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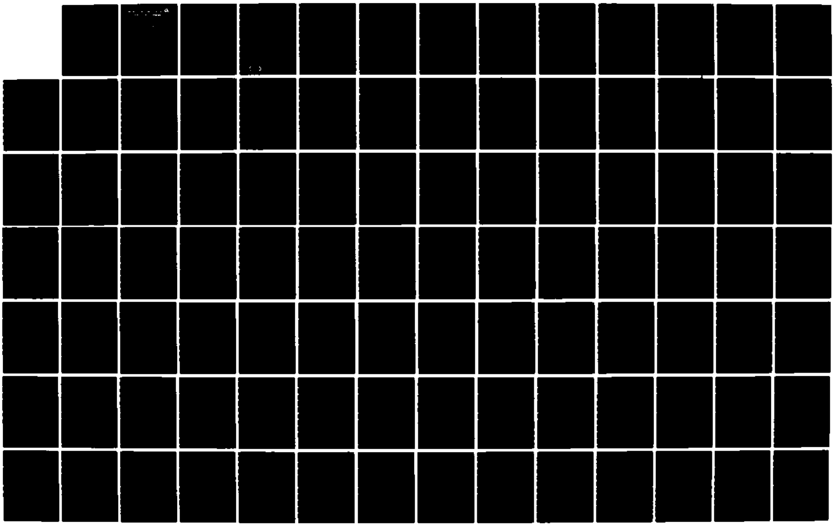

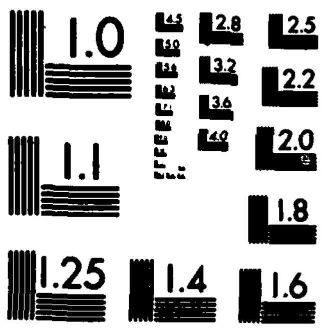
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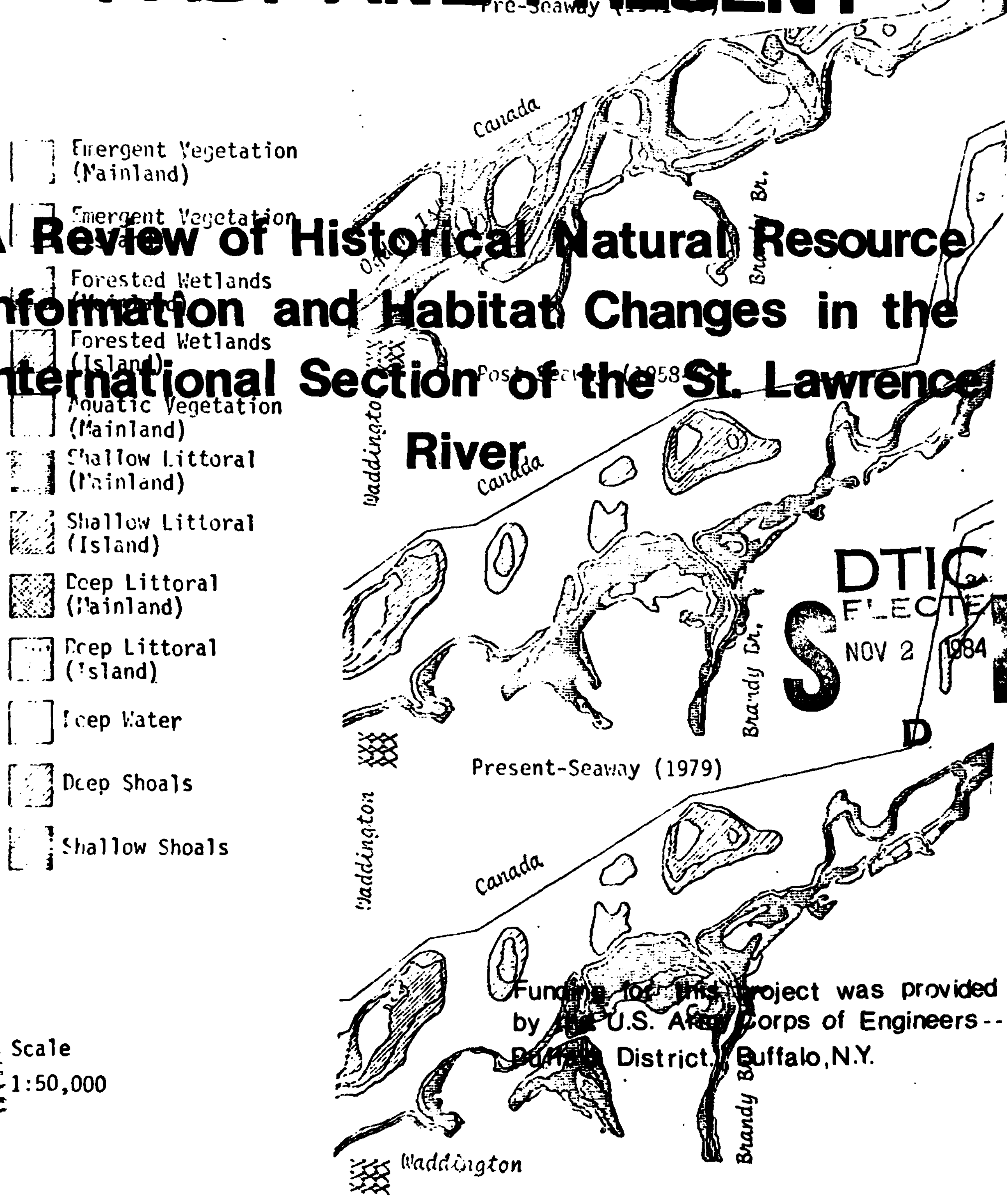
THE ST. LAWRENCE RIVER--PAST AND PRESENT

A Review of Historical Natural Resource Information and Habitat Changes in the International Section of the St. Lawrence River



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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report provides a review of historical natural resource data and habitat changes in the international section of the St. Lawrence River. The report is keyed to both published and unpublished natural resource information and includes an extensive bibliography, cross-referenced to individual fish and wildlife species and their habitat requirements for this section of the river.
Originator-supplied keywords include: Ecosystem,

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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THE ST. LAWRENCE RIVER -- PAST AND PRESENT

A Review of Historical Natural Resource Information And Habitat Changes in the International Section Of the St. Lawrence River

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Executive Summary

The St. Lawrence River ecosystem is a multi-use natural resource area. It is currently used for drinking water, fish and wildlife production, water recreation, commercial navigation, hydropower production, industrial water supply, and even for waste disposal. Simply stated, some uses conflict with other uses.

In order to protect/enhance the natural resources and to understand the cost of the impacts of noncompatible uses, the ecology of the ecosystem needs to be understood. Since the acquisition of new biological information is costly, it is prudent to build on that which was collected in the past. This report presents a compilation of published and unpublished natural resource information concerning the International section of the St. Lawrence River. It includes an extensive bibliography, cross-referenced to individual species and their habitat requirements.

In addition to searching out the literature, we used aerial photo interpretation to identify major habitat changes. Photos from 1941, supplemented by 1955 photos, were used to identify "pre-Seaway" habitats. Immediate "post-Seaway" habitats were mapped from 1959/1962 photos. Photos from 1979 were used to show "present" habitats. These data were used in conjunction with abundance information on various fish and wildlife index species to discuss the present ecological setting and to attempt to relate changes in abundance to causes.

Index species were chosen based on such factors as habitat requirements and vulnerability to habitat changes, importance to man, and available information. Twelve fish species, eight birds, four mammals, six amphibians, and six reptiles were chosen as index species.

Based on the available information, we found that historically abundant fish species, such as lake sturgeon, northern pike, and walleye had declined in abundance by the 1940's. Probable causes for the decrease would be destruction of spawning habitat in the various tributaries due to dam construction, overharvest, and pollution.

The construction of the hydropower complex and navigation system in the late 1950's caused major habitat changes. The damming of the River resulted in the flooding of uplands, islands, shoals, and shallow nearshore areas, resulting in an increase of water-covered areas. For example, "deep water" areas (over 18 feet deep), increased by more than 7,000 acres. Dredging for water flow control for hydropower production and adequate navigation depth destroyed some shoals; however, the flooding created more shoals, for a net gain of approximately 350 acres (38 percent increase). Most of this new shoal acreage was formerly island upland. Habitats which were lost and not replaced include "riffle" areas and mainland deep littoral zone (6 to 18 feet deep). The latter decreased by over 700 acres (9 percent decrease). These areas were replaced by deep water.

Current abundance of some major fish and wildlife species is not as great as would be expected from the quantity of available habitat. Limiting factors have not been documented but probably include lost fish spawning areas due to riffle flooding and the chemical loading of some areas of the River by industries (a secondary impact of the hydropower development).

Specific cause and effect relationships between habitat changes and the abundance of index species were not readily apparent. This was due to the scarcity of historic biological information on the St. Lawrence River.

Studies needed to better understand the system and to measure the impact of changes are outlined in this report. Areas of special attention are hydraulics, contaminants, and life history requirements of fish and wildlife index species.

"The search for truth is in one way hard and in another easy. For it is evident that no one can master it fully or miss it wholly. But each adds a little to our knowledge about Nature, and from all the facts assembled there arises a certain grandeur."

Aristotle, 384-322 B.C.

Preface

The importance of the St. Lawrence River to the North American continent is being recognized. As the navigational entrance/outlet to the Great Lakes, the St. Lawrence River is of international importance. As a source of hydropower and recreation, its impact is very great in eastern Canada and the United States. Its importance on a one-to-one basis is probably greatest to the local resident who enjoys the benefits of living near the great river.

The present and potential use of the resources of the St. Lawrence River can result in conflicts between user groups. Conflict resolution and resource decision making will be on firmer ground if detailed environmental knowledge is available. The needed knowledge includes basic information as to how the system works and policy positions such as fish, wildlife and habitat management plans by the respective agencies.

The ultimate goal is to use the historic knowledge concerning this area, and build on it in an organized, systematic fashion towards ecosystem management and impact evaluations. Such progress would make the St. Lawrence River an exception to Handler's (1970)[1] comment "...in most of the world, environmental biology has not yet passed the stage of inventory and survey, and is far from ready to grapple with the galloping degradation of the human habitat."

Wolf-Dieter N. Busch

[1] Handler, P., ed. 1970. Biology and the future of man. Oxford Univ. Press, New York. 936 p.

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The following people contributed to the preparation of this document: S. P. Patch, W.-D. N. Busch, T. D. Schwartz and T. H. McCartney wrote parts of the report; D. Ryan, L. Lewis, M. Clough, L. Edwards and J. McCauley conducted aerial photo interpretation and L. Edwards and J. McCauley also assisted in the literature review; E. Pendleton and J. Scurry and their staff digitized the habitat data and produced computerized habitat maps and acreage tables (all of the above are Fish and Wildlife Service employees).

Individuals from other agencies assisted us on this effort. L. McDowell, Agricultural Stabilization and Conservation Service, Watertown, NY, and J. Dominque, State University of New York College of Environmental Science and Forestry, Syracuse, NY, made their aerial photos available. J. Geis, State University of New York College of Environmental Science and Forestry, Syracuse, NY, opened his files to us and provided assistance in aerial photo interpretation and habitat mapping. R. Tiner, USFWS, Newton Corner, MA, provided photo interpretation instructions and loaned us a zoom transfer scope. C. Kulp, USFWS, State College, PA, also loaned us a zoom transfer scope.

Additional data were provided by C. Burt, St. Lawrence - Eastern Ontario Commission, Watertown, NY, in the form of references and bibliographies. L. Blake, New York State Dept. of Environmental Conservation, Watertown, NY, opened his agency's files and reviewed the report. P. Bewick, M. Hart, and E. Eckersley, Ontario Ministry of Natural Resources, made Canadian data available.

The draft report was reviewed by T. Cutter, St. Lawrence - Eastern Ontario Commission, Watertown, NY, T. Edsall, USFWS - Great Lakes Fishery Laboratory, Ann Arbor, MI, J. Forney, Cornell University - Shackleton Point Field Station, Bridgeport, NY, and D. Wilson, NYSDEC, Watertown, NY. L. Bryniarski and P. Frapwell provided comments for the Buffalo Corps of Engineers. General Hilmes transmitted comments for the International St. Lawrence River Board of Control. D. Faulkenham, NYSDEC - Wildlife, commented on the wildlife section.

Special thanks go to M. Patch, P. Bonney and A. Snyder (Tunison Laboratory of Fish Nutrition), USFWS, Cortland, NY, for typing the drafts and final report.

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List of Agency Abbreviations

AOU - American Ornithologist's Union
ASCS - Agricultural Stabilization and Conservation Service
DEC - (see NYSDEC)
EPA - Environmental Protection Agency
GLWQB - Great Lakes Water Quality Board
IJC - International Joint Commission
ILERSB - International Lake Erie Regulation Study Board
ISLRBC - International St. Lawrence River Board of Control
NCET - National Coastal Ecosystems Team
NOAA - National Oceanic and Atmospheric Administration
NYSDEC - New York State Department of Environmental Conservation
NYSDOH - New York State Department of Health
OMNR - Ontario Ministry of Natural Resources
PASNY - Power Authority of the State of New York
SLEOC - St. Lawrence-Eastern Ontario Commission
SLSDC - St. Lawrence Seaway Development Corporation
SUNY - ESF - State University of New York College of Environmental Science and Forestry
SUNY - Potsdam - State University of New York College at Potsdam
USACOE - United States Army Corps of Engineers
USDOI - United States Department of the Interior
USFWS - United States Fish and Wildlife Service
USGS - United States Geological Survey

INTRODUCTION

I. INTRODUCTION

Purpose

This report describes, based on available information, the fish and wildlife habitats and communities of the U.S. side of the St. Lawrence River, both past and present. The goal was to provide a comprehensive reference which presents the accumulated knowledge concerning fish and wildlife of the area. The presentation includes trend analysis through evaluations of changes in habitat and, when data were available, in the abundance of key species. Particular attention was given to index species selected from those with available life history data. These species were used to discuss changes in habitat suitability (availability) and to describe the current condition. Major information gaps which need to be addressed in order to understand how the system works and to evaluate the impacts of new environmental changes are identified. This information should also be of use to management agencies to optimize fish and wildlife resource management.

Geological Origin and Evolution of the River

The present shoreline and upland topography of the St. Lawrence River region is the product of many geological processes, including glaciation, marine inundations, uplift, erosion, deposition, and weathering; some of these processes are still ongoing. Two primary geological phases are responsible for the St. Lawrence-Eastern Ontario topography. The first, a pre-glacial period, occurred from one billion to four hundred million years ago. During this period the sediments, from which all the major bedrock formations were formed, were deposited. The second phase consisted of the final glacial advance and retreat, which drastically altered the relatively flat landscape by changing the course of streams and rivers, scouring bedrock surfaces, and spreading glacial debris. The melt waters from the retreating glacier flooded areas and carried mineral debris. The coarse materials were deposited close to where they were discharged, while the fine materials were held in suspension and settled out as the velocity of the melt water decreased. The deposition of this glacial till provided the principle parent material for most of the soils of New York State (St. Lawrence-Eastern Ontario Commission 1977).

Geologically, the St. Lawrence is a relatively young river. As the last ice cap melted 20,000-30,000 years ago, the present Great Lakes were formed. Retreating ice clogged the melt water flow outlets to the north. Lake Michigan's outflow was the Mississippi River and water from Lake Erie flowed southwest down the Maumee Valley. Later, after the ice melted to a level below the lake surface, Lakes Huron and Michigan flowed eastward to the Ottawa River.

Meanwhile, Lake Iroquois (presently Lake Ontario) drained through the Mohawk Valley. About 5,000 years ago the topography had altered. All five Great Lakes began flowing out through the St. Lawrence River. Since the Great Lakes Basin is still rising, some geologists predict that all of the Great Lakes except Lake Ontario could, under natural conditions, drain into the Mississippi River Basin (Menefee 1940; St. Lawrence-Eastern Ontario Commission 1977).

Hydrology

The St. Lawrence River runs almost due northeast, emptying into the Gulf of St. Lawrence near the 50th parallel. The River is approximately 540 miles long, arising from Lake Ontario at Tibbett's Point, New York, and emptying into the Gulf of St. Lawrence at Father Point (Pointe au Pere), Quebec. The International section of the River is approximately 113 miles long, 28 of which is Lake St. Lawrence, formed by the Moses-Saunders and Long Sault Dams and extending upriver to the Iroquois Dam (Fig. 1). Eight miles of the River are located downriver of the dam, while the remaining 77 miles extend from Tibbett's Point to Iroquois Dam.

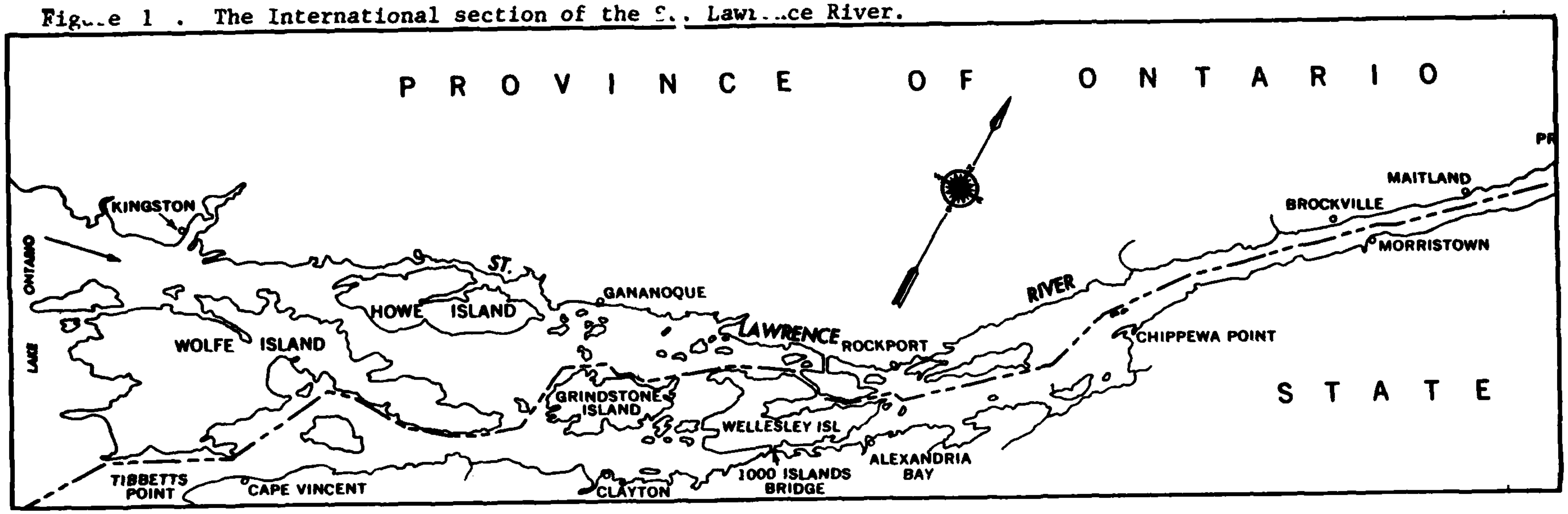
The St. Lawrence River is dependent on the Great Lakes for most of its water. The surface area of the five lakes totals 95,160 square miles and represents one-third of the surface supply of freshwater on earth. The precipitation catchment area of the Great Lakes Basin is 298,080 square miles, of which 32 percent is lake surface. Approximately 40 percent of the precipitation on the basin is lost by evaporation, which sometimes exceeds the supply in winter months (Menefee 1940).

The quantity of water flow in the St. Lawrence River is dependent on three main factors: 1) precipitation on the Great Lakes Basin; 2) evaporation from the land and lake surfaces; and 3) the amount of water released from Lake Ontario by the control structures in the St. Lawrence River. The average outflow is approximately 243,000 cfs. The maximum recorded mean monthly flow of 350,000 cfs occurred in both June and July of 1973, and July, 1976, while the minimum monthly flow of 154,000 cfs was recorded in February, 1936 (Table 1). This 2:1 ratio is the lowest of the major rivers in North America (compared to a range of 6:1 for the Richelieu River and 53.5:1 for the Tennessee River). The uniformity of flow results from the Great Lakes acting as large reservoirs. Also, there are no major tributaries flowing into this section of the River (the longest is less than 125 miles in length). These factors result in less violent water level/flow fluctuations and little problem with silt (Menefee 1940; New York State Dept. of Health 1963).

Excluding flow from the Great Lakes, the drainage basin of the International section of the St. Lawrence River is 120 miles wide and drains 7,230 square miles, including all of St. Lawrence County, most of Franklin County, and parts of Essex, Hamilton, Herkimer, Lewis, and Jefferson Counties. The principal tributaries in the United States are the Oswegatchie, Grasse, Raquette, St. Regis, Salmon, and Chateaugay Rivers. The latter three flow through the Province of Quebec, Canada, for a distance before entering the St. Lawrence (New York State Dept. of Health 1963).

The total fall of the St. Lawrence River averages about 245 feet, one-third of which occurs in the International section (Fig. 2). The water elevation at Lake Ontario averages about 245 feet, and at Iroquois Dam about 241 feet; prior to the construction of the dam, the water level at Iroquois averaged approximately 229 feet. This dam can be used in an emergency to control the outflow from Lake Ontario. The water elevation at the Moses-Saunders Dam, formerly 159-169 feet, now averages about 240 feet. In addition to the Moses-Saunders Dam, the Long Sault Dam was constructed near Massena as a flood control dam. If necessary, this dam is capable of controlling the entire flow of the River (NYS Dept. of Env. Cons. 1978; NYS Dept. of Health 1963).

Fig..e 1 . The International section of the S.. Lawr..ce River.



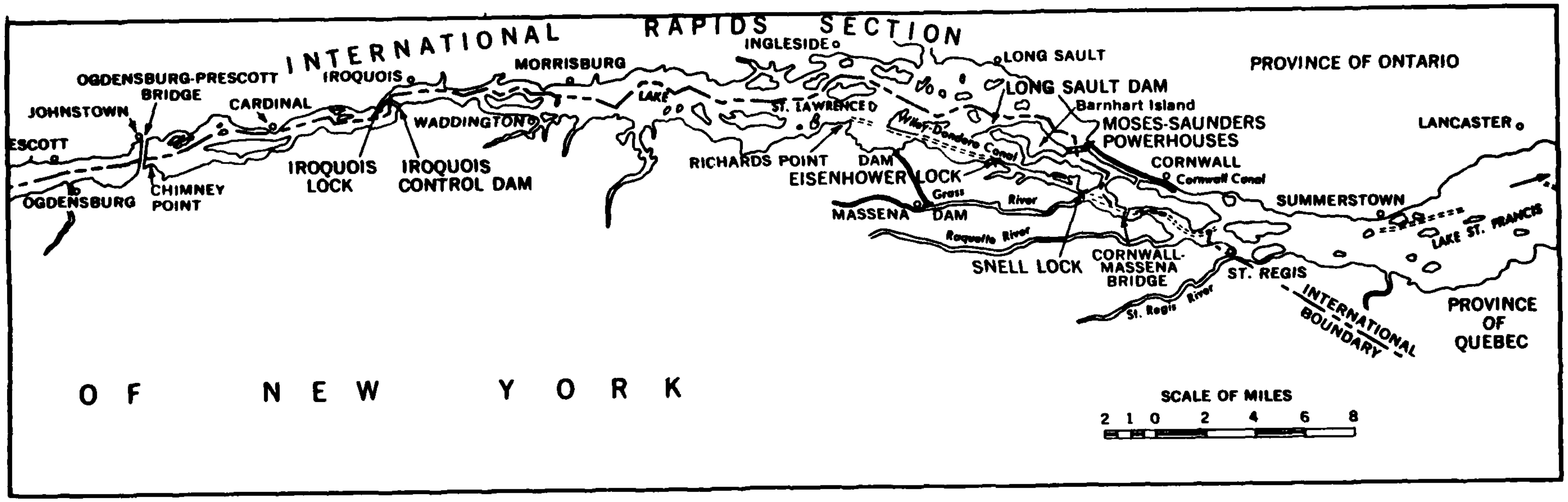


Table 1 . Normal monthly means (all days) for discharges recorded at the Cornwall Gauge on the St. Lawrence River near Massena, New York, from June 1860 through September 1982. All discharge figures are in thousands of cubic feet per second (c.f.s.). Data through 1974 were compiled by the National Oceanographic and Atmospheric Administration - National Ocean Survey - Lake Survey Center, Detroit; data from 1975-1982 is from the U.S. Geological Survey, Albany, New York.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1860	---	---	---	---	---	276	279	276	269	261	267	264	---
1861	234	241	262	279	300	303	304	296	284	286	285	283	280
1862	259	248	262	289	311	305	302	294	282	272	262	260	279
1863	261	257	256	278	294	296	290	280	271	260	260	258	272
1864	238	246	253	265	287	297	287	278	269	262	264	268	268
1865	259	238	255	280	285	285	279	268	255	246	243	240	261
1866	219	213	227	244	256	267	269	266	260	258	260	270	251
1867	238	254	258	278	295	303	295	283	268	253	248	230	267
1868	221	209	222	244	247	262	260	252	252	239	234	241	240
1869	218	211	205	255	271	275	283	282	279	274	265	252	256
1870	258	259	258	290	314	308	306	290	278	269	260	256	279
1871	241	236	253	265	274	274	270	260	253	244	231	224	252
1872	210	194	198	220	231	238	239	235	230	224	226	209	221
1873	197	197	210	251	270	272	270	264	257	247	242	246	244
1874	254	230	274	276	275	281	279	273	259	251	241	233	260
1875	194	173	206	235	247	250	251	247	238	235	230	225	228
1876	229	238	254	282	295	300	302	291	276	273	262	259	272
1877	210	235	243	257	262	262	263	255	245	240	234	236	245
1878	228	233	251	261	270	270	266	267	264	257	254	272	258
1879	246	257	254	264	268	267	264	254	249	237	227	227	251
1880	232	236	243	253	256	261	260	249	244	235	238	227	244
1881	182	195	228	243	247	252	254	247	237	229	231	234	232
1882	243	244	261	267	269	282	282	274	261	248	241	243	260
1883	204	208	224	252	263	279	288	285	272	264	261	261	255
1884	232	244	260	288	296	289	291	283	270	258	252	249	268
1885	240	229	218	232	266	276	278	271	270	262	265	271	256
1886	267	270	272	291	302	297	287	280	273	263	263	256	277
1887	245	252	264	282	292	292	286	272	261	255	243	237	265
1888	224	205	218	248	253	256	255	254	246	237	236	236	239
1889	238	220	231	252	255	265	269	264	251	236	232	241	246
1890	250	254	264	260	280	288	292	277	270	262	263	256	268
1891	240	248	262	278	276	266	263	253	242	229	220	217	250
1892	212	200	201	228	232	244	258	253	251	239	232	230	232
1893	212	193	210	246	272	279	274	259	256	247	235	231	243
1894	229	207	242	249	255	266	261	244	238	233	228	218	239

Table 1. (Continued)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1895	207	190	195	223	228	226	219	215	207	200	193	194	208
1896	197	198	196	231	238	236	233	226	214	207	207	202	215
1897	197	191	203	227	237	243	240	240	225	213	209	213	220
1898	211	215	228	242	247	248	243	235	226	219	220	221	230
1899	215	210	221	238	245	249	244	233	222	213	210	212	226
1900	208	209	215	239	245	246	244	237	230	221	216	222	228
1901	214	209	206	234	244	248	242	235	229	223	211	215	226
1902	210	189	222	238	240	243	248	250	243	235	230	224	231
1903	220	220	240	258	260	258	260	255	250	239	227	220	242
1904	203	206	220	256	270	277	278	273	264	255	243	221	247
1905	209	218	212	238	242	249	259	257	254	247	241	235	238
1906	242	234	232	241	244	246	250	243	234	231	229	227	238
1907	223	230	235	255	261	262	263	258	249	247	245	244	248
1908	232	231	248	278	292	294	288	279	262	247	238	227	260
1909	215	208	224	241	261	266	264	256	244	236	225	222	238
1910	209	200	228	237	248	249	246	241	231	226	220	214	229
1911	204	200	206	224	232	232	231	223	215	211	212	212	217
1912	202	191	198	236	255	268	259	252	247	243	241	243	236
1913	247	243	249	273	280	280	275	265	252	244	242	238	257
1914	226	215	218	253	257	257	252	245	241	229	226	215	236
1915	213	203	222	222	221	220	221	227	229	224	219	212	219
1916	218	216	214	245	262	275	277	266	252	239	230	223	243
1917	215	224	221	242	245	257	268	266	257	253	251	246	245
1918	230	223	241	258	260	259	257	248	243	237	239	234	244
1919	239	235	238	251	267	277	275	266	255	245	240	233	252
1920	212	204	209	229	229	229	232	229	226	223	219	226	222
1921	227	221	235	245	251	250	245	236	226	219	210	215	232
1922	208	198	213	240	248	252	257	248	237	229	219	208	230
1923	200	196	196	221	229	236	231	225	216	208	204	207	214
1924	210	202	208	224	240	243	242	238	230	226	218	208	224
1925	183	188	215	227	230	226	222	216	208	204	206	210	211
1926	195	180	187	214	225	224	222	217	214	218	227	227	212
1927	211	200	221	236	237	242	239	234	224	217	216	233	226
1928	236	231	231	247	249	250	254	251	242	234	231	235	241
1929	231	229	239	262	286	287	285	279	267	255	252	238	259
1930	249	252	269	278	279	281	279	266	255	242	231	222	259
1931	214	205	205	216	219	224	221	213	207	201	197	194	210
1932	204	216	219	233	240	237	235	229	216	208	204	203	220
1933	204	198	197	212	222	224	217	208	202	193	184	179	203
1934	169	173	183	203	206	202	195	187	180	175	170	170	184

Table 1. (Continued)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1935	166	168	177	187	194	199	202	197	188	183	176	175	184
1936	169	154	180	218	223	218	211	200	195	193	193	186	195
1937	198	207	210	217	233	236	237	231	223	214	214	210	219
1938	196	201	208	233	235	233	229	229	220	215	211	206	218
1939	197	183	196	230	239	237	234	230	218	212	202	198	215
1940	188	184	185	210	226	234	234	228	221	213	210	211	212
1941	215	202	202	228	226	221	216	210	205	199	199	194	210
1942	193	188	204	225	232	237	236	232	226	221	221	222	220
1943	209	220	226	257	274	292	287	282	271	256	256	250	257
1944	235	227	229	242	256	259	260	252	243	234	222	222	240
1945	195	207	232	256	267	273	271	267	259	268	263	265	252
1946	260	239	256	263	258	260	256	250	241	236	237	232	249
1947	227	232	233	257	271	294	296	289	279	265	255	250	262
1948	224	220	240	274	282	284	278	269	255	244	241	234	254
1949	233	237	247	254	255	249	241	230	223	216	208	208	233
1950	220	225	231	259	262	263	257	249	240	235	234	240	243
1951	243	230	262	284	294	292	292	278	269	257	252	253	267
1952	258	265	276	294	302	305	297	284	274	264	251	254	277
1953	254	257	259	272	279	283	276	266	259	245	237	239	260
1954	228	232	254	267	282	279	271	261	254	253	254	256	258
1955	260	246	267	289	294	287	276	265	256	254	258	249	267
1956	238	234	238	257	276	282	274	265	260	247	240	236	254
1957	230	229	234	241	245	247	248	242	234	224	218	214	234
1958	219	212	213	230	229	230*	227	223	219	215	207	209	219
1959	178	190	203	247	263	263	252	231	219	209	210	214	223
1960	213	217	227	247	269**	290	275	262	234	204	207	210	238
1961	211	213	209	219	250	279	267	253	247	231	216	214	234
1962	211	209	204	191	197	213	214	217	216	211	208	211	208
1963	210	208	197	190	188	206	214	217	212	212	205	210	206
1964	211	206	193	179	184	196	201	207	207	205	200	193	198
1965	183	182	180	184	176	189	201	206	203	203	210	227	195
1966	222	222	234	234	212	212	219	220	221	216	212	217	220
1967	219	228	215	212	219	218	226	233	232	249	277	281	234
1968	241	249	237	262	246	237	253	262	270	262	254	252	252
1969	235	252	255	264	276	291	297	295	277	255	248	243	266
1970	228	235	235	236	249	249	256	265	258	263	265	259	250
1971	236	248	263	271	285	272	261	259	263	259	247	235	258
1972	222	231	254	273	291	300	310	310	310	302	293	270	280
1973	252	279	299	325	337	350	350	323	317	317	294	266	309
1974	240	265	302	310	308	327	336	330	314	303	277	281	299

Table 1. (Continued)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1975	256	250	289	301	306	308	290	283	281	302	**297**	239	**284**
1976	247	261	290	306	329	348	**350**	326	309	302	**297**	239	300
1977	222	215	247	276	280	263	250	260	277	300	296	257	262
1978	250	**285**	299	293	315	308	290	278	274	263	249	225	277
1979	221	248	270	284	290	296	279	275	283	292	288	289	276
1980	254	253	253	278	296	291	288	294	301	287	280	252	277
1981	236	240	265	260	248	253	263	279	296	299	**297**	**300**	270
1982	240	251	255	274	288	290	291	278	272	265	266	270	270
1983	232	245	268	275	281	298	282	276	---	---	---	---	---

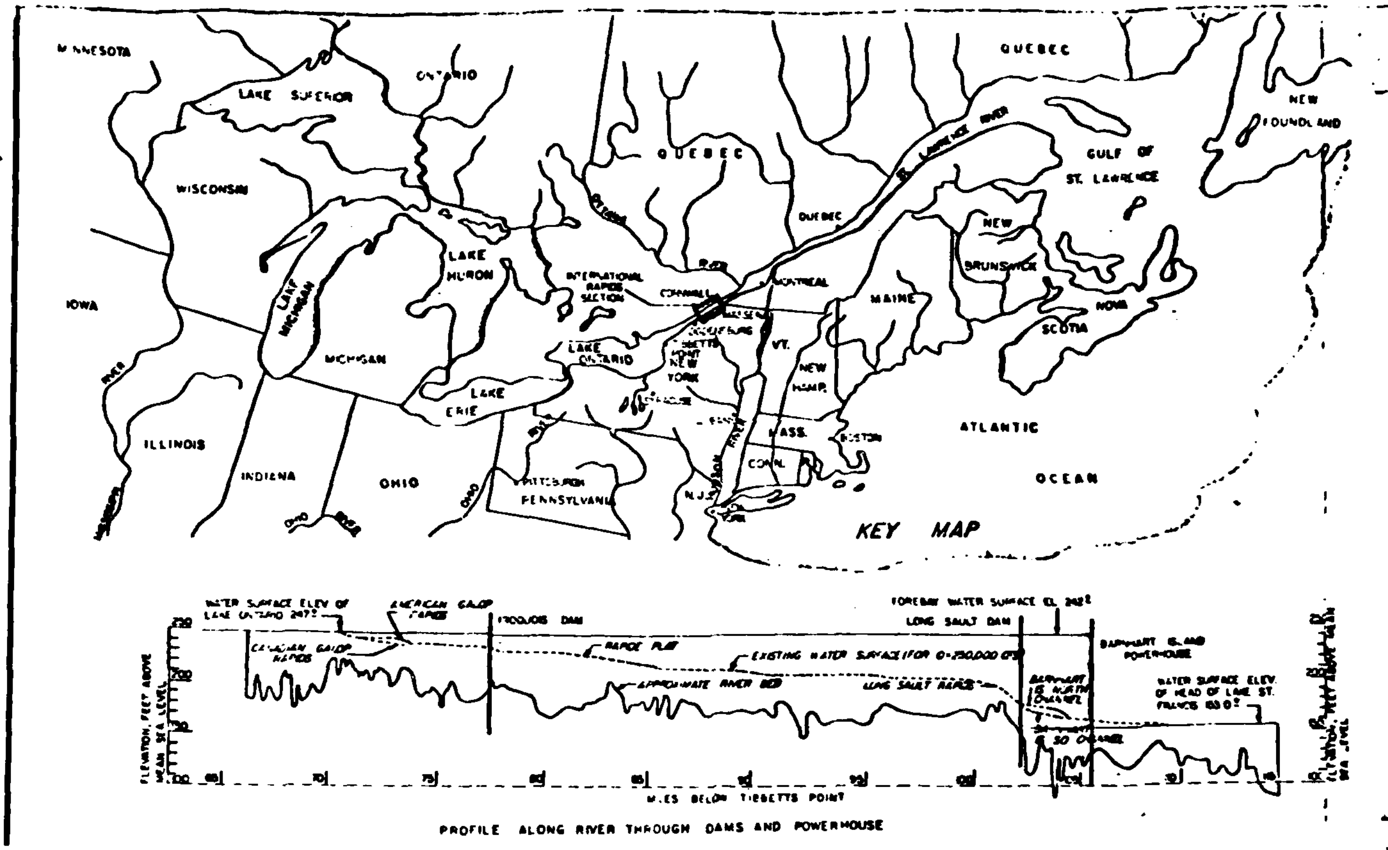
* Power pool at Moses-Saunders Dam formed by flooding St. Lawrence River.

** Lake Ontario outflow regulated from this date forward in accordance with a regulation plan.

Figures in **boldface** type are the maximums and minimums for each month.

Note: Between July 1958(*) and April 1960(**), "pre-project" releases were made from the project.

Figure 2. Profile of the St. Lawrence River through the dams and powerhouse to Lake St. Francis.



Following the formation of the impoundment at the Moses-Saunders Dam in July, 1958, the International section of the relatively fast and free flowing St. Lawrence River was changed into three limnologically distinct sections.

The first section, the Thousand Islands, consists of large islands and expansive bays, with numerous small islands and shoals. This section of the River was not changed much. It is mostly influenced by Lake Ontario and behaves essentially like an extension of the Lake with large open and slowly-flowing expanses of water.

The middle section, which extends from Chippewa Point to Iroquois Lock, is narrow with few islands and shoals. The transition from channel to upland is abrupt. The reach from Brockville to Ogdensburg is uninterrupted by dry land, while the reach from Ogdensburg to Cardinal includes several large islands which occur in the channel (Fig. 1). In this area, the middle section of the River narrows over a shallow bottom, culminating in the Red Mills Rapids. Water flow used to be rapid, dropping approximately 15 feet in the last 15 miles. The Iroquois Dam has decreased this drop to 1 foot.

The lower section of the River, now known as Lake St. Lawrence, is highly modified and contains several large islands and extensive shoals, many of which were formerly islands that are now flooded. This section of the River was fast-flowing water. It is now a reservoir which serves as the power pool for the Moses-Saunders Hydroelectric Project (NYS Dept. of Env. Cons. 1978).

Navigational History

The River has been navigated by canoe and small boats for many years. The first locks were built in 1783 between Lake St. Francis and Lake St. Louis in the Province of Quebec, Canada. In 1825 the LaChine Canal and locks were built, making the River navigable from Montreal to Cornwall. In 1843, the rapids west of Cornwall were passed by locks, and by 1845 the Beauharnois Canal was completed. In 1847, the Farrans Point, Rapide Plat, and Galops Canals were completed with a 9-foot draft, allowing barges, boats, and canoes to reach Lake Ontario. These latter three canals, all located in Canada, are now known collectively as the Williamsburg Canals. By 1875, the canals and locks had been enlarged to accommodate 14-foot draft vessels. In the meantime, the Welland Canals were being constructed, linking Lakes Erie and Ontario and bypassing Niagara Falls. The first canal, which was 8 feet deep, was completed in 1829. Later canals were completed in 1841 (9 feet deep), 1887 (14 feet deep), and 1932 (23.5-foot draft). By 1940, twenty-foot draft boats could travel from Duluth, Minnesota to the Gulf of St. Lawrence, except for a 184-mile stretch from Lake Ontario to Montreal (Menefee 1940).

History of Seaway Construction

Cooperative, international resource management started with the signing of the Boundary Waters Treaty in 1909 by the United States and Canada. This treaty, which provided principles, rules, and procedures for dealing with boundary water problems and uses, has been the cornerstone of resource development in boundary waters and also created the International Joint Commission (IJC). Under this treaty, no uses, obstructions, or diversions by one country which would affect natural levels and flows in the other country and which were not permitted prior to the treaty, would be permitted without approval of the IJC. In 1920 the IJC began studying the feasibility of a navigation and power project on the St. Lawrence River. In 1921, they reported favorably on a proposal for a 25-foot deep waterway (with provisions for a 30-foot depth) and a single-stage power development at the foot of Barnhart Island (Bryce 1982).

In 1924, the Joint Engineering Board was formed to study the proposals and came out with two alternatives -- one favored by the United States and the other favored by Canada. The United States favored a 25-foot deep channel and a one-stage power development at Barnhart Island with a control dam at the head of Galop Rapids. The Canadians favored a 30-foot deep channel and a two-stage power development -- one at Barnhart Island and one at Ogden Island (Bryce 1982).

In 1929, Canada approved a 16-mile canal between Lake St. Francis and Lake St. Louis to provide water power for the Beauharnois Light, Heat and Power Company. At the downstream end of the canal the Beauharnois Power Station was constructed. An initial diversion of 40,000 cfs was permitted, with provisions to gradually increase the canal size until essentially the entire river flow could eventually be diverted through the canal. Combined with two locks which were constructed at the downstream end of the canal, this canal allowed deep draft navigation. An additional 53,000 cfs diversion was authorized in 1932, and 30,000 cfs more was added in 1942 to provide the power needed during World War II. The operation of the Beauharnois powerdam under the existing authorizations had the effect of raising (compared to natural levels) the minimum and low levels in Lake St. Francis and upriver, including the site of the future St. Lawrence River Power Project (Bryce 1982).

A 1941 agreement by the United States and Canada called for completion of power and navigation works in the International section of the River by 1948. This was never ratified by the U.S. Congress. In 1942, the final report of the U.S. Army Corps of Engineers recommended a plan very similar to what was eventually built. This plan included a powerhouse at the foot of Barnhart Island, Long Sault Dam, a control dam near Iroquois, channel enlargements in the Galop Rapids to reduce velocities for navigation, and in other areas to reduce velocities and allow ice-packing to occur, a navigation channel in the South Galop channel (later modified to pass through Galop Island), and three locks, two at Barnhart and one at Point Rockaway (on the U.S. side) (Bryce 1982).

A Power Priority Plan, similar to the Corps' report but without navigation features, was proposed in 1948 but never formally submitted to the IJC. In 1951, the Canadians proposed an All-Canadian Seaway with a joint U.S.-Canadian power project. This proposal had the result of forcing the U.S. Congress to act. It was followed in 1952 by the submittal of power development plans to the IJC by the governments of the United States and Canada. Under these plans, Canada would construct the necessary works for 27-foot navigation between Lake Erie and Montreal. This action was followed by a variety of memorandums and agreements between the two countries (Bryce 1982).

In early 1953, the International St. Lawrence River Board of Control was established by the IJC to regulate outflows from Lake Ontario in accordance with a regulation plan that would distribute the benefits of regulation among the power, navigation, and shoreline interests on Lake Ontario and the St. Lawrence River. This action was preceded by record high water levels on Lake Ontario in 1952, which resulted in extensive flooding and damages. On November 5, 1953, by executive order, President Eisenhower designated the Power Authority of the State of New York (PASNY) as the United States' entity for power development on the St. Lawrence River. The order ensured that the power project would proceed. The Canadians were still taking action on an All-Canadian Seaway, which forced the U.S. Congress to act. On May 13, 1954, Congress approved the Wiley-Dondero Act, which provided for U.S. participation in the Seaway and created the St. Lawrence Seaway Development Corporation (SLSDC). An agreement between the United States and Canada on August 17, 1954, called for Canada to construct all the Canadian facilities and a lock at Iroquois, while the United States would build a canal and locks at Barnhart Island and conduct dredging operations in the Thousand Islands (Bryce 1982) (Table 2).

On August 4, 1954, two weeks before the final notes of agreement were formally exchanged, construction was started simultaneously by the United States and Canada. On June 30, 1958, navigation was suspended; the dike at the Moses-Saunders Dam was closed at 4:00 A.M. on July 1, 1958, and the power pool began to fill. Seventy-two hours later, at 4:00 A.M. on July 4, 1958, the pool had reached the approved level of elevation (EL236) and navigation was resumed. Dredging below the powerhouse was completed in November, 1961. A final "sweeping" of upstream channels by the Department of Transport in 1961 and 1962 ensured the required depths for 27-foot navigation (Bryce 1982) (Fig. 3).

Biological Studies of the River

Relatively few biological studies of the St. Lawrence River have been conducted. Historical surveys are particularly scarce. Only two relatively major biological surveys were conducted prior to construction of the Seaway in the late 1950's. In 1930, the State of New York Conservation Department conducted a biological survey of the St. Lawrence River watershed (State of New York Conservation Dept. 1931). The survey concentrated on the fish and water chemistry aspects of the watershed. Among the areas of study were fish stocking policies, fish foods, general fish survey (including relative abundance), fish parasites, chemical properties of the water, pollution, aquatic vegetation, and plankton. Another major study was conducted by the Academy of Natural Sciences of Philadelphia (1953) for Canadian Industries, Ltd. This survey included information on benthic organisms, protozoa, plankton, insects, algae, and fish. This study, however, was limited to a relatively small segment of the River.

A variety of "small-scale" studies was conducted from 1918-1959. Merwin (1918) studied common tern (*Sterna hirundo*) nesting. Other bird surveys (waterfowl) were conducted by Hyde (1939) and Kutz (1948). Snakes and turtles were studied in various areas between 1935 and 1941 (Toner 1935, 1936; Toner and de St. Remy 1941). Werner studied mammals (Werner 1956) and amphibians and reptiles (Werner 1959). Fishery studies were conducted by Cuerrier and Roussow (1951)

Table 2. Physical dimensions of the St. Lawrence River navigation system.*

Reach	Lakes and channels: Open waters (miles)	Lakes and channels: Channels & canals (miles)	Lakes and channels: Minimum depth (ft.)	Locks: Number	Locks: Year completed	Locks: Size length X width (ft.)	Locks: Depth over sill (ft.)	Locks: Lift (ft.)
Atlantic Ocean to Father Point, Que.	700	-	-	-	-	-	-	-
Father Point to Montreal	300	-	35	-	-	-	-	-
Montreal to Lake Ontario	189							
Lachine section		31	27	2 (Can.)	1958	800X80	30	226
Soulanges section		16	27	2 (Can.)	1958	800X80	30	
International Rapids sec.		44	27	1 (Can.)	1958	800X80	30	
				2 (U.S.)	1958	800X80	30	

*International Lake Erie Regulation Study Board 1981.

FIGURE 3

(Figure 3 is a color photograph located at the back of this report.)

[lake sturgeon (Acipenser fulvescens)] and by Stone, et al. (1951, 1954) [smallmouth bass (Micropterus dolomieui)]. Dore and Gillett (1955) conducted a botanical survey prior to the formation of Lake St. Lawrence. Most of these studies were limited in scope and were confined to localized areas.

Few studies were conducted in the years following the opening of the Seaway. Some limited fishery work was conducted. Pearce (1961) reported on the ice fishery of the St. Lawrence River, while McLeod reported on the fish of Lake St. Lawrence almost annually from 1961 through 1968 (McLeod ND, 1961, 1963, 1964, 1965, 1966a, 1966b). McLeod's reports also included waterfowl surveys (also McLeod 1969, 1971), and Belanger reported on Canadian waterfowl hunter success from 1965 through 1968 (Belanger 1965, 1966, 1967, 1968). Casselman (1967) studied northern pike (Esox lucius) in the upper St. Lawrence River.

Recent surveys have been more numerous. Four major surveys have been conducted. The St. Lawrence-Eastern Ontario Commission conducted a coastal resources inventory in 1972 (Marler 1972; Leaf, Coffey, and Ferrell 1972; Eschner and Wicker 1972; Webb, Bart, and Komarek 1972; Werner and Ford 1972; Harper and Dean 1972; Tully, et al. 1972; Geis and Luscomb 1972).

The second, coordinated by the U.S. Fish and Wildlife Service, was undertaken in 1976 to assess the potential effects of winter navigation (USFWS 1976a, 1976b, 1976c, 1976d, 1976e; Van Druff and Wright 1976; Werner 1976; Ringler 1976; Palm 1976; Mills and Forney 1976; Maxwell and Smith 1976; Kurczewski, et al. 1976; Alexander 1976).

A further study, published by the State University of New York College of Environmental Science and Forestry in 1978, studied fish and wildlife resources in the Winter Navigation Demonstration Corridor (Institute of Env. Program Affairs 1978).

In 1979, the U.S. Fish and Wildlife Service conducted a biological survey for the Additional Locks and Other Navigation Improvements Study (USFWS 1979) (see Tables 66-88 and Figs. 29-40 in Appendix D for site-specific data). This survey covered the entire International section of the River, but concentrated in the locks area near Massena.

Many of the same authors contributed to each of these studies, and some continued work through various other grants and projects. These authors and their work are summarized below:

Subject[1]	Year[2]	Authors[3]
Fisheries	1966	Jolliff, LeTendre
	1970	LeTendre, Schneider
	1972	Werner, Ford
	1976	Werner, Ringler
	1978	Dunning, Evans, Tarby
	1979	Dunning, Evans, Tarby, Panek
	1982	Dunning, Ross, Gladden, McCullough

Subject[1]	Year[2]	Authors[3]
Birds	1975	Maxwell
	1976	Maxwell, Smith, Ruta, Carrollan
	1978	Maxwell, Smith
	1983	Maxwell, Smith, Karwowski
Mammals	1976	VanDruff, Wright, Lackey
	1978	VanDruff, Lomolino, Wright
	1982	Lomolino
	1983	Lomolino
Amphibians and Reptiles	1978	Petokas, Alexander
	1979	Petokas, Alexander
	1980	Petokas, Alexander
	1981	Petokas, Alexander
	1982	Petokas, Gawlik
Benthos, Primary Productivity	1976	Mills, Forney
	1977	Mills, Forney
	1978	Mills, Smith, Forney
Vegetation, Wetlands	1972	Geis, Luscomb
	1976	Geis, Hyduke
	1977	Geis, Kee
	1978	Geis, Hyduke, Raynal
	1979	Geis, Hyduke, Raynal, Ruta
Islands and Shoals	1978	Geis, Hyduke
	1983	Geis, Hyduke

[1]See Tables 52, 53, 55, and 57 for specific references for each species present along the St. Lawrence River.

[2]Year that report was published (the data were usually collected in the same or the previous year).

[3]See Literature Cited for exact references.

A variety of limited studies has been conducted at various times between 1960 and 1983. The following is a brief summarization of these works:

Subject	Year	Authors
Fisheries	1960	Anonymous
	1976	Marean
	1977	BUFO

Subject	Year	Authors
Fisheries (Cont.)	1981	Menz
	1982	Goodyear
Birds	1960	Anonymous
	1969	Parker, Maxwell
	1975	Woods, Morris
	1977	Chamberlaine, BUFO
	1978	Chamberlaine, Bradstreet, McCracken
	1979	Chamberlaine, Brown
	1980	Longabucco, Brown
	1982	Brown
Mammals	1960	Anonymous
	1977	BUFO
Amphibians and Reptiles	1973	Woods
	1974	Rivard, Smith
	1976	Parsons, Smith
	1977	BUFO
Anthropods	1975	Anonymous
Vegetation, Wetlands	1969	New York State Dept. of Environmental Conservation
	1975	Armstrong
	1976	Marean
	1977	BUFO
	1983	U.S. Fish and Wildlife Service

A number of studies are ongoing. Osterburg (SUNY-Potsdam) and Ringler (SUNY-ESF) are conducting independent studies on the muskellunge (Osterburg 1981, 1983; LaPan 1982; Anon. 1983), while Maxwell and Smith (SUNY-Oswego) are censusing birds and studying common tern colonies. The St. Lawrence-Eastern Ontario Commission is just completing an oil pollution response model which describes important habitats along the River.

METHODS

II. METHODS

Habitat Mapping

Habitats along the United States' portion of the St. Lawrence River were mapped from aerial photography. A search was conducted to locate available photography. This was done via computer, word-of-mouth, and by checking various agencies that produce or use aerial photography. Three time frames were needed to correspond with the three periods under study. For the historical, pre-Seaway period, photos prior to 1959 (when the Seaway opened) were needed. Since actual construction began in 1954, a time frame prior to 1954 was preferred. The most complete set available was from August 1941 (Table 3). Photo coverage was available for almost all of Jefferson County and much of St. Lawrence County. A September, 1942, set was also available for Franklin County. A May, 1955, set was available for St. Lawrence County from Ogdensburg to the Franklin County line. All three of these sets were black-and-white photography. The 1941 and 1942 sets were printed at a scale of 1:20,000. The 1955 set was available as blow-ups (scale unknown) and at a scale of 1:15,000 (both sets were used for interpretation). A 1948 set for Jefferson County was rejected because the quality was not as good as that of the 1941 set.

For the post-Seaway historical period, photos taken between 1959 and 1965 were desirable, with 1959 the preferred time period. A complete set of June, 1959, photos at a scale of 1:20,000 was available for Jefferson County. Photos of St. Lawrence County and Franklin County from May and June, 1962, were available at a scale of 1:20,000. All three sets were in black-and-white.

A variety of photo sets was available for the present time-frame. An April, 1979, color set at a scale of 1:12,000 was chosen. The 1979 photos were the best aerial photos available for the St. Lawrence River. Because of the clarity of these photos, and to allow production of a map with more complete habitat descriptions for future use, upland land-use categories were identified and were broken down into sub-categories for the "present" time-frame.

After the photos were acquired, habitats were identified and transferred to mylar overlays. Since most of the photos were available as stereo pairs, a stereoscope was used to identify habitat types. When this process was completed, the habitat data were transferred to navigation charts using a zoom transfer scope. The charts were at a scale of 1:15,000, while the photos ranged from less than 1:12,000 to 1:20,000. Navigation charts (produced by the National Oceanic and Atmospheric Administration) were chosen rather than the more commonly used U.S. Geological Survey topographic maps for two reasons: 1) the larger scale, 1:15,000 as opposed to 1:24,000; and 2) the accuracy of the depth soundings and contour lines. Since some areas of the River were only mapped at a scale of 1:30,000, these maps were blown up to a scale of 1:15,000. A total of 15 charts was needed to cover the International section of the St. Lawrence River.

Following the transfer of habitat data onto the navigation charts, the islands, shoals and littoral areas were identified and labelled on the charts. These areas were added to the maps by tracing the contour lines shown on the charts. A different color was used to delineate each habitat type. Since the depths

Table 3. Available aerial photography for the St. Lawrence River.

Date Flown	Scale	Counties	Where to Obtain	Comments
PRE-SEAWAY				
August 1941	1:20,000	Jefferson, St. Lawrence, Franklin	1,4	Spotty coverage outside of Jefferson Co. (Photos were taken but not obtainable)
September 1942	1:20,000	Franklin	5	
September 1948	1:20,000	Jefferson	1	Spotty coverage
May 1955	Variable	St. Lawrence, Franklin	11	
POST-SEAWAY				
May 1959	1:20,000	Jefferson	1	Available at USFWS (Cortland)
June 1962	1:20,000	St. Lawrence, Franklin	2,3	Available at USFWS (Cortland)
July 1966	1:20,000	Jefferson	1	
April 1968	1:24,000	Jefferson, St. Lawrence, Franklin	6	LUNR Survey
PRESENT				
May 1972	1:24,000	Franklin	10	
Spring 1972	1:12,000	Jefferson	9	
March 1973	1:48,000	Jefferson	9	
May 1975	1:24,000	St. Lawrence	8	
September 1978	1:38,000	Jefferson	1	
September 1978	1:40,000	Franklin	2	
April 1979	1:12,000	Jefferson, St. Lawrence, Franklin	7	Color; available at SLEOC, USFWS (Cortland)

1. ASCS Watertown, NY*
2. ASCS Malone, NY*
3. ASCS Canton, NY*
4. SUNY-ESF Syracuse, NY

Table 3. (continued)

5. National Archives Washington, DC+
6. Lockwood Mapping Rochester, NY**
7. James Sewall Co. Old Town, ME++
8. Real Property Tax Services Canton, NY
9. Jefferson Co. Tax Mapping Watertown, NY
10. Real Property Tax Office Malone, NY
11. U.S. Army Corps of Engineers Buffalo, NY

*Purchase from: U.S. Dept. of Agriculture
Aerial Photography Field Office, ASCS-USDA
222 West 2300 South
P. O. Box 30010
Salt Lake City, Utah 84130
801-524-5856 (Commercial) 588-5856 (FTS)

+Purchase from: Cartographic Branch
National Archives
Washington, DC 20408

**Purchase from: Lockwood Mapping
P. O. Box 9790
580 Jefferson Rd.
Rochester, NY 14623
716-244-9840

++Purchase from: James W. Sewall Co.
P. O. Box 433
Old Town, Maine 04468
207-827-4456

and configuration of the River changed radically following construction of the Seaway, 1953 navigation charts were obtained and used to delineate the shoals and littoral areas on the charts for the pre-Seaway time frame. The transfer of contour lines from the 1:30,000 scale historical charts to the new 1:15,000 scale charts was accomplished using the zoom transfer scope.

When all charts were completed and proofed for errors, the three sets of charts (three time frames) were cross-checked for consistency. The completed charts were then taken to the National Coastal Ecosystems Team (U.S. Fish and Wildlife Service) in Slidell, Louisiana, where they were digitized and entered into a computer. The computer was then used to produce tables showing information such as the quantity and location of each type of habitat, and how it changed from one time frame to the next. The computer was also used to generate maps showing habitat changes over time (see Figures 4-6 in rear pocket). The computerized information will also be available for future habitat comparisons.

Mapping Conventions and Descriptions of Zones

The categories used for mapping the habitats of the St. Lawrence River were taken from Cowardin, et al. (1979) (Table 4).

> "For purposes of this classification, wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year." (Cowardin, et al. 1979).

For this study, islands and shoals have been placed into different categories from the mainland. To distinguish an island from a shoal, an island is defined as any offshore landmass greater than 1 acre in size and surrounded by water, or islands or rocks named as islands on U.S. Geological Survey (USGS) topographic maps or National Oceanic and Atmospheric Administration (NOAA) navigation charts even if less than 1 acre in size. A shoal is defined as any offshore (i.e., outside the 18-foot contour along the mainland or an island) shallow water area less than 6 meters (18 feet) in depth and less than 1 acre in size if exposed. Shoals may be rocky or sandy and include rocks that are exposed, rocks that are sometimes submerged and sometimes exposed, and/or submerged rocks. Those areas that meet this definition but are designated on USGS maps or NOAA charts as islands are not included. These definitions have been adopted with modifications from Geis and Hyduke (1983).

For the set of maps representing the present conditions (1979), the upland was broken down into five categories, defined as follows: (1) Active agricultural (U_a) - pasture, cropland, and orchards; (2) Developed (U_d) - towns, marinas, etc.; (3) Successional (U_s) - areas once farmed, logged, or otherwise disturbed (vegetation can include old field or shrub types); (4) Wooded (U_w) - deciduous, coniferous, mixed, and plantation vegetation; (5) Rock outcrop (U_r) - areas with exposed bedrock and poorly developed soils which may be vegetated with either herb/shrubs or tree/shrubs (Table 5). Uplands located on islands

Table 4 . Wetland classification system used to produce habitat maps of the St. Lawrence River for three time frames. (Cowardin, et al. 1979).

RIVERINE SYSTEM-R

SUBSYSTEM	CLASS	SUBCLASS
1 TIDAL 2 LOWER PERENNIAL	EM EMERGENT WETLAND+	(2) NONPERSISTENT
1 TIDAL 2 LOWER PERENNIAL 3 UPPER PERENNIAL	RB ROCK BOTTOM	(1) BEDROCK (2) RUBBLE
	UB UNCONSOLIDATED BOTTOM	(1) COBBLE-GRAVEL (2) SAND (3) MUD (4) ORGANIC
	AB AQUATIC BED	(1) ALGAL (2) AQUATIC MOSS (3) ROOTED VASCULAR (4) FLOATING
	RS ROCKY SHORE	(1) BEDROCK (2) RUBBLE
	US UNCONSOLIDATED SHORE	(1) COBBLE-GRAVEL (2) SAND (3) MUD (4) ORGANIC (5) VEGETATED (pioneer)
	OW *open water/unknown bottom	
4 INTERMITTENT	SB STREAMBED	(1) BEDROCK (2) RUBBLE (3) COBBLE-GRAVEL (4) SAND (5) MUD (6) ORGANIC (7) VEGETATED (pioneer)

+EMERGENT WETLAND class only in RIVERINE TIDAL and RIVERINE LOWER PERENNIAL systems

*Terms added by U.S. Fish and Wildlife Service National Wetlands Inventory

Table 4. (continued)

LACUSTRINE SYSTEM - L

SUBSYSTEM	CLASS	SUBCLASS
1 LIMNETIC	RB ROCK BOTTOM	(1) BEDROCK (2) RUBBLE
	UB UNCONSOLIDATED BOTTOM	(1) COBBLE-GRAVEL (2) SAND (3) MUD (4) ORGANIC
	AB AQUATIC BED	(1) ALGAL (2) AQUATIC MOSS (3) ROOTED VASCULAR (4) FLOATING
	OW *open water/ unknown bottom	
2 LITTORAL	RB ROCK BOTTOM	(1) BEDROCK (2) RUBBLE
	UB UNCONSOLIDATED BOTTOM	(1) COBBLE-GRAVEL (2) SAND (3) MUD (4) ORGANIC
	AB AQUATIC BED	(1) ALGAL (2) AQUATIC MOSS (3) ROOTED VASCULAR (4) FLOATING
	RS ROCKY SHORE	(1) BEDROCK (2) RUBBLE
	US UNCONSOLIDATED SHORE	(1) COBBLE-GRAVEL (2) SAND (3) MUD (4) ORGANIC (5) VEGETATED (pioneer)
	EM EMERGENT WETLAND	(2) NONPERSISTENT
	OW *open water/ unknown bottom	

Table 4 . (continued)

PALUSTRINE SYSTEM

(NO SUBSYSTEM)	CLASS	SUBCLASS
P PALUSTRINE	RB ROCK BOTTOM	(1) BEDROCK (2) RUBBLE
	UB UNCONSOLIDATED BOTTOM	(1) COBBLE-GRAVEL (2) SAND (3) MUD (4) ORGANIC
	AB AQUATIC BED	(1) ALGAL (2) AQUATIC MOSS (3) ROOTED VASCULAR (4) FLOATING
	US UNCONSOLIDATED SHORE	(1) COBBLE-GRAVEL (2) SAND (3) MUD (4) ORGANIC (5) VEGETATED (pioneer)
	ML MOSS-LICHEN WETLAND	(1) MOSS (2) LICHEN
	EM EMERGENT WETLAND	(1) PERSISTENT (2) NONPERSISTENT
	SS SCRUB/SHRUB WETLAND FO FORESTED WETLAND	(1) BROAD-LEAVED DECIDUOUS (2) NEEDLE-LEAVED DECIDUOUS (3) BROAD-LEAVED EVERGREEN (4) NEEDLE-LEAVED EVERGREEN (5) DEAD
	OW *open water/unknown bottom	

Table 4. (continued)

WATER REGIME MODIFIERS

Tidal		Nontidal	
L	SUBTIDAL	H	PERMANENTLY FLOODED
M	IRREGULARLY EXPOSED	G	INTERMITTENTLY EXPOSED
N	REGULARLY FLOODED	F	SEMIPERMANENTLY FLOODED
P	IRREGULARLY FLOODED	C	SEASONALLY FLOODED
V	PERMANENTLY FLOODED - TIDAL	B	SATURATED
		A	TEMPORARILY FLOODED
T	SEMIPERMANENTLY FLOODED - TIDAL	J	INTERMITTENTLY FLOODED
R	SEASONALLY FLOODED - TIDAL	K	ARTIFICIALLY FLOODED
S	TEMPORARILY FLOODED - TIDAL	D	*seasonal/well-drained
		C	*seasonal/saturated
U	*unknown	Z	*permanently flooded/ intermittently exposed
		Y	*semipermanently flooded/ seasonally flooded/saturated
		W	*temporarily flooded/ intermittently flooded

SPECIAL MODIFIERS

x	EXCAVATED	b	*beaver
	IMPOUNDED		
	DIKED		
	PARTLY DRAINED		
f	FARMED		
r	ARTIFICIAL		

SOIL MODIFIERS

g	ORGANIC
n	MINERAL

WATER CHEMISTRY MODIFIERS

Salinity Modifiers: Coastal		Salinity Modifiers: Inland		pH Modifiers	
1	HYPERHALINE	7	HYPERSALINE	a	ACID
2	EUHALINE	8	EUSALINE	t	CIRCUMNEUTRAL
3	MIXOHALINE	9	MIXOSALINE	1	ALKALINE
4	POLYHALINE		POLYSALINE		
5	MESOHALINE		MESOSALINE		
6	OLIGOHALINE		OLIGOSALINE		
0	FRESH	0	FRESH		

utilize the same mapping conventions with a subscript "i" added. All upland areas were designated "U" on the pre-Seaway and post-Seaway map sets, with a subscript "i" added to island upland (Table 5).

Four wetland categories were defined. A subscript "i" is used to distinguish wetlands located on islands from those located on the mainland.

Broad-leaved deciduous forests (PFO1) are characterized by woody vegetation that is 6 meters (20 feet) tall or taller (Table 5). These wetlands generally occur on mineral soils or highly decomposed organic soils. They normally consist of an overstory of trees, an understory of young trees or shrubs, and an herbaceous layer. Common dominants are species such as red maple (Acer rubrum), American elm (Ulmus americana), ashes (Fraxinus spp.), and swamp white oak (Quercus bicolor) (Cowardin , et al. 1979).

Broad-leaved scrub/shrub wetlands (PSS1) are dominated by woody vegetation that is less than 6 meters (20 feet) tall. There may be a successional stage leading to forested wetland or relatively stable communities. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. Typical dominants are species such as alders (Alnus spp.), willows (Salix spp.), buttonbush (Cephalanthus occidentalis), red osier dogwood (Cornus stolonifera), and young trees of species such as red maple and spruce (Picea spp.) (Cowardin, et al. 1979).

Emergent wetlands (PEM) are characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. These wetlands are dominated by perennials and vegetation is generally present for most of the growing season. They generally maintain the same appearance from year to year. Among the dominant plants are cattails (Typha spp.), bulrushes (Scirpus spp.), sedges (Carex spp.), reed grass (Phragmites communis), manna grasses (Glyceria spp.), purple loosestrife (Lythrum salicaria), smartweeds (Polygonum spp.), swamp loosestrife (Decodon verticillatus), arrowheads (Sagittaria spp.), pickerelweed (Pontederia cordata), and arrow arum (Peltandra virginica) (Cowardin, et al. 1979).

The rooted vascular and floating vascular categories were combined because of the difficulty in distinguishing these two types on the black-and-white aerial photos. This new category, rooted vascular/floating-leaved (R2AB3), occurs at all depths within the photic zone. It often is found in sheltered areas with little water movement. Among the dominant plant species are waterweed (Elodea canadensis), pondweeds (Potamogeton spp.), water lilies (Nymphaea spp. and Nuphar spp.), duckweeds (Lemna spp. and Spirodella polyrhiza), coontail (Ceratophyllum demersum), and water celery (Vallisneria americana) (Cowardin, et al. 1979).

Several categories for shoreline and open water were used. All segments of the River downstream from Tibbett's Point to the Iroquois Dam, and downstream from the Moses-Saunders Dam/Long Sault Dam/Snell Lock area to the International border were considered riverine. The area between Iroquois Dam and the Moses-Saunders/Long Sault/Snell Lock area was considered lacustrine because it was impounded and Lake St. Lawrence had been formed. Iroquois Dam was arbitrarily chosen as the upstream border of the impoundment because no precise border exists, and Iroquois Dam has been used in past studies to depict the start of

Table 5. Mapping categories, conventions, and abbreviations used to produce habitat maps of the St. Lawrence River for three time frames.

UPLAND (MAINLAND)

Category	Mapping Convention	Abbreviation*
Active agricultural includes pasture, cropland, and orchards.	U_a	M1
Developed includes towns, marinas, etc.	U_d	M2
Successional includes areas once farmed, logged, or otherwise disturbed; vegetation can include old field or shrub.	U_s	M3
Wooded includes deciduous, coniferous, mixed, and plantation vegetation.	U_w	M4
Rock outcrop includes areas with exposed bedrock and poorly developed soils; vegetated with either herb/shrubs or tree/shrubs.	U_r	M5

UPLAND (ISLAND)

Category	Mapping Convention	Abbreviation*
Active agricultural	U_{ia}	I1
Developed	U_{id}	I2
Successional	U_{is}	I3
Wooded	U_{iw}	I4
Rock outcrop	U_{ir}	I5

Table 5. (continued)

WETLAND (MAINLAND)

Category	Mapping Convention	Abbreviation*
Broad-leaved deciduous forest	PFO1	M6
Broad-leaved scrub/shrub	PSS1	M7
Emergent	PEM	M8
Rooted vascular floating-leaved	R2AB3	M9
Palustrine open water	POW	POW

WETLAND (ISLAND)

Category	Mapping Convention	Abbreviation*
Broad-leaved deciduous forest	$PFO1_i$	I6
Broad-leaved scrub/shrub	$PSS1_i$	I7
Emergent	PEM_i	I8
Rooted vascular floating-leaved	$R2AB3_i$	I9
Palustrine open water	POW_i	POW_i

WATER

Category		Mapping Convention	Abbreviation*
	River Segment		
Shallow littoral mainland	(< 6 ft.)	R2UB	R1
Deep littoral mainland	(6-18 ft.)	R2UBH	R2
Deepwater	(> 18 ft.)	R2OWH	R3
Shallow shoal	(< 6 ft.)	R2RB	R4
Deep shoal	(6-18 ft.)	R2RBH	R5
Streambed mainland		R2SB	R6
Shallow littoral island	(< 6 ft.)	$R2UB_i$	R7
Deep littoral island	(6-18 ft.)	$R2UBH_i$	R8

Table 5. (continued)

Category	Mapping Convention	Abbreviation*
Streambed island	$R2SB_i$	R9
Breakwater, Dam	$R2RS_r$	RO
Mudflat mainland	R2US3	RX
Mudflat island	$R2US3_i$	RY

Category	Impounded Segment	Mapping Convention	Abbreviation*
Mudflat mainland		L2US3	L1
Shallow littoral mainland	(<6 ft.)	L2UB	L2
Deep littoral mainland	(6-18 ft.)	L1UB	L3
Deepwater	(>18 ft.)	L1OWH	L4
Shallow shoal	(<6 ft.)	L2RB	L5
Deep shoal	(6-18 ft.)	L1RB	L6
Mudflat island		$L2US3_i$	L7
Shallow littoral island	(<6 ft.)	$L2UB_i$	L8
Deep littoral island	(6-18 ft.)	$L1UB_i$	L9
Breakwater, Dam		$L1RS_r$	LO
Flooded stream channel		LOW	LOW

*Abbreviations are used on the pre-seaway (1941-1955) and post-seaway (1959-1962) charts. Regular mapping conventions are used on the present (1979) charts.

Lake St. Lawrence. The entire River was considered riverine on the historical (pre-Seaway) charts since the dams and locks did not exist. Riverine mapping conventions began with an "R", while lacustrine mapping conventions began with an "L". For purposes of this study, the shallow littoral zone (R2UB or L2UB) (Table 5) was defined as the open-water area between the shoreline and the 6-foot contour depicted on the NOAA navigation charts. This zone is characterized by a dense growth of rooted aquatic macrophytes and is important as spawning and nursery sites for fish. The deep littoral area (R2UBH or L1UB) was defined as the open-water area between the 6-foot and 18-foot contours. This zone contains important fish habitat and is characterized by low density rooted aquatic plant growth. The 18-foot contour is a reasonable approximation of the limit of rooted aquatic vegetation. The subscript "i" was appended to the mapping convention when the littoral zone was surrounding an island and was separate from the mainland littoral area (e.g., an island located between the mainland and the 6-foot contour would not have its own littoral zone; the littoral area around the island would be considered part of the mainland littoral zone). These definitions have been adopted with modification from Geis and Hyduke (1978a, 1983).

Shoal areas were broken down into shallow shoals (R2RB or L2RB) and deep shoals (R2RBH and L1RB) (Table 5). All shoal areas within a 6-foot contour line were considered to be shallow shoals. All shoal areas between 6-foot and 18-foot contour lines were defined as deep shoals. A shallow-water area (i.e., a polygon formed by a 6-foot contour line) located within the 18-foot contour line along the mainland or around an island was considered to be shallow littoral (either mainland or island) rather than shallow shoal because it was not surrounded by deepwater. All water greater than 18 feet in depth was considered to be deepwater (R2OWH or L1OWH).

Several other seldom-occurring categories were defined. Palustrine open water (POW or POW_i) was an open-water area surrounded by wetland (upland ponds were not included) (Table 5). Large breakwaters and dikes extending perpendicular to shore or surrounded by water were designated by the conventions R2RSr or L1RSr. Dams were also considered in this category and were arbitrarily placed in riverine or lacustrine since they represented the dividing line for the two areas. Mud flats (R2US3, $R2US3_i$, L2US3, or $L2US3_i$) were defined as unconsolidated shores with a mud substrate. These were found in rare instances where great water level fluctuations occurred, exposing the mud for a portion of the year but not long enough for plants to become established. The final category used was streambed (R2SB, $R2SB_i$, or LOW). This category included the open-water areas of tributary streams where no contour lines were present to distinguish shallow and deep littoral areas.

Literature Search

While the mapping was being done, a search for literature, both published and unpublished, was conducted to locate all the data available on the St. Lawrence River. The collected literature was organized and cataloged. The reports and data were then searched, and all information on the abundance of each index species was tabulated. Information was also obtained on the habitat requirements and preferences of each index species.

The literature information was then used in conjunction with the mapped habitat data to determine changes in habitat availability for index species. The data were also used to describe the current ecosystem and to identify those areas where studies are needed to better understand the system.

WATERSHED CHARACTERIZATION

III WATERSHED CHARACTERIZATION

Hydrology and Hydraulics

General

The St. Lawrence River starts as the outflow of Lake Ontario. At any moment in time, prior to the construction of the St. Lawrence Project, the volume of outflow was dictated by the level of Lake Ontario (including wind set-up) and the channel capacity, which consists of the channel cross section, channel roughness, and channel slope. The outflow is now regulated. Historic water levels (1900-1978) for Lake Ontario by year and month are provided in Table 6, while outflows (1860-1983, as recorded at the Cornwall, Ontario gauge) are provided in Table 1.

Pre-Seaway

Prior to construction of the St. Lawrence Seaway, there were no major water level and flow controls on the St. Lawrence River. River flows were relatively uniform, however, due to the great storage basin of the Great Lakes System. Mean annual flows, based on the gauge at Cornwall, ranged from 184,000 cfs in 1934 and 1935 to 280,000 cfs in 1861 (Table 1). The 1930's were relatively dry years. Mean annual flows from 1931 to 1942 ranged from 184,000 cfs to 220,000 cfs, well below the pre-Seaway average of 241,000 cfs. For the ten-year period immediately prior to the Seaway opening (1949-1958), the mean annual flows ranged from 219,000 cfs in 1958 to 277,000 cfs in 1952 (Table 1). During the period from 1949 through 1958, the lowest mean monthly flow was 207,000 cfs (Table 1) in November, 1958, and the highest was 305,000 cfs in June, 1952. The mean annual flow for the ten-year period (1949-1958) immediately prior to the power pool formation at Moses-Saunders Dam was 251,000 cfs.

The lowest range in monthly means for any year between 1860 and 1958 was 23,000 cfs, which occurred in 1906, 1928, and 1958 (Table 7); the 1958 range was the lowest for the ten-year period prior to the Seaway opening (Table 8). The highest range in monthly means for any pre-Seaway year was 86,000 cfs in 1893. For the 1949-1958 period, the highest range was only 64,000 cfs (in 1951). The average annual range in monthly means (i.e., the annual range equals the difference between the maximum monthly mean and the minimum monthly mean) during this period was 46,000 cfs, while the average annual range in monthly means from 1860 through 1958 was 51,000 cfs. These data are indicative of relatively uniform flows throughout the years and from month-to-month. In addition, the ranges during the dry years in the 1930's were as great or greater than the ranges during the relatively wet years of 1951-1953.

The total fall over the 540 mile length of the St. Lawrence River was approximately 245 feet, about one-third of which occurred in the International section. The elevations averaged El.245 at Lake Ontario, El.229 at Point Rockaway (present location of Iroquois Dam), and El.159-169 at Barnhart Island (present location of Moses-Saunders Dam) (NYS Dept. of Health 1963).

Table 6 . Monthly mean water levels recorded for Lake Ontario. Figures are in feet, according to International Great Lakes Data (1955).

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC	MEAN
1900	243.16	243.39	243.72	244.35	244.63	244.56	244.42	244.19	243.76	243.39	243.16	243.41	243.85
1901	243.28	243.13	243.00	244.14	244.52	244.62	244.43	244.12	243.77	243.30	242.90	242.98	243.68
1902	243.10	243.04	243.75	244.14	244.16	244.20	244.64	244.77	244.34	244.00	243.72	243.50	243.95
1903	243.44	243.56	244.34	245.24	245.24	245.13	245.17	245.00	244.69	244.30	244.02	243.64	244.48
1904	243.36	243.60	244.20	245.52	246.20	246.50	246.50	246.26	245.89	245.50	244.98	244.42	245.24
1905	244.40	244.01	243.88	244.70	244.92	245.29	245.65	245.64	245.46	245.10	244.74	244.58	244.86
1906	244.82	244.80	244.62	244.89	245.02	245.10	245.26	245.00	244.50	244.29	244.28	244.34	244.74
1907	245.10	245.23	245.23	245.63	245.85	245.80	245.77	245.54	245.18	245.04	244.96	245.09	245.37
1908	245.49	245.75	246.15	246.78	247.26	247.30	247.03	246.62	245.85	245.16	244.59	244.27	246.02
1909	243.93	244.04	244.46	244.98	245.85	246.02	245.86	245.57	245.02	244.54	244.10	244.02	244.87
1910	243.66	243.74	244.29	244.67	245.15	245.22	245.05	244.83	244.50	244.15	243.88	243.50	244.39
1911	243.36	243.48	243.58	243.97	244.24	244.34	244.20	243.85	243.52	243.27	243.11	243.28	243.68
1912	243.52	243.53	243.65	244.68	245.48	246.01	245.68	245.32	245.06	244.78	244.66	244.76	244.76
1913	245.13	245.41	245.41	246.40	246.71	246.76	246.53	246.06	245.49	245.00	244.81	244.63	245.70
1914	244.38	244.44	244.34	245.21	245.57	245.58	245.38	245.01	244.72	244.25	243.87	243.51	244.69
1915	243.35	243.60	243.85	243.77	243.82	243.80	243.82	244.16	244.14	243.94	243.62	243.43	243.78
1916	243.73	244.05	244.12	244.98	245.80	246.63	246.67	246.05	245.54	244.89	244.37	244.09	245.08
1917	243.95	243.77	243.93	244.96	245.25	245.73	246.21	246.07	245.68	245.40	245.41	245.22	245.13
1918	244.89	244.78	245.34	245.91	245.89	245.77	245.56	245.18	244.90	244.73	244.72	244.68	245.20
1919	244.80	244.68	244.81	245.34	246.23	246.78	246.53	246.12	245.63	245.15	244.88	244.54	245.46
1920	244.09	243.77	243.84	244.31	244.46	244.37	244.48	244.44	244.23	244.07	243.92	244.21	244.18
1921	244.37	244.35	244.62	245.18	245.46	245.36	245.10	244.65	244.18	243.81	243.58	243.57	244.52
1922	243.52	243.46	243.90	244.80	245.30	245.37	245.67	245.27	244.78	244.31	243.82	243.38	244.47
1923	243.31	243.19	243.47	244.06	244.35	244.65	244.51	244.09	243.79	243.35	243.07	243.20	243.75
1924	243.46	243.59	243.58	244.10	244.81	245.01	244.92	244.77	244.35	244.16	243.64	243.30	244.14

Table 6 . (Continued)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC	MEAN
1925	242.99	243.13	243.89	244.34	244.34	244.19	243.89	243.40	243.31	242.99	243.04	243.24	243.5
1926	242.97	242.79	242.81	243.65	244.09	244.06	243.92	243.78	243.67	243.68	243.99	244.19	243.6
1927	244.02	244.01	244.45	244.72	244.73	244.87	244.78	244.48	244.02	243.72	243.60	244.34	244.3
1928	244.80	244.79	244.68	245.15	245.35	245.35	245.48	245.40	244.90	244.51	244.39	244.54	244.9
1929	244.56	244.61	244.93	246.06	247.04	247.19	247.09	246.70	246.55	245.68	245.36	245.17	245.9
1930	245.61	245.88	246.45	246.77	246.82	246.87	246.80	246.20	245.58	244.96	244.40	244.04	245.8
1931	243.70	243.50	243.43	243.70	243.89	244.16	243.98	243.64	243.30	242.97	242.75	242.66	243.4
1932	243.14	243.80	243.96	244.57	244.90	244.77	244.59	244.29	243.74	243.30	243.17	243.05	243.9
1933	243.08	242.99	242.94	243.55	244.07	244.15	243.89	243.52	243.15	242.67	242.25	242.21	243.2
1934	242.46	242.50	242.54	243.07	243.22	243.02	242.77	242.29	242.02	241.72	241.48	241.46	242.3
1935	241.69	241.83	242.11	242.39	242.67	242.93	243.09	242.84	242.43	242.05	241.91	241.86	242.3
1936	241.78	241.56	242.26	243.77	244.03	243.88	243.54	243.07	242.81	242.59	242.50	242.30	242.8
1937	242.79	243.42	243.57	243.86	244.60	244.82	244.78	244.56	244.12	243.64	243.60	243.42	243.9
1938	243.24	243.55	244.05	244.59	244.75	244.68	244.48	244.40	244.03	243.82	243.48	243.21	244.0
1939	243.09	243.12	243.68	244.53	244.94	244.86	244.70	244.47	243.96	243.56	243.15	242.91	243.9
1940	242.76	242.56	242.59	243.52	244.32	244.69	244.75	244.47	244.06	243.70	243.48	243.54	243.7
1941	243.93	244.00	244.03	244.35	244.30	244.05	243.80	243.51	243.21	242.91	242.85	242.74	243.6
1942	242.77	242.75	243.30	244.22	244.59	244.91	244.75	244.58	244.29	244.00	243.96	243.96	244.0
1943	244.40	244.66	245.22	245.80	246.67	247.51	247.35	247.01	246.53	245.88	245.75	245.37	246.0
1944	244.87	244.62	244.61	245.13	245.78	245.98	245.94	245.58	245.16	244.69	244.21	244.07	245.0
1945	244.03	244.06	244.76	245.70	246.30	246.67	246.66	246.37	245.99	246.29	246.19	246.23	245.7
1946	246.11	245.89	246.24	246.12	245.94	246.03	245.89	245.53	245.08	244.79	244.68	244.48	245.5
1947	244.57	244.90	244.92	245.81	246.50	247.63	247.72	247.50	246.93	246.14	245.64	245.34	246.1
1948	245.11	245.09	245.60	246.58	246.95	247.08	246.81	246.34	245.74	245.17	244.90	244.66	245.8
1949	244.73	245.05	245.36	245.67	245.75	245.49	245.11	244.58	244.18	243.88	243.48	243.39	244.7

Table 6 . (Continued)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC	MEAN
1950	243.99	244.52	244.80	245.88	246.12	246.07	245.87	245.53	245.16	244.82	244.70	244.97	245.20
1951	245.19	245.50	246.12	247.08	247.61	247.51	247.43	246.87	246.34	245.78	245.52	245.59	246.38
1952	245.88	**246.41**	**246.77**	247.61	247.96	**248.06**	247.66	247.14	246.61	246.06	245.53	245.50	**246.77**
1953	245.37	245.36	245.58	246.12	246.54	246.69	246.34	245.97	245.54	245.01	244.55	244.45	245.63
1954	244.32	244.50	245.22	245.89	246.63	246.54	246.15	245.66	245.33	245.26	245.32	245.39	245.52
1955	245.63	245.51	246.16	247.02	247.20	246.97	246.45	246.03	245.53	245.40	245.51	245.25	246.06
1956	244.84	244.54	244.78	245.40	246.34	246.55	246.22	245.76	245.56	244.99	244.52	244.26	245.31
1957	244.09	244.12	244.31	244.59	244.87	245.05	245.18	244.83	244.42	243.94	243.55	243.50	244.37
1958	243.69	243.54	243.77	244.10	244.28	244.23*	244.07	243.81	243.59	243.33	243.10	242.92	243.70
1959	242.85	243.29	243.82	244.88	245.12	244.93	244.57	243.98	243.40	243.13	243.02	243.34	243.86
1960	243.77	244.12	244.22	245.16	245.94**	246.05	245.59	244.95	244.31	243.94	243.92	243.71	244.64
1961	243.37	243.23	243.87	244.63	245.37	245.59	245.43	244.99	244.57	244.00	243.61	243.56	244.35
1962	243.38	243.19	243.33	244.32	245.08	245.35	245.19	245.10	244.73	244.58	244.33	244.27	244.40
1963	243.91	243.39	243.30	244.44	245.33	245.77	245.65	245.46	244.91	244.19	243.63	243.40	244.45
1964	242.88	242.37	242.37	243.18	244.07	244.49	244.53	244.17	243.72	242.96	242.30	241.85	243.24
1965	241.74	241.91	242.45	243.11	243.96	244.38	244.63	244.45	244.26	244.07	244.02	244.19	243.60
1966	244.13	244.03	244.44	244.72	244.88	245.27	245.24	245.97	244.66	244.22	243.91	244.16	244.64
1967	244.23	244.25	244.05	244.81	245.48	245.85	246.06	245.92	245.46	245.26	245.15	244.81	245.11
1968	244.50	244.56	244.59	245.24	245.24	245.64	245.86	245.51	245.10	245.45	245.05	245.26	245.17
1969	244.35	244.56	244.35	244.97	245.66	246.07	245.86	245.35	244.54	243.93	243.77	243.74	244.76
1970	243.69	243.73	243.81	244.56	245.21	245.39	245.54	245.25	244.73	244.39	244.15	244.15	244.55
1971	244.27	244.11	244.49	245.05	245.56	245.50	245.39	245.04	244.74	244.27	243.82	243.80	244.67
1972	244.07	244.31	244.69	245.41	246.26	246.43	246.72	246.41	245.64	244.87	244.61	244.94	245.36
1973	245.73	246.28	246.66	**247.73**	**247.97**	247.87	247.30	246.47	245.62	244.88	244.39	244.38	246.27
1974	245.03	245.63	245.93	246.52	247.23	247.50	247.22	246.42	245.46	244.56	244.03	244.06	245.80
1975	244.15	244.62	245.07	245.62	245.92	245.91	245.54	245.04	244.72	244.59	244.27	244.14	244.97
1976	244.34	244.64	245.82	246.81	247.35	247.35	246.98	246.33	245.58	245.04	244.50	244.07	245.73
1977	243.92	243.73	244.29	245.06	245.19	244.97	245.00	245.11	244.98	245.03	244.77	245.10	244.76
1978	245.84	245.97	245.53	246.32	246.64	246.33	245.73	245.23	244.68	244.18	243.73	243.69	245.32

* Power pool at Moses-Saunders Dam formed by flooding St. Lawrence River.
** Lake Ontario outflow regulated from this date forward in accordance with a regulation plan (see Table 1 footnotes).
Figures in **boldface** type are the maximums and minimums for each month.

Table 7 . Annual means, highest and lowest monthly means, and range of monthly means for discharges at the Cornwall Gauge on the St. Lawrence River for the pre-Seaway period, 1860-1958. All figures are in thousands of cubic feet per second (cfs).

YEAR	Normal Annual Means (all days)	Highest Monthly Means (all days)	Lowest Monthly Means (all days)	Range of Monthly Means
1860	---*	---	---	--
1861	280	304	234	70
1862	279	311	248	63
1863	272	296	256	40
1864	268	297	238	59
1865	261	285	238	47
1866	251	270	213	57
1867	267	303	230	73
1868	240	262	209	53
1869	256	283	205	78
1870	279	314	256	58
1871	252	274	224	50
1872	221	239	194	45
1873	244	272	197	75
1874	260	281	230	51
1875	228	251	173	78
1876	272	302	229	73
1877	245	263	210	53
1878	258	272	228	44
1879	251	268	227	41
1880	244	261	227	34
1881	232	254	182	72
1882	260	282	241	41
1883	255	288	204	84
1884	268	296	232	64
1885	256	278	218	60
1886	277	302	256	46
1887	265	292	237	55
1888	239	256	205	51
1889	246	269	220	49
1890	268	292	250	42
1891	250	278	217	61
1892	232	258	200	58
1893	243	279	193	86
1894	239	266	207	59

Table 7 . (Continued)

YEAR	Normal Annual Means (all days)	Highest Monthly Means (all days)	Lowest Monthly Means (all days)	Range of Monthly Means
1895	208	228	190	38
1896	215	238	196	42
1897	220	243	191	52
1898	230	248	211	37
1899	226	249	210	39
1900	228	246	208	38
1901	226	248	206	42
1902	231	250	189	61
1903	242	260	220	40
1904	247	278	203	75
1905	238	259	209	50
1906	238	250	227	23
1907	248	263	223	40
1908	260	294	227	67
1909	238	266	208	58
1910	229	249	200	49
1911	217	232	200	32
1912	236	268	191	77
1913	257	280	238	42
1914	236	257	215	42
1915	219	229	203	26
1916	243	277	214	63
1917	245	268	215	53
1918	244	260	223	37
1919	252	277	233	44
1920	222	232	204	28
1921	232	251	210	41
1922	230	257	198	59
1923	214	236	196	40
1924	224	243	202	41
1925	211	230	183	47
1926	212	227	180	47
1927	226	242	200	42
1928	241	254	231	23
1929	259	287	229	58
1930	259	281	222	59
1931	210	224	194	30
1932	220	240	203	37
1933	203	224	179	45
1934	184	206	169	37

Table 7. (Continued)

YEAR	Normal Annual Means (all days)	Highest Monthly Means (all days)	Lowest Monthly Means (all days)	Range of Monthly Means
1935	184	202	166	36
1936	195	223	154	69
1937	219	237	198	39
1938	218	235	196	39
1939	215	239	183	56
1940	212	234	184	50
1941	210	228	194	34
1942	220	237	188	49
1943	257	292	209	83
1944	240	260	222	38
1945	252	271	195	76
1946	249	263	232	31
1947	262	296	227	69
1948	254	282	220	62
1949	233	255	208	47
1950	243	263	220	43
1951	267	294	230	64
1952	277	305	251	54
1953	260	283	237	46
1954	258	282	228	54
1955	267	294	246	48
1956	254	282	234	48
1957	234	248	214	34
1958	219	230	207	23
AVERAGE	241	263	212	51

*Data available for only June through December in 1860.

Table 8 . Annual means, highest and lowest monthly means, and range of monthly means for discharges at the Cornwall Gauge on the St. Lawrence River for the ten-year period prior to the formation of Lake St. Lawrence (1949-1958). All figures are in thousands of cubic feet per second (cfs).

YEAR	Normal Annual Means (all days)	Highest Monthly Means (all days)	Lowest Monthly Means (all days)	Range of Monthly Means
1949	233	255	208	47
1950	243	263	220	43
1951	267	294	230	64
1952	277	305	251	54
1953	260	283	237	46
1954	258	282	228	54
1955	267	294	246	48
1956	254	282	234	48
1957	234	248	214	34
1958	219	230	207	23
AVERAGE	251	274	228	46

Post-Seaway

The St. Lawrence Seaway and Power Project greatly altered the hydrology of the St. Lawrence River. Around the same time, the International Joint Commission (IJC) established water level regulations for Lake Ontario. The total fall over the length of the River remained 245 feet, but the distribution of the fall was altered. The elevation of the River at Iroquois Dam was raised from 229 feet to 241 feet, reducing the fall from Lake Ontario to Point Rockaway from 16 feet to only 4 feet. The elevation just upriver of the Moses-Saunders Dam was raised from 160 feet to about 240 feet. This resulted in most of the fall in the International section of the River occurring at the Moses-Saunders Dam (NYS Dept. of Env. Cons. 1978; NYS Dept. of Health 1963).

When the River was first flooded for the power project, the maximum elevation at Moses-Saunders Dam was limited by design to 237.0 feet. At that time, Iroquois Dam had a fall of 3 to 5 feet. When the forebay restrictions at Moses-Saunders Dam were lifted a short time later, Iroquois Dam was operated in a fully-opened position with no fall. Since that time, Iroquois Dam has normally been operated in a fully-opened position, except when certain combinations of Lake Ontario levels and regulated flows cause undesirably high forebay levels at the Power Project, at which time the gates at Iroquois are partially closed to limit these high levels. This situation usually occurs above elevation 242. The gates at Iroquois are also used to help form an ice cover above the dam and to limit the amount of ice moving downstream (Bryce 1982).

At one point during construction, Iroquois Dam controlled Lake Ontario and had a head of 15 feet. The original location of the dam was to be Iroquois Point. However, hydraulic conditions proved to be unsatisfactory at that location due to an abrupt change in the direction of flow. As a result of that discovery, Iroquois Dam was located at Point Rockaway (Bryce 1982).

Upon completion, the St. Lawrence Power Project extended throughout the International Rapids section from the Ogdensburg/Prescott area downriver a distance of 45 miles to Cornwall. The natural fall in this area had been 92 feet, distributed as follows: Galop Rapids - 9 feet; Plat Rapids - 12 feet; Long Sault Rapids - 30 feet; the rest as river slope and small drops (Bryce 1982) (Fig. 2).

Throughout the project construction, adequate flows to ensure 14-foot navigation were provided. This condition existed until June 30, 1958, at which time navigation was suspended while the power pool was flooded. When navigation resumed on July 4, it was under deep-draft conditions in the Lake St. Lawrence area. When the project was completed, the navigation route was as follows: the headwater pool was entered through the Eisenhower/Snell Locks; the ships proceeded up the flooded river channel to Morrisburg and through the enlarged river channel to Iroquois; after passing through Iroquois Lock, the ships continued through the enlarged channel to Chimney Point, at which point they entered the natural river (Bryce 1982).

Numerous changes were made in the river channel to achieve the deep-draft navigation route and to provide "proper" flow conditions for the power project (Fig. 3; see also Fig. 41 in Appendix B). From the powerhouse down to Polly's Gut, channel enlargements were made to lower tailwater levels. This work was completed in November, 1961. Extensive channel enlargements were also made between Morrisburg and Sparrowhawk Point.

In addition to providing clearance for 27-foot draft navigation, the channel enlargements were made so that water-flow velocities would not exceed those at which an ice cover could form. This was determined to be 2.25 feet per second. Once the pack formed, it would continue to advance upstream provided the flow was less than or equal to 2.25 feet per second. A stable ice cover was required to prevent ice jams which restrict the outflow from Lake Ontario and reduce the head at Moses-Saunders Dam, resulting in a loss of power production. The ice cover first forms at the powerhouse at Moses-Saunders Dam, then progressively "packs" upriver until a firm, stable ice cover extends to the Cardinal area. Five ice booms were installed in 1959 to prevent ice from moving through the Galop Channel; a sixth boom was later added when five proved inadequate (Bryce 1982).

Extensive channel enlargements were also made in the reach from Cardinal to Chimney Point for the purpose of reducing velocities below 4 feet per second, a speed which was considered safe for navigation (Bryce 1982).

Record high water levels on Lake Ontario in 1952 caused extensive flooding and damages. In June of that year, the IJC began studying water level regulations for Lake Ontario and the St. Lawrence River. The regulation requirements of the three main user groups were basically incompatible. The riparian property owners wanted a reduction in the extremes of stage with a narrow range of stages (stable low water). The navigation interests wanted high minimums to reduce the need for dredging, and low maximums to reduce the height of docking facilities (stable medium /high water). The power interests, on the other hand, wanted a large range in lake levels to produce more uniform regulated flows; they also wanted high levels to maximize head and a flow distribution in phase with their load demand. A variety of plans was developed and modified to best meet the needs of all users (Bryce 1982).

The current plan, called 1958-D, went into effect in October, 1963. This plan was modified from 1958-C to improve Montreal Harbor water levels during low supply conditions. The Board of Control was also given discretionary authority under "Criterion K". When supplies exceeded the range on which the regulation plan was designed, the regulation plan could be abandoned and the levels and flows adjusted to provide the most benefits for upstream and downstream interests, while providing the least damages to all interests (Bryce 1982).

The early 1960's, particularly 1963-1965, were a period of low water supply (levels) in the Great Lakes, which impacted on the quantity of outflow. The mean annual flow for the ten-year period following the formation of Lake St. Lawrence (1959-1968) was 221,000 cfs (Table 9). The lowest mean annual flow during this period was 195,000 cfs in 1965, while the highest was 252,000 cfs in 1968. The lowest monthly mean flow was 176,000 cfs in May, 1965, while the

Table 9 . Annual means, highest and lowest monthly means, and range of monthly means for discharges at the Cornwall Gauge on the St. Lawrence River for the post-Seaway period, 1959-1968. All figures are in thousands of cubic feet per second (cfs).

YEAR	Normal Annual Means (all days)	Highest Monthly Means (all days)	Lowest Monthly Means (all days)	Range of Monthly Means
1959	223	263	178	85
1960	238	290	204	86
1961	234	279	209	70
1962	208	217	191	26
1963	206	217	188	39
1964	198	211	179	32
1965	195	227	176	51
1966	220	234	212	22
1967	234	281	212	69
1968	252	270	237	33
AVERAGE	221	249	199	50

highest was 290,000 cfs in June, 1960 (Table 9). The average annual range in monthly mean flows for this ten-year period was 50,000 cfs; the minimum range for any year was 22,000 cfs in 1966, while the maximum range was 86,000 cfs in 1960.

Present

> "The water resources picture of the St. Lawrence River-Eastern Lake Ontario shoreline is dominated by the massive, relatively constant volume of flow of the Great Lakes/River system. Inputs into the study area from precipitation are low, for New York State, and the contribution of large tributary streams is minor -- even though they originate in some of the highest precipitation areas of the state. The tributaries generally contain water of lower quality, have a more widely fluctuating regime and relative small volume." (Eschner and Wicker 1972).

The average flow of the St. Lawrence River at Ogdensburg is 30 times as large as the total flow of the five major streams (Oswegatchie, Grasse, Raquette, St. Regis, and Chateaugay Rivers) flowing into the International section. Approximately 86 percent of the flow entering the River from Lake Ontario comes from the upper four Great Lakes. Large variations in the water supply to the River from surrounding lands has little immediate effect on river flows (Eschner and Wicker 1972). High water levels from 1972-1975 were caused by long term above average precipitation in the Great Lakes Basin (SLEOC 1975).

The flow of the River is broken up by many islands and shoals which create back-eddies and quiescent areas. The River is stratified at its source, (Lake Ontario) in late summer, but a constriction in the main channel near Alexandria Bay results in complete mixing throughout the remainder of the River's course (Lawler, Matusky, and Skelly 1977).

The Moses-Saunders Dam and/or the Long Sault Dam control the outflow from Lake Ontario, and consequently affect its levels. The power project operates at times in a peaking mode (peaking flows are short-term increases in the water flow above the run-of-the-river flow to benefit hydropower production). The original peaking limits were ± 10,000 cfs from the daily mean flow prescribed by the regulation plan; the prescribed mean for the day had to be preserved, however. Later, the limits were expanded to ± 30,000 cfs with occasional increases to ± 50,000 cfs for short periods of time in the event of critical energy shortages. Increased flows caused by "peaking" are not allowed to exceed a total flow of 280,000 cfs. Most of the river flow exits through the powerhouse, but there are four other outlets for the River at Massena. These are Long Sault Dam, which can control the entire flow of the River, if necessary, but which seldom has water flowing through it; the Wiley-Dondero Canal, which uses a small amount for navigation; the Cornwall Canal, which utilizes a small amount for domestic and industrial purposes; and the Massena Intake, which provides small quantities of water for ALCOA and the Village of Massena (Bryce 1982).

The mean annual flow for the ten-year period 1969-1978 was 279,000 cfs (Table 10). This period included several years of rather high water levels. The lowest mean annual flow during this period was 250,000 cfs in 1970, which was almost equal to the greatest mean annual flow during the previous ten-year period (252,000 cfs in 1968). The greatest mean annual flow was 309,000 cfs, which occurred during a very wet year, 1973. The lowest monthly mean flow for any of these years was 215,000 cfs in February, 1977, while the highest, 350,000 cfs, occurred in June and July, 1973, and July, 1976.

The greatest range in mean monthly flows for any year between 1969 and 1982 (most recent year with complete records) occurred in 1976, when flows varied from a mean monthly high of 350,000 cfs in July (Table 11), to a mean monthly low of 239,000 cfs in December, a difference of 111,000 cfs. The lowest annual range for this period was 37,000 in 1970. The average annual range during this period was 73,000 cfs, which is high for the St. Lawrence River (53,000 cfs was the average annual range from 1861-1982), but not for most major rivers, which have extremely high annual fluctuations.

Prior to July, 1972, only twice since 1886 had the monthly mean flow exceeded 300,000 cfs -- in May and June of 1952 (Table 1). Since that time, this figure has been exceeded at least once in most years; in those years when it was not exceeded, the highest monthly mean still exceeded 295,00 cfs. Prior to 1886, there were five years when the monthly mean flow exceeded 300,000 cfs in May, June, and/or July. Since June, 1965, no mean monthly flow has been below 200,000 cfs; prior to that time, flows less than this level were commonplace, especially in the 1930's and early 1960's. These figures indicate changes in precipitation and the effects of the water level regulation, particularly the high outflows caused by the release of water to decrease flooding along the shores of Lake Ontario.

Regulation of the outflow has not completely prevented Lake Ontario shoreline flooding; higher rates of precipitation throughout the Great Lakes Basin offset the regulatory controls. Water flow in the St. Lawrence during the past years has been much higher than average (Tables 1 and 11).

Historically, a synchrony existed between high Lake Ontario water levels (Table 6) and St. Lawrence River flows. This synchrony has been modified to some extent by the changes in the "natural" hydraulics of the system caused by the construction and by the flow regulations. The Iroquois Dam increases the "roughness" of the channel, which decreases the water flow, which in turn backs up some water into Lake Ontario. If no means of regulation had existed during the recent period of high water supply, downstream shoreline damage could have been much higher. Tables 12 and 13 and Figures 7, 8, and 9 graphically illustrate some of these changes. The high levels shown for the winter months in Figure 7 were caused by annual ice jams at the foot of Cornwall Island. The construction and operation of the St. Lawrence Project essentially eliminated these peaks.

The months and years of minimum flows in the St. Lawrence River have corresponded quite well with the months and years of low water levels in Lake Ontario, especially during pre-Seaway times. Most of the minimum water levels occurred between 1934 and 1936, and the minimum flows corresponded with these

Table 10 . Annual means, highest and lowest monthly means, and range of monthly means for discharges at the Cornwall Gauge on the St. Lawrence River for the ten-year period from 1969-1978. All figures are in thousands of cubic feet per second (cfs).

YEAR	Normal Annual Means (all days)	Highest Monthly Means (all days)	Lowest Monthly Means (all days)	Range of Monthly Means
1969	266	297	235	62
1970	250	265	228	37
1971	258	285	235	50
1972	280	310	222	88
1973	309	350	252	98
1974	299	336	240	96
1975	284	308	239	69
1976	300	350	239	111
1977	262	300	215	85
1978	277	315	225	90
AVERAGE	279	312	233	79

Table 11 . Annual means, highest and lowest monthly means, and range of monthly means for discharges at the Cornwall Gauge on the St. Lawrence River for the present time period, 1969 through 1982 (the last year of record). All figures are in thousands of cubic feet per second (cfs).

YEAR	Normal Annual Means (all days)	Highest Monthly Means (all days)	Lowest Monthly Means (all days)	Range of Monthly Means
1969	266	297	235	62
1970	250	265	228	37
1971	258	285	235	50
1972	280	310	222	88
1973	309	350	252	98
1974	299	336	240	96
1975	284	308	239	69
1976	300	350	239	111
1977	262	300	215	85
1978	277	315	225	90
1979	276	296	221	75
1980	277	301	252	49
1981	270	300	236	64
1982	270	291	240	51
AVERAGE	277	307	234	73

Table 12 . Maximum and minimum monthly mean flows recorded at the Cornwall Gauge on the St. Lawrence River, as compared to the maximum and minimum monthly mean water levels on Lake Ontario. The period of record is 1900-1978.

		YEAR RECORDED					
		Minimum			Maximum		
MONTH	L[1]/F[2]	1st[3]	2nd	3rd	1st[4]	2nd	3rd
January	L	1935	1965	1936	1946	1952	1978
	F	1935	1934//1936		1946//1955		1952
February	L	1936	1935	1965	1952	1973	1978
	F	1936	1935	1934	1978	1973	1952//1974
March	L	1935	1936	1964	1952	1973	1930
	F	1935	1936//1965		1974	1973//1978	
April	L	1935	1934	1965	1973	1952	1951
	F	1964	1965	1935	1973	1974	1976
May	L	1935	1934	1915	1973	1952	1951
	F	1965	1964	1963	1973	1976	1978
June	L	1935	1934	1915	1952	1973	1947
	F	1965	1964	1935	1973	1976	1974
July	L	1934	1935	1936	1947	1952	1941
	F	1934	1964//1965		1973//1976		1974
August	L	1934	1935	1936	1947	1952	1943
	F	1934	1935	1936	1974	1976	1973
September	L	1934	1935	1936	1947	1952	1929
	F	1934	1935	1936	1973	1974	1972
October	L	1934	1935	1936	1945	1947	1952
	F	1934	1935	1936//1933	1973	1974	1972//1975//1976
November	L	1934	1935	1933	1945	1943	1947
	F	1934	1935	1933	1975//1976		1977
December	L	1934	1935//1964		1945	1951	1952
	F	1934	1935	1933	1967//1974		1972
Annual Mean	L	1935	1934	1936	1952	1951	1973
	F	1935//1934		1936	1973	1976	1974

[1]L=Lake Ontario Water Levels
[2]F=St. Lawrence River Flows (at Cornwall, Ontario)
[3]1st=Year lowest value occurred; 2nd=Year second lowest value occurred; 3rd=Year third lowest value occurred.
[4]1st=Year highest value occurred; 2nd=Year second highest value occurred; 3rd=Year third highest value occurred.
// Indicates tie (i.e., equal values for both or all three years).

Table 13 . Number of times each year between 1900 and 1978 ranked first, second, or third for maximum or minimum St. Lawrence River flows or Lake Ontario water levels (see Table 12). Years not ranked are not listed.

MINIMUM

YEAR	L[1]/F[2]	Number of Months Ranked 1st[3]	2nd	3rd	Total[4]
1915	L	0	0	2	2
	F	0	0	0	0
1933	L	0	0	1	1
	F	0	0	3	3
1934	L	6	4	0	10
	F	7	1	1	9
1935	L	6	7	0	13
	F	3	6	2	11
1936	L	1	1	6	8
	F	1	2	4	7
1963	L	0	0	0	0
	F	0	0	1	1
1964	L	0	1	1	2
	F	1	3	0	4
1965	L	0	1	2	3
	F	2	3	0	5
TOTALS[6]	L	13	14	12	39
	F	14	15	11	40

MAXIMUM

YEAR	L[1]/F[2]	Number of Months Ranked 1st[5]	2nd	3rd	Total[4]
1929	L	0	0	1	1
	F	0	0	0	0
1930	L	0	0	1	1
	F	0	0	0	0
1943	L	0	1	1	2
	F	0	0	0	0
1945	L	3	0	0	3
	F	0	0	0	0
1946	L	1	0	0	1
	F	1	0	0	1
1947	L	3	1	2	6
	F	0	0	0	0
1951	L	0	2	3	5
	F	0	0	0	0
1952	L	4	6	2	12
	F	0	0	2	2
1955	L	0	0	0	0
	F	1	0	0	1
1967	L	0	0	0	0
	F	1	0	0	1
1972	L	0	0	0	0
	F	0	0	3	3
1973	L	2	3	1	6
	F	7	2	1	10
1974	L	0	0	0	0
	F	3	3	4	10
1975	L	0	0	0	0
	F	1	0	1	2
1976	L	0	0	0	0
	F	2	4	2	8
1977	L	0	0	0	0
	F	0	0	1	1
1978	L	0	0	2	2
	F	1	1	1	3
TOTALS[6]	L	13	13	13	39
	F	17	10	15	42

[1]L=Lake Ontario Water Levels
[2]F=St. Lawrence River Flows (at Cornwall, Ontario)
[3]1st=Number of times specific year had the lowest mean water level/flow; 2nd and 3rd refer to number of times ranked second and third lowest.
[4]Total=Number of times specific year ranked in top three between 1900 and 1978.
[5]1st=Number of times specific year had the highest mean water level/flow; 2nd and 3rd refer to number of times ranked second and third highest.
[6]Totals do not necessarily add up to 13 (12 months plus annual mean) due to ties.

Figure 7. St. Lawrence River monthly mean water levels, 1920-1981 (International St. Lawrence River Board of Control 1982).

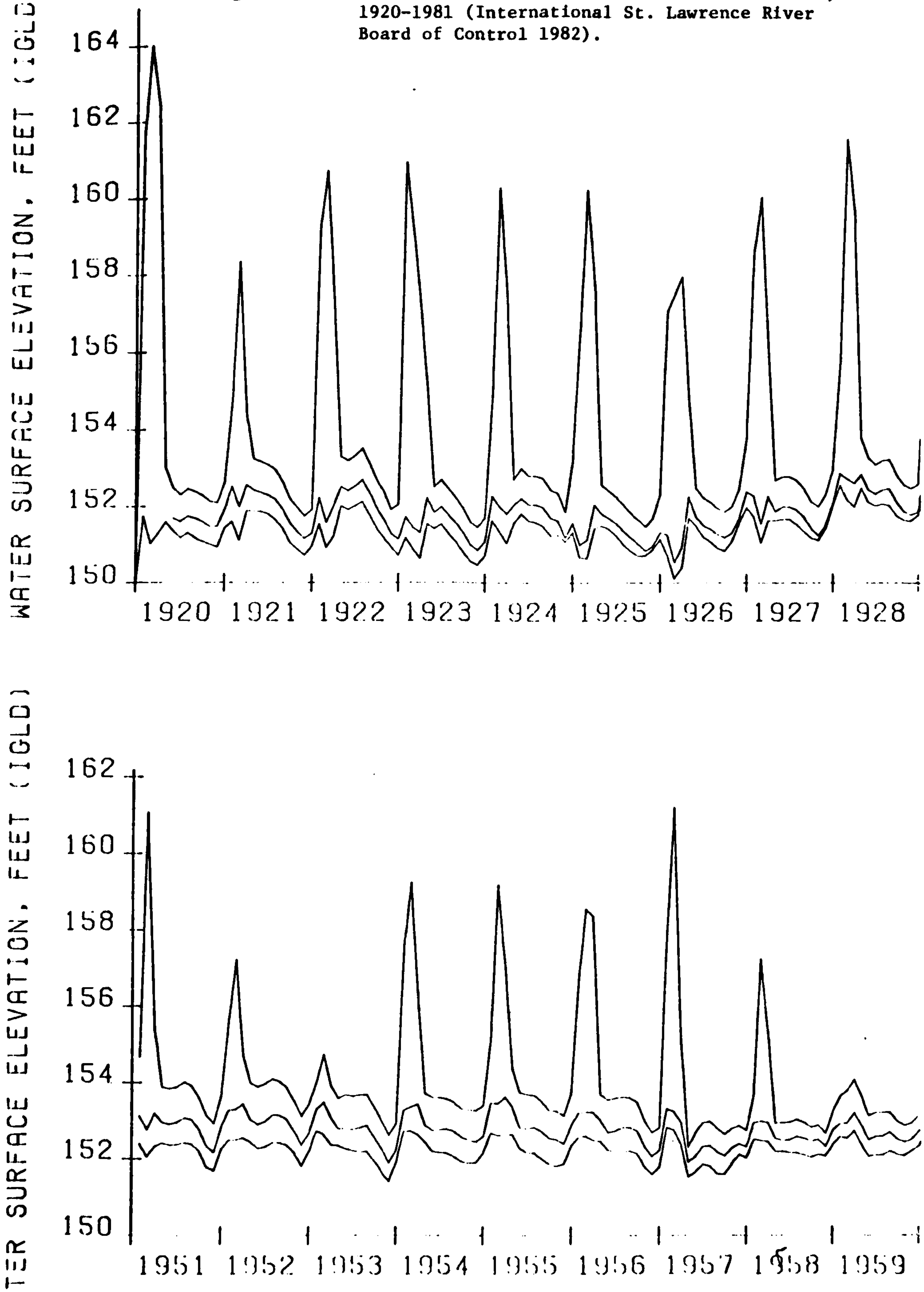
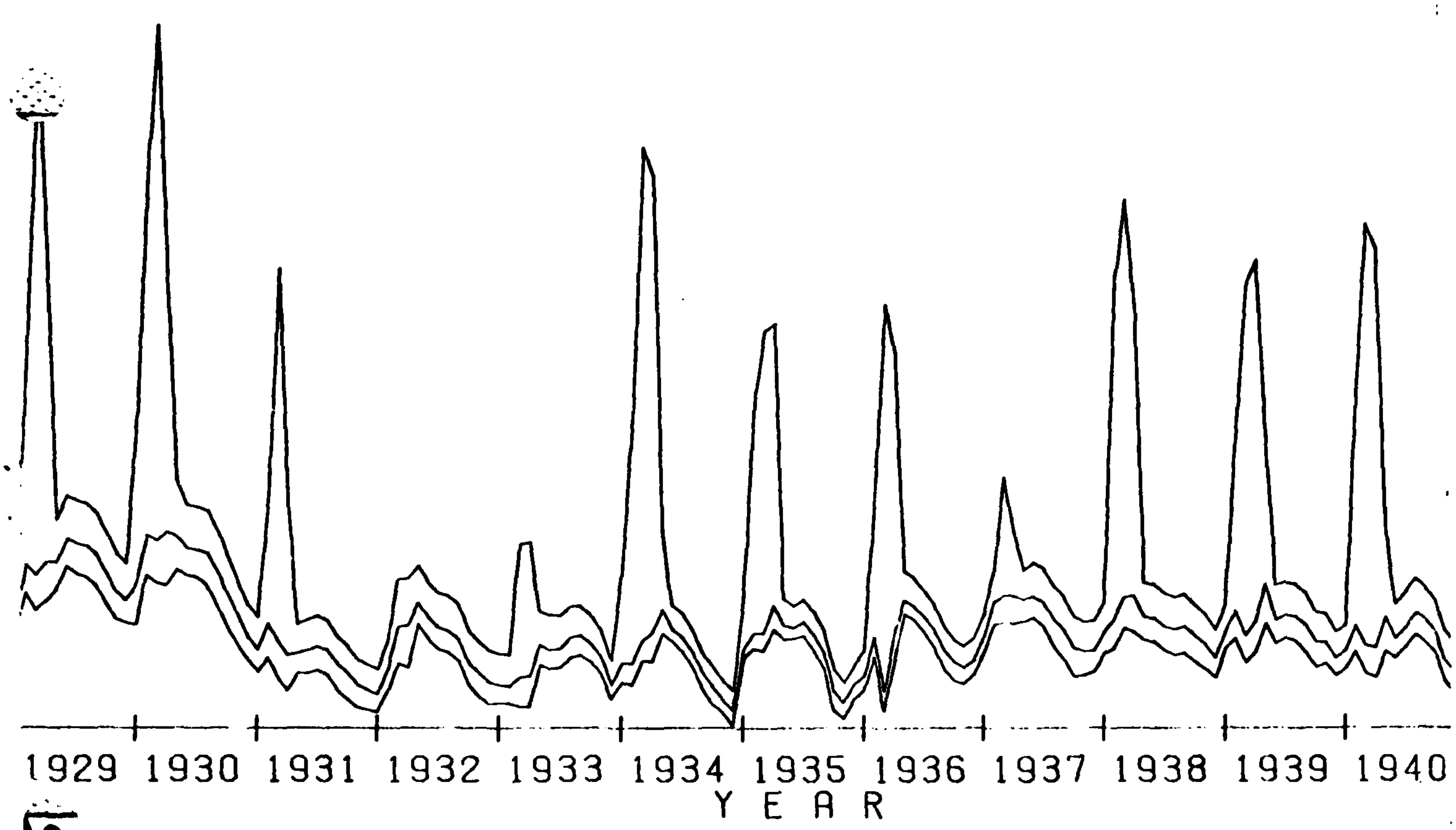


Figure 7. (Continued)



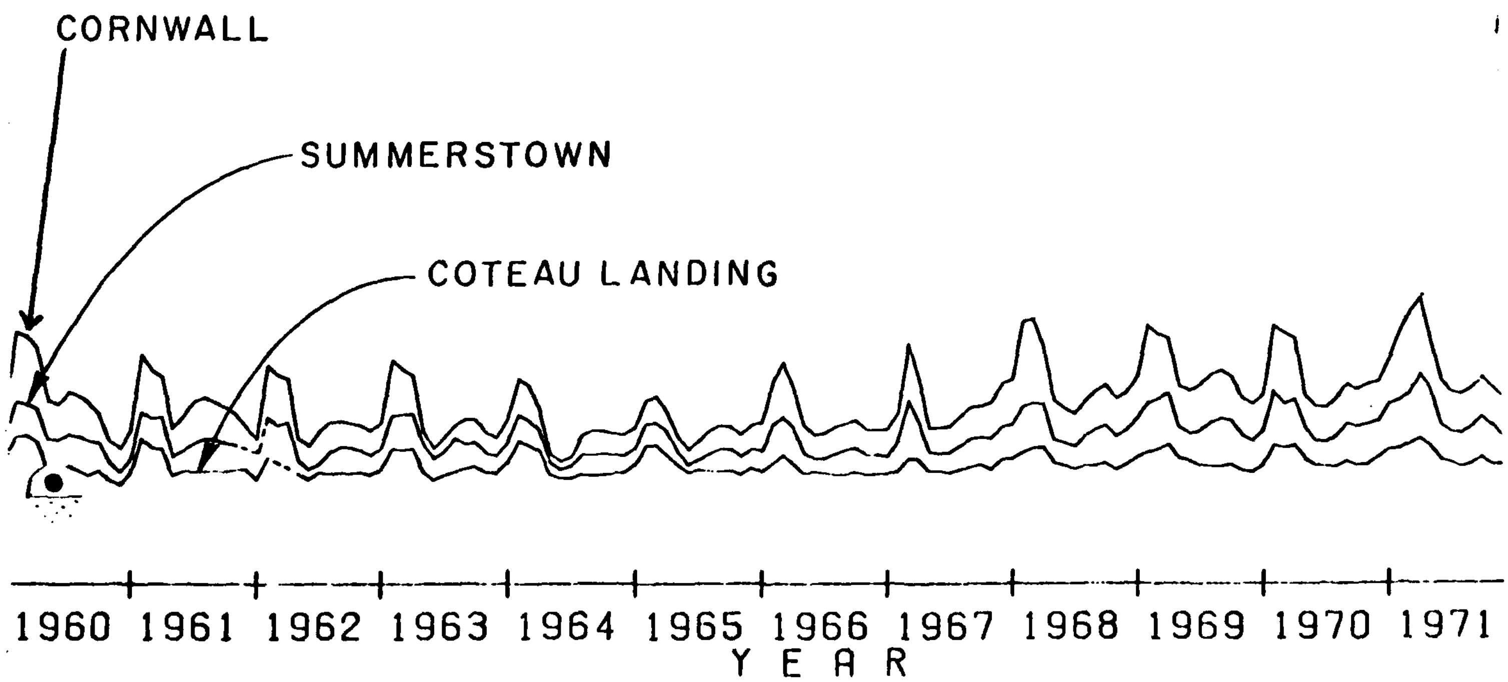
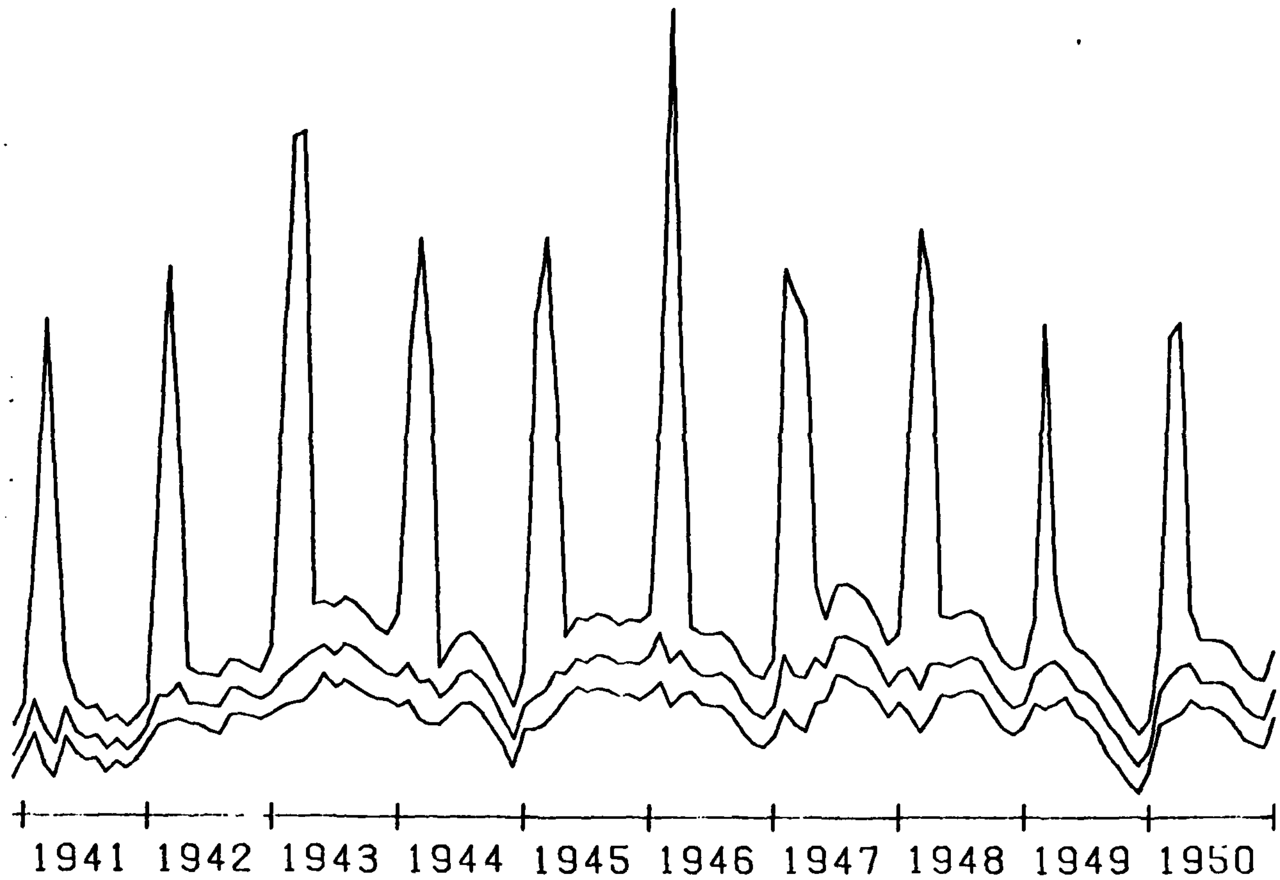


Figure 7. (Continued)



ST. LAWRENCE RIVER
MONTHLY MEAN WATER LEVELS

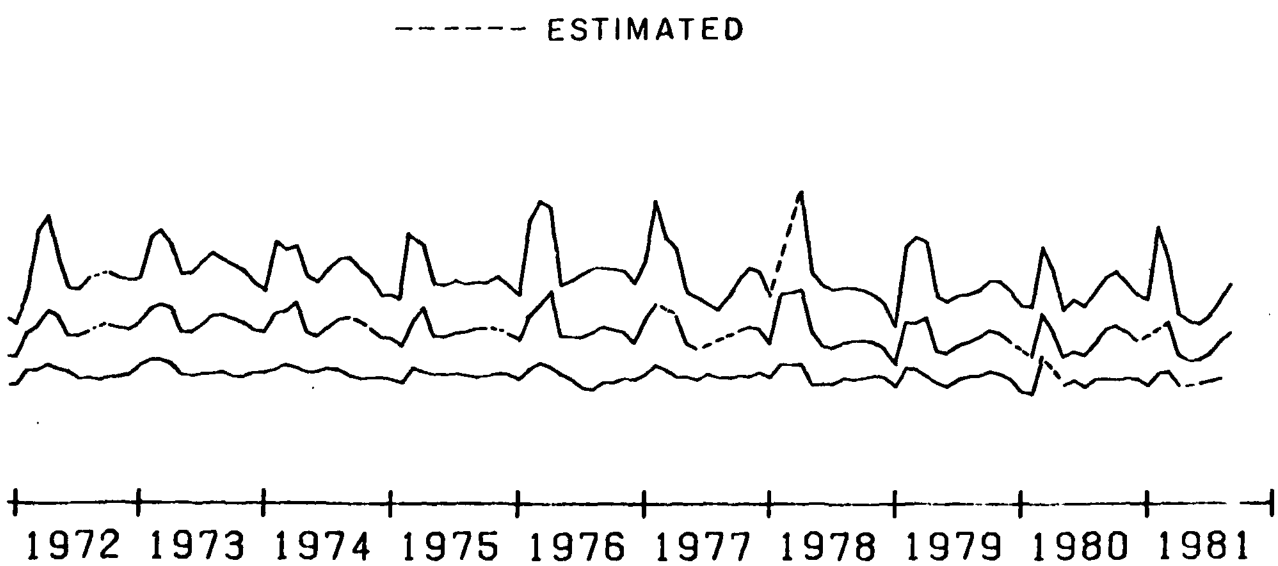
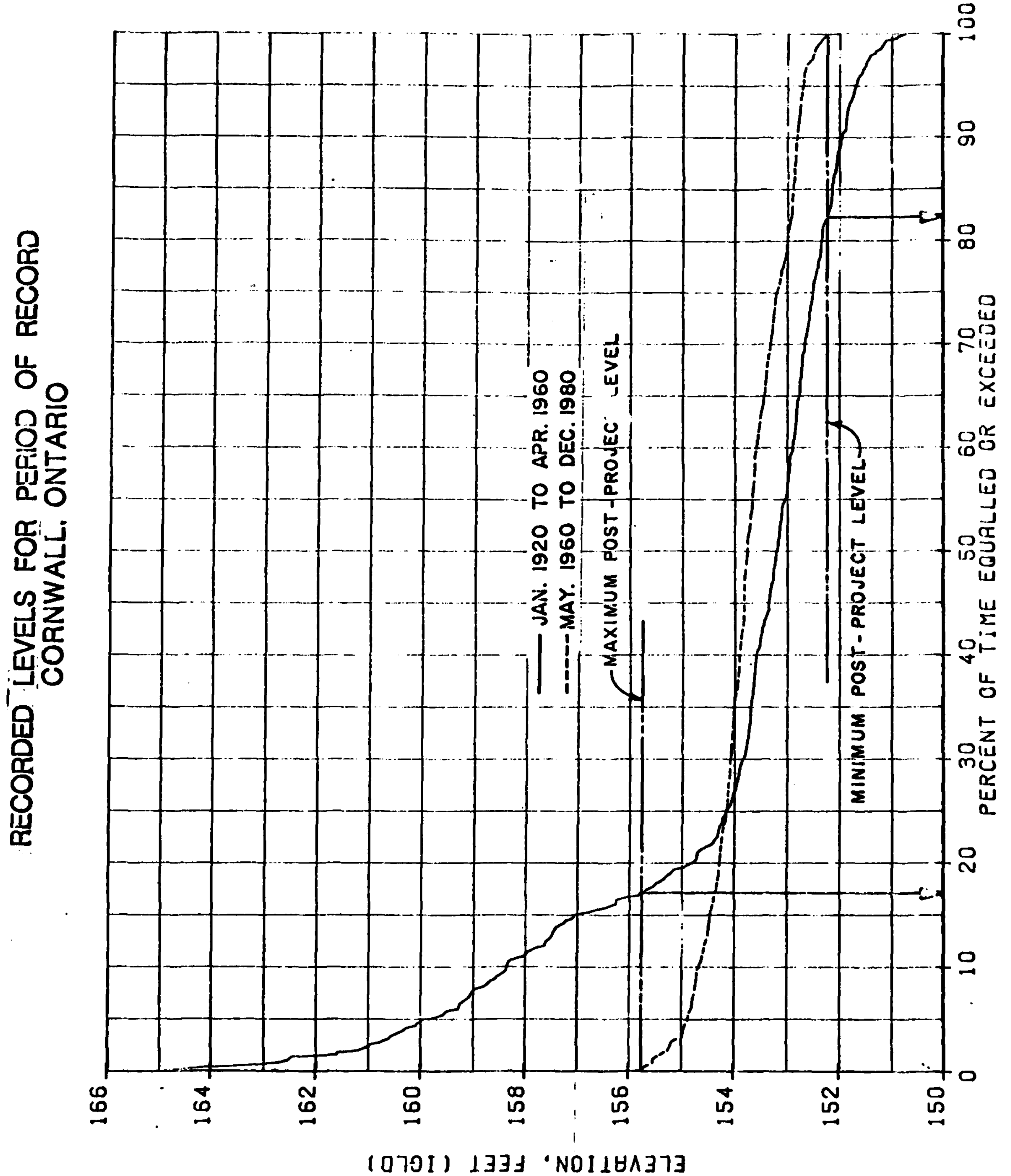
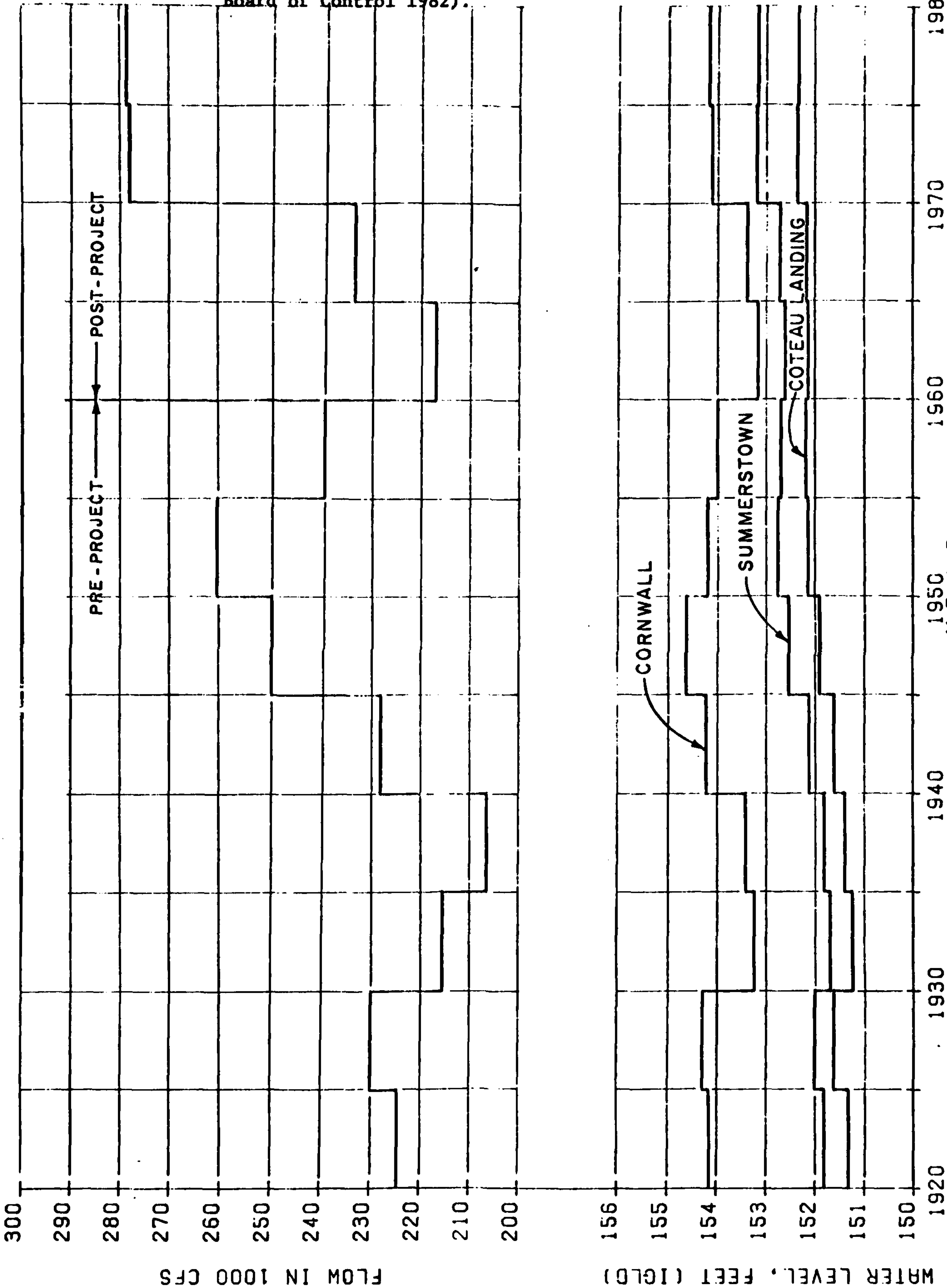


Figure 8. Stage duration curves for pre-project (1920-1960) and post-project (1960-1980) water levels at Cornwall, Ontario (International St. Lawrence River Board of Control 1982).



Summerstown, and Couteau Landing (International St. Lawrence River Board of Control 1982).



levels. However, in May, June, and July, the low flow years were generally 1963-1965, while the low water level years were 1934-1936, just as they had been for other months (this was a period of very dry years during the "dustbowl" era). The fact that the flows do not correspond with the water levels indicates that water was held back during the summer months in the 1963 through 1965 period.

The maximum levels and flows do not correspond as well. The high water level years appear to be 1951, 1952, 1973, 1945, 1947, while the years of high flow are the 1970's, particularly 1973, 1974, and 1976. These were all generally wet years. However, only the 1973 data show a correlation between high Lake Ontario water levels and high St. Lawrence River outflows. This indicates that water levels were artifically reduced in the 1970's by allowing a greater flow in the River. Had regulation not been in effect and the additional channel capacity not available, the maximum flow years would have correlated more closely with the maximum water level years.

Physicochemical Environment

Pre-Seaway

Very little physicochemical data are available for the St. Lawrence River prior to Seaway construction. Much of the data that is available deals with tributary streams and lakes in the St. Lawrence watershed. The State of New York Conservation Department (1931) sampled the River at various locations in 1930. They also conducted some sampling throughout the watershed. All of the sampling in the main River occurred between Ogdensburg and Cornwall. No upriver areas were sampled.

The samples were taken in late June and early July when the air temperature was 19°-$30^{\circ}C$ and the water temperature ranged from 17°-$22.5^{\circ}C$. Parameters that were measured included free carbon dioxide, alkalinity, dissolved oxygen [parts per million (ppm) and percent saturation], and pH. The pH was slightly basic, ranging from 8.0-8.6 (Table 14), with the highest readings occurring near sewer outlets or creek mouths. The typical pH reading was 8.2. The oxygen saturation was quite high, ranging from 84.5 percent to 124.6 percent. This was due to the rapid flow throughout most of that stretch of the River. The dissolved oxygen content ranged from 8.0 ppm to 10.1 ppm.

The Conservation Department also conducted extensive sampling throughout the Grasse, Salmon, Chateaugay, Marble, Trout, Raquette, and Oswegatchie Rivers, and the tributaries and watersheds of each. Results varied, but most had pH readings that were slightly basic, although the upper Grasse River was slightly acidic in places, perhaps due to acid mine drainage. With the exception of the upper Grasse River, most of the sampling stations were at or near oxygen saturation. The dissolved oxygen saturation in the Grasse River from DeGrasse to Massena was only 60-70 percent, which is low for such a long stretch of northern New York water. This relatively low saturation level was due to serious pollution problems such as municipal sewage, iron ore waste, and paper pulp, although the latter two were in a decline when the survey was taken.

Table 14. Water quality data for the St. Lawrence River for the pre-Seaway time frame (prior to 1959). All data is in parts per million (mg/l) except pH (pH scale).

WATER QUALITY PARAMETERS

Sample location	Alkalinity as $CaCO_3$	Hardness as $CaCO_3$	B.O.D.	pH	Dissolved oxygen	Chloride	Iron	Calcium	Magnesium	Nitrite	Nitrate	Total phosphorus	Sulfate
Patterson Bay[1]	94.0	139	0.4	8.3	8.7	22.0	0.060	40.0	9.5	0.002	0.05	0.100	23.0
Maitland, Ont.[1]	96.0	138	1.0	8.3	9.3	23.0	0.030	40.0	9.2	0.003	0.05	0.090	23.4
Little Church Bay[1]	98.0	138	0.7	8.3	8.4	22.0	0.020	40.0	9.2	0.003	0.05	0.140	22.2
Prescott[1]	97.0	138	1.1	8.3	9.2	22.0	0.030	40.0	9.2	0.003	0.05	0.120	21.6
Ogdensburg[2]	90.6	---	---	8.2	8.3	---	---	---	---	---	---	---	---
Tibbits Creek Mouth[2]	97.4	---	---	8.5	10.1	---	---	---	---	---	---	---	---
Red Mills[2]	100.2	---	---	8.0	8.0	---	---	---	---	---	---	---	---
Waddington[2]	87.0	---	---	8.2	9.0	---	---	---	---	---	---	---	---
Cornwall[2]	87.0	---	---	8.2	9.4	---	---	---	---	---	---	---	---

[1]Academy of Natural Sciences of Philadelphia 1953 (23^{o} C Water Temperature)

[2]State of New York Conservation Dept. 1931 (18.5^{o}-22.2^{o} C Water Temperature)

Other physicochemical data were collected on the Canadian side of the River between Patterson Bay and Prescott in 1952 by the Academy of Natural Sciences of Philadelphia (1953). Data were collected at four stations, and included such parameters as dissolved oxygen, alkalinity, hardness, turbidity, pH, biochemical oxygen demand, specific conductivity, and quantities of various minerals and chemical compounds. Since the stations were in close proximity, the data varied little between stations. The dissolved oxygen ranged from 8.4-9.3 ppm (Table 14), while the pH was 8.3 at all stations. Calcium was present at 40 ppm at all sites, while chlorine ranged from 22.0-23.0 ppm and sulfides (SO_4) ranged from 21.6-23.4 ppm. All other chemicals were found in relatively small quantities. The biochemical oxygen demand ranged from 0.4 ppm to 1.1 ppm.

In general, early researchers found the St. Lawrence to have excellent water quality, with localized areas of pollution near sewer outfalls and other waste sites. This was due to the large volume of flow which enabled the River to dilute and carry away most of the pollution, and the relatively sparse human populations, which put less demand on the River.

Post-Seaway

During the period following the Seaway opening in 1959, the water quality remained much the same as it had been. The surface water resources were generally of good quality due to sparse populations, low levels of industrial activity, the location of the larger communities and industries adjacent to the River, and the high recovery characteristics of the St. Lawrence and its tributaries. Water quality problems were generally localized around individual waste sources such as cottages (Eschner and Wicker 1972; NYS Dept. of Health 1963).

All of the villages along the St. Lawrence River except Waddington discharged raw municipal sewage into the River. In addition to sewage, other pollution sources included industrial wastes in Massena, power plant discharges in Ogdensburg, oil pollution from industrial shipping and recreational boating throughout the River, and several point sources such as runoff from rural and urban land; residues from the application of chemicals, fertilizers, pesticides, and de-icing compounds; and erosion products, particularly those from subdivision and roadway construction (Eschner and Wicker 1972; NYS Dept. of Health 1963).

Some pollution also existed in the major tributary streams. The main pollution source in the Raquette River was municipal wastes, particularly around the Potsdam area, where a sharp increase in biochemical oxygen demand (BOD) and coliform count, and a drop in dissolved oxygen, occurred. In the Grasse River, the prime sources of pollution were treated municipal wastes from Canton and Massena and industrial wastes from Massena. The lower reaches of the Grasse River had a lower dissolved oxygen content due to these pollution sources and the warmer temperatures and slower currents which resulted in less re-aeration. Paper mill wastes were the prime pollution source in the upper section of the Oswegatchie River, while municipal, institutional, and dairy wastes provided the bulk of pollution in the lower reach, beginning around Gouverneur. Chippewa Creek was also extensively polluted by a slaughterhouse and milk-processing plant; however, natural turbulence over a rocky bottom dissipated much of the pollution before it reached the St. Lawrence (NYS Dept. of Health 1963).

Eschner and Wicker (1972) compiled water quality data for two sites on the St. Lawrence River -- Cape Vincent and Massena (Table 15). There were also sites near the mouth of the Oswegatchie River in Ogdensburg and near the mouth of the Grasse River in Massena. The data were compiled for a period from October, 1964, through September, 1967, and from October, 1967, through September, 1970. There was little difference in data between Cape Vincent and Massena for either time frame. At Cape Vincent, pH was 8.1 for both time frames, while at Massena it was 8.0 and 7.8 for the two time periods, respectively. The pH was lower in the tributaries -- 7.4 in the Oswegatchie River and 7.3 in the Grasse River. Both tributaries were classified "C" (best usage fishing, and other uses besides bathing and water supply), while the St. Lawrence was classified "A" (best usage water supply used for drinking or food processing purposes) at both sites. Coliform count was much higher in the tributaries (2,400/100 ml for the Grasse River, 240/100 ml for the Oswegatchie River) than in the main River (8.8/100 ml at Cape Vincent, 39/100 ml and 77/100 ml at Massena) (see Table 19). Total alkalinity was twice as high in the St. Lawrence as in the tributaries, while phosphates and nitrates were lower. In general, the St. Lawrence had a higher water quality than its major tributaries but was relatively unaffected by pollution from these tributaries due to their small flow relative to the volume flowing through the St. Lawrence.

Present

The water quality of the St. Lawrence River is high, except in the vicinity of municipal and industrial discharges. The dissolved oxygen level is at or near the saturation point. In general, the water quality in the main flow of the St. Lawrence River closely reflects that of Lake Ontario. However, the water quality in peripheral areas along the River, such as wetlands and bays, is independent of that in the main flow during periods of ice cover and spring thaw (Lawler, Matusky, and Skelly 1977; Young, DePinto, and Marshall 1979).

The general water quality of the River has improved since the period when the Seaway was constructed. Some sources of pollution on the tributary streams, such as pulp mills and iron mines, have closed down. Most villages now have sewage treatment facilities, and most industries have at least partially cleaned up their effluents (Tables 16 and 17). The Village of Gouverneur is the last significant community in the New York State portion of the St. Lawrence River drainage basin which has not constructed secondary wastewater treatment. The Village now discharges raw wastes from about 4,000 people into the Oswegatchie River, creating an area of degraded water quality. The Village is expected to start construction on a wastewater treatment plant in the near future. Some major localized sources of pollution (such as heavy metals) are a recent problem, especially in the Maitland, Ontario - Ogdensburg, New York area, due to the industrial development that occurred following the availability of cheap hydropower.

Table 15. Water quality data for the St. Lawrence River during the post-Seaway time frame (1959-1968). All data is in parts per million (mg/l) except pH (pH scale) and coliform count (#/100 ml). This data was collected from 1964-1967.*

WATER QUALITY PARAMETERS

Sample location	Alkalinity as $CaCO_3$	Hardness as $CaCO_3$	Coliform (MPN)	pH	Nitrate	Total phosphorus
Oswegatchie River (Ogdensburg)	32.0	53	240	7.4	1.17	0.220
Cape Vincent	86.0	134	8.8	8.1	0.52	0.140
Massena	88.0	125	76.6	8.0	---	---
Grasse River (Massena)	41.0	64	2400	7.3	0.91	0.410

*Eschner and Wicker 1972 (Means for Entire Year)

Table 16 . Discharge loads into the St. Lawrence River from municipal dischargers in New York State.

DISCHARGER & LOCATION	DISCHARGE TO INDICATED PROBLEM AREA	AVERAGE FLOW MGD	REPORTED PARAMETERS	EFFLUENT REQUIREMENTS	REPORT LOADINGS	REMARKS
1. Alexandria Bay STP		0.75	BOD_5 SS F.C.	Secondary Stds.		In compliance
2. Canton STP		2.0	BOD_5 SS F.C.	Secondary Stds.		
3. Cape Vincent STP		0.140	BOD_5 SS F.C.	Secondary Stds.		In compliance
4. Clayton STP		0.3	BOD_5 SS F.C.	Secondary Stds.		In compliance
5. Ogdensburg STP		6.5	BOD_5 SS Phosphorus F.C.	Secondary Stds.		In compliance
6. Potsdam STP		3.3	BOD_5 SS F.C.	Secondary Stds.		In Compliance
7. Thousand Island Park, STP		0.250	BOD_5 SS F.C.	Secondary Stds.		In Compliance
8. Waddington STP		0.16	BOD_5 SS F.C.	Secondary Stds.		Nearly in Compliance

Table 17 . Discharge loads into the St. Lawrence River from industrial dischargers in New York State.

DISCHARGER & LOCATION	DISCHARGE TO INDICATED PROBLEM AREA	AVERAGE FLOW MGD	REPORTED PARAMETERS	EFFLUENT REQUIREMENTS	REMARKS
1. Aluminum Company * of America, Massena (Main process discharge)	Grass River	18	Oil & Grease	15 mg/1	
			TSS	885 kg/da. Avg.	
			F	1200 #/da. "	
			Cu	13.6 kg/da. "	
			NH_3	2 mg/1 "	
			CN	6.8 kg/da. "	
			Al	590 kg/da.	
2. General Motors * Corp. (Raquette River)			BOD_5	102 kg/da. Max.	
			COD_5	265 kg/da. Avg.	
			TOC	183 kg/da. Avg.	
			Phenol	2.3 kg/da. Avg.	
			TSS	129 kg/da. Avg.	
			Cr	0.2 kg/da. Avg.	
			Cu	0.3 kg/da. "	
			PCB's	1 mg/1 Avg.	
3. James River Corp. * Natural Dam Div.- (Oswegatchie R.)		1.1	BOD_5	475 #/day. Avg.	
			TSS	380 #/day. Avg.	
4. Newton Falls * Paper Mill, Inc. (Process water)			BOD_5	4645 #/day. Avg.	
			TSS	6275 #/da. Avg.	
5. Potsdam Paper Corp. * (Raquette River)			BOD_5	1175 #/da. Avg.	
			TSS	1375 #/da. Avg.	
6. Reynolds Metals * Co. - Massena			F (total)	322 kg/da. Avg.	
			Zn	2.49 kg/da. "	
			TSS	199 kg/da.	
			phenols	0.5 mg/1 Max.	
7. Chagrin Fibers, Inc. * (Raquette River)			BOD_5	225 #/da. Avg.	
			TSS	223 #/da. Avg.	

Table 17 . (continued)

DISCHARGER & LOCATION	DISCHARGE TO INDICATED PROBLEM AREA	AVERAGE FLOW MGD	REPORTED PARAMETERS	EFFLUENT REQUIREMENTS	REMARKS
8. St. Joe Minerals (Turnpike Cr.)			TSS	20 mg/1 daily avg.	
			Cu (total)	0.15 " " "	
			Zn "	0.3 " " "	
			Pb "	0.1 " " "	
			Hg "	0.001 " " "	
			Cd "	0.05 " " "	
			Oil & Grease	15 mg/1 daily max.	
			Fe	2.0	
			Mn	1.0 " " "	

* Limits on extended permits. The new discharge permits, when issued, will likely contain, more stringent limits.

A variety of surveys have been conducted since the early 1970's to determine various water quality parameters on the St. Lawrence River. Whereas earlier studies tended to concentrate on the tributary streams and the watershed, recent studies have focused on the main River. Mills, Smith, and Forney (1978a) found that phosphorus is the primary nutrient controlling algal production during the summer. Phosphorus concentrations were higher downriver from the Ogdensburg-Prescott area; however, the relatively low standing crop of phytoplankton in this area indicates that retention time for the phosphorus is low, due to the current velocities which are much greater than in upriver areas. Thus, the available nutrients are not being converted to biomass. Lawler, Matusky, and Skelly (1977) found that the highest phosphorus values had been recorded downriver near Cornwall.

Nitrate and nitrite concentrations are higher in the winter than in the summer, but Mills, Smith, and Forney (1978a) found very little variability from Cape Vincent to Lake St. Lawrence (Tables 18 and 19). However, Lawler, Matusky, and Skelly (1977) noted that while nitrogen levels vary only slightly throughout the River, they are indicative of wastewater discharges; the maximum level occurs near a waste discharge at Brockville, Ontario. The upper end of the River between Kingston and Alexandria Bay shows nitrate variations with depth. However, near Alexandria Bay the waters mix and nitrates are evenly distributed. BUFO (1977) also found that the water chemistry in the Lake of the Isles area is relatively homogeneous, due to the flushing and mixing action of the St. Lawrence River.

Silicon, which is important to diatoms for cell wall formation, is highest in the Lake St. Lawrence area due to water level controls and the suspension of sand. Other important elements include calcium, the dominant cation, and chloride, an important anion (Mills, Smith, and Forney 1978a).

Although several water quality studies have been conducted on the St. Lawrence River in the last ten years, there are relatively little data to compare. Few sites were duplicated and different water quality parameters were chosen for each study. The available data have been summarized in Table 19. The general trends show pH levels ranging from 6.9 to 8.2, with most around 8.0 and 8.1. The lower values are found in marshes. The dissolved oxygen level varies from 4.6 ppm (parts per million) to 14.6 ppm, with most values, except those in marshes or small tributary streams, being around 14.4 ppm or 14.5 ppm. Most of these dissolved oxygen samples were collected during winter; oxygen saturation at 0° C is about 14.2 ppm. Most of the chemical elements show very little variation in quantity from one portion of the River to another. Calcium values ranged from 35 to 49 ppm. Chloride values varied from 3.0 to 35.0 ppm, but the low values (below 30.0 ppm) were found in marshes and wetlands.

In summary, water quality parameters are fairly homogenous throughout the River and are indicative of good water quality. The exceptions are localized. Water quality has also not been drastically changed over time. Most of the changes that did occur are as a result of sewage treatment and other pollution controls.

Table 18. Comparison of water quality data for two areas of the St. Lawrence River from 1953 through 1978. All data is in parts per million (mg/l) except pH (pH scale).

Water quality parameters	Ogdensburg/Prescott		Cape Vincent		
	1953[1]	1978[2]	1964-1967[3]	1967-1970[3]	1978[2]
Alkalinity as $CaCO_3$	97.0	55.0	86.0	90.0	58.0
pH	8.3	8.1	8.1	8.1	7.8-8.0
Chloride	22.0	31.1	- -	- -	- -
Iron	0.030	0.006	- -	- -	- -
Calcium	40	42	- -	- -	- -
Magnesium	9.2	8.4	- -	- -	- -
Nitrite	0.003	0.002	- -	- -	- -
Nitrate	0.05	0.35	0.52	0.40	0.35
Total phosphorus	0.120	0.019	0.140	0.100	0.021
Sulfate	21.6	9.2	- -	- -	- -

[1]Academy of Natural Sciences of Philadelphia 1953 (23° C Water Temperature)

[2]Mills, Smith, and Forney 1978d. (Winter Samples)

[3]Eschner and Wicker 1972 (Means for Entire Year)

Table 19. Water quality data for the St. Lawrence River and Lake Ontario during the present time frame (1970-1979). (Data for Lake Ontario was collected in 1965 and is included for comparison with St. Lawrence River Channel sites.) All data is in parts per million (mg/l) except pH (pH scale) and coliform count (#/100 ml).

WATER QUALITY PARAMETERS

Sample location	Alkalinity as $CaCO_3$	Hardness as $CaCO_3$	Coliform (MPN)	Suspended solids	pH	Dissolved oxygen	Chloride	Iron	Calcium	Magnesium	Nitrite	Nitrate	Total phosphorus	Sulfate	Potassium	Sodium
St. Lawrence River (Channel)[3,4]	87-94	128-134	---	1.0-7.2	7.4-8.2	14.5	30-35	---	38-42	7.8-8.4	---	---	0.010-0.025	24.3-27.6	1.2-1.4	10.4-11.0
Lake Ontario[4,5,6]	95-100	---	---	---	8.0-9.0	11.6-13.6	24.7	---	43-46	8.9-9.4	---	---	0.016-0.035	29.5-31.3	1.4-2.1	11.5
Cape Vincent[1]	90.0	126	8.8	---	8.1	---	---	---	---	---	---	0.40	0.010	---	---	---
Cape Vincent[2]	58.0	---	---	1.8	7.9	---	32.7	0.015	39	7.8	0.002	0.35	0.021	8.6	1.26	10.4
Millen Bay Marsh[7]	119.9	---	---	---	7.2	8.1	19.2	0.100	49	12.5	---	0.33	0.039	---	2.97	42.2
Upper French Creek Mainstream Marsh[7]	110.2	---	---	---	7.2	7.2	6.2	0.050	48	7.6	---	0.11	0.040	---	1.81	34.1
Upper French Creek Tributary Marsh[7]	99.1	---	---	---	7.2	4.6	3.0	0.110	38	8.2	---	0.17	0.122	---	1.43	33.8
Mullet Creek Marsh[7]	90.7	---	---	---	7.3	7.6	13.8	0.150	35	9.3	---	0.21	0.027	---	2.66	34.4
Lake of the Isles[3]	---	123	<200	---	---	12.7	---	---	---	---	---	<0.05	0.060	25.0	---	---
Cranberry Creek Marsh[7]	97.5	---	---	---	7.3	6.5	6.5	0.150	35	11.4	---	0.14	0.040	---	2.36	35.0
Chippewa Bay[2]	63.3	---	---	1.3	8.0	---	30.0	0.009	42	8.4	0.001	0.38	0.020	9.0	1.40	11.0

Table 19. (continued)

Sample location	Alkalinity as $CaCO_3$	Hardness as $CaCO_3$	Coliform (MPN)	Suspended solids	pH	Dissolved oxygen	Chloride	Iron	Calcium	Magnesium	Nitrite	Nitrate	Total phosphorus	Sulfate	Potassium	Sodium
Blind Bay (Channel)[4]	90.8	133	---	1.2	8.1	14.5	32.8	---	41	---	---	---	0.015	---	---	---
Blind Bay (Shore/Shoal)[4]	91.0	132	---	1.1	8.1	14.4	32.2	---	41	---	---	---	0.016	---	---	---
Blind Bay (Bay)[4]	88.9	129	---	2.4	8.0	14.4	30.8	---	40	---	---	---	0.019	---	---	---
Blind Bay (Wetland)[4]	130.9	154	---	48.2	6.9	12.6	16.5	---	48	---	---	---	0.129	---	---	---
Morristown (Channel)[4]	90.5	131	---	1.4	8.3	14.5	31.7	---	40	---	---	---	0.015	---	---	---
Morristown (Shore/Shoal)[4]	90.4	132	---	0.8	8.2	14.0	32.5	---	40	---	---	---	0.017	---	---	---
Morristown (Bay)[4]	90.7	132	---	1.0	8.1	13.9	33.0	---	40	---	---	---	0.018	---	---	---
Morristown (Wetland)[4]	113.5	146	---	4.3	7.6	11.4	26.7	---	43	---	---	---	0.070	---	---	---
Oswegatchie River (Ogdensburg)[1]	38.0	13	240	---	---	---	---	---	---	---	---	0.74	0.120	---	---	---
Ogdensburg/Prescott[2]	55.0	---	---	1.8	8.1	---	31.1	0.006	42	8.4	0.001	0.35	0.019	9.2	1.36	11.0
Galop Island[2]	56.7	---	---	4.5	8.1	---	30.4	0.004	42	8.2	0.002	0.29	0.025	8.1	1.36	10.6
Brandy Brook (Channel)[4]	89.6	132	---	1.6	8.1	14.6	34.8	---	40	---	---	---	0.014	---	---	---
Brandy Brook (Shore/Shoal)[4]	83.7	120	---	1.8	8.0	14.5	31.2	---	37	---	---	---	0.019	---	---	---

Table 19. (continued)

Sample location	Alkalinity as $CaCO_3$	Hardness as $CaCO_3$	Coliform (MPN)	Suspended solids	pH	Dissolved oxygen	Chloride	Iron	Calcium	Magnesium	Nitrite	Nitrate	Total phosphorus	Sulfate	Potassium	Sodium
Brandy Brook (Bay)[4]	82.8	122	---	1.7	7.9	13.4	27.2	---	36	---	---	---	0.042	---	---	---
Brandy Brook (Wetland)[4]	85.9	117	---	1.7	7.6	12.7	21.5	---	35	---	---	---	0.083	---	---	---
Lake St. Lawrence[2]	55.0	---	---	3.1	8.0	---	29.0	0.013	42	8.2	0.002	0.34	0.018	9.0	1.36	10.6
Massena[1]	88.0	122	77	---	7.8	---	---	---	---	---	---	---	---	---	---	---
Grasse River (Massena)[1]	39.0	58	2400	---	---	---	---	---	---	---	---	0.80	0.240	---	---	---

[1]Eschner and Wicker 1972 (Means for Entire Year)

[2]Mills, Smith, and Forney 1978d (Winter Samples)

[3]BUFO 1977 (21^{o}-25^{o} C Water Temperature)

[4]Young, DePinto, and Marshall 1979 (Winter Samples)

[5]Casey, Fisher, and Klevano 1965

[6]Great Lakes Water Quality Board 1973

[7]Marean 1976 (0^{o}-25^{o} C Water Temperature)

Contaminants

Pre-Seaway

Very few studies were conducted on pollution and contaminants prior to Seaway construction. The most serious causes of pollution were municipal sewage and paper mill wastes. Most of the pollution was localized and was rapidly diluted downriver. All of the major towns along the St. Lawrence dumped raw sewage into the River. Most of the major tributary streams, such as the Oswegatchie, Grasse, and Raquette Rivers, were heavily polluted by paper mill wastes, mine drainage, and/or municipal sewage. The Grasse River contained a great amount of soda pulp (State of New York Conservation Dept. 1931).

No studies have been found that dealt with the role of contaminants in the food web. The studies that were conducted just identified pollution sources.

Post-Seaway

Some work with contaminants was done in the 1960's. The principle sources of contaminants in the St. Lawrence River were identified as the Grasse, Oswegatchie, and Raquette Rivers in New York, and industries located along the Canadian shore. Another source of contaminants was the outflow from Lake Ontario (Table 20). Mercury contamination was found in some fish species, and pesticides were observed in the food chain beginning in 1962. Bacterial pollution was found to be relatively local in nature, with a progressive downstream increase in coliform densities from less than 5 per hundred milliliters to greater than 1,000 per hundred milliliters (International Joint Commission 1970).

While eutrophication reduced the dissolved oxygen concentration and caused an increase in algal growth in Lake Ontario, different effects were found in the St. Lawrence River. The dissolved oxygen remained at or near saturation levels due to the turbulence of the River. Although growth of green algae was not great, profuse growths of aquatic vegetation were prevalent in the Thousand Islands area (International Joint Commission 1970).

A potential environmental problem can be caused by accidental spills. The International Joint Commission (1970) listed several cargoes that were carried by commercial vessels on the St. Lawrence that could pose environmental problems. Among these cargoes were petroleum products, organic and inorganic chemicals, sulphuric acid, glycol, fertilizers, and dyestuffs.

Present

While a lot of studies have been conducted on contaminants in the Great Lakes in recent years, little work has been done on the St. Lawrence River itself. Some work was done for the Winter Navigation Demonstration Program from 1976 through 1978, and some work was done following the oil spill in 1976.

Table 20 . Wastes discharged to Lake Ontario and the St. Lawrence River during the 1960's*

(MILLIONS OF POUNDS PER YEAR)

Source	Total Solids	Suspended Solids	BOD_5	Total Nitrogen	Total Phosphorus	Chlorides
			TO LAKE ONTARIO			
Niagara River	85,600	10,060	+	191	15	10,400
New York State	11,106	1,692	173	44	5	2,456
Province of Ontario	8,319	985	236	88	7	870
TOTALS	105,025	12,737	+	323	27	13,726
			TO INTERNATIONAL SECTION OF THE ST. LAWRENCE RIVER			
New York State	1,161	281	42	7	1	42
Province of Ontario	689	57	105	12	1	100
TOTALS	1,850	338	147	19	2	142

+ Not determined

* International Joint Commission, 1970

The water quality of the St. Lawrence River is rated as Class A. This category includes waters that are suitable for drinking, culinary or food processing purposes, and other uses. Air quality is also good, with most of the area classified as Level I, except the corporate limits of Ogdensburg and Massena, which are Level II, and a section of Massena that is Level III. Level I (as defined by the New York State air quality classification system), includes areas whose predominant uses are timber, agricultural crops, dairy farming, and recreation. Human habitat and industry are usually sparse. Level II areas are predominantly occupied by single and two-family residences and small farms with limited commercial services and industrial development. Level III areas are densely populated, with primarily commercial and office buildings, department stores, and light industries in small and medium metropolitan complexes, or suburban areas of limited commercial and industrial development near large metropolitan complexes (U.S. Army Corps of Engineers 1982).

Studies by Scrudato (1978) in the Ogdensburg area revealed a variety of contaminants in the sediments. The Ogdensburg Harbor sediments contained oil, grease, chromium, lead, nickel, zinc, and measurable quantities of mercury. The latter probably came from the Oswegatchie River, which is known to have a high mercury content. Chimney Bay sediments contained the same contaminants, but no zinc was present; copper was also detected at this site. Blue Church Bay, on the Canadian side of the River, was heavily polluted with mercury. Measurable quantities of PCB's and mirex were found at all sites. Select samples contained appreciable amounts of cyanide, but these levels were below the "dangerous" classification under EPA criteria.

In June, 1976, a major oil spill occurred on the St. Lawrence River. Approximately 308,000 gallons of oil were spilled. Heavy losses of fish, frogs, turtles, ducks, geese, herons, and muskrats occurred. Clean-up crews were successful in saving some wildlife, especially the great blue herons. According to studies conducted following the spill, the River was able to recover in a couple of years from this pollution (Alexander, Longabucco, and Phillips 1978, 1981).

Toxic pollutants may be a localized problem in some areas of the St. Lawrence River (Table 17). For example, a problem area known to the New York State Department of Environmental Conservation (NYSDEC) is in the vicinity of the General Motors and Reynolds Metals plants, downstream of the confluence with the Grasse River. Both General Motors and Reynolds Metals may have had historic PCB discharges to the River. Also, non-point source PCB discharges may exist. The present point source discharges are controlled to less than 2 mg/l maximum and 1 mg/l average by their NYSDEC discharge permits.

A number of studies have also indicated that detectable levels of PCB's exist in the Grasse River sediments downstream of Massena Village. A suspected source of the PCB's is historic process water discharges from the ALCOA plant. The current wastewater discharges from the plant are believed not to contain PCB's at significant levels and there is now no known significant continuing PCB discharge (NYSDEC personal communication).

On the Ontario side, a fish sample of northern pike captured near Maitland (summer 1983) showed significant spinal deformity in approximately 50 percent of the fish. Laboratory results have not been received to identify the cause. However, heavy metal contamination is suspected.

In general, the St. Lawrence River is relatively unpolluted, but some chemical contaminants exist in the food chain and in the sediments. Further studies are needed to determine the full extent of contamination.

Habitat Composition

General

Habitats were mapped for three time frames through the use of aerial photos. Black-and-white photos from August, 1941, supplemented by black-and-white photos from May, 1955, were used for the pre-Seaway time frame (Table 3). The habitats during the post-Seaway time frame were mapped from black-and-white photos flown in May, 1959, and June, 1962. The habitats for the present time frame were mapped from color photos flown in April, 1979.

The habitat mapping effort covered the entire United States' portion of the St. Lawrence River during all three time frames, but coverage did not extend very far inland; the purpose of the study was to map the immediate shoreline and those areas affected by water level fluctuations, including those caused by the formation of Lake St. Lawrence and the dredging that was done for the Seaway and power project. Coverage of tributaries generally extended to the limits of influence of river water levels, which is approximately the 250-foot contour line from Iroquois Dam upriver. In some cases, mapping of tributaries was terminated at the first dam or at a bridge crossing or some other landmark that could be readily discerned on all three sets of photos. Therefore, the acreage of various wetland types mapped does not necessarily represent the exact total acreage found along the River; rather, it presents a figure that accounts for most of the acreage influenced by the River's water levels, and provides a basis of comparison of relative abundance between time periods.

Pre-Seaway

During the pre-Seaway period (1941-1955), approximately 2,112 acres of emergent wetlands were found along the River; 812 of these were located on islands (Table 21). Broad-leaved deciduous forest wetlands and broad-leaved scrub/shrub wetlands were difficult to distinguish on the black-and-white aerial photos; however, 101 acres of scrub/shrub wetlands were mapped. The rooted vascular/floating-leaved zone, located between the emergent wetlands and the shallow littoral zone, contributed 328 acres along the mainland, and an additional 286 acres around the islands. The total wetland acreage was 2,835, of which 1,684 acres were located on the mainland, the rest being found on islands. Shallow shoals (areas less than 6 feet deep surrounded by deep shoals or deepwater) occupied 296 acres, while deep shoals (areas 6 to 18 feet deep surrounded by water greater than 18 feet deep) occupied approximately 631 acres, for a total shoal acreage of around 927.

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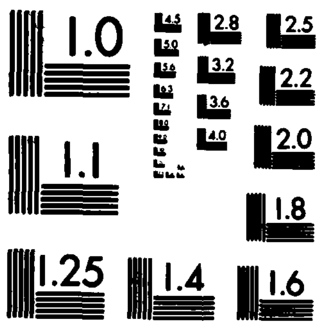
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Table 21. Number of acres of each type of habitat mapped from aerial photos of the St. Lawrence River for each of three time frames: pre-Seaway (1941, 1955), post-Seaway (1959, 1962), present (1979).

Category	Mapping Convention	Pre-Seaway	Post-Seaway			Present		
		Riverine	Total	Riverine	Lacustrine	Total	Riverine	Lacustrine
MAINLAND								
Broad-leaved deciduous forest wetland	PFO1	0	2	----	----	179	----	----
Broad-leaved scrub/shrub wetland	PSS1	50	42	----	----	117	----	----
Deciduous forest/scrub/shrub wetland	PFO1/PSS1	6	0	----	----	109	----	----
Emergent wetland	PEM	1,300	1,317	----	----	1,197	----	----
Emergent wetland/scrub/shrub wetland	PEM/PSS1	0	7	----	----	27	----	----
Rooted vascular/floating-leaved	R2AB3	328	94	----	----	0	----	----
Emergent wetland/rooted vascular/floating-leaved	PEM/R2AB3	0	11	----	----	0	----	----
Total Mainland Wetlands	----	1,684	1,473	----	----	1,629	----	----
Palustrine open water	POW	0	3	----	----	7	----	----
Streambed	R2SB or LOW	54	16	16	0	59	59	0
Mud flat	R2US3 or L2US3	0	0	0	0	30	17	13
Shallow littoral	R2UB or L2UB	7,864	10,660	6,056	4,604	10,525	6,109	4,416
Deep littoral	R2UBH or L1UB	8,098	7,377	5,969	1,408	7,361	5,948	1,413
Breakwater, dam	R2RSr or L1RSr	10	55	22	33	59	23	36
ISLAND								
Broad-leaved deciduous forest wetland	$PFO1_i$	3	0	----	----	116	----	----
Broad-leaved scrub/shrub wetland	$PSS1_i$	51	15	----	----	192	----	----
Deciduous forest/scrub/shrub wetland	$PFO1_i/PSS1_i$	0	0	----	----	28	----	----
Emergent wetland	PEM_i	812	840	----	----	803	----	----
Emergent wetland/scrub/shrub wetland	$PEM_i/PSS1_i$	0	85	----	----	3	----	----

Table 21. (Continued)

Category	Mapping Convention	Pre-Seaway	Post-Seaway			Present		
		Riverine	Total	Riverine	Lacustrine	Total	Riverine	Lacustrine
Rooted vascular/floating-leaved	$R2AB3_i$	286	100	----	----	0	----	----
Total Island Wetlands	----	1,151	1,040	----	----	1,142	----	----
Streambed	$R2SB_i$ or LOW_i	32	0	0	0	0	0	0
Mud flat	$R2US3_i$ or $L2US3_i$	0	0	0	0	22	0	22
Shallow littoral	$R2UB_i$ or $L2UB_i$	5,749	7,655	5,889	1,766	7,620	5,854	1,766
Deep littoral	$R2UBH_i$ or $L1UB_i$	5,889	6,935	5,300	1,635	7,005	5,381	1,624
Upland	U_i	24,097	23,890	----	----	23,756	----	----
<u>WETLAND TOTALS</u>								
Emergent wetland	PEM and PEM_i	2,112	2,157	----	----	2,000	----	----
Scrub/shrub wetland	PSS1 and $PSS1_i$	101	57	----	----	309	----	----
Forested wetland	PFO1 and $PFO1_i$	3	2	----	----	295	----	----
Rooted vascular/floating-leaved	R2AB3 and $R2AB3_i$	613	194	----	----	0	----	----
Total Wetlands	----	2,835	2,513	----	----	2,771	----	----
<u>OPEN WATER</u>								
Deep water	R2OWH or L1OWH	37,130	44,437	36,221	8,216	44,437	36,502	7,935
Shallow shoal	R2RB or L2RB	296	305	242	63	302	242	60
Deep shoal	R2RBH or L1RB	631	974	530	444	980	520	460
Total Shoals	----	927	1,279	772	507	1,282	762	520

---- = Not broken into riverine and lacustrine sub-categories.

Littoral areas were extensive; roughly 8,098 acres of deep littoral (6 to 18 feet deep) and 7,864 acres of shallow littoral (less than 6 feet deep) zone were present along the mainland (Table 21). Around islands, about 5,749 acres of shallow littoral and 5,889 acres of deep littoral area were present. The rest of the River habitat consisted of over 37,000 acres of deep water (over 18 feet) and over 24,000 acres of island upland, along with very small amounts of habitat consisting of streambed, breakwaters and dams.

The Thousand Islands region had significant quantities of shallow and deep littoral zones. Just under 8,800 acres of shallow littoral were present, while almost 9,800 acres of deep littoral existed (Table 22; Fig. 4). Of the 2,100 acres of emergent wetland found along the River, over 1,700 acres were located in the Thousand Islands area. In addition, most of the rooted vascular/floating-leaved acreage found along the River was located in this area. Also, about two-thirds of the shoal acreage was found in this segment of the River.

The Thousand Islands area during this time period was more lake-like (effect from Lake Ontario) than the rest of the River, with many large bays and quiescent areas. Four of these large areas were Eel Bay, Lake of the Isles, Goose Bay, and Chippewa Bay.

The middle section of the River extended from Morristown downriver to Point Rockaway, the present site of Iroquois Dam. This area was fairly straight and relatively unbroken by islands and bays (Fig. 5). Only 43 acres of emergent vegetation were present in this section, and only 20 acres of rooted vascular/floating-leaved zone were identified (Table 23). Shoals were relatively scarce, consisting of 129 acres of shallow shoals and 88 acres of deep shoals. There were 667 acres of shallow littoral zone around islands, but no deep littoral zone. Along the mainland, 1,706 acres of deep littoral zone were present, along with 949 acres of shallow littoral. Deep water accounted for 5,143 acres.

The lower section of the River extended from Point Rockaway to the International Border (Fig. 6). This area was narrow and fast-flowing, with many large islands. Shoals occupied 110 acres of river; shallow shoals accounted for only 5 acres of this total (Table 24). There were over 3,200 acres of shallow littoral zone, and over 2,500 acres of deep littoral zone; most of this acreage was located along the mainland. Approximately 354 acres of emergent wetlands were present, most of this along the tributary streams. Twenty-five acres of forested wetlands and 24 acres of rooted vascular/floating-leaved vegetation were identified and mapped.

In summary, most of the wetlands and shoals, and the majority of the shallow and deep littoral areas, were located in the Thousand Islands region. Most of the remainder were found in the lower section. The Thousand Islands area had over five times as much deep water acreage as the middle section, and almost nine times as much as the lower section. Island acreage was similar in the Thousand Islands and lower sections, although there was much greater interspersion between islands and water in the Thousand Islands section. The middle section had very little island acreage. The Thousand Islands section had the greatest diversity of habitats, followed by the lower River section, with the least diversity in the middle section.

Table 22. Acreage changes for the upper portion of the U.S. side of the St. Lawrence River (Thousand Islands - Tibbetts Point to Morristown) for the various habitat types mapped for the pre-Seaway (1941, 1955), post-Seaway (1959, 1962), and present (1979) time periods.

Category*	Pre-Seaway (1941-1955) Acreage	Post-Seaway (1959-1962) Acreage	Present (1979) Acreage	Change From Pre-Seaway to Post-Seaway (1955-1962)		Change From Post-Seaway to Present (1962-1979)	
				Acres	Percent	Acres	Percent
MAINLAND							
Broad-leaved deciduous forest wetland	0	0	19	---	---	+19	I
Broad-leaved scrub/shrub wetland	45	5	7	-40	-88.9%	+2	+40.0%
Deciduous forest/scrub/shrub wetland	6	0	0	-6	-100.0%	---	---
Emergent wetland	987	924	930	-63	-6.4%	+6	+0.6%
Rooted vascular/floating-leaved	296	50	0	-246	-83.1%	-50	-100.0%
Total Mainland Wetlands	1,334	979	956	-355	-26.6%	-23	-2.3%
Palustrine open water	0	0	2	---	---	+2	I
Streambed	45	0	59	-45	-100.0%	+59	I
Shallow littoral	4,572	4,829	4,864	+257	+5.6%	+35	+0.7%
Deep littoral	4,236	4,340	4,329	+104	+2.5%	-11	-0.3%
Breakwater, dam	3	0	3	-3	-100.0%	+3	I
ISLAND							
Broad-leaved deciduous forest wetland	1	0	11	-1	-100.0%	+11	I
Broad-leaved scrub/shrub wetland	33	2	92	-31	-93.9%	+90	+4,500.0%
Deciduous forest/scrub/shrub wetland	0	0	1	---	---	+1	I
Emergent wetland	728	619	708	-109	-15.0%	+89	+14.4%
Emergent wetland/scrub/shrub wetland	0	0	3	---	---	+3	I
Rooted vascular/floating-leaved	273	55	0	-218	-76.2%	-55	-100.0%
Total Island Wetlands	1,035	676	815	-359	-34.7%	+139	+20.6%

Table 22. (Continued)

Category*	Pre-Seaway (1941-1955) Acreage	Post-Seaway (1959-1962) Acreage	Present (1979) Acreage	Change From Pre-Seaway to Post-Seaway (1955-1962)		Change From Post-Seaway to Present (1962-1979)	
				Acres	Percent	Acres	Percent
Shallow littoral	4,217	5,330	5,306	+1113	+26.4%	-24	-0.5%
Deep littoral	5,527	4,756	4,834	-771	-13.9%	+78	+1.6%
Upland	16,597	16,618	16,379	+21	+0.1%	-239	-1.4%
WETLAND TOTALS							
Emergent wetland	1,715	1,543	1,638	-172	-10.0%	+95	+6.2%
Scrub/shrub wetland	78	7	99	-71	-91.0%	+92	+1,314.3%
Forested wetland	1	0	30	-1	-100.0%	+30	I
Rooted vascular/floating-leaved	569	105	0	-464	-81.5%	-105	-100.0%
Total Wetlands	2,369	1,655	1,771	-714	-30.1%	+116	+7.0%
OPEN WATER							
Deep water	28,641	28,978	28,771	+337	+1.2%	-207	-0.7%
Shallow water	162	95	93	-67	-41.4%	-2	-2.1%
Deep shoal	438	416	416	-22	-5.0%	0	N/C
Total Shoals	600	511	509	-89	-14.8%	-2	-0.4%

*See Table 21 for mapping conventions.
I = Infinite (mathematically impossible to divide by zero).
--- = No acreage present in either time period.
N/C = No change.

Table 23. Acreage changes for the middle portion of the U.S. side of the St. Lawrence River (Morristown to Iroquois Dam) for the various habitat types mapped for the pre-Seaway (1941, 1955), post-Seaway (1959, 1962), and present (1979) time periods.

Category*	Pre-Seaway (1941-1955) Acreage	Post-Seaway (1959-1962) Acreage	Present (1979) Acreage	Change From Pre-Seaway to Post-Seaway (1955-1962)		Change From Post-Seaway to Present (1962-1979)	
				Acres	Percent	Acres	Percent
MAINLAND							
Broad-leaved deciduous forest wetland	0	0	4	---	---	+4	I
Broad-leaved scrub/shrub wetland	0	2	8	+2	I	+6	+300.0%
Emergent wetland	43	20	21	-23	-53.5%	+1	+5.0%
Rooted vascular/floating-leaved	20	2	0	-18	-90.0%	-2	-100.0%
Total Mainland Wetlands	63	24	33	-39	-61.9%	+9	+37.5%
Palustrine open water	0	0	1	---	---	+1	I
Streambed	9	16	0	+7	+77.8%	-16	-100.0%
Shallow littoral	949	840	846	-109	-13.0%	+6	+0.7%
Deep littoral	1,706	1,368	1,351	-338	-19.8%	-17	-1.2%
Breakwater, dam	0	10	4	+10	I	-6	-60.0%
ISLAND							
Emergent wetland	0	0	1	---	---	+1	I
Total Island Wetlands	0	0	1	---	---	+1	I
Shallow littoral	667	307	299	-360	54.0%	-8	-2.6%
Deep littoral	0	159	155	+159	I	-4	-2.5%
Upland	569	691	672	+122	+21.4%	-19	-2.7%
WETLAND TOTALS							
Emergent wetland	43	20	22	-23	-53.5%	+2	+10.0%
Scrub/shrub wetland	0	2	8	+2	I	+6	+300.0%

Table 23. (Continued)

Category*	Pre-Seaway (1941-1955) Acreage	Post-Seaway (1959-1962) Acreage	Present (1979) Acreage	Change From Pre-Seaway to Post-Seaway (1955-1962)		Change From Post-Seaway to Present (1962-1979)	
				Acres	Percent	Acres	Percent
Forested wetland	0	0	4	---	---	+4	I
Rooted vascular/floating-leaved	20	2	0	-18	-90.0%	-2	-100.0%
Total Wetlands	63	24	34	-39	-61.9%	+10	+41.7%
OPEN WATER							
Deep water	5,143	6,207	6,319	+1,064	+20.7%	+112	+1.8%
Shallow shoal	129	141	143	+12	+9.3%	+2	+1.4%
Deep shoal	88	62	59	-26	-29.5%	-3	-4.8%
Total Shoals	217	203	202	-14	-6.5%	-1	-0.5%

*See Table 21 for mapping conventions.
I = Infinite (mathematically impossible to divide by zero).
--- = No acreage present in either time period.

Table 24. Acreage changes for the lower portion of the U.S. side of the St. Lawrence River (Lake St. Lawrence - Iroquois Dam to the International Border) for the various habitat types mapped for the pre-Seaway (1941, 1955), post-Seaway (1959, 1962), and present (1979) time periods.

Category*	Pre-Seaway (1941-1955) Acreage	Post-Seaway (1959-1962) Acreage	Present (1979) Acreage	Change From Pre-Seaway to Post-Seaway (1955-1962)		Change From Post-Seaway to Present (1962-1979)	
				Acres	Percent	Acres	Percent
MAINLAND							
Broad-leaved deciduous forest wetland	0	2	156	+2	I	+154	+7,700.0%
Broad-leaved scrub/shrub wetland	5	35	102	+30	+600.0%	+67	+191.4%
Deciduous forest/scrub/shrub wetland	0	0	109	---	---	+109	I
Emergent wetland	270	373	246	+103	+38.1%	-127	-34.0%
Emergent wetland/scrub/shrub wetland	0	7	27	+7	I	+20	+285.7%
Rooted vascular/floating-leaved	12	42	0	+30	+250.0%	-42	-100.0%
Emergent wetland/rooted vascular/floating-leaved	0	11	0	+11	I	-11	-100.0%
Total Mainland Wetlands	287	470	640	+183	+63.8%	+170	+36.2%
Palustrine open water	0	3	4	+3	I	+1	+33.3%
Mud flat	0	0	29	---	---	+29	I
Shallow littoral	2,343	4,991	4,815	+2,648	+113.0%	-176	-3.5%
Deep littoral	2,156	1,669	1,682	-487	-22.6%	+13	+0.8%
Breakwater, dam	7	45	53	+38	+542.9%	+8	+17.8%
ISLAND							
Broad-leaved deciduous forest wetland	2	0	105	-2	-100.0%	+105	I
Broad-leaved scrub/shrub wetland	18	13	100	-5	-27.8%	+87	+669.2%

Table 24. (Continued)

Category*	Pre-Seaway (1941-1955) Acreage	Post-Seaway (1959-1962) Acreage	Present (1979) Acreage	Change From Pre-Seaway to Post-Seaway (1955-1962)		Change From Post-Seaway to Present (1962-1979)	
				Acres	Percent	Acres	Percent
Deciduous forest/scrub/shrub wetland	0	0	27	---	---	+27	I
Emergent wetland	84	221	94	+137	+163.1%	-127	-57.5%
Emergent wetland/scrub/shrub wetland	0	85	0	+85	I	-85	-100.0%
Rooted vascular/floating-leaved	12	45	0	+33	+275.0%	-45	-100.0%
Total Island Wetlands	116	364	326	+248	+213.8%	-38	-10.4%
Streambed	32	0	0	-32	-100.0%	---	---
Mud flat	0	0	22	---	---	+22	I
Shallow littoral	865	2,018	2,015	+1,153	+133.3%	-3	-0.1%
Deep littoral	362	2,020	2,016	+1,658	+458.0%	-4	-0.2%
Upland	6,931	6,581	6,705	-350	-5.1%	+124	+1.9%
WETLAND TOTALS							
Emergent wetland	354	594	340	+240	+67.8%	-254	-42.8%
Scrub/shrub wetland	23	48	202	+25	+108.7%	+154	+320.8%
Forested wetland	2	2	261	0	N/C	+259	+12,950.0%
Rooted vascular/floating-leaved	24	87	0	+63	+262.5%	-87	-100.0%
Total Wetlands	403	834	966	+431	+106.9%	+132	+15.8%
OPEN WATER							
Deep water	3,346	9,251	9,346	+5,905	+176.5%	+95	+1.0%
Shallow shoal	5	69	65	+64	+1,280.0%	-4	-5.8%
Deep shoal	105	496	505	+391	+372.4%	+9	+1.8%
Total Shoals	110	565	570	+455	+413.6%	+5	+0.9%

*See Table 21 for mapping conventions.
--- = No acreage present in either time period.
I = Infinite (mathematically impossible to divide by zero).
N/C = No change.

Post-Seaway

After construction of the Moses-Saunders Dam, Lake St. Lawrence was formed in the lower section of the River, and many islands, shoals, and upland areas were flooded. Other shoals and islands were created by this flooding (Figs. 4, 5, and 6). During the period (1959-1962) immediately following the flooding and the subsequent opening of the River to deep draft navigation, the habitats of the International section of the River could be classified into two categories — riverine and lacustrine. Lacustrine habitats were found in the impounded segment of the River — the area between Iroquois Dam and Moses-Saunders Dam. The remainder of the habitats could be classified as riverine. The wetlands in both sections were classified as palustrine according to National Wetlands Inventory guidelines.

Approximately 1,473 acres of wetlands were present on the mainland, while 1,040 acres were found on islands (Table 21). The majority of this acreage was emergent wetlands, with about 1,317 acres found on the mainland and 840 acres found on the islands. The remaining wetlands were mostly of the rooted vascular/floating-leaved variety. Forested wetlands were difficult to distinguish on the black-and-white aerial photos. Some forested wetlands may have been included with the emergent wetlands.

The total shoal acreage was 1,279, of which 974 acres were deep shoals (6-18 feet deep) (Table 31). There were slightly more deep shoals in the riverine section than in the lacustrine section -- 530 acres and 444 acres, respectively. Shallow shoals (less than 6 feet) were predominantly found in the riverine section where 242 acres were present, compared to only 63 acres in the lacustrine section.

Shallow (less than 6 feet) and deep (6-18 feet) littoral areas were more prevalent in the riverine sections than in the lacustrine sections. A total of 10,660 acres of shallow littoral zone was present along the mainland, with nearly 60 percent of the total being found in the riverine sections (Table 21). The mainland deep littoral zone totalled 7,377 acres, of which only 1,408 were found in the lacustrine sections. A similar pattern held true around islands, where about 7,655 acres of shallow littoral zone existed, along with 6,935 acres of deep littoral zone. Only 1,766 acres and 1,635 acres of shallow and deep island littoral zone, respectively, were found in the lacustrine reaches.

There were 23,890 acres of island upland, and over 44,400 acres of deep water (greater than 18 feet deep) (Table 21). Nearly 82 percent of the deep water zone was found in the riverine section, with most of the lacustrine deep water being found in Lake St. Lawrence.

The remaining acreage in the River was divided among streambeds, palustrine open water areas, and breakwaters and dams, the latter accounting for 55 acres (Table 21).

The Thousand Islands region, which was classified as riverine, had vast acreages of deep water, totalling nearly 29,000 acres (Table 22; Fig. 4). Shallow and deep littoral zones were also found in significant quantities. Over 10,100 acres of shallow littoral zone were present, about evenly divided between mainland and islands. The deep littoral zone was also evenly divided between islands and mainlands, with a total of nearly 9,100 acres. These figures represent over half of the deepwater and shallow littoral zones of the River, and nearly two-thirds of the deep littoral zone identified for this time period.

Nearly half of the deep shoals along the River were found in the Thousand Islands area (416 out of 974 acres) (Tables 21 and 22; Fig. 4). Approximately one-third of the shallow shoals (95 out of 305 acres) were also found in this area. Emergent wetlands were relatively abundant, with over 1,500 acres present, compared to only 614 acres on the rest of the River. Forested wetlands were scarce in this area; only 7 of the 59 acres mapped along the River during this time frame were found here. Over 100 acres of rooted vascular/floating-leaved vegetation were plotted, which is approximately half of the identified total on the River.

The middle segment of the River was characterized by long, straight stretches relatively unbroken by islands and bays. This section was also classified as riverine (Fig. 5). Only 20 acres of emergent vegetation were found here, along with 2 acres of forested wetlands and 2 acres of rooted vascular/floating-leaved vegetation (Table 23). Over 73 percent of the 1,147 acres of shallow littoral zone was located along the mainland, while nearly 90 percent of the 1,527 acres of deep littoral zone was located along the mainland.

Deep shoals were scarce in the middle section of the River, accounting for only 62 acres (Table 23). This compares to 141 acres of shallow shoals, which was nearly half the total in the River. Deep water areas were relatively scarce, with only 6,207 acres being mapped (less than 14 percent of the total for the River). Island upland was also scarce in this section, where Galop Island was the only major island.

The entire lacustrine portion of the River was located in the lower section, which extended from Iroquois Dam to the International Border. The small section between Moses-Saunders Dam and the International Border was classified as riverine (Fig. 6). The deep water zone was extensive, covering nearly half of the open water area. However, the 9,251 acres of deep water equalled only one-third of the total found in the Thousand Islands area, even though the river mileage is half that found in the Thousand Islands (Tables 22 and 24).

Deep shoals were common in the lower section of the River, totalling nearly 500 acres. ly 69 acres of shallow shoals were present (Table 24). Shallow littoral zones along the mainland were similar in size to those found in the Thousand Islands (4,991 acres and 4,829 acres, respectively). However, the shallow littoral areas around islands and the deep littoral areas, both mainland and island, were far less abundant in the lower section than in the Thousand Islands area. There were 2,018 acres of shallow littoral island, 1,669 acres of deep littoral mainland, and 2,020 acres of deep littoral island. This compares with over 9,000 acres of deep littoral zone in the Thousand Islands area.

Nearly 600 acres of emergent wetland were present; this is slightly less per river mile than in the Thousand Islands area, which had over 1,500 acres of emergent wetland but was less than twice the river length of the lower section (Tables 22 and 24). Most of the forested wetland mapped during this time frame was found in the lower section of the River (50 of the 59 acres). Approximately half (87 out of 194 acres) of the rooted vascular/floating-leaved vegetation was found in this section.

In summary, vast differences can be seen in the habitat types found in various sections of the River immediately after the construction of the Seaway and Power Project. The wetlands were fairly evenly divided (based on river miles) between the Thousand Islands and the lower section of the River, with few being found in the middle section. Shallow littoral areas were most extensive in the Thousand Islands area, and relatively scarce in the middle section. Deep littoral areas were more prevalent in the middle section than were shallow littoral areas. However, the Thousand Islands had significantly more deep littoral zone. Deep water was most extensive in the Thousand Islands, while the other two areas had similar totals relative to their river mileage. Shallow shoals were most common in the middle section, while deep shoals were much more prevalent in the other two areas. In general, the greatest diversity of habitats was found in the Thousand Islands, although Lake St. Lawrence was more diverse than the middle section.

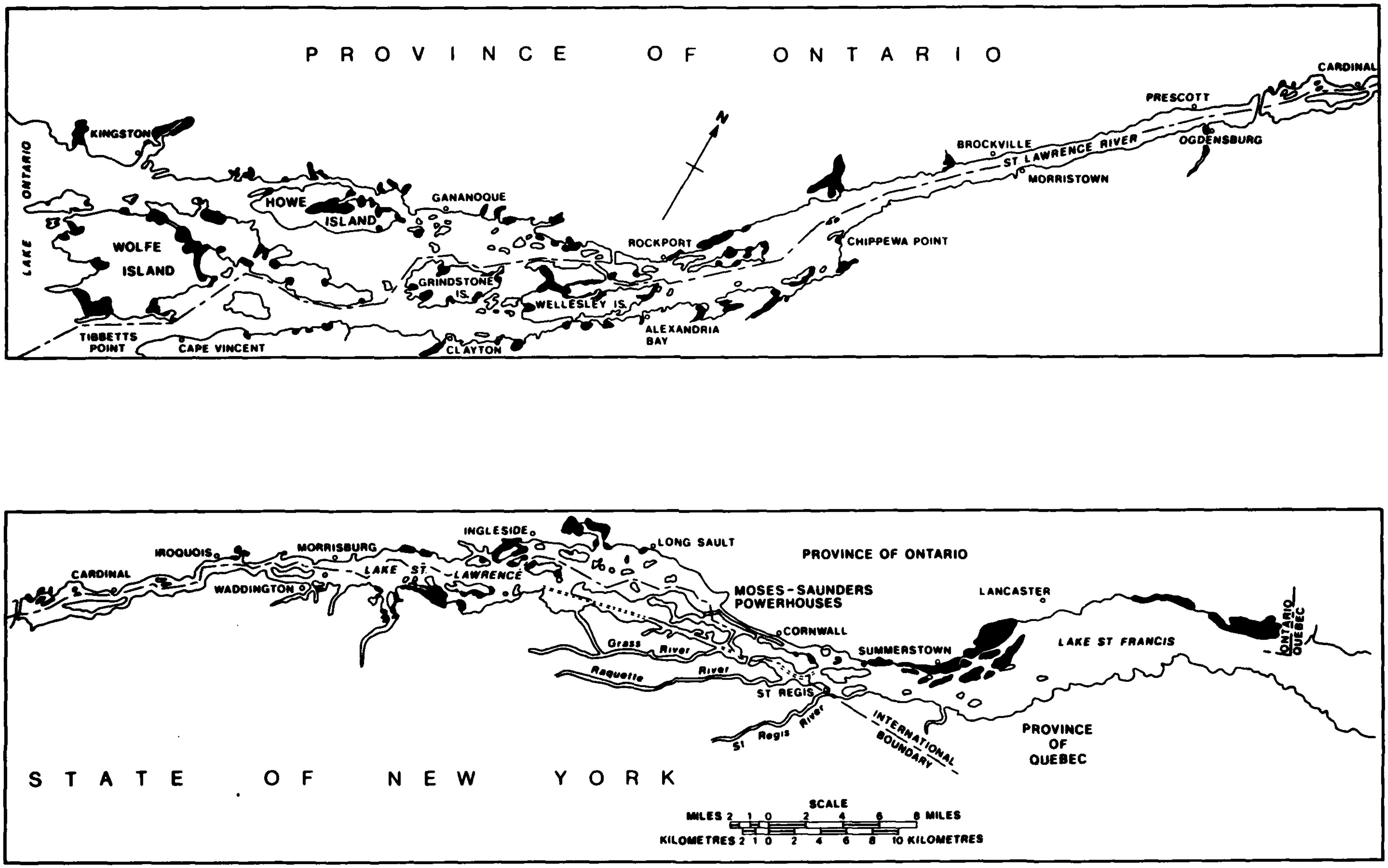
Present

Under present conditions, the St. Lawrence River habitats can be classified into both riverine and lacustrine categories. The lacustrine area encompasses the impounded river segment between Iroquois Dam and Moses-Saunders Dam, while the rest of the River is classified as riverine. The wetland habitats throughout the River can be classified as palustrine.

The total wetland acreage along the River is 2,771 (Table 21; Figs. 4, 5, and 6). This can be broken down into 1,629 acres on the mainland and 1,142 acres on islands. The vast majority of this acreage is in the form of emergent wetlands -- 1,197 acres on the mainland and 803 acres on islands. On the mainland, 179 acres of broad-leaved deciduous forest wetlands are present, along with 117 acres of broad-leaved scrub/shrub wetlands and 109 acres of mixed forest and scrub/shrub wetlands. On islands, the totals are 116, 192, and 28, respectively. The rooted vascular/floating-leaved zone could not be detected on the aerial photos because they were taken in early spring - before growth. Figure 9.5 shows the major wetlands located along the International section of the St. Lawrence River.

Deep littoral areas (6-18 feet deep) along the mainland are found throughout the River, with the majority located in the riverine section (5,948 out of 7,361 acres) (Table 21). The shallow littoral areas (6 feet deep or less) along the mainland are more evenly distributed between riverine and lacustrine, with 6,109 acres in the riverine section and 4,416 in the lacustrine section. Around islands, most of the littoral zone is in the riverine sections, with 5,381 acres of deep littoral and 5,854 acres of shallow littoral. In the lacustrine section, the total acreages are 1,624 and 1,766, respectively.

Figure 9.5. Wetlands of the International section of the St. Lawrence River (from International Lake Erie Regulation Study Board 1981).



There are over 44,400 acres of deep water (greater than 18 feet deep) present in the River, of which over 36,500 are found in the riverine sections (Table 21). Shoals are fairly evenly distributed, with 762 riverine acres and 520 lacustrine acres. The majority of this acreage is in the form of deep shoals (6-18 feet deep), with 520 riverine acres and 460 lacustrine acres. The majority of the shallow shoal (less than 6 feet) acreage (80 percent) is in the riverine section.

Island upland acreage totals 23,756. This is fairly evenly divided between the riverine and lacustrine areas. The remainder of the River acreage is in the form of streambeds, mudflats, palustrine open water, and breakwaters and dams. The total acreage of these four categories is only 177 of which 59 is streambed and 59 is breakwaters and dams.

The Thousand Islands Region is classified as riverine because it is not impounded. The River in this area has many islands, bays, and quiescent areas (Fig. 4). Much of the deepwater acreage in the River is found in this section (28,771 acres of the 44,437 acre total) (Tables 21 and 22). Deep shoals are also extensive in this area, with 416 of the 980 acres being found here. Shallow shoals are relatively scarce, occupying only 93 acres, compared to 209 acres for the rest of the River. The total shoal acreage is less than half that for the River as a whole, although this region encompasses almost half of the International section of the River.

This region has over 9,100 acres of deep littoral area, about evenly divided between island and mainland (Table 22). This represents well over half (63.8 percent) the deep littoral area on the River. There are over 10,000 acres of shallow littoral area, with slightly more than half located around islands. These figures represent over 56 percent of the shallow littoral zone in the River, and nearly 70 percent of the island shallow littoral zone.

Wetlands are relatively common in the Thousand Islands region. Over 1,600 acres of emergent vegetation are present, with 57 percent located on the mainland (Table 22; Fig. 4). This represents the majority of the emergent vegetation on the River. Forested wetlands occupy 130 acres, mostly on islands.

The middle section of the River is also classified as riverine. It is fairly straight and relatively unbroken by islands, shoals, and bays (Fig. 5). Galop Island is the only major island in this section. Deep water occupies two-thirds of the open-water area in this section, and encompasses 6,319 acres (Table 23). Most of the remaining open-water area is evenly divided between shallow and deep littoral. Shallow littoral occupies 846 acres along the mainland and 299 acres around islands; deep littoral occupies 1,351 acres along the mainland and 155 acres around islands. Shallow shoals are relatively abundant, with 143 acres in this 26-mile stretch of river. Deep shoals occupy only 59 acres.

Wetlands are scarce in this section of the River, with 22 acres (only one acre on islands) of emergent vegetation and 12 acres of forested wetlands. This represents just over one percent of the wetland acreage along the St. Lawrence River.

The lower section of the River is generally referred to as Lake St. Lawrence. Most of this section is classified as lacustrine because it is impounded by Moses-Saunders Dam. The area below the dam and locks is classified as riverine. This section is about 33 miles long, 9 miles of which are riverine. There are many islands and shoals in this section (Fig. 6). Shoals occupy a total of 570 acres, of which 505 acres are deep shoals. This represents over 50 percent of the deep shoals in the River. The 65 acres of shallow shoals represent less than 22 percent of the River's total.

Wetlands are relatively common in this section. Of the 340 acres of emergent wetland, 246 are located on the mainland (Table 24; Fig. 6). The emergent wetland acreage is small compared to that of the Thousand Islands region. This is probably due to fluctuating water levels caused by lock and power operations. Forested wetlands are common, occupying 599 acres, much of this in the Wilson Hill Island area. This accounts for 81 percent of the forested wetlands (including both broad-leaved deciduous forest and broad-leaved scrub/shrub wetlands, as well as interspersions) found along the River.

There are 9,346 acres of deep water in this section, which translates to 283 acres per river mile, compared to 243 acres/mile in the middle section, and 553 acres/mile in the Thousand Islands region (Tables 22-24; Figs. 4-6). Shallow littoral zones occupy 6,830 acres (two-thirds of which is mainland), while deep littoral zones occupy 3,698 acres (almost evenly divided between mainland and island). There are 207 acres of shallow littoral zone per river mile, which is similar to the 196 acres per mile in the Thousand Islands. The deep littoral zone occupies 112 acres per mile, compared to 176 acres per mile for the Thousand Islands. The figures are considerably lower for the middle section, where there are 44 acres per mile of shallow littoral zone and 58 acres per mile of deep littoral zone.

In summary, there are some similarities between the habitats of the Thousand Islands region and Lake St. Lawrence, both of which are broad, lake-like areas with many bays, islands, and shoals. However, the outflow of Lake Ontario created the natural river conditions in the Thousand Islands section, while Lake St. Lawrence is man-made and man-regulated. There is a greater diversity and interspersion of habitats in the Thousand Islands region. There are more wetlands in the Thousand Islands, and far more acreage of emergent wetland. There is significantly more acreage of forested wetland in the lower section of the River, particularly on the mainland. Although the acres per mile of shallow littoral zone is similar between the two regions, the greater island littoral area of the Thousand Islands creates a greater interspersion of habitat types. The deep littoral zone is significantly greater in the Thousand Islands, as is the open water area. There is more shoal acreage per mile in Lake St. Lawrence, particularly deep shoals; most of these shoals were created as a result of the flooding of islands by Moses-Saunders Dam.

The middle section of the River is significantly different than the other two and is less diverse with less interspersion of habitats. Shallow shoals are significantly greater, but this is essentially due to one large sand bar off Ogdensburg Harbor which was created from shallow littoral area by channel dredging. Deep shoals are significantly less, and shallow littoral areas and all types of wetlands are relatively scarce. Deep littoral mainland acreage is similar to the Lake St. Lawrence area, but much less than the acreage found in the Thousand Islands.

Changes Over Time

The formation of Lake St. Lawrence by construction of the Moses-Saunders Dam, along with the dredging for navigation and power production, greatly altered the habitats of the St. Lawrence River. Islands, shoals, and mainland areas were flooded, while new shoals and islands were created. Some islands were created from dredge spoil disposal.

As was expected, the habitat maps produced from aerial photos showed very little change over time in the Thousand Islands section of the River (Lake Ontario to Morristown) (Fig. 4). Changes became apparent at Galop Island in the middle section of the River (Fig. 5). The changes in the lower section (Iroquois Dam to the International Border) were quite vivid (Fig. 6). The most dramatic changes are documented to have occurred between the pre-Seaway (1941-1955) and post-Seaway (1959-1962) time frames.

The largest acreage change from pre-Seaway to post-Seaway was in the deep water category, which increased by 7,307 acres, a change of 19.7 percent (Table 25). Most of this increase came in the lower section of the River, where Lake St. Lawrence was formed. The increase from Iroquois Dam to the International Border (a 33 mile section of river) was 5,905 acres, a 176.5 percent increase from the 3,346 acres that were present in 1955 (Table 24). There was also a 20.7 percent increase in the deep water zone in the middle section of the River (Table 23), caused mainly by dredging (Fig. 3).

The second largest acreage change was in the shallow littoral zone. The total increase was 4,702 acres, with a 2,796 acre increase along the mainland and a 1,906 acre increase around islands (Table 25). There was a total increase of 34.5 percent; the figure for the mainland was 35.6 percent, while the figure for islands was 33.2 percent. Most of this increase occurred in the lower section of the River, due to the creation of Lake St. Lawrence. Mainland shallow littoral was up 113.0 percent in this section, while island shallow littoral was up 133.3 percent (Table 24; Fig. 6). There was also a 26.4 percent increase in island shallow littoral area in the Thousand Islands region. There was a decrease in shallow littoral zone in the middle section of the River (Table 23; Fig. 5). The island shallow littoral area in this section decreased 54.0 percent (360 acres), while the mainland shallow littoral area decreased 13.0 percent (109 acres). Most of this acreage was lost around Galop Island, where a new channel was created and dredge and fill operations drastically altered the configuration of the islands in the area.

The deep littoral zone decreased along the mainland, but increased around islands, for a net increase of 325 acres (2.3 percent) (Table 25). There was a 17.8 percent increase (1,046 acres) around islands. This increase occurred from Chimney Point downriver. There was an increase from 0 acres to 159 acres in the middle section of the River (Table 23; Fig. 5); this was due to a channel that was dug, creating deep water, which in turn redefined some mainland deep littoral as island deep littoral. There was a 338 acre (19.8 percent) loss of mainland deep littoral acreage in this section of the River. Most of the increase occurred in the lower section, where 1,658 acres of island deep littoral were added (a 458.0 percent increase). This increase was caused by flooding of islands, which created deep littoral zone out of upland, or which redefined mainland littoral as island littoral. There was a loss of 487

Table 25. Habitat changes in the St. Lawrence River between the pre-Seaway (1941, 1955) and post-Seaway (1959, 1962) time frames and between the post-Seaway and present (1979) time frames. Changes are expressed in number of acres and percent increase or decrease.

Category*	Change From Pre-Seaway to Post-Seaway (1955-1962)		Change From Post-Seaway to Present (1962-1979)					
			Total		Riverine		Lacustrine	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
MAINLAND								
Broad-leaved deciduous forest wetland	+2	I	+177	+8,850.0%	---	---	---	---
Broad-leaved scrub/shrub wetland	-8	-16.0%	+75	+178.6%	---	---	---	---
Deciduous forest/scrub/shrub wetland	-6	-100.0%	+109	I	---	---	---	---
Emergent wetland	+17	+1.3%	-120	-9.1%	---	---	---	---
Emergent wetland/scrub/shrub wetland	+7	I	+20	+285.7%	---	---	---	---
Rooted vascular/floating-leaved	-234	-71.3%	-94	-100.0%	---	---	---	---
Emergent wetland/rooted vascular/floating-leaved	+11	I	-11	-100.0%	---	---	---	---
Total Mainland Wetlands	-211	-12.5%	+156	+10.6%	---	---	---	---
Palustrine open water	+3	I	+4	+133.3%	---	---	---	---
Streambed	-38	-70.4%	+43	+268.8%	+43	+268.8%	N/C	N/C
Mud flat	N/C	N/C	+30	I	+17	I	+13	I
Shallow littoral	+2,796	+35.6%	-135	-1.3%	+53	+0.9%	-188	-4.1%
Deep littoral	-721	-8.9%	-16	-0.2%	-21	-0.4%	+5	+0.4%
Breakwater, dam	+45	+450.0%	+4	+7.3%	+1	+4.5%	+3	+9.1%
ISLAND								
Broad-leaved deciduous forest wetland	-3	-100.0%	+116	I	---	---	---	---
Broad-leaved scrub/shrub wetland	-36	-70.6%	+177	+1,180.0%	---	---	---	---

Table 25. (Continued)

Category*	Change From Pre-Seaway to Post-Seaway (1955-1962)		Change From Post-Seaway to Present (1962-1979)					
			Total		Riverine		Lacustrine	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Deciduous forest/scrub/shrub wetland	N/C	N/C	+28	I	---	---	---	---
Emergent wetland	+28	+3.4%	-37	-4.4%	---	---	---	---
Emergent wetland/scrub/shrub wetland	+85	I	-82	-96.5%	---	---	---	---
Rooted vascular/floating-leaved	-186	-65.0%	-100	-100.0%	---	---	---	---
Total Island Wetlands	-111	-9.6%	+102	+9.8%	---	---	---	---
Streambed	-32	-100.0%	N/C	N/C	N/C	N/C	N/C	N/C
Mud flat	N/C	N/C	+22	I	N/C	N/C	+22	I
Shallow littoral	+1,906	+33.2%	-35	-0.5%	-35	-0.6%	N/C	N/C
Deep littoral	+1,046	+17.8%	+70	+1.0%	+81	+1.5%	-11	-0.2%
Upland	-207	-0.9%	-134	-0.6%	---	---	---	---
<u>WETLAND TOTALS</u>								
Emergent wetland	+45	+2.1%	-157	-7.3%	---	---	---	---
Scrub/shrub wetland	-44	-43.6%	+252	+442.1%	---	---	---	---
Forested wetland	-1	-33.3%	+293	+14,650.0%	---	---	---	---
Rooted vascular/floating-leaved	-419	-68.4%	-194	-100.0%	---	---	---	---
Total Wetlands	-322	-11.4%	+258	+10.3%	---	---	---	---
<u>OPEN WATER</u>								
Deep water	+7,307	+19.7%	N/C	N/C	+281	+0.8%	-281	-3.4%
Shallow shoal	+9	+3.0%	-3	-1.0%	N/C	N/C	-3	-4.8%
Deep shoal	+343	+54.4%	+6	+0.6%	-10	-1.9%	+16	+3.6%
Total Shoals	+352	+38.0%	+3	+0.2%	-10	-1.3%	+13	+2.6%

*See Table 21 for mapping conventions and acreage totals.
I = Infinite (mathematically impossible to divide by zero).
--- = Not broken into riverine and lacustrine sub-categories.
N/C = No change (including no acreage present in either time period).

acres (22.6 percent) of mainland deep littoral in the lower section of the River. In the Thousand Islands section, the deep littoral zone decreased slightly around islands (13.9 percent) and increased slightly along the mainland (2.5 percent). These changes were partly as a result of dredging and channelization.

The total acreage of shoals increased by 352 acres (38.0 percent). Deep shoals increased by 54.4 percent (343 acres), while shallow shoals increased by 3.0 percent (9 acres) (Table 25). Most of the change in this category occurred in the lower section of the River. Some shoals were flooded by Lake St. Lawrence, but this represented only a small area. Several islands were turned into shoals, the largest being Goose Neck, Clark, and Murphy (Figs. 3 and 6). Most of these island areas were sufficiently flooded to be classified as deep shoals. The increase in the lower section of the River was 391 acres (372.4 percent) of deep shoals and 64 acres (1,280.0 percent) of shallow shoals (Table 24). Only 5 acres of shallow shoals had existed prior to the flooding of Lake St. Lawrence. In the middle section of the River, shallow shoals increased 9.3 percent (12 acres), while deep shoals decreased 29.5 percent (26 acres). These losses occurred at Iroquois Dam and in the shoal off Ogdensburg Harbor. In the Thousand Islands region, deep shoals decreased slightly (22 acres, 5.0 percent), while shallow shoals were reduced by 41.4 percent (67 acres). Most of this loss occurred between Chippewa Bay and Morristown where channelization was conducted.

Total wetland acreage decreased with construction of the Seaway. A net loss of 322 acres (11.4 percent) occurred (Table 25). All categories except emergent wetlands (which increased 2.1 percent) were reduced. Both island and mainland wetlands decreased. Emergent wetlands increased by 17 acres (1.3 percent) on the mainland and by 28 acres (3.4 percent) on islands. The most significant emergent wetland changes occurred in the Lake St. Lawrence section. Mainland acreage increased 38.1 percent (103 acres) and island acreage increased 163.1 percent (137 acres). These changes were the result of flooding of uplands. Most of the increase occurred in the Wilson Hill area and on Croil Island. There was actually a loss of wetlands near the mouth of the Grasse River (Fig. 6). In the middle section of the River, no island emergent vegetation was present either before or after Seaway construction. However, mainland emergent wetland decreased by 53.5 percent (23 acres). This loss occurred at Whitehouse Creek and was the result of Lake St. Lawrence flooding and the construction of Iroquois Dam and Lock. There was also a decrease in emergent wetlands in the Thousand Islands region. Mainland acreage decreased by 6.4 percent (63 acres), while island acreage decreased by 15.0 percent (109 acres). The causes for this decrease may be erosion and/or man-made activities, such as filling for development. There were relatively few emergent wetlands in close proximity to the shipping channel, and these were relatively unchanged. It should be noted, however, that deep-draft navigation had just begun when the photos were taken in 1959.

Changes in other types of wetlands are hard to define. The areas covered by other wetland types were small, and there was great variability in the resolution of these habitat types from one set of photos to another. The mainland broad-leaved deciduous forest increased from 0 to 2 acres. The island acreage decreased by 100 percent (3 acres) (Table 25). Broad-leaved scrub/shrub forests decreased by 8 acres (16.0 percent) on the mainland and by

36 acres (70.6 percent) on the islands. The rooted vascular/floating-leaved zone decreased 71.3 percent (234 acres) on the mainland and 65.0 percent (186 acres) on islands. For mapping purposes, the forested wetlands and scrub/shrub wetlands were lumped together on the final charts (Figs. 4-6). In the Thousand Islands area, the quantity changes in these two categories may be a reflection of natural adjustments. The 2 acre increase in the middle section of the River occurred at Whitehouse Creek (now Whitehouse Bay) and appears to be the result of flooding (Table 23; Fig. 5). In the lower section of the River, an area of forested wetland on Long Sault Island was lost by flooding (Table 24; Fig. 6). Most of the apparent reduction in rooted vascular/floating-leaved acreage could be the result of photo interpretation, primarily that the 1959 photos were taken in May, before the aquatic beds were really established. There was a slight increase in acreage in this category in the Lake St. Lawrence area, primarily due to flooding of small tributary streams such as Sucker Brook.

Due to the difficulties in distinguishing wetland types on different photos, the best way to determine wetland changes is to look at the wetlands as a whole (emergent, forested, and aquatic bed combined). In the Lake St. Lawrence section, there was a net increase of 431 acres (106.9 percent) (Table 24). This was primarily the result of flooding of upland areas. Much of the increase occurred in the vicinity of Wilson Hill, Coles Creek, Brandy Brook, and Sucker Brook (Figs. 3 and 6). In the middle section of the River, there was a net decrease of 39 acres (61.9 percent) (Table 23). This loss occurred near Iroquois Dam as a result of flooding and construction activities. There was also a decrease in the Thousand Islands region (714 acres, 30.1 percent) (Table 22). These losses were generally caused by site specific development activities.

There was also a decrease in the streambed category. This was essentially due to flooding of tributary stream channels by the creation of Lake St. Lawrence. The breakwater/dam category increased substantially (45 acres, 50.0 percent) (Table 25). This is easily accounted for by Iroquois, Long Sault, and Moses-Saunders Dams, plus some dikes constructed in the Wilson Hill area (Fig. 3). These dams replaced upland, open water, and littoral area. However, the hydraulic changes caused by the dams overwhelm the direct physical changes caused to the habitat by the dams themselves. The habitat lost to the dams was insignificant compared to that altered by construction and hydraulic changes.

The changes between the post-Seaway period (1959-1962) and the present (1979) are not as great nor as obvious as those changes between the pre-Seaway and post-Seaway periods. This is to be expected since the most dramatic changes would take place during construction and flooding. Some habitat changes resulting from construction may be more gradual; for example, a water level change may cause a wetland to slowly deteriorate over a period of years, in which case the change would not show up on the 1959 photos, but would be obvious on the 1979 photos. Changes caused by such factors as ship movements and water level fluctuations would also be expected to show up over a period of years, rather than immediately following the Seaway opening.

The creation of the power pool divided the River into two categories: riverine and lacustrine. The riverine section includes the entire Thousand Islands section, the middle section of the River (Morristown to Iroquois Dam), and the section below Moses-Saunders Dam. The lacustrine section encompasses the area between Iroquois Dam and Moses-Saunders Dam. The lacustrine section is impounded and functions like a lake. Comparisons can be made to show changes in habitats over time in the riverine versus the lacustrine categories.

The total area of deep water was unchanged during the twenty years following the opening of the Seaway. The changes were within ± 1.8 percent in each of the three major sections of the River. Water levels present at the time the photos were taken, the clarity of the photos, and the precision of the mapping and digitizing process all can lead to minor variations. The maps show no significant changes in the areas covered by deep water. These results are not unexpected. The major changes in deep water habitat occurred with dredging (see Figure 41 in Appendix B) and flooding (Fig. 3). Normal erosion, ship traffic, and other occurrences over time would not be expected to significantly alter the quantities of deep water habitat. Future changes involving dredging, channel widening, or island and shoal removal could increase the deep water acreage at the expense of other habitat. The shallow and deep littoral zones around islands also showed only minor changes. The deep littoral zone increased only 1.0 percent (70 acres), while the shallow zone decreased 0.5 percent (35 acres) (Table 25). The lacustrine shallow littoral zone was unchanged, while the deep littoral zone decreased 0.2 percent. The riverine shallow littoral zone decreased 0.6 percent, while the deep littoral zone increased 1.5 percent. The changes were slightly greater along the mainland, where the deep littoral zone decreased by 0.2 percent (16 acres) and the shallow littoral zone decreased by 1.3 percent (135 acres). The biggest change was in the shallow littoral mainland zone in the lower section of the River, where a 3.5 percent (176 acre) decrease was shown (Table 24). However, there are no major areas on the map where a significant change appears.

No large changes were apparent in the shoal acreage between 1962 and 1979. Shallow shoals decreased 1.0 percent (3 acres), while deep shoals increased 0.6 percent (6 acres) (Table 25). The lacustrine changes were greater than the riverine changes (+ 3.6 and -1.9 percent deep shoals and -4.8 and 0.0 percent shallow shoals for lacustrine and riverine habitats, respectively). Shallow shoals were down 5.8 percent (4 acres) in the Lake St. Lawrence area (Table 24). No significant changes in shoals have occurred during the last 20 years.

Total wetland acreage has shown a significant change over the past 20 years. An increase of 10.3 percent (258 acres) has been shown on the maps (Table 25). The changes in broad-leaved deciduous forest and broad-leaved scrub/shrub wetlands can probably be discounted because these categories were much easier to distinguish on the 1979 photos; therefore, much of the acreage in this category was probably mapped as other wetland types for the post-Seaway time frame. Since the 1979 photos were taken in April, no rooted vascular/floating-leaved zone could be seen on the photos. Therefore, no comparison can be made for this category with the post-Seaway period. Emergent wetlands decreased 7.3 percent (157 acres) during this time period. Island emergent wetlands decreased 4.4 percent (37 acres), while mainland emergent wetlands decreased 9.1 percent (120 acres). The most significant changes in emergent vegetation occurred on islands in the Thousand Islands region, where an increase of 14.4 percent (89 acres) was observed, and in the Lake St. Lawrence area, where a decrease of 57.5 percent (127 acres) was observed (Tables 22 and 24). The mainland emergents in the Lake St. Lawrence area were 34.0 percent (127 acres) less in 1979 than in 1959. The changes in the Thousand Islands area are not readily detectable on the map (Fig. 4). The decreases in the emergent wetland in the Lake St. Lawrence area can probably be traced to successional changes. In these areas located along Little Sucker Brook, Great Sucker Brook, Brandy Brook, Coles Creek, and Wilson Hill, "succession" may have replaced emergents with trees and shrubs over the 20-year period.

The total wetland acreage increase in the Lake St. Lawrence area for the past 20 years is 132 acres (15.8 percent) (Table 24). This change may be attributed to a stabilization of the water regime after the initial flooding, allowing the wetlands time to become established.

In summary, the environmental/physical changes that occurred as a result of Seaway/power construction were significant, particularly in the area from the Iroquois Dam to the International Border. Changes in the Thousand Islands region and the middle section down to Chimney Point were relatively insignificant. The largest increases were in deep water and shallow littoral areas, both changes being a result of flooding of islands. Emergent wetlands increased in the Lake St. Lawrence area due to flooding. Essentially, this section of river was changed from a narrow, fast-flowing riverine habitat to a wide, slower-moving lacustrine habitat. Unfortunately, the habitat maps do not show such things as rapids, which are important to many species of fish and invertebrates. Although certain habitats such as emergent wetlands were increased by the construction, this does not necessarily mean that the habitat was improved. Other factors, which will be discussed in later sections, come into play here.

Between 1959, when the Seaway opened, and 1979, relatively few significant changes in habitats occurred. The most substantial changes occurred in total wetland acreage and forested wetlands (broad-leaved deciduous forest and broad-leaved scrub/shrub wetlands). These changes may be attributable to natural successional changes and stabilization of wetlands.

Although great care was exercised in photo-interpretation and mapping, some small habitat changes seen on the maps can be attributed to the procedures. Photo-interpretation could have affected results in several ways. The 1979 photos were newer, in color, and much clearer than the older photos. Therefore, it was easier to identify habitats, particularly the interspersion of scrub/shrub and forested wetlands. The time of year that the photos were taken also affects the interpretation. The 1979 photos were flown in April, before the rooted vascular/floating-leaved vegetation was present. Therefore, this category could not be identified for the 1979 maps. Habitat normally falling into this category was probably classified as emergent wetland, although some may have been classified as shallow littoral. Another factor influencing interpretation was the relative ability of various interpreters and their subjective determinations. All interpreters were trained and their products were checked. However, subjective determination would come into play when various wetland types were interspersed or difficult to distinguish on the photos.

PRIMARY AND SECONDARY PRODUCTIVITY

IV. PRIMARY AND SECONDARY PRODUCTION

General Discussion

Primary production consists of phytoplankton, periphyton, and macrophytes. Secondary production consists of zooplankton and benthic organisms (Geis 1977). Most of the plankton found in the St. Lawrence is imported from Lake Ontario; the planktonic biomass declines progressively downriver. One of the critical factors influencing the selection and elimination of planktonic forms downriver from Lake Ontario may be the physical setting, which consists of increased current flow and reduced retention time, which gives rise to eddies and backflow currents, causing larger forms to accumulate nearshore. The current speed is two to three times greater below Ogdensburg than where the River begins at Lake Ontario (Mills, Smith, and Forney 1978b). Turbulence, seasonal vegetative growth, and selective grazing also influence the spatial differences of phytoplankton along the river (Mills, Smith, and Forney 1978a).

Pre-Seaway

Information on primary and secondary production in the St. Lawrence River prior to the Seaway is scarce. The only significant studies were conducted in 1930 by Muenscher (1931), in 1952 by the Academy of Natural Sciences of Philadelphia (1953), and in 1955 by Dore and Gillett (1955). The Academy surveyed four sites in the Brockville area along the Canadian side of the River. According to this study, plankton was one of the more important food sources in the River, and the insect fauna was fairly diverse.

The vegetation, characterized by higher plants and algae, in this section of the St. Lawrence River was more representative of a lake than a river. This was due to the lack of strong current, gradual shoaling, and the many coves and bays which produced conditions conducive to the growth of many higher plants which could not exist in swifter currents. Among these plants were Scirpus spp., Eleocharis spp., and Myriophyllum spp. (Table 26). The zooplankton and phytoplankton were also more indicative of lakes and ponds than a river.

The wave action of the River produced an intertidal effect, with water levels varying as much as a foot in places when the wind shifted 180 degrees. As a result of this scouring action, the dominant form of algae found on the rocky shores was Cladophora, a green alga characterized by a holdfast (attached).

Protozoans were scarce. This was probably due to a scarcity of bacteria which provided the main food source for protozoans, and to the abundance of crustaceans, which fed on the protozoans.

Among the lower invertebrates, 55 species were collected, with the most common being the omnivorous foragers such as oligochaete worms, snails, and crustaceans. These organisms comprised an important food source for fish.

The insect fauna was not as large as that found in more lake-like areas of the St. Lawrence River. Among the possible reasons for this were the scarcity of mud or other habitats for burrowers, a lack of accumulated organic debris, and

Table 26. List of submergent and emergent aquatic plants found in bays of the St. Lawrence River during the summer of 1931 (Muenscher 1931).*

Plants	French Creek	Eel Bay	Goose Bay	Chippewa Bay	Morristown Bay
Typha angustifolia	c	c	c	f	-
Scirpus acutus	r	c	f	f	-
Scirpus americanus	-	c	f	f	-
Scirpus validus	f	f	f	f	r
Eleocharis palustris var. *major*	c	c	c	f	r
Zizania aquatica	-	f	c	c	-
Zizania palustris	c	c	a	a	r
Sagittaria heterophylla	c	c	c	f	f
Nymphaea tuberosa	f	f	a	c	a
Nymphozanthus advena	c	c	a	a	a
Najas flexilis	c	a	a	a	f
Potamogeton richardsonii	c	a	a	c	f
Potamogeton crispus	-	-	-	-	f
Potamogeton gramineus var. *graminifolius*	f	c	f	c	r
Potamogeton pectinatus	c	c	c	c	f
Potamogeton pusillus	c	c	c	c	c
Potamogeton compressus	c	c	f	f	c
Potamogeton robbinsii	-	-	c	f	-
Potamogeton friesii	f	c	c	f	c
Vallisneria americana	a	a	a	a	a
Elodea canadensis	a	a	a	c	a
Lemna trisulca	c	a	a	a	a
Heteranthera dubia	c	a	a	a	c

Table 26. (continued)

Plants	French Creek	Eel Bay	Goose Bay	Chippewa Bay	Morristown Bay
Myriophyllum exalbescens	c	c	c	c	c
Utricularia vulgaris	f	f	c	c	r
Ceratophyllum demersum	c	f	c	c	c
Bidens beckii	f	c	c	f	f

a = abundant; c = common; f = frequent; r = rare; - = absent

*Mills and Forney 1976.

the relative lack of a large algal food source. In general, the insect population could be described as healthy, with all habitats occupied by a reasonable number of species. The most common species were caddisflies (Trichoptera spp.), which were particularly characteristic of rocky areas. June bugs (Phyllophaga spp.), beetles (Coleoptera), and midges (Chironomidae) were more characteristic of lake-like conditions.

The 1952 study was conducted on a limited area of the River and does not begin to describe the primary and secondary productivity that existed on the River prior to the Seaway. However, no other data except plant species lists are available in the literature (see Table 61 in Appendix A). Therefore, a data gap exists that cannot be filled.

Post-Seaway

Studies on primary and secondary productivity in the St. Lawrence River during the post-Seaway time frame are virtually non-existent. Lawler, Matusky, and Skelly (1977) made brief mention of phytoplankton standing stock values in the 1960's, based on literature review. They found that these values were lower along the upper St. Lawrence River than in Lake Ontario, which was consistent with lower nutrient values found in the River. Depressed phytoplankton standing stocks near Brockville, Ontario, in the upper River, were related to municipal and industrial discharges. The study in the 1960's, which provided Lawler, et al., with their data, was conducted by the International Lake Erie Water Pollution Board (1969). This study also observed that the seasonal pattern on phytoplankton growth in the River was similar to that found in Lake Ontario; however, blue-green algae was not dominant in the River, which suggested a maintenance of oligotrophic conditions as a result of less nutrient enrichment.

Since the primary production in the St. Lawrence is highly dependent on input from Lake Ontario, it is likely that the upriver productivity remained relatively unchanged following Seaway construction. Changes may have occurred in the Lake St. Lawrence area, but there is no evidence to document this.

Present

A variety of studies of primary and secondary production in the St. Lawrence River have been conducted in the last ten years. Mills, Smith, and Forney (1978a, 1978b, 1978c, 1978d) conducted studies in the summers and winters of 1976 and 1978; Geis, Ruta, and Raynal (1979) studied littoral vegetation in 1979; and the U.S. Fish and Wildlife Service (1979) sampled benthos in 1979. Lawler, Matusky, and Skelly (1977) discussed the present status of knowledge of these ecological components.

During the summer of 1976, 103 phytoplankton species were identified in the St. Lawrence River; this population was dominated by Chrysophyta-Bacillariophyceae, which accounted for 73 of the species (Table 27; Figs. 10-12). Only 60 species were taken during the summer of 1978; these were dominated by green algae, cryptomonads, and small chrysophytes (Fig. 13). Diatoms dominated the winter,

Table 27. Number of phytoplankton species observed at five sites in the St. Lawrence River during 1976 and 1978. S = summer; W = winter.

	Number of Phytoplankton Species Observed												
	Cape Vincent			Chippewa Bay			Ogdensburg/ Prescott		Galop Island		Lake St. Lawrence		
Taxa	S76[1]	W78[2]	S78[3]	S76[1]	W78[2]	S78[3]	W78[2]	S78[3]	W78[2]	S78[3]	S76[1]	W78[2]	S78[3]
Chlorophyta	39	10	32	41	15	32	10	31	12	30	42	12	29
Euglenophyta	0	1	0	1	1	0	2	0	1	0	1	1	0
Pyrrophyta	3	2	3	3	3	3	2	2	2	3	2	2	3
Cryptophyta	2	2	2	2	2	2	2	2	2	2	2	2	2
Chrysophyta-Chrysophyceae	9	5	8	10	5	6	5	7	4	7	9	5	7
Chrysophyta-Bacillariophyceae	16	14	21	18	18	21	18	22	16	23	22	16	23
Cyanophyta	9	2	8	8	3	6	4	4	3	6	10	3	6
TOTAL	78	36	74	83	47	70	43	68	40	71	88	41	70

[1]Mills and Forney 1976

[2]Mills, Smith, and Forney 1978b

[3]Mills, Smith, and Forney 1978a

Figure 10. Monthly distribution of phytoplankton biomass (g/m^3) by % taxonomic group at selected depths at Cape Vincent, June through September, 1976. (Mills and Forney 1976).

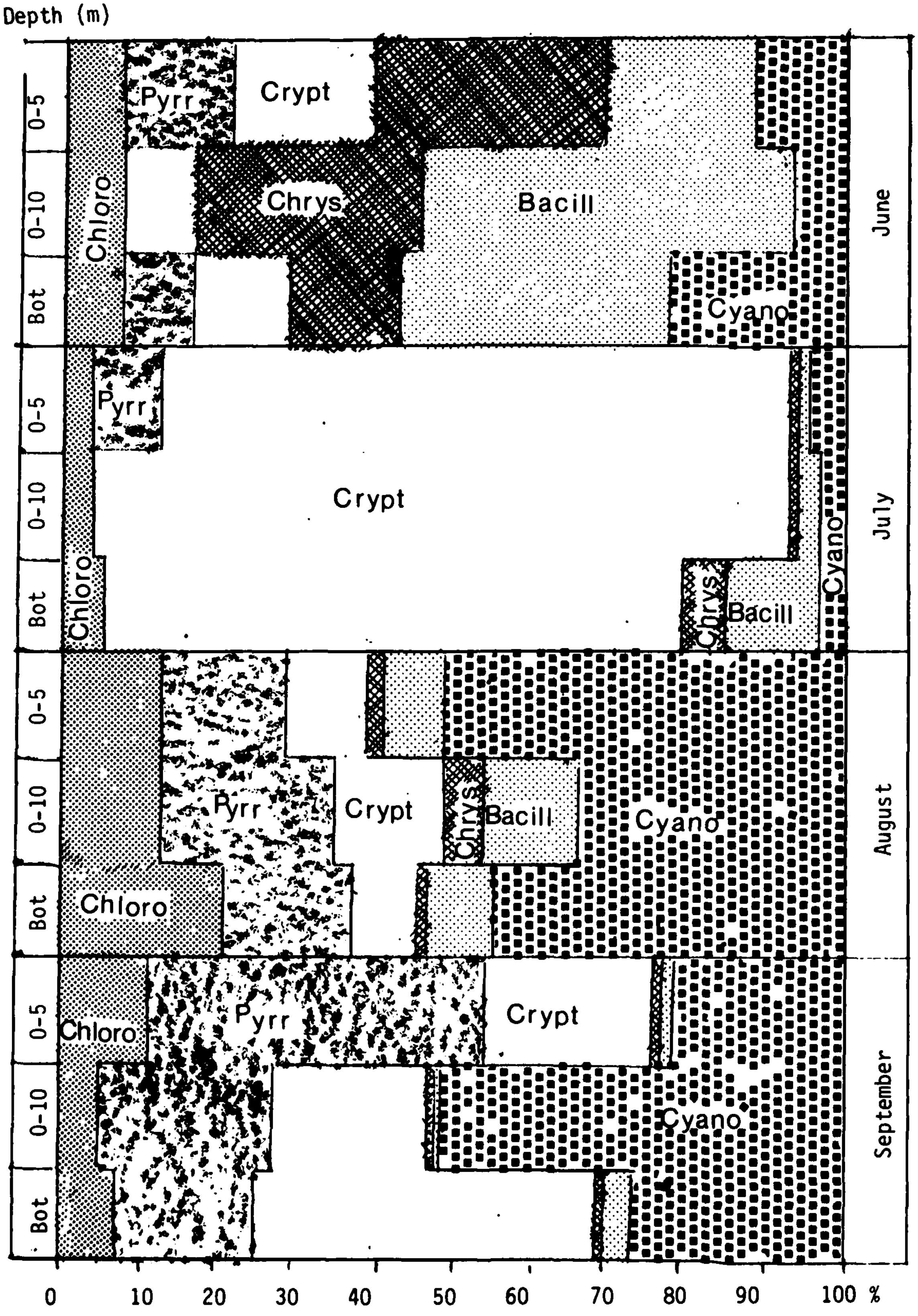


Figure 11. Monthly distribution of phytoplankton biomass (g/m^3) by % taxonomic group at selected depths in Chippewa Bay, June through September, 1976. (Mills and Forney 1976).

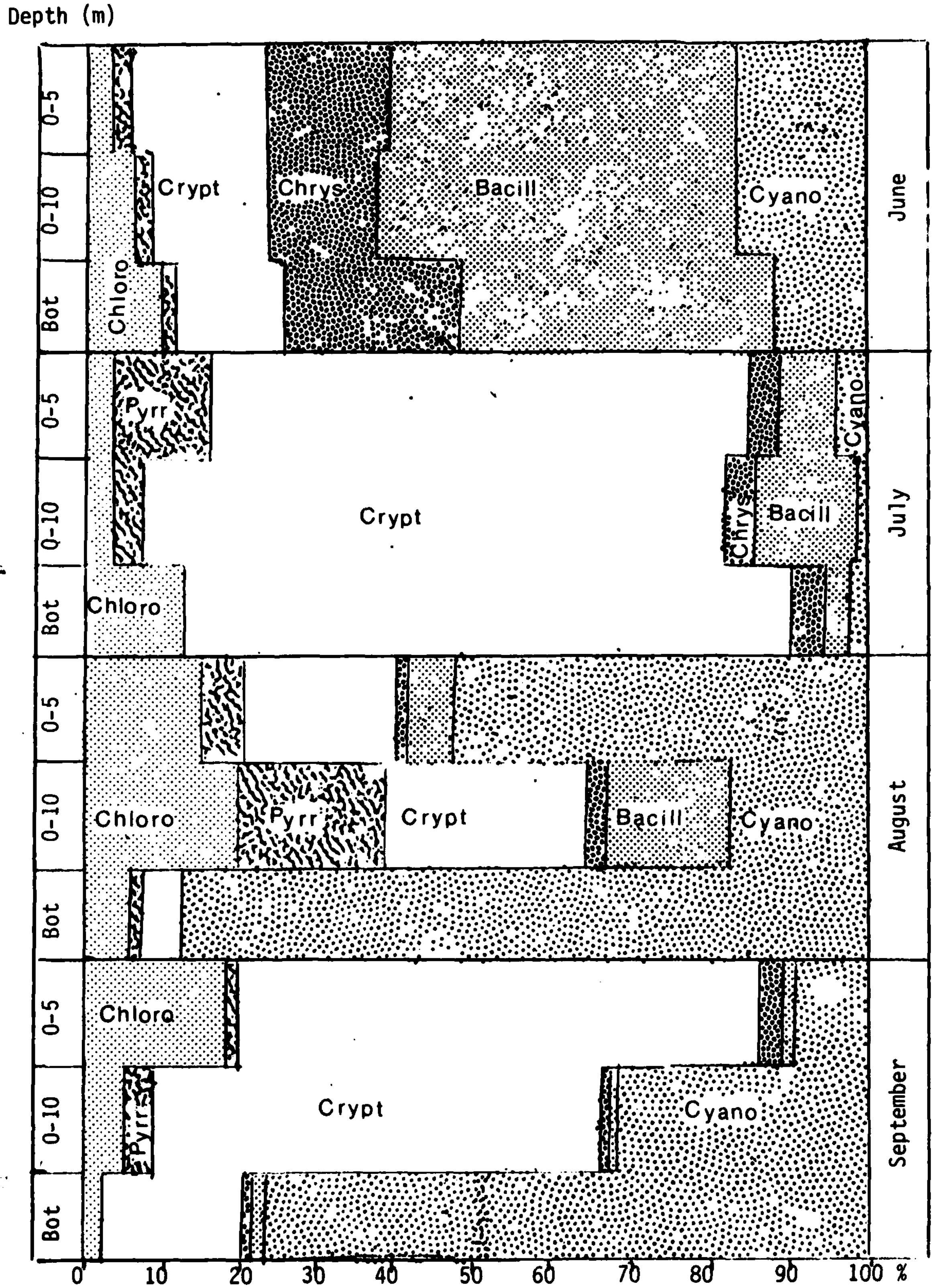


Figure 12. Monthly distribution of phytoplankton biomass (g/m^3) by % taxonomic group at selected depths in Lake St. Lawrence, June through September, 1976. (Mills and Forney 1976).

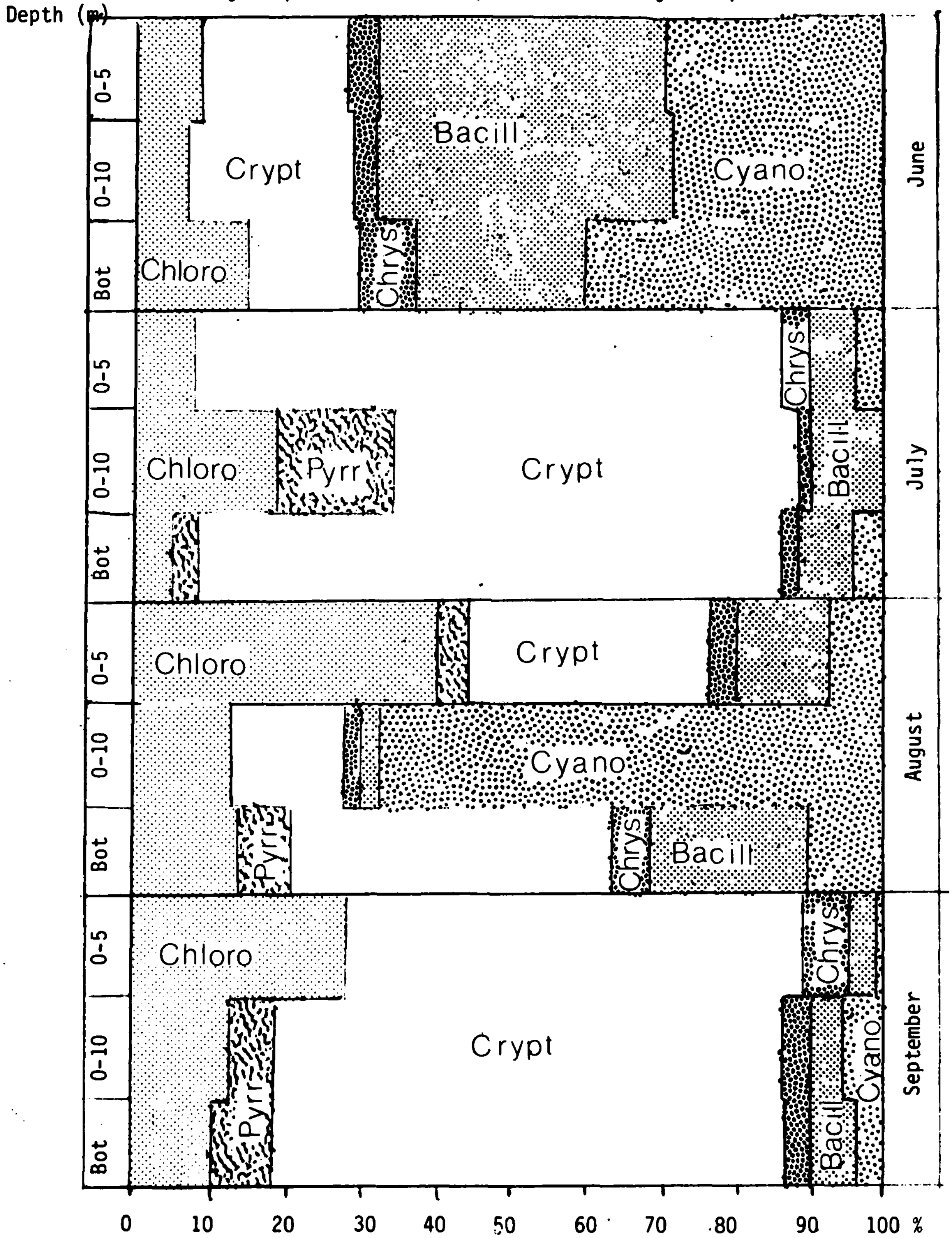
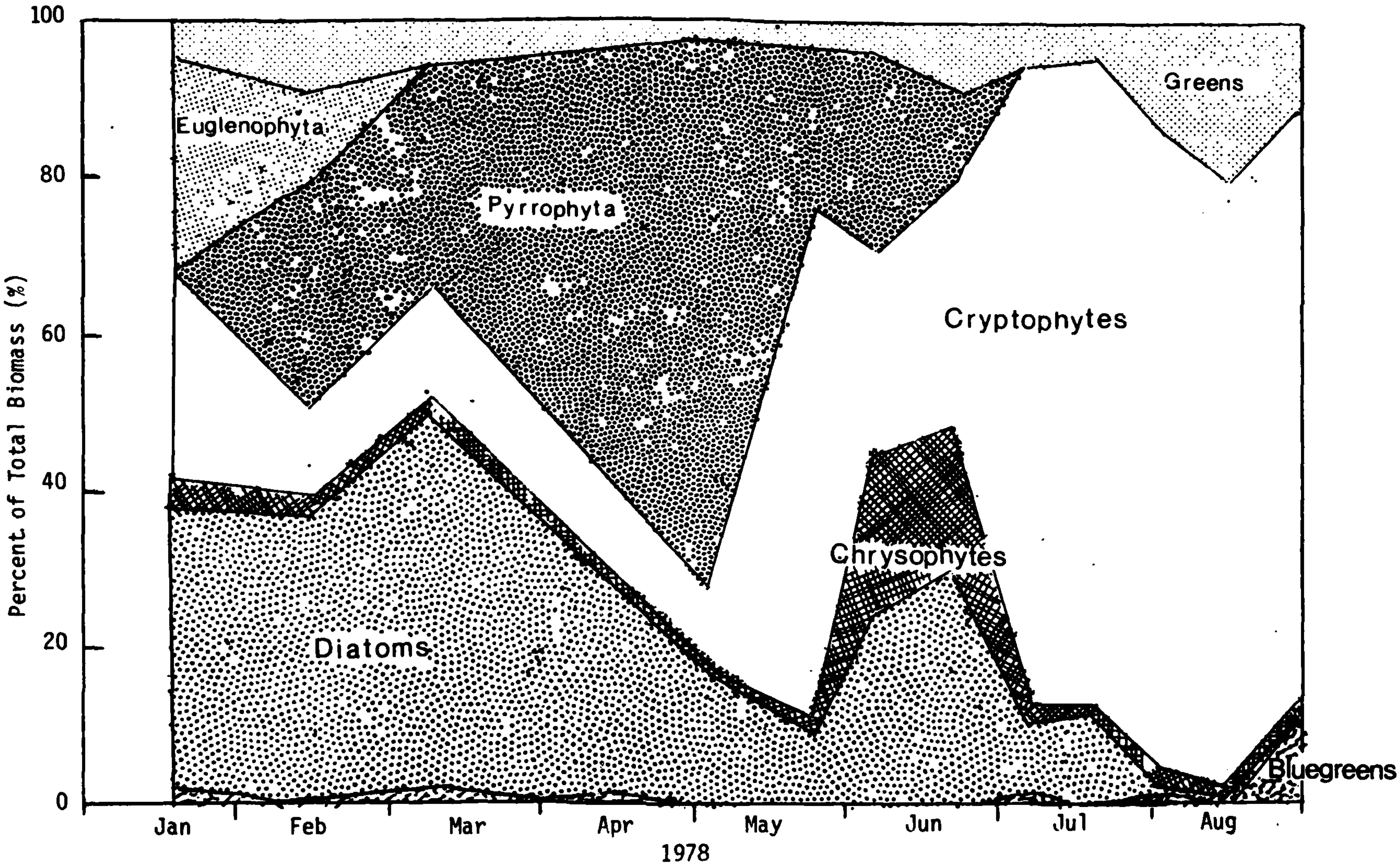


Figure 13. Percent composition of total biomass of phytoplankton taxonomic groups in Chippewa Bay, January through August, 1978. (Mills, Smith, and Forney 1978a).



spring, and early summer phytoplankton crops, with cryptomonads also being important in winter. Cladophora was the predominant periphyton organism identified. The algal biomass was low in winter and decreased downriver. The maximum phytoplankton biomass and chlorophyll a were detected in the spring, and declined throughout the summer. The phytoplankton biomass was greatest offshore during the winter 1978 studies at all sites except Galop Island, where a strong current exists (Geis 1977; Mills, Smith and Forney 1978a, 1978b, 1978d; Mills and Forney 1976).

The second most significant source of primary production during the winter is the standing stock of submerged macrophytes (Mills, Smith and Forney 1978b) (Table 28). Geis, Ruta, and Raynal (1979) found that the standing crop biomass of littoral vegetation increases progressively from July through October. Lawler, Matusky, and Skelly (1977) stated that rooted aquatics are abundant in depths less than 6 meters where gradual slope profiles and minimum flows permit the deposition of organic materials and fine sediments. The most important macrophyte species in the shallow littoral zone (0-3 meters deep) are Myriophyllum exalbescens, Potamogeton zosteriformis, Vallisneria americana, and Ceratophyllum demersum. In the deep littoral zone (3-6 meters deep), the important species are Nitellopsis obtusa, Potamogeton pectinatus, Elodea canadensis, Ceratophyllum demersum, and Vallisneria americana (Table 29) (Geis, Ruta, and Raynal 1979). (See Table 62 in Appendix A for a plant species list).

A large zooplankton standing crop enters from Lake Ontario, and decreases in abundance downriver. Twenty-one species were identified during the summer of 1976 (Table 30), while 22 species were found during the summer of 1978. Rotifers dominated in early July (Figs. 14-17), while cladocerans, which were low in June, became dominant in late July and August. The copepods were dominated by Cyclops and Diaptomus, while Bosmina was the dominant cladoceran. The zooplankton standing crop was much lower in the summer than in the spring, although the peak crustacean zooplankton crop occurred in late July and early August. During the winter, the zooplankton biomass, which was dominated by cyclopoid copepods, was low, equalling about one-tenth the algal standing crop. A greater biomass occurred in deeper waters than in shallow bays throughout the year (Mills, Smith, and Forney 1978a, 1978b, 1978d; Mills and Forney 1976; Geis 1977).

Benthic organisms are important because of their association with the sediment/water interface. They are also an important link in the food chain as well as an essential component in the decomposition process. Many benthic invertebrates serve as indicator organisms of clean or polluted water (USFWS 1979; Mills, Smith, and Forney 1978d). Kinney (1972) found that the upper St. Lawrence River supports a diverse macrofauna indicative of non-polluted waters. In general, the International section of the River supports an abundant and diverse benthic community, with many pollution-sensitive species, such as caddisflies, mayflies, amphipods, snails, and clams (Lawler, Matusky, and Skelly 1977).

The standing crop of benthic invertebrates is greatest near Lake Ontario, due to the abundance of molluscs and other fine-particle feeders; the standing crop decreases downriver and the community shifts to coarse particle feeders such as annelids and chironomids. Among the factors influencing this community shift

Table 28. List of submergent macrophytes collected at selected sites in the St. Lawrence River during the summer of 1976.*

Plants	Whaleback Island	Goose Bay	Cape Vincent	Chippewa Bay	Kring Point	Lake St. Lawrence
Ceratophyllum demersum	X	X	X	X	X	
Elodea canadensis	X	X	X	X	X	
Heteranthera dubia	X	X		X	X	X
Lemna trisulca		X		X		
Myriophyllum exalbescens	X	X	X	X		X
Potamogeton crispus			X			
Potamogeton pectinatus	X			X		X
Potamogeton richardsonii			X	X		X
Potamogeton zosteriformis	X	X	X	X		
Ranunculus aquatilis		X		X		
Sparganium sp.			X			
Vallisneria americana	X	X	X	X	X	

*Mills and Forney 1976.

Table 29. General species composition of littoral vegetation in the St. Lawrence River during the 1978 growing season by one meter water depth categories.*

Depth	General species composition
0-1	*Myriophyllum exalbescens* *Vallisneria americana* *Potamogeton zosteriformis*
1-2	*Vallisneria americana* *Myriophyllum exalbescens* *Potamogeton zosteriformis*
2-3	*Myriophyllum exalbescens* *Potamogeton pectinatus* *Ceratophyllum demersum* *Vallisneria americana* *Nitellopsis obtusa*
3-4	*Potamogeton pectinatus* *Ceratophyllum demersum* *Elodea canadensis* *Vallisneria americana* *Lemna trisulca* *Nitellopsis obtusa* *Potamogeton zosteriformis* *Cladophora glomerata*
4-5	*Nitellopsis obtusa* *Ceratophyllum demersum* *Elodea canadensis* *Potamogeton pectinatus*
5-6	*Ceratophyllum demersum* *Elodea canadensis* *Heteranthera dubia* *Vallisneria americana* *Lemna trisulca*
6-7	*Nitellopsis obtusa* *Ceratophyllum demersum*

*Geis, Ruta, and Raynal 1979

Table 30. Zooplankton species observed at five sites in the St. Lawrence River during 1976 and 1978. S = summer; W = winter; X = observed.

Species	Cape Vincent				Chippewa Bay				Ogdensburg/ Prescott			Galop Island			Lake St. Lawrence			
	S76[1]	W78[2]	W78[3]	S78[4]	S76[1]	W78[2]	W78[3]	S78[4]	W78[2]	W78[3]	S78[4]	W78[2]	W78[3]	S78[4]	S76[1]	W78[2]	W78[3]	S78[4]
Calanoid Copepods																		
Diaptomus minutus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Epischura lacustris											X							
Limnocalanus macrurus				X				X										
Cyclopoid Copepods																		
Cyclops bicuspidatus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mesocyclops edax	X				X										X			
Cladocera																		
Acroperus harpae		X	X		X			X			X			X				
Bosmina longirostris	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ceriodaphnia lacustris	X			X	X	X		X			X	X		X	X			X
Chydorus sphaericus	X			X	X		X	X	X	X	X			X	X	X	X	X
Daphnia galeata mendota	X	X	X	X	X	X	X		X	X	X		X	X	X			X
Daphnia longiremis											X			X				
Daphnia retrocurva				X				X			X			X				X
Diaphanosoma leuchtenbergianum				X				X	X	X	X			X				X
Leptodora kindtii				X				X			X							X
Protozoans																		
Difflugia lebes															X			
Rotifers																		
Asplanchna priodonta	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Brachionus quadridenta	X																	
Conochilus unicornus	X			X	X			X			X			X	X			X
Conochiloides sp.	X														X			
Filinia longiseta	X				X													
Gastropus stylifer	X				X										X			
Kellicottia longispina	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 30 . (continued)

Species	Cape Vincent S76	Cape Vincent W78	Cape Vincent W78	Cape Vincent S78	Chippewa Bay S76	Chippewa Bay W78	Chippewa Bay W78	Chippewa Bay S78	Ogdensburg/ Prescott W78	Ogdensburg/ Prescott W78	Ogdensburg/ Prescott S78	Galop Island W78	Galop Island W78	Galop Island S78	Lake St. Lawrence S76	Lake St. Lawrence W78	Lake St. Lawrence W78	Lake St. Lawrence S78
Rotifers (continued)																		
Keratella cochlearis	X			X	X				X	X	X	X	X		X			
Keratella earlinae				X				X			X			X				X
Keratella quadrata	X	X	X	X	X			X	X	X	X			X	X	X		X
Notholca acuminata	X			X	X			X			X			X	X			X
Pleosoma hudsoni					X													
Polyarthra vulgaris	X			X	X			X							X			
Trichocerca cylindrica	X																	
Nauplii		X	X	X		X	X	X	X	X	X	X	X	X		X	X	X
TOTAL SPECIES	19	8	8	18	18	7	7	17	10	10	19	7	7	16	17	7	6	15

[1]Mills and Forney 1976

[2]Mills, Smith, and Forney 1978d

[3]Mills, Smith, and Forney 1978b

[4]Mills, Smith, and Forney 1978a

Figure 14. Monthly distribution of zooplankton biomass (g/m^3) by percent taxonomic group averaged at five deep sites in the St. Lawrence River during the spring and summer, 1978. (Mills, Smith, and Forney 1978a).

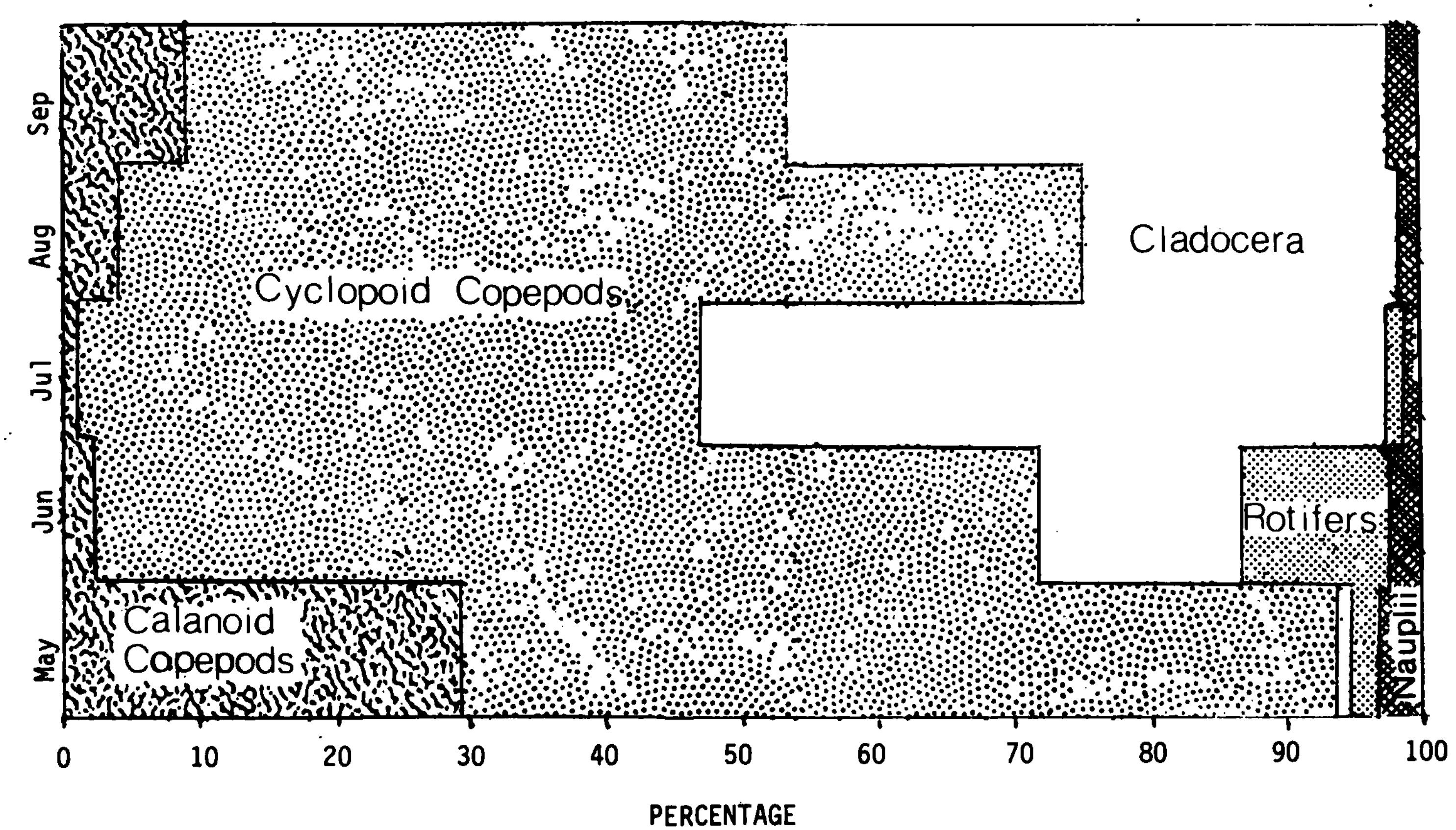


Figure 15. Monthly distribution of zooplankton (individuals/m^3) by % taxonomic group at selected depths at Cape Vincent, June through September, 1976. (Mills and Forney 1976).

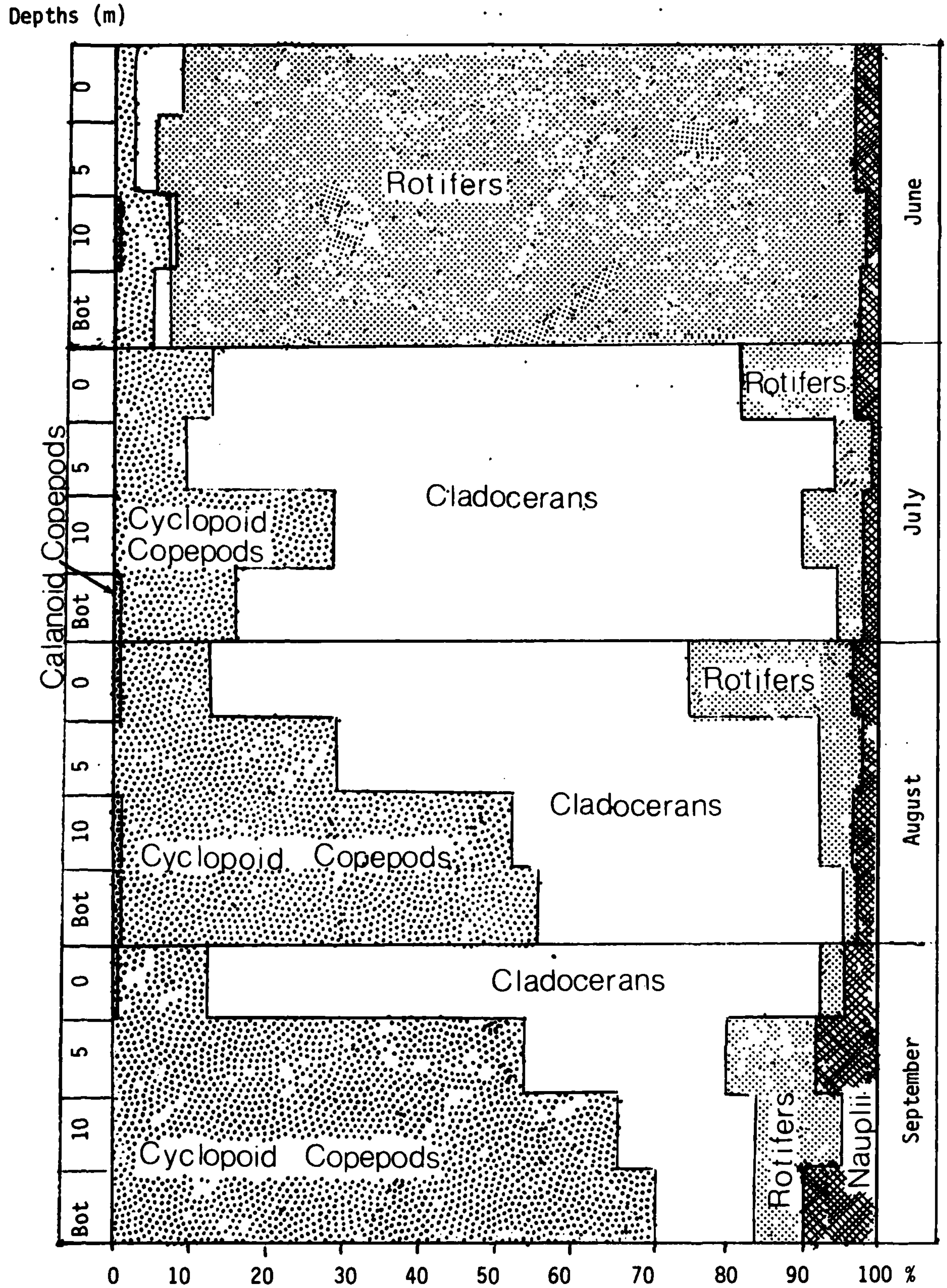


Figure 16. Monthly distribution of zooplankton (individuals/m^3) by % taxonomic group at selected depths in Chippewa Bay, June through September, 1976. (Mills and Forney 1976).

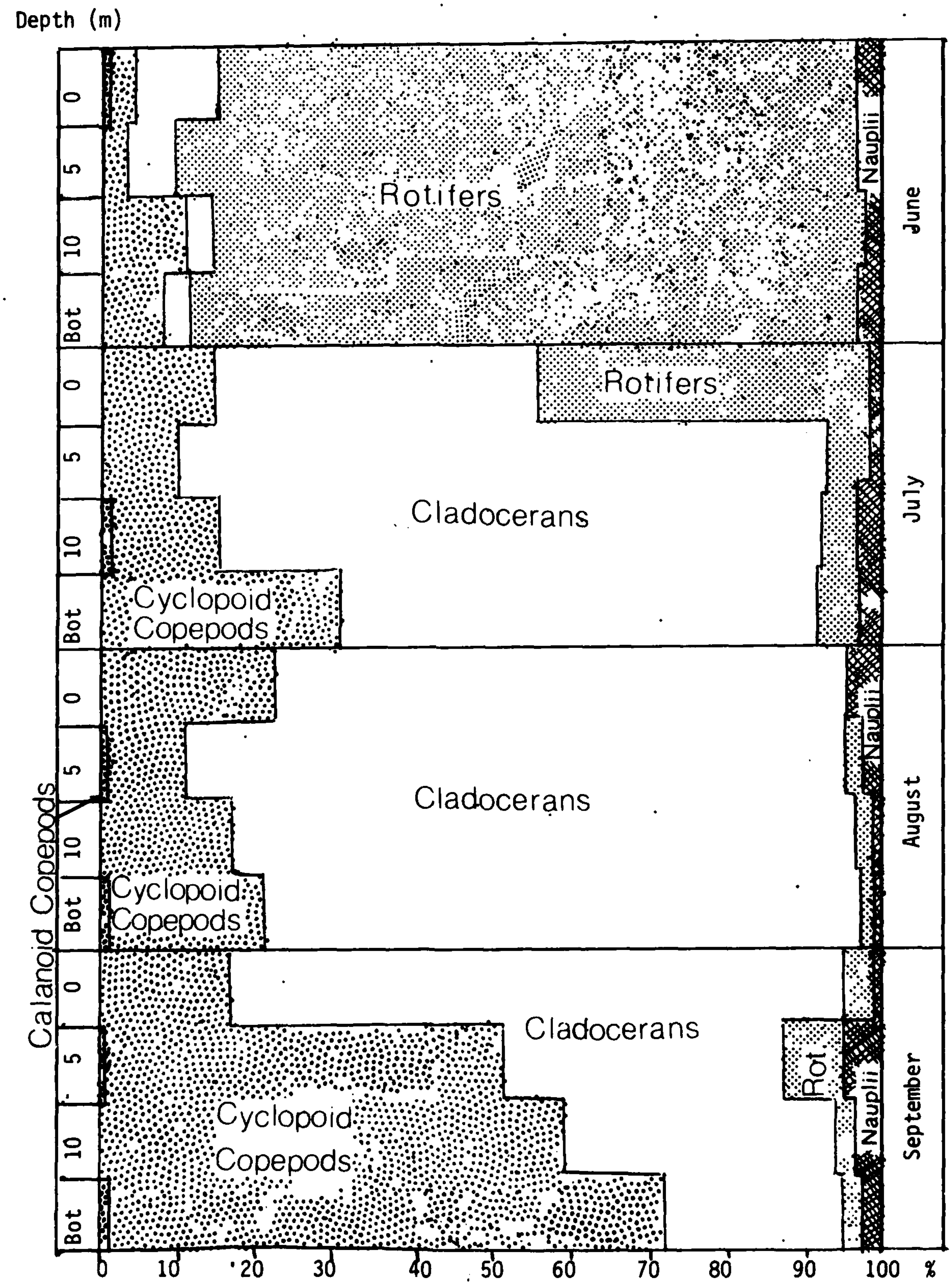
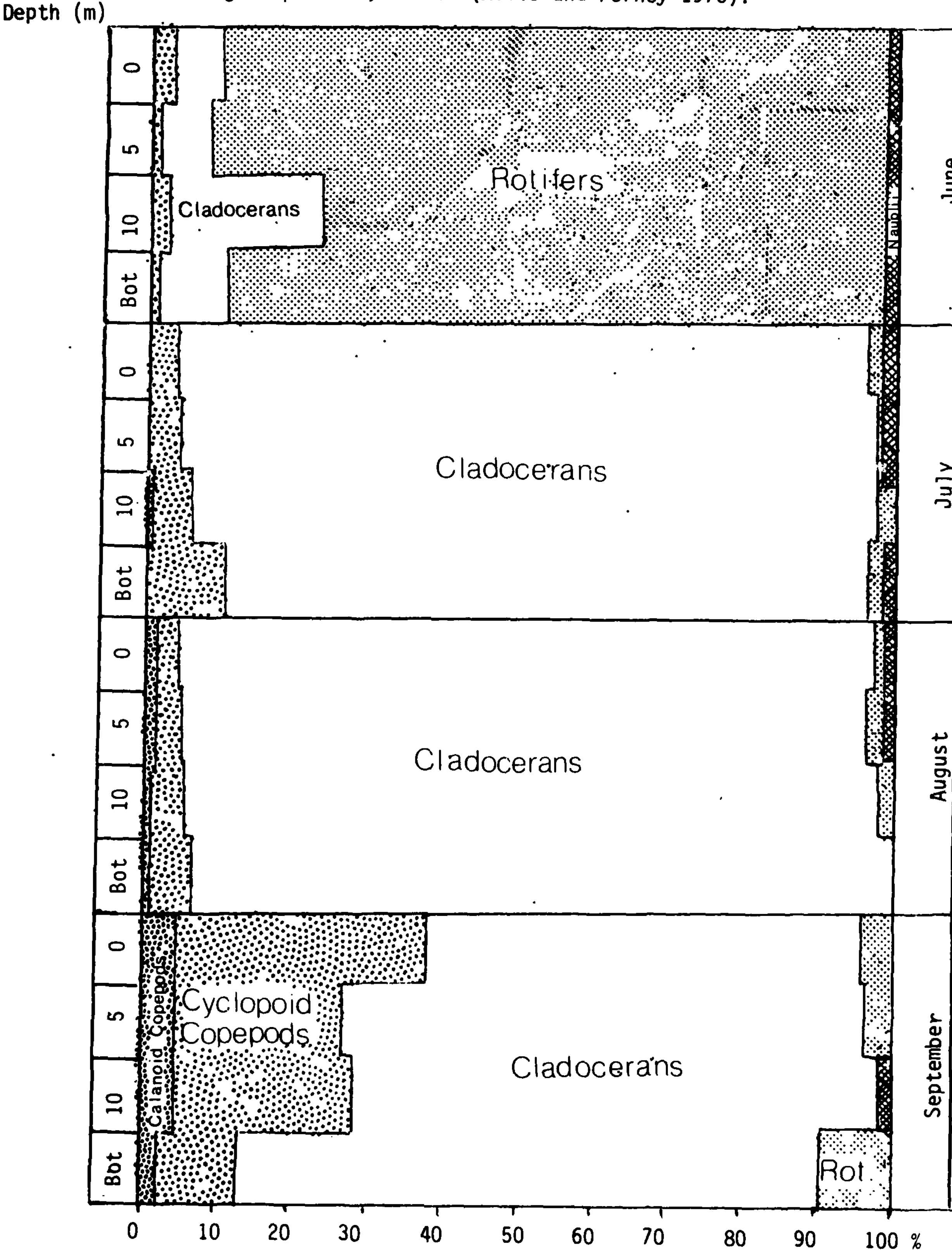


Figure 17. Monthly distribution of zooplankton (individuals/m^3) by % taxonomic group at selected depths in Lake St. Lawrence, June through September, 1976. (Mills and Forney 1976).



are current flows, available food resources, presence of organic wastes, and the substrate character, which shifts to sand, clay, and gravel. Depth, substrate, location, and season all play major roles in defining the benthic community structure. In general, the benthic community has a patchy, non-random distribution, and within similar depths, substrates, and habitat, the abundance, biomass, and diversity can be quite variable (USFWS 1979; Mills, Smith and Forney 1978a, 1978b, 1978c; Geis 1977; Mills and Forney 1976).

Mills, Smith, and Forney (1978c) found excessive numbers of oligochaetes and chironomids downstream from Dupont of Canada, Maitland, Ontario. These organisms, along with nematodes, are indicative of enriched conditions such as those found below sewer outfalls. Nematodes were more apt to be found around sewage, while the chironomids were more common near industrial chemical sites. Kinney (1972) found benthic populations reduced in abundance near urbanized areas, while Mills, Smith, and Forney (1978b) found beds of accumulated detrital material rich in benthic invertebrates.

The U.S. Fish and Wildlife Service (1979) found that shoals were important benthic habitats due to large concentrations of macrophytes such as Myriophyllum spp. Shallow sites have a higher standing crop of benthos than deeper sites, except in Lake St. Lawrence (Geis 1977). In general, the benthic invertebrate community is sparse in Lake St. Lawrence due to the homogenous substrate and the fact that it was drastically altered by the Moses-Saunders Dam (Lawler, Matusky, and Skelly 1977). The canal area between Eisenhower and Snell Locks also has relatively low productivity (Tables 31 and 32), due to poor substrate (clay and sand), water level fluctuations from lock operation, ship activity, and maintenance dredging (USFWS 1979).

In 1979, the U.S. Fish and Wildlife Service found oligochaetes, chironomids, amphipods, and molluscs to be the most abundant taxa in the River; isopods and nematodes were also abundant (Table 33). Mills, Smith, and Forney (1978d) found chironomids, oligochaetes, amphipods, and molluscs were the major forms in winter, with molluscs being the major component of the benthic biomass (Table 34). They found the same organisms dominating the samples during the summer (Mills, Smith, and Forney 1978a). Geis (1977) reported amphipods, tubificids, and chironomids as important components of the bottom fauna. All together, over 50 taxa (mostly keyed to the family level) were collected on the St. Lawrence River between 1972 and 1979 (Table 35).

Table 31 . Benthic Invertebrate Abundance, Frequency, and Biomass for St. Lawrence Additional Locks Study, 1979.[a]
Stations: Between Locks - In Channel (B31, B33, B38, B41)
Total Number of Samples: 8 Number of Samples Containing Organisms: 8
L=Larvae P=Pupae A=Adult +=<0.1% or <0.0001g or <1/m² *=Colonies X=No biomass estimate made

TAXA	LIFE STAGE	ABUNDANCE MEAN #/m²	% BY NUMBER	CUM. PERCENT	RANK BY NUMBER	FREQUENCY # OF OCCUR.	% OCCUR.	RANK BY FREQUENCY	BIOMASS MEAN BIO. g/m²	% BY BIO.	CUM. PERCENT	% BY BIO w/o MOL.	CUM.% w/o MOL	RANK BY BIO
Oligochaeta	A	1769	55.4	55.4	1	8	100.0	1	1.0614	60.2	60.2	78.7	78.7	1
Chironomidae	L	1112	34.8	90.2	2	8	100.0	1	0.2224	12.6	95.8	16.5	95.2	3
Ceratopogonidae	L	149	4.7	94.9	3	5	62.5	3	0.0298	1.7	97.5	2.2	97.4	4
Nematoda	A	35	1.1	96.0	4	2	25.0	8	0.0011	0.1	100.0	0.1	100.0	10
Trichoptera	L	35	1.1	97.1	4	4	50.0	4	0.0210	1.2	98.7	1.6	99.0	5
Hydracarina	A	30	0.9	98.0	6	4	50.0	4	0.0012	0.1	99.9	0.1	99.9	9
Nematomorpha	A	18	0.6	98.6	7	3	37.5	7	0.0018	0.1	99.8	0.1	99.8	8
Amphipoda	A	15	0.5	99.1	8	2	25.0	8	0.0090	0.5	99.2	0.7	99.7	6
Sphaeriidae	A	15	0.5	99.6	8	4	50.0	4	0.4050	23.0	83.2	--	--	2
Valvatidae	A	5	0.2	99.8	10	1	12.5	11	0.0080	0.5	99.7	--	--	7
Ephemeroptera	L	5	0.2	100.0	10	2	25.0	8	0.0010	0.1	100.0	0.1	100.1	11
Turbellaria	A	3	0.1	100.1	12	1	12.5	11	0.0006	+	100.1	+	100.1	12
Bryozoa	A	*	*	*	13	1	12.5	11	X	X	X	X	X	13
TOTAL	---	3191	---	100.1	13	8	100.0	13	1.7623	---	100.1	---	100.1	13

[a] USFWS 1979

Table 32 . Benthic Invertebrate Abundance, Frequency, and Biomass for St. Lawrence Additional Locks Study, 1979.
Stations: Between Locks - Non-Channel (B27-30, 32, 34-37, 39, 40, 42-44)
Total Number of Samples: 28 Number of Samples Containing Organisms: 28
L=Larvae P=Pupae A=Adult +=<0.1% or <0.0001g or <1/m² *=Colonies X=No biomass estimate made

		ABUNDANCE				FREQUENCY			BIOMASS					
TAXA	LIFE STAGE	MEAN #/m²	% BY NUMBER	CUM. PERCENT	RANK BY NUMBER	# OF OCCUR.	% OCCUR.	RANK BY FREQUENCY	MEAN BIO. g/m²	% BY BIO.	CUM. PERCENT	% BY BIO w/o MOL.	CUM.% w/o MOL	RANK BY BIO
Oligochaeta	A	2937	57.6	57.6	1	24	85.7	2	1.7622	39.7	84.1	80.7	80.7	2
Chironomidae	L	1485	29.1	86.7	2	27	96.4	1	0.2970	6.7	90.8	13.6	94.3	3
Ceratopogonidae	L	176	3.5	90.2	3	18	64.3	3	0.0352	0.8	98.4	1.6	98.3	6
Nematoda	A	143	2.8	93.0	4	17	60.7	4	0.0043	0.1	99.9	0.2	99.7	11
Nematomorpha	A	95	1.9	94.9	5	17	60.7	4	0.0095	0.2	99.8	0.4	99.5	10
Trichoptera	L	89	1.7	96.6	6	15	53.6	6	0.0534	1.2	97.6	2.4	96.7	5
Sphaeriidae	A	73	1.4	98.0	7	10	35.7	8	1.9710	44.4	44.4	--	--	1
Amphipoda	A	30	0.6	98.6	8	9	32.1	9	0.0180	0.4	99.4	0.8	99.1	8
Hydracarina	A	17	0.3	98.9	9	12	42.9	7	0.0007	+	99.9	+	99.7	13
Valvatidae	A	17	0.3	99.2	9	6	21.4	11	0.0272	0.6	99.0	--	--	7
Planorbidae	A	14	0.3	99.5	11	6	21.4	11	0.0098	0.2	99.6	--	--	9
Hydrobiidae	A	6	0.1	99.6	12	3	10.7	14	0.2484	5.6	96.4	--	--	4
Turbellaria	A	4	0.1	99.7	13	3	10.7	14	0.0008	+	99.9	+	99.7	12
Ephemeroptera	L	3	0.1	99.8	14	4	14.3	13	0.0006	+	99.9	+	99.7	14
Unid. Coleoptera	L	3	0.1	99.9	14	1	3.6	20	X	X	X	X	X	19
Chironomidae	P	2	+	99.9	16	3	10.7	14	0.0004	+	99.9	+	99.7	16
Haliplidae	L	2	+	99.9	16	2	7.1	17	0.0006	+	99.9	+	99.7	14
Ancylidae	A	1	+	99.9	18	2	7.1	17	0.0003	+	99.9	--	--	17
Isopoda	A	1	+	99.9	18	2	7.1	17	0.0003	+	99.9	+	99.7	17
Dytiscidae	L	1	+	99.9	18	1	3.6	20	X	X	X	X	X	19
Tipulidae	L	1	+	99.9	18	1	3.6	20	X	X	X	X	X	19
Bryozoa	A	*	*	*	22	8	28.6	10	X	X	X	X	X	19
TOTAL	---	5100	---	99.9	22	28	100.0	22	4.4397	---	99.9	---	99.7	22

USFWS 1979

Table 33 . Benthic Invertebrate Abundance, Frequency, and Biomass for St. Lawrence Additional Locks Study, 1979.
Stations: All (B01-B120, A01-A10, C01-C10, D01-D10, Q01-Q05)
Total Number of Samples: 294 Number of Samples Containing Organisms: 292
L=Larvae P=Pupae A=Adult +=<0.1% or <0.0001g or <1/m² *=Colonies X=No biomass estimate made

TAXA	LIFE STAGE	ABUNDANCE				FREQUENCY			BIOMASS					
		MEAN #/m²	% BY NUMBER	CUM. PERCENT	RANK BY NUMBER	# OF OCCUR.	% OCCUR.	RANK BY FREQUENCY	MEAN BIO. g/m²	% BY BIO.	CUM. PERCENT	% BY BIO w/o MOL.	CUM.% w/o MOL	RANK BY BIO
Oligochaeta	A	2420	31.0	31.0	1	271	92.2	2	1.4520	0.5	99.0	50.2	50.2	4
Chironomidae	L	2077	26.6	57.6	2	284	96.6	1	0.4154	0.2	99.8	14.4	88.6	7
Amphipoda	A	1156	14.8	72.4	3	210	71.4	3	0.6936	0.3	99.6	24.0	74.2	6
Hydrobiidae	A	602	7.7	80.1	4	157	53.4	7	24.9228	9.1	95.8	--	--	2
Sphaeriidae	A	273	3.5	83.6	5	191	65.0	4	7.3710	2.7	98.5	--	--	3
Isopoda	A	208	2.7	86.3	6	106	36.1	12	0.0624	+	100.0	2.2	96.8	14
Planorbidae	A	196	2.5	88.8	7	123	41.8	9	0.1372	0.1	100.0	--	--	9
Nematoda	A	162	2.1	90.9	8	158	53.7	6	0.0049	+	100.0	0.2	99.9	23
Trichoptera	L	160	2.1	93.0	9	191	65.0	4	0.0960	+	100.0	3.3	91.9	11
Ancylidae	A	88	1.1	94.1	10	52	17.7	20	0.0264	+	100.0	--	--	15
Valvatidae	A	86	1.1	95.2	11	109	37.1	11	0.1376	0.1	99.9	--	--	8
Turbellaria	A	60	0.8	96.0	12	70	23.8	16	0.0120	+	100.0	0.4	98.1	17
Ceratopogonidae	L	56	0.7	96.7	13	113	38.4	10	0.0112	+	100.0	0.4	98.5	18
Nematomorpha	A	51	0.7	97.4	14	138	46.9	8	0.0051	+	100.0	0.2	99.7	22
Haliplidae	L	34	0.4	97.8	15	34	11.6	26	0.0102	+	100.0	0.4	98.9	19
Glossiphoniidae	A	32	0.4	98.2	16	87	29.6	15	0.0768	+	100.0	2.7	94.6	12
Physidae	A	29	0.4	98.6	17	62	21.1	18	0.1015	+	100.0	--	--	10
Hydracarina	A	21	0.3	98.9	18	100	34.0	13	0.0008	+	100.0	+	100.2	27
Ephemeroptera	L	20	0.3	99.2	19	47	16.0	22	0.0040	+	100.0	0.1	100.0	24
Lepidoptera	L	18	0.2	99.4	20	60	20.4	19	0.0090	+	100.0	0.3	99.2	20
Unionidae	A	14	0.2	99.6	21	70	23.8	16	237.4722	86.7	86.7	--	--	1
Pleuroceridae	A	11	0.1	99.7	22	39	13.3	24	0.8525	0.3	99.3	--	--	5
Chironomidae	P	10	0.1	99.8	23	52	17.7	20	0.0020	+	100.0	0.1	100.1	25
Erpobdellidae	A	10	0.1	99.9	23	47	16.0	22	0.0260	+	100.0	0.9	97.7	16

Table (Continued).

TAXA	LIFE STAGE	ABUNDANCE MEAN #/m²	% BY NUMBER	CUM. PERCENT	RANK BY NUMBER	FREQUENCY # OF OCCUR.	% OCCUR.	RANK BY FREQUENCY	BIOMASS MEAN BIO. g/m²	% BY BIO.	CUM. PERCENT	% BY BIO w/o MOL.	CUM.% w/o MOL	RANK BY BIO
Lymnaeidae	A	6	0.1	100.0	25	37	12.6	25	0.0762	+	100.0	--	--	13
Odonata	L	2	+	100.0	26	15	5.1	28	0.0018	+	100.0	0.1	100.2	26
Hirudinidae	A	1	+	100.0	27	11	3.7	29	0.0081	+	100.0	0.3	99.5	21
Tipulidae	L	1	+	100.0	27	7	2.4	30	X	X	X	X	X	28
Unid. Coleoptera	L	+	+	100.0	29	2	0.7	32	X	X	X	X	X	28
Sialidae	L	+	+	100.0	29	4	1.4	31	X	X	X	X	X	28
Athericidae	L	+	+	100.0	29	2	0.7	32	X	X	X	X	X	28
Unid. Coleoptera	A	+	+	100.0	29	2	0.7	32	X	X	X	X	X	28
Dytiscidae	A	+	+	100.0	29	2	0.7	32	X	X	X	X	X	28
Curculionidae	L	+	+	100.0	29	2	0.7	32	X	X	X	X	X	28
Dytiscidae	L	+	+	100.0	29	2	0.7	32	X	X	X	X	X	28
Trichoptera	P	+	+	100.0	29	2	0.7	32	X	X	X	X	X	28
Chaoboridae	L	+	+	100.0	29	1	0.3	39	X	X	X	X	X	28
Coccinellidae	A	+	+	100.0	29	1	0.3	39	X	X	X	X	X	28
Collembola	A	+	+	100.0	29	1	0.3	39	X	X	X	X	X	28
Corydalidae	A	+	+	100.0	29	1	0.3	39	X	X	X	X	X	28
Unid. Diptera	L	+	+	100.0	29	1	0.3	39	X	X	X	X	X	28
Elateridae	A	+	+	100.0	29	1	0.3	39	X	X	X	X	X	28
Elmidae	L	+	+	100.0	29	1	0.3	39	X	X	X	X	X	28
Hemiptera	A	+	+	100.0	29	1	0.3	39	X	X	X	X	X	28
Hydrophilidae	L	+	+	100.0	29	1	0.3	39	X	X	X	X	X	28
Unid. Pelecypoda	A	+	+	100.0	29	1	0.3	39	X	X	X	X	X	28
Piscicolidae	A	+	+	100.0	29	1	0.3	39	X	X	X	X	X	28
Sisyridae	L	+	+	100.0	29	1	0.3	39	X	X	X	X	X	28
Bryozoa	A	*	*	*	29	98	33.3	14	X	X	X	X	X	28

Table 33 (Continued).

TAXA	LIFE STAGE	ABUNDANCE MEAN #/m²	% BY NUMBER	CUM. PERCENT	RANK BY NUMBER	FREQUENCY # OF OCCUR.	% OCCUR.	RANK BY FREQUENCY	BIOMASS MEAN BIO. g/m²	% BY BIO.	CUM. PERCENT	% BY BIO w/o MOL.	CUM.% w/o MOL	RANK BY BIO.
Hydrozoa	A	*	*	*	29	17	5.8	27	X	X	X	X	X	28
Porifera	A	*	*	*	29	1	0.3	39	X	X	X	X	X	28
TOTAL	---	7804	---	100.0	51	292	99.3	51	273.9887	---	100.0	---	100.2	51

USFWS 1979

Table 34. Percent composition of benthic invertebrates based on mean abundance for selected locations in the St. Lawrence River during the present time frame (1969-1983). Shallow sites were 0-5m deep, deep sites were 6-18m deep. 1 = May-August 1978; 2 = Winter 1978; 3 = August 1970.

	CAPE VINCENT					BARTLETT PT	CHIPPEWA BAY					MORRISTOWN
	Shallow			Deep		Deep	Shallow		Deep			Deep
TAXA	1	2	3	1	2	3	1	2	1	2	3	3
Coelenterata	0.8	0.0	0.0	0.3	0.3	0.0	*	1.4	0.6	3.1	0.0	0.0
Turbellaria	1.2	0.0	0.0	1.5	0.0	0.0	0.8	0.0	*	0.0	0.0	0.0
Nematoda	0.5	3.8	0.0	3.7	1.2	0.0	2.0	8.3	8.1	8.0	0.0	0.0
Annelida												
Oligochaeta	11.3	16.8	46.0	24.6	22.9	54.1	15.9	44.3	30.8	22.0	19.6	4.7
Polychaeta	1.0	1.3	1.2	5.0	5.2	0.0	0.0	0.0	9.2	1.6	0.0	0.3
Hirudinea	0.6	0.9	1.1	1.3	0.2	0.0	0.4	0.0	0.0	1.2	3.0	1.3
Crustacea												
Ostracoda	0.5	0.4	0.0	0.0	0.6	0.0	0.4	0.9	1.9	5.4	0.0	0.0
Isopoda	5.6	0.0	0.0	1.0	1.2	0.0	3.7	2.7	0.0	0.0	0.0	0.0
Amphipoda	25.7	30.5	11.2	17.3	25.6	8.2	7.5	27.1	1.8	2.3	26.7	10.5
Decapoda	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hydracarina	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.2	0.0	0.0	0.0
Insecta												
Ephemeroptera	0.0	0.0	0.0	0.0	0.0	0.0	*	0.0	0.0	0.0	0.0	0.0
Odonata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hemiptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Hymenoptera (adult)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Megaloptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trichoptera	0.9	0.5	0.0	0.3	0.2	0.0	0.1	0.0	0.4	0.2	0.5	0.0
Trichoptera (adult)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*	0.0	0.0	0.0
Lepidoptera	*	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Coleoptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tipulidae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chironominae	23.0	40.6	3.7	5.5	11.9	3.3	56.2	6.4	21.0	28.0	2.1	0.7
Tanypodinae	0.8	1.7	0.5	0.4	0.6	0.0	0.7	0.9	19.4	26.0	0.0	0.0

Table 34. (continued)

TAXA	CAPE VINCENT Shallow 1	CAPE VINCENT Shallow 2	CAPE VINCENT Shallow 3	CAPE VINCENT Deep 1	CAPE VINCENT Deep 2	BARTLETT PT Deep 3	CHIPPEWA BAY Shallow 1	CHIPPEWA BAY Shallow 2	CHIPPEWA BAY Deep 1	CHIPPEWA BAY Deep 2	CHIPPEWA BAY Deep 3	MORRISTOWN Deep 3
Insecta (continued)												
Chironomidae (pupae)	0.6	0.0	0.0	*	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Chironomidae (adult)	0.4	0.0	0.0	0.1	0.0	0.0	*	0.0	0.1	0.0	0.0	0.0
Ceratopogonidae	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
TOTAL WITHOUT MOLLUSCS	72.9	96.7	63.7	61.0	69.3	65.6	88.0	92.7	93.8	98.6	51.9	17.5
Gastropoda												
Bithyniidae	6.3	0.0	29.5	15.0	0.0	32.8	0.1	0.0	0.0	0.0	40.6	77.3
Viviparidae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0
Valvatidae	2.8	1.1	0.0	2.3	2.2	0.0	5.3	1.8	0.6	0.0	0.0	0.0
Hydrobiidae	13.3	1.7	0.0	9.4	24.0	0.0	4.4	3.7	0.1	0.2	0.0	0.0
Pleuroceridae	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lymnaeidae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Physidae	0.4	0.0	0.0	0.0	0.0	0.0	0.7	0.5	0.0	0.0	0.0	0.0
Planorbidae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ancylidae	*	0.0	0.0	0.0	0.0	0.0	*	1.4	0.0	0.0	0.0	0.0
Unidentified snails	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pelecypoda												
Unionidae	0.3	0.0	0.5	0.5	0.7	0.0	0.0	0.0	0.0	0.2	2.1	1.7
Sphaeriidae	3.8	0.5	5.3	11.9	3.8	1.6	1.3	0.0	5.2	1.0	4.7	3.4
NUMBER OF TAXONOMIC GROUPS	22	13	10	18	15	5	21	13	19	14	9	8

Table 34. (continued)

TAXA	OGDENSBURG/PRESCOTT Shallow 1	Shallow 2	Deep 1	Deep 2	Deep 3	GALOP ISLAND Shallow 1	Shallow 2	Deep 1	Deep 2	Deep 3	LAKE ST. LAWRENCE Shallow 1	Shallow 2	Deep 1	Deep 2	Deep 3
Coelenterata	1.1	8.9	1.0	0.0	0.0	0.1	1.5	2.8	32.3	0.0	0.1	0.5	0.9	6.5	0.0
Turbellaria	1.4	0.0	0.7	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Nematoda	3.0	4.4	6.9	29.3	0.0	2.1	9.6	7.0	14.9	0.0	2.2	1.6	5.2	4.0	0.0
Annelida															
Oligochaeta	29.7	25.2	30.1	47.6	61.4	13.0	28.5	45.7	18.5	0.5	17.7	8.8	28.4	18.5	69.7
Polychaeta	0.1	0.0	2.7	4.9	0.0	*	0.3	3.2	1.4	0.0	*	9.4	0.1	3.5	0.0
Hirudinea	0.2	3.9	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Crustacea															
Ostracoda	0.2	0.0	2.1	0.0	0.0	0.5	0.5	0.6	2.5	0.0	0.6	1.0	0.0	0.9	0.0
Isopoda	3.2	7.9	0.0	0.0	0.0	3.1	0.2	0.0	0.3	0.0	0.0	0.0	0.1	0.0	0.0
Amphipoda	15.1	2.0	26.2	1.2	36.0	16.5	21.6	6.9	5.6	4.2	2.6	0.0	1.2	0.9	0.0
Decapoda	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hydracarina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0
Insecta															
Ephemeroptera	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
Odonata	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Hemiptera	0.1	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
Hymenoptera (adult)	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
Megaloptera	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trichoptera	0.1	0.0	0.7	0.0	0.9	0.3	1.7	0.9	0.0	94.8	0.1	0.0	0.0	0.0	0.0
Trichoptera (adult)	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
Lepidoptera	0.3	0.0	0.0	0.0	0.0	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Coleoptera	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	0.0
Tilpulidae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Chironominae	33.9	16.1	16.8	6.1	0.0	53.4	17.2	22.9	19.1	0.0	73.9	78.1	59.1	63.4	25.0
Tanypodinae	1.8	0.5	0.0	0.0	0.0	1.3	1.4	0.4	2.0	0.0	0.0	0.4	0.0	0.4	0.0

Table 34. (continued)

TAXA	OGDENSBURG/PRESCOTT Shallow 1	Shallow 2	Deep 1	Deep 2	Deep 3	GALOP ISLAND Shallow 1	Shallow 2	Deep 1	Deep 2	Deep 3	LAKE ST. LAWRENCE Shallow 1	Shallow 2	Deep 1	Deep 2	Deep 3
Insecta (continued)															
Chironomidae (pupae)	0.8	0.0	0.1	0.0	0.0	0.6	0.0	0.4	0.0	0.0	1.2	0.0	2.5	0.0	0.0
Chironomidae (adult)	*	0.0	1.0	0.0	0.0	*	0.0	0.2	0.0	0.0	*	0.0	0.4	0.0	0.0
Ceratopogonidae	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
TOTAL WITHOUT MOLLUSCS	91.0	62.9	89.3	91.5	98.3	92.1	83.2	91.1	94.7	99.5	98.6	99.8	98.5	98.7	94.7
Gastropoda															
Bithyniidae	0.2	0.0	3.4	0.0	0.9	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3
Viviparidae	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
Valvatidae	1.4	2.5	0.6	2.4	0.0	0.6	0.7	1.6	1.1	0.0	0.0	0.0	0.0	0.0	0.0
Hydrobiidae	4.9	20.7	2.4	1.2	0.0	3.1	3.6	2.2	2.5	0.0	0.1	0.1	0.2	0.0	0.0
Pleuroceridae	0.0	0.0	0.6	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lymnaeidae	*	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Physidae	1.4	0.0	0.3	1.2	0.0	1.3	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planorbidae	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Ancylidae	0.0	0.0	0.0	0.0	0.0	1.8	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unidentified snails	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pelecypoda															
Unionidae	0.0	0.0	0.1	0.0	0.0	*	0.3	0.2	0.0	0.5	0.0	0.0	0.0	0.0	0.0
Sphaeriidae	1.0	5.9	3.0	3.6	0.0	0.7	3.3	6.8	1.7	0.0	1.1	0.1	0.9	1.3	0.0
NUMBER OF TAXONOMIC GROUPS	22	12	19	9	5	25	18	16	12	4	13	9	18	10	3

1 - Mills, Smith, and Forney 1978a.

2 - Mills, Smith, and Forney 1978b.

3 - Lawler, Matusky, and Skelly 1977.

* = < 0.1%.

Table 35 . Phylogenetic list of invertebrates collected on the St. Lawrence River during the present time frame (1969-1983).*

Phylum Porifera
    Order Haplosclerina
        Family Spongillidae (Sponges)

Phylum Coelenterata
    Class Hydrozoa (Hydroids) - colonies

Phylum Platyhelminthes
    Class Turbellaria (Flatworms)

Phylum Nematoda (Roundworms)

Phylum Nematomorpha (Horsehair worms)

Phylum Bryozoa (Moss animalcules) - colonies

Phylum Annelida
    Class Oligochaeta (Aquatic earthworms)
    +Class Polychaeta (Worms)
    Class Hirudinea (Leeches)
        Order Rhynchobdellidae
            Family Glossiphoniidae
            Family Piscicolidae
        Order Gnathobdellidae
            Family Hirundinidae
        Order Pharyngobdellidae
            Family Erpobdellidae

Phylum Arthropoda
    Class Crustacea
        +Subclass Ostracoda
            +Order Podocopa (Seed shrimp)
        Subclass Malacostraca
            Division Peracarida
                Order Isopoda (Aquatic sow bugs)
                Order Amphipoda (Scuds)
            +Division Eucarida
                +Order Decapoda (Crayfish)
    Class Arachnoidea
        Family Hydrachnellae (Hydracarina) (Water mites)
    Class Insecta
        Order Collembola (Springtails) - adults
        Order Ephemeroptera (Mayflies) - larvae
        Order Odonata (Dragonflies, Damselflies) - larvae
        Order Hemiptera (Bugs) - adults
        +Order Hymenoptera (Ants, Bees, Wasps) - adults
        Order Megaloptera (Alderflies, Dobsonflies, Fishflies)
            Family Sialidae - larvae
            Family Corydalidae - larvae
        Order Sisyridae (Spongilla flies) - larvae
        Order Trichoptera (Caddisflies) - larvae, pupae, +adults

Table 35 . (Continued)

- Order Lepidoptera (Aquatic caterpillars) - larvae
- Order Coleoptera (Beetles)
    - Family Haliplidae (Crawling water beetles) - larvae
    - Family Dytiscidae (Predaceous diving beetles) - larvae, adults
    - Family Hydrophilidae (Water scavenger beetles) - larvae
    - Family Elmidae (Riffle beetles) - larvae
    - Family Curculionidae (Weevils) - larvae
    - Family Coccinellidae (Ladybird beetles) - adults
    - Family Elateridae (Click beetles) - adults
- Order Diptera (Flies)
    - Suborder Nematocera
        - Family Tipulidae (True crane flies) - larvae
        - Family Culicidae
            - Subfamily Chaoborinae (Phantom midges) - larvae
        - Family Chironomidae (Midges) - larvae, pupae
            - +Subfamily Chironominae - larvae
            - +Subfamily Tanypodinae - larvae
        - Family Ceratopogonidae (Punkies) - larvae
    - Suborder Brachycera
        - Family Athericidae - larvae

Phylum Mollusca

- Class Gastropoda (Snails, limpets)
    - Subclass Prosobranchia
        - Order Mesogastropoda
            - +Family Bithyniidae
            - #Family Viviparidae
            - Family Valvatidae (Round-mouthed snails)
            - Family Hydrobiidae
            - Family Pleuroceridae (River snails)
    - Subclass Pulmonata
        - Order Bosommatophora
            - Family Lymnaeidae (Pond snails)
            - Family Physidae (Pouch snails)
            - Family Planorbidae (Orb snails)
            - Family Ancylidae (Limpets)
- Class Pelecypoda (Clams, mussels)
    - Family Unionidae (Freshwater mussels)
    - Family Sphaeriidae (Fingernail clams)

* USFWS 1979.

\+ Mills, Smith, and Forney 1978a. (not taken in 1979).

\# Lawler, Matusky, and Skelly 1977. (not taken in 1978 or 1979).

FOOD WEBS

V. FOOD WEBS

Pre-Seaway

Very little information is available on the food web structure in the St. Lawrence River prior to the Seaway. The 1952 study of plankton and other invertebrates conducted by the Academy of Natural Sciences of Philadelphia (1953) and a 1930 study of food habits of selected fish species conducted by Sibley and Rimsky-Korsakoff (1931) provide the only data available. Therefore, any description of the food web during this time frame will be rather sketchy.

Insects were relatively abundant on the St. Lawrence River and provided a major food source for many fish species. Among the major game fish species that fed on insects were northern pike (Esox lucius) juveniles, smallmouth bass (Micropterus dolomieui) adults and juveniles, yellow perch (Perca flavescens), rock bass (Ambloplites rupestris), pumpkinseed (Lepomis gibbosus), and brown bullhead (Ictalurus nebulosus) (Table 36). Other common species that consumed insects were alewives (Alosa pseudoharengus), white suckers (Catostomus commersoni), and johnny darters (Etheostoma nigrum) (Sibley and Rimsky-Korsakoff 1931).

Other invertebrates, particularly amphipods, isopods, and molluscs, were also important food sources for fish. These were readily consumed by brown bullhead, northern pike juveniles, yellow perch adults, and pumpkinseed adults (Sibley and Rimsky-Korsakoff 1931).

Most of the major gamefish species were partly or wholly piscivorous. Walleye (Stizostedion vitreum vitreum) adults and northern pike adults were almost totally piscivorous. Other piscivores included brown bullhead (over 12 cm), smallmouth bass adults and juveniles, largemouth bass (Micropterus salmoides), yellow perch, pumpkinseed, and brown bullhead. Alewives were also found to consume young perch fry (Table 37) (Sibley and Rimsky-Korsakoff 1931).

Post-Seaway

Food web studies on the St. Lawrence River during the post-Seaway time frame are non-existent. This represents a data gap that cannot be filled.

Present

A variety of studies have been conducted on the components that make up the food web of the St. Lawrence River, but only one study (Cooley 1978) attempts to tie these components together (Fig. 18). Cooley found the data set for the deep water zone (> 10 meters deep; defined differently than our habitat descriptions) to be more complete than other data sets, due mainly to sampling difficulties in other zones. In the deep zone, the phytoplankton community turns over almost daily. Detritus is an important component of the deep water zone food web (Figs. 19 and 20).

The shallow littoral zone (< 5 meters deep; defined differently than our habitat descriptions) has a greater diversity of habitats and thus is more difficult to sample quantitatively. The detrital component is also very

Table 36. Food habits of fish sampled in the St. Lawrence River in 1930. Foods recorded in percentages.*

Species	Length (cm)	Date	No. of records	Zooplankton	Surface drift	Aquatic insects	Miscellaneous
Lake sturgeon	- -	9/10	2	- -	- -	30	Snails 70
Mooneye	31.0	7/3-4	7	- -	100	- -	
Whitefish	1.5-3.0	6/6-17	18	100	- -	- -	
Shorthead redhorse	8.6	6/30	1	- -	- -	100	
Longnose dace	4.0	6/6	1	- -	100	- -	Caddisfly eggs
Fallfish	6.0	7/1	4	- -	100	- -	
"	4.4-7.7	8/13	9	- -	50	50	
Emerald shiner	2.6-4.4	6/17	10	60	- -	40	
Sand shiner	5.4	7/1	1	- -	100	- -	
Spottail shiner	3.0-3.9	6/6	5	- -	80	20	
" "	7.0-8.4	6/6	5	- -	100	- -	
" "	4.0-4.4	6/21	5	100	- -	- -	
" "	7.0-8.7	6/21	3	- -	- -	100	
" "	7.0-8.4	6/30	6	- -	100	- -	
" "	4.0-4.4	6/30	8	- -	70	30	
" "	6.0-7.3	8/13	5	- -	30	70	
Mimic shiner	4.0-5.3	6/21	10	85	- -	15	
" "	4.2	7/1	8	- -	- -	100	
Bluntnose minnow	6.5	6/30	5	- -	50	50	
" "	4.9-6.6	6/21	5	- -	100	- -	Caddisflies
Cutlips minnow	3.1-5.2	6/17	2	- -	- -	100	
" "	6.8	6/30	1	- -	- -	- -	Molluscs 100
Banded killifish	2.7-4.0	6/30	8	15	- -	60	Amphipods 25
Logperch	4.6-5.2	6/6	5	- -	- -	90	Fish eggs, amphipods 10
Logperch	4.7-5.8	6/21	11	- -	15	55	Fish eggs 10, snails 10, amphipods 10
Logperch	5.7	6/30	8	- -	- -	75	Amphipods 20, molluscs 5
Logperch	7.6	8/13	2	- -	- -	100	
Channel darter	4.0-4.7	7/21	7	- -	- -	100	
Mottled sculpin	3.3-4.5	6/6	4	- -	- -	95	Amphipods 5
" "	4.6	7/1	1	- -	- -	5	Amphipods 95
" "	1.9	7/21	5	- -	- -	60	Amphipods 40

*Sibley and Rimsky-Korsakoff 1931.

Table 37. Food habits of piscivorous fish sampled in the St. Lawrence River in 1930.*

Piscivore	Fish found in stomachs
Alewife	Yellow perch fry
Northern pike	Mooneye, white sucker, spottail shiner, common shiner, fallfish, bluntnose minnow, bullhead, mudminnow, logperch, johnny darter, rock bass, brook stickleback, three-spined stickleback, yellow perch
Fallfish	Unidentified fish
Brown bullhead	Pumpkinseed, white sucker, pearl dace
Pumpkinseed	Yellow perch
Smallmouth bass	White sucker, brassy minnow, northern redbelly dace, yellow perch, johnny darter, slimy sculpin
Largemouth bass	Unidentified fish
Yellow perch	Yellow perch, johnny darter, brook stickleback
Walleye	Yellow perch, johnny darter
Slimy sculpin	Unidentified fish

*Sibley and Rimsky-Korsakoff 1931.

Figure 18 . Overview of the interrelationships between the ecological zones of the St. Lawrence River. (Cooley 1978)

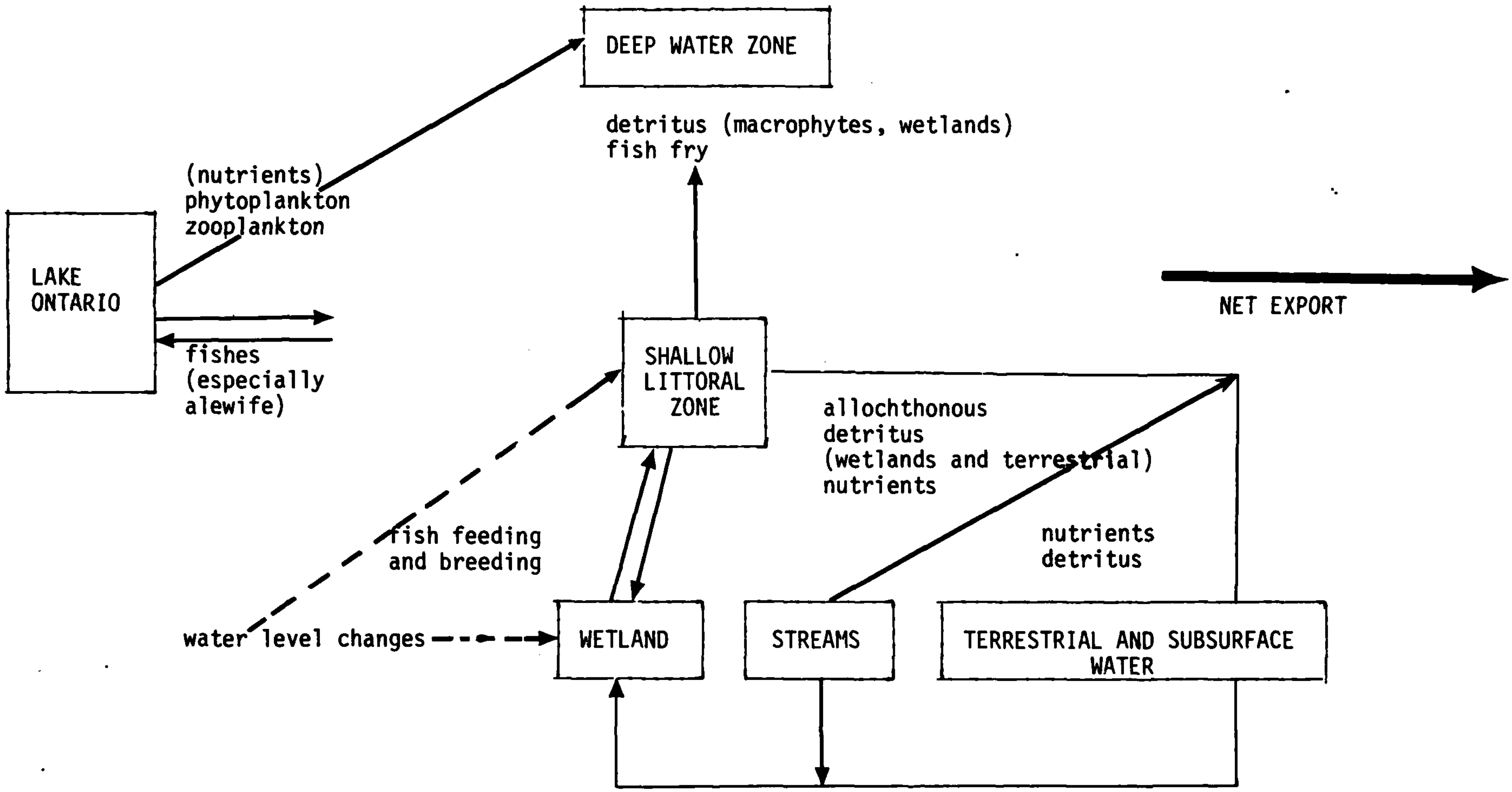


Figure 19 . Conceptual outline of the food web for the deep water zone (>10 m) in the St. Lawrence River during summer 1976 and 1977. (Cooley 1978)

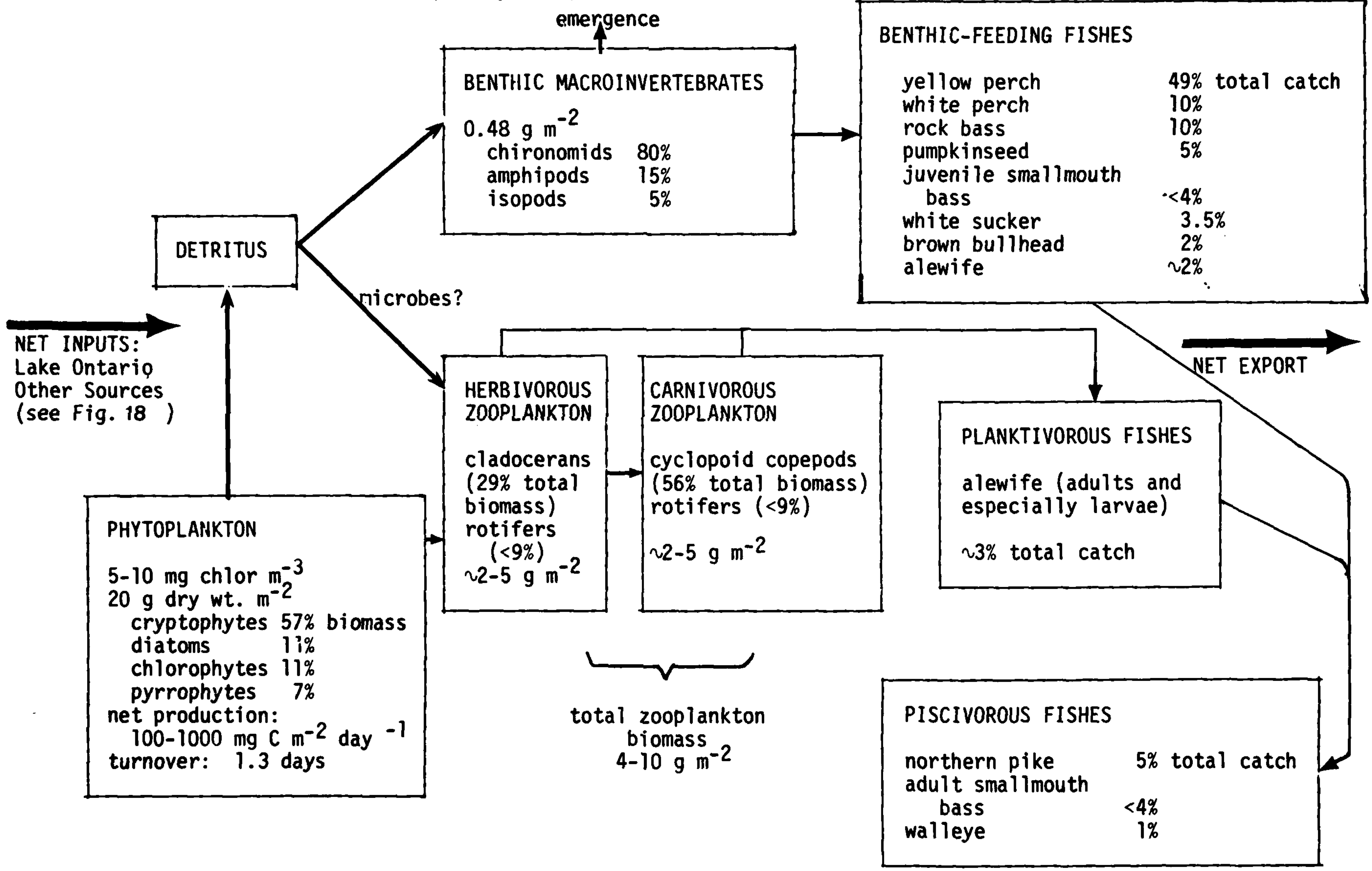
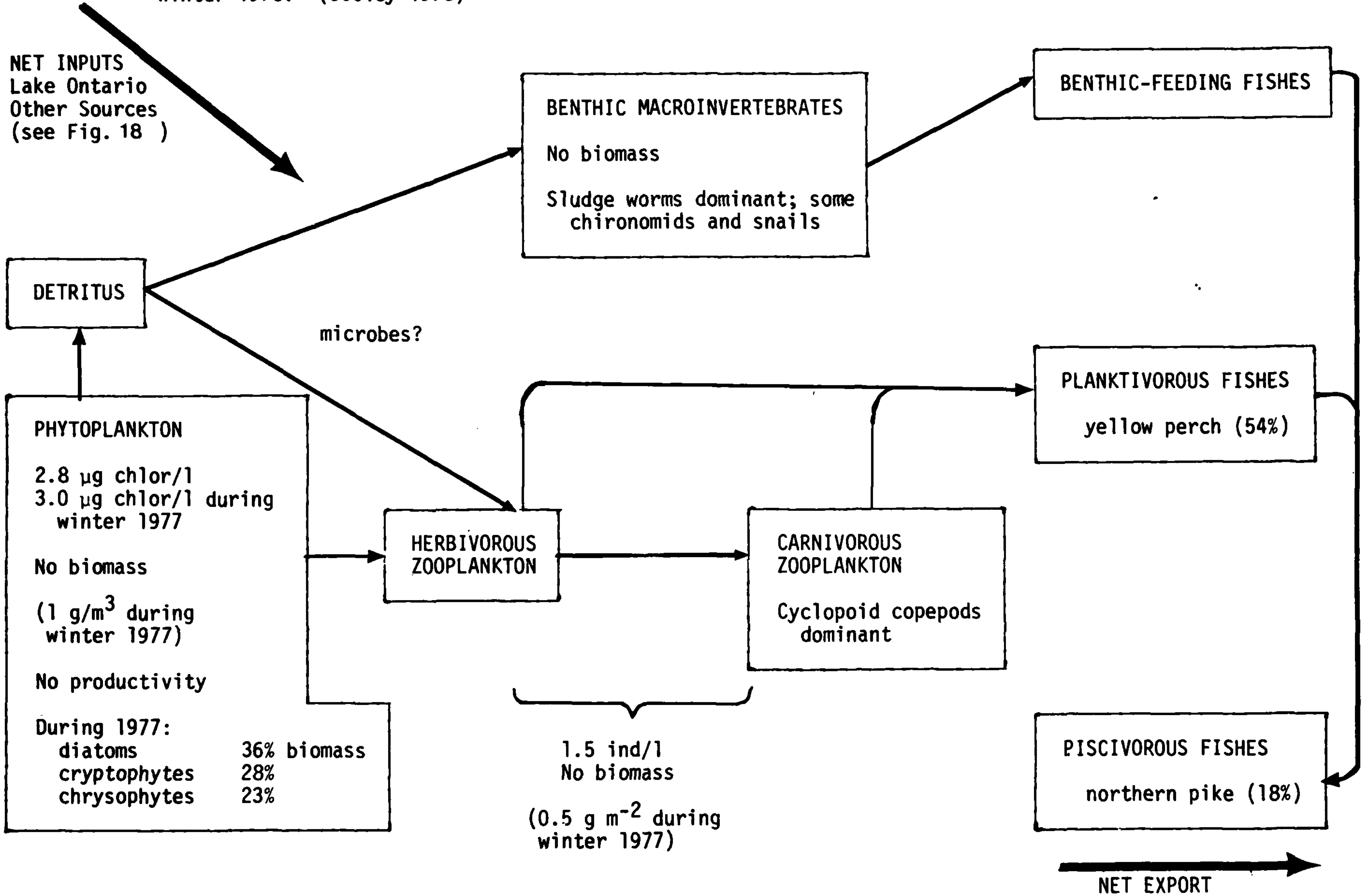


Figure 20 . Conceptual outline of the food web for the deep water zone (>10 m) in the St. Lawrence River during winter 1978. (Cooley 1978)



important in this zone; macrophyte productivity enters the food web primarily through the detrital pathway (Figs. 21 and 22). The shallow littoral zone is also important because it provides habitat for different life-history stages of fish. Dense macrophyte beds provide refuge from predators and serve as resting areas (Cooley 1978).

The wetland zone supports a complex food web that is driven by detritus from marsh plants. Periphyton may also be an important component in this food web (Fig. 23). Wetlands are important as refuge, resting, and feeding areas for many fish, especially larvae and young-of-the-year. They also provide nesting and breeding sites for other organisms. Several species of fish appeared to move into the wetlands during the winter (Cooley 1978).

In general, the "dominant autochthonous energy source is probably periphyton or macrophytes in the St. Lawrence River" (Cooley 1978). Because of the complexity of the River, which includes extensive wetland, island, and shoal areas, it is difficult to construct a single food web for the entire River (Cooley 1978).

A study of food items of juvenile fish was conducted in 1976 by Johnson (1983). He found that the major food items of juveniles were chironomids, cladocerans, amphipods, corixids, and fish (Table 38). Young-of-the-year largemouth bass (Micropterus salmoides) became piscivorous by the time they attained a length of 60 millimeters. The greatest overlap in food usage occured among juveniles of smallmouth bass (Micropterus dolomieui), yellow perch (Perca flavescens), and pumpkinseed (Lepomis gibbosus). Amphipods were found to be locally important food sources for juvenile fish.

In the Cape Vincent area, largemouth bass juveniles fed primarily on fish and amphipods, while in the Massena area they fed on corixids and fish. In Morristown, corixids, amphipods, and baetid mayflies comprised the bulk of their diet (Table 38). Alewife (Alosa pseudoharengus) juveniles fed primarily on cladocerans in the Cape Vincent area, while copepods were also an important dietary component in the Massena area. Smallmouth bass juveniles fed on amphipods and chironomids in the Morristown area. They utilized chironomids and corixids in the Massena area. Yellow perch juveniles preferred chironomids in the Massena area, but showed a preference for amphipods in the Morristown area (Johnson 1983).

In summary, although a variety of studies have been conducted on various components of the food web, the complexity of the system makes it difficult to tie these components together and relate them to the system as a whole. More specific quantitative data for selected areas will be needed to describe the food webs of the St. Lawrence River.

Figure 21 . Conceptual outline of the food web for the shallow littoral zone (<5 m) in the St. Lawrence River during summer 1976 and 1977. (Cooley 1978)

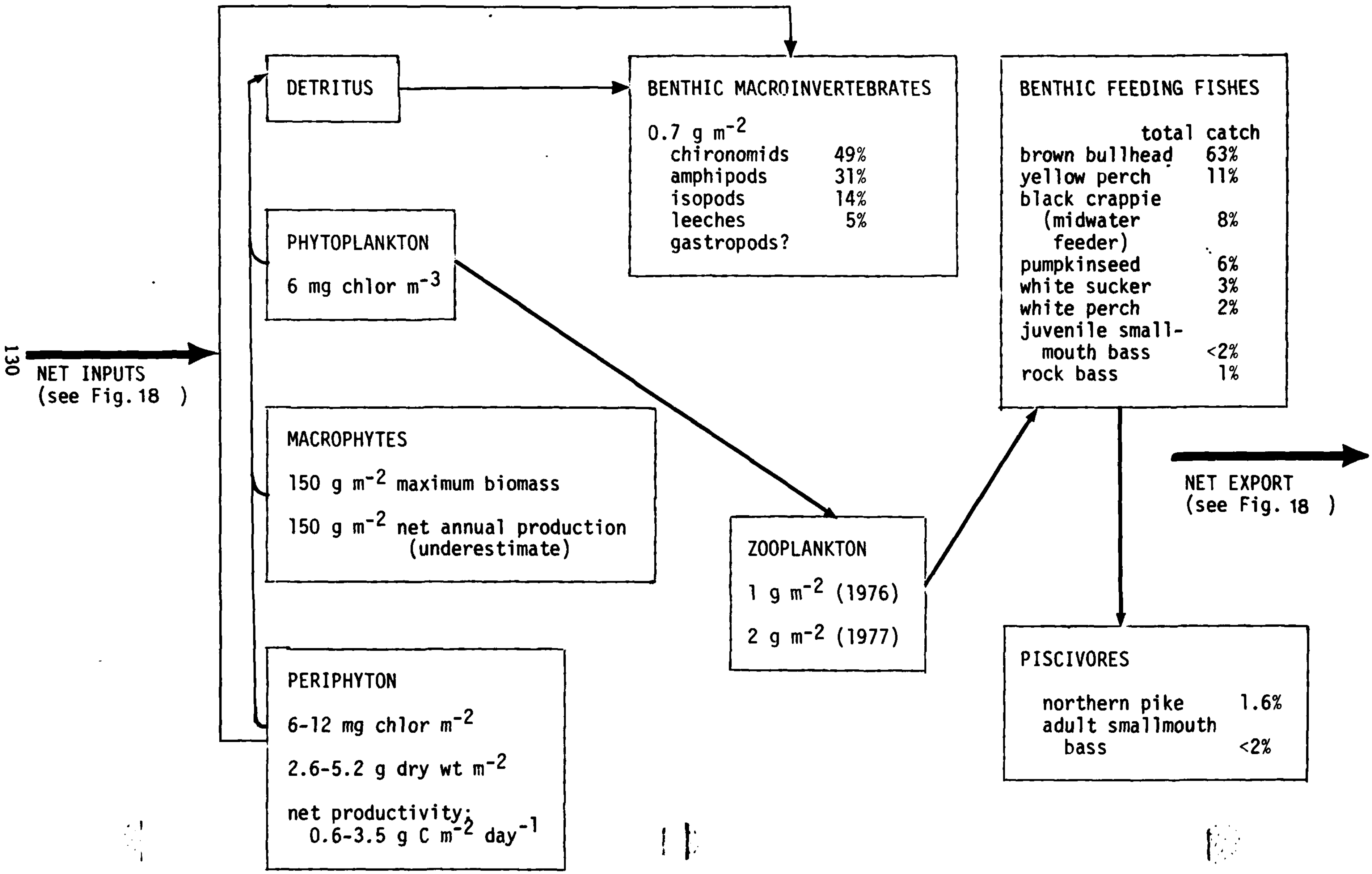


Figure 22 . Conceptual outline of the food web for the shallow littoral zone (<5 m) in the St. Lawrence River during winter 1978. (Cooley 1978)

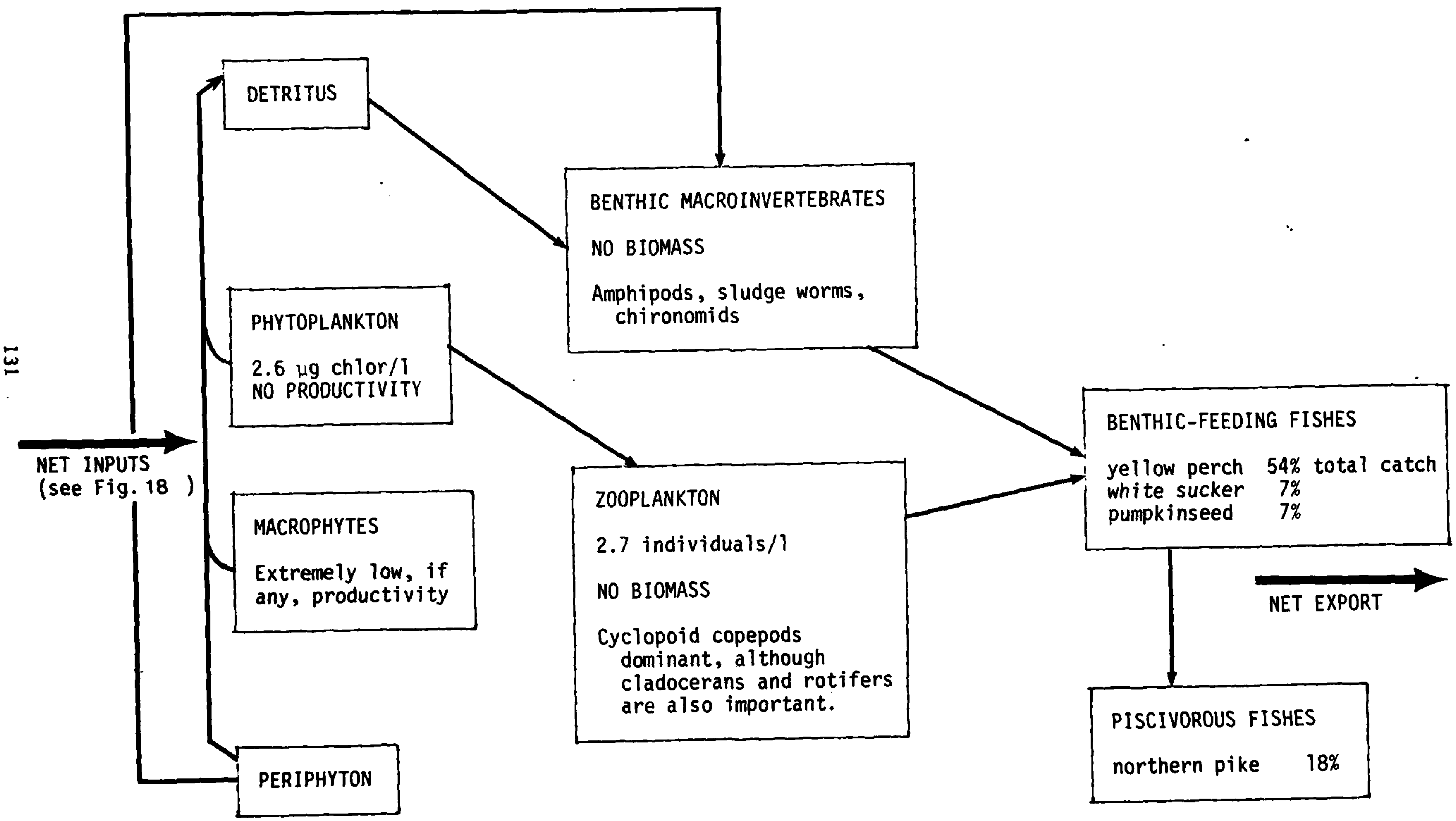


Figure 23. Conceptual outline of the food web for the wetland zone in the St. Lawrence River (marshy area and streams). (Cooley 1978)

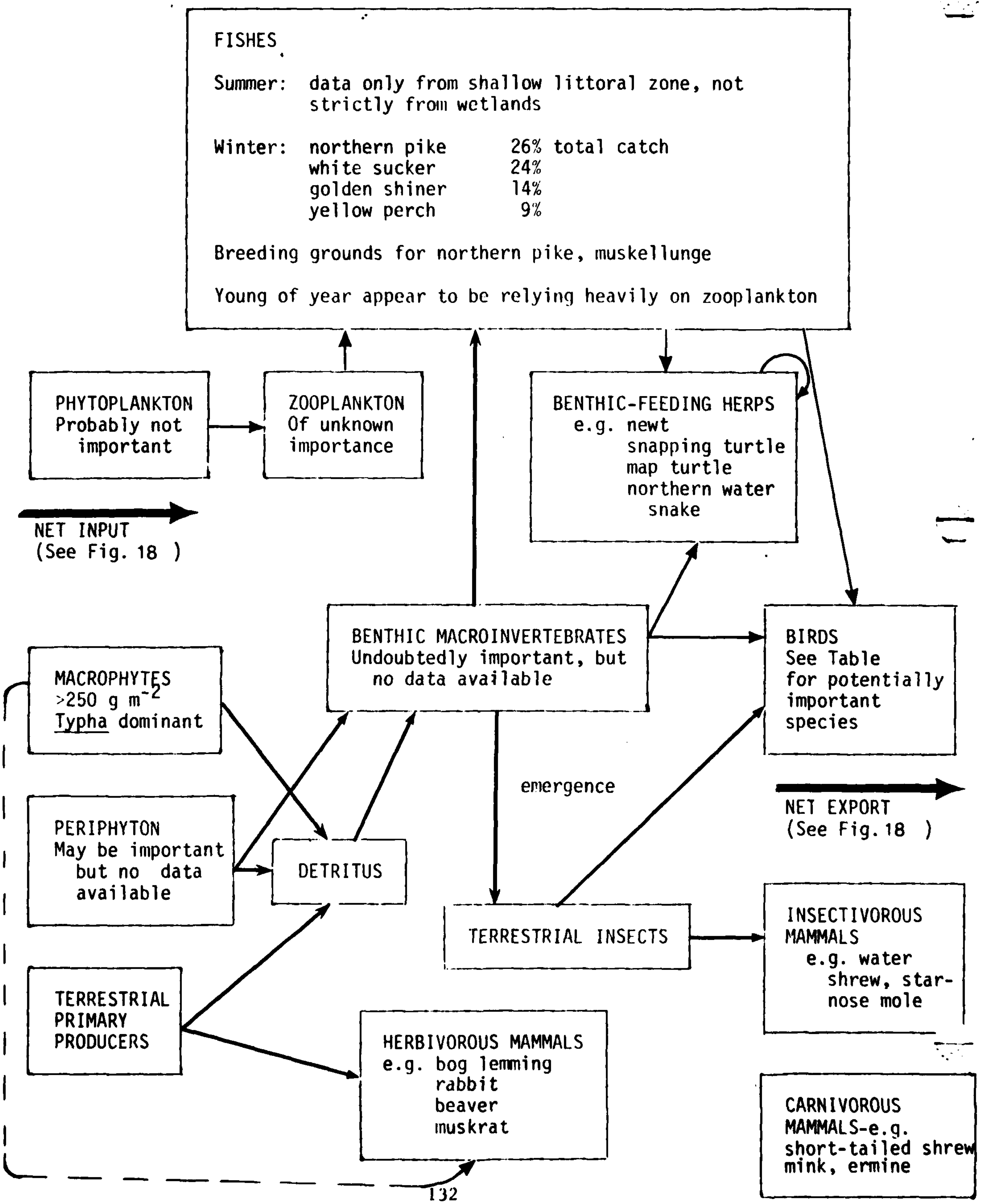


Table 38. Stomach contents of juvenile fish collected at three sites in the St. Lawrence River during August 1976.*

	Percentage of dry weight							
	Largemouth bass			Rock bass	Smallmouth bass		Alewife	
Food	CV[1]	MT[2]	MS[3]	CV	MT	MS	CV	MS
Invertebrates								
Planariidae	--	--	--	--	--	--	--	--
Hirudinea	--	--	--	--	--	--	--	--
Cladocera	--	--	--	20.52	0.55	--	96.64	83.85
Copepoda	--	--	--	0.75	0.07	--	1.60	11.38
Ostracoda	--	--	--	2.99	0.02	--	0.25	1.60
Hydracarina	--	--	--	17.91	--	--	--	0.01
Isopoda	--	--	--	--	--	--	--	--
Amphipoda	19.24	37.77	--	12.69	69.83	5.56	--	0.10
Collembola	--	--	--	--	--	--	--	0.01
Leptoceridae	--	--	--	0.37	--	--	--	--
Ephemeridae	--	--	--	--	--	--	--	--
Baetidae	--	10.58	--	--	--	--	--	--
Coenagrionidae	--	--	--	--	--	1.85	--	--
Caenidae	--	4.91	--	--	--	--	--	--
Corixidae	--	42.49	47.09	--	--	9.26	--	--
Trichoptera (pupae)	--	--	--	--	5.81	--	--	--
Hydroptilidae	--	--	--	--	--	--	--	--
Dytiscidae	--	--	--	--	--	--	--	--
Chironomidae	2.38	1.89	8.07	44.40	23.72	74.07	1.51	3.05
Ceratopogonidae	--	--	--	--	--	--	--	--
Diptera (aerial)	--	--	--	--	--	--	--	--
Syrphidae	--	--	--	--	--	--	--	--
Homoptera	--	--	--	--	--	--	--	--
Hymenoptera	--	2.36	--	--	--	--	--	--
Lepidoptera	--	--	--	0.37	--	--	--	--
Gastropoda	--	--	--	--	--	--	--	--
Planorbidae	--	--	--	--	--	--	--	--
Physidae	--	--	--	--	--	--	--	--
Hydrobiidae	--	--	--	--	--	--	--	--
Fish								
Etheostoma spp.	--	--	--	--	--	1.86	--	--
Alewife (post larvae)	7.13	--	--	--	--	--	--	--
Unidentified	71.25	--	44.84	--	--	7.40	--	--
Number of fish examined	15	7	10	20	20	15	20	20
Length (mm)								
Mean	59	71	66	34	42	99	49	100
Range	35-68	63-77	61-72	30-38	30-50	57-137	39-57	91-109

*Johnson 1983
[1]Cape Vincent
[2]Morristown
[3]Massena

Table 38 . (continued)

Food	Percentage of dry weight					
	Brown bullhead	Yellow perch		Black crappie	Pumpkin-seed	White perch
	MT	MT	MS	MS	MS	MS
Invertebrates						
Planariidae	--	0.87	--	--	--	--
Hirudinea	--	5.43	--	--	--	--
Cladocera	0.75	0.24	0.04	15.38	1.62	40.69
Copepoda	5.45	0.01	0.02	--	--	34.12
Ostracoda	2.22	0.67	0.03	1.28	2.06	6.03
Hydracarina	0.13	0.29	0.08	--	--	0.05
Isopoda	30.27	2.96	--	--	--	--
Amphipoda	30.54	49.17	8.20	4.70	0.44	0.34
Collembola	--	--	--	--	--	--
Leptoceridae	--	--	--	--	--	0.05
Ephemeridae	--	--	--	--	--	0.33
Baetidae	2.82	--	--	--	--	0.05
Coenagrionidae	--	--	--	--	--	--
Caenidae	2.62	--	--	--	--	--
Corixidae	4.54	--	2.68	37.18	0.32	7.10
Trichoptera (pupae)	--	--	--	--	--	--
Hydroptilidae	--	3.59	--	--	1.50	0.10
Dytiscidae	2.72	--	--	--	--	--
Chironomidae	17.15	33.68	87.28	41.03	93.63	10.99
Ceratopogonidae	0.79	--	--	--	0.06	0.10
Diptera (aerial)	--	--	1.34	--	--	--
Syrphidae	--	0.78	--	--	--	--
Homoptera	--	0.71	--	--	0.06	--
Hymenoptera	--	--	--	--	--	--
Lepidoptera	--	--	--	--	0.31	--
Gastropoda	--	0.26	0.33	--	--	--
Planorbidae	--	0.34	--	--	--	--
Physidae	--	0.52	--	--	--	--
Hydrobiidae	--	0.48	--	--	--	--
Fish						
Etheostoma spp.	--	--	--	--	--	--
Alewife (post larvae)	--	--	--	--	--	--
Unidentified	--	--	--	0.43	--	0.05
Number of fish examined	10	20	20	20	20	20
Length (mm)						
Mean	74	103	122	110	88	119
Range	60-92	95-114	106-143	100-135	77-113	109-134

FISHERIES

VI. FISHERIES

Historical Trends

The St. Lawrence River has supported an excellent and diverse fishery resource. A wide variety of habitats, produced by the many bays, shoals, islands, and quiescent areas, have been available. Construction of the St. Lawrence Seaway and Power Project altered some of the habitat resources. However, they still support an excellent fishery resource with great diversity. A big threat to the fishery resource in recent years has been toxic contaminants. The contaminants are causing some species to be potential health hazards to consumers. They may also be impacting the health and abundance of fish populations.

In order to evaluate the impact of man-caused changes in the St. Lawrence on the fishery resources, twelve species were chosen as "indicator species" (Table 39). All of the species selected are important as gamefish, panfish, or have been important in the commercial fishery. Forage fish were not chosen due to the scarcity of information (such as relative abundance) regarding these species in the literature on the St. Lawrence River. The twelve species chosen were lake sturgeon (Acipenser fulvescens), northern pike (Esox lucius), muskellunge (Esox masquinongy), brown bullhead (Ictalurus nebulosus), white perch (Morone americana), rock bass (Ambloplites rupestris), pumpkinseed (Lepomis gibbosus), bluegill (Lepomis macrochirus), smallmouth bass (Micropterus dolomieui), largemouth bass (Micropterus salmoides), yellow perch (Perca flavescens), and walleye (Stizostedion vitreum vitreum).

Based on the available information, the relative abundance of the indicator species ranged from "absent" to "abundant" during the pre-Seaway period (Table 39). White perch was the only one of the indicator species not present in the pre-Seaway period. Those species listed as "abundant" were brown bullhead, rock bass, pumpkinseed, and yellow perch. All of these species have remained "abundant" into the present time period. In addition, one species, smallmouth bass, which was "common" through the post-Seaway period is now considered "abundant".

Some species have shown a marked decline over the years. Lake sturgeon declined from "moderately common" in the pre-Seaway period to "uncommon" in the post-Seaway period to "rare" at present. Walleye also declined, from "common" to "uncommon". Muskellunge may have declined slightly since the 1930's.

A total of 99 species of fish have been captured on the St. Lawrence River in various surveys, starting with Greeley and Greene in 1930 (Table 40; also see Tables 52 and 63 in Appendix A). A maximum of 93 species has been captured in any one survey.

The Canadian commercial fish catch statistics illustrate some trends on the River (Table 41; Figs. 24 and 24a). For the 1924 through 1960 period, the statistical district extended from Gananoque, Ontario downriver through, and including, Lake St. Francis. From 1961 through 1980, the statistics are from the same area plus the reach from Tibbetts Point to Gananoque. Total catch fluctuated in the early years, but no major decline occurred until 1938, when

Table 39. The occurrence and relative abundance[1] of certain indicator species of fish in the St. Lawrence River during three time frames.*

Species	Pre-Seaway 1930's	1940's	1950's	Post-Seaway 1959-1968	Present 1970-1983
Lake sturgeon[2]	M	M	M	U	R
Northern pike	A	C	C	M	C
Muskellunge	M[3]	-	-	U	U
Brown bullhead	A	A	A	A	A
White perch	0[4]	0	0	0-R	C
Rock bass	A	A	A	A	A
Pumpkinseed	A	A	A	A	A
Bluegill[5]	R	R	U	U	U
Smallmouth bass	C	C	C	C	A
Largemouth bass	M	M	M	M	M
Yellow perch	A	A	A	A	A
Walleye[6]	C	C	-	U	U

[1]Based on a variety of trapping methods (seines, gill nets, trap nets, electrofishing), creel censuses, angler diaries, and commercial catches. R (Rare) < U (Uncommon) < M (Moderately common) < C (Common) < A (Abundant). 0 = Not known to occur in the St. Lawrence River. - = No information.

[2]The lake sturgeon commercial fishery in the St. Lawrence River had already collapsed by 1930. Greeley reported them to be moderately common in the lower river in 1930 and rare in the Thousand Islands in 1931. He reported that 18 licensed commercial fishermen took a little over 6,000 pounds of sturgeon in 1929. However, this may have represented only 100 fish or so.

[3]Probably has never been very common in the St. Lawrence River. Greeley found them rare in the lower river (Ogdensburg to International Boundary) in 1930 but moderately common in the upper river (Thousand Islands) in 1931. They are apparently declining but can still be found concentrated in local areas by experienced anglers and guides.

[4]White perch were not native to the St. Lawrence River. They appeared in Lake Ontario in the late 1940's, probably via the Oswego River after moving westward from the Hudson River up the Mohawk River-Barge Canal System. They are now well-established and abundant in Eastern Lake Ontario and have moved down the St. Lawrence River.

Table 39. (continued)

[5]The bluegill may not even have been present in any great numbers in the St. Lawrence River although they are common in localized areas of suitable habitat. River-wide they do not appear to comprise a significant species.

[6]Greeley found walleyes common in the lower river and moderately common in the Thousand Islands in 1930 and 1931. Canadian commercial catch figures show a fair amount taken in the 1940's, but a sharp decline from the late 1950's on.

*Anon. 1982; Division of Fish and Wildlife 1972a,b; Dolan 1982b; Dunning 1979a,b; Dunning and Evans 1979; Dunning, Evans, and Tarby 1978; Dunning, Tarby, and Evans 1978; Hamilton 1974; Hart 1979, 1983; Jolliff and Eckert 1971; Jolliff and LeTendre 1966; LeTendre and Schneider 1970; Marean 1976; McCullough 1982a,b; McLeod 1961, 1963, 1964, 1965, 1966a,b; NYS Dept. of Env. Consv. 1981a,b; Ontario Ministry of Natural Resources 1981; Osterburg 1981, 1983; Panek 1979; Readman 1971; Ridgley 1976; USFWS 1976d, 1979; Werner 1976; Werner and Ford 1972.

Table 40. Summary of fish species captured or noted in the St. Lawrence River during various studies and in various taxonomic keys between 1930 and 1982 (Taxonomy according to Bailey, et al. 1970). X = Present; — = Not Found.

Species	1930[1]	1931[2]	1952[3]	1966[4]	1970[5]	1973[6]	1976[7]	1976[8]	1977[9]	1978[10]	1979[11]	1979[12]	1982[13]
Northern brook lamprey	—	—	—	—	X	X	—	—	—	—	—	—	—
Silver lamprey	X	X	X	—	X	X	X	—	X	—	—	—	—
American brook lamprey	—	—	—	—	X	X	—	—	—	—	—	—	—
Sea lamprey	X	X	—	—	X	X	X	—	X	—	—	—	—
Lake sturgeon	X	X	—	—	X	X	X	—	X	X	—	—	—
Longnose gar	X	X	—	—	X	X	X	—	X	X	—	—	—
Bowfin	X	X	—	X	X	X	X	X	X	X	X	—	X
American eel	X	X	—	—	X	X	X	—	X	X	X	—	X
Alewife	X	X	X	X	X	X	X	—	X	—	X	X	X
Gizzard shad	—	—	—	X	X	X	X	—	X	X	X	X	—
Mooneye	X	X	—	—	X	X	X	—	X	—	—	—	—
Cisco	X	—	—	—	X	X	—	—	—	—	—	—	—
Lake whitefish	—	—	—	—	—	X	—	—	—	—	—	—	—
Round whitefish	—	—	—	—	X	X	—	—	—	—	—	—	—
Rainbow trout	—	—	—	—	X	X	X	—	X	—	—	—	—
Atlantic salmon	X	—	—	—	X	X	—	—	—	—	—	—	—
Brown trout	—	—	—	—	X	X	X	—	X	—	—	—	—
Lake trout	—	—	—	—	X	X	—	—	—	—	—	—	—
Rainbow smelt	—	—	—	—	X	X	X	—	X	X	—	X	—
Central mudminnow	X	—	—	—	X	X	X	X	X	—	—	—	—
Grass pickerel	—	—	—	—	X	X	X	—	X	—	—	—	X
Northern pike	X	X	X	X	X	X	X	X	X	X	X	X	X
Muskellunge	X	X	—	X	X	X	X	—	X	X	—	—	—

Table 40. (continued)

Species	1930[1]	1931[2]	1952[3]	1966[4]	1970[5]	1973[6]	1976[7]	1976[8]	1977[9]	1978[10]	1979[11]	1979[12]	1982[13]
Chain pickerel	—	—	—	—	X	X	—	—	—	—	—	—	—
Goldfish	—	—	—	—	X	—	—	—	—	X	—	—	—
Redside dace	—	—	—	—	X	—	—	—	—	—	—	—	—
Lake chub	—	—	—	—	X	X	—	—	—	—	—	—	—
Carp	X	X	—	X	X	X	X	X	X	X	X	X	X
Cutlips minnow	X	X	—	—	X	X	X	—	X	—	—	—	—
Brassy minnow	—	—	—	—	X	X	X	—	X	—	—	—	—
Silvery minnow	—	—	—	—	—	X	X	—	X	—	X	—	—
River chub	—	—	—	—	—	X	—	—	—	—	—	—	—
Golden shiner	X	X	X	X	X	X	X	X	X	X	X	—	X
Pugnose shiner	—	—	—	—	X	X	X	—	X	—	X	—	—
Emerald shiner	X	X	—	—	X	X	X	—	X	X	X	—	X
Bridle shiner	X	X	—	—	X	X	X	—	X	—	X	—	—
Common shiner	X	X	—	—	X	X	X	—	X	—	X	—	X
Blackchin shiner	X	X	—	—	X	X	X	—	X	—	—	—	—
Blacknose shiner	X	—	—	—	X	X	X	—	X	—	—	—	X
Spottail shiner	X	X	X	—	X	X	X	—	X	X	X	—	X
Rosyface shiner	X	—	—	—	X	X	X	—	X	—	X	—	—
Spotfin shiner	X	X	X	—	X	X	X	—	X	X	—	—	—
Sand shiner	X	X	X	—	X	X	X	—	X	—	—	—	—
Mimic shiner	X	X	—	—	—	X	X	—	X	—	—	—	—
Northern redbelly dace	—	—	—	—	X	X	—	—	—	—	—	—	—

Table 40. (continued)

Species	1930[1]	1931[2]	1952[3]	1966[4]	1970[5]	1973[6]	1976[7]	1976[8]	1977[9]	1978[10]	1979[11]	1979[12]	1982[13]
Finescale dace	—	—	—	—	X	X	—	—	—	—	—	—	—
Bluntnose minnow	X	X	X	—	X	X	X	—	X	X	X	—	X
Fathead minnow	X	—	—	—	X	X	X	X	X	—	X	—	—
Blacknose dace	—	—	—	—	X	X	—	—	—	—	—	—	—
Longnose dace	X	X	X	—	X	X	X	—	—	—	—	—	—
Creek chub	X	—	—	—	X	X	X	—	X	—	—	—	—
Fallfish	X	X	—	X	X	X	X	—	X	X	X	X	X
Pearl dace	—	—	—	—	X	X	—	—	—	—	—	—	—
Quillback	—	—	—	—	X	X	—	—	—	X	—	—	—
Longnose sucker	—	—	—	—	X	X	—	—	—	—	—	X	—
White sucker	X	X	X	X	X	X	X	X	X	X	X	X	X
Creek chubsucker	—	—	—	—	X	—	—	—	—	—	—	—	—
Silver redhorse	X	X	—	X	X	X	X	—	X	X	—	X	—
River redhorse	—	—	—	—	X	X	—	—	—	—	—	—	—
Black redhorse	—	—	—	—	X	X	—	—	—	—	—	—	—
Copper redhorse	—	—	—	—	X	—	—	—	—	—	—	—	—
Shorthead redhorse	X	X	—	—	X	X	X	—	X	—	X	X	—
Greater redhorse	X	X	—	—	X	X	X	—	X	X	X	X	—
Black bullhead	—	—	—	—	X	X	—	—	—	—	—	—	—
Yellow bullhead	—	—	—	—	X	X	X	—	X	X	—	—	—
Brown bullhead	X	X	X	X	X	X	X	X	X	X	X	X	X
Channel catfish	X	X	—	—	X	X	X	—	X	X	X	X	—

Table 40. (continued)

Species	1930[1]	1931[2]	1952[3]	1966[4]	1970[5]	1973[6]	1976[7]	1976[8]	1977[9]	1978[10]	1979[11]	1979[12]	1982[13]
Stonecat	X	X	—	—	X	X	—	—	—	X	—	X	—
Tadpole madtom	—	—	—	—	X	X	X	X	X	—	—	—	X
Trout-perch	X	X	—	—	X	X	X	—	X	X	—	—	—
Burbot	X	X	—	—	X	X	X	—	X	X	—	—	—
Banded killifish	X	X	X	—	X	X	X	—	X	X	—	—	X
Brook silverside	X	X	—	—	X	X	X	—	X	X	X	—	X
Brook stickleback	X	—	—	—	X	X	X	—	X	X	—	—	—
Threespine stickleback	X	X	—	—	X	X	X	—	X	X	—	—	—
Ninespine stickleback	—	—	—	—	—	X	—	—	—	—	—	—	—
White perch	—	—	—	—	X	X	X	—	X	X	X	X	X
White bass	—	—	—	X	X	X	X	—	X	X	—	—	—
Rock bass	X	X	X	X	X	X	X	X	X	X	X	X	X
Pumpkinseed	X	X	X	X	X	X	X	X	X	X	X	X	X
Bluegill	—	—	X	—	X	X	X	X	X	X	X	X	X
Longear sunfish	—	—	—	—	X	—	—	—	—	—	—	—	—
Smallmouth bass	X	X	X	X	X	X	X	X	X	X	X	X	X
Largemouth bass	X	X	X	X	X	X	X	X	X	X	X	X	X
Black crappie	—	—	—	X	X	X	X	X	X	X	X	—	X
White crappie	—	—	—	—	—	—	—	—	—	—	—	X	—
Eastern sand darter	—	—	—	—	X	X	—	—	—	—	—	—	—
Rainbow darter	—	—	—	—	X	—	—	—	—	—	—	—	—
Iowa darter	X	X	—	—	X	X	X	—	X	—	—	—	—

Table 40. (continued)

Species	1930[1]	1931[2]	1952[3]	1966[4]	1970[5]	1973[6]	1976[7]	1976[8]	1977[9]	1978[10]	1979[11]	1979[12]	1982[13]
Fantail darter	—	X	—	—	X	X	—	—	—	—	—	—	—
Johnny darter	X	X	—	—	X	X	X	—	X	X	X	—	X
Yellow perch	X	X	X	X	X	X	X	X	X	X	X	X	X
Logperch	X	X	—	—	X	X	X	—	X	X	X	—	X
Channel darter	X	X	—	—	X	X	—	—	—	—	—	—	—
Sauger	X	—	—	—	X	X	—	—	—	—	—	—	—
Walleye	X	X	—	X	X	X	X	—	X	X	X	X	—
Freshwater drum	—	—	—	—	X	X	X	—	X	—	—	—	—
Mottled sculpin	X	X	X	—	X	X	X	—	X	X	X	—	X
Slimy sculpin	—	—	—	—	X	X	X	—	X	—	—	—	—
Total number of species	56	48	19	19	93	92	67	16	66	43	35	23	29

[1]Greeley and Greene 1931 (Ogdensburg to International Boundary)
[2]Greeley and Bishop 1932 (Cape Vincent to Ogdensburg)
[3]Academy of Natural Sciences of Philadelphia 1953 (Patterson Point to Prescott)
[4]McLeod 1966 (Lake St. Lawrence)
[5]Hubbs and Lagler 1970 (Taxonomic Key)
[6]Scott and Crossman 1973 (Taxonomic Key)
[7]USFWS 1976d (International Section)
[8]Marean 1976 (Millens Bay to Goose Bay)
[9]Geis 1977 (International Section)
[10]Dunning, Tarby, and Evans 1978; Dunning, Evans, and Tarby 1978 (Chippewa Bay to Coles Creek)
[11]USFWS 1979 (Lower Grasse River)
[12]Panek 1979 (Thousand Islands and Lake St. Lawrence)
[13]USFWS 1983 (Wellesley Island and Chippewa Bay)

Table 41 . Canadian commercial fishery catch statistics for the International section[1] of the St. Lawrence River for the period 1924 through 1980 (compiled from Div. of Fish and Wildlife 1972a, 1972b; Ridgley 1976; Ontario Ministry of Natural Resources 1981; and Haxell 1983).

SPECIES	CATCH IN POUNDS (% of TOTAL CATCH) 1924	1925	1926	1927	1928	1929	1930
Lake sturgeon[2]	4346(8.0)	4864(11.3)	6931(13.4)	5627(13.9)	4507(15.0)	2666(13.2)	3356(15.2)
Bowfin[3]	----	----	----	----	----	----	----
American eel	7185(13.3)	6171(14.4)	7389(14.2)	3350(8.3)	2055(6.8)	645(3.2)	2050(9.3)
Cisco	----	----	----	----	----	----	----
Lake whitefish	----	----	----	----	----	----	----
Lake trout	----	----	----	----	----	----	----
Smelt[3]	----	----	----	----	----	----	----
Northern pike	5186(9.6)	2410(5.6)	2639(5.1)	1879(4.6)	885(2.9)	405(2.0)	381(1.7)
Carp	300(0.6)	650(1.5)	1714(3.3)	1000(2.5)	300(1.0)	----	100(0.5)
Sucker[3,4]	----	----	----	----	----	----	----
Catfish[5]	2380(4.4)	2550(5.9)	8016(15.4)	5750(14.2)	3985(13.2)	3550(17.6)	3290(14.9)
Bullhead[5]	----	----	----	----	----	----	----
White perch[3]	----	----	----	----	----	----	----
White bass[3]	----	----	----	----	----	----	----
Rock bass[3,6]	----	----	----	----	----	----	----
Sunfish[3,7]	----	----	----	----	----	----	----
Crappie[6,8]	----	----	----	----	----	----	----
Yellow perch	----	2524(5.9)	2108(4.1)	565(1.4)	550(1.8)	456(2.3)	950(4.3)
Walleye[9]	----	----	300(0.5)	----	75(0.2)	----	200(0.9)
Freshwater drum[10]	----	----	----	----	----	----	----
Unclassified[11]	34622(64.1)	23712(55.3)	22812(43.9)	22423(55.2)	17766(59.0)	12446(61.7)	11712(53.1)
TOTAL POUNDS	54019(100)	42881(100)	51909(100)	40594(100)	30123(100)	20168(100)	22039(100)

Table 41 . (Continued)

SPECIES	CATCH IN POUNDS (% of TOTAL CATCH) 1931	1932	1933	1934	1935	1936	1937
Lake sturgeon[2]	2219(7.7)	2293(9.8)	3065(9.2)	3094(10.9)	3845(6.3)	4905(17.1)	5191(14.2)
Bowfin[3]	----	----	----	----	----	----	----
American eel	2510(8.7)	550(2.3)	2720(8.2)	2355(8.3)	1409(2.3)	1150(4.0)	84(0.2)
Cisco	----	----	----	----	----	----	----
Lake whitefish	----	----	----	----	----	----	----
Lake trout	----	----	----	----	----	----	----
Smelt[3]	----	----	----	----	----	----	----
Northern pike	1005(3.5)	2685(11.4)	4665(14.0)	3693(13.0)	6787(11.1)	2532(8.8)	2304(6.3)
Carp	100(0.3)	900(3.8)	1540(4.6)	----	25043(41.0)	150(0.5)	----
Sucker[3,4]	----	----	----	----	----	----	----
Catfish[5]	5417(18.7)	6330(27.0)	6489(19.5)	4415(15.6)	7533(12.3)	1535(5.4)	11693(32.0)
Bullhead[5]	----	----	----	----	----	----	----
White perch[3]	----	----	----	----	----	----	----
White bass[3]	----	----	----	----	----	----	----
Rock bass[3,6]	----	----	----	----	----	----	----
Sunfish[3,7]	----	----	----	----	----	----	----
Crappie[6,8]	----	----	----	----	----	----	----
Yellow perch	584(2.0)	1200(5.1)	1428(4.3)	475(1.7)	380(0.6)	----	----
Walleye[9]	----	100(0.4)	375(1.1)	35(0.1)	224(0.4)	244(0.9)	----
Freshwater drum[10]	----	----	----	----	----	----	----
Unclassified[11]	17164(59.2)	9420(40.1)	13062(39.2)	14289(50.4)	15805(25.9)	18172(63.3)	17299(47.3)
TOTAL POUNDS	28999(100)	23478(100)	33344(100)	28356(100)	61026(100)	28688(100)	36571(100)

[1]Data from 1924 through 1960 encompasses the St. Lawrence River from Gananoque, Ontario (opposite Clayton, NY) downstream through Lake St. Francis (which is not part of our study area). Data from 1961 through 1980 includes the same areas plus the rest of the International section (Tibbetts Point to Clayton); this encompasses Canadian statistical districts 5 & 7.

Table 41 . (Continued)

SPECIES	CATCH IN POUNDS (% of TOTAL CATCH) 1938	1939	1940	1941	1942	1943	1944
Lake sturgeon[2]	3712(20.5)	6512(37.3)	5951(33.1)	5448(30.7)	5152(25.7)	8022(26.4)	9811(22.7)
Bowfin[3]	----	----	----	----	----	----	----
American eel	----	----	800(4.5)	500(2.8)	----	245(0.8)	266(0.6)
Cisco	----	----	----	----	----	----	----
Lake whitefish	----	----	----	----	----	----	----
Lake trout	----	----	----	----	----	----	----
Smelt[3]	----	----	----	----	----	----	----
Northern pike	1618(9.0)	----	----	----	----	1030(3.4)	360(0.8)
Carp	----	----	----	3000(16.9)	12000(59.8)	----	----
Sucker[3,4]	----	----	----	----	----	----	----
Catfish[5]	2420(13.4)	----	600(3.3)	300(1.7)	----	1670(5.5)	3453(8.0)
Bullhead[5]	----	----	----	----	----	----	----
White perch[3]	----	----	----	----	----	----	----
White bass[3]	----	----	----	----	----	----	----
Rock bass[3,6]	----	----	----	----	----	----	----
Sunfish[3,7]	----	----	----	----	----	----	----
Crappie[6,8]	----	----	----	----	----	----	----
Yellow perch	----	----	----	----	----	5165(17.0)	5465(12.7)
Walleye[9]	----	----	----	----	----	1278(4.2)	1597(3.7)
Freshwater drum[10]	----	----	----	----	----	----	----
Unclassified[11]	10314(57.1)	10958(62.7)	10606(59.1)	8511(47.9)	2900(14.5)	12938(42.6)	22216(51.5)
TOTAL POUNDS	18064(100)	17470(100)	17957(100)	17759(100)	20052(100)	30348(100)	43168(100)

[2]May have included other sturgeon species prior to 1961.
[3]Lumped in the "Unclassified" category prior to 1952.
[4]Includes several species of suckers and redhorses.

Table 41 . (Continued)

SPECIES	CATCH IN POUNDS (% of TOTAL CATCH) 1945	1946	1947	1948	1949	1950	1951
Lake sturgeon[2]	7334(13.6)	6700(12.5)	4974(9.9)	5042(6.8)	4734(4.6)	6623(4.5)	6169(6.7)
Bowfin[3]	----	----	----	----	----	----	----
American eel	87(0.2)	190(0.4)	311(0.6)	1108(1.5)	410(0.4)	1708(1.2)	1515(1.6)
Cisco	----	----	----	----	----	----	----
Lake whitefish	----	----	----	----	----	----	----
Lake trout	----	----	----	----	----	----	----
Smelt[3]	----	----	----	----	----	----	----
Northern pike	1000(1.9)	400(0.7)	----	----	----	----	17(0.0)
Carp	----	2810(5.2)	400(0.8)	----	64(0.1)	789(0.5)	180(0.2)
Sucker[3,4]	----	----	----	----	----	----	----
Catfish[5]	6586(12.2)	6085(11.4)	13909(27.8)	22539(30.5)	26776(26.0)	71830(49.0)	30085(32.7)
Bullhead[5]	----	----	----	----	----	----	----
White perch[3]	----	----	----	----	----	----	----
White bass[3]	----	----	----	----	----	----	----
Rock bass[3,6]	----	----	----	----	----	----	----
Sunfish[3,7]	----	----	----	----	----	----	----
Crappie[6,8]	----	----	----	----	----	----	----
Yellow perch	6782(12.6)	6601(12.3)	7401(14.8)	11852(16.0)	18861(18.3)	9873(6.7)	13420(14.6)
Walleye[9]	1675(3.1)	1600(3.0)	1146(2.3)	1325(1.8)	92(0.1)	126(0.1)	68(0.1)
Freshwater drum[10]	----	----	----	----	----	----	----
Unclassified[11]	30400(56.4)	29215(54.5)	21879(43.7)	32021(43.3)	52163(50.6)	55496(37.9)	40592(44.1)
TOTAL POUNDS	53864(100)	53601(100)	50020(100)	73887(100)	103100(100)	146445(100)	92046(100)

[5]Bullhead (Ictalurus spp.) were separated out in 1952; prior to that, they may have been included with catfish or were listed as "Unclassified".

[6]Crappie included with rock bass from 1971 through 1975.

Table 41 . (Continued)

SPECIES	CATCH IN POUNDS (% of TOTAL CATCH 1952	1953	1954	1955	1956	1957	1958
Lake sturgeon[2]	----	2116(7.3)	574(2.1)	1615(8.2)	938(5.6)	744(5.2)	----
Bowfin[3]	349(1.3)	972(3.4)	734(2.7)	266(1.4)	131(0.8)	178(1.2)	678(5.1)
American eel	7378(27.8)	3971(13.7)	7189(26.9)	4543(23.1)	4195(25.0)	750(5.3)	65(0.5)
Cisco	----	----	----	----	----	----	----
Lake whitefish	----	----	----	----	----	----	----
Lake trout	----	----	----	----	----	----	----
Smelt[3]	----	----	----	----	----	----	----
Northern pike	----	----	----	----	----	----	----
Carp	1196(4.5)	1409(4.9)	3443(12.9)	943(4.8)	262(1.6)	587(4.1)	606(4.6)
Sucker[3,4]	264(1.0)	181(0.6)	113(0.4)	111(0.6)	25(0.1)	459(3.2)	853(6.5)
Catfish[5]	11(0.0)	658(2.3)	523(2.0)	184(0.9)	286(1.7)	127(0.9)	----
Bullhead[5]	973(3.7)	1836(6.3)	1276(4.8)	1484(7.5)	----	1111(7.8)	1819(13.8)
White perch[3]	----	----	----	----	----	----	----
White bass[3]	----	----	----	----	----	----	----
Rock bass[3,6]	----	----	----	----	----	----	----
Sunfish[3,7]	1912(7.2)	3813(13.2)	2540(9.5)	1443(7.3)	527(3.1)	3347(23.5)	3551(26.9)
Crappie[6,8]	----	----	----	----	----	----	----
Yellow perch	14424(54.4)	14033(48.4)	10368(38.7)	8762(44.5)	10227(60.9)	6133(43.0)	5472(41.5)
Walleye[9]	----	----	----	347(1.8)	194(1.2)	824(5.8)	148(1.1)
Freshwater drum[10]	----	----	----	----	----	----	----
Unclassified[11]	----	----	----	----	----	----	----
TOTAL POUNDS	26507(100)	28989(100)	26760(100)	19698(100)	16785(100)	14260(100)	13192(100)

[7]Includes all *Lepomis* spp.
[8]Lumped in the "Unclassified" category prior to 1971.

Table 41 . (Continued)

SPECIES	CATCH IN POUNDS (% of TOTAL CATCH) 1959	1960	1961	1962	1963	1964	1965
Lake sturgeon[2]	----	681(4.3)	7631(3.7)	9049(4.9)	7030(1.7)	5757(1.9)	4554(1.4)
Bowfin[3]	----	651(4.1)	----	----	----	----	----
American eel	69(1.4)	683(4.3)	12712(6.1)	10999(5.9)	19902(4.8)	29677(9.8)	26137(7.9)
Cisco	----	----	3(0.0)	----	25(0.0)	9(0.0)	107(0.0)
Lake whitefish	----	----	5476(2.6)	8922(4.8)	10611(2.5)	3861(1.3)	----
Lake trout	----	----	----	----	----	----	----
Smelt[3]	----	----	776(0.4)	737(0.4)	1159(0.3)	192(0.1)	131(0.0)
Northern pike	----	----	35(0.0)	----	9(0.0)	238(0.1)	250(0.1)
Carp	----	1292(8.2)	36503(17.6)	48594(26.2)	190211(45.5)	72576(23.9)	149337(45.2)
Sucker[3,4]	----	1380(8.7)	1767(0.9)	837(0.5)	754(0.2)	6864(2.3)	5155(1.6)
Catfish[5]	34(0.7)	----	3560(1.7)	6901(3.7)	11274(2.7)	14059(4.6)	20895(6.3)
Bullhead[5]	----	2289(14.4)	31913(15.4)	31522(17.0)	48582(11.6)	48370(15.9)	25363(7.7)
White perch[3]	----	----	1823(0.9)	----	982(0.2)	1017(0.3)	2538(0.8)
White bass[3]	----	----	5(0.0)	27(0.0)	239(0.1)	----	----
Rock bass[3,6]	----	----	3373(1.6)	2023(1.1)	1847(0.4)	2589(0.9)	6391(1.9)
Sunfish[3,7]	----	2951(18.6)	60448(29.1)	56193(30.3)	74491(17.8)	89219(29.4)	44370(13.4)
Crappie[6,8]	----	----	----	----	----	----	----
Yellow perch	4699(93.5)	5924(37.4)	37906(18.3)	8579(4.6)	15762(3.8)	19558(6.4)	38535(11.7)
Walleye[9]	223(4.4)	----	1462(0.7)	----	----	204(0.1)	350(0.1)
Freshwater drum[10]	----	----	----	----	----	----	----
Unclassified[11]	----	----	2242(1.1)	1045(0.6)	35545(8.5)	9595(3.2)	6539(2.0)
TOTAL POUNDS	5025(100)	15851(100)	207635(100)	185428(100)	418423(100)	303784(100)	330652(100)

[9]Listed as "yellow pickerel" in catch statistics.
[10]Lumped in the "Unclassified" category prior to 1961.

Table 41 . (Continued)

SPECIES	CATCH IN POUNDS (% of TOTAL CATCH)						
	1966	1967	1968	1969	1970	1971	1972
Lake sturgeon[2]	1881(0.8)	763(0.3)	1773(0.6)	405(0.3)	1016(0.3)	347(0.1)	558(0.2)
Bowfin[3]	----	----	----	----	----	----	----
American eel	18071(8.0)	19973(7.3)	16641(5.3)	12774(4.1)	19377(6.2)	12847(3.8)	10419(3.0)
Cisco	----	90(0.0)	45(0.0)	17(0.0)	----	----	7(0.0)
Lake whitefish	880(0.4)	8(0.0)	----	----	----	----	13(0.0)
Lake trout	----	----	----	----	----	----	----
Smelt[3]	----	160(0.1)	175(0.1)	245(0.1)	25(0.0)	415(0.1)	----
Northern pike	----	----	----	14(0.0)	92(0.0)	----	36(0.0)
Carp	78381(34.9)	116064(42.2)	145993(46.3)	152156(48.7)	176619(56.4)	173224(51.6)	156792(45.2)
Sucker[3,4]	3801(1.7)	7045(2.6)	3852(1.2)	6660(2.1)	4288(1.4)	2750(0.8)	2892(0.8)
Catfish[5]	16180(7.2)	6592(2.4)	11619(3.7)	8114(2.6)	11085(3.5)	7841(2.3)	9691(2.8)
Bullhead[5]	19512(8.7)	20036(7.3)	19487(6.2)	27569(8.8)	29869(9.5)	50324(15.0)	45862(13.2)
White perch[3]	----	450(0.2)	2745(0.9)	1591(0.5)	255(0.1)	467(0.1)	554(0.2)
White bass[3]	----	155(0.1)	----	----	53(0.0)	----	----
Rock bass[3,6]	2452(1.1)	9715(3.5)	9098(2.9)	5470(1.7)	9837(3.1)	10411(3.1)	6072(1.8)
Sunfish[3,7]	51635(23.0)	59246(21.5)	73425(23.3)	65685(21.0)	46790(14.9)	59545(17.7)	73502(21.2)
Crappie[6,8]	----	----	----	----	----	----	----
Yellow perch	6360(2.8)	13962(5.1)	17346(5.5)	13920(4.5)	7287(2.3)	12513(3.7)	33719(9.7)
Walleye[9]	----	14(0.0)	52(0.0)	21(0.0)	25(0.0)	----	----
Freshwater drum[10]	----	----	5(0.0)	----	54(0.0)	55(0.0)	----
Unclassified[11]	25363(11.3)	20776(7.6)	13051(4.1)	17600(5.6)	6760(2.2)	5164(1.5)	6475(1.9)
TOTAL POUNDS	224516(100)	275049(100)	315307(100)	312741(100)	313432(100)	335903(100)	346592(100)

[11]Listed as "Mixed Course" or "Animal Food (Unclassified)" in catch statistics.

Table 41 . (Continued)

SPECIES	CATCH IN POUNDS (% of TOTAL CATCH) 1973	1974	1975	1976	1977	1978	1979	1980
Lake sturgeon[2]	811(0.2)	336(0.1)	614(0.1)	525(0.1)	4271(0.9)	3975(1.2)	----	813(0.2)
Bowfin[3]	----	----	----	----	----	----	70(0.0)	120(0.0)
American eel	12381(3.4)	8107(2.3)	30963(5.7)	33977(5.7)	46903(9.8)	40795(12.2)	68291(15.1)	45818(12.7)
Cisco	1(0.0)	----	----	7(0.0)	----	----	----	----
Lake whitefish	----	----	----	----	----	----	----	----
Lake trout	----	----	----	131(0.0)	----	----	----	----
Smelt[3]	2542(0.7)	87(0.0)	----	----	----	104(0.0)	----	----
Northern pike	25(0.0)	75(0.0)	----	532(0.1)	18(0.0)	----	----	146(0.0)
Carp	122360(33.6)	110791(31.1)	130521(24.0)	181951(30.3)	85845(17.9)	6009(1.8)	5500(1.2)	----
Sucker[3,4]	5808(1.6)	3160(0.9)	2583(0.5)	2337(0.4)	3264(0.7)	2916(0.9)	2075(0.5)	4384(1.2)
Catfish[5]	9469(2.6)	6063(1.7)	6856(1.3)	403(0.1)	6063(1.3)	3173(1.0)	----	6369(1.8)
Bullhead[5]	62059(17.0)	60884(17.1)	126399(23.2)	127695(21.2)	128023(26.7)	87362(26.2)	133741(29.6)	126945(35.2)
White perch[3]	1058(0.3)	----	1391(0.3)	6493(1.1)	1053(0.2)	41(0.0)	238(0.1)	431(0.1)
White bass[3]	49(0.0)	----	283(0.1)	2(0.0)	179(0.0)	2(0.0)	121(0.0)	61(0.0)
Rock bass[3,6]	10605(2.9)	7038(2.0)	15831(2.9)	19708(3.3)	14265(3.0)	5870(1.8)	7270(1.6)	2077(0.6)
Sunfish[3,7]	91342(25.1)	95906(26.9)	192592(35.4)	158547(26.4)	77817(16.2)	83688(25.1)	103862(23.0)	100023(27.8)
Crappie[6,8]	----	----	----	----	915(0.2)	4657(1.4)	5228(1.2)	8974(2.5)
Yellow perch	37261(10.2)	52990(14.9)	22862(4.2)	56121(9.3)	111249(23.2)	87078(26.1)	116930(25.9)	59655(16.6)
Walleye[9]	90(0.0)	----	----	----	----	----	----	17(0.0)
Freshwater drum[10]	3(0.0)	----	10(0.0)	280(0.0)	----	----	----	56(0.0)
Unclassified[11]	8547(2.3)	10611(3.0)	13508(2.5)	12350(2.1)	57(0.0)	7620(2.3)	8200(1.8)	4474(1.2)
TOTAL POUNDS	364411(100)	356048(100)	544413(100)	601059(100)	479922(100)	333290(100)	451526(100)	360363(100)

Figure 24. Canadian commercial fishery catch statistics for the 1924-1960 period for the section of the St. Lawrence River from Gananoque, Ontario, through Lake St. Francis (graphed from Table 41 data).

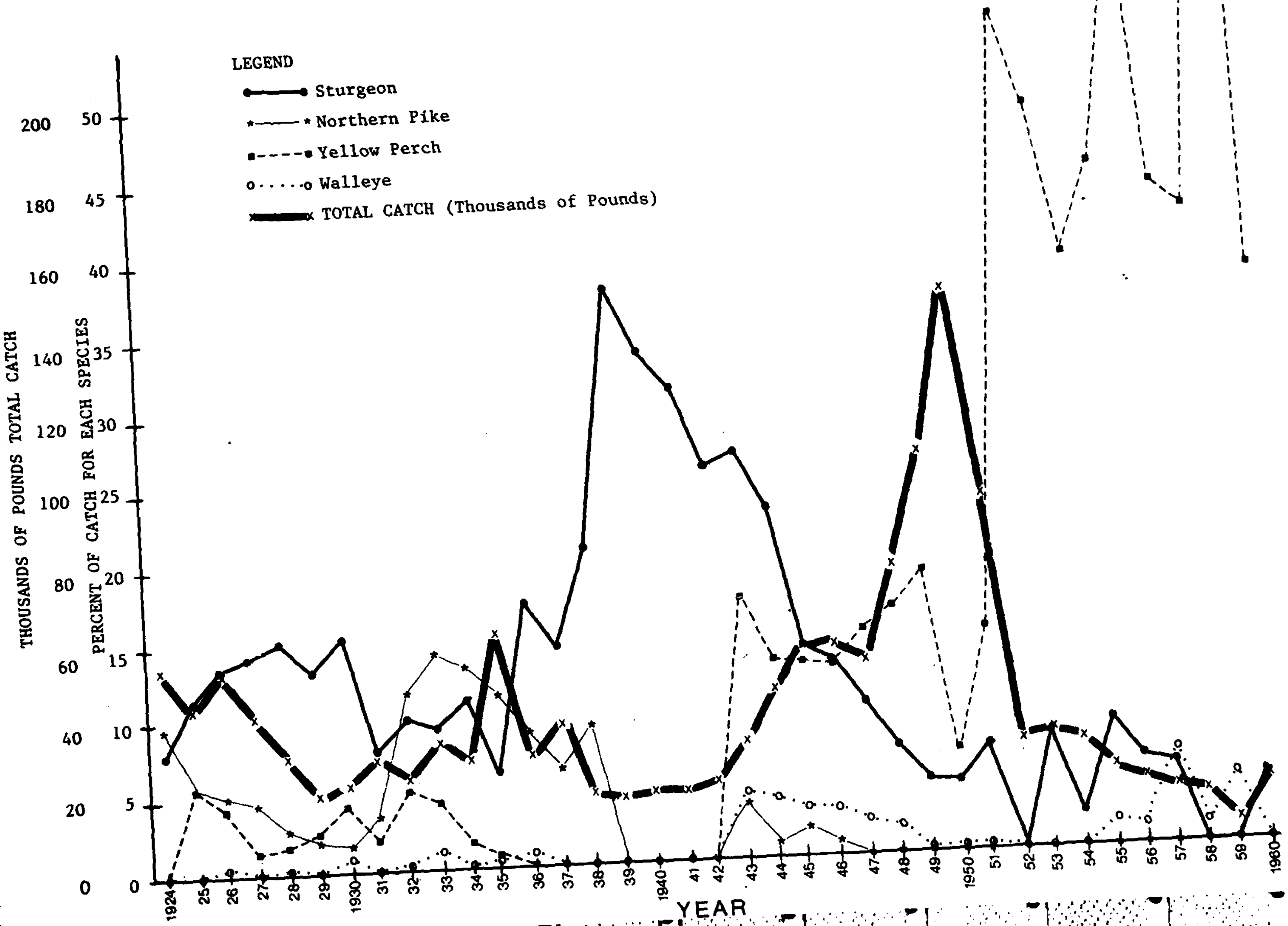
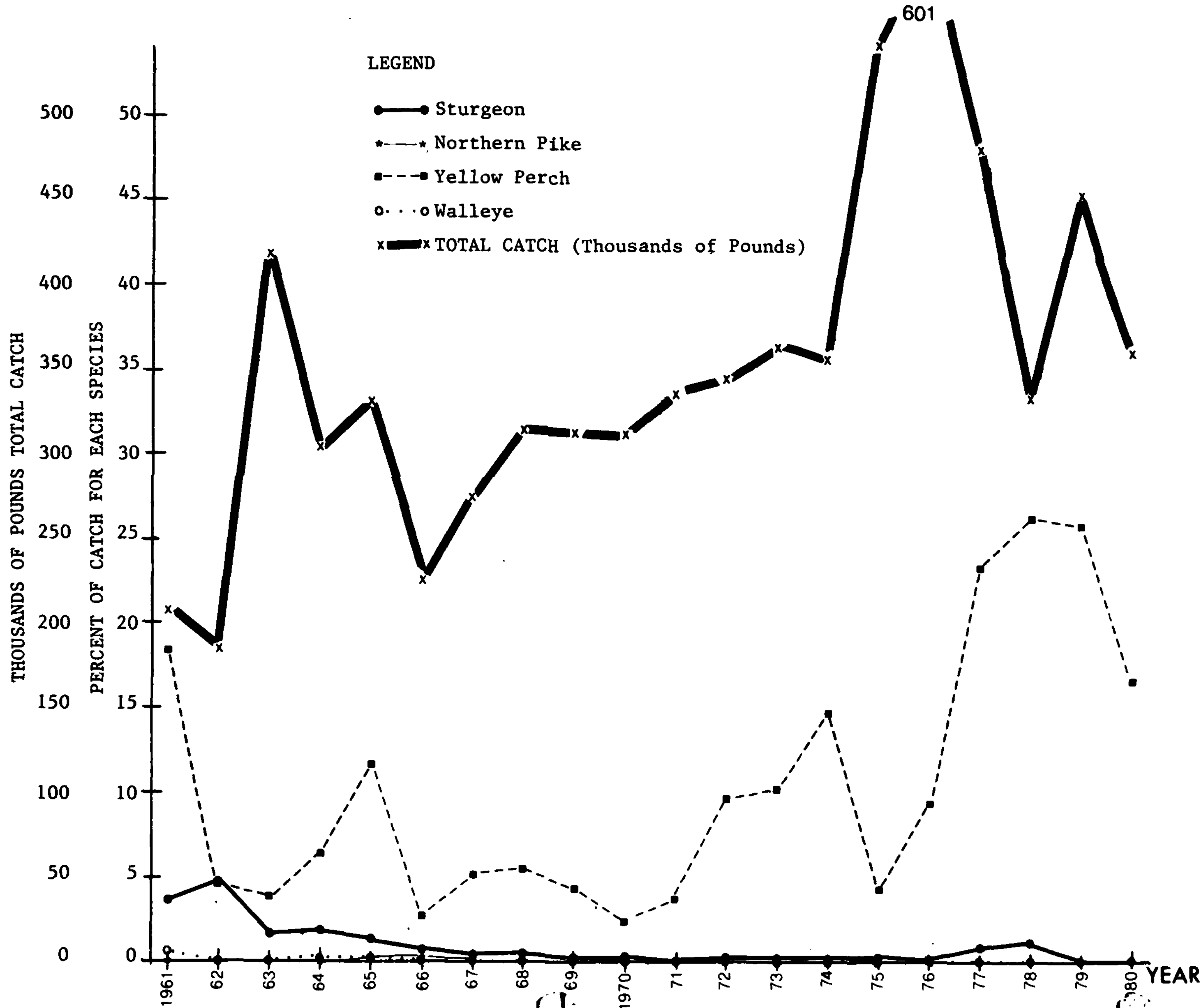


Figure 24a. Canadian commercial fishery catch statistics for the 1961-1980 period for the section of the St. Lawrence River from Tibbetts Point through Lake St. Francis (graphed from Table 41 data).



dropped below 20,000 pounds and remained there until 1943. Sturgeon, eels, northern pike, and catfish dominated the catch during these years, along with a large group of assorted unclassified fish (generally around 50 percent of the total catch).

Catches increased steadily through 1950, then rapidly declined. Yellow perch, catfish, and eels comprised the bulk of the catch during this period (Fig. 24).

The catch during the 1960's and 1970's fluctuated from year to year, but averaged around 350,000 pounds per year. It appears from the statistics that the bulk of the catch was taken in the upriver section. These data were not included in earlier statistics. Carp, bullhead, sunfish, and yellow perch dominated the catch during the 1960's. In 1970, carp contributed 56.4 percent of the total catch. Carp harvest has declined steadily, bottoming out at 0 pounds in 1980. Yellow perch, sunfish, and bullhead dominated the catch throughout the 1970's.

Several fish species found in the St. Lawrence River have been/are listed as endangered, threatened, or special concern species by the New York State Department of Environmental Conservation (DEC). The species listed as endangered are the round whitefish (Prosopium cylindraceum), pugnose shiner (Notropis anogenus), eastern sand darter (Ammocrypta pellucida), and deepwater sculpin (Myoxocephalus thompsoni) (Table 42). The State-listed threatened species include lake sturgeon, mooneye (Hiodon tergisus), and longear sunfish (Lepomis megalotis). The species of special concern are the blackchin shiner (Notropis heterodon) and the black redhorse (Moxostoma duquesnei).

No fish species found in the St. Lawrence River are listed as endangered or threatened by the U.S. Department of Interior.

The River as a Nursery

Pre-Seaway

During the pre-Seaway period, much of the River was an important fish spawning and nursery area. Since biological studies prior to construction are rare, data on fish spawning success are scarce. The few surveys that were conducted concentrated on specific sites, rather than the entire River. Several sites along the River were found to be excellent spawning and nursery areas for a variety of species. Much of the spawning and nursery data have been compiled by Goodyear, et al. (1982a). Much of the pre-Seaway data was drawn from surveys by Greeley and Green (1931).

Smallmouth bass (Micropterus dolomieui), one of the most important gamefish species on the River, was found to spawn throughout the River. Preferred spawning habitat was generally inshore in 3 to 15 feet of water over gravel shoals and rock ledges. Many of the tributary streams hosted large spawning runs, with most of the spawning occurring near the mouths of the tributary streams. Among the major tributary streams where smallmouth bass were found to spawn in significant numbers were French Creek, Cranberry Creek, Chippewa Creek, Tibbits Creek, Little Sucker Brook, Brandy Brook, Grasse River, and

Table 42. Endangered, threatened, and special concern species of New York State (NYSDEC 1983).

I. ENDANGERED[1]

Molluscs

(T)	Chittenango ovate amber snail	*Succinea chittenangoensis*

Insects

	Karner blue butterfly	*Lycaeides melissa*

Fish

(E)	Shortnose sturgeon	*Acipenser brevirostrum*
(E)	Longjaw cisco	*Coregonus alpenae*
*	Round whitefish	*Prosopium cylindraceum*
*	Pugnose shiner	*Notropis anogenus*
*	Eastern sand darter	*Ammocrypta pellucida*
	Bluebreast darter	*Etheostoma camurum*
	Gilt darter	*Percina evides*
(E)	Blue pike	*Stizostedion vitreum glaucum*
	Spoonhead sculpin	*Cottus ricei*
*	Deepwater sculpin	*Myoxocephalus thompsoni*

Amphibians

	Tiger salamander	*Ambystoma tigrinum*

Reptiles

	Bog turtle	*Clemmys muhlenbergi*
(E)	Leatherback sea turtle	*Dermochelys coriacea*
(E)	Hawksbill sea turtle	*Eretmochelys imbricata*
(E)	Atlantic Ridley sea turtle	*Lepidochelys kempii*
	Massasauga rattlesnake	*Sistrurus catenatus*

Birds

*	Golden eagle	*Aquila chrysaetos*
(E) *	Bald eagle	*Haliaeetus leucocephalus*
(E) *	Peregrine falcon	*Falco peregrinus*
(E) *	Eskimo curlew	*Numenius borealis*
	Least tern	*Sterna albifrons*
	Roseate tern	*Sterna dougallii*
*	Loggerhead shrike	*Lanius ludovicianus*

Table 42. (Continued)

Mammals		
(E)	* Indiana bat	*Myotis sodalis*
(E)	Sperm whale	*Physeter catodon*
(E)	Sei whale	*Balaenoptera borealis*
(E)	Blue whale	*Balaenoptera musculus*
(E)	Finback whale	*Balaenoptera physalus*
(E)	Humpback whale	*Megaptera novaeangliae*
(E)	Right whale	*Balanea glacialis*
(E)	* Gray wolf	*Canis lupus*
(E)	* Cougar	*Felis concolor*
II. THREATENED[2]		
Fish		
	* Lake sturgeon	*Acipenser fulvescens*
	* Mooneye	*Hiodon tergisus*
	Lake chubsucker	*Erimyzon sucetta*
	Mud sunfish	*Acantharchus pomotis*
	* Longear sunfish	*Lepomis megalotis*
Amphibians		
	Cricket frog	*Acris crepitans*
Reptiles		
	Mud turtle	*Kinosternon subrubrum*
	* Blanding's turtle	*Emydoidea blandingi*
(T)	Loggerhead sea turtle	*Caretta caretta*
(T)	Green sea turtle	*Chelonia mydas*
	Timber rattlesnake	*Crotalus horridus*
Birds		
	* Osprey	*Pandion haliaetus*
	* Red-shouldered hawk	*Buteo lineatus*
	* Northern harrier	*Circus cyaneus*
	* Spruce grouse	*Dendragapus canadensis*
	* Piping plover	*Charadrius melodus*
	* Common tern	*Sterna hirundo*
Mammals		
	Eastern woodrat	*Neotoma floridana*

Table 42. (Continued)

III. SPECIAL CONCERN[3]

Fish

Silver chub	*Hybopsis storeriana*
Gravel chub	*Hybopsis x-punctata*
* Blackchin shiner	*Notropis heterodon*
* Black redhorse	*Moxostoma duquesnei*
Longhead darter	*Percina macrocephala*

Amphibians

Southern leopard frog	*Rana sphenocephala*
Hellbender	*Cryptobranchus alleganiensis*
Jefferson salamander	*Ambystoma jeffersonianum*
* Blue-spotted salamander	*Ambystoma laterale*
* Spotted salamander	*Ambystoma maculatum*

Reptiles

Spotted turtle	*Clemmys guttata*
* Wood turtle	*Clemmys insculpta*
Diamondback terrapin	*Malaclemys terrapin*
Worm snake	*Carphophis amoenus*
Eastern hognose snake	*Heterodon platyrhinos*

Birds

* Common loon	*Gavia immer*
* Least bittern	*Ixobrychus exilis*
* Cooper's hawk	*Accipiter cooperii*
Black rail	*Laterallus jamaicensis*
* Upland sandpiper	*Bartramia longicauda*
* Black tern	*Chlidonias niger*
* Common barn owl	*Tyto alba*
* Short-eared owl	*Asio flammeus*
* Common nighthawk	*Chordeiles minor*
* Common raven	*Corvus corax*
Sedge wren	*Cistothorus platensis*
* Eastern bluebird	*Sialia sialis*
* Henslow's sparrow	*Ammodramus henslowii*
* Grasshopper sparrow	*Ammodramus savannarum*
* Vesper sparrow	*Pooecetes gramineus*

Table 42. (Continued)

Mammals

* Small-footed bat	*Myotis leibii*
New England cottontail	*Sylvilagus transitionalis*
Harbor porpoise	*Phocoena phocoena*

(T) Currently listed as "threatened" by U.S. Department of the Interior.
(E) Currently listed as "endangered" by U.S. Department of the Interior.
* Reported for St. Lawrence River area in literature.

1 Any native species in imminent danger of extirpation or extinction in New York or any species listed as endangered by U.S.D.O.I. (Code of Federal Regulations 50 CFR 17.11).

2 Any native species likely to become an endangered species within the foreseeable future in New York or any species listed as threatened by U.S.D.O.I. (Code of Federal Regulations 50 CFR 17.11).

3 Native species not yet recognized as endangered or threatened, but for which documented concern exists for their continued welfare in New York. These species could become endangered or threatened in the future and should be closely monitored. Species of special concern are not protected under Endangered and Threatened Species laws.

Raquette River. Other areas where major spawning occurred were Carleton Island, Millen Bay, Dodge Bay, Linda Island, Cedar Point, Beadle Bay, Grindstone Island, Eel Bay, Goose Bay, Morristown Bay, Brooks Point, Odgensburg, Iroquois, and Little Sny Channel. In Morristown Bay, the smallmouth bass were found spawning in 1 to 2 feet of water among rocks, gravel, and sticks. Many of the above-mentioned areas also served as nursery areas.

Largemouth bass (Micropterus salmoides), another important game species, was found to spawn in shallow embayments and marshy littoral areas. Adults were found spawning in French Creek, Cranberry Creek, Chippewa Creek, and Eel Bay, and near Odgensburg. The largemouth bass undoubtedly spawned in other areas, including some of those frequented by smallmouth bass, but no largemouth spawning was noted in these areas by the reporting investigators.

Another important game species, the northern pike (Esox lucius), spawned in marshes and creeks. Among the locations where spawning pike were taken were French Creek, Chippewa Creek, Tibbits Creek, Sucker Brook, and the Raquette River. Large marshes were found near the mouths of these creeks. Another important member of the pike family, the muskellunge (Esox masquinongy), was reported to spawn near Ogdensburg and in Tibbits Creek. Muskellunge are known to spawn in marshy areas.

Brown bullhead (Ictalurus nebulosus) also spawned in shallow marshes along creek mouths and bays. Some of the prime spawning sites included Cape Vincent Harbor, French Creek, Goose Bay (particularly Cranberry Creek mouth), Chippewa Creek, Morristown Bay, Tibbits Creek, and Coles Creek. Another member of the catfish family, the channel catfish (Ictalurus punctatus), spawned in many of these areas. In Eel Bay, the channel catfish were found to construct nests in layers of submerged turf.

The lake sturgeon (Acipenser fulvescens), an important commercial fish species in pre-Seaway days, spawned in the many tributaries of the St. Lawrence and over gravel and stone bottoms in the shallow bays of the main River. Among the prime spawning areas were the Oswegatchie, Grasse, and Raquette Rivers, and near Morristown. The St. Regis River was also an excellent sturgeon spawning area until dams eliminated much of the habitat.

In the 1820's, the Atlantic salmon (Salmo salar) was abundant in every tributary of the St. Lawrence River, and was known to spawn in the Oswegatchie, Grasse, Raquette, and St. Regis Rivers. By 1859, however, they were extirpated downstream to Quebec.

Walleye (Stizostedion vitreum vitreum) were formerly abundant throughout the St. Lawrence. They entered many of the tributaries to spawn. Brandy Brook was historically one of the premier walleye spawning areas. Another important area was the Long Sault Rapids. Walleye were also known to spawn in Sucker Brook, Little Sucker Brook, the Grasse River, and the St. Regis River.

Among the popular panfish species, black crappie (Pomoxis nigromaculatus), rock bass (Ambloplites rupestris) and pumpkinseed (Lepomis gibbosus) were all known to spawn throughout the River. Rock bass spawned in a variety of habitats, including gravel shoals, rocky ledges, and creek mouths. Millen Bay, Morristown Bay, and Tibbits Creek were prime rock bass spawning and nursery sites. Black crappie spawned in the bays, creek mouths, and lower sections of tributary streams, including French Creek, Cranberry Creek, and Chippewa Creek. Chippewa Bay was an important spawning and nursery area. Pumpkinseed were found spawning at Cape Vincent and in French Creek and Tibbits Creek.

Carp (Cyprinus carpio), which were present in the St. Lawrence River prior to 1900, probably escaped from private ponds in the area. A prime spawning site was the lagoon at the mouth of Tibbits Creek. Many other Cyprinidae were found spawning in Tibbits Creek. These included golden shiner (Notemigonus crysoleucus), common shiner (Notropis cornutus), and bluntnose minnow (Pimephales notatus). Another Cyprinid, spottail shiner (Notropis hudsonius), spawned near Cape Vincent and in the shallow sandy areas near Ogdensburg. These minnow species were all important as forage fish.

Members of the sucker family (Catostomidae) were abundant in much of the River. White suckers (Catostomus commersoni) entered the tributary streams after ice breakup. Chimney Bay and the Raquette River were important spawning areas. The St. Regis and Grasse Rivers were also important areas until dams limited the spawning habitat for white suckers. By the 1930's, these dams also curtailed spawning runs of the shorthead redhorse (Moxostoma macrolepidotum). However, they continued to spawn in the Raquette River and near Odgensburg. The silver redhorse (Moxostoma anisurum) also spawned in these same areas. Greater redhorse (Moxostoma valenciennesi) spawned in the rapids of the St. Lawrence River; they also spawned among boulders in the Thousand Islands area, where the fry then moved into the shallow fast water.

Several other species were reported to spawn in the St. Lawrence River and its tributaries. Mooneye (Hiodon tergisus) spawned below the Oswegatchie Dam and at the mouth of Tibbits Creek. Longnose gar (Lepisosteus osseus) spawned on the shoals at Ogdensburg and used the mouth of Little Sucker Brook and the lower Grasse River as nursery areas. Alewives (Alosa pseudoharengus) spawned near Waddington and in Brandy Brook and the Oswegatchie River. They utilized creek mouths and the shore of the main River as nursery areas. Iowa darters (Etheostoma exile) and logperch (Percina caprodes) spawned in lower Tibbits Creek. The banded killifish (Fundulus diaphanus) spawned near Cape Vincent. A large bowfin (Amia calva) nursery existed near Cornwall. The first rainbow smelt (Osmerus mordax) were reported in the River and found spawning in Gananoque Creek in 1939.

In general, Tibbits Creek was one of the prime spawning areas for many species of fish. All of the major tributaries, including the Grasse River, Raquette River, St. Regis River, and Oswegatchie River, as well as the smaller ones such as French Creek, Chippewa Creek, Cranberry Creek, Sucker Brook, and Brandy Brook were very important as spawning areas. Marsh areas and shorelines of islands were also important to many species. Other locations besides those mentioned above may have been important spawning areas, but they were not surveyed or reported.

Post-Seaway

Following completion of the Seaway, the River habitat was drastically altered. Rapids were lost and islands, shoals, and shorelines were flooded. Some shoals and wetlands were lost, while others were created. The dams also blocked migration for some fish species. The net result was a decline in the abundance of some species and an increase in others. Some spawning and nursery areas were lost, while others were created.

No specific surveys were conducted in the years immediately following the opening of the Seaway. No data are available on the spawning and nursery areas of the St. Lawrence River during this time frame. However, changes in spawning and nursery locations and spawning success were probably very rapid following the flooding of extensive areas and the blocking of migration routes and spawning runs. The population declines and increases were probably more gradual as succeeding year classes failed or were extremely successful. Within a few years after the Seaway opening, the current spawning and nursery locations were probably established, although others may have existed that have since been lost to development.

Present

Several studies on the use of fish spawning and nursery areas in the St. Lawrence River have been conducted in the last ten years, both in the United States and Canada. Much of this data has been compiled by Goodyear, et al. (1982a). Despite major changes in habitats caused by flooding and dredging associated with Seaway construction, many species still spawn successfully and thrive in the St. Lawrence River. Other species have declined greatly. The main cause of this decline has been attributed to loss of spawning habitat or blockage of migration routes.

The most popular gamefish on the River is the smallmouth bass (*Micropterus dolomieui*). This species generally spawns inshore in 3 to 15 feet of water over gravel shoals and rock ledges. Young-of-the-year are found in the littoral zone (Tables 43-48). A major spawning and nursery area in Canada is the shoreline and bays of Wolfe Island. Among the prime spawning sites are Hinckley Point, Hinckley Flats Shoal, Button Bay, Bayfield Island, Banford Point, Beauvais Point, Quebec Head, Brakey Bay, Dignam Point, Rattray Point, Irvine Bay, Holliday Point, Oak Point, Brophy Point, Knapp Point, Browns Bay, Dawson Point, and Ferguson Point. Other key spawning and nursery areas identified in the United States' and Canadian portions of the River are Carleton Island, Cape Vincent, Quinns Point, Cassidy Point, Milton Island, The Spectacles, Eel Bay, Point Vivian Marsh, Chippewa Bay, Morristown Bay, Tibbits Creek, and Coles Creek.

A related game species, largemouth bass (*Micropterus salmoides*), spawns in shallow embayments and marshy littoral areas. Among the prime spawning sites on the U.S. side of the River are French Creek, Cranberry Creek, and Chippewa Creek. Several sites around Wolfe Island in Canada were also identified as being important. These sites were Button Bay, McGregor Bay, Macandie Point, Beauvais Point, Irvine Bay, Navy Bay, and Madoma Marsh. (See Tables 43-48 for data on nursery areas).

Table 43 . Number of young-of-year (Y-O-Y) and yearling (1^+) pan fish and game fish caught during the summer and fall of 1976 in shore seines between Tibbetts Point and Bartlett Point, including the western end of Grindstone Island.* (USFWS 1976b).

	Number Taken (Average Number/Haul)					
Dates	6/29 - 7/1		8/23 - 8/25		10/18 - 10/19	
Number of Hauls	20		23		13	
SPECIES	Y-O-Y	1^+	Y-O-Y	1^+	Y-O-Y	1^+
Northern Pike	1(0.05)	----	----	1(0.04)	---	---
Muskellunge	---	----	----	----	4(0.31)	---
Rock Bass	---	3(0.15)	32(1.39)	----	---	---
Pumpkinseed	---	5(0.25)	23(1.00)	----	2(0.15)	---
Smallmouth Bass	---	1(0.05)	10(0.43)	----	---	---
Largemouth Bass	---	----	13(0.57)	----	---	---
Yellow Perch	---	372(18.60)	3(0.13)	25(1.09)	---	5(0.38)
Totals	1(0.05)	381(19.05)	81(3.52)	26(1.13)	6(0.46)	5(0.38)

*Fairly deep area without extensive shoals or tributaries. (16 miles long).

Table 44 . Number of young-of-year (Y-O-Y) and yearling (1^+) pan fish and game fish caught during the summer and fall of 1976 in shore seines between Bartlett Point and Jacques Cartier State Park.* (USFWS 1976b).

	Number Taken (Average Number/Haul)					
Dates	7/28 - 7/30		9/21 - 9/23		11/15 - 11/16	
Number of Hauls	31		21		15	
SPECIES	Y-O-Y	1^+	Y-O-Y	1^+	Y-O-Y	1^+
Grass Pickerel	8(0.26)	------	1(0.05)	4(0.19)	----	1(0.07)
Northern Pike	2(0.06)	------	3(0.14)	1(0.05)	----	1(0.07)
Brown Bullhead	1(0.03)	1(0.03)	15(0.71)	------	----	42(2.80)
White Perch	------	1(0.03)	------	------	----	------
Rock Bass	4(0.13)	5(0.16)	12(0.57)	------	1(0.07)	------
Pumpkinseed	49(1.58)	30(0.97)	53(2.52)	64(3.05)	----	2(0.13)
Smallmouth Bass	262(8.45)	------	3(0.14)	------	----	------
Largemouth Bass	21(0.68)	44(1.42)	86(4.10)	3(0.14)	1(0.07)	------
Black Crappie	------	9(0.29)	------	6(0.29)	3(0.20)	1(0.07)
Yellow Perch	3(0.10)	442(14.26)	46(2.19)	449(21.38)	24(1.60)	68(4.53)
Totals	350(11.29)	532(17.16)	219(10.43)	527(25.10)	29(1.93)	115(7.67)

*Great deal of littoral zone, many marshy bays, and numerous small tributaries - Thousand Islands. (30 miles long).

Table 45 . Number of young-of-year (Y-O-Y) and yearling (1^+) pan fish and game fish caught during the summer and fall of 1976 in shore seines between Jacques Cartier State Park and the Oswegatchie River.* (USFWS 1976b).

	Number Taken (Average Number/Haul)					
Dates	6/29 - 6/30		8/24 - 8/25		10/19 - 10/20	
Number of Hauls	26		18		19	
SPECIES	Y-O-Y	1^+	Y-O-Y	1^+	Y-O-Y	1^+
Grass Pickerel	---	-----	1(0.06)	------	---	1(0.05)
Northern Pike	---	-----	1(0.06)	------	2(0.11)	---
Muskellunge	---	-----	1(0.06)	------	---	---
Rock Bass	---	1(0.04)	2(0.11)	1(0.06)	1(0.05)	---
Pumpkinseed	---	1(0.04)	----	15(0.83)	---	---
Smallmouth Bass	---	-----	38(2.11)	------	---	---
Largemouth Bass	---	8(0.31)	3(0.17)	1(0.06)	3(0.16)	---
Black Crappie	---	2(0.08)	----	------	---	---
Yellow Perch	---	247(9.50)	----	351(19.50)	---	5(0.26)
Totals	---	259(9.96)	46(2.56)	368(20.44)	6(0.32)	6(0.32)

*Deep trench-like section containing very little littoral area or bottom relief. (13 miles long).

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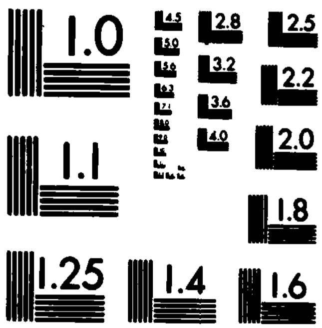
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Table 46 . Number of young-of-year (Y-O-Y) and yearling (1^+) pan fish and game fish caught during the summer and fall of 1976 in shore seines between the Oswegatchie River and Iroquois Dam.* (USFWS 1976b).

	Number Taken (Average Number/Haul)					
Dates	7/28 - 7/29		9/21 - 9/22		11/15 - 11/16	
Number of Hauls	29		31		29	
SPECIES	Y-O-Y	1^+	Y-O-Y	1^+	Y-O-Y	1^+
Northern Pike	1(0.03)	----	----	1(0.03)	---	----
Brown Bullhead	47(1.62)	6(0.21)	----	2(0.06)	1(0.07)	----
White Perch	----	2(0.07)	----	----	---	----
Rock Bass	----	31(1.07)	10(0.32)	2(0.06)	1(0.07)	1(0.07)
Pumpkinseed	----	86(2.97)	5(0.16)	4(0.13)	3(0.10)	----
Smallmouth Bass	16(0.55)	2(0.07)	10(0.32)	----	---	----
Largemouth Bass	1(0.03)	3(0.10)	2(0.06)	----	---	----
Black Crappie	----	29(1.00)	----	1(0.03)	---	1(0.07)
Yellow Perch	----	136(4.69)	----	67(2.16)	1(0.07)	26(0.90)
Totals	65(2.24)	295(10.17)	27(0.87)	77(2.48)	6(0.21)	28(0.97)

*Area greatly changed by original Seaway project; contains several areas of high current velocities. (14 miles long).

Table 47 . Number of young-of-year (Y-O-Y) and yearling (1^+) pan fish and game fish caught during the summer and fall of 1976 in shore seines between Iroquois Dam and Moses-Saunders Dam.* (USFWS 1976b).

	Number Taken (Average Number/Haul)					
Dates	6/29 - 7/1		8/23 - 8/25		10/18 - 10/20	
Number of Hauls	28		49		38	
SPECIES	Y-O-Y	1^+	Y-O-Y	1^+	Y-O-Y	1^+
Northern Pike	1(0.04)	-----	-----	1(0.02)	----	----
Brown Bullhead	---	45(1.61)	4(0.08)	----	1(0.03)	----
White Perch	---	2(0.07)	-----	47(0.96)	----	----
Rock Bass	---	3(0.11)	6(0.12)	2(0.04)	1(0.03)	----
Pumpkinseed	---	49(1.75)	20(0.41)	51(1.04)	2(0.05)	----
Smallmouth Bass	---	4(0.14)	22(0.45)	6(0.12)	1(0.03)	----
Largemouth Bass	---	4(0.14)	11(0.22)	----	1(0.03)	----
Black Crappie	---	5(0.18)	-----	29(0.59)	----	----
Yellow Perch	2(0.07)	128(4.57)	62(1.27)	417(8.51)	5(0.13)	----
Totals	3(0.11)	240(8.57)	125(2.55)	553(11.29)	11(0.29)	----

*Area greatly changed by original Seaway project; contains many islands, bays, and tributaries - Lake St. Lawrence. (29 miles long).

Table 48. Number of young-of-year (Y-O-Y) and yearling (1^+) pan fish and game fish caught during the summer and fall of 1976 in shore seines between Moses-Saunders Dam and the Canadian border.* (USFWS 1976b).

	Number Taken (Average Number/Haul)					
Dates	7/28 - 7/29		9/21 - 9/22		11/15 - 11/16	
Number of Hauls	17		20		17	
SPECIES	Y-O-Y	1^+	Y-O-Y	1^+	Y-O-Y	1^+
Muskellunge	1(0.06)	------	-----	-----	---	---
Brown Bullhead	------	------	1(0.05)	6(0.30)	---	---
White Perch	------	1(0.06)	-----	-----	---	---
Rock Bass	6(0.35)	8(0.47)	32(1.60)	4(0.20)	---	---
Pumpkinseed	------	61(3.59)	61(3.05)	37(1.85)	---	---
Smallmouth Bass	15(0.88)	------	1(0.05)	1(0.05)	---	---
Largemouth Bass	556(32.71)	------	5(0.25)	1(0.05)	---	---
Black Crappie	------	1(0.06)	6(0.30)	1(0.05)	---	---
Yellow Perch	1(0.06)	100(5.88)	1(0.05)	68(3.40)	---	---
Totals	579(34.06)	171(10.06)	107(5.35)	118(5.90)	---	---

*Area containing high current velocities and three large tributary rivers. (7 miles long).

The pike family (Esocidae) is probably the second most important family of gamefish in the St. Lawrence River. The northern pike (Esox lucius) spawns in almost every marsh and tributary stream. Spawning success is affected by low or fluctuating water levels. Small marshes were generally found to be more productive (number produced per acre) than larger ones. Marean (1976) conducted an extensive study of pike in the St. Lawrence River. He defined a good spawning marsh as one with a central channel with a slow flow, flooded shallow areas along the shore, an average depth of 1.6 feet or less, dead and decaying vegetation on the bottom, and a supply of fathead minnows (Pimephales promelas) as food for the young. Along Wolfe Island, the prime spawning sites are Hinckley Point, Button Bay, Bayfield Bay, Lewis Bay, Murray Bay, and Irvine Bay, with most of the spawning occurring at the heads of the bays. Most of the major tributary streams along the River also serve as pike spawning sites. Included among these are French Creek, Cranberry Creek, Crooked Creek, Chippewa Creek, Jones Creek, Louce Creek, Tibbits Creek, Sucker Brook, Brandy Brook, and the Raquette River. Other important spawning sites that have been noted are Millen Bay Marsh, Madoma Marsh, Chipmans Bay, Firman's Bay, Howe Island (the head of Quinn Bay), Blind Bay Marsh, Swan Bay, Point Vivian, Morristown Point, St. Lawrence State Park, and Flynn Bay, McCrea Bay, and Delaney Bay on Grindstone Island. (See Tables 43-47 for data on nursery areas).

The other important member of the pike family, the muskellunge (Esox masquinongy), has been reported to spawn in marshy areas throughout the River. Among the important locations that have been identified are the heads of Browns Bay and McDonnel Bay on Wolfe Island, and the mouths of Crooked Creek and Chippewa Creek at Chippewa Bay. Recent research, however, raises questions about the habitat used for spawning muskellunge. Instead of using shallow marshy areas as reported by Scott and Crossman (1973), the muskellunge may be spawning in the River at depths of 3 to 6 feet (person. comm. N. Ringler and R. Werner, SUNY-ESF, Syracuse). Similar spawning preferance has been documented for the Niagara River muskellunge (Harrison 1978). (See Tables 43, 45, and 48 for data on nursery areas).

The most abundant gamefish on the River, yellow perch (Perca flavescens), spawns over shallow, weedy areas throughout the River. The larvae are found in less than 12 feet of water (Tables 43-48). Among the noted sites are Cape Vincent, Wolfe Island (Button Bay, Bayfield Island, Lewis Point, Chub Point), Quinns Bay, Chippewa Bay, Morristown Harbor, Morristown Point, St. Lawrence State Park, Ogdensburg, Tibbits Creek, Chimney Bay, and Coles Creek.

Another very important member of the perch (Percidae) family is the walleye (Stizostedion vitreum vitreum). The population between Ogdensburg and Massena declined dramatically between 1960 and 1970, probably as a result of the flooding of historic spawning areas. Today, most of the walleye in the St. Lawrence River are found downstream of the dam. Among the present known spawning locations are Chippewa Creek and Brandy Brook. Spawning walleye still congregate at the mouth of the Oswegatchie River, but spawning is probably unsuccessful since the dam near the mouth of the river prevents upstream migration.

The lake sturgeon (Acipenser fulvescens) is another species that has declined rapidly in the last 20 years. Most lake sturgeon present in the St. Lawrence River are found downstream of the Moses-Saunders Dam. They are rare above it. No active spawning sites have been found in recent years.

Centrarchids are abundant on the St. Lawrence River and are popular as panfish. Rock bass (Ambloplites rupestris) spawn over gravel shoals and rocky ledges. Two spawning sites recorded in recent years are Cape Vincent and French Creek. Pumpkinseed (Lepomis gibbosus) spawn in shallow embayments and creek mouths. The larvae are commonly found in shallow water zones of the upper River. Some of the spawning locations that have been noted are Millen Bay, French Creek, and Cranberry Creek. A related species, the bluegill (Lepomis macrochirus), spawns in shallow areas throughout the River, including French Creek Marsh, Cranberry Creek Marsh, and Chippewa Bay. The black crappie (Pomoxis nigromaculatus) spawns in bays, creek mouths, and lower sections of streams. Among the verified spawning locations are French Creek, Alexandria Bay, Cranberry Creek, and Chippewa Bay. (See Tables 43-48 for data on nursery areas).

Another popular species for fishermen is the brown bullhead (Ictalurus nebulosus). The bullhead spawns in shallow marshes in creek mouths and along bays. Among the noted spawning sites are Cape Vincent, French Creek, and Cranberry Creek. (See Tables 44, 46, 47, and 48 for data on nursery areas).

Carp (Cyprinus carpio) have been found to spawn in flooded marsh areas in less than 2 feet of water between Ogdensburg and Massena. Fluctuating water levels can reduce spawning success. On Nairne Island in the Upper Canada Bird Sanctuary Marsh, carp spawned in 2 to 4 feet of water with a muck bottom along a gently-sloping shoreline that was periodically flooded. Scattered emergent, submergent, and floating marsh vegetation was present. Active carp spawning in Millen Bay Marsh has also been verified.

Members of the sucker family (Catostomidae) were found to spawn in most tributaries of the upper St. Lawrence River, including French Creek, Mullett Creek, Cranberry Creek, and Tibbits Creek. The silver redhorse (Moxostoma anisurum) and the greater redhorse (Moxostoma valenciennesi) also spawn in the Raquette River, with the latter spawning in the Thousand Islands as well.

The Cape Vincent area is a popular spawning site for the Cyprinidae, which are important as forage fish. Among the species found spawning there were river chub (Nocomis micropogon), bluntnose minnow (Pimephales notatus), longnose dace (Rhinichthys cataractae), and spottail shiner (Notropis hudsonius). The latter spawns over sand shoals at Morristown Point and Chimney Point, as well as near Cape Vincent. The pugnose shiner (Notropis anogenus) spawns in Eel Bay over gravel and sand substrate with weed growth. Golden shiners (Notemigonus crysoleucas) spawn in many areas throughout the upper St. Lawrence River.

Two other species of fish spawn throughout the St. Lawrence River. The rainbow smelt (Osmerus mordax) first appeared in the St. Lawrence in 1939. It spawns throughout the inshore waters and tributaries. Among the noted spawning locations are Morristown, Brandy Brook, and Coles Creek. Alewives (Alosa pseudoharengus), which are important forage fish, were the most common ichthyoplankton taken in several surveys of the River. They spawn along the inshore zone and in tributaries along the entire New York shoreline. The same sites are used as nursery areas.

Spawning sites of a few other species have been recorded in recent years. Burbot (Lota lota) spawn near Morristown and Chimney Bay over sand and gravel in water 1 to 4 feet deep. Iowa darters (Etheostoma exile) move inshore to spawn near Waddington and Massena, while johnny darters (Etheostoma nigrum) spawn under rocks along the shore near Cape Vincent and Chimney Bay. Logperch (Percina caprodes) spawn in the sandy shallows of Chippewa Bay, while slimy sculpins (Cottus cognatus) spawn in inshore waters and tributaries.

The literature on spawning and nursery areas is spotty. Many species undoubtedly spawn in other areas besides those mentioned above. Other species also spawn in the St. Lawrence River, but nothing has been recorded in the literature regarding their use of specific sites.

The major changes in abundance of habitat from historical to present time appear to be the loss of spawning sites and access to these sites above Moses-Saunders Dam for walleye and lake sturgeon. In addition, numerous dams on the major tributaries (Oswegatchie River, Grasse River, Raquette River, and St. Regis River) have reduced spawning runs of many species. Spawning by longnose gar (Lepisosteus osseus), mooneyes (Hiodon tergisus), and channel catfish (Ictalurus punctatus) was historically recorded in the River but has not been verified in recent studies. The percent of catch for these species has dropped considerably from historical surveys. The reason for these declines is unknown.

Spawning site availability of many species, such as northern pike, smallmouth bass, largemouth bass, pumpkinseed, bluegill, brown bullhead, and rock bass has remained relatively unchanged despite the habitat changes resulting from the Seaway/Power Project construction. Other species have increased their numbers since this construction. Among these are alewives and rainbow smelt, both of which probably invaded from Lake Ontario.

The general low level of change in abundance of fish species, with the exception of walleye and sturgeon, is of interest. A large river was dammed and a large reservoir (Lake St. Lawrence) was created. Usually after such an occurrence, the flooded land and vegetation (trees, shrubs, etc.) provide new habitat for fish and a large increase in abundance is noted for some species. However, from the available data, species abundance has not increased dramatically, although aquatic habitat was increased. Some species such as walleye have in fact greatly declined in abundance.

More research is needed to document the important spawning and nursery areas for key species and their life history requirements.

Index Species

LAKE STURGEON (Acipenser fulvescens)

Habitat Requirements

There are two known remnant sturgeon populations in the International section of the St. Lawrence River separated by the Moses-Saunders Power Dam near Massena, New York. The upper population utilizes the more than 100 miles of river between the dam and Lake Ontario, while the lower population is found in the 9 miles of International river below the dam, although these fish seem to be concentrated at the dam.

Adapted for bottom feeding, sturgeon are usually found over shoal areas in large lakes or large rivers, most often in 15 to 30 feet of water. Mud, gravel, or gravel-mud bottoms are preferred (Table 49).

The lake sturgeon spawns from early May to late June. Riffles or rapids are the preferred spawning habitat, but in the absence of suitable riffle areas, sturgeon have been known to use wave-washed rocky ledges along the shore or shoals around rocky islands. In tributaries such as the Oswegatchie River, sturgeon may spawn in the riffle area at the base of the first dam. This dam on the Oswegatchie River is about 1 mile above the confluence with the St. Lawrence River. There has been one report of sturgeon spawning on sandy bottom in 10 to 15 feet of water in the St. Lawrence River near Morristown, New York (Jolliff and Eckert 1971; Scott and Crossman 1973; Goodyear, et al. 1982b). (See Appendix C for further information).

Changes in Abundance

Endemic to the St. Lawrence River and present in large numbers a century ago, the lake sturgeon now exists only as two remnant populations in the New York section of the River between Tibbetts Point and the International Border. Greeley reported the lake sturgeon as "moderately common" in the lower River in 1930 (Greeley and Greene 1931), and "rare" in the Thousand Islands in 1931 (Greeley and Bishop 1932). They were "uncommon" in the post-Seaway period, and are reported as "rare" in most recent surveys (Table 39).

The once thriving commercial fishery for this species flourished in the mid to late 19th century. It collapsed in the 1890's and has never recovered. The pattern found here and repeated in most historical sturgeon fisheries is of a high initial harvest invariably followed by a precipitous and permanent decline (Table 41; Figs. 24 and 24a). The cause of the decline was chiefly due to intensive indiscriminate fishing coupled with very low annual recruitment to the fishable population under the best of conditions. Other factors most likely contributing to the demise of the fishery are pollution of sturgeon waters and loss of spawning habitat.

Jolliff and Eckert (1971) found no evidence that pollution, either municipal or industrial, was a limiting factor in sturgeon production in the River. They concluded that the impact of the dams located on the River was far greater than that of pollution. Impoundment of river waters for navigation and hydropower purposes has inundated most or all of the former riffle or rapid areas which are the preferred spawning habitat for lake sturgeon. It appears that even if sturgeon were totally protected from harvest, the lack of usable spawning habitat precludes the recovery of the lake sturgeon fishery of the St. Lawrence River.

Figures 25 and 26 illustrate the decline over the past five decades of the sturgeon fishery of the International section of the St. Lawrence River in both the American and Canadian waters. The data depicted in Figure 26 include both

Table 49. Life history summary of major warmwater sport and commercial fish in eastern Lake Ontario and the St. Lawrence River.[1]*

Species	Adult habitat Spring	Adult habitat Summer	Adult habitat Fall/Winter	Adult food supply
American eel	Shallow inshore waters	Inshore areas in vegetation and mud	Inshore areas buried in mud	Fish and invertebrates
Brown bullhead	Shallow bays, slow moving rivers	Shallow bays and streams	Open bays	Insects, leaches, worms, plant materials
Carp	Weedy shallows	Slow moving waters	Slow moving waters	Plant and animal tissue
Lake sturgeon	Shoal areas	Shoal areas and deeper water	Moderate depths	Small organisms found on the bottom
Largemouth bass	Shallow bays	Upper waters of slow moving rivers	Bottom areas, somewhat active in winter	Fish, insects, frogs, and crayfish
Muskellunge	Wetlands, weedy bays	Weedy bays, slow moving rivers	Weedy bays, slow moving rivers	Vertebrates, mainly fish
Northern pike	Shallow weedy areas of creeks, wetlands	Weedy bays, slow moving rivers	Weedy bays, slow moving rivers	Vertebrates, mainly fish
Pumpkinseed	Shallow inshore waters	Cover of submerged vegetation	Cover of submerged vegetation	Insects and other invertebrates
Rock bass	Shallow inshore waters	Shallow water, associated with bass	Shallow water, associated with bass	Aquatic insects, crayfish, small fish
Sea lamprey	Estuaries and streams	Deep water as parasites	Stream or lake	Parasitic on fish
Smallmouth bass	Shallow inshore waters	Seek deeper water	Bottom areas, inactive in winter	Insects, crayfish, fish

Table 49. (continued)

Species	Adult habitat Spring	Adult habitat Summer	Adult habitat Fall/Winter	Adult food supply
Walleye	Spring run to shallow shoals or tributary rivers	Large streams, rivers, lakes. Seek turbid water and other shields from sunlight	Same as summer but avoid strong currents	Fish, adult insects
White perch	Shallow inshore waters	Move inshore at night and to deeper water at dawn	School in lake	Fish, amphipods
Yellow perch	Shallow inshore waters	Open lake in areas of moderate vegetation (under 30 ft. deep)	Under 30 ft. depth, school in lake, active all winter	Insects, crayfish, fish

Species	Spawning period	Spawning habitat	Young habitat	Young food supply
American eel	Fall	Vicinity of Sargasso Sea	Drift in ocean for a year	Unknown
Brown bullhead	April to June	Mud or sand in shallow water of lake and streams	Same as adult	Same as adult
Carp	Spring and early summer	Weedy or grassy shallows	Same as adult	Same as adult
Lake sturgeon	Early May to late June	Swift water or wave washed areas	Same as adult	Invertebrates, some plant life
Largemouth bass	Late spring to mid-summer, usually prior to smallmouth	Quiet bays among emergent vegetation	Same as adult	Invertebrates
Muskellunge	Late April to early May	Shallow wetland areas, weedy bays	Remain near spawning ground until July	Zooplankton, fish after 3 to 4 weeks

Table 49. (continued)

Species	Spawning period	Spawning habitat	Young habitat	Young food supply
Northern pike	April to early May	Shallow wetland areas, weedy bays	Remain near spawning ground; move out in July	Zooplankton, fish after one week
Pumpkinseed	Late spring to early summer	6-12" of water along lakeshore w/vegetation	Same as adult but with more vegetation	Same as adult
Rock bass	Spring to early summer	Inshore gravel bottom areas	Same as adult but with more vegetation	Same as adult
Sea lamprey	June	Tributary streams	Pool areas in stream	Minute plant and animal material
Smallmouth bass	Late May to early June	Shallow gravelly bottom areas of lake, river, and some streams	Same as adult	Insects, crayfish by the time they reach 50mm in length
Walleye	Spring, shortly after ice breaks up	Rocky areas in white water or gravel shoals in lakes	Near bottom in 30-40 feet of water	Invertebrates and fish
White perch	Mid-May through June	Most shallow areas	Same as adult	Microplankton, invertebrates
Yellow perch	Mid-April to May	Shallows of lake and tributary rivers	Shallow water near vegetation	Insects, invertebrates

[1]The species are found in Lake Ontario and the St. Lawrence River and all spawn successfully in nature.

*St. Lawrence-Eastern Ontario Commission 1978.

Figure 25. Commercial sturgeon harvest in the Canadian waters of the Thousand Islands section of the St. Lawrence River between 1961 and 1980. (Division of Fish and Wildlife 1972a,b; Ontario Ministry of Natural Resources 1981; Ridgley 1976).

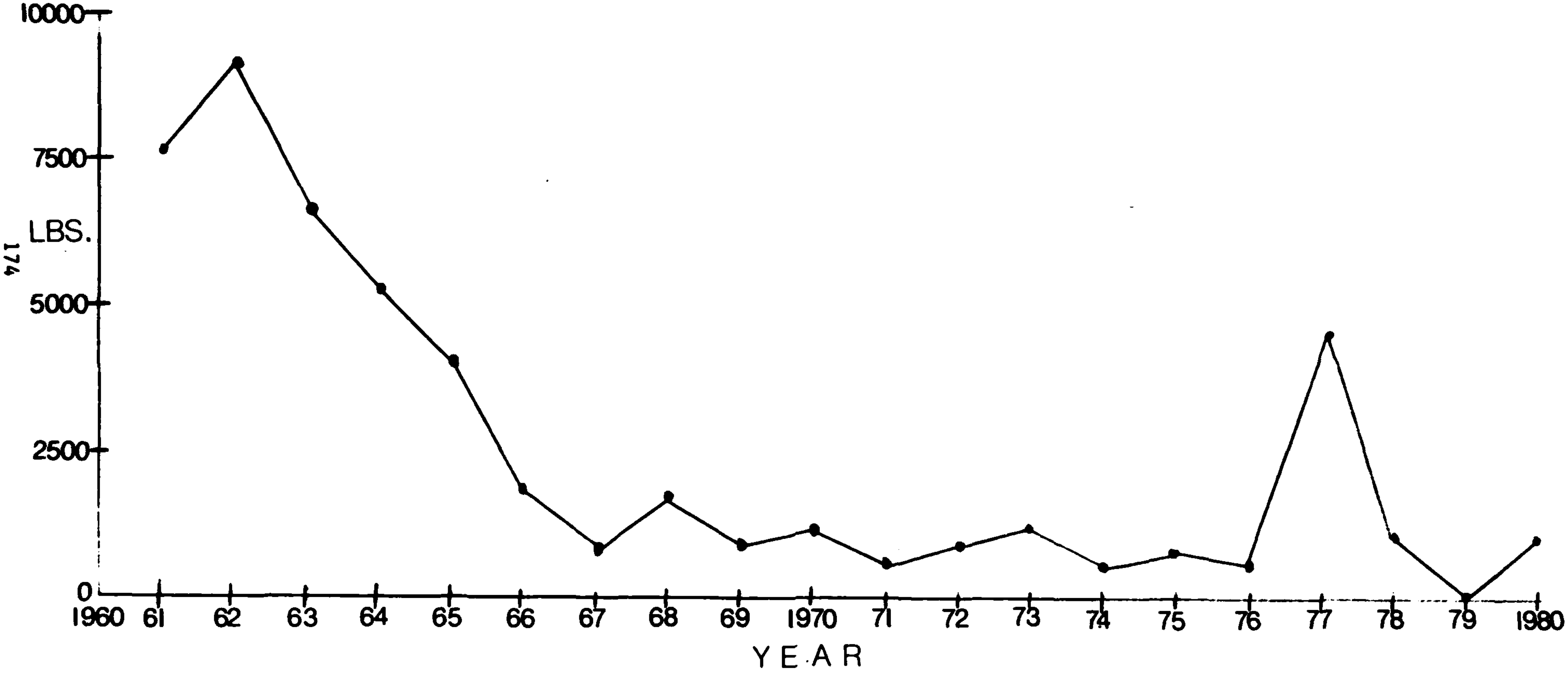
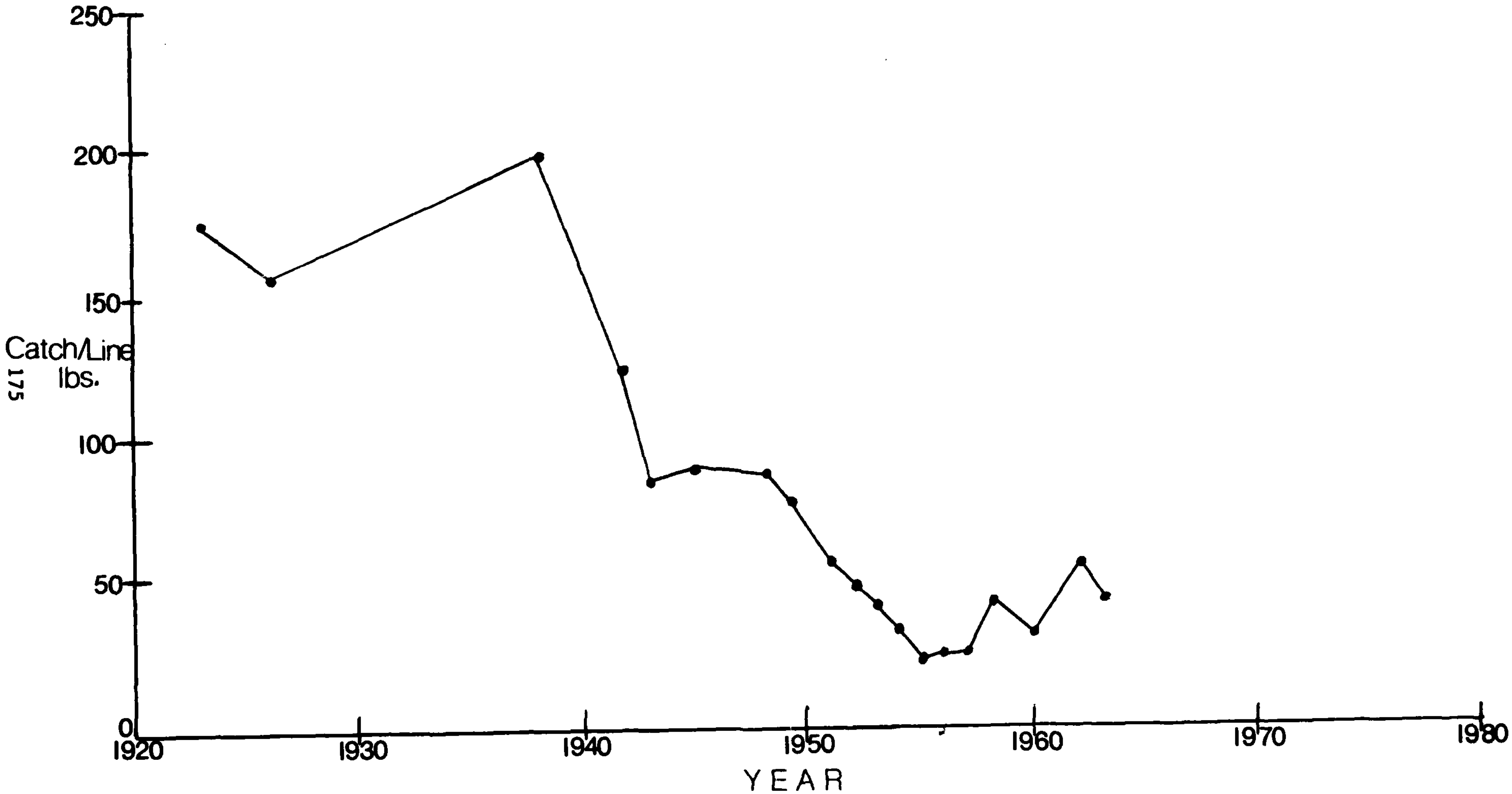


Figure 26. Sturgeon harvest in the St. Lawrence and Niagara Rivers for years between 1923 and 1963. (Joliff and Eckert 1971).



the Niagara and St. Lawrence Rivers as the New York Conservation Department Annual Reports for those years did not separate the two. In the earlier years, the Niagara River fishery may have been the more productive but it is now insignificant. Catches in recent years are almost entirely from the St. Lawrence River.

NORTHERN PIKE (Esox lucius)

Habitat Requirements

The northern pike is native to the St. Lawrence River and the population is completely self-sustaining. Typically, spawning takes place in spring immediately after the ice melts in April or early May. Pike will even move into shallow water beneath the ice cover (Table 49).

Spawning generally occurs in wetland areas, including vegetated flood plains of rivers, marshes, and in bays of larger water bodies. Along the St. Lawrence River, pike are known to spawn in Flynn and Delaney Bays on Grindstone Island, Chippewa Bay, Crooked Creek, Coles Creek, Brandy Brook, Sucker Brook, and the Grasse River.

They spawn in shallow, vegetated water areas in as little as 7 inches of water and most often less than 10 inches. Hatching in 12 to 14 days, the young pike remain in the vicinity of the shallow, vegetated spawning area for several weeks.

Adult pike typically inhabit warm, clean, slow, meandering (even stagnant), heavily vegetated rivers, or warm, weedy bays in lakes. They usually occupy shallower water in spring and fall but will move to cooler, deeper waters during high summer temperatures. Adults, and particularly the young, are taken in the top 15 feet of water (Scott and Crossman 1973; St. Lawrence-Eastern Ontario Commission 1978). (See Appendix C for further information).

Changes in Abundance

Northern pike, although much less abundant now than prior to the 1930's, are one of the species that have shown a slight increase in abundance in the St. Lawrence River in recent years (Table 39). Early studies listed them as "common", while most recent surveys consider them "abundant". However, these are relative terms. They are presently one of the major gamefish on the St. Lawrence River.

Canadian commercial catch statistics for the St. Lawrence show a drastic decline in northern pike landings since 1940 (Table 41; Figs. 24 and 24a). The sporadic landings in the 1960's and 1970's were less than one-tenth the quantity of those prior to 1940. This change in landings could be due in part to market conditions. However, the data appear to indicate that northern pike were not being captured in greater quantities. In 1976, for example, 173,514 pounds out of a total of 601,059 pounds of landed fish sold for less money per pound than northern pike (Ontario Ministry of Natural Resources 1981). This does not imply that the commercial fishing industry was fishing for northern pike. It is an incidental catch while fishing for sunfish, yellow perch, carp, eel, or other species. However, landings, as an incidental catch, can still indicate relative abundance if there is a market demand. In this case, it can be assumed that relative abundance of northern pike drastically decreased after 1940.

The major northern pike spawning areas were relatively unaffected by Seaway construction. Many of the prime sites are located in the wetlands and bays of the Thousand Islands area. Among the major spawning sites in this section of the River are Flynn Bay, Delaney Bay, Chippewa Bay, and Crooked Creek. The prime spawning sites in the lower section of the River consist mainly of wetlands along tributary streams such as Coles Creek and Brandy Brook. These areas were flooded and altered by the lock and dam construction. However, the wetland acreage remained similar in quantity, and the pike apparently are still able to spawn in these marshes.

Northern pike populations may be increasing at the expense of the muskellunge population (Osterburg 1983). Since these two species may utilize many of the same spawning areas, the pike, which spawn earlier, could have a competitive advantage over the muskellunge. This could be contributing to the decline of the muskellunge population, while helping to increase the pike population. The upper River has a more productive pike fishery than the lower River (Tables 50 and 51; Fig 27). This is probably due to the abundance of shallow, vegetated bays and marshes in the Thousand Islands area.

Contaminants may be impacting the northern pike populations. A summer, 1983, sample of approximately 80 northern pike captured near Maitland, Ontario by staff of the Ontario Ministry of Natural Resources exhibited very significant, visible, spinal deformity in half the fish. The symptom is that caused by heavy metal contamination. Such deformity would effect the search for food and the growth of the fish. It could also directly or indirectly impact reproduction.

MUSKELLUNGE (<u>Esox</u> <u>masquinongy</u>)

<u>Habitat Requirements</u>

The muskellunge is native to the St. Lawrence River. Although the population is self-sustaining, the numbers of muskellunge are apparently declining in the International section of the River.

According to most of the literature, the muskellunge typically spawns shortly after ice melt in late April to early May (Table 49), but later than the northern pike. The muskellunge spawns in wetlands, choosing flooded, heavily vegetated areas in water 15 to 20 inches deep. The young remain in the shallow areas of bays and marshes until about July when they begin moving out (Scott and Crossman 1973).

Direct observations by LaPan (1982), however, at no time found muskellunge spawning in shallow vegetated backwater areas along the St. Lawrence River. Paired adult muskellunge were found only in moving water (1.3 to 4.0 meters deep, velocity not less than 0.1 m/sec.). Young-of-the-year (YOY) muskellunge

Table 50. Catch of northern pike per gill net haul over a 3-year period in two reaches of the St. Lawrence River.*

Year	Catch/haul	
	Thousand Islands	Lake St. Lawrence
1976	2.17	0.250
1977	3.19	0.500
1978	2.31	0.125
1978	3.90	0.300
1978	2.10	2.900
Mean[+] catch/haul	2.734	0.815

[+]Mean catch per net haul for the respective areas was statistically different (that is the difference in mean catch was statistically significant at the 99% confidence level using Student's "T" test for inferring differences between two means of small samples). Mendenhall (1971).

*Dunning, Tarby, and Evans 1978; Dunning 1979; Dunning, Evans, and Tarby 1978; USFWS 1976d.

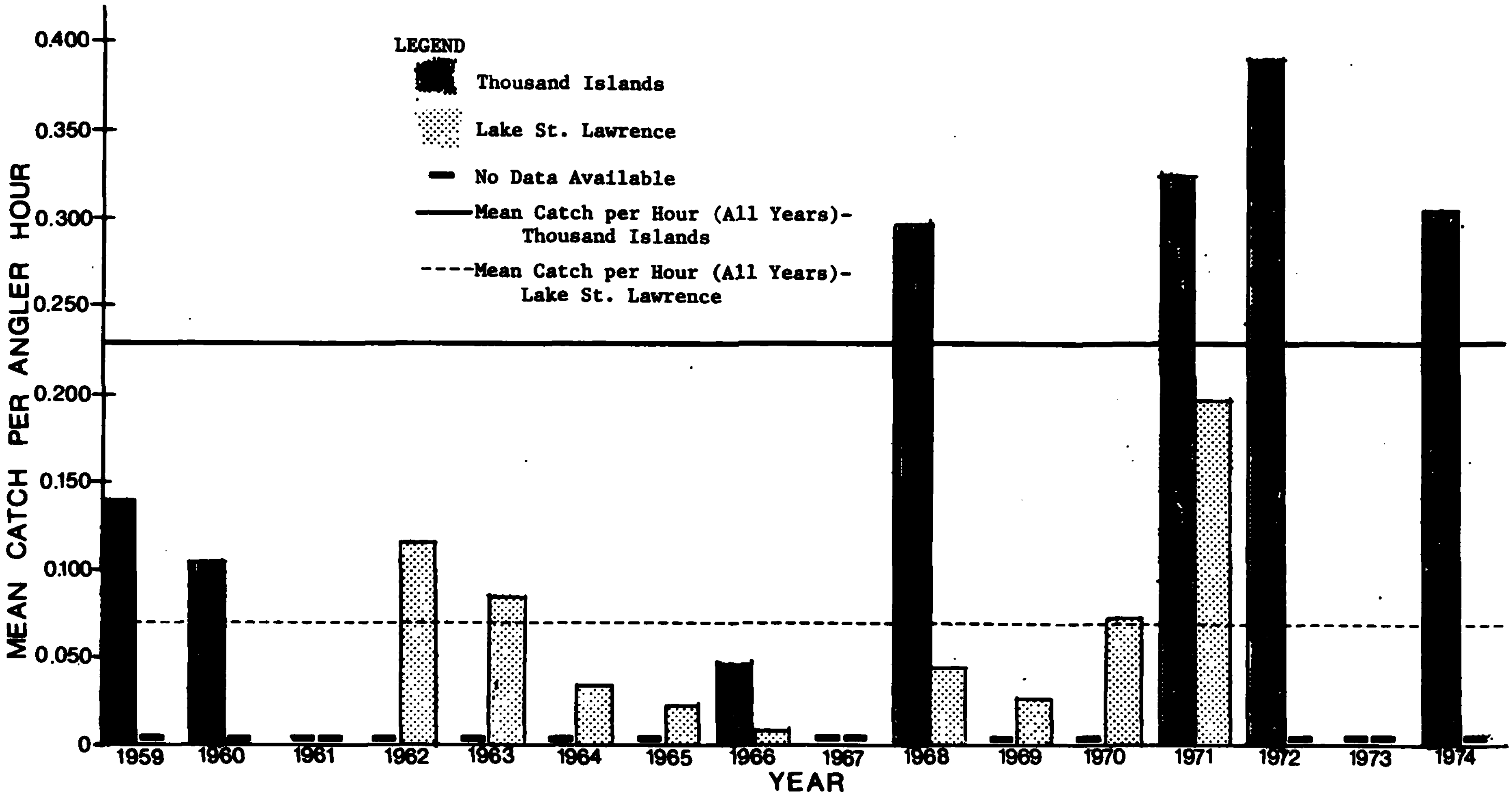
Table 51. Catch of northern pike per angler hour over a 16-year period in two reaches of the St. Lawrence River.*

Year	Catch/angler hr: Thousand Islands	Catch/angler hr: Lake St. Lawrence
1959	0.140	- - -
1960	0.104	- - -
1962	- - -	0.116
1963	- - -	0.084
1964	- - -	0.032
1965	- - -	0.022
1966	0.048	0.010
1968	0.297	0.046
1969	- - -	0.030
1970	- - -	0.071
1971	0.321	0.198
1972	0.390	- - -
1974	0.303	- - -
Mean+ catch/hr	0.229	0.068

+Mean catch per angler hour for the respective areas was statistically different (that is the difference in mean catch was statistically significant at the 99% confidence level using Students "T" test for inferring differences between two means of small samples). Mendenhall (1971).

*Pearce 1961; McLeod 1966a,b; Jolliff and LeTendre 1966; Panek 1979.

Figure 27. Catch of northern pike per angler hour over a 16-year period in two reaches of the St. Lawrence River. (Graphed from Table 51 data).



also were found only in moving water 1 to 3 meters in depth. These data are similar to those reported by Harrison (1978) for the Niagara River population(s).

In August, 1981, near Red Mills, New York, an area of river was found to contain the largest number of YOY muskellunge of any area sampled. The characteristics of the area were: current 0.25 m/sec., flowing over clean sand and gravel; and Secchi readings of 2 to 3 meters. Vegetation characteristic of this area included water celery (Vallisneria americana), pondweed (Potamogeton spp.), water milfoil (Myriophyllum exalbescens), and coontail (Ceratophyllum demersum) (LaPan 1982).

Reported habitat preferences of the adult are warm, heavily vegetated lakes, weedy bays with an abundance of submerged or semi-emergent tree stumps, and slow, heavily vegetated rivers or portions of rivers. The muskellunge is so often found among dense growths of various pondweed species that these plants are referred to as "lungeweed" by anglers.

Except for the largest specimens, muskellunge are rarely found very far from a variety of submerged and emergent aquatic plants, including pondweed, water lily (Nuphar spp. and Nymphaea spp.), pickerelweed (Pontederia cordata), arrowhead (Sagittaria spp.), coontail, and cattail (Typha spp.), in the areas of drowned stumps and timber. The largest fish may often be found in or over less-vegetated, deeper water to a depth of 50 feet (Scott and Crossman 1973; La Pan 1982). (See Appendix C for further information).

Changes in Abundance

The muskellunge was reported as "moderately common" in the lower River in 1930 (Greeley and Greene 1931), and "rare" in the Thousand Islands in 1931 (Greeley and Bishop 1932). More recent surveys have listed them as "uncommon" (Table 39). This species has apparently been declining in recent years. One theory proposes that because muskellunge use the same type of spawning area as northern pike and spawn later than pike, they are subject to heavy predation by the more advanced pike fingerlings. The larger young-of-the-year (YOY) pike also compete for the same forage fish as the young muskellunge. Habitat encroachment by pike may be a significant contributing factor in the decline of the muskellunge in the St. Lawrence River (Osterburg 1983). LaPan (1982) captured northern pike in typical muskellunge habitat, but the reverse was not true. Another theory can be presented that the St. Lawrence River muskellunge spawn in the River (La Pan 1982). As such, they could be impacted by River changes and human activities.

BROWN BULLHEAD (Ictalurus nebulosus)

Habitat Requirements

This species is native to the St. Lawrence River and the population is self-sustaining. A late spring to summer spawner at this latitude, this species is a nest builder (Table 49). One or both sexes clear a shallow nest in bottom mud or sand, or among the roots of aquatic vegetation. The nest is usually near the protection of a rock, tree or stump. Occasionally nest burrows are constructed. Brown bullhead have been known to nest in hollow stumps, under boards, or even in old tires. Water depths over nesting areas range from 6 inches to several feet. Nesting areas are usually the shores of lakes, or in bays, coves, or creek mouths.

Adult brown bullhead are usually found near the bottom in shallow, warmwater areas of ponds and small lakes, shallow bays of larger water bodies, and larger slow-moving streams with sand to mud bottoms and abundant aquatic vegetation (Scott and Crossman 1973). (See Appendix C for further information).

Changes in Abundance

The brown bullhead has been relatively abundant since the first fishery surveys were taken on the St. Lawrence River. It is found throughout the River, particularly in the bays, marshes, and tributary streams. According to the data, the population has remained relatively unchanged over the last few decades. Following Seaway construction, the prime habitats in the upper River were unchanged, while those in the lower River were somewhat altered, but still appear to be suitable for the adaptable bullhead.

WHITE PERCH (Morone americana)

Habitat Requirements

The white perch is a late spring to late summer spawner (mid-May to late July) (Table 49). Spawning occurs in shallow water over virtually any bottom type with no evidence of preference. Spawning sites include nearshore reefs and shoals, bays, or tributary waters. Adults thrive in a variety of habitats but do seem to be most selective of waters that reach temperatures of 75°F or more during the summer (Scott and Crossman 1973; Goodyear, et al. 1982b). (See Appendix C for further information).

Changes in Abundance

The white perch was not noted in the St. Lawrence prior to Seaway construction. It invaded Lake Ontario in the late 1940's, probably via the Oswego River after moving westward from the Hudson River up the Mohawk River-Barge Canal System. It probably reached the St. Lawrence River in the late 1950's or early 1960's (Table 39). White perch have been recorded during fishery surveys since the early 1970's. They are well-established today, and are considered "common" in most recent surveys. The ability to use a wide variety of habitats and spawning sites has enabled the white perch to thrive in the St. Lawrence River, despite competition from many native species. Although its flesh is tasty, the white perch is not heavily sought as a gamefish, due to the relativly small sizes of the fish attained by the populations in this area. As a result of this and the relative lack of predators, the white perch population is expected to continue to increase.

ROCK BASS (Ambloplites rupestris)

Habitat Requirements

A native, self-sustaining species, the rock bass spawns from April to early August (Table 49). The male constructs a shallow nest that may reach 2 feet in diameter, in gravel, mud, sand, rock, clay, or marl on vegetation excavated to expose the roots. Nests are constructed in shallow, sheltered nearshore areas that include bays, harbors, lagoons, marshes, creek mouths, and the lower reaches of tributaries. Other habitat types known to be used include current-swept ledges and lake shoals, and moderately swift water in streams. The nest is usually in a shaded site next to or under a rock, log, or other type of shelter.

The adults are generally found in or over rocky, shallow water areas in lakes, or the warm, lower reaches of streams. They are often found in association with smallmouth bass (Micropterus dolomieui) and pumpkinseed (Lepomis gibbosus) (Scott and Crossman 1973; Goodyear, et al. 1982b). (See Appendix C for further information).

Changes in Abundance

Rock bass have been relatively abundant since the first surveys on the St. Lawrence River (Table 39). They are found throughout the River, and are an important panfish species. They also serve as a forage fish for some of the larger predators. The prime spawning sites that have been noted are protected bays in the upriver area, such as Millen Bay, Morristown Bay, and French Creek. These areas were relatively unaffected by Seaway construction. Rock bass are very adaptable and are found in a variety of habitats. These are two factors which enable them to survive major habitat alterations.

PUMPKINSEED (Lepomis gibbosus)

Habitat Requirements

The pumpkinseed is native to the St. Lawrence River and the population is self-sustaining. Spawning takes place from May to August, usually in 6 to 12 inches of water near shore (Table 49). The male constructs a conspicuous shallow depression 4 to 16 inches in diameter in quiet nearshore areas including bays, harbors, marshes, lagoons, backwaters, and creek mouths. They will also use running water in tributaries as spawning sites. Substrates include sand, gravel, mud, or detritus excavated to expose coarse gravel or plant roots. Nests are always among vegetation. The pumpkinseed may also spawn over the nests of other centrarchids.

Adult pumpkinseeds are usually found in small lakes, ponds, or shallow weedy bays in large lakes. They range over a variety of bottom types and prefer clean water and the cover of submerged vegetation or brush (Scott and Crossman 1973; Goodyear, et al. 1982b). (See Appendix C for further information).

Changes in Abundance

Pumpkinseed is another species that has remained "abundant" in the St. Lawrence River since the earliest surveys (Table 39). They are an adaptable fish that is found in a wide variety of habitats. The submerged vegetation required for spawning and feeding is prevalent throughout the River. The habitat changes caused by the Seaway construction appear to have had no documented long-term impacts, either favorable or unfavorable, on the pumpkinseed population.

BLUEGILL (*Lepomis macrochirus*)

Habitat Requirements

The bluegill is native to the St. Lawrence River and the population is self-sustaining. This species begins nesting in late spring. Spawning continues into mid-summer, probably peaking in early July. The male fans an area, usually 18 to 24 inches in diameter, making a shallow depression down to firm bottom on gravel, mud, sand, marl, or clay, or in detritus, usually among vegetation. The nests are sited in quiet near-shore areas of lakes or stream pools, including wetlands, marshes, coves, bays, lagoons, harbors and creek mouths.

The adults inhabit shallow, weedy, warm waters in large lakes, small lakes, ponds, and heavily vegetated, slow moving waters of small rivers and large creeks. In winter they retreat to deeper water. In summer the larger individuals may move down as deep as 20 feet (Scott and Crossman 1973; Goodyear, *et al*. 1982b).

Changes in Abundance

Bluegill were listed as "rare" by early surveyors. In later studies, they were recorded as "uncommon". They are not nearly as numerous in the St. Lawrence River as their nearest relative, the pumpkinseed. These two species frequently hybridize, often making it difficult to distinguish the two populations. The bluegill is important as a sport fish and forage fish.

SMALLMOUTH BASS (*Micropterus dolomieui*)

Habitat Requirements

Smallmouth bass are native to the St. Lawrence River. The population is self-sustaining. They spawn in the late spring and early summer (usually late May to early July) (Table 49). The male constructs a nest 1 to 6 feet in diameter in 2 to 20 feet of water. The substrate is usually clean gravel, sand, rock, or rubble. They prefer clean water in tributaries, river mouths, harbors, bays, lake shores, or shoals. The nests are usually built close to boulders, logs, docks, or some other structure and occasionally among rooted macrophytes.

Adult habitat preferences vary with the time of year. In spring they congregate in the spawning grounds. After spawning they usually are found in rocky, sandy areas of lakes and rivers in moderately shallow water. During the heat of summer they often retreat to greater depths. They prefer the protection of rocks on shoals or submerged talus slopes, or the protection of submerged logs. They are much less apt to be associated with dense vegetative growth than are largemouth bass and prefer cooler water temperatures than that species. In winter, they aggregate near the bottom and are very inactive (Scott and Crossman 1973; Goodyear, et al. 1982b). (See Appendix C for further information).

Changes in Abundance

Smallmouth bass are the most important gamefish in the St. Lawrence River. They were reported as "common" by early researchers, but are now considered "abundant" (Table 39). The prime habitat on the St. Lawrence River is in the Thousand Islands area. Since this area has changed little due to man's activities, the habitats utilized by the smallmouth bass population were relatively unaffected.

LARGEMOUTH BASS (*Micropterus salmoides*)

Habitat Requirements

A native, self-sustaining species in the St. Lawrence River, the largemouth bass spawns from late spring to mid-summer (sometimes as late as August) (Table 49). The male sweeps clean a nesting area 2 to 3 feet in diameter and 1 to 8 inches deep in almost any substrate: gravel, rock, clay, sand, mud, detritus, or vegetation. Softer substrates are swept away to leave a firm bottom. Nesting habitats are protected littoral areas in lakes or tributaries such as marshes, bays, sloughs, lagoons, harbors, and creek mouths. Water depth over the nest ranges from 1 to 4 feet. The nest is usually located among vegetation or near logs or stumps.

Adult largemouth habitat is the upper levels of warm water in small, shallow lakes, shallow bays of larger lakes, and rarely, large, slow rivers. This species is rarely taken at depths exceeding 20 feet and is invariably associated with soft bottoms, stumps, and extensive growths of aquatic vegetation, in particular water lilies (*Nymphaea* spp. and *Nuphar* spp.), cattails (*Typha* spp.), and various pondweed species (*Potamogeton* spp.).

Even though both this species and smallmouth bass may be found in the same lake, the largemouth is rarely found in characteristic smallmouth habitat, or vice versa.

Largemouth move to the bottom in winter and are more active than wintering smallmouth, often being taken by ice fishermen (Scott and Crossman 1973; Goodyear, et al. 1928b). (See Appendix C for further information).

Changes in Abundance

Largemouth bass have been reported as "moderately common" in nearly all of the biological surveys of the St. Lawrence River (Table 39). Although not as common as the smallmouth bass, they are still an important gamefish. Their prime habitats are located in the shallow bays, particularly in the Thousand Islands area.

YELLOW PERCH (Perca flavescens)

Habitat Requirements

The yellow perch is native to the River and the species is completely self-sustaining. The yellow perch spawns in the spring, usually between mid-April and early May but sometimes as late as July in some areas (Table 49). Spawning usually takes place in shallow water over rooted vegetation, submerged brush, fallen trees, or at times over sand or gravel. Once they are free-swimming, the young perch readily school up and large numbers may be seen feeding on immature insects and invertebrates in shallow water near vegetation.

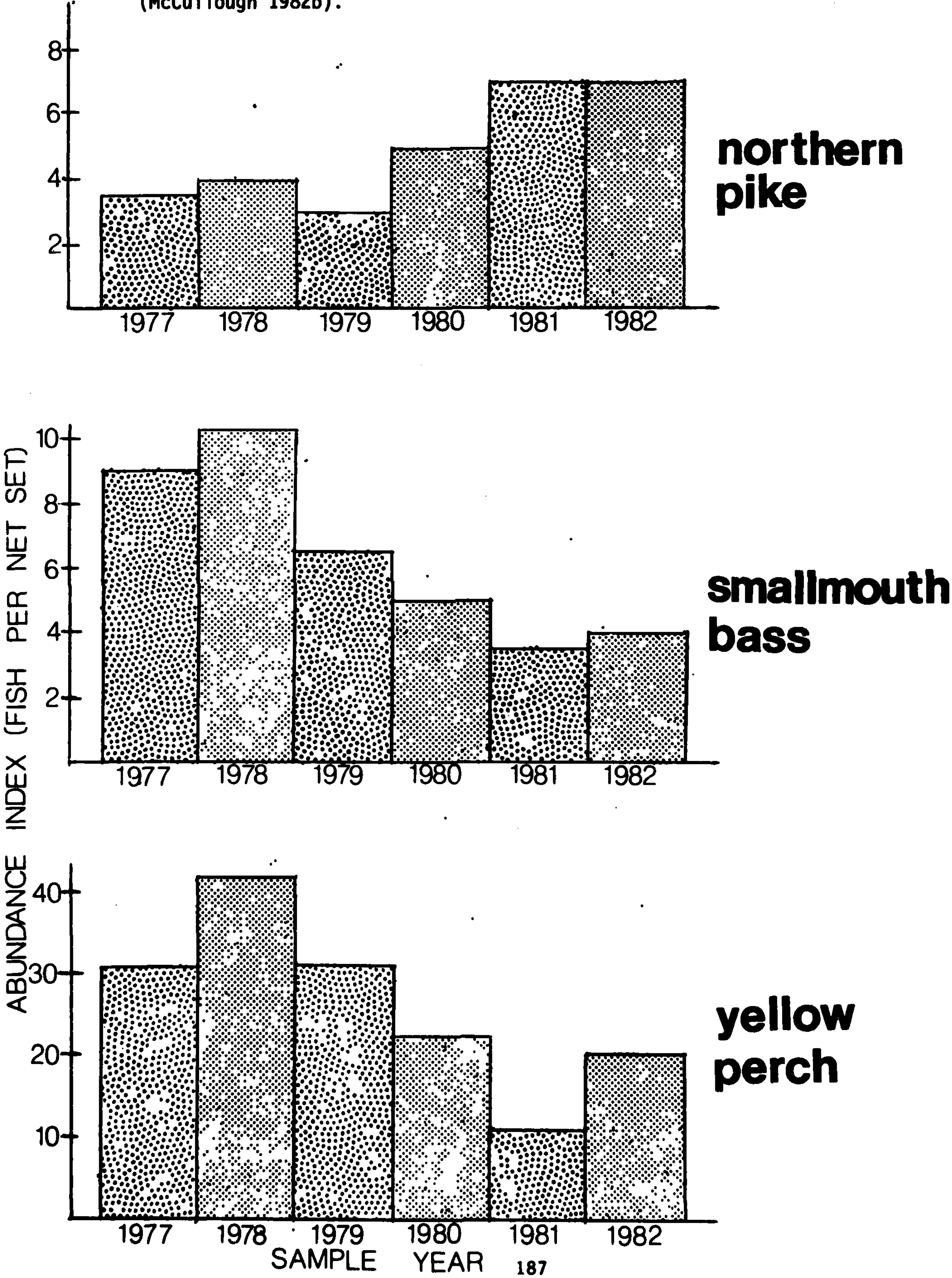
Yellow perch are common in the St. Lawrence River and are able to easily adapt to a wide variety of habitats in warm to cool water, from large lakes to ponds to quiet rivers. They are most abundant in areas of clear waters with moderate vegetation and muck to sand and gravel bottom. They are basically a shallow water fish and usually are not taken below 30 foot depths (Scott and Crossman 1973; St. Lawrence-Eastern Ontario Commission 1978). (See Appendix C for further information).

Changes in Abundance

Yellow perch have been "abundant" in most fishery surveys on the St. Lawrence River (Table 39). They ranked first in abundance in many surveys (Fig. 28). They are found throughout the River in a variety of habitats.

Yellow perch have been an important part of the Canadian commercial catch from the St. Lawrence River since 1943 (Table 41; Figs. 24 and 24a). The catch has increased tremendously in recent years, with the largest catch, 116,930 pounds, occurring in 1979. For the River stretch from Gananoque, Ontario through Lake St. Francis, which includes most of the International section of the River, yellow perch comprised an average of 13.9 percent (9,500 pounds) of the commercial catch from 1943 through 1951. However, for the following nine years (1952 through 1960), the percent of catch averaged an astounding 51.4 (8,900 pounds). Although the poundage decreased in the 1950's, the percent of catch increased due to a tremendous decline in the catches of sturgeon and catfish. For the period from 1961 through 1980, the commercial catch data encompass an area covering the entire International section of the St. Lawrence River as well as Lake St. Francis. From 1961 through 1971, yellow perch comprised an average of 6.2 percent (17,430 pounds) of the commercial catch for this area. From 1972 through 1982, the average catch of yellow perch increased to 64,207 pounds (15.6 percent).

Figure 28 . Abundance indices (fish/net set) for primary target species sampled by gill nets in the Thousand Islands region from 1977 through 1982. (McCullough 1982b).



Yellow perch are also an important sport fish. Although not considered a trophy fish like pike and bass, the yellow perch is sought as a panfish and is easily caught by children.

Due to the wide variety of habitats which they utilize, yellow perch were relatively unaffected by the documented habitat changes. The vegetation which provides nursery areas and supplies their major food source (insects and other invertebrates) is abundant throughout the River.

WALLEYE (Stizostedion vitreum vitreum)

Habitat Requirements

Originally native to the entire St. Lawrence River, the walleye now occurs mainly below the Moses-Saunders Power Dam. There is a small remnant population of walleyes upstream above the dam, where Brandy Brook, a tributary 12 miles below the Iroquois Dam, provides 8 to 10 miles of accessible spawning habitat. Estimates of walleye abundance in Brandy Brook indicate a very small population with good growth and high survival. This is probably the best spawning tributary in the area (LeTendre and Schneider 1970).

Spawning occurs in the spring, from April to May, depending on the water temperature (Table 49). Preferred spawning areas (3 to 14 feet deep) are rocky areas in white water below falls and dams in rivers, and on boulder to coarse-gravel shoals in lakes. Adult walleyes tolerate a wide range of habitat conditions, but apparently reach their greatest abundance in large, shallow, mesotrophic lakes. They can thrive in clear water, but a unique structure in their eye, the "Tapetum lucidum", is sensitive to bright daylight intensities which often restricts their feeding to twilight or darkness. Large streams or rivers that are turbid or deep enough to provide daylight shelter are the best habitat. Walleyes will often use boulder shoals, weed beds, sunken trees, or thick layers of ice and snow as a shield from the sun. In clear water they often lie in contact with the bottom. In turbid water they are more active during the day, swimming close to the bottom in slow-moving schools.

Walleyes often associate with other species including yellow perch, northern pike, muskellunge, and smallmouth bass. White suckers (Catostomus commersoni) may orient themselves in schools of walleye and behave as part of the school. Obviously, preservation or enhancement of pike/bass habitat would have potential benefits to walleye (Scott and Crossman 1973). (See Appendix C for further information).

Changes in Abundance

The walleye was considered "common" in early biological surveys of the St. Lawrence River. Following construction of the Seaway, it was reported as "uncommon" (Table 39). There is a small population upstream of the Moses-Saunders Dam, but most are found below the dam.

Canadian commercial catch statistics show two cyclic declines in the walleye catch (Table 41; Figs. 24 and 24a). The first began in 1952 and extended through 1960 (the statistics for this time period include the River from

Gananoque, Ontario through Lake St. Francis). The percentage of catch remained relatively constant, but the poundage drastically declined. This could be due to any number of factors, including fewer fishermen, poor fish catches in general (for whatever reasons), or a decline in the walleye population. The second decline began around 1966 and extended through the 1970's. The statistics for this period include the upper portion of the River (Tibbetts Point to Gananoque), as well as the portion included in earlier data. The average percent of catch dropped from 4.9 percent in 1962 to 0.1 percent or 0.2 percent from 1971 through 1976. The poundage decreased from over 4,500 pounds in 1965 to less than 1,000 pounds in most years between 1967 and 1976. This decline is probably due to the formation of Lake St. Lawrence in 1958, which eliminated the rocky whitewater areas and rapids which were the preferred spawning habitat for walleye. The impact of no or low recruitment took a few years to show its effect on the abundance of the adult walleye population.

It appears that the walleye were directly impacted by the change in habitat caused by construction of the Seaway/Power Project. Other species have also declined since the habitat changes. However, the decline of the other species can be traced in part to the influence of such factors as overharvesting, contaminants, or competition from other species. Life history requirements for the walleye have been well studied in other parts of the country. Their spawning habitat requirements are rather specific and they tend to return to the same area year after year. Therefore, destruction of habitat will often cause a direct decline of the population. Although walleye are capable of spawning on shallow shoals in lakes or lake-like areas, a population tends to be imprinted on spawning habitat locations. They will not readily adjust to another location unless the population is so strong that they "spill over" into new areas with suitable habitat.

BIRDS

VII. BIRDS

Historical Trends

The St. Lawrence River supports a diverse avian fauna, with 302 species reported in the literature (see Table 53 in Appendix A). Among these species are the federally listed endangered bald eagle (Haliaeetus leucocephalus) and peregrine falcon (Falco peregrinus), along with several species listed as endangered or threatened by the State of New York Department of Environmental Conservation (Table 42). This latter group includes the loggerhead shrike (Lanius ludovicianus), osprey (Pandion haliaetus), red-shouldered hawk (Buteo lineatus), northern harrier (Circus cyaneus), spruce grouse (Dendragapus canadensis), piping plover (Charadrius melodus), and the common tern (Sterna hirundo). In addition, New York lists approximately 14 species of special concern which have been seen along the St. Lawrence River.

The St. Lawrence River area provides a diversity of habitats which supports the diverse avian fauna. The open water areas, numerous islands, marshes, bays, and tributary streams all attract different bird species. A variety of upland habitats, both developed and undeveloped, contributes to the diversity.

Construction of the Seaway and Power Project changed habitats and may have adversely affected some species; however, habitats for other species were improved. In recent years, the biggest threat to birdlife along the River is probably contaminants, which reduce breeding success and render some species less able to compete. For purposes of this biological review, eight species representative of the St. Lawrence River were chosen as indicator species to try to identify the impact of habitat changes on species abundance (Table 54). The species chosen were great blue heron (Ardea herodias), mallard (Anas platyrhynchos), black duck (Anas rubripes), common tern, northern harrier, bald eagle, ring-billed gull (Larus delawarensis), and herring gull (Larus argentatus). These species were chosen as indicator species for a variety of reasons. Each one is representative of a group of birds which are dependent on the aquatic habitat of the area. Some species are important due to their endangered or threatened status, while some are quite common on the River. These species were also chosen because they utilize habitats that have been changed and may be impacted by future activities.

Very little pre-Seaway literature concerning abundance of birds in the St. Lawrence River area was available. What little literature was available showed the black duck and common tern to be "abundant" during at least one season. Both of these species have gradually declined over the years. The herring gull was "common" during the pre-Seaway period, but has begun to decline in recent years. The bald eagle has also shown a decline in recent years.

The mallard, on the other hand, has increased in recent years, probably at the expense of the black duck. The great blue heron is the only other species to show an increase. No data was available prior to the Seaway, but from the post-Seaway period to the present there has been a slight increase in the spring and summer populations. The other two species, ring-billed gull and northern harrier, have remained relatively constant, although the gull is probably increasing while the harrier is decreasing. A more in-depth discussion of each species follows.

Table 54. Seasonal relative abundance and breeding occurrence of certain indicator bird species in shoreline habitats along the St. Lawrence River during three time frames -- Pre-Seaway, Post-Seaway, and Present*.

	Relative Abundance and Breeding Occurrence[1]														
	Pre-Seaway (prior to 1959)					Post-Seaway (1959-1968)					Present (1969-1983)				
Species	Spring	Summer	Fall	Winter	Breeds	Spring	Summer	Fall	Winter	Breeds	Spring	Summer	Fall	Winter	Breeds
Great blue heron	---[2]	---	---	---	yes	U[3]	U	U	---	yes	U-C	U-C	U	VR-R	yes
Mallard	---	C	FC	U	yes	---	---	C	U-FC	yes	C-VC	C	C	U-FC	yes
Black duck	---	C	A	U	yes	---	C	---	FC	---	FC-C	U	FC	U-FC	yes
Common tern	---	A	---	---	yes	C	C	C	---	yes	FC-C	C	FC-C	---	yes
Northern marsh harrier	---	---	---	---	---	U	U	U	---	---	U	R-C	R-C	VR	yes
Bald eagle	---	---	---	R	---	R	R	R	R	---	VR-R	VR	VR	VR-U	no
Ring-billed gull	---	---	---	---	yes	VC	VC	VC	---	yes	C-A	C-A	C-A	R-U	yes
Herring gull	---	C	---	---	yes	C	C	C	R	yes	U-FC	U-FC	FC-C	U-FC	yes

[1]Based on visual observations, song identifications, Christmas counts, breeding bird censuses, roadside censuses, intensive colony studies, colony surveys, marsh surveys, roost surveys, general waterbird and waterfowl counts, island surveys, aerial surveys, waterfowl trapping studies, and various other information presented in the literature.
VERY RARE < RARE < UNCOMMON < FAIRLY COMMON < COMMON < VERY COMMON < ABUNDANT

[2]Unknown or not reported in the literature.

[3]VR = Very Rare; R = Rare; U = Uncommon; FC = Fairly Common; C = Common; VC = Very Common; A = Abundant.

*Allen, et al. (1960); Belanger (1965, 1966, 1967, 1968); Blokpoel (1976); Bradstreet and McCracken (1978); Brown (1979, 1980, 1982); BUFO (1977); Bull (1964); Chamberlain (1977a, 1977b, 1977c, 1978a, 1978b, 1978c, 1978d, 1979); Geis (1977); Lawler, Matusky, and Skelly (1977); Maxwell and Smith (1976 , 1977, 1978a, 1978b, 1978c, 1983a, 1983b); Maxwell, Smith, Ruta, and Carrolan (1976); McLeod (ND, 1961, 1963, 1964, 1965, 1969, 1971); Meents and Suchecki (1979); Payne and Cochran (1971); Smith, Karwowski, and Maxwell (1983); USFWS (1976a, 1979); Webb, Bart, and Komarek (1972).

Index Species

GREAT BLUE HERON (Ardea herodias)

Habitat Requirements

Water Requirements: The great blue heron is a common wading bird of lakes, ponds, rivers, and marshes (Bull and Farrand 1977). It is common on freshwater as well as on saltwater (Robbins, et al. 1966). The great blue heron lays three to five pale, greenish-blue eggs on a platform of sticks which is lined with finer material (Bull and Farrand 1977). A sociable species, the heron prefers to nest in colonies varying in size from a few pairs to hundreds (Bent 1963b). Maxwell and Smith (1978b) list the largest colony on the St. Lawrence River as the one at Ironsides Island near Kring Point, New York; this colony contains 286 nests. No other colonies were noted on the River proper, but a number of small colonies exist on the U.S. and Canadian mainlands near the River. The great blue heron will occasionally nest with other species (Austin 1967). Red-shouldered hawks (Buteo lineatus), red-tailed hawks (Buteo jamaicensis), and great horned owls (Bubo virginianus), have been recorded as nesting in or near heron rookeries (Bent 1963b).

Where trees are available, the great blue heron prefers to nest in them (Bent 1963b). Usually, selecting the tallest trees available, it will place its nest 50 to 100 feet above ground (Austin 1967). If alive, the trees will usually die as a result of the droppings from the birds (Luttringer 1973). The great blue heron will also nest in low trees, or bushes, or even on the ground (Bent 1963b). Bent (1963b) indicates that the location of the nesting rookery probably depends more on the availability of a food supply for the young than on the presence of suitable nesting trees. He notes, however, that a remote and fairly inaccessible site is always chosen to provide safety for the eggs and young.

Food Requirements: The great blue heron principally feeds on aquatic animal life which it finds in shallow water (Robbins, et al. 1966). Herons fish by night as well as by day and employ two very different methods of obtaining food: still hunting and stalking (Bent 1963b). Prey is usually obtained by spearing (Maxwell and Smith 1976). Maxwell and Smith (1978) list the large marshes of Chippewa Bay and Goose Bay and the small islands of the area between Morristown and Alexandria Bay as important feeding areas for the great blue heron in the St. Lawrence River area.

Both parents will feed the young, at first by regurgitation, later on with whole fish (Austin 1967). Parker and Maxwell (1969) list, on the basis of food specimens dropped by young, the diet of nestlings on Ironsides Island as being comprised of fish (alewife, rock bass, yellow perch, and bluegill) and pickerel frogs (Rana palustris).

The principal food of the great blue heron is fish. It seems to feed on whatever species of fish is most readily available (Bent 1963b). Knight (1908) lists the heron's food as: frogs, eels, hornpouts, pickerel (occasionally), suckers, shiners, chubs, black bass, herrings, water puppies, salamanders, and tadpoles. Audubon (1840) adds lizards, snakes, birds, insects, and small mammals to the heron's food list. Wilson (1832) includes in the heron's food grasshoppers, dragonflies, and the seeds of spatterdocks. Crustaceans are added to the list by Howell (1911).

Changes in Abundance

The great blue heron was chosen as an index species because it is an important colonial waterbird. The largest colony in New York is located on Ironsides Island. The great blue heron is also used by several organizations as a symbol of the St. Lawrence River.

Detailed data concerning the great blue heron on the St. Lawrence River prior to Seaway construction do not exist. It was known to breed here, but no records of abundance are available (Table 54). During the post-Seaway period, this species was listed as "uncommon" in the spring, summer and fall. In recent years the heron has been recorded as "uncommon" to "common" in the spring and summer, "uncommon" in the fall, and "very rare" to "rare" in the winter. It continues to breed along the River, with the majority nesting on Ironsides Island.

The habitat changes caused by the St. Lawrence River development in the late 1950's probably had little effect on the great blue heron population. No dredging, flooding, or island removal occurred on heron rookeries or other important habitat. Wetlands were altered downriver, but this apparently had little or no impact on the heron population. Although the shipping channel passes adjacent to Ironsides Island, this colony continues to thrive, indicating that any direct Seaway impacts on this heron colony were temporary in nature. The major food sources of the heron (several fish species listed above) are thriving in the St. Lawrence River and have received no known direct impacts from the habitat changes.

MALLARD (Anas platyrhynchos)

Habitat Requirements

Water Requirements: Mallards are essentially freshwater ducks (Bent 1962). Among dabbling ducks, mallards exhibit the greatest adaptability to a variety of breeding habitats and climates (Bellrose 1979). They are secretive and are commonly found in small ponds and potholes (Chabreck 1979). Semi-domesticated birds may be found on almost any body of water. Among the preferred habitats are marshes, wooded swamps, ponds, lakes, rivers, bays, and grain fields (Peterson 1980; Bull and Farrand 1977). Maxwell and Smith (1978b) and USFWS (1979) seldom found mallards in woodlands, shrublands, or developed areas along the St. Lawrence River.

Dense vegetation at least 24 inches high appears to be the primary nest cover requirement (Bellrose 1976). Mallards spend more time resting than feeding in timbered areas, while the reverse is true in marsh areas. Reservoirs are used as rest areas while the ducks are feeding in adjacent grain fields. The relationship of open water or marsh to terrestrial habitat determines the attractiveness of a particular habitat to mallards. Water depth is important mostly as it affects feeding (Chabreck 1979; Cowardin 1969; White and Malaher 1964).

Mallards, the progenitors of nearly all domestic breeds, frequently cross with black ducks (Anas rubripes) and are known to cross with gadwall (Anas strepera), pintail (Anas acuta), baldpate (Anas americana), and green-winged teal (Anas crecca) (Kortright 1967; Bull and Farrand 1977). Sportsmen recognize two varieties: the larger yellow-legged variety and the smaller red-legged variety. The yellow-legged arrive later and are better fed and heavier feathered, due to the fact that they breed farther north (Kortright 1967).

Mallards are early migrants, arriving shortly after ice-out (Bent 1962). The spring migration in the St. Lawrence River area lasts from approximately March 20 through May 10 (Maxwell and Smith 1978b). The nest location is generally on or near the edges of a slough or lake, among dead vegetation where the ground is dry or slightly marshy, or among thick dead reeds on higher land not far from water (Bent 1962). Mallards are also known to nest on open prairies, often far from water (Bent 1962; Bull 1974; Bellrose 1976). Sometimes they will lay eggs in the nest of another duck (Bent 1962), and occasionally they will occupy abandoned hawks nests in tree crotches or use unoccupied barns or similar buildings (Kortright 1967).

The mallard nest consists of a bowl-shaped scrape 7 to 8 inches in diameter and 1 to 2 inches deep. Down is added sparingly until just prior to completion of the clutch, when larger quantities are added. This down, which is thickest around the edges of the nest, is used to cover the eggs when the hen leaves the nest (Bellrose 1976; Bent 1962). Eggs are laid one per day until the clutch is complete. An average of nine eggs (varies from 6 to 15) is laid per nest. The eggs are grayish to greenish buff in color, ovate, and average 57.8 mm by 41.6 mm (Bellrose 1976; Bent 1962; Bull and Farrand 1977; Addy 1964). The incubation period lasts 23 to 29 days. One set of eggs is laid per season, although some mallards will attempt to renest if the nest is destroyed early in the breeding season. Most mallards breed late in their first year; a large proportion of those failing to breed, particularly in dry years, are yearlings (Bellrose 1976; Addy 1964).

Food Requirements: Mallards pick food up on or above the surface, or obtain it by partial immersion in shallow water (Bent 1962). They generally feed in water 11 cm to 16 cm deep on their wintering and stopover areas (Taylor 1977). Female mallards switch their food source to higher trophic levels during pre-laying and laying stages (Frederickson and Drobney 1979). Mallard reproduction is adversely affected when hen access to animal matter is curtailed (Swanson, Krapu, and Serie 1979; Krapu 1979). Invertebrates comprise 70 percent of the food of breeding mallards; this can be broken down into 40 percent molluscs, 16 percent crustaceans, and 14 percent insects. Earthworms are an important food source during wet years (Swanson, Krapu, and Serie 1979). Mallards generally do not use amphipods, which are an important component of the blue-winged teal's (Anas discors) diet (Perret 1962).

The widespread use of mechanical cornpickers has improved the quality and extent of mallard habitat due to the large quantity of grain left on the ground (Addy 1964). Ninety percent of the non-breeding mallard diet is derived from the vegetable material. This includes 22 percent sedges (Carex spp.), 13 percent grasses (Gramineae), 10 percent smartweeds (Polygonum spp.), 8 percent pondweeds (Potamogeton spp.), 6 percent duckweeds (Lemna spp.), 6 percent coontail (Ceratophyllum demersum), 4 percent wild celery (Vallisneria americana) and its allies, 4 percent water elm (Planera aquatica) and hackberries (Celtis spp.), 4 percent wapato (Sagittaria spp.) and its allies, 2 percent acorns (Quercus spp.), 2 percent buttonbush (Cephalanthus occidentalis), 1 percent cypress (Taxodium distichum) cones and galls, and 9 percent miscellaneous plant food (Bent 1962, McAtee 1918, Kortright 1967). The animal component consists of 6 percent molluscs, 3 percent insects, 0.5 percent fish, 0.5 percent crustaceans, and 0.25 percent miscellaneous (McAtee 1918, Bent 1962). Mallards feed on mosquito larvae and are sometimes used for mosquito abatement (MacKenzie 1977, Dixon 1914).

Mallards are adaptable, consuming whatever native foods are available. Various studies have found mallard diets to be dominated by bulrushes (Scirpus spp.) and pondweed seeds in British Columbia (Munro 1939), seeds of wild millet (Echinochloa spp.), beaked sedge, and reed canary grass (Phalaris arundinacea) in Washington (Yocom 1951), and pondweed and sedge seeds, bulrush, spike rush (Eleocharis spp.), and eelgrass (Vallisneria spp.) in California (Yocum and Keller 1961). In Illinois the diets were dominated by rice cut-grass (Leersia oryzoides), coontail, and seeds of wild millet and smartweed (Anderson 1959), smartweed, millet seeds, and acorns in Missouri (Korschgen 1955), acorns, millet, and grasses in Arkansas (Wright 1961), acorns, duckweed, and seeds of smartweed, buttonbush, and bald cypress in Tennessee (Rawls 1954), Jamaica saw grass, jungle rice, spike rush, brownseed paspaulum and wild millet seeds in Louisiana (Dillon 1959), and blue mussels (Mytilus edulis) (45 percent of the diet) in Rhode Island (Cronan and Halla 1968). In North Carolina the diets included pondweeds, widgeon grass (Ruppia maritima), and bulrush seeds (Quay and Critcher 1965), while in South Carolina, rice cut-grass seeds, Hydrochloa, sweet gum (Liquidambar styraciflua), buttonbush, and smartweed were the main components (McGilvrey 1966). Mallards will also consume whatever cultivated food is available (Bellrose 1976).

Changes In Abundance

The mallard was chosen as an index species because it is the most abundant and widely distributed duck, and the most important game bird (Bent 1962). It is also the most common waterfowl species on the St. Lawrence River.

The mallard is present along the St. Lawrence River during all seasons and is known to breed in the area (Table 54). It is "uncommon" during the winter, but "common" to "very common" during the remaining seasons. The available literature indicates that mallards were somewhat less abundant during pre-Seaway and post-Seaway times. Bradstreet and McCracken (1978) indicated that the mallard has been known to breed along the River since 1942, but not prior to that year. Toner, et al. (1942) reported no nesting records for the mallard in Leeds County. Allen, et al. (1960) listed the mallard as a "common" summer resident, but an "occasional" winter resident. Maxwell and Smith (1977) stated that mallards were "abundant" during most or all annual counts from 1955 through 1978. Chamberlaine (1977a, 1977b, 1977c, 1978a, 1978b, 1978c, 1978d, 1979) reported the mallard populations along the St. Lawrence River for several years. Both 1977 and 1978 were very successful nesting years; the mallard was the most common breeding duck along the River in 1978. In the winter of 1979, numbers were down from previous years.

The Wilson Hill Island area is the major waterfowl production area of the eastern half of the International section of the St. Lawrence River (Lawler, Matusky, and Skelly 1977). It contains the largest concentration of dabbling ducks on the River (Maxwell and Smith 1976).

Mallards are resident throughout New York, and are a "common" to "locally abundant" migrant (Bull 1964). Much of the New York population is derived from captive stock (Bull 1974). Mallards were rare in the East up through the 1960's; the black duck was more prevalent (Kortright 1967). Since the 1960's, however, the mallard has been increasing at the possible expense of the black duck (Bull 1964). In surveys conducted between 1972 and 1977, the mallard was found to be the most common summering waterfowl species in the Thousand Islands (Bradstreet and McCracken 1978). Quilliam (1973) noted that mallards were more common in the Kingston area than at the turn of the century.

BLACK DUCK (<u>Anas</u> <u>rubripes</u>)

<u>Habitat Requirements</u>

Water requirements: Black duck habitat consists of marshes, lakes, streams, coastal mud flats, and estuaries (Bull and Farrand 1977). Peterson (1947) states that the black duck is most characteristic of creeks, ponds, and marshes. It is the most abundant surface-feeding duck in the East (Robbins, <u>et al</u>. 1966). According to Maxwell and Smith (1976), black ducks frequent all areas of the St. Lawrence River, utilizing shores, shoals, and islands for resting areas. They report that the largest concentrations of black ducks along the St. Lawrence occur in the shallow habitat of the Wilson Hill Game Management Area. Black ducks are surface feeders, or dabblers, in shallow waters, where they reach the bottom by tipping up their tails and probing in the mud with their bills (Bent 1962).

The black duck nests in a variety of situations and does not seem to show any preference for any particular type of habitat as long as there is sufficient concealment. Its nest is generally placed on dry ground, usually not very far from the water (Bent 1962). The female black duck digs a scrape, using both feet and her bill, and lines it with adjacent plant material. Small amounts of down are added after several eggs are laid, but most of the down is added when the clutch is completed (Bellrose 1976). Black ducks lay an average of nine eggs, most clutches ranging from 7 to 12 eggs (Bellrose 1976). The brood area selected by the female black duck encompasses a wide variety of habitats: sedge, cattail, and bulrush marshes, beaver ponds, alder-fringed streams, and swamp loosestrife bogs (Bellrose 1976).

Maxwell and Smith (1978b) report that the black duck has virtually disappeared as a breeder west of Waddington on the St. Lawrence River. A few breeders persist, but they report that many pairs in this area are mixed mallards X black ducks. Quilliam (1973) notes that the black duck was formerly the most common nesting duck in the Kingston, Ontario area. However, she feels that the number of nesters may be decreasing, possibly due to increased competition with the mallard.

The home range of the black duck in New England is up to 5 square miles in size (Coulter and Miller 1968). The heart of the home range is "the activity center", which includes the waiting site (Barclay 1970). A waiting site is defined as usually an area of shoreline open on one side with a vegetative screen on the other. A pair spends much of its preincubation time in the activity center, where the male waits for his mate during the early stages of incubation.

Food requirements: The black duck is an omnivore, consuming a variety of animal and plant foods (Maxwell and Smith 1976). In the shallow, muddy ponds and swamps where black ducks spend their summers, they feed largely on aquatic insects and larvae, salamanders, tadpoles and small frogs, leeches, various worms, and small mollusks. They also feed on the many varieties of snails which are found on the stems of sedges and grasses. In addition, small toads and even small mammals are eaten occasionally. With this animal food they mix a fair proportion of vegetable matter. Seeds of aquatic and land plants are eaten and the succulent roots of many water plants are pulled up and consumed (Bent 1962). Yorke (1899) records the following genera of plants as recognized in the food of the black duck: Limnobium, Zizania, Elymus, Danthonia, Piper, Myriophyllum, Callitriche, and Utricularia.

Phillips (1911) reports the stomach analyses of 29 black ducks shot in Massachusetts in the fall of 1909 as 88.4 percent vegetable matter, the principal items being seeds of bur-reed (Sparganium), pondweed (Potamogeton), bulrush (Scirpus), eelgrass (Zostera) and mermaid weed (Proserpinaca), and buds, rootstocks, etc., of wild celery (Vallisneria). The animal matter identified amounted to 11.6 percent, including, in the order of importance, snails, ants, chironomid larvae, bivalves, crustacea, and insects.

Waste corn available in harvested fields near water areas frequented by black ducks is an important food source, particularly in late fall and winter. Black ducks have been known to leave their rest areas at daybreak and shortly before sunset to fly up to 25 miles in an effort to find sufficient waste corn (Bellrose 1976). Bent (1962) reports that black ducks will also feast in ripened grain fields on wheat, barley, buckwheat, and Indian corn. He also states that black ducks will visit woodlands where acorns and beechnuts can be found in the vicinity of woodland ponds.

Changes in Abundance

The black duck was chosen as an index species because it has been a common waterfowl on the St. Lawrence River and is representative of the habitats vital to several waterfowl species. In addition, it has been declining throughout its range in the Atlantic Flyway in recent years.

Early literature indicated that the black duck was "abundant" in the fall along the St. Lawrence prior to Seaway construction (Table 54). It was "common" in the summer, "uncommon" in the winter, and no data was available for the spring. Black ducks were known to breed on the St. Lawrence River. Literature reports in the 1960's are somewhat scarce; however, the black duck was considered "common" in the summer and fairly "common" in the winter. No information was available on the other seasons, nor was their breeding status indicated. This information, although incomplete, indicates relatively little change in the black duck population up through the late 1960's.

Data from recent years have shown a marked decline in the black duck population. Although they are still known to breed along the St. Lawrence, their abundance has declined from "common" to "uncommon" in the summer, and from "abundant" to "fairly common" in the fall. The major reasons for this local decline seems to be the effect of the general decline in the flyway (posibly due to harvest pressure in the wintering areas) and hybridization with and competition from the mallard. Black duck habitat and prime food sources are still abundant on the St. Lawrence River.

BALD EAGLE (*Haliaeetus leucocephalus*)

Habitat Requirements

Water requirements: Bald eagle habitat includes lakes, rivers, marshes, and seacoasts (Bull and Farrand 1977). Robbins, et al. (1966) state that the bald eagle is rare and local along shores. The bald eagle utilizes a variety of aquatic-bordered habitats of all types (Maxwell and Smith 1976). Meents and Suchecki (1979), in their studies along the St. Lawrence River, reported that the bald eagle exhibited a distinct dependency on open water areas. They reported that the eagles were concentrated at certain points along their study corridor. The physical and biological characteristics of the pools influenced eagle distribution, and it appeared that shallow depth, isolation from disturbances, moderate currents, and a concentrated food supply determined the attractiveness of open water areas.

Eagles perch on a variety of objects (Southern 1963, 1964; Steenhof 1978), but prefer tree perches over other types (Steenhof 1976). Proximity to food sources is probably the primary factor in perch site selection (Steenhof 1978). Meents and Suchecki (1979) report that the preferred perches of eagles within their St. Lawrence River study area were in large trees, usually on islands isolated from human development and activities.

Wintering bald eagles tend to concentrate where water remains open throughout the winter. This demonstrates the eagle's dependency on fish and waterfowl as food sources (Meents and Suchecki 1979). Meents and Suchecki (1979) report that, from the 1800's to the early 1900's, bald eagles were commonly observed wintering in New York State wherever open water was available. Now, an estimated 20 to 30 migratory bald eagles winter in New York, primarily in Sullivan County and along the St. Lawrence River. At least seven bald eagles wintered in the vicinity of Meents and Suchecki's 1979 study area along the St. Lawrence River.

Sensitive to human activity, bald eagles prefer to use areas with lower disturbance levels (Steenhof 1976; Stalmaster and Newman 1978). While Steenhof (1978) reports that more disturbance is tolerated at feeding sites than at loafing or roosting areas, Stalmaster and Newman (1978) found feeding birds to be most sensitive to human activity. Stalmaster and Newman (1978) stated that birds were most disturbed by approach from open habitats, particularly from the riverbank or river channel.

The female bald eagle lays two or three white eggs in a huge, conspicuous mass of sticks in the top of a tall tree or, less frequently, on top of a cliff (Bull and Farrand 1977). Quilliam (1973) documents the nesting decline of the bald eagle on the St. Lawrence River up to the last nest in 1957. The locations of at least six former bald eagle nest sites are known in the St. Lawrence Islands National Park area. These nests were usually situated in large trees near water (Bradstreet and McCracken 1978). Sprunt (1969) lists human disturbance, habitat loss, and pesticides as the principal causes for the decline in bald eagle numbers throughout southern Ontario and elsewhere. In the Thousand Islands region, near Ivy Lea, the bald eagle presently occurs only as a winter visitor (Bradstreet and McCracken 1978).

Food requirements: Eagles feed their young much the same diet as they eat themselves, with perhaps a somewhat larger proportion of chickens, other birds, and small mammals. The bulk of the food for adults and their young consists of fish. Probably most of the fish taken are dead or dying fish, picked up along the shores or floating on the surface of lakes, ponds, or streams (Bent 1961). Eagles commonly congregate at spawning grounds, fish kills, or below dams to scavenge the easily available fish. Stealing of fish from ospreys, gulls, and waterfowl is also common (Meents and Suchecki 1979). However, eagles are perfectly capable of catching live fish (Bent 1961).

The eagle's diet is most varied, especially during the seasons when fish are not easily obtained. Waterfowl, grebes, loons, gulls, any of the Alcidae, cormorants, coots, grouse, ptarmigan, and even the smaller land birds are eaten by bald eagles (Bent 1961). Sick or crippled ducks and geese are frequently preyed upon by bald eagles, and some eagle migration appears to directly accompany waterfowl migration. Goldeneyes, mergansers, and gulls were observed to be eaten by eagles in Maine. Waterfowl are undoubtedly important to the eagles wintering on the St. Lawrence River (Meents and Suchecki 1979).

Many kinds of small mammals, such as muskrats, rabbits, squirrels, and rats, are also eaten by bald eagles (Bent 1961). A food item of last choice is carrion, including deer (Erskine 1968), sheep (Hancock 1964), or cattle carcasses (Meents and Suchecki 1979). Eagles may often be seen in company with ravens feeding on the carcasses of any animals they can find (Bent 1961). Severe weather and lack of fish or waterfowl may cause the eagles to move upland in search of carrion (Meents and Suchecki 1979).

Changes in Abundance

The bald eagle was chosen as an index species because it is listed as "endangered" by the U.S. Fish and Wildlife Service (Table 42). It is the largest avian predator found along the St. Lawrence River. Bald eagles are also indicators of the relative "health" of certain habitats along the River.

Early literature references are scarce, but the bald eagle was considered "rare" during the winter (Table 54). Following Seaway construction, it was listed as "rare" during all seasons. In recent surveys, the bald eagle is generally listed as "very rare" and is not known to breed along the River.

A few bald eagles have been known to winter along the St. Lawrence River, where open water pools are vital to their feeding. Seaway construction (notably dredging) and hydropower production (stable ice cover requirement) impacted the size and locations of open-water areas in the winter. Any significant loss of winter open-water area could adversely impact the bald eagle.

Human disturbance and contaminants have caused the decline in bald eagles throughout the country. The increasing commercial ship and recreational boating activity, as well as contaminant loading in the St. Lawrence River, may have contributed to the localized decline of the bald eagle.

NORTHERN HARRIER (Circus cyaneus hudsonius)

Habitat Requirements

Water Requirements: Northern harriers (marsh hawks) can be seen in marshes and open grasslands (Bull and Farrand 1977; Robbins, et al. 1966). They occasionally perch on trees or bushes. Harriers will normally stand on the ground or will perch on stumps, fence posts, or telephone poles. They roost on the ground at night (Bent 1961). In hunting, the harrier will glide over fields or marshes, barely high enough to clear the vegetation, holding its wings above the horizontal and tilting from side to side. Its keen eyes are so quick to detect prey, and its flight is under such perfect control, that it can stop suddenly and drop quickly down upon its prey. The harrier will usually eat its prey right there on the ground. At other times the food is carried to some convenient stump or post, or carried away to feed its mate or young (Bent 1961). Harriers seldom pursue their prey in the air, nor do they watch quietly from an exposed perch as do other hawks and falcons (Bull and Farrand 1977).

Breeding occurs in meadows and bushy marshes (Peterson 1947). Four or five pale blue or white eggs, unmarked or with light brown spots, will be laid by the harrier in a mound of dead reeds and grass in a marsh or shrubby meadow (Bull and Farrand 1977).

Food Requirements: The harrier is of high economic value as a destroyer of mammal pest species, including mice and rats. The principal prey of the harrier is small mammals and small birds. Meadow mice seem to constitute the bulk of its diet. Among other mammals taken are young rabbits, young skunks, pocket gophers, rats, squirrels, shrews, and moles. Birds eaten include bitterns, green herons, teal and other ducks, coots, rails, grouse, quail, partridges, pheasants, plovers, sandpipers, woodcock, snipe, sparrow hawks, screech owls, flickers, doves, starlings, meadlow larks, blackbirds, grackles, sparrows, cardinals, towhees, warblers, wrens, mockingbirds, catbirds, thrashers, robins, bluebirds, and thrushes. Frogs form a large item in the harrier's diet, and small snakes and lizards are also eaten. It also feeds on grasshoppers, locusts, crickets, and other insects. The harrier can be quite destructive to poultry and game (Bent 1961).

Based on examinations of large harrier nests at all seasons during a 50-year period, Luttringer (1973) found that 87 percent had consumed mice and rats, 12.75 percent consumed birds, 2.45 percent consumed other mammals, 0.25 percent consumed poultry, 50 percent consumed fish, insects, etc., and 5 percent consumed game.

Urner (1925) observed, from remains picked up in the general vicinity of nests, that mice and small birds, supplemented with insects, constitute the principal fare of the harrier's diet during early life. As the bird grows, rats assume a more important role, and, in or near two different nests, Urner found the remains of practically full-grown American bitterns (Botaurus lentiginosus).

Changes in Abundance

The northern harrier was selected as an index species because it is listed as "threatened" by the New York State Department of Environmental Conservation (Table 42). The St. Lawrence River is one of its last known breeding areas in the State. Harriers are representative of a variety of raptors.

Northern harriers were not mentioned in the early literature of the St. Lawrence River. Literature from the 1960's indicated that they were "uncommon" throughout the year (Table 54). No mention is made of their breeding status. Recent surveys have listed the harrier anywhere from "very rare" to "common". In general, it averages out to "uncommon", which is relatively unchanged from the immediate post-Seaway period. The harrier breeds on the St. Lawrence River.

Although the harrier has declined throughout the State, probably due to such factors as habitat loss and pesticides, it seems to be maintaining its presence on the St. Lawrence River. Maxwell and Smith (1978b) estimated that 12 to 15 pairs of harriers may be found along the St. Lawrence River between Cape Vincent and Hawkins Point. They state that this is one of the most important areas for this declining species in New York State. According to Maxwell and Smith (1978b), it is probably the only healthy breeding population in New York.

HERRING GULL (Larus argentatus)

Habitat Requirements

Water Requirements: The herring gull is common in all aquatic habitats. It is found on lakes, rivers, estuaries, and beaches (Bull and Farrand 1977). It is abundant along the coast, particularly in harbors and garbage dumps, and at fish docks (Robbins, et al. 1966). Studies have shown that gulls utilize the islands in the St. Lawrence River (USFWS 1979). Some of these islands are important nesting sites. Gulls utilize the nearby open-water areas for feeding.

Peterson (1947) lists the gull as a long-winged swimming bird with superb power of flight. Gulls are fine soarers, able to ride updrafts. They will circle a water body until they spot a floating object which might be food. Sometimes they will pick the object off the water in flight, but usually they will land next to it. While gulls swim well, they cannot swim underwater and they usually do not dive under the surface from the air. They can reach down into the water about a foot or so - the length of their neck and bill (Austin 1967).

Gulls are sociable birds, migrating, hunting, scavenging, quarreling, and nesting together, sometimes in large colonies (Austin 1967). Maxwell and Smith (1978b) showed that most herring gull colonies consisted of one to eight pairs each, on small islands in the St. Lawrence River. They noted that the gulls were restricted to rather low-lying, sparsely vegetated islands rarely visited by humans. Nesting on islands allows the gull nests to be safe from such predators as foxes, weasels, and skunks (Austin 1967). Most gulls nest on the ground. They build a bulky structure of seaweed and other handy vegetation (Austin 1967). Gulls lay from two to four heavily spotted olive-brown eggs (Bull and Farrand 1977).

Herring gulls commonly nest in close association with terns. Gulls will eat the eggs and young of other bird species when given the opportunity (Austin 1967). Austin (1967) states that gulls and terns seem to go through abundancy cycles on protected islands, alternating with each other for periods that may last for 15 to 30 years. Herring gulls will come into a tern colony, gradually take it over, and finally occupy it solidly for a period of years. Then the gulls will leave it and the terns will come back.

Food Requirements: Although primarily a scavenger, the herring gull will also eat large numbers of aquatic and marine animals, and plant material such as berries. It will often drop clams and other shellfish on such hard surfaces as exposed rocks or parking lots in order to break the shells and get at the soft interior (Bull and Farrand 1977). Gulls are noted for robbing other species, including mergansers and bald eagles, of fish they have caught (Lien 1975). Austin (1967) notes that although gulls prefer animal food and fish when they can get it, they will eat almost anything. Gulls are such opportunists that few sources of food go unnoticed. They are not good fishermen and seldom catch live food unless it is crippled.

Dutcher and Bailey (1903) report that examination of stomach contents of young herring gulls showed that, besides fish and squid, various insects (moths, flies, and beetles) had been eaten. As a rule, the young are given the same food that is consumed by the adults.

Changes in Abundance

Herring gulls were chosen as an index species because they are a common bird species utilizing the River. They are gregarious and nest in colonies, which may make them more likely to be impacted by dredging/island removal than other birds. They are also a major competitor of the "threatened" (NYSDEC) (Table 42) common tern.

Prior to Seaway construction, herring gulls were listed in the literature as breeders on the River and as being "common" during the summer (Table 54). After Seaway construction, the literature is more thorough, indicating that this species is "common" in all seasons except winter, when it is "rare". The herring gull is also listed as a breeder on the River during this time frame. Recent studies have indicated that the herring gull now ranges from "uncommon" to "fairly common" during all seasons except fall, when they are "fairly common" to "common". They are still listed as breeders on the St. Lawrence River.

The recent decline in the herring gull population is probably due to reproductive failures as a result of contaminants. The gulls are also susceptible to human disturbance, and increased shipping/boating activities may have adversely impacted the population. In addition, future disturbances, particularly to nesting islands, could adversely impact the herring gull population.

RING-BILLED GULL (*Larus delawarensis*)

Habitat Requirements

Water Requirements: The ring-billed gull occurs in most types of aquatic habitats (Maxwell and Smith 1976). It is found on lakes and rivers but many move to salt water in the winter (Bull and Farrand 1977). Robbins, *et al.* (1966) list the ring-bill as being common, especially inland. They gather in large numbers at garbage dumps and fish docks. Studies have shown that, like the herring gull, ring-billed gulls utilize the islands in the St. Lawrence River, some of which are important nesting sites. The nearby open-water areas are used for feeding (USFWS 1979). Recent studies indicated that the ring-billed gull and the red-winged blackbird were the most abundant species in the open fields during the breeding season (USFWS 1979).

Gulls are sociable birds, migrating, hunting, resting, scavenging, quarreling, and nesting together (Austin 1967). Ring-billed gulls nest together in a few large colonies rather than in small colonies. These few large colonies are extremely vulnerable to human disturbance (Maxwell and Smith 1978b). Maxwell and Smith (1978b) state that the largest colony in the St. Lawrence River is the one on Strachan Island, Ontario, which consists of approximately 6,000 pairs.

The ring-billed gull yields readily to persecution, is easily driven away from its breeding grounds, and seems to prefer to breed in remote unsettled regions, far from man (Bent 1963a). It nests on low islands with sparse vegetation (Maxwell and Smith 1976). Two to four spotted buff or olive eggs will be laid in a hollow in the ground, which is sometimes lined with grass or debris. In the North, ring-bills sometimes nest in low trees (Bull and Farrand 1977). Nesting on islands allows the gull nests to be safe from such predators as foxes, weasels, and skunks (Austin 1967).

The ring-billed gull will often nest in colonies with other gull species or with terns (Bull and Farrand 1977). However, the ring-bill will eat the eggs and young of other bird species when given the opportunity (Austin 1967).

Food Requirements: Primarily a scavenger, the ring-billed gull feeds in all areas of the St. Lawrence River upon fish, invertebrates, garbage, and a variety of other foods (Maxwell and Smith 1976). The alewife has been found to be an important food of Great Lakes ring-bills (Jarvis and Southern 1976). Gulls are noted for robbing other species, including mergansers and bald eagles, of fish they have caught (Lien 1975). Austin (1967) notes that although gulls prefer animal food and fish when they can get it, they will eat almost anything. Gulls are such opportunists that few sources of food go unnoticed. They are not good fishermen and seldom catch live food unless it is crippled. When food is discovered, the ring-bill either plunges straight downward or floats down more slowly in a spiral curve, and picks up its food without wetting its plumage (Bent 1963a).

Changes in Abundance

The ring-billed gull was chosen as an index species for the same reasons that the herring gull was chosen: it is common, nests in vulnerable colonies, and is a major competitor of the common tern.

The ring-billed gull is more abundant than the herring gull along the St. Lawrence River. No abundance data is available prior to Seaway construction, but the literature indicates that the ring-bill bred along the River (Table 54). Ring-bills were considered "very common" during all seasons except winter during the post-Seaway period. Breeding occurred during this period. Recent surveys have listed the ring-billed gull as "common" to "abundant" during all seasons except winter, when it is "rare" to "uncommon". Ring-billed gulls still breed along the River.

The success of the ring-bill is due to its ability to compete with the herring gull and common tern for limited nesting islands. However, this species is susceptible to human disturbances, and the population could be impacted by future activities on the River.

COMMON TERN (Sterna hirundo hirundo)

Habitat Requirements

Water requirements: Common tern habitat includes lakes, ponds, rivers, coastal beaches, and islands (Bull and Farrand 1977). Shoals, rocks, and other such habitats are extensively used by common terns for resting (Maxwell and Smith 1976). This species is a familiar sight on almost all large bodies of water where protected nesting sites exist (Bull and Farrand 1977). Their flight is buoyant; terns fly with their bill pointed downward as they search for fish (Robbins, et al. 1966). When feeding, most terns dive into the water with a splash and immediately fly out of the water with their catch. Although terns are web-footed and float buoyantly on the surface, they are poor swimmers, as their feet are too small and weak to propel them efficiently (Austin 1967).

Common terns nest on small islands which are low-lying and sparsely vegetated (Maxwell and Smith 1978b). Nesting occurs in colonies. Bradstreet and McCracken (1978) report that, within the Thousand Islands region of the St.

Lawrence River, there is a large successful colony (75 nests in 1977) of common terns on Ice Island. This colony is the only remaining tern colony of significant size in this area. Maxwell and Smith's (1978b) studies show that most colonies along the St. Lawrence River occur in the areas between Cape Vincent and Clayton, Chippewa Bay to Morristown, and from Waddington to the Moses-Saunders Power Dam. Colony size ranges up to 120^+ pairs with four to ten pairs in a number of small colonies.

Sensitive to disturbance during the breeding season, whole colonies of common terns often fail to breed successfully because of disruption by humans and, as a result, their numbers are slowly declining (Bull and Farrand 1977). Human activities which adversely impact tern colonies include urbanization and recreational development (Gochfeld 1974a, 1974b), intentional disruption (Gochfeld 1976), toxic chemical pollution, and fluctuations in "regulated" water levels (Smith, et al. 1983). Morris and Hunter (1976) list the various factors that influence colony site desertion by terns as: availability of nesting substrate, reproductive failure, food supply, human disturbance, predation, and competition with ring-billed gulls for nest sites. In the St. Lawrence River and Great Lakes area, Smith, et al. (1983) indicate that the common tern breeding populations are being adversely affected by a massive population explosion of ring-billed gulls. They state that the gulls have an advantage in nest site competition due to their larger size and four to six week earlier arrival on the breeding grounds. This competition is being intensified due to the destruction of nesting sites by human disturbance.

The common tern lays two, three, or rarely four spotted olive-buff eggs in a depression in sand or in a shallow cup of dead grass on sandy or pebbly beaches or open rocky places (Bull and Farrand 1977). Windrows of seaweed or dry eelgrass, just above the high-water mark, are favorite nesting sites (Bent 1963a). The nest may be lined with a few pebbles, bits of shell, or seaweed, but it is often bare (Austin 1967).

Most terns breed for the first time when they are three or four years old. Young terns will return to the area where they were hatched to nest. Once having bred, the tern will return to the identical spot year after year, or as close to it as suitable nesting conditions are available (Austin 1967).

Food Requirements: The food of the common tern consists almost wholly of small fish, not over 3 or 4 inches long. Aquatic insects are eaten to some extent (Bent 1963a). Knight (1908) reports watching a tern chase, catch, and devour a yellow swallow-tail butterfly (*Papilio turnus*).

Changes in Abundance

The common tern was chosen as an index species because it is listed as a "threatened" species by the New York State Department of Environmental Conservation (Table 42). It is a colonial waterbird species which nests in a few large colonies, a fact which makes the population more susceptible to habitat changes and disturbances. The species has been declining and is fairly vulnerable to human disturbances.

Pre-Seaway surveys identified the common tern as a species that breeds along the St. Lawrence River (Table 54). Common terns were considered "abundant" during the summer. No relative abundance figures were available for the remainder of the year. This species was considered "common" during the post-Seaway period in all seasons except winter. It was known to breed on the St. Lawrence River. Recent surveys have listed the common tern as "fairly common" to "common" in all seasons except winter. It still breeds along the River.

There are probably many reasons for the decline of the tern population. There is tremendous competition for suitable nesting sites. The prime competitor is the ring-billed gull, although herring gulls also compete with the tern. Environmental contaminants and human disturbance may also have contributed to the decline. Data from 1979 (USFWS 1979) indicates that the decline is continuing, particularly in the Thousand Islands region.

Since pre-Seaway data is scarce, it is difficult to determine if the formation of Lake St. Lawrence flooded any key nesting islands. However, the loss of any nesting islands may have been mitigated by the creation of new islands from upland. Future disturbances or loss of island habitat could adversely affect an already threatened population.

MAMMALS

VIII. MAMMALS

Historical Trends

A variety of mammalian species exists along the St. Lawrence River. A total of 62 species have been identified in the literature as having been sighted along the River (see Table 55 in Appendix A). Construction of the Seaway and Power Project altered the habitat, but secondary development has probably taken a much greater toll on the wildlife than the actual Seaway development.

Four species were chosen as indicator species. These were the muskrat (Ondatra zibethicus), American beaver (Castor canadensis), river otter (Lutra canadensis), and raccoon (Procyon lotor) (Table 56). These species were chosen because they require aquatic habitat for all or part of their life functions. Two of these species, the muskrat and river otter, had the same relative abundance for both the pre-Seaway and present time frames, while the other two species increased in relative abundance. No data exists to tie the relative increase in beaver and raccoon populations to the Seaway construction.

Three mammalian species found along the St. Lawrence River are listed as "endangered" by the State of New York and the U. S. Department of the Interior (Table 42). These are the Indiana bat (Myotis sodalis), gray wolf (Canis lupus), and cougar (Felis concolor). The latter two species have not been sighted in recent years in the St. Lawrence River area. New York also lists one "species of special concern" that has been seen on the St. Lawrence River; this is the small-footed bat (Myotis leibii).

Index Species

BEAVER (Castor canadensis)

Habitat Requirements

Water Requirements: The beaver is an aquatic rodent which occurs in streams, ponds, and the margins of large lakes. One of the main determining factors for suitable beaver habitat is the presence of a stable aquatic habitat providing adequate water (Williams 1965). This suitable aquatic habitat must be provided year-round, as beavers are active throughout the year and the adults are nonmigratory (Allen 1982). Beavers will only occupy streams which have channel gradients less than 15 percent (Retzer, et al. 1956).

Lodges or burrows, or both, serve as the beaver's major source of escape, resting, thermal, and reproductive cover (Jenkins and Busher 1979). Water surrounding the lodge helps protect the lodge from predators and provides concealment for the beaver's movements to and from food gathering areas and caches (Allen 1982).

An adequate and accessible supply of quality food species must be present for the establishment of a beaver colony (Slough and Sadlier 1977). If suitable water access to food supplies is not present, then beavers will channelize and

Table 56. Occurrence and relative abundance[1] of certain indicator mammal species in shoreline habitats along the St. Lawrence River.*

Species	Pre-Seaway (prior to 1959)	Post-Seaway[2] (1959-1968)	Present (1969-1983)
Muskrat	Abundant	- -	Abundant
Beaver	Rare	- -	Common
River otter	Rare	- -	Rare
Raccoon	Common	- -	Abundant

[1]Based on trapping records and studies, tracking, visual observations, roadkill surveys, interviews, and various other information presented in the literature; rare < common < abundant.

[2]Literature regarding the occurrence and relative abundance of the indicator species within the project area during the post-Seaway period is lacking.

*Geis 1977; Institute of Environmental Program Affairs 1978; Lackey 1976; N.Y. State Dept. of Environmental Conservation 1978; US Fish and Wildlife Service 1976a, 1976b, 1976e, 1979; Van Druff and Lomolino 1978a, 1978b; Van Druff and Wright 1976; Webb, Bart, and Komarek 1972; Werner 1956; Wright 1978.

dam waterways to provide aquatic access to, and transportation of, food materials.

Food Requirements: The beaver's diet is strictly vegetarian. Strong preferences are shown for certain plant species and size classes (Jenkins 1975; 1979; Collins 1976). Beavers eat the leaves, twigs, and bark of woody plants, as well as many species of aquatic and terrestrial herbaceous vegetation (Allen 1982). Martin, et al. (1961) list woody plant beaver foods for the Northeast as: poplar [including aspen (Populus spp.)], willow (Salix spp.), beech (Betula spp.), hazelnut (Corylus spp.), serviceberry (Amelanchier spp.), maple (Acer spp.), alder (Alnus spp.), and ash (Fraxinus spp.). An important source of winter food may be the rhizomes and roots of aquatic vegetation (Longley and Moyle 1963; Allen 1982). If it is available, beavers appear to prefer herbaceous vegetation over woody vegetation during all seasons (Jenkins 1981). Such aquatic vegetation as duck potato (Sagittaria spp.), duckweed (Lemna spp.), pondweed (Potamogeton spp.), and water weed (Elodea spp.) are preferred foods when available (Collins 1976). The waterlily (Nymphaea spp.) and cowlily (Nuphar spp.) are listed by Martin, et al. (1961) as foods used by beavers in the Northeast.

Changes in Abundance

The beaver was considered "rare" prior to Seaway construction (Table 56). No literature is available on the beaver for the immediate post-Seaway period. Recent literature has listed the beaver as "common".

This species was chosen as an index species because it is vulnerable to changing water levels and is dependent on the water supply for its existence. Most mammals found along the St. Lawrence River are not dependent on the River itself, a fact which limits the number of species available as reliable index species.

Very little information on the beaver in the St. Lawrence River is available in the literature. Due to the lack of information, it is difficult to determine what has caused the recent increase in beaver populations along the River, and what effects future alterations to the habitat may have on the beaver.

MUSKRAT (Ondatra zibethicus)

Habitat Requirements

Water requirements: Muskrats are semiaquatic rodents which inhabit heavy growths of herbaceous vegetation near slow-running water, swamps, marshes, and bogs, and along shores of creeks, canals, ponds, and lakes that have no large or sudden fluctuations in depth (Godin 1977). The muskrat may either dig a den in a bank or, when the banks are too low and shallow for a den, build a house with aquatic plants in approximately 2 feet of water (Godin 1977). One or more feeding huts or shelter huts, called "feeders", are constructed by the muskrats at a distance around their house. These feeders are roofed feeding platforms made of aquatic plants where the muskrat can bring food to eat and be protected from predators and the elements (Godin 1977). "Push-ups" are constructed in winter by muskrats cutting a hole through ice on a marsh and pushing up a pile of fine fibrous roots or other vegetation. This pile of debris, forming an enclosed cavity, rests on top of the ice and serves as a rest site and/or feeding area in severe weather (Chapman and Feldhamer 1982).

The normal muskrat home range is within 200 yards of their house or den (Errington and Errington 1937) and tends to be more or less circular toward the center of marshes and "strip-shaped" along banks, extending out from bank burrows several hundred feet into deeper water (Errington 1937).

Proper water levels are extremely important for good muskrat habitat. Changing water levels have been found to: (1) be more important than the type of marsh vegetation in determining muskrat population levels in the Illinois River valley (Bellrose and Brown 1941); (2) be the principal factor limiting muskrat populations in the marshes of Currituck Sound, North Carolina (Wilson 1949); (3) adversely affect muskrat populations in Illinois marshes (Bellrose 1950); and (4) prevent the establishment of muskrat food plants in certain areas of Louisiana (Moody 1950).

Food requirements: Chiefly herbivorous, muskrats feed mainly on cattails (Typha spp.), arrowhead or duck potato (Sagittaria spp.), bur-reed (Sparganium spp.), bulrushes (Scirpus spp.), pondweed (Potamogeton spp.), swamp loosestrife (Decodon verticillatus), duckweed (Lemna spp.), pickerelweed (Pontederia cordata), and water lilies (Nuphar spp. and Nymphaea spp.). Occasionally, they also feed on smartweed (Polygonum spp.), dandelion roots (Taraxacum officinale), and various other tender and succulent plants (Godin 1977). Godin (1977) reports that muskrats also eat corn, clover, alfalfa, soybeans, carrots, apples and other fruits, insects, crayfish, freshwater clams, snails, mussels, frogs, reptiles, young turtles, minnows, sluggish fish such as bullheads, and young birds and carrion.

The muskrat does not store large quantities of food (Smith 1938; Errington 1941; Schwartz and Schwartz 1959); therefore, during the winter, food is often restricted to underground plant parts or to what can be reached under ice (Fuller 1951; Dozier 1953). Although largely vegetarians, in certain habitats or seasons, especially winter, muskrats may rely upon animal food (Lantz 1910; Bailey 1937). Sather (1958) suggested that utilization of animal matter may result from a shortage of preferred vegetation.

Changes in Abundance

Prior to Seaway construction, biological surveys recorded the muskrat as "abundant" (Table 56). Although no literature is available for the immediate post-Seaway period, recent literature has indicated that the muskrat is still "abundant".

The muskrat was chosen as an index species for a variety of reasons. It is dependent on the River for most of its habitat requirements. The muskrat is abundant, is very sensitive to water level change, and is important economically as a furbearer.

The muskrat populations along the St. Lawrence have remained relatively unchanged. The formation of Lake St. Lawrence flooded some muskrat habitat while creating additional habitat. In general, there is probably a similar amount of habitat available now as there was prior to the Seaway, not including that which was lost to other development. Since muskrats are very susceptible to changing water levels, any activities which could alter the hydrology could have deleterious effects on the muskrat population.

RACCOON (Procyon lotor)

Habitat Requirements

Water Requirements: Raccoons prefer fairly open mature hardwood areas with hollow trees near streams, rivers, ponds, and lakes (Godin 1977). Within their range, raccoons are found almost everywhere that water is available. Raccoons are most abundant in hardwood swamps, mangroves, floodplain forests, and fresh and salt marshes (Chapman and Feldhamer 1982). Denning generally occurs in hollow trees located near water. In four studies the average distance of den trees to water was 67 to 140 m, with maximum distances of 180 to 800 m (Giles 1942; Stuewer 1943; Cabalka, et al. 1953; Schneider, et al. 1971). While the female usually keeps her cubs in a hollow tree for approximately their first 50 to 60 days, she will then move them to a ground bed, which most often will be in a wetland area (Godin 1977).

Home ranges for raccoons are reported to vary greatly in size due to differences in sex, age, population levels, habitat quality, season, length of study, and methods of obtaining and analyzing data (Chapman and Feldhamer 1982). Johnson (1970) indicated that raccoons restrict most of their short-term movements to relatively small, shifting areas within a larger area of general familiarity. In fact, some portions of the larger area, especially those away from watercourses, are visited rarely, if at all. Schneider, et al. (1971) tracked raccoons which, within any two-week period, visited all portions of their seasonal home ranges, but spent more time in marshes, swamps, and oak woods than in bogs and open fields.

Food Requirements: Raccoons are opportunistic omnivores. Scats and stomach analyses show the use of hundreds of species of plant and animal food. While the relative proportion of different foods varies with season and locality, in most habitats, plants are generally more important than animals in the raccoon's diet (Chapman and Feldhamer 1982). Only in the spring do raccoons consume more animal than plant food. Crayfish are the most important food at this time, followed by insects and small vertebrates (Stuewer 1943; Baker, et al. 1945; Llewellyn and Uhler 1952; Dorney 1954). Martin, et al. (1961) list the primary raccoon plant foods in the Northeast as: corn and the fruits and nuts of oak (*Quercus* spp.), persimmon (*Diospyros virginiana*), pokeweed (*Phytolacca* spp.), grape (*Vitis* spp.), beech (*Fagus grandifolia*), hazelnut (*Corylus* spp.), holly (*Ilex* spp.), pawpaw (*Asimina* spp.), greenbrier (*Smilax* spp.), hackberry (*Celtis* spp.), and hickory (*Carya* spp.). Animals eaten include crayfish, frogs, turtles, snails, fish, snakes, earthworms, grasshoppers, crickets, bees, wasps, moths, small birds and their eggs, shrews, mice, muskrats, squirrels, carrion, and garbage (Godin 1977).

Changes in Abundance

Raccoons were considered "common" prior to Seaway construction (Table 56). Recent literature lists them as "abundant". There are no literature references during the post-Seaway period.

Raccoons were chosen as an index species because they are abundant and dependent on the water supply. The lack of literature on the raccoons of the St. Lawrence River makes it impossible to relate population changes with habitat changes. The formation of Lake St. Lawrence probably had little long-term impact on the quantity and quality of raccoon habitat along the River.

RIVER OTTER (Lutra canadensis)

Habitat Requirements

Water Requirements: The semiaquatic river otter occurs along streams, sloughs, swamps, rivers, and lakes, and not infrequently near brackish water (Godin 1977).

Northern river otters are generally most abundant along food-rich coastal areas, such as the lower portions of streams and rivers and in estuaries, and in areas having extensive nonpolluted waterways and minimal impact by humans (Wilson 1959; Tabor and Wight 1977; Mowbray, et al. 1979).

The permanent den of the otter is often dug into banks and has underwater and exposed entrances. The otter also uses resting places under roots or overhangs, in hollow logs, burrows of other animals, or in thickets near water. Abandoned beaver lodges or bank dens or enlarged muskrat houses may also serve as river otter dens (Whitaker 1980; Godin 1977).

Great travelers, river otters have been known to wander 100 miles or more seeking new territory. However, during the warmer seasons otters tend to remain near water and constantly move up and down the waterway shores, often crossing from one stream to another in search of easy food sources. In winter they may search out entrances to water for fishing by traveling many miles along shores and overland (Godin 1977).

River otter copulation normally occurs in the water (Liers 1951; McDaniel 1963), but may also occur on land.

Food Requirements: The majority of the river otter's diet is fish, with crustaceans (primarily crayfish), amphibians, insects, birds, and mammals comprising lesser portions (Chapman and Feldhamer 1982). Studies have indicated that otters prey on fish in direct proportion to their availability (i.e., occurrence and density) and in inverse proportion to their swimming ability (Ryder 1955; Erlinge 1968; Toweill 1974). In other words, otters do not select a particular species of fish when hunting, but simply capture the first fish they encounter that is not able to escape capture efforts (Chapman and Feldhamer 1982). Fish species which tend to be captured by river otters include: suckers (Catostomus spp.), redhorses (Moxostoma spp.), carp (Cyprinus carpio), chubs (Semotilus spp.), daces (Rhinichthys spp.), shiners (Notropis spp.), squawfishes (Ptychocheilus spp.), bullheads and catfishes (Ictalurus spp.), sunfishes (Lepomis spp.), darters (Etheostoma spp.), perches (Perca spp.), mudminnows (Umbra limi), and sculpins (Cottus spp.) (Lagler and Ostenson 1942; Wilson 1954; Greer 1955; Ryder 1955; Hamilton 1961; Sheldon and Toll 1964; Knudsen and Hale 1968; Field 1970; Toweill 1974; and Lauhachinda 1978).

Changes in Abundance

River otters were considered "rare" in early surveys conducted along the St. Lawrence River, and were still considered "rare" in recent surveys (Table 56). No information is available for the post-Seaway time frame. The otter is probably rare because of the human disturbance along the River.

AMPHIBIANS

IX. AMPHIBIANS

Historical Trends

Amphibians as a group have not been extensively studied. Few surveys have been conducted along the St. Lawrence River, and most of these have consisted of general observations of species presence or absence. A total of 20 species - ten salamanders and ten frogs and toads - have been recorded in the literature (see Table 57 in Appendix A).

Six species were chosen as indicator species (Table 58). These included three salamanders - the red-spotted newt (Notophthalmus viridescens), blue-spotted salamander (Ambystoma laterale), and red-backed salamander (Plethodon cinereus) - and three frogs - the bullfrog (Rana catesbeiana), green frog (Rana clamitans melanota), and northern leopard frog (Rana pipiens). The blue-spotted salamander is listed as a "species of special concern" by the New York State Department of Environmental Conservation (Table 42). They also list another amphibian species found on the St. Lawrence River, the spotted salamander (Ambystoma maculatum), as a "species of special concern". "Species of special concern" are those which may soon become threatened and are listed to enhance public awareness of their condition.

The index species were chosen to reflect the different habitat needs of amphibians along the River. Three of these species are listed as "abundant", one as "common", and two as "rare". Based on the limited literature available, it appears that the populations of these six species were relatively unchanged between the pre-Seaway and present time periods. Although amphibian habitat was definitely altered by the creation of the locks and the formation of Lake St. Lawrence, there are no data available to relate population changes to Seaway construction.

Index Species

RED-SPOTTED NEWT (Notophthalmus viridescens viridescens)

Habitat Requirements

Water Requirements: The most frequent habitats for the adult red-spotted newt include ponds, small lakes, marshes, ditches, quiet portions of streams, or other shallow permanent or semipermanent bodies of unpolluted water. Adults may be seen resting motionless or swimming about slowly in open water or crawling on the bottom or through vegetation. Often they remain active all winter and may be observed through the ice (Conant 1975).

The red-spotted newt mates in water in the early spring. The female lays her eggs singly, usually fastening them to a leaf or the stem of a small plant, in quiet water (Goin and Goin 1971). Eggs will hatch in 20 to 35 days; the gilled larvae that emerge are aquatic (Klots 1966). Following a larval period of two or three months (Goin and Goin 1971), the larvae lose their gills, metamorphose, and move up into the moist woodlands for two to three years; there they are known as subadults, or red efts (Klots 1966). The eft later returns to the water and changes into the aquatic adult. Sometimes the eft stage is omitted and the larvae metamorphose directly into adults, in which case remnants of the external gills may be retained (Conant 1975).

Table 58. Occurrence and relative abundance[1] of certain indicator amphibian and reptile species in shoreline habitats along the St. Lawrence River.*

Species	Pre-Seaway (Prior to 1959)	Post-Seaway[2] (1959-1968)	Present (1969-1983)
AMPHIBIANS			
Salamanders			
Red-spotted newt	Rare	- -	Rare
Blue-spotted salamander	Rare	- -	Rare
Red-backed salamander	Abundant	- -	Abundant
Frogs			
Bullfrog	Common	- -	Common
Green frog	Abundant	- -	Abundant
Northern leopard frog	Abundant	- -	Abundant
REPTILES			
Turtles			
Midland painted turtle	Abundant	- -	Abundant
Common snapping turtle	Common	- -	Common
Blanding's turtle	Rare	- -	Rare
Snakes			
Eastern garter snake	Abundant	- -	Abundant
Northern water snake	Abundant	- -	Abundant
Northern ribbon snake	Rare	- -	Rare

[1]Based on visual observations, trapping records and studies, collections, auditory identification, call counts, and various other information presented in the literature; rare < common < abundant.

[2]Literature regarding the occurrence and relative abundance of the indicator species within the project area during the post-Seaway period is lacking.

*Alexander 1976, 1978; Geis 1977; N.Y. State Dept. of Environmental Conservation 1978; Petokas 1979, 1981; Petokas and Alexander 1978, 1979a, 1979b, 1980a, 1980b, 1980c, 1981; Petokas and Gawlik 1982a, 1982b; US Fish and Wildlife Service 1976a, 1976b, 1976e, 1979; Webb, Bart, and Komarek 1972; Werner 1959.

Food Requirements: Newts feed on insects, leeches, worms, molluscs, crustaceans, tadpoles, and frogs' eggs (Klots 1966).

Changes in Abundance

The red-spotted newt is "rare" along the St. Lawrence River (Table 58). It was also reported as being "rare" during the pre-Seaway time period. No information exists for the post-Seaway time frame. The newt generally prefers smaller, quieter water bodies. The impact of the Seaway on red-spotted newts is unknown.

BLUE-SPOTTED SALAMANDER (Ambystoma laterale)

Habitat Requirements

Water Requirements: The adult blue-spotted salamander is terrestrial, spending most of its life underground (Conant 1975). However, in early spring the adults migrate to small ponds, ditches, etc., to breed. The female attaches her eggs to slender twigs or other objects below the surface in quiet pools (Goin and Goin 1971). After 30 to 45 days, the eggs hatch into aquatic larvae. Metamorphosis into the adult terrestrial form usually occurs two to four months after hatching (Goin and Goin 1971).

Food Requirements: Alexander (1976) reports that blue-spotted salamanders feed on insects, earthworms, millipedes, and spiders.

Changes in Abundance

The blue-spotted salamander is considered "rare" along the St. Lawrence River (Table 58). Early surveys also considered it "rare". No information exists for the post-Seaway time frame. This species is presently listed by the New York State Department of Environmental Conservation as a "species of special concern" (Table 42) indicating that it may be approaching "threatened" status. Suitable habitat for the blue-spotted salamander is generally lacking along the St. Lawrence. The lack of information on the population of blue-spotted salamanders along the River precludes any determination of impacts from the habitat changes.

RED-BACKED SALAMANDER (Plethodon cinereus cinereus)

Habitat Requirements

Water Requirements: The red-backed salamander is a terrestrial salamander, and is found under logs, rocks, etc., in damp woodlands (Alexander 1976). These salamanders either aestivate or seek optimum conditions of moisture in rock crevices or below the surface of the ground during hot, dry weather. When it is damp or rainy, the red-backed salamander prowls at night. They seek shelter during the day in burrows, under stones, under damp boards, etc., where there is little danger of dessiccation (Conant 1975).

Eggs are laid in small clusters in damp logs, moss, etc. (Conant 1975). The embryos develop rapidly and soon show large, well developed, external gills. These gills are lost at hatching and the young have the same form as the adults. There is no aquatic larval stage (Goin and Goin 1971).

Food Requirements: The red-backed salamander has been known to feed on insects, worms, snails, slugs, and spiders (Conant 1975; Alexander 1976).

Changes in Abundance

The red-backed salamander is considered to be "abundant" along the St. Lawrence River (Table 58). It was also "abundant" during the pre-Seaway time period. No information exists for the post-Seaway period. The red-backed is the most common salamander along the River. No data exists to determine the impacts of habitat changes upon the salamander.

BULLFROG (Rana catesbeiana)

Habitat Requirements

Water Requirements: The bullfrog is aquatic and prefers larger bodies of water than most other species of frogs. Bullfrogs inhabit lakes, ponds, bogs, sluggish portions of streams, cattle tanks, etc. They are usually seen at water's edge or amidst vegetation or snags where they can hide (Conant 1975). Bullfrogs prefer large ponds or lakes with both deep and shallow water, where the water is screened from the shore by willow, alder, and other water-loving plants (Dickerson 1969).

Eggs are laid in large masses, sometimes free in the water, but more often they are attached to vegetation or other objects (Dickerson 1969). Depending upon the temperature, the eggs may hatch in anywhere from three days to two weeks (Klotz 1966). These aquatic larvae are known as tadpoles. Bullfrog tadpoles do not develop into frogs during the first season. In fact, it is not until the second season, and sometimes the third, that the tadpole makes its final transformation (Dickerson 1969).

Food Requirements: Bullfrog tadpoles are essentially herbivorous, scraping algae off rocks and nibbling on vegetation (Klots 1966). Dickerson (1969) reports that the tadpole is also carnivorous, acting as a scavenger and disposing of dead fish and dead tadpoles. The adult bullfrog feeds on insects, fish, small turtles, young birds, ducklings and other frogs (Klots 1966; Dickerson 1969; Alexander 1976).

Changes in Abundance

The bullfrog is considered "common" in the St. Lawrence River (Table 58). It was also considered "common" prior to Seaway development. No information is available regarding the post-Seaway period. Since excessive turbidity is harmful to the frog's eggs (USFWS 1979), dredging in breeding areas could have short-term impacts on the bullfrog population.

GREEN FROG (Rana clamitans melanota)

Habitat Requirements

Water Requirements: The aquatic green frog may be found wherever there is shallow freshwater - in marshes, springs, rills, creeks, and ditches, and along the edges of lakes and ponds (Conant 1975; Alexander 1976). The female lays her eggs in a large mass usually fastened to a twig or other support. These egg clusters are often laid during times of high water (Dickerson 1969). Placed just below the surface of the pond and attached to the twigs of buttonbush, alder, or other shrubs that are growing in the water, they are kept some distance above the surface when the water recedes (Dickerson 1969). Early development of the eggs is rapid. The aquatic tadpole which emerges may live two years before the final metamorphosis. It is not until the second summer, and possibly not until the third, that the transformation into the adult frog form occurs (Dickerson 1969).

Food Requirements: Food for the green frog includes insects, crustaceans, spiders, earthworms, and snails (Alexander 1976).

Changes in Abundance

The green frog was considered "abundant" during the pre-Seaway time frame, and is still considered "abundant" today (Table 58). No information is available for the post-Seaway period. The lack of data makes it difficult to assess the impacts of the habitat changes upon green frog populations. However, it is doubtful that these changes had any long-term adverse impacts upon the green frog population, since they are still relatively abundant.

NORTHERN LEOPARD FROG (Rana pipiens)

Habitat Requirements

Water Requirements: The shallow margins of ponds, lakes, streams, and marshes provide habitat for the northern leopard frog (Alexander 1976; Dickerson 1969). The leopard frog may also wander a considerable distance from water into fields, orchards, etc. (Dickerson 1969), earning itself the name "meadow frog" (Conant 1975).

Eggs are laid in masses in the shallow water, either attached to sticks and grasses or left free in the water. The eggs hatch into aquatic tadpoles in approximately ten days (Dickerson 1969). In two to three months, the tadpoles complete their transformation into adult frogs (Alexander 1976).

Food Requirements: Alexander (1976) and Dickerson (1969) report that the diet of the Northern leopard frog includes insects, spiders, slugs, snails, and worms.

Changes in Abundance

The northern leopard frog was "abundant" during the pre-Seaway period and is still "abundant" (Table 58). No information exists regarding the post-Seaway time period. Although data is scarce regarding leopard frog populations along the St. Lawrence River, it is doubtful that the habitat changes had any long-term adverse impacts, since this species is still relatively abundant.

REPTILES

X. REPTILES

Historical Trends

As was the case with amphibians, reptiles as a group have not been extensively studied on the St. Lawrence River. Most of the studies have been general observations indicating presence or absence of various species. A total of 18 species of reptiles, including eight turtles, nine snakes, and a skink, have been reported along the St. Lawrence River (see Table 57 in Appendix A).

Six species have been chosen as indicator species. These are midland painted turtle (*Chrysemys picta* X *marginata*), common snapping turtle (*Chelydra serpentina serpentina*), Blanding's turtle (*Emydoidea blandingi*), eastern garter snake (*Thamnophis sirtalis sirtalis*), northern water snake (*Nerodia sipedon sipedon*), and northern ribbon snake (*Thamnophis sauritus sauritus*) (Table 58). These species were chosen to reflect the different habitat needs of reptiles along the River. Of these species, only the Blanding's turtle is listed as "threatened" by the New York State Department of Environmental Conservation (Table 42). They also list the wood turtle (*Clemmys insculpta*) as a "species of special concern".

As with the amphibians, three of the index species are considered "abundant", two "rare", and one "common". None of the index species changed in relative abundance between the pre-Seaway period and the present.

The construction of the Seaway and Power Project altered reptilian habitat. The locks area, with its fluctuating water levels and turbidity, is especially poor reptile habitat, particularly for breeding. However, the index species have not shown a decline, and the scarcity of data precludes the determination of any cause and effect relationships between the changes in habitat and changes in the reptile populations.

Index Species

MIDLAND PAINTED TURTLE (*Chrysemys picta marginata*)

Habitat Requirements

Water Requirements: The midland painted turtle lives mainly where the water is shallow, the aquatic vegetation profuse, and the bottom soft and muddy. It is found in ponds, marshes, ditches, edges of lakes, backwaters of streams, and in adjacent wet areas (Conant 1975; Alexander 1976). Midland painted turtles are very aquatic, mainly leaving water only to lay eggs, although they do bask on floating logs and vegetation (Reilly N.D.). The female lays five to eight eggs in the soil (Alexander 1976).

Food Requirements: The diet of the omnivorous midland painted turtle includes aquatic vegetation, insects, crayfish, earthworms, and small mollusks (Conant 1975; Alexander 1976). It generally swallows its food under water (Reilly N.D.).

Changes in Abundance

The midland painted turtle is considered "abundant" along the St. Lawrence River (Table 58). It was apparently also "abundant" during the pre-Seaway time frame. No information exists for the post-Seaway time period. Although little specific data exist to describe the painted turtle populations, it can be assumed that these populations are relatively stable. Their favored habitat is still common along the River.

COMMON SNAPPING TURTLE (*Chelydra serpentina serpentina*)

Habitat Requirements

Water Requirements: Any permanent body of fresh water, large or small, including lakes, ponds, rivers, and deep marshes, may provide habitat for the common snapping turtle (Conant 1975; Alexander 1976). Very aquatic, the snapping turtle rarely basks as most other turtles do. Snappers often bury themselves in mud in shallow water with only their eyes showing (Conant 1975). Burying itself in mud or into the banks of ponds, streams, etc., the snapping turtle hibernates from early November to early March (Reilly N.D.).

The common snapping turtle leaves the water only to lay eggs. Approximately 30 eggs are laid per nest in soil or in a muskrat house (Alexander 1976). The eggs are usually laid in June, but nesting has been reported from May to October. Soil nests are dug at various distances from the water, their sites apparently determined not only by the soil nature, but also by the whim of the female (Goin and Goin 1971). Eggs hatch in the fall or the next spring, and the young quickly return to the water (Alexander 1976).

Food Requirements: Food for the omnivorous common snapping turtle includes aquatic invertebrates, fish, reptiles, birds, mammals, and carrion (Conant 1976). It generally swallows its food underwater.

Changes in Abundance

The snapping turtle is "common" along the St. Lawrence River today and was also "common" in pre-Seaway times (Table 58). No information exists for the post-Seaway time period. However, they are fairly adaptable and adequate habitat for this species exists along the River. Therefore, the population appears to be stable.

BLANDING'S TURTLE (*Emydoidea blandingi*)

Habitat Requirements

Water Requirements: Essentially aquatic, the Blanding's turtle often wanders about on land, although seldom far from marshes, bogs, lakes, or small streams (Conant 1975). This turtle hibernates in mud or under trash (Reilly N.D.). Five to ten eggs are laid in soil (Alexander 1976).

Food Requirements: Alexander (1976) lists the food of the Blanding's turtle as succulent vegetation, berries, earthworms, slugs, insects, crayfish, and carrion. Reilly (N.D.) states that Blanding's turtle is omnivorous, mainly feeding on invertebrates in the aquatic habitat, and on vegetation on land.

Changes in Abundance

The Blanding's turtle is listed as "threatened" by the New York State Department of Environmental Conservation (Table 42). "Threatened" species are "those whose populations in New York are subject to a significant threat from known or unknown causes, but which face little danger of extirpation within the foreseeable future if certain actions are taken and maintained" (USFWS 1979). This species was considered "rare" along the St. Lawrence River during early surveys, and is still listed as "rare" (Table 58). No information exists for the post-Seaway time period.

The St. Lawrence area represents the eastern limits of the Blanding's turtle's range (USFWS 1979). Because of this, the stability of the population is uncertain, and future habitat changes may adversely affect this population.

EASTERN GARTER SNAKE (*Thamnophis sirtalis sirtalis*)

Habitat Requirements

Water Requirements: The eastern garter snake occupies a wide variety of habitats including meadows, marshes, woodlands, hillsides, along streams and drainage ditches, and sometimes city lots, parks, and cemeteries (Conant 1975). Although terrestrial, the garter snake will often go into the water, swimming with lateral undulations of the body while holding the head above the surface, and occasionally diving beneath (Klots 1966).

Ovoviviparous, the eggs of the eastern garter snake will hatch, either in the oviduct or just after they are laid, producing 15 to 40 young (Alexander 1976).

Food Requirements: Foods of the eastern garter snake consist chiefly of frogs, toads, salamanders, fish, tadpoles, and earthworms, but other items eaten include leeches, small mammals, birds, and carrion (Conant 1975; Alexander 1976).

Changes in Abundance

The garter snake was the most common reptile found in the locks area during a 1979 survey (USFWS 1979). It is listed as "abundant" along the St. Lawrence River, and was also considered "abundant" during pre-Seaway times (Table 58). No information exists for the post-Seaway period. The abundance of this species is probably due to the wide variety of habitats that it can occupy.

The garter snake may have increased in abundance in recent years. The abundant old field and shrubland habitat created near Massena during Seaway construction provides nearly ideal habitat conditions for the garter snake (USFWS 1979). No data exist to quantify this observation, however.

NORTHERN WATER SNAKE (Natrix sipedon sipedon)

Habitat Requirements

Water Requirements: The semiaquatic northern water snake is found in or near water in virtually every non-polluted swamp, marsh, bog, stream, pond, or lake border within its range (Conant 1975; Alexander 1976). Quiet waters are preferred, but water snakes will also inhabit swift-flowing streams (Conant 1975). They often sun themselves on rocks, docks, and along banks (Alexander 1976; Klots 1966).

Mating of the northern water snake occurs in early spring and the young are born from late summer to early fall. The water snake is ovoviviparous. The average brood size ranges from 16 to 40, but much larger (more than 75 young) broods have been recorded (Goin and Goin 1971).

Food Requirements: Conant (1975) reports that the northern water snake obtains most of its food, including frogs, salamanders, fish, and crayfish, in or near the water. Alexander (1976) reports that the water snake's diet also includes insects and small mammals.

Changes in Abundance

The water snake is another species that was considered to be "abundant" in both early surveys and recent literature (Table 58). No information is available for the post-Seaway period.

Although data are scarce, it appears that the water snake population suffered no long-term impacts from habitat changes. This species is very adaptable and occupies a wide variety of aquatic habitats.

NORTHERN RIBBON SNAKE (Thamnophis sauritus septentrionalis)

Habitat Requirements

Water Requirements: The semiaquatic northern ribbon snake seldom wanders far from streams, ponds, bogs, or swamps. Ribbon snakes swim at the surface instead of diving. Deep water is normally avoided by ribbon snakes, and, when fleeing, they will skirt the shore, threading their way through the vegetation (Conant 1975).

Alexander (1976) lists the northern ribbon snake as ovoviviparous. The eggs will hatch either in the oviduct or just after they are laid, producing 5 to 15 young.

Food Requirements: The diet of the northern ribbon snake includes salamanders, frogs, and small fish (Conant 1975; Alexander 1976). Unlike other garter snakes, ribbon snakes will usually not eat earthworms (Conant 1975).

Changes in Abundance

The ribbon snake was "rare" prior to Seaway construction, and is still considered "rare" (Table 58). No information exists for the post-Seaway time period. Although data are scarce, it appears that the habitat changes caused by the Seaway may have reduced ribbon snake habitat. This species normally avoids deep water, a habitat type which increased greatly during the formation of Lake St. Lawrence. In addition, many of the small tributary streams were flooded in their lower reaches, reducing the quality of the ribbon snake habitat.

COMPARISONS AND CONTRASTS WITH OTHER CONNECTING CHANNELS

XI. COMPARISONS AND CONTRASTS WITH OTHER CONNECTING CHANNELS

The St. Lawrence River is one of the "connecting waterways" of the Great Lakes. The others are the Niagara River/Welland Canal, the Detroit River, the St. Clair River and the St. Marys River. The St. Lawrence and the St. Marys Rivers are geologically and biologically more similar than the other connecting waterways. The St. Clair River - Lake St. Clair - Detroit River complex has a more gentle gradient, more shallow water/mud flats and wetlands (St. Clair flats) than the others. The Niagara River/Welland Canal complex is different from the St. Lawrence in that the Welland Canal is used for navigation, while the Niagara River is used for hydropower production. The upper Niagara River ecology is influenced greatly by Lake Erie, while the lower Niagara is influenced by, and influences, Lake Ontario.

Industrial and shoreline development is relatively light (spotty) on the St. Lawrence and St. Marys Rivers. The U.S. side of the St. Clair and Detroit Rivers is highly developed. Portions of the Niagara River shoreline (upper) are also highly developed, although other areas have moderate development.

The impact of shoreline development and river channel modification on fish and wildlife resources of the St. Lawrence area has not been studied extensively, as documented in this report. Generally, the system-wide studies which have been completed were concerned with winter navigation. More work has been done in the area of system-wide studies for the St. Marys River. Some of the impact analysis is contained in the reports by Behmer, et al. (1979), Hiltunen and Schloesser (1984), and Koshinsky and Edwards (1983). These reports provide needed detailed background data against which proposed or caused changes could be measured.

Although each of the connecting waterways has its distinctive physical (Eda and DeBord 1981) and biological characteristics, some information seems to be transferable. For example, Schloesser and Manny (1982) reported that a statistically valid correlation was found between the density of submersed macrophyte beds and the degree of exposure of the beds to vessel passage in the St. Clair-Detroit River waterway. They also indicated that further research was needed to demonstrate that vessel movements reduce the density of macrophyte beds and expressed concern that larger vessels would cause potentially greater reductions in plant bed density and that the density of submersed macrophyte beds was directly related to their value as fish habitat.

Navigation and related channel changes also appear to impact fish abundance. Comparisons of fish abundance in a navigation area (Lake Nicolet) and a similar area not used for navigation (Lake George) in the St. Marys River showed consistently lower catches in the navigated area (Liston, et al. 1983). Similar conclusions were also reached by Protasov and Gusar (1982). They also showed a direct relationship of fish abundance decreasing as distance from the shipping lane decreased. The meaning of these findings on present and future fishery management of the St. Lawrence River needs to be evaluated.

INFORMATIONAL NEEDS

XII. INFORMATIONAL NEEDS

This document has presented or summarized the information available on the ecology and hydrology of the St. Lawrence River. Despite the large quantity of information, there are numerous "data gaps" which need to be filled before the ecosystem of the St. Lawrence River is understood. In general, quantitative data is lacking; the qualitative data that is available has minimal utility.

Most of the existing research tried to study all species, rather than concentrating on a few key indicator species. Future efforts should concentrate on selected species which are representative of other species utilizing the resources of the St. Lawrence River. NYSDEC (Wildlife) identified several species as candidates for additional studies (Table 59).

Detritus may be a critical linkage in the ecosystem (Cooley 1978); very little research has been conducted on this component. In addition, more emphasis needs to be given to energy flow and food webs.

Some other major areas where data are generally lacking are exact fish spawning and nursery locations, quantitative benthic data, particularly for areas likely to be dredged or used as disposal sites, and contaminants, particularly those found in sediments in areas likely to be dredged.

A major force in environmental studies is the potential of man-caused development of an area. Such a potential exists for the River. Recently, a list of 18 studies was prepared by the Fish and Wildlife Service for the Corps of Engineers. These studies are needed to identify and quantify potential impacts from proposed new navigational development in the International section of the St. Lawrence River (Table 60). These broad studies identify specific data needs. Other studies would also be needed. For example, studies would be needed to thoroughly understand the ecosystem during winter and to assess any impacts from winter navigation or other winter activities that may be proposed in the future.

Table 59. New York State Department of Environmental Conservation candidate species for additional studies to establish baseline data for use in evaluating navigation project impacts along the St. Lawrence River.

Birds

Common Loon	Killdeer
Pied-billed Grebe	Spotted Sandpiper
American Bittern	Common Tern
Green Heron	Black Tern
Black-crowned Night Heron	Short-eared Owl
Mallard	Tree Swallow
Gadwall	Rough-winged Swallow
American Widgeon	Bank Swallow
Osprey	Cliff Swallow
Bald Eagle	Sedge Wren
Red-shouldered Hawk	Marsh Wren
Peregrine Falcon	Song Sparrow
Virginia Rail	Swamp Sparrow
Common Gallinule	Red-winged Blackbird
American Coot	Common Grackle

Mammals

Raccoon	Muskrat
Mink	Bats (*Myotis* spp.)

Amphibians and Reptiles

Blanding's Turtle	Stinkpot
Spiny Softshell Turtle	Mudpuppy

Table 60 . Studies needed to identify and quantify potential project-caused impacts from navigational improvements to the International section of the St. Lawrence River.

	Title	Explanation
1.	Hydrology and physical limnology of the International section of the St. Lawrence River	Dredging to increase channel size in restricted areas will affect the flow characteristics of the River, could decrease water movement in back waters and bays, and could impact the Lake Ontario outflow. Accurate field information is needed (baseline data) to predict and evaluate project-caused changes.
2.	Erosion patterns of the shoreline, including islands, impacted by changes in the system's hydrology or by increased navigation or through use of large vessels	This study is an extension of #1 into collecting data on shoreline materials (types). This data would then be used with the results from #1 to evaluate changes in erosion and to recommend corrective action when needed.
3.	Evaluation and mapping of sediments with special attention to "hot spots of contaminants" and modeling of sediment relocation caused by dredging	This study would obtain baseline field data. The results would be needed for safe dredging and dredge material disposal. The data would also be used in conjunction with the results from #1 to identify potential relocation of contaminated sediments and sediments in general.
4.	Determination and modeling of movement of contaminants in the water (Complements studies #1, #2 and #3)	This study would focus on contaminants suspended or dissolved in the water. It would seek to identify the passage of these contaminants and also identify the interaction among the various chemicals (synergistic and cumulative) and the impact on fish and wildlife resources.
5.	Distribution, productivity and ecology of macrophyte communities in the International section of the St. Lawrence	Macrophyte abundance and distribution relates directly to the abundance of some fish species. Dredging, changes in the system's hydrology, relocation of contaminants, hazardous substance spills, etc., can directly impact the health of macrophytes.
6.	Distribution, productivity, and ecology of benthic invertebrates in the International section of the St. Lawrence with special concentration on the areas of the river directly impacted by the proposed modifications	Benthic invertebrates are a very important portion of the aquatic food chain. Invertebrates need to be identified and quantified in order to predict short and/or long term changes caused by the project and to predict potential recolonization.

Table 60 . (Continued)

	Title	Explanation
7.	Baseline data on force (strength) of water movement which causes disruption of benthos, and the impact of relocation (drift)	This study is an extension of #6. Increased pressure waves (bow) and propeller wash from either increased navigation or increased vessel size need to be measured and the impact evaluated.
8.	Identification and mapping of important historic, currently used and potential fish spawning sites in the St. Lawrence River	Fish spawning areas (current and potential) can be impacted by dredging, changes in the hydrology (study #1), sedimentation (study #2), contaminants (study #3 and #4), etc.
9.	Distribution, abundance and ecology of larval fish in the St. Lawrence River	This study is an extension of study #8. Larval fish may, for example, hatch in a "protected" spawning area and then move or drift into unsuitable areas (e.g., navigation channel, areas of poor water quality, etc.).
10.	The source, ecological significance and movement of detritus and associated organisms within the St. Lawrence River system	Detritus is a very important component to the food chain (other areas of the Great Lakes). Detritus is easily moved by water currents. This study would compliment studies #1, #2, #3, #5, #6, and #7 and is needed for #9 and #11.
11.	Distribution in relation to preferred habitat and factors affecting abundance and feeding habits (potential impact on food source?) of selected fish species (e.g., walleye, muskellunge, northern pike, smallmouth bass, white sucker, yellow perch, brown bullhead, fathead and bluntnose minnows, golden and spottail shiners, eels, sturgeon and gizzard shad) in the St. Lawrence River	Fish are a good indicator of ecosystem health. Fish are vital to the economy of the region. Project impacts (negative and/or positive) as measured in studies #1 through #10 will impact fish abundance which directly relates to human use values.

Table 60 . (Continued)

Title	Explanation
12. Analysis of habitat requirements and food chain contributions of riverine reptiles and amphibians	These components of the ecosystem and their habitats may be impacted by the project (e.g., change in hydrology, dredging/disposal, vessel passage).
13. Use and importance to selected mammals of project-affected habitat	Mammals may be impacted directly through lost habitat and/or indirectly through changes in the food chains.
14. Use and importance to select resident and migratory birds of project-affected habitat or project-caused ecological changes	Waterfowl and other migratory birds are important to the ecology and economy of the river. Their habitats may be impacted and their food chain could be impacted, thus changing the abundance and/or distribution of the birds.
15. Update past environmental studies concerning the Lock area construction and/or the modification of the Snell and Eisenhower locks	
16. Design of navigational aid platforms for bird nesting	
17. Recreational use such as fishing, boating and swimming in the St. Lawrence River	
18. Identification of dredge disposal sites and potential use of these areas as habitat	

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AD-A147 119 THE SAINT LAWRENCE RIVER--PAST AND PRESENT A REVIEW OF HISTORICAL NATURAL..(U) FISH AND WILDLIFE SERVICE CORTLAND NY P P HAMILTON APR 84 4/7

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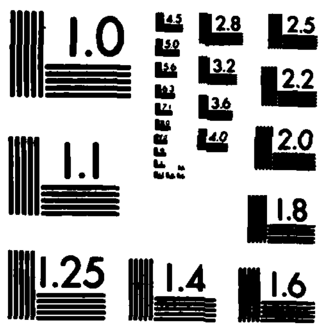
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APPENDIX A.
SPECIES LISTS/LITERATURE REFERENCES

Table 52. Common and scientific names of fish found in the St. Lawrence River. Literature references pertaining to abundance, habitat requirements, age and growth, early life history, and food habits of each species are noted. (Numbers refer to main bibliography.)

Species		Literature references concerning					
		Abundance					
Common name[1]	Scientific name[1]	General[2]	Specific[2]	Habitat requirements	Age & growth	Early life history	Food habits
Northern brook lamprey	*Ichthyomyzon fossor*	274	-----	113,274,329, 373	329	329	329
Silver lamprey	*Ichthyomyzon unicuspis*	88,89,143, 219,220,274, 336,373	370,373	113,274,329, 373,387	329	329,387	329
American brook lamprey	*Lampetra lamottei*	274	-----	113,274,329, 373	329	329	329
Sea lamprey	*Petromyzon marinus*	88,89,143, 274,336,373	370,373	113,128,129, 274,311,314, 329,373,387	311,329	129,311,314, 329,387	311,314,329
Lake sturgeon	*Acipenser fulvescens*	88,89,143, 149,177,253, 274,297,311, 336,373,388	90,91,161, 177,250	76,77,84,113, 128,129,274, 311,314,329, 333,352,373, 387	311,329	76,77,128, 129,311,314, 329,333.352, 387	311,314,329, 336
Longnose gar	*Lepisosteus osseus*	88,89,143, 218,220,221, 274,296,297, 336,373	91,250,313, 370,373	113,127,128, 129,143,274, 329,373,387	329	127,128,129, 143,329,387	329
Bowfin	*Amia calva*	88,89,143, 149,218,219, 220,274,297, 336,373,376	53,88,89,91, 113,161,203, 224,250,313, 370,373,376	113,128,129, 274,329,350, 373,387	297,329	128,129,329, 350,387	329

Table 52. (continued)

Species		Literature references concerning					
		Abundance					
Common name	Scientific name	General	Specific	Habitat requirements	Age & growth	Early life history	Food habits
American eel	*Anguilla rostrata*	88,89,94, 143,149,218, 219,220,274, 296,297,304, 311,336,373, 376,388	88,89,91, 250,313,370, 373,376	94,113,128, 129,274,311, 314,319,373, 387	311,329	94,128,129, 311,314,329	311,314,329
American shad	*Alosa sapidissima*	88,89,373	-----	113,329,373	329	329	329
Alewife	*Alosa pseudoharengus*	88,89,143, 216,218,219, 220,253,274, 304,336,373, 376	53,88,89, 113,224,268, 313,370,373 387	28,113,128, 129,143,191, 274,311,329, 373,387	219,311,329	28,128,129, 143,191,311, 329,387	113,176,304, 311,329,336
Gizzard shad	*Dorosoma cepedianum*	88,89,218, 219,253,274, 297,304,373, 376	88,89,91, 113,224,250, 268,313,370, 373,376	113,129,274, 329,373,387	219,297,329	129,329,387	329
Mooneye	*Hiodon tergisus*	88,89,143, 274,336,373	113,370	113,128,129, 143,274,329, 373,387	329	128,129,143, 329,387	329,336
Cisco	*Coregonus artedii*	88,89,143, 274,336,373	-----	113,128,129, 274,329,388	329	128,129,329	329
Lake whitefish	*Coregonus clupeaformis*	143,274,336	-----	113,128,129, 274,329	329	128,129,329	329,336
Round whitefish	*Prosopium cylindraceum*	143,274,336	-----	129,274,329	329	129,329	329

Table 52. (continued)

Species		Literature references concerning					
		Abundance					
Common name	Scientific name	General	Specific	Habitat requirements	Age & growth	Early life history	Food habits
Rainbow trout	*Salmo gairdneri*	88,89,143, 274,336,373	370,373	113,129,274, 311,314,329, 336,373,387	311,329	129,311,314, 329,336,387	311,314,329, 336
Atlantic salmon	*Salmo salar*	3,29,143, 274,336	-----	96,113,128, 129,274,329, 373	329	96,128,129, 329	329
Brown trout	*Salmo trutta*	88,89,143, 274,336,373	113	113,129,274, 311,314,329, 373,387	311,329	129,311,314, 329,387	311,314,329, 336
Brook trout	*Salvelinus fontinalis*	143,274,336, 373	-----	113,129,274, 329	329	129,329	329
Lake trout	*Salvelinus namaycush*	143,274,336	-----	113,128,129, 274,311,314, 329,373	311,329	128,129,311, 314,329	311,314,329
Rainbow smelt	*Osmerus mordax*	88,89,143, 221,253,274, 297,311,336, 351,373,388	88,89,90,91, 113,161,250, 268,370	88,89,113, 128,129,191, 246,274,311, 329,373,387	311,329	88,89,128, 129,191,246, 311,329,387	311,329
Central mudminnow	*Umbra limi*	88,89,143, 274,336,373	88,89,203, 313,370,387	113,129,273, 274,329,387	329	129,329,387	329,336
Grass pickerel	*Esox americanus*	88,89,274, 311,373,388	53,313,370	113,129,273, 274,329,387	329	129,329,387	329

Table 52. (continued)

Species		Literature references concerning					
		Abundance					
Common name	Scientific name	General	Specific	Habitat requirements	Age & growth	Early life history	Food habits
Northern pike	*Esox lucius*	88,89,143, 177,178,216, 218,219,220, 221,222,253, 261,274,277, 296,297,304, 311,336,373, 376,388	53,88,89,90, 91,113,161, 203,215,224, 250,268,313, 370,373,376, 387	60,84,91, 107,113,116, 128,129,143, 160,171,203, 218,262,274, 311,314,329, 336,373,387, 388	88,91,92, 160,203,218, 219,250,262, 268,296,297, 311,329	60,91,107, 116,128,129, 143,160,171, 203,262,311, 314,329,336, 373,387,388	88,91,113, 160,203,304, 311,314,329, 336
Muskellunge	*Esox masquinongy*	88,143,177, 218,219,220, 221,222,261, 274,296,297, 311,336,373, 388	90,91,113, 161,224,250, 370,373	113,128,129, 143,262,274, 311,314,329, 387,388	156,262,296, 297,311,329	128,129,143, 150,262,311, 314,329,387	156,296,311, 314,329
Chain pickerel	*Esox niger*	274	-----	113,274,329, 373	329	329	329
Goldfish	*Carassius auratus*	88,89,253	91	113,129,329	329	129,329	329
Redside dace	*Clinostomus elongatus*	-----	-----	113,329,373	329	329	329
Lake chub	*Couesius plumbeus*	143,274,336	-----	113,129,274, 329,373	329	129,329	329,336
Carp	*Cyprinus carpio*	143,149,177, 218,219,220, 221,222,253, 274,296,297, 304,336,344, 373,376,388	53,88,89,90, 91,113,161, 203,224,250, 268,313,370, 373,376,387	84,113,128, 129,143,171, 274,311,314, 329,336,343, 344,373,387	219,296,297, 311,329,336	128,129,143, 171,311,314, 329,336,343, 344,387	311,314,329, 336

Table 52. (continued)

Species		Literature references concerning					
		Abundance					
Common name	Scientific name	General	Specific	Habitat requirements	Age & growth	Early life history	Food habits
Cutlips minnow	*Exoglossum maxillingua*	88,89,143, 274,336,373	370	113,274,329, 387	329	329,387	329,336
Brassy minnow	*Hybognathus hankinsoni*	88,89,143, 274,336,373	88,89	113,274,329, 373,387	329	329,387	329,336
Silvery minnow	*Hybognathus nuchalis*	88,89,274, 373,376	88,89,91, 370,376	113,274,329, 387	329	329,387	329
River chub	*Nocomis micropogon*	274	-----	128,129,152, 274,329	329	128,129,152, 329	329
Golden shiner	*Notemigonus crysoleucus*	88,89,143, 218,219,220, 274,296,297, 304,336,373, 376	53,88,89,90, 91,161,203, 224,250,313, 370,373,376	113,128,129, 143,274,329, 373,387	296,329	128,129,143, 329,373,387	329,336
Pugnose shiner	*Notropis anogenus*	88,89,373, 376	370,376	113,128,129, 329,373,387	329	128,129,329, 373,387	329
Emerald shiner	*Notropis atherinoides*	88,89,143, 274,336,373, 376	88,89,91, 250,370,376	113,129,274, 329,387	329	129,329,387	329,336
Bridle shiner	*Notropis bifrenatus*	88,89,143, 274,336,373, 376	370,376	113,128,129, 152,274,329, 387	329	128,129,152, 329,387	329,336
River shiner	*Notropis blennius*	143,336	-----	329	329	329	329,336
Common shiner	*Notropis cornutus*	88,89,143, 274,336,373 376	113,376	113,128,129, 143,274,329, 387	329	128,129,143, 329,387	329,336

Table 52. (continued)

Species		Literature references concerning					
		Abundance		Habitat		Early life	
Common name	Scientific name	General	Specific	requirements	Age & growth	history	Food habits
Blackchin shiner	*Notropis heterodon*	88,89,143, 219,274,336, 373	370	113,129,274, 329,387	329	129,329,387	329
Blacknose shiner	*Notropis heterolepis*	88,89,143, 274,336,373	88,89	113,129,274, 329	329	129,329	329
Spottail shiner	*Notropis hudsonius*	88,89,143, 219,274,336, 373,376	88,89,90,91, 161,250,313, 370,376,387	91,109,113, 128,129,143, 152,274,311, 329,387	311,329	91,109,128, 129,143,152, 311,329,387	311,329,336
Rosyface shiner	*Notropis rubellus*	88,89,143, 274,336,373, 376	376	113,129,274, 329,387	329	129,329,387	329,336
Spotfin shiner	*Notropis spilopterus*	88,89,143, 274,336,373	88,89,91, 370	113,129,274, 329,387	329	129,329,387	329,336
Sand shiner	*Notropis stramineus*	88,89,143, 274,336,373	88,89,370	113,129,274, 329,387	329	129,329,387	329,336
Mimic shiner	*Notropis volucellus*	88,89,143, 219,274,336, 373	-----	113,129,274, 329	329	129,329	329,336
Northern redbelly dace	*Phoxinus eos*	88,89,143, 274,336	53,88,89	113,129,274, 329,373	329	129,329	329,336
Finescale dace	*Phoxinus neogaeus*	88,89,143, 274,336,373	88,89	113,274,329, 373	329	329	329,336

Table 52. (continued)

Species		Literature references concerning					
		Abundance					
Common name	Scientific name	General	Specific	Habitat requirements	Age & growth	Early life history	Food habits
Bluntnose minnow	*Pimephales notatus*	88,89,143, 219,274,304, 336,373,376	53,88,89,91, 250,370,376	113,128,129, 143,152,274, 329, 387	329	128,129,143, 152,329,387	329,336
Fathead minnow	*Pimephales promelas*	88,89,143, 274,336,373, 376	88,89,203, 370,376,387	113,129,274, 329,387	329	129,329,387	329,336
Blacknose dace	*Rhinichthys atratulus*	143,274,336	-----	113,129,274, 329,373	329	129,329	329,336
Longnose dace	*Rhinichthys cataractae*	88,89,143, 274,336,373	370	113,128,129, 152,274,329, 373,387	329	128,129,152, 329,387	329,336
Creek chub	*Semotilus atromaculatus*	88,89,143, 274,336,373	53,370	113,129,274, 329,373,387	329	129,329,387	329,336
Fallfish	*Semotilus corporalis*	88,89,143, 218,219,253, 274,296,297, 304,336,373, 376	53,88,89,90, 91,113,161, 224,250,268, 370,373,376	113,129,274, 329,373,387	296,329	129,329,387	329,336
Pearl dace	*Semotilus margarita*	143,274,336	-----	113,274,329, 373	329	329	329,336
Quillback	*Carpiodes cyprinus*	88,89,274	91	113,129,274, 329	329	129,329	329
Longnose sucker	*Catostomus catostomus*	88,89,253, 274	268	113,129,274, 329,373	329	129,329	329

Table 52. (continued)

Species		Literature references concerning					
		Abundance		Habitat requirements	Age & growth	Early life history	Food habits
Common name	Scientific name	General	Specific				
White sucker	*Catostomus commersoni*	143,149,177, 216,218,219, 220,253,274, 296,297,304, 336,373,376	53,88,89,90, 91,113,161, 203,224,250, 268,313,370, 373,376,387	29,88,89, 113,128,129, 143,203,274, 329,352,387	296,297,329	29,88,89, 128,129,143, 203,329,352, 387	329,336
Creek chubsucker	*Erimyzon oblongus*	-----	-----	113,129,329	329	129,329	329
Silver redhorse	*Moxostoma anisurum*	88,89,143, 219,253,274, 296,297,304, 336,373	88,89,90,91, 250,268,370, 373	113,128,129, 143,274,329, 387	296,297,329	128,129,143, 329,387	329
River redhorse	*Moxostoma carinatum*	88,89,274	88,89	113,274,329	329	329	329
Black redhorse	*Moxostoma duquesnei*	-----	-----	113,129,329	329	129,329	329
Copper redhorse	*Moxostoma hubbsi*	274	-----	113,274,329	329	329	329
Shorthead redhorse	*Moxostoma macrolepidotum*	88,89,143, 253,273,274, 304,336,376	268,370,373, 376	113,128,129, 143,274,329, 387	329	128,129,143, 329,387	329,336
Greater redhorse	*Moxostoma valenciennesi*	88,89,274, 373,376	90,91,250, 268,370,373, 376	113,128,129, 274,329,352, 387	329	128,129,329, 352,387	329
Black bullhead	*Ictalurus melas*	-----	-----	113,129,329	329	129,329	329
Yellow bullhead	*Ictalurus natalis*	88,89,274	53,91,250, 313	113,129,274, 329	329	129,329	329

Table 52. (continued)

Species		Literature references concerning					
		Abundance					
Common name	Scientific name	General	Specific	Habitat requirements	Age & growth	Early life history	Food habits
Brown bullhead	*Ictalurus nebulosus*	88,89,143, 149,216,218, 219,220,221, 222,253,274, 296,297,304, 311,336,373, 376,388	53,88,89,90, 91,113,161, 203,224,250, 268,313,370, 373,376,387	84,109,113, 128,129,143, 152,203,274, 311,314,329, 373,387,388	296,297,311, 329	109,128,129, 143,152,203, 311,314,329, 373,387	113,176,304, 311,314,329, 336
Channel catfish	*Ictalurus punctatus*	88,89,143, 149,177,221, 274,297,304, 336,373,376	53,91,113, 250,268,370, 373,376	113,128,129, 143,274,329, 353,373,387	297,329	128,129,143, 329,352,387	329
Stonecat	*Noturus flavus*	88,89,143, 253,274,336 373	268	113,128,129, 274,329,373	329	128,129,329	329
Tadpole madtom	*Noturus gyrinus*	88,89,274, 373	53,203,370, 387	113,129,274, 329,387	329	129,329,387	329
Trout-perch	*Percopsis omiscomaycus*	88,89,143, 274,336,373	91,113,161, 250,370	113,129,274, 329,373,387	329	129,329,387	329
Burbot	*Lota lota*	88,89,143, 274,336,373	88,89,91,113	88,89,113, 128,129,246, 274,329	329	88,89,128, 129,246,329	329
Banded killifish	*Fundulus diaphanus*	88,89,143, 219,274,336, 373	53,88,89,90, 91,161,250, 313,370	109,113,128, 129,274,329, 373,387	329	109,128,129, 329,387	329,336
Brook silverside	*Labidesthes sicculus*	88,89,143, 219,274,304, 336,373,376	88,89,91, 250,370,376	113,129,274, 329,373,387	329	129,329,387	329

Table 52. (continued)

Species		Literature references concerning					
		Abundance					
Common name	Scientific name	General	Specific	Habitat requirements	Age & growth	Early life history	Food habits
Brook stickleback	*Culaea inconstans*	88,89,143, 274,336,373	53,88,89,90, 91,161,250, 370	113,129,274, 329,373,387	329	129,329,387	329,336
Threespine stickleback	*Gasterosteus aculeatus*	88,89,143, 274,336,373	91,250,370	113,129,274, 329,387	329	129,329,387	329,336
Ninespine stickleback	*Pungitius pungitius*	274	-----	113,129,274, 329,373	329	129,329	329
White perch	*Morone americana*	88,89,219, 253,274,297, 304,373,376, 388	88,89,90,91, 113,161,250, 268,313,370, 373,376	113,129,274, 311,314,329 387,388	297,311,329	129,311,314, 329,387	113,176,304, 311,314,329
White bass	*Morone chrysops*	88,89,218, 219,220,222, 274,296,297, 373	91,113,224, 250,370,373	113,129,274, 311,329,387, 388	219,296,297, 329	129,329,387	329
Rock bass	*Ambloplites rupestris*	88,89,143, 149,178,216, 218,219,220, 221,222,253, 274,296,297, 304,336,373, 376	53,88,89,90, 91,113,161, 203,224,250, 268,313,370, 373,376,387	113,128,129, 143,152,203, 274,311,314, 329,387,388	218,219,268, 296,297,311, 329	128,129,143, 152,203,311, 314,329,387	113,176,304, 311,314,329
Pumpkinseed	*Lepomis gibbosus*	88,89,143, 149,216,218, 219,220,253, 274,296,297, 304,311,336, 373,376,388	53,88,89,90, 91,113,161, 203,224,250, 268,313,370, 373,376,387	84,109,113, 128,129,143, 203,274,311, 314,329,373, 387,388	219,268,296, 297,311,329	109,128,129, 143,150,203, 311,314,329, 387	113,176,304, 311,314,329, 336

Table 52. (continued)

Species		Literature references concerning					
		Abundance					
Common name	Scientific name	General	Specific	Habitat requirements	Age & growth	Early life history	Food habits
Bluegill	*Lepomis macrochirus*	88,89,253, 274,297,311, 373,376,388	53,90,91, 113,161,203, 250,268,313, 370,373,376, 387	113,128,129, 203,274,329, 373,387	297,329	128,129,203, 329,387	329
Longear sunfish	*Lepomis megalotis*	274	-----	113,274,329	329	329	329
Smallmouth bass	*Micropterus dolomieu*	39,88,89, 143,177,178, 216,218,219, 220,221,222, 252,253,274, 296,297,304, 311,336,340, 373,376,388	53,88,89,91, 113,203,215, 224,250,268, 313,340,370, 373,376,387	84,91,107, 113,128,129, 143,258,259, 274,299,311, 314,329,336, 340,373,386, 387,388	91,128,218, 219,220,252, 268,296,297, 311,329,340	91,107,128, 129,143,150, 258,259,299, 311,314,329, 340,373,386, 387	113,176,304, 311,314,329, 336
Largemouth bass	*Micropterus salmoides*	88,89,143, 216,218,219, 220,221,222, 274,296,297, 304,311,336, 373,376,388	53,88,89,90, 91,113,161, 203,224,250, 268,313,370, 373,376,387	84,113,128, 129,143,203, 274,311,314, 329,336,341, 373,387,388	218,219,220, 296,297,311, 313,329,341	128,129,143, 150,203,314, 329,341,373, 387	113,176,304, 311,314,329, 336,341
White crappie	*Pomoxis annularis*	253	-----	129	329	129	-----
Black crappie	*Pomoxis nigromaculatus*	88,89,149, 218,219,220, 274,296,297, 304,311,373, 376,388	53,88,89,90, 91,113,161, 203,250,268, 313,370,373, 376,387	113,128,129, 143,203,274, 329,373,387	218,219,296, 297,329	128,129,143, 203,329,373, 387	113,176,304, 329
Eastern sand darter	*Ammocrypta pellucida*	143,274,336	-----	113,274,329	329	329	329

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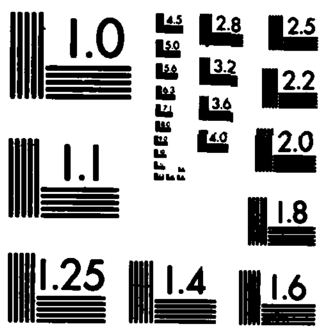
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Table 52. (continued)

Species		Literature references concerning					
		Abundance		Habitat		Early life	
Common name	Scientific name	General	Specific	requirements	Age & growth	history	Food habits
Rainbow darter	*Etheostoma caeruleum*	-----	-----	129,329	329	129,329	329
Iowa darter	*Etheostoma exile*	88,89,143, 274,336,373	-----	113,128,129, 143,274,329, 373,387	329	128,129,143, 329,387	329,336
Fantail darter	*Etheostoma flabellare*	88,89,143, 274,336,373	-----	113,129,274, 329,373	329	129,329	329,336
Johnny darter	*Etheostoma nigrum*	88,89,143, 219,274,336, 376	88,89,91, 250,370,376	88,89,128, 129,152,274, 329,387	329	88,89,128, 129,152,329, 387	329
Tessellated darter	*Etheostoma olmstedi*	143,274,336, 373	91,250	274,329	-----	-----	-----
Yellow perch	*Perca flavescens*	88,89,143, 149,178,216, 218,219,220, 221,222,252, 253,274,296, 297,304,311, 336,373,376, 388	53,88,89,90, 91,113,161, 203,215,224, 250,268,313, 370,373,376, 387	84,88,89,91, 107,113,128, 129,152,246, 274,311,314, 329,387,388	88,91,218, 219,250,252, 268,296,297, 311,313,329	88,89,91,107, 128,129,152, 246,311,314, 329,387	88,113,176, 304,311,314, 329,336
Logperch	*Percina caprodes*	88,89,143, 219,274,336, 373,376	88,89,91, 370,376	91,113,128, 129,143,274, 329,387	329	91,128,129, 143,329,387	329,336
Channel darter	*Percina copelandi*	88,89,143, 274,336,373	-----	113,129,274, 329	329	129,329	329,336
Sauger	*Stizostedion canadense*	88,89,143, 274,336	-----	113,129,274, 329	329	129,329	329

Table 52. (continued)

Species		Literature references concerning					
		Abundance					
Common name	Scientific name	General	Specific	Habitat requirements	Age & growth	Early life history	Food habits
Walleye	*Stizostedion vitreum vitreum*	88,89,143, 177,216,218, 219,221,222, 253,274,296, 297,311,336, 373,376,388	88,89,90,91, 113,161,224 250,268,370, 373,376	84,91,113, 116,128,129, 143,171,274, 311,314,329, 373,387,388	296,297,311, 329	91,116,128, 129,143,171, 311,314,329, 373,387,388	311,314,329, 336
Freshwater drum	*Aplodinotus grunniens*	88,89,274, 297,373	370,373	113,129,274, 329,387	329	129,329,387	329
Mottled sculpin	*Cottus bairdi*	88,89,143, 274,336,373, 376	88,89,90,91, 161,250,370, 376	113,129,274, 329,373,387	329	129,329,387	329,336
Slimy sculpin	*Cottus cognatus*	88,89,143, 274,336,373	-----	128,129,191, 274,311,329, 373	311,329	128,129,191, 311,329	311,329,336
Deepwater sculpin	*Myoxocephalus quadricornis*	143,336	-----	329	329	329	329

[1]Common and scientific names according to Bailey, et al. (1970).

[2]Specific abundance refers to those sources that quote exact numbers for fairly specific areas. General abundance includes such things as specific numbers for large areas, s, cies lists, and notations of a species presence in an area.

Table 53. Common and scientific names of birds found along the St. Lawrence River. Literature references pertaining to abundance, habitat requirements, and nesting of each species are noted. (Numbers refer to main bibliography.)

Species		Literature references concerning			
		Abundance			
Common name[1]	Scientific name[1]	General[2]	Specific[2]	Habitat requirements	Nesting
Common loon	*Gavia immer*	53,113,154,161, 209,210,213,250, 273,376	62,63,64,65,66, 67,68,161,209, 210,250,376	53,209,213,250, 376,385	53,209,213,250, 376
Red-throated loon	*Gavia stellata*	53,113,210,213, 376	62,63,228	53,213,385	213,376
Red-necked grebe	*Podiceps grisegena*	113,209,210,213, 250,376	61,62,67	53,213,385	213,376
Horned grebe	*Podiceps auritus*	53,113,209,210, 213,250,376	62,64,68,228, 376	53,213,385	213,376
Pied-billed grebe	*Podilymbus podiceps*	53,113,210,213, 273,376	62,66,67,68, 210,213,376	213,376,385	209,213,250,376
Leach's petrel	*Oceanodroma leucorhoa*	113,210,213,376	-----	-----	213,376
White-tailed tropicbird	*Phaeton lepturus*	-----	-----	385	-----
White pelican	*Pelecanus erythrorhynchos*	113,210,213,376	67	-----	213,376
Double-crested cormorant	*Phalacrocorax auritus*	53,113,210,213, 273,376	62,63,64,66,67, 68,210,213,376	53,213,385	11,67,213,376
Great blue heron	*Ardea herodias*	53,71,113,154, 175,209,210,213, 250,273,276,376	53,61,62,63,64, 66,67,68,186, 210,228,376	53,71,213,271, 376,385	53,67,71,209, 213,250,271,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance		Habitat	
Common name	Scientific name	General	Specific	requirements	Nesting
Green heron	*Butorides striatus*	53,113,210,213, 273,376	53,62,63,66,67, 210,376	53,213,376,385	53,213,376
Little blue heron	*Florida caerulea*	273	-----	385	-----
Cattle egret	*Bubulcus ibis*	53,113,210,213, 273,376	62,67	53,213,385	53,213,376
Great egret	*Casmerodius albus*	53,113,210,213, 376	62,66,213	53,213,385	53,213,376
Snowy egret	*Egretta thula*	113,210,213,376	-----	213,385	213,376
Black-crowned night heron	*Nycticorax nycticorax*	53,113,210,213, 273,376	62,63,66,67, 210,376	53,213,376,385	53,67,213,376
Least bittern	*Ixobrychus exilis*	53,113,210,213, 273,376	62,63,67,210, 213,313	53,213,376,385	67,209,213,250, 376
American bittern	*Botaurus lentiginosus*	53,113,210,213, 273,376	53,62,63,66,67, 210,313,376	53,213,376,385	67,209,213,250, 376
Glossy ibis	*Plegadis falcinellus*	113,210,213,376	-----	213,385	213,376
Mute swan	*Cyngus olor*	113,208,210,213, 376	-----	213,385	213,376
Whistling swan	*Olor columbianus*	53,113,208,210, 213,376	62,68	53,213,385	53,213,376
Canada goose	*Branta canadensis*	53,61,80,113, 161,186,209,210, 213,218,219,220, 221,222,228,250, 376	62,63,64,65,66, 67,68,161,209, 210,228,250,376	67,209,213,220, 221,222,250, 376,385	67,213,220,221, 222,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Brant	*Branta berniola*	53,113,186,210, 213,376	62,64,66,68, 210,376	53,213,385	53,213,376
White-fronted goose	*Anser albifrons*	-----	-----	385	-----
Snow goose	*Chen caerulescens*	53,113,210,213, 376	62,64,66,68, 376	53,213,385	53,213,376
Egyptian goose	*Alopochen aegyptiacus*	376	376	-----	376
Mallard	*Anas platyrhynchos*	53,71,80,113, 154,161,175,186, 208,209,210,213, 219,220,221,222, 228,250,273,376	53,62,63,64,66, 67,68,161,201, 209,210,213,228, 250,313,376	53,186,209,213, 250,376,385	53,186,213,334, 376
Black duck	*Anas rubripes*	53,80,113,154, 161,175,186,208, 209,210,213,219, 220,221,222,228, 250,273,376	61,62,63,64,65, 66,67,68,161, 186,188,201,209, 210,213,228,250, 313,376	53,186,209,213, 250,376,385	53,186,213,334, 376
Gadwall	*Anas strepera*	53,113,161,209, 210,213,250,376	53,62,63,64,65, 66,67,68,161, 209,210,213,250, 376	53,209,213,250, 376,385	53,213,376
Pintail	*Anas acuta*	53,113,186,209, 210,213,219,220, 221,222,250,273, 376	62,63,64,65,66, 67,68,209,250, 376	53,186,209,213, 250,385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance		Habitat	
Common name	Scientific name	General	Specific	requirements	Nesting
Green-winged teal	*Anas crecca*	53,113,186,209, 210,213,219,220, 221,222,250,273, 376	62,63,64,65,66, 68,161,201,209, 210,213,228,250, 313,376	53,186,209,213, 250,385	53,186,213,376
Blue-winged teal	*Anas discors*	53,113,186,210, 213,219,220,221, 222,273,376	62,63,64,66,67, 68,201,210,213, 313,376	53,186,213,376, 385	53,186,213,376
European widgeon	*Mareca penelope*	-----	-----	385	-----
American widgeon	*Anas americana*	53,80,113,208, 209,210,213,219, 220,222,250,376	61,62,63,64,65, 66,67,68,210, 213,228,376	53,209,213,250, 376,385	53,213,376
Northern shoveler	*Anas clypeata*	53,113,210,213, 219,220,222,273, 376	62,63,64,66,68, 376	53,213,385	53,186,213,376
Wood duck	*Aix sponsa*	53,113,186,209, 210,213,219,220, 222,250,273,376	62,63,64,67,201, 210,213,313,376	53,186,213,376, 385	53,186,213,220, 221,334,376
Redhead	*Aythya americana*	53,113,161,208, 209,210,213,219, 220,222,250,273, 376	61,62,63,64,65, 66,67,68,161, 209,210,213,228, 250,376	53,209,213,250, 376,385	53,213,376
Ring-necked duck	*Aythya collaris*	53,113,186,210, 213,219,222,273, 376	62,63,64,66,67, 68,376	53,186,213,385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance		Habitat	
Common name	Scientific name	General	Specific	requirements	Nesting
Canvasback	*Aythya valisineria*	53,80,113,154, 186,188,208,209, 210,213,250,376	61,62,63,64,65, 66,67,68,228, 376	53,186,209,213, 250,385	53,213,376
Greater scaup	*Aythya marila*	53,80,113,154, 161,186,208,209, 210,213,219,220, 221,228,250,376	61,62,63,64,65, 66,67,68,161, 209,228,250,376	53,186,209,213, 250,385	53,213,376
Lesser scaup	*Aythya affinis*	53,113,186,210, 213,219,220,221, 222,228,376	64,65,66,67,68, 228,376	53,186,213,385	53,213,376
Common goldeneye	*Bucephala clangula*	53,80,113,154, 161,186,208,209, 210,213,221,222 228,250,273,376	61,62,63,64,65, 66,67,68,161, 209,228,250,376	53,186,209,213, 250,385	53,213,376
Barrow's goldeneye	*Bucephala islandica*	113,161,209,210, 213,250,376	65,66,209,250,	209,213,250,385	213,376
Bufflehead	*Bucephala albeola*	53,113,154,186, 208,209,210,213, 220,222,228,250, 376	61,62,64,65,66, 68,228,376	53,186,209,213, 250,385	53,213,376
Old squaw	*Clangula hyemalis*	53,113,186,208, 209,210,213,250, 376	61,62,65,66,68, 376	53,213,385	53,213,376
Common eider	*Somateria mollissima*	113,210,213,273, 376	-----	213,385	213,376

Table 53 . (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
King eider	*Somateria spectabilis*	53,113,210,213, 376	65	53,213,385	53,213,376
White-winged scoter	*Melanitta deglandi*	53,113,186,210, 213,376	64,68,376	53,213,385	53,213,376
Surf scoter	*Melanitta perspicillata*	53,113,210,213, 376	68,376	53,213,385	53,213,376
Black scoter	*Melanitta nigra*	113,210,213, 219,376	68,376	213,385	213,386
Ruddy duck	*Oxyura jamaicensis*	53,113,210,213, 219,273,376	62,63,64,67, 68,376	53,213,385	53,213,376
Hooded merganser	*Lophodytes cucullatus*	53,113,208,210, 213,220,221,222, 273,376	61,62,63,64,65, 66,68,210,376	53,213,385	53,213,376
Common merganser	*Mergus merganser*	53,80,113,154, 161,208,209,210, 213,220,222,228, 250,273,376	61,62,63,64,65, 68,161,209,210, 213,228,250,376	53,209,213,250, 385	53,213,376
Red-breasted merganser	*Mergus serrator*	53,113,154,161, 186,208,209,210, 213,250,273,376	61,62,64,65,66, 67,68,161,209, 210,228,250,376	53,209,213,250, 385	53,213,376
Turkey vulture	*Cathartes aura*	53,113,210,213, 376	36,62,63,64,66, 67,68,210,376	53,213,376,385	36,53,213,376
Goshawk	*Accipiter gentilis*	53,113,154,161, 209,210,213,250, 273,376	61,62,63,65,66, 68,161,209,210, 213,250,376	53,209,213,250, 376,385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance		Habitat	
Common name	Scientific name	General	Specific	requirements	Nesting
Sharp-shinned hawk	*Accipiter striatus*	53,80,113,161, 209,210,213,250, 273,376	61,62,63,64,65, 67,68,161,209, 210,250	53,209,213,250, 376,385	53,213,376
Cooper's hawk	*Accipiter cooperii*	53,113,210,213, 273,376	61,62,63,64,65, 66,67,68,210, 213,228,376	53,213,376,385	53,213,376
Red-tailed hawk	*Buteo jamaicensis*	53,80,113,154, 161,208,209, 210,213,228, 250,273,376	53,61,62,63,64, 65,66,68,161, 210,250,376	53,209,213,250, 376,385	53,213,376
Red-shouldered hawk	*Buteo lineatus*	53,113,210,213, 273,376	62,66,67,68	53,213,385	53,213,376
Broad-winged hawk	*Buteo platypterus*	53,113,210,213, 273,376	66,68,210,213	53,213,385	53,213,376
Rough-legged hawk	*Buteo lagopus*	53,113,154,161, 208,209,210,213, 250,376	61,62,64,65,66, 68,161,209,213, 250	53,209,213,250, 385	53,213,376
Golden eagle	*Aquila chrysaetus*	53	62	53,385	53
Bald eagle	*Haliaeetus leucocephalus*	53,113,161,209, 210,213,228,250, 273,353,376	47,48,49,61,62, 63,65,66,67,68, 161,209,213,228, 250	53,209,213,250, 257,385	53,209,213,250, 257,376
Northern harrier	*Circus cyaneus*	53,113,175,210, 213,273,376	61,62,63,64,65, 66,67,68,210, 213,313,376	53,213,376,385	53,209,213,250, 376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Osprey	*Pandion haliaetus*	53,113,210,213, 273,376	62,63,64,66,67, 68,210,376	53,213,385	53,213,376
Gyrfalcon	*Falco rusticolus*	113,210,213,376	-----	213,385	213,376
Peregrine falcon	*Falco peregrinus*	53,113,210,213, 376	68,228	53,213,385	53,213,376
Merlin	*Falco columbarius*	113,210,213,273, 376	64,68	213,385	213,376
American kestrel	*Falco sparverius*	53,80,113,154, 161,208,209,210, 213,228,250,273, 376	53,61,62,63,64, 65,66,67,68,161, 209,210,213,250, 376	53,209,213,250, 376,385	53,213,376
Spruce grouse	*Canachites canadensis*	53,273	67	53,385	53
Ruffed grouse	*Bonasa umbellus*	53,80,113,154, 159,161,208,209, 210,213,250,273, 376	53,61,62,63,64, 66,67,68,161, 208,209,210,250, 376	53,209,213,250, 334,376,385	53,213,376
Bobwhite	*Colinus virginianus*	113,213	-----	213,385	213
Ring-necked pheasant	*Phasianus colchicus*	53,113,209,210, 213,250,273,376	68,209,250	53,209,213,250, 334,385	53,213,376
Gray partridge	*Perdix perdix*	53,80,113,154, 161,208,209,210, 213,250,273,376	61,62,63,64,65, 66,67,68,209, 210,250,376	53,209,250,334, 376,385	53,213,376
Turkey	*Meleagris gallopavo*	53,80,113,154, 161,208,209,210, 213,250,376	65,67,68,209, 213,250	53,213,250,376, 385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance		Habitat	
Common name	Scientific name	General	Specific	requirements	Nesting
Virginia rail	*Rallus limicola*	53,113,21[illegible], [illegible], 273,376	[illegible],210,213,376	53,213,376,385	53,209,213, 250,376
Sora	*Porzana carolina*	[illegible],113,210,213, 273,376	210	53,213,385	53,213,376
Yellow rail	*Coturnicops noveboracensis*	273	-----	385	-----
Common gallinule	*Gallinula chlorop[illegible]*	53,113,210,213, 273,376	53,62,210,213, 313,376	53,213,376,385	53,213,376
American coot	*Fulica americana*	53,113,208,210, 213,273,376	62,213,376	53,213,385	53,213,376
Semipalmated plover	*Charadrius semipalmatus*	53,113,210,213, 376	62,63,64,67,68, 210,213	213,385	213,376
Piping plover	*Charadrius melodus*	53	-----	53,385	53
Killdeer	*Charadrius vociferus*	53,113,209,210, 213,228,250,273, 376	62,64,66,210, 228,376	53,213,376,385	53,213,376
American golden plover	*Pluvialis dominica*	53,113,210,213, 376	62,64	53,213,385	213,376
Black-bellied plover	*Pluvialis squatarola*	53,113,210,213, 376	62,63,64,67,213, 376	53,213,385	213,376
Ruddy turnstone	*Arenaria interpres*	53,113,210,213, 376	62,63,64,67,68, 210,376	53,213,385	53,213,376
American woodcock	*Philohela minor*	53,113,210,213, 273,376	53,63,66,68,210, 376	53,213,376,385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Common snipe	*Capella gallinago*	53,113,210,213, 273,376	62,66,67,210, 313,376	53,213,376,385	53,209,213, 250,376
Long-billed curlew	*Numenius americanus*	-----	-----	385	-----
Whimbrel	*Numenius phaeopus*	113,210,213,376	62,67,213	213	213,376
Upland sandpiper	*Bartramia longicauda*	53,113,210,213, 273,376	62,63,66,210, 376	53,213,376,385	53,213,376
Spotted sandpiper	*Actitis macularia*	53,113,210,213, 273,376	53,62,63,210, 376	53,213,385	53,213,376
Willet	*Catoptrophorus semipalmatus*	-----	67	385	-----
Solitary sandpiper	*Tringa solitaria*	53,113,210,213, 376	63,210,213,376	53,213,385	53,213,376
Greater yellowlegs	*Tringa melanoleuca*	53,113,210,213, 376	62,63,67,210, 376	53,213,385	53,213,376
Lesser yellowlegs	*Tringa flavipes*	53,113,213,376	62,63,67,68,210, 376	53,213,385	53,213,376
Red knot	*Calidris canutus*	53,113,210,376	62	53,213,385	53,213,376
Purple sandpiper	*Calidris maritima*	113,210,213,376	-----	213,385	213,376
Pectoral sandpiper	*Calidris melanotus*	53,113,210,213, 376	62,67,68,210	53,213,385	53,213,376
White-rumped sandpiper	*Calidris fuscicollis*	113,210,213,376	-----	213,385	213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Baird's sandpiper	*Calidris bairdii*	113,210,213,376	64,213	213,385	213,376
Least sandpiper	*Calidris minutilla*	53,113,210,213, 376	62,63,67,68,210, 376	53,213,385	53,213,376
Dunlin	*Calidris alpina*	53,113,210,213, 376	62,63,66,210, 376	53,213,385	53,213,376
Western sandpiper	*Calidris mauri*	113,210,213,376	-----	213,385	213,376
Semipalmated sandpiper	*Calidris pusilla*	53,113,210,213, 376	62,63,67,68,210, 376	53,213,385	53,213,376
Sanderling	*Calidris alba*	53,113,210,213, 376	62,63,64,67,68, 210,213,376	53,213,385	53,213,376
Ruff	*Philomachus pugnax*	-----	-----	385	-----
Short-billed dowitcher	*Limnodromus griseus*	113,210,213,376	62,63,64,67,68, 210,213	213,385	213,376
Long-billed dowitcher	*Limnodromus scolopaceus*	113,210,213,376	-----	213,385	213,376
Stilt sandpiper	*Micropalama himantopus*	113,210,213,376	63,213	213,385	213,376
Buff-breasted sandpiper	*Tryngites subruficollis*	113,210,213,376	63	213,385	213,376
Marbled godwit	*Limosa fedoa*	-----	62,68	-----	-----
Hudsonian godwit	*Limosa haemastica*	113,210,213,376	-----	213	213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Red phalarope	*Phalaropus fulicarius*	113,210,213,376	-----	213,285	213,376
Wilson's phalarope	*Steganopus tricolor*	53,113,210,213, 376	-----	53,213,385	53,213,376
Northern phalarope	*Lobipes lobatus*	53,113,210,213, 376	376	53,213,385	53,213,376
Parasitic jaeger	*Stercorarius parasiticus*	376	376	213,385	376
Glaucous gull	*Larus hyperboreus*	53,113,161,208, 209,210,213,250, 376	61,62,64,65,66, 161,209,228,250	53,209,213,250, 385	53,213,376
Iceland gull	*Larus glaucoides*	113,161,208,209, 210,213,250,376	61,62,64,65,66, 161,209,228	209,213,250,385	213,376
Great black-backed gull	*Larus marinus*	53,80,113,154, 161,208,209,210, 213,228,250,273, 376	61,62,64,65,66, 67,68,161,209, 210,213,228,250, 376	53,209,213,250, 385	53,213,376
Herring gull	*Larus argentatus*	53,80,113,154, 161,208,209,210, 213,228,250,273, 353,376	41,61,62,64,65, 66,67,68,161, 209,210,250,376	53,209,213,250, 376,385	40,41,53,123, 209,211,213, 250,376
Ring-billed gull	*Larus delawarensis*	53,80,113,154, 161,208,209,210, 213,228,250,273, 353,376	41,61,62,64,65, 66,67,68,161, 209,210,228,250, 376	53,209,213,250, 376,385	40,41,53,209, 211,212,213, 250,376
Franklin's gull	*Larus pipixcan*	53	61	-----	-----

Table 53. (continued)

Species		Literature references concerning			
		Abundance		Habitat	
Common name	Scientific name	General	Specific	requirements	Nesting
Bonaparte's gull	*Larus philadelphia*	53,113,210,213, 376	62,63,64,66,67, 68,210,213,376	53,213,385	53,213,376
Little gull	*Larus minutus*	376	64,376	213	213,376
Ivory gull	*Pagophila eburnea*	-----	65	-----	-----
Black-legged kittiwake	*Rissa tridactyla*	113,209,210,213, 250,376	64,65,161,209, 250	209,213,250	213,376
Sabine's gull	*Xema sabini*	113,210,250,376	-----	213	213,376
Forster's tern	*Sterna forsteri*	113,210,250,376	67,213	213,385	213,376
Common tern	*Sterna hirundo*	53,113,210,213, 273,332,353,376	41,62,63,66,67, 68,210,276	53,213,376,385	40,41,53,209, 211,212,213, 232,240,241, 250,332,376
Caspian tern	*Sterna caspia*	53,113,210,250, 273,376	41,62,63,64,66, 67,68,210,213	53,213,385	40,41,53,209, 213,250,376
Black tern	*Chlidonias niger*	53,113,210,213, 273,376	63,66,67,210, 313,376	53,213,376,385	53,209,213, 250,376
Thick-billed murre	*Uria lomvia*	53,113,210,213, 376	-----	213,385	213,376
Rock dove	*Columba livia*	53,80,113,154, 161,208,209,210, 213,250,273,376	161,209,210, 250,376	53,209,213,250, 376,385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Mourning dove	*Zenaida macroura*	53,80,113,154, 208,209,210,213, 250,273,376	53,61,62,63,64, 65,66,67,68,210, 376	53,209,213,250, 376,385	53,213,376
Yellow-billed cuckoo	*Coccyzus americanus*	53,113,210,213, 273,376	62,63,66,376	53,213,376,385	53,213,376
Black-billed cuckoo	*Coccyzus erythropthalmus*	53,113,210,213, 273,376	53,62,63,67,210, 376	53,213,376,385	53,213,376
Barn owl	*Tyto alba*	113,210,213,273, 376	-----	213,385	213,376
Screech owl	*Otus asio*	53,80,113,161, 209,210,213,250, 273,376	61,65,66,68,161, 209,210,250	53,209,213,250, 376,385	53,213,376
Great horned owl	*Bubo virginianus*	53,71,80,113,154, 161,208,209,210, 213,250,273,376	53,61,65,66,67, 68,161,209,210, 250,376	53,209,213,250, 376,385	53,213,376
Snowy owl	*Nyctea scandiaca*	53,113,208,209, 210,213,250,376	61,64,65,68,228	53,213,385	53,213,376
Hawk owl	*Surnia ulula*	113,210,213,273, 376	-----	213,385	213,376
Barred owl	*Strix varia*	53,113,209,210, 213,250,273,376	65,210	53,209,213,250 376,385	53,213,376
Great gray owl	*Strix nebulosa*	53	-----	53,385	-----
Long-eared owl	*Asio otus*	53,113,210,213, 273,376	-----	53,213,385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Short-eared owl	*Asio flammeus*	53,113,210,213, 273,376	61,65,68	53,213,385	53,213,376
Boreal owl	*Aegolius funereus*	53,113,210,213, 376	-----	53,213,385	53,213,376
Saw-whet owl	*Aegolius acadicus*	53,113,210,213, 273,376	-----	53,213,385	53,213,376
Whip-poor-will	*Caprimulgus vociferus*	53,113,210,213, 273,376	53,62,66,210	53,213,376,385	53,213,376
Common nighthawk	*Chordeiles minor*	53,113,210,213, 273,376	62,66,67,210	53,213,376,385	53,213,376
Chimney swift	*Chaetura pelagica*	53,113,210,213, 273,376	62,63,66,67, 210,376	53,213,376,385	53,213,376
Ruby-throated hummingbird	*Archilochus colubris*	53,113,159,210, 213,273,376	53,62,66,67,210	53,213,376,385	53,213,376
Belted kingfisher	*Megaceryle alcyon*	53,113,154,210, 213,273,376	53,61,62,64,65, 66,68,210,376	53,213,376,385	53,213,376
Common flicker	*Colaptes auratus*	53,113,154,159, 210,213,273,376	53,61,64,66,68, 208,210,213,376	53,213,376,385	53,213,376
Pileated woodpecker	*Dryocopus pileatus*	53,80,113,154, 159,161,209,210, 213,250,273,376	61,62,63,64,65, 66,68,161,208, 209,210,250,376	53,209,213,250, 376,385	53,213,376
Red-bellied woodpecker	*Melanerpes carolinus*	113,209,210,213, 250,376	-----	213,385	213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Red-headed woodpecker	*Melanerpes erythrocephalus*	53,113,210,213, 273,376	62,63,65,66,67, 68,210,376	53,213,385	53,213,376
Yellow-bellied sapsucker	*Sphyrapicus varius*	53,113,210,213, 273,376	67,376	53,213,385	53,213,376
Hairy woodpecker	*Picoides villosus*	53,80,113,154, 159,161,208,209, 210,213,250,273, 376	53,61,62,63,64, 65,66,67,68,161, 209,210,250,376	53,209,213,250, 376,385	53,213,376
Downy woodpecker	*Picoides pubescens*	53,80,113,154, 159,161,208,209, 210,213,250,273, 376	53,61,62,63,64, 65,66,67,68,161, 209,210,250,376	53,209,213,250, 376,385	53,213,376
Black-backed three-toed woodpecker	*Picoides arcticus*	53,113,154,210, 213,273,376	-----	53,213,385	213,376
Northern three-toed woodpecker	*Picoides tridactylus*	53,113,154,210, 213,376	-----	53,213,385	213,376
Eastern kingbird	*Tyrannus tyrannus*	53,113,210,213, 273,376	53,62,63,66,67, 376	53,213,376,385	53,213,376
Western kingbird	*Tyrannus verticalis*	-----	-----	385	-----
Great-crested flycatcher	*Myiarchus crinitus*	53,113,159,210, 213,273,376	53,62,66,67,208, 210,376	53,213,376,385	53,213,376
Eastern phoebe	*Sayornis phoebe*	53,113,210,213, 273,376	53,62,66,67,68, 210,376	53,213,376,385	53,213,376

Table 53 . (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Yellow-bellied flycatcher	*Empidonax flaviventris*	53,113,210,213, 273,376	-----	213,385	213,376
Willow flycatcher	*Empidonax trailli*	53,113,210,213, 376	53,62,63,210, 376	53,213,376	53,213,376
Alder flycatcher	*Empidonax alnorum*	53,113,210,213, 273,376	62,63,66,67,210, 376	53,213,376,385	53,213,376
Acadian flycatcher	*Empidonax virescens*	53	-----	-----	-----
Least flycatcher	*Empidonax minimus*	53,113,210,213, 273,376	53,62,67,208, 376	53,213,385	53,213,376
Western flycatcher	*Empidonax difficilis*	273	-----	-----	-----
Eastern wood pewee	*Contopus virens*	53,113,159,210, 213,273,376	53,62,66,67,208, 210,376	53,213,376,385	53,213,376
Olive-sided flycatcher	*Nuttallornis borealis*	53,113,210,213, 273,376	53,67	53,213,385	53,213,376
Horned lark	*Eremophila alpestris*	53,80,113,154, 208,209,210,213, 250,273,376	61,62,63,64,65, 66,68,210,376	53,209,213,250, 376,385	53,213,376
Tree swallow	*Iridoprocne bicolor*	53,113,210,213, 273,376	53,66,67,68,208, 210,228,376	53,213,376,385	53,213,376
Bank swallow	*Riparia riparia*	53,113,210,213, 273,376	62,67,210,376	53,213,376,385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Rough-winged swallow	*Stelgidopteryx ruficollis*	53,71,113,210,213,273,376	62,210,213,376	53,213,376,385	53,213,376
Barn swallow	*Hirundo rustica*	53,113,210,213,273,376	53,63,66,67,68,210,213,376	53,213,376,385	53,213,376
Cliff swallow	*Petrochelidon pyrrhonata*	53,113,210,213,273,376	62,63,67,210 376	53,213,376,385	53,213,376
Purple martin	*Progne subis*	53,113,210,213,273,376	62,63,66,67,210,376	53,213,376,385	53,213,376
Gray jay	*Perisoreus canadensis*	53,80,113,210,213,273,376	64	53,213,385	53,213,376
Blue jay	*Cyanocitta cristata*	53,80,113,154,159,161,208,209,210,213,250,273,376	53,61,64,65,66,67,68,161,208,209,210,250,376	53,209,213,250,376,385	53,213,376
Common raven	*Corvus corax*	53,113,210,213,273,376	64,65	53,213,385	213,376
Common crow	*Corvus brachyrhynchos*	53,80,113,154,159,161,208,209,210,213,228,250,273,376	53,61,64,65,66,67,68,161,209,210,228,250,376	53,209,213,250,376,385	53,213,376
Black-capped chickadee	*Parus atricapillus*	53,71,80,113,154,159,161,208,209,210,213,250,273,376	53,65,67,68,161,208,209,210,250,376	53,209,213,250,376,385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance		Habitat requirements	Nesting
Common name	Scientific name	General	Specific		
Boreal chickadee	*Parus hudsonicus*	53,80,113,210, 213,376	-----	53,213,385	213,376
Tufted titmouse	*Parus bicolor*	53	-----	53,385	-----
White-breasted nuthatch	*Sitta carolinensis*	53,80,113,154, 159,161,208, 209,210,213, 250,273,376	53,61,63,64,65, 66,67,68,161, 209,210,250,376	53,209,213,250, 376,385	53,213,376
Red-breasted nuthatch	*Sitta canadensis*	53,80,113,154, 208,209,210,213, 250,273,376	53,61,62,65,67, 68,210	53,213,376,385	53,213,376
Brown creeper	*Certhia familiaris*	53,80,113,154, 159,208,209,210, 213,250,273,376	53,61,62,63,64, 65,66,67,68,210	53,209,213,250, 376,385	53,213,376
House wren	*Troglodytes aedon*	53,113,210,213, 273,376	53,63,66,67,208, 210,376	53,213,376,385	53,213,376
Winter wren	*Troglodytes troglodytes*	53,113,154,210, 213,273,376	62,64	53,213,385	53,213,376
Carolina wren	*Troglodytes ludovicianus*	53,113,210,213, 376	63,66,67,213	53,213	53,213,376
Long-billed marsh wren	*Cistothorus palustris*	53,113,210,213, 273,376	53,62,63,66,67, 210,313,376	53,213,376,385	53,213,376
Short-billed marsh wren	*Cistothorus platensis*	53,113,210,213, 273,376	62	53,213,385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Mockingbird	*Mimus polyglottos*	53,113,210,213, 273,376	62,63,66,67,68	53,213,385	53,213,376
Gray catbird	*Dumetella carolinensis*	53,113,159,210, 213,273,376	53,62,63,67,208, 210,376	53,213,376,385	53,213,376
Brown thrasher	*Toxostoma rufum*	53,113,210,213, 273,376	53,62,210,376	53,213,376,385	53,213,376
Sage thrasher	*Oreoscoptes montanus*	113,210,213,376	-----	213	213,376
American robin	*Turdus migratorius*	53,71,113,154, 159,161,209,210, 213,250,273,376	53,61,62,63,64, 65,67,68,161, 208,209,210,250, 376	53,209,250,376, 385	53,213,376
Varied thrush	*Ixoreus naevius*	-----	-----	385	-----
Wood thrush	*Hylocichla mustelina*	53,113,210,213, 273,376	53,68,208,210, 376	53,213,376,385	53,213,376
Hermit thrush	*Catharus guttatus*	53,113,210,213, 273,376	66,67,72	53,213,385	53,213,376
Swainson's thrush	*Catharus ustulatus*	53,113,210,213, 273,376	62,66	53,213,385	213,376
Gray-cheeked thrush	*Catharus minimus*	53,113,210,213, 376	66	213,385	213,376
Veery	*Catharus fuscescens*	53,113,159,210, 213,273,376	53,67,208,210, 376	53,213,376,385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance		Habitat requirements	Nesting
Common name	Scientific name	General	Specific		
Eastern bluebird	*Sialia sialis*	53,113,154,210, 213,273,376	62,66,68	53,213,385	53,213,376
Blue-gray gnatcatcher	*Polioptila caerulea*	53,113,210,213, 376	62	53,213,385	213,376
Golden-crowned kinglet	*Regulus satrapa*	53,113,154,210, 213,273,376	53,61,62,64,66, 213,376	53,213,385	53,213,376
Ruby-crowned kinglet	*Regulus calendula*	53,113,154,210, 213,273,376	62,68,376	53,213,385	213,376
Water pipit	*Anthus spinoletta*	53,113,210,376	62,64,376	53,213,385	213,376
Bohemian waxwing	*Bombycilla garrulus*	53,113,161,209, 210,213,250,376	61,62,65,66, 209,250	53,209,213,250, 385	213,376
Cedar waxwing	*Bombycilla cedrorum*	53,113,154,159, 210,213,273,376	53,61,62,63,65, 67,68,208,210 376	53,213,376,385	53,213,376
Northern shrike	*Lanius excubitor*	53,80,113,154, 161,208,209,210, 213,250,376	61,62,64,65,66, 68,161,209,250	53,209,213,250, 385	213,376
Loggerhead shrike	*Lanius ludovicianus*	53,113,210,213, 273,376	62,63,67,376	53,213,376,385	53,213,376
Starling	*Sturnus vulgaris*	53,80,113,154, 161,208,209,210, 213,250,376	53,65,161,208, 209,210,250,376	53,209,213,250, 376,385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
White-eyed vireo	*Vireo griseus*	113,210,213,376	213	213	213,376
Bell's vireo	*Vireo bellii*	273	-----	-----	-----
Yellow-throated vireo	*Vireo flavifrons*	53,113,210,213, 273,376	53,63,210	53,213,376,385	53,213,376
Solitary vireo	*Vireo solitarius*	53,113,210,213, 273,376	62	53,213,385	213,376
Red-eyed vireo	*Vireo olivaceus*	53,113,159,210, 213,273,376	53,62,66,208, 210,376	53,213,376,385	53,213,376
Philadelphia vireo	*Vireo philadelphicus*	53,113,210,213, 273,376	376	213,385	213,376
Warbling vireo	*Vireo gilvus*	53,113,209,210, 213,273,376	53,62,66,208, 210,376	53,213,376,385	53,213,376
Black-and-white warbler	*Mniotilta varia*	53,113,159,210, 213,273,376	67,208,210,376	53,213,376,385	53,213,376
Prothonotary warbler	*Protonotaria citrea*	53	-----	-----	-----
Worm-eating warbler	*Helmitheros vermivorus*	-----	-----	385	-----
Golden-winged warbler	*Vermivora chrysoptera*	53,113,210,213, 376	62,66,67	53,213,385	53,213,376
Blue-winged warbler	*Vermivora pinus*	53	67	385	53
Tennessee warbler	*Vermivora peregrina*	53,113,210,213, 273,376	62,65,68,376	53,213,385	213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Orange-crowned warbler	*Vermivora celata*	53,113,210,213, 376	-----	53,213,385	213,376
Nashville warbler	*Vermivora ruficapilla*	53,113,210,213, 273,376	62,63,67,210	53,213,376,385	53,213,376
Northern parula	*Parula americana*	53,113,210,213, 273,376	62,213	53,213,385	53,213,376
Yellow warbler	*Dendroica petechia*	53,71,113,210, 213,273,376	53,62,63,66,67, 208,210,376	53,213,376,385	53,213,376
Magnolia warbler	*Dendroica magnolia*	53,113,210,213, 273,376	66,376	53,213,385	53,213,376
Cape May warbler	*Dendroica tigrina*	53,113,210,213, 273,376	62,66	53,213,385	213,376
Black-throated blue warbler	*Dendroica caerulescens*	53,113,210,213, 273,376	62,65,210	53,213,385	53,213,376
Yellow-rumped warbler	*Dendroica coronata*	53,113,210,213, 273,376	61,62,64,66,67, 68,210,376	53,213,376,385	53,213,376
Black-throated green warbler	*Dendroica virens*	53,113,159,210, 213,273,376	53,62,66,210	53,213,385	53,213,376
Cerulean warbler	*Dendroica cerulea*	53,113,210,213, 273,376	-----	53,213,385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Blackburnian warbler	*Dendroica fusca*	53,113,210,213, 273,376	62,66	53,213,385	53,213,376
Chestnut-sided warbler	*Dendroica pensylvanica*	53,113,210,213, 273,376	62,66,210	53,213,376,385	53,213,376
Bay-breasted warbler	*Dendroica castanea*	53,113,210,213, 273,376	62,66,376	53,213,385	53,213,376
Blackpoll warbler	*Dendroica striata*	53,113,210,213, 376	53,66	53,213,385	53,213,376
Pine warbler	*Dendroica pinus*	53,113,210,213, 273,376	53,62,66,67, 210,376	53,213,376,385	53,213,376
Palm warbler	*Dendroica palmarum*	113,210,213,273, 376	62	213,385	213,376
Ovenbird	*Seiurus aurocapillus*	53,113,159,210, 213,273,376	53,62,66,208, 210,376	53,213,376,385	53,213,376
Northern waterthrush	*Seiurus noveboracensis*	53,113,210,213, 273,376	66,210	53,213,385	53,213,376
Louisiana waterthrush	*Seiurus motacilla*	-----	-----	385	-----
Connecticut warbler	*Oporornis agilis*	113,210,213,376	-----	213,385	213,376
Mourning warbler	*Oporornis philadelphia*	53,113,210,213, 273,376	67,210	53,213,376,385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Common yellowthroat	*Geothlypis trichas*	53,113,210,213, 273,376	53,62,66,67,208, 210,376	53,213,376,385	53,213,376
Yellow-breasted chat	*Icteria virens*	53	-----	385	-----
Hooded warbler	*Wilsonia citrina*	-----	-----	385	-----
Wilson's warbler	*Wilsonia pusilla*	53,113,210,213, 376	-----	53,213,385	213,376
Canada warbler	*Wilsonia canadensis*	53,113,210,213, 273,376	63,210	53,213,376,385	53,213,376
American redstart	*Setophaga ruticilla*	53,113,159,210, 213,273,376	53,62,66,208, 210,376	53,213,376,385	53,213,376
House sparrow	*Passer domesticus*	53,80,113,154, 161,208,209,210, 213,250,376	161,209,210,250, 376	53,209,213,250, 376,385	53,213,376
Bobolink	*Dolichonyx oryzivorus*	53,113,210,213, 273,376	62,63,66,67,210, 376	53,213,376,385	53,213,376
Eastern meadowlark	*Sturnella magna*	53,113,154,208, 209,210,213,250, 273,376	64,66,67,68,210, 376	53,213,376,385	53,213,376
Western meadowlark	*Sturnella neglecta*	53,113,210,213, 376	-----	53,213	213,376
Red-winged blackbird	*Agelaius phoeniceus*	53,80,113,154, 208,209,210,213, 250,273,376	53,61,64,65.66, 68,208,210,313, 376	53,213,376,385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Orchard oriole	*Icterus spurius*	53,113,210,213, 273,376	-----	53,213	53,213,376
Northern oriole	*Icterus galbula*	53,71,113,154, 159,210,213,273, 376	53,62,63,66,208, 210,376	53,213,376,385	53,213,376
Rusty blackbird	*Euphagus carolinus*	53,113,210,213, 376	62,66,376	53,213,385	53,213,376
Brewer's blackbird	*Euphagus cyanocephalus*	53	-----	-----	-----
Common grackle	*Quiscalus quiscula*	53,80,113,154, 208,209,210,213, 250,273,376	53,61,65,66,67, 208,210,376	53,213,376,385	53,213,376
Brown-headed cowbird	*Molothrus ater*	53,80,113,154, 208,209,210,213, 250,273,376	53,61,65,67,68, 208,210,376	53,209,213,250, 376,385	53,213,376
Scarlet tanager	*Piranga olivacea*	53,113,210,213, 273,376	53,62,66,210, 376	53,213,376,385	53,213,376
Cardinal	*Cardinalis cardinalis*	53,80,113,154, 161,208,209,210, 213,250,273,376	53,61,64,65,66, 67,68,161,208, 209,210,250,376	53,250,385	53,213,376
Rose-breasted grosbeak	*Pheucticus ludovicianus*	53,113,210,213, 273,376	53,62,63,66,208, 210,376	53,376,385	53,213,376
Indigo bunting	*Passerina cyanea*	53,113,210,213, 273,376	66,208,210,376	53,376,385	53,213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Dickcissel	*Spiza americana*	113,210,213,376	-----	-----	213,376
Evening grosbeak	*Hesperiphona vespertina*	53,80,113,154, 161,208,209,210, 213,250,273,376	53,61,64,65,66, 67,68,161,209, 210,250,376	53,209,250,385	53,213,376
Purple finch	*Carpodacus purpureus*	53,113,154,209, 210,213,250,273, 376	53,61,62,63,64, 65,66,67,68,210, 376	53,385	53,213,376
House finch	*Carpodacus mexicanus*	-----	62,66,67,68	-----	-----
Pine grosbeak	*Pinicola enucleator*	53,80,113,154, 161,208,209,210, 213,250,376	61,62,64,65,66, 161,209,250	53,209,250,385	213,376
Hoary redpoll	*Carduelis hornemanni*	53,113,210,213, 376	-----	53,385	213,376
Common redpoll	*Carduelis flammea*	53,80,113,154, 161,208,209,210, 213,250,376	64,65,66,161, 209,250,376	53,209,250,385	213,376
Pine siskin	*Carduelis pinus*	53,80,113,208, 209,210,213,250, 273,376	53,64,65,66,68	53,385	213,376
American goldfinch	*Carduelis tristis*	53,80,113,154, 161,208,209,210, 213,250,273,376	53,61,64,65,66, 68,161,208,209, 210,250,376	53,209,250,376, 385	213,376
Red crossbill	*Loxia curvirostra*	53,113,210,213, 273,376	-----	53,385	213,376

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
White-winged crossbill	*Loxia leucoptera*	53,113,210,273, 376	64,65	53,385	213,376
Rufous-sided towhee	*Pipilo erythrophthalmus*	53,113,210,213, 273,376	53,61,62,66,68, 208,210,376	53,376,385	53,213,376
Savannah sparrow	*Passerculus sandwichensis*	53,113,210,213, 273,376	61,62,63,66,67, 210,376	53,376,385	53,213,376
Grasshopper sparrow	*Ammodramus savannarum*	53,113,210,213, 273,376	62,210,313	53,385	213,376
Henslow's sparrow	*Ammodramus henslowii*	53,113,210,213, 273,376	62,210,213,376	53,376,385	53,213,376
Vesper sparrow	*Pooecetes gramineus*	53,113,210,213, 273,376	62,63,66,67,376	53,376,385	53,213,376
Dark-eyed junco	*Junco hyemalis*	53,80,113,154, 161,208,209,210, 213,250,273,376	61,62,64,66,68, 161,209,210,250, 376	53,209,250,385	53,213,376
Tree sparrow	*Spizella arborea*	53,80,113,154, 161,208,209,210, 213,250,376	53,62,64,65,66, 68,161,250,376	53,209,250,385	53,213,376
Chipping sparrow	*Spizella passerina*	53,80,113,210, 213,273,376	53,61,62,63,66, 67,208,210,376	53,376,385	53,213,376
Clay-colored sparrow	*Spizella pallida*	273	62,63	-----	-----

Table 53. (continued)

Species		Literature references concerning			
		Abundance			
Common name	Scientific name	General	Specific	Habitat requirements	Nesting
Field sparrow	*Spizella pusilla*	53,113,210,213, 273,376	53,64,67,210, 376	53,376,385	53,213,376
White-crowned sparrow	*Zonotrichia leucophrys*	53,80,113,154, 208,210,213,376	62,64,65,66,68, 376	53,385	213,376
White-throated sparrow	*Zonotrichia albicollis*	53,113,154,209, 210,213,250,273, 376	53,61,62,64,65, 66,67,68,208, 210,376	53,376,385	53,213,376
Fox sparrow	*Passerella iliaca*	53,113,210,213, 376	64,66,376	53,385	213,376
Lincoln's sparrow	*Melospiza lincolnii*	53,113,210,213, 273,376	376	53,385	213,376
Swamp sparrow	*Melospiza georgiana*	53,113,210,213, 273,376	53,62,66,67, 210,313,376	53,376,385	53,213,376
Song sparrow	*Melospiza melodia*	53,80,113,154, 208,209,210,213, 250,273,376	53,64,65,208, 210,376	53,376,385	53,213,376
Lapland longspur	*Calcarius lapponicus*	58,80,113,154, 208,210,213,376	61,65	53,385	213,376
Snow bunting	*Plectrophenax nivalis*	53,80,113,154, 161,208,209,210, 213,250,376	61,62,64,65,68, 161,209,250,376	53,209,250,385	213,376

[1]Common and scientific names according to American Ornithologist's Union (1957)

[2]Specific abundance refers to those sources that quote exact numbers for fairly specific areas. General abundance includes such things as specific numbers for large areas, species lists, and notations of a species' presence in an area.

Table 55. Common and scientific names of mammals found along the St. Lawrence River. Literature references pertaining to abundance and habitat requirements of each species are noted. (Numbers refer to main bibliography.)

		Literature references concerning		
		Abundance		Habitat requirements
Common name[1]	Scientific name[1]	General[2]	Specific[2]	
Opossum	*Didelphis virginiana*	113,274,381,385, 397	-----	113,248,274,379, 381,385,397
Masked shrew	*Sorex cinereus*	187,248,274,376, 379,385,397,398	53,248,376,379, 380	187,248,274,379, 385,397,398
Smokey shrew	*Sorex fumeus*	187,248,274,376, 379,385,397,398	389	187,248,274,379, 385,389,397,398
Longtail shrew	*Sorex dispar*	385	-----	385
Northern water shrew	*Sorex palustris*	187,274,385,398	-----	187,274,385,398
Pygmy shrew	*Microsorex hoyi*	187,248,274,376, 379,385,397,398	248,379,380	187,248,274,379, 385,397,398
Short-tailed shrew	*Blarina brevicauda*	113,187,248,274, 376,379,381,385, 397,398	53,376,380,389	113,187,248,274, 379,385,389,397, 398
Star-nosed mole	*Condylura cristata*	187,248,274,376, 379,385,397,398	380,389	187,248,274,379, 385,389,397,398
Eastern mole	*Scalopus aquaticus*	376	-----	-----
Hairy-tailed mole	*Parascalops breweri*	187,274,376,385, 397	-----	187,248,274,379, 385,397
Little brown bat	*Myotis lucifugus*	187,248,274,376, 379,385,398	53,389	187,274,385,389, 398

Table 55. (continued)

Common name	Scientific name	Literature references concerning: Abundance — General	Abundance — Specific	Habitat requirements
Keen myotis	*Myotis keenii*	187,274,385	-----	187,274,385
Indiana bat	*Myotis sodalis*	187,385	-----	187,385
Small-footed myotis	*Myotis leibii*	187,274,385	-----	187,274,385
Silver-haired bat	*Lasionycteris noctivagans*	187,248,274,376, 379,385,398	-----	187,274,385,398
Eastern pipistrel	*Pipistrellus subflavus*	187,248,274,379, 385	389	187,274,385
Big brown bat	*Eptesicus fuscus*	187,248,274,376, 379,385,398	-----	187,274,385,398
Red bat	*Lasiurus borealis*	187,248,274,379, 385	389	187,274,385
Hoary bat	*Lasiurus cinereus*	187,248,274,379, 385	-----	187,274,385
Snowshoe hare	*Lepus americanus*	113,248,274,376, 379,381,385,397, 398	161,248,376,379, 380	113,248,274,334, 379,381,385,397, 398
European hare	*Lepus europaeus*	113,274,381,397	-----	113,248,274,379, 381,397
Eastern cottontail	*Sylvilagus floridanus*	113,248,274,376, 379,381,385,397, 398	53,161,248,376, 379,380,389	113,248,274,334, 379,381,385,398

Table 55. (continued)

Common name	Scientific name	Literature references concerning: Abundance, General	Abundance, Specific	Habitat requirements
Eastern chipmunk	*Tamias striatus*	113,187,248,274, 376,379,381,385, 397,398	53,248,376,379, 380,389	113,187,248,274, 379,381,385,397, 398
Woodchuck	*Marmota monax*	113,187,248,274, 376,379,381,385, 397,398	53,248,376,379, 380,389	113,187,248,274, 379,381,385,397, 398
Gray squirrel	*Sciurus carolinensis*	113,248,274,376, 379,381,385,397, 398	53,161,248,376, 379,380,389	13,113,248,274, 334,379,381,385, 389,397,398
Red squirrel	*Tamiasciurus hudsonicus*	113,187,248,274, 376,379,381,385, 397,398	53,161,248,376, 379,380,389	113,187,248,274, 379,381,385,389, 397,398
Southern flying squirrel	*Glaucomys volans*	113,187,248,274, 376,379,381,397, 398	248,376,379,380	113,187,248,274, 379,381,397,398
Northern flying squirrel	*Glaucomys sabrinus*	113,187,248,274, 376,379,381,385, 397,398	389	113,187,248,274, 379,381,385,389, 397,398
American beaver	*Castor canadensis*	113,248,274,376, 379,381,385,397, 398	53	12,113,248,274, 379,381,385,397, 398
Deer mouse	*Peromyscus maniculatus*	187,248,274,376, 379,397,398	161,248,376,379, 380	187,248,274,379, 397,398

Table 55. (continued)

		Literature references concerning		
		Abundance		Habitat
Common name	Scientific name	General	Specific	requirements
White-footed mouse	*Peromyscus leucopus*	113,187,248,274, 379,381,385,397, 398	53,161,248,379, 389	187,248,274,379, 385,389,397,398
Southern bog lemming	*Synaptomys cooperi*	187,274,385,398	-----	187,274,385,398
Red-backed vole	*Clethrionomys gapperi*	187,248,274,379, 385,397,398	-----	187,248,274,379, 385,397,398
Meadow vole	*Microtus pennsylvanicus*	71,113,187,248, 274,376,379,381, 385,397,398	53,161,248,376, 379,380,389	133,187,248,274, 379,385,389,397, 398
Pine vole	*Microtus pinetorum*	187,274,397,398	-----	187,248,274,379, 397,398
Muskrat	*Ondatra zibethicus*	113,248,376,379, 381,385,397,398	53,313,376,389	113,248,313,379, 381,385,389,397, 398
Norway rat	*Rattus norvegicus*	113,248,274,376, 379,381,397,398	376,380,389	113,248,274,379, 381,397,398
House mouse	*Mus musculus*	274,376,397,398	53	248,274,379,397, 398
Meadow jumping mouse	*Zapus hudsonius*	113,187,248,274, 376,379,381,385, 397,398	248,376,379,380, 389	187,248,274,379, 385,398

Table 55. (continued)

		Literature references concerning		
		Abundance		Habitat
Common name	Scientific name	General	Specific	requirements
Woodland jumping mouse	*Napeozapus insignis*	187,248,274,376, 379,385,397,398	248,376,379,380	187,248,274,379, 385,397,398
Porcupine	*Erethizon dorsatum*	113,187,248,274, 379,381,385,397, 398	53,376,389	113,187,248,274, 379,381,385,389, 397,398
Coyote	*Canis latrans*	113,248,274,376, 379,381,385,397	53,161,248,376, 379	113,248,274,379, 381,385,397
Wolf	*Canis lupus*	113,274,381,397	-----	113,248,274,379, 381,397
Red fox	*Vulpes vulpes*	248,274,376,379, 385,397,398	53,161,248,376, 379,389	248,274,379,385, 397,398
Gray fox	*Urocyon cinereoargenteus*	113,248,274,376, 379,381,385,397	161,248,379	113,248,274,379, 381,385,397
Black bear	*Ursus americanus*	113,274,381,397, 398	-----	113,248,274,379, 381,397,398
Raccoon	*Procyon lotor*	113,248,274,376, 379,381,385,397, 398	53,248,376,379, 380,389	113,248,274,379, 381,385,397,398
American marten	*Martes americana*	113,248,274,376, 379,381,385,397, 398	161,248,379	113,248,274,379, 381,385,397,398

Table 55. (continued)

Common name	Scientific name	Literature references concerning: Abundance — General	Abundance — Specific	Habitat requirements
Fisher	*Martes pennanti*	113,248,274,376, 379,381,385,397, 398	161,248,379	113,248,274,379, 381,385,397,398
Ermine	*Mustela erminea*	113,248,274,376, 379,381,385,397, 398	53,161,248,376, 379,380,389	113,248,274,379, 381,385,397,398
Long-tailed weasel	*Mustela frenata*	113,248,274,376, 379,381,385,397, 398	161,248,376,379, 380	113,248,274,379, 381,385,397,398
American mink	*Mustela vison*	113,248,274,376, 379,381,385,397, 398	161,248,379	113,248,274,379, 381,385,397,398
River otter	*Lutra canadensis*	113,248,274,376 379,381,385,397, 398	161,248,379	113,248,274,379, 381,385,397,398
Wolverine	*Gulo gulo*	113,274,381,397	-----	113,248,274,379, 381,397
Striped skunk	*Mephitis mephitis*	113,248,274,376, 379,381,385,397, 398	161,248,376,379, 380,389	113,248,274,379, 381,385,397,398
Harbor seal	*Phoca vitulina*	274	-----	274
Mountain lion	*Felix concolor*	113,274,381,397	-----	113,248,274,379, 381,397

Table 55. (continued)

Common name	Scientific name	Literature references concerning: Abundance, General	Abundance, Specific	Habitat requirements
Lynx	*Lynx lynx*	113,274,381,397, 398	-----	113,248,274,379, 381,397,398
Bobcat	*Lynx rufus*	113,248,274,379, 381,385,397,398	-----	113,248,274,379, 381,385,397,398
White-tailed deer	*Odocoileus virginianus*	113,248,274,376, 379,381,385,397, 398	53,376,389	113,248,274,334, 379,381,385,397, 398
Moose	*Alces alces*	113,274,381,397, 398	-----	113,248,274,379, 381,397,398
American elk	*Cervus elaphus*	113,274,381,397	-----	113,248,274,379, 381,397

[1]Common and scientific names according to Burt and Grossenheider (1976).

[2]Specific abundance refers to those sources that quote exact numbers for fairly specific areas. General abundance includes such things as specific numbers for large areas, species lists, and notations of a species presence in an area.

Table 57. Common and scientific names of amphibians and reptiles found along the St. Lawrence River. Literature references pertaining to abundance and habitat requirements of each species are noted. (Numbers refer to main bibliography.)

Species		Literature references concerning		
		Abundance		
Common name[1]	Scientific name[1]	General[2]	Specific[2]	Habitat requirements
	AMPHIBIANS			
Mudpuppy	*Necturus maculosus*	5,113,250,274, 354,376,390	-----	5,274,385
Red-spotted newt	*Notophthalmus viridescens*	5,53,113,250,274, 354,376,390	-----	5,274,354,385, 390
Northern dusky salamander	*Desmognathus fuscus fuscus*	5,113,250,274	-----	5,274
Spotted salamander	*Ambystoma maculatum*	5,113,250,274, 354,376,390	-----	5,274,385
Blue-spotted salamander	*Ambystoma laterale*	5,113,250,274, 376	-----	5,274,376,385
Tremblay's salamander	*Ambystoma tremblayi*	5,113,354,376, 390	-----	385
Red-backed salamander	*Plethodon cinereus*	5,53,113,250, 274,354,376,390	-----	5,274,385
Four-toed salamander	*Hemidactylium scutatum*	5,53,113,250, 274,286,376,390	286	5,274,390
Northern spring salamander	*Gyrinophilus porphyriticus porphyriticus*	274	-----	274,385
Northern two-lined salamander	*Eurycea bislineata bislineata*	5,113,250,274,354, 376	-----	5,274,385

Table 57. (continued)

Species		Literature references concerning		
		Abundance		Habitat requirements
Common name	Scientific name	General	Specific	
American toad	*Bufo americanus*	5,53,113,250, 274,354,376,390	-----	5,274,376,385
Spring peeper	*Hyla crucifer*	5,53,113,250, 274,354,376,390	-----	5,274,376,385, 390
Gray treefrog	*Hyla versicolor*	5,53,113,250, 274,354,376,390	-----	5,274,376,385
Western chorus frog	*Pseudacris triseriata triseriata*	5,53,113,250, 274,354,376,390	-----	5,274,376
Bullfrog	*Rana catesbeiana*	5,53,113,250, 274,354,376,390	-----	5,274,376,385
Green frog	*Rana clamitans melanota*	5,53,113,250,274, 354,376,390	-----	5,274,354,376, 385
Mink frog	*Rana septentrionalis*	5,113,250,274,354	-----	5,274,385
Wood frog	*Rana sylvatica*	5,53,113,250,354, 376,390	-----	5,354,376,385
Northern leopard frog	*Rana pipiens*	5,53,113,250,274, 354,376,390	-----	5,274,376,385
Pickerel frog	*Rana palustris*	5,113,250,274,354, 376,390	-----	5,274,354,385

Table 57. (continued)

Species		Literature references concerning		
		Abundance		
Common name	Scientific name	General	Specific	Habitat requirements
		REPTILES		
Common snapping turtle	*Chelydra serpentina serpentina*	5,53,113,250,274, 280,287,349,376, 390	280,287	5,274,280,281, 376,385
Stinkpot	*Sternotherus odoratus*	5,53,113,250,274, 283,289,349,376, 390	283,289	5,274
Wood turtle	*Clemmys insculpta*	250,274	-----	274,385
Eastern box turtle	*Terrapene carolina carolina*	5,113,390	-----	5
Painted turtle	*Chrysemys picta X marginata*	5,53,113,250, 274,280,349,376, 390	280	5,274,280,376, 385
Blanding's turtle	*Emydoidea blandingi*	5,53,113,250,274, 282,284,285,290, 349,376,390	282,285,290	5,274,376
Map turtle	*Graptemys geographica*	5,53,113,250,274, 349,376,390	-----	5,274,376,385
Eastern spiny softshell turtle	*Trionyx spiniferus spiniferus*	250,274	-----	274,385
Five-lined skink	*Eumeces fasciatus*	5,113,250	-----	5

Table 57. (continued)

Species		Literature references concerning		
		Abundance		
Common name	Scientific name	General	Specific	Habitat requirements
Northern watersnake	*Nerodia sipedon sipedon*	5,53,113,250, 274,348,376,390	-----	5,274,348,385
Eastern garter snake	*Thamnophis sirtalis sirtalis*	5,53,113,250, 274,348,376,390	-----	5,274,348,385
Northern ribbon smake	*Thamnophis sauritus sauritus*	5,53,113,250, 274,348,376,390	-----	5,274
Northern brown snake	*Storeria dekayi dekayi*	5,53,113,250, 274,348,376,390	-----	5,274,385
Red-bellied snake	*Storeria occipitomaculata*	5,113,250,274, 348,376	-----	5,274,348,376, 385
Northern ringneck snake	*Diadophis punctatus edwardsi*	5,113,250,274, 348,376	-----	5,274,385
Smooth green snake	*Opheodrys vernalis*	5,53,113,250,274, 348,376,390	-----	5,274,348,385
Black rat snake	*Elaphe obsoleta obsoleta*	5,53,113,250,274, 348,390	-----	5,274,348
Eastern milk snake	*Lampropeltis triangulum triangulum*	5,53,113,250,274, 348,376,390	-----	5,274,385

[1]Common and scientific names according to Conant (1975).

[2]Specific abundance refers to those sources that quote exact numbers for fairly specific areas. General abundance includes such things as specific numbers for large areas, species lists, and notations of a species' presence in an area.

Table 61. Plant species found along the St. Lawrence River prior to Seaway construction (1955) that were not found in more recent studies, and their occurrence by habitat type. Data taken from studies in 1932 and 1955.+@

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
	BRYOPHYTA						
**Amblystegium irriguum*	water-loving hypnum	x	x				
**Drepanocladus aduncus*	hooked moss	x	x				
**Riccia fluitans*	slender riccia	x	x				
	EQUISETACEAE						
Equisetum hyemale	rough horsetail	x		x	x		
Equisetum variegatum	variegated horsetail	x		x	x	x	x
	ISOETACEAE						
**Isoetes echinospora*	quillwort	x					
	LYCOPODIACEAE						
Lycopodium flabelliforme	clubmoss			x			
	SELAGINELLACEAE						
Ophioglossum vulgatum	adder's-tongue fern			x	x	x	
#Selaginella apoda	meadow spikemoss	x	x			x	x
	POLYPODIACEAE						
Athynum thelypteroides	silvery spleenwort			x	x		
Dryopteris austriaca	mountain woodfern			x			
Dryopteris disjuncta	woodfern			x			
Dryopteris phegopteris	woodfern			x			
Dryopteris simulata	evergreen woodfern			x			
	PINACEAE						
Pinus banksiana	jack pine			x	x	x	

(Columns from Littoral areas to Roadsides and waste areas: Occurrence by habitat)

Table 61. (continued)

Scientific name	Common name	Occurrence by habitat: Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
	POTAMOGETONACEAE						
**Potamogeton americanus*	long-leaved pondweed	x	x				
**Potamogeton angustifolius*	narrow-leaved pondweed	x	x				
Potamogeton berchtoldii var. *acuminatus*	Berchtold's pondweed	x	x				
**Potamogeton bupleuroides*	clasping-leaved pondweed	x	x				
**Potamogeton compressus*	eel-grass pondweed	x	x				
**Potamogeton filiformis*	shallow water pondweed	x	x				
**Potamogeton friesii*	Fries' pondweed	x	x				
**Potamogeton gramineus*	various-leaved pondweed	x	x				
Potamogeton illinoensis	Illinois pondweed	x	x				
Potamogeton nodosus	long-leaved pondweed	x	x				
**Potamogeton obtusifolius*	blunt-leaved pondweed	x	x				
**Potamogeton panormitanus*	pondweed	x	x				
**Potamogeton praelongus*	white-stemmed pondweed	x	x				
**Potamogeton vaginatus*	pondweed	x	x				
	NAJADACEAE						
**Zannichellia palustris*	horned pondweed	x	x				
	ALISMATACEAE						
**Alisma geyeri*	submerged water plantain	x	x				
Sagittaria graminea	grass-leaved arrowhead	x	x				
Sagittaria heterophylla	arrowhead	x	x				
	GRAMINEAE						
#*Agropyron trachycaulum*	quackgrass				x	x	x
Agrostis alba	bent grass				x	x	x
Agrostis palustris	bent grass				x	x	x
Agrostis scabra	bent grass				x	x	x
Alopecurus aequalis	foxtail	x	x				
#*Andropogon gerardii*	beard grass					x	x
Avena fatua	oat					x	x
Avena sativa	oat						x
Brachyelytrum erectum	brachyelytrum			x			
Bromus ciliatus	brome grass	x		x			

Table 61. (continued)

Scientific name	Common name	Occurrence by habitat: Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
Cinna arundinacea	wood reed grass			x	x		
Digitaria ischaemum	finger grass					x	x
Eragrostis pectinacea	love grass		x				x
Eragrostis poaeoides	love grass		x				x
Festuca elatior	meadow fescue					x	x
Festuca rubra	fescue grass			x			
Glyceria borealis	manna grass	x	x				
Hordeum jubatum	squirrel-tail grass					x	x
Hordeum vulgare	barley						x
Hystrix patula	bottle-brush grass			x			
Lolium perenne	perennial rye grass					x	x
Miscanthus sacchariflorus	grass						x
Muhlenbergia mexicana	meadow muhlenbergia	x					x
Oryzopsis asperifolia	mountain rice	x		x			
Panicum flexile	panic grass					x	x
Panicum lanuginosum	panic grass			x			
Panicum linearifolium	panic grass			x			
Panicum tuckermanii	panic grass			x			
Panicum virgatum	switch grass					x	
Pennisetum setaceum	fountain grass						x
Poa alsodes	meadow grass			x	x	x	
Poa annua	low spear grass						x
Poa palustris	meadow grass					x	
Setaria glauca	pigeon grass						x
Setaria verticillata	bristly foxtail grass						x
Setaria viridis	bottle grass						x
Spartina pectinata	cord grass	x					
Sphenopholis intermedia	slender wedgegrass	x	x	x			
Sporobolus neglectus	drop-seed					x	x
Triticum aestivum	wheat-grass					x	x
**Zizania palustris*	wild rice	x	x				
	CYPERACEAE						
**Carex aquatilis*	northern water sedge		x				
Carex arctata	drooping wood sedge			x	x		
Carex debilis	slender-stalked sedge			x	x		
Carex deweyana	Dewey's sedge			x	x		
Carex esculentus	sedge		x				

Table 61. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
		Occurrence by habitat					
Carex gracillima	graceful sedge			x	x	x	
Carex hystricina	porcupine sedge		x				
Carex intumescens	bladder sedge	x	x	x	x	x	
Carex lasiocarpa	slender sedge	x	x				
Carex pallescens	pale sedge					x	
Carex pensylvanica	Pennsylvania sedge					x	
Carex projecta	sedge		x				
Carex retrorsa	hop sedge		x				
Carex rosea	stellate sedge			x			
Carex rostrata	yellowish sedge	x	x				
Carex scoparia	pointed broom sedge					x	x
Carex tenera	marsh straw sedge		x				
Carex trisperma	three-fruited sedge		x	x			
Carex viridula	green sedge	x	x				
#*Cladium mariscoides*	twig rush	x	x				
Cyperus rivularis	umbrella sedge		x				
*#*Dulichium arundinaceum*	three-way sedge	x	x				
**Eleocharis calva*	spike rush		x				
Eleocharis compressa	spike rush		x				
**Eleocharis palustris*	large creeping spike-rush		x				
Eleocharis smallii	Small's spike rush		x				
Scirpus fluviatilis	river bulrush	x	x				
Scirpus rubrotinctus	bulrush	x	x				
#*Scirpus smithii*	bulrush	x	x				
	ARACEAE						
Arisaema triphyllum	jack-in-the-pulpit		x	x			
#*Symplocarpus foetidus*	skunk cabbage	x	x				
	LEMNACEAE						
Wolffia columbiana	water meal		x				
	JUNCACEAE						
Juncus alpinus	rush		x				
Juncus brevicaudatus	rush		x				
Juncus bufonius	toad rush		x				x
Juncus dudleyi	rush	x	x			x	
Juncus tenuis	rush		x			x	x

Table 61. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
		Occurrence by habitat					
	LILIACEAE						
Asparagus officinalis	asparagus					x	x
Convallaria majalis	lily-of-the-valley						x
Hemerocallis fulva	day-lily					x	
Polygonatum pubescens	hairy solomon's-seal			x	x		
Trillium undulatum	painted trillium		x	x			
Uvularia grandiflora	large-flowered bellwort			x			
	ORCHIDACEAE						
Habenaria hyperborea	northern green orchis		x	x	x		
Habenaria psycodes	small purple fringed orchis		x			x	
Liparis loeselii	bog twayblade	x	x			x	
Orchis spectabilis	showy orchis			x			
	SALICACEAE						
Populus alba	white poplar			x	x		
Populus canadensis	Canadian poplar			x	x		
Salix bebbiana	bebb willow		x				
Salix rigida	rigid willow		x				
	CORYLACEAE						
Corylus americana	American hazel				x		x
	ULMACEAE						
Celtis occidentalis	hackberry			x	x		
Ulmus thomasii	rock elm			x	x		
	CANNABINACEAE						
Humulus sp.	hop				x	x	x

Table 61. (continued)

Scientific name	Common name	Occurrence by habitat: Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
	URTICACEAE						
Pilea pumila	clearweed		x				
Urtica gracilis	slender nettle		x		x		
	SANTALACEAE						
Comandra richardsiana	sandalwood				x	x	
	POLYGONACEAE						
Fagopyrum sagittatum	buckwheat						x
Polygonum achoreum	knotweed						x
Polygonum aviculare	prostrate knotweed						x
Polygonum convolvulus	black bindweed	x			x	x	x
Polygonum cuspidatum	Japanese knotweed				x	x	
Polygonum scandens	climbing false buckwheat	x			x	x	x
Rumex orbiculatus	water dock	x	x				
	CHENOPODIACEAE						
Atriplex patula	orache						x
Chenopodium capitatum	strawberry-blite			x	x	x	
Chenopodium glaucum	chenopodium				x	x	x
	AMARANTHACEAE						
Acnida altissima	water hemp		x				
Amaranthus retroflexus	green amaranth					x	x
	NYCTAGINACEAE						
Mirabilis hirsuta	four-o'clock					x	
Mirabilis nyctaginea	four-o'clock						x
	CARYOPHYLLACEAE						
Arenaria lateriflora	grove sandwort		x				
Stellaria longifolia	long-leaved chickweed		x		x	x	
Stellaria media	common chickweed					x	x

Table 61. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
	NYMPHACEAE						
Nuphar rubrodiscum	yellow water lily	x	x				
**Nymphozanthus advena*	yellow pond lily	x	x				
	RANUNCULACEAE						
Anemone riparia	thimbleweed			x	x		
Ranunculus abortivus	kidneyleaf buttercup			x	x		
**Ranunculus aquatilus*	water crowfoot	x	x				
Ranunculus longirostris	white water-buttercup	x	x				
Ranunculus recurvatus	hooked buttercup			x			
Ranunculus reptans	creeping spearwort	x	x				
	BERBERIDACEAE						
Berberis vulgaris	common barberry			x			
	MENISPERMACEAE						
Menispermum canadensis	Canada moonseed	x					
	CRUCIFERAE						
#*Arabis divaricarpa*	rock cress	x					
Armoracia lapathifolia	horseradish						x
Brassica kaber	charlock						x
#*Dentaria maxima*	large toothwort			x			
Erucastrum gallicum	erucastrum						x
Erysimum cheiranthoides	worm-seed mustard	x				x	
**Radicula aquatica*	lake cress		x				
Rorippa islandica	yellow cress		x				
Rorippa sylvestris	yellow cress		x				
	PODOSTEMACEAE						
**Podostemum ceratophyllum*	river weed	x					

The six habitat columns are printed under the spanning heading "Occurrence by habitat".

Table 61. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
	Occurrence by habitat						
	SAXIFRAGACEAE						
Mitella nuda	naked miterwort		x	x			
Ribes cynosbati	pasture gooseberry			x	x	x	
Ribes sativum	garden red currant				x	x	
	ROSACEAE						
Amelanchier intermedia	swamp juneberry			x	x		
Amelanchier stolonifera	running juneberry			x	x		
Atonia melanocarpa	chokeberry	x	x		x		
Crataegus chrysocarpa	hawthorn				x	x	
Crataegus punctata	hawthorn				x	x	
Crataegus submollis	hawthorn				x	x	
Crataegus succulenta	hawthorn				x	x	
Fragaria vesca	wood strawberry			x	x	x	
Potentilla argentea	silvery cinquefoil					x	
Potentilla intermedia	cinquefoil					x	
Potentilla recta	rough-fruited cinquefoil					x	x
Prunus nigra	Canada plum				x	x	x
Rosa virginiana	Virginia rose				x	x	x
Rubus canadensis	smooth blackberry				x	x	x
Rubus hispidus	bristly dewberry				x	x	x
Rubus occidentalis	black raspberry				x	x	x
Rubus setosus	bramble		x			x	
Rubus strigosus	red raspberry				x	x	x
Sorbus aucuparia	European mountain ash			x			x
	LEGUMINOSAE						
#*Apios americana*	groundnut				x	x	
#*Astragalus canadensis*	milk-vetch	x			x	x	
Desmodium canadense	showy tick-trefoil			x	x		
Trifolium procumbens	smaller hop clover						x
	OXALIDACEAE						
Oxalis montana	common wood-sorrel			x			

Table 61. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
	EUPHORBIACEAE						
Acalypha rhomboidea	three-seeded mercury			x	x	x	x
Euphorbia glyptosperma	spurge						x
Euphorbia helioscopia	sun spurge						x
Euphorbia maculata	spurge						x
Euphorbia platyphylla	spurge						x
Euphorbia supina	milk-purslane						x
Euphorbia vermiculata	spurge						x
	CALLITRICHACEAE						
Callitriche hermaphroditica	water starwort	x					
Callitriche palustris	water starwort	x	x				
	ACERACEAE						
Acer nigrum	black maple			x	x		
	HIPPOCASTANACEAE						
Aesculus hippocastanum	horsechestnut			x			
	BALSAMINACEAE						
Impatiens glandulifera	jewelweed		x	x			
	RHAMNACEAE						
Ceanothus americanus	New Jersey tea					x	
	VITACEAE						
Parthenocissus inserta	thicket creeper		x	x	x		
	MALVACEAE						
Malva pusilla	mallow					x	x

Occurrence by habitat: columns Littoral areas through Roadsides and waste areas.

Table 61. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
	GUTTIFERAE						
Hypericum boreale	St. Johnswort	x	x				
Hypericum canadense	Canadian St. Johnswort		x				
Hypericum virginicum	marsh St. Johnswort		x				
	VIOLACEAE						
Viola conspersa	dog violet	x			x	x	
Viola pallens	northern white violet		x	x	x		
Viola pubescens	downy yellow violet			x			
Viola rostrata	long-spurred violet			x			
Viola septentrionalis	northern blue violet			x			
	ELAEAGNACEAE						
Shepherdia canadensis	buffalo-berry						x
	ONAGRACEAE						
Circaea alpina	smaller enchanter's nightshade			x			
Epilobium coloratum	purple-leaved willow-herb		x				
Epilobium glandulosum	northern willow-herb		x				
Epilobium leptophyllum	narrow-leaved willow-herb		x				
Epilobium strictum	downy willow-herb		x				
Oenothera perennis	evening primrose				x		
	HALORAGACEAE						
**Hippuris vulgaris*	mare's tail	x	x				
**Myriophyllum alterniflorum*	loose-flowered water milfoil	x	x				
	ARALIACEAE						
Panax trifolius	dwarf ginseng			x			

Table 61. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
		Occurrence by habitat					
	UMBELLIFERAE						
#*Heracleum lanatum*	parsley					x	
Hydrocotyle americana	water pennywort		x				
Osmorhiza longistylis	sweet cicely			x			
Sanicula gregaria	snakeroot			x	x		
	CORNACEAE						
Cornus obliqua	narrowleaf dogwood		x				
Cornus rugosa	roundleaf dogwood		x				
	ERICACEAE						
Gaylussacia baccata	black huckleberry				x	x	
Kalmia angustifolia	sheep laurel		x			x	
Pyrola elliptica	shinleaf			x			
	GENTIANACEAE						
Gentiana crinita	fringed gentian	x	x			x	
	APOCYNACEAE						
Apocynum cannabinum	indian hemp	x			x		
	BORAGINACEAE						
Lappula echinata	stickseed						x
Lythospermum officinale	common gromwell					x	x
Myosotis scorpioides	true forget-me-not	x	x				
	VERBENACEAE						
Verbena urticifolia	white vervain			x	x		

Table 61. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
	LABIATAE						
Elsholtzia cristata	elsholtzia	x				x	x
Lamium amplexicaule	henbit						x
Mentha piperita	peppermint	x					x
Scutellaria galericulata	skullcap	x	x				
Teucrium canadense	germander	x		x	x		
	SOLANACEAE						
Physalis alkekengi	ground-cherry			x	x	x	
Physalis heterophylla	clammy ground-cherry			x	x	x	
	SCROPHULARIACEAE						
Chaenorrhinum minus	dwarf snapdragon						x
Cymbalaria muralis	kenilworth-ivy						x
Gerardia paupercula	small-flowered gerardia		x				
Veronica beccabunga	European brooklime	x					x
Veronica scutellata	marsh speedwell		x				
Veronica serpyllifolia	thyme-leaved speedwell					x	x
	OROBANCHACEAE						
Epifagus virginiana	beechdrops			x			
	RUBIACEAE						
Falium palustre	bedstraw	x	x				
	CAPRIFOLIACEAE						
Echinocystis lobata	wild cucumber	x	x		x		
Lonicera dioica	mountain honeysuckle				x	x	x
Symsharicarpos occidentalis	wolfberry					x	x

Table 61. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
		Occurrence by habitat					
	CAMPANULACEAE						
Campanula uliginosa	marsh bellflower		x				
Lobelia siphilitica	great lobelia		x				
	COMPOSITAE						
Ambrosia trifida	great ragweed					x	x
Antennaria fallax	pussytoes			x	x	x	
Antennaria neodioica	pussytoes			x	x	x	
Antennaria petaloidea	pussytoes			x	x	x	
Artemisia biennis	biennial wormwood						x
Artemisia vulgaris	mugwort						x
Aster novi-belgii	New York aster	x	x			x	
Aster ontarionis	Ontario aster				x	x	
**Bidens beckii*	water marigold	x	x				
Bidens connata	swamp beggar-ticks		x				
Chrysanthemum parthenium	feverfew						x
Erigeron canadensis	horseweed					x	x
Galinsoga ciliata	galinsoga						x
Helenium autumnale	sneezeweed		x		x	x	
Helianthus annuus	common sunflower					x	x
Helianthus grosseserratus	saw-toothed sunflower					x	x
Helianthus tuberosus	Jerusalem artichoke				x	x	
Heliopsis helianthoides	ox-eye	x			x		
Hieracium scabrum	rough hawkweed			x	x		
Lactuca biennis	blue lettuce		x		x		
Lactuca canadensis	wild lettuce				x		x
Lactuca scariola	prickly lettuce						x
Matricaria matricarioides	pineapple-weed						x
Megalodonta beckii	water-marigold	x	x				
Rudbeckia triloba	thin-leaved coneflower			x	x		
Senecio vulgaris	common groundsel						x
Senecio viscosus	stinking groundsel						x
Solidago nemoralis	gray goldenrod				x	x	
Solidago rugosa	rough-stemmed goldenrod				x	x	x
Sonchus arvensis	field sow-thistle					x	x
Sonchus asper	spiny-leaved sow-thistle						x

Table 61. (continued)

+Dore and Gillett 1955 (except as noted below)

*Muenscher 1931

#Predicted by Dore and Gillett (1955) to disappear from region (Johnstown to Cornwall, Ontario) following flooding from Seaway Project

@Common names and some habitat information according to:
Britton and Brown 1896; Brockman 1968; Cobb 1963; Crum, Steere, and Anderson 1973; Fassett 1975; Grout 1936; Hitchcock 1935; Peterson and McKenny 1968; Petrides 1972; Rickett 1966; Robinson and Fernald 1908; Shuttleworth and Zim 1967; Symonds 1963; Torrey and Gray 1969; and Lesquereux and James 1884.

Table 62. Plant species found along the St. Lawrence River and their occurrence by habitat type. Data taken from studies in the 1970's and 1980's.[a]**

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
	BRYOPHYTA						
**Atrichum hausknichtii*	moss			x	x		
**Brachythecium* spp.	hypnum moss	x		x			
**Bryum argentium*	silvery bryum					x	x
**Callicladium haldanianum*	moss			x			
**Ceratodon purpureus*	purple horn cap moss					x	x
**Climacium dendroides*	European tree moss	x	x	x			
**Dicranum fuscescens*	fuscous dicranum			x			
**Dicranum montanum*	moss			x			
**Dicranum scoparium*	broom moss			x			
**Drepanocladus uncinatus*	moss	x		x			
**Fontinalis* sp.	water moss	x	x				
**Funaria hygrometrica*	cord moss					x	x
**Herzogiella striatella*	moss			x			
**Hypnum pallescens*	hypnum moss			x			
**Leptodictyum riparium*	moss		x				
**Leucobryum glaucum*	white moss			x			
**Plagiothecium cavifolium*	moss			x			
**Pohlia nutans*	nodding bryum		x	x			
**Polytrichum juniperinum*	juniper hair-cap					x	
**Polytrichum ohioense*	Ohio hair-cap			x			
**Rhacomitrium* spp.	moss			x			
**Tetraphis pellucida*	common Georgia pellucida		x	x			
**Thuidium delicatulum*	common fern moss			x			
**Thuidium recognitum*	fern moss			x			
	CHARACEAE						
Chara vulgaris	stonewort	x	x				
	EQUISETACEAE						
Equisetum arvense	common horsetail				x	x	x
#Equisetum fluviatile	water horsetail	x	x				
Equisetum sylvaticum	wood horsetail			x	x		

Table 62. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Succesional fields	Roadsides and waste areas
		Occurrence by habitat					
LYCOPODIACEAE							
Lycopodium clavatum	running clubmoss			x	x	x	
Lycopodium complanatum	ground cedar			x	x		
Lycopodium lucidulum	shining clubmoss			x			
Lycopodium obscurum	tree club moss			x			
OSMUNDACEAE							
Osmunda cinnamomea	cinnamon fern		x	x			
Osmunda claytoniana	interrupted fern			x	x		x
Osmunda regalis	royal fern		x	x			
POLYPODIACEAE							
Adiantum pedatum	maidenhair fern			x			
Athyrium filix-femina	lady fern			x	x		
Cystopteris bulbifera	bulblet fern			x			
Dennstaedtia punctilobula	fragile fern			x			
Dryopteris cristata	hay-scented fern				x	x	x
Dryopteris marginalis	crested wood fern		x	x			
Dryopteris noveboracensis	marginal shield fern			x	x		
Dryopteris spinulosa	spinulose wood fern			x	x		
Dryopteris thelypteris	marsh fern		x	x			
Onoclea sensibilis	sensitive fern		x	x			
Polypodium virginianum	rock polypody			x			
Polystichum acrostichoides	Christmas fern			x	x		
Pteridium aquilinum	bracken fern			x	x	x	
Pteretis pensylvanica	ostrich fern		x	x			
TAXACEAE							
Taxus canadensis	Canadian yew			x	x		
PINACEAE							
Abies balsamea	balsam fir			x			
Juniperus communis	common juniper			x	x	x	
Juniperus virginiana	red cedar			x	x	x	

Table 62. (continued)

Scientific name	Common name	Occurrence by habitat: Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
Larix laricina	tamarack		x	x			
Picea abies	Norway spruce			x	x		
Picea glauca	white spruce			x	x		
+*Picea pungens*	Colorado blue spruce			x	x		
Pinus resinosa	red pine			x	x		
Pinus rigida	pitch pine			x	x		
Pinus strobus	white pine			x	x		
Pinus sylvestris	Scotch pine			x	x		
Thuja occidentalis	white cedar		x	x	x	x	
Tsuga canadensis	eastern hemlock			x			
	TYPHACEAE						
Typha angustifolia	narrow-leaved cattail		x				
Typha glauca	glaucous cattail		x				
Typha latifolia	common cattail		x				
	SPARGANIACEAE						
Sparganium americanum	Nuttall's bur-reed		x				
Sparganium androcladum	branching bur-reed	x	x				
Sparganium chlorocarpum	green-fruited bur-reed	x	x				
Sparganium eurycarpum	giant bur-reed		x				
	POTAMOGETONACEAE						
Potamogeton amplifolius	large-leaved pondweed	x	x				
Potamogeton crispus	curly pondweed	x	x				
Potamogeton epihydrus	Nuttall's pondweed	x	x				
Potamogeton foliosus	leafy pondweed	x	x				
Potamogeton natans	swimming pondweed	x	x				
Potamogeton pectinatus	sago pondweed	x	x				
Potamogeton pusillus	small pondweed	x	x				
Potamogeton richardsonii	Richardson's pondweed	x	x				
Potamogeton robbinsii	Robbins' pondweed	x	x				
Potamogeton zosteriformis	flat-stem pondweed	x	x				

Table 62. (continued)

Scientific name	Common name	Occurrence by habitat: Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
NAJADACEAE							
Najas flexilis	flexible naiad	x	x				
ALISMATACEAE							
Alisma gramineum	Geyer's water plantain	x	x				
+*Alisma plantago-aquatica*	common water plantain	x	x				
Alisma triviale	water plantain		x				
Sagittaria cuneata	arrowhead	x	x				
Sagittaria latifolia	wapato	x	x				
Sagittaria rigida	stiff arrowhead	x	x				
BUTOMACEAE							
Butomus umbellatus	flowering rush		x				
HYDROCHARITACEAE							
Elodea canadensis	waterweed	x	x				
Hydrocharis morsus-ranae	European frog bit	x	x				
Vallisneria americana	wild celery	x	x				
GRAMINEAE							
Agropyron repens	common quackgrass				x	x	x
Agrostis perennans	upland bent grass				x	x	x
Agrostis gigantea	red top				x	x	x
Bromus inermis	awnless brome				x	x	x
Calamagrostis canadensis	blue-joint grass		x				x
Dactylis glomerata	orchard grass				x	x	x
Danthonia spicata	poverty oat grass					x	x
Digitaria sanguinalis	crab grass				x	x	x
Echinocloa crusgalli	barnyard grass		x			x	x
Echinocloa pungens	wild millet		x			x	x
Elymus canadensis	rye grass				x	x	x
Elymus virginicus	wild rye				x	x	x
Festuca ovina	sheep fescue				x	x	

Table 62. (continued)

Scientific name	Common name	Occurrence by habitat: Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
Glyceria grandis	reed meadow grass		x				
Glyceria striata	meadow grass		x				
Leersia oryzoides	rice cutgrass		x			x	
Panicum capillare	witch grass				x	x	x
Phalaris arundinacea	reed canary grass		x			x	
Phleum pratense	timothy				x	x	x
Phragmites communis	giant reed grass		x				x
Poa compressa	Canada bluegrass		x		x	x	
Poa pratensis	Kentucky bluegrass				x	x	x
Poa trivialis	common meadow grass				x	x	x
Zizania aquatica	wild rice	x	x				
	CYPERACEAE						
Carex annectens	sedge					x	x
Carex bebbii	sedge		x			x	
Carex convoluta	sedge				x	x	x
Carex criniata	sedge		x	x			
Carex granularis	sedge		x	x		x	
Carex lacustris	ripgut		x				
Carex lupulina	sedge		x	x			
Carex pedunculata	sedge		x		x		
#*Carex scabrata*	sedge		x	x	x	x	
Carex stricta	tussock sedge		x				
Carex tribuloides	sedge		x	x			
Carex virescens	sedge			x	x	x	
Carex vulpinoidea	sedge		x			x	
Cyperus diandrus	umbrella sedge		x				x
#*Cyperus engelmanni*	umbrella sedge		x			x	x
Cyperus strigosus	umbrella sedge		x				
Eleocharis acicularis	needle rush	x	x				
Eleocharis intermedia	spike rush		x				
Eleocharis obtusa	blunt spike rush		x				
Eleocharis ovata	spike rush		x			x	
Eleocharis robbinsii	triangle spike rush		x				
Scirpus acutus	hard-stemmed bulrush	x	x				
Scirpus americanus	American three-square bulrush	x	x				
Scirpus atrovirens	dark green bulrush	x	x				
Scirpus cyperinus	common woolgrass		x			x	
Scirpus validus	soft-stemmed bulrush	x	x				

Table 62 . (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
		Occurrence by habitat					
	ARACEAE						
Acorus calamus	sweet flag		x				
Arisaema atrorubens	jack-in-the-pulpit			x			
Peltandra virginica	arrow-arum		x				
	LEMNACEAE						
Lemna minor	lesser duckweed		x				
Lemna trisulca	star duckweed	x	x				
Spirodella polyrhiza	greater duckweed		x				
Wolffia punctata	water meal		x				
	PONTEDERIACEAE						
Heteranthera dubia	water-stargrass	x	x				
Pontederia cordata	pickerel weed		x				
	JUNCACEAE						
Juncus atriculatus	rush		x			x	
Juncus balticus	creeping rush		x				
Juncus effusus	soft rush		x			x	
Juncus filiformis	rush		x			x	
Juncus nodosus	rush		x			x	
#*Juncus torreyi*	rush		x			x	x
	LILIACEAE						
Clintonia borealis	clintonia			x			
Erythronium americanum	trout lily			x	x		
Lilium philadelphicum	wood lily			x	x	x	x
Maianthemum canadense	Canada mayflower			x	x		
Medeola virginiana	indian cucumber			x			
Polyganatum biflorum	solomon's seal			x			
Smilacina racemosa	false solomon's-seal			x			
Smilacina stellata	starry false solomon's-seal			x		x	x
Smilax herbacea	greenbrier		x	x	x		
Streptopus roseus	rose twisted-stalk			x			

Table 62. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
		Occurrence by habitat					
Trillium erectum	purple trillium			x			
Trillium grandiflorum	white trillium			x			
Uvularia perfoliata	bellwort			x			
Uvularia sessilifolia	wild oats			x	x	x	
AMARYLLIDACEAE							
Leucojum aestivum	summer snowflake			x	x	x	
IRIDACEAE							
Iris pseudacorus	yellow iris		x			x	
Iris versicolor	blue flag		x	x			
Sisyrinchium montanum	blue-eyed grass				x	x	x
ORCHIDACEAE							
Carallorhiza maculata	spotted coralroot		x				
Cypripedium acaule	stemless lady's slipper		x				
Epipactis helleborine	helleborine		x		x	x	x
Spiranthes cernua	common ladies tresses			x	x	x	
Spiranthes romanzoffiana	hooded ladies tresses			x	x	x	
SAURURACEAE							
Saururus cernuus	lizard's tail		x	x			
SALICACEAE							
Populus balsamifera	balsam poplar			x	x		
Populus deltoides	cottonwood		x	x			
Populus grandidentata	bigtooth aspen			x	x		
+*Populus nigra var. italica*	lombardy poplar				x	x	x
Populus tremuloides	quaking aspen			x	x		
Salix alba	white willow		x		x		
Salix bebbiana	long-beaked willow		x				
Salix discolor	pussy willow		x				
Salix fragilis	crack willow		x				
Salix gracilis	slender willow		x				
Salix lucida	shining willow		x				

Table 62. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
		Occurrence by habitat					
Salix nigra	black willow		x				
Salix purpurea	purple willow		x				
	MYRICACEAE						
Comptonia peregrina	sweet-fern			x	x	x	x
+*Myrica pensylvanica*	northern bayberry	x			x	x	x
	JUGLANDACEAE						
Carya cordiformis	bitternut hickory			x	x		
Carya ovata	shagbark			x	x		
Juglans cinerea	butternut			x	x		
+*Juglans nigra*	black walnut			x	x		
	CORYLACEAE						
Alnus rugosa	speckled alder		x		x		
Betula lutea	yellow birch			x	x		
Betula papyrifera	paper birch			x	x		
Betula populifolia	gray birch			x	x		
Carpinus caroliniana	hornbeam			x	x		
Corylus cornuta	beaked hazelnut			x	x		
Ostrya virginiana	hophornbeam			x	x		
	FAGACEAE						
Castanea dentata	chestnut			x			
Fagus grandifolia	beech			x			
Quercus alba	white oak			x			
Quercus bicolor	swamp white oak			x			
Quercus macrocarpa	bur oak			x			
Quercus rubra	red oak			x			
Quercus velutina	black oak			x	x		
	ULMACEAE						
Ulmus americana	american elm		x	x	x		
Ulmus rubra	red elm			x	x		

Table 62. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
	CANNABINACEAE						
Cannabis sativa	hemp				x	x	x
	URTICACEAE						
Boehmeria cylindrica	false nettle		x				
Laportea canadensis	wood nettle		x		x	x	
Urtica dioica	stinging nettle		x		x	x	x
	ARISTOLOCHIACEAE						
Asarum canadense	wild ginger			x			
	POLYGONACEAE						
Polygonella articulata	knotweed					x	x
Polygonum amphibium	water smartweed		x				
Polygonum coccineum	smartweed		x		x		
Polygonum hydropiper	common smartweed		x				
Polygonum hydropiperoides	water pepper		x				
Polygonum lapathifolium	dock-leaved sorrel				x	x	x
Polygonum pensylvanicum	pink weed				x	x	x
Polygonum persicaria	smartweed		x			x	x
Polygonum punctatum	water smartweed		x				
Polygonum sagittatum	arrow-leaved tearthumb		x				
Rumex acetosella	sheep sorrel				x	x	x
Rumex crispus	yellow dock				x	x	x
Rumex verticillatus	swamp dock		x				
	CHENOPODIACEAE						
Chenopodium album	goosefoot				x	x	x
Salsola kali	common saltwort				x	x	x
	PORTULACACEAE						
Claytonia caroliniana	spring beauty		x				

Table 62. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
		Occurrence by habitat					
CARYOPHYLLACEAE							
**Cerasteum vulgatum*	common mouse-eared chickweed				x	x	x
Dianthus armeria	deptford pink				x	x	x
Lychnis alba	white campion				x	x	x
Saponaria officinalis	bouncing bet					x	x
**Silene cucubalus*	bladder campion				x	x	x
Stellaria graminea	common stitchwort				x	x	x
CERATOPHYLLACEAE							
Ceratophyllum demersum	coontail	x	x				
MAGNOLIACEAE							
Liriodendron tulipifera	tulip tree			x	x		
NYMPHAEACEAE							
Nuphar microphyllum	small yellow water lily	x	x				
Nuphar variegatum	northern yellow water lily	x	x				
**Nymphaea odorata*	sweet-scented white water lily	x	x				
Nymphaea tuberosa	tuberous white water lily	x	x				
RANUNCULACEAE							
Actaea pachypoda	white baneberry			x			
Actaea rubra	red baneberry			x			
Anemone canadensis	anemone			x	x	x	
Aquilegia canadensis	columbine			x	x	x	x
Aquilegia vulgaris	garden columbine					x	x
Caltha palustris	marsh marigold		x	x			
Clematis virginiana	virgin's bower				x	x	x
Coptis groenlandica	goldthread			x			
Delphinium tricorne	dwarf larkspur					x	x
Hepatica acutiloba	sharp-lobed liverleaf			x			
Hepatica americana	round-lobed liverleaf			x			

Table 62. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
		Occurrence by habitat					
Ranunculus acris	common buttercup				x	x	x
Ranunculus repens	creeping buttercup		x		x	x	x
Ranunculus sceleratus	cursed buttercup		x	x			
Ranunculus septentrionalis	swamp buttercup		x				
Ranunculus trichophyllus	water crowfoot		x	x			
Thalictrum dioicum	early meadow rue			x	x	x	
Thalictrum polygamum	tall meadow rue			x	x	x	
BERBERIDACEAE							
Caulophyllum thalictroides	blue cohosh			x			
#*Podophyllum peltatum*	may apple			x	x		
PAPAVERACEAE							
Corydalis sempervirens	corydalis			x	x	x	
Dicentra canadensis	squirrel corn			x			
Dicentra cucullaria	dutchman's breeches			x			
Sanguinaria canadensis	bloodroot			x			
CRUCIFERAE							
**Arabis canadensis*	sicklepod			x			
**Barbarea vulgaris*	winter cress	x			x	x	x
Berteroa incana	hoary alyssum					x	x
Brassica nigra	black mustard					x	x
Capsella bursa-pastoris	shepherd's purse				x	x	x
Cardamine bulbosa	spring cress		x				
Cardamine pensylvanica	bitter cress		x				
Dentaria diphylla	toothwort			x			
Dentaria laciniata	cut-leaved toothwort			x			
Lepidium campestre	cow-cress					x	x
Lepidium densiflorum	peppergrass					x	x
Nasturtium officinale	watercress		x	x			
Raphanus raphanistrum	wild radish					x	x

Table 62. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
	DROSERACEAE						
Drosera rotundifolia	sundew		x				
	CRASSULACEAE						
Sedum acre	mossy stonecrop				x	x	x
Sedum telephium	garden orpine						x
	SAXIFRAGACEAE						
Mitella diphylla	miterwort			x			
Penthorum sedoides	ditch stonecrop		x				
Philadelphus coronarius	mock orange				x		x
Ribes americanum	black currant			x	x		
Ribes hirtellum	gooseberry			x	x		
Tiarella cordifoilia	foamflower			x			
	HAMAMELIDACEAE						
#*Hamamelis virginiana*	witchhazel			x	x		
	ROSACEAE						
Agrimonia gryposepala	agrimony			x	x		
Amelanchier laevis	juneberry			x	x		
Crataegus spp.	hawthorns			x	x	x	x
Fragaria virginiana	strawberry				x	x	
Geum aleppicum	yellow avens				x	x	x
Geum canadense	white avens			x	x		
Geum laciniatum	avens				x	x	x
Geum macrophyllum	large avens			x	x		
Potentilla anserina	silverweed				x	x	x
Potentilla canadensis	Canadian potentilla				x	x	x
Potentilla norvegica	Norwegian cinquefoil				x	x	x
Potentilla palustris	marsh cinquefoil		x				
Potentilla recta	rough-fruited cinquefoil				x	x	x
Potentilla simplex	common cinquefoil				x	x	x
Prunus pensylvanica	fire cherry			x	x	x	

Table 62. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
Prunus serotina	black cherry			x	x		
Prunus virginiana	choke cherry			x	x	x	
+*Pyrus americanus*	American mountain ash			x	x	x	x
Pyrus malus	apple			x	x	x	x
Pyrus melanocarpa	black chokeberry		x	x	x		
Rosa blanda	rose				x	x	
Rosa palustris	marsh rose		x				
Rubus allegheniensis	blackberry			x	x	x	
Rubus idaeus	red raspberry				x	x	x
Rubus odoratus	purple flowering raspberry				x	x	x
+*Rubus parviflorus*	thimbleberry				x	x	x
Rubus pubescens	dwarf blackberry			x	x	x	
Spiraea alba	narrowleaf meadowsweet		x		x		
Spiraea latifolia	meadowsweet		x	x	x	x	
Spiraea tomentosa	hardhack		x		x		
Waldensteinia fragarioides	barren strawberry			x	x		
	LEGUMINOSAE						
Amphicarpa bracteata	hog peanut		x	x			
Desmodium glutinosum	beggar's ticks				x	x	x
Lathyrus palustris	marsh vetchling		x		x	x	
Lathyrus pratensis	yellow vetchling				x	x	
Lathyrus tuberosus	tuberous vetchling				x	x	x
Lotus corniculatus	birdsfoot trefoil					x	x
Medicago lupulina	black medick					x	x
Medicago sativa	alfalfa					x	x
Melilotus alba	white sweet clover				x	x	x
Melilotus officinalis	yellow sweet clover				x	x	x
Robinia pseudo-acacia	black locust			x	x		
Trifolium agrarium	hopclover				x	x	x
Trifolium compestre	low hopclover				x	x	x
Trifolium dubium	little hopclover				x	x	x
Trifolium hybridum	alsike clover					x	x
Trifolium pratense	clover				x	x	x
Trifolium repens	yellow clover				x	x	x
Vicia americana	blue vetch				x	x	x

(Columns Littoral areas through Roadsides and waste areas are grouped under: Occurrence by habitat)

Table 62. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
		Occurrence by habitat					
Vicia cracca	vetch					x	x
Vicia tetrasperma	slender vetch					x	x
	OXALIDACEAE						
Oxalis europaea	European wood sorrel		x	x			
Oxalis stricta	yellow wood sorrel				x	x	x
	GERANIACEAE						
Geranium maculatum	spotted cranesbill				x	x	x
Geranium robertianum	herb robert			x	x		
	RUTACEAE						
Xanthoxylum americanum	prickley ash			x	x	x	
	POLYGALACEAE						
Polygala sanguinea	red milkwort				x	x	
	ANACARDIACEAE						
Rhus radicans	poison ivy		x	x	x	x	x
Rhus typhina	staghorn sumac				x	x	x
	AQUIFOLIACEAE						
Ilex verticillata	winterberry		x		x		
Nemopanthus mucronata	mountain holly		x		x		
	CELASTRACEAE						
Celastrus scandens	climbing bittersweet				x	x	x
	STAPHYLEACEAE						
Staphylea trifolia	bladdernut			x	x		

Table 62. (continued)

Scientific name	Common name	Occurrence by habitat: Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
	ACERACEAE						
Acer negundo	boxelder			x	x	x	x
Acer pensylvanicum	striped maple			x	x		
+*Acer plantanoides*	norway maple			x	x		
Acer rubrum	red maple		x	x	x		
Acer saccharinum	silver maple		x	x			
Acer saccharum	sugar maple			x	x		
Acer spicatum	mountain maple			x	x		
	BALSAMINACEAE						
Impatiens capensis	spotted jewelweed		x	x			
	RHAMNACEAE						
Rhamnus cathartica	buckthorn			x	x	x	x
	VITACEAE						
Parthenocissus quinquefolia	Virginia creeper		x	x	x		
Vitis riparia	frost grape				x	x	x
	TILIACEAE						
Tilia americana	basswood			x	x		
	MALVACEAE						
Hibiscus palustris	marsh mallow		x				
Malva moschata	musk mallow				x	x	x
Malva neglecta	common mallow					x	x
	GUTTIFERAE						
Hypericum perforatum	common St. John's wort				x	x	x
Hypericum punctatum	spotted St. John's wort		x	x		x	

Table 62. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
	Occurrence by habitat						
	VIOLACEAE						
Viola canadensis	tall white violet			x	x		
Viola cucullata	hooded violet			x	x		
Viola papilionacea	butterfly violet			x	x		
Viola pensylvanica	yellow violet						
Viola sororia	violet						
	LYTHRACEAE						
Decodon verticillatus	swamp loosestrife		x				
Lythrum salicaria	purple loosestrife		x				x
	ONAGRACEAE						
Circaea quadrisculcata	enchanter's nightshade		x	x			
**Epilobium angustifolium*	fireweed		x				
Epilobium coloratum	purple-leaved willow herb		x		x	x	
Epilobium hirsutum	willow herb		x				
Ludwigia palustris	water purslane		x				
Oenothera biennis	evening primrose				x	x	x
	HALORAGACEAE						
Myriophyllum exalbescens	spiked water milfoil	x	x				
Myriophyllum heterophyllum	various-leaved water milfoil	x	x				
Myriophyllum verticillatum	green milfoil	x	x				
	ARALIACEAE						
Aralia racemosa	spikenard			x			
Aralia nudicaulis	sarsaparilla			x	x		
	UMBELLIFERAE						
Aegopodium podagraria	honewort						x
#*Angelica atropurpurea*	angelica					x	x
Cicuta bulbifera	water hemlock		x	x			

Table 62. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
Cicuta maculata	spotted cowbane		x			x	
Cryptotaenia canadensis	honewort			x	x		
Daucus carota	wild carrot				x	x	x
Pastinaca sativa	cow parsnip					x	x
Sium suave	water parsnip		x				
#*Zizia aurea*	golden alexanders		x	x			
	CORNACEAE						
Cornus alternifolia	alternate-leaf dogwood			x	x		
Cornus amomum	red willow		x	x	x		
Cornus canadensis	bunchberry			x	x	x	x
Cornus racemosa	panicled dogwood		x	x	x	x	x
Cornus stolonifera	red osier		x		x	x	
	PYROLACEAE						
Monotropa uniflora	indian pipe			x			
Pyrola elliptica	shinleaf			x	x		
	ERICACEAE						
Gaultheria procumbens	wintergreen			x	x		
Vaccinium angustifolium	blueberry			x	x	x	
Vaccinium corymbosum	high bush blueberry		x		x		
	PRIMULACEAE						
Lysimachia ciliata	loosestrife		x	x			
Lysimachia nummularia	moneywort			x			x
Lysimachia quadrifolia	whorled loosestrife		x				
Lysimachia terrestris	swamp candles		x	x			
Lysimachia thyrsiflora	tufted loosestrife		x				
Trientalis borealis	star flower			x			
	OLEACEAE						
Fraxinus americana	white ash		x	x	x	x	
Fraxinus nigra	black ash		x				
Fraxinus pennsylvanica	red ash		x	x	x		
Syringa vulgaris	lilac					x	x

Table 62 . (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
GENTIANACEAE							
Centaurium umbellatum	centaury					x	x
Gentiana andrewsii	closed gentian		x		x		
APOCYNACEAE							
Apocynum androsaemifolium	spreading dogbane				x	x	x
Vinca minor	periwinkle				x	x	x
ASCLEPIADACEAE							
Asclepias incarnata	swamp milkweed		x		x		
Asclepias syriaca	milkweed				x	x	x
CONVOLVULACEAE							
Convolvulus arvenis	field bindweed					x	x
Convolvulus sepium	hedge bindweed					x	x
+*Cuscuta gronovii*	dodder				x	x	x
+*Ipomoea purpurea*	morning glory						x
HYDROPHYLLACEAE							
Hydrophyllum virginianum	waterleaf		x	x			
BORAGINACEAE							
Cynoglossum officinale	Hound's tongue					x	x
Echium vulgare	vipers bugloss				x	x	x
Myosotis laxa	forget-me-not					x	x
VERBENACEAE							
Verbena hastata	blue vervain		x		x		
LABIATAE							
Galeopsis tetrahit	hemp nettle					x	x

Table 62. (continued)

Scientific name	Common name	Occurrence by habitat: Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
Glechoma hederacea	ground ivy					x	x
Leonurus cardiaca	motherwort					x	x
Lycopus americanus	cut-leaved water-horehound		x			x	
Lycopus uniflorus	bugleweed		x			x	
Mentha arvensis	horseweed		x			x	
#*Monarda fistulosa*	wild bergamot			x	x	x	
Nepeta cataria	catnip					x	x
Prunella vulgaris	heal all					x	x
Satureja vulgaris	basil					x	x
Scutellaria epilobiifolia	marsh skullcap		x		x	x	
Scutellaria laterifolia	mad-dog skullcap		x			x	
Stachys palustris	sound wort		x	x		x	
Stachys tenuifolia	hedge nettle		x	x			
SOLANACEAE							
Lycium halimifolium	matrimony ivy				x		x
Solanum dulcamara	bittersweet nightshade				x	x	x
Solanum nigrum	common nightshade						x
SCROPHULARIACEAE							
Chelone glabra	turtlehead		x				
Euphrasia officinalis	eyebright					x	x
Gerardia tenuifolia	gerardia			x	x	x	
Gratiola neglecta	hedge hyssop		x			x	
Linaria vulgaris	butter-and-eggs					x	x
Mimulus ringens	monkey flower		x			x	
#*Penstemon hirsutus*	beard tongue					x	x
Scrophularia lanceolata	figwort			x	x		
Scrophularia marilandica	carpenter's square			x	x		
Verbascum thapsus	common mullein				x	x	x
Veronica officinalis	speedwell					x	x
LENTIBULARIACEAE							
Utricularia vulgaris	blatterwort	x	x				
ACANTHACEAE							
+*Justicia americana*	water willow	x	x				

Table 62. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
		Occurrence by habitat					
	PHRYMACEAE						
Phryma leptostachya	lopseed			x			
	PLANTAGINACEAE						
Plantago lanceolata	ribgrass				x	x	x
Plantago major	common plantain				x	x	x
Plantago rugelli	plantain				x	x	x
	RUBIACEAE						
Cephalanthus occidentalis	buttonbush		x		x		
Galium mollugo	wild madder				x	x	x
Galium obtusum	bedstraw				x	x	
Galium triflorum	sweet scented bedstraw				x	x	
Mitchella repens	partridge berry			x			
	CAPRIFOLIACEAE						
Diervilla lonicera	bush honeysuckle			x	x	x	
Lonicera canadensis	fly honeysuckle			x	x	x	
Lonicera sempervirens	trumpet honeysuckle					x	x
Lonicera tatarica	tartarium honeysuckle				x	x	x
Sambucus canadensis	elderberry		x	x	x	x	x
Sambucus pubens	red elderberry			x	x	x	x
Symphoricarpos albus	snowberry				x	x	x
Viburnum acerifolium	maple-leafed viburnum			x	x		
**Viburnum alnifolium*	hobblebush			x	x		
Viburnum cassinoides	wild raisin		x	x	x		
Viburnum lentago	nannyberry			x	x	x	
Viburnum recognitum	arrow wood			x	x	x	
	VALERIANACEAE						
Valeriana officinalis	valerian				x	x	x

Table 62. (continued)

Scientific name	Common name	Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
		Occurrence by habitat					
	CAMPANULACEAE						
Campanula aparinoides	marsh bellflower		x				
Campanula glomerata	clustered bellflower					x	x
Campanula rapunculoides	bellflower					x	x
#*Campanula rotundifolia*	harebell		x		x		
Lobelia cardinalis	cardinal flower		x			x	
Lobelia inflata	indian tobacco					x	x
Lobelia kalmii	lobelia		x			x	
	COMPOSITAE						
Achillea millefolium	yarrow				x	x	x
Ambrosia artemisiifolium	ragweed					x	x
Anaphalis margaritacea	pearly everlasting				x	x	x
Antennaria neglecta	pussy's toes					x	x
Anthemis cotula	mayweed						x
Arctium minus	burdock					x	x
Aster acuminatus	whorled wood aster			x	x		
Aster cordifolius	heart-leaved aster			x	x	x	
Aster lateriflorus	calico aster				x	x	
Aster lowrieanus	lowrie's aster			x	x		
Aster macrophyllus	large-leaved aster			x	x		
Aster novae-angliae	New England aster				x	x	x
Aster prenanthoides	crooked-stemmed aster			x			
Aster puniceus	purple-stemmed aster				x	x	
Aster simplex	panicled aster				x	x	
Aster tradescanti	tradescant's aster					x	
Aster umbellatus	flat-topped white aster				x	x	
Bidens cernua	stick tight		x				
Bidens frondosa	beggar ticks				x	x	x
Bidens laevis	bur marigold		x				
Centaurea maculosa	Star thistle					x	x
Chrysanthemum leucanthemum	ox-eye daisy					x	x
Cichorium intybus	chicory				x	x	x
Cirsium arvense	Canadian thistle				x	x	
Cirsium discolor	field thistle				x	x	
Cirsium vulgare	common thistle				x	x	
Erigeron annuus	daisy fleabane				x	x	x
Erigeron philadelphicus	common fleabane				x	x	x

Table 62. (continued)

Scientific name	Common name	Occurrence by habitat: Littoral areas	Wetlands	Forests	Shrubby fields and shrublands	Successional fields	Roadsides and waste areas
Erigeron strigosus	daisy fleabane					x	x
Eupatorium maculatum	spotted Joe-Pye-weed		x			x	
Eupatorium perfoliatum	boneset		x	x		x	
Eupatorium purpureum	sweet Joe-Pye-weed		x			x	
Eupatorium rugosum	white snakeroot			x	x		
Gnaphalium obtusifolium	sweet everlasting				x	x	
Gnaphalium uliginosum	low cudweed					x	x
Helianthus divaricatus	woodland sunflower			x	x		
Hieracium aurantiacum	orange hawkweed					x	x
Hieracium florentinum	yellow hawkweed					x	x
Hieracium pratense	king devil					x	x
Inula helenium	elecampane				x	x	x
Picris hieracioides	picris				x	x	x
Prenanthes alba	lion's foot			x	x		
Prenanthes altissima	rattlesnake root			x			
Prenanthes trifoliota	gall-of-the-earth				x	x	
Rudbeckia hirta	black-eyed susan				x	x	x
Solidago altissima	tall goldenrod				x	x	
Solidago bicolor	silverrod				x	x	
Solidago caesia	blue-stem goldenrod			x			
Solidago canadensis	canada goldenrod				x	x	x
**Solidago flexicaulis*	zigzag goldenrod			x	x		
Solidago gigantea	late goldenrod				x	x	
Solidago graminifolia	lance-leaved goldenrod				x	x	
Solidago juncea	early goldenrod				x	x	x
Sonchus oleraceus	sow thistle					x	x
Tanacetum vulgare	tansy					x	x
Taraxacum officinale	dandelion				x	x	x
Tragopogon pratensis	goat's beard					x	x
Xanthium strumarium	cocklebur					x	x

@Geis 1977 (except as noted below)

*U.S. Fish and Wildlife Service 1979

+U.S. Fish and Wildlife Service 1983

#Predicted by Dore and Gillett (1955) to disappear from region (Johnstown to Cornwall, Ontario) following flooding from Seaway Project

Table 62. (continued)

**Common names and some habitat information according to Britton and Brown 1896; Brockman 1968; Cobb 1963; Crum, Steere, and Anderson 1973; Fassett 1975; Grout 1936; Hitchcock 1935; Peterson and McKenny 1968; Petrides 1972; Rickett 1966; Robinson and Fernald 1908; Shuttleworth and Zim 1967; Symonds 1963; Torrey and Gray 1969; and Lesquereux and James 1884.

Table 63 . Annotated list of fishes of the St. Lawrence River watershed.*

Petromyzontidae - lampreys

1. Ichthyomyzon fossor - Northern brook lamprey. Nonparasitic. May be found in tributary streams, but has not been recorded from the St. Lawrence River. Scott and Crossman give its habitat as creeks and small rivers, but state that it avoids both small brooks and large rivers.

2. Ichthyomyzon unicuspis - Silver lamprey. Parasitic. Adults occasionally found attached to fish. Greeley listed this species as rare. Ammocetes probably do not occur in the St. Lawrence River.

3. Lampetra lamottei - American brook lamprey. Nonparasitic. Prefers cold brooks and small rivers. Has not been recorded from the St. Lawrence River.

4. Petromyzon marinus - Sea lamprey. Parasitic. Considered rare by Greeley. Occasionally found attached to fish. A 1971 survey of New York's St. Lawrence tributaries failed to discover any ammocete populations (Eckert, unpublished manuscript). Adults found in the St. Lawrence probably come mainly from Lake Ontario.

Acipenseridae - sturgeons

5. Acipenser fulvescens - Lake sturgeon. A once abundant species, now drastically reduced due to a combination of overexploitation and degradation of its habitat. Greeley considered it rare in the St. Lawrence above Ogdensburg, but moderately common below. A two year study of the sturgeon in New York waters of the St. Lawrence carried out in 1969 and 1970 (Jolliff and Eckert, unpublished report) found the species rare above the Moses-Saunders Power Dam, but moderately common below. However, even this population was composed mainly of young individuals, and appeared to be overexploited. Male sturgeon in spawning condition were found to congregate below the Moses-Saunders Dam, but spawning could not be documented.

   Rare in 1976 project sampling due primarily to inappropriate sampling gear.

Lepisosteidae - gars

6. Lepisosteus osseus - Longnose gar. Moderately common in shallow bays and creeks. Rarely taken by anglers. May have increased in the lower St. Lawrence following formation of Lake St. Lawrence.

Table 63 . (Continued)

Amiidae - bowfins

7. Amia calva - Bowfin. Moderately common in shallow areas. Rarely taken by anglers.

Anguillidae - freshwater eels

8. Anguilla rostrata - American eel. Common throughout the river, abundant in Lake Ontario. Young eels moving upstream are delayed and at times concentrated below the Moses-Saunders Dam. Adult eels moving downstream are often killed as they attempt to pass through the dam's turbines. The extent and significance of this mortality is unknown.

Clupeidae - herrings

9. Alosa pseudoharengus - Alewife. Abundant throughout most areas of the St. Lawrence River. An important forage fish. Probably increased in the lower St. Lawrence due to the formation of Lake St. Lawrence.

10. Alosa sapidissima - American shad. Greeley reported a single specimen from Cape Vincent. Apparently the result of introductions into Lake Ontario which eventually proved unsuccessful. Now extinct in Lake Ontario and the St. Lawrence above the Ottawa River.

11. Dorosoma cepedianum - Gizzard shad. Fairly common throughout the St. Lawrence River. Common to abundant in Lake Ontario. May be a fairly recent arrival to the St. Lawrence, and was not reported by Greeley.

Hiodontidae - mooneyes

12. Hiodon tergisus - Mooneye. Rare. One specimen collected just above Iroquois Dam; a second reported from Ogdensburg in 1973. Apparently has declined in abundance since the 1930's. Greeley listed them as fairly common and made several large catches with gill nets. Scott and Crossman report them to be sensitive to siltation and turbidity. Degradation of the river may be a factor in their decline.

Table 63. (continued)

Salmonidae - trouts

13. Coregonus artedii - Cisco. Greeley reported catching numbers of young (0+) ciscoes around Waddington and Ogdensburg, and that adults were common in Lake Ontario. The population in Lake Ontario has apparently declined since that time, but adults are still fairly common and undoubtedly stray into the upper end of the river (area 1). No specimens were collected in 1976.

14. Coregonus clupeaformis - Lake whitefish. Greatly reduced populations in Lake Ontario and some Adirondack lakes. Could stray into the St. Lawrence River, although it has never been reported.

15. Coregonus hoyi - Bloater. One of the deepwater ciscoes. Now rare and possibly on the way to extinction in Lake Ontario. Could conceivably stray in the St. Lawrence River, although it has never been reported.

16. Coregonus kiyi - Kiyi. Another deepwater cisco. Now rare or extinct in Lake Ontario. Could conceivably stray in the St. Lawrence River, although it has never been reported.

17. Coregonus nigripinnus - Blackfin cisco. Same as for C. kiyi.

18. Coregonus reighardi - Shortnose cisco. Same as for C. kiyi.

19. Oncorhynchus kisutch - Coho salmon. Introduced into Lake Ontario. Individuals undoubtedly stray into the river, but would not tolerate the warm summer temperatures. Was not collected or positively identified from angler catches in 1976.

20. Oncorhynchus nerka - Sockeye or kokanee salmon. Same as for O. kisutch but is rare in Lake Ontario.

21. Oncorhynchus tshawytscha - Chinook salmon. Same as for O. kisutch.

22. Prosopium cylindraceum - Round whitefish. Rare in Lake Ontario and some Adirondack Lakes. Could possibly stray into the St. Lawrence River, although none have ever been documented.

23. Salmo gairdneri - Rainbow trout. Common in Lake Ontario, Adirondack Lakes, and tributary streams. Occasionally strays into the St. Lawrence River. Reports of these strays taken by anglers are not uncommon. Was documented from the river in 1976. Probably limited by warm water temperatures in the summer months.

24. Salmo salar - Atlantic salmon. Once abundant throughout Lake Ontario and the St. Lawrence system, but extinct by 1900. Has been reintroduced into connecting waters, and could conceivably stray into the St. Lawrence when water temperatures are cool. Has not been reported in recent years.

Table 63 . (Continued)

25. Salmo trutta - Brown trout. Same as for S. gairdneri.

26. Salvelinus fontinalis - Brook trout. Common throughout the watershed in headwater tributaries and ponds. Might stray into the St. Lawrence River, but would be unable to tolerate the summer water temperatures.

27. Salvelinus namaycush - Lake trout. Common in Lake Ontario and some Adirondack lakes. Could stray into the St. Lawrence River, but would be unable to tolerate the summer water temperatures.

28. Salvelinus namaycush x fontinalis - Splake. Have been stocked in Lake Ontario and the Adirondacks. Could stray into the river but would also be unable to tolerate summer temperatures.

Osmeridae - smelts

29. Osmerus mordax - Rainbow smelt. A recent invader into Lake Ontario, where it is abundant, and the St. Lawrence River, where it is common. Temperatures may be something of a limiting factor in the river. A local ice fishery for smelt occurs in the Lake St. Lawrence area.

Umbridae- mudminnows

30. Umbra limi - Central mudminnow. Uncommon in the open areas of the St. Lawrence River. Prefers heavily vegetated areas and are therefore found most frequently in creek mouths, bays, marshes. Abundant in tributaries to the St. Lawrence River.

Esocidae - pikes

31. Esox americanus - Redfin or grass pickerel. Common in shallow weedy bays and tributaries. Rare in open river.

32. Esox lucius - Northern pike. An abundant and very important game fish throughout the length of the river. According to a 1973 angler survey, the river is the most important northern pike water in New York, accounting for approximately 22% of the State's harvest. Marshes and flooded shorelines are used for spawning, and undoubtedly are a key factor in the succcss of pike reproduction.

33. Esox masquinongy - Muskellunge. A relatively uncommon but extremely important game and trophy fish. Generates a great deal of public interest. The world record muskellunge, 69 lbs. 15 oz., was taken in the Thousand Islands area in 1957.

34. Esox niger - Chain pickerel. Exists in lakes and ponds within the St. Lawrence-Lake Ontario watershed. Has not been reported from the river.

Table 63. (continued)

Cyprinidae - minnows and carps

35. Campostoma anomalum - Stoneroller. Common in tributaries to Lake Ontario. Could conceivably stray into the St. Lawrence River, but has never been recorded.

36. Carassius auratus - Goldfish. Occasionally observed in the river. Some are gold in color and are probably recent introductions. Wild populations are known in Lake Ontario, but have not been observed in the St. Lawrence.

37. Clinostomus elongatus - Redside dace. Present in clear cool water tributaries. Have not been documented from the St. Lawrence River.

38. Couesius plumbeus - Lake chub. Fairly common in Lake Ontario, and lakes and rivers in the Adirondacks. Generally limited to cold water areas. Has not been documented from the St. Lawrence.

39. Cyprinus carpio - Carp. Very common throughout the river, and may comprise a significant part of the biomass in some areas. Receives little attention from sport or commercial anglers. Probably has increased in the areas below Ogdensburg due to the formation of Lake St. Lawrence.

40. Exoglossum maxillingua - Cutlips minnow. Considered common by Greeley in the St. Lawrence below Ogdensburg. A few were collected around Ogdensburg in 1976, and now should probably be considered uncommon.

41. Hybognathus hankinsoni - Brassy minnow. Rare. Only a few specimens taken in 1976 sampling. Greeley did not find this minnow in the St. Lawrence, but listed it as common in Adirondack streams. Apparently prefers cooler waters.

42. Hybognathus nuchalis - Silvery minnow. Common in 1976 samplings. Distribution appears spotty, but several very large collections were made. Greeley listed this species for eastern Lake Ontario, but did not find it in the St. Lawrence River.

43. Notemigonus crysoleucas - Golden shiner. Greeley lists this species as abundant. Very common in 1976 sampling, including several large collections of young-of-the-year. Undoubtedly an important forage fish. Used extensively for bait fishing.

44. Notropis analostanus - Satinfin shiner. Has been reported in the Black and Oswegatchie River systems, but never from the St. Lawrence River.

Table 63 . (Continued)

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45. Notropis anogenus - Pugnose shiner. Rare. Greeley reporting collecting a single individual in lower French Creek near Clayton, New York. The 1976 sampling resulted in a single collection of nine fish from Eel Bay, also near Clayton, New York. Some of these specimens appeared to be in spawning condition.

46. Notropis antherinoides - Emerald shiner. Uncommon in Greeley's surveys and in the 1976 project sampling. Only a few individuals scattered here and there.

47. Notropis bifrenatus - Bridle shiner. Listed by Greeley as very common in marsh areas along the St. Lawrence River. This species was rare in the 1976 sampling, with only two collections, both from the Thousand Islands. One collection contained 16 specimens, while the second had only one specimen.

48. Notropis cornutus - Common shiner. Greeley states that the common shiner is abundant everywhere, and that it is found in the St. Lawrence. However, he gives no real indication as to its abundance in the river. This species was rare in the 1976 sampling, with a few scattered collections containing one or two individuals.

49. Notropis heterodon - Blackchin shiner. Rare in 1976. Present in four collections, eight individuals total. Listed by Greeley as moderately common above Ogdensburg, but rare below.

50. Notropis heterolepis - Blacknose shiner. Rare in 1976. Present in four collections, 12 individuals total, all from the river below Ogdensburg. Listed by Greeley as uncommon to moderately common, but gives no specifics for the St. Lawrence River.

51. Notropis hudsonius - Spottail shiner. Abundant. One of the most common minnows in the 1976 sampling. Found throughout the river, often in large numbers. Undoubtedly an extremely important forage fish. Occasionally used as bait. Greeley also listed this minnow as abundant.

52. Notropis rubellus - Rosyface shiner. Rare in 1976. Represented by a single specimen taken in Lake St. Lawrence. Listed by Greeley as rare or uncommon in lower areas of St. Lawrence River tributaries, but did not sample this species in the river proper.

53. Notropis spilopterus - Spotfin shiner. A common minnow, but generally found scattered in small groups. One exceptionally large collection (620 individuals) was taken near Cape Vincent. Listed by Greeley as moderately common. He also makes the statement that although it is quite numerous, it does not appear to predominate in the minnow fauna at any one place.

Table 63. (continued)

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54. Notropis stramineus - Sand shiner. A common minnow in areas 4 and 5 of the St. Lawrence River. Not taken elsewhere in 1976. Listed by Greeley as common in eastern Lake Ontario, but rare in the St. Lawrence with a few scattered collections around Ogdensburg.

55. Notropis volucellus - Mimic shiner. Rare in 1976. Only one collection of four fish from the St. Lawrence below the Moses-Saunders Power Dam (area 6). Greeley listed this species as very common, and important as a forage and bait fish.

56. Phoxinus eos - Northern redbelly dace. Listed by Greeley as abundant in Adirondack tributaries of the St. Lawrence, but not in the river proper. Could possibly stray into the river when water temperatures are cooler.

57. Phoxinus neogaeus - Finescale dace. Same as for P. eos.

58. Pimephales notatus - Bluntnose minnow. Abundant. One of the most common minnows in the 1976 sampling. Found throughout the river, often in large numbers. Undoubtedly an extremely important forage fish. Greeley also listed this minnow as abundant.

59. Pimephales promelas - Fathead minnow. Common in ponds and tributaries of the St. Lawrence, but rare in the river proper. Seven specimens from five collections were taken in 1976. Greeley reported a single individual from the mouth of a tributary.

60. Rhinichthys atratulus - Blacknose dace. Common to abundant in tributary streams. Prefers swift moving waters, and consequently has not been reported from the St. Lawrence proper.

61. Rhinichthys cataractae - Longnose dace. Prefers rocky areas, but often with less gradient than for the blacknose dace. Greeley lists this species as common in tributaries, with some(?) collections in the St. Lawrence. Seven individuals were taken in five collections in 1976. May have declined as a result of the formation of Lake St. Lawrence.

62. Semotilus atromaculatus - Creek chub. Prefers small tributary streams and ponds. Greeley reported a few taken at the mouth of Sucker Brook near Waddington. One individual was taken in area 3 in 1976.

63. Semotilus corporalis - Fallfish. A common species in the river, especially in areas of faster current. Probably important as a forage fish. Greeley also listed this species as common, and states that it was an important bait fish.

Table 63. (continued)

64. _Semotilus margarita_ - Pearl dace. Prefers cool headwater streams. Common in some tributaries, but has not been reported from the St. Lawrence.

Catostomidae - suckers

65. _Carpiodes cyprinus_ - Quillback. Occasionally found in Lake Ontario, and may be present in the river. Was not collected by Greeley or by project sampling.

66. _Catostomus catostomus_ - Longnose sucker. Prefers clear cold waters. Common in the Adirondacks. Has been reported from Lake Ontario, but not from the St. Lawrence.

67. _Catostomus commersoni_ - White sucker. An abundant fish species throughout the St. Lawrence River. Probably constitutes a large part of the biomass in some areas. Utilized for bait, and occasionally for food. Also an important forage fish.

68. _Erimyzon oblongus_ - Creek chubsucker. Found in eastern Lake Ontario and possibly some tributaries of the St. Lawrence. Has not been reported from the river.

69. _Hypentelium nigricans_. Northern hogsucker. Common in tributaries of eastern Lake Ontario. Prefers gravel and rubble bottomed streams. Has not been reported from the St. Lawrence River.

70. _Moxostoma anisurum_ - Silver redhorse. A large relatively common sucker in the 1976 sampling. Taken mainly in gill nets. Listed as rare by Greeley.

71. _Moxostoma carinatum_ - River redhorse. Reported to have a discontinuous distribution. Found in the lower St. Lawrence River near Montreal, and in the Great Lakes west of Lake Ontario. Has not been reported from New York's portion of the St. Lawrence.

72. _Moxostoma duquesnii_ - Black redhorse. Reported from western Lake Ontario, and the St. Lawrence near Montreal. Has not been reported from New York's portion of the river.

73. _Moxostoma erythrurum_ - Golden redhorse. Reported from western Lake Ontario, but not from the St. Lawrence River.

74. _Moxostoma hubbsi_ - Copper redhorse. Found in the St. Lawrence River near Montreal. Has not been reported from New York's portion of the river.

Table 63 . (continued)

75. Moxostoma macrolepidotum - Shorthead redhorse. Listed by Greeley as the most common redhorse sucker in the St. Lawrence. Uncommon in the 1976 sampling, with only a few taken in gill nets.

76. Moxostoma valenciennesi - Greater redhorse. A common fish in the 1976 sampling, and probably the most common redhorse taken. Captured in both gill nets and trap nets. Is probably taken by spearing in the spring. Greeley listed this species as rare.

Ictaluridae - Freshwater catfishes

77. Ictalurus melas - Black bullhead. Has been found in a few tributaries of Lake Ontario and the St. Lawrence River. Listed as rare. Has not been reported from the St. Lawrence River proper.

78. Ictalurus natalis - Yellow bullhead. Rare. Two specimens collected in area 2 in 1976. Scattered specimens have also been seen from eastern Lake Ontario during the past several years. Easy to confuse with the brown bullhead, and some specimens may be missed because of this. Greeley reported taking them only in Black Lake, Oswegatchie watershed.

79. Ictalurus nebulosus - Brown bullhead. A very abundant and important sport fish throughout the river. Trap net catches indicate that this fish is one of the dominant species, at least in shallower waters. Highly regarded as a food fish and provides a great deal of angling, especially in the spring. Commercially harvested on the Canadian shore of the river, and on both sides of Lake Ontario. The 1973 angler survey estimated that approximately 460,000 were harvested in the St. Lawrence by New York fishermen. Spawns in shallow water along shore, in bays, and in creek mouths.

80. Ictalurus punctatus - Channel catfish. Relatively common throughout the river. Occasionally taken by angling. Greeley listed the species as rare, but was able to document spawning nearshore in Eel and Chippewa Bays.

81. Noturus flavus - Stonecat. Common in tributary streams. Greeley listed this species as moderately common along the rocky shores of the St. Lawrence and Lake Ontario. Several specimens have been taken in gill nets set in Lake Ontario in recent years, but was not taken in the river in 1976.

82. Noturus gyrinus - Tadpole madtom. Rare. One specimen collected in area 2 in 1976. Greeley reported taking a single specimen at the mouth of Tibbits Creek, near Ogdensburg.

Table 63. (continued)

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83. Noturus insignis - Margined madtom. Reported from the south shore of Lake Ontario, but not from the St. Lawrence River.

84. Noturus miurus - Brindled madtom. Same as N. insignis.

Percopsidae - trout-perches

85. Percopsis omiscomaycus - Trout-perch. Abundant in deep water in Lake Ontario and the upper St. Lawrence, where it is vulnerable to otter trawls. Undoubtedly an important forage fish in those areas. Present throughout the remainder of the river, but difficult to assess due to sampling problems. Greeley lists this species as rare, but also mentioned sampling difficulties.

Gadidae - codfishes

86. Lota lota - Burbot. Rare. Two specimens taken in gill nets just below the Moses-Saunders Power Dam. Greeley also considered it rare.

Cyprinodontidae - killifishes

87. Fundulus diaphanus - Banded killifish. An abundant, widely distributed species, probably important as a forage fish. Greeley lists it as common in the upper, but uncommon in the lower river. Abundance has probably increased in the lower river due to the formation of Lake St. Lawrence.

Atherinidae - silversides

88. Labidesthes sicculus - Brook silverside. An uncommon but widely distributed fish in 1976 sampling. Difficult to sample since it tends to remain near the surface in open water. Greeley listed this fish as moderately common in the upper river, but rare in the lower river.

Gasterosteidae - sticklebacks

89. Culaea inconstans - Brook stickleback. Common in tributaries of Lake Ontario and the St. Lawrence. Prefers cool, weedy waters. Rare in the St. Lawrence with a few fish taken in area 4. Greeley reported a few specimens in the river from the mouth of a stream.

Table 63. (continued)

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90. Gasterosteus aculeatus - Threespine stickleback. Common in Lake Ontario but rare in the St. Lawrence River. Only one collection of five individuals was made in 1976 in Lake St. Lawrence. Greeley reported this species as rare to moderately common.

91. Pungitius pungitius - Ninespine stickleback. Reported to be present in the deep cool waters of Lake Ontario. Has not been found in the St. Lawrence River.

Percichthyidae - temperate bases

92. Morone americana - White perch. Abundant in Lake Ontario, relatively common in the upper St. Lawrence, and very common in the lower river (areas 5 and 6). A recent invader of the system, it was not present when Greeley did his surveys. While not highly esteemed by most fishermen, it does provide some angling opportunity.

93. Morone chrysops - White bass. Uncommon in Lake Ontario, rare in the upper St. Lawrence, but common in the river below the Moses-Saunders Power Dam. Greeley failed to capture any during his surveys.

Centrarchidae - sunfishes

94. Ambloplites rupestris - Rock bass. An abundant and important fish throughout the river. While not highly regarded as a sport fish, it is easy to catch and does provide a great deal of angling. Listed by Greeley as abundant.

95. Lepomis cyanellus - Green sunfish. Known to occur along southern Lake Ontario. Has not been reported from the St. Lawrence River.

96. Lepomis gibbosus - Pumpkinseed. An abundant pan fish, especially in shallow bays. Although it does not reach a large size, it is easy to catch and consequently provides a great deal of angling. Listed by Greeley as abundant.

97. Lepomis macrochirus - Bluegill. Relatively common in bays and shallow areas of some portions of the river. Value as a sport fish is not high due to small sizes reached in these northern waters, and spotty distribution. Greeley recorded this species in lakes in the Oswegatchie watershed, but not from the St. Lawrence.

98. Lepomis megalotis - Longear sunfish. Reported from the St. Lawrence River in Quebec, and possibly western New York. Has not been identified in New York's portion of the St. Lawrence.

Table 63. (continued)

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99. Micropterus dolomieui - Smallmouth bass. Abundant. Unquestionably the most important game fish in the area. Highly esteemed by anglers; most of whom prefer to fish for this species. The 1973 angler survey estimated that 287,000 were taken by New York fishermen, second only to Lake Ontario. Shallow water gravel areas are required for spawning. Young-of-the-year bass make extensive use of the littoral zone.

100. Micropterus salmoides - Largemouth bass. Common, especially in shallow weedy bays. Highly regarded as a game fish. The 1973 angler survey estimated that 96,000 were taken by New York anglers, making the river the number one largemouth water for the State. Young bass make extensive use of the littoral zone.

101. Pomoxis annularis - White crappie. Reported from western New York and Lake Ontario. Has not been reported from the St. Lawrence River.

102. Pomoxis nigromaculatus - Black crappie. Common throughout the river. Makes extensive use of bays and stream mouths during the spring, probably for spawning. Is well regarded as a pan fish, and provides a great deal of angling opportunity, mostly in the spring. Apparently has increased in the river below Ogdensburg as a result of the formation of Lake St. Lawrence.

Percidae - perches

103. Ammocrypta pellucida - Eastern sand darter. Found in the St. Lawrence River near Montreal, and to the southwest in Lake Erie. Has not been reported in the New York portion of the St. Lawrence.

104. Etheostoma blennioides - Greenside darter. Reported from southern Lake Ontario. Has not been reported from the St. Lawrence River.

105. Etheostoma caeruleum - Rainbow darter. Reported from western Lake Ontario. Has not been reported from the St. Lawrence River.

106. Etheostoma exile - Iowa darter. Rare in 1976 sampling. A few were sampled in area 5, near Waddington, in exploratory seining on May 20. The fish were in spawning condition. Apparently moved into deeper water after spawning, and was not captured in later sampling. Greeley listed this species as uncommon, and reported capturing it only during the spawning period.

107. Etheostoma flabellare - Fantail darter. Common in tributary streams and in deep waters of Lake Ontario. Greeley listed this species as rare in the river, finding only a few among the rocks near shore. Has not been taken in the 1976 sampling.

Table 63. (continued)

108. Etheostoma microperca - Least darter. Same as E. caeruleum.

109. Etheostoma olmstedi - Tessellated darter. The taxonomy of this species is quite confused. Has been previously listed as E. nigrum - Johnny darter. Abundant throughout the river. Undoubtedly is an important forage fish.

110. Perca flavescens - Yellow perch. Abundant throughout the river. An extremely important pan fish, providing a great deal of angling opportunity. Highly esteemed as a food fish. The 1973 angler survey estimated that nearly 1,560,000 were taken by New York anglers from the river, making the St. Lawrence the third most productive perch water in the State.

111. Percina caprodes - Logperch. Relatively common in the river below Ogdensburg. However, was not sampled above Ogdensburg in 1976. Common in tributary streams. Greeley listed the species as common to abundant in the river, and stated that it was an important forage fish.

112. Percina copelandi - Channel darter. Listed by Greeley as rare, although widely distributed along the river. Was not collected in 1976.

113. Percina maculata - Blackside darter. Reported from western Lake Ontario. Has not been recorded in the St. Lawrence.

114. Stizostedion canadense - Sauger. Considered rare throughout Lake Ontario and the St. Lawrence River. None were identified from either Greeley's or the 1976 sampling.

115. Stizostedion vitreum - Walleye. A very desirable game and food fish. Common in the river below the Moses-Saunders Power Dam, but uncommon in the river above the dam. The walleye population between Ogdensburg and Massena decreased following the formation of Lake St. Lawrence. Walleyes in the area typically are large, old, with low rates of mortality and recruitment. Spawning runs still occur in Brandy Brook and the Oswegatchie River. The only important walleye fishery still remaining in the river is found below the power dam.

Sciaenidae - drums

116. Aplodinotus grunniens - Freshwater drum. Rare. Only two specimens were collected in 1976. Greeley included the drum in his lists, but states that none were actually taken by his sampling.

Table 63 . (Continued)

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117. Cottus bairdi - Mottled sculpin. Uncommon in the 1976 sampling. However, this may in part be due to its habit of hiding under rocks and thus avoiding capture. Greeley listed the species as rare.

118. Cottus cognatus - Slimy sculpin. Requires cold waters. Abundant in deep waters of Lake Ontario, and in some Adirondack streams. Has not been recorded from the St. Lawrence River.

119. Cottus ricei - Spoonhead sculpin. Prefers cool waters. Reported to be present in Lake Ontario and at least some northern areas of the St. Lawrence. Was not captured either by Greeley's or the 1976 sampling.

120. Myoxocephalus quadricornis - Fourhorn sculpin. Found in deep cold water lakes. Formerly abundant in Lake Ontario, but now rare or possibly extinct. Has not been reported from the St. Lawrence River.

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*USFWS 1976d.

Table 64. Sensitive areas denoted for the Gananoque section of the St. Lawrence River. This data is part of the Canadian ecological sensitivity mapping for the lower Great Lakes watershed. (Anon. 1977).

Site No.	Sensitive area	Location	Description
1	Wetland	Herbert Bog 44^{o} 29'-76^{o} 29'	- this area is designated as a nature reserve
			- this sphagnum bog contains many rare or endangered plant and animal species
2	Lake	Loughborough Lake 44^{o} 26'-76^{o} 26'	- high density of cottages
		44^{o} 25'-76^{o} 30'	- lake trout and whitefish spawning area
		44^{o} 25'-76^{o} 28'	- Lakes Bay, lake trout and whitefish spawning area
3	Lake	Collins Lake 44^{o} 22'-76^{o} 29'	- maskinonge spawning and angling in this lake
			- the southerly part of this lake is utilized by waterfowl for breeding and a migration stopover
4	Lake, park	Little Cranberry Lake 44^{o} 29'-76^{o} 16'	- high cottage concentration on all three lakes
			- waterfowl nesting

Table 64 . (continued)

Site No.	Sensitive area	Location	Description
		Seeleys Bay 44^{o} 29'-76^{o} 14'	- Seeleys Bay Conservation Area, administered by the Cataraqui Conservation Authority
			- fishing
4	Lake, park	Cranberry Lake 44^{o} 26'-76^{o} 19'	- high boating concentration due to the Rideau Canal through Little Cranberry and Cranberry Lake
		Dog Lake 44^{o} 26'-76^{o} 20'	
5	River	River Styx 44^{o} 17'-76^{o} 21'	- Casey's point Provincial Park Reserve
			- concentrated boating activity due to presence of Rideau Canal
		44^{o} 22'-76^{o} 28'	- high cottage concentration
			- small commercial fishing for bullheads in this area
		Steventown Creek 44^{o} 19' - 76^{o} 21' to 44^{o} 20' - 76^{o} 25'	- both creeks are important for angling and as spawning areas for pike and largemouth bass

Table 64. (continued)

Site No.	Sensitive area	Location	Description
		Bear Creek 44^{o} 21' - 76^{o} 23' to 44^{o} 23' - 76^{o} 26'	
6	Wetland, river	44^{o} 17' - 76^{o} 28'	- conservation area along 401 administered by the Cataraqui Conservation Authority - Cataraqui marsh - important waterfowl area for breeding and migration - muskrats are harvested locally from this area - coarse fish are harvested on a small scale - boating activity is concentrated here due to the presence of the Rideau Canal
7	Bay	Johnson Bay Howe Island 44^{o} 17' - 76^{o} 17'	- nesting site for waterfowl
8	Marshland	Wiltse Creek 44^{o} 26' - 76^{o} 11'	- vast stand of cattails - scrub willow - waterfowl habitat

AD-A147 119 THE SAINT LAWRENCE RIVER--PAST AND PRESENT A REVIEW OF HISTORICAL NATURAL..(U) FISH AND WILDLIFE SERVICE CORTLAND NY P P HAMILTON APR 84 6/7

UNCLASSIFIED F/G 5/4 NL

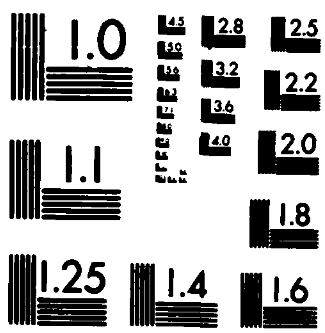

1.0
4.5
5.0
5.6
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

Table 64. (continued)

Site No.	Sensitive area	Location	Description
9	Bay	Landon Bay 44^{o} 22' - 76^{o} 0.4'	- waterfowl - commercial fishing - spawning site
10	Lake	Traverse Lake 44^{o} 30' - 76^{o} 17'	- waterfowl nesting

NOTE: The shoreline and associated marshes along the St. Lawrence River are used by a wide variety of ducks and geese throughout the year. Herring gulls nest on Admiralty Islands.

Table 65. Sensitive areas denoted for the Wolfe Island section of the St. Lawrence River. This data is part of the Canadian ecological sensitivity mapping for the lower Great Lakes watershed. (Anon. 1977).

Site No.	Sensitive area	Location	Description
1	River	Cataraqui River	- waterfowl nesting area
		44° 14'-76° 28'	- boating area, entrance to the Rideau Canal System
2	Park	Cedar Island 44° 13'-76° 27'	- St. Lawrence Island National Park
3	Shoreline, wetland	Wolfe Island	- the waters surrounding Wolfe Island are important for angling, commercial fishing and a spawning area for pike, smallmouth bass, and yellow perch
			- this area also has concentrations of trout and salmon
		44° 08'-76° 30' to 44° 08'-76° 28'	- shoreline area is a spawning area for smallmouth bass
		44° 08'-76° 30' to 44° 06'-76° 30'	- an important waterfowl area, migration stopover and staging area
		(Long Point Reeds Bay) 44° 07'-76° 28'	- both shorelines of Long Point are smallmouth bass spawning areas
		Big Sandy Bay 44° 06'-76° 27'	- waterfowl migration stopover and staging area

Table 65. (continued)

Site No.	Sensitive area	Location	Description
		Bear Point 44^{o} 06'-76^{o} 27'	- smallmouth bass spawning area
		44^{o} 08'-76^{o} 25' to 44^{o} 08'-76^{o} 21'	- smallmouth bass spawning area - waterfowl migration stopover and staging area
4	Shoreline/ wetland	Wolfe Island Hinckley Point 44^{o} 08'-76^{o} 21'	- shoreline areas in the vicinity of this point are smallmouth bass spawning areas
		Button Bay 44^{o} 08'-76^{o} 21'	- this bay and the shoreline areas extending in either direction are utilized by waterfowl for migration stopovers and staging areas
		Bayfield Bay 44^{o} 12'-76^{o} 21'	- staging and migration stopover area for waterfowl - wetland area at head of the bay is important as a nesting area for waterfowl - the shoreline of this bay is utilized by smallmouth bass for spawning
5	Shoreline	Wolfe Island Beauvais Point Quebec Head Brakey Bay Dignam Point Rattray Point to Irvine Bay Holiday Point Oak Point Brophy Point Knapp Point	- these areas are important for the spawning of smallmouth bass

Table 65. (continued)

Site No.	Sensitive area	Location	Description
5		Brown Bay Dawson Point Barrett Bay Garden Island Mill Point to Boat Channel	- these areas are important for the spawning of smallmouth bass

NOTE: The shoreline and islands are used by a number of divers, dabblers, sea ducks and Canada geese throughout the year.

APPENDIX B.
HISTORIC DREDGING MAPS

Figure 41 . Historic dredging maps showing sites of excavation and spoil disposal during Seaway construction. (From U.S. Army Corps of Engineers-Buffalo District).

These maps were reduced from larger maps to fit into the report. The following list gives general locations for each map. Legends can be found on maps 7, 11, 17, 24 and 29.

Map Number	General Location
1	Johnstown, Ontario
2	Chimney Point
3	Galop Island (West)
4	Galop Island (East)
5	Sparrowhawk Point
6	Toussaint Island
7	Rockway Point
8	Rockway Point
9	Leishman's Point
10	Ogden Island
11	Clark Island
12	Morrisburg, Ontario
13	Doran Island
14	Chrysler Island
15	Bradford Point
16	Steens Island
17	Cat Island
18	Croil Island
19	Delany Island
20	Hopson's Bay
21	Long Sault Dam
22	Robinson Bay
23	Snell Lock
24	Massena Point
25	Hawkins Point
26	Polly's Gut
27	Cornwall Island
28	Pilon Island
29	St. Regis Island

Figure 41 . (Continued)

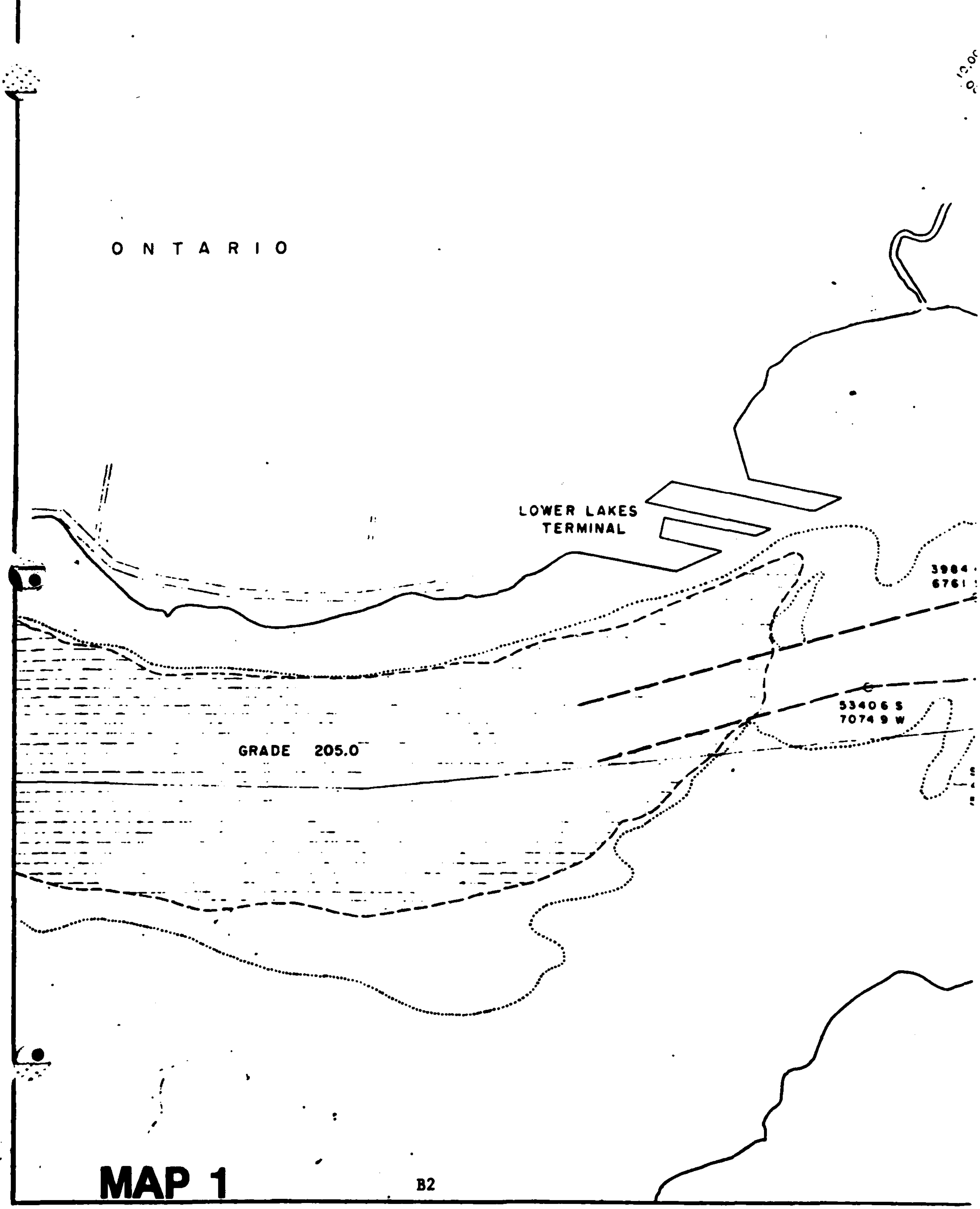


Figure 41. (Continued)

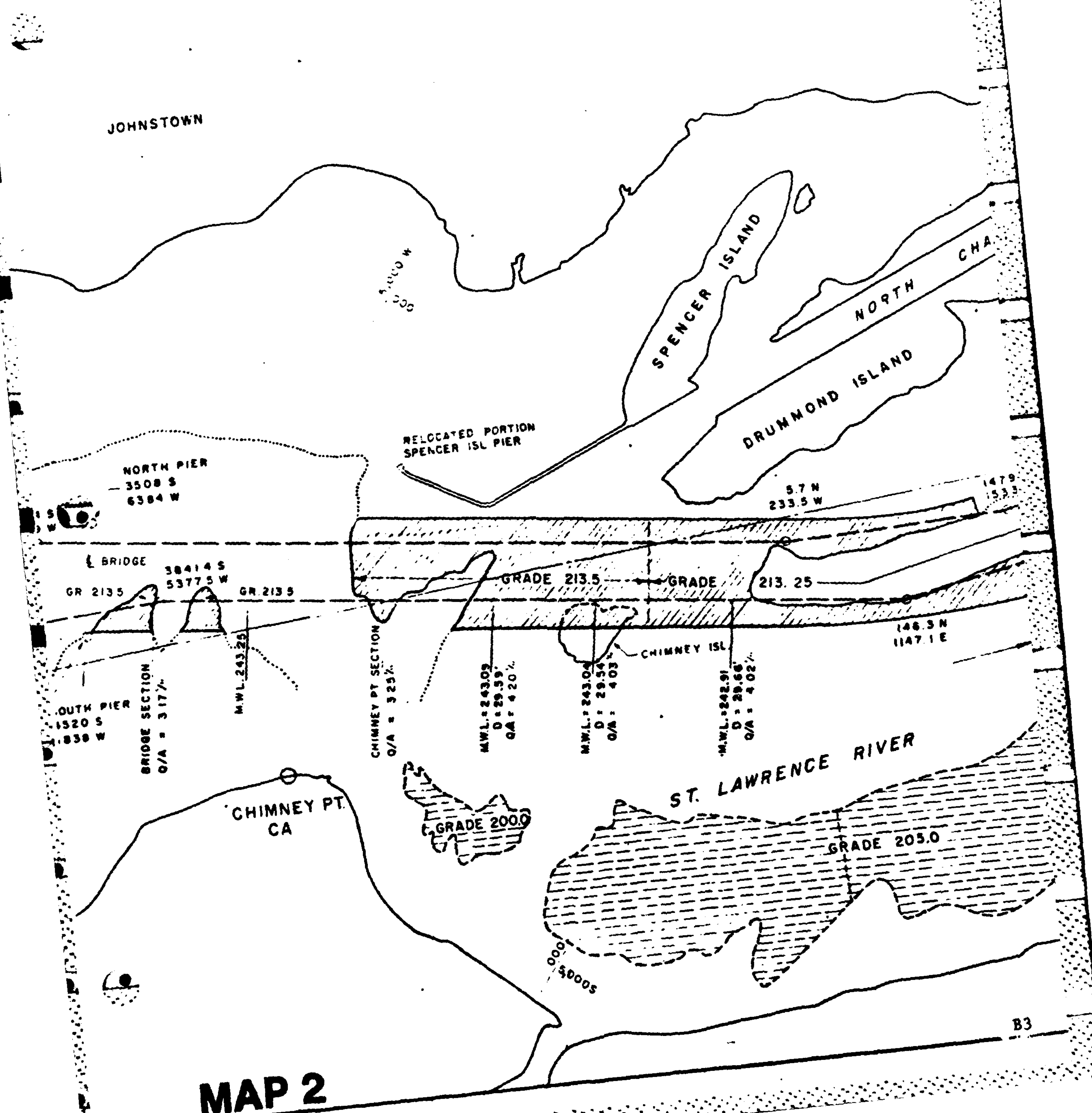
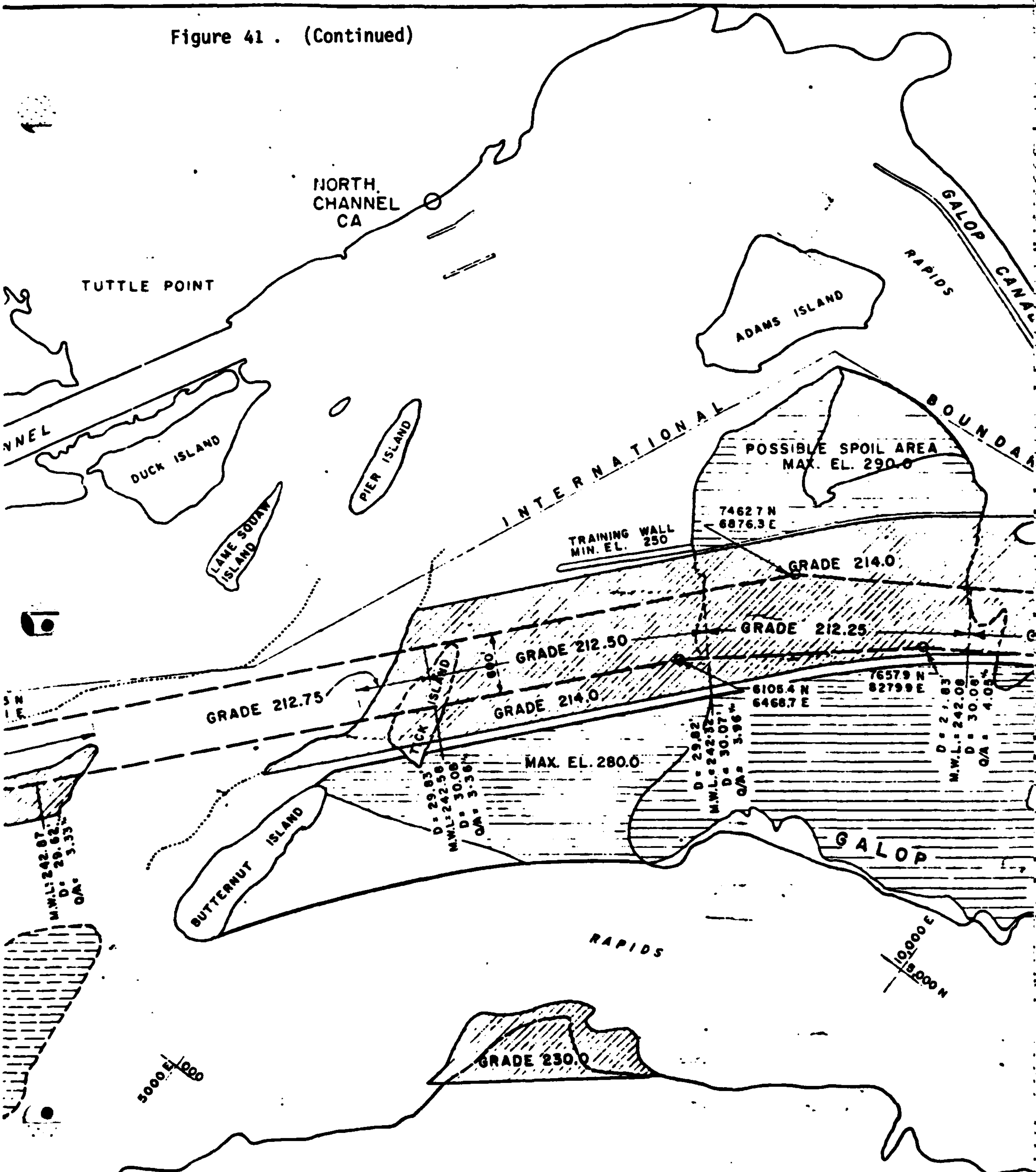
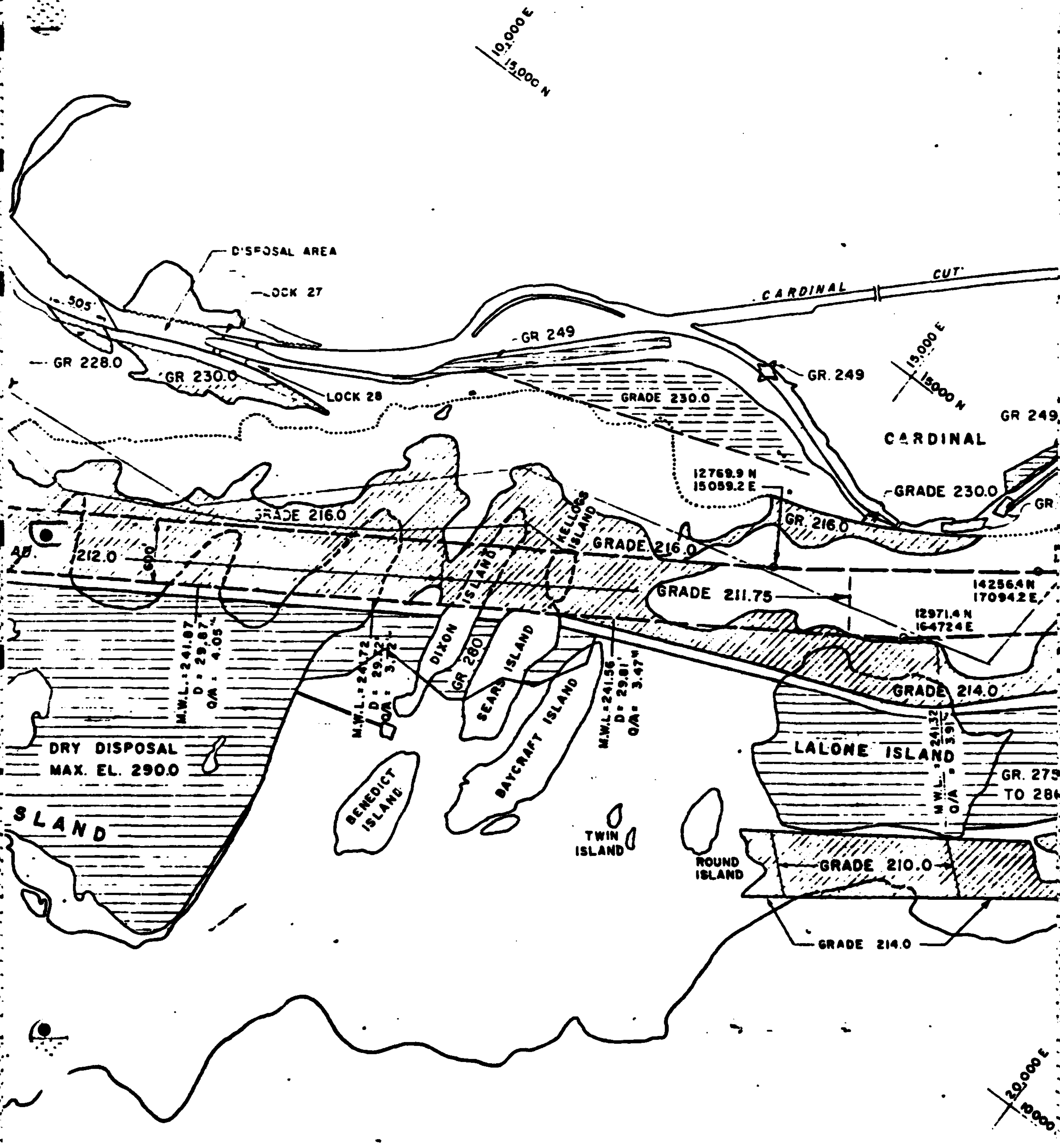


Figure 41 . (Continued)



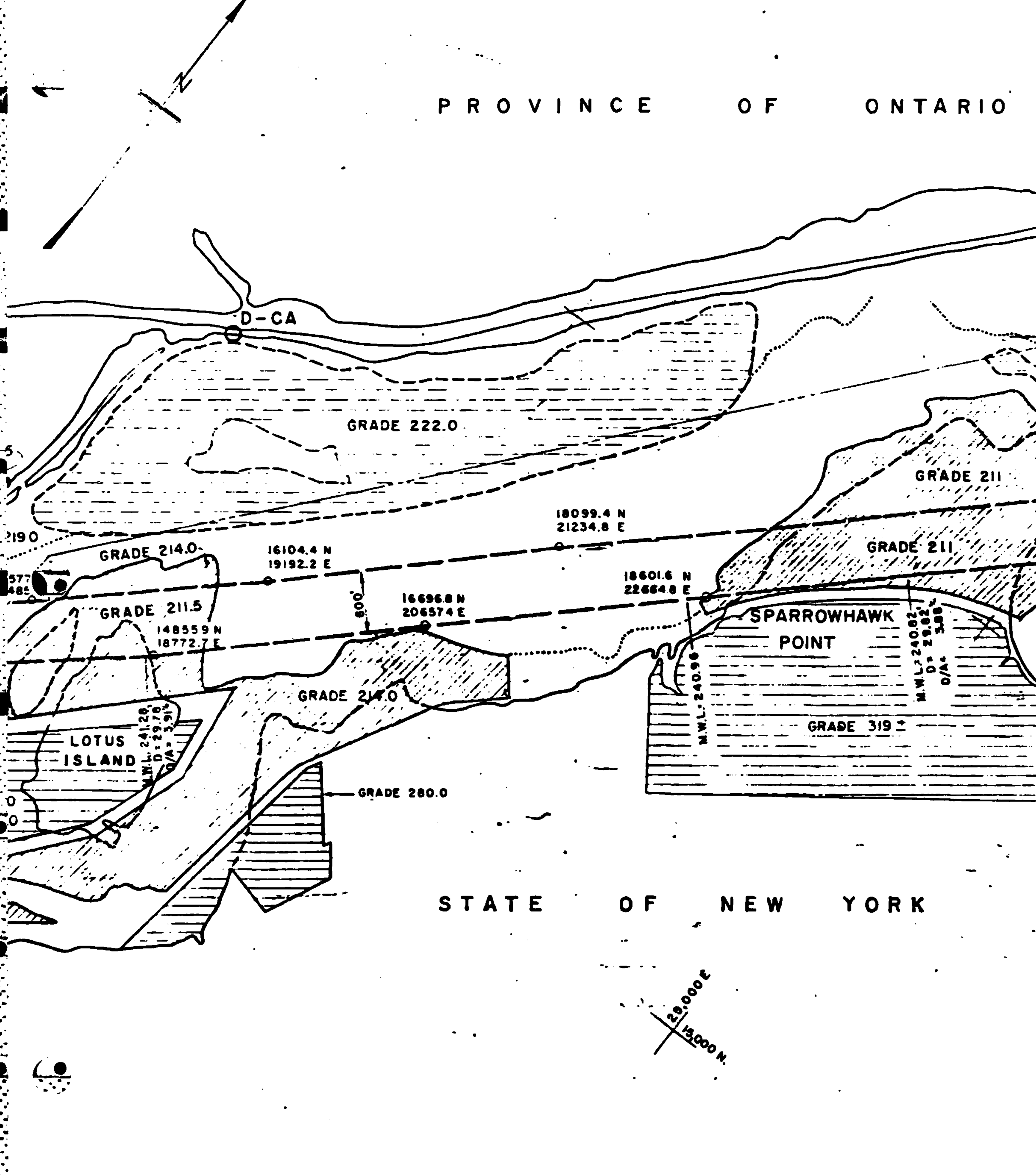
MAP 3

Figure 41 . (Continued)



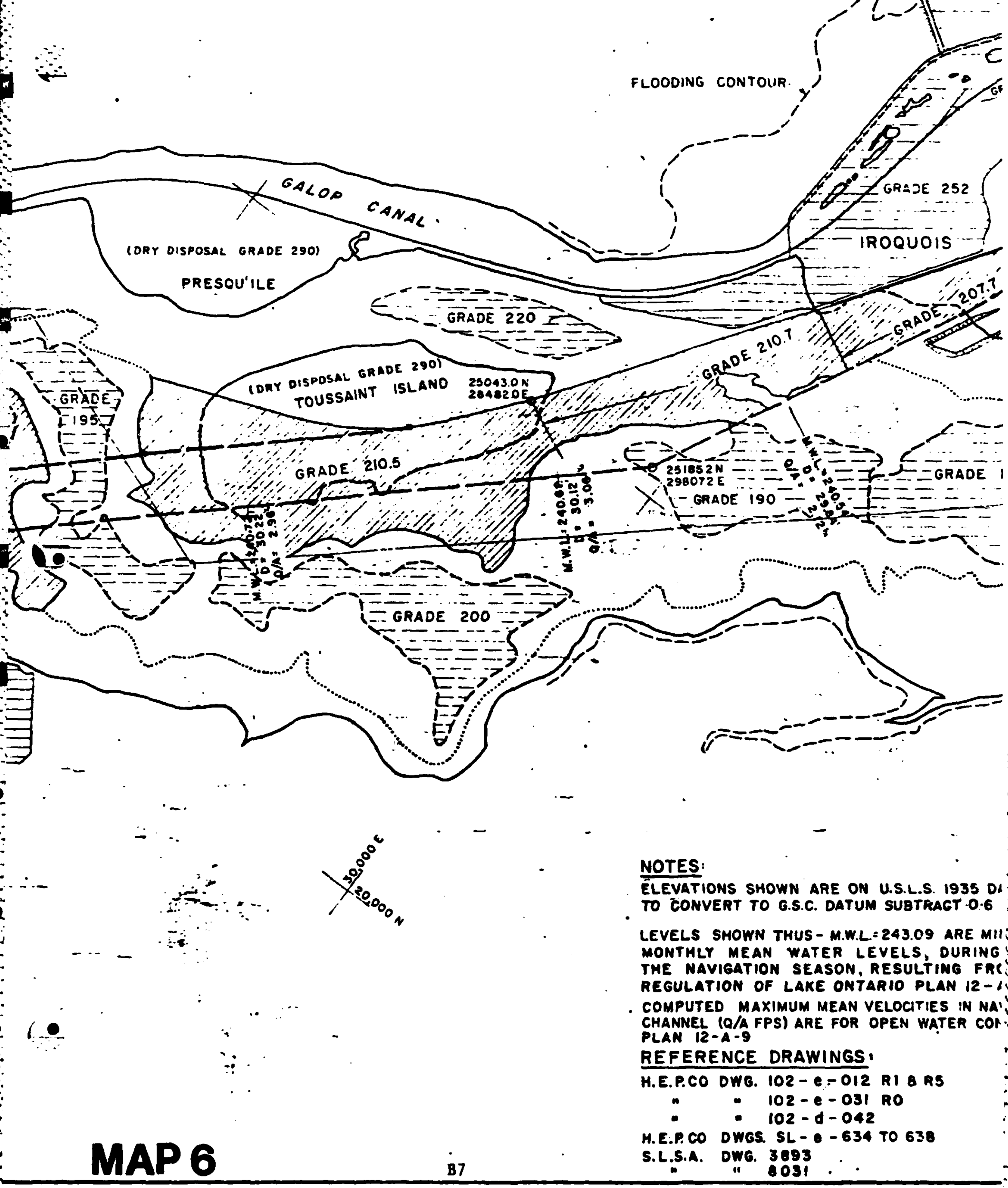
MAP 4

Figure 41 . (Continued)



MAP 5

Figure 41. (Continued)



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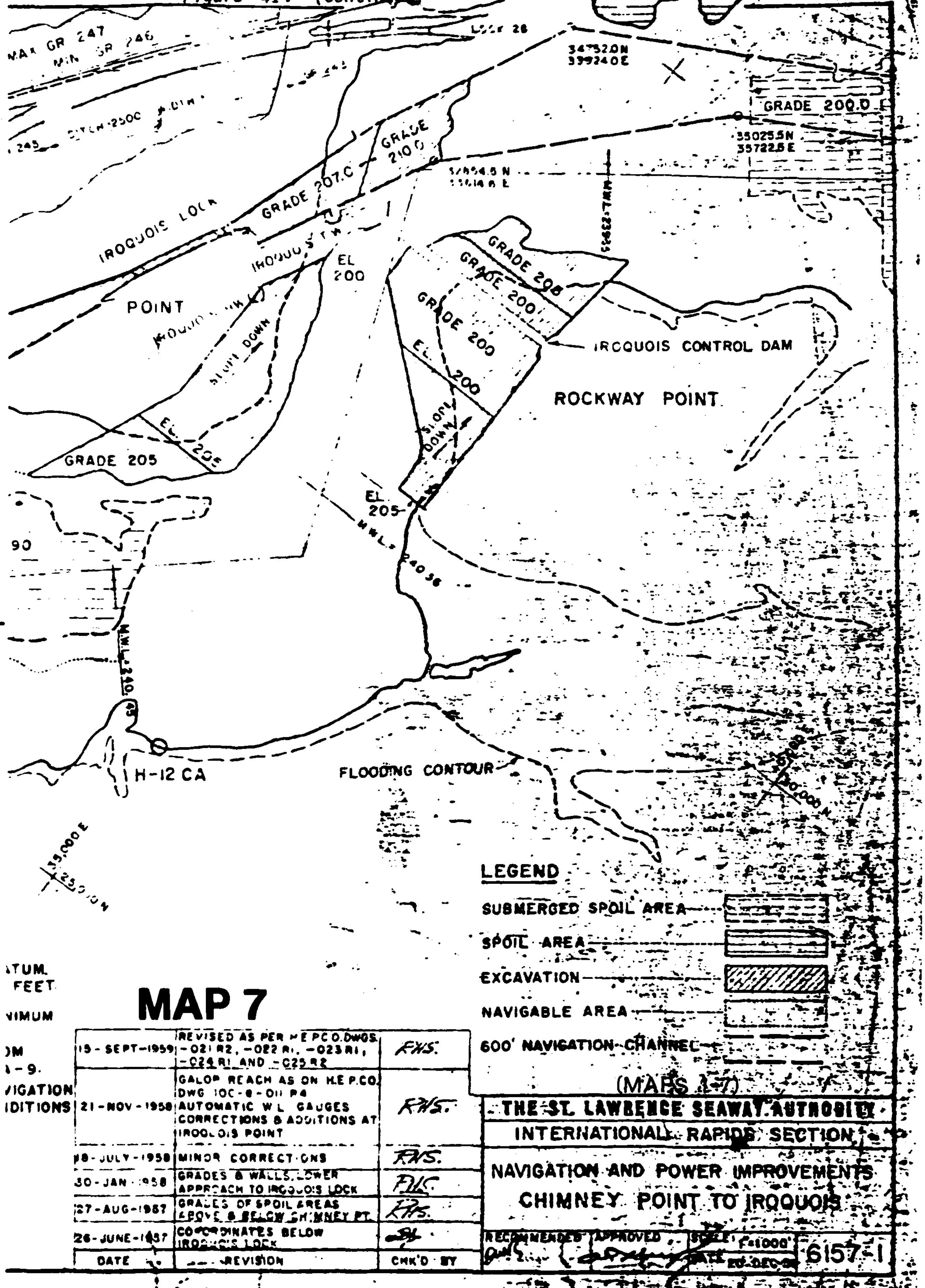

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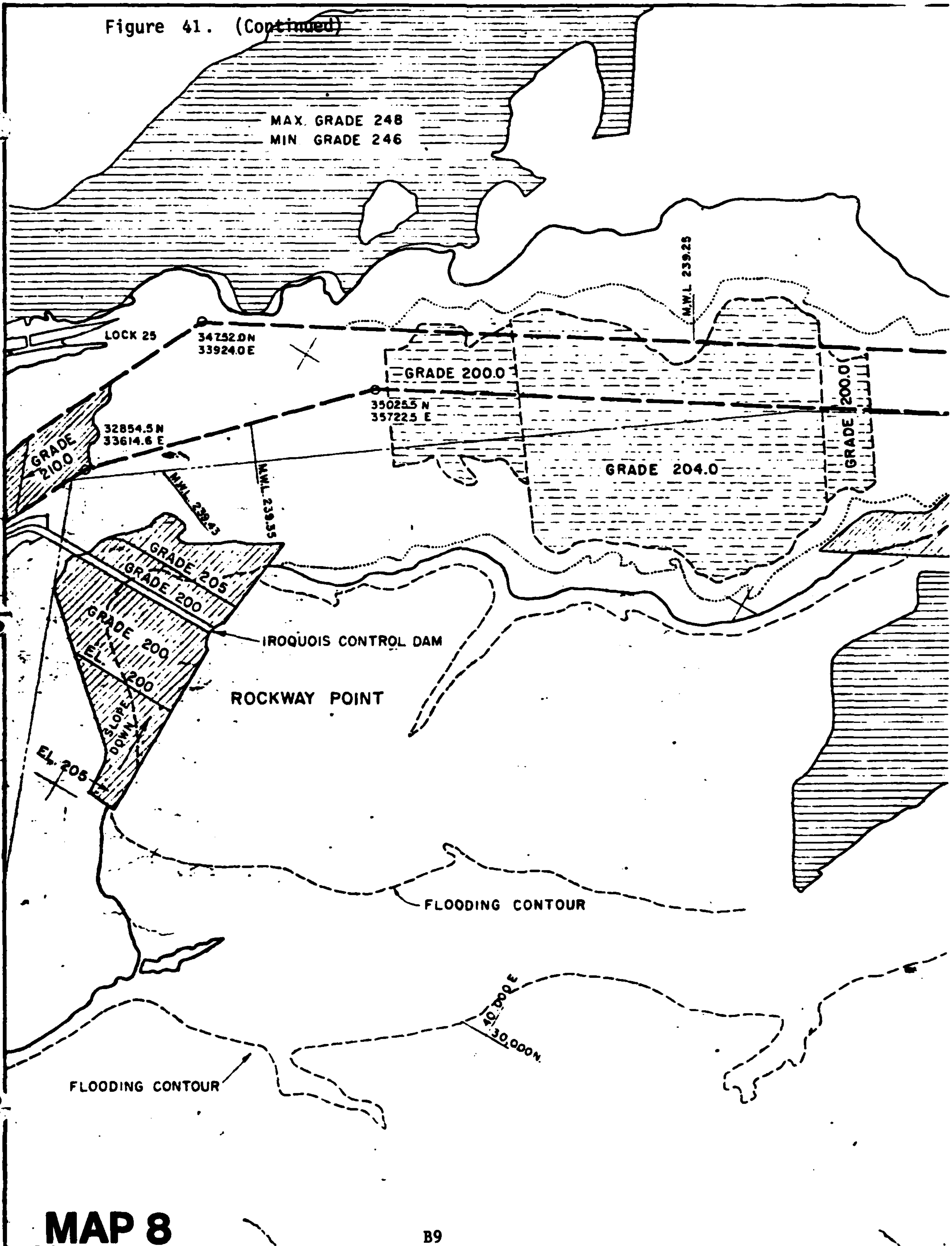

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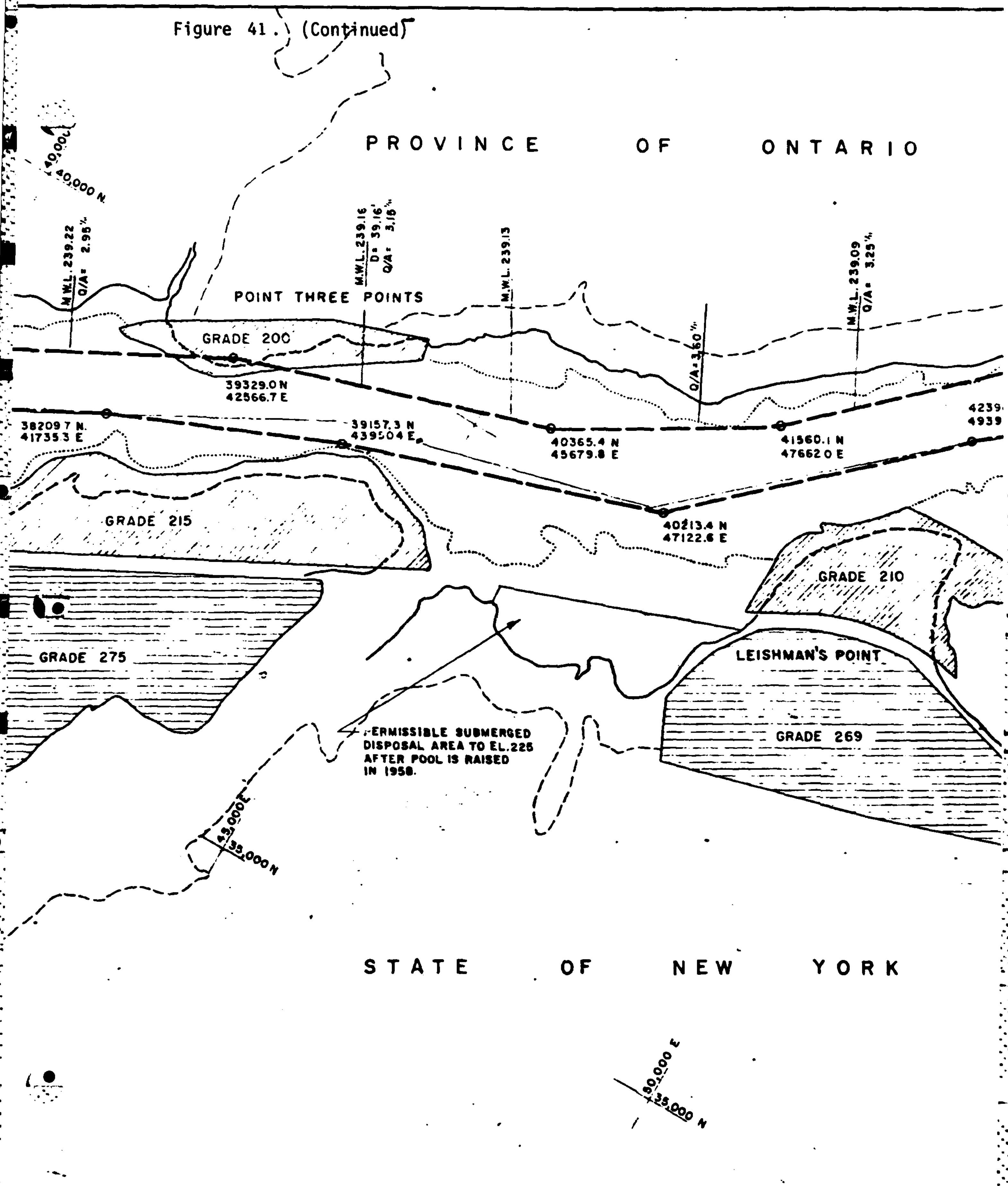
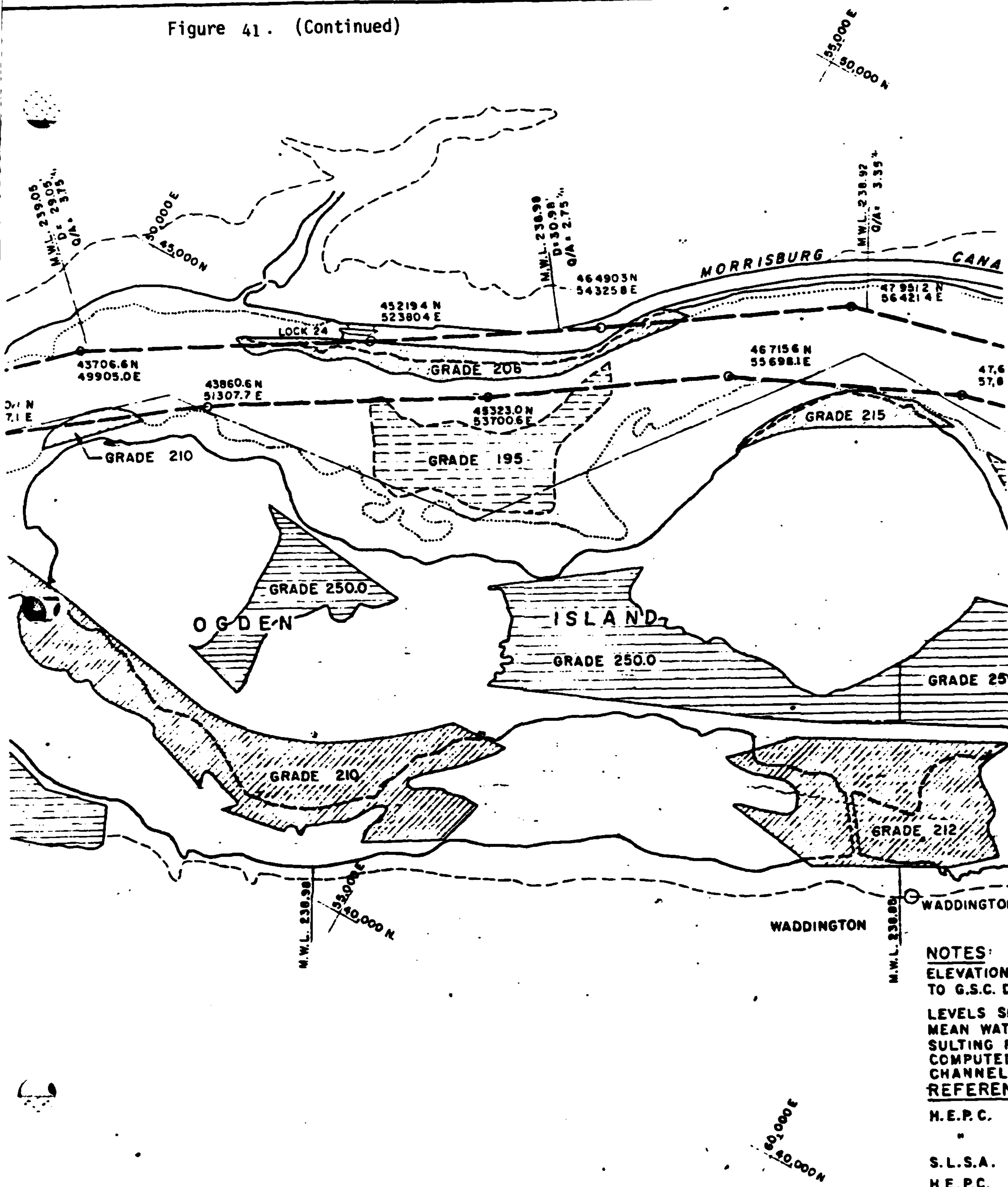


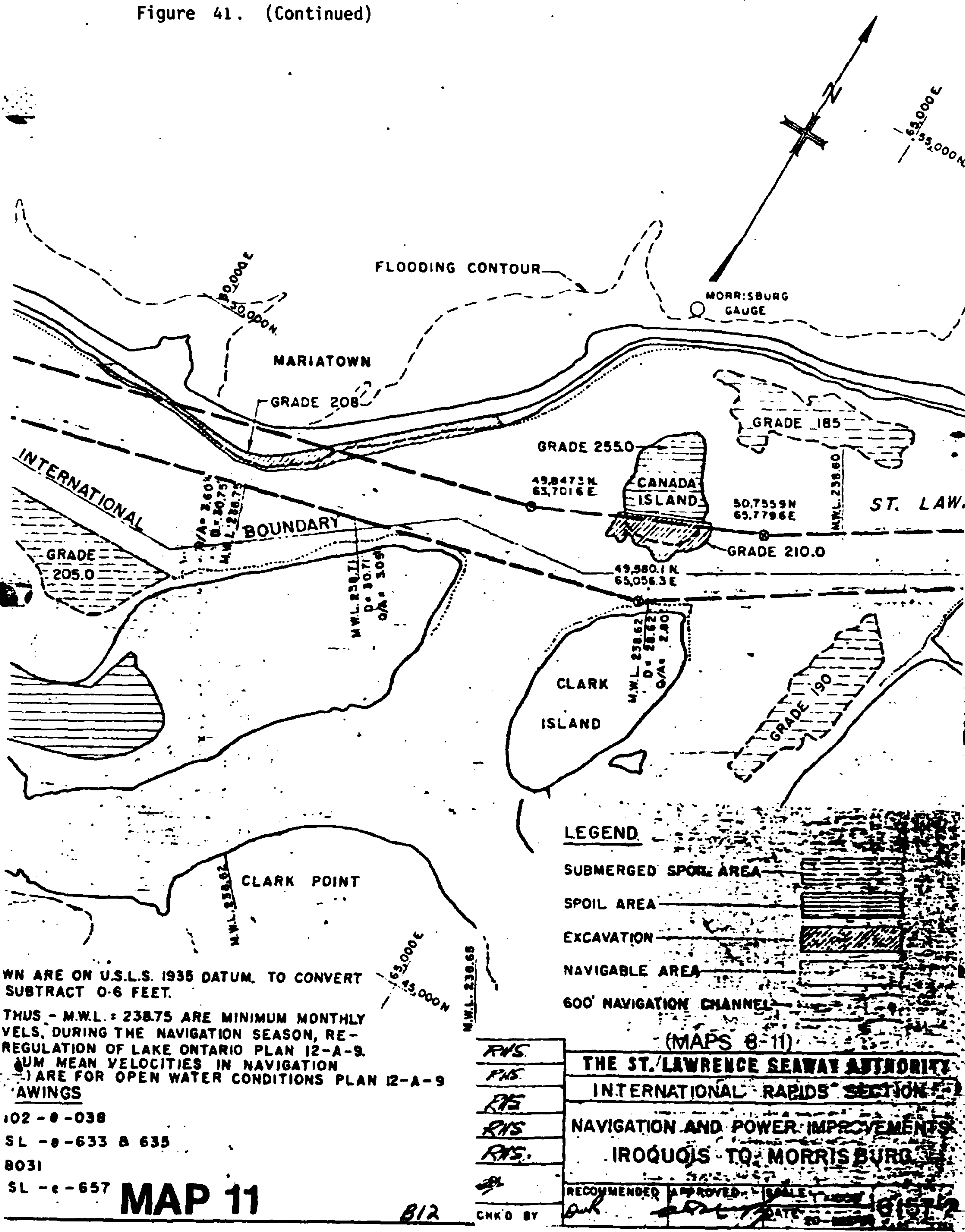
MAP 9

Figure 41. (Continued)



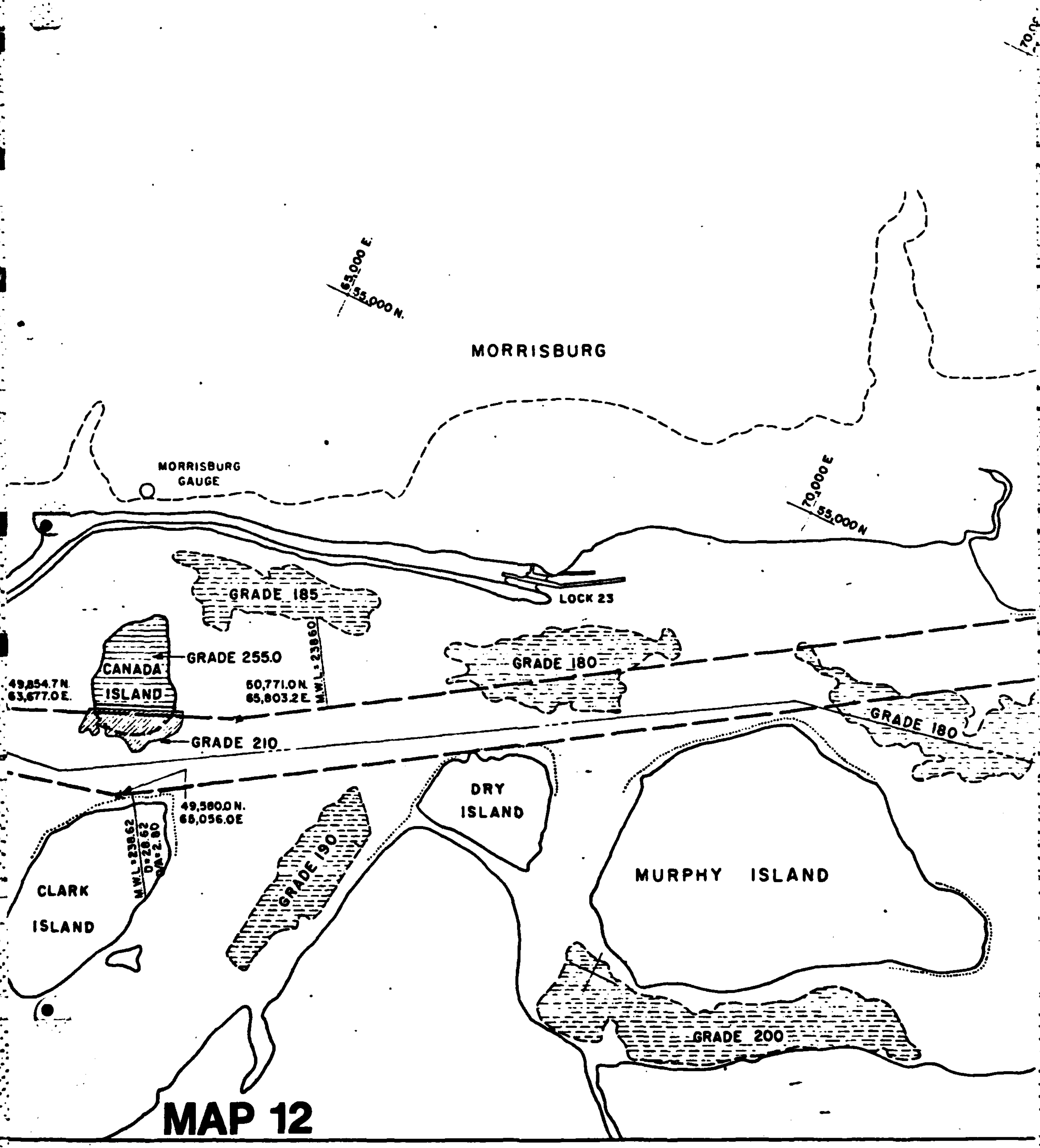
MAP 10

Figure 41. (Continued)



B12

Figure 41. (Continued)



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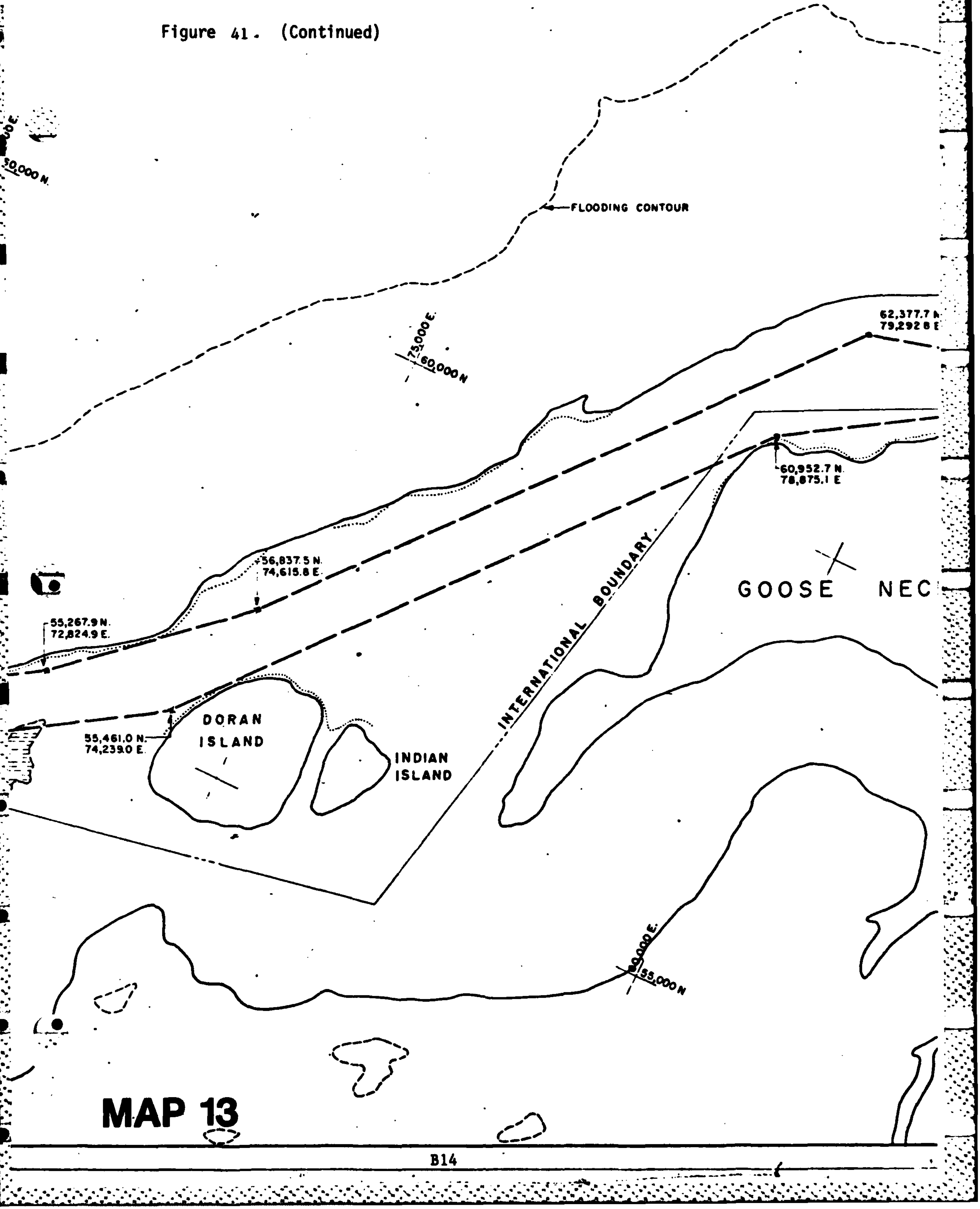
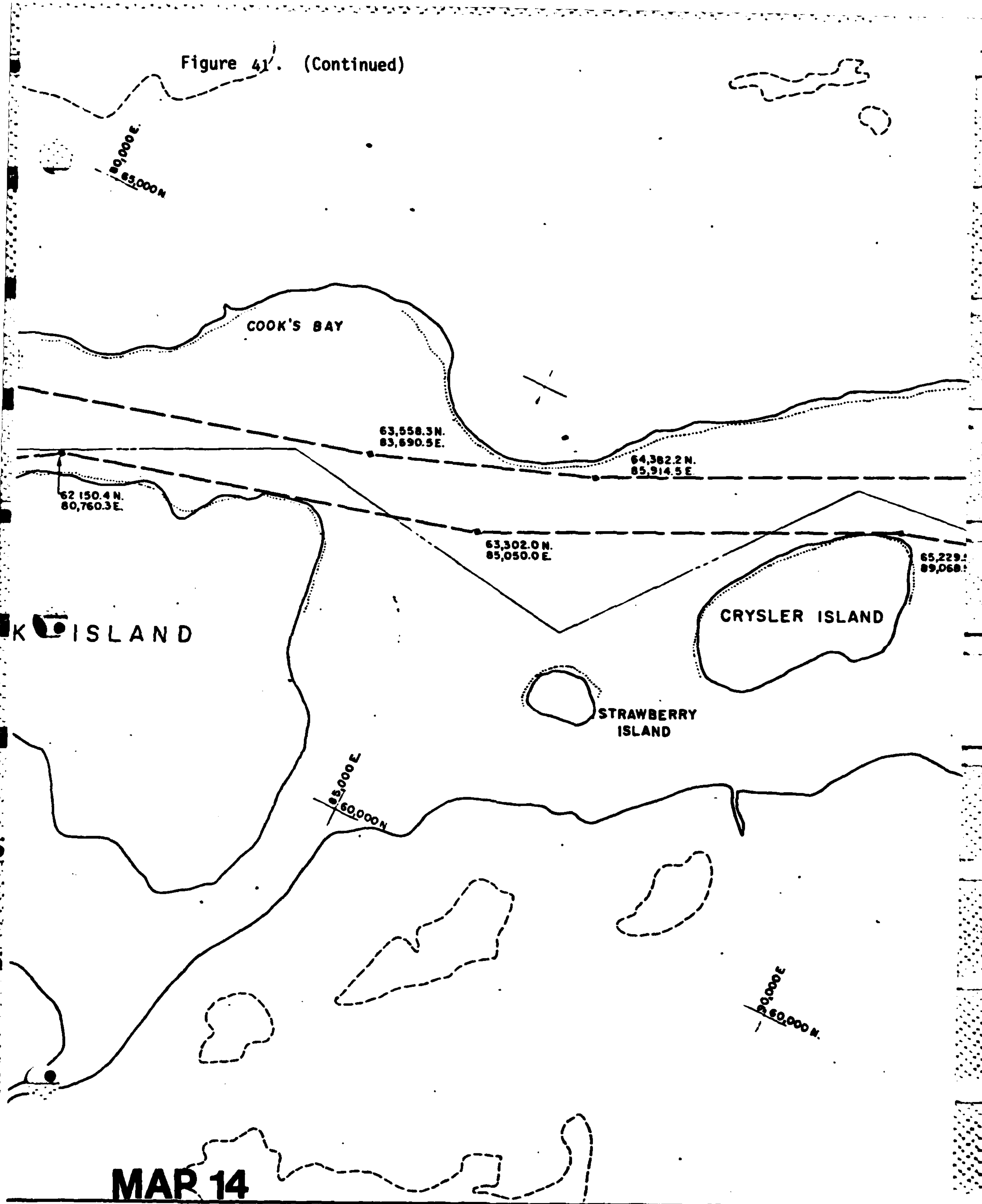


Figure 41. (Continued)



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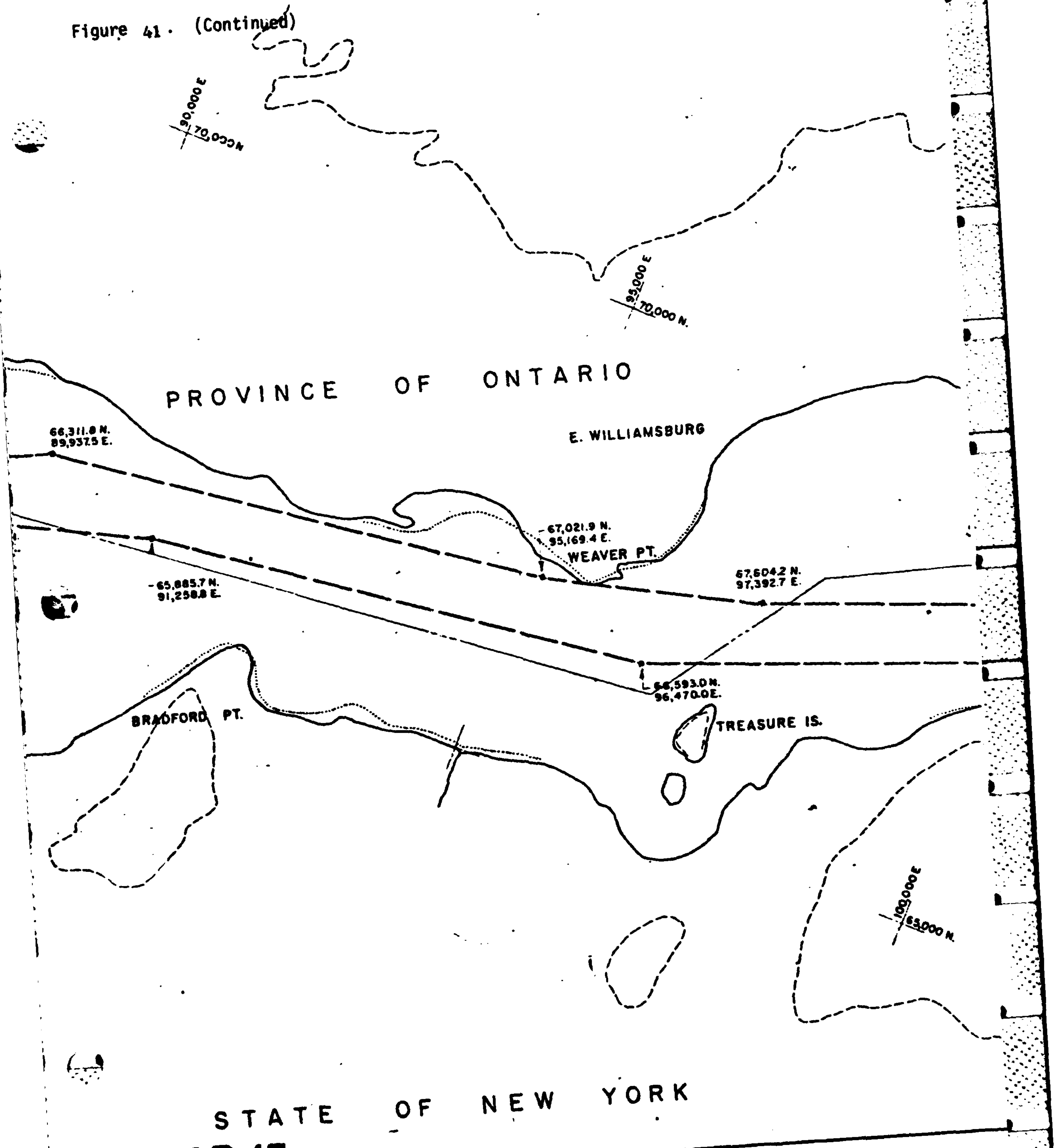

MAP 15

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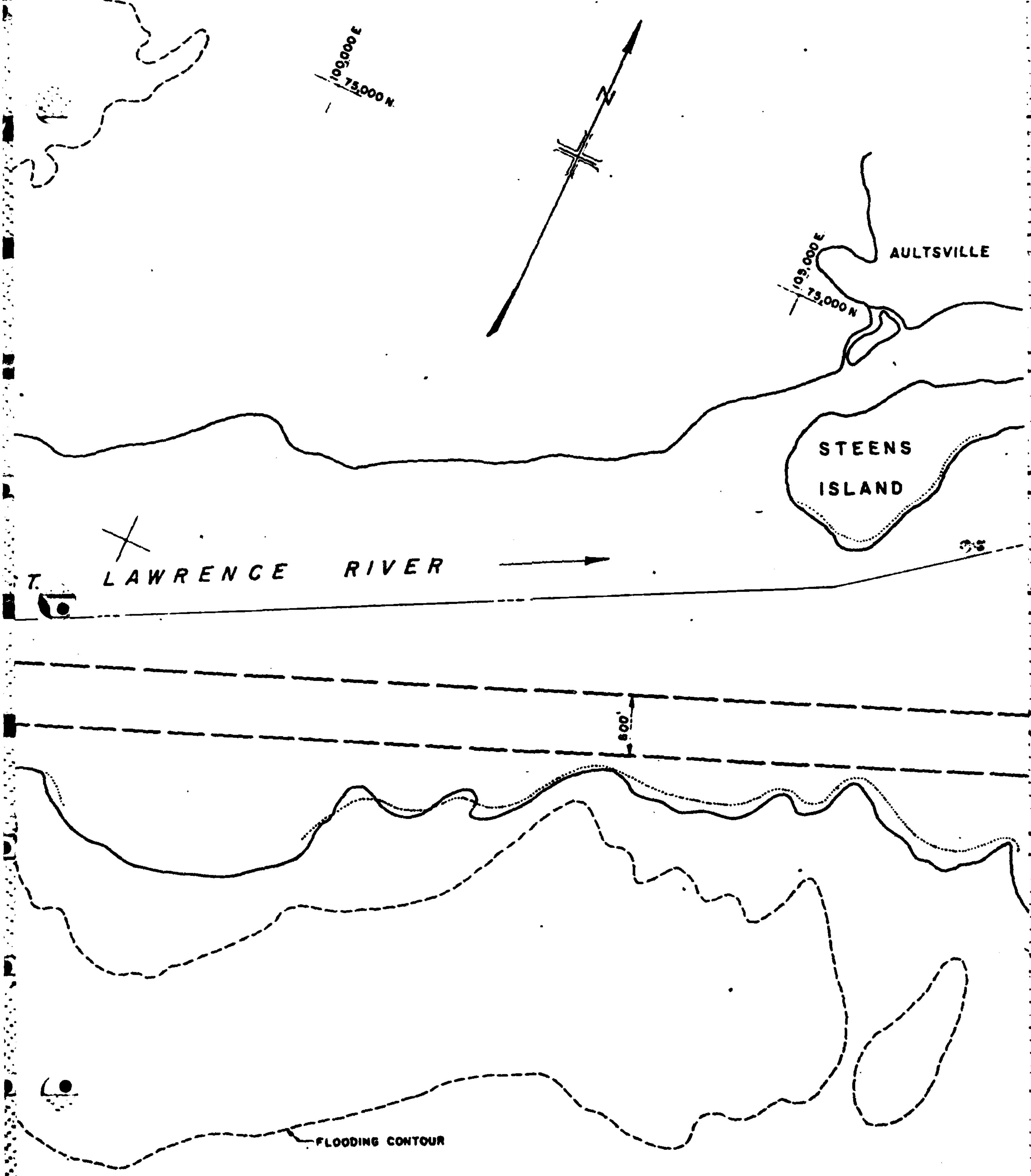

MAP 16

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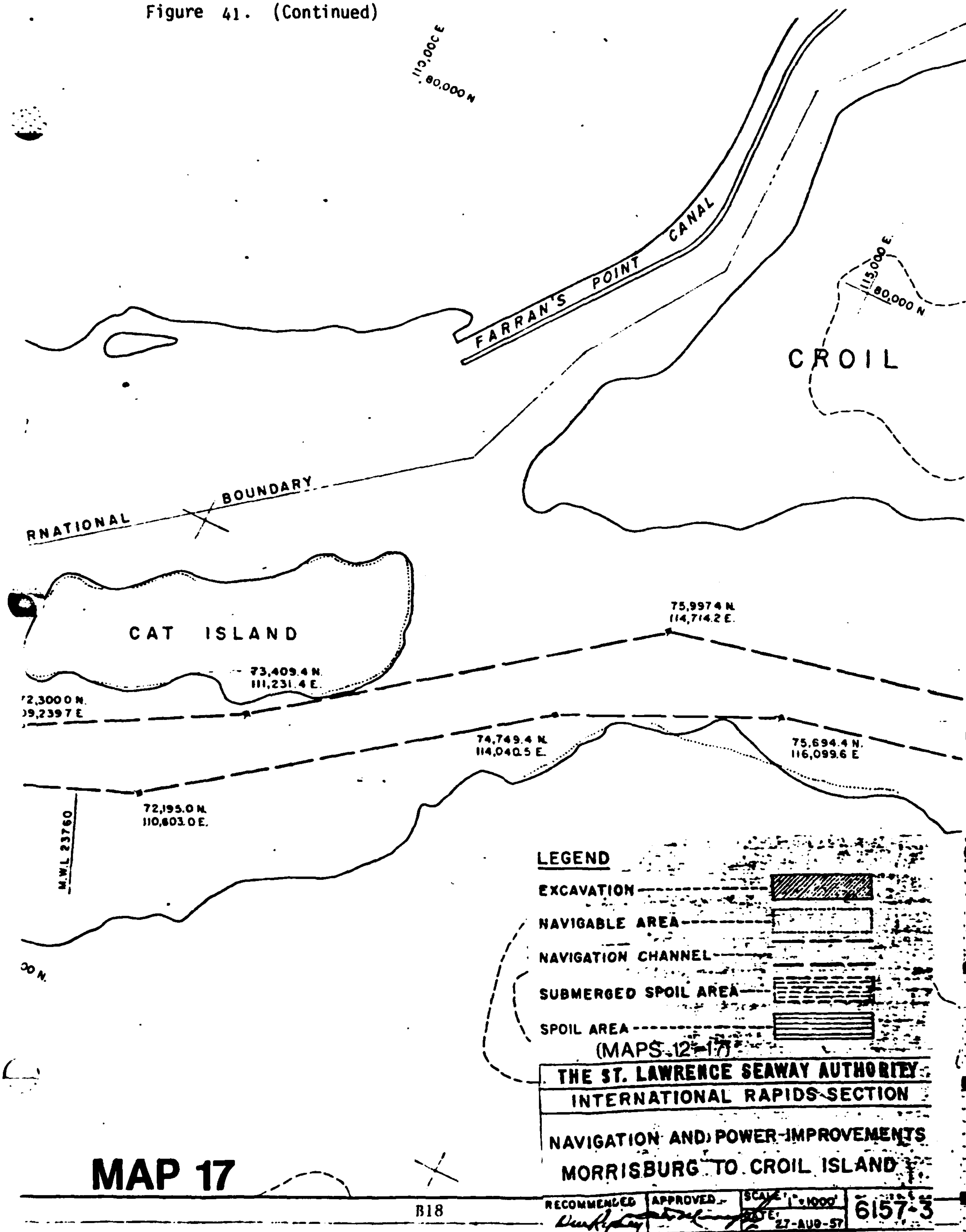
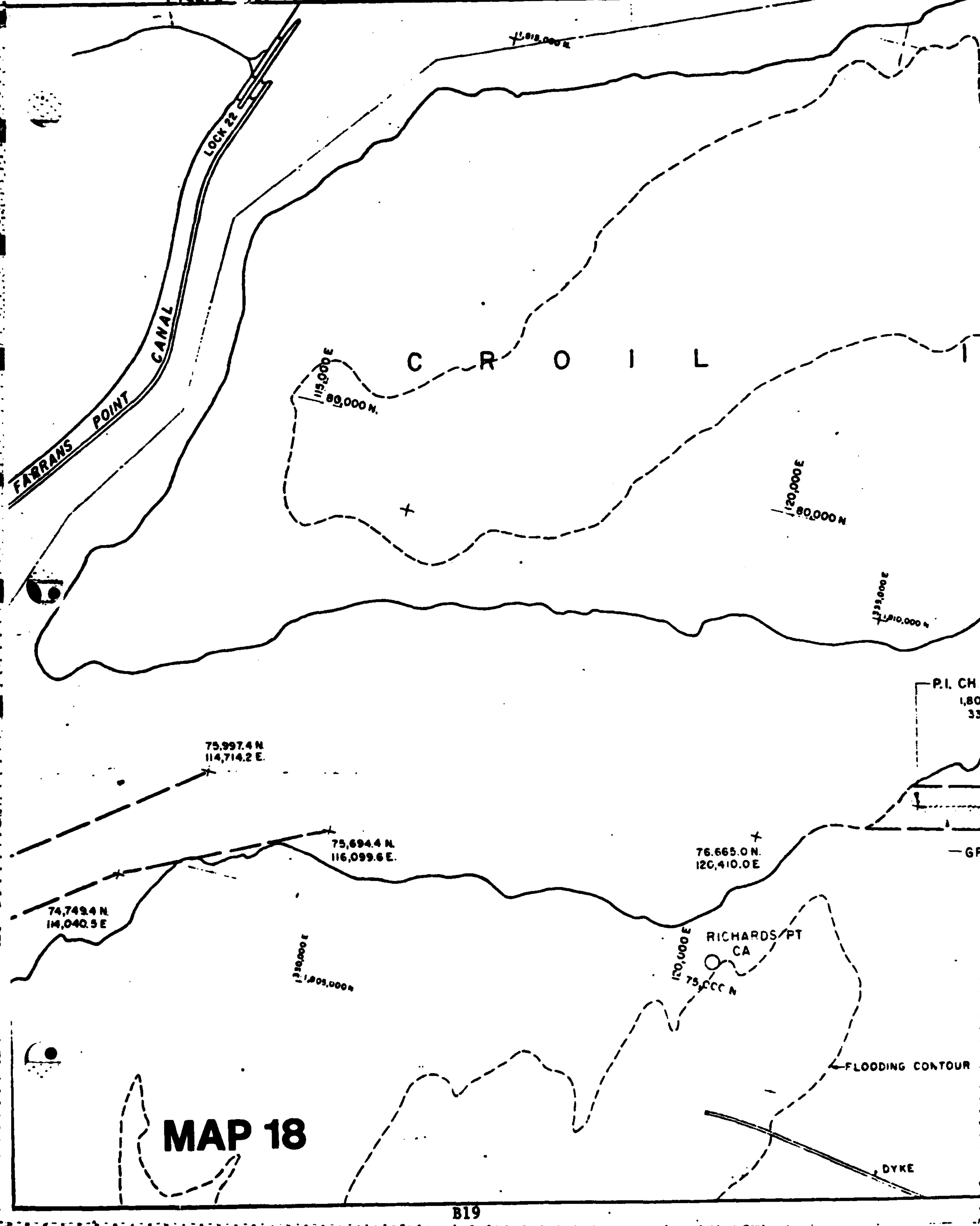


Figure 41. (Continued)



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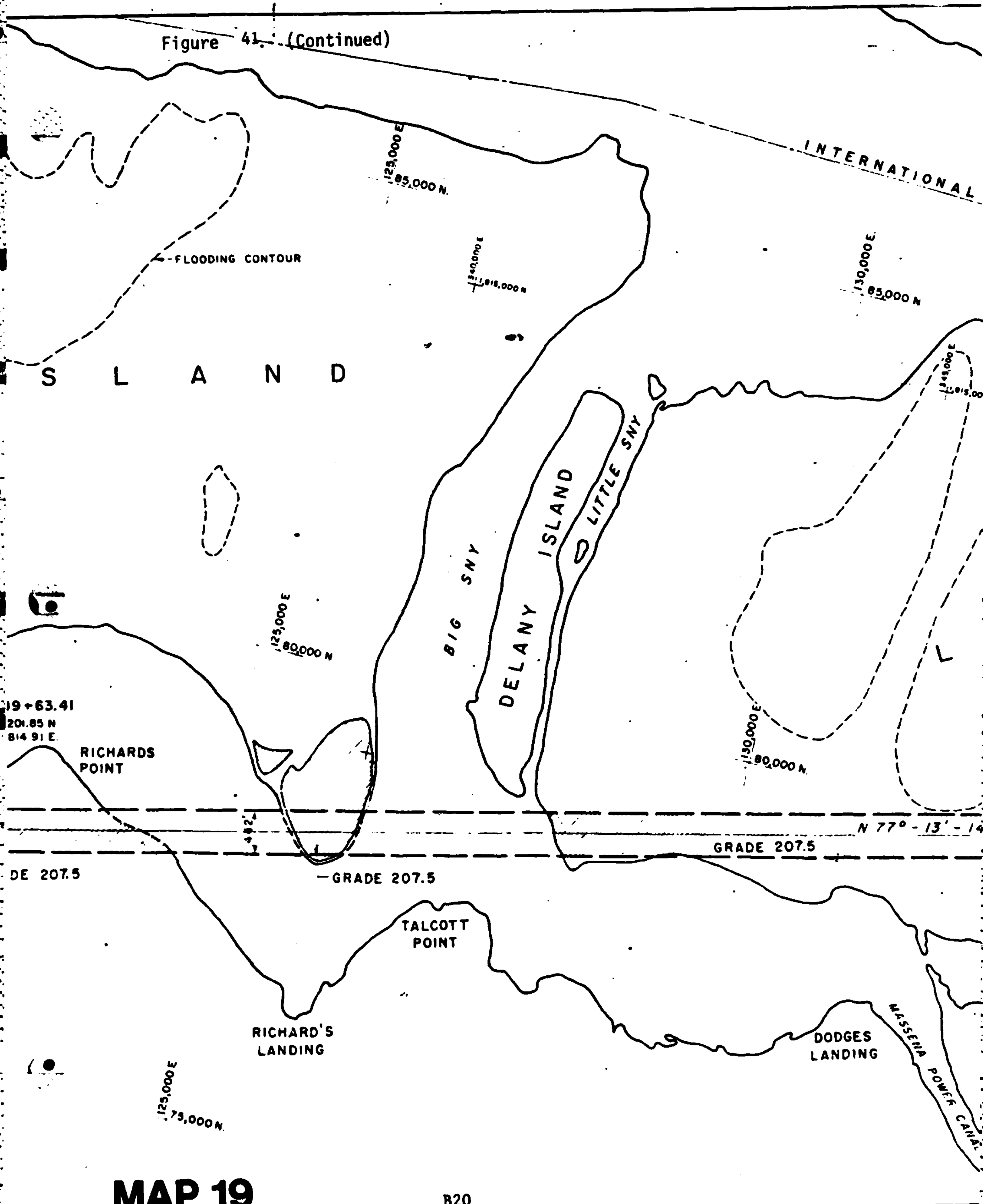

MAP 19

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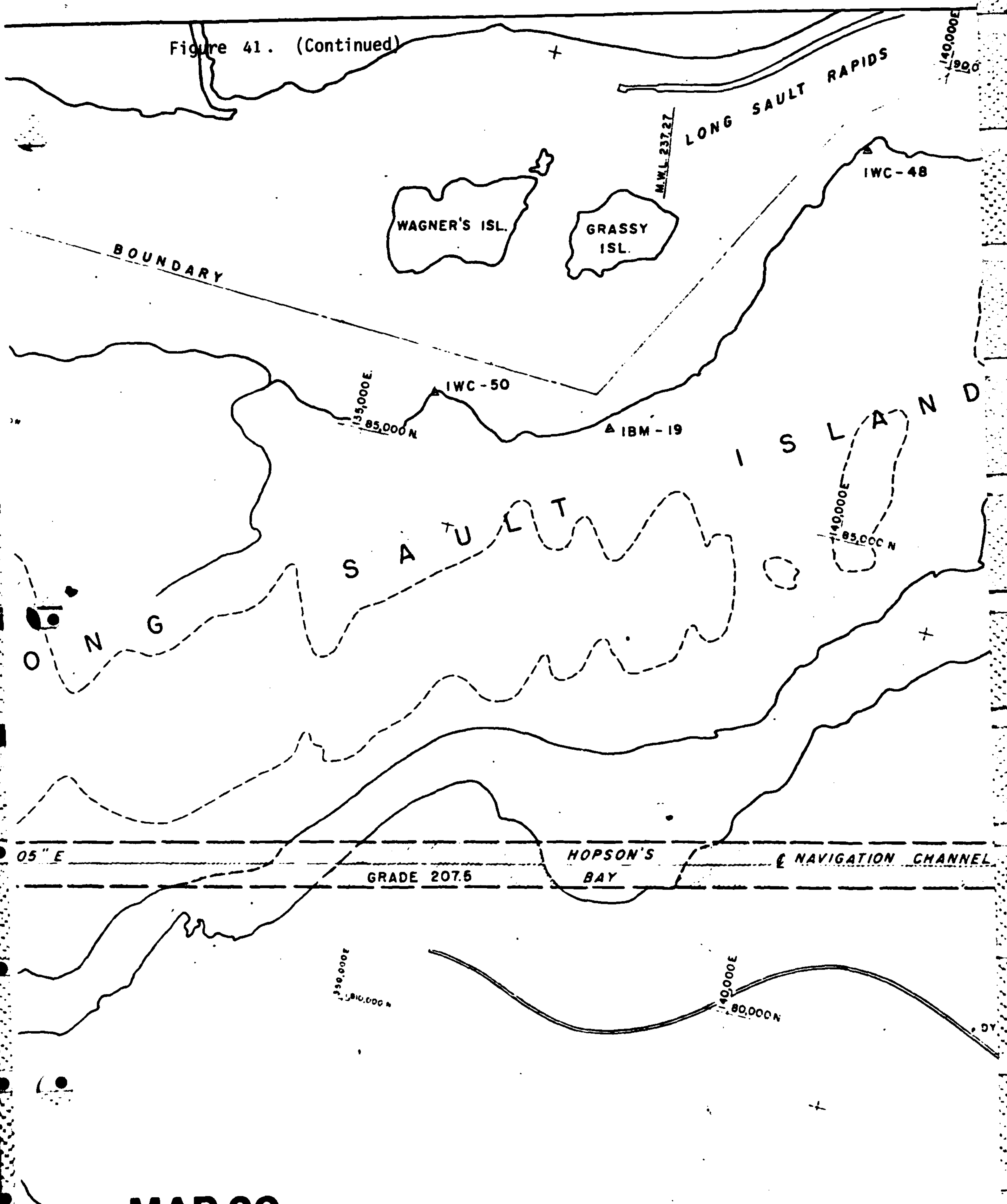

MAP 20

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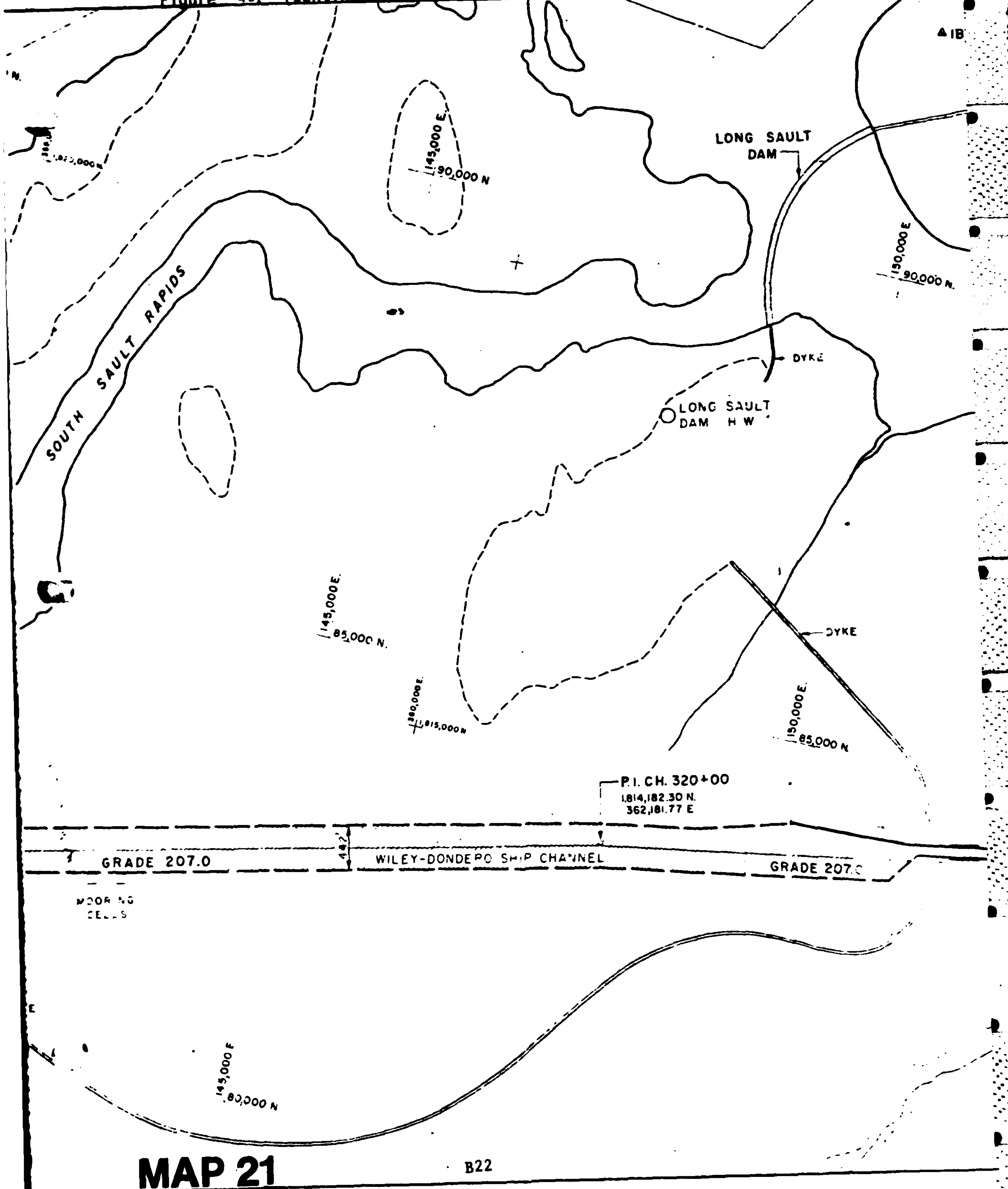

MAP 21

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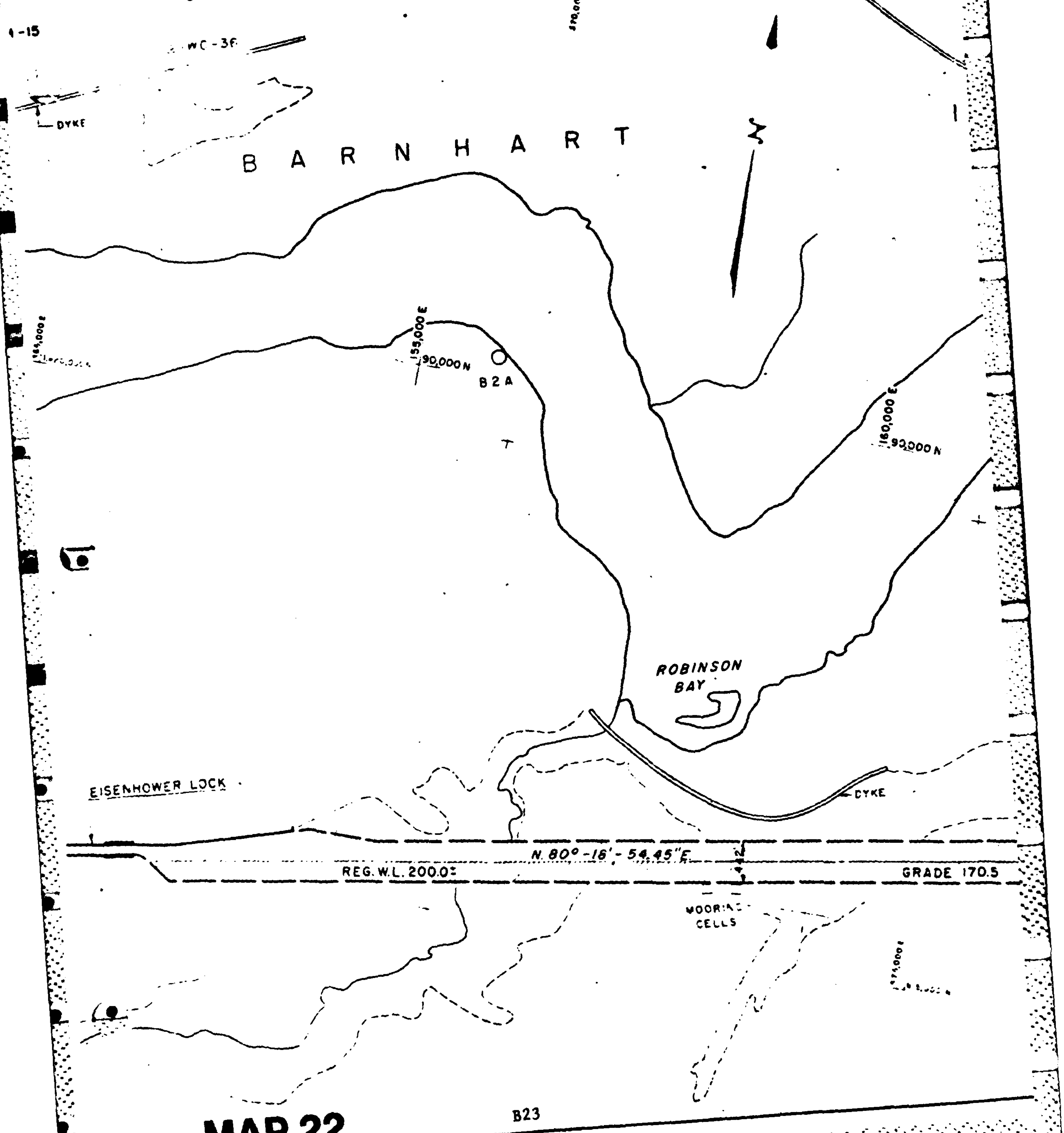

MAP 22

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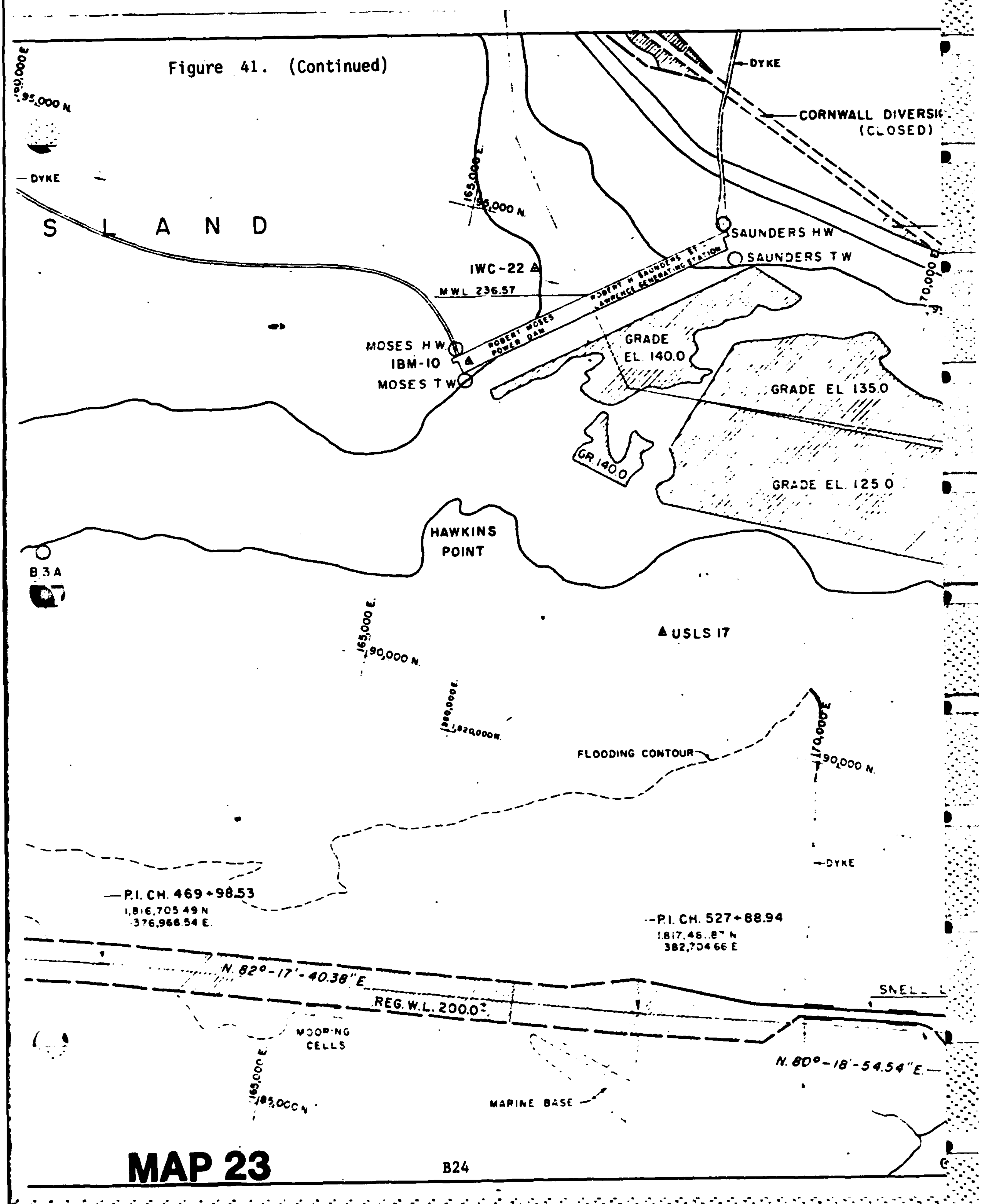

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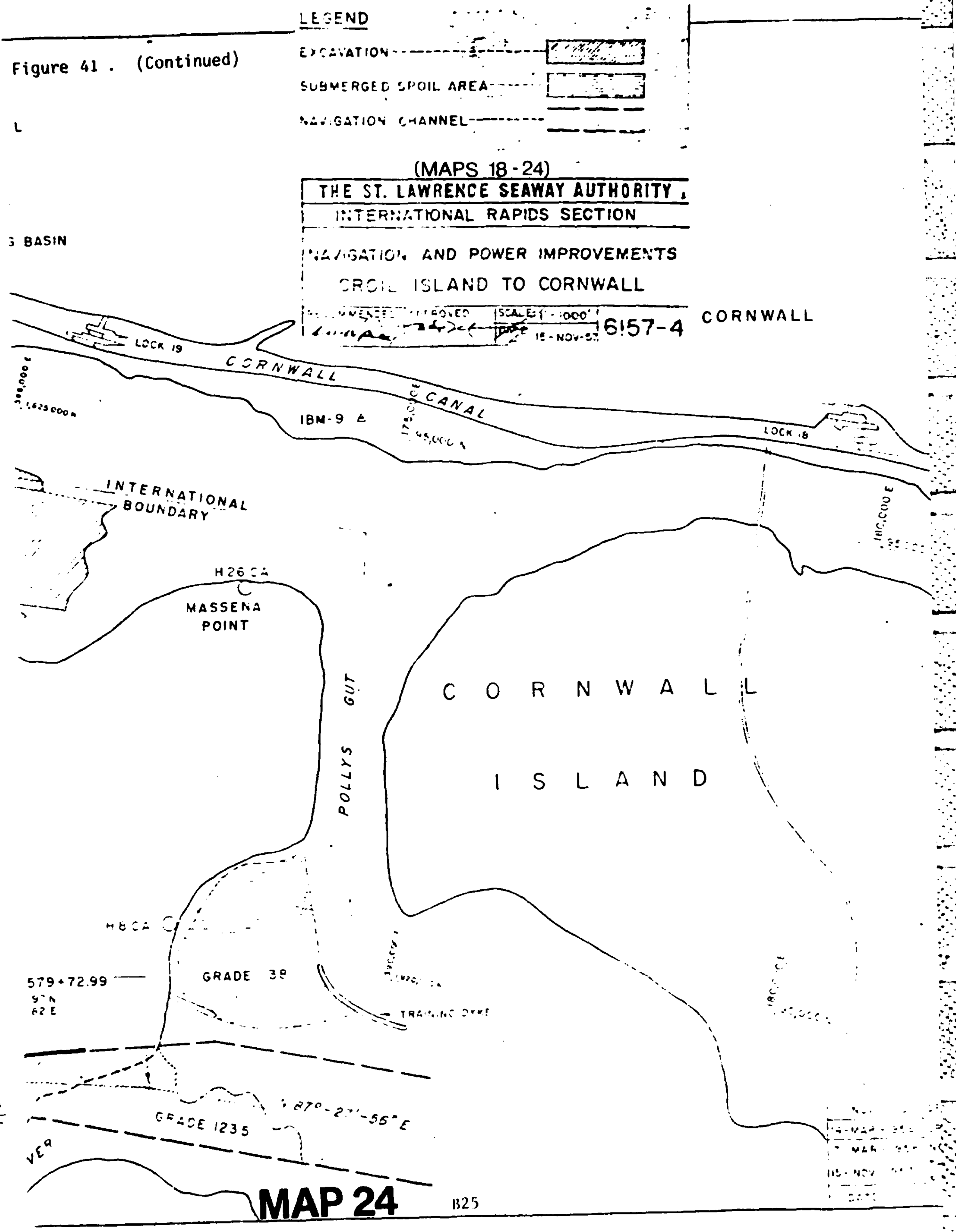
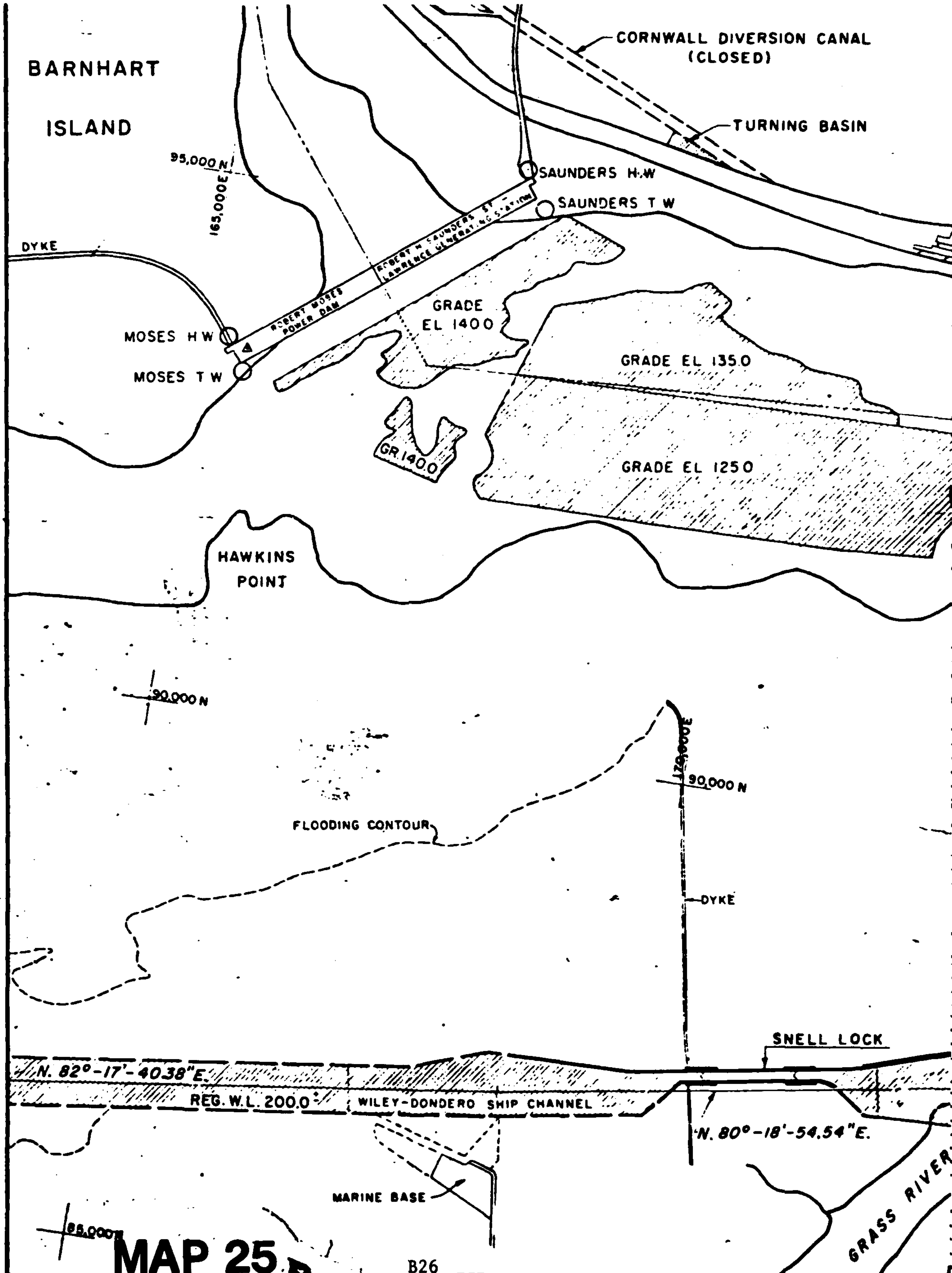
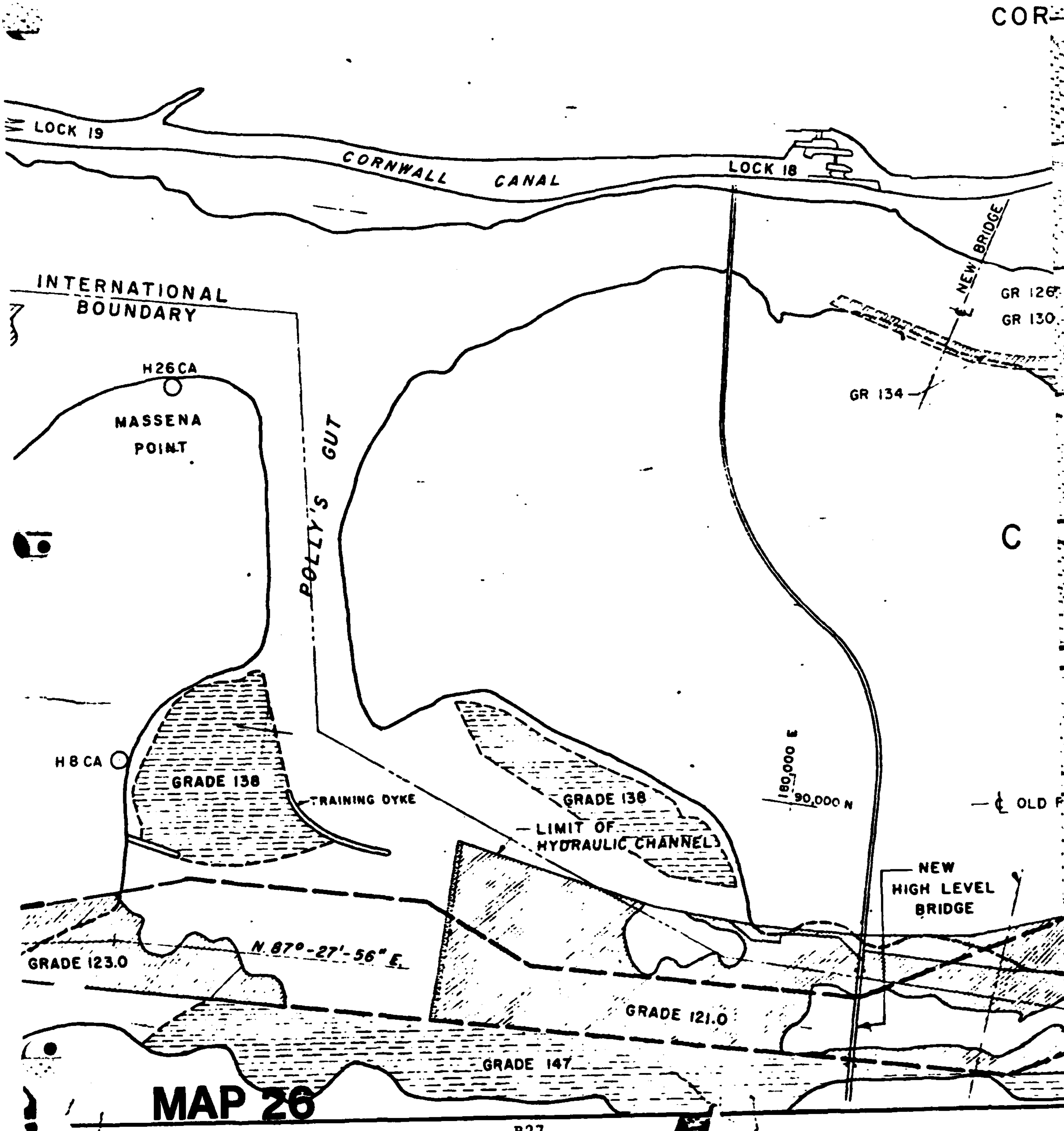
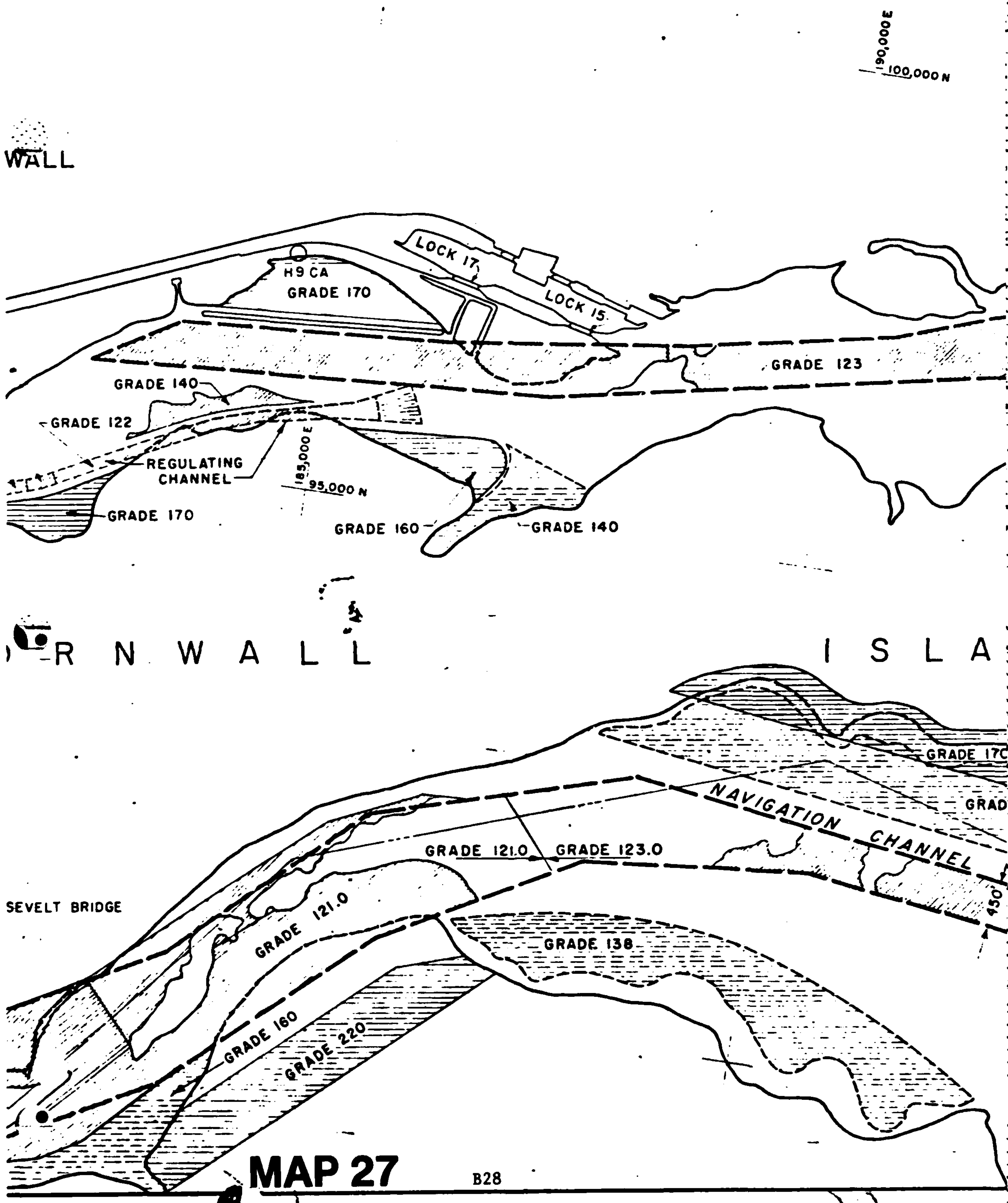



CORNWALL DIVERSION CANAL (CLOSED)
BARNHART ISLAND
TURNING BASIN
95,000 N
165,000 E
SAUNDERS H.W
SAUNDERS T W
DYKE
ROBERT MOSES POWER DAM
GRADE EL 1400
MOSES H W
MOSES T W
GRADE EL 135.0
GR 140.0
GRADE EL 1250
HAWKINS POINT
90,000 N
170,000 E
90,000 N
FLOODING CONTOUR
DYKE
SNELL LOCK
N. 82°-17'-4038"E.
REG. W.L. 200.0
WILEY-DONDERO SHIP CHANNEL
N. 80°-18'-54.54"E.
MARINE BASE
85,000
GRASS RIVER

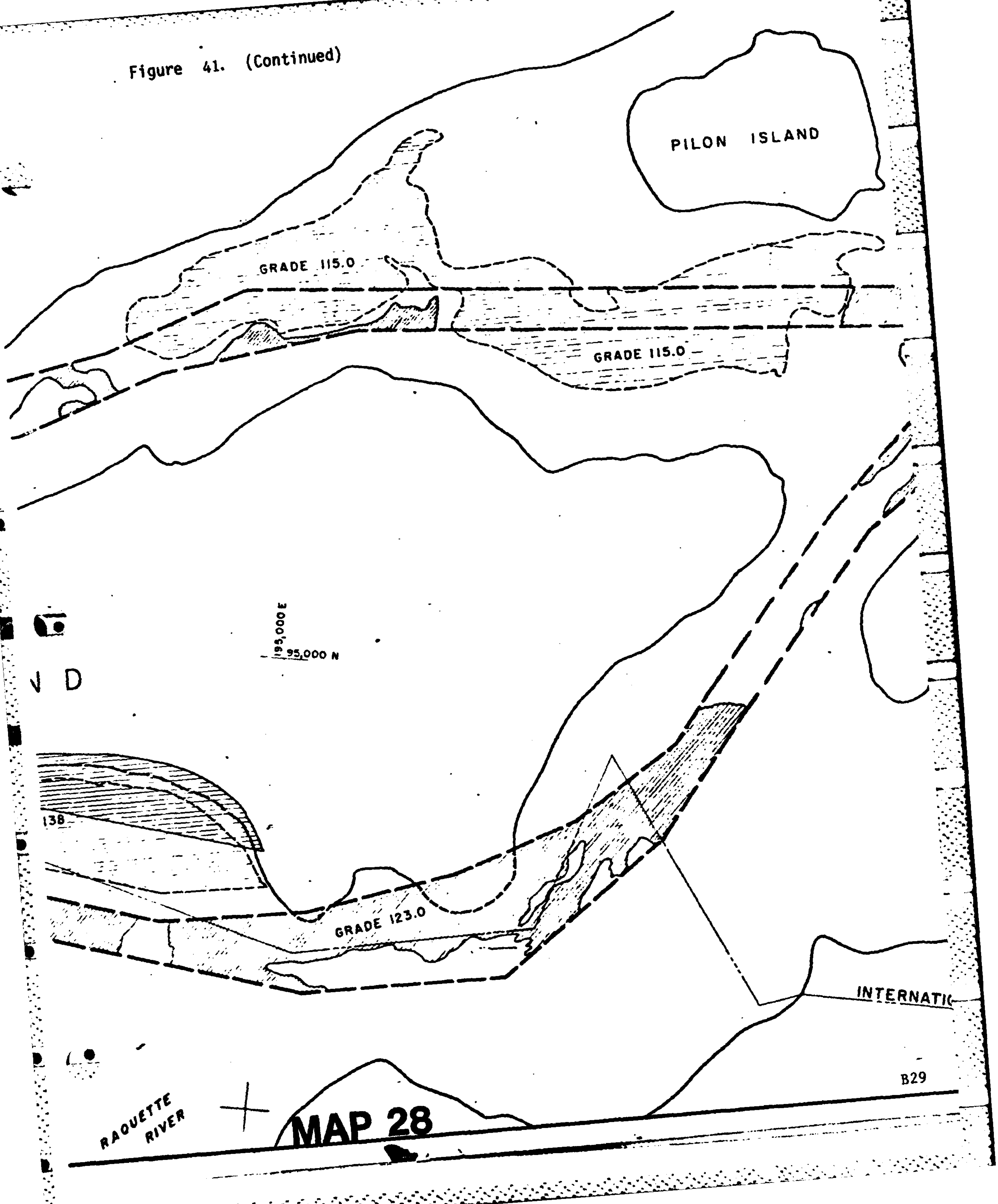
MAP 25


COR
LOCK 19
CORNWALL CANAL
LOCK 18
NEW BRIDGE
INTERNATIONAL BOUNDARY
GR 126
GR 130
GR 134
H26CA
MASSENA POINT
POLLY'S GUT
C
H8CA
GRADE 138
TRAINING DYKE
GRADE 138
LIMIT OF HYDRAULIC CHANNEL
180,000 E
90,000 N
OLD F
NEW HIGH LEVEL BRIDGE
GRADE 123.0
N.87°-27'-56" E.
GRADE 121.0
GRADE 147
MAP 26


190,000 E
100,000 N
WALL
LOCK 17
LOCK 15
H9 CA
GRADE 170
GRADE 123
GRADE 140
GRADE 122
REGULATING CHANNEL
185,000 E
95,000 N
GRADE 170
GRADE 160
GRADE 140
RNWALL
ISLA
GRADE 17C
GRAD
NAVIGATION CHANNEL
GRADE 121.0
GRADE 123.0
450
SEVELT BRIDGE
GRADE 121.0
GRADE 138
GRADE 160
GRADE 220

MAP 27

Figure 41. (Continued)



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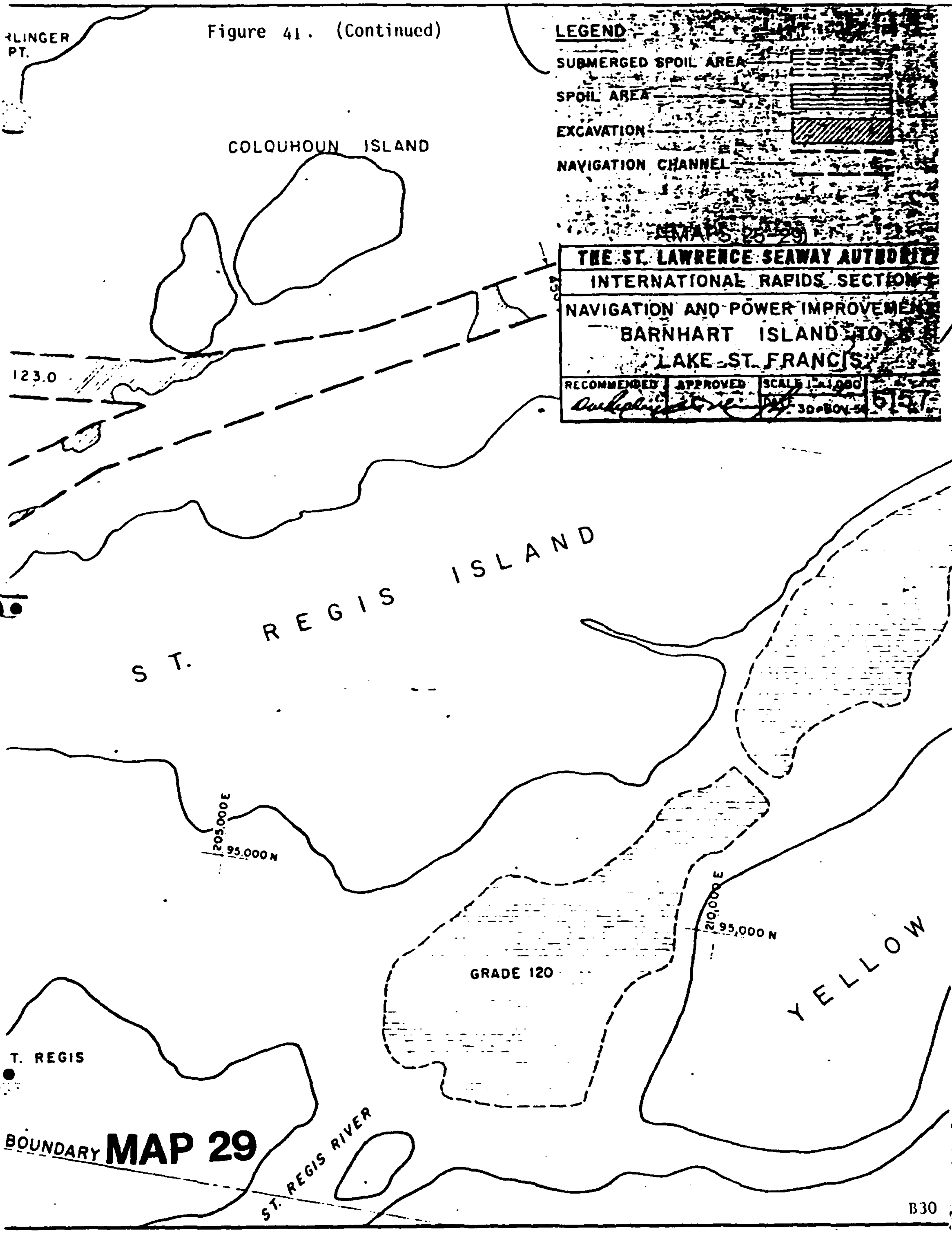

APPENDIX C.
LIFE HISTORY INFORMATION FOR IMPORTANT FISH SPECIES

Appendix C . Life history information for important fish species found in the St. Lawrence River.*

A. Warmwater Species

1) Sea Lamprey (*Petromyzon marinus* Linnaeus)

Sea lamprey spawn in the spring in gravelly areas of tributary streams. Adults congregate in the estuaries of rivers during late winter, starting to move upstream during the dark hours once stream temperature exceeds 4.4°C (44°F). Migrating adults can manage rapids easily by alternatively swimming and attaching to stones with their sucking disc mouth. They can surmount nearly vertical barriers of 152 to 183 cm (5 to 6 ft.) if the current is not excessive by creeping up the face with the sucking disc for support.

Nest building is usually begun in late May or early June by the males. Small stones are carried or dragged out of the nest site by means of the sucking disk and lighter material cleared by the thrashing action of the body. The nest is usually 254 to 1003 mm (10-39½ inches) in diameter and as much as 25 pounds of gravel is moved into a downstream, crescent lip often as high as 254 mm (10 inches). The nests are sufficiently resistant to erosion in most New York State streams that they essentially remain identifiable for much if not all of the spawning season. Nest counts in tributaries to Lake Ontario have been used by DEC as an index of relative adult lamprey population size in Lake Ontario.

Spawning activity is closely related to stream temperatures and is at its peak at 14.4° to 15.6°C (58°-60°F). The sticky eggs are fertilized by the male in repeated spawning acts over 16 to 48 hours. The eggs adhere to sand and are carried by the current to spaces between the stones in the lip downstream of the nest.

After completion of spawning, females drop downstream from the nest almost immediately and die very quickly. In one to three days, the males also die.

Hatchery rearings of eggs showed that Cayuga Lake eggs hatched in 13-14 days at 13.9° to 18.3°C (57°-65°F). The young lamprey are called ammocoetes, and burrow out of the nest in 18 to 21 days. They drift downstream to eddies or pools with areas of sandy silt and mud. They burrow tail first about 13 mm deep, often in densities of 6 to 17 per square foot. They remain in U-shaped burrows, except for surfacing to feed on plankton, throughout their ammocoete life. This period may be for as long as seven years.

In the year of the ammocoetes' transformation to an adult form, they are about 112 to 167 mm (4.4-6.6 inches) in length. At this stage, they develop the sucking disc, and rasping tongue with sharp teeth. Prior to this stage, the chemical TFM, sometimes in conjunction with Bayer 73, is used for killing the ammocoetes in their burrows, before they emerge as adult forms.

*Edited from SLEOC 1978.

The adult form seeks a host for the parasitic stage of its life. As adults, the landlocked sea lamprey may reach a length of 762 mm (30 inches). The adults migrate to deep water where they live as external parasites of fishes. As soon after transformation as a host is available, they attach themselves to it by means of the suctoral disc, usually low on the body between the paired fins of a fish. The teeth of the tongue rasp a hole in the skin of the host and its body fluids and blood are consumed. A secretion by the lamprey slows and prevents coagulation of the host's blood and breaks down muscle tissue to a state ingestible by the lamprey. Usually the lamprey penetrates only part way through the body wall, but at times they penetrate all the way through and consume the gut content of the host. Length of time attached to the host varies with lamprey size. Newly transformed lamprey spend more than nine days on a host and larger lamprey of 328 mm (12.9 inches) spend only about 40 hours on a host.

Among the species the sea lamprey attacks in fresh water are lake trout, whitefish, chubs, white suckers, yellow perch, rainbow trout, burbot, channel catfish, northern pike, carp, walleye and Pacific salmon. They prefer the larger fish species and have been a major contributor to the decline in lake trout populations in the Great Lakes. The International Great Lakes Fishery Commission was formed in 1955 to deal with the lamprey and presently coordinates the Great Lakes sea lamprey control program.

2) Lake Sturgeon (*Acipenser fulvescens*)

The lake sturgeon is the largest fish found in the SLEO area growing to over 7 feet in length and 100 pounds or more. It is found rarely above the Moses-Saunders Power Dam and is fairly common below the dam.

Spawning takes place from early May to late June when water temperatures fall within the range of 13°C to 18°C (55.4°F-64.4°F). They spawn in depths of 2-15 feet and in areas of swift water or rapids. In the St. Lawrence River, these areas are usually at the base of dams in the river or tributaries. Even if suitable spawning habitat is available, sturgeon are very sensitive to man-made disturbances on the spawning grounds and may not spawn. In an unpublished study of lake sturgeon in the St. Lawrence River, it was concluded that a significant amount of successful reproduction must take place below the Moses-Saunders Dam due to the high catch of young sturgeon (below age ten) found by the authors. It is known that sturgeon can spawn successfully in wave-washed rocky shoals and these areas may provide spawning grounds for sturgeon in Lake Ontario and the St. Lawrence River.

At temperatures of 15.6°C to 17.8°C (60°-64°F), most all eggs hatch by eight days. By September of the first year, they reach 123 mm (4.8 inches) in length. In the first five years sturgeon increase rapidly in length and from age five to fifteen, weight increases faster than length. Compared to other species, the sturgeon reaches sexual maturity at a late age.

Reported spawning ages vary greatly, but it appears that first spawning takes place at 12-19 years for males and 14-23 years for females. The time between spawning varies, but is reported to be from one to three years for males and every four to six years for females. Such infrequent spawning and late sexual maturity render the sturgeon even more vulnerable to environmental degradation since their potential for population increase is limited.

As such, the re-establishment of substantial sturgeon populations is complicated by many factors and will take many years of carefully controlled regulations and habitat improvement.

The sturgeon is not a popular sport fish and it is illegal in New York State to possess lake sturgeon. Indians at the St. Regis Mohawk Indian Reservation, however, are still permitted to harvest them as they have for years.

3) American Eel (*Anguilla rostrata* Lesueur)

The American eel is placed in the warmwater fish section because it spends much of its adult life in the shallow areas of Lake Ontario. Little information is known about its life history. It is native to the St. Lawrence River and Lake Ontario, but it is considered to have invaded the upper Great Lakes via the Welland Canal. It is relatively rare in all the Great Lakes except Lake Ontario.

The American eel is a catadromous fish. That is, it lives most of its life in fresh water but returns to the sea to spawn. Spawning migrations take place during the fall. Once at sea, the adults move to the southwest part of the North Atlantic Ocean near the Sargasso Sea where spawning occurs. They presumably die after spawning.

The number of eggs reported per female has ranged from five to twenty million. There is a lack of information concerning the adult's movements and behavior in the sea. Also, investigations have yet to find eggs, concentrations of small larvae or spawning adult eels at sea. It is known that the eggs hatch into a true larval stage, with no resemblance to the adult, in the form of a transparent ribbonlike creature called a leptocephalus. The larvae eventually move in the direction of the North American continent, arriving in the coastal waters in one year. There they metamorphose during the winter into the adult form, becoming small transparent eels about 60 mm (2½ inches) long. By the time they reach the streams and rivers of the coast, they have become completely pigmented, are from 60 to 90 mm (2½ to 3½ inches) long and are called elvers. These elvers sometimes occur in great numbers.

The life span of the American eel is not known definitively. Nine-year-olds were recognized in a study of New Brunswick lakes. In Canada, large females may be 762 to 1,016 mm (30 to 40 inches) long and weigh 2½ to 3½ pounds. Males seldom exceed 610 mm (24 inches) in length.

Eels in fresh water move freely into muddy, silty bottoms of lakes, where they lie buried in the daylight hours in summer. They apparently spend winter buried in mud and are sought by spear fishermen who probe the bottom with specially constructed spears. They tend to avoid cool, spring-fed waters, which are most important to young salmon and brook trout.

There is some evidence that eels have home territories in eastern Lake Ontario, but very little is known about their local movements in fresh water. Eels are voracious carnivores, feeding mainly at night, consuming a wide variety of fish and invertebrates. The food is reported to include blacknose dace, larval insects, crayfish, snails and earthworms, although detailed food studies have not been published.

Eels probably have few predators because of their nocturnal habits. However, there is little doubt that young eels contribute to the diet of larger fish. They are probably vulnerable when they move in large numbers upstream from the sea.

The American eel supports a successful commercial fishery in Canada, especially along the St. Lawrence River. An eel ladder was constructed by Ontario Hydro in an effort to increase the number of eels reaching Lake Ontario. More ladders may be needed if the eel fishery is to be expanded.

In the U.S., eels may be caught commercially in Lake Ontario but are currently banned from sale within the U.S. due to high concentrations of mirex and PCB's.

4) Northern Pike (Esox lucius Linnaeus)

The northern pike is a native species in this area, completely self-sustaining. This fish is another spring spawner. Spawning takes place immediately after the ice melts in April to early May when water temperatures are 4.4° to 11.1°C (40° to 52°F). Spawning activities are initiated by a movement into shallow waters, and particularly into marshes if these are accessible. There is some indication that a spawning migration occurs, perhaps as a search for marshy areas.

Spawning generally takes place during daylight hours in wetland areas, mainly vegetated flood plains of rivers, marshes, and bays of large lakes. In this area, northern pike are known to spawn around Deer Creek, Wilson Bay, Mud Bay, Flynn and Delany Bays, Chippewa and Crooked Creek, in Coles Creek, Brandy Brook and Sucker Brook, the Grasse River and others. The sexes pair at this time, with a larger female usually attended by one or two smaller males. They swim over and through vegetation in waters often no deeper than 7 inches and usually less than 10 inches. The pike is a broadcast spawner: the eggs and milt are extruded simultaneously and from five to sixty eggs are scattered at random for each spawning act. The eggs are demersal, very adhesive, and remain attached to the vegetation of the spawning area. The fish move quickly from the spawning areas after mating is over. Egg number increases with the size of the female, but averages 32,000 eggs for mature females. A large number of eggs are deposited, with egg fertility rates in nature usually over 50 percent.

However, the number of young resulting from them is very low. One habitat in Michigan had an estimated mortality rate of 99.8 percent. Both the eggs and young are preyed upon by a wide variety of fish, including other northern pike, minnows and perches. The large larvae of various aquatic insects, waterfowl and other diving birds also contribute to mortality rates. Because the pike spawn in such shallow areas, water level fluctuations are particularly critical for spawning success. Eggs and young stranded by fallen water levels are destroyed. High alkalinity is reported to reduce or prevent spawning and influences the growth of the young.

The eggs usually hatch in 12 to 14 days at prevailing water temperatures, usually of 9° to 11°C (48.2° to 51.8°F). The fry are 6 to 8 mm (0.24 to 0.32 inches) in length. They remain inactive for six to ten days feeding on the yolk sac, often attached to vegetation by means of adhesive glands on the head.

Growth is very rapid with the pike capable of growing at the rate of one tenth of an inch per day. Within a month, they may measure 1 3/4 inches, and by the end of their first summer, 6 inches.

The young remain in the shallow spawning area for several weeks after hatching. The young pike are predominantly found in the top 15 feet of water. They begin feeding on microcrustaceans and larger zooplankton and some immature aquatic insects for seven to ten days, after which small fish enter the diet. By 34.5 mm (2 inches) in length, the pike are almost entirely predatory on other fish. Growth in length continues rapidly for the first three years, but slows after sexual maturity is reached. Thereafter, weight gain increases. By the third year, they average 483 to 600 mm (19 inches to 26 inches) in length, weighing 1½ to 3½ pounds.

Growth varies from place to place depending on the length of growing season and food availability. There is a decrease in growth rates northward, with a corresponding increase in longevity. Females over the whole range live longer and attain a greater maximum size than males. There is a corresponding northward difference in age of sexual maturity. In the Lake Ontario area, females mature at three to four years and males at two to three years to age.

Adult pike usually inhabit clear, warm, slow, meandering, heavily-vegetated rivers, or warm, weedy bays of lakes. They are generally found in shallower water in the spring and fall but move to deeper, cooler water at the height of summer temperatures. This species is fairly sedentary, establishing a vague territory where food and cover are adequate.

Adults are usually taken in the top 15 feet of water, but have been recorded in depths greater than 100 feet. Average individuals are usually 457 to 762 mm (18 to 30 inches) in length. They are active and feed to a lesser degree in the winter and are an important ice fishing quarry. Feeding occurs during the daylight hours. Adult pike will eat any living vertebrate available to them within the size range they can engulf. The optimum food size has been calculated at between one-third and one-half the size of the pike.

Pike are opportunists, feeding on whatever is readily available. Fish make up over 90 percent of the adult pike's diet, while at times feeding heavily on frogs and crayfish. Mice, muskrat and ducklings have also been found in pike stomachs. It has been estimated that it takes five to six pounds of food for each pound increase in body weight of a northern pike. Considering the potential maximum weight of this fish (the North American record is 46 pounds, 2 ounces), the northern pike can have quite an effect on other vertebrates in its habitat.

Northern pike prey on other predaceous and sometimes economically more important species such as bass, walleye and muskellunge, and also compete with them for food. Adult pike, however, are large and secretive enough so that lampreys and man are probably their only significant enemies. During spawning, when the adults are in very shallow water, the smaller ones may be captured by bears, dogs, eagles and ospreys.

Pike host a number of parasites. The trematode (Uvulifer omblopIitis) is the one that most anglers see. It appears as an external cyst called "blackspot" and can be present in high numbers on individual fish. This parasite is harmless to man and is readily killed by adequate cooking or can be removed by skinning the fish.

The fish also suffers from a "red sore" disease caused by a bacterium, as well as tumors. Both give the fish an unsightly appearance and usually result in discarded catches. Neither is known to be transferred by contact to man.

The northern pike is one of the most sought-after warmwater sport fish in the SLEO area. Pike are found in good to excellent numbers at the mouth of the Salmon River, near the mouth of and in North Sandy Pond and Sandy Pond, along the shore of Lake Ontario and bays at Henderson and Sackets Harbor, along the lake shore in

Brownville, in and around the Black River, in French Creek Bay and the lower reaches of French Creek and Carrier Creek in Clayton, in Eel Bay and South Bay at Fisher's Landing, in Alexandria Bay, Chippewa Bay and in Coles Creek.

Northern pike support a substantial winter sport fishery, especially on the upper St. Lawrence. Several ice fishing derbies attracting large numbers of people are held during the winter season. Most of these fishermen come a considerable distance (some more than 40 miles one way). These derbies aid the economy of the community. Particular areas where ice fishing for pike occur are in Sandy Pond, Sackets Harbor, Cape Vincent, Eel Bay, South Bay, Goose Bay, Chippewa Bay, in the bay in Ogdensburg and in Coles Creek.

The role of the northern pike in its relation to other warmwater species is considered important. They are looked on as a good natural control over the numbers of smaller species (sunfish and perch), helping to prevent overpopulation and stunting. In a Master's thesis involving northern pike activity in fourteen wetland areas along the Lake Ontario and St. Lawrence River shoreline in Jefferson County, it was suggested that the density ratio of pike, established as the number of adults or fry per acre of wetland, could be used as a management tool in evaluating northern pike usage and the overall contribution of a particular wetland.

5) Muskellunge (*Esox masquinongy* Mitchill)

The muskellunge is native to this area and has a self-sustaining population. Next to the now very rare lake sturgeon, it is the largest freshwater fish in New York State waters.

The muskellunge (or "muskie") spawns in spring shortly after the ice has melted, generally in late April to early May when water temperatures range from 4.4°-15°C (49° to 59°F), but optimum temperature is 12.8°C (55°F). The muskie is a wetlands spawner, choosing heavily vegetated, flooded areas in water 381 mm - 508 mm (15 to 20 inches) deep. They are broadcast spawners, with the spawning act carried out many times at irregular intervals over several days (usually not longer than a week). The eggs are semi-demersal and non-adhesive, dropping into the vegetation. The usual number of eggs per female is about 120,000.

The eggs hatch in eight to fourteen days at water temperatures of 11.7°-17.2°C (53° to 63°F). Often only 34 percent of the eggs spawned naturally are fertile, whereas fertility of hatchery-raised eggs is often as high as 95 percent. Newly hatched young are 9.5-10.3 mm (0.38-0.40 inches) long. They may remain dormant in the vegetation until the yolk sac is absorbed (about ten days), at which time they become active and begin feeding.

The first food is larger zooplankton, usually cladocerans, for the first one to three weeks. Then the fish begin consuming some plankton and small fish. By the time they are about 1½ inches long, the diet is usually fish exclusively.

The young remain in the shallows of bays and marshes till around July, when they begin moving out. Growth is rapid in the first season. By ten weeks of age, muskie are about 152 mm (6 inches) long and by November of their first year, they may measure 254 - 305 mm (10 to 12 inches).

Growth is also rapid during the first few years. Greatest growth occurs in early summer and fall when available forage is at a maximum and when water temperatures are more favorable, about 20°C (68°F). The rate of increase in length slows as sexual maturity is achieved, but rate of increase in weight continues virtually into old age. There is a definite sexual dimorphism in growth. Females grow faster than males, are larger at any age and live longer. Sexual maturity is reached between three to five years, with males maturing at a smaller size. Average size fish are from 604.6 mm - 1219.2 mm (24 to 48 inches) long and weigh from 5 to 36 pounds.

The young, nearly immobile muskies fall prey to many fish species including northern pike, yellow perch, smallmouth and largemouth bass, rock bass and sunfish. Newly hatched young are probably eaten by diving beetles and large larvae of some of the aquatic insects. Where earlier-hatching northern pike and muskie use the same spawning grounds, predation of muskie hatchlings by pike fingerlings is considered as a major threat to muskie survival.

Juvenile and adult muskie inhabit areas similar to the northern pike: warm, heavily vegetated lakes; stumpy, weedy bays; and slow, heavily vegetated rivers. They are regularly found among dense growths of pondweed (Potamogeton spp.) and are rarely found far from the protection of growths of emergent and submergent plants or areas of drowned timber and stumps.

Water temperatures up to 25.6^{o}C (78^{o}F) appear to be optimal, but muskie can tolerate temperatures as high as 32.2^{o}C (90^{o}F). They can apparently tolerate the low summer oxygen levels of their sluggish, shallow habitats. Very large muskies are often found in or over deeper, less vegetated water and to a depth of 50 feet. They are solitary, sedentary fish, except at spawning time, staying concealed in vegetation or near stumps. They move little, other than to dart swiftly after single prey fish, which they often carry back to the protective area before swallowing.

There is apparently a direct relation between the size of a muskie and the size of the food fish selected. Growth and survival of larger muskies is often impaired if food of sufficiently large size is not available, despite the presence of vast numbers of smaller fish.

A wide variety of warmwater fish such as perch, sucker, larger minnow species, alewife, catfish and sunfish are usually represented in the diet, depending on habitat. Although fish form the largest part of the diet, muskellunge will eat crayfish, frogs, muskrats, mice, shrews and a variety of both young and adult waterfowl.

Larger muskie are nearly free of predation themselves, except man and possibly large birds of prey and bears. The great size of some spawners, the high regard in which the fish is held, the shallow water of spawning sites and the loss of wariness at spawning time make the muskie easy prey to disastrous reduction of numbers by poaching.

A most critical stage in the life of the muskellunge is during spawning and immediately after. Their habit of spawning in wetland areas can constitute a serious limiting factor. Even slight drops in water level in these areas can result in the stranding and death of the spawners or the young. More drastic changes in level can expose the developing eggs.

Muskellunge are apparently limited by the success of northern pike over the muskie where they co-exist. The northern pike's earlier spawning, faster growth, early dominance of fish in its diet and more efficient food conversion are cited as contributing factors. Young and older pike consume young muskies, and the pike at all ages is a direct more successful competitor of the muskie for space, food and spawning sites.

Muskellunge host a number of parasites. Muskie are also subject to growth of cancerous red tumors, which result in the fish being discarded by fishermen.

Muskellunge are among the most highly prized freshwater trophy fishes in North America. The anticipation of the possibility of capturing a world's record muskie (which now would have to exceed 70 pounds), or even a single, legal-size fish (36 inches long), annually draws thousands of anglers and their families to known haunts of this species. The present world record is a muskie caught in the St. Lawrence River in 1957. To guides, boat and motor sales and rental agencies, tourist operators and merchants, the pursuit of the muskie means cash incomes. The muskie fishery contributes an estimated several million dollars annually to the Canadian economy.

It is estimated that the capture of a legal muskie requires 100 man-hours of angling. Once hooked, a muskie is a strong fighter and may take up to an hour to land. This fish provides a considerable challenge to any fisherman and is a prized trophy fish. Because of its great esteem as a game fish, the species is propagated and planted in some waters and variously protected in others.

The principal means of protecting the muskie is to permit it to attain substantial size so that it may breed at least once before it is taken by anglers. In the St. Lawrence-Eastern Ontario area, muskellunge are found in localized areas of suitable habitat in the St. Lawrence River near Cape Vincent, Clayton, Fisher's Landing, Alexandria Bay, Chippewa Bay, Morristown (near the lee of islands or points), and in the bay and lower reaches of the Oswegatchie River. They spawn in the mouth of Crooked Creek and Chippewa Creek.

6) Carp (*Cyprinus carpio* Linnaeus)

Carp are an introduced, vigorously self-sustaining fish found throughout area waters. They spawn when water temperature reaches at least 17°C (62.6°F) and cease at about 28°C (82.4°F). In Lake St. Lawrence, it has been observed that spawning may be interrupted if the temperature drops below 17°C (62.6°F) and begins again when suitable temperature returns. Spawning season is usually extended when temperatures permit and in the Great Lakes region, may last from May to August. As the waters warm in the spring, adults move into weedy or grassy shallows, at first gathering in rather large numbers near the surface. The adhesive eggs are deposited randomly and become attached to submerged vegetation. Observations of carp spawning in Lake St. Lawrence revealed that eggs laid on the marsh vegetation hatched within three to six days after fertilization, depending on water temperature.

By the end of the first growing season, carp usually attain lengths of 130 to 190 mm (5.1 - 7.5 inches). Males become mature at ages three and four, females at ages four and five. The spawning population in Lake St. Lawrence is composed of carp ranging from age two to sixteen.

Carp consume a great variety of plant and animal life. A carp will select food from the bottom by sucking up a mouthful of bottom ooze and expelling it back into the water where it can choose the worthwhile food particles. Due to this feeding habit, carp can be detrimental to native fish populations since they increase the turbidity of the water and uproot aquatic vegetation needed by other life.

Compounding their image as an undesirable fish species is their tolerance of water quality unsuitable for other warmwater species. As such, carp population numbers relative to population numbers of such less pollution-tolerant species as smallmouth bass can be indicative of overall water quality.

In the 1977 Lake Ontario U.S. commercial fish catch, carp made up less than one percent of the total.

7) <u>Brown Bullhead</u> (<u>Ictalurus</u> <u>nebulosus</u> Lesueur)

The brown bullhead is a native fish with a self-sustaining population. Although this fish is an important sport and commercial species, there is a lack of detailed life history information about it. It spawns in late spring and summer (April to June) when water temperatures approach 21.1°C (70°F). A shallow nest is prepared by one or both sexes in a sandy or muddy bottom, or among the roots of aquatic vegetation usually near the protection of a stump, rock or tree. Sometimes nest burrows are made by tunnelling into the bottom or into a bank. These nests are usually found around the shores of lakes, or in coves, bays or creek mouths in water depths ranging from six inches to several feet, but usually less than four feet.

Spawning apparently takes place in the daytime. A large number of spawning acts take place with an increasing number of eggs released at each act. Females 203 to 330 mm (8 to 13 inches) in length may contain from 2,000 to 13,000 eggs. After the eggs are in the nest, one or both parents care for them. They are fanned with the parent's paired fins, moved and stirred with the barbels and fin spines, and sometimes picked up in the mouth and ejected. The fanning and manipulating is necessary as bullhead eggs will not hatch without it, even in water containing more than adequate oxygen.

The eggs take six to nine days to hatch at 20.6° - 23.3°C (69° to 74°F). Sometimes one or more parent will eat some or all of the eggs before they can hatch. At hatching, the young are about one-quarter inch long. They remain in the nest about a week while the yolk sac is being absorbed. The young, resembling tadpoles, then begin to swim and feed actively, herded about for several weeks in a loose congregation by one or both parents. When the young are about two inches long, the guarding and the school break down and they disperse.

The young fish, from about 25.4 to 38.1 mm (1 to 1½ inches) long, feed primarily on chironomid larvae, cladocerans, ostracods and newly hatched fish. Small fish and eggs may be taken at times as well.

Growth is moderately rapid. The young are usually two inches long before the end of their first summer. Overall rate of growth depends on such things as available food supply and temperature. In unsuitable habitats, such as cold, elevated lakes, they grow poorly. Overcrowding can also result in stunted populations. Average-sized bullhead are usually 203.2 - 355.6 mm (8 to 14 inches) long, weighing three-quarters to one pound.

Brown bullhead are usually near or on the bottom in shallow, warm water in ponds, small lakes, shallow bays of larger lakes and larger, slow-moving streams with abundant aquatic vegetation and sand to mud bottoms. They are sometimes found in depths of 12.2 m (40 feet).

These fish are very tolerant of conditions of temperature, oxygen and pollution which might be limiting for other species. They can survive at water temperatures of 36.1°C (97°F) and during the winter are able to live at an oxygen content of 0.2 ppm. They are reported to be able to bury themselves in the bottom mud to avoid adverse conditions. They seem to be particularly resistant to domestic and industrial pollution, sometimes being the only species present in heavily polluted streams.

Bullhead feed on or near the bottom, mainly at night. The food is searched out by means of the barbels and by the senses of taste and smell. They are omnivorous as adults, consuming offal, waste, mollusks, immature insects, terrestrial insects, leeches, crustaceans (crayfish and plankton), worms, algae, plant materials and fish eggs.

Brown bullheads, especially the young, are eaten by a wide variety of predatory fishes, at times out of proportion to their numbers relative to other available forage fishes. Chain pickerel, northern pike, muskellunge and walleye are among the predators. They probably prey on the smaller bullhead, for which the spines do not provide maximum protection.

Bullhead probably compete quantitatively for bottom organisms with a wide variety of fishes. It is an indirect competition, due to their nocturnal feeding habits and tactile searching methods. They have definitely been reported to have eaten eggs of cisco, herring and lake trout, but may not be the egg predators that they are assumed to be. Bullhead host several parasites but none of great concern to man.

Brown bullhead are very popular sport fish with some people, sought after not so much for sport as for the food. This species is not covered by season, size or bag limit regulations and often provides the angler with enjoyment and food prior to the opening season of the more popular sport fish. "Bullhead suppers" sponsored by various organizations in spring and summer are quite popular in the St. Lawrence-Eastern Ontario (SLEO) area. Fish consumed are usually supplied by the local commercial fishery. Many of the area's restaurants also serve as a local market for these fish. In the 1977 U.S. commercial catch for Lake Ontario, bullhead made up 22 percent of the total reported catch, with 45,923 pounds reported.

Bullhead are found in good to excellent numbers in Mud Brook, Sandy Creek, South and North Colwell Ponds, Goose Pond, Floodwood Pond, Lakeview Pond, in the bay and mouth of the Black and Perch Rivers, at the mouths and lower reaches of the Chaumont River, Guffin Creek, and other inlets to Chaumont Bay, in Cranberry and Crooked Creeks, in the mouths of other creeks leading into Goose Bay, and in the Grasse River.

8) <u>White Perch</u> (<u>Morone</u> <u>americana</u> Gmelin)

As mentioned in Section II, the white perch is not a native resident of the lower Great Lakes. It invaded Lake Ontario via the Oswego River probably sometime between 1946 and 1948. The population is self-sustaining. This fish has become very abundant since its initial invasion and is the dominant species in several sections of the lake.

The white perch spawns in the spring about mid-May, sometimes extending through late June, when temperatures are in the range of 11° to 15°C (51.8° to 59°F). Most reports indicate that spawning is prolonged, continuing for one to two weeks. Spawning takes place over shallow water and is said to occur over any bottom type with little evidence of preference. Large numbers of male and female adult fish mill around in the shallow water and appear to release their sperm and eggs more or less randomly. The eggs are adhesive and so become attached to vegetation, rocks and other bottom objects. Total number of eggs vary from 20,000 to 300,000, depending partly on the size of the female. This is a large number of eggs for such a relatively small fish whose average size is 5 to 7 inches.

There is no parental care of the eggs that hatch in four to four-and-a-half days at expected spawning temperatures of 15°C (59°F). The young at hatching are 2.3 mm (0.09 inches) long and grow rapidly, reaching 40 to 65 mm (1½ to 2½ inches) in length by July and August. Growth rates vary widely by area and the condition of the population. Because of their propensity to increase in number rapidly, white perch tend to become overpopulated leading to stunted populations.

In general, the females average slightly larger than males after the second year. The ratio of females to males tends to increase with age, suggesting that males have a higher mortality rate than females. The average life span for most populations seems to be five to seven years.

Young white perch consume microplankton and, as they grow larger, aquatic insect larvae become a significant part of the diet. Adults consume a higher percentage of fish, including yellow perch, smelt, johnny darters and young of their own species. Fish constitute about 35 percent of the diet of 7-inch white perch and 70 percent of the diet of 216 to 254 mm (8½ to 10 inch) white perch. Two peak feeding periods are reported daily, one at noon and a more important one about midnight.

The white perch thrive in a variety of habitats but seem to be more successful in waters reaching 24°C (75.2°F) or more in the summer. They have been generally observed to move onshore at night and offshore into deeper water at dawn. At times, very dense schools may be formed. The movement is apparently associated in part with feeding.

White perch are seldom preyed on by fish species (except other white perch) and are only lightly affected by parasites.

The white perch is highly regarded in the eastern United States as a good food fish. It figures highly in the U.S. commercial catch from Lake Ontario. In 1977, white perch ranked first in pounds harvested (68,433 pounds), accounting for 33 percent of the total catch. However, they are not often exploited as a game fish and are not commercially harvested to a great extent relative to their abundance.

This could be the start of a serious problem. If white perch become abundant in specific areas, they can provide serious competition for more valuable game fish. Direct predation by white perch on game fish could also become a problem.

9) Rock Bass (Ambloplites rupestris Rafinesque)

The rock bass is a native, self-sustaining fish in this area. There is not much information on this species' life history. It spawns in the late spring and early summer when the water temperature is 15.6° to 21.1°C (60° to 70°F). The male digs a shallow nest up to 2 feet in diameter in areas ranging from swamps or marshy areas to gravel shoals, in water depths of less than a foot to four feet or more. Often nests are very close together in areas used heavily for spawning. Defense of territory and attempts to attract and hold females are very aggressive.

Spawning takes place at short intervals over a period of an hour or more, but only a few eggs are laid at a time. More than one female may spawn in the same nest and one female may spawn in more than one nest. Egg number varies from 3,000 to 11,000 depending on the size of the female. The eggs are adhesive. The female leaves the nest after spawning, while the male guards and fans the eggs and later broods the young for a short period.

The eggs hatch in three to four days in aquaria at water temperatures of 20.5° to 21.0°C (68.9° to 69.8°F). An average number of 800 fry resulted from a nest in Michigan.

Growth is rapid. In northern states, the young average between 38.1 and 50.8 mm (1½ to 2 inches) in length at the end of their first year, between 101.6 and 127 mm (4 and 5 inches) at three years, and between 127 and 152.4 mm (5 and 6 inches) at five years. An average adult is 152.4 to 254 mm (6 to 10 inches) long. In crowded ponds or smaller streams, rock bass are often stunted and rarely exceed 228.6 mm (9 inches).

Rock bass generally inhabit rocky areas in shallow water in lakes and the lower, warm reaches of streams. The young occupy littoral to limnetic areas of lakes. The adults are usually found in aggregations and most often in association with other sunfish such as the smallmouth bass and pumpkinseed. They feed largely upon both immature and adult aquatic insects, crayfish and small fishes (especially minnows, yellow perch, and at times their own young). They take some food at the surface.

The young and small adults are probably preyed on by the larger basses, northern pike, muskie and possibly walleye. Rock bass compete with smallmouth bass for food. They are host to several parasites, with the black-spot most commonly seen.

In the SLEO area, the fish is an important commercial species. Rock bass made up six percent of the U.S. commercial catch in Lake Ontario in pounds for 1977 with 12,089 pounds harvested. The species is not a major sport fish, although it is easily caught from shore using various baits and lures, providing a good deal of enjoyment for children. Rock bass can also be caught when still fishing or casting for bass, northern pike or walleye.

This species may be important in an indirect way in its ecological association with other species more valued by man, such as the basses.

10) Pumpkinseed (Lepomis gibbosus Linnaeus)

Pumpkinseed (sunfish) are native to this area and populations are self-sustaining. They spawn from late spring to early summer when water temperatures reach 68°F. The male constructs a nest in the shallow water of ponds, lakes or slow moving streams.

usually in depths of 152 to 305 mm (6 to 12 inches) near shore. The nests are shallow depressions 102 to 406 mm (4 to 16 inches) in diameter in areas of submerged aquatic vegetation. There are often numerous nests very close together in one area. The bottom type can be clay to sand, gravel or rock, since the male only sweeps deep enough to expose a clean, hard bottom.

There is considerable display and swimming in a circular path during courtship and mating. Egg laying takes place during these circulations with small quantities of eggs and sperm released at irregular intervals. Males may spawn more than once in the same season, in the same nest, with the same or different females.

The eggs adhere to the bottom of the nest on soil particles, small stones, roots or sticks. The average number of eggs is from 600 to 3,000 for females between two to five years old and 61 to 92 mm (2.9 to 3.7 inches) long. After the eggs are deposited, the female leaves and the male remains to guard and fan the eggs.

The newly hatched young are minute and transparent. The male guards the young for a period up to eleven days, returning them to the nest in his mouth if they stray. After this time, the young leave the nest and the male may begin to clean the nest in preparation for a second spawning.

Growth is moderately fast. Pumpkinseed in Ohio have reached 20 to 81 mm (0.8 to 3.2 inches) in length by October. Average sized fish are 177.8 to 288.6 mm (7 to 9 inches) long. Sexual maturity is usually reached by age two. In small productive bodies of water with large populations, stunting takes place and maximum length may not exceed 101.6 to 127 mm (4 or 5 inches).

Food of both the young and adult consists mainly of a variety of insects and other invertebrates, with some shift according to size and season. Small fishes or other vertebrates such as larval salamanders can at times form a considerable part of an adult's diet. Food is taken from the surface, off the bottom and in the water mass.

Pumpkinseed are usually found in small lakes, ponds, shallow weedy bays of larger lakes and in the quiet waters of slow moving streams. They range over various bottom types, preferring clear water and the cover of submerged vegetation or brush. They are usually seen in large numbers and often near or at the surface of areas exposed to the sun.

Small pumpkinseed form part of the diet of almost all predatory fishes, and to a lesser extent of the pumpkinseed and other sunfish. They are eaten by the bass, walleye, yellow perch, northern pike and muskellunge. They host several parasites, the black-spot being seen most often.

Pumpkinseed rank high as a sport fish with children. Their presence in large numbers in shallow, sheltered situations close to shore makes them easily accessible. This sunfish attacks even small pieces of live bait viciously and will put up a strong fight to the delight of children and novice fishermen. The pumpkinseed, along with other sunfish, is caught commercially in Lake Ontario where they comprised about four percent of the total U.S. catch in pounds for 1977 (9,070 pounds).

11) <u>Largemouth Bass</u> (<u>Micropterus salmoides</u>)

The largemouth bass is a naturally occurring, self-sustaining species found in area waters. Spawning takes place from late spring into summer when water temperatures reach 16.7^{o} to 18.3^{o}C (62^{o}-65^{o}F). Since their spawning habitat is usually in shallow areas and quiet bays among emergent vegetation, largemouth bass usually spawn earlier than the smallmouth bass. The water temperature warms sooner in the shallows and bays than in the deeper, rockier sites used for spawning by the smallmouth bass. Spawning grounds can vary from gravelly sand (more rarely) to soft mud around reeds, bullrushes or water lilies in water 1 to 4 feet deep. The male sweeps out a nest 2 to 3 feet in diameter, usually at least 30 feet from other nests. It is thought that females spawn yearly between the ages of five and twelve, often with several males on different nests. Males reach sexual maturity in three to four years.

The number of fry found in a single nest averages 5,000-7,000. They remain in the bottom of the nest until the yolk is absorbed, usually six or seven days. Then they rise to begin feeding and schooling. For almost a month the male guards over the brood. Even then, survival rate is low and usually only five to ten of a particular hatch survive to reach 10 inches in length.

Spawning success, growth and survival in the first year determine strength of the year-classes. As in smallmouth bass, good and poor year-classes make strikingly different contributions to the population and angler harvest.

The habitat of the largemouth is the upper, warmer levels of the water body, usually in association with soft bottoms, stumps and extensive vegetative growth. This is in contrast to the habitat of the smallmouth, which is usually found in rocky areas at deeper levels, though both species are commonly found in the same waters. Despite the largemouth's preference for warm waters, they have a low tolerance for low oxygen levels. They are more active in the winter than smallmouth bass and are sometimes taken by ice fishermen.

Adult largemouth eat other fish, plankton, insects, crayfish and frogs. They tend to feed at the surface in the morning and evening, and in the water mass and from the bottom during the day. They are sight feeders, usually close to vegetation. It has been reported that up to ten percent of the food eaten by largemouth bass 8 inches and longer is largemouth fry.

There are numerous parasites that can plague the largemouth bass. As with the smallmouth bass, the parasites of most concern are the bass tapeworms, blackspot and yellow grub. The tapeworm can cause sterility and the other two are unsightly. None of these are dangerous to man.

12) Smallmouth Bass (*Micropterus dolomieui* Lacepede)

The smallmouth bass is a native, entirely self-sustaining species. Spawning occurs in the late spring and early summer, most often from late May to early July, when water temperatures range from 12.8° - 20°C (55°-68°F). In Lake Ontario, spawning occurs in May to early June in tributary streams and some of the warmer bays and from late June to July in the lake itself.

Spawning lasts over a period of six to ten days with egg deposition mostly taking place at temperatures of 16.1° to 18.3°C (61°-65°F). The male builds a nest, usually selecting a firm bottom type consisting of sand, gravel or rocks in shallow water ranging from 61 to 610 cm (2 to 20 feet) of lakes and rivers. The nest is a saucer-shaped depression a few inches deep and from 30.5 to 183 cm (1 to 6 feet) in diameter, most often found near the protection of rocks, logs or, more rarely, dense vegetation. A temperature drop below 15.5°C (60°F) during the process of nest-building may cause the male to quit the preparation. Nest-building may take from one-half to more than two days.

After nest building, there is considerable pre-spawning activity before the eggs are deposited in the nest and fertilized by the male. Egg number in females depends on size and appears to range from 5,000 to 14,000 eggs per female. The eggs become attached to clean stones near the center of the nest.

The female leaves the nest after spawning and may spawn again in another nest with another male. The male guards the nest, fans the eggs and guards the young after they hatch. If there is a decrease in temperature, the male may desert the nest and all the eggs may be destroyed. About 40 percent of the nests can be failures, with about 2,000 fry resulting from those that are successful. Sudden shifts of temperature upward or downward, changes in water level and fungal infections kill many eggs. The larger the female and guarding male, the greater the hatching success.

The eggs usually hatch in four to ten days, with the young measuring 5.6 to 5.9 cm (0.224-0.226 inches) in length. Within twelve days, the young have absorbed the yolk sac and can rise off the bottom. In another week, they begin to leave the nest, but they are still guarded by the male for several days.

The fry begin feeding on plankton and switch to immature aquatic insects at about 20 mm (0.8 inches). They begin eating crayfish and fish by the time they are 50 mm (2 inches) long. Growth of the young fish is rapid at first. By the end of their first summer, they usually are of good fingerling size ranging from 51 to 102 mm (2 to 4 inches), primarily depending on water temperature and food availability.

Many factors including summer temperature, water levels, wind, nest desertion, predation, angling and the bass tapeworm greatly affect reproduction and survival of the young. This can result in large and small year classes with large differences in contributions to the population and harvest.

Males usually reach sexual maturity in their third to fifth year and females in their fourth to sixth year. The fish have an average size of from 203 to 381 mm (8 to 15 inches), weighing from 1/2 to 1 pound in weight. Females probably spawn every year.

The adults occupy varying habitats, depending on the time of year. In the spring, the adults are congregated on the spawning grounds. Following spawning, they are usually found in rocky and sandy areas of lakes and rivers in moderately shallow water. They move to greater depths during the heat of summer. They are usually found near rocks or submerged logs that offer protection. They are much less associated with dense growths of aquatic vegetation than are the largemouth bass.

The smallmouth prefers a lower temperature range than the largemouth - 20.3^o to 21.3^{o}C (68.5^o to 70.3^{o}F). Diet and seasonal movements are partly in response to attempts to remain in water of the preferred temperature. The upper lethal temperature for this species has been experimentally determined as 35^{o}C (95^{o}F), but it is generally considered that the smallmouth cannot tolerate high environmental temperatures as well as the largemouth. In the winter, the smallmouth aggregate near the bottom, are very inactive, eat little and are rarely taken by anglers.

In general, the food of adults consists of insects, crayfish and fish taken from the surface, in the water and off the bottom. They begin feeding in the spring when the water temperature reaches 8.5^{o}C (47.3^{o}F). The choice of food shifts with availability from place to place. For adults in most habitats, crayfish form about 60 to 90 percent of the food volume, fish 10 to 30 percent and aquatic and terrestrial insects 0 to 10 percent. The yellow perch seems to be the dominant fish species in the diet.

The attraction of smallmouth bass for anglers is famous. It is a very important species to the sport fishery and associated businesses in the St. Lawrence-Eastern Ontario area. It is the most sought after species of the area. The average size of those caught by anglers is 203 to 301 mm (8 to 15 inches), usually weighing under 3 pounds. In the SLEO area, it takes from four to six years for the smallmouth to reach a length of 254 mm (10 inches)

Most tagging studies have shown smallmouth bass move within a limited range of from 1/2 to 5 miles from place of capture. There is some evidence of homing to spawning grounds and summer territory. In the SLEO area, studies have been conducted on the migrating habits of the smallmouth bass.

It was found that the bass population as a whole is composed of a number of local populations, distinguished mainly by rate of growth and migration. Distinct populations are recognized for Eel Bay, Wilson Bay, Charity Shoals, Chaumont Bay and the Galloo-Stony Island area. It was found that the bass in Wilson Bay contribute appreciably to fishing in the St. Lawrence River above Clayton. Tagging studies done on the populations in Eel Bay, Wilson Bay and Charity Shoals indicated that most of the bass did not migrate more than five miles from the point of release.

There are several predators of smallmouth bass. Rock bass in groups apparently cause a significant loss of eggs and fry. One distracts the guarding male while the rest of the group feeds. Yellow perch, sunfish, catfish, longnose gar, suckers and turtles are also predators.

Competition for food does not seem to be a serious limiting factor. However, there is apparently competition for nesting areas with rock bass and in shallower areas with sunfish. Competition with rock bass is an important limiting factor of the bass populations in the St. Lawrence River.

The bass tapeworm (Proteocephalus ambloplitis) is a serious parasite which can cause sterility or seriously limit smallmouth bass reproduction. Black-spot and yellow grub, when present, often deter anglers from eating their catch.

13) Yellow Perch (Perca flavescens Mitchill)

The yellow perch is another species native to the area with a completely self-sustaining population. Spawning occurs in the spring, usually from mid-April to early May, but extends into July in some areas. Spawning takes place during the night and early morning in a temperature range of about 8.4° to 12.2°C (44° to 54°F).

The spawning grounds are in the shallows of lakes and tributary rivers, usually near rooted vegetation, submerged brush or fallen trees, but occasionally over sand or gravel. No nest is built, but the female extrudes the eggs in a gelatinous "zig-zag rope" or tube that contains an average of 23,000 eggs. The total number of eggs per female increases with size. These egg masses are semi-buoyant and undulate with the water currents. They adhere to the submerged vegetation and, at times, to the bottom. These "ropes" are easily cast ashore by wind, waves and current, and are lost. Parents give no protection to the egg masses or the young. The eggs usually hatch in eight to ten days.

The young are about 5 mm (0.2 inches) long. They remain inactive for about five days while absorbing the yolk sac , before they begin feeding on plankton. Growth is usually rapid at first, but extremely variable depending on population size, habitat size and food availability. Great Lakes perch average 63.5 to 89 mm (2½ to 3½ inches) long after their first year. Yellow perch are gregarious and, in the first summer, large compact schools of young are often seen in the shallow water near vegetation, feeding on immature insects and invertebrates. Young perch are often found in mixed schools that include a minnow species such as the spottail shiner.

When crowding of the young occurs, stunted populations can result with adults never exceeding 152.4 mm (6 inches) in length. Normal growth may reach 355.6 mm (14 inches). Females grow faster than males even at age one and attain a greater ultimate size. Northern populations grow more slowly and live longer. Males become sexually mature at age three and females at age four. The maximum age is usually nine or ten years. The average length in the SLEO area is from 101.6 to 254 mm (4 to 10 inches).

This perch is usually found in water temperatures of 19^{o} to 21^{o}C (66.2^{o} to 69.8^{o}F). Their seasonal vertical movements suggest that they follow the 20^{o}C (68^{o}F) isotherm.

The yellow perch is very adaptable and is able to use a wide variety of warm to cooler habitats, from large lakes to ponds or quiet rivers. They are most abundant in the open waters of lakes with moderate vegetation, clear water and bottom types ranging from muck to sand and gravel. Population numbers will decrease in a body of water where turbidity increases or vegetation decreases. This species appears to be more tolerant of low oxygen content than sunfish species.

In the SLEO area, the yellow perch is a very abundant fish found along the entire lake shoreline and in the St. Lawrence River.

The yellow perch is generally considered shallow water species and usually is not taken below 9.2 m (30 feet). The adults and young often move about in loose schools of 50 to 200 individuals, segregated by size. The adult schools are close together in summer and more separated in winter. These fish move inshore and out, moving vertically in the water during the day. At night, they are inactive and rest on the bottom. Yellow perch are active all winter under the ice in shallow or deeper water. Their seasonal movements are out of and into deeper water in response to temperature and probably to food distribution. They exhibit migratory movements in the spring.

The adults feed primarily on immature insects, larger invertebrates and fish taken in open water or off the bottom. They apparently prey on the eggs and young of a wide variety of fish. Active feeding takes place morning through about six p.m. with little or none occurring at night. Perch feed actively all through the winter.

Predators of the yellow perch include almost all other warm to coldwater predatory fish such as bass, sunfish, crappie, walleye, other yellow perch, northern pike, muskellunge and to some extent, lake trout. Water birds, including gulls, mergansers, loons and kingfishers also prey on the young and adults.

Young and adult perch may compete for food with brook trout, cisco, lake whitefish, bass, crappie and bluegill. Yellow perch with their high reproductive potential, voracious appetite and effectiveness at feeding can lead to serious competition in some locations with more valued species such as trout and bass, as well as with themselves.

The yellow perch is host to a wide variety of parasites that reduce growth and cause mortality. Those of more direct interest to man are the black-spot, yellow grub and the broad tapeworm (Diphyllobothrium latum). The first two are harmless to man but render the fish unsightly, often causing the angler to discard his catch. The broad tapeworm could infect man if an infected fish were eaten raw or improperly cooked.

Yellow perch can suffer from a number of fish diseases and such pathological conditions as tumors.

The yellow perch has a prominent role in both the commercial and sport fisheries of the St. Lawrence River and eastern Lake Ontario. It inhabits a wide territory, a wide variety of habitats, and is a schooling fish that congregates nearshore in the spring. All these factors make this fish readily accessible to both commercial and sport fishermen. It is also a much sought-after species during the ice fishing season. In addition, yellow perch are used as live bait for other fish such as northern pike and muskellunge and as cut bait for a variety of fish.

Commercially, yellow perch made up 24 percent of the total U.S. catch in pounds in Lake Ontario for 1977 (48,868 pounds).

14) Walleye (Stizostedion vitreum vitreum)

The walleye is a prized game fish in the St. Lawrence River and is found in the SLEO area mainly below the Moses-Saunders Power Dam. The population of walleyes upstream from the dam decreased following the formation of Lake St. Lawrence, since walleye prefer to spawn in rocky areas in white water.

Spawning usually begins when water temperature falls in the range of 5.6^{0} to 11.1^{0}C (42^{0}-52^{0}F). Walleye spawn at night in tributary rivers or below dams. The eggs are broadcast and fall into the substrate, where they hatch in 12 to 18 days. By the end of the summer, the young are found at depths of 20 to 30 feet. They have reached up to 213 mm (8.4 inches) in the Bay of Quinte, Lake Ontario, after one year of growth. The average sized walleye seen by anglers are usually 1 to 3 pounds in weight but have been reported to reach over 20 pounds.

Walleye are tolerant of a great range of habitat conditions, but they require shelter from daylight due to their sensitivity to bright light. Large streams or rivers, providing they are deep or turbid enough to provide shelter in daylight, are preferred habitat. Walleye often use sunken trees, shoals, weed beds or thick layers of ice as shields from the sun.

Feeding occurs primarily at twilight and most often the presence of walleye is associated with other species such as yellow perch, northern pike, muskellunge and smallmouth bass. They are active all winter and in the St. Lawrence River are the third most common fish sought in ice fishing, after northern pike and yellow perch.

Both northern pike and muskellunge prey on the walleye. The northern pike is thought to be a major competitor as it is the only other major shallow-water predator in the north.

Walleye comprised less than half a percent of the 1977 Lake Ontario U.S. commercial fish catch.

B. Forage Fish

1) Alewife (Alosa pseudoharengus Wilson)

The alewife is a marine fish native to the east coast of North America. As indicated in the historical section, the alewife was first recorded in Lake Ontario in 1873. It is not established with certainty whether it invaded naturally or was accidentally introduced. Landlocked populations now occur in all the Great Lakes. Attention will be given to the life history of these landlocked populations.

Landlocked alewives inhabit the open lake waters during most of the year and move inshore to spawn beginning in April in Lake Ontario. The migration lasts from April to July depending on location and water temperatures. Freshwater populations spawn on sand or gravel bottoms in streams or in shallow areas along the lake shore, often in areas with some vegetation.

Females appear on the spawning grounds first, with the males arriving shortly after. Spawning takes place at night, in groups of three or in pairs, in water 152.4 to 304.8 mm (6 to 12 inches) deep. The eggs are broadcast at random, demersal, and essentially non-adhesive. Egg numbers are variously estimated from 10,000 to 12,000 for freshwater females. At mean water temperature of 15.6°C (60°F), incubation takes six days.

Adults leave inshore waters immediately after spawning. Most migrate to deep water sometime in late August. About mid-September, they appear in water 45.7 to 91.4 m (150 to 300 feet) deep and remain in deep water until March.

Juvenile alewives migrate inshore in the spring like the adults. They are found in shallow water during the night, and are located on the bottom in 1.8 to 3.1 m (6 to 10 feet) of water during the day. It is probable that the migration time of juvenile alewives to deep water and the time spent there are similar to the adults.

Lake Ontario alewives display rapid early growth, which decreases with the onset of maturity (age two for males, three for females). Female alewives grow larger and live longer than the males and exhibit a faster growth rate.

Both adult and young alewives are zooplankton feeders. The diet does not seem to change appreciably as the young grow and develop. In fresh water, the principal food items are copepods, cladocerans, mysids and ostracods. Insect larvae may be important in the diet of inshore adults. Alewives display a high degree of selectivity in feeding.

Predators of freshwater alewife populations are primarily the larger piscivores such as the burbot and lake trout. Rainbow trout, cisco, smallmouth bass, northern pike, yellow perch and walleye are also reported to eat alewives. A recent study indicated that large rainbow smelt commonly prey on young alewives during the fall when the two species occupy the same depth (18.3 to 73.2 m (60 to 240 feet)). This predation could represent an important part of the alewife's total mortality during its first year of life. Spottail and emerald shiners are reported to feed on alewife eggs.

The alewife is considered a nuisance in the Great Lakes, primarily because of its periodic die-offs in shallow water during the spring and summer months. The large number of dead and dying fish that are washed up on shore produces an unpleasant situation. Many theories are advanced to explain these mortalities. One suggests that the alewife is unable to acclimate rapidly to rising or fluctuating tempertures. Mortalities occur when the alewife moves into warm spring shoal waters while acclimated to the cold temperatures of the lake bottom.

In its native environment along the Atlantic coast, the alewife is large and meaty and considered desirable food for human consumption as well as forage fish for large predators. However, Great Lakes populations are thin, bony and average only 152.4 mm (6 inches) in length. They are harvested commercially for use in the preparation of pet food, fish meal and oil.

They have proved to be an important forage fish for the stocked coho salmon in Lake Michigan and elsewhere. However, alewives accumulate DDT in their tissues (particularly the body fat) by feeding on zooplankton. This leads to large accumulations of DDT in the coho that feed on large numbers of alewives.

2) Rainbow Smelt (Osmerus mordax Mitchell)

The rainbow smelt is an anadromous species native to the North American coast. Its introduction into Lake Ontario and the Great Lakes was discussed in Section II.

Smelt spawn in the spring not long after the ice is out, usually in March, April or May, with the precise time depending on locality and weather. In the Great Lakes region, spawning usually, but not always, occurs in streams. If exceedingly stormy weather prevails during the spawning period, smelt may spawn offshore. One study indicated that survival of shore-spawned eggs was similar to that of stream-spawned eggs. This shore spawning may be of greater importance to the species' survival than previously realized.

Spawning may last up to three weeks, but the peak seldom lasts more than a week. It takes place mainly at night, with the spawners dropping downstream to the lake by day. Two or more males maintain a position against a female in swift water and the eggs are released in clusters. Presumably the milt is released at the same time. The eggs become adhesive after they are released and quickly become attached to the bottom gravel. The egg is held by its outer coat and allowed to stay in the current.

Egg number varies with the size of the female. Although no Lake Ontario data is available, a Lake Superior study found about 15,000 eggs per ounce of female. The eggs hatch in two to three weeks depending on temperature. The young are about 5 mm (0.2 inches) long when hatched and drift downstream to the lake.

Growth is fairly rapid, depending on local environment. In a few months the young may measure 20 - 40 mm (0.8 to 1.6 inches) long and are extremely slender and transparent. By August, they may be 51 mm (2 inches) long and are found close to shore along the sand and gravel beaches. They are mature by their third year. The females grow faster and larger and live longer than males. Average adult length is 177.8 to 203.2 mm (7 to 8 inches), but some reach 355.6 mm (14 inches).

Smelt are schooling fish, inhabiting mid-waters of lakes. They do not inhabit flowing water of streams or rivers except at spawning time. They are sensitive to temperature and especially to light. In Lake Erie, most smelt were found near or at the bottom at depths of 24.4 m (80 feet) or more during daylight hours. They seem to prefer temperatures near 7.2°C (45°F).

Smelt are carnivorous, feeding on a wide variety of smaller creatures. The oppossum shrimp is the primary food in the Great Lakes. They also eat amphipods, ostracods, aquatic insect larvae and aquatic worms. Fish constitute six to ten percent of the volume. In the Great Lakes, sculpin and small smelt are commonly eaten. Other fish reported in their diet are small burbot, white bass, whitefish, emerald shiner and alewive. Even though studies have not exposed the smelt as a heavy predator of other fishes, it is still regarded with suspicion by many biologists and fishermen. They occur in such large numbers that predation by even a very small percentage of smelt could be significant.

Smelt are preyed upon by a variety of fish, including burbot, walleye, perch, other smelt and especially lake trout. They are an important food for the stocked salmon in the Great Lakes. Smelt were first introduced in Michigan waters for that purpose. A wide variety of birds including gulls and crows prey on the smelt during post-spawning mortalities. The rainbow smelt hosts a number of parasites.

This fish is a popular sport fish in the SLEO area. During nights of spawning runs in April and May, fishermen with dip nets line the shores of Lake Ontario near the mouths of the Salmon and Black Rivers to catch the fish as they move to the streams to spawn. Smelt are part of the commercial catch of the U.S. and Canada. In 1977, U.S. commercial catch data for Lake Ontario indicated 13,175 pounds of smelt were harvested.

3) Spottail Shiner (*Notropis hudsonius* Clinton)

The spottail shiner spawns in the spring and early summer, the precise date depending on latitude and seasonal weather. In Lake Erie, spawning occurs in 0.91 to 1.2 m (3 to 4 feet) of water over sandy shoals in late June and early July. There is some evidence that, in Lake Superior, spottails use the mouths and lower reaches of tributary streams for spawning. They spawn in closely packed groups with no evidence of nesting.

Data concerning egg number, incubation period and rate of development is generally lacking. One study conducted in Clear Lake, Iowa, indicated that two-year-old females contained 1,300 to 2,600 eggs each. The same study found faster growths were related to higher temperatures.

Spottail shiners average 63.5 to 76.2 mm (2½ to 3 inches) in length. Spottails spawn from age one to three, but apparently do not spawn until they are over 68.6 mm (2.7 inches) long at the spawning season.

Little information is available about the food of this species, which is mainly plankton. *Daphnia* forms about 40 percent of the diet. Algae, crustaceans, aquatic insects and sometimes eggs and larvae of their own species can be part of their diet.

The spottail shiner is a forage fish of considerable value since it is eaten by almost all predaceous fish (including large spottail) in the Great Lakes. It is frequently used as bait fish in the SLEO area.

4) Slimy Sculpin (*Cottus cognatus* Richardson)

The slimy sculpin is a native of northern North America. In the past, it served as a major food fish for lake trout. Its role as a forage fish is considered important in efforts to restock lake trout in Lake Ontario.

There is a lack of information about the spawning habits of the slimy sculpin. Spawning behavior in Cayuga Lake begins at a temperature of 5°C (41°F). The male selects a nest site under a rock, ledge or sometimes a submerged tree root. After courting, the female enters the nest, deposits the adhesive eggs in a mass on the nest's ceiling and either leaves or is driven out. The male guards the nest and young after they hatch.

Details concerning egg sizes, rate of development and growth rates are largely unavailable in published form. In a northern Saskatchewan population, three-year-old females about 4 inches long produced 1,400 eggs. Near Montreal along the St. Lawrence River, spawning occurs during early May at about 8°C (46°F). The eggs hatch in about four weeks and the fry fall to the bottom of the nest. The yolk sac is absorbed in three to six days, depending on water temperature and the young left in the nest.

In general, sculpin occupy deeper waters of rocky or gravelly lakes and cooler streams. In a Great Lakes survey conducted in the late 1950's and early 1960's, slimy sculpin were taken in numbers from 5.5 to 82.3m (18 to 270 feet) and appeared most commonly in depths of 36.6 - 73.2 m (120 to 240 feet). The largest catches of slimy sculpin in Lake Superior have been made at 91.4 to 107.9 m (300 to 354 feet).

Evidence suggests that the primary food is invertebrate bottom fauna, particularly aquatic insect larvae. The species eaten depends upon availability, which in turn is related to habitat. The average size of the adult is three inches.

A number of larger predaceous fish including lake trout, northern pike and burbot feed on sculpin.

Besides being important as a forage fish, the slimy sculpin is used as a bait fish for trout. It is commonly associated with both lake and brook trout and is part of their diets. It may compete with the brook trout since both eat aquatic invertebrates, but the extent of such competition is unknown.

APPENDIX D.
SITE-SPECIFIC DATA FOR MASSENA LOCKS AREA

Table 66. Species of Fish Captured from May 7 through November 27, 1979 in the Lower Grasse River. (USFWS 1979).

All species taken were from the Class Osteichthyes (Bony fishes)

ORDER	FAMILY	GENUS AND SPECIES	COMMON NAME	GEAR Trap Net	GEAR 15' Seine	GEAR 60' Seine
Amiiformes	Amiidae	Amia calva Linnaeus	Bowfin	X		X
Anguilliformes	Anguillidae	Anguilla rostrata (Lesueur)	American eel	X		X
Clupeiformes	Clupeidae	Alosa pseudoharengus (Wilson)	Alewife			X
		Dorosoma cepedianum (Lesueur)	Gizzard shad			X
Salmoniformes	Esocidae	Esox lucius (Linnaeus)	Northern pike	X		
Cypriniformes	Cyprinidae	Cyprinus carpio Linnaeus	Carp			X
		Hybognathus nuchalis Agassiz	Silvery minnow		X	X
		Notemigonus crysoleucas (Mitchill)	Golden shiner	X	X	X
		Notropis atherinoides Rafinesque	Emerald shiner		X	X
		Notropis hudsonius (Clinton)	Spottail shiner		X	X
		Notropis rubellus (Agassiz)	Rosyface shiner			X
		Notropis bifrenatus (Cope)	Bridle shiner			X
		Notropis anogenus Forbes	Pugnose shiner		X	X
		Notropis cornutus (Mitchill)	Common shiner			X
		Pimephales notatus (Rafinesque)	Bluntnose minnow			X
		Pimephales promelas Rafinesque	Fathead minnow			X
		Semotilus corporalis (Mitchill)	Fallfish			X
	Catostomidae	Catostomus commersoni (Lacepede)	White sucker	X		X
		Moxostoma macrolepidotum (Lesueur)	Shorthead redhorse	X		
		Moxostoma valenciennesi Jordan	Greater redhorse			X
Siluriformes	Ictaluridae	Ictalurus punctatus (Rafinesque)	Channel catfish	X		
		Ictalurus nebulosus (Lesueur)	Brown bullhead	X	X	X
Atheriniformes	Atherinidae	Labidesthes sicculus (Cope)	Brook silverside			X
Perciformes	Percichthyidae	Morone americana (Gmelin)	White perch	X		X
	Centrarchidae	Ambloplites rupestris (Rafinesque)	Rockbass	X		X
		Lepomis gibbous (Linnaeus)	Pumpkinseed	X	X	X
		Lepomis macrochirus Rafinesque	Bluegill		X	X
		Micropterus dolomieui Lacepede	Smallmouth bass			X
		Micropterus salmoides (Lacepede)	Largemouth bass			X
		Pomoxis nigromaculatus (Lesueur)	Black crappie	X		X
	Percidae	Etheostoma nigrum Rafinesque	Johnny darter		X	X
		Perca flavescens (Mitchill)	Yellow perch	X		X
		Percina caprodes (Rafinesque)	Logperch			X
		Stizostedion vitreum vitreum (Mitchill)	Walleye	X		
	Cottidae	Cottus bairdi Girard	Mottled sculpin			X

Table 67. Species of Fish Captured in 1979 in the Lower Grasse River. Monthly Summary.*

SPECIES	May	June	July	Aug.	Sept.	Oct.	Nov.
Bowfin	X		X				
American eel	X	X	X				
Alewife					X		
Gizzard shad					X		
Northern pike	X	X					
Carp		X	X				X
Silvery minnow	X	X			X		X
Golden shiner	X	X	X	X	X	X	X
Emerald shiner	X		X		X	X	X
Spottail shiner	X	X	X	X	X	X	X
Rosyface shiner	X						
Bridle shiner	X						
Pugnose shiner	X			X			
Common shiner	X						
Bluntnose minnow	X	X	X				X
Fathead minnor	X				X		
Fallfish		X	X	X	X	X	X
White sucker	X	X	X	X	X	X	X
Shorthead redhorse	X						
Greater redhorse	X						
Channel catfish	X						
Brown bullhead	X	X		X	X		X
Brook silverside		X					
White perch	X	X	X	X	X	X	X
Rockbass	X	X		X	X		
Pumpkinseed	X	X	X	X	X		X
Bluegill	X	X	X	X	X	X	X
Smallmouth bass		X	X	X	X		
Largemouth bass				X	X		
Black crappie	X	X	X	X	X	X	X
Johnny darter	X	X	X	X	X	X	X
Yellow perch	X	X	X	X	X	X	X
Logperch	X	X	X	X	X	X	
Walleye	X						
Mottled sculpin					X		
Number of species	27	20	17	16	21	11	15
Number of sampling days	10	5	2	2	3	1	2
trap net	6	3	0	0	0	0	0
15' seine	2	1	0	0	0	0	0
60' seine	2	1	2	2	3	1	2

*USFWS 1979

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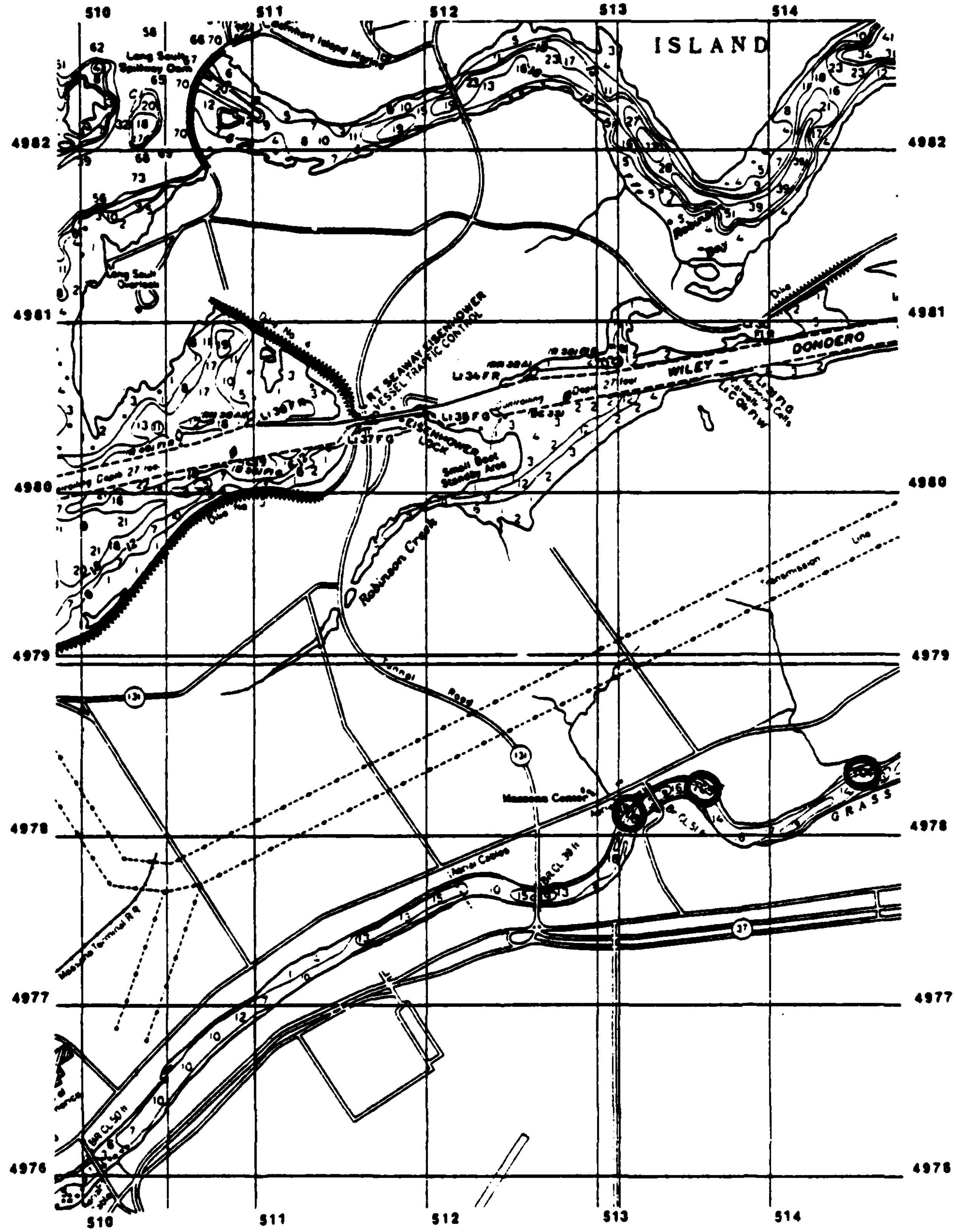

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Fig.29. Locations of seine station S06 and trap net stations T04-T05. (USFWS 1979).

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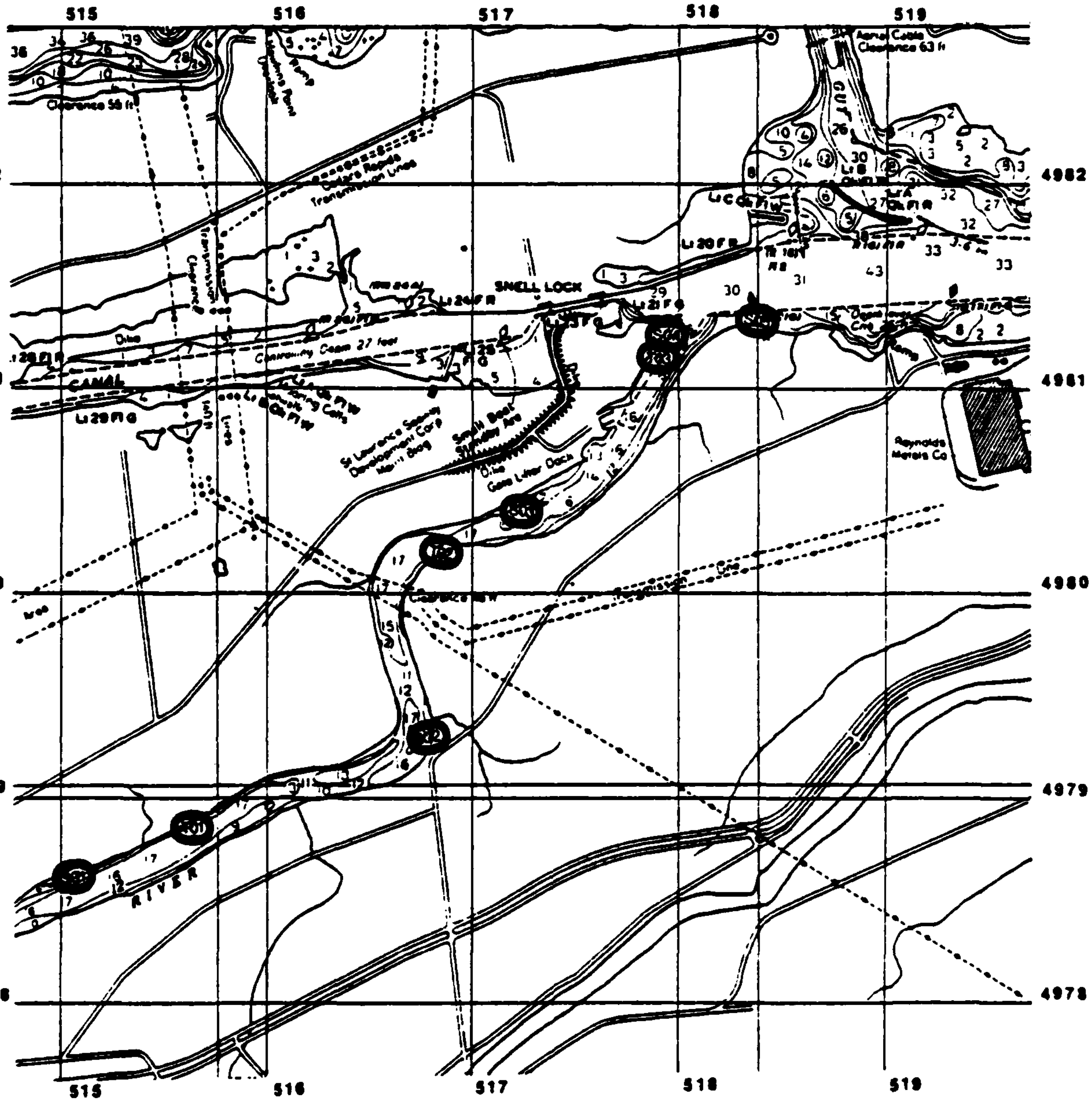

Fig.30. Locations of seine stations S01-S05 and trap net stations T01-T03. (USFWS 1979).

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TABLE 68. TOTAL NUMBER OF FISH CAUGHT BY SEINE IN THE GRASSE RIVER AT ALL STATIONS.

SPECIES	SAMPLING PERIOD													TOTAL	# HAULS PRESENT	AVG. # PER HAUL PRESENT	RANK BY #
	5/7	5/29	6/18	7/6	7/23	8/6	8/20	9/5	9/17	9/27	10/15	11/6	11/27				
Bowfin	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1.0	28
American eel	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1.0	28
Alewife	0	0	0	0	0	0	0	0	4	0	0	0	0	4	1	4.0	21
Gizzard shad	0	0	0	0	0	0	0	0	5	0	0	0	0	5	2	2.5	20
Cyprinidae	0	0	0	0	6	0	0	0	1	0	0	0	0	7	3	2.3	18
Carp	0	0	1	0	1	0	0	0	0	0	0	1	1	4	4	1.0	21
Silvery minnow	14	5	15	0	0	0	0	0	1	0	0	0	1	36	10	3.6	14
Golden shiner	79	32	46	1	15	0	3	8	82	28	2	380	16	692	34	20.4	2
Emerald shiner	40	2	0	0	1	0	0	36	13	5	2	0	1	100	19	5.3	11
Spottail shiner	310	12	15	1	18	5	0	2	22	14	19	41	277	736	33	22.3	1
Rosyface shiner	2	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1.0	26
Bridle shiner	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.0	28
Pugnose shiner	2	5	0	0	0	0	1	0	0	0	0	0	0	8	6	1.3	17
Common shiner	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.0	28
Bluntnose minnow	0	1	1	1	0	0	0	0	0	0	0	0	1	4	4	1.0	21
Fathead minnow	5	0	0	0	0	0	0	0	1	0	0	0	0	6	2	3.0	19
Fallfish	0	0	17	53	32	3	10	2	13	9	1	1	8	149	19	7.8	7
White sucker	25	7	50	16	14	0	14	6	10	8	2	7	7	166	25	6.6	6
Greater redhorse	0	4	0	0	0	0	0	0	0	0	0	0	0	4	2	2.0	21
Brown bullhead	4	6	7	0	0	9	8	0	1	12	0	3	26	76	19	4.0	12
Brook silverside	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1.0	28
White perch	43	3	0	0	10	3	14	14	60	41	30	3	9	230	16	14.4	5
Centrarchidae	0	0	0	0	2	0	0	0	0	0	0	0	0	2	1	2.0	26
Rockbass	0	0	0	0	0	1	0	1	1	0	0	0	0	3	3	1.0	25
Pumpkinseed	7	20	19	3	4	4	1	7	1	1	0	2	0	69	25	2.8	13

TABLE 68. continued.

SPECIES	SAMPLING PERIOD 5/7	5/29	6/18	7/6	7/23	8/6	8/20	9/5	9/17	9/27	10/15	11/6	11/27	TOTAL	# HAULS PRESENT	AVG. # PER HAUL PRESENT	RANK BY #
Bluegill	5	5	2	0	1	1	35	182	30	120	8	83	6	478	27	17.7	3
Smallmouth bass	0	0	4	2	2	1	2	4	3	0	0	0	0	18	14	1.3	16
Largemouth bass	0	0	0	0	0	6	4	6	3	4	0	0	0	23	14	1.6	15
Micropterus sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	1.0	28
Black crappie	0	0	1	3	0	0	6	67	16	14	12	9	4	132	14	9.4	10
Johnny darter	19	32	33	7	6	1	5	8	8	8	2	10	2	141	36	3.9	8
Yellow perch	26	10	36	8	10	1	7	7	13	10	3	7	2	140	34	4.1	9
Logperch	1	3	44	168	116	17	27	13	33	2	1	0	0	425	21	20.2	4
Mottled sculpin	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1.0	28
#Specimens	584	148	291	263	240	53	137	363	322	276	82	547	361	3667	59	62.2	---
# Species	17	16	15	11	17	13	14	15	22	14	11	12	14	34	---	----	----

TABLE 69 . TOTAL NUMBER OF FISH CAUGHT BY 60' BAG SEINE IN THE GRASSE RIVER IN 1979 AT ALL STATIONS.*

SPECIES	SAMPLING PERIOD													TOTAL	# HAULS PRESENT	AVG. # PER HAUL PRESENT	RANK BY #
	5/7	5/29	6/18	7/6	7/23	8/6	8/20	9/5	9/17	9/27	10/15	11/6	11/27				
Bowfin	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1.0	28
American eel	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1.0	28
Alewife	0	0	0	0	0	0	0	0	4	0	0	0	0	4	1	4.0	20
Gizzard shad	0	0	0	0	0	0	0	0	5	0	0	0	0	5	2	2.5	19
Cyprinidae	0	0	0	0	6	0	0	0	1	0	0	0	0	7	3	2.3	17
Carp	0	0	1	0	1	0	0	0	0	0	0	1	1	4	4	1.0	20
Silvery minnow	12	5	15	0	0	0	0	0	1	0	0	0	1	34	8	4.3	14
Golden shiner	65	32	46	1	15	0	3	8	82	28	2	380	16	678	30	22.6	2
Emerald shiner	30	1	0	0	1	0	0	36	13	5	2	0	1	89	16	14.8	11
Spottail shiner	281	10	15	1	18	5	0	2	22	14	19	41	277	705	27	26.1	1
Rosyface shiner	2	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1.0	26
Bridle shiner	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.0	28
Pugnose shiner	0	2	0	0	0	0	1	0	0	0	0	0	0	3	3	1.0	24
Common shiner	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.0	28
Bluntnose minnow	0	1	1	1	0	0	0	0	0	0	0	0	1	4	4	1.0	20
Fathead minnow	5	0	0	0	0	0	0	0	1	0	0	0	0	6	2	3.0	18
Fallfish	0	0	17	53	32	3	10	2	13	9	1	1	8	149	19	7.8	7
White sucker	25	7	50	16	14	0	14	6	10	8	2	7	7	166	25	6.6	6
Greater redhorse	0	4	0	0	0	0	0	0	0	0	0	0	0	4	2	2.0	20
Brown bullhead	4	5	6	0	0	9	8	0	1	12	0	3	26	74	17	4.4	12
Brook silverside	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1.0	28
White perch	43	3	0	0	10	3	14	14	60	41	30	3	9	230	16	14.4	5
Centrarchidae	0	0	0	0	2	0	0	0	0	0	0	0	0	2	1	2.0	26
Rockbass	0	0	0	0	0	1	0	1	1	0	0	0	0	3	3	1.0	24
Pumpkinseed	7	19	18	3	4	4	1	7	1	1	0	2	0	67	23	2.9	13

*USFWS 1979

TABLE 69. continued

SPECIES	SAMPLING PERIOD 5/7	5/29	6/18	7/6	7/23	8/6	8/20	9/5	9/17	9/27	10/15	11/6	11/27	TOTAL	# HAULS PRESENT	AVG. # PER HAUL PRESENT	RANK BY #
Bluegill	4	2	2	0	1	1	35	182	30	120	8	83	6	474	25	19.0	3
Smallmouth bass	0	0	4	2	2	1	2	4	3	0	0	0	0	18	14	1.3	16
Largemouth bass	0	0	0	0	0	6	4	6	3	4	0	0	0	23	14	1.6	15
Micropterus sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	1.0	28
Black crappie	0	0	1	3	0	0	6	67	16	14	12	9	4	132	14	9.4	9
Johnny darter	14	20	11	7	6	1	5	8	8	8	2	10	2	102	28	3.6	10
Yellow perch	26	10	36	8	10	1	7	7	13	10	3	7	2	140	34	4.1	8
Logperch	1	3	44	168	116	17	27	13	33	2	1	0	0	425	21	20.2	4
Mottled sculpin	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1.0	28
# Specimens	521	125	267	263	240	53	137	363	322	276	82	547	361	3557	46	77.3	--
# Species	16	16	15	11	17	13	14	15	22	14	11	12	14	34	--	--	--

TABLE 70 . TOTAL NUMBER OF FISH CAUGHT BY 15' FLAT SEINE IN THE GRASSE RIVER IN 1979 AT ALL STATIONS.*

SPECIES	SAMPLING PERIOD 5/7	5/29	6/18	TOTAL	# HAULS PRESENT	AVG. # PER HAUL PRESENT	RANK BY NUMBER
Silvery minnow	2	0	0	2	2	1.0	7
Golden shiner	14	0	0	14	4	3.5	3
Emerald shiner	10	1	0	11	3	3.7	4
Spottail shiner	29	2	0	31	6	5.2	2
Pugnose shiner	2	3	0	5	3	1.7	5
Brown bullhead	0	1	1	2	2	1.0	7
Pumpkinseed	0	1	1	2	2	1.0	7
Bluegill	1	3	0	4	2	2.0	6
Johnny darter	5	12	22	39	8	4.9	1
# Specimens	63	23	24	110	13	8.5	--
# Species	7	7	3	9	--	--	--

*USFWS 1979

TABLE 71 .TOTAL NUMBER OF FISH CAUGHT BY TRAP NET IN THE GRASSE RIVER IN 1979 AT ALL STATIONS.*

SPECIES	SAMPLING PERIOD WEEK 1 5/7	5/8	5/9	WEEK	WEEK 2 5/29	5/30	5/31	WEEK	WEEK 3 6/18	6/19	6/20	WEEK	TOTAL	# SETS PRESENT	AVG. # PER SET PRESENT	RANK BY #
Bowfin	0	0	1	1	0	0	0	0	0	0	0	0	1	1	1.0	12
American eel	0	0	0	0	0	0	1	1	0	1	0	1	2	2	1.0	10
Northern pike	0	1	0	1	0	1	0	1	2	0	0	2	4	3	1.3	9
Golden shiner	1	0	2	3	0	0	5	5	1	5	6	12	20	10	2.0	3
White sucker	5	2	2	9	0	2	0	2	0	0	0	0	11	4	2.8	6
Shorthead redhorse	0	0	0	0	1	0	0	1	0	0	0	0	1	1	1.0	12
Channel catfish	0	0	0	0	0	1	0	1	0	0	0	0	1	1	1.0	12
Brown bullhead	4	1	11	16	4	5	1	10	2	3	1	6	32	12	2.7	2
White perch	0	0	12	12	5	4	3	12	2	16	10	28	52	13	4.0	1
Rockbass	0	0	6	6	1	1	5	7	1	1	0	2	15	8	1.9	5
Pumpkinseed	0	0	0	0	0	0	1	1	2	4	3	9	10	4	2.5	7
Black crappie	0	0	0	0	0	0	2	2	0	4	3	7	9	4	2.3	8
Yellow perch	1	1	4	6	1	0	6	7	2	1	2	5	18	12	1.5	4
Walleye	2	0	0	2	0	0	0	0	0	0	0	0	2	1	2.0	10
# Specimens	13	5	38	56	12	14	24	50	12	35	25	72	178	23	7.7	--
# Species	5	4	7	9	5	6	8	12	7	8	6	9	14	--	--	--

*USFWS 1979

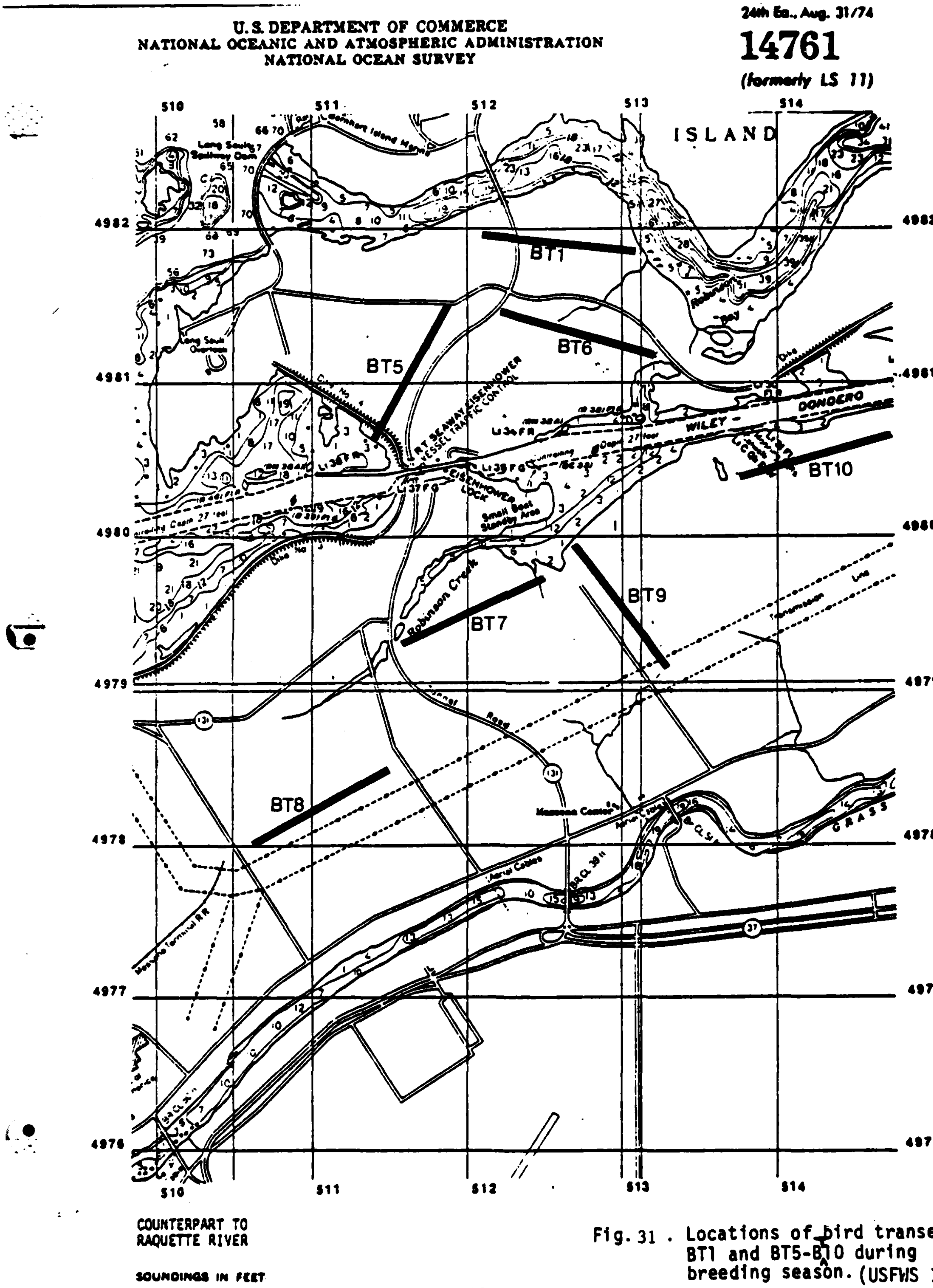

Fig. 31 . Locations of bird transects BT1 and BT5-BT10 during breeding season. (USFWS 1979).

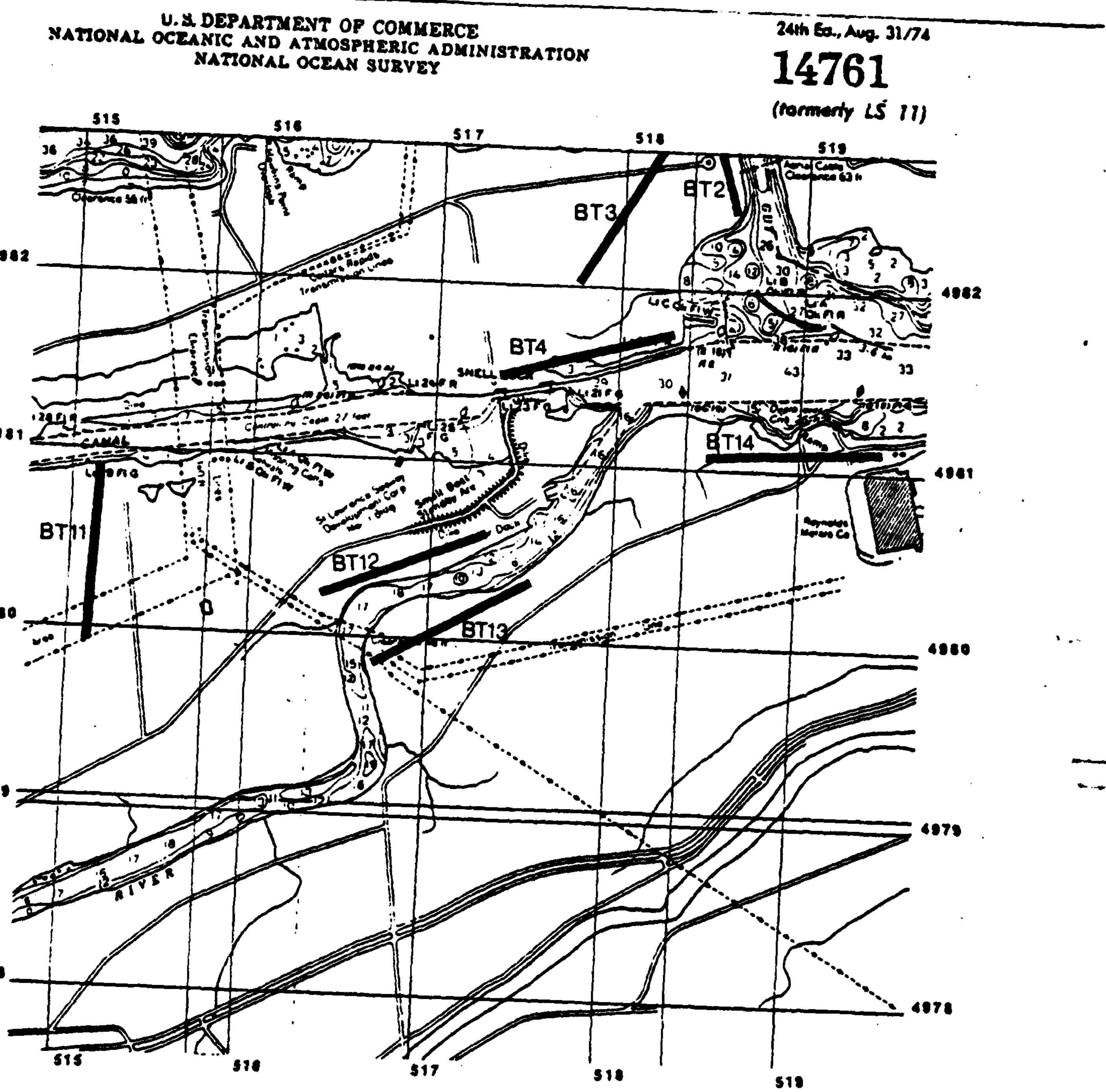

Fig. 32. Locations of bird transects BT4, BT11-BT14, and parts of BT2 and BT3 during breeding season. (USFWS 1979).

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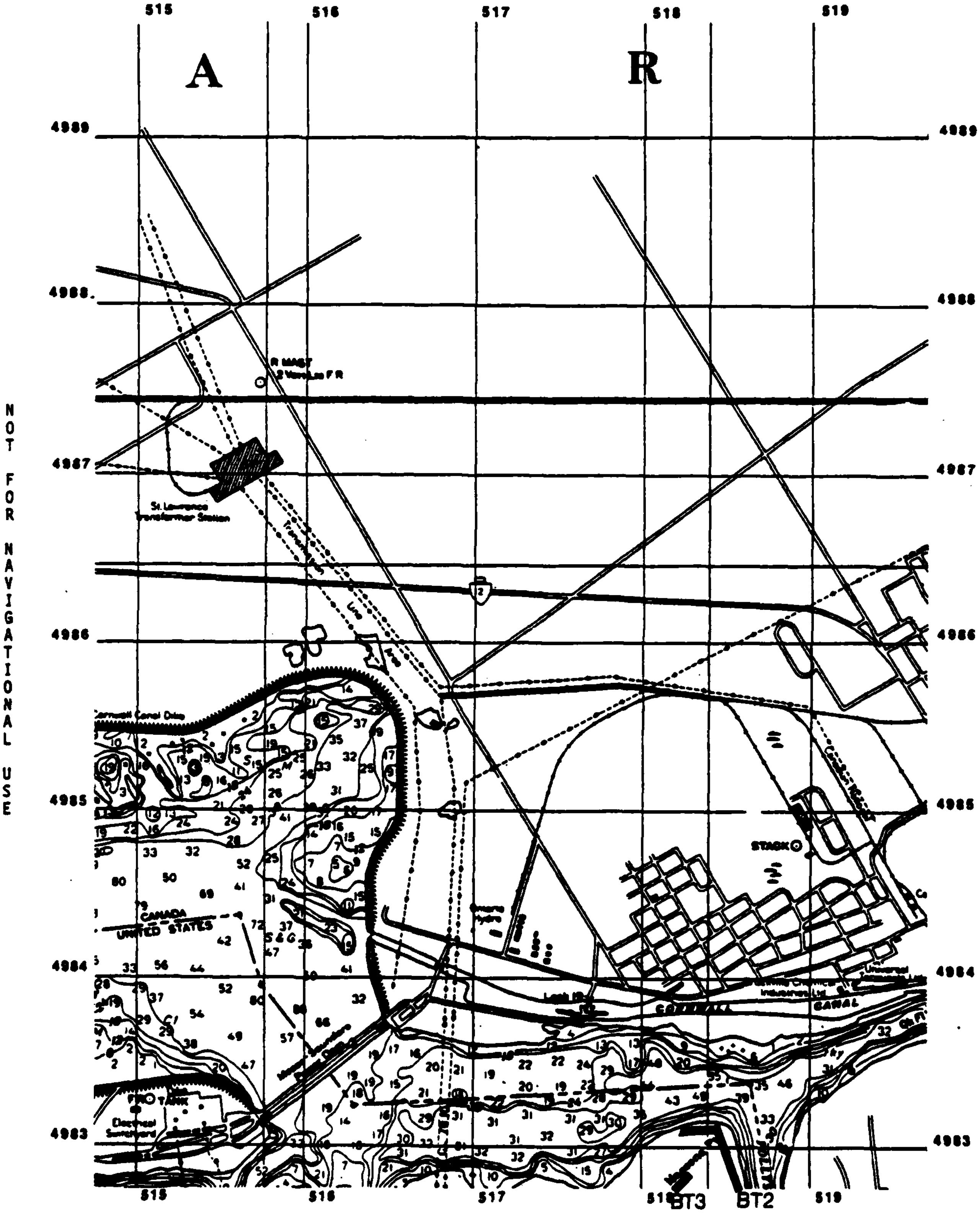

COUNTERPART TO
CORNWALL WEST

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Fig. 33. Locations of parts of bird transects BT2 and BT3 during breeding season. (USFWS 1979).

Table 72. Bird transects in the Massena sampling area on the St. Lawrence River in 1979.*•

TRANSECTS

Number	Name
BT1	Robert Moses Park
BT2	Polly's Gut Woods
BT3	Polly's Gut Field
BT4	Snell Lock North
BT5	Eisenhower Lock North
BT6	Eisenhower Woods
BT7	Robinson Creek Area
BT8	Route 131 - Horton Road
BT9	Donahue Road
BT10	Kinne Road West
BT11	Kinne Road North
BT12	Snell Lock South
BT13	Grasse River
BT14	Reynolds Metals Area

* Each transect was approximately one kilometer (0.6 miles) in length and was surveyed three times during the breeding season, prior to July 10, 1979. A survey usually required about two hours to complete. The three surveys of each route were averaged to provide a basic figure for comparative purposes. This figure is used in the table. All birds noted were recorded. The numbers and name of each transect are listed above.
+ = < 1

• USFWS 1979

Table 72.(continued)

Species	1/ 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Number of Transects Present
	TRANSECTS														
Common Loon	0	+	0	0	0	0	0	0	0	0	0	0	+	0	2
Great Blue Heron	+	1	+	0	0	0	+	0	0	+	0	0	+	1	7
Green Heron	+	0	0	+	0	0	1	0	0	1	0	0	+	0	5
Black-crowned Night Heron	0	1	0	0	0	0	0	0	0	0	0	0	+	4	3
American Bittern	0	0	0	0	0	0	0	0	0	0	0	0	1	+	2
Canada Goose	0	0	0	+	0	1	+	0	0	0	0	0	+	+	5
Mallard	0	0	0	+	0	1	1	0	0	0	0	0	1	3	5
Black Duck	0	0	0	0	0	0	0	0	0	0	0	0	0	+	1
Gadwall	0	0	0	0	0	0	0	0	0	0	0	0	+	2	2
Blue-winged Teal	0	0	0	0	0	0	+	0	0	0	0	0	1	0	2
American Wigeon	0	0	0	0	0	+	0	0	0	0	0	+	1	6	4
Sharp-shinned Hawk	0	+	0	0	0	0	0	0	0	0	0	0	0	0	1
Red-tailed Hawk	0	+	+	0	0	1	0	+	1	0	+	0	1	+	8
Northern Harrier	0	0	+	0	0	0	0	0	+	0	+	0	1	+	5
American Kestrel	1	0	1	+	0	1	1	1	0	0	+	0	+	0	8
Ruffed Grouse	0	+	0	0	0	1	0	0	0	+	0	0	0	0	3
Virginia Rail	0	0	0	0	+	0	0	0	0	0	0	0	0	0	1
Common Gallinule	0	0	0	0	0	0	0	0	0	0	0	0	+	0	1
Killdeer	2	0	2	1	0	2	2	+	0	0	0	2	2	4	9
American Woodcock	0	0	+	0	0	+	0	0	0	0	0	+	0	0	3
Common Snipe	+	0	0	0	1	+	0	0	0	0	+	0	0	0	4
Upland Sandpiper	0	0	1	0	0	0	0	0	0	0	0	+	2	1	4
Spotted Sandpiper	0	0	0	+	0	0	+	0	0	0	0	+	1	1	5
Herring Gull	0	0	+	0	0	0	0	0	0	0	0	0	0	2	2
Ring-billed Gull	3	15	40	10	0	+	6	14	8	2	5	10	50	1000	13

1/ Transects 1 through 14 are the same as transects BT1 through BT14.

Table 72. (continued)

Species	TRANSECTS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Number of Transects Present
Common Tern	0	0	+	0	0	0	0	0	0	0	0	0	+	3	3
Rock Dove	0	0	0	2	0	+	0	3	0	0	0	4	+	4	6
Mourning Dove	2	0	1	0	0	+	2	0	0	+	0	0	2	+	7
Yellow-billed Cuckoo	0	+	0	0	0	0	0	+	0	+	0	0	0	0	3
Black-billed Cuckoo	+	1	0	+	0	0	0	+	2	1	0	0	0	+	7
Great Horned Owl	+	+	0	0	0	0	0	0	0	0	0	0	0	0	2
Chimney Swift	2	0	+	+	1	0	0	2	0	0	0	0	2	1	7
Ruby-throated Hummingbird	+	+	0	0	0	0	0	0	+	0	0	0	0	0	3
Belted Kingfisher	+	1	0	0	0	1	+	0	0	0	0	0	1	+	6
Common Flicker	2	1	0	+	+	2	+	0	1	2	+	0	1	+	11
Pileated Woodpecker	1	+	0	0	0	1	0	0	+	0	0	0	0	0	4
Hairy Woodpecker	0	+	0	0	+	1	0	0	+	+	0	0	0	0	5
Downy Woodpecker	1	1	0	0	1	1	0	0	1	+	+	0	0	+	8
Eastern Kingbird	3	1	5	2	1	3	6	4	2	1	3	2	6	4	14
Great-crested Flycatcher	1	1	0	0	+	1	1	+	2	1	0	0	0	0	8
Eastern Phoebe	+	0	0	0	0	0	1	0	+	0	0	0	0	+	4
Willow Flycatcher	1	0	1	2	1	2	+	3	2	1	5	1	2	1	13
Alder Flycatcher	2	0	0	1	1	+	+	1	2	1	4	2	1	2	12
Least Flycatcher	1	1	0	0	+	1	+	0	1	+	0	0	0	0	7
Eastern Wood Pewee	2	2	0	0	1	2	0	0	1	+	0	+	0	0	7
Tree Swallow	3	0	1	0	+	6	2	2	+	1	2	2	10	1	12
Bank Swallow	0	0	0	+	0	0	+	0	2	+	0	1	2	4	7

Table 72. (continued)

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Number of Transects Present
	TRANSECTS														
Barn Swallow	2	2	6	2	4	4	2	+	0	4	+	4	6	8	13
Cliff Swallow	0	0	0	0	0	0	+	0	0	0	0	+	2	6	4
Purple Martin	0	2	2	+	+	0	10	3	+	0	0	6	8	4	10
Blue Jay	1	+	0	0	0	1	+	2	0	0	0	+	+	0	7
Common Crow	1	2	3	+	2	4	2	1	+	3	5	+	1	2	14
Black-capped Chickadee	1	+	0	0	0	2	0	0	+	+	1	0	0	0	6
White-breasted Nuthatch	0	1	0	0	0	1	0	0	1	+	+	0	0	0	5
Brown Creeper	0	+	0	0	0	+	0	0	0	0	0	0	0	0	2
House Wren	4	4	+	1	2	5	2	1	1	+	3	1	2	1	14
Gray Catbird	3	1	2	1	2	4	2	1	4	3	6	2	4	2	14
Brown Thrasher	0	+	0	+	1	1	+	0	0	+	1	0	1	+	9
American Robin	9	12	+	3	6	9	6	5	4	6	5	4	6	3	14
Wood Thrush	2	2	0	0	+	4	1	0	1	2	2	0	+	0	9
Veery	3	5	0	+	+	9	1	0	3	8	5	3	+	1	12
Eastern Bluebird	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Cedar Waxwing	1	0	+	1	2	2	2	2	+	4	2	2	+	0	12
Loggerhead Shrike	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Starling	4	+	4	3	2	4	6	2	+	4	2	2	10	22	14
Yellow-throated Vireo	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Red-eyed Vireo	4	8	0	+	3	4	+	0	5	2	3	0	0	0	9
Warbling Vireo	1	1	0	1	+	2	1	1	2	1	1	+	1	2	13
Black and White Warbler	1	0	0	0	0	+	0	0	0	0	1	0	0	0	3
Nashville Warbler	0	0	0	0	0	+	0	0	+	1	0	0	0	0	3

Table 72. (continued)

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Number of Transects Present
	TRANSECTS														
Yellow Warbler	5	8	2	2	2	8	8	5	7	5	6	5	6	6	14
Chestnut-sided Warbler	0	+	0	0	0	+	1	0	0	+	0	0	0	0	4
Ovenbird	1	1	0	0	0	1	0	0	0	+	1	0	0	0	5
Northern Waterthrush	1	0	0	0	0	+	0	0	0	0	0	0	0	0	2
Mourning Warbler	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Common Yellowthroat	4	3	1	1	2	4	4	4	5	5	6	5	4	5	14
American Redstart	6	10	0	1	3	12	0	0	7	4	2	0	0	0	8
House Sparrow	0	0	0	2	0	0	0	0	0	0	0	0	0	4	2
Bobolink	0	0	4	1	0	+	2	4	1	0	1	2	5	4	9
Eastern Meadowlark	+	0	3	+	2	0	2	3	1	0	2	3	4	3	11
Red-winged Blackbird	4	8	20	7	8	10	12	22	4	2	4	9	18	10	14
Northern Oriole	2	4	1	1	1	5	2	1	3	3	1	1	1	1	14
Common Grackle	3	3	30	+	6	2	5	2	0	+	1	2	8	4	13
Brown-headed Cowbird	4	2	3	+	2	1	4	0	2	+	4	4	3	2	13
Scarlet Tanager	1	1	0	0	+	1	0	0	+	1	+	0	0	0	7
Rose-breasted Grosbeak	4	5	0	0	2	2	2	0	2	4	2	3	1	0	10
Indigo Bunting	0	0	+	+	0	+	1	1	+	0	0	1	2	1	9
American Goldfinch	+	1	5	4	2	2	2	3	2	+	+	1	6	2	14
Rufous-sided Towhee	+	1	0	+	1	4	1	1	1	2	1	+	1	+	13
Savannah Sparrow	0	0	4	2	0	0	2	5	0	0	0	2	4	3	7
Chipping Sparrow	+	1	0	1	2	0	1	2	0	+	0	1	+	1	10
Field Sparrow	0	0	0	0	0	1	1	0	0	0	1	0	+	+	5
White-throated Sparrow	2	0	0	0	+	1	1	0	0	0	0	1	0	0	5
Swamp Sparrow	1	0	0	0	0	0	0	0	0	0	0	+	0	0	2
Song Sparrow	6	4	2	3	4	9	6	7	2	3	1	5	4	6	14
Species Richness	57	52	35	43	41	61	53	36	46	48	42	42	60	56	

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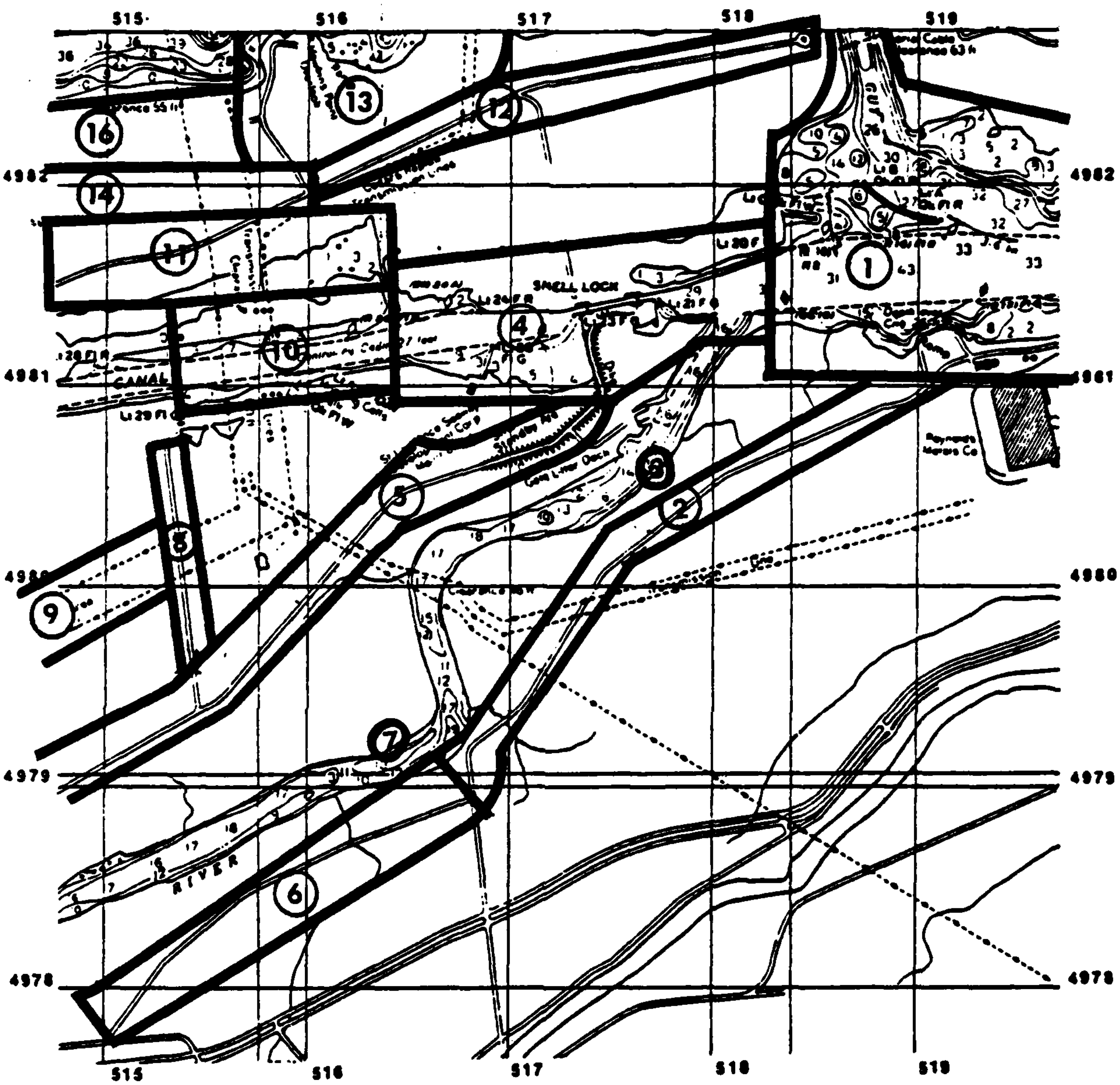

Fig. 34 Locations of bird survey sites 2-4, 6-8, 10-13, and parts of sites 1, 5, 9, 14, and 16. (USWFS 1979).

COUNTERPART TO
RAQUETTE RIVER

SOUNDINGS IN FEET

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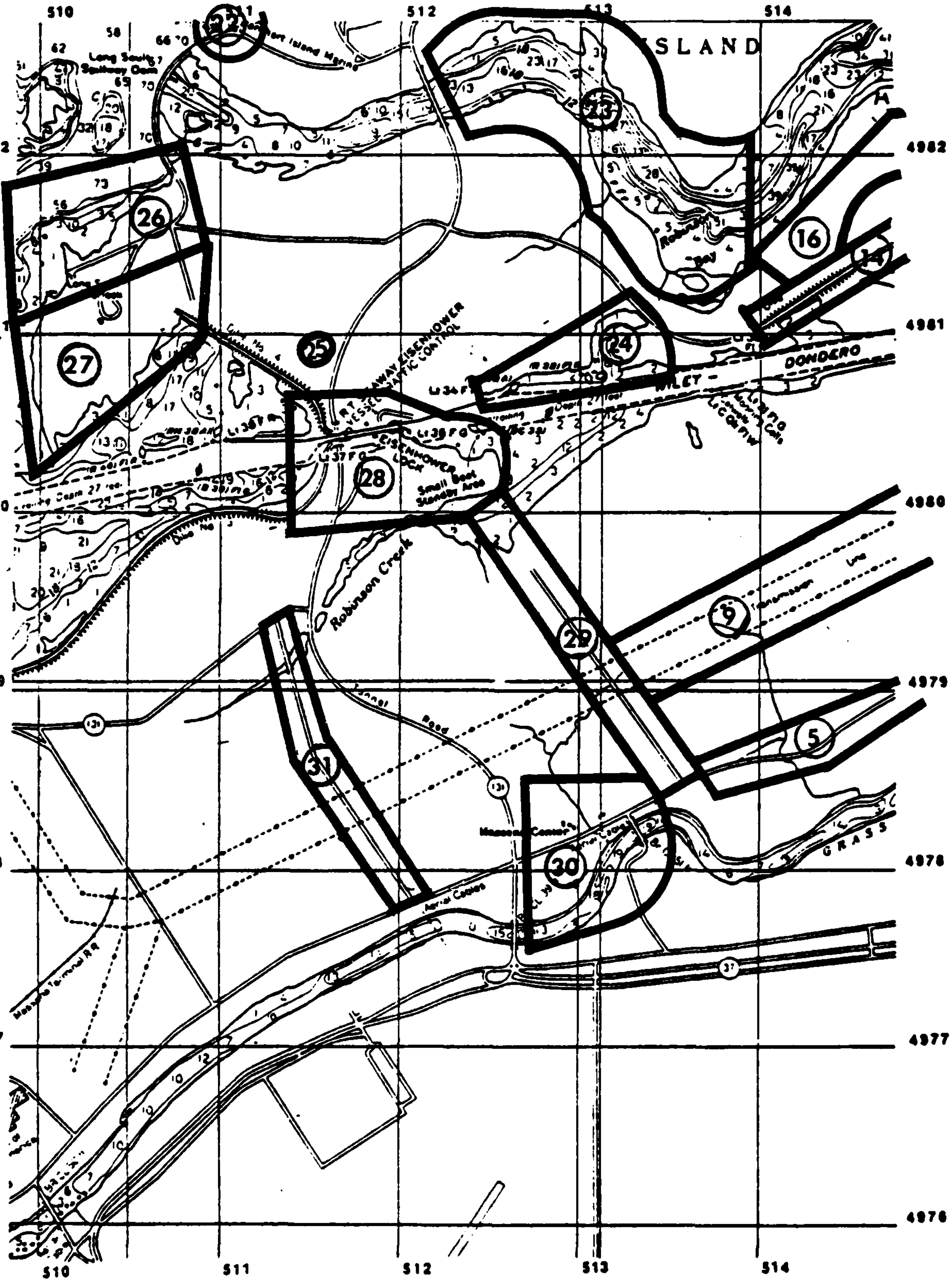

COUNTERPART TO
RAQUETTE RIVER

SOUNDINGS IN FEET

Fig.35. Locations of bird survey sites 23-31 and parts of sites 5, 9, 14, 16, and 22. (USFWS 1979).

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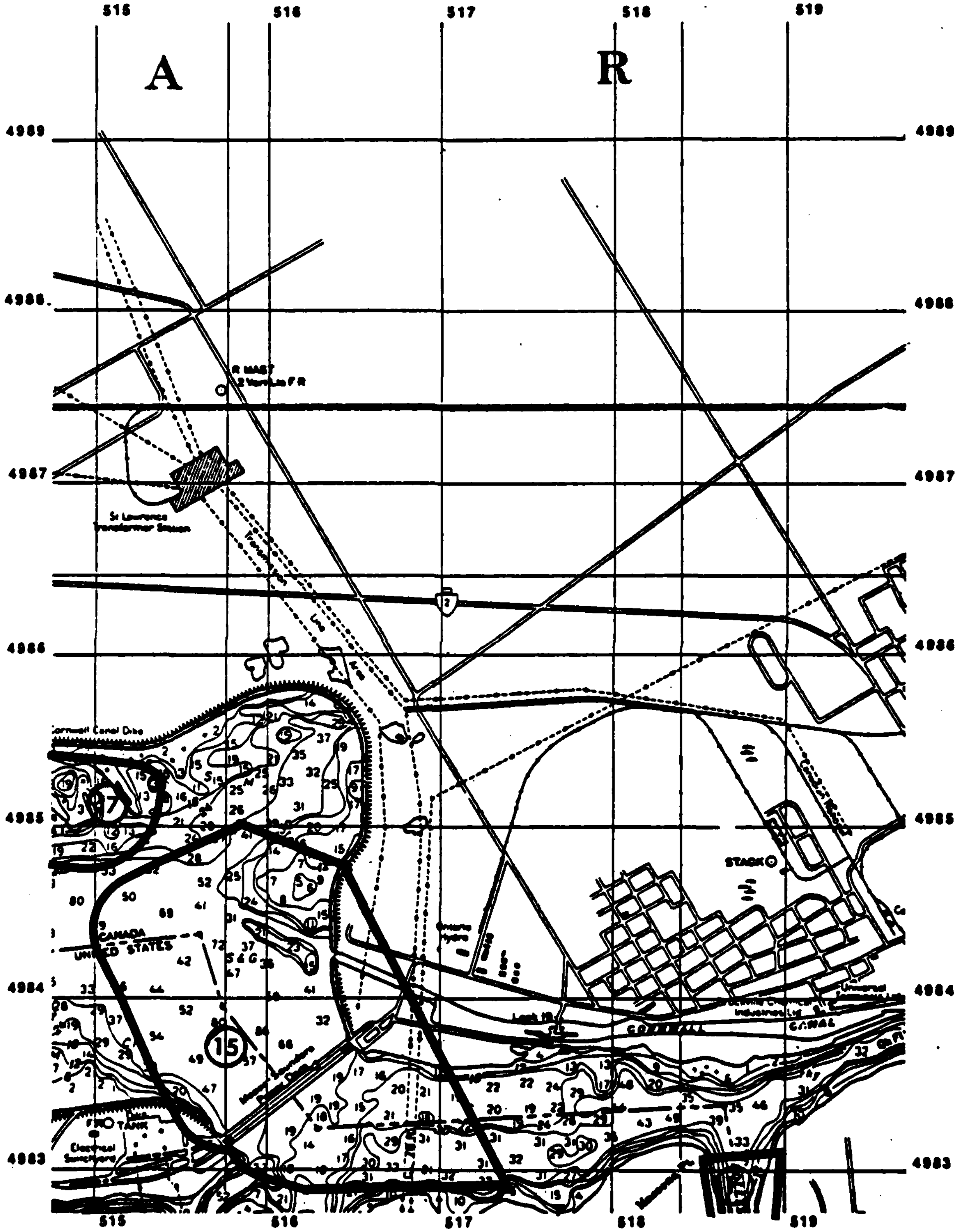

COUNTERPART TO
CORNWALL WEST

SOUNDINGS IN FEET

Fig.36. Locations of bird survey site 15 and parts of sites 1 and 17. (USFWS 1979).

Table 73 . Number of birds sighted on the St. Lawrence River in 1979 at station 4

SPECIES	6/5	6/7	6/11	6/14	6/21	6/26	7/2	7/5	7/19	
Great Blue Heron			1				1			
Mallard				1			2			
Northern Marsh Harrier								1		
American Kestrel						1	1			
American Woodcock	1		1							
Common Snipe	1					2	1			
Herring Gull	1									
Ring-billed Gull	30	18	39	41	15	7	18	6	5	
Black-billed Cuckoo							1			
Common Flicker				1	2	2	3	1		
Eastern Kingbird	4	4	5	4	3	2		7	14	
Great-crested Flycatcher		1		1	1			1		
Tree Swallow	4	6	6	5	40	36	50	250	150	
Bank Swallow	2	1	4	18	32	50	120	400	300	
Barn Swallow	3	8	20	12	15	26	30	50	75	
Cliff Swallow	20	40	30	8	150	250	400	350	200	
Purple Martin	2			3	5	8	14	7	4	
Black-capped Chickadee			2	1	2	1				
House Wren	1	1	1		1			1	1	
Gray Catbird				2	1	2	1			
Brown Thrasher				1			1			
American Robin		4	5	10	8	7	6	5	4	
Starling	8	12	15	30	50	40	80	120	200	
Warbling Vireo			1	1		1				
Yellow Warbler	7	9	4	6	5	6	8	14	6	
Common Yellowthroat	2	3	4	3	3	2	1	2	1	
American Redstart	1			1	5		1	1	1	
Bobolink	4	5	6	6	4	5	4	4	2	

*No birds sighted +Mean number per sampling period present (Average per occurrence)

USFWS 1979

Table 73.(continued)

SPECIES	6/5	6/7	6/11	6/14	6/21	6/26	7/2	7/5	7/19	
Eastern Meadowlark	4	4	5	4	3	3	7	2	1	
Red-winged Blackbird	6	10	15	8	7	4	10	15	20	
Northern Oriole	1	1		3	1	2		1		
Common Grackle	4	7	9	15	16	8	13	7	15	
Brown-headed Cowbird		4	3	2			8	6	1	
Scarlet Tanager	1									
Rose-breasted Grosbeak	2	1	1		1	1		1		
American Goldfinch	4	3	2	2	2	1	2	1	6	
Rufous-sided Towhee		2	1	1			1			
Savannah Sparrow	1	3	4		3	1	1	1	1	
Chipping Sparrow	1	1		1	1			1		
Field Sparrow	1				1				1	
Song Sparrow	5	3	4	8	7	5	1	1	3	
Species Richness	27	24	25	29	28	26	28	27	22	

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 73. (continued)

SPECIES	Total	Avg./+ Occ.								
Great Blue Heron	2	1.0								
Mallard	3	1.5								
Northern Marsh Harrier	1	1.0								
American Kestrel	2	1.0								
American Woodcock	2	1.0								
Common Snipe	4	1.3								
Herring Gull	1	1.0								
Ring-billed Gull	179	19.9								
Black-billed Cuckoo	1	1.0								
Common Flicker	9	1.8								
Eastern Kingbird	43	5.4								
Great-crested Flycatcher	4	1.0								
Tree Swallow	547	60.8								
Bank Swallow	927	103.0								
Barn Swallow	239	26.6								
Cliff Swallow	1448	160.9								
Purple Martin	43	6.1								
Black-capped Chickadee	6	1.5								
House Wren	6	1.0								
Gray Catbird	6	1.5								
Brown Thrasher	2	1.0								
American Robin	49	6.1								
Starling	555	61.7								
Warbling Vireo	3	1.0								
Yellow Warbler	65	7.2								
Common Yellowthroat	21	2.3								
American Redstart	10	1.7								
Bobolink	40	4.4								

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 73.(continued)

SPECIES	Total	Avg./Occ.+								
Eastern Meadowlark	33	3.7								
Red-winged Blackbird	95	10.6								
Northern Oriole	9	1.5								
Common Grackle	94	10.4								
Brown-headed Cowbird	24	4.0								
Scarlet Tanager	1	1.0								
Rose-breasted Grosbeak	7	1.2								
American Goldfinch	23	2.6								
Rufous-sided Towhee	5	1.3								
Savannah Sparrow	15	1.9								
Chipping Sparrow	5	1.0								
Field Sparrow	3	1.0								
Song Sparrow	37	4.1								
Species Richness	41									

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 74. . Number of birds sighted on the St. Lawrence River in 1979 at station 5

SPECIES	7/30	8/1	8/6	8/9	8/29	9/24*	10/5	10/15	10/17	10/22
Great Blue Heron									1	
Canada Goose									61	
Mallard			2						2	
Black Duck									1	
Red-tailed Hawk										
American Kestrel			1	3	6					1
Gray Partridge									18	
Killdeer		2							2	
Rock Dove										
Mourning Dove			1							
Belted Kingfisher			1							
Common Flicker		2	5							
Downy Woodpecker									1	1
Eastern Kingbird		9	9	4	4					
Horned Lark										
Tree Swallow		10	4	10				3	7	
Bank Swallow		3								
Barn Swallow		30	50	40						
Purple Martin				2						
Blue Jay							3		25	
Common Crow	5	8	8				20		3	5
Black-capped Chickadee							4		5	
Brown Thrasher		1								
American Robin		3		15			30		15	5
Water Pipit									1	
Cedar Waxwing				1						
Starling	200	20	20	110	150		140	500	50	200
Yellow Warbler			1				5			

*No birds sighted +Mean number per sampling period present (Average per occurrence)

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Table 74. continued

SPECIES	7/30	8/1	8/6	8/9	8/29	9/24*	10/5	10/15	10/17	10/22
House Sparrow		10		50					15	
Bobolink		3	50							
Eastern Meadowlark		4					5			
Red-winged Blackbird			1800	20	500		10		42	
Unidentified Blackbirds			200							
Common Grackle				3					5	5
Brown-headed Cowbird									25	
American Goldfinch			5							
Savannah Sparrow		3	3							
Rufous-sided Towhee							1			
White-throated Sparrow							4			
Song Sparrow		4		20			15		4	
Species Richness	2	15	15	13	4	0	11	2	19	6

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 74. continued

SPECIES	10/30*	11/8	11/10	11/20		Total	Avg./+ Occ.			
Great Blue Heron						1	1.0			
Canada Goose						61	61.0			
Mallard						4	2.0			
Black Duck						1	1.0			
Red-tailed Hawk		1		1		2	1.0			
American Kestrel						11	2.8			
Gray Partridge						18	18.0			
Killdeer			1			5	1.7			
Rock Dove		15	50			65	32.5			
Mourning Dove						1	1.0			
Belted Kingfisher						1	1.0			
Common Flicker						7	3.5			
Downy Woodpecker						2	1.0			
Eastern Kingbird						26	6.5			
Horned Lark			12			12	12.0			
Tree Swallow						34	6.8			
Bank Swallow						3	3.0			
Barn Swallow						120	40.0			
Purple Martin						2	2.0			
Blue Jay		2				30	10.0			
Common Crow						49	8.2			
Black-capped Chickadee		3				12	4.0			
Brown Thrasher						1	1.0			
American Robin						68	13.6			
Water Pipit						1	1.0			
Cedar Waxwing						1	1.0			
Starling						1390	154.4			
Yellow Warbler						6	3.0			

*No birds sighted   +Mean number per sampling period present (Average per occurrence)

Table 74.continued

SPECIES	10/30*	11/8	11/10	11/20		Total	Avg./+ Occ.			
House Sparrow		10				85	21.3			
Bobolink						53	26.5			
Eastern Meadowlark						9	4.5			
Red-winged Blackbird						2372	474.4			
Unidentified Blackbirds						200	200.0			
Common Grackle						13	4.3			
Brown-headed Cowbird						25	25.0			
American Goldfinch						5	5.0			
Savannah Sparrow						6	3.0			
Rufous-sided Towhee						1	1.0			
White-throated Sparrow						4	4.0			
Song Sparrow						43	10.8			
Species Richness	0	5	3	1		40				

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 75 . Number of birds sighted on the St. Lawrence River in 1979 at station 8 .

SPECIES	6/5	6/6	6/8	6/12	6/21	6/29	7/5	8/1	8/6	8/9
Green Heron	1					1				
Mallard		1								
Red-tailed Hawk	1			1						
Northern Marsh Harrier								1		
American Kestrel	1	2		1	2		2			
Ruffed Grouse	1									
Killdeer								3	3	
Upland Sandpiper	1	1	1			1				
Ring-billed Gull	8	4	1				5			
Mourning Dove	1				1		1			
Belted Kingfisher			1							
Common Flicker	1			2	1		3		2	
Hairy Woodpecker		1							3	
Downy Woodpecker	1			1						
Eastern Kingbird	8	4	5	5	3	4	5	2	4	
Great-crested Flycatcher	2	2	1	3	1	2	2	1		
Eastern Phoebe	1		1	1						
Willow Flycatcher	2	2	1	3	1					
Alder Flycatcher	3	2	2	3	1	1		1		
Eastern Wood Pewee									1	
Bank Swallow								5		
Barn Swallow	4		3	6		4	20	5	4	5
Purple Martin	2				1					
Blue Jay										
Common Crow			1	1		1	4		3	
Black-capped Chickadee			4			2				
House Wren			1		1	2				
American Robin	6	5	8	4	4	5	4		20	

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 75.continued

SPECIES	6/5	6/6	6/8	6/12	6/21	6/29	7/5	8/1	8/6	8/9
Woodthrush			1	2		1	1			
Veery			1	1		1				
Cedar Waxwing		2	1	2		1	2			
Starling	2	5	4	4	10	15	30			
Red-eyed Vireo	2	2	1	2		2	1			
Warbling Vireo	1		1	1		1				
Yellow Warbler	8	5	2	5	3	5	3			
Common Yellowthroat	4	3	3	3	2	4	1			
American Redstart	2	2	1	1	1		1	50		
Bobolink	1	1	1	2	1	1				
Eastern Meadowlark	2	2	1	3	2	1			4	
Red-winged Blackbird	10	15	7	8	8	4	15			10
Northern Oriole	4	3	3	2		1	2			
Brown-headed Cowbird	2		1	1	2		1			
Rose-breasted Grosbeak	2	1	3	2	2	1	1			
American Goldfinch									6	
Rufous-sided Towhee		1			1					1
Savannah Sparrow	2	1	2	1	1		1		4	
Field Sparrow		1	1		1					
Song Sparrow	11	8	7	4	5	6	5	10	4	
Species Richness	31	25	31	29	23	24	22	9	12	3

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 75. continued

SPECIES	10/17	10/22	11/8	11/10		Total	Avg./+ Occ.			
Green Heron						2	1.0			
Mallard						1	1.0			
Red-tailed Hawk		1				3	1.0			
Northern Marsh Harrier				1		2	1.0			
American Kestrel						8	1.6			
Ruffed Grouse						1	1.0			
Killdeer						6	3.0			
Upland Sandpiper						4	1.0			
Ring-billed Gull						18	4.5			
Mourning Dove						3	1.0			
Belted Kingfisher						1	1.0			
Common Flicker						9	1.8			
Hairy Woodpecker						4	2.0			
Downy Woodpecker						2	1.0			
Eastern Kingbird						40	4.4			
Great-crested Flycatcher						14	1.8			
Eastern Phoebe						3	1.0			
Willow Flycatcher						9	1.8			
Alder Flycatcher						13	1.9			
Eastern Wood Pewee						1	1.0			
Bank Swallow						5	5.0			
Barn Swallow						51	6.4			
Purple Martin						3	1.5			
Blue Jay	4		2			6	3.0			
Common Crow		10				20	3.3			
Black-capped Chickadee			5			11	3.7			
House Wren						4	1.3			
American Robin						56	7.0			

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 75. continued

SPECIES	10/17	10/22	11/8	11/10		Total	Avg./+ Occ.			
Woodthrush						5	1.3			
Veery						3	1.0			
Cedar Waxwing						8	1.6			
Starling	20	50				140	15.6			
Red-eyed Vireo						10	1.7			
Warbling Vireo						4	1.0			
Yellow Warbler						31	4.4			
Common Yellowthroat						20	2.9			
American Redstart						58	8.3			
Bobolink						7	1.2			
Eastern Meadowlark						15	2.1			
Red-winged Blackbird						77	9.6			
Northern Oriole						15	2.5			
Brown-headed Cowbird						7	1.4			
Rose-breasted Grosbeak						12	1.7			
American Goldfinch						6	6.0			
Rufous-sided Towhee						3	1.0			
Savannah Sparrow						12	1.7			
Field Sparrow						3	1.0			
Song Sparrow						60	6.7			
Species Richness	2	3	2	1		48				

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 76 . Number of birds sighted on the St. Lawrence River in 1979 at station 9

SPECIES	7/30	8/1	8/6	9/24	10/5		Total	Avg./+ Occ.		
Green Heron			1				1	1.0		
Common Flicker	1	8	22	5			36	9.0		
Hairy Woodpecker			1				1	1.0		
Downy Woodpecker			2	2			4	2.0		
Eastern Kingbird	3	4	10				17	5.7		
Eastern Wood Pewee			1				1	1.0		
Tree Swallow	60						60	60.0		
Blue Jay		2					2	2.0		
Common Crow		5	5				10	5.0		
Black-capped Chickadee			2				2	2.0		
Gray Catbird				1			1	1.0		
American Robin	5	3	15				23	7.7		
Veery	1		1				2	1.0		
Ruby-crowned Kinglet				2			2	2.0		
Cedar Waxwing	3	4					7	3.5		
Starling			50		50		100	50.0		
Yellow Warbler		2	3				5	2.5		
Common Yellowthroat	1		8	5			14	4.7		
Eastern Meadowlark			1				1	1.0		
Red-winged Blackbird	15	600	20		10		645	161.3		
Northern Oriole			5				5	5.0		
Common Grackle			2				2	2.0		
Rose-breasted Grosbeak		2	15				17	8.5		
American Goldfinch		8	15				23	11.5		
Rufous-sided Towhee		1					1	1.0		
Dark-eyed Junco			5				5	5.0		
Field Sparrow					2		2	2.0		
White-crowned Sparrow				25	30		55	27.5		

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 76 (continued)

SPECIES	7/30	8/1	8/6	9/24	10/5		Total	Avg./+ Occ.		
White-throated Sparrow			2	40	20		62	20.7		
Lincoln's Sparrow				5			5	5.0		
Swamp Sparrow			4	20	2		26	8.7		
Song Sparrow	3	10	140	225	40		418	83.6		
Species Richness	9	12	22	11	7		32			

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 77 . Number of birds sighted on the St. Lawrence River in 1979 at station 11

SPECIES	7/26	7/30	8/29	9/8	9/24	10/5	10/17	10/23	10/30	11/8
Great Blue Heron			2		3	2	3	1		
Canada Goose		32	8	200	5		4	50	1	1
Mallard			35	34	90	262	25	80	20	21
Black Duck			36	58	210	266	110	240	135	80
Gadwall				2	60	17	36	65	115	16
Pintail						3				
Green-winged Teal					2					
Blue-winged Teal			4	3						
American Wigeon			19	8	80	10	35	25	10	
Northern Shoveler						41	4			30
Redhead					5		205	345	850	800
Canvasback					2	1			2	29
Ring-necked Duck					70		210	775	650	550
Greater Scaup							320	100	10	
Lesser Scaup							6			
Unidentified Scaup										30
Common Goldeneye									2	
Hooded Merganser								2	2	1
Common Merganser						2	18		6	10
Red-breasted Merganser							4			
Red-tailed Hawk					1		2			2
Northern Marsh Harrier	1	1	1						1	2
American Kestrel		1		1		1				
American Coot							1			
Killdeer						2				
Great Black-backed Gull								2		1
Herring Gull		1	5					2	1	
Ring-billed Gull		10	60					8	61	20

*No birds sighted +Mean number per sampling period present (Average per occurrence)

USFWS 1979

Table 77. continued

SPECIES	7/26	7/30	8/29	9/8	9/24	10/5	10/17	10/23	10/30	11/8
Albino Ring-billed Gull										
Common Tern	3									
Belted Kingfisher			1							
Common Flicker				2						
Eastern Kingbird	5	4								
Common Crow				50	5				2	2
Starling		30		50						
Bobolink		2								
Red-winged Blackbird		55								
White-crowned Sparrow									5	
Swamp Sparrow						1				
Song Sparrow		6	5							
Species Richness	3	10	11	10	12	12	15	13	17	16

*No birds sighted +Mean number per sampling period present (Average per occurrence)

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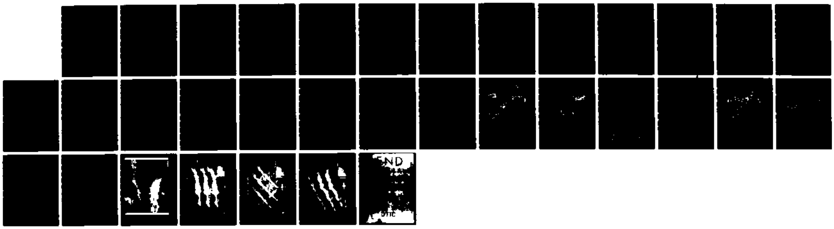

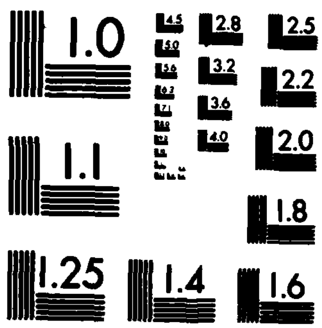
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Table 77. continued

SPECIES	11/10	11/13	11/20		Total	Avg./+ Occ.
Great Blue Heron					11	2.2
Canada Goose			4		305	33.9
Mallard	26	31	11		635	57.7
Black Duck	145	100	104		1484	134.9
Gadwall	17	22	10		360	36.0
Pintail					3	3.0
Green-winged Teal					2	2.0
Blue-winged Teal					7	3.5
American Wigeon					187	26.7
Northern Shoveler	1	41			117	23.4
Redhead	850	840	800		4695	586.9
Canvasback	2	3			39	6.5
Ring-necked Duck	700	450	200		3605	450.6
Greater Scaup	3		10		443	88.6
Lesser Scaup					6	6.0
Unidentified Scaup		10			40	20.0
Common Goldeneye					2	2.0
Hooded Merganser			15		20	5.0
Common Merganser	10	5	14		65	9.3
Red-breasted Merganser		4			8	4.0
Red-tailed Hawk		2	1		8	1.6
Northern Marsh Harrier		1			7	1.2
American Kestrel					3	1.0
American Coot					1	1.0
Killdeer					2	2.0
Great Black-backed Gull		2			5	1.7
Herring Gull					9	2.3
Ring-billed Gull		200	100		459	65.6

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 77. continued

SPECIES	11/10	11/13	11/20		Total	Avg./+ Occ.
Albino Ring-billed Gull		1			1	1.0
Common Tern					3	3.0
Belted Kingfisher					1	1.0
Common Flicker					2	2.0
Eastern Kingbird					9	4.5
Common Crow	470				529	105.8
Starling					80	40.0
Bobolink					2	2.0
Red-winged Blackbird					55	55.0
White-crowned Sparrow					5	5.0
Swamp Sparrow					1	1.0
Song Sparrow					11	5.5
Species Richness	10	14	11		39	

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 78 . Number of birds sighted on the St. Lawrence River in 1979 at station 28

SPECIES	6/5	6/27	7/30	8/1	8/9	8/21	10/5	10/17	11/8	11/10
Green Heron					1					
Canada Goose			70			100	190			
Egyptian Goose							1			
Northern Marsh Harrier				1			1			
Killdeer						2				
Herring Gull						1	2	1		
Ring-billed Gull	15	20		33	5		30	20	22	200
Great Horned Owl				1						
Common Flikcer						7				
Eastern Kingbird			4	15						
Tree Swallow	5									
Blue Jay						2				
Common Crow										2
American Robin						6				
Starling					50	10	50			
Red-winged Blackbird				150						
Northern Oriole						3				
Common Grackle	3					3				
Savannah Sparrow		2								
Song Sparrow		3	3							
Species Richness	3	3	3	5	3	9	6	2	1	2

*No birds sighted +Mean number per sampling period present (Average per occurrence)

USFWS 1979

Table 78. continued

SPECIES	11/13	11/20		Total	Avg./+ Occ.
Green Heron				1	1.0
Canada Goose				260	86.7
Egyptian Goose				1	1.0
Northern Marsh Harrier				2	1.0
Killdeer				2	2.0
Herring Gull		2		6	1.5
Ring-billed Gull	200	20		565	56.5
Great Horned Owl				1	1.0
Common Flicker				7	7.0
Eastern Kingbird				19	9.5
Tree Swallow				5	5.0
Blue Jay	5			7	3.5
American Robin				6	6.0
Starling		50		160	40.0
Red-winged Blackbird				150	150.0
Northern Oriole				3	3.0
Common Grackle				6	3.0
Savannah Sparrow				2	2.0
Song Sparrow				6	3.0
Species Richness	2	3		20	

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 79. Number of birds sighted on the St. Lawrence River in 1979 at station 29.

SPECIES	7/30	8/1	8/6	10/5	10/17	11/8	11/10*	11/13	11/20	
Common Merganser						10			2	
American Kestrel	1									
Ruffed Grouse					1					
Spotted Sandpiper		1								
Herring Gull						1				
Ring-billed Gull						2		14	10	
Rock Dove									30	
Common Flicker	2	8	2		3					
Downy Woodpecker	2									
Eastern Kingbird	11	12	3							
Eastern Pewee	15									
Barn Swallow			6							
Blue Jay	8							5	2	
Common Crow				5						
Black-capped Chickadee				20	4	10			10	
House Wren					1					
Gray Catbird		3	2							
American Robin	10	3			40					
Wood Thrush	1									
Veery	1									
Ruby-crowned Kinglet				40						
Cedar Waxwing								20		
Starling	30									
Red-eyed Vireo	1									
Yellow Warbler			2							
Yellow-rumped Warbler				30	2					
Common Yellowthroat	41									
Bobolink	10									

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 79.continued

SPECIES	7/30	8/1	8/6	10/5	10/17	11/8	11/10*	11/13	11/20	
Red-winged Blackbird	2		6		500					
Northern Oriole	2									
Common Grackle	2									
Evening Grosbeak									10	
American Goldfinch			2							
Dark-eyed Junco				25	5					
Tree Sparrow			4			15				
White-crowned Sparrow				10						
White-throated Sparrow				5	5					
Swamp Sparrow	1	1	1							
Song Sparrow	5	4	4	40	10					
Species Richness	18	7	10	8	10	5		3	6	

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 79. continued

SPECIES	Total	Avg./+ Occ.
Common Merganser	12	6.0
American Kestrel	1	1.0
Ruffed Grouse	1	1.0
Spotted Sandpiper	1	1.0
Herring Gull	1	1.0
Ring-billed Gull	26	8.7
Rock Dove	30	30.0
Common Flicker	15	3.8
Downy Woodpecker	2	2.0
Eastern Kingbird	26	8.7
Eastern Pewee	15	15.0
Barn Swallow	6	6.0
Blue Jay	15	5.0
Common Crow	5	5.0
Black-capped Chickadee	44	11.0
House Wren	1	1.0
Gray Catbird	5	2.5
American Robin	53	17.7
Wood Thrush	1	1.0
Veery	1	1.0
Ruby-crowned Kinglet	40	40.0
Cedar Waxwing	20	20.0
Starling	30	30.0
Red-eyed Vireo	1	1.0
Yellow Warbler	2	2.0
Yellow-rumped Warbler	32	16.0
Common Yellowthroat	41	41.0
Bobolink	10	10.0

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 79. continued

SPECIES	Total	Avg./+ Occ.
Red-winged Blackbird	508	169.3
Northern Oriole	2	2.0
Common Grackle	2	2.0
Evening Grosbeak	10	10.0
American Goldfinch	2	2.0
Dark-eyed Junco	30	15.0
Tree Sparrow	19	9.5
White-crowned Sparrow	10	10.0
White-throated Sparrow	10	5.0
Swamp Sparrow	3	1.0
Song Sparrow	63	12.6
Species Richness	39	

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 80 . Number of birds sighted on the St. Lawrence River in 1979 at station 31.*

SPECIES	6/11	6/18	6/26	6/27	7/19	7/26	7/30	8/1	8/9	9/24
Canada Goose					70			40	45	
Mallard			3	2	2					
Hooded Merganser										
Common Merganser										
Red-tailed Hawk										
Northern Marsh Harrier				1						
American Kestrel									1	
Ring-billed Gull	35	48	14	12	14	230				
Common Tern			1	3						
Belted Kingfisher	1			1				1	1	2
Common Flicker		1		1	2					
Hairy Woodpecker			1							
Downy Woodpecker	1	1	1	1						
Eastern Kingbird								12	6	
Great-crested Flycatcher	1	1	1	1						
Tree Swallow	12	14	18	26	38		15	10		
Barn Swallow							20	5		
Cliff Swallow				4			1			
Purple Martin	40	48	46	46	29	80	60	20	15	
Blue Jay									2	
Black-capped Chickadee	5									
House Wren	2	3	3	3	4					
Gray Catbird	1	2	4	1	3					
Brown Thrasher		1	1	1						
American Robin	20	31	24	34	39			5	7	
Veery	1	1		1						
Cedar Waxwing	2	4	4	9	15		4		4	
Starling	8	3	16	38	89		5			

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 80. continued.

SPECIES	6/11	6/18	6/26	6/27	7/19	7/26	7/30	8/1	8/9	9/24
Red-eyed Vireo		1								
Warbling Vireo	1	1	1							
Yellow Warbler	16	12	10	8	12			2		
Common Yellowthroat	8	5	7	6	3					
American Redstart		1	1							
Bobolink	6	8	5	8	4					
Eastern Meadowlark	6	5	6	4	3					
Red-winged Blackbird	25	22	31	18	86	50	5	20		
Northern Oriole	3	3	4	1						
Common Grackle	6	12	5	9	15					
Brown-headed Cowbird		5	1	3	2					
Evening Grosbeak										
Rufous-sided Towhee	1	2	2	2	2	1				
Savannah Sparrow	11	9	2	8	6					
Chipping Sparrow	2	4	1	1	1					
Swamp Sparrow	1	1	1	3						
Song Sparrow	8	6	5	6	5					10
Species Richness	26	29	29	31	22	4	7	8		2

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 80. continued

SPECIES	10/17	10/30	11/8	11/10	11/13		Total	Avg./+ Occ.		
Canada Goose							155	51.7		
Mallard							7	2.3		
Hooded Merganser				2			2	2.0		
Common Merganser					1		1	1.0		
Red-tailed Hawk		1	1				2	1.0		
Northern Marsh Harrier							1	1.0		
American Kestrel							1	1.0		
Ring-billed Gull							353	58.8		
Common Tern							4	2.0		
Belted Kingfisher							6	1.2		
Common Flicker							4	1.3		
Hairy Woodpecker							1	1.0		
Downy Woodpecker							4	1.0		
Eastern Kingbird							18	9.0		
Great-crested Flycatcher							4	1.0		
Tree Swallow							133	19.0		
Barn Swallow							24	12.5		
Cliff Swallow							5	2.5		
Purple Martin							384	42.7		
Blue Jay							2	2.0		
Black-capped Chickadee							5	5.0		
House Wren							15	3.0		
Gray Catbird							11	2.2		
Brown Thrasher							3	1.0		
American Robin		15					175	21.9		
Veery							3	1.0		
Cedar Waxwing							42	6.0		
Starling	50	100					309	38.6		

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 80. continued

SPECIES	10/17	10/30	11/8	11/10	11/13		Total	Avg./+ Occ.		
Red-eyed Vireo							1	1.0		
Warbling Vireo							3	1.0		
Yellow Warbler							60	10.0		
Common Yellowthroat							29	5.8		
American Redstart							2	1.0		
Bobolink							31	6.2		
Eastern Meadowlark							24	4.8		
Red-winged Blackbird	100						357	40.0		
Northern Oriole							11	2.8		
Common Grackle							47	9.4		
Brown-headed Cowbird							11	2.8		
Evening Grosbeak			30				30	30.0		
Rufous-sided Towhee							10	1.7		
Savannah Sparrow							36	7.2		
Chipping Sparrow							9	1.8		
Swamp Sparrow							6	1.5		
Song Sparrow							40	6.7		
Species Richness	2	3	2		1		45			

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 81. Species occurrence and general abundance of mammals in the Massena area.*

Species (latin name)	Abundance category*
Shrews and Moles (Insectivora)	
Masked shrew (*Sorex cinereus*)	C
Smokey shrew (*Sorex fumeus*)[1]	R
Pygmy shrew (*Microsorex hoyi*)	C
Short-tailed shrew (*Blarina brevicauda*)	A
Hairy-tailed mole (*Parascalops breweri*)[2]	R
Eastern mole (*Scalopus aquaticus*)[2]	R
Star-nosed mole (*Condylura cristata*)	C
Bats (Chiroptera)[3,4]	
Little brown bat (*Myotis lucifugus*)	S
Big brown bat (*Eptesicus fuscus*)	S
Silver-haired bat (*Lasionycteris noctivagans*)	S
Rabbits and Hares (Lagomorpha)	
Eastern cottontail (*Sylvilagus floridanus*)	C
Snowshoe hare (*Lepus americanus*)	C
Rodents (Rodentia)	
Eastern chipmunk (*Tamias striatus*)	A
Woodchuck (*Marmota monax*)	A
Gray squirrel (*Sciurus carolinensis*)	C
Red squirrel (*Tamiasciurus hudsonicus*)	C
S. flying squirrel (*Glaucomys volans*)	C-R
N. flying squirrel (*Glaucomys sabrinus*)	R
American beaver (*Castor canadensis*)	R
Deer mouse (*Peromyscus* spp.)	A
Meadow vole (*Microtus pennsylvanicus*)	A
Muskrat (*Ondatra zibethica*)	C
Norway rat (*Rattus norvegicus*)	R
House mouse (*Mus musculus*)	R
Meadow jumping mouse (*Zapus hudsonius*)	C
Woodland jumping mouse (*Napaeozapus insignis*)	R

Table 81. (continued).

Carnivores (Carnivora)	
Coyote (*Canis latrans*)	C-R
Red fox (*Vulpes vulpes*)	C
Gray fox (*Urocyon cinereoargenteus*)	R
Raccoon (*Procyon lotor*)	C
Fisher (*Martes pennanti*)[5]	R
Ermine (*Mustela erminea*)	C-R
Long-tailed Weasel (*Mustela frenata*)	C-R
American mink (*Mustela vison*)	C-R
River otter (*Lutra canadensis*)	R
Striped skunk (*Mephitis mephitis*)	C
Ungulates (Artiodactyla)	
White-tailed deer (*Odocoileus virginianus*)	C

* Abundance category symbols; A = Abundant, C = Common, R = Rare, and S = Seasonal.

[1]Wright, 1978.

[2]VanDruff and Lomolino, 1978.

[3]Lackey, 1977.

[4]Wrigley, 1969.

[5]Sainola, 1979.

• USFWS 1979

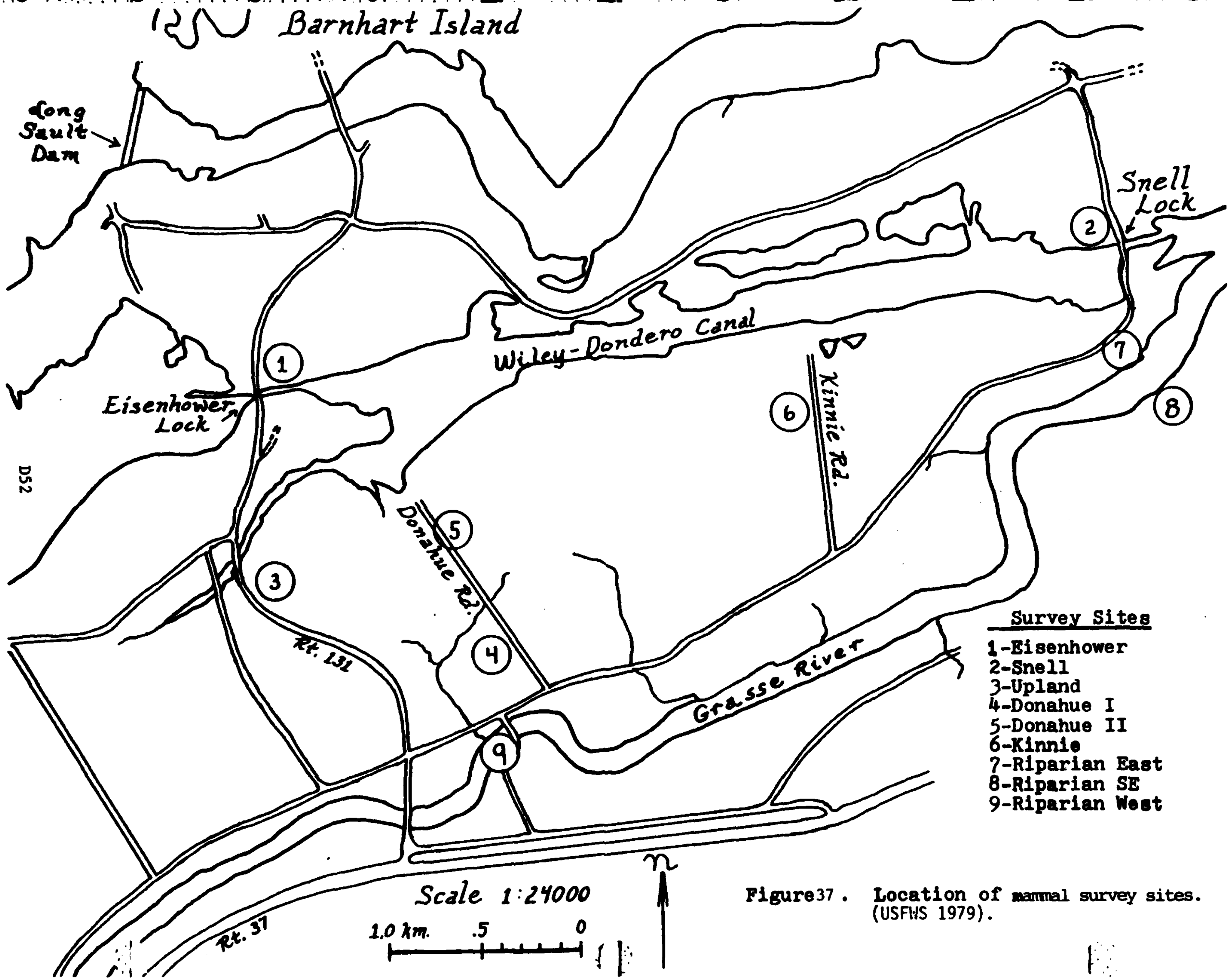

Figure37. Location of mammal survey sites. (USFWS 1979).

Table 82. Comparison of habitat parameters recorded at Snell and Eisenhower (a dredge-spoil area) trapping sites during late June, 1979.[•] Standard deviations are included in parentheses (n = 20).

Habitat Parameter	Snell	Eisenhower	t[a]
Soil Character[b]			
- Hardness	2.0(.00)	2.8(.43)	2.63*
- Moisture	2.5(.50)	1.3(.43)	2.57*
- Organic	2.0(.00)	1.3(.43)	2.30*
Percent Cover			
- Rock	0.0(0.0)	5.0(3.5)	2.02*
- Soil	2.5(2.5)	17.5(18.9)	1.11
- Litter	0.0(0.0)	0.0(0.0)	0.00
- Grass	38.8(17.8)	43.8(26.5)	0.22
- Lichen	8.8(7.4)	6.3(2.2)	0.46
- Herbs	46.3(24.3)	23.8(21.3)	1.09
- Saplings & shrubs	2.5(4.3)	1.3(2.2)	0.35
- Ferns	0.0(0.0)	0.0(0.0)	0.00
- Trees	3.8(4.1)	2.5(4.3)	0.31
Canopy Closure (%)	3.8(4.1)	0.0(0.0)	1.31

[a]t values representing a significant difference ($P < .05$) between sites are indicated by an asterisk.

[b]Soil character parameters were rated as 1, 2, or 3 for the particular characteristic with 3 being the maximum for that qualitative parameter.

[•]USFWS 1979

Table 83. Habitat parameters recorded at mammalian trapping sites in the Massena area along the St. Lawrence River, June-July 1979. (Numbers in parentheses are standard deviations).*

Habitat Parameter	Donahue I	Kinnie Rd.	Upland	Donahue II	Riparian (Grasse River) E	Riparian (Grasse River) W	Riparian (Grasse River) SE
Canopy Closure %	0(0)	0(0)	69.4(22.7)	65(22.5)	1.3(2.2)	63.8(20.7)	20(18.4)
Soil - hardness	2.0(0)	2.0(0)	2.0(0)	2.0(0)	2.0(0)	2.0(0)	2.0(0)
- moisture	2.8(0.4)	2.0(0)	2.0(0)	2.1(0.3)	2.3(0.4)	2.5(0.5)	2.5(0.5)
- organics	2.0(0)	2.0(0)	2.4(4.8)	2.1(0.3)	2.0(0)	2.8(0.4)	2.0(0)
Percent Cover							
- rock	0(0)	7.5(2.5)	14.4(6.3)	3.8(4.1)	6.3(5.4)	2.5(4.3)	3.8(6.5)
- soil	3.8(6.5)	35.0(3.5)	5.0(3.5)	10.6(5.3)	7.0(4.7)	16.3(13.9)	15.0(8.7)
- litter	8.8(2.2)	5.0(0)	33.1(17.3)	13.8(9.3)	8.8(2.2)	11.3(2.2)	11.3(4.1)
- grass	38.8(7.4)	22.5(5.6)	8.1(6.1)	4.4(4.6)	51.3(22.7)	16.7(16.5)	10.0(5.0)
- lichen & moss	2.5(4.3)	1.3(2.2)	4.4(3.0)	8.8(9.9)	1.3(2.2)	6.3(2.2)	18.8(23.8)
- herbs	40.0(12.7)	22.5(7.5)	10.6(8.1)	33.8(21.5)	17.5(10.3)	21.3(9.6)	27.5(20.8)
- saplings & shrubs	3.8(4.1)	11.3(2.2)	10.0(3.5)	11.9(6.1)	7.5(5.6)	6.3(2.2)	6.3(2.2)
- ferns	0(0)	0(0)	4.0(3.2)	0(0)	0(0)	0(0)	0(0)
- trees	0(0)	2.5(2.5)	11.9(2.4)	9.4(6.3)	1.3(2.2)	15.0(5.0)	7.5(2.5)

* USFWS 1979.

Table 84. Species occurrence at the four major habitat types in the Massena area as indicated by summer trapping surveys (s) and winter track surveys (w).*

Species	Habitat Type			
	Grassland	Riparian	Old-Field	Hardwoods
Masked or Pygmy Shrew		s	s	s
Short-tailed shrew	w	s	w	s,w
Meadow vole	s,w	s	s,w	
Deer mouse		w	w	s,w
Meadow jumping mouse		s	s	
Chipmunk		s		s
Red squirrel		s,w		s,w
Gray squirrel		w		w
S. flying squirrel				w
Woodchuck			s	s
Cottontail rabbit			w	w
Snowshoe hare	s		s,w	w
Weasel			w	w
Skunk	s			
Red fox	w	w	w	w
Eastern coyote				w
White-tailed deer			w	w
Richness	5	9	11	14

*USFWS 1979

Table 85. Species of mammals detected during winter track surveys in four habitat types in the Massena area, 1980.*

Species	Habitat Type Grassland	Riparian	Old-Field	Hardwoods
Short-tailed shrew	x		x	x
Meadow vole	x		x	
Deer mouse		x	x	x
Red squirrel		x		x
Gray squirrel		x		x
S. flying squirrel				x
Cottontail rabbit			x	x
Snowshoe hare			x	x
Weasel			x	x
Red fox	x	x	x	x
Eastern coyote				x
White-tailed deer			x	x
Richness	3	4	8	11

*USFWS 1979

Table 86 Comparison of trapping success at Massena, New York (1979). *•

Species	Grassland		Riparian			Old Field		Hardwood	
	Donahue I	Kinnie Rd.	E	W	SE	Snell	Eisenhower	Upland	Donahue I
Masked or Pygmy Shrew	0	0	1.0	0	0	2.0	0	0	0.6
Short-tailed Shrew	0	0	0	1.1	0.9	0	0	0	2.3
Meadow vole	1.9	0	0	2.1	12.0	25.5	1.9	0	0
Meadow jumping mouse	0	0	0	0	3.7	2.9	2.9	0	0
Chipmunk	0	0	0	17.8	0	0	0	1.9	4.2
Deer mouse	0	0	0	0	0	0	0	1.5	5.8
Woodchuck	0	0	0	0	0	2.8	2.4	0	2.7
Snowshoe hare	2.4	0	0	0	0	0	2.4	0	0
Domestic cat	0	2.9	0	0	0	0	0	2.7	0
Striped skunk	0	5.0	0	0	0	0	0	0	0
Red squirrel	0	0	0	0	1.9	0	0	0	1.0
All Mammals	1.5	2.1	0.5	6.1	9.4	16.5	3.5	1.9	5.8
Richness	2	2	1	3	4	4	4	3	5

*Data collected from 9 sites; 3,210 trapdays during summer, 1979.
•USFWS 1979

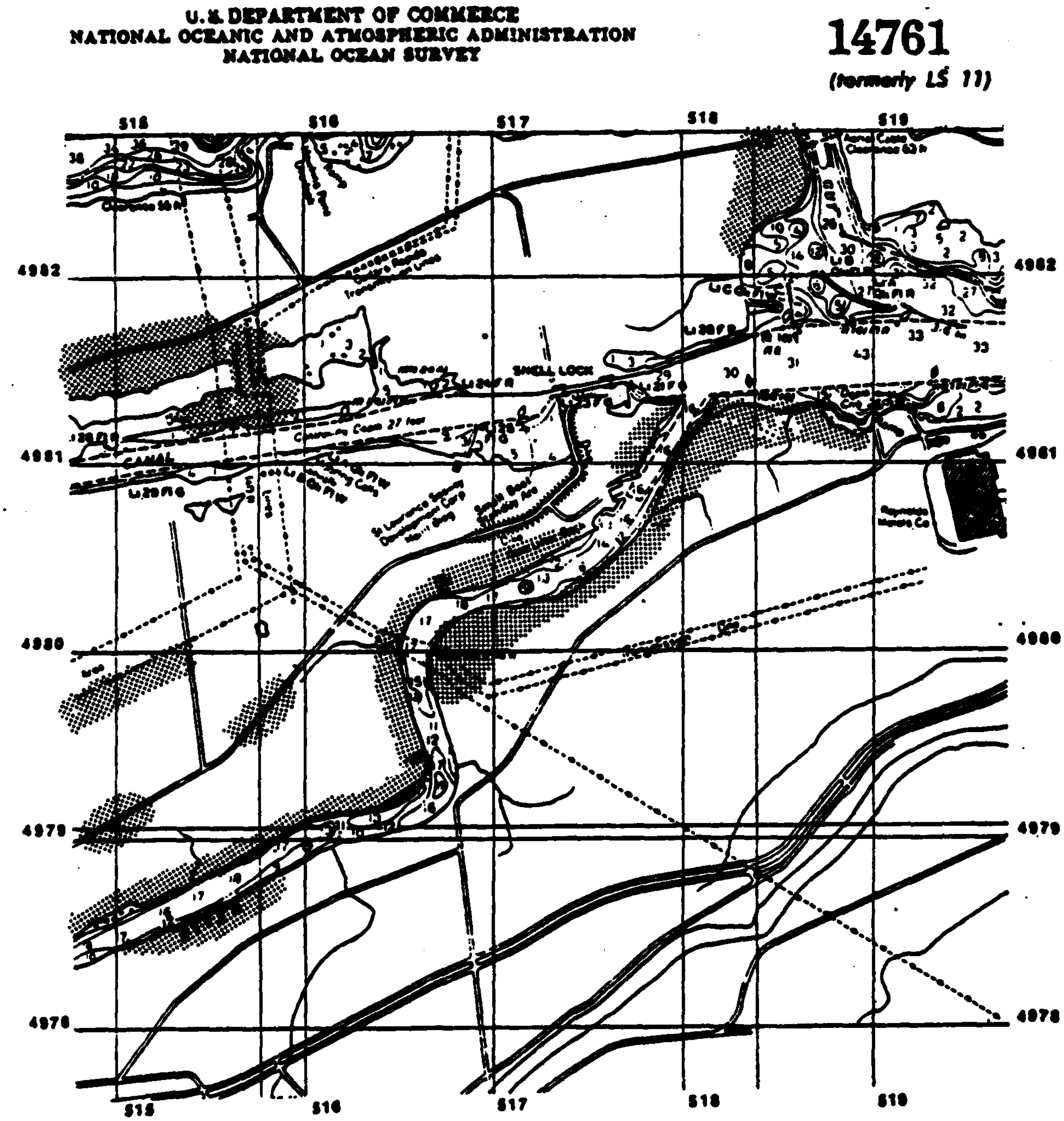

Fig.38. General area surveyed for amphibians and reptiles, vicinity of Eisenhower and Snell Locks, Jefferson County, New York. Stippling indicates areas where field reconnaissance and trapping were concentrated. (USFWS 1979).

COUNTERPART TO
RAQUETTE RIVER

SOUNDINGS IN FEET

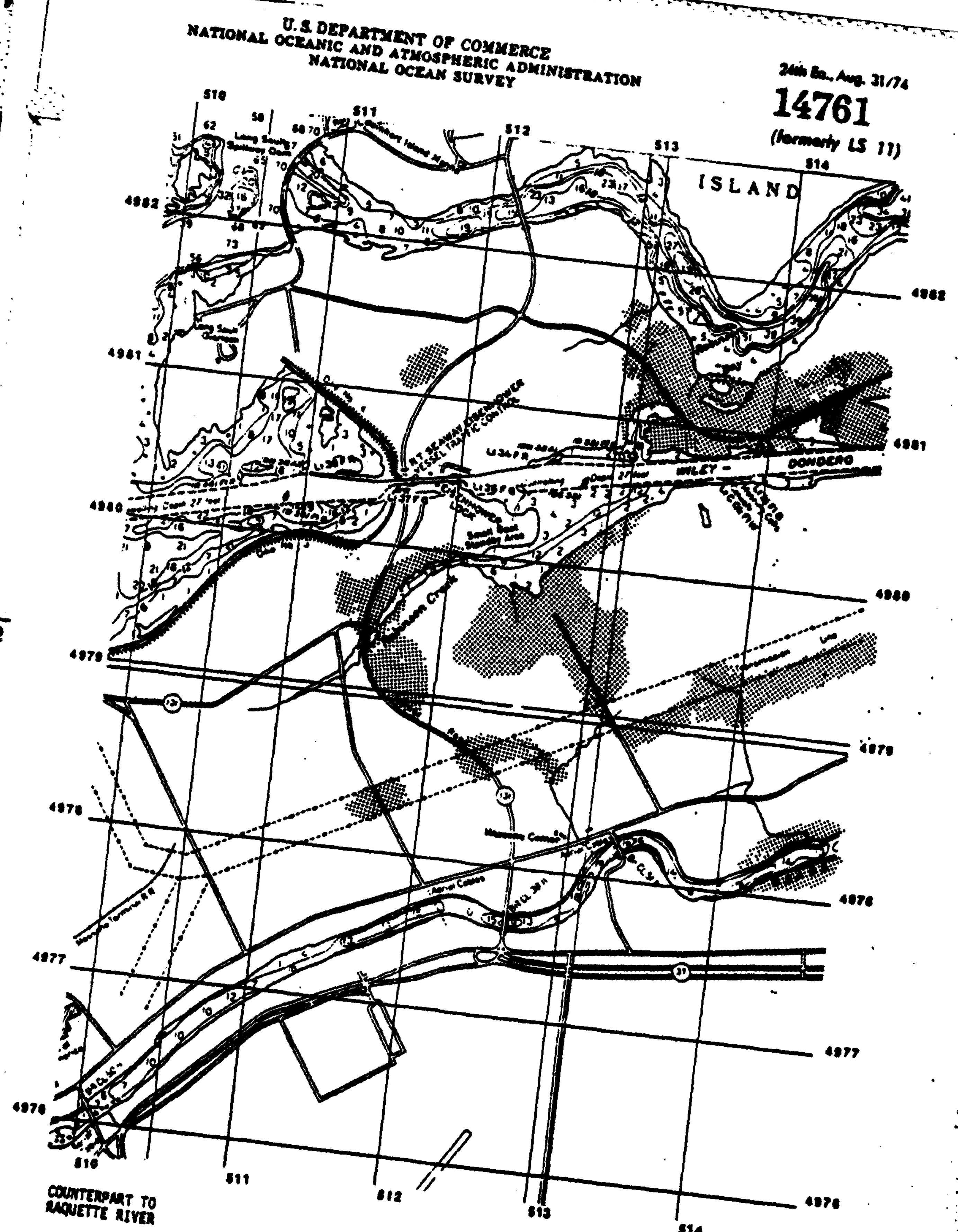

Fig. 38. (continued).

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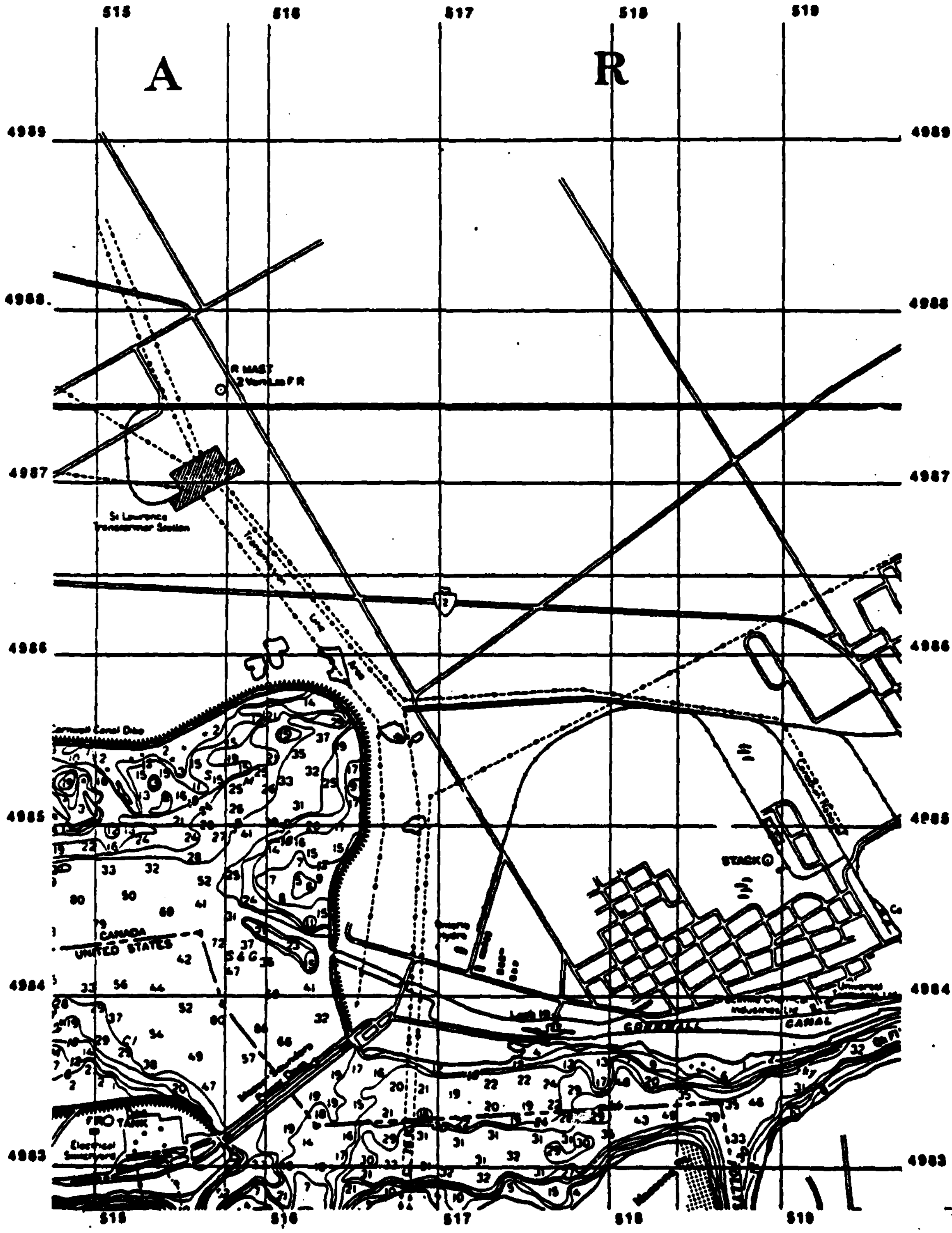

COUNTERPART TO
CORNWALL WEST

SOUNDINGS IN FEET

Fig.38. (continued).

*No birds sighted +Mean number per sampling period present (Average per occurrence)

Table 87. -- Amphibian and reptile species determined to be present in the vicinity of the Eisenhower and Snell Locks, Massena, New York. A plus sign (+) denotes the observed presence of a species in a particular area or habitat type. Data are summarized from field reconnaissance conducted between April 17 and August 21, 1979.*

SPECIES	Habitat												
	Emergent Marsh	Wet Meadow	Shrub Swamp	Forested Wetland	Upland Shrub	Mature Decid Hdwd	Second Growth Hdwd	Robinson Creek	Wiley-Dondero Canal	Powerline Row	Grass Field	Pond	Grasse River
Amphibians													
Blue-spotted Salamander							+						
American Toad						+					+	+	
Spring Peeper		+		+									
Gray Treefrog										+			
Western Chorus Frog	+	+	+	+						+		+	
Bullfrog	+									+		+	+
Green Frog	+									+		+	+
Northern Leopard Frog	+	+	+	+				+	+	+	+	+	+
Wood Frog				+	+							+	
Reptiles													
Snapping Turtle	+											+	+
Painted Turtle	+											+	+
Blanding's Turtle	+							+	+				
Map Turtle													+
Eastern Garter Snake			+	+	+						+	+	
Red-bellied Snake											+		

*USFWS 1979

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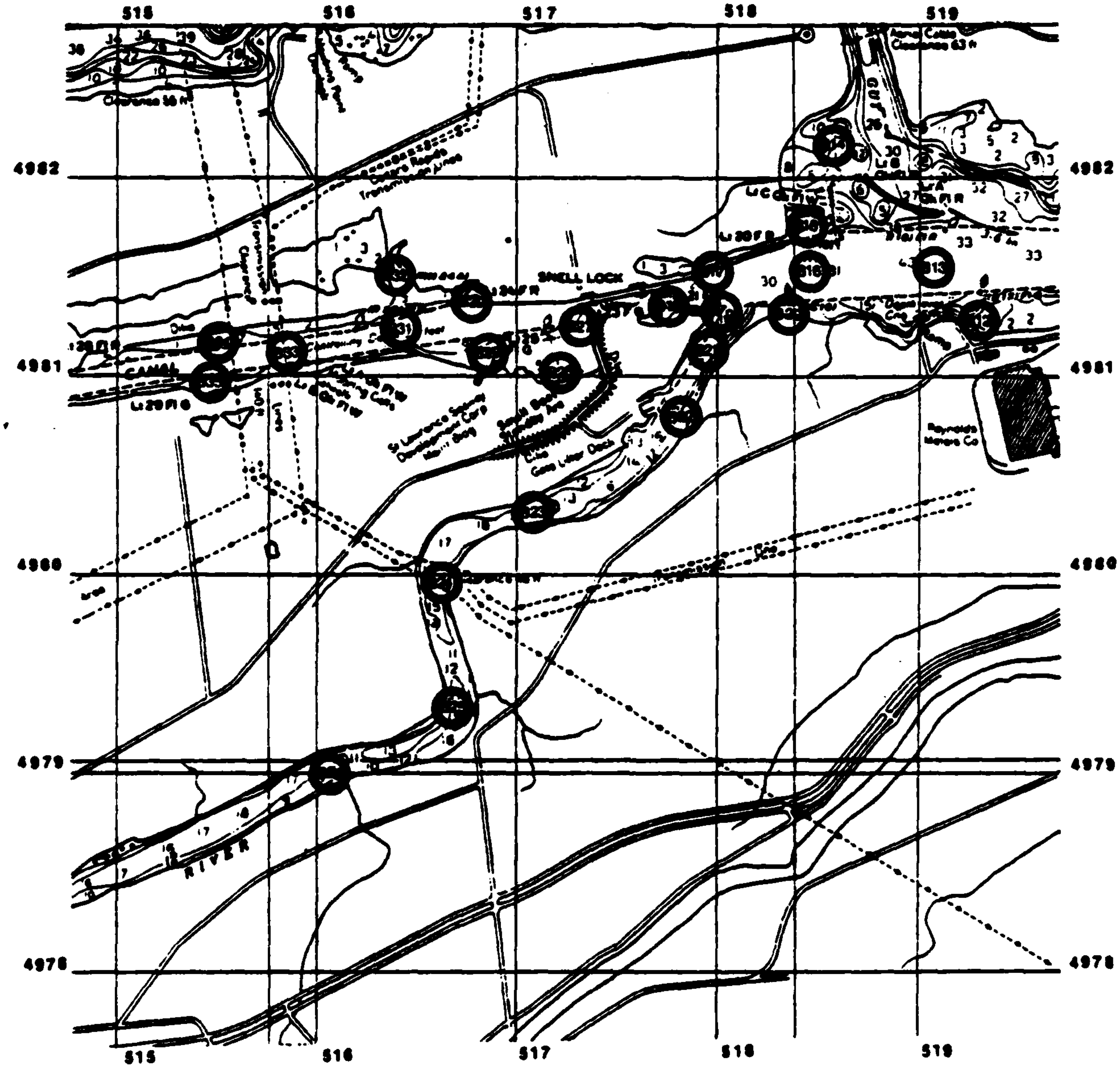

Fig.39. Locations of benthos stations B12-B35. (USFWS 1979).

COUNTERPART TO
RAQUETTE RIVER

SOUNDINGS IN FEET

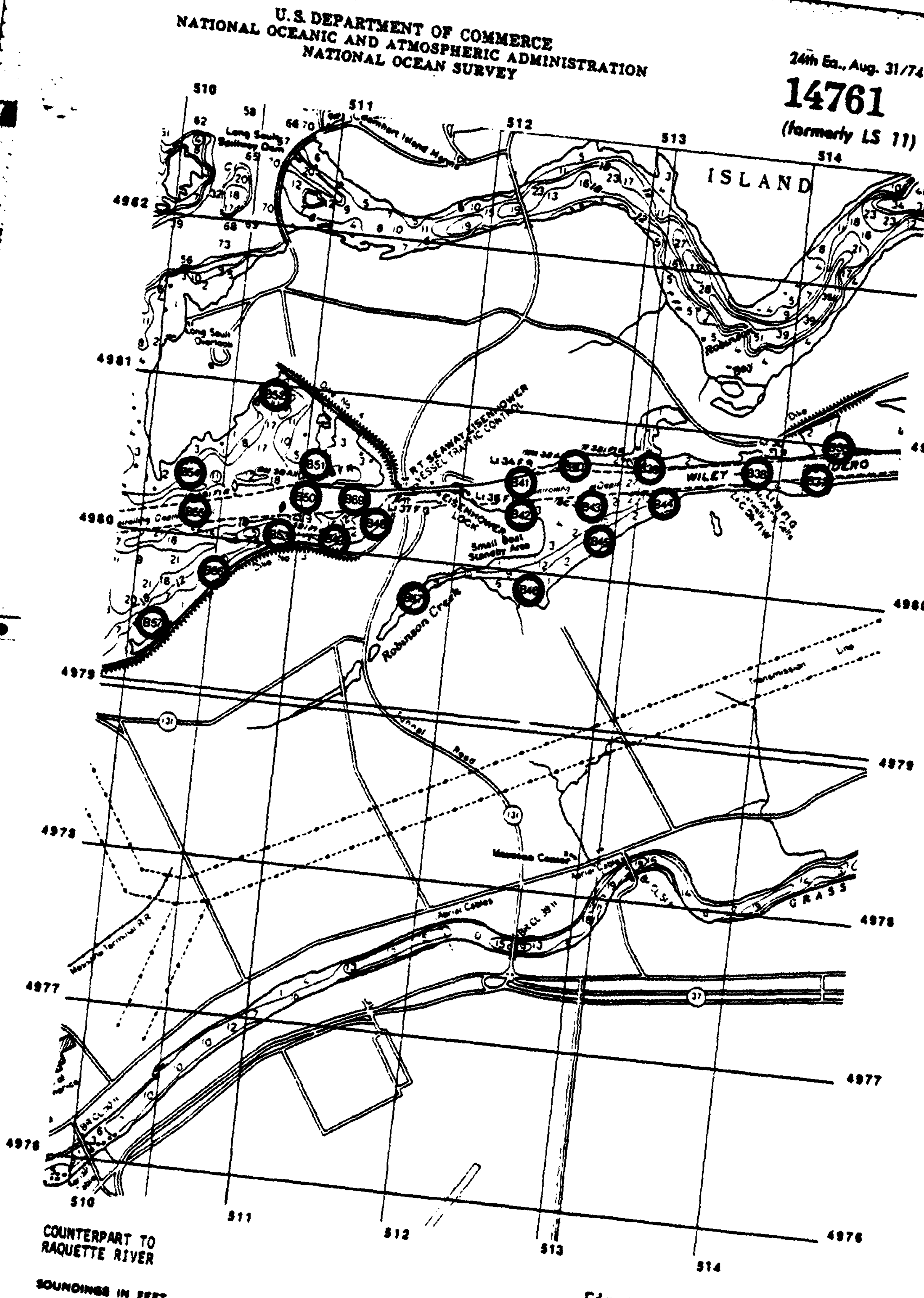

Fig.40. Locations of benthos stations B36-B57 and B69. (USFWS 1979).

Table 88. Occurrence of benthic invertebrate taxa at various locations along the St. Lawrence River from May through October, 1979.*

Taxa	Month Location		May Massena	July Upriver	Aug. Massena	Oct. Massena	Oct. Upriver	Aug. Islands & Shoals	All Massena	All Upriver
Family Spongillidae (Sponges)		A				X			X	
Class Hydrozoa (Hydroids)		A					X			X
Class Turbellaria (Flatworms)		A		X		X	X	X	X	X
Phylum Nematoda (Roundworms)		A	X	X	X	X	X	X	X	X
Phylum Nematomorpha (Horsehair worms)		A	X	X	X	X	X	X	X	X
Phylum Bryozoa (Moss animalcules)		A			X	X	X		X	X
Class Oligochaeta (Aquatic earthworms)		A	X	X	X	X	X	X	X	X
Family Glossiphoniidae (Leech)		A	X	X	X	X	X	X	X	X
Family Piscicolidae (Leech)		A					X			X
Family Hirundinidae (Leech)		A		X		X	X		X	X
Family Erpobdellidae (Leech)		A	X	X	X	X	X	X	X	X
Order Isopoda (Aquatic sow bugs)		A	X	X	X	X	X	X	X	X
Order Amphipoda (Scuds)		A	X	X	X	X	X	X	X	X
Family Hydracarina (Water mites)		A	X	X	X	X	X	X	X	X
Order Collembola (Sprintails)		A				X			X	
Order Ephemeroptera (Mayflies)		L	X	X	X	X	X	X	X	X
Order Odonata (Dragonflies)		L	X			X	X	X	X	X
Order Hemiptera (Bugs)		A	X						X	
Family Sialidae (Alderflies)		L	X			X	X	X	X	X
Family Corydalidae (Dobsonflies)		L				X			X	
Order Sisyridae (Spongilla flies)		L				X			X	
Order Trichoptera (Caddisflies)		L	X	X	X	X	X	X	X	X
Order Trichoptera (Caddisflies)		P			X			X	X	
Order Lepidoptera (Aquatic caterpillars)		L	X	X	X	X	X	X	X	X
Order Coleoptera (Unidentified beetles)		L				X			X	
Order Coleoptera (Unidentified beetles)		A				X			X	
Family Haliplidae (Crawling water beetles)		L	X	X	X	X		X	X	X
Family Dytiscidae (Predaceous diving beetles)		L				X	X		X	X
Family Dytiscidae (Predaceous diving beetles)		A				X		X	X	
Family Hydrophilidae (Water scavenger beetles)		L				X			X	
Family Elmidae (Riffle beetles)		L	X						X	
Family Curculionidae (Weevils)		L						X		
Family Coccinellidae		A						X		
Family Elateridae		A						X		
Order Diptera (Unidentified flies)		L	X						X	

Table 88. (Continued)

Taxa / Month Location		May Massena	July Upriver	Aug. Massena	Oct. Massena	Oct. Upriver	Aug. Islands & Shoals	All Massena	All Upriver
Family Tipulidae (True crane flies)	L	X			X	X		X	X
Subfamily Chaoborinae (Phantom midges)	L	X						X	
Family Chironomidae (Midges)	L	X	X	X	X	X	X	X	X
Family Chironomidae (Midges)	P	X	X	X	X	X	X	X	X
Family Ceratopogonidae	L	X	X	X	X	X	X	X	X
Family Athericidae	L				X			X	
Family Valvatidae	A		X	X	X	X	X	X	X
Family Hydrobiidae	A	X	X	X	X	X	X	X	X
Family Pleuroceridae	A	X	X	X	X	X	X	X	X
Family Lymnaeidae	A	X	X	X	X	X	X	X	X
Family Physidae	A	X	X	X	X	X	X	X	X
Family Planorbidae	A	X	X	X	X	X	X	X	X
Family Ancylidae (Limpets)	A	X	X		X	X	X	X	X
Class Pelecypodia (Unidentified clams)	A				X			X	
Family Unionidae (Freshwater mussels)	A	X	X	X	X	X	X	X	X
Family Sphaeriidae (Fingernail clams)	A	X	X	X	X	X	X	X	X

A = Adult P = Pupae L = Larvae

*USFWS 1979.

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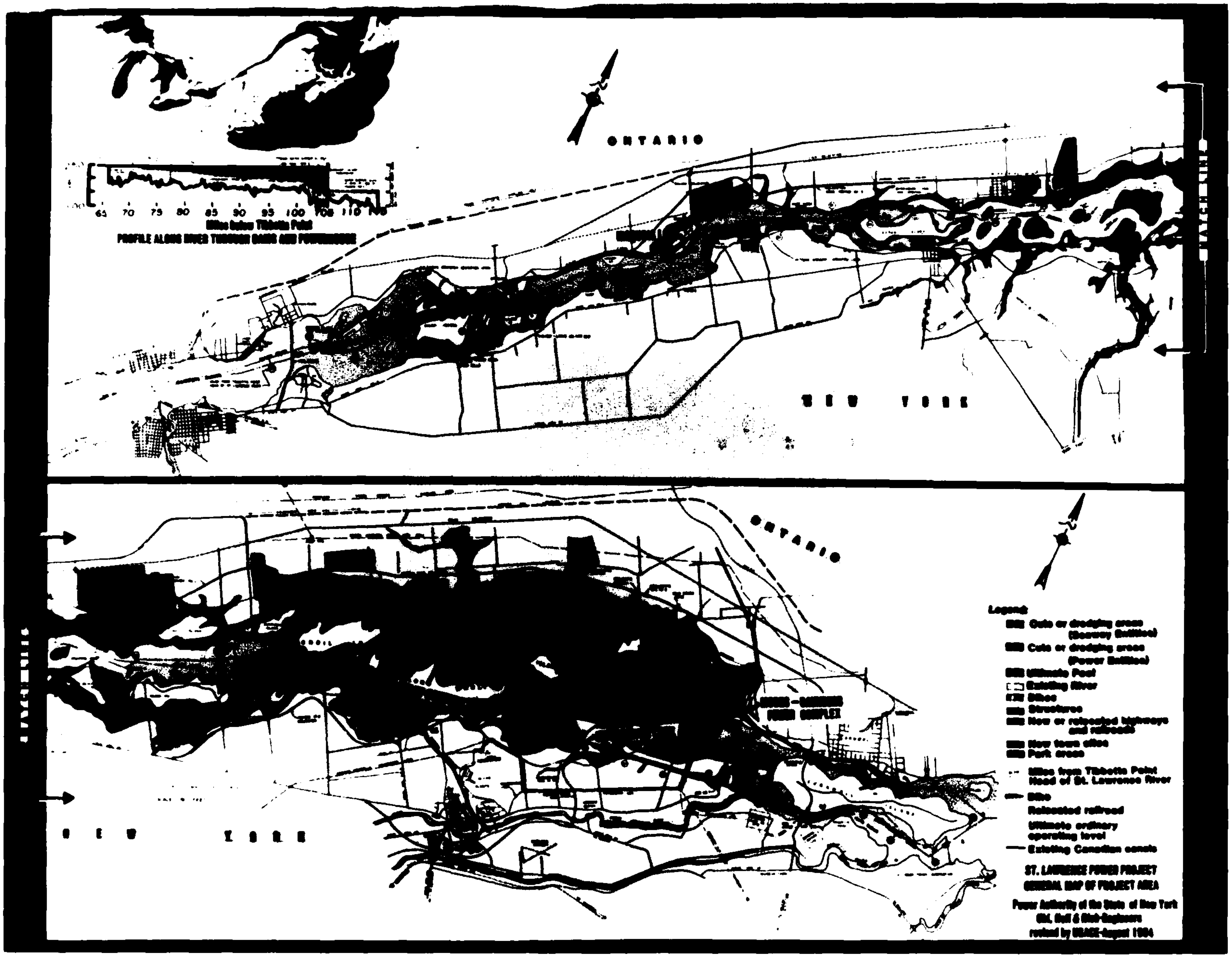

ONTARIO
NEW YORK
65 70 75 80 85 90 95 100 105 110 115
Miles below Tibbetts Point
PROFILE ALONG RIVER THROUGH DAMS AND POWERHOUSE
MATCH LINE
ONTARIO
NEW YORK
MOSES—SAUNDERS POWER COMPLEX
Legend
Cuts or dredging areas (Seaway Entities)
Cuts or dredging areas (Power Entities)
Ultimate Pool
Existing River
Dikes
Structures
New or relocated highways and railroads
New town sites
Park areas
Miles from Tibbetts Point Head of St. Lawrence River
Dike
Relocated railroad
Ultimate ordinary operating level
Existing Canadian canals
ST. LAWRENCE POWER PROJECT
GENERAL MAP OF PROJECT AREA
Power Authority of the State of New York
Uhl, Hall & Rich-Engineers
revised by USACE-August 1984

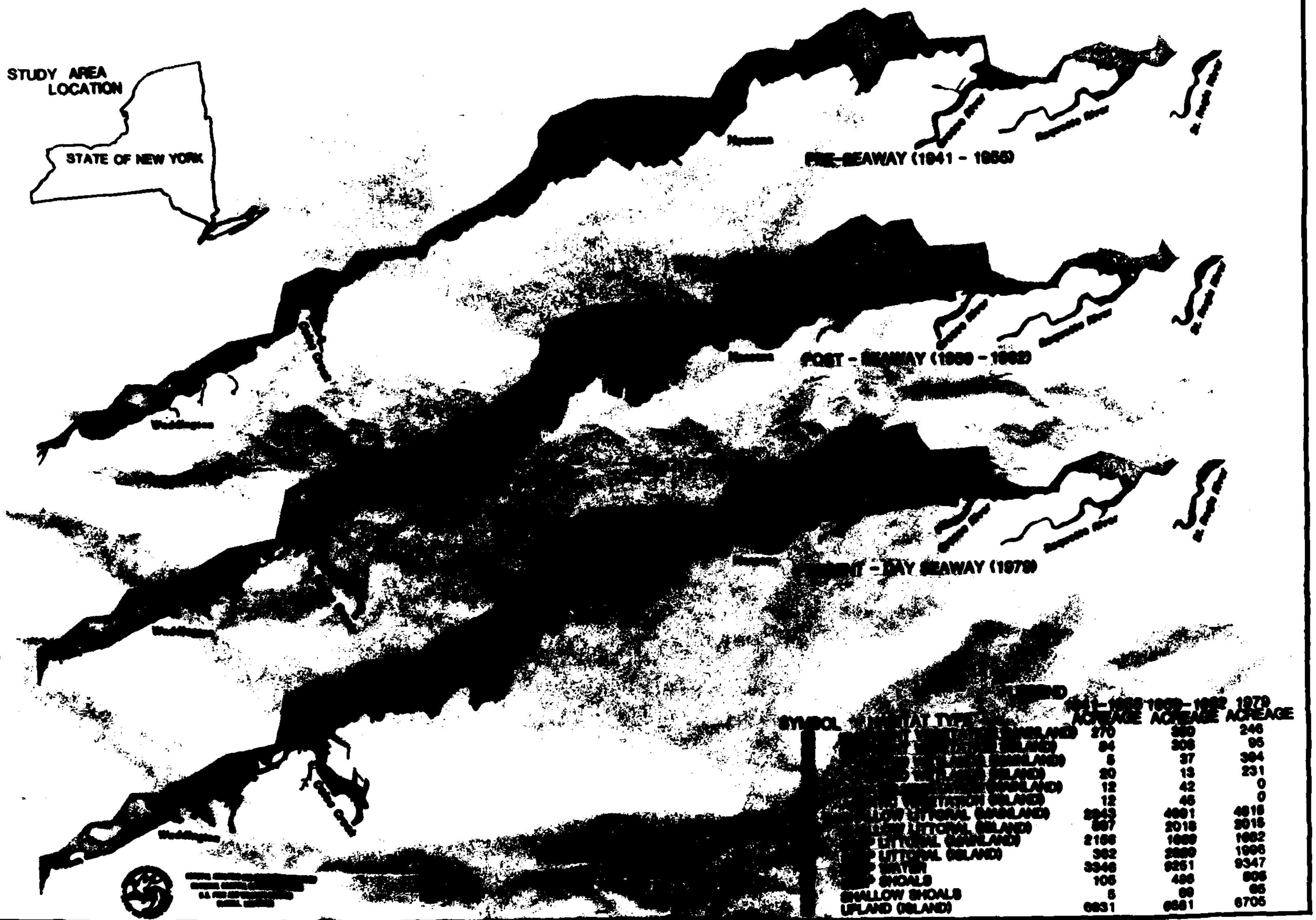
FIGURE 4 **WETLAND CHANGE FOR SELECTED HABITATS IN THE ST. LAWRENCE SEAWAY, NEW YORK (1941-1979)**

THE UPPER SEAWAY FROM LAKE ONTARIO TO MORRISTOWN

FIGURE 5 WETLAND CHANGE FOR SELECTED HABITATS IN THE ST. LAWRENCE SEAWAY, NEW YORK (1941-1979)

FIGURE 6 **WETLAND CHANGE FOR SELECTED HABITATS IN THE ST. LAWRENCE SEAWAY, NEW YORK (1941-1979)**

THE LOWER SEAWAY FROM IROQUOIS DAM TO THE NEW YORK STATE-CANADIAN BORDER



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