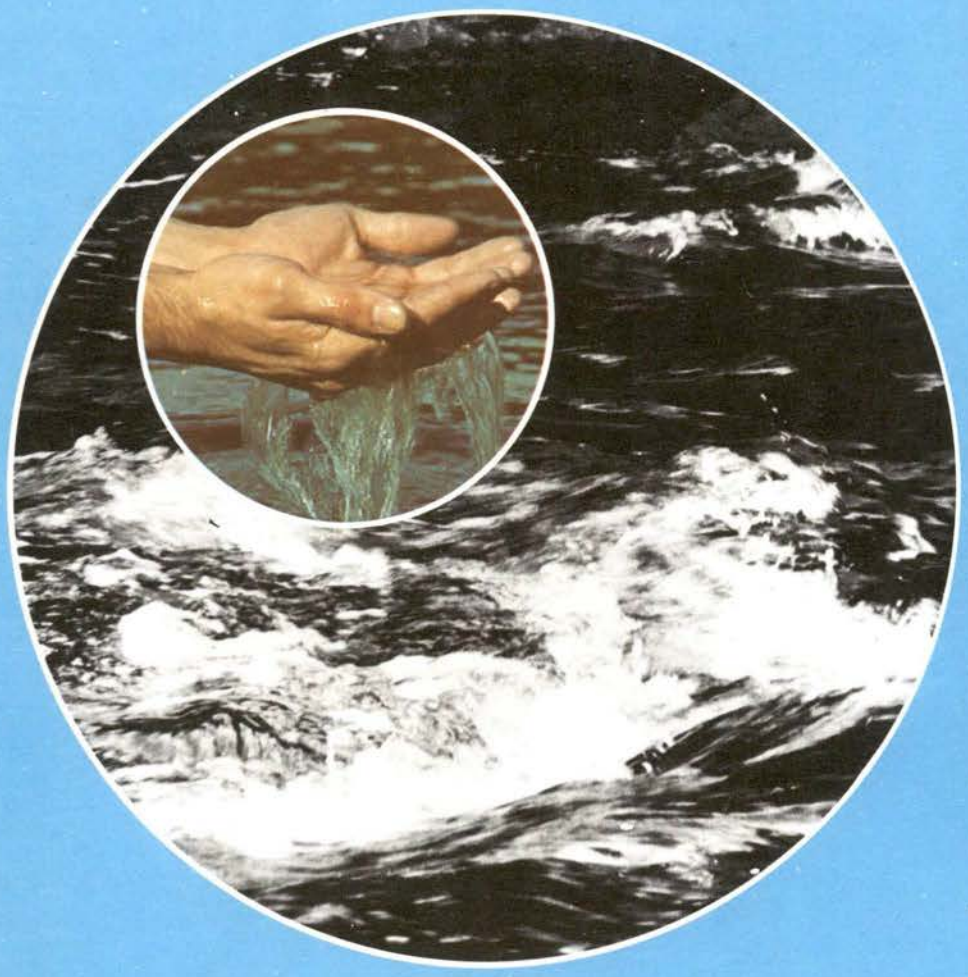
Fishes of the Saint John Estuary



Report No. 7a

The Saint John River Basin Board

REPORTS PREPARED FOR THE SAINT JOHN RIVER BASIN BOARD

1. Population and Economic Trends in the Saint John River Basin
2. Hydrology of the Saint John River Basin
3. The Flooding Problem in the Saint John River Basin
4. Water Quality in the Saint John River Basin
5.a Agriculture and Water Management in the Saint John River Basin—Vol. 1
5.b Agriculture and Water Management in the Saint John River Basin—Vol. 2
6. The Forest Industry and Water Management in the Saint John River Basin
7.a Fishes of the Saint John Estuary
7.b Sports and Commercial Fisheries of the Saint John Estuary
7.c Fishes of the Upper and Middle Saint John River
7.d Sports and Commercial Fisheries of the Upper and Middle Saint John River
7.e Fishery Management in the Saint John River Basin
8.a Wildlife Resources of the Saint John River Basin
8.b The Economics of Wildlife in the Saint John River Basin
9. Mineral Development and Water Management in the Saint John River Basin
10. Tourism and Outdoor Recreation in the Saint John River Basin
11. Outlook for the Potato Starch Industry in the Saint John River Basin
12. Manufacturing Industries and Water Management in the Saint John River Basin
13. Municipalities and Water Management in the Saint John River Basin
14. Electric Power and Water Management in the Saint John River Basin
15.a Phytoplankton of the Saint John River Headponds
15.b Summer Headpond Ecology in the Saint John River Basin
15.c Sludgeworms (Oligochaetes) as Indicators of Water Pollution in the Saint John River
15.d Zooplankton of the Saint John River Headponds
15.e Macrobenthos of the Saint John River Headponds
15.f Aquatic Ecology of the Saint John River—Volume 1
15.g Aquatic Ecology of the Saint John River—Volume 2
15.h An Ecological Survey in the Saint John Estuary
16. Toxic Pollutants in the Saint John River Basin
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S 2 The Water Resources of the Saint John River Basin
S 3 Floods in the Saint John River Basin
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S 7 Water Uses for Fisheries in the Saint John River Basin
S 8 Water Use for Wildlife in the Saint John River Basin
S 9 Water Use for Mineral Development in the Saint John River Basin
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FOREWORD

This study is one of a series commissioned by the Saint John River Basin Board as part of its program for preparing a water management plan for the Basin. A draft has been reviewed by members of the Board, its Advisory and Liaison Committee and Planning Office. The reviewers are satisfied that the work was conducted conscienciously by highly qualified people and that they have fulfilled their terms of reference. Although the report has been checked carefully for errors, inconsistencies and omissions, a few almost certainly remain. The Planning Office would appreciate hearing of them.

This is a report made to the Board, and the recommendations put forward in it are the author's own. Each recommendation will be carefully considered during the process of developing the comprehensive plan for the river basin. However, some recommendations made with the aim of improving conditions for one water use may not be compatible with needs of other uses. As the objective of the plan is to seek an optimum balance among all uses of the water resource, it is quite possible that the Board will not include in its final plan all the recommendations contained in this report. They are presented here, nevertheless, for public information and debate.

The Saint John River Basin Board,
Fredericton, New Brunswick,
November, 1973.

FISHES OF THE SAINT JOHN ESTUARY

A report prepared
for the
Saint John River Basin Board

by

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Halifax, Nova Scotia

December 1971

TABLE OF CONTENTS

INTRODUCTION

During the late summer and fall of 1971 (Aug 2-Oct 28) a survey of fishes in the Saint John River estuary (Fig 1) was carried out at a series of sampling stations between Reversing Falls and the head of tide at McKinley Ferry. (See TABLE NO 1) The survey was conducted using : (i) gillnets of various sizes set overnight on bottom; and (ii) shore seines operated manually in the littoral zone.[1] The entire circuit of stations was sampled 3 times. A wide variety of species (TABLE 1) was observed during this survey, ranging from purely marine through anadromous to purely freshwater forms, and thus reflecting the variety of conditions existing in the estuary.

The upper two-thirds of the estuary is entirely freshwater, while the lower one-third (the approximate boundary being at Evandale) is increasingly saline downstream as a direct result of incoming tides. This brackish water forms a surface layer of varying depth (5-20 meters) over the more saline deeper waters of both Long Reach and Kennebecasis Bay (Trites, 1960) .

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[1] It was orginally intended to supplement these methods by the use of an otter trawl and of a gang of drift nets. However, this gear was totally unproductive and extremely time-consuming when used on the initial circuit of sampling stations, and was not used in the balance of the survey.

In spring and summer this denser saline layer is much colder than the surface waters, while in fall and winter it is warmer (Trites, 1960). It is not inconceivable that a similar condition exists in the deeper portion of Belleisle Bay as well, although at the time of writing there was no evidence available to either justify or refute this speculation.

Typically freshwater species are encountered in the upper two-thirds of the estuary, while in the lower portion salinities of the order referred to above are apparently sufficient to allow at least periodic, if not permanent, invasions by some marine species. As well, in both types of environments, extremely seasonal concentrations of anadromous species occur, as they migrate to their spawning areas. Due to the timing of the survey, none of these principal spawning runs were encountered.

Two species are notable by their virtual absence from the catches: the Atlantic salmon, Salmo salar, and the striped bass, Morone saxatilis. It was felt that other ongoing programmes of the Resource Development Branch would provide sufficient information with respect to the Atlantic salmon. The experimental gear was thus designed so as not to entrap salmon, and as a consequence did not entrap striped bass, although it is known that both species are temporary inhabitants of the system.

The species encountered at the various sampling stations are tabulated in TABLE 1. This is followed by a catalogue of

all fish known to occur in the river - this catalogue is based on a thorough literature review[2] as well as the results of the current sampling programme. The catalogue takes the form of a summary of the characteristics of the main families encountered (i.e.: those families represented by species of common appearance in the estuary), followed by a detailed account of all species - this account includes comments on habitat type, relative abundance in the system, and other factors where pertinent. A special section deals with erroneous reports.

The classification arrangement used in this catalogue follows that used by Leim & Scott (1966) which is essentially the system proposed by C. Tate Regan (1929) of the British Museum of Natural History. Generic and specific names are based on the American Fisheries Society list (1970).

A more complete review of the development of freshwater ichthyology in the province of New Brunswick can be found in Scott & Crossman (1959), and an extensive bibliography of works on marine fishes of Eastern Canada is contained in Leim & Scott (1966).

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[2]In addition to academic journals, this review encompasses internal reports of the Resource Development Branch, and accumulated data which has not yet reached the report stage.

II. FAMILY SUMMARIES

FAMILY PETROMYZONTIDAE - the Lampreys

The lampreys are not "true" fishes, although they are fish-like in some respects, and they are the most primitive of living vertebrates. They have smooth skins rather than scales, and a skeleton comprised of cartilage rather than bone. Other characteristics distinguishing them from true fishes are the absence of: jaws, true teeth, and paired fins.

Lampreys are anadromous or freshwater, inhabiting temperate waters of the northern and southern hemispheres. The adults commonly are parasitic and present a threat to some fisheries.

FAMILY SQUALIDAE - the Dogfish Sharks

These are "true" fishes, which have a cartilaginous skeleton, but have true jaws and teeth, paired fins, and scales. There is no swim bladder present. They may easily be distinguished from other fish by the 5 to 7 separate gill slits located laterally immediately anterior to the pectoral fin.

These sharks have typically small, elongate, fusiform bodies, inhabit inshore waters, and are vicious carnivores.

FAMILY RAJIDAE - the Skates

Skates are very similar to sharks in many ways, but have some major differences: they are conspicuously flattened dors-ventrally, they have 5 pairs of gill slits on the lower surface, and the pectoral fin is attached to the side of the head to form a type of "wing".

These fish are bottom-dwellers in the relatively shallow waters of temperate and cool seas. They swim by graceful wave-like undulations of the broad pectoral fins, and feed on crustaceans and small fish.

FAMILY ACIPENSERIDAE - the Sturgeons

The sturgeons are extremely primitive fishes which are very similar to fossils laid down more than 100 million years ago. The body is elongate with five longitudinal rows of bony plates in addition to a bony skeleton, the head is covered with bony plates, the well-developed snout has four fleshy barbels in front of the mouth, and there are more fin rays in the fins than basal supports for these fin rays.

Sturgeons are found close to shore, in rivers, and in lakes in north temperate zones.

FAMILY CLUPEIDAE - the Herrings

The herrings are bony fishes with many distinctive characteristics: the fins are soft-rayed; pelvic fins are

abdominal; a swim bladder is present and is connected to the oesophagus by an open duct; the scales are large, deciduous, and cycloid; there is no lateral line; the body is laterally compressed; there is no adipose fin; the caudal fin is deeply forked; and teeth are small or absent.

These fishes are mainly marine and usually occur in immense schools near the surface in coastal waters. They are all plankton feeders. Herrings form by far the major portion of the commercial fishing catch in the Maritime provinces. (ranking 1st in landed wt. (56.9%) and 4th in landed value (11.6%) in 1968)

FAMILY SALMONIDAE - the Salmon, Trouts, Chars and Whitefishes

This family is very similar to the herrings in many aspects, but some significant differences exist: there is an adipose fin on the back; the pelvic fin has an axillary process; the caudal fin is not deeply forked; the body is robust, much less laterally compressed than the herrings; most have well-developed teeth; and there is a well-developed lateral line.

This important sport and commercial group of cold water inhabitants is widely distributed throughout both fresh and salt waters of the northern hemisphere. Very often the whitefishes are considered as a separate family, the Coregonidae.

FAMILY OSMERIDAE - the Smelts

The smelts are similar in most respects to the Salmonids, but do not have a pelvic axillary process.

The smelts are small marine or anadromous fishes and are distributed around the northern hemisphere.

FAMILY ESOCIDAE - the Pikes

The pikes are a group of bony fishes also having soft-rayed fins, abdominal pelvic fins, cycloid scales, and a lateral line. They may be distinguished from other fish with the same characteristics by some unique features: the snout and top of the head is flattened; the jaws are elongated and have large, strong teeth; the dorsal fin is in an extreme posterior position, opposite and equal to the anal fin.

They are strictly freshwater fish, confined to Eurasia and America. They occur in warm as well as cold water, where they feed voraciously on all types of fish. The smaller members of the group are known as "pickerel".

FAMILY CATOSTOMIDAE - the Suckers

The suckers are bottom-dwelling forms found only in the freshwaters of North America and Eastern Asia. They derive their name from a protrusible sucking mouth and fleshy lips - as well the fins are soft-rayed, the scales cycloid, there is no adipose fin, and there is a single dorsal

fin. While the jaws are toothless, a comb-like row of many fine teeth has developed on the last gill arch, apparently for straining food. Another distinctive feature of this group is the presence of a Weberian apparatus, a complex modification of the first four or five vertebrae, with a chain of small bones on either side connecting the front end of the double-chambered gasbladder to the inner ear in the skull. Its purpose may be sound or pressure detection.

Suckers inhabit both rivers and lakes, where they feed mainly on microscopic life or planktonic plants and animals. They are a food source for larger predaceous fishes.

FAMILY CYPRINIDAE - the Minnows

The minnows are very similar to the suckers in most respects - they have the Weberian apparatus, toothless jaws, cycloid scales, a single soft dorsal fin, and no adipose fin. However, they do not exhibit the same fleshy lips, and the pharyngeal teeth are further developed. They may be hooked for tearing or blunt for grinding, and are in 1 to 3 rows on each side. They bite against a bony pad at the base of the skull.

The Cyprinids constitute the largest family of fishes in the world, and may occur in great variety, but North American minnows are relatively uniform. They are small in size, and are forage for carnivorous species.

FAMILY ICTALURIDAE - the Freshwater Catfishes

The catfishes also share as a character the Weberian apparatus. They have an adipose fin, and the body is covered by a smooth, tough skin rather than by scales. The body is generally short and thickset, and the dorsal and pectoral fins have strong sharp spines at their leading edges.

These fish are entirely freshwater, living in warm weedy lakes and rivers. They are nocturnal in habit.

FAMILY ANGUILLIDAE - Freshwater Eels

The eels are characterized by: elongate body shape; soft-rayed fins; absence of pelvic fins; long dorsal and anal fins continuous with the candal fin. While most eels have no scales, the freshwater family does have cycloid scales.

The Anguillidae are catadromous - that is, they spawn in the sea but live the major part of their lives in freshwater. There are two species in the North Atlantic, only one of which enters North American waters.

FAMILY CYPRINODONTIDAE - the Killifishes

These small fishes are soft-rayed, with abdominal pelvic fins, no lateral line, a posterior dorsal fin, a rounded or squared caudal fin, cycloid scales, and a swim bladder without a duct to the gut. They are adapted to surface feeding and have flattened heads and snouts, with

oblique mouths.

This family occurs in fresh, brackish and marine waters from tropic to temperate zones.

FAMILY GASTEROSTEIDAE - the Sticklebacks

These small fishes are aggressive, fusiform, spiny-rayed fishes, lacking scales but usually having bony plates along the sides and on the slender caudal peduncle. The pelvic fins, which are thoracic in position, have a sharp strong spine, as do the anal and dorsal fins, the dorsal being preceded by a number of such spines. They have ductless swim bladders.

The breeding behavior of this family is unusual - the male builds a nest to which he entices the female with a courtship ritual; he then guards the nest until the young emerge.

The sticklebacks are restricted to the cool waters of the northern hemisphere, where they exhibit a wide range of salinity tolerance.

FAMILY GADIDAE - the Cods

The cods are soft-rayed fishes with 2 or 3 dorsal fins, and 1 or 2 anal fins. The pelvic fins are jugular and may be filamentous, and the caudal fin may not always be distinct from the dorsal and anal fins. Cods have small cycloid scales, and often there is a small barbel on the chin.

These predaceous fishes occur primarily in cool waters of northern seas, and are abundant in the shallow waters of the continental shelves where they contribute immensely to the commercial fisheries (12.4% of landed wt. and 11.6% of landed value in the Maritimes, 1968).

FAMILY PERCICHTHYIDAE - the Temperate Basses

These are spiny-rayed fishes, the pelvic fins being thoracic with one spine and five soft rays, the dorsal fin divided into two with the first one spiny and the second soft-rayed, the anal fin with 3 spines, and the caudal fin having 17 soft rays. The scales are ctenoid, the lateral line is well-developed, and the body laterally compressed.

This family inhabits coastal waters of temperate seas, although it is not exclusively marine. They are predaceous fishes which provide both commercial and sporting benefits.

FAMILY CENTRARCHIDAE - the Sunfishes

Sunfishes are laterally compressed spiny-rayed fishes with a dorsal fin of spiny and soft-rayed portions, usually joined, anal fin with 3 to 6 spines, and thoracic pelvic spines. Scales are ctenoid, and there is a prominent lateral line. Like the sticklebacks, the male builds a nest and protects the young aggressively for a time.

These fish are strictly freshwater and are native to warm lakes and rivers of North America, where they are predators on other fish.

FAMILY PERCIDAE - the Perches

This is a family of elongate, spiny-rayed fishes having: two distinct dorsal fins, the first one spiny; an anal fin with 1 or 2 spines; thoracic pelvic fins; ctenoid scales; and a lateral line usually present.

All members of the family are predaceous, and live in freshwater only in North America and Eurasia. They are of considerable economic importance in some areas.

FAMILY ATHERINIDAE - the Silversides

A family of small, slender, silvery fishes, this spiny-rayed group has abdominal pelvic fins with one spine and five soft rays, pectoral fins elevated on the sides, and the spiny and soft-rayed dorsal fins widely separated.

These small carnivorous fish live in salt and fresh waters of tropic to temperate zones.

FAMILY COTTIDAE - the Sculpins

The cottids are among those spiny-rayed fishes which have a distinctive bony modification of the cheek. They have broad, flat heads often dotted with spines, and have large, fan-like pectoral fins. There is a spiny and a soft-rayed dorsal fin, and often the pelvic fin is reduced. The body may be prickled, plated, scaled, or naked.

The family is primarily marine, in cooler seas of the northern hemisphere, but many species have invaded

freshwater. They are bottom dwellers, are carnivorous, and act as forage for other fishes.

FAMILY PLEURONECTIDAE - the Flatfishes

These fishes, the flounders, are closely related to the spiny-rayed fishes but are strongly compressed and have long, well-developed soft-rayed dorsal and anal fins. The body is asymmetricial in that it lies on its left side, with the uppermost right side being pigmented and bearing both eyes.

Flounders are essentially bottom-living fishes of continental shore waters, and are widely distributed in tropical and temperate seas, where they lead a carnivorous existence. Some flounders contribute substantially to commercial fisheries.

There were representatives of several other families encountered, both in the sampling programme and in the literature review. However, these were never of sufficient frequency to warrant inclusion as regular inhabitants of the system, and thus they are not treated in depth. These families are: Syngnathidae, Stromateidae, Scorpaenidae, Cyclopteridae, and Lophiidae.

III. SPECIES ACCOUNT

FAMILY PETROMYZONTIDAE - the Lampreys

Petromyzon marinus - sea lamprey

This species is anadromous, primarily a coastal species, but can landlock. It has been well documented throughout the estuary, and although none were seen during the present survey, many lake whitefish (*Coregonus clupeaformis*) showed fresh lamprey scars, thus attesting to their considerable presence.

FAMILY SQUALIDAE - the Dogfish Sharks

Squalus acanthias - spiny dogfish

The spiny dogfish is essentially a marine species, with seasonal appearances only in Canadian waters. It has been recorded in Kennebecasis Bay by Huntsman (1922) and Squires (1967), who calls it a regular inhabitant of the area. It is also a rare visitor as far upstream as Westfield on the Saint John River (Gorham, 1970). None were caught in the present survey.

FAMILY RAYIDAE - the Skates

Raja ocellata - winter skate

This skate is an inshore marine species which has been reported only once in the system, in Kennebecasis Bay by Huntsman (1922).

Raja radiata - thorny skate

A marine skate, this species has been recorded from the lower Kennebecasis by Gorham (1970).

Both Trites (1960) and Squires (1967) list skates as being inhabitants of Kennebecasis Bay, but the species is not identified in either case. Neither species was seen during the present survey.

FAMILY ACIPENSERIDAE - the Sturgeons

Acipenser brevirostrum - shortnose sturgeon

This species is typically anadromous, although all Canadian records are from freshwater (Leim & Scott, 1966). They are common in the Saint John River (Scott & Crossman, 1959; Trites, 1960; Squires, 1967; MacDonald, 1968; Smith, 1969; Gorham, 1970) and were found in both freshwater and brackish portions of the estuary during this survey. Previous records indicate a maximum size of 3 ft., but specimens up to 4 ft. in length were observed.

Acipenser oxyrhynchus - Atlantic sturgeon

The Atlantic sturgeon is generally regarded as an anadromous fish, entering rivers to spawn in May and June. However, it was present in the river throughout the sampling period, and thus may be a permanent freshwater dweller. It is found to the head of tide in the river, and is common throughout the estuary (see references above).

Both these species are fished commercially in the Glenwood area on Long Reach, and are lumped under the single heading of "sturgeon" in the commercial catch statistics issued by the DOMINION BUREAU OF STATISTICS. It is likely that the shortnose sturgeon constitutes an insignificant portion of this catch, however, since only those fish longer than 4 ft. in length are legally retainable.

FAMILY CLUPEIDAE - the true Herrings

Alosa aestivalis - blueback herring

This anadromous species has been reported from the Brown's Flat area by Gorham (1965), and one specimen was caught at Westfield during the present survey. Probably it is an infrequent visitor to the estuary, although it may be more plentiful in the spring during spawning time.

Alosa pseudoharengus - alewife

The alewife, or gaspereau, is an anadromous herring which may easily become landlocked, although the Saint John population returns to sea after spawning, with the juveniles following within six months. The present study indicates that there are permanent residents in the brackish water of the lower estuary. The alewife is the basis of a major commercial fishery in the estuary during the spring spawning run, a fishery which has increased markedly since the construction of Mactaquac Dam.

The superficial distinction between bluebacks and alewives is indistinct, and the blueback may be far more common than is suspected. In fact, Day (1959) speculates that the middle and late spawning runs are predominantly bluebacks, although both species are listed as "gaspereau" in commercial catch statistics.

Alosa sapidissima - American shad

Another anadromous herring, this fish is present throughout the estuary in the spring, when it is exploited by both commercial and sport fishermen. While little is presently known of the biology of this species in the Saint John, it is the subject of a post-graduate research project.

Brevoortia tyrannus - Atlantic menhaden

This typically marine species, although reported from Saint John harbour by Perley (1852), has been considered rare in this area (Leim & Scott, 1966). A recent report (Gorham, 1970) of its occurrence in the Saint John as far as fifteen miles above the mouth is substantiated by the present survey.

Clupea harengus - Atlantic herring

A typically marine herring, this species may appear inshore at certain times of the year, although it is a rare visitor to the estuary. Two specimens were caught in Kennebecasis Bay during the present survey.

FAMILY SALMONIDAE - Salmon, Trouts, Chars, and Whitefishes

Coregonus clupeaformis - lake whitefish

The lake whitefish is a typically freshwater species, but it has been reported from marine environments at Black's Harbour, N. B. (Leim & Day, 1959) and inshore James Bay and Ungava Bay. It has been recorded in the lower Saint John frequently (Perley, 1852; Cox, 1893, 1896; Scott & Crossman, 1959; Gorham, 1965, 1970; MacDonald, 1968; Smith, 1969) and in Kennebecasis Bay (Trites, 1960). The present study indicated no whitefish in the river during the summer months, but showed a sudden influx of whitefish in late September and October into both the river and the Grand Lake and Washademoak tributaries. (It has previously been reported from Grand Lake by Perley, 1852). This was definitely a spawning run, but the source of the fish is a mystery. Cox (1893) speculated that these fish were a sea-run population, but as yet there is no evidence to support this. In fact, records from experimental trap nets fished at Westfield indicate that very few whitefish move through that particular area. This suggests that the fish reside elsewhere in the estuary.

That portion of the spawning run which bred upstream from Mactaquac Dam has been effectively decimated by the destruction of suitable spawning habitat since construction of the dam.

Salmo salar - Atlantic salmon

This most popular of anadromous fishes was still, despite heavy depletion of stocks, the major commercial fish in the river until this year. It is still unrivalled as a sport fish. The insults to the salmon resource in the Saint John have been summarized by Dominy (1971), and the major portion of the efforts of the Resource Development Branch (of the Dept. of the Environment, Fisheries Service) has been directed towards minimizing the impact of these insults.

Salvelinus fontinalis - speckled trout

This species is primarily a freshwater fish, although sea-run populations are common on the east coast. It is generally found in cool, clear streams and lakes, and thus was not observed in the current survey. Its presence in the Saint John watershed is well documented, however, (Gorham, 1965, 1970; Hyatt, 1969; Semple, 1971) and it is a prime sport fish in its typical habitat.

FAMILY OSMERIDAE - the Smelts

Osmerus mordax - Rainbow smelt

The rainbow smelt is an anadromous species having an inshore marine habitat, and freshwater populations are common. The present survey realized smelt only in the brackish water portion of the estuary, where the species attracts a considerable winter sport fishery. Smelt ascend the river in early spring to spawn.

FAMILY ESOCIDAE - the Pikes

Esox niger - chain pickerel

This species, a smaller member of the pike family, is entirely freshwater, inhabiting quiet, weedy waters of lakes, rivers and streams. It is extremely predaceous on all manner of fish, including its own kind. Originally introduced to New Brunswick, it has spread to much of the Saint John River estuary (Catt, 1949; Scott & Crossman, 1959; Gorham, 1965, 1970; MacDonald, 1968; Zitko et al, 1971) and was caught throughout the freshwater portion of the sampling area. While it is considered a game fish in the more southerly portion of its range, it is only fished lightly in this area. It also contributes very slightly to the commercial fishery.

FAMILY CATOSTOMIDAE - the Suckers

Catostomus catostomus - longnose sucker

This freshwater fish is common in the upper Saint John but is only rarely seen in the estuary. It has been recorded at Brown's Flat by Gorham (1965), and one was caught in Grand Lake in the present survey.

Catostomus commersoni - white sucker

The white sucker is found in the shallow waters of freshwater lakes and rivers, and frequents the bottom where it feeds. Its presence throughout the freshwater portion of the estuary is thoroughly documented, beginning with Perley (1852), and it was shown to be very abundant in the same area by this survey. The species has no commercial value at present, and is not known as a sport fish.

FAMILY CYPRINIDAE - the Minnows

Couesius plumbeus - lake chub

This minnow frequents lakes and rivers, where it may be a forage fish. Although Gorham (1970) claims that it is common throughout the province, Scott & Crossman (1959) found it only in the upper portion of the Saint John, and only a few were caught during the present survey (these in Grand and Washademoak Lakes). It is occasionally sold as a bait minnow.

Notemigonus crysoleucas - golden shiner

The golden shiner inhabits warm weedy lakes and the slower moving water along river banks. This fish was plentiful throughout the freshwater portion of the estuary, and one was caught in the brackish water of Kennebecasis Bay. An ideal forage fish, this minnow is probably the most common bait minnow in New Brunswick.

Notropis cornutus - common shiner

This species is predominantly a stream species, but does occur in lakes. It is widely distributed in the Saint John watershed (Scott & Crossman, 1959), and was caught throughout the freshwater portion of the estuary, and on one occasion several were netted at Westfield in brackish water. It is an important forage fish and bait minnow.

Notropis heterolepis - blacknose shiner

The blacknose shiner occurs in weedy and sandy shallows of lakes. It has a spotty distribution in the province (Gorham, 1970) and was seen only at one site in the present survey. It is an important forage fish where abundant, and is frequently sold as a bait minnow.

Phoxinus eos - northern redbelly dace

This species prefers acid waters of bog lakes, streams and beaver ponds, where it is a prime forage fish for speckled trout. Although it was not caught in this survey, it has been attributed to the area by Scott & Crossman (1959) and Gorham (1970).

Phoxinus neogaeus - finescale dace

The finescale dace is found in bog lakes, streams and lakes, usually in association with the redbelly and pearl daces. This species has a spotty distribution in the province, and although Scott & Crossman (1959) record it from the lower Saint John, it was not collected during this survey.

Rhinichthyes atratulus - blacknose dace

The blacknose dace occurs in cool, clear streams where it is an important forage fish for speckled trout. No specimens were collected, but its presence in the smaller tributaries of the system has been thoroughly attested to

(Scott & Crossman, 1959; Gorham, 1965, 1970; Hyatt, 1969; Semple, 1971). In fact, this minnow is probably the commonest and most abundant species in New Brunswick.

Semotilus atromaculatus - creek chub

This fish inhabits clear streams rather than lakes, where it provides excellent forage for the speckled trout. However, this benefit is balanced by the fact that it preys upon, and competes with, young trout. It is successfully used as a bait minnow.

The creek chub was not seen in the course of this survey, but it is listed as common by both Scott & Crossman (1959) and Gorham (1970).

Semotilus corporalis - fallfish

This species, the largest of the native minnows, is usually found in eddies at the foot of falls and rapids, although it also occurs in lakes. It feeds primarily on insects and other fish, and thus is a predator upon and a competitor with the speckled trout, with which it is associated.

It is widely distributed in New Brunswick (Scott & Crossman, 1959; Gorham, 1970) and was caught in French, Grand and Washademoak Lakes, as well as the Saint John River at Oromocto, during the current survey.

FAMILY ICTALURIDAE - the Catfishes

Ictalurus nebulosus - brown bullhead

This freshwater catfish frequents quiet, weedy, mud-bottomed lakes, ponds, and slow-flowing rivers. It is hardier than most fish, and can tolerate such adverse conditions as high temperatures and low oxygen. It feeds mainly on aquatic insect larvae, crayfish, molluscs, snails, and plant material, and only occasionally on other fish. An extremely tasty flesh makes it a prized catch in some areas of North America, but there is no interest locally.

While it was caught only in French Lake during the present survey, it exists in shallower waters of the estuary (Perley, 1852; Gorham, 1965; MacDonald, 1968; Smith, 1969).

FAMILY ANGUILLIDAE - the freshwater Eels

Anguilla rostrata - American eel

This catadromous species is abundant throughout the estuary, where it feeds on such fish as shiners and chubs. Recent studies in the upper Saint John indicate little eel predation on salmonid frey, but there are reports of such predation in other areas (Elson, 1941; Godfrey, 1957). While very few were actually caught in this survey (due to the type of gear used, through which eels pass easily) there was ample evidence of their presence.

Eels form the basis of a considerable commercial fishery on the Saint John, which has expanded rapidly and dramatically over the past two years and has overtaken the Atlantic salmon in total value.

FAMILY CYPRINODONTIDAE - the Killifishes

Fundulus diaphanus - banded killifish

This species is essentially freshwater, but is euryhaline and is known to occur in brackish water as well. It inhabits shallow, weedy waters in rivers and in the bays of lakes, and is frequently near the surface in large schools. It is an important forage fish and an excellent bait minnow.

The banded killifish was distributed throughout the estuary in this survey.

FAMILY SYNGNATHIDAE - the Seahorses and Pipefishes

Syngnathus fuscus - northern pipefish

This is a strictly marine species which may move into brackish water. It lives amongst seaweed and eelgrass in warm-water coastal areas and inlets. This fish has been reported from the estuary, that report based on two specimens taken at Public Landing, Kings Co., 18 miles from the mouth of the Saint John (Squires & Gorham, 1967).

FAMILY GASTEROSTEIDAE - the Sticklebacks

Apeltes quadracus - fourspine stickleback

This stickleback is essentially marine, but common in brackish water, and can occur in freshwater. It is known from Kennebecasis Bay and the lower Saint John River (Cox, 1923; Gorham, 1965, 1970) and was found in the middle third of the estuary during this survey, its distribution extending from the upper brackish water region into the lower fresh water region.

Culaea inconstans - brook stickleback

The brook stickleback is primely freshwater, found in the weedy portions of streams, pools and small bog lakes. It may occasionally be eaten by other fish, but it is not important as a forage fish. Although recent records are scarce, and none were seen in the present survey, Cox (1896) noted that it was not uncommon on the lower Saint John. White (1953) lists it as rare for the province, while Gorham (1970) gives it a spotty distribution.

Gasterosteus aculeatus - threespine stickleback

This species is a shore species which is at home in both fresh and salt water. In the present survey this fish seems to be confined to the brackish water portion of the estuary, where it was previously recorded by Huntsman (1922) and Gorham (1965).

Pungitius pungitius - nine-spine stickleback

The nine-spine stickleback is found in both freshwater and marine environments, in open water as well as along weedy shorelines. It may be a substantial forage fish for such species as brook trout, yellow perch and burbot. Smith (1935-1937) reports it from Stephenson's Pond near Loch Lomond, St. John Co., and Gorham (1970) notes that it is widely distributed in inner coastal waters and extends into some freshwater rivers and lakes. While no specimens were collected in the regular survey, one was taken at McKinley Ferry, just downstream from Mactaquac Dam, in some incidental catches made earlier in the year.

FAMILY GADIDAE - the Cods

Gadus morhua - Atlantic cod

This typically marine species has been recorded in the lower Kennebecasis by Trites (1960) and by Squires (1967) who designated it as a regular inhabitant of that body of water. Gorham (1970) notes that it has been taken there only during the winter. No cod were taken during the present survey.

Lota lota - burbot

This is the only freshwater species of the cod family. It frequents deep inland lakes, where it can find cool water, and large rivers. The burbot is carnivorous and is highly predaceous on smaller fish of all sorts. It is common in the Saint John, according to early authors (Perley, 1852; Adams, 1873; Cox, 1893) but only recently has it been well documented. Hyatt (1969) records it in the Keswick and Kennebecasis Rivers, MacDonald (1968) in the main stem at Springhill, and Gorham (1965) at Brown's Flat. The present survey found this species in the main stem at Gagetown and at Hampstead, but they were not plentiful. The burbot was also observed amongst gaspereau catches taken in French Lake during June.

Despite having a delicately flavoured white flesh, this fish arouses little interest as a sport fish.

Microgadus tomcod - Atlantic tomcod

This cod is an anadromous species frequenting coastal marine and brackish waters, and ascending rivers during the winter to spawn. It may prey on young smelt and striped bass. A small fish (maximum length 15"), it has some commercial value as animal food in northern New Brunswick, but it is not plentiful enough in the Kennebecasis and in Long Reach where it occurs, to be fished. The tomcod is the object of a winter ice fishing in the St. Lawrence, and probably is taken locally during the smelt ice fishing.

Urophycis chuss - red hake

This marine fish is common in the lower Saint John and in Kennebecasis Bay, where it is fished through the ice in winter. The red hake feeds on a variety of small fish and crustaceans.

Catches during this survey coincide with published reports of its distribution (Huntsman, 1922; Trites, 1960; Squires, 1967; Gorham, 1970).

This species is sometimes distinguished from the white hake, Urophycis tenuis, but as there is complete intergrading of the characters used to distinguish them, in Canadian waters at least, they are considered as one species (see Leim and Scott, 1966).

FAMILY PERCICHTHYIDAE - the temperate Basses

Morone americanus - white perch

The white perch is considered to be an anadromous fish, but its marine distribution is always close to the mouths of rivers. It can, and frequently does, become landlocked. It feeds on aquatic insects and small fishes such as smelt, yellow perch, elvers, and its own young (Thoits, 1958). Stomach examination of fish caught locally showed a heavy reliance upon juvenile alewives.

The white perch has been reported in the Saint John watershed from Fredericton downstream (Perley, 1852; Cox, 1896) and more recently from Springhill (MacDonald, 1968) and Brown's Flat (Gorham, 1965). It was caught throughout the freshwater portion of the estuary in the present survey, and has appeared in experimental trap nets at Westfield, where brackish water prevails. Although the white perch disappeared from catches in the main stem in late fall, it persisted in Grand Lake, which seems to sustain a sizable permanent population.

This fish reaches a size of approximately 9", and at this size it makes an excellent pan-fryed fish. There does not seem to be much interest in it locally as a sport fish, however.

Morone saxatilis - striped bass

The striped bass is also an anadromous species, moving upriver from its coastal habitat in spring and early summer to spawn near the head of tide. The species is euryhaline, however, and may spend prolonged periods in fresh water. A voracious feeder on small fish and invertebrates, it commonly reaches weights of twenty pounds and more, and a seventy-five pound fish has been taken from the Saint John River.

"Stripers" have been well known in the area for some time (Cox, 1896) and their distribution throughout the Saint John estuary has been carefully itemized by Wilson (1958). Raney (1952) speculated that the striped bass in Grand Lake constituted an endemic population. The species has been reported in large numbers at tidehead as recently as 1968 (MacDonald), and Ballance (1969) reported good fishing for striped bass in Grand Lake. There is a substantial commercial fishery for striped bass in Belleisle Bay during the winter months (Dec-Feb), and it is a highly-prized sport fish as well. The species was very scarce in the estuary this past year, however, with the Westfield experimental facilities and the Mactaquac fish-passage facilities reporting only 16 and 13 fish, respectively. The commercial fishery to date has also been much lower than normal. Such extreme fluctuations in abundance have occurred frequently in the past (Merriman, 1941) and have been variously attributed to changes in migratory patterns, over-fishing, and increased

pollution (see Bigelow & Welsh, 1925; Merriman, 1941; Raney, 1952).

At present, the biology of this fish in the Saint John is the subject of a post-graduate research programme which may be expected to reveal more details about its habits in the estuary.

FAMILY CENTRARCHIDAE - the Sunfishes

Lepomis auritus - redbreast sunfish

This colourful freshwater fish grows to an average size of six inches, on a diet of insects, small fishes and molluscs, and makes a good pan-fried fish where available.

Due to some confusion over nomenclature among early New Brunswick ichthyologists, initial records of this species are meaningless (see Scott and Crossman, 1959). It has been reported from only a few locals in the lower Saint John drainage recently (Scott and Crossman, 1959; Gorham, 1970; Zitko et al, 1971). None were seen in the present study.

Lepomis gibbosus - pumpkinseed

The pumpkinseed inhabits weedy ponds, lakes and slow-flowing rivers. It is very similar to the redbreast, but may average slightly larger, and thus be slightly more satisfying as a pan-fried fish.

It has been recorded in the Saint John estuary by Gorham (1970). During the present survey it was taken throughout the freshwater portion of the estuary, and a single specimen was netted in slightly brackish water at Glenwood. Gorham (1965) also reports it in this area.

Micropterus dolomieui - smallmouth bass

The smallmouth, often called the black bass, thrives in clear, rocky lakes having depths in excess of twenty-five feet, with rocky or gravelly shoals and sparse aquatic vegetation. It feedson crayfish and other fish, and commonly reaches a size of 1½ to 2 pounds. The smallmouth is a superb sport fish, offering both a rewarding battle and an excellent meal. At this time, however, there does not seem to be much local interest.

The species is not a native fish, but spread through southern New Brunswick as a result of original plantings in Maine. A detailed account of this introduction is given by Smith (1942) and Catt (1949).

It has been reported recently from the Kennebecasis River (Catt, 1949), the Hammond River (Wilson, 1958) and the mainstem at tidehead (MacDonald, 1968). The present survey showed only one specimen, from the main stem at Oromocto, while three were caught earlier at McKinley Ferry in some preliminary work. However, this low catch is probably not a true reflection of the relative abundance of the species, but rather a reflection of the bass' ability to avoid gillnets. Another type of gear might be expected to catch greater numbers.

FAMILY PERCIDAE - the Perches

Perca flavescens - yellow perch

The yellow perch is essentially a lake fish, often found in ponds and quiet streams as well, where it feeds on insects, crayfish and small fish.

This species has a widespread range throughout the province (Perley, 1852; Cox, 1896), but few positive records exist. Recent reports indicate that it is well-established throughout the system (Gorham, 1965; MacDonald, 1968; Zitko, 1971) and it was caught in the entire freshwater portion of the estuary during this survey.

The yellow perch can mature at a very small size, depending upon local conditions, but when it reaches a size of eight inches it is a good sport fish and makes excellent eating. It is, however, ignored by local sport fishermen.

FAMILY STROMATEIDAE - the Butterfishes

Peprilus triacanthus - butterfish

This marine fish has been taken upriver as far as Westfield (Gorham, 1970) but it is by no means common, and was not seen in the present survey.

FAMILY ATHERINIDAE - the Silversides

Menidia menidia - Atlantic silverside

This marine silverside occurs in large schools close to shore and in brackish water. When plentiful, it is a food source for the striped bass, and it has been used as live food for trout in hatcheries.

The Atlantic silverside has been recorded in Kennebecasis Bay (Huntsman, 1922) and in Long Reach at Brown's Flat (Squires & Gorham, 1967). It was collected in both of these areas during the current study.

FAMILY SCORPAENIDAE - the Rockfishes

Sebastes marinus - redfish (ocean perch)

This marine fish is usually found in cold water down to a depth of 160 fathoms. It has been recorded in Kennebecasis Bay by Trites (1960), but is an occasional visitor only.

Sebastes mentella - deepwater redfish

The deepwater redfish is found in seas of 160 fathoms or more. It was reported in Kennebecasis Bay at Millidgeville by Squires & Gorham (1966), but the presence of only one specimen indicates that it is very rare here.

FAMILY COTTIDAE - the Sculpins

Cottus cognatus - slimy sculpin

This sculpin is found in freshwater, in lakes and cool rocky streams. It is often found in association with speckled trout, for which it is an important food source, and for which it is often used as live bait.

There are few reports of this fish in the Saint John estuary, although it is probably quite common. Gorham (1965) found it in tributary streams to the mainstem at Brown's Flat, and Hyatt (1969) recorded it in the Kennebecasis, Keswick, and Nashwaak river systems.

FAMILY CYCLOPTERIDAE - the Lumpfishes and Snailfishes

Cyclopterus lumpus - lumpfish

The lumpfish is a marine bottom dweller, which is common along the coast. It has been taken in Kennebecasis Bay and in Long Reach at Public Landing (Squires, 1967) but it is not common.

FAMILY PLEURONECTIDAE - the Righteye Flounders

Hippoglossus hippoglossus - Atlantic halibut

This typically marine fish has been recorded only once from the estuary, in Kennebecasis Bay at Drury Cove (Squires, 1967).

Limanda ferruginea - yellowtail flounder

The yellowtail flounder is common in marine environments at 20 to 40 fathom depths. There are no apparent records in the Saint John, and according to Gorham (1970) this species is rare in the Bay of Fundy.

The yellowtail flounder was caught in Kennebecasis Bay and in Grand Bay at Westfield.

Both Trites (1960) and Squires (1967) refer to flounders caught in Kennebecasis Bay, but neither author identified the species in question.

FAMILY LOPHIIDAE - the Goosefishes

Lophius americanus - monkfish

The monkfish is a marine fish which dwells on bottom and has been reported at depths of 365 fathoms. It is common in the Bay of Fundy, and has been reported from the lower Saint John by Squires (1967). However, this report is based on one cadaver which apparently was not seen by the author.

IV. ERRONEOUS REPORTS

ERRONEOUS REPORTS

There have been many cases in the past in which specimens have been misidentified, or in which, through confusion in nomenclature, it has been impossible to determine which species is actually under discussion. Such reports have been treated in detail by Scott and Crossman (1959), and will not be repeated here.

However, there are some recent instances in which Dept. of the Environment - Fisheries Service - Resource Development Branch technical personnel, through no fault of their own, have misidentified certain specimens and included them in their project summaries.

Alosa mediocris - hickory shad

This marine fish has been recorded as a result of misidentification. The fish in question is actually the Atlantic menhaden, Brevoortia tyrannus (see page 19). The true hickory shad has only been recorded once from Canadian waters, in the mouth of the Bay of Fundy near Campobello Island (Perley, 1852), although this record is doubted by Huntsman (1922). The extreme northern limit of its range is the Gulf of Maine, where it is extremely uncommon (Bigelow & Schroeder, 1953).

Dorosoma cepedianum - gizzard shad

This fish, a freshwater member of the CLUPEIDAE family,

does not occur in the Maritimes, but is known in eastern North America from Cape Cod to Mexico, and is a permanent resident throughout the Mississippi valley (Jordan and Evermann, 1896). It is also found in the lower and, more recently, the upper Great Lakes (Scott, 1967). The fish which has created this confusion is the lake whitefish, Coregonus clupeaformis, locally known as the "gizzard fish" because of the thickened muscular wall of the stomach, a character which is shared by the gizzard shad.

In addition to these errors, a systematic confusion has occurred in Dom. Bur. Stat. Rept. for the province of New Brunswick, and as a result in the Canadian Summaries as well. This confusion is a result of two vastly different fishes carrying the same common name.

In Eastern Quebec, Ontario, and western Canada, the yellow pike-perch, Stizostedion vitreum, is also known as "pickerel". This species, a member of the perch family, constitutes a sizable sport and commercial fishery in these areas, and has been listed under the heading of "pickerel" in the D.B.S. reports. In eastern Canada, the chain pickerel, Esox niger, a smaller member of the true pike family, is also known as "pickerel", and forms the basis of a small commercial fishery in some areas. It has been recorded under the same heading of "pickerel" by D.B.S., without any attempt being made to distinguish between the two species.

V. GLOSSARY

GLOSSARY

abdomen - the lower surface of the body between the pectoral fins and the anus.

adipose fin - a small fleshy rayless fin on the back between the dorsal and caudal fins.

axillary process - a triangular scale-like projection lying in the angle between the base of the pectoral or pelvic fin and the body.

barbel - a slender flexible projection near the mouth, usually provided with touch or taste receptors.

caudal fin - tail fin.

ctenoid - scales bearing teeth or prickles on the exposed posterior margin.

cycloid - oval or smoothly rounded scales having no prickles or teeth.

deciduous - easily shed.

dorsal fin - the fin or fins on the back bearing spines or rays.

euryhaline - able to tolerate a wide range of osmotic pressures in the environment; a fish that can move freely from a salt to a freshwater environment, or vice-versa.

fusiform - spindle-shaped; referring to the form of fishes which have the body tapering both anteriorly and posteriorly, and slightly or not at all compressed.

gill arch - the V-shaped bony supports bearing the gills and gill rakers.

jugular - pertaining to the throat: said of the pelvic fins when located in advance of the point of attachment of the pectorals.

lateral line - a sensory system on the side of the body usually consisting of a canal below the skin that opens to the surface through pores.

oesophagus - part of the gut between the pharynx and the stomach.

pectoral fin - paired fins either close behind or below the gill openings, corresponding to the forelimb of a mammal.

peduncle - the fleshy end of the body between the anal fin and before the caudal fin.

pelvic fins - ventral paired fins lying below the pectoral fin, or between it and the anal fin, and corresponding to the hind limbs of mammals.

pharynx - the first portion of the digestive tract behind the mouth.

ray - a jointed rod, usually branched at its tip, that supports the membranes of a fin.

swim bladder - a sac filled with air or other gases lying beneath the backbone within the body cavity.

thoracic - pertaining to the chest or thorax; anterior to the abdomen.

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TABLE 1

NUMBERS OF FISH CAUGHT PER SPECIES

PER SAMPLING SITE AND PER CIRCUIT

DURING THE SAINT JOHN RIVER ESTUARY SURVEY

AUG - OCT, 1971

The upper line of figures for each species represents gill net catches, while the lower line represents seine net catches.

SPECIES	SAMPLING SITE AND CIRCUIT																																	Sub Total	Total
	Westfield			Glenwood			Kennebecasis			Belleisle			Hampstead			Gagetown			Oromocto			Washademoak			Princess Pk.			Newcastle Ck.			French L.				
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3		
Acipenser brevirostrum	3	-	4	9	18	11	-	-	-	-	-	-	-	2	14	-	-	3	-	1	3	-	1	-	-	-	-	-	-	-	-	-	-	69	69
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Acipenser oxyrhynchus	1	10	-	14	27	28	-	-	-	-	-	2	17	14	8	-	3	-	3	6	-	-	-	-	-	-	-	-	-	-	-	-	-	133	133
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Alosa aestivalis	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Alosa pseudoharengus	40	16	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	61	616
	-	6	-	-	22	-	-	10	7	341	10	3	-	-	-	-	-	-	-	-	-	30	29	-	61	-	-	-	6	-	30	-	-	555	
Alosa sapidissima	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Brevoortia tyrannus	10	3	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	14
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Clupea harengus harengus	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2
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Coregonus clupeaformis	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	15	-	13	5	-	10	1	-	-	1	-	2	34	-	-	-	83	83
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Salmo salar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
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Catostomus commersoni	-	-	-	-	-	-	-	-	-	-	-	7	49	7	1	25	10	14	22	24	11	21	12	14	12	9	10	25	32	10	36	14	23	388	500
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Couesius plumbeus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	1	-	-	-	-	-	-	-	4	4
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Semotilus corporalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	2	-	-	-	-	-	3	2	-	10	-	21	140
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SPECIES	Westfield 1	2	3	Glenwood 1	2	3	Kennebecasis 1	2	3	Belleisle 1	2	3	Hampstead 1	2	3	Gagetown 1	2	3	Oromocto 1	2	3	Washademoak 1	2	3	Princess Pk. 1	2	3	Newcastle Ck. 1	2	3	French L. 1	2	3	Sub Total	Total
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Fundulus diaphanus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	494
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Gasterosteus aculeatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	766
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Micropterus dolomieui	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
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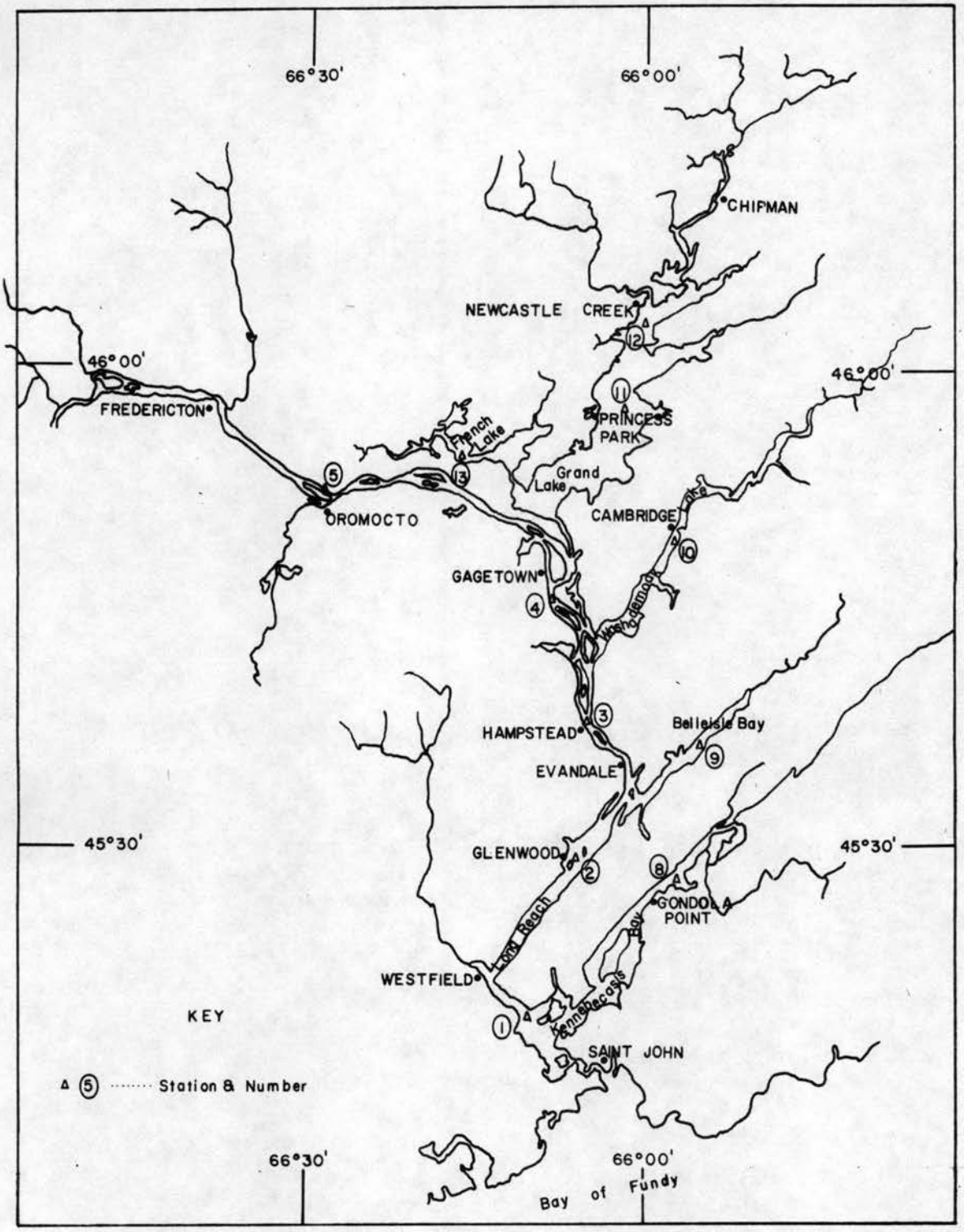

Fig 1. Location of the Saint John River estuary showing fish sampling stations occupied during the 1971 survey.