2	444.0	99.5	
Total	9599		3.030			4423		442.246		

@ less than 0.1%

+ dry weights of benthic invertebrates could not be determined due to presence as body parts. Invertebrate body parts were used to estimate abundance.

* overwintering cyst

RESULTS

TOTAL ICE BOOM AREA

A tabulation of all benthos samples collected in the St. Lawrence River between Stillwell's Point (opposite Dupont of Canada) to the Galop Island ice boom area is given in Table 2. The benthos composition of each of the 26 individual samples is described in Appendix B, while notes on substrate composition and sampling are provided in Appendix C.

Chironomidae (midges) and Oligochaetae (sludge worms) were the only invertebrates comprising over 10% of the numbers present in samples taken at shallow depths (< 5 m). Ninety-nine percent of the biomass, however, was dominated by Mollusca (snails and clams). Hydrobiidae and Valvatidae gastropods (snails) and Sphaeriidae pelecypods (finger nail clams) were the major contributors to the molluscan biomass at the shallow sites. Excluding the Mollusca, oligochaetes (40.6%), chironomids (22.2%), and amphipods (scuds, 19.9%) were responsible for the greatest biomass of the non-shelled invertebrates.

Oligochaeta was the only group of invertebrates in the deep water (> 5 m) samples that comprised more than nearly 10% of the total numbers present. Dry weight biomass for all invertebrates was dominated by the Unionidae pelecypods (large bivalve clams, 99.6%). Only Hydrobiidae gastropods and oligochaetes had enough biomass to comprise more than 0.1% of the total biomass. Biomass estimates excluding Mollusca showed oligochaetes (75.8%), chironomids (10.2%), and amphipods (6.4%) to comprise the majority of the non-shelled invertebrate biomass present in the deep total ice boom sampling sites (Table 1). There were 20 groups of invertebrates in the shallow sites and 22 groups in the deep sites.

UPSTREAM FROM OSWEGATCHIE RIVER

Samples taken upstream from the Oswegatchie River are summarized in Table 3. Chironomids were the most abundant invertebrates in samples collected at six shallow sites and accounted for over 50% of the composition by numbers. Oligochaetes and Hydrobiidae gastropods were also abundant and accounted for 22% and 10% of the composition by numbers, respectively. Fifty-four percent of the total upstream shallow sites biomass was composed of Hydrobiidae gastropods. The molluscs made up 95.5% of the total biomass. Excluding the molluscan biomass, oligochaetes, amphipods, and chironomids made up the majority of the non-shelled biomass. Although chironomids were abundant, the standing crop biomass was low, indicating a dominance of small organisms at the shallow sampling sites.

Oligochaete numbers at the four upstream deep sites made up 91% of the total, due to the high numbers recovered below Dupont of Canada. Total upstream deep site biomass was dominated by the Unionidae pelecypods collected from sand substrates. Excluding molluscan biomass, the oligochaete biomass accounted for 89% of the non-shelled biomass. There were 13 and 11 taxa of invertebrates at the upstream shallow and deep sites, respectively.

DOWNSTREAM FROM THE OSWEGATCHIE RIVER

Samples taken downstream from the Oswegatchie River are summarized in Table 4. Oligochaeta and chironomids were the only invertebrates in the 10 downstream shallow sites to account for more than 10% of the total numbers. Total biomass was highest for Hydrobiidae gastropods. If molluscs were excluded from the total biomass, Hirudinea (leeches) and Amphipoda were also important components of the non-shelled biomass.

Oligochaetes and amphipods were the only groups of invertebrates accounting for more than 10% of the total numbers in the six downstream deep sites. Unionidae pelecypods comprised 99.5% of the deep site biomass. Without Mollusca in the total biomass, Oligochaeta, Amphipoda, Chironomidae, Ephemeroptera (mayflies) and Nematoda (round worms) all were important to the total non-shelled invertebrate biomass. There were 20 and 22 taxa of invertebrates present in the downstream shallow and deep sites, respectively.

BENTHOS COMPOSITION AT INDIVIDUAL SAMPLE LOCATIONS

The distribution of benthic invertebrates is aggregated. Therefore, within similar depths, substrates, and habitats, population numbers and biomass are highly variable. Individual sampling location results are presented at locations along the St. Lawrence River where substrate types and benthic populations are somewhat homologous. Total biomass includes all Mollusca in this section.

Stillwell's Point

Oligochaetes, chironomids, amphipods and molluscs were numerically the most important component of the Stillwell's Point benthos. Only shallow sites were sampled. The non-molluscan invertebrates comprised 77% of the total number but only 15% of the total biomass. One sample (No. 1) taken in the hard substrate contained very few organisms (see Figures 1 and 2).

Dupont of Canada

The one sample taken upstream from Dupont was typical of other shallow St. Lawrence River sites. Molluscs, chironomids and oligochaetes were well represented in the sample comprising 55% of the numbers and 100% of the total weight (Figures 1 and 2).

Deep sites downstream from Dupont had extremely high numbers of oligochaetes ($> 20,000/m^2$) with their biomass comprising 57% of the total. Other important invertebrates in the downstream Dupont deep sites were nematoda and chironomids. The molluscs that were present accounted for over 30% of the total biomass. The shallow downstream Dupont sample was taken in Blue Church Bay, approximately 200 meters from the direct effluent, but still receiving enrichment from the plant. Chironomid numbers approached $24,000/m^2$ with the oligochaetes also abundant ($> 7,000/m^2$). Biomass was dominated by the oligochaetes even though chironomids were far more abundant, indicating many small chironomid larvae present in the sand and clay substrate at the shallow site (see Figures 1 and 2).

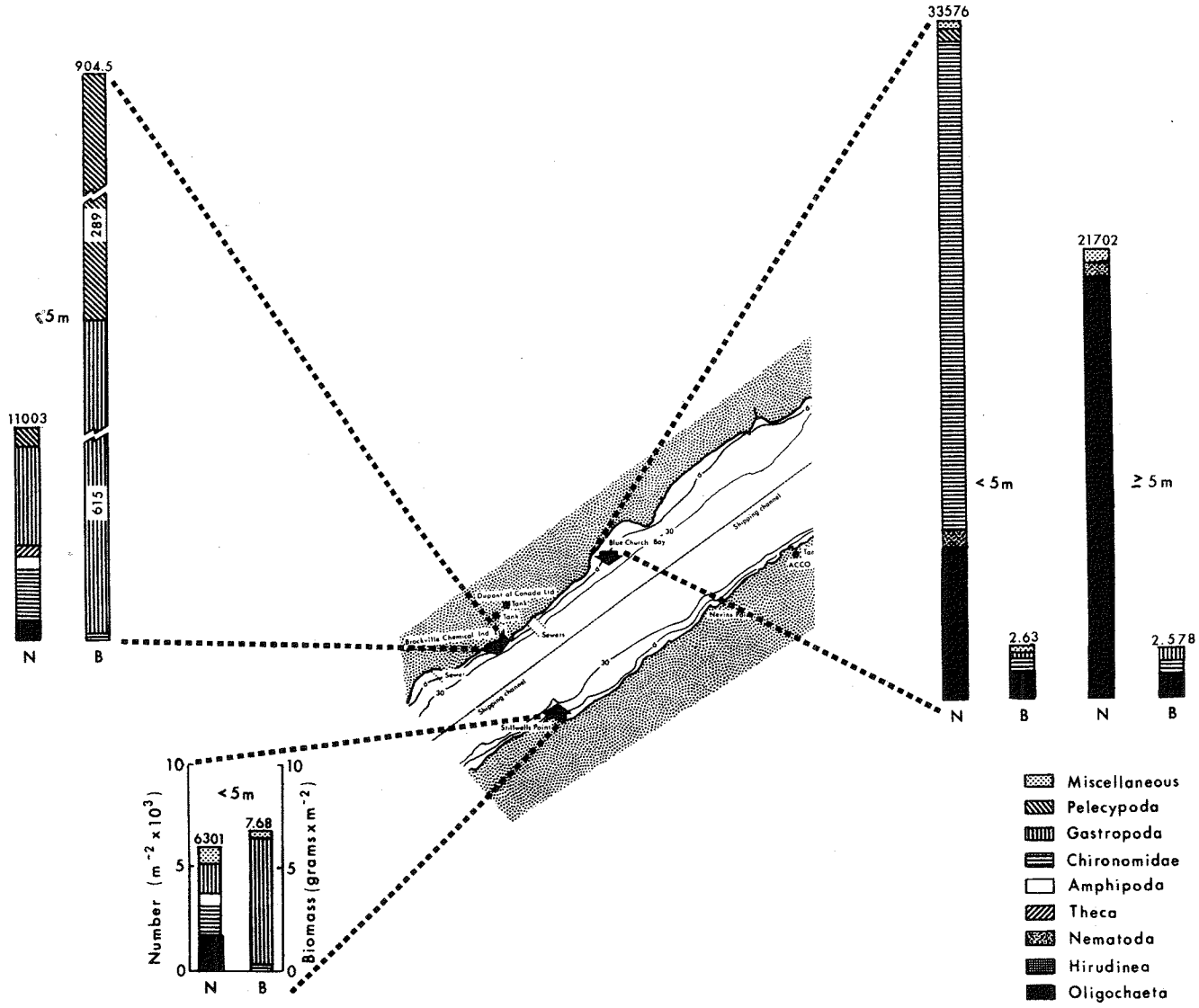

Figure 1. Mean Benthic Invertebrate Numbers (no/m^2) and Dry Weight Biomass (g/m^2) from the St. Lawrence River near Stillwell's Point and Dupont of Canada (less than 300/m^2 or 0.2 g/m^2 included in miscellaneous).

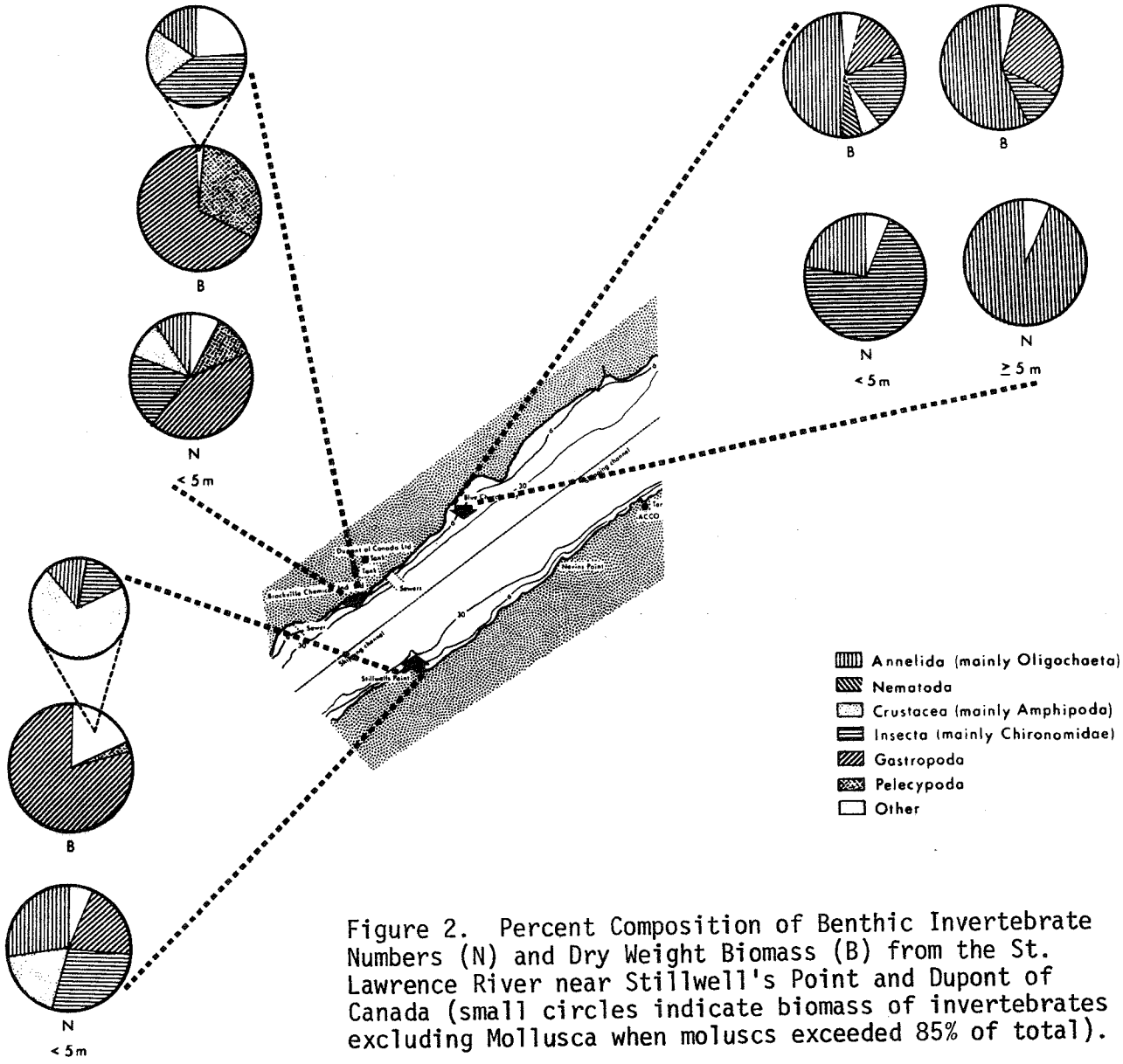

Figure 2. Percent Composition of Benthic Invertebrate Numbers (N) and Dry Weight Biomass (B) from the St. Lawrence River near Stillwell's Point and Dupont of Canada (small circles indicate biomass of invertebrates excluding Mollusca when moluscs exceeded 85% of total).

Abandoned Light House Bay

The shallow site numbers at this Ogdensburg station were dominated by oligochaetes and Hydrobiidae gastropods. Shallow site biomass was highest for the Hydrobiidae gastropods, which accounted for 71% of the total biomass. The deep sites were characterized numerically by oligochaetes, nematodes and chironomids. Dry weight biomass at the deep sites was dominated by Mollusca (100%). The Unionidae pelecypods made up 99.7% of the total biomass and Hydrobiidae gastropods, even though their biomass was 9.7 gm/m^2 and only accounted for 0.3% of the total dry weight (see Figures 3 and 4).

Bay Between Port of Ogdensburg and Ogdensburg-Prescott Bridge

Shallow sites in the Ogdensburg Harbor area were dominated numerically by oligochaetes (49%) and chironomids (33%). Biomass was highest for the Hydrobiidae gastropods which comprised 42% of the total dry weight. Biomass of oligochaetes comprised 22% of the total, while chironomid biomass at the shallow sites made up only 9% of the total. The high numbers and low biomass of Chironomidae indicates many small organisms present (see Figures 3 and 4).

The one deep site in the bay was dominated numerically by oligochaetes and amphipods. A Unionidae pelecypod dominated the biomass, comprising 99.9% of the deep site total biomass (see Figures 3 and 4).

Prescott Elevator, Canada

One shallow sample was collected at this location below a sewer outfall and high numbers of oligochaetes and nematodes were recovered. Gastropoda biomass was responsible for most of the dry weight, however, oligochaete biomass was important and accounted for 34% of the total (see Figures 3 and 4).

Chimney Bay

Oligochaetes, nematodes and chironomids were the most abundant invertebrates at the shallow site in Chimney Bay. High numbers of nematodes and oligochaetes are likely due to effluents from the St. Lawrence State Hospital and the sewage plant, both located near Tibbits Creek. Biomass at the shallow site, however, was dominated by Hydrobiidae gastropods and Sphaeriidae pelecypods (see Figures 5 and 6).

Oligochaetes were the most abundant invertebrates recovered from samples taken at the deeper sites. Biomass was dominated by Valvatidae and Hydrobiidae gastropods (see Figures 3 and 6).

Dawson's Point, Canada

Oligochaetes, nematodes, and chironomids were the most abundant taxa in these shallow sampling sites. Hydrobiidae and Valvatidae gastropods, oligochaetes and chironomids all were major contributors to the biomass (see Figures 5 and 6).

DISCUSSION

In large river systems, currents, inflowing streams, substrate composition, aquatic macrophytes, and cultural effluents influence the type and abundance of benthic invertebrates. Benthos populations sampled in the St. Lawrence River at similar depths and locations in comparable substrates show tremendous variation due to the non-random or aggregate distribution of the populations.

In the ice boom areas near Ogdensburg-Prescott to near Galop Island, Oligochaetae, Chironomidae, Amphipoda, Nematoda, and Gastropoda and Pelecypod Mollusca were the dominant forms present. Dry weight biomass from the ice boom area was entirely dominated by Mollusca. The Unionidae Pelecypoda were collected in very few numbers only at the deep sites and when present, were responsible for 99% of the total biomass. Without the Mollusca biomass, Oligochaeta were responsible for the greatest contribution to the non-shelled biomass. Chironomid numbers frequently exceeded the oligochetes but many small organisms of the subfamily Chironominae and Orthocladinae were present. Amphipoda also were important in their contribution to the non-shelled biomass.

The abundance and distribution of benthic invertebrates can be influenced by the level of organic enrichment of bottom sediments. The presence of certain benthic forms depends upon their environmental tolerance, and their abundance depends on the food resource of the habitat. An important character of the benthic community in the Demonstration Corridor is the decreased diversity of invertebrates upstream of the Oswegatchie River. Causal factors affecting this distribution are likely the character of the bottom substrate and the presence of point-source organic wastes. Bottom sediments in the New York side of the St. Lawrence were generally hard and composed of sand, gravel, and clay. Enriched organic sediments were evident below Dupont of Canada, and a reduction was noted in the number of benthic taxa accompanied with high numbers of oligochaetes and chironomids.

Downstream from Dupont of Canada, sampling sites over 5 m in depth exhibited high numbers of oligochaetes (20,000/m^2). Brinkhurst (1967) suggests that the proportion of oligochaetes to other life forms is a useful guide to the degree of organic pollution in a locality. Excessive numbers of chironomids (23,000/m^2) were observed at a downstream shallow site in Blue Church Bay. Although chironomids and oligochaetes are generally tolerant of a wide variety of environmental conditions, it would appear that factors affecting invertebrate populations in this section of the river were related to wastes from Dupont since the upstream site was similar to other shallow river sites.

Bartsch and Ingram (1967) categorized zones of organic pollution by their dominant organisms. Sludgeworms were most tolerant of enriched conditions and were better able to thrive near a polluted effluent than other bottom dwellers. Chironomids replaced sludgeworms in peripheral areas of point-source pollutants. Observations of benthic populations in this section of the river may support this generalized pattern. The primary toxic and organic wastes released by Dupont may not be entering the shallow waters of Blue Church Bay but may be transported by the river current into deeper waters. The benthic invertebrates appear to be sensitive to environmental conditions and may be indicative of changes resulting from activities altering current patterns and transport of

organic material. The enrichment of bottom sediments using benthic invertebrates as an index of the pollution status below Dupont of Canada is supported by the chemical nature of the sediments (see Technical Report C, this document).

Samples were also collected near the sewer effluent at the Prescott Elevator, at the mouth of Tibbits Creek adjacent to the St. Lawrence State Hospital sewage treatment plant, and near the Ogdensburg sewage treatment effluents. Nematodes as well as oligochaetes were abundant in these benthos samples, while the number of other invertebrate taxa was reduced. Smith (1978) and Chang and Kabler (1963) found high recovery of nematodes in samples taken from below sewage treatment effluents where aeration lagoons were involved. Chang and Kabler (1963) express concern, that due to the nematode feeding habits, the remote possibility exists of their serving as carriers of human enteric pathogens in the receiving waters.

CONCLUSIONS

Sediment samples were collected through a stable ice cover at 26 stations along the St. Lawrence River shoreline above and below ice boom sites near Ogdensburg-Prescott and Galop Island. A wide variety of benthic invertebrates were present in the samples, with oligochaetes, chironomids, amphipods, and molluscs representing the most abundant forms. Benthic invertebrate biomass was dominated by molluscs.

The abundance of benthic populations in similar substrates was quite variable. Fewer taxa of benthic forms were collected upstream from the Oswegatchie River than downstream from the point where it enters the St. Lawrence. Causal factors affecting this distribution are likely the character of bottom sediments and the presence of organic wastes. Excessive numbers of oligochaetes and chironomids were observed below Dupont of Canada and are indicative of enriched conditions. The abundance of oligochaetes, chironomids, and nematodes appears to be associated with enriched conditions below sewer outfalls at Prescott Elevator, Chimney Bay, Dupont of Canada, and Ogdensburg Harbor.

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APPENDIX A.

Location of Benthic Sampling Stations in the Demonstration Corridor Near the Ogdensburg-Prescott and Galop Island Ice Boom Sites.

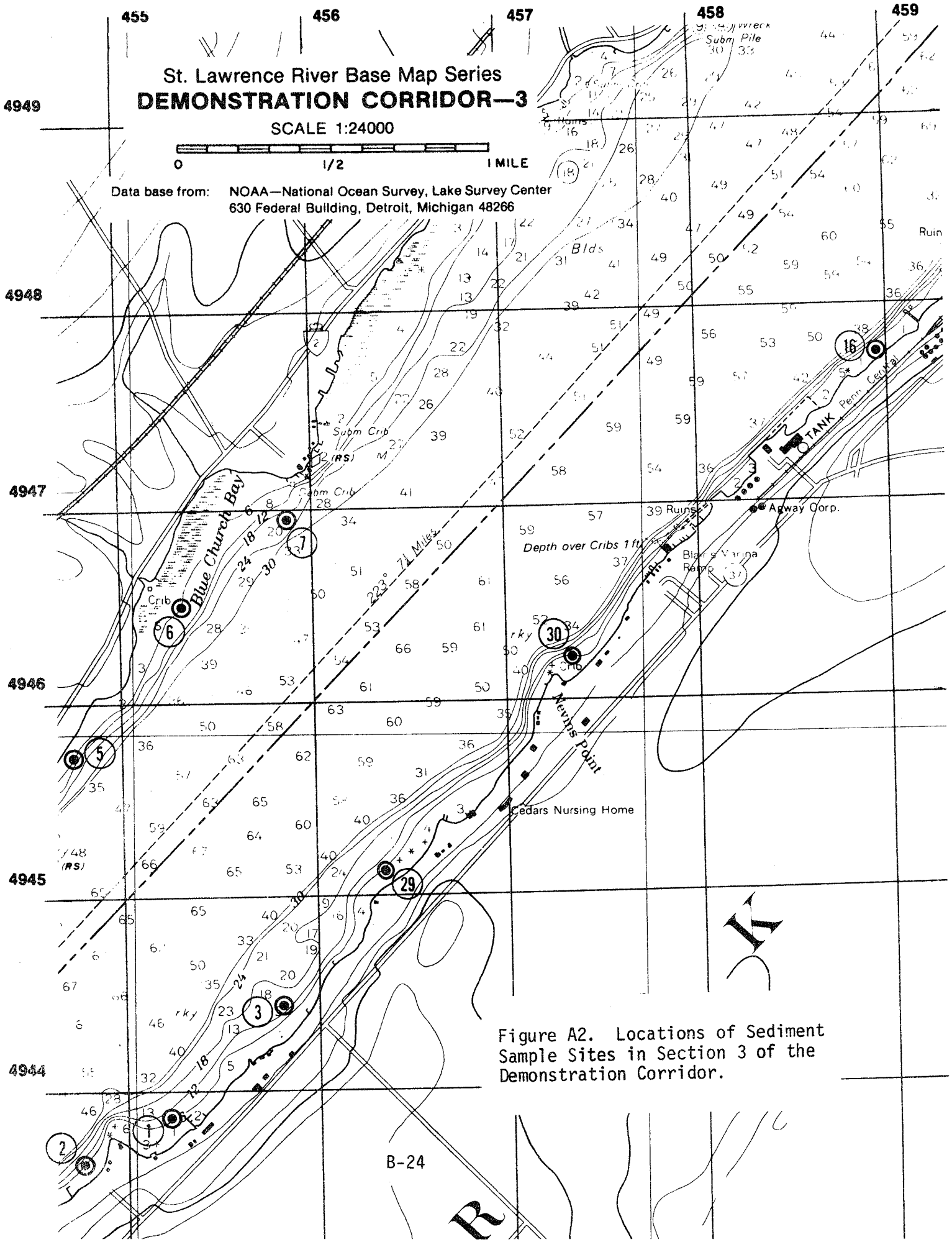

Figure A2. Locations of Sediment Sample Sites in Section 3 of the Demonstration Corridor.

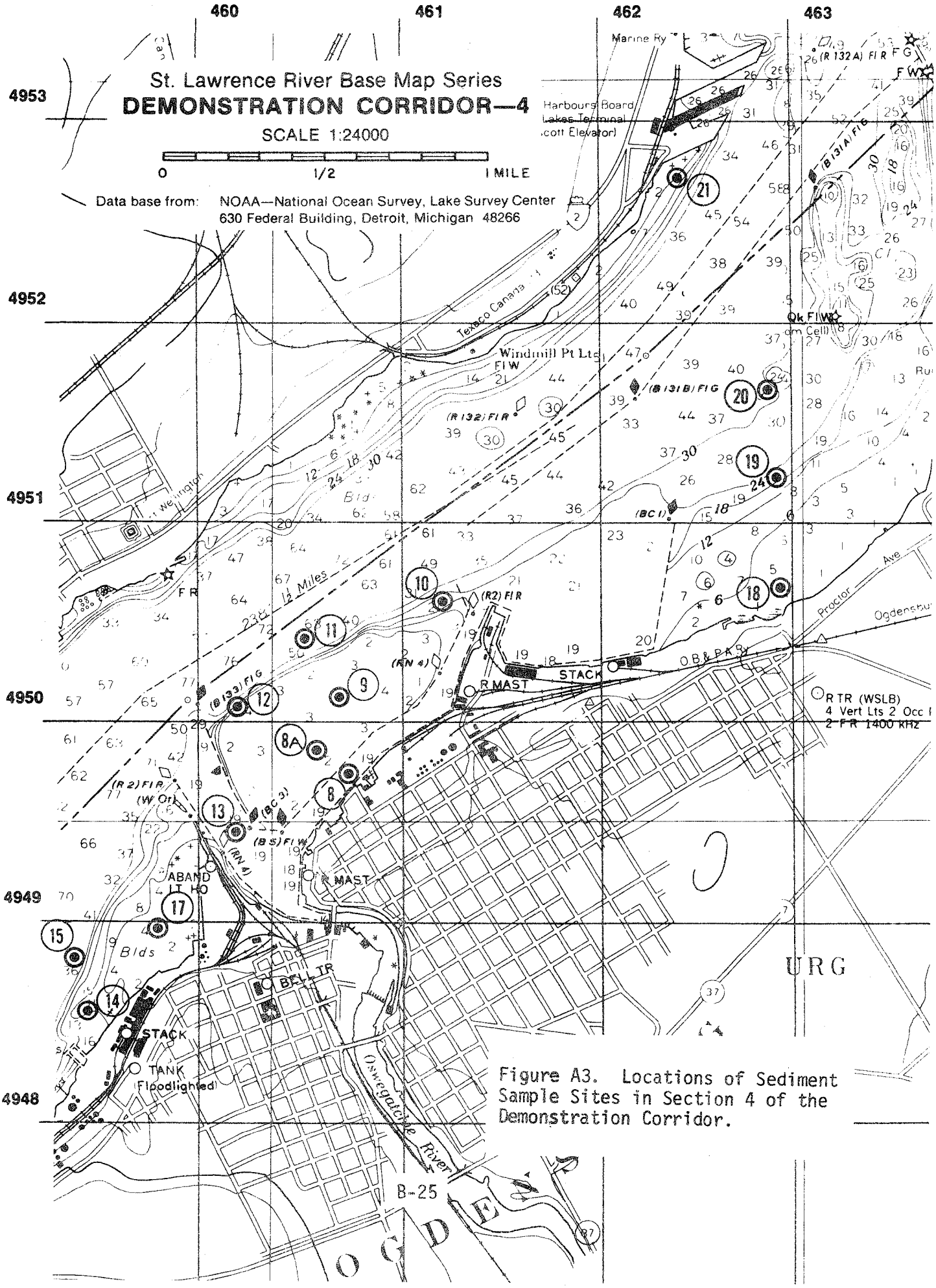

Figure A3. Locations of Sediment Sample Sites in Section 4 of the Demonstration Corridor.

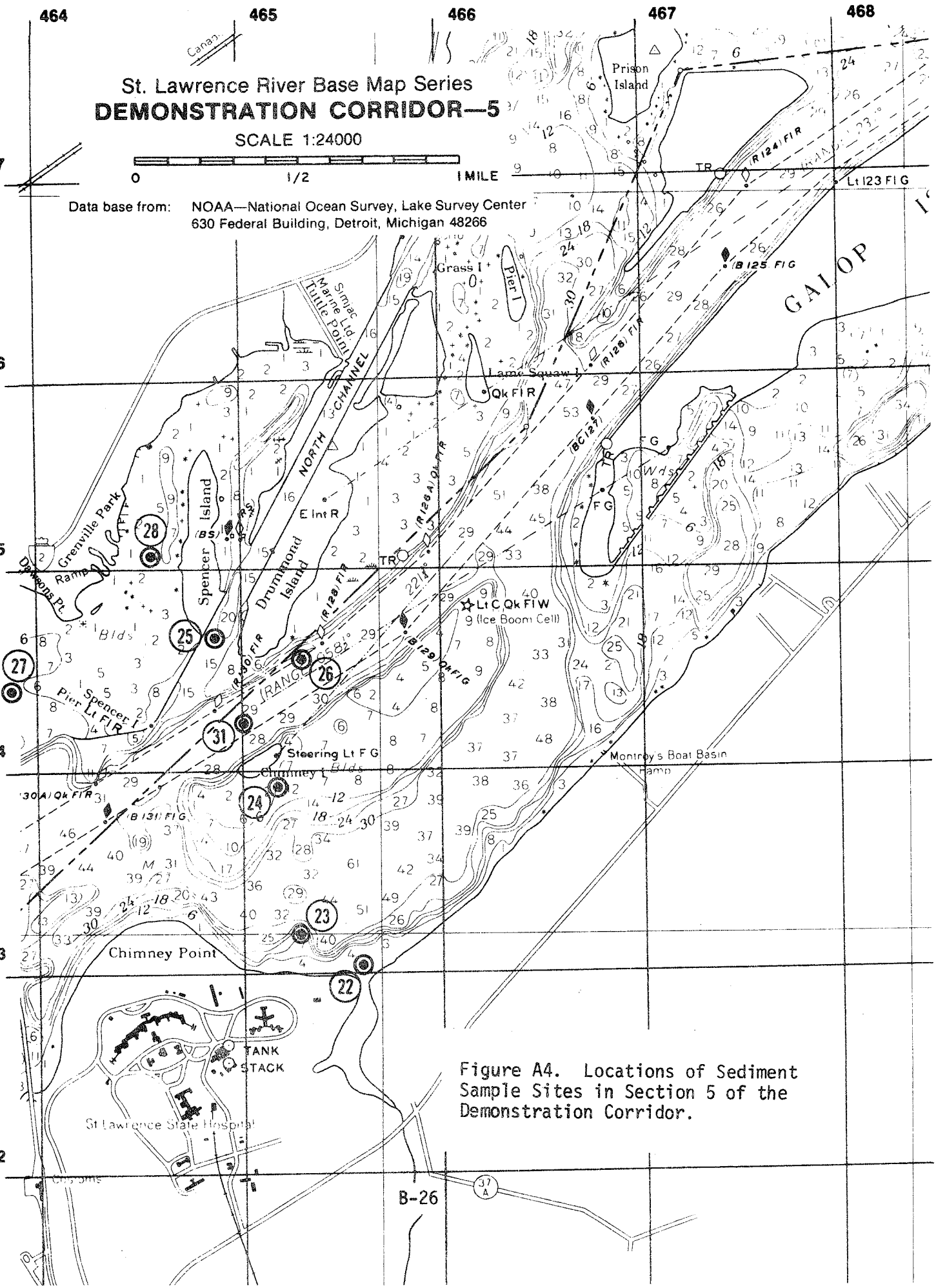

Figure A4. Locations of Sediment Sample Sites in Section 5 of the Demonstration Corridor.

APPENDIX B.

Benthic Invertebrates from
St. Lawrence River Ice Boom Sampling Sites.

Table B1. Benthic Invertebrates Collected from St. Lawrence River Ice Boom Sites 1 through 8, January 24 to February 1, 1978. Numbers expressed as no/m^2. Percent Composition in Parentheses.

Taxa	Sample Number 1	2	3	4	5	6	7	8
Annelida								
Oligochaeta (sludgeworms)	182 (47.4)	4514 (34.8)	910 (16.4)	988 (9.0)	15,409 (96.9)	7618 (22.7)	25,535 (92.8)	708 (22.3)
Polychaeta	0	0	0	0	0	0	0	0
Hirundinea (leeches)	0	0	0	0	20 (0.1)	0	0	0
Coelenterata								
Hydra	0	0	0	0	0	0	0	0
Theca*	0	0	0	423 (3.8)	0	0	0	384 (12.1)
Nematoda (roundworms)	0	141 (1.1)	20 (0.4)	0	263 (1.6)	0	564 (2.0)	20 (0.6)
Merithoidea	0	284 (2.2)	0	0	0	1129 (3.4)	141 (0.5)	20 (0.6)
Crustacea								
Ostracoda	0	0	142 (2.6)	0	0	141 (0.4)	0	0
Malacostraca								
Isopoda	0	0	81 (1.5)	141 (1.3)	0	0	0	0
Amphipoda	0	1552 (12.0)	1941 (35.0)	846 (7.7)	0	282 (0.8)	141 (0.5)	506 (0.5)

Continued

Table B1 (Continued)

Taxa	Sample Number 1	2	3	4	5	6	7	8
Hydracarina (water mites)	0	0	20	141	0	0	0	0
Insecta								
Coleoptera								
Haliplidae	0	0	0	0	0	0	0	40 (1.3)
Diptera								
Chironomidae								
Tanypodinae	0	0	40 (0.7)	0	0	0	282 (1.0)	61 (1.9)
Chironominae-orthocladinae	202 (56.6)	2257 (17.4)	2224 (40.2)	2398 (21.8)	0	23,701 (70.6)	423 (1.5)	991 (31.2)
Ceratopogonidae	0	0	0	0	0	0	0	121 (3.8)
Ephemeroptera (mayfly)	0	0	0	0	0	0	0	20 ((0.6)
Lepidoptera (aquatic caterpillar)	0	0	0	0	20 (0.1)	0	0	0
Megaloptera								
Sialidae (adler fly)	0	0	0	0	0	0	0	0
Trichoptera (caddis fly)	0	0	0	0	0	0	0	40 (1.3)

Continued

Table B1 (Concluded)

Taxa	Sample Number 1	2	3	4	5	6	7	8
Mollusca								
Gastropoda								
Ancylidae	0	0	0	0	0	0	0	20 (0.6)
Planorbidae	0	0	0	0	0	0	0	0
Physidae	0	141 (1.1)	0	0	0	0	0	0
Lymnaeidae	0	0	0	0	0	0	0	0
Valvatidae	0	2257 (17.4)	0	1551 (14.1)	162 (1.0)	0	141 (0.5)	0
Pleuroceridae	0	0	0	0	0	0	0	0
Hydrobiidae	0	1270 (9.8)	40 (0.7)	3245 (29.5)	0	141 (0.4)	0	20 (0.6)
Pelecypoda								
Sphaeriidae	0	564 (4.3)	121 (2.2)	1270 (11.5)	20 (0.1)	564 (1.7)	282 (1.0)	222 (7.0)
Unionidae	0	0	0	0	0	0	0	0
TOTAL	384	12980	5539	11003	15894	33576	27509	3173

* overwintering cyst form

Table B2. Benthic Invertebrates Collected from St. Lawrence River Ice Boom Sites 8A-13, January 24 to February 1, 1978. Numbers Expressed as No/m^2. Percent Composition in Parentheses.

Taxa	Sample Number 8A	9	10a	10b	11	12	13
Annelida Oligochaeta (sludge worms)	8606 (48.4)	2539 (47.4)	1780 (22.4)	1411 (62.5)	3809 (60.0)	13,403 (62.1)	423 (50.0)
Polychaeta	0	0	20 (0.2)	0	0	0	0
Hirundinea (leeches)	0	0	0	0	0	0	0
Coelenterata Hydra	282	0	0	0	0	0	0
Theca*	0	141 (2.6)	303 (3.8)	0	0	423 (2.0)	0
Nematoda (round worms)	282	141	40	141	846	1411	0
Mermithoidea	988 (5.6)	705 (13.2)	142 (1.8)	0	564 (8.9)	1411 (6.5)	141 (16.7)
Crustacea Ostracoda	0	0	61 (0.8)	0	0	0	0
Malacostraca Isopoda	0	0	40 (0.5)	0	0	0	0
Amphipoda	3104 (17.5)	282 (5.3)	2285 (28.7)	0	0	1411 (6.5)	0

Continued

Table B2 (Continued)

Taxa	Sample Number 8A	9	10a	10b	11	12	13
Hydracarina (water mites)	0	0	20 (0.2)	0	0	141 (0.6)	0
Insecta							
Coleoptera							
Haliplidae	0	0	162 (2.0)	0	0	141 (0.6)	0
Diptera							
Chironomidae							
Tanypodinae	0	0	121 (1.5)	0	0	0	0
Chironominae-orthocladinae	2539 (14.3)	1552 (28.9)	1375 (17.3)	423 (18.7)	705 (11.1)	1975 (9.1)	282 (33.3)
Ceratopogonidae	0	0	0	0	0	141 (0.6)	0
Ephemeroptera (mayfly)	0	0	0	0	0	0	0
Lepidoptera (aquatic caterpillar)	141 (0.8)	0	61 (0.8)	0	141 (2.2)	423 (2.0)	0
Megaloptera							
Sialidae (alder fly)	0	0	0	0	0	0	0
Trichoptera (caddis fly)	0	0	0	0	0	0	0

Continued

Table B2 (Concluded)

Taxa	Sample Number 8A	9	10a	10b	11	12	13
Mollusca							
Gastropoda							
Amcylidae	1129 (6.4)	0	0	0	0	423 (2.0)	0
Planorbidae	0	0	0	0	0	0	0
Physidae	282 (1.6)	0	81 (1.0)	0	0	0	0
Lymnaeidae	0	0	0	0	0	0	0
Valvatidae	141 (0.8)	0	142 (1.8)	0	0	0	0
Pleuroceridae	0	0	0	0	0	0	0
Hydrobiidae			809 (10.3)	20 (6.2)	141 (2.2)	141 (0.6)	0
Pelecypoda							
Sphaeriidae	282 (1.6)	0	485 (6.1)	141 (6.2)	141 (2.2)	141 (0.6)	0
Unionidae	0	0	20 (0.2)	0	0	0	0
TOTAL	177,776	5360	7964	2257	6347	21,585	846

* overwintering cyst form

Table B3. Benthic Invertebrates Collected from St. Lawrence River Ice Boom Sites 14-22, January 24 to February 1, 1978. Numbers Expressed as no/m^2. Percent Composition in Parentheses.

Taxa	Sample Number 14	15	17	18	19	20	21	22
Annelida								
Oligochaeta (sludge worms)	3245 (69.8)	564 (36.4)	1411 (34.5)	6349 (39.1)	6896 (89.5)	3519 (47.3)	2680 (51.4)	5502 (54.9)
Polychaeta	0	0	0	0	0	0	0	0
Hirundinea (leeches)	0	0	0	282 (1.7)	0	0	0	0
Coelenterata								
Hydra	0	0	0	0	0	0	0	0
Theca*	0	0	141 (3.4)	0	+	991 (13.3)	0	423 (4.2)
Nematoda (round worms)	423 (9.1)	287 (18.2)	141 (3.4)	282 (1.7)	61 (0.8)	0	2116 (40.5)	1834 (18.3)
Mermithoidea	0	0	0	141 (0.9)	142 (1.8)	20 (0.3)	0	0
Crustacea								
Ostracoda	0	0	0	141 (0.9)	20 (0.2)	20 (0.3)	0	141 (1.4)
Malacostraca								
Isopoda	0	0	0	141 (0.9)	0	0	0	0
Amphipoda	0	0	141 (3.4)	564 (3.5)	20 (0.2)	2326 (31.3)	0	0

Continued

Table B3 (Continued)

Taxa	Sample Number 14	15	17	18	19	20	21	22
Hydracarina (water mites)	0	0	0	0	0	0	0	0
Insecta								
Coleoptera								
Haliplidae	0	0	0	0	0	0	0	0
Diptera								
Chironomidae								
Tanypodinae	0	0	0	141 (0.9)	0	20 (0.3)	0	0
Chironominae	423 (9.1)	282 (18.2)	0	4232 (26.1)	425 (5.5)	121 (1.6)	141 (2.7)	1269 (12.7)
Orthocladinae								
Ceratopogonidae	0	0	0	0	20 (2.6)	0	0	0
Ephemeroptera (mayfly)	0	0	0	0	0	20 (0.3)	0	0
Legidoptera (aquatic caterpillar)	0	0	0	0	0	0	0	0
Magaloptera								
Sialidae (alder fly)	0	0	0	0	0	0	0	0
Trichoptera (caddis fly)	0	0	0	0	0	0	0	141 (0.4)

Continued

Table B3 (Concluded)

Taxa	Sample Number 14	15	17	18	19	20	21	22
Mollusca								
Gastropoda								
Ancylidae	0	0	0	0	0	0	0	0
Planorbidae	0	0	0	0	0	0	0	0
Physidae	141 (3.0)	0	0	141 (0.9)	0	0	0	0
Lymnaeidae	0	0	0	0	0	0	0	0
Valvatidae	0	0	0	0	0	0	0	0
Pleuroceridae	0	0	423 (10.3)	564 (3.5)	0	0	0	0
Hydrobiidae	141 (3.0)	141 (9.1)	1693 (41.4)	2256 (13.9)	40 (0.5)	0	141 (2.7)	141 (1.4)
Pelecypoda								
Sphaeriidae	282 (6.0)	141 (9.1)	141 (3.4)	986 (6.1)	81 (1.0)	384 (5.2)	141 (2.7)	564 (5.6)
Unionidae	0	141 (9.1)	0	0	0	20 (0.3)	0	0
TOTAL	4655	1551	4091	16,220	7705	7441	5219	10,015

* overwintering cyst form

+ present

Table B4. Benthic Invertebrates Collected from St. Lawrence River Ice Boom Sites 23-28, January 24 to February 1, 1978. Numbers Expressed as no/m^2. Percent Composition in Parentheses.

Taxa	Sample Number 23	24	27	28
Annelida				
Oligochaeta (sludge worms)	282 (15.4)	1411 (52.6)	4091 (56.9)	2822 (48.8)
Polychaeta	0	0	0	0
Hirundinea (leeches)	0	0	0	0
Coelenterata				
Hydra	0	0	0	0
Theca*	0	0	0	0
Nematoda (round worms)	282 (15.4)	141 (5.3)	564 (7.8)	141 (2.4)
Mermithoidea	0	141 (5.3)	423 (5.9)	1411 (24.4)
Crustacea				
Ostracoda	0	0	0	0
Malacostraca				
Isopoda	0	0	0	0
Amphipoda	846 (46.1)	0	564 (7.8)	141 (2.4)

Continued

Table B4 (Continued)

Taxa	Sample Number 23	24	27	28
Hydracarina (water mites)	0	0	0	0
Insecta				
Coleoptera				
Haliplidae	0	0	0	0
Diptera				
Chironomidae				
Tanypodinae	0	0	282 (3.9)	0
Chironominae-orthocladinae	141 (7.7)	141 (5.3)	705 (9.8)	1129 (19.5)
Certopogonidae	0	0	0	0
Ephemeroptera (mayfly)	0	0	0	0
Lepidoptera (aquatic caterpillar)	0	0	0	0
Megaloptera				
Sialidae (alder fly)	0	0	0	0
Trichoptera (caddis fly)	0	0	0	0

Continued

Table B4 (Concluded)

Taxa	Sample Number 23	24	27	28
Mollusca				
Gastropoda				
Ancylidae	0	0	0	0
Planorbidae	0	0	0	0
Physidae	0	0	0	0
Lymnaeidae	0	0	0	0
Valvatidae	0	564 (21.0)	141 (2.0)	0
Pleuroceridae	0	0	0	0
Hydrobiidae	141 (7.7)	282 (10.5)	141 (2.0)	141 (2.4)
Pelecypoda				
Sphaeriidae	141 (7.7)	0	282 (3.9)	0
Unionidae	0	0	0	0
TOTAL	1833	2680	7193	5785

* overwintering cyst form

APPENDIX C. Characteristics of the Substrate and Notes on Sampling Equipment Used at Sediment Sampling Sites in the St. Lawrence River.

Sample Number	Depth Meters	Sampler	Description
1	2.5	ponar	sand, gravel, clay
2	3.0	auger	sand, shells, wood chips
3	4.25	ponar	sand, shells
4	4.0	auger	sand, gravel, clay
5	3.0	ponar	mud, shells
6	1.0	auger	sand, clay
7	8.0	auger	mud, sand [1]
8	7.5	ponar	sand
8A	2.0	auger	sand
9	2.0	auger	sand
10a	5.0	ponar	sand
10b	5.0	auger	sand
11	2.0	auger	sand
12	1.0	auger	sand and gravel
13	8.2	auger	sand [2]
14	5.0	auger	rock, gravel, Chara
15	11.6	auger	sand, hard to bottom
17	1.25	auger	clay, sand, gravel
18	2.0	auger	mud with sand

Sample Number	Depth Meters	Sampler	Description
19	4.0	ponar	mud with detritus
20	10.0	ponar	mud with detritus
21	1.5	auger	sand
22	1.5	auger	sand
23	10.0	auger	clay, shells
24	8.0	auger	clay, shells
27	3.0	auger	clay, gravel, rocks
28	1.5	auger	sand with clay

[1] oil-like matter observed while rinsing sample

[2] particles of a coal-like material observed in sample